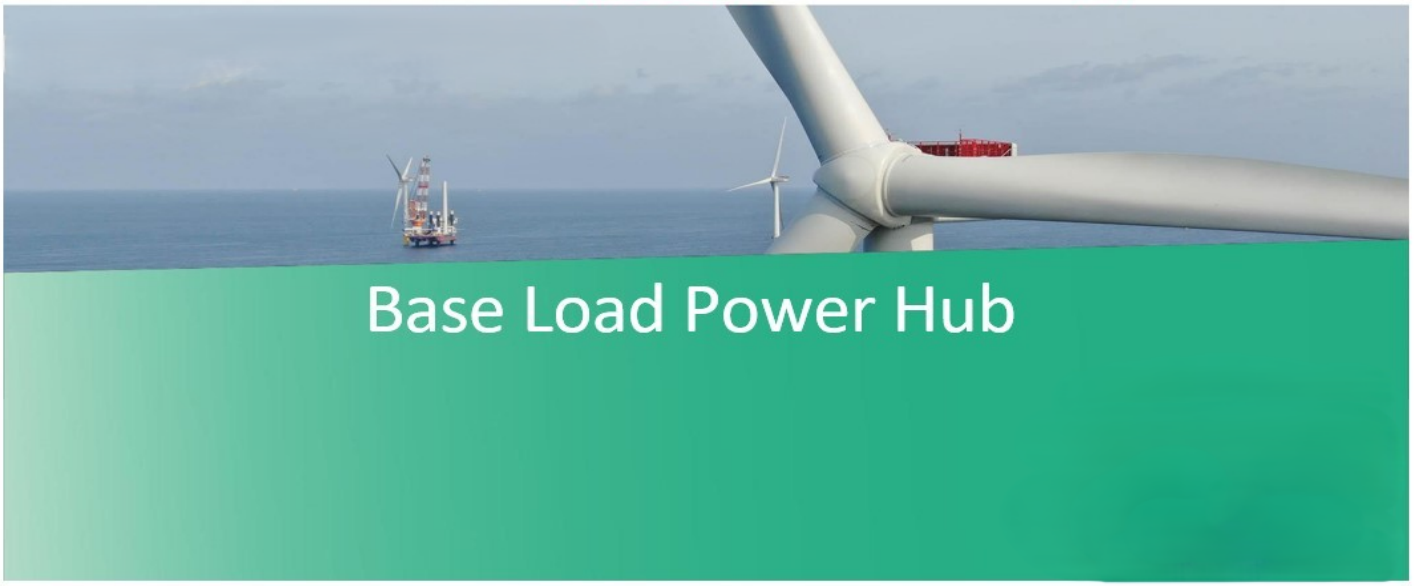
CROSSWIND

ROSETTI MARINO

PROVERLIS

PROJECT **123A90 - HOLLANDSE KUST NOORD WIND PARK**
BLPH Project



COMMISSIONING DOSSIER (ONSHORE)

SYSTEM	80 Hydrogen Fuel Cell Package
SUBSYSTEM	80-00 Hydrogen Fuel Cell Package (A-80000)

CROSSWIND

123A90 - HOLLANDSE KUST NOORD WIND PARK
BLPH Project

COMMISSIONING DOSSIER INDEX

ROSETTI MARINO

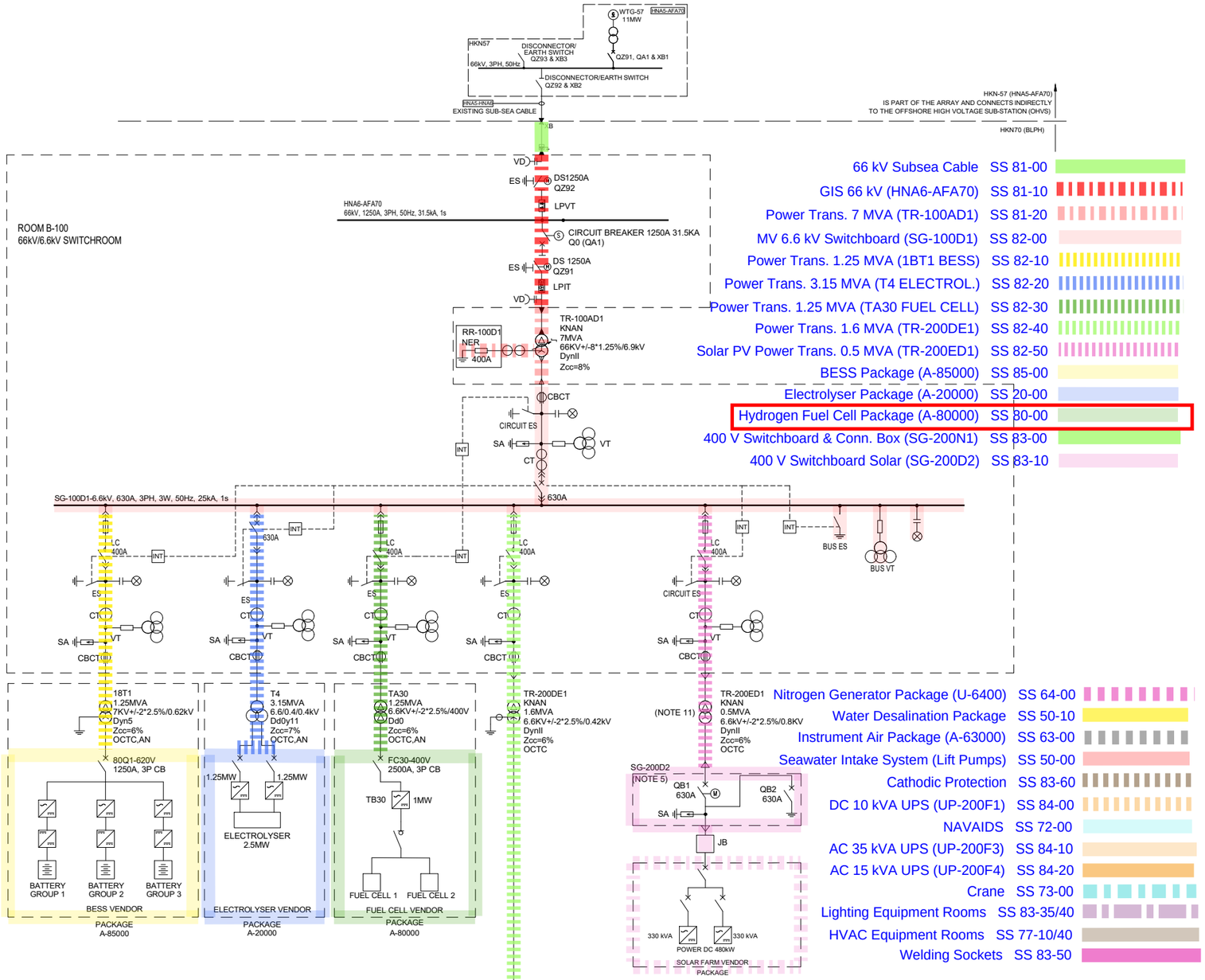
Sub System N°:	80-00	**Tick as appropriate**	ONSHORE	OK
Description:	Hydrogen Fuel Cell Package (A-80000)		OFFSHORE	

1. *SUB-SYSTEM DEFINITION*	OK
1.1 Sub-System Description / Boundary Limit Drawings	
2. *READY FOR OPERATION CERTIFICATE*	OK
2.1 Achievement Of Ready for Operation Certificate (RFO)	
2.2 Exception Punch Lists (per discipline)	
2.3 “As-Commissioned” P&ID’s / SLD’s / D&ID’s / C&E’s	
3. *CONSOLIDATED PUNCH LISTS*	OK
3.1 Cleared and Residual Items (sorted by discipline)	
4. *FUNCTIONAL TESTS SHEETS*	OK
4.1 Electrical functional test sheets index	
4.2 Electrical “As-Commissioned” interconnection diagrams	
4.3 Instrumentation Functional Test Sheets Index	
4.4 Instrumentation “As-Commissioned” interconnection diagrams	
4.5 Telecommunication Functional Test Sheets Index	
4.6 Telecommunication “As-Commissioned” I.C.D. / TSLD’s	
5. *SITE / OPERATIONAL:*	OK
5.1 Operational Test Procedure	
5.2 Operational Test Certificates	
6. *PIPING AND VESSEL PREPARATION*	NA
6.1 Final Mechanical / Vessel Inspection Checks Index	
6.2 Leak Test / Drying / Inerting Test Sheets Index	
6.3 Chemical Loading & First Fill records Index	
6.4 Chemical Cleaning Reports and Records Index	
6.5 Lubrication Schedule	
7. *VENDORS*	OK
7.1 Vendor Package Summary Index	
7.2 SAT Procedure with associated punch list and reference (Front Page)	
7.3 Vendor Spares & Special Tools lists references	
7.4 Vendor Data / Operations / Maintenance Manuals References	
8. *LIST OF MODIFICATIONS*	OK
8.1 List of changes initiated during the WORKSITE Commissioning phase pertaining to the relevant Sub-System will be incorporated in this section with relevant references (with location and position of blinds/spades, isolation LO & LC valves, list of electrical isolation status, and remaining inhibits and overrides)	
9. *SUPPORTING DOCUMENTS*	OK
9.1 Other supporting documents (as applicable)	

	Contractor Commissioning Site Leader	Company Commissioning Site Leader
Name	Anthony Iveson	Martin Taylor
Date	2025-08-07	2025-08-07
Signature	PROVERLIS Digitaly signed by Anthony Iveson 2025-08-07T10:17:22.639Z	PROVERLIS Digitaly signed by Martin Taylor 2025-08-07T12:30:05.722Z

Section 1 SUB-SYSTEM DEFINITION

DRAWING NO. 123A90-DDL-EL-DG-20158 REV. 01



SYMBOL LEGEND:

- VOLTAGE DETECTOR
- EARTHING SWITCH DISCONNECTOR
- MOTORIZED EARTHING SWITCH
- CIRCUIT BREAKER
- FUSE
- CONTACTOR
- THREE-PHASE TRANSFORMER WITH TAP CHANGER
- THREE-PHASE TRANSFORMER
- CURRENT TRANSFORMER
- THREE-PHASE TRANSFORMER, WITH THREE WINDINGS
- NEUTRAL EARTHING RESISTOR
- SURGE ARRESTER
- CORE BALANCE CURRENT TRANSFORMER
- SURGE ARRESTOR FOR T-CONNECTOR (N.1 FOR EACH PHASE)
- VOLTAGE & CURRENT TRANSFORMER (3Ø X 2) (LPIT TYPE)
- VOLTAGE TRANSFORMER (3Ø X 2) (LPVT TYPE)
- VOLTAGE TRANSFORMER
- CABLE BOX
- T-CONNECTOR CABLE TERMINATION
- CABLE AIR TERMINATION

OLTC	= ON LOAD TAP CHANGER
OCTC	= OPEN CIRCUIT TAP CHANGER
KNAN	= NON-MINERAL OIL NATURAL AIR COOLED
AN	= AIR NATURAL
XB	= CABLE BOX
QZ	= DISCONNECT SWITCH & EARTH SWITCH
QA	= CIRCUIT BREAKER
LC	= LATCHED FUSED CONTACTOR (400A)
INT	= INTERLOCK SYSTEM
SA	= SURGE ARRESTER
CBCT	= CORE BALANCE CURRENT TRANSFORMER
ES	=EARTHING SWITCH
VD	=VOLTAGE DETECTOR
LCP	=LOCAL CONTROL PANEL
LPVT	=LOW POWER VOLTAGE TRANSFORMER
LPCT	=LOW POWER CURRENT TRANSFORMER
LPIT	=LOW POWER INSTRUMENT TRANSFORMER
JB	=JUNCTION BOX

NOTES:

1. TEMPORARY POWER SUPPLY CONNECTION BOX LOCATED ON OUTSIDE WALL OF LV SWITCHROOM / CONTAINER.
2. LOAD DEFINITION 'ESSENTIAL' / 'NON-ESSENTIAL' IS SHOWN IN THE LOAD LIST. THE CCS, EMCS AND 'SMART' SWITCHGEAR WILL OPEN / CLOSE CIRCUIT BREAKERS AS REQUIRED.
3. A COMBINED CCS/EMCS SYSTEM COMPRISES A MICROPROCESSOR BASED SYSTEM, ASSOCIATED SOFTWARE AND REQUIRED PERIPHERALS FOR MONITORING AND CONTROLLING OF ELECTRICAL POWER NETWORK. ALL ELECTRICAL EQUIPMENT AND PACKAGE UNITS SHALL BE CONNECTED TO THE CENTRAL CONTROL SYSTEM .
4. IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM SUPPLIED BY COMPANY.
5. THE SOLAR FARM IN-FEED POWER CIRCUIT BREAKERS PANEL IS LOCATED INSIDE THE LV SWITCHGEAR ROOM B-200.
6. DELETED.
7. DELETED.
8. DELETED.
9. CROSSWIND SHALL BE ABLE TO CONTROL THE BLPH 66KV MOTORISED CIRCUIT BREAKER Q0 (QA1) & MOTORISED ELECTRICAL DISCONNECTOR / EARTH SWITCH (QZ92, TYPE B) USING THEIR 'HV-SCADA' SYSTEM. THIS BACK-UP / REDUNDANT CONTROL SHALL BE ADDITIONAL TO THAT PROVIDED BY THE CCS AND BE OF HIGHER PRIORITY OVER A SEPARATE FIBRE OPTIC CABLE (FOC). THE CCS OPERATOR AND 'HV-SCADA' SHALL BOTH BE KEPT FULLY AWARE OF EQUIPMENT STATUS AT ALL TIMES. INTERTRIPPING, INHIBITS & INTERLOCKING FOR BLPH 66KV EQUIPMENT SHALL BE AS PER THE WIND FARM.
10. THE LOADS IN THE LOW VOLTAGE SWITCHGEAR AND THE CURRENT VALUES OF THE CIRCUIT BREAKERS ARE ONLY INDICATIVE.
11. NEUTRAL POINT OF TR-200ED1 SHALL NOT BE GROUNDED AS REQUIRED BY SOLAR FARM SUPPLIER IN 123A90-PML-PM-TQ-00040.

REFERENCES:

1. 123A90-DDL-EL-DG-20014 ELECTRICAL CONTROL, PROTECTION AND METERING DIAGRAMS
2. 123A90-DDL-EL-DG-20015 ELECTRICAL SINGLE LINE DIAGRAM 6.6kV SYSTEMS
3. 123A90-DDL-EL-DG-20159 ELECTRICAL SINGLE LINE DIAGRAMS LV SYSTEM
4. 123A90-DDL-EL-DG-20160 ELECTRICAL SINGLE LINE DIAGRAMS AC UPS SYSTEMS
5. 123A90-DDL-EL-DG-20161 ELECTRICAL SINGLE LINE DIAGRAMS DC UPS SYSTEMS
6. 123A90-DDL-EL-DG-20185 ELECTRICAL SINGLE LINE DIAGRAM HV SYSTEMS
7. 123A90-DDL-EL-DL-20104 ELECTRICAL EQUIPMENT LAYOUT - HV SWITCHROOM
8. 123A90-DDL-EL-DL-20105 ELECTRICAL EQUIPMENT LAYOUT - LV SWITCHROOM
9. 123A90-DDL-EL-LIS-20016 ELECTRICAL LOAD LIST and BALANCE -CCS MODE CHARGING-
10. 123A90-DDL-EL-RE-20152 ELECTRICAL EQUIPMENT SIZING CCALCULATION REPORT
11. 123A90-DDL-EL-RE-20170 ELECTRICAL SYSTEM STUDY REPORT - LOAD FLOW
12. 123A90-DDL-EL-RE-20171 ELECTRICAL SYSTEM STUDY REPORT - SHORT CIRCUIT
13. 123A90-DDL-EL-RE-20172 ELECTRICAL SYSTEM STUDY REPORT - ARC FLASH ENERGY CALCULATION
14. 123A90-DDL-EL-RE-20173 ELECTRICAL SYSTEM STUDY REPORT - HARMONICS

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	26/03/2024	GPA	LMA/AMA	LMA/MDO	ISSUE FOR REVIEW (IFR)
00	02/11/2023	DSF	CB/AMA	OYFO/MDO	ISSUE FOR REVIEW (IFR)

CROSSWIND

ROSETTI MARINO

TITLE :

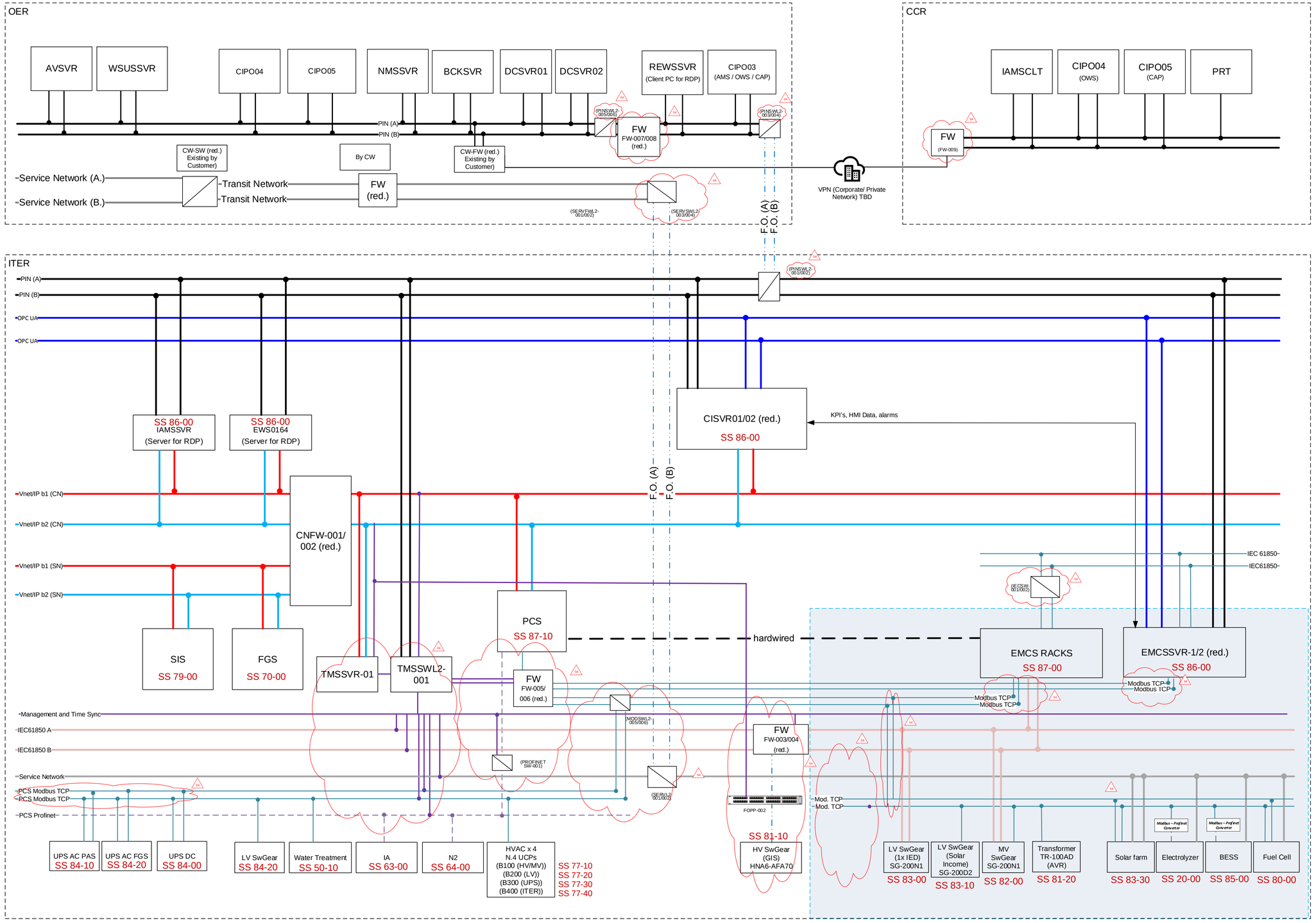
OVERALL/KEY SINGLE LINE DIAGRAM

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK			SCALE N/A
DRAWN GPA	CHECKED LMA/AMA	APPROVED LMA/MDO	DATE 26/03/2023
A1	DRAWING NO. 123A90-DDL-EL-DG-20158	SHEET 001	REV. 01

01

File Name : 123A90-DDL-EL-DG-20158_REV01.dwg

CROSSWIND BLPH PROJECT - SYSTEM BLOCK DIAGRAM



AMS	: Alarm Management System	FCS	: Field Control Station
AV	: Anti-virus	FGS	: Fire & Gas System
BCK	: Backup Server	FO	: Fiber Optic
BESS	: Battery Energy Storage System	FOPP	: Fiber Optic Patch Panel (by others)
BLPH	: Base Load Power Hub	FTA	: Field Termination Assembly
CAP	: Critical Alarm Panel	HIST	: Historian
CCR	: Central Control Room	HKN	: Hollandse Kust Noord
CI	: Collaborative Infomation	IAMS	: Instrument Asset Management System
CN	: Control Network	ITER	: Instrument & Telecom Equipment Room
DC	: Domain Controller	LHVS	: Land High Voltage Station
DMZ	: De-militarized Zone	MCC	: Motor Control Center
ESB	: IO communication bus	MODB	: Modbus
EWS	: Engineering Work Station	MQTT	: Message Queuing Telemetry Transport
FC	: Field Communication (Vnet/IP)	NMS	: Network Management System
OER	: Onshore Equipment Room		
OHVS	: Offshore High Voltage Station		
OWS	: Operator Work Station		
PIN	: Plant Information Network		
PKG	: Package		
RDP	: Remote Desktop Protocol		
SCS	: Safety Control Station		
SIS	: Safety Instrumented System		
SN	: Safety Network		
SW	: Switch		
UCP	: Unit Control Panel (3rd party systems)		
VM	: Virtual Machine		
Vnet/IP	: Yokogawa's Control network		
WSUS	: Windows Security Update Services		

LEGEND:

- PIN (Plant Information Network)
- Vnet/IP BUS 1 PCS
- Vnet/IP BUS 2 PCS
- Vnet/IP BUS 1 SIS/FGS
- Vnet/IP BUS 2 SIS/FGS
- ESB bus connection
- IEC61850 connection
- OPC UA connection
- Service Network connection
- Modbus TCP connection
- Profinet (non redundant)
- Fiber Optic Patch Cords
- Fiber Optic connection (core by Crosswind)
- Fiber Optic backbone (by Crosswind)
- System Cable connection
- Management and Time sync.

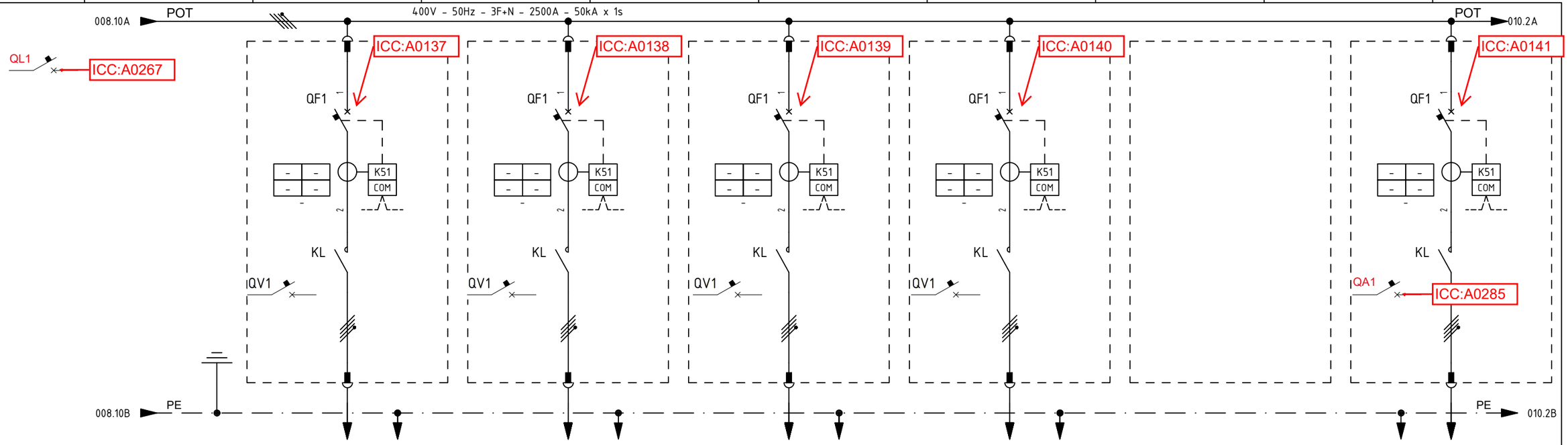
Note 1 : Exact assignment of Servers per cabinet to be defined in cabinet General Arrangement Drawing.
Note 2 : For IP Addresses refer to 1724000594-IN-RE-00043 Cyber Security Settings
Note 3 : All Network Components will be installed in Network Cabinet.
Note 4 : Supply of Console Desk in CCR is in Customer Scope.
Note 5 : All Network Switches and Firewall is configured in VLAN.
Note 6 : Intermediate FO Connection between HNA5 and OER Intentionally not shown.

Zone-1	: PCS Control Zone	Zone-2	: Safety Control Zone
Zone-3	: PCS Zone	Zone-4	: Application Server Facility Zone
Zone-5	: Security Management Zone-1	Zone-6	: Security Management Zone-2
Zone-7	: Demilitirized Zone	Zone-8	: Croswind Zone
Zone-9	: Service Network Zone	Zone-10	: Application Server Facility Zone-OD
Zone-11	: Third Party System Zone		: Out of Scope

REV	DWG BY	CHK BY	APP BY	DATE
04	SKR	MP/AB	SC	12-Feb-25
03	SKR	MP/AB	SC	26-Aug-24
02	SKR	MP/AB	SC	28-Jun-24
01	SKR	MP/AB	SC	24-May-24
00	SKR	AB	SC	23-Apr-24

Doc No : 1724000594-IN-DD-00015
Doc Name : System Architecture

ROSETTI MARINO
HOLLANDSE KUST NOORD WIND PART Project
CROSSWIND
YOKOGAWA


008.10A
POT
400V - 50Hz - 3F+N - 2500A - 50kA x 1s
POT
010.2A
QL1
ICC:A0267
ICC:A0137
ICC:A0138
ICC:A0139
ICC:A0140
ICC:A0141
QF1
K51
COM
KL
QV1
QA1
ICC:A0285
008.10B
PE
PE
010.2B

| | | |

DRAWING NO. DRAWING_NO.

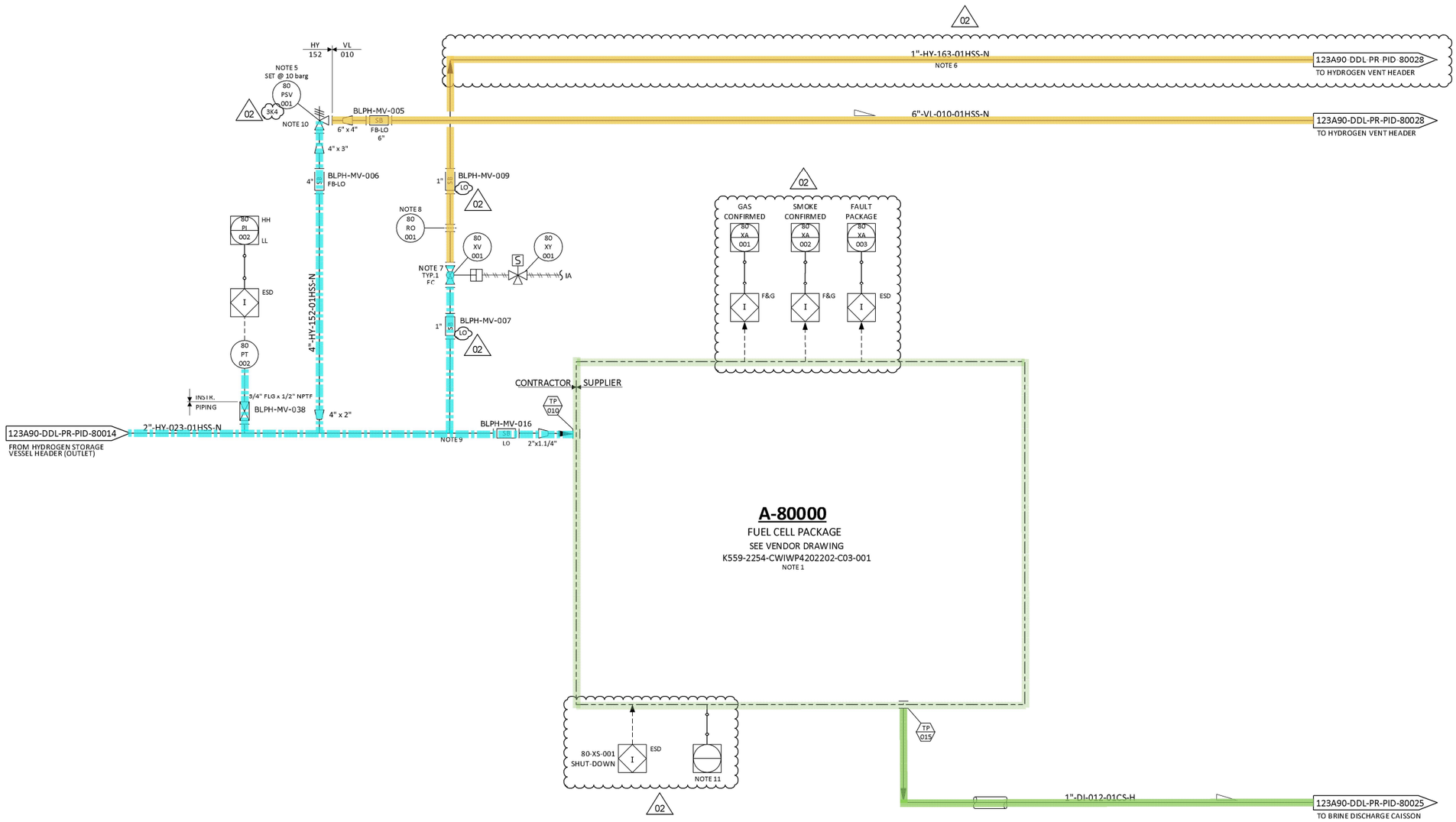
REV. REV

Hydrogen Vent Header & Drum System SS 43-00

Hydrogen Storage Vessels Header (Outlet) SS 25-08

Waste Water Brine Discharge System SS 55-01

Hydrogen Fuel Cell Package SS 80-00



NOTES

1. THE VENDOR PACKAGE WILL CONTAIN AIR INTAKE AND EXHAUST, SUITABLY SAFEGUARDED AND SEPARATED.
2. DELETED.
3. DELETED.
4. DELETED
5. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
6. LINE REQUIRED FOR PURGING OF PIPING WORK.
7. TIGHT SHUT-OFF VALVE.
8. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
9. LINE 1"-HY-163-01HSS-N WILL BE LOCATED AS CLOSE TO THE PACKAGE AS POSSIBLE TO ENSURE COMPLETE PURGING OF THE LINE.
10. 80PSV001 SIZED FOR CV FAILURE OF UPSTREAM CONTROL VAVE 25PV055A/B.
11. SERIAL COMMUNICATION WITH CONTROL SYSTEM. 02

HOLDS

1. DELETED.
2. DELETED.

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
02	12/06/2024	CIM	RZI	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
01	15/02/2024	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND

ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
FUEL CELL PACKAGE

CONTRACT NO./TITLE	CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK		SCALE NTS
DRAWN	CHECKED	APPROVED	DATE

A1	DRAWING NO. 123A90-DDL-PR-PID-80012	SHEET 001	REV. 02

File Name : FILE_NAME

Section 2 READY FOR OPERATION

Section 2.1 Achievement Of Ready for Operation Certificate (RFO)

ROSETTI MARINO

123A90 - HOLLANDSE KUST NOORD WIND PARK
BLPH Project

CROSSWIND

Ready For Operation (RFO) Certificate

COMPLETE	●	PARTIAL	

Revision:	4		Issued on:	2025-07-29	
System:	80	/	Hydrogen Fuel Cell Package		
SubSystem:	80-00	/	Hydrogen Fuel Cell Package (A-80000)		

We hereby confirm that all Mechanical Completion (MC) and Pre-Commissioning/Commissioning (Pre-Comm./Comm.) activities for the above-mentioned System/Sub-System have been successfully completed in accordance with project specifications, relevant standards and contractual requirements. The System/Sub-System has been tested and verified to ensure readiness for operation. Issuance of this Certificate shall not release CONTRACTOR from any of his obligations, responsibilities or liabilities under the CONTRACT.

	Mechanical Completion: All required MC activities have been completed and approved
	Pre-Commissioning & Commissioning: All required Pre-Comm. and Comm. activities and OTPs have been completed and approved (Status Index attached)
	Punch List: All Punch items categorized as A and B have been cleared (PL report attached)
	Documentation: As-built documentation and Commissioning dossier has been completed, reviewed and approved

PUNCH LIST	PENDING POINTS
Note: All Category "A" and "B" Items must be cleared prior to issuance of the Ready For Operation (RFO) Certificate	B '0

REMARKS:

	CONTRACTOR Commissioning Manager	**COMPANY** Commissioning Lead
Name	Anthony Iveson	Martin Taylor
Date	2025-07-29	2025-08-01
Signature	PROVERLIS Digitaly signed by Anthony Iveson 2025-07-29T07:41:18.034Z	PROVERLIS Digitaly signed by Martin Taylor 2025-08-01T08:48:50.537Z

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00 & process: COMM

Electrical	80-00 Hydrogen Fuel Cell Package (A-80000)						
ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
A4/+03-QF1	FUEL CELL AUX LOAD - A4/+03-QF1	ONSHORE	C10002949	FP00	100	2024-12-07	RFO 4
		ONSHORE	C10002950	FTR-2	100	2024-10-02	RFO 4
		ONSHORE	C10002951	FTR-6	100	2024-10-03	RFO 4
		ONSHORE	C10003024	FTR-5	100	2025-04-29	RFO 4

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00 & process: COMM

Instrumental	80-00 Hydrogen Fuel Cell Package (A-80000)						
ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
80-XA-001	A-80000 Fuel cell PKG confirmed gas alarm	ONSHORE	C10004481	FJ01D	100	2025-03-26	RFO 4
80-XA-002	A-80000 Fuel cell PKG confirmed fire alarm	ONSHORE	C10004482	FJ01D	100	2025-03-26	RFO 4
80-XA-003	A-80000 Fuel cell PKG UCP fault	ONSHORE	C10004483	FJ01D	100	2025-03-26	RFO 4
80-XS-001	SHUT-DOWN A-80000 Fuel cell PKG	ONSHORE	C10003806	FJ01D	100	2025-06-09	RFO 4
A-80000	Fuel Cell	ONSHORE	C10004886	FJ05	100	2025-03-24	RFO 4

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00 & process: COMM

Miscellaneous	80-00 Hydrogen Fuel Cell Package (A-80000)						
ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
123A90-PML-COM-PRO-03062	OTP – Hydrogen Fuel Cell Package	ONSHORE	C10004619	5300	100	2025-07-28	RFO 4

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Instrumental

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000637	A	C-80-XA-003/B400-SIS-001 C10001456	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000640	A	C-80-XS-001/B400-SIS-001 C10001449	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000643	A	80-UCP-001/B400-FGS-003 C10001466	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000636	B	C-80-XA-003/B400-SIS-001 C10001456	The terminal strip dont have any refer number inside the Package	.		Gtangianu 2024-11-20	2025-02-13	Ecarotenuto 2025-02-13	2025-02-13
C30000638	B	C-80-XA-003/B400-SIS-001 C10001456	Missing cable tags on routing inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000639	B	C-80-XS-001/B400-SIS-001 C10001449	Missing core identification tags on terminals inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000641	B	C-80-XS-001/B400-SIS-001 C10001449	Missing cable tags on routing inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000642	B	80-UCP-001/B400-FGS-003 C10001466	The terminal strip dont have any refer number inside (A-80000 FUEL CELL UCP).	.		Gtangianu 2024-11-20	2025-02-13	Ecarotenuto 2025-02-13	2025-02-13

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Electrical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000689	A	83012-CEL C10000523	The cable termination is not complete. See attached photo.	.		Gtangianu 2024-11-21	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000686	B	83012-CEL C10000523	Bending radius on MCT is not correct. See attached photo.	.	Work performed by Ballard	Gtangianu 2024-11-21	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30000687	B	83012-CEL C10000523	Missing plastic cable tag on internal/external side of package (Fuel Cell A-80000).	.		Gtangianu 2024-11-21	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000688	B	83012-CEL C10000523	Identification tag wire missing inside panel +UC50 (package Fuel Cell A-80000).	.		Gtangianu 2024-11-21	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30001187	B	A-80000	HMI message does not specify that the external e-stop is activated. Must present a relevant alarm. 04-09-2024: Will be corrected with next sw			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001188	B	A-80000	Current reading in pct vol. To be changed to pct LEL. 04-09-2024: Will be corrected with next sw release (17C - H2 sensor reading in HMI)		Performed by Ballard - 250605	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30001189	B	A-80000	At FC module #3, there is coolant leakage (drops) at the connections to the heat exchanger, both connections. To be tightened and/or gaskets			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001190	B	A-80000	Error messages not elaborate enough. Review error message readability (must be more explanatory) 04-09-2024: Will be corrected with			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001191	B	A-80000	To be investigated and sealed 04-09-2024: Will be corrected when HT coolant is drained. (27C - H2 and smoke detector voting, currently 1/3. CW		Work performed by Ballard	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Electrical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30001192	B	A-80000	Operator screen built for HMI use not ready (Engineering interface not designed for HMI but for laptop use). Must be developed by Ballard			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001193	B	A-80000	During shutdown of the FCwave, an intermittent timeout occurs (ca 5% of shutdowns) where the test stalls. Expected to be a software glitch to be		Work performed by Ballard	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30001252	B	A-80000	Lack of signage on the JB to indicate IS circuits inside			CPY 2024-12-04	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30004393	B	A4/+03-QF1 C10002949	Ref. LV Switchboard SG-200N1 – “Missing Ground Fault and Long-Time Trip Test Reports” During the RFO dossier review for cubicle	Protection relays were tested per the approved Protection Settings Document using ABB’s Ekip T&P kit. Crosswind was duly	Rosetti confirms that testing was performed accordingly and accepts full responsibility	RDegliEsposti 2025-04-06	RDegliEsposti 2025-04-06	RDegliEsposti 2025-04-06	2025-04-06

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM 80 Hydrogen Fuel Cell Package
SUBSYSTEM 80-00 Hydrogen Fuel Cell Package (A-80000)

Telecom

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000973	A	80-UCP-001/B400-NET-001.01 C10004351	The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29.	.		APolo 2024-11-27	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000977	A	80-UCP-001/B400-NET-001.02 C10004352	The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29.	.		APolo 2024-11-27	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000970	B	80-UCP-001/B400-NET-001.01 C10004351	The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001.01)	.		APolo 2024-11-27	2025-01-22	APolo 2025-01-22	2025-01-22
C30000971	B	80-UCP-001/B400-NET-001.01 C10004351	Missing cables tag , cabinet inside Panel A-80000 80-UCP-001.	.		APolo 2024-11-27	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000972	B	80-UCP-001/B400-NET-001.01 C10004351	Missing cable tag SS project, outside MCT.	.		APolo 2024-11-27	2025-02-26	Pschintu 2025-02-26	2025-02-26
C30000974	B	80-UCP-001/B400-NET-001.02 C10004352	The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001)	.		APolo 2024-11-27	2025-01-22	APolo 2025-01-22	2025-01-22
C30000975	B	80-UCP-001/B400-NET-001.02 C10004352	Missing cable tag , cabinet input A-80000 80-UCP-001.	.		APolo 2024-11-27	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000976	B	80-UCP-001/B400-NET-001.02 C10004352	Missing cable tag SS project, outside MCT.	.		APolo 2024-11-27	2025-02-26	Pschintu 2025-02-26	2025-02-26

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM 80 Hydrogen Fuel Cell Package

SUBSYSTEM 80-00 Hydrogen Fuel Cell Package (A-80000)

Mechanical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000604	B	A-80000 C10002358	Container 459079-4. The item n.19 "Drain interface - TP 015" (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet	.		KAlbonetti 2024-11-19	2025-03-31	LNovaga 2025-03-31	2025-03-31
C30000605	B	A-80000 C10002358	10ft Container. Item n.21 Customer MV Connection (6,6kV AC 3P, 92A) (General arrangement	.		KAlbonetti 2024-11-19	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000606	B	A-80000 C10002358	30ft Container. Item n.10 Vents (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000607	B	A-80000 C10002358	30 ft container. No Ballard's nameplate. 10ft Container. Ballard's nameplate is in soft plastic and just glued to the structure.	.		KAlbonetti 2024-11-19	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000608	B	A-80000 C10002358	Containers' nameplates on both the 30 ft container and the 10 ft one have rust rising from underneath.	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000609	B	A-80000 C10002358	Several painting touch-ups to be performed. See as example on SHS above anchor points A, B and H (images attached).	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000610	B	A-80000 C10002358	There are discrepancies between the General arrangement document (K559-2254-CWIWP4202202-B01-001 R.8).	.	Ballard have updated the drawing to reflect the as-built status	KAlbonetti 2024-11-19	JDuinhoven 2025-06-27	JDuinhoven 2025-06-27	JDuinhoven 2025-06-27
C30001186	B	A-80000	No door mounted to the cabinet Internal (cabinet door to be added) (15C - 10ft inspection hatch control panel)			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30004330	B	A-80000	During execution of Cause & Effect OTP doc. n. 123A90-PML-COM-PRO-03054, it had been noted that on equipment packages provided with		Closed out by Ballard	GDelmissier 2025-04-15	JDuinhoven 2025-06-10	JDuinhoven 2025-06-10	JDuinhoven 2025-06-10

Section 2.2 Exception Punch Lists (per discipline)

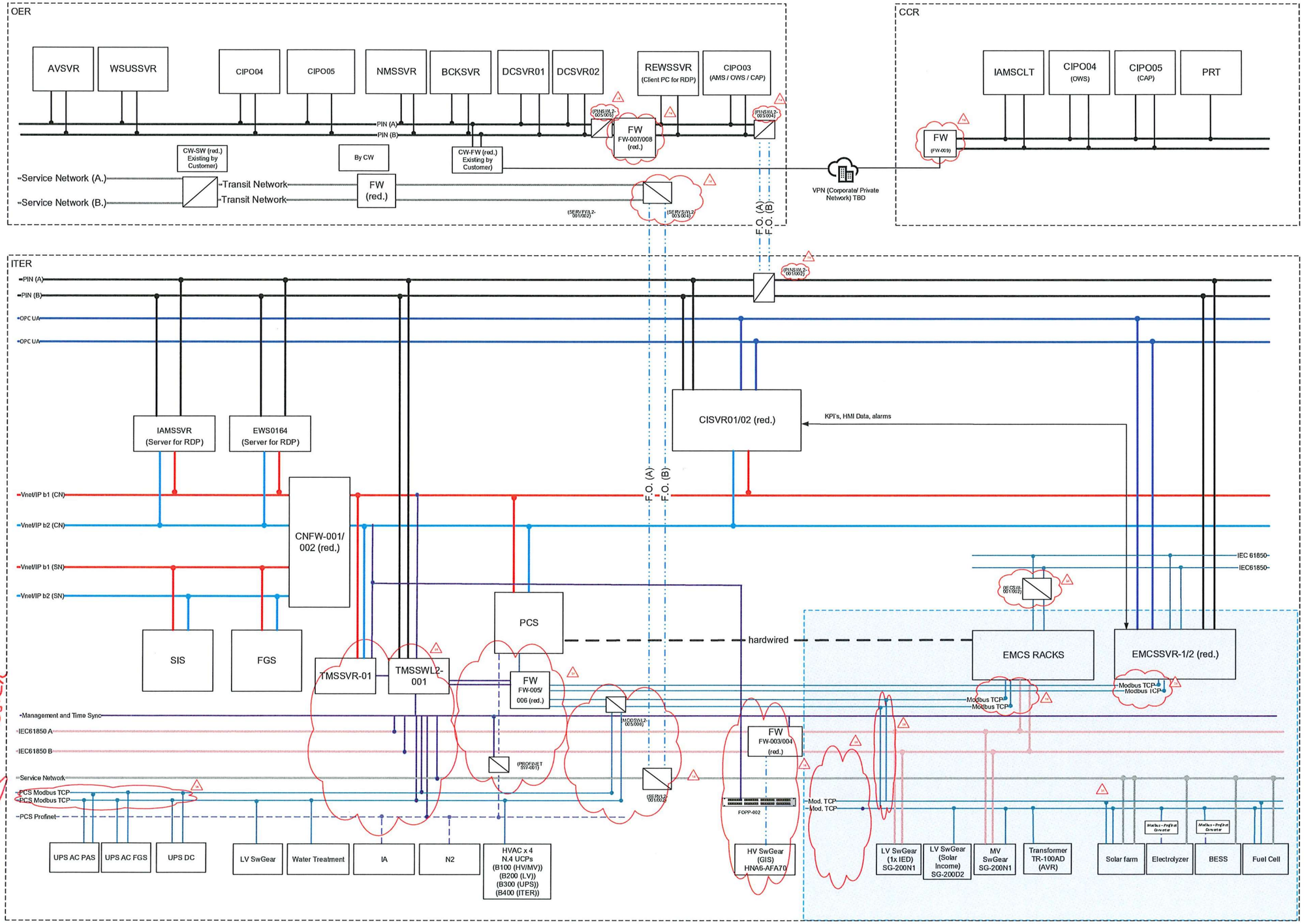
Project CROSSWIND

PUNCH LIST REPORT

NO DATA AVAILABLE

Section 2.3 “As-Commissioned” P&ID's / SLD's / D&ID's / C&E's

CROSSWIND BLPH PROJECT - SYSTEM BLOCK DIAGRAM



As Commissioning
08-05-2025
Gianluca De Nisco

AMS	: Alarm Management System	FCS	: Field Control Station
AV	: Anti-virus	FGS	: Fire & Gas System
BCK	: Backup Server	FO	: Fiber Optic
BESS	: Battery Energy Storage System	FOPP	: Fiber Optic Patch Panel (by others)
BLPH	: Base Load Power Hub	FTA	: Field Termination Assembly
CAP	: Critical Alarm Panel	HIST	: Historian
CCR	: Central Control Room	HKN	: Hollandse Kust Noord
CI	: Collaborative Information	IAMS	: Instrument Asset Management System
CN	: Control Network	ITER	: Instrument & Telecom Equipment Room
DC	: Domain Controller	LHVS	: Land High Voltage Station
DMZ	: De-militarized Zone	MCC	: Motor Control Center
ESB	: IO communication bus	MODB	: Modbus
EWS	: Engineering Work Station	MQTT	: Message Queuing Telemetry Transport
FC	: Field Communication (Vnet/IP)	NMS	: Network Management System
OER	: Onshore Equipment Room		
OHVS	: Offshore High Voltage Station		
OWS	: Operator Work Station		
PIN	: Plant Information Network		
PKG	: Package		
RDP	: Remote Desktop Protocol		
SCS	: Safety Control Station		
SIS	: Safety Instrumented System		
SN	: Safety Network		
SW	: Switch		
UCP	: Unit Control Panel (3rd party systems)		
VM	: Virtual Machine		
Vnet/IP	: Yokogawa's Control network		
WSUS	: Windows Security Update Services		

LEGEND:

- PIN (Plant Information Network)
- Vnet/IP BUS 1 PCS
- Vnet/IP BUS 2 PCS
- Vnet/IP BUS 1 SIS/FGS
- Vnet/IP BUS 2 SIS/FGS
- ESB bus connection
- IEC61850 connection
- OPC UA connection
- Service Network connection
- Modbus TCP connection
- Profinet (non redundant)
- Fiber Optic Patch Cords
- Fiber Optic connection (core by Crosswind)
- Fiber Optic backbone (by Crosswind)
- System Cable connection
- Management and Time sync.

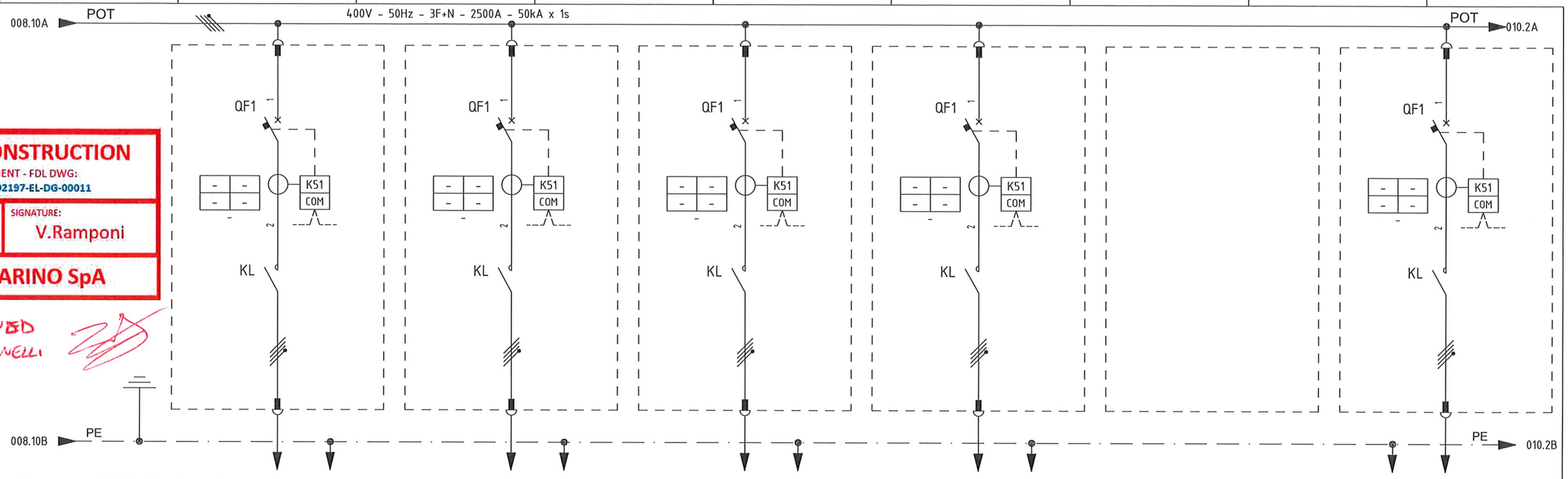
Note 1 : Exact assignment of Servers per cabinet to be defined in cabinet General Arrangement Drawing.
Note 2 : For IP Addresses refer to 1724000594-IN-RE-00043 Cyber Security Settings
Note 3 : All Network Components will be installed in Network Cabinet.
Note 4 : Supply of Console Desk in CCR is in Customer Scope.
Note 5 : All Network Switches and Firewall is configured in VLAN.
Note 6 : Intermediate FO Connection between HNA5 and OER Intentionally not shown.

Zone-1 : PCS Control Zone
Zone-2 : Safety Control Zone
Zone-3 : PCS Zone
Zone-4 : Application Server Facility Zone
Zone-5 : Security Management Zone-1
Zone-6 : Security Management Zone-2
Zone-7 : Demilitirized Zone
Zone-8 : Croswind Zone
Zone-9 : Service Network Zone
Zone-10: Application Server Facility Zone-OD
Zone-11: Third Party System Zone
: Out of Scope

REV	DWG BY	CHK BY	APP BY	DATE
04	SKR	MP/AB	SC	12-Feb-25
03	SKR	MP/AB	SC	26-Aug-24
02	SKR	MP/AB	SC	28-Jun-24
01	SKR	MP/AB	SC	24-May-24
00	SKR	AB	SC	23-Apr-24

Doc No : 1724000594-IN-DD-00015
Doc Name : System Architecture

ROSETTI MARINO
HOLLANDSE KUST NOORD WIND PART Project
CROSSWIND
YOKOGAWA



VALID FOR CONSTRUCTION

VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1723002197-EL-DG-00011

REV.:	DATE:	SIGNATURE:
4_A	18/12/24	V.Ramponi

ROSETTI MARINO SpA

AS - COMMISSIONED
DAVIDE ZUCCONELLI
20/03/2025
NO MARK UP

ITEM				1	A-80000	CP-850F03	SPARE	SPARE		K-63001-A
UTILITY				2	FUEL CELL AUXILIARY LOAD	BESS PCS CABINET	SPARE	SPARE		INSTRUMENTS AIR PACKAGE 01A
COLUMN/CUBICLE				3	A4 / +03	A4 / +04	A4 / +05	A4 / +06		A4 / +08
RATED POWER | RATED CURRENT				4/5	20 kW | 32.84 A	11,09 kW | 17.42 A	- kW | - A	- kW | - A		68.75 kW | 111.24 A
TYPICAL FUNCTIONAL				6	LK1-63	LK1-40	LK1-40	LK1-40		LK2-160
CIRCUIT BREAKER (ABB)	TYPE			7	XT2S - 160	XT2S - 160	XT2S - 160	XT2S - 160		XT4S - 250
	VERSION			8	4P - FIXED	4P - FIXED	4P - FIXED	4P - FIXED		4P - FIXED
	TRIP UNITS			9	EKIP HI TOUCH LSIG (In = 63A)	EKIP HI TOUCH LSIG (In = 40A)	EKIP HI TOUCH LSIG (In = 40A)	EKIP HI TOUCH LSIG (In = 40A)		EKIP HI TOUCH LSIG (In = 160A)
	Icu	KA		10	50 kA	50 kA	50 kA	50 kA		50 kA
OVERLOAD	L	Range	A	11	(0.4 - 1) x In	(0.4 - 1) x In	(0.4 - 1) x In	(0.4 - 1) x In		(0.4 - 1) x In
		Range	t	12	k/I^2	k/I^2	k/I^2	k/I^2		k/I^2
SEL. SHORT-CIRCUIT	S	Range	A	13	(0.6 - 10) x In	(0.6 - 10) x In	(0.6 - 10) x In	(0.6 - 10) x In		(0.6 - 10) x In
		Range	t	14	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2		0.05 - 0.4 sec / k/I^2
INST. SHORT-CIRCUIT	I	Range	A	15	(1.5 - 15) x In	(1.5 - 15) x In	(1.5 - 15) x In	(1.5 - 15) x In		(1.5 - 15) x In
		Range	t	16	instantaneous	instantaneous	instantaneous	instantaneous		instantaneous
EARTH FAULT PROTECTION	G	Range	A	17	(0.1 - 1) x In	(0.1 - 1) x In	(0.1 - 1) x In	(0.1 - 1) x In		(0.1 - 1) x In
		Range	t	18	t=k / t=k/I^2	t=k / t=k/I^2	t=k / t=k/I^2	t=k / t=k/I^2		t=k / t=k/I^2
CONTACTOR (ABB)				19	AF52-40-00-13 (100A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC		AF190-40-11-13 (275A-AC1); 100-250 VAC/DC
THERMAL OVERLOAD RELAY (ABB)				20	-	-	-	-		-
SURGE ARRESTER (DEHN)				21	-	-	-	-		-
TOROIDAL CURRENT TRANSFORMER (FRER)				22	-	-	-	-		-
FUSE HOLDER (ITALWEBER)				23	-	-	-	-		-
INDIRECT PROTECTION (ABB)				24	-	-	-	-		-
VOLTMETER				25	-	-	-	-		-
CURRENT TRANSFORMER FOR MEASURE (FRER)	TYPE			26	-	-	-	-		-
	PERFORMANCE/CLASS			27	-	-	-	-		-
VOLTAGE TRANSFORMER FOR MEASURE (FRER)	TYPE			28	-	-	-	-		-
	PERFORMANCE/CLASS			29	-	-	-	-		-
LOCK-OUT RELAY (-)				30	-	-	-	-		-
POWER CONDUCTOR			mmq	31	5G16	4 x 10	-	-		5G70

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DWG n° : 231298/SD/11
Item n° : PF1002983/26

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
4	28/08/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
3	08/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
2	03/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
1	28/03/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
0	15/02/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

SINGLE LINE DIAGRAM

Single Line Drawing

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00011

SHEET 009

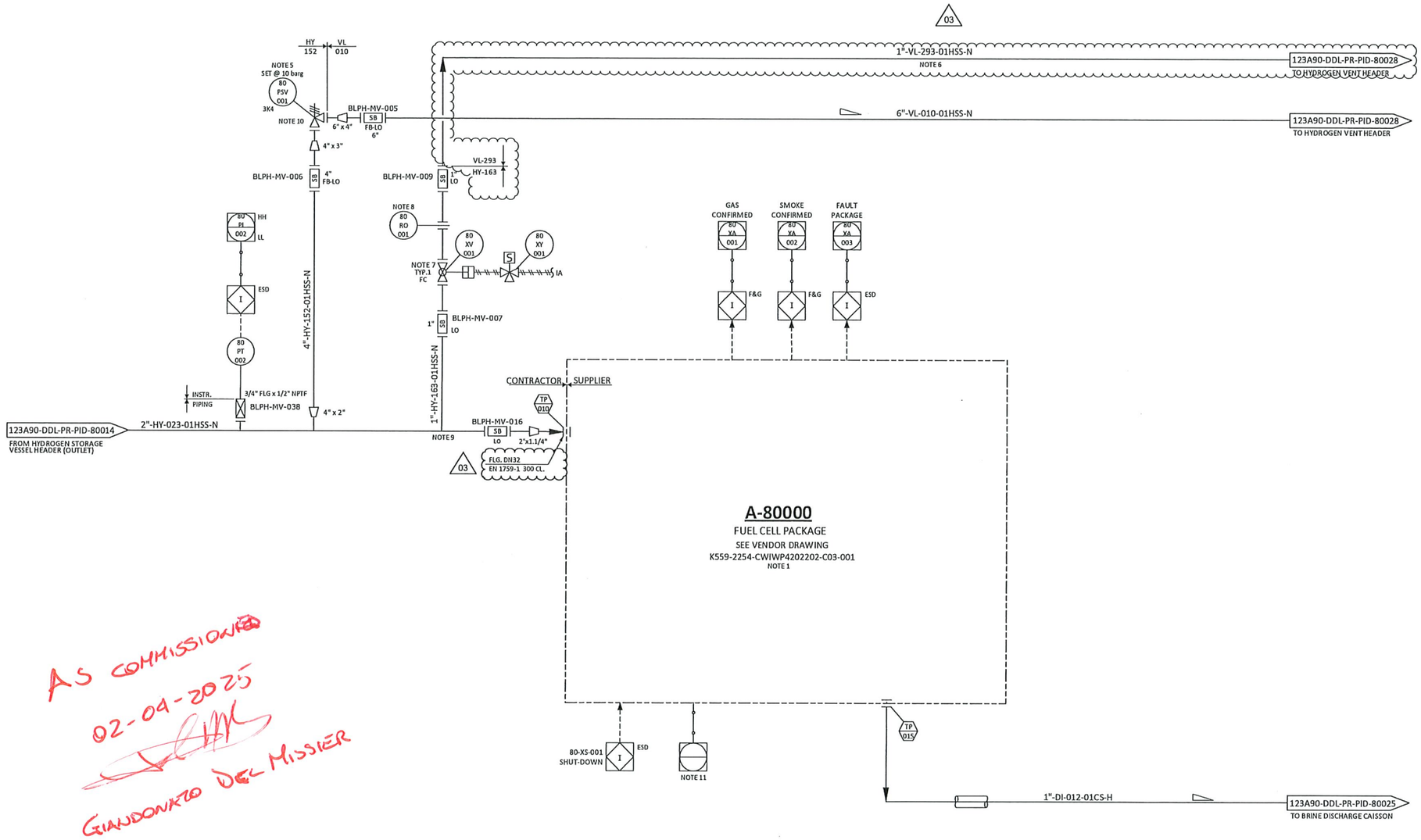
REV. 04

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00011 Rev. 04

DRAWING NO. DRAWING_NO.

REV. REV



NOTES

1. THE VENDOR PACKAGE WILL CONTAIN AIR INTAKE AND EXHAUST, SUITABLY SAFEGUARDED AND SEPARATED.
2. DELETED.
3. DELETED.
4. DELETED
5. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
6. LINE REQUIRED FOR PURGING OF PIPING WORK.
7. TIGHT SHUT-OFF VALVE.
8. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "REUEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
9. LINE 1"-HY-163-01HSS-N WILL BE LOCATED AS CLOSE TO THE PACKAGE AS POSSIBLE TO ENSURE COMPLETE PURGING OF THE LINE.
10. 80-PSV-001 SIZED FOR CV FAILURE OF UPSTREAM CONTROL VALVE 25-PV-055A/B.
11. SERIAL COMMUNICATION WITH CONTROL SYSTEM.

HOLDS

1. DELETED.
2. DELETED.

AS COMMISSIONED
02-09-2025
GIANDONATO DEL MISSIER

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
03	09/09/2024	CIM	RZI	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
02	12/06/2024	CIM	RZI	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
01	15/02/2024	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND

ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
FUEL CELL PACKAGE

CONTRACT NO./TITLE	CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK	SCALE	NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80012	SHEET 001	REV. 03

File Name : FILE_NAME

Section 3 CONSOLIDATED PUNCH LISTS

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Instrumental

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000637	A	C-80-XA-003/B400-SIS-001 C10001456	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000640	A	C-80-XS-001/B400-SIS-001 C10001449	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000643	A	80-UCP-001/B400-FGS-003 C10001466	Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side	.		Gtangianu 2024-11-20	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000636	B	C-80-XA-003/B400-SIS-001 C10001456	The terminal strip dont have any refer number inside the Package	.		Gtangianu 2024-11-20	2025-02-13	Ecarotenuto 2025-02-13	2025-02-13
C30000638	B	C-80-XA-003/B400-SIS-001 C10001456	Missing cable tags on routing inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000639	B	C-80-XS-001/B400-SIS-001 C10001449	Missing core identification tags on terminals inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000641	B	C-80-XS-001/B400-SIS-001 C10001449	Missing cable tags on routing inside the Package	.		Gtangianu 2024-11-20	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000642	B	80-UCP-001/B400-FGS-003 C10001466	The terminal strip dont have any refer number inside (A-80000 FUEL CELL UCP).	.		Gtangianu 2024-11-20	2025-02-13	Ecarotenuto 2025-02-13	2025-02-13

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM 80 Hydrogen Fuel Cell Package
SUBSYSTEM 80-00 Hydrogen Fuel Cell Package (A-80000)

Electrical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000689	A	83012-CEL C10000523	The cable termination is not complete. See attached photo.	.		Gtangianu 2024-11-21	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000686	B	83012-CEL C10000523	Bending radius on MCT is not correct. See attached photo.	.	Work performed by Ballard	Gtangianu 2024-11-21	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30000687	B	83012-CEL C10000523	Missing plastic cable tag on internal/external side of package (Fuel Cell A-80000).	.		Gtangianu 2024-11-21	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000688	B	83012-CEL C10000523	Identification tag wire missing inside panel +UC50 (package Fuel Cell A-80000).	.		Gtangianu 2024-11-21	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30001187	B	A-80000	HMI message does not specify that the external e-stop is activated. Must present a relevant alarm. 04-09-2024: Will be corrected with next sw			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001188	B	A-80000	Current reading in pct vol. To be changed to pct LEL. 04-09-2024: Will be corrected with next sw release (17C - H2 sensor reading in HMI)		Performed by Ballard - 250605	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30001189	B	A-80000	At FC module #3, there is coolant leakage (drops) at the connections to the heat exchanger, both connections. To be tightened and/or gaskets			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001190	B	A-80000	Error messages not elaborate enough. Review error message readability (must be more explanatory) 04-09-2024: Will be corrected with			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001191	B	A-80000	To be investigated and sealed 04-09-2024: Will be corrected when HT coolant is drained. (27C - H2 and smoke detector voting, currently 1/3. CW		Work performed by Ballard	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM 80 Hydrogen Fuel Cell Package
SUBSYSTEM 80-00 Hydrogen Fuel Cell Package (A-80000)

Electrical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30001192	B	A-80000	Operator screen built for HMI use not ready (Engineering interface not designed for HMI but for laptop use). Must be developed by Ballard			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30001193	B	A-80000	During shutdown of the FCwave, an intermittent timeout occurs (ca 5% of shutdowns) where the test stalls. Expected to be a software glitch to be		Work performed by Ballard	CPY 2024-12-03	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05	JDuinhoven 2025-06-05
C30001252	B	A-80000	Lack of signage on the JB to indicate IS circuits inside			CPY 2024-12-04	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30004393	B	A4/+03-QF1 C10002949	Ref. LV Switchboard SG-200N1 – “Missing Ground Fault and Long-Time Trip Test Reports” During the RFO dossier review for cubicle	Protection relays were tested per the approved Protection Settings Document using ABB’s Ekip T&P kit. Crosswind was duly	Rosetti confirms that testing was performed accordingly and accepts full responsibility	RDegliEsposti 2025-04-06	RDegliEsposti 2025-04-06	RDegliEsposti 2025-04-06	2025-04-06

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Telecom

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000973	A	80-UCP-001/B400-NET-001.01 C10004351	The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29.	.		APolo 2024-11-27	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000977	A	80-UCP-001/B400-NET-001.02 C10004352	The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29.	.		APolo 2024-11-27	2024-12-03	Gtangianu 2024-12-03	2024-12-03
C30000970	B	80-UCP-001/B400-NET-001.01 C10004351	The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001.01)	.		APolo 2024-11-27	2025-01-22	APolo 2025-01-22	2025-01-22
C30000971	B	80-UCP-001/B400-NET-001.01 C10004351	Missing cables tag , cabinet inside Panel A-80000 80-UCP-001.	.		APolo 2024-11-27	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000972	B	80-UCP-001/B400-NET-001.01 C10004351	Missing cable tag SS project, outside MCT.	.		APolo 2024-11-27	2025-02-26	Pschintu 2025-02-26	2025-02-26
C30000974	B	80-UCP-001/B400-NET-001.02 C10004352	The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001)	.		APolo 2024-11-27	2025-01-22	APolo 2025-01-22	2025-01-22
C30000975	B	80-UCP-001/B400-NET-001.02 C10004352	Missing cable tag , cabinet input A-80000 80-UCP-001.	.		APolo 2024-11-27	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000976	B	80-UCP-001/B400-NET-001.02 C10004352	Missing cable tag SS project, outside MCT.	.		APolo 2024-11-27	2025-02-26	Pschintu 2025-02-26	2025-02-26

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM 80 Hydrogen Fuel Cell Package

SUBSYSTEM 80-00 Hydrogen Fuel Cell Package (A-80000)

Mechanical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30000604	B	A-80000 C10002358	Container 459079-4. The item n.19 "Drain interface - TP 015" (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet	.		KAlbonetti 2024-11-19	2025-03-31	LNovaga 2025-03-31	2025-03-31
C30000605	B	A-80000 C10002358	10ft Container. Item n.21 Customer MV Connection (6,6kV AC 3P, 92A) (General arrangement	.		KAlbonetti 2024-11-19	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000606	B	A-80000 C10002358	30ft Container. Item n.10 Vents (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000607	B	A-80000 C10002358	30 ft container. No Ballard's nameplate. 10ft Container. Ballard's nameplate is in soft plastic and just glued to the structure.	.		KAlbonetti 2024-11-19	2025-03-07	JKrizanic 2025-03-07	2025-03-07
C30000608	B	A-80000 C10002358	Containers' nameplates on both the 30 ft container and the 10 ft one have rust rising from underneath.	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000609	B	A-80000 C10002358	Several painting touch-ups to be performed. See as example on SHS above anchor points A, B and H (images attached).	.		KAlbonetti 2024-11-19	2025-04-10	JDuinhoven 2025-04-10	2025-04-10
C30000610	B	A-80000 C10002358	There are discrepancies between the General arrangement document (K559-2254-CWIWP4202202-B01-001 R.8).	.	Ballard have updated the drawing to reflect the as-built status	KAlbonetti 2024-11-19	JDuinhoven 2025-06-27	JDuinhoven 2025-06-27	JDuinhoven 2025-06-27
C30001186	B	A-80000	No door mounted to the cabinet Internal (cabinet door to be added) (15C - 10ft inspection hatch control panel)			CPY 2024-12-03	2025-04-10	JDuinhoven 2025-04-10	JDuinhoven 2025-04-10
C30004330	B	A-80000	During execution of Cause & Effect OTP doc. n. 123A90-PML-COM-PRO-03054, it had been noted that on equipment packages provided with		Closed out by Ballard	GDelmissier 2025-04-15	JDuinhoven 2025-06-10	JDuinhoven 2025-06-10	JDuinhoven 2025-06-10

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

PUNCH LIST REPORT

SYSTEM	80	Hydrogen Fuel Cell Package
SUBSYSTEM	80-00	Hydrogen Fuel Cell Package (A-80000)

Mechanical

CODE	CAT	ITEM	DEFECT DESCRIPTION	CORRECTIVE ACTION	PERFORMED ACTION	ISSUED	CARRIED	CHECKED	APPROVED
C30004416	B	A-80000 C10002358	Refer to the attached detailed description (yellow highlighted section)	Refer to the attached detailed description (Yellow highlighted section).		RDegliEsposti 2025-08-04			

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000974

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004352	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.02	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001)

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	RM_CONSTR RM	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

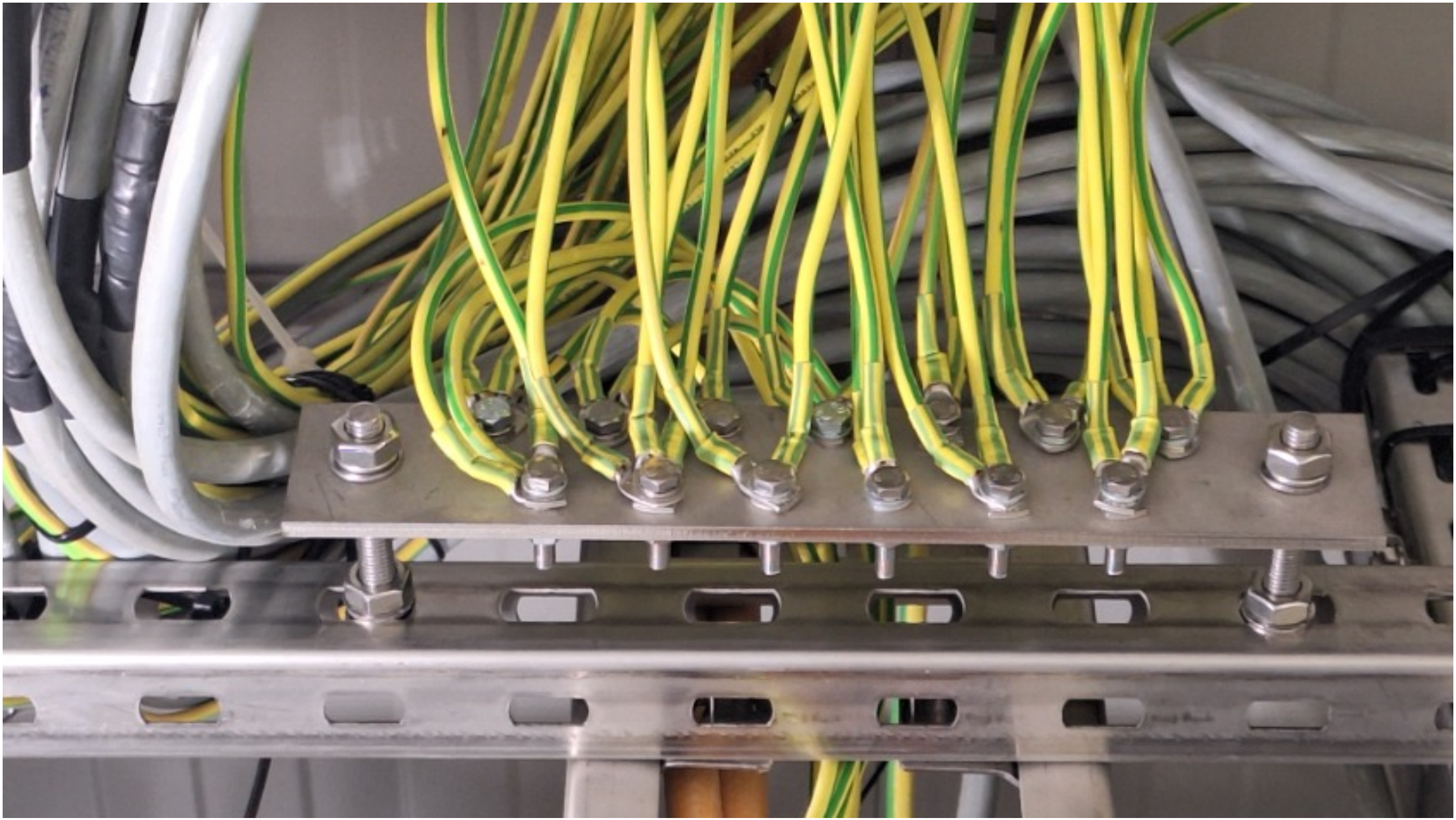
5 - CLEARANCE CHECK

DONE

Name: Alessio Polo
Date: 2025-01-22
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000975

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004352	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.02	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cable tag , cabinet input A-80000 80-UCP-001.

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

DONE

Name: Josip Krizanic
Date: 2025-03-07
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


L2
L3
N
DURING INSULA
REMOVE PLUG-I
SURGE PROTE

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000976

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004352	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.02	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cable tag SS project, outside MCT.

Name: Alessio Polo

Date: 2024-11-27

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	RM_CONSTR RM	Signature	

4 - PERFORMED ACTION

Name:

Date:

Signature:

5 - CLEARANCE CHECK

DONE

Name: Paolo Schintu

Date: 2025-02-26

Signature:

6- CLEARANCE APPROVAL

Name:

Date:

Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000977

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004352	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.02	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29. (A-80000 80-UCP-001)

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


L2
L3
N
DURING INSULA
REMOVE PLUG-I
SURGE PROTE

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001186

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Mechanical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

No door mounted to the cabinet Internal (cabinet door to be added) (15C - 10ft inspection hatch control panel)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001187

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

HMI message does not specify that the external e-stop is activated. Must present a relevant alarm. 04-09-2024: Will be corrected with next sw release (16C - Customer/external E-stop)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001188

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

Current reading in pct vol. To be changed to pct LEL. 04-09-2024: Will be corrected with next sw release (17C - H2 sensor reading in HMI)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Performed by Ballard - 250605

Name Jan Duinhoven

Date 2025-06-05

Signature

5 - CLEARANCE CHECK

Reported closed by package manager - email 250605

Name Paul Kyle

Date 2025-06-05

Signature

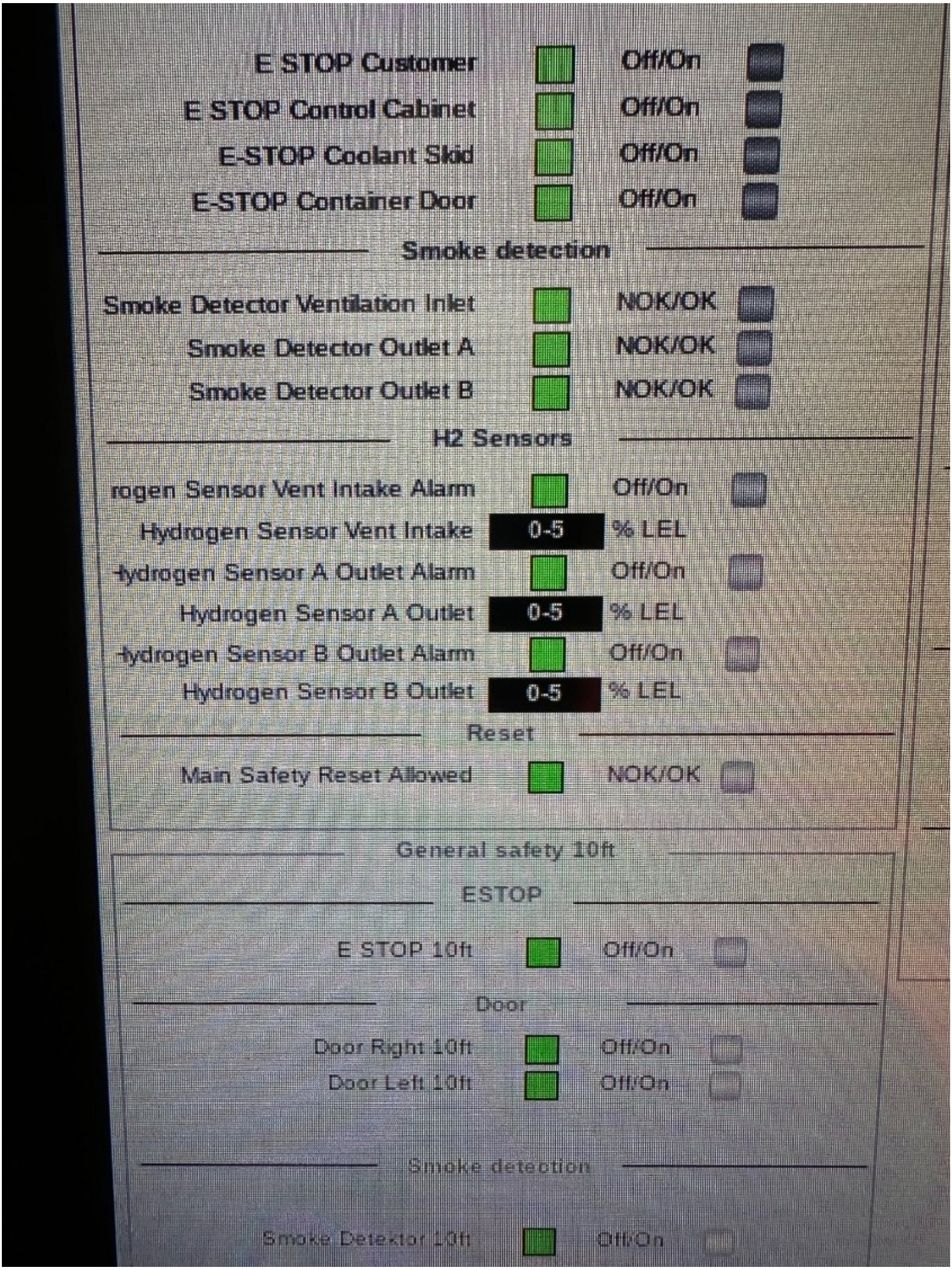
6- CLEARANCE APPROVAL

Closed -out

Name Jan Duinhoven

Date 2025-06-05

Signature


E STOP Customer
Off/On
E STOP Control Cabinet
Off/On
E-STOP Coolant Skid
Off/On
E-STOP Container Door
Off/On
Smoke detection
Smoke Detector Ventilation Inlet
NOK/OK
Smoke Detector Outlet A
NOK/OK
Smoke Detector Outlet B
NOK/OK
H2 Sensors
rogen Sensor Vent Intake Alarm
Off/On
Hydrogen Sensor Vent Intake
0-5
% LEL
ydrogen Sensor A Outlet Alarm
Off/On
Hydrogen Sensor A Outlet
0-5
% LEL
ydrogen Sensor B Outlet Alarm
Off/On
Hydrogen Sensor B Outlet
0-5
% LEL
Reset
Main Safety Reset Allowed
NOK/OK
General safety 10ft
ESTOP
E STOP 10ft
Off/On
Door
Door Right 10ft
Off/On
Door Left 10ft
Off/On
Smoke detection
Smoke Detektor 10ft
Off/On

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001189

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

At FC module #3, there is coolant leakage (drops) at the connections to the heat exchanger, both connections. To be tightened and/or gaskets replaced. 04-09-2024: Gasket will be changed when LT coolant is drained prior to shipment.
17-09-2024: To be corrected during installation (18C - FCwave #3 - Coolant leak)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

Signature

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001190

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Error messages not elaborate enough. Review error message readability (must be more explanatory) 04-09-2024: Will be corrected with next sw release (22C - Error Messages)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001191

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

To be investigated and sealed 04-09-2024: Will be corrected when HT coolant is drained. (27C - H2 and smoke detector voting, currently 1/3. CW would like 2/3).

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Witness waived
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by	VND Vendor	Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Work performed by Ballard

Name Jan Duinhoven

Date 2025-06-05

Signature

5 - CLEARANCE CHECK

Reported completed by package manager

Name Paul Kyle

Date 2025-06-05

Signature

6- CLEARANCE APPROVAL

Name Jan Duinhoven

Date 2025-06-05

Signature

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001192

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Operator screen built for HMI use not ready (Engineering interface not designed for HMI but for laptop use). Must be developed by Ballard 28-08-2024: Draft HMI ready for review @FAT2 (36B - HMI operator screen)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001193

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

During shutdown of the FCwave, an intermittent timeout occurs (ca 5% of shutdowns) where the test stalls. Expected to be a software glitch to be corrected by FC wave dev team. (41B - Intermittent timeout of FCwave shutdown test)

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-03
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Work performed by Ballard

Name Jan Duinhoven

Date 2025-06-05

Signature

5 - CLEARANCE CHECK

Reported closed by package manager

Name Paul Kyle

Date 2025-06-05

Signature

6- CLEARANCE APPROVAL

No evidence available to attach.

Name Jan Duinhoven

Date 2025-06-05

Signature

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30001252

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Electrical
1.2 Item	A-80000		Fuel Cell
1.3 Subsystem	80-00		Hydrogen Fuel Cell Package (A-80000)

2 - OBSERVATION

Lack of signage on the JB to indicate IS circuits inside

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	-
3.4 Activity code	CPY Company	Date	2024-12-04
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Name

Date

Signature

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

6- CLEARANCE APPROVAL

Work has been completed by CPI Vendor and confirmed by package manager.

Name Jan Duinhoven

Date 2025-04-10

Signature

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30004330

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task		1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

During execution of Cause & Effect OTP doc. n. 123A90-PML-COM-PRO-03054, it had been noted that on equipment packages provided with a dedicated PLC controller, it was not possible to remotely reset the C&E trip command. Equipment package PLC internal logic to be updated and tested from Yokogawa workstation

Name

Date

Signature

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giandonato Delmissier
3.4 Activity code	COMM Commissioning	Date	2025-04-15
3.5 Action by		Signature	--- Proverlis --- Duplicata issued from database information Signature is on original form

4 - PERFORMED ACTION

Closed out by Ballard

Name Jan Duinhoven

Date 2025-06-10

Signature

5 - CLEARANCE CHECK

Confirmed by Package Manager

Name Paul Kyle

Date 2025-06-10

Signature

6- CLEARANCE APPROVAL

Confirmed closed

Name Jan Duinhoven

Date 2025-06-10

Signature

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30004393

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002949	1.4 Discipline	Electrical
1.2 Item	A4/+03-QF1	FUEL CELL AUX LOAD - A4/+03-QF1	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Ref. LV Switchboard SG-200N1 – “Missing Ground Fault and Long-Time Trip Test Reports”

During the RFO dossier review for cubicle A4/+03, a comment was raised regarding the absence of specific evidence for ground fault and long-time trip tests in the ABB protection report.
This also applies to systems: SS 72-00, 83-50, 83-60, 85-00 and 83-20.

Name: RAFFAELE DEGLI ESPOSTI
Date: 04/06/2025
Signature:

3 - DEFECT ASSESSMENT

3.1 Corrective action proposal: Protection relays were tested per the approved Protection Settings Document using ABB’s Ekip T&P kit. Crosswind was duly invited to attend all test activities.
The kit performs functional simulations via secondary injection and does not support primary current injection.
This is standard ABB methodology for this equipment class.

3.2 Material required:

3.3 Priority: B PL B

3.4 Activity code: COMM Commissioning

3.5 Action by: RM Rosetti Marino Quality

Name: RAFFAEL DEGLI ESPOSTI
Date: 04/06/2025
Signature:

4 - PERFORMED ACTION

Rosetti confirms that testing was performed accordingly and accepts full responsibility for the validity of the results.
No reports with actual current or timing values were produced due to the simulation-based method.
This Punch item formally records and traces the clarification in the CMS.

Name: Raffaele Degli Esposti
Date: 04/06/2025
Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: RAFFAELE DEGLI ESPOSTI
Date: 04/06/2025
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30004416

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Refer to the attached detailed description (yellow highlighted section)

Name: Raffaele Degli Esposti

Date: 2025-08-04

Signature:

3 - DEFECT ASSESSMENT

Refer to the attached detailed description (Yellow highlighted section).

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Raffaele Degli Esposti
3.4 Activity code	CPY Company	Date	2025-08-04
3.5 Action by	CPY COMPANY	Signature	

4 - PERFORMED ACTION

Name:

Date:

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name:

Date:

Signature:

6- CLEARANCE APPROVAL

Name:

Date:

Signature:

It may be worthwhile separating the cabling for the overall stack voltage measurement (the blue and brown cables tied directly to the bus plates) from the individual cell voltage measurement cables (white) in order to eliminate the possibility that this is causing electrical interference. Connections are available on the opposite side of the stacks to allow this separation.

Recommendation yet to be received from vendor i.e. Elogen.

2. PT-206 – to be replaced.

   This differential pressure transmitter inside WP3 is faulty and requires replacement. Spare on order from Elogen.

   Delivery TBC by vendor i.e. Elogen.

3. RO membrane (Ovivo package) to be replaced.

   Ovivo WTP has been fully drained & preservation fluid for the membrane has not been introduced to the RO unit. Fluid is due to arrive onsite next week but by this point the membrane will have been dry for in excess of one week. Recommend removing the RO completely to be replaced with new in final location.

   Delivery TBC by vendor i.e. Elogen.

4. Ovivo UV lamp requires replacing.

   Delivery TBC by vendor i.e. Elogen.

5. HVAC Setpoints To Be Provided by Elogen.

   We are still awaiting feedback from Elogen regarding the correct setpoints on HVAC alarms/trips for parameters such as pressure and humidity. In the case of WP3 the pressure trip performs a process safety function and therefore it is crucial that these details are supplied to us by Elogen

   Detail TBC by vendor i.e. Elogen.

6. Rectifier / Stacks Cabling

   As per drawings Rectifier 1 should supply power to Stacks 1 – 4 and Rectifier 2 should supply stacks 5 – 8. This was reversed in reality. The preferred solution is to update the drawings to reflect the current installation.

   Detail TBC by vendor i.e. Elogen.

Fuel Cell – System 80-00

1. Fuel Cell trips on transition to Island / Emergency mode

   Several trips were observed during OIT relating to nano grid instability. This may have been due to the power quality of the diesel generators as the Fuel Cell appeared to be stable when BESS was grid forming. Ballard have been asked if parameters / protection settings can be relaxed to ensure greater reliability from the package.

   Recommendation to be provided by vendor i.e. Freqcon. .

2. Temperature sensor BT01.

   Temperature sensor was spiking during initial part of OIT resulting in package trips. Sensor, cable, transmitter and controller all replaced during OIT. Latterly no spikes were observed but runtime since repair has been short. Sensor should be observed during operation for extended period so that repair can be confirmed as successful.

BESS = System 85-00

1. Secondary Protection Settings for Island / Emergency mode

   As per OTP a secondary set of protection settings, relevant only for island mode, should be confirmed as installed on the ABB switchgear by Rosetti. Awaiting confirmation from Anthony.

   RM Commissioning to provide details.

H2 = System 25

1. PCV Tuning

   PCVs require further tuning to achieve greater stability & control of H2 supply to fuel cell.

   RM Commissioning to provide details.

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000610

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

There are discrepancies between the General arrangement document (K559-2254-CWIWP4202202-B01-001 R.8). Sh.12/14. The interface point is different in field compared to the document. Two more in/out-lets exist. In addition there is one vent more originating from the point. See picture n.2 compared to sh.05/14. Finally there is one additional hose going to the Low temperature cooler compared to sh.05/14.

Name: Kangi Albonetti
Date: 2024-11-19
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Ballard have updated the drawing to reflect the as-built status

Name: Paul Kyle
Date: 2025-06-27
Signature:

5 - CLEARANCE CHECK

Ballard will trasmit the document through Aconex

Name: Paul Kyle
Date: 2025-06-27
Signature:

6- CLEARANCE APPROVAL

Punchlist item closed

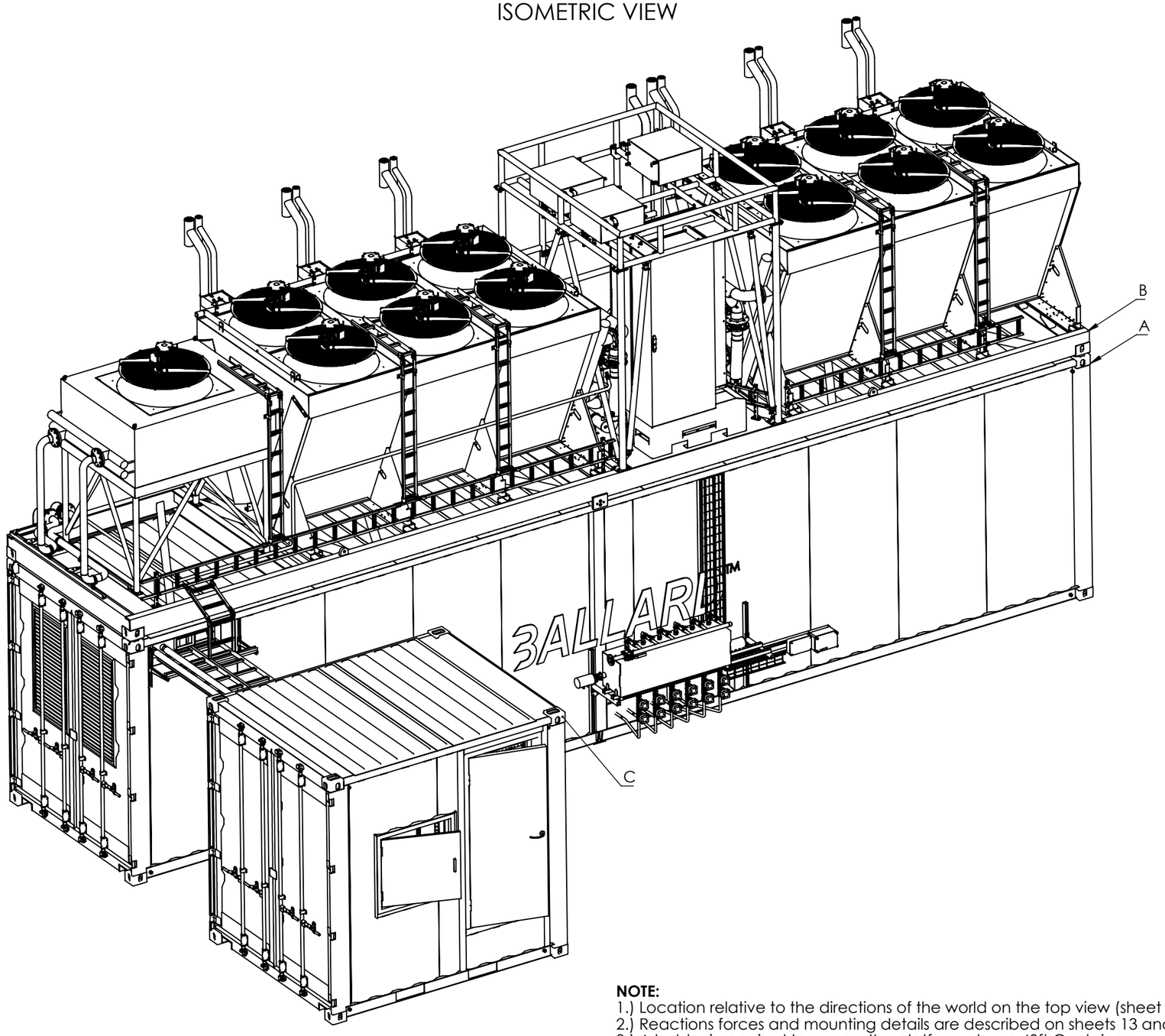
Name: Jan Duinhoven
Date: 2025-06-27
Signature:




BALDINI


DC

ISOMETRIC VIEW



No	Name	Operating Masses	Dry Masses
A	40ft container	21680kg	21320kg
B	40ft fladbed	10060kg	9060kg
C	10ft container	7350kg	7310kg

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

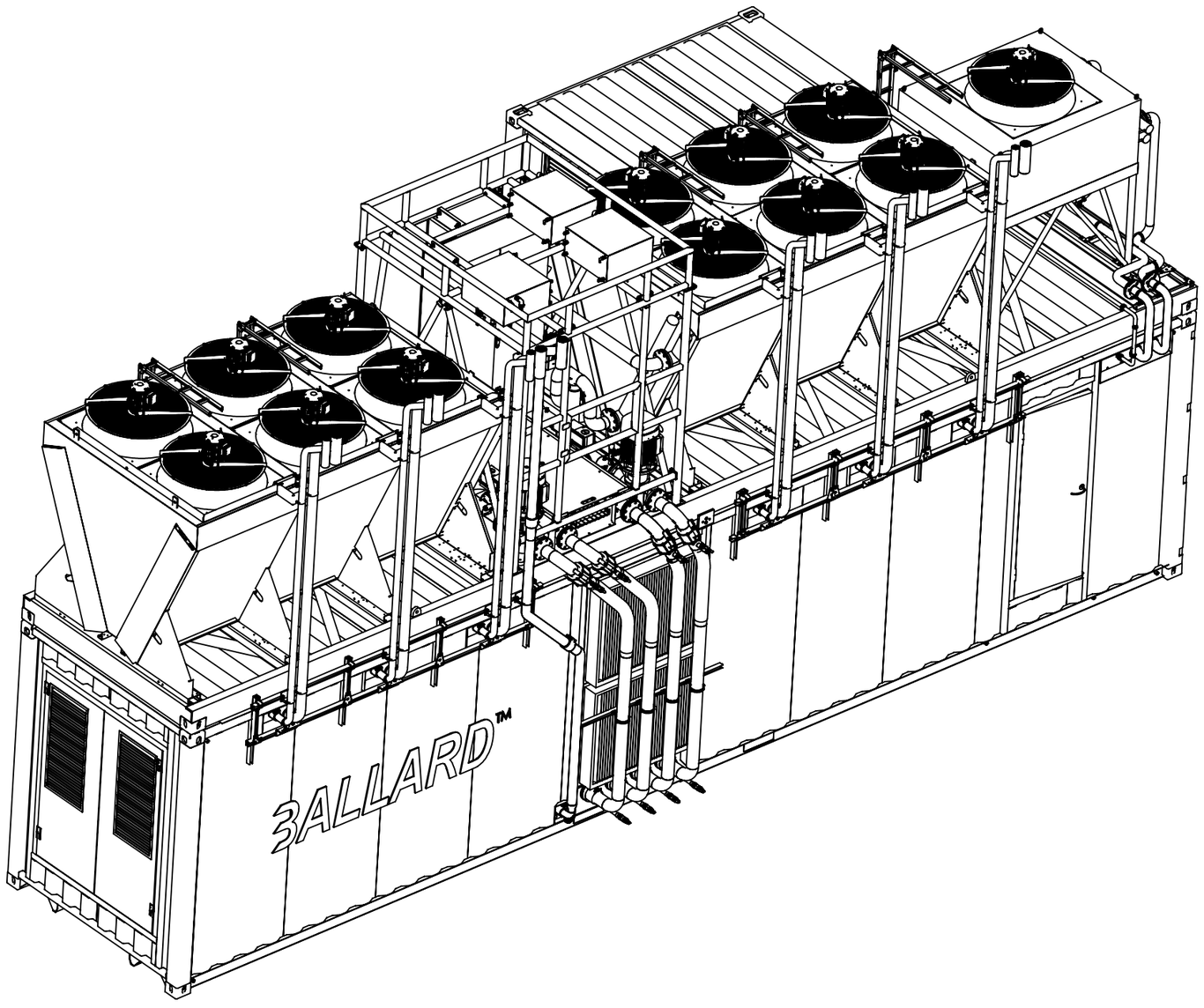
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	1/14	1:50	601456B	10

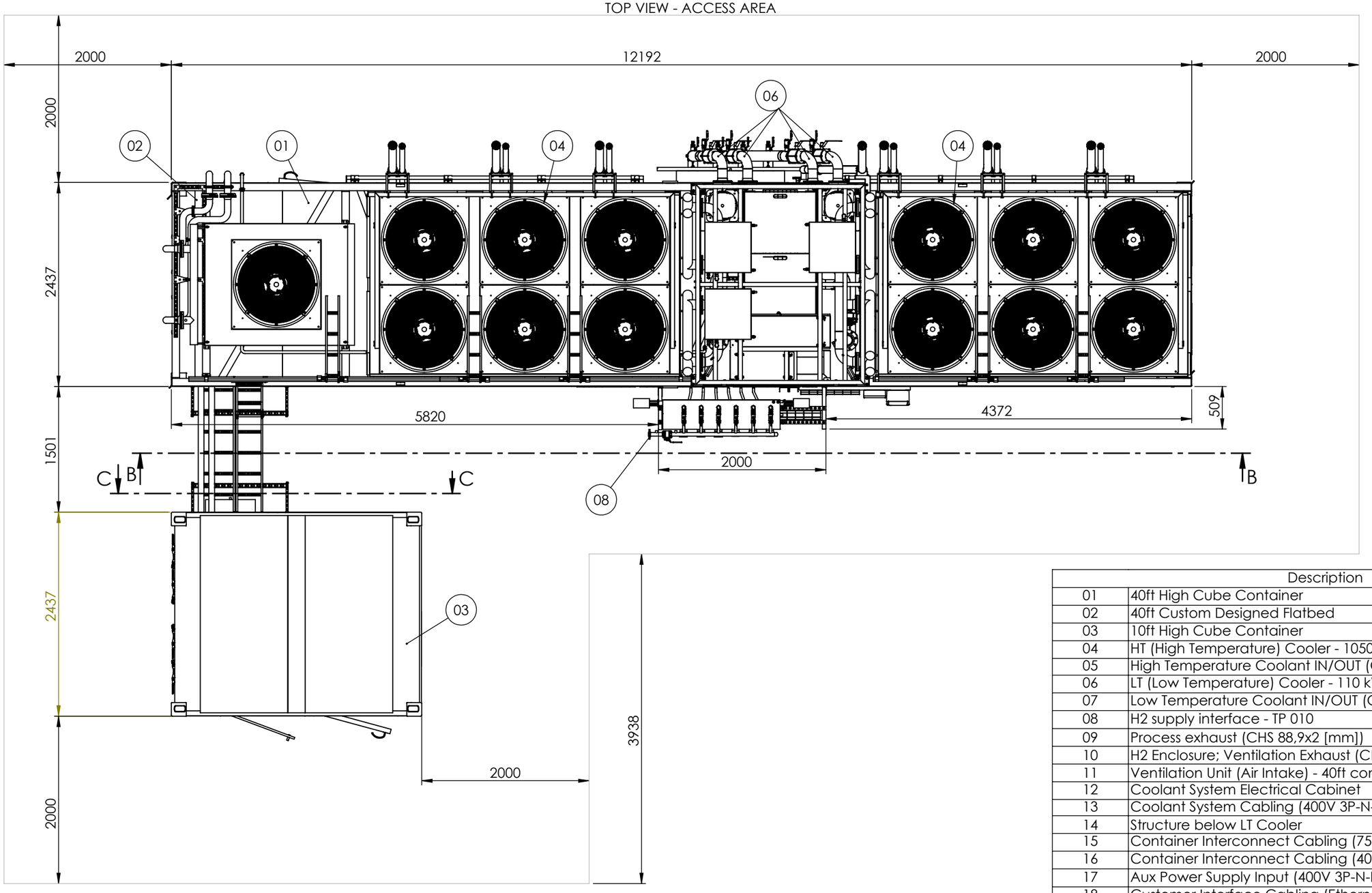
ISOMETRIC VIEW



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
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4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)				BALLARD™				
Tolerances for linear and angular dimensions without individual tolerance according to ISO668		By	Date	General arrangement				
	Drawn	ASM	20-02-2024					
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision							
	Released							
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TOP VIEW - ACCESS AREA





	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

		By	Date
Drawn		ASM	20-02-2024
Revision			
Released			

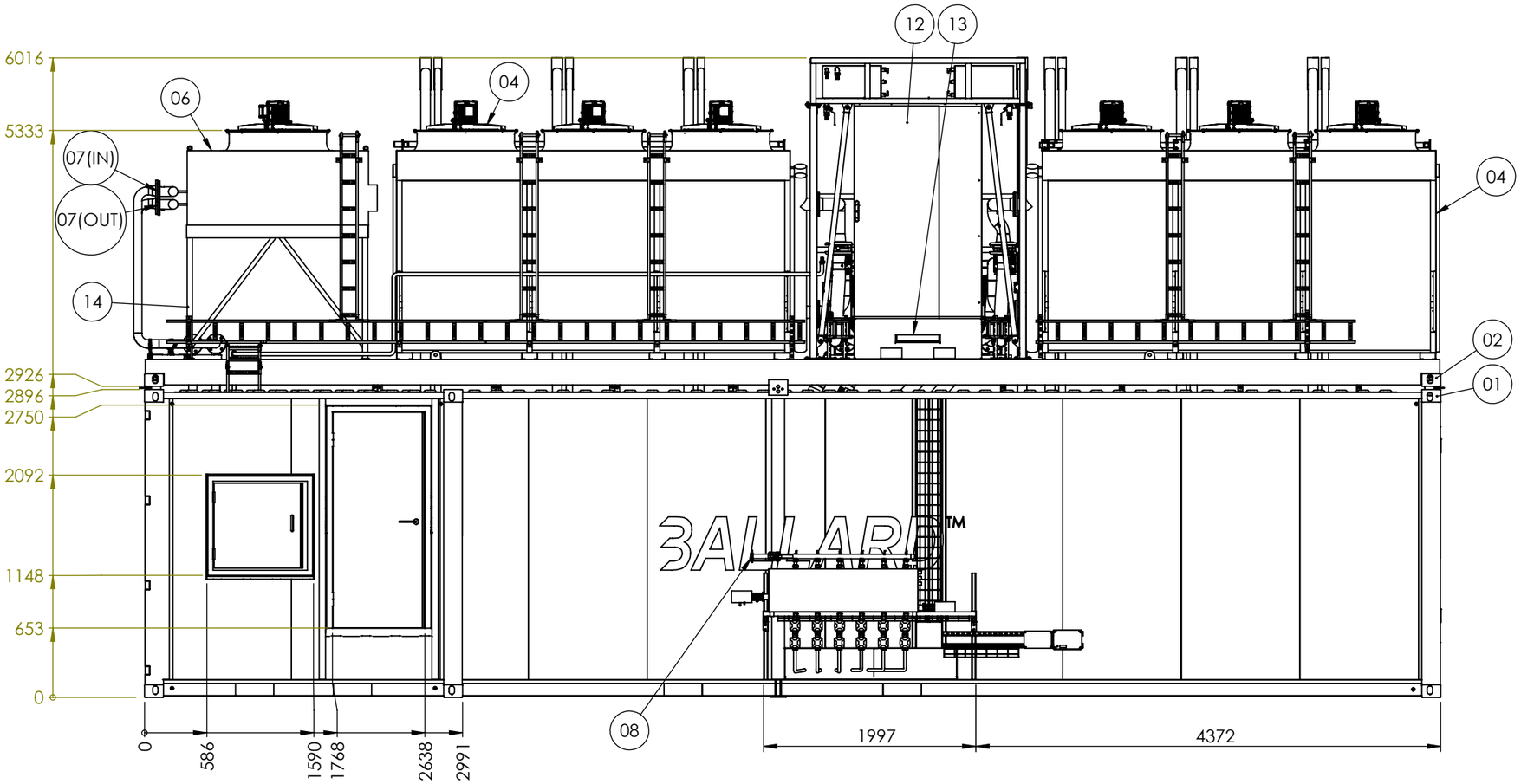
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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	3/14	1:50	601456B	10

FRONT VIEW
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
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2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

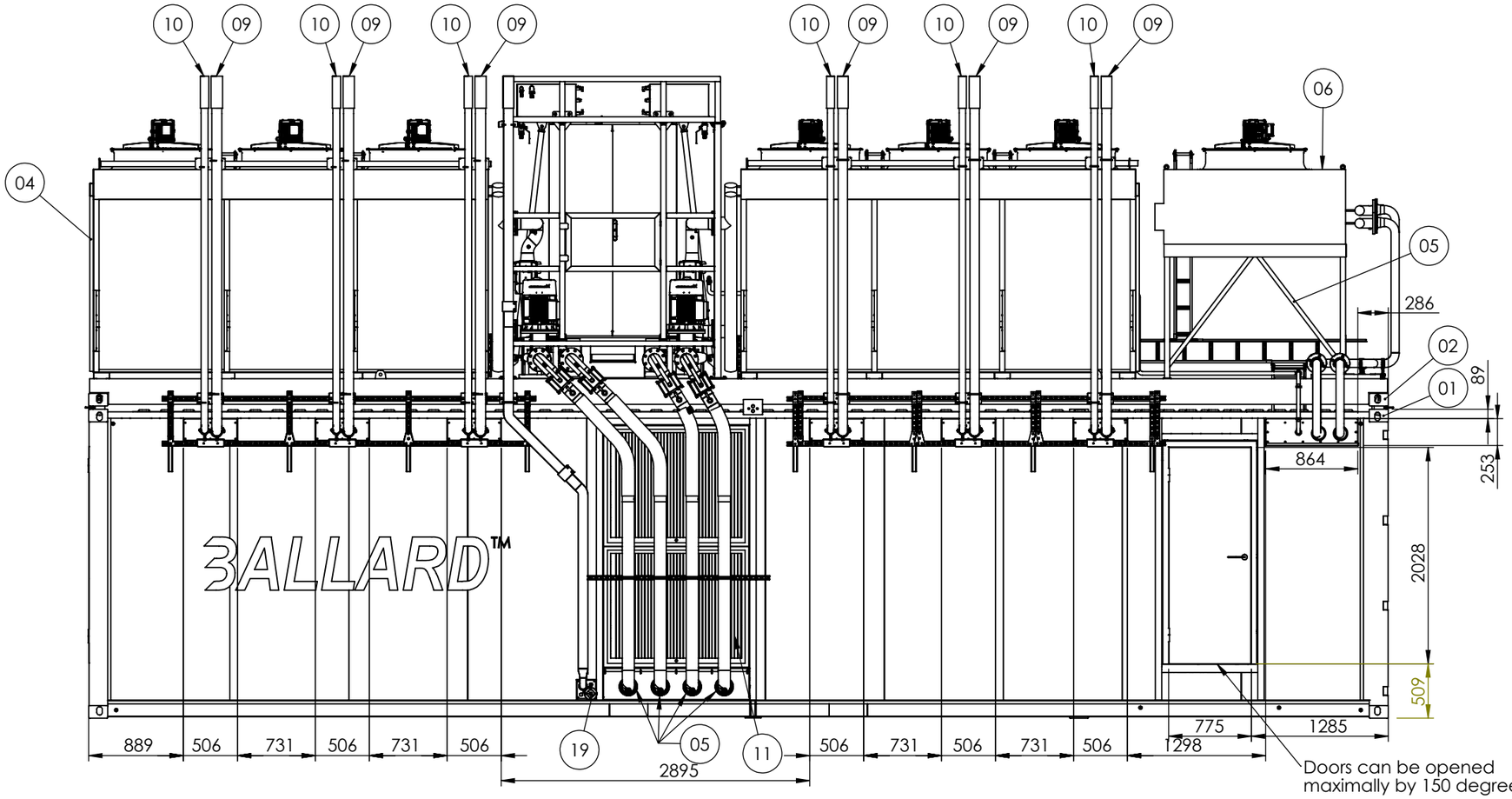
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Released		

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	4/14	1:50	601456B	10

BACK VIEW
(LOOKING NORTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
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3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

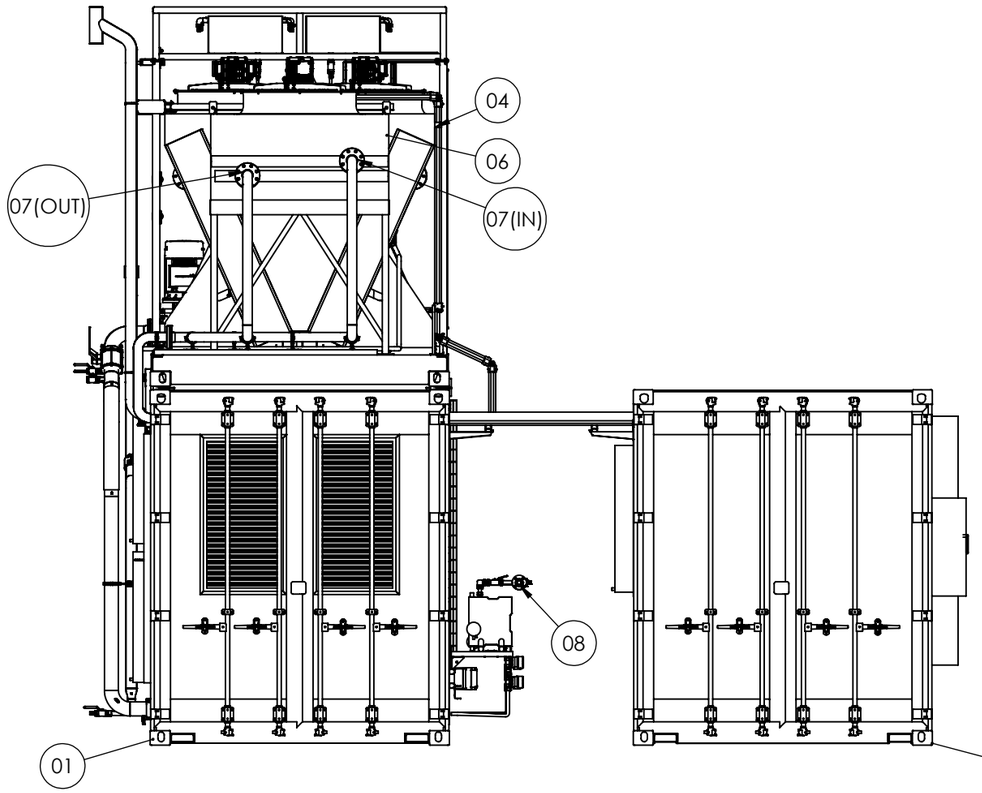
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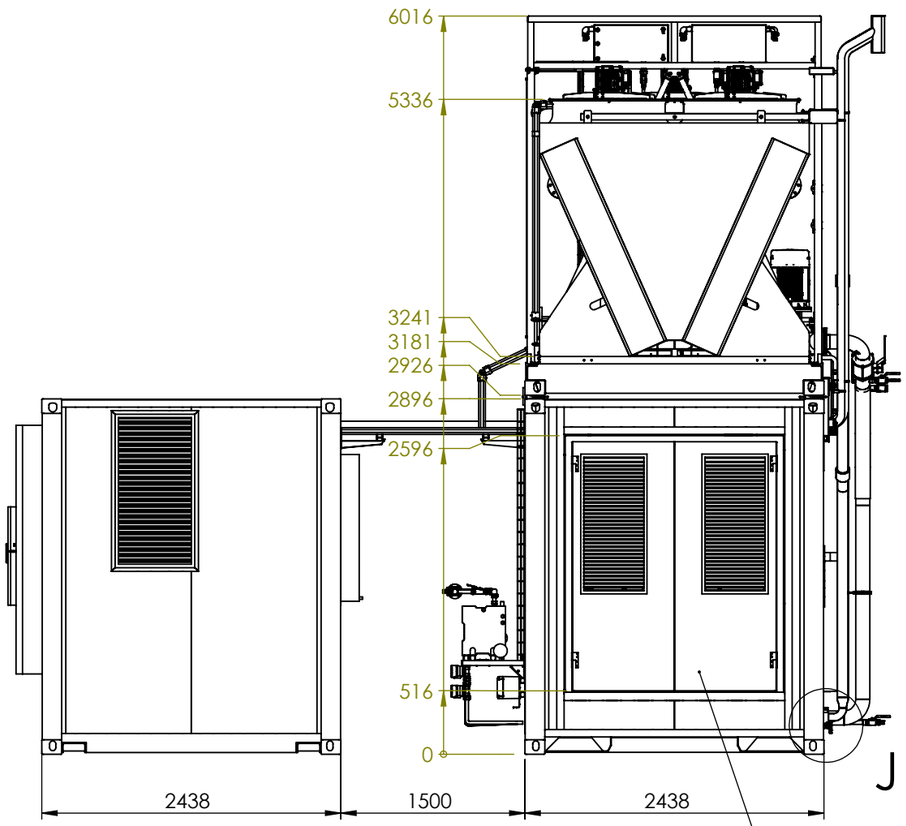
General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	5/14	1:50	601456B	10

RIGHT VIEW
(LOOKING WEST)

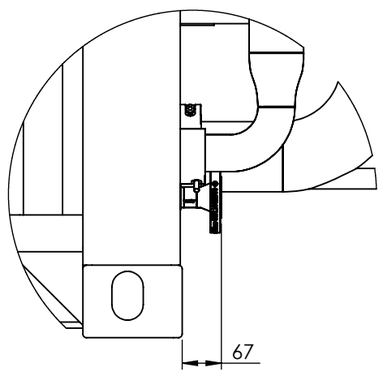


LEFT VIEW
(LOOKING EAST)



Doors can be opened
maximally by 150 degrees

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
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09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
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16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		



DETAIL J
SCALE 1 : 10

NOTE:
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3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

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	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

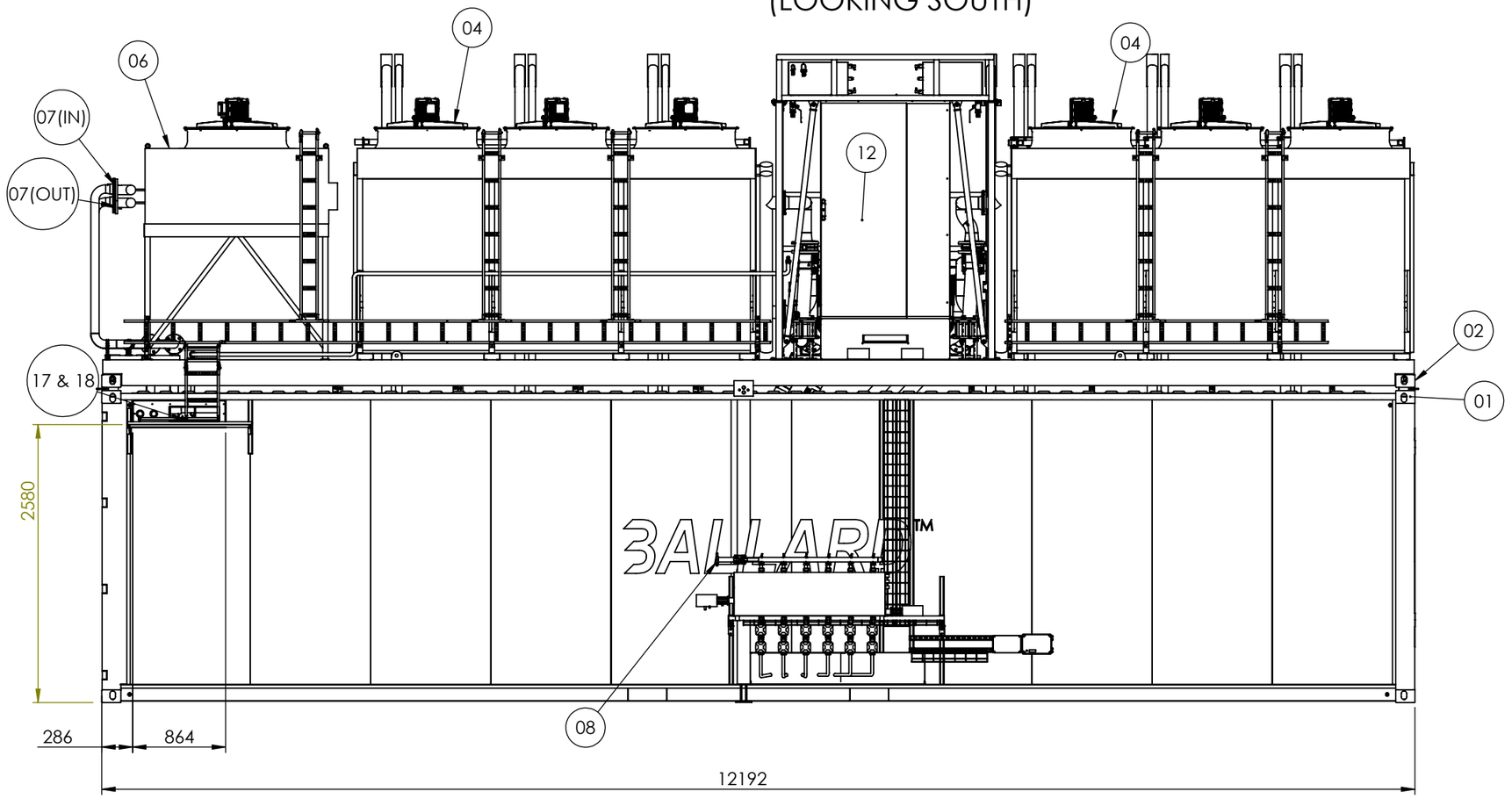
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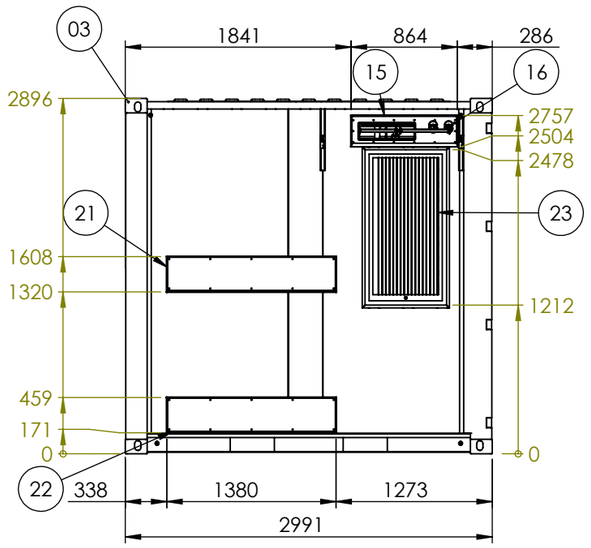
General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	6/14	1:50	601456B	10

FRONT VIEW
(LOOKING SOUTH)



SECTION B-B



SECTION C-C

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
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19	Drain interface - TP 015	CIP
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21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
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23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

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4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

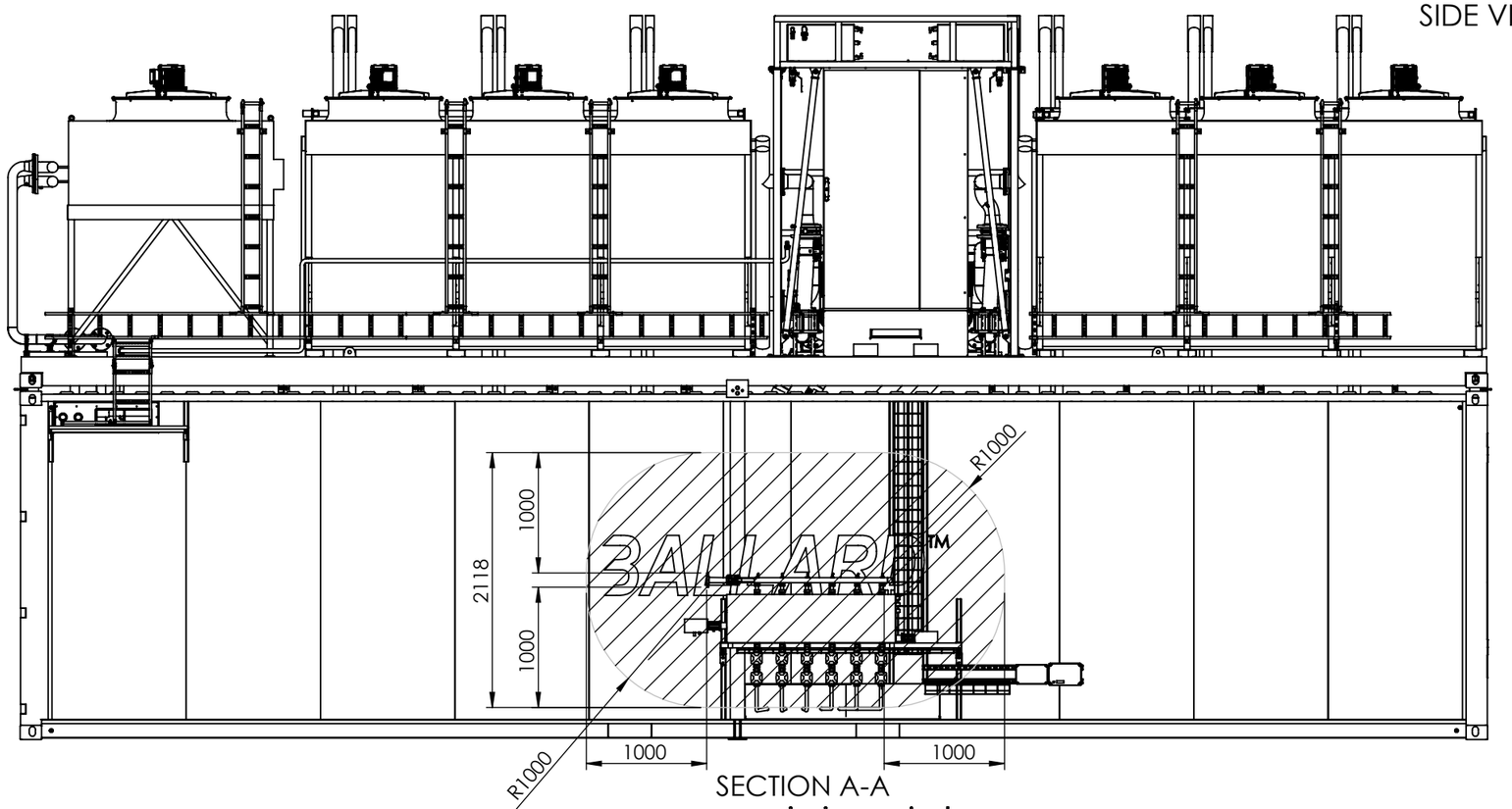
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Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	7/14	1:50	601456B	10

SIDE VIEW - HAZARD AREA



SECTION A-A

Zone 2 Gc IIC T1

TOP VIEW – HAZARD AREA

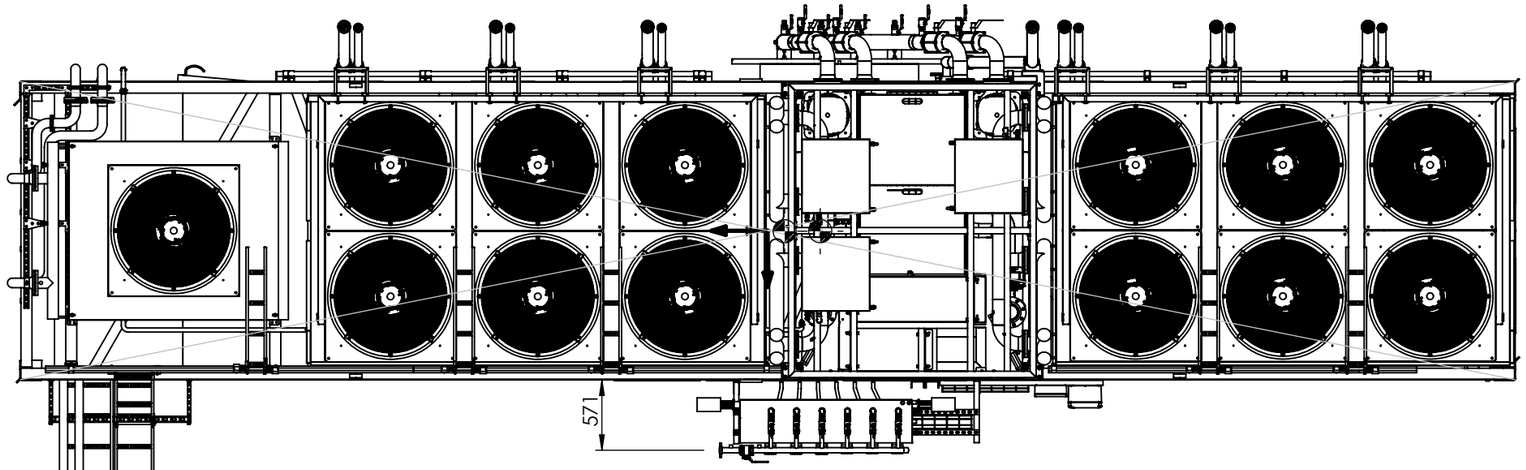
NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

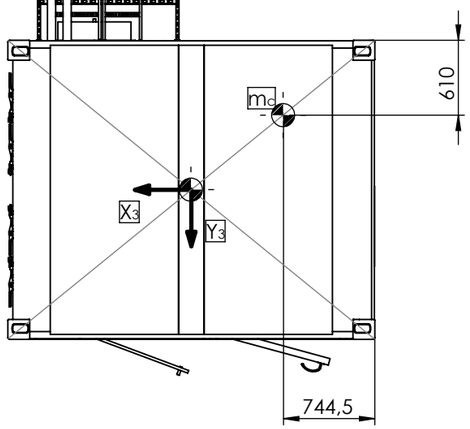
MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)			BALLARD™
Tolerances for linear and angular dimensions without individual tolerance according to ISO 668		By	Date
	Drawn	ASM	20-02-2024
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision		
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	8/14	1:50	601456B	10

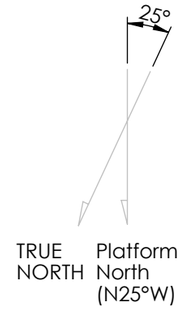
TOP VIEW - Center of Gravity

Access area





Access area



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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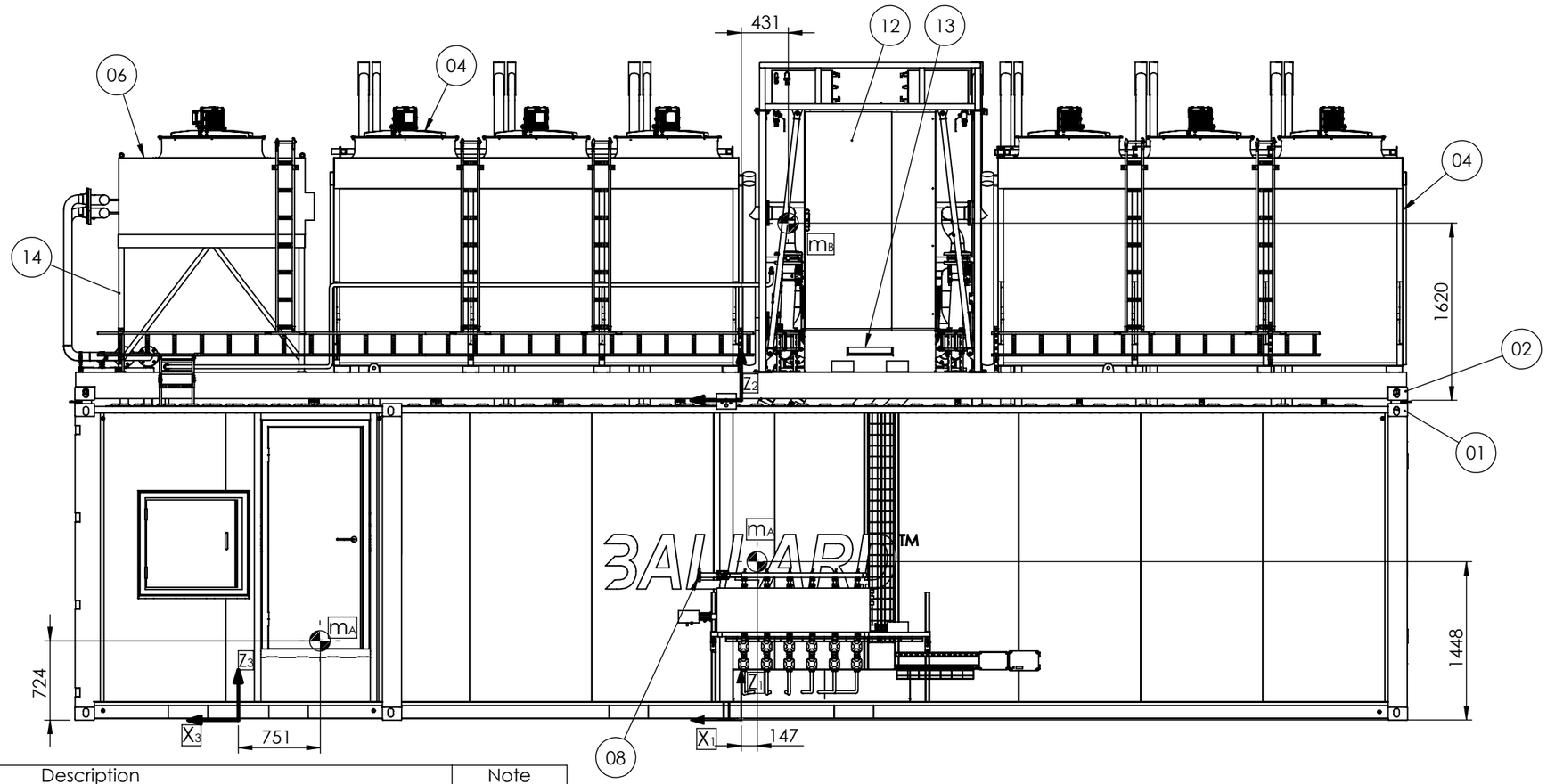
		By	Date
Tolerances for linear and angular dimensions without individual tolerance according to	Drawn	ASM	20-02-2024
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision		
	Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	9/14	1:50	601456B	10

FRONT VIEW - Center of Gravity
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
	CHS = Circular Hollow Section	
	CIP - Customer Interface Point	

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

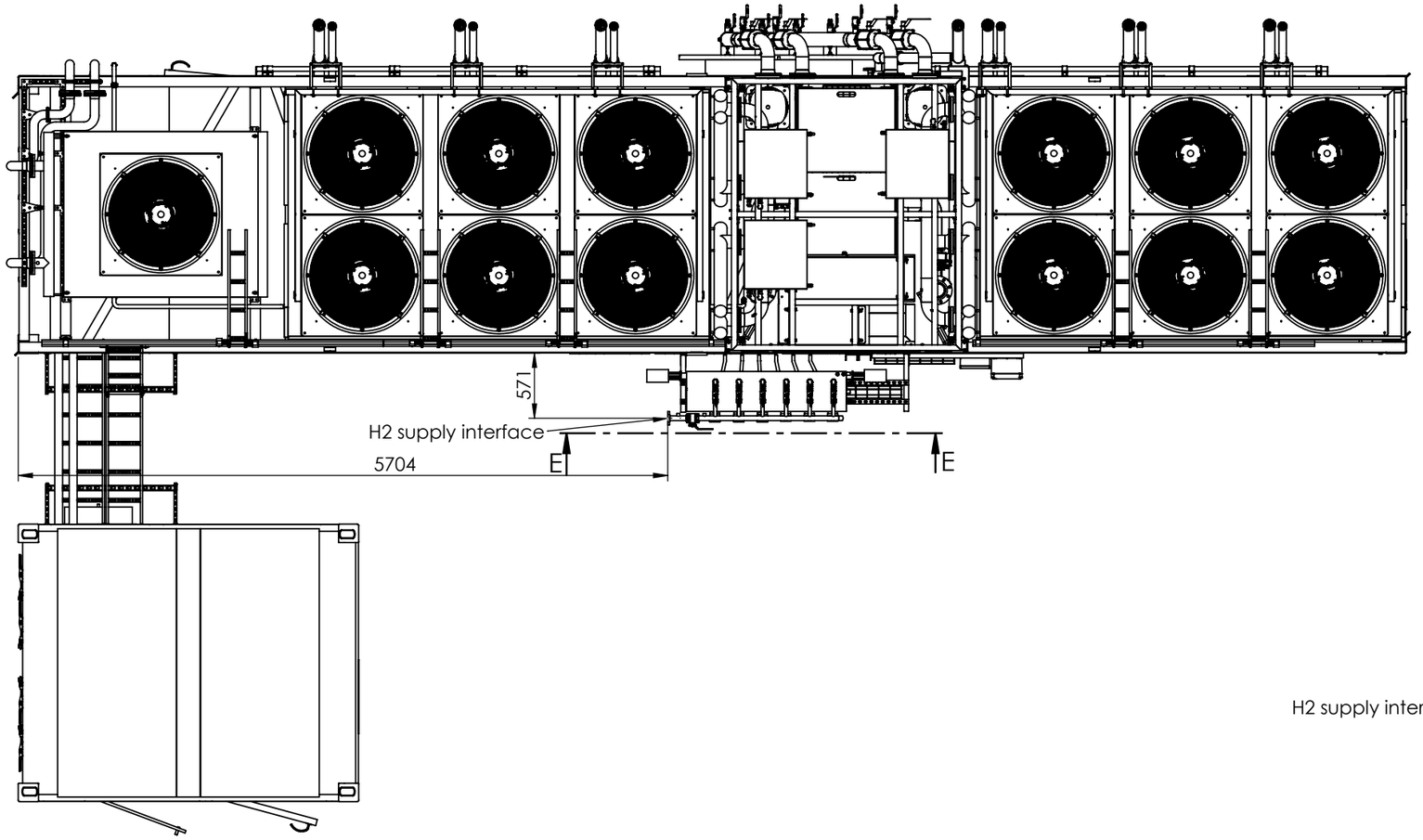
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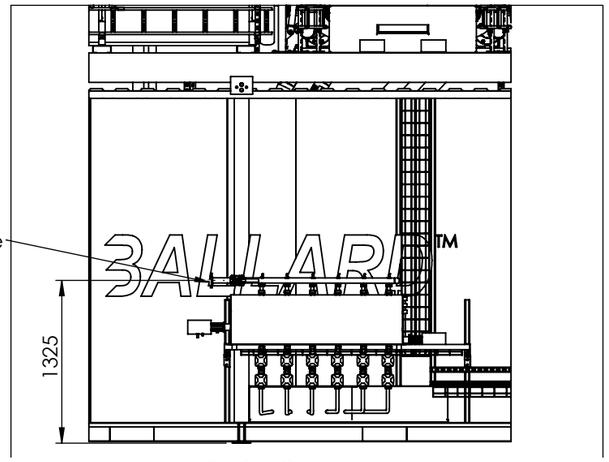
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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	10/14	1:50	601456B	10

TOP VIEW - H2 SUPPLY INTERFACE





SECTION E-E

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
08	H2 supply interface - TP 010	DN32	EN1759-1	300	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
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WEIGHT 25596124 g

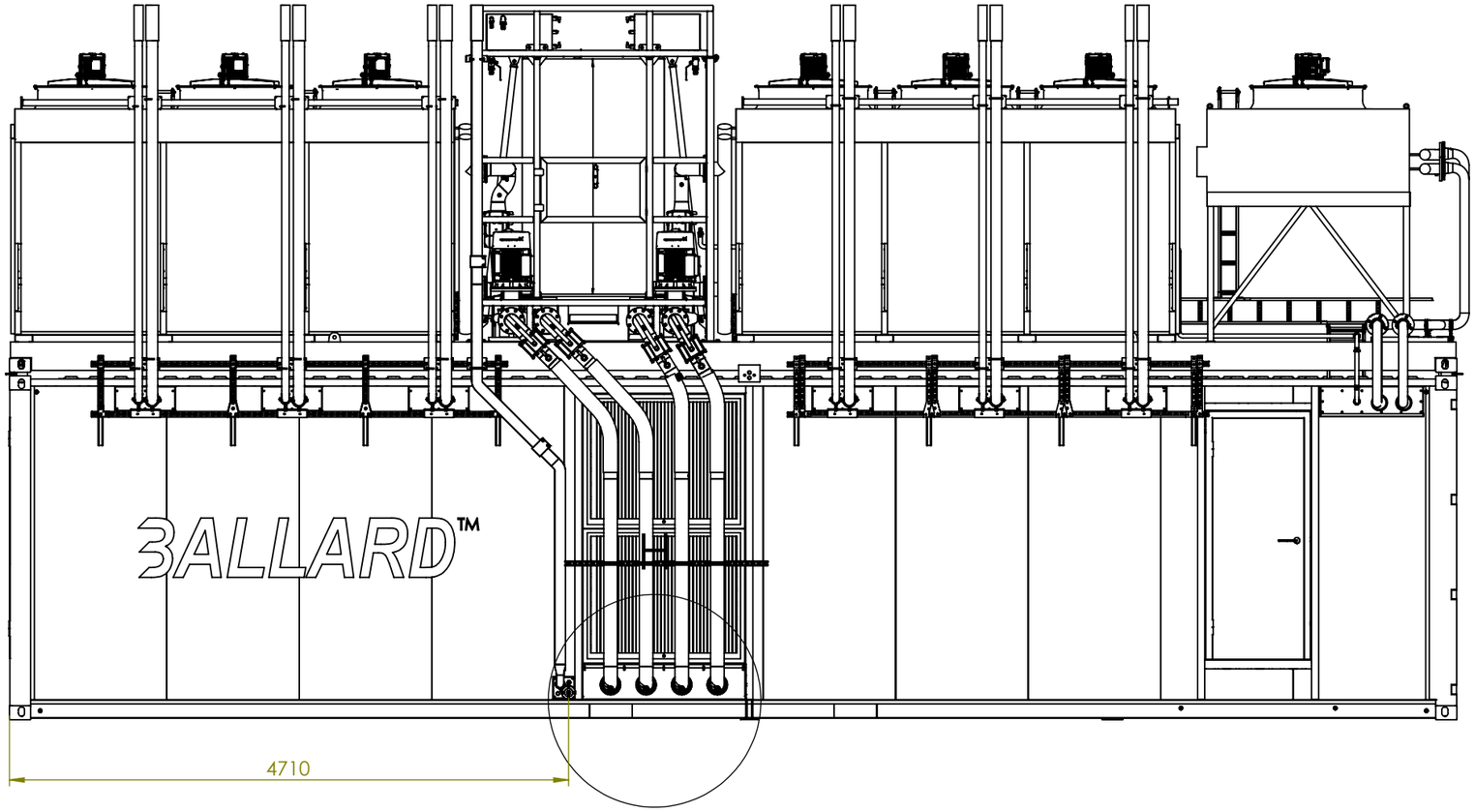
1st angle projection

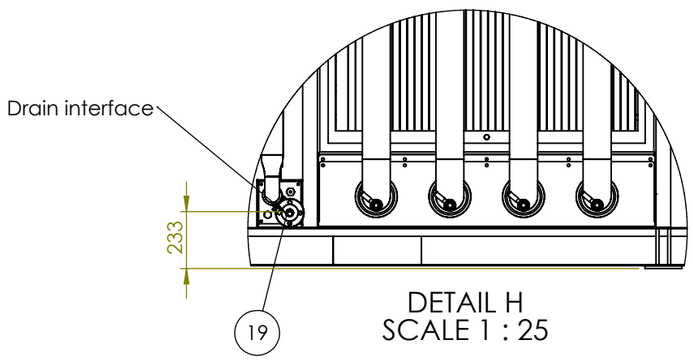
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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	11/14	1:50	601456B	10

FRONT VIEW LOOKING NORTH- DRAIN INTERFACE





DETAIL H
SCALE 1 : 25

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
19	Drain interface - TP 015	1"	ASME B 16.5	150	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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Drawn	ASM	20-02-2024
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WEIGHT 25596124 g

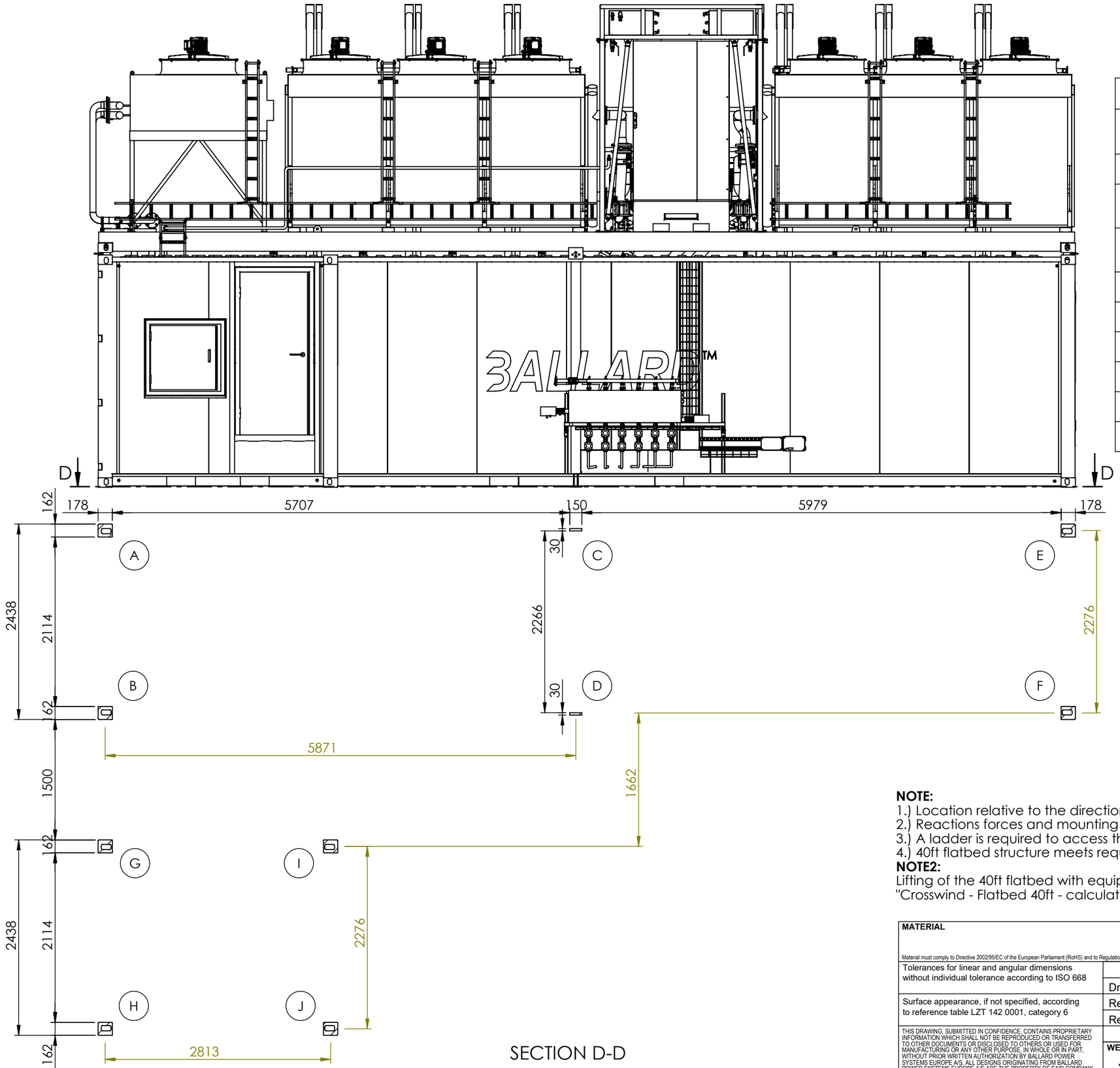
1st angle projection

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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	12/14	1:50	601456B	10

REACTIONS BOTTOM



SECTION D-D

Pointer	Element description	Required support description
A	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
B	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
C	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
D	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
E	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
F	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
G	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
H	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
I	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
J	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

NOTE2:
Lifting of the 40ft flatbed with equipment in accordance to guidelines specified in structural calculation report: "Crosswind - Flatbed 40ft - calculation report rev_1.pdf"

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

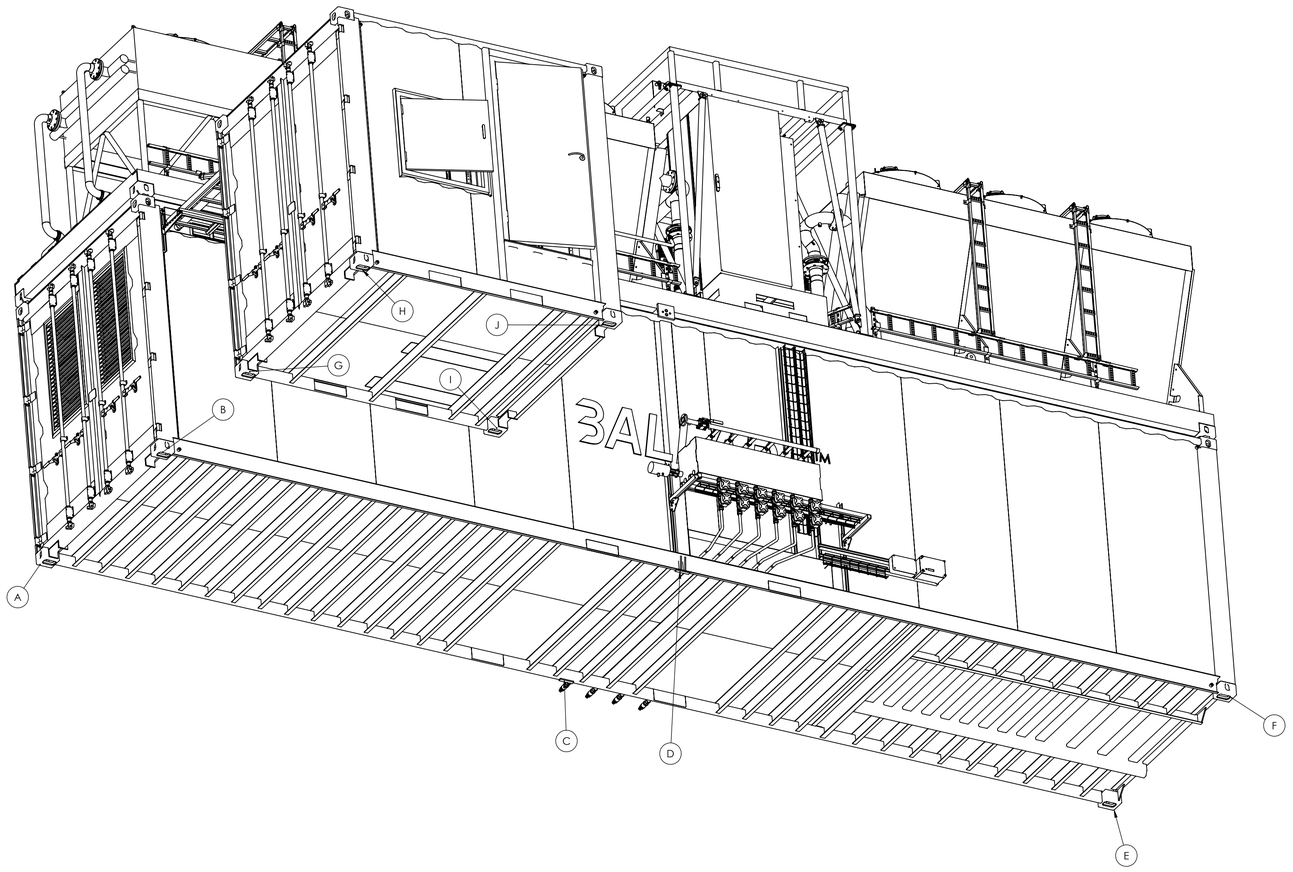
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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
25596124 g	1st angle projection	A3	13/14	1:50	601456B	10



40ft container							
Ultimate Limit State: LC5 - Lifting of 40ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-	-	126	A	-	-	125
B	-	-	133	B	-	-	134
C	-	-	-	C	-	-	-
D	-	-	-	D	-	-	-
E	-	-	133	E	-	-	134
F	-	-	128	F	-	-	128

40ft container							
Ultimate Limit State: LC5 - Lifting of 10ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-	-	25	G	-	-	25
H	-	-	17	H	-	-	16
I	-	-	100	I	-	-	99
J	-	-	22	J	-	-	23

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
40ft container + 40ft flatbed (max self-weight) LC7 MAX-Sea transport on the barge Head sea, bow down, Y+[Pitch case 1]				40ft container + 40ft flatbed (min self-weight) LC7 MIN-Sea transport on the barge Head sea, bow down, Y+[Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	39	-75	-158	A	65	-72	-217
B	-103	-63	300	B	-76	-63	234
C	-	-	113	C	-	-	53
D	-	-	130	D	-	-	24
E	11	-42	27	E	-24	-60	-70
F	53	-83	138	F	35	-67	93
40ft container + 40ft flatbed (max self-weight) LC8 MAX-Sea transport on the barge Quatering sea, bow down, X+Y+ [Quatering 1]				40ft container + 40ft flatbed (min self-weight) LC8 MIN-Sea transport on the barge Quatering sea, bow down, X+ Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-64	-39	-60	A	-42	-37	-98
B	-153	-49	263	B	-131	-50	207
C	-	-	101	C	-	-	34
D	-	-	127	D	-	-	41
E	-45	-33	30	E	-74	-48	-42
F	-37	-44	85	F	-52	-30	21
40ft container + 40ft flatbed (max self-weight) LC9 MAX-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]				40ft container + 40ft flatbed (min self-weight) LC9 MIN-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-130	9	80	A	-111	10	48
B	-131	-12	141	B	-111	-13	90
C	-	-	99	C	-	-	31
D	-	-	124	D	-	-	47
E	-44	2	70	E	-70	-11	-10
F	-78	2	-4	F	-92	13	-41
40ft container + 40ft flatbed (max self-weight) LC10 MAX-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]				40ft container + 40ft flatbed (min self-weight) LC10 MIN-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-154	51	206	A	-132	53	172
B	-67	31	-6	B	-44	31	-65
C	-	-	105	C	-	-	30
D	-	-	126	D	-	-	49
E	-4	46	127	E	-32	32	61
F	-74	37	-39	F	-90	49	-82
40ft container + 40ft flatbed (max self-weight) LC11 MAX-Sea transport on the barge Head sea, stern down, Y-[Pitch case 2]				40ft container + 40ft flatbed (min self-weight) LC11 MIN-Sea transport on the barge Head sea, stern down, Y-[Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-104	68	265	A	-79	71	225
B	33	65	-126	B	61	64	-164
C	-	-	118	C	-	-	23
D	-	-	130	D	-	-	59
E	77	85	178	E	43	67	101
F	-6	43	-13	F	-26	59	-79
40ft container + 40ft flatbed (max self-weight) LC12 MAX-Sea transport on the barge Quatering sea, stern down, X-Y-[Quatering 3]				40ft container + 40ft flatbed (min self-weight) LC12 MIN-Sea transport on the barge Quatering sea, stern down, X- Y-[Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	0	33	161	A	22	35	129
B	88	51	-101	B	111	51	-166
C	-	-	118	C	-	-	41
D	-	-	120	D	-	-	51
E	129	75	164	E	101	61	99
F	81	6	60	F	66	19	10
40ft container + 40ft flatbed (max self-weight) LC13 MAX-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]				40ft container + 40ft flatbed (min self-weight) LC13 MIN-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	69	-14	19	A	88	-13	-13
B	66	14	9	B	87	13	-31
C	-	-	115	C	-	-	47
D	-	-	117	D	-	-	40
E	126	39	120	E	100	25	60
F	122	-38	120	F	107	-27	83
40ft container + 40ft flatbed (max self-weight) LC14 MAX-Sea transport on the barge Quatering sea, stern down, X-Y+[Quatering 4]				40ft container + 40ft flatbed (min self-weight) LC14 MIN-Sea transport on the barge Quatering sea, stern down, X- Y+[Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	92	-57	-108	A	113	-55	-150
B	1	-29	170	B	24	-30	116
C	-	-	113	C	-	-	53
D	-	-	120	D	-	-	35
E	88	-5	70	E	59	-20	-5
F	119	-74	154	F	104	-61	116

10ft container (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
10ft container (max self-weight) LC7 MAX-Sea transport on barge Head sea, bow down, Y+[Pitch case 1]				10ft container (min self-weight) LC7 MIN-Sea transport on barge Head sea, bow down, Y+[Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	3	-3	14	G	5	-7	1
H	-17	-19	15	H	-8	-11	5
I	11	-18	63	I	4	-16	7
J	2	-7	24	J	-1	-14	12
10ft container (max self-weight) LC8 MAX-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]				10ft container (min self-weight) LC8 MIN-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	3	24	G	-21	0	13
H	-27	-26	14	H	-20	-19	6
I	-7	-12	52	I	-13	-10	6
J	-7	5	19	J	-10	-1	10
10ft container (max self-weight) LC9 MAX-Sea transport on barge Beam sea, X+ [Roll case 1]				10ft container (min self-weight) LC9 MIN-Sea transport on barge Beam sea, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-33	10	29	G	-32	6	19
H	-27	-23	13	H	-21	-17	5
I	-13	-3	54	I	-19	-1	11
J	-9	16	13	J	-12	11	4
10ft container (max self-weight) LC10 MAX-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]				10ft container (min self-weight) LC10 MIN-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-29	14	28	G	-28	11	17
H	-21	-15	11	H	-13	-8	3
I	-9	7	63	I	-15	9	17
J	-5	25	8	J	-8	20	-2
10ft container (max self-weight) LC11 MAX-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]				10ft container (min self-weight) LC11 MIN-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-8	14	19	G	-5	10	7
H	-6	-2	10	H	3	6	0
I	8	12	80	I	0	14	24
J	5	24	6	J	2	18	-6
10ft container (max self-weight) LC12 MAX-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]				10ft container (min self-weight) LC12 MIN-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	18	7	7	G	20	3	-3
H	6	5	10	H	13	12	1
I	25	7	84	I	19	8	37
J	15	12	9	J	12	6	0
10ft container (max self-weight) LC13 MAX-Sea transport on barge Beam sea, X- [Roll case 2]				10ft container (min self-weight) LC13 MIN-Sea transport on barge Beam sea, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	29	0	3	G	30	-3	8
H	6	3	11	H	13	9	3
I	31	-3	80	I	26	-1	37
J	17	0	15	J	14	-6	6
10ft container (max self-weight) LC14 MAX-Sea transport on barge Quatering sea, stern down, X-Y+[Quatering 4]				10ft container (min self-weight) LC14 MIN-Sea transport on barge Quatering sea, stern down, X-Y+[Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	25	-4	4	G	26	-7	7
H	-1	-6	13	H	6	2	5
I	27	-12	73	I	21	-10	26
J	13	-8	21	J	10	14	11

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
40ft container + 40ft flatbed (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-67	2	58	A	-61	3	48
B	-69	-4	99	B	-63	-4	83
C	-	-	84	C	-	-	63
D	-	-	102	D	-	-	78
E	1	10	71	E	-7	6	51
F	-23	-8	20	F	-27	-4	9
40ft container + 40ft flatbed (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	65	-95	-260	A	71	-95	-275
B	-115	-82	362	B	-108	-81	347
C	-	-	103	C	-	-	92
D	-	-	105	D	-	-	80
E	-4	-65	-38	E	-12	-69	-61
F	53	-95	158	F	50	-92	149
40ft container + 40ft flatbed (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	16	-7	26	A	21	-6	17
B	13	6	39	B	19	6	21
C	-	-	97	C	-	-	76
D	-	-	102	D	-	-	78
E	69	24	91	E	61	20	72
F	60	-24	78	F	56	-20	66
40ft container + 40ft flatbed (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-117	90	332	A	-111	91	323
B	60	83	-237	B	67	83	-257
C	-	-	98	C	-	-	76
D	-	-	119	D	-	-	106
E	73	98	189	E	65	94	172
F	-17	66	-72	F	-21	69	-88

10ft container (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
10ft container (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-28	16	32	G	-24	13	28
H	-8	-14	-1	H	-7	-11	-1
I	6	-25	38	I	2	-21	26
J	-7	23	22	J	-8	19	17
10ft container (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-19	0	4	G	-15	-4	0
H	-7	-26	13	H	-6	-23	13
I	21	-30	39	I	16	-26	27
J	6	7	36	J	4	3	31
10ft container (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-4	6	2	G	1	3	-2
H	6	-10	0	H	7	-7	1
I	27	-16	38	I	22	-12	56
J	8	19	21	J	7	15	16
10ft container (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	28	35	G	-18	25	30
H	-2	2	-17	H	-1	5	-17
I	21	-10	60	I	17	-6	48
J	3	29	13	J	2	25	8

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach).

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

WEIGHT: 25596124 g

1st angle projection

BALLARD™

General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A1	14/14	1:30	601456B	10

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000636

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001456	1.4 Discipline	Instrumental
1.2 Item	C-80-XA-003/B400-SIS-001	UCP FAULT ALARM / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The terminal strip dont have any refer number inside the Package

Name: Giovanni Tangianu

Date: 2024-11-20

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date:

Signature:

5 - CLEARANCE CHECK

DONE

Name: Eleonora Carotenuto

Date: 2025-02-13

Signature:

6- CLEARANCE APPROVAL

Name:

Date:

Signature:

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000637

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001456	1.4 Discipline	Instrumental
1.2 Item	C-80-XA-003/B400-SIS-001	UCP FAULT ALARM / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side

Name: Giovanni Tangianu
Date: 2024-11-20
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


C-80-XA-003/B400-

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000638

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001456	1.4 Discipline	Instrumental
1.2 Item	C-80-XA-003/B400-SIS-001	UCP FAULT ALARM / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cable tags on routing inside the Package

Name: Giovanni Tangianu

Date: 2024-11-20

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date: 2025-04-10

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

Signature:

6- CLEARANCE APPROVAL

Name:

Date: 2025-04-10

Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000639

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001449	1.4 Discipline	Instrumental
1.2 Item	C-80-XS-001/B400-SIS-001	TRIP SIGNAL TO UCP / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing core identification tags on terminals inside the Package

Name: Giovanni Tangianu

Date: 2024-11-20

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date: 2025-04-10

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

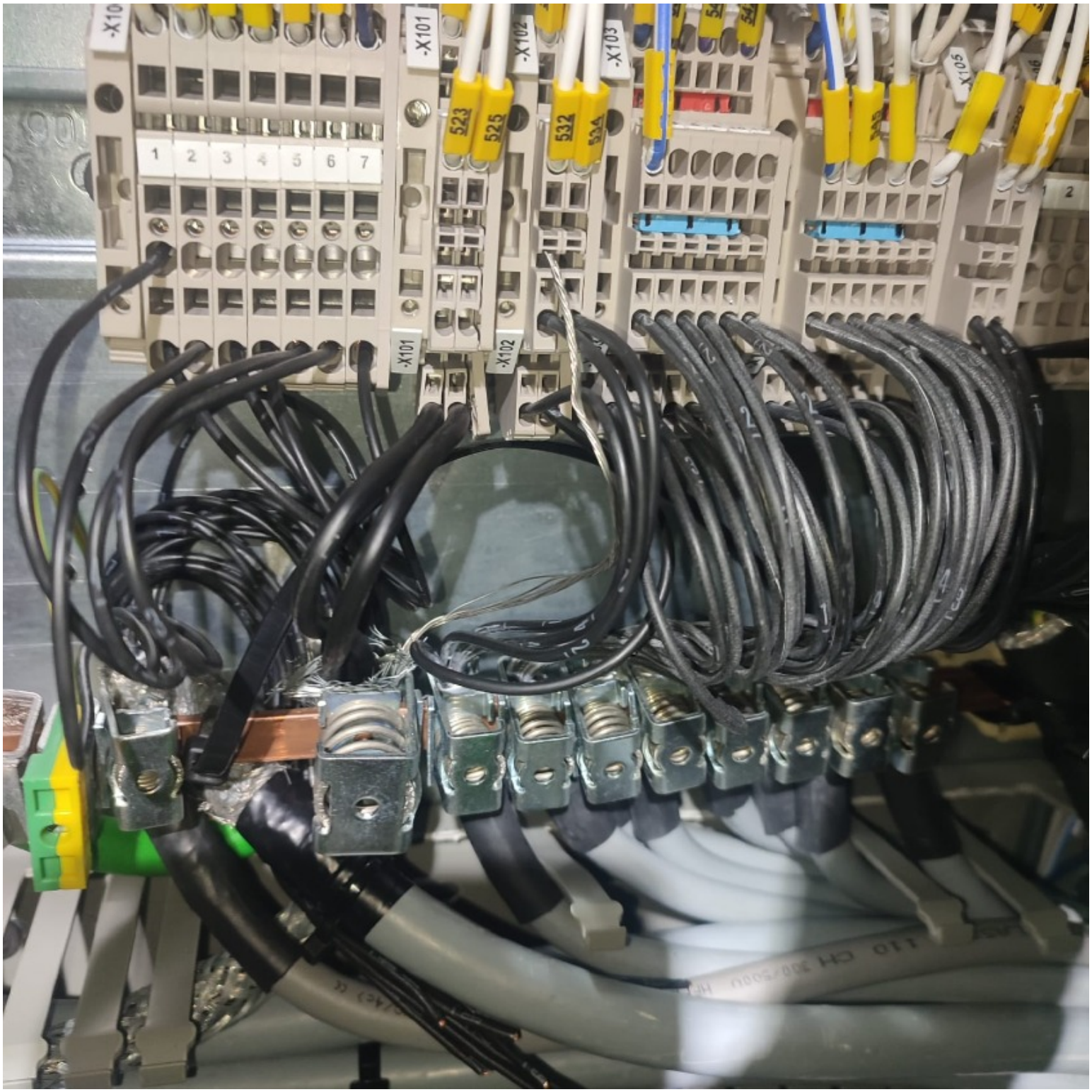
Signature:

6- CLEARANCE APPROVAL

Name:

Date: 2025-04-10

Signature:


-X101
-X102
-X103
-X105
1 2 3 4 5 6 7
523
525
532
534

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000640

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001449	1.4 Discipline	Instrumental
1.2 Item	C-80-XS-001/B400-SIS-001	TRIP SIGNAL TO UCP / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side

Name: Giovanni Tangianu
Date: 2024-11-20
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

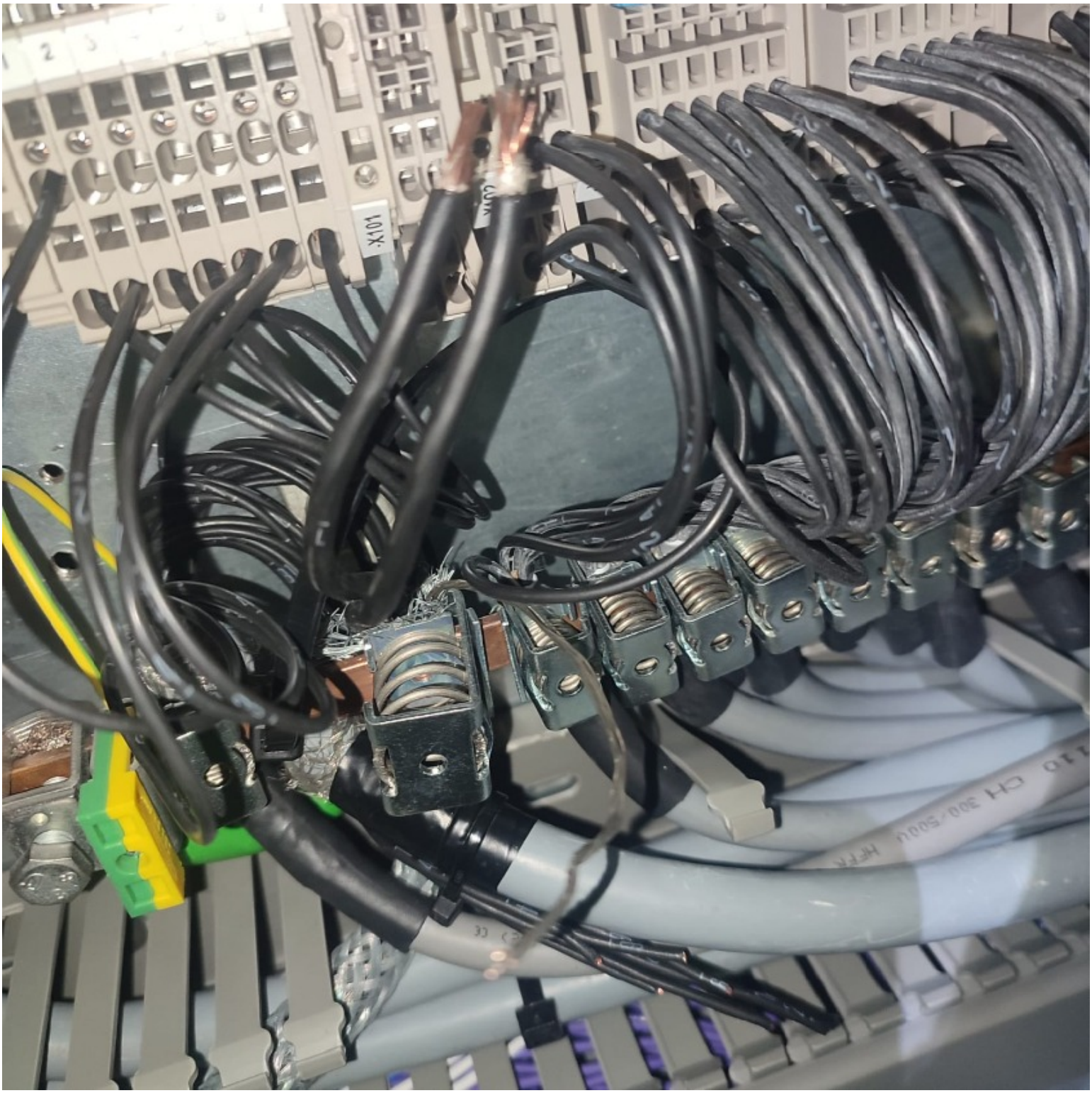
5 - CLEARANCE CHECK

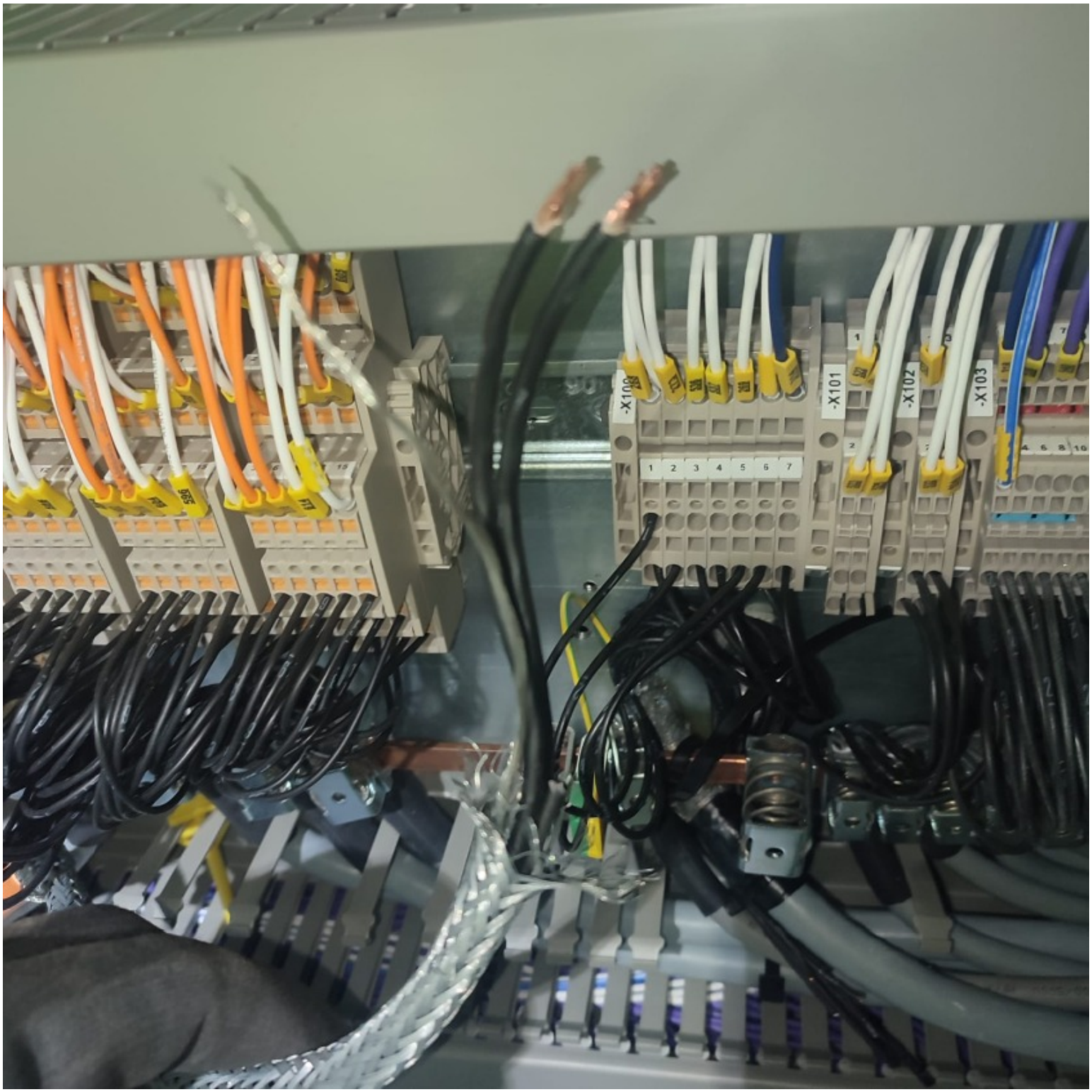
Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


X101


-X101
-X102
-X103
1 2 3 4 5 6 7

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000641

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001449	1.4 Discipline	Instrumental
1.2 Item	C-80-XS-001/B400-SIS-001	TRIP SIGNAL TO UCP / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cable tags on routing inside the Package

Name: Giovanni Tangianu

Date: 2024-11-20

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date: 2025-04-10

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

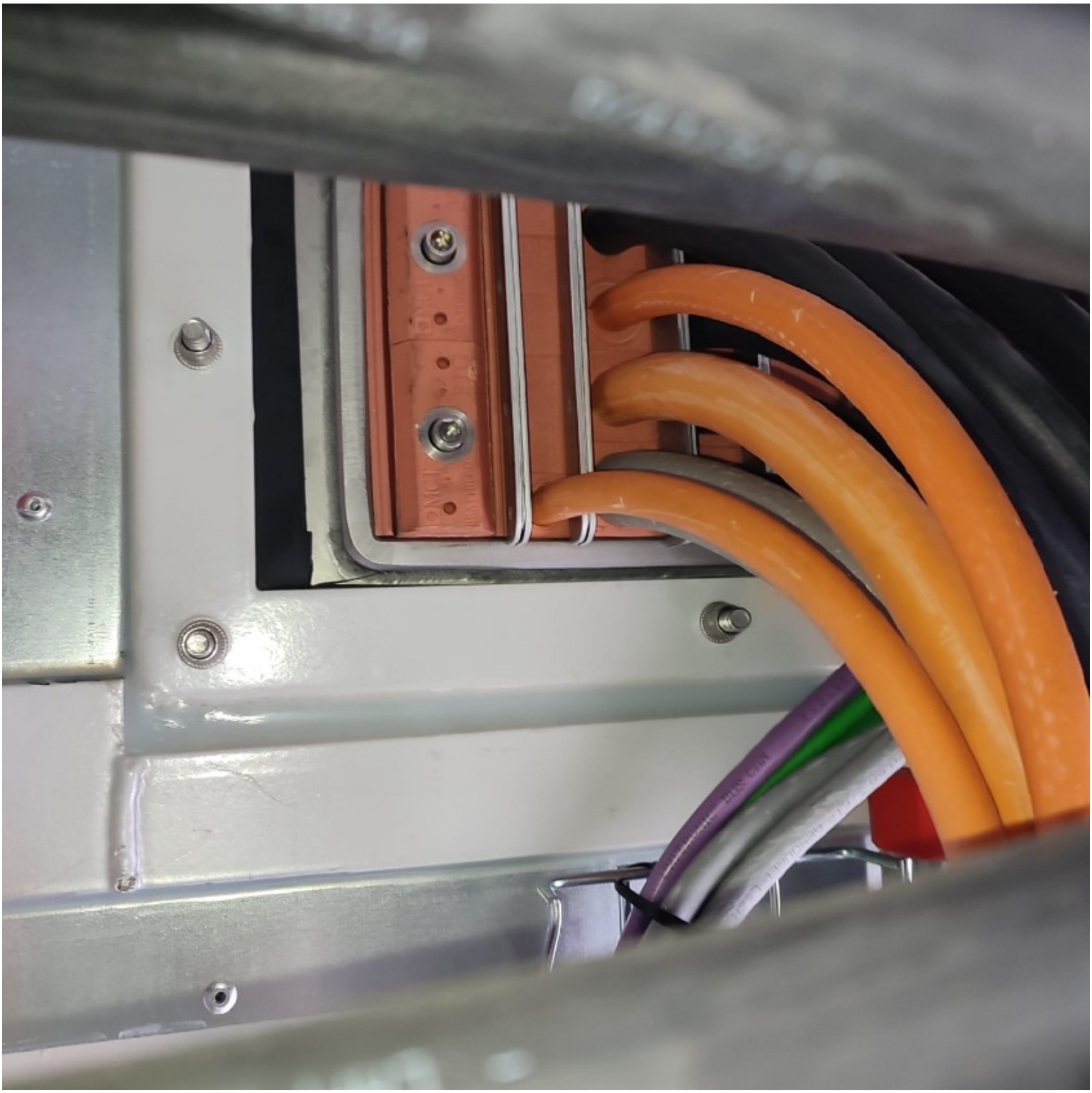
Signature:

6- CLEARANCE APPROVAL

Name:

Date: 2025-04-10

Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000642

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001466	1.4 Discipline	Instrumental
1.2 Item	80-UCP-001/B400-FGS-003	CONFIRMED GAS ALARM / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The terminal strip dont have any refer number inside the Package

Name: Giovanni Tangianu
Date: 2024-11-20
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

DONE

Name: Eleonora Carotenuto
Date: 2025-02-13
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000643

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10001466	1.4 Discipline	Instrumental
1.2 Item	80-UCP-001/B400-FGS-003	CONFIRMED GAS ALARM / MARSHALLING PCS	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Cable terminations are not as per typical installation drawing 123A90-DDL-EL-DD-20090, by package side

Name: Giovanni Tangianu
Date: 2024-11-20
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-20
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000686

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10000523	1.4 Discipline	Electrical
1.2 Item	83012-CEL	LV Switchgear / Fuel Cell Auxiliary Load	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Bending radius on MCT is not correct. See attached photo.

Name: Giovanni Tangianu
Date: 2024-11-21
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-21
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Work performed by Ballard

Name: Jan Duinhoven
Date: 2025-06-05
Signature:

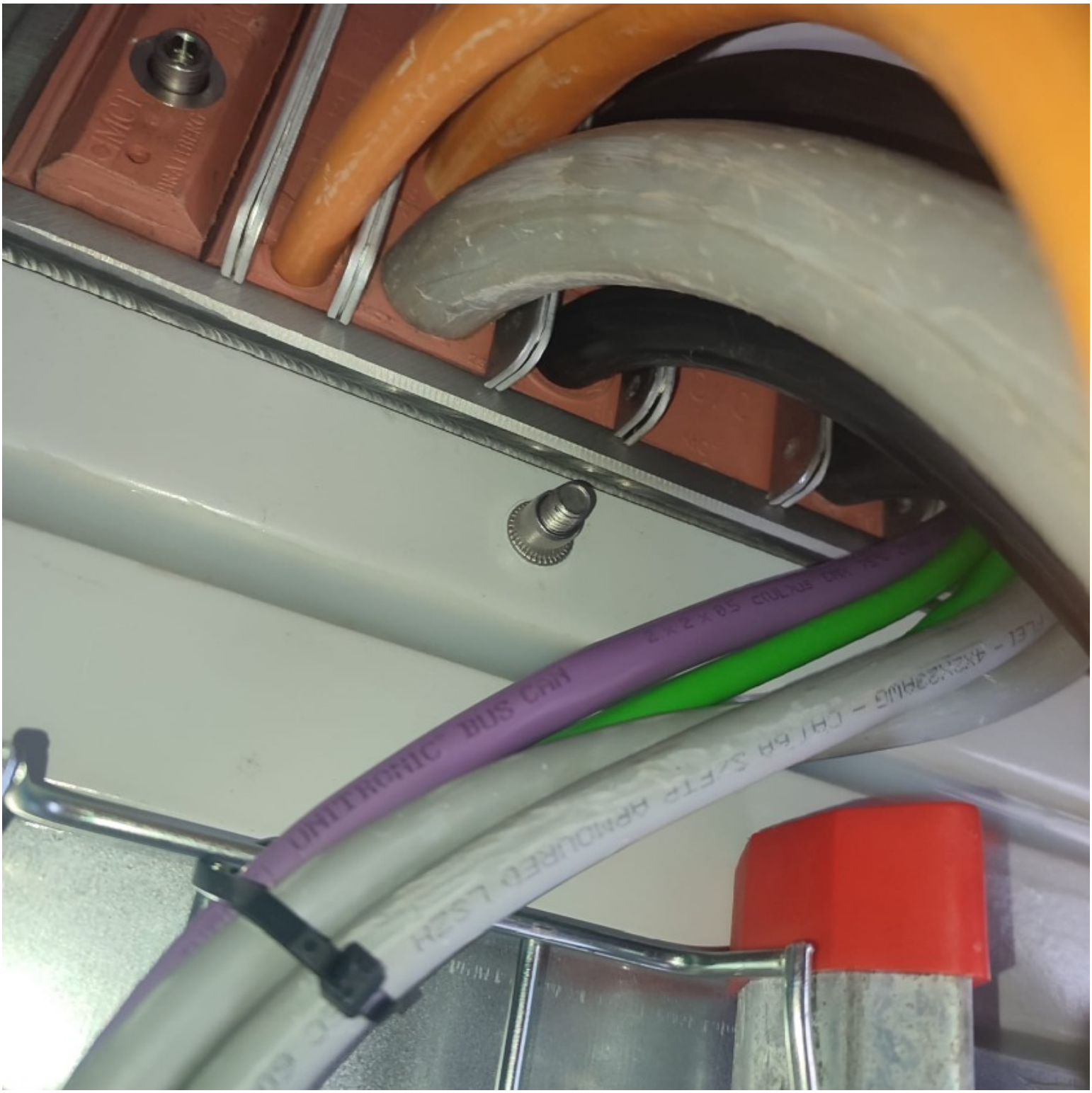
5 - CLEARANCE CHECK

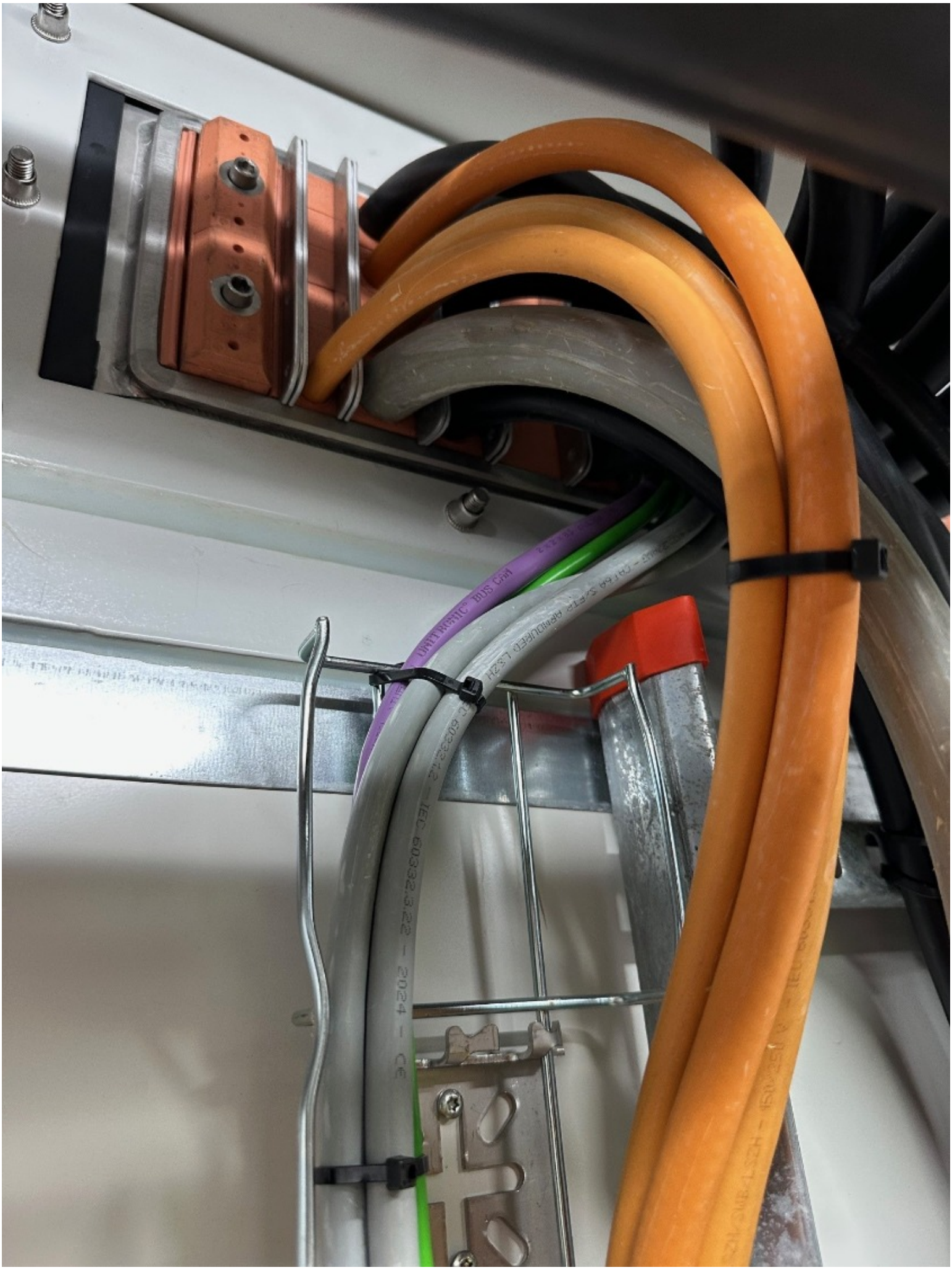
Reviewed by John M and myself. Installation is ok. Photo attached.

Name: Paul Kyle
Date: 2025-06-05
Signature:

6- CLEARANCE APPROVAL

Name: Jan Duinhoven
Date: 2025-06-05
Signature:


UNITRONIC BUS CAN



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000687

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10000523	1.4 Discipline	Electrical
1.2 Item	83012-CEL	LV Switchgear / Fuel Cell Auxiliary Load	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing plastic cable tag on internal/external side of package (Fuel Cell A-80000).

Name: Giovanni Tangianu
Date: 2024-11-21
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-21
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date: 2025-04-10
Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven
Date: 2025-04-10
Signature:

6- CLEARANCE APPROVAL

Name:
Date: 2025-04-10
Signature:

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000688

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10000523	1.4 Discipline	Electrical
1.2 Item	83012-CEL	LV Switchgear / Fuel Cell Auxiliary Load	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Identification tag wire missing inside panel +UC50 (package Fuel Cell A-80000).

Name: Giovanni Tangianu
Date: 2024-11-21
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-21
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date: 2025-04-10
Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven
Date: 2025-04-10
Signature:

6- CLEARANCE APPROVAL

Name:
Date: 2025-04-10
Signature:

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000689

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10000523	1.4 Discipline	Electrical
1.2 Item	83012-CEL	LV Switchgear / Fuel Cell Auxiliary Load	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The cable termination is not complete (side FUEL CELL A-80000).
See attached photo.

Name: Giovanni Tangianu
Date: 2024-11-21
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Giovanni Tangianu
3.4 Activity code	MC Mechanical Completion	Date	2024-11-21
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

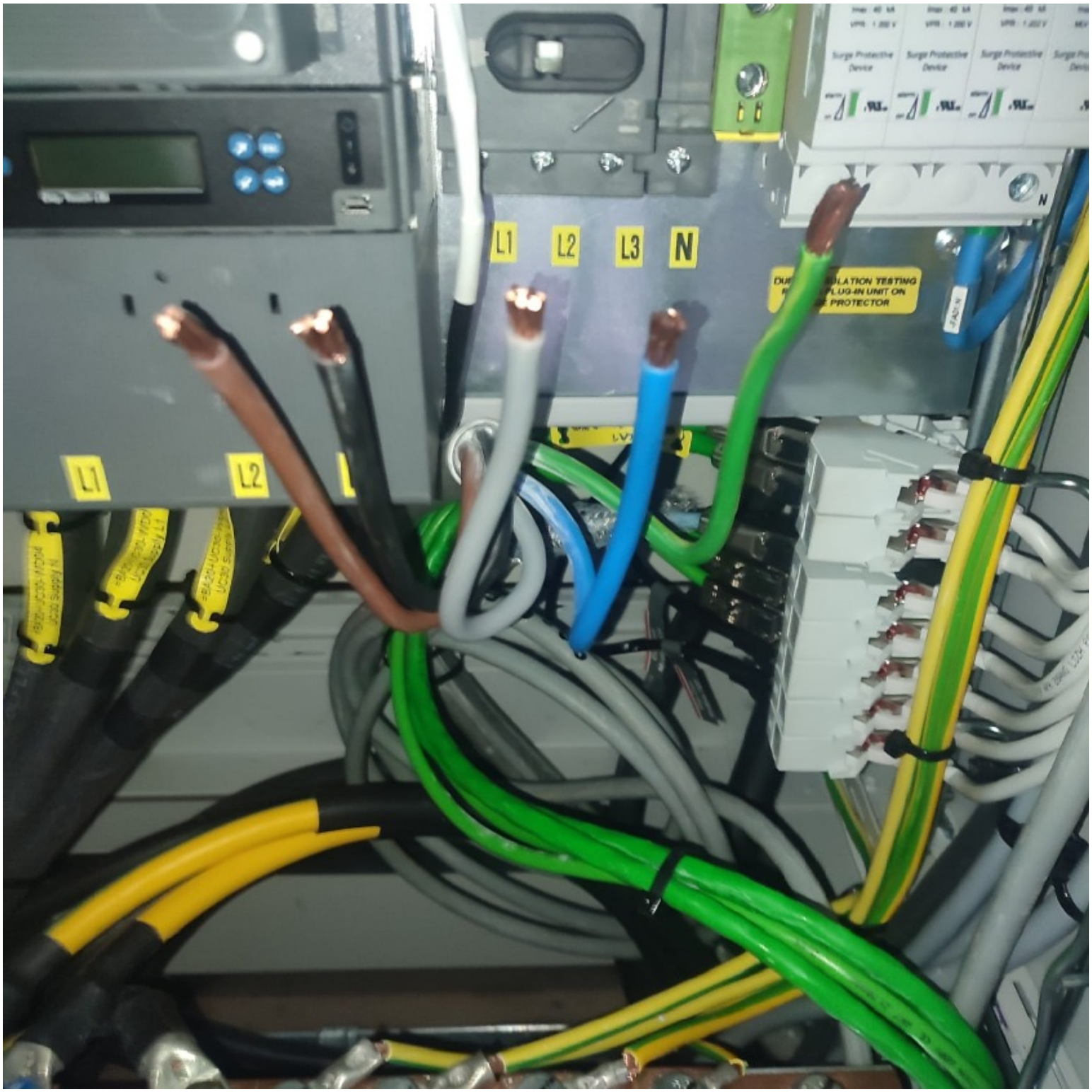
5 - CLEARANCE CHECK

Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


L1
L2
L3
N
Surge Protective Device
Surge Protective Device
Surge Protective Device
PLUG-IN UNIT ON
PROTECTOR

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000970

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004351	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.01	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The copper conductor of the cable armor must be individually connected to the earthing bar. See 123A90-DDL-EL-DD-20090. (B400-NET-001.01)

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	RM_CONSTR RM	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

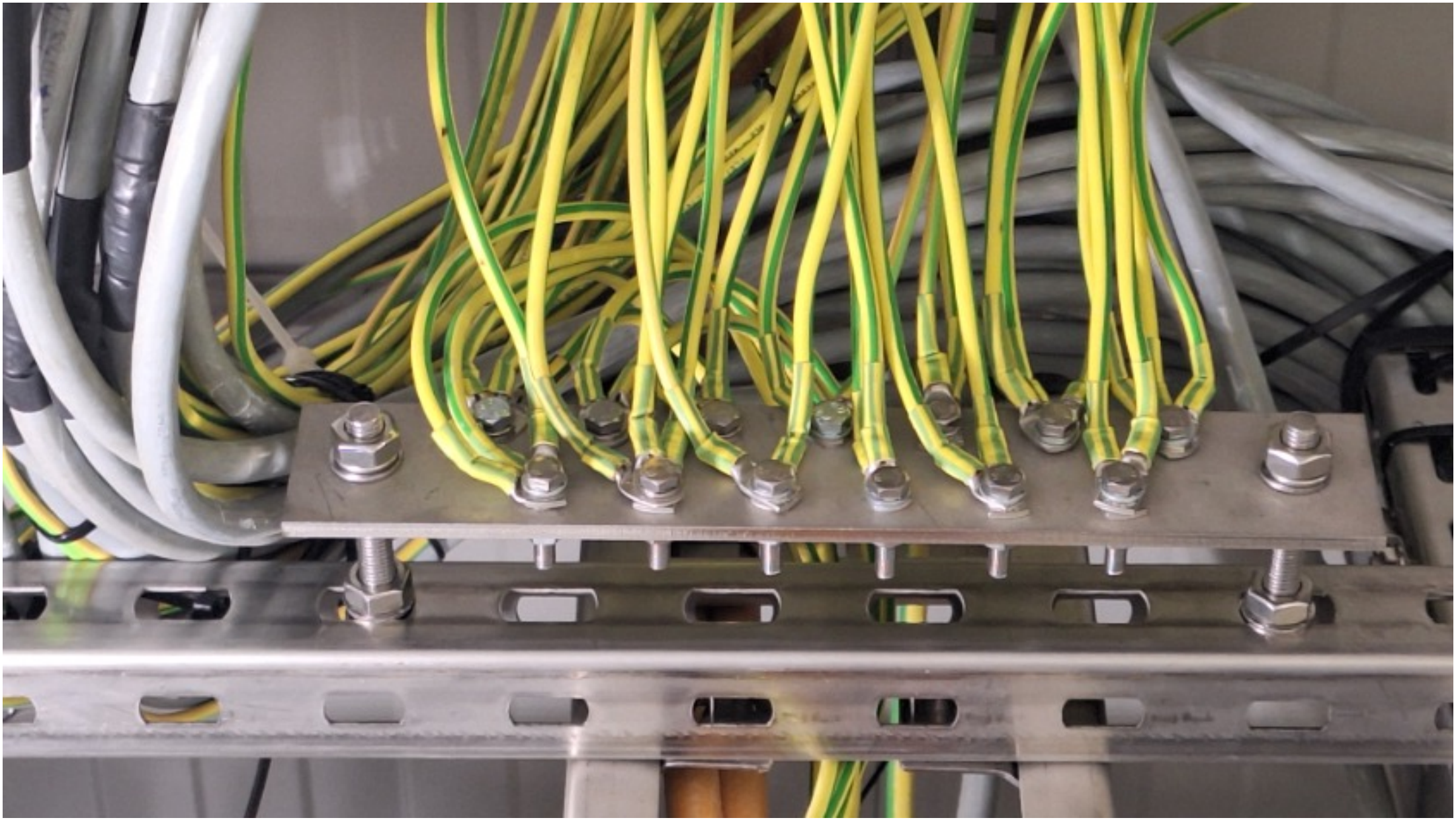
5 - CLEARANCE CHECK

DONE

Name: Alessio Polo
Date: 2025-01-22
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000971

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004351	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.01	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cables tag , cabinet inside Panel A-80000 80-UCP-001.

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

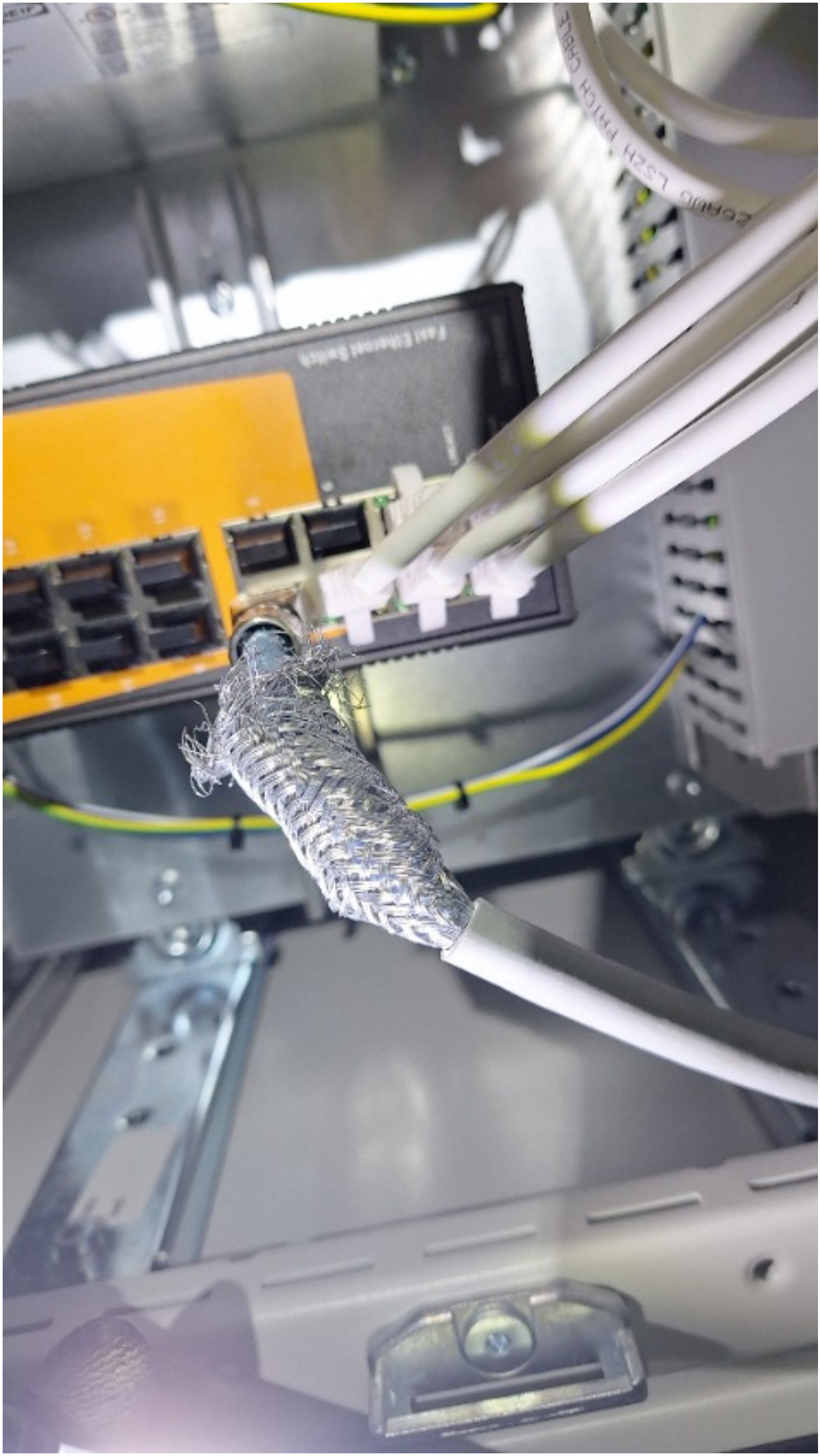
5 - CLEARANCE CHECK

DONE

Name: Josip Krizanic
Date: 2025-03-07
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000972

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004351	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.01	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Missing cable tag SS project, outside MCT.

Name: Alessio Polo

Date: 2024-11-27

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	RM_CONSTR RM	Signature	

4 - PERFORMED ACTION

Name:

Date:

Signature:

5 - CLEARANCE CHECK

DONE

Name: Paolo Schintu

Date: 2025-02-26

Signature:

6- CLEARANCE APPROVAL

Name:

Date:

Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000973

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10004351	1.4 Discipline	Telecom
1.2 Item	80-UCP-001/B400-NET-001.01	COMMUNICATION / NETWORK CABINET	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

The cable termination is not installed in accordance with Electrical Typical Installation Details. see 123A90-DDL-EL-DD-20090 sh.8 / 29. (SIDE 80-UCP-001)

Name: Alessio Polo
Date: 2024-11-27
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	A PL A	Name	Alessio Polo
3.4 Activity code	MC Mechanical Completion	Date	2024-11-27
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

Terminations completed.

Name: Giovanni Tangianu
Date: 2024-12-03
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000604

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Container 459079-4. The item n.19 "Drain interface - TP 015" (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet 6/14) shall measure 57 mm from structure but It does measure 67 mm.

Name: Kangi Albonetti
Date: 2024-11-19
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date: 2025-03-31
Signature:

5 - CLEARANCE CHECK

done.

Name: Lorenzo Novaga
Date: 2025-03-31
Signature:

6- CLEARANCE APPROVAL

Name:
Date: 2025-03-31
Signature:


UNISTRUT
P1026SS
7
8
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10
11
12
13

ROSETTI MARINO CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000605

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

10ft Container. Item n.21 Customer MV Connection (6,6kV AC 3P, 92A) (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet 7/14) has missing screws.

Name: Kangi Albonetti

Date: 2024-11-19

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date:

Signature:

5 - CLEARANCE CHECK

DONE

Name: Josip Krizanic

Date: 2025-03-07

Signature:

6- CLEARANCE APPROVAL

Name:

Date:

Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000606

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

30ft Container. Item n.10 Vents (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet 5/14). Two Vents have rust spots on the entire surface of the top side. One image attached as example.

Name: Kangi Albonetti
Date: 2024-11-19
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date: 2025-04-10
Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven
Date: 2025-04-10
Signature:

6- CLEARANCE APPROVAL

Name:
Date: 2025-04-10
Signature:



ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000607

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

30 ft container. No Ballard's nameplate.
10ft Container. Ballard's nameplate is in soft plastic and just glued to the structure.

Name: Kangi Albonetti
Date: 2024-11-19
Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:
Date:
Signature:

5 - CLEARANCE CHECK

DONE

Name: Josip Krizanic
Date: 2025-03-07
Signature:

6- CLEARANCE APPROVAL

Name:
Date:
Signature:


BALLARD™
Ballard Power Systems Europe A/S
Majsmarken 1, 9530 Hobro – DK
Phone: + 45 88435500
E-mail: service@ballardeurope.com
Product name: Power converter container
Part number: 6014568-7003716
Sub-assembly in: FC PowerGen 1000kW, part number 6014568-7002362
Range of ambient temperature (°C): MAX: 25 °C
MIN: -10 °C
Weight (kg): DRY: 7310 kg
WET: 7350 kg
Rated Power (kW): 1000 kW @ 100% duty
Electrical Output: 3P 6600V 50Hz, 93 A
Short circuit capacity (A): 93 A
Power Factor: 0.95

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000608

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Containers' nameplates on both the 30 ft container and the 10 ft one have rust rising from underneath.

Name: Kangi Albonetti

Date: 2024-11-19

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date: 2025-04-10

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

Signature:

6- CLEARANCE APPROVAL

Name:

Date: 2025-04-10

Signature:


Building year
NSN no
Customer serial no
DC-Supply project no 22– 1337
DC-SUPPLY A/S | Virkelyst 8 | 9400 Noerresundby | Denmar

ROSETTI MARINO
CROSSWIND

PUNCH ITEM ENTRY / CLEARANCE FORM

C30000609

PROVERLIS

1 -ELEMENT IDENTIFICATION

1.1 Task	C10002358	1.4 Discipline	Mechanical
1.2 Item	A-80000	Fuel Cell	
1.3 Subsystem	80-00	Hydrogen Fuel Cell Package (A-80000)	

2 - OBSERVATION

Several painting touch-ups to be performed. See as example on SHS above anchor points A, B and H (images attached).

Name: Kangi Albonetti

Date: 2024-11-19

Signature:

3 - DEFECT ASSESSMENT

.

3.1 Corrective action proposal

3.2 Material required

3.3 Priority	B PL B	Name	Kangi Albonetti
3.4 Activity code	MC Mechanical Completion	Date	2024-11-19
3.5 Action by	VND Vendor	Signature	

4 - PERFORMED ACTION

Name:

Date: 2025-04-10

Signature:

5 - CLEARANCE CHECK

Work has been completed by CPI Vendor and confirmed by package manager.

Name: Jan Duinhoven

Date: 2025-04-10

Signature:

6- CLEARANCE APPROVAL

Name:

Date: 2025-04-10

Signature:






ICOU 1991
LLA

Section 4 FUNCTIONAL TESTS SHEETS

Section 4.1 Electrical functional test sheets index

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00 & process: COMM & discipline : E

Electrical	80-00 Hydrogen Fuel Cell Package (A-80000)						
ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
A4/+03-QF1	FUEL CELL AUX LOAD - A4/+03-QF1	ONSHORE	C10002949	FP00	100	2024-12-07	RFO 4
		ONSHORE	C10002950	FTR-2	100	2024-10-02	RFO 4
		ONSHORE	C10002951	FTR-6	100	2024-10-03	RFO 4
		ONSHORE	C10003024	FTR-5	100	2025-04-29	RFO 4

ITEM	Tag	A4/+03-QF1	: FUEL CELL AUX LOAD - A4/+03-QF1			Dwg	1723002197-EL-DG-00011
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	
TASK	code	C10002949		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	PRE-COMM	Activity FTS	Discipline	Electrical	Form	FP00 Miscellaneous electrical Consumer

DATA

Switchboard	SG-200N1	Circuit ref:	SG-200N1-A4/+03
Breaker rating (A)	63A	Nominal current (A)	32,84A

FUNCTION TEST REQUIREMENT

1	Check pre-commissioning activities have been carried out					OK
2	Check equipment for cleaness					OK
3	Measure I/R value of equipment and feeder cable at 1000V (Min value: 10 Mohm)	100	MΩ			OK
4	Energise control of equipment feeder					OK
5	Full test feeder breaker operation in test position					OK
6	Check protection setting					OK
7	Test interface trips and signals (remote alarms & status). Check the relevant ITR presence in the system					OK
8	Test control and safety functions according to manufacturer's procedure.					OK
9	Energize					OK
10	Measure Voltage and Current values at feeder breaker	397	V	0,2	A	OK
11	Attach test procedure, if any					NA

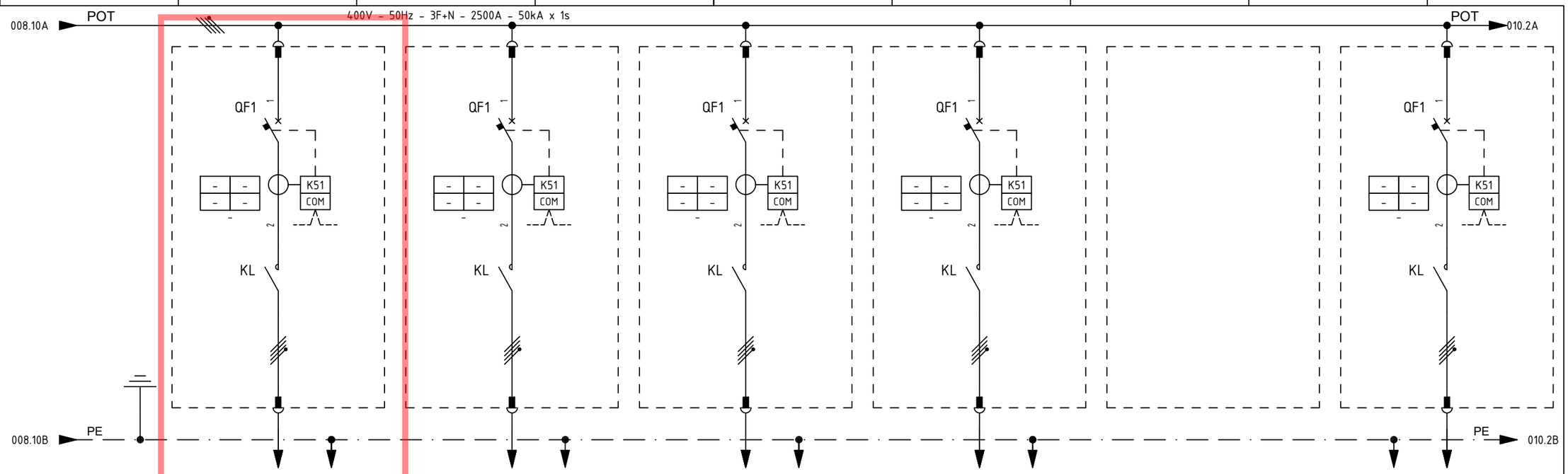
FUNCTION TEST REQUIREMENT	RESULT

Testing & measurement instruments used

Type	Serial n°	Calibration certificate	Validity
FLUKE 1663	5380144	7727/24	10/07/2025
FLUKE 376	A1711003	7710/20	10/07/2025

Comments: POINT 6: See the ftr-2 associated with the drawer for protection study.

	Performed by	☐ WITNESS ☑ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CPY NOT PRESENT
Name	Davide Zucconelli	Kristian Castellani	Witness waived
Date	2024-12-04	2024-12-05	2024-12-07
Signature	PROVERLIS Digitaly signed by Davide Zucconelli 2024-12-04T12:52:24.307Z	PROVERLIS Digitaly signed by Kristian Castellani 2024-12-05T09:29:27.001Z	PROVERLIS Digitaly signed by Witness waived 2024-12-07T10:34:56.552Z



ITEM			1	A-80000	CP-850F03	SPARE	SPARE		K-63001-A
UTILITY			2	FUEL CELL AUXILIARY LOAD	BESS PCS CABINET	SPARE	SPARE		INSTRUMENTS AIR PACKAGE 01A
COLUMN/CUBICLE			3	A4 / +03	A4 / +04	A4 / +05	A4 / +06		A4 / +08
RATED POWER | RATED CURRENT			4/5	20 kW | 32.84 A	11,09 kW | 17.42 A	- kW | - A	20.0 kW | 32.1 A		68.75 kW | 111.24 A
TYPICAL FUNCTIONAL			6	LK1-63	LK1-40	LK1-40	LK1-40		LK2-160
CIRCUIT BREAKER (ABB)	TYPE		7	XT2S - 160	XT2S - 160	XT2S - 160	XT2S - 160		XT4S - 250
	VERSION		8	4P - FIXED	4P - FIXED	4P - FIXED	4P - FIXED		4P - FIXED
	TRIP UNITS		9	EKIP HI TOUCH LSIG (In = 63A)	EKIP HI TOUCH LSIG (In = 40A)	EKIP HI TOUCH LSIG (In = 40A)	EKIP HI TOUCH LSIG (In = 40A)		EKIP HI TOUCH LSIG (In = 160A)
	Icu	KA	10	50 kA	50 kA	50 kA	50 kA		50 kA
OVERLOAD	L	Range A	11	(0.4 - 1) x In	(0.4 - 1) x In	(0.4 - 1) x In	(0.4 - 1) x In		(0.4 - 1) x In
		Range t	12	k/I^2	k/I^2	k/I^2	k/I^2		k/I^2
SEL. SHORT-CIRCUIT	S	Range A	13	(0.6 - 10) x In	(0.6 - 10) x In	(0.6 - 10) x In	(0.6 - 10) x In		(0.6 - 10) x In
		Range t	14	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2	0.05 - 0,4 sec / k/I^2		0.05 - 0.4 sec / k/I^2
INST. SHORT-CIRCUIT	I	Range A	15	(1.5 - 15) x In	(1.5 - 15) x In	(1.5 - 15) x In	(1.5 - 15) x In		(1.5 - 15) x In
		Range t	16	instantaneous	instantaneous	instantaneous	instantaneous		instantaneous
EARTH FAULT PROTECTION	G	Range A	17	(0.1 - 1) x In	(0.1 - 1) x In	(0.1 - 1) x In	(0.1 - 1) x In		(0.1 - 1) x In
		Range t	18	t=k / t=k/I^2	t=k / t=k/I^2	t=k / t=k/I^2	t=k / t=k/I^2		t=k / t=k/I^2
CONTACTOR (ABB)			19	AF52-40-00-13 (100A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC	AF40-40-00-13 (70A-AC1); 100-250VAC/DC		AF190-40-11-13 (275A-AC1); 100-250 VAC/DC
THERMAL OVERLOAD RELAY (ABB)			20	-	-	-	-		-
SURGE ARRESTER (DEHN)			21	-	-	-	-		-
TOROIDAL CURRENT TRANSFORMER (FRER)			22	-	-	-	-		-
FUSE HOLDER (ITALWEBER)			23	-	-	-	-		-
INDIRECT PROTECTION (ABB)			24	-	-	-	-		-
VOLTMETER			25	-	-	-	-		-
CURRENT TRANSFORMER FOR MEASURE (FRER)	TYPE		26	-	-	-	-		-
	PERFORMANCE/CLASS		27	-	-	-	-		-
VOLTAGE TRANSFORMER FOR MEASURE (FRER)	TYPE		28	-	-	-	-		-
	PERFORMANCE/CLASS		29	-	-	-	-		-
LOCK-OUT RELAY (-)			30	-	-	-	-		-
POWER CONDUCTOR		mmq	31	5G16	4 x 10	-	-		5G70

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
=					
+					
3	08/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
2	03/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
1	28/03/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
0	15/02/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

IMESA ELECTRICAL ENGINEERING

DWG n° : 231298/SD/11

Item n° : PF1002983/26

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

SINGLE LINE DIAGRAM

Single Line Drawing

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00011

SHEET 009

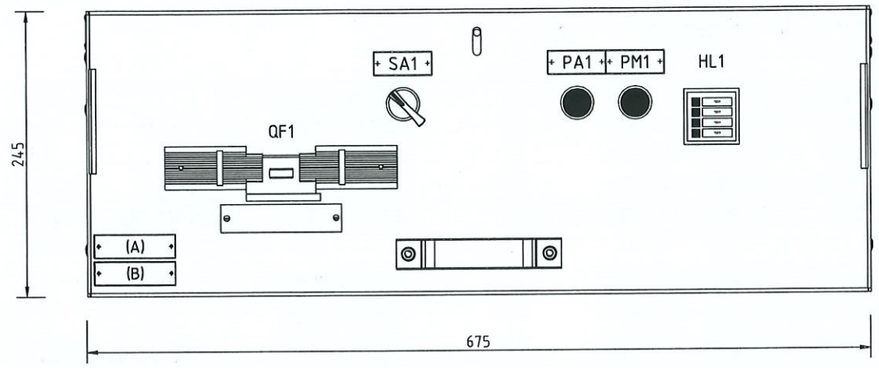
REV. 03

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00011 Rev. 03

DOOR FRONT LAY-OUT

TYPICAL : LINE FEEDER "LK1-n"

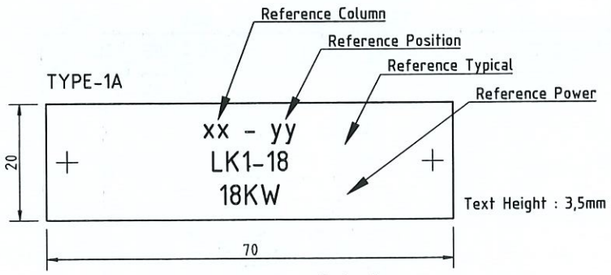


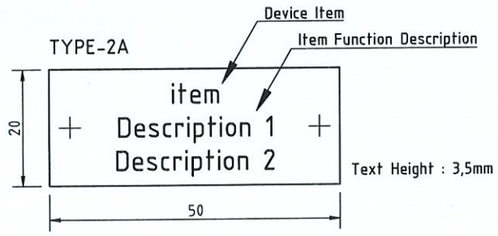
NOTE :

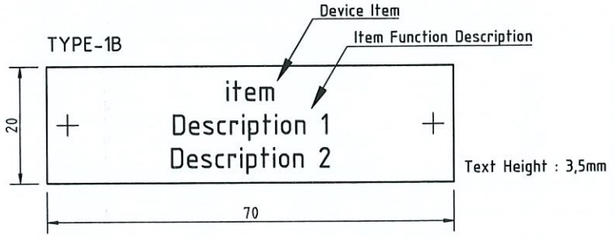
A) IDENTIFICATION name plate (type-1A) , with :
- Drawer position [Column / Position inside SWB]
- Typical name [reference applicability typical used]
- Power [reference applicability typical used]

B) USER name plate (type-1B), with :
- Item User [to see SLD diagrams]
- User Description [to see SLD diagrams]

DEVICES name plate			
ITEM	DESCRIPTION 1	DESCRIPTION 2	NOTE
QF1	Circuit Breaker		NO plate
SA1	LOC-REM	SELECTOR	Type-2A
PA1	STOP	~~MOTOR~~ OK	Type-2A
PM1	RUN	~~MOTOR~~ OK	Type-2A
HL1	Multiled	Signalling	NO plate







=	TYPICAL
+	LK-x
DWG n° :	231298/SD/31
Item n° :	PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Door Front Lay-Out - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 034

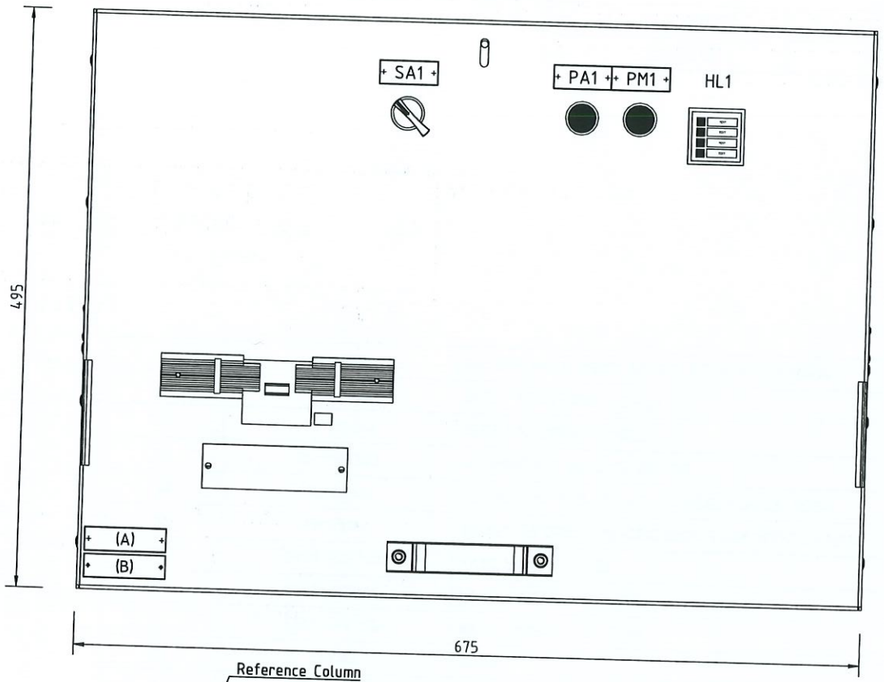
REV. 00

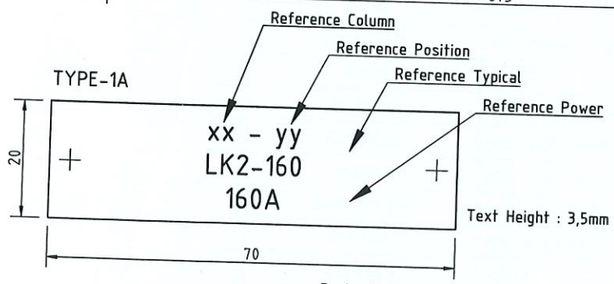
F.to UNI A3: 420mmx297mm

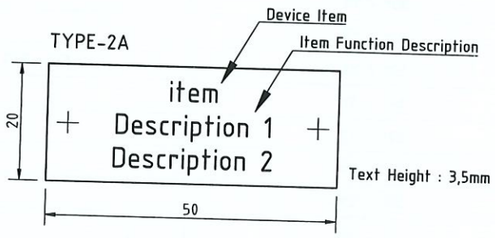
File Name : 1723002197-EL-DG-00031 Rev. 00

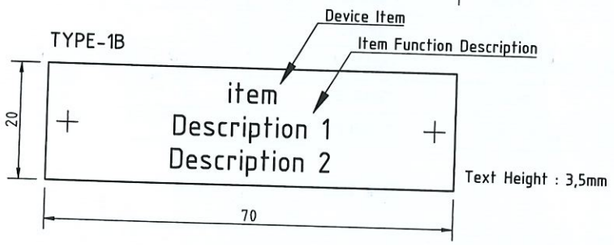
DOOR FRONT LAY-OUT

TYPICAL : LINE FEEDER "LK2-n"









NOTE :

A) IDENTIFICATION name plate (type-1A) , with :
- Drawer position [Column / Position inside SWB]
- Typical name [reference applicability typical used]
- Power [reference applicability typical used]

B) USER name plate (type-1B), with :
- Item User [to see SLD diagrams]
- User Description [to see SLD diagrams]

DEVICES name plate			
ITEM	DESCRIPTION 1	DESCRIPTION 2	NOTE
QF1	Circuit Breaker		NO plate
SA1	LOC-REM	SELECTOR	Type-2A
PA1	STOP	MOTOR ok	Type-2A
PM1	RUN	MOTOR ok	Type-2A
HL1	Multiled	Signalling	NO plate

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Door Front Lay-Out - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 035

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

USERS LEGEND

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"

TYPICAL APPLICABILITY					
ITEM	ITEM TAG	DESCRIPTION TAG	REFERENCE POSITION (written on name name plate "type-1A)	REFERENCE NOMINAL CURRENT C.B. TRIP UNIT (written on name name plate "type-1A)	REFERENCE TYPICAL (written on name name plate "type-1A)
1	DP-200N2	DB-LIGHTING & SMALL POWER INSIDE LV ROOM	A2 / +05	40A	LK1-40
2	JB-200E2	CRANE	A3 / +02	40A	LK1-40
3	DP-200N1	DB-LIGHTING & SMALL POWER BoP	A3 / +03	40A	LK1-40
4	SPARE	SPARE	A3 / +04	63A	LK1-63
5	SPARE	SPARE	A3 / +05	40A	LK1-40
6	A-50000	WATER PACKAGE	A3 / +08	160A	LK2-160
7	B100-HSB-001	HVAC PANELS HV ROOM	A4 / +02	40A	LK1-40
8	A-80000	FUELL CELL AUXIALIRY LOAD	A4 / +03	63A	LK1-63
9	CP-850F03	BESS PCS CABINET	A4 / +04	40A	LK1-40
10	DP-300N1	DB-LIGHTING & SMALL POWER INSIDE UPS ROOM	A4 / +05	40A	LK1-40
11	SPARE	SPARE	A4 / +06	40A	LK1-40
12	DP-630E01A	INSTRUMENTS AIR PACKAGE 01A	A4 / +08	160A	LK2-160
13	SPARE	SPARE	A5 / +01	40A	LK1-40
14	B200-HSB-001	HVAC PANELS - LV ROOM	A5 / +02	40A	LK1-40
15	B300-HSB-001	HVAC PANELS - UPS ROOM	A5 / +03	40A	LK1-40
16	B400-HSB-001	HVAC PANELS - ITER	A5 / +04	40A	LK1-40
17	CN-200N1	IMPRESSED CURR. CATHODIC PROTECTION (ICCP) SYSTEM	A5 / +05	40A	LK1-40
18	DP-400N1	DB-LIGHTING & SMALL POWER INSIEDE INSTR. ROOM	A5 / +06	40A	LK1-40
19	DP-630E01B	INSTRUMENTS AIR PACKAGE 01B	A5 / +08	160A	LK2-160
20	CP-850F01	BESS LV1 CABINAT (+DISTR 1)	A6 / +02	40A	LK1-40
21	CP-850F02	BESS LV2 CABINAT (+DISTR 2)	A6 / +03	40A	LK1-40
22	DP-100N1	DB-LIGHTING & SMALL POWER INSIDE HV/MV ROOM	A6 / +04	40A	LK1-40

= TYPICAL
+ LK-x

OWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Users Legend - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 036 | REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

ITEMS ACRONYM

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"

Composition of Typical :

LK-x = Common Parts
LK1-"nn" or LK2-"nn"= Specific Parts

Example for Composition of LK1-63:
- to take "LK-x" plus "LK1-63"

Example for Composition of LK2-160:
- to take "LK-x" plus "LK2-160"

	ACRONYM ITEMS (Comun parts)	ACRONYM ITEMS (Specific parts)				
	LK-x	LK1-40 (In=40A) (Current Trip Unit)	LK1-63 (In=63A) (Current Trip Unit)	LK2-160 (In=160A) (Current Trip Unit)		
ASSOCIATED TYPICAL	This Item include all devices that are comun for both "Specific Parts" Items	This Items include only devices that are detail for "Specific Parts" Items				
LK1-40	X	X				
LK1-63	X		X			
LK2-160	X			X		
-						

=	TYPICAL					
+	LK-x					
DWG n° : 231298/SD/31						
Item n° : PF1002983/26						
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)	
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION	

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

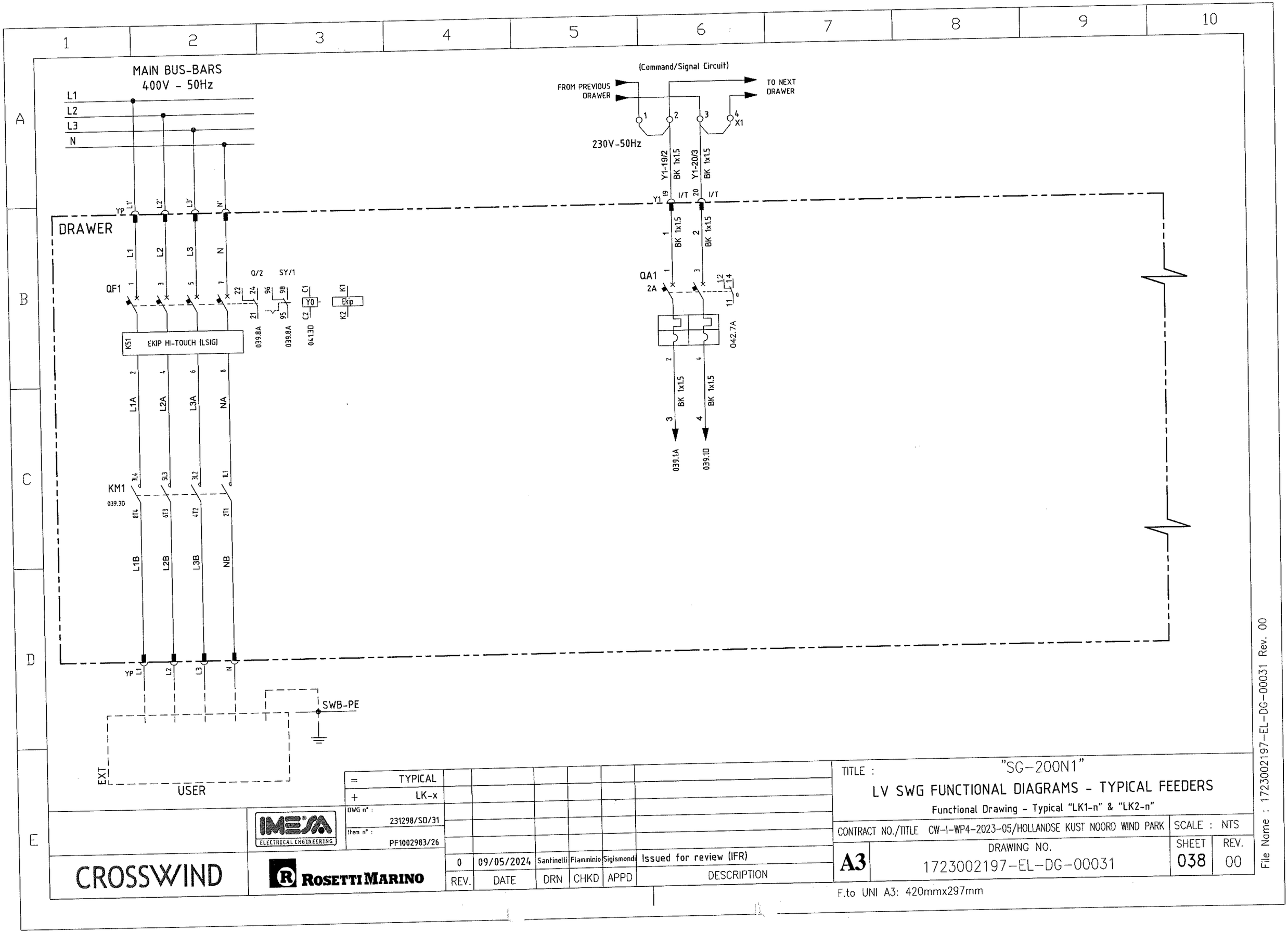
TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Items Acronym - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 037 | REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00



=	TYPICAL						
+	LK-x						
DWG n° : 231298/SD/31							
Item n° : PF1002983/26							
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)		
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION		

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 038

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

APERTO IN INS.

038.6C 3 230V-50Hz

KA3 039.8D

KA6 042.9D

SA1 LOC REM CLOSE ON "LOC" 042.9A 039.7B 039.5B

SA1 039.3B CLOSE ON "REM"

PM1 GR

KM1 039.3D

PA1 RD

KA7 042.6D

KA6 042.5D

KA3 039.8D

SA1 039.3B CLOSE ON "REM"

KM1 039.3D

KA5 039.9D

QF1 038.1B Q

QF1 038.1B SY

Y1 22 T Y1 21 I/T

3 040.1B

7 BK 1x1.5

8 BK 1x1.5

9 BK 1x1.5

10 BK 1x1.5

11 BK 1x1.5

12 BK 1x1.5

5 BK 1x1.5

6 BK 1x1.5

13 BK 1x1.5

14 BK 1x1.5

15 BK 1x1.5

16 BK 1x1.5

17 BK 1x1.5

18 BK 1x1.5

19 BK 1x1.5

KM1 A1 A2 MAIN CONTACTOR

KA1 A1 A2 STATUS C.B/CONTACTOR

KA2 A1 A2 USER AVAILABLE

KA3 A1 A2 C.B. OPEN/CLOSED

KA4 A1 A2 C.B. TRIPPED

KA5 A1 A2 DRAWER ON TEST

038.6C 4

4 040.1D

038.1C 2T1 1L1
038.1C 4T2 3L2
038.1C 6T3 5L3
038.1C 8T4 7L4
039.6B 14 13
039.4B 24 23
039.5B 34 33
040.3B 44 43

042.4A 11 12 14 22 21 24 32 31 34 42 41 44

042.6A 11 12 14 22 21 24 32 31 34 42 41 44

039.6A 039.2A 040.3B 11 12 14 22 21 24 32 31 34 42 41 44

040.4B 042.6A 11 12 14 22 21 24 32 31 34 42 41 44

042.5A 039.7B 11 12 14 22 21 24 32 31 34 42 41 44

= TYPICAL
+ LK-x

DWG n° : 231298/SD/31
Item n° : PF1002983/26

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

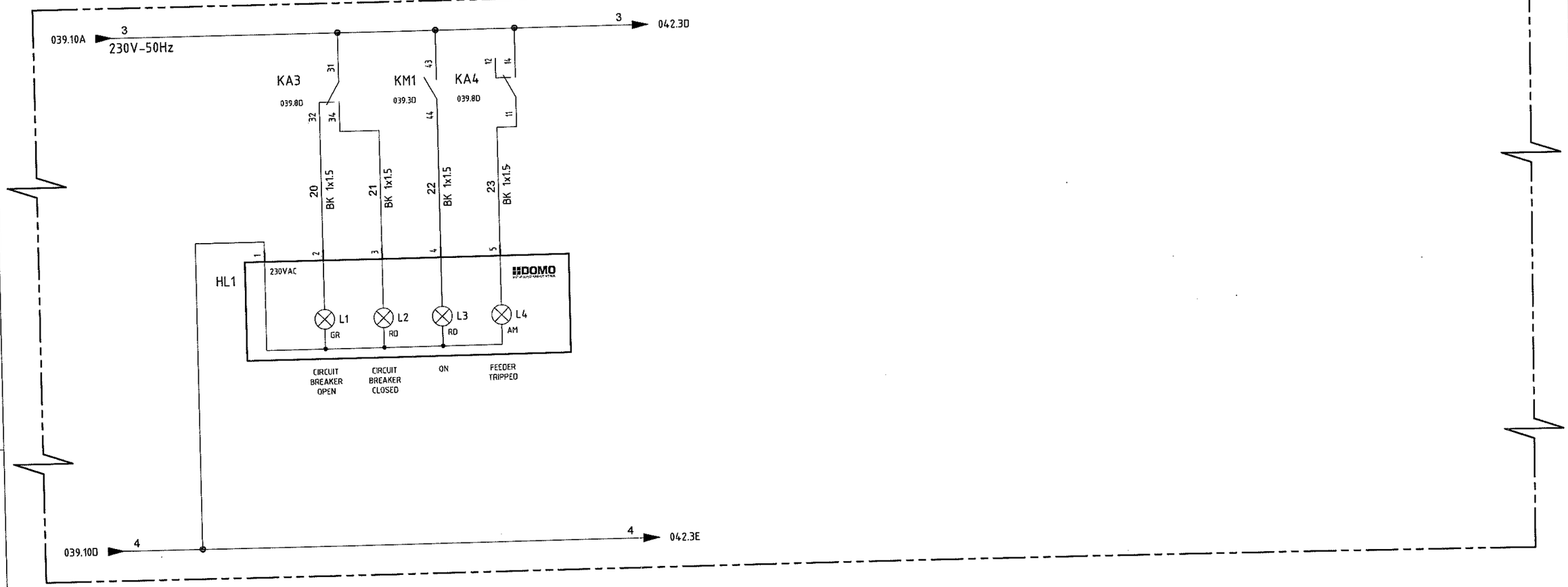
DRAWING NO. 1723002197-EL-DG-00031

SHEET 039

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00



=	TYPICAL						
+	LK-x						
DWG n° :	231298/SD/31						
Item n° :	PF1002983/26						
		0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
		REV.	DATE	DRN	CHKD	APPD	DESCRIPTION

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

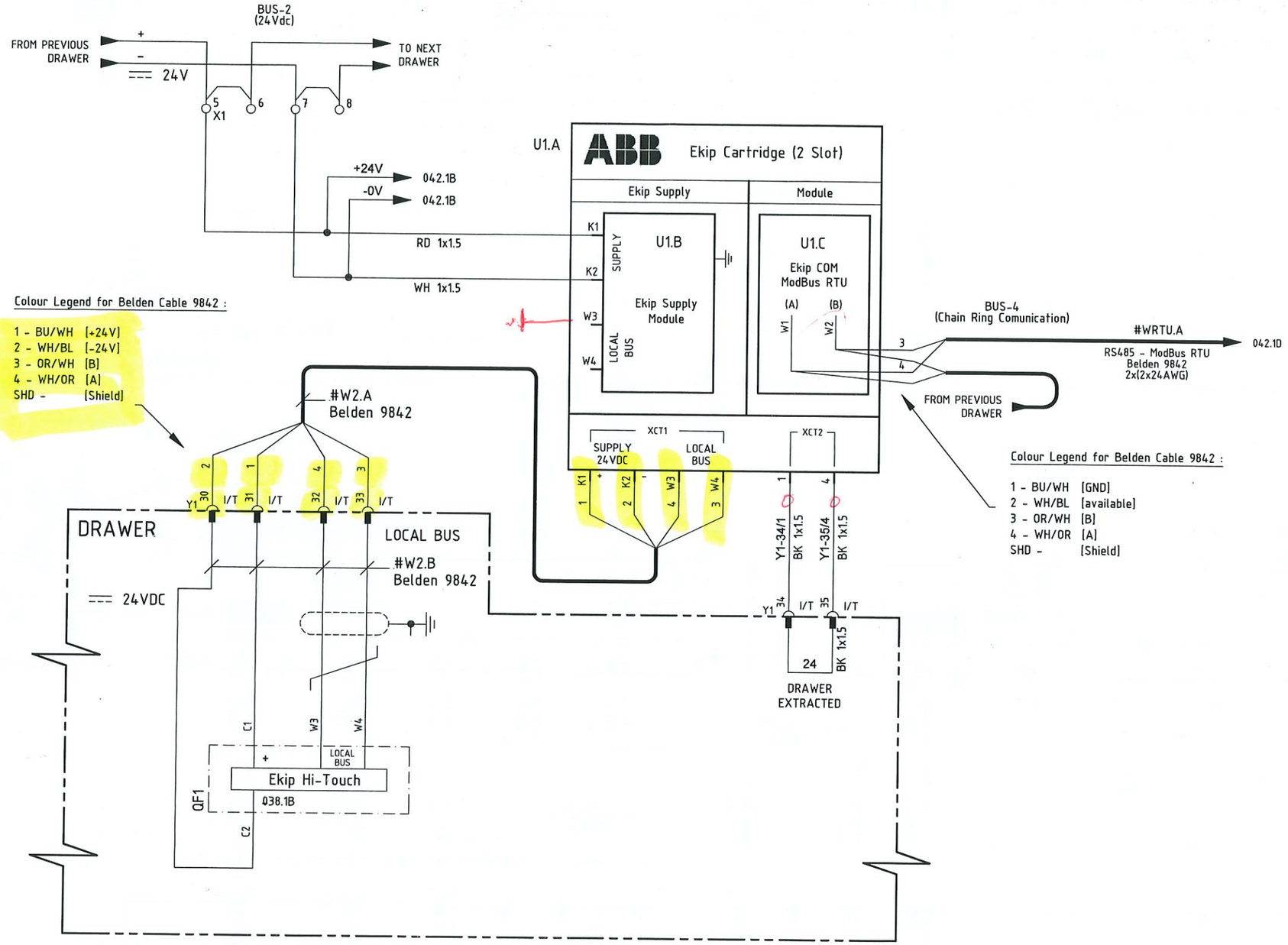
DRAWING NO. 1723002197-EL-DG-00031

SHEET 040

REV. 00

F.to UNI A3: 420mmx297mm

3 Name : 1723002197-EL-DG-00031 Rev. 00



=	TYPICAL						
+	LK-x						
DWG n° : 231298/SD/31							
Item n° : PF1002983/26							
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)		
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION		

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

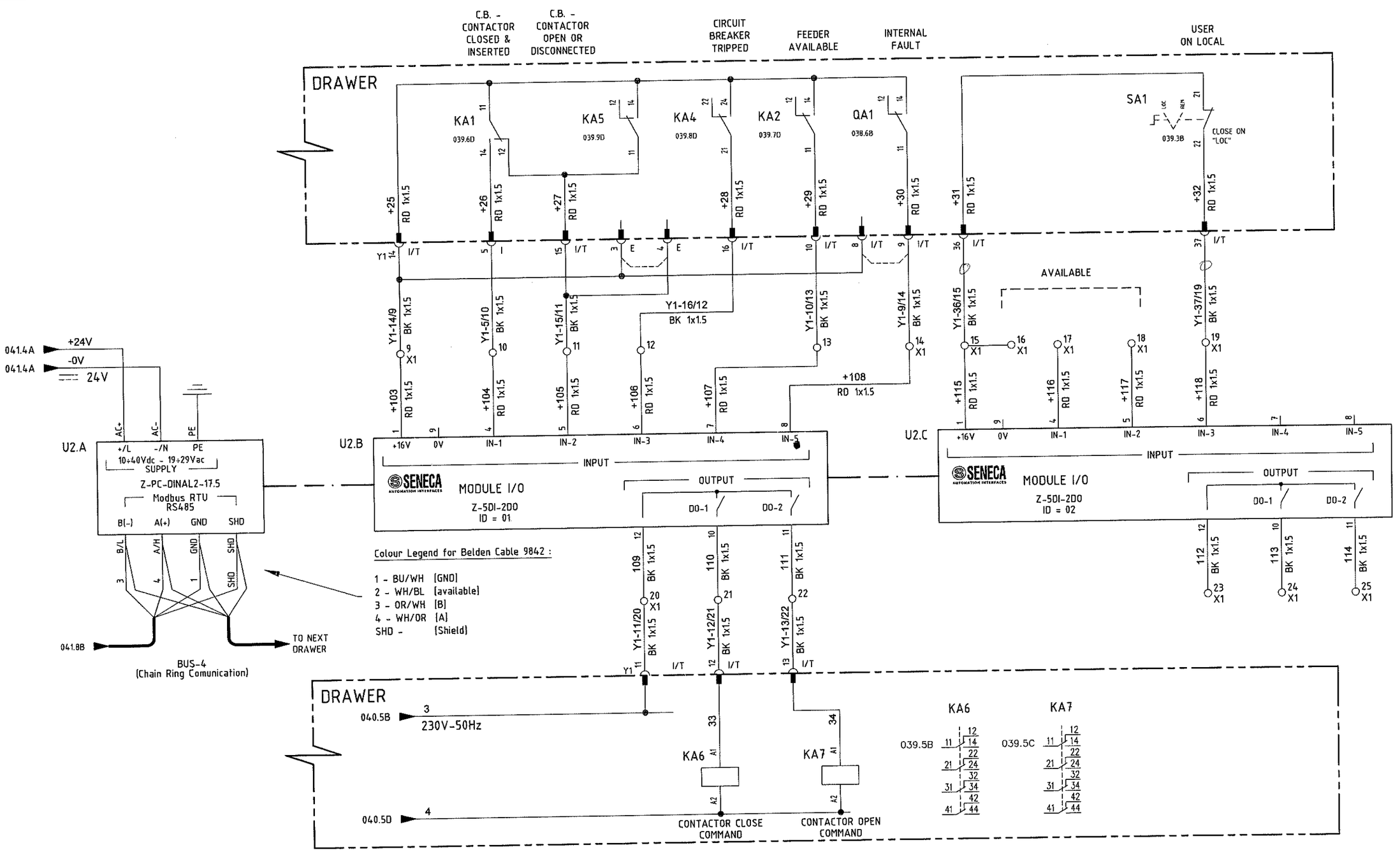
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 041 | REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00



=	TYPICAL						
+	LK-x						
OWG n° : 231298/SD/31							
item n° : PF1002983/26							
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)		
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION		

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 042

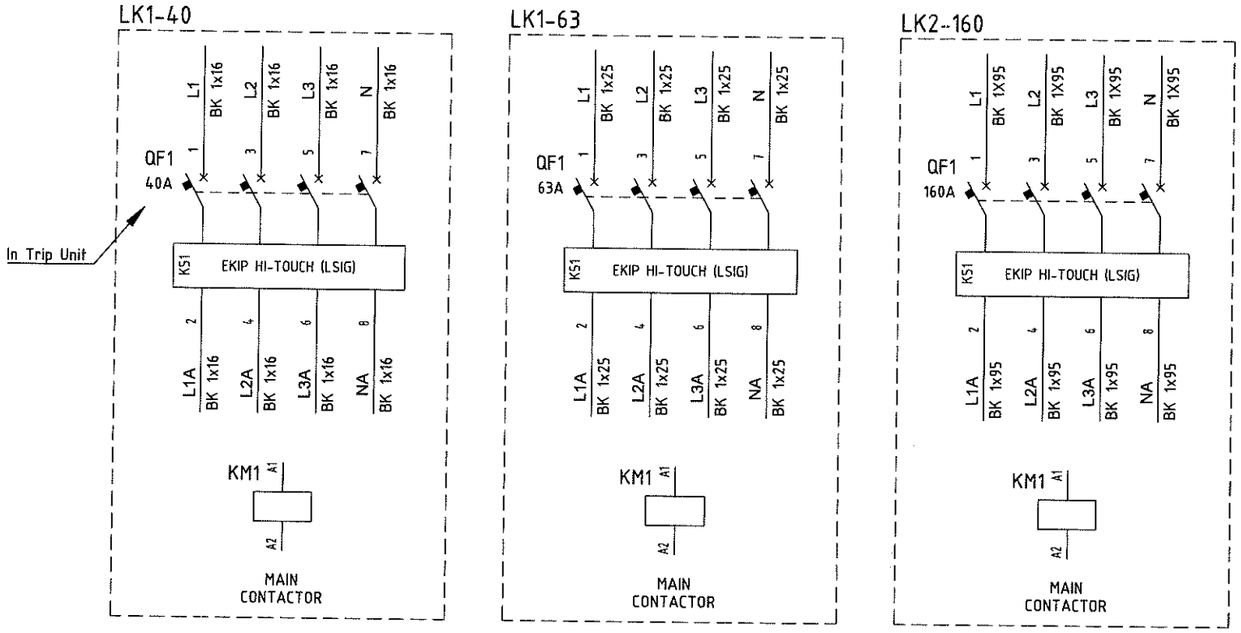
REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

SPECIFIC PARTS

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"



=	TYPICAL						
+	LK-x						
DWG n° :	231298/SD/31						
Item n° :	PF1002983/26						
		0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
		REV.	DATE	DRN	CHKD	APPD	DESCRIPTION

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 043

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

AUXILIARY SOCKET

136450/001 (PF – 2 pcs) + 136458/004 (PM – 2 pcs)

N° PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
JUMP			•	•				•	•																																			
RACKED–OUT			X	X				X	X																																			
TEST								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RACKED–IN					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIN USED			042.5B	042.5B	042.4B			042.6B	042.7B	042.6B	042.5D	042.5D	042.6D	042.3B	042.4B	042.6B			038.6A	038.6A	039.9A	039.9A								041.3C	041.3C	041.4C	041.4C	041.6C	041.7C	042.7B	042.9B							

TYPICAL - LK-x - Y1

SX DX

- FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN RACKED-OUT POSITION
- FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN TEST POSITION
- FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN RACKED-IN POSITION
- CROS-REFERENCE USED PIN

x 19 CASSETTI

=	TYPICAL						
+	LK-x						
DWG n° :	231298/SD/31						
Item n° :	PF1002983/26						
		0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)
		REV.	DATE	DRN	CHKD	APPD	DESCRIPTION

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG–200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 044 | REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

TYPICAL - LK-x

X1

NumM	Fg.	Sez.	Tipo	Descrizione	Costruttore
			BT003	BT/3 End bracket	Cabur
1	038.5A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
2	038.6A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
3	038.6A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
4	038.6A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
5	041.3A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
6	041.3A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
7	041.4A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
8	041.4A	2.5	HD100GR__	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
			HD101GR	HMD/PT/GR End section - Grey	Cabur
9	042.3B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
10	042.4B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
11	042.4B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
12	042.5B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
13	042.6B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
14	042.7B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
15	042.7B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
16	042.7B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
17	042.8B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
18	042.8B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
19	042.9B	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
20	042.5C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
21	042.5C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
22	042.6C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
23	042.9C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
24	042.9C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
25	042.10C	2.5	HD400GR__	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
			HD201GR	HMD.1/PT/GR End section - Grey	Cabur
			BT003	BT/3 End bracket	Cabur

=	TYPICAL
+	LK-x

IMESA ELECTRICAL ENGINEERING

DWG n° : 231298/SD/31

Item n° : PF1002983/26

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 045

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
HL1	040	ML22/484L230STLTTR	1	MULTILED 48x48 - 4 LED - Vaux=230Vac/dc + LAMP TEST + TROP	DOMO	TYPICAL LK-x
KA1	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA2	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA3	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA4	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA5	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA6	042	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA7	042	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
PA1	039	KW 075 2	1	MP1-10R PUSH BUTTON RED WITH BLACK RING	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 571 3	2	MCB-01 CONTACT NC FOR PUSHBUTTOM	ABB	TYPICAL LK-x
PM1	039	KW 076 0	1	MP1-10G PUSH BUTTON GREEN WITH BLACK RING	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 570 5	2	MCB-10 CONTACT NO FOR PUSHBUTTONS	ABB	TYPICAL LK-x
QA1	038	S550239	1	S202M C 2 AUTOMATIC CIRCUIT BREAKER 10KA 2P	ABB	TYPICAL LK-x
		A563819	1	S2-CS/H6R AUXILIARY STATE CONTACT 1CO	ABB	TYPICAL LK-x
SA1	039	KW 329 3	1	M2SS2-10B HANDLE SELECTOR 2P 90° BLACK RING BLACK	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 570 5	2	MCB-10 CONTACT NO FOR PUSHBUTTONS	ABB	TYPICAL LK-x
		EO 571 3	2	MCB-01 CONTACT NC FOR PUSHBUTTOM	ABB	TYPICAL LK-x
U1.2	041	1SDA074173R1	1	MODUL EKIP SUPPLY 24÷48VDC	ABB	TYPICAL LK-x
U1.3	041	1SDA105166R1	1	Module Ekip Com Modbus RS485 Tmax XT	ABB	TYPICAL LK-x
U1.A	041	1SDA105203R1	1	EKIP CARTRIDGE 2SLOT FOR XT2-XT4-XT5	ABB	TYPICAL LK-x
U2.A	042	Z-PC-DINAL2-17.5	1	DIN RAIL 2SLOT WITH HEAD FOR "Z-5DI-2DO"	SENECA	TYPICAL LK-x
U2.B	042	Z-5DI-2DO	1	I/O MODUL 5DI+2DO modbus RS485 Vaux=10÷40Vdc 19÷28Vac	SENECA	TYPICAL LK-x
U2.C	042	Z-5DI-2DO	1	I/O MODUL 5DI+2DO modbus RS485 Vaux=10÷40Vdc 19÷28Vac	SENECA	TYPICAL LK-x
X1		HD100GR_	8	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur	TYPICAL LK-x
		HD400GR_	17	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur	TYPICAL LK-x
		BT003	2	BT/3 End bracket	Cabur	TYPICAL LK-x
		HD101GR	1	HMD/PT/GR End section - Grey	Cabur	TYPICAL LK-x

=	TYPICAL
+	LK-x

DWG n° : 231298/SD/31

Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 046

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
X1		HD201GR	1	HMD.1/PT/GR End section - Grey	Cabur	TYPICAL LK-x

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF40400013	1	AF40-40-00-13 CONTACTOR 4P 40A 100-250VAC/DC	ABB	TYPICAL LK1-40
		CA440E	1	CA4-40E AUXILIARY FRONT CONTACT 4NO	ABB	TYPICAL LK1-40
QF1	043	1SDA068169R1	1	XT2S 160 BREAKING PART 4p F F	ABB	TYPICAL LK1-40
		1SDA100162R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=40A XT2 4p	ABB	TYPICAL LK1-40
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK1-40

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF52400013	1	AF52-30-00-13 CONTACTOR 4P 53A(AC3) 100-250VAC/DC	ABB	TYPICAL LK1-63
		CA440E	1	CA4-40E AUXILIARY FRONT CONTACT 4NO	ABB	TYPICAL LK1-63
QF1	043	1SDA068169R1	1	XT2S 160 BREAKING PART 4p F F	ABB	TYPICAL LK1-63
		1SDA100163R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=63A XT2 4p	ABB	TYPICAL LK1-63
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK1-63

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF190401113	1	AF190-40-11-13 CONT 4P 190A AC3 100-250VAC/DC	ABB	TYPICAL LK2-160
		CAL1911	1	CAL19-11 CONTATTO AUSILIARIO 1NA+1NC PER AF116÷AF370	ABB	TYPICAL LK2-160
		CAL1911B	2	CAL19-11B AUXILIARY CONTACT 1NA+1NC PER AF116÷AF370	ABB	TYPICAL LK2-160
QF1	043	1SDA068179R1	1	XT4S 250 BREAKING PART 4p F F	ABB	TYPICAL LK2-160
		1SDA100334R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=160A XT4 4p	ABB	TYPICAL LK2-160
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK2-160

=	TYPICAL
+	LK-x

DWG n° : 231298/SD/31

Item n° : PF1002983/26

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

DRAWING NO. 1723002197-EL-DG-00031

SHEET 047

REV. 00

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 00

ITEM	Tag	A4/+03-QF1	: FUEL CELL AUX LOAD - A4/+03-QF1	Dwg	1723002197-EL-DG-00011		
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)	Module			
TASK	code	C10002950	Location	Onshore Activities	User	Rosetti Marino Quality Control	
FORM	Process	PRE-COMM	Activity FTS	Discipline	Electrical	Form FTR-2	Protection Relay

FTR2 - Protection relay
Record sheet

RELAY DATA

Manufacturer:	ABB	Serial N°:	EF8000153700N000	Relay type:	EKIP HI TOUCH LSIG
Auxiliary supply:	24Vdc	Location:	B200	Cubicle:	A4/+03
Switchboard:	SG-200N1				

Current transformers

Tag	Number of	Ratio	Location

Voltage transformers

Tag	Number of	Ratio	Location

Test result (refer to manufacturer's procedure)

ANSI function	Setting	Injection	Trip value	Time delay Setting	Time delay Trip value
L	37.8A	189A		3s	1106ms
S	189A	315A		0.1s	103ms
I	378A	630A		INSTANT	29ms
G	12.6A			0.1s	

Testing & measurement instruments used

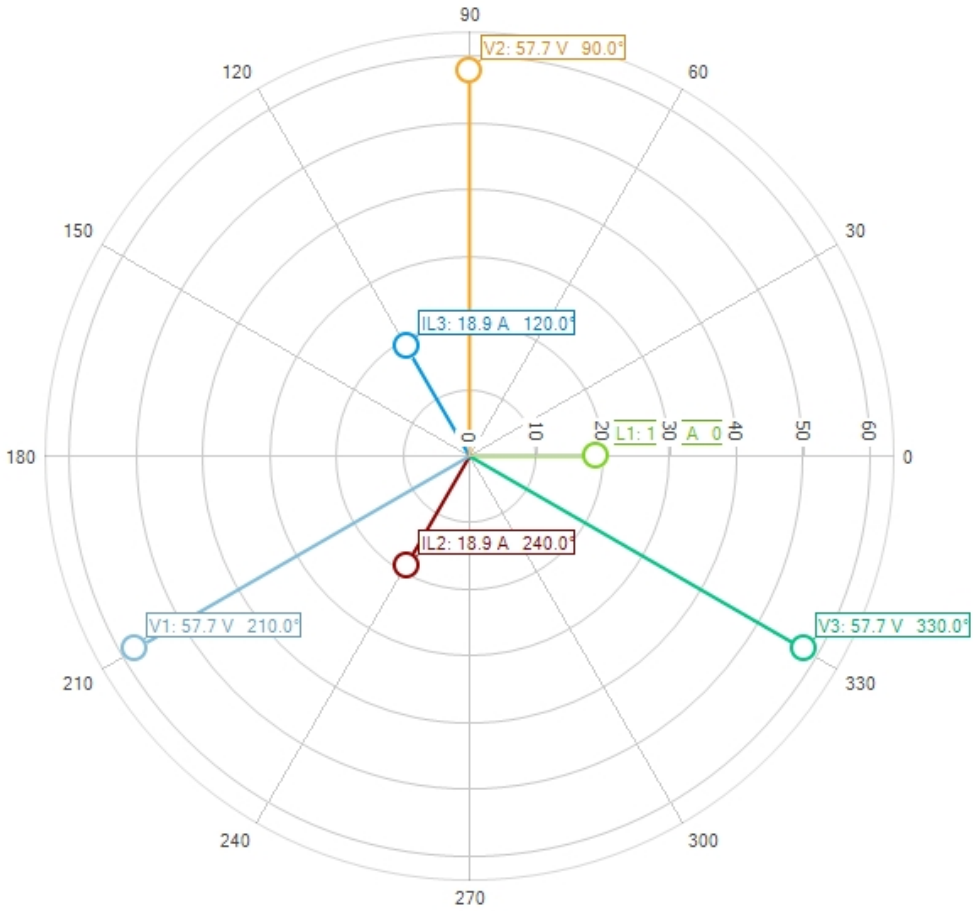
Type	Serial n°	Calibration certificate	Validity
ABB EKIP T&P	E34013804410W050		

Comments: See attchments for full tests

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CPY NOT PRESENT
Name	Mattia Girotti	Kristian Castellani	Witness waived
Date	2024-10-01	2024-10-01	2024-10-02
Signature	PROVERLIS Digitaly signed by Mattia Girotti 2024-10-01T11:34:44.647Z	PROVERLIS Digitaly signed by Kristian Castellani 2024-10-01T14:45:45.603Z	PROVERLIS Digitaly signed by Witness waived 2024-10-02T06:36:35.459Z

Page Name	Group Name	Variable Name	Variable Value	Variable Unit
Settings A				
	Overload Protection (L - ANSI 49)			
		PU nominal current In	63	
		Status	Enabled	
		Function	t=k/i^2	
		Prealarm I1	90	% I1
		Threshold I1	0.600	In
		Time t1 std	3.00	s
		Thermal memory (TM)	Disabled	
		TM Algorithm	RMS-independent	
		TM Time	Automatic	
		TM custom time	830	s
	Time-delayed overcurrent protection (S - ANSI 50 TD/68/51)			
		Status	Enabled	
		Trip enable	Enabled	
		BlockOnStartUp	--------	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Function	t=k	
		Threshold I2 (t=k)	3.00	In
		Time t2 (t=k) IEC - UL489	0.10	s
		Startup enable	Disabled	
		Startup time	0.10	s
		Startup threshold	0.60	In
		Set Startup th. on ProgStatusD	--------	
		Thermal memory status	Disabled	
		Zone Selectivity status	Disabled	
		Zone Selectivity time	0.04	s
		Zone Selectivity Type	Logic and Hardware	
	Second time-delayed overcurrent protection (S2 - ANSI 50 TD)			
		Status	Disabled	
		Trip enable	Enabled	
		BlockOnStartUp	--------	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Threshold I5 (t=k)	2.00	In
		Time t5 (t=k)	0.05	s
		Startup enable	Disabled	
		Startup time	0.10	s
		Startup threshold	2.00	In
		Set Startup th. on ProgStatusD	--------	
		Zone Selectivity status	Disabled	
		Zone Selectivity time	0.04	s
		Zone Selectivity Type	Logic and Hardware	
	Instantaneous overcurrent protection (I - ANSI 50)			
		Status	Enabled	
		Threshold I3	6.00	In
		Startup enable	Disabled	
		Startup time	0.10	s
		Startup threshold	1.50	In
		Set Startup th. on ProgStatusD	--------	
		BlockOnStartUp	--------	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Zone Selectivity status	Disabled	
		Zone Selectivity Type	Logic and Hardware	
	Second I			
		Prot Second I	---	
		Status	Disabled	
		Threshold I31	1.50	In
		Zone Selectivity status	Disabled	
		Zone Selectivity Type	Logic and Hardware	
		Second I Mode	Function Dependent	
		Function	Disabled	
		Delay On	0.00	s
		Delay Off	15.00	s
	Earth fault protection (G - ANSI 50N TD/68/51N)			
		Status	Enabled	
		Trip enable	Enabled	
		BlockOnStartUp	--------	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Function	t=k	
		Prealarm I4	90	% I4
		Threshold I4 (t=k)	0.200	In
		Time t4 (t=k) IEC - UL489	0.10	s

		Startup enable	Disabled	
		Startup time	0.10	s
		Startup threshold	0.20	In
		Set Startup th. on ProgStatusD	--------	
		Zone selectivity status	Disabled	
		Zone selectivity time	0.04	s
		Zone Selectivity Type	Logic and Hardware	
	Directional overcurrent protection (D - ANSI 67/68)			
		Status	Disabled	
		Trip enable	Disabled	
		tripOnlyForward	--------	
		tripOnlyBackward	--------	
		BlockOnStartUp	--------	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Threshold I7 FWD	2.00	In
		Time t7 FWD	0.20	s
		Threshold I7 BWD	2.00	In
		Time t7 BWD	0.20	s
		Startup enable	Disabled	
		Startup time	0.10	s
		Startup threshold FWD	2.00	In
		Startup threshold BWD	2.00	In
		Set Startup th. on ProgStatusD	--------	
		Zone Selectivity status	Disabled	
		Zone Selectivity time FWD	0.13	s
		Zone Selectivity time BWD	0.13	s
		Zone Selectivity Type	Logic and Hardware	
		Direction minimum angle	3.6	°
	Closing on short-circuit protection (MCR)			
		Status	Disabled	
		BlockOnOutOfFrequency	--------	
		BlockOnProgStatusA	--------	
		BlockOnProgStatusB	--------	
		BlockOnProgStatusC	--------	
		BlockOnProgStatusD	--------	
		Threshold I3	6.00	In
		Time t3	0.04	s
		Zone Selectivity status	Disabled	
		Zone Selectivity Type	Logic and Hardware	
	Over Temperature (T)			
		Trip enable	Disabled	



Test

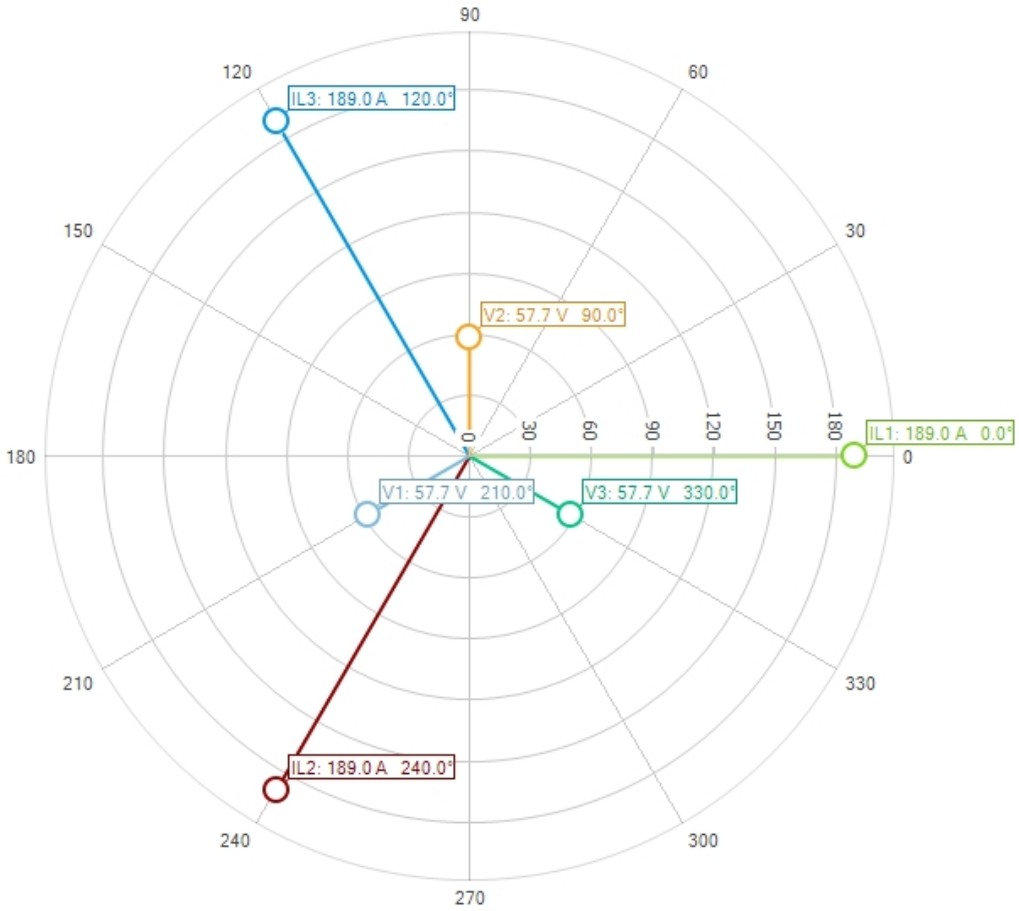
Name	Automatic test 1
Session	Default session
Customer	
Location	
Operator	

Device

Tag name	A4/+03
Relay Serial Number	EF8000153700N000
Circuit Breaker Serial Number	CE61066013number
	XT2/4
Device settings	In = 63 A Un = 100 V fn = 50 Hz
Protection Settings	Protection = L Curve type = t=k/i^2 Threshold = 0.600 In Time = 3.00 s Protection = S Curve type = t=k Threshold = 3.00 In Time = 0.10 s Protection = I Threshold = 6.00 In Protection = G Curve type = t=k Threshold = 0.200 In Time = 0.10 s
Preconditions	All preconditions satisfied.

Test result

⚠ Test completed without any trip in 3000 ms.



Test

Name	Automatic test 2
Session	Default session
Customer	
Location	
Operator	

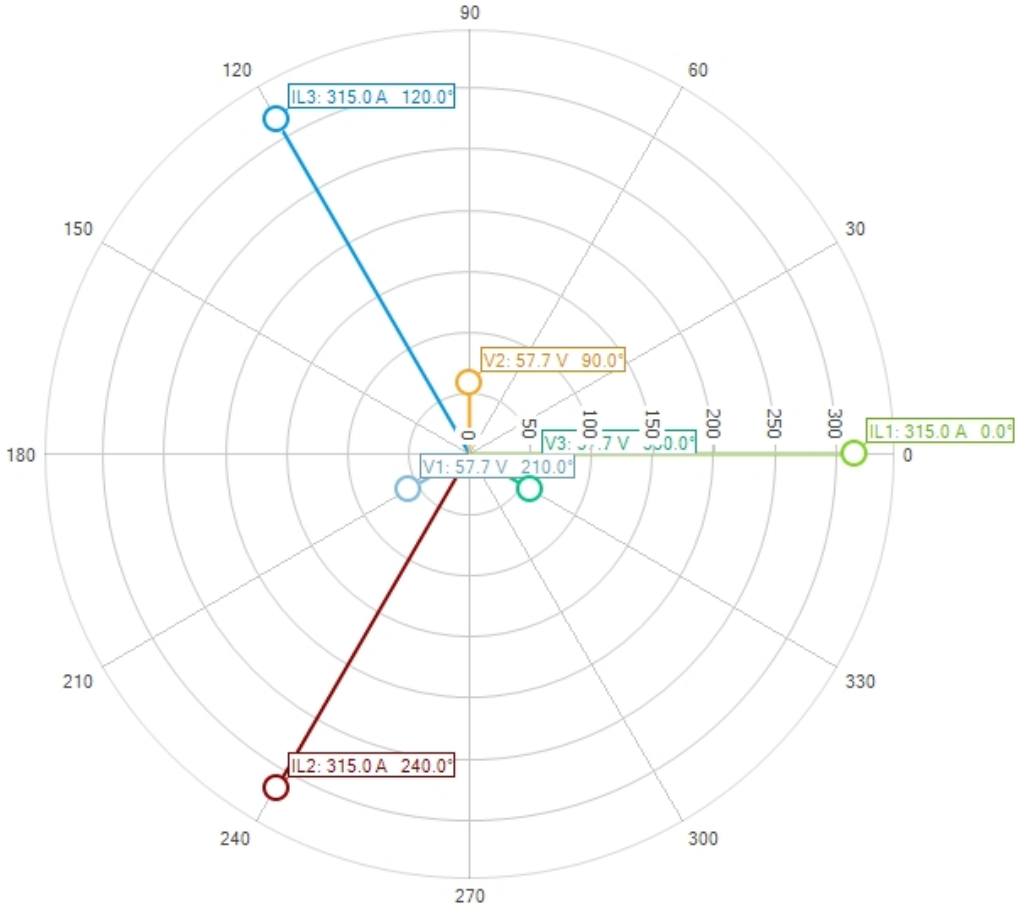
Device

Tag name	A4/+03
Relay Serial Number	EF8000153700N000
Circuit Breaker Serial Number	CE61066013number
	XT2/4
Device settings	In = 63 A Un = 100 V fn = 50 Hz
Protection Settings	Protection = L Curve type = t=k/i^2 Threshold = 0.600 In Time = 3.00 s Protection = S Curve type = t=k Threshold = 3.00 In Time = 0.10 s Protection = I Threshold = 6.00 In Protection = G Curve type = t=k Threshold = 0.200 In Time = 0.10 s
Preconditions	All preconditions satisfied.

Test result

⚠ Test completed with trip but out of time. Protection L tripped in 1106 ms.
Trip time must be between 0 ms and 1000 ms

Trip time must be between 0 ms and 1000 ms.



Test

Name	Automatic test 3
Session	Default session
Customer	
Location	
Operator	

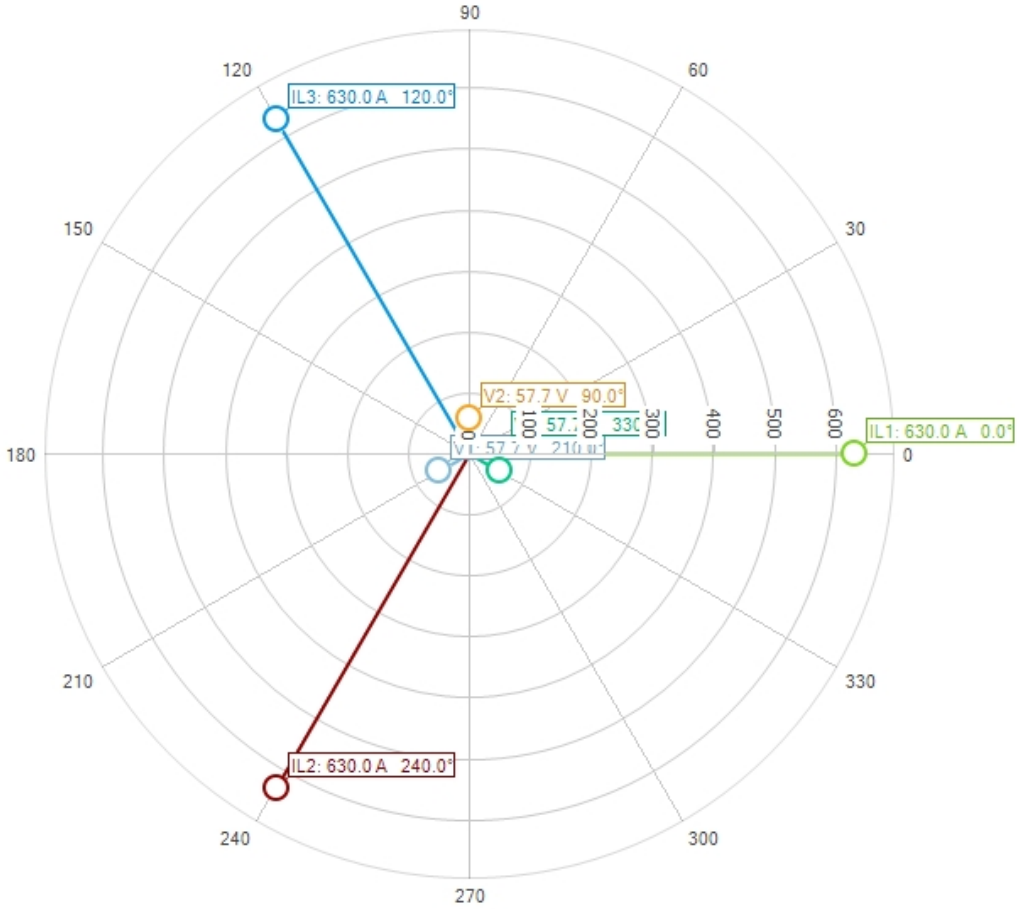
Device

Tag name	A4/+03
Relay Serial Number	EF8000153700N000
Circuit Breaker Serial Number	CE61066013number
	XT2/4
Device settings	In = 63 A Un = 100 V fn = 50 Hz
Protection Settings	Protection = L Curve type = t=k/i^2 Threshold = 0.600 In Time = 3.00 s Protection = S Curve type = t=k Threshold = 3.00 In Time = 0.10 s Protection = I Threshold = 6.00 In Protection = G Curve type = t=k Threshold = 0.200 In Time = 0.10 s
Preconditions	All preconditions satisfied.

Test result

Test completed with trip. Protection S tripped in 103 ms.
Trip time must be between 0 ms and 1000 ms

Trip time must be between 0 ms and 1000 ms.



Test

Name	Automatic test 4
Session	Default session
Customer	
Location	
Operator	

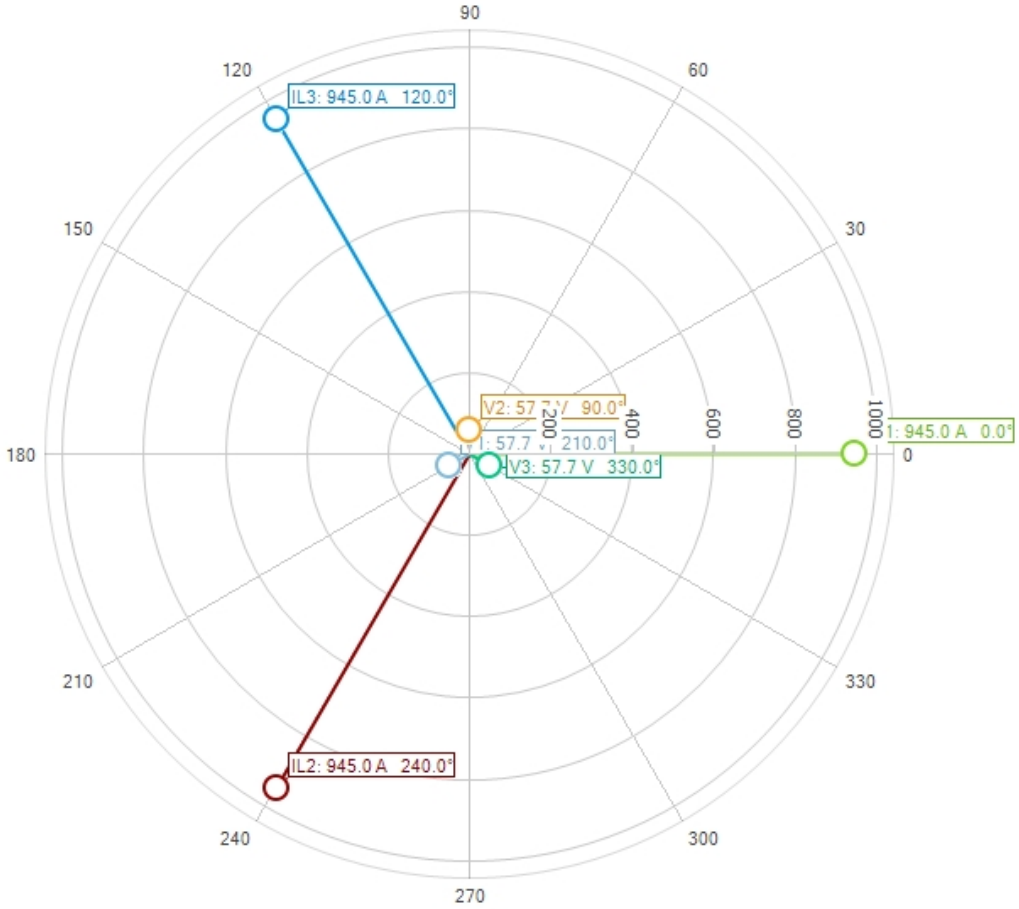
Device

Tag name	A4/+03
Relay Serial Number	EF8000153700N000
Circuit Breaker Serial Number	CE61066013number
	XT2/4
Device settings	In = 63 A Un = 100 V fn = 50 Hz
Protection Settings	Protection = L Curve type = t=k/i^2 Threshold = 0.600 In Time = 3.00 s Protection = S Curve type = t=k Threshold = 3.00 In Time = 0.10 s Protection = I Threshold = 6.00 In Protection = G Curve type = t=k Threshold = 0.200 In Time = 0.10 s
Preconditions	All preconditions satisfied.

Test result

Test completed with trip. Protection I tripped in 29 ms.
Trip time must be between 0 ms and 1000 ms

Trip time must be between 0 ms and 1000 ms.



Test

Name	Automatic test 5
Session	Default session
Customer	
Location	
Operator	

Device

Tag name	A4/+03
Relay Serial Number	EF8000153700N000
Circuit Breaker Serial Number	CE61066013number
	XT2/4
Device settings	In = 63 A Un = 100 V fn = 50 Hz
Protection Settings	Protection = L Curve type = t=k/i^2 Threshold = 0.600 In Time = 3.00 s Protection = S Curve type = t=k Threshold = 3.00 In Time = 0.10 s Protection = I Threshold = 6.00 In Protection = G Curve type = t=k Threshold = 0.200 In Time = 0.10 s
Preconditions	All preconditions satisfied.

Test result

Test completed with trip. Protection I tripped in 29 ms.
Trip time must be between 0 ms and 1000 ms

Trip time must be between 0 ms and 1000 ms.

ITEM	Tag	A4/+03-QF1	: FUEL CELL AUX LOAD - A4/+03-QF1	Dwg	1723002197-EL-DG-00011		
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)	Module			
TASK	code	C10002951	Location	Onshore Activities	User	Rosetti Marino Quality Control	
FORM	Process	PRE-COMM	Activity FTS	Discipline	Electrical	Form FTR-6	Electrical IO

FTR 6 - Electrical I/O check record sheet

Equipment Tag:	A-80000 FUEL CELL AUXILIARY LOAD	Instrument Type / Serial N° :	FLUKE 175 / 17140769
Cubicle N°:	A4/+03	Calibration certificate date:	7715/24 - 10/07/2025

Link Type:	●	Hardwired	Communication	(strike through unapplicable type)
I/O Type:	●	Digital	Analogic	(strike through unapplicable type)

DIGITAL

Item	Signal description	Link Type (Hardwired/ Communication)	I/O Type (Digital/Analogic)	Point of Origin (From)	Point of Receival (to)	Text Labelling Display Satisfactory (Y/N)	Blinking/Static Display Satisfactory (Y/N)	Color Coding Satisfactory (Y/N)	Status Check			Time Stamping Satisfactory (Y/N)	Refresh Time (if >1s)	Appearing in all applicable display (Y/N)
									Event (Y/N)	Alarm (Y/N)	Fault (Y/N)			
1	C.B. - CLOSED & INSERTED	HW	DI	A4/+03 - KA1/11-14	A4/+03 - X1/9-10	NA	NA	NA	Y	NA	NA	NA	NA	NA
2	C.B. - OPEN OR DISCONNECTED	HW	DI	A4/+03 - KA1/11-12	A4/+03 - X1/9-11	NA	NA	NA	Y	NA	NA	NA	NA	NA
3	C.B. - TRIPPED	HW	DI	A4/+03 - KA4/21-24	A4/+03 - X1/9-12	NA	NA	NA	NA	NA	Y	NA	NA	NA
4	INTERNAL FAULT	HW	DI	A4/+03 - QA1/11-14	A4/+03 - X1/9-14	NA	NA	NA	NA	NA	Y	NA	NA	NA
5	FEEDER AVAILABLE	HW	DI	A4/+03 - KA2/11-14	A4/+03 - X1/9-13	NA	NA	NA	Y	NA	NA	NA	NA	NA
6	USER ON LOCAL	HW	DI	A4/+03 - SA1/21-22	A4/+03 - X1/15-19	NA	NA	NA	Y	NA	NA	NA	NA	NA
7	DRAWER ON TEST	HW	DI	A4/+03 - KA5/11-14	A4/+03 - X1/9-11	NA	NA	NA	Y	NA	NA	NA	NA	NA
8														

ANALOGIC

Item	Signal description	Link Type (Hardwired/ Communication)	I/O Type (Digital/Analogic)	Point of Origin (From)	Point of Receival (to)	Min value sent	Min value received	Max value sent	Max value received	Intermediate value sent	Intermediate value received	Out of scale test (OK, Not OK)	Refresh time (if >2s)	Appearing in all applicable display (Y/N)
1														
2														
3														

Comments: The test of the cubicle was carried out on a test bench.

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CPY NOT PRESENT
Name	Mattia Girotti	Kristian Castellani	Witness waived
Date	2024-10-03	2024-10-03	2024-10-03
Signature	PROVERLIS Digitaly signed by Mattia Girotti 2024-10-03T10:27:36.973Z	PROVERLIS Digitaly signed by Kristian Castellani 2024-10-03T13:55:29.640Z	PROVERLIS Digitaly signed by Witness waived 2024-10-03T14:30:28.764Z

ITEM	Tag	A4/+03-QF1	: FUEL CELL AUX LOAD - A4/+03-QF1			Dwg	1723002197-EL-DG-00011
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	
TASK	code	C10003024		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	COMM	Activity FTS	Discipline	Electrical	Form	FTR-5 Remote Signalling

FTR5 - Remote signalling
Record sheet

DATA

Switchboard:	SG-200N1	Cubicle N°:	A4/+03

FUNCTION TEST

	Order/Inputs				Status/Output											
	Start order		Stop order		Run		Fault		Stop Signalisation		Available/Ready to start		TRIP		CB OPEN/CLOSED	
UCP																
ECS																
SSS																
PSS																
PCS	●	●	●	●	●	●	●	●			●	●	●	●	●	●
Control Station																
Control Panel																
HVAC Panel																
MCC	●	●	●	●	●	●							●	●	●	●

Column 1 (To check) to be filled during commissioning preparation stage - black if the check is asked
Column 2 (Checked) to be filled black if check is Ok

Comments: During the test, we tested all the Analog Input with success: Current "L1",Current "L2",Current "L3", Voltage "L1-L2", Voltage "L2-L3", Voltage "L1-L3", Frequency, Apparent Power, Real Power, Reactive Power and Power Factor.

	Performed by	☐ WITNESS ☒ REVIEW	☒ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CW
Name	Davide Zucconelli	Kristian Castellani	David Musgrove
Date	2025-04-29	2025-04-29	2025-04-29
Signature	Digitaly signed by Davide Zucconelli 2025-04-29T07:58:04.754Z	Digitaly signed by Kristian Castellani 2025-04-29T14:09:54.490Z	Digitaly signed by David Musgrove 2025-04-29T15:44:46.819Z

Section 4.2 Electrical
“As-Commissioned” interconnection diagrams

FROM	TO

DESCRIPTION: LV Switchgear
TAG NUMBER: SG-200N1

COLUMN/CUBIC.: A2/~~+08~~ +02

L1	BK	83010-CEL-L1	1C X 95 mm²
L2	BK	83010-CEL-L2	1C X 95 mm²
L3	BK	83010-CEL-L3	1C X 95 mm²
N	BK	83010-CEL-N	1C X 95 mm²
PE	Y/G	83010-CEL-E	1C X 95 mm²

P.E. BUS BAR

NO MARK UP
19/3/25 MARCO MORETTO

DESCRIPTION: TEMPORARY GENERATOR / MOBILE BATTERY PACK
TAG NUMBER: JB-200E2

BK	L1	INCOMING FROM LV SWITCHGEAR SG-200N1
BK	L2	
BK	L3	
BK	N	
Y/G	PE	

P.E. BUS BAR

COLUMN/CUBIC.: A1/+08

L1	BK	83013-CEL-L1	1C X 300 mm²
L2	BK	83013-CEL-L2	1C X 300 mm²
L3	BK	83013-CEL-L3	1C X 300 mm²
N	BK	83013-CEL-N	1C X 300 mm²
PE	Y/G	83013-CEL-E	1C X 150 mm²

P.E. BUS BAR

NO MARK UP MARCO MORETTO
21/3/25

DESCRIPTION: ELECTROLYSER AUXILIARY LOAD
TAG NUMBER: A-20000

BK	L1	
BK	L2	
BK	L3	
BK	N	
Y/G	PE	

P.E. BUS BAR

DESCRIPTION: FUEL CELL AUXILIARY LOAD
TAG NUMBER: A-80000

COLUMN/CUBIC.: A4/+03

L1	BN	
L2	BK	
L3	GY	
N	BU	
	Y/G	
	PE	

P.E. BUS BAR

83012-CEL
5G16 mm²

NO MARK UP
MARCO MORETTO
21/3/25

-XB01

BN	1	L1
BK	2	L2
GY	3	L3
BU	4	N
Y/G	5	PE

Y/G
PE
P.E. BUS BAR

AS COMMISSIONED : MARCO MORETTO
22/3/25

VALID FOR CONSTRUCTION
FDL DWG: 123A90-FDL-EL-DG-20149

REV.:	DATE:	SIGNATURE:
2_F	09/01/25	G.Randi

ROSETTI MARINO SpA

CROSSWIND

ROSETTI MARINO

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
02	19/11/24	SAI	FMA/AMA	FPA/DLO	ACCEPTED FOR CONSTRUCTION (AFC)
01	16/10/24	SAI	FMA/AMA	FPA/DLO	ACCEPTED FOR CONSTRUCTION (AFC)
00	08/07/24	SAI	FMA/AMA	FPA/DLO	ISSUE FOR REVIEW (IFR)

TITLE : BASE LOAD POWER HUB (BLPH)
ELECTRICAL INTERCONNECTING WIRING DIAGRAM
LV SWITCHGEAR SG-200N1

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : 1:X

A3 | DRAWING NO. 123A90-DDL-EL-DG-20149 | SHEET 021 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 123A90-DDL-EL-DG-20149 Rev. 02

Section 4.3 Instrumentation functional test sheets index

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00 & discipline : I

Instrumental	80-00 Hydrogen Fuel Cell Package (A-80000)

ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
80-XA-001	A-80000 Fuel cell PKG confirmed gas alarm	ONSHORE	C10004481	FJ01D	100	2025-03-26	RFO 4
80-XA-002	A-80000 Fuel cell PKG confirmed fire alarm	ONSHORE	C10004482	FJ01D	100	2025-03-26	RFO 4
80-XA-003	A-80000 Fuel cell PKG UCP fault	ONSHORE	C10004483	FJ01D	100	2025-03-26	RFO 4
80-XS-001	SHUT-DOWN A-80000 Fuel cell PKG	ONSHORE	C10003806	FJ01D	100	2025-06-09	RFO 4
A-80000	Fuel Cell	ONSHORE	C10004886	FJ05	100	2025-03-24	RFO 4

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	80-XS-001	: SHUT-DOWN A-80000 Fuel cell PKG			Dwg	123A90-DDL-IN-LIS-40089
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	
TASK	code	C10003806		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	COMM	Activity FTS	Discipline	Instrumental	Form	FJ01D Digital Loop

LOOP DATA

Loop TAG	80-XS-001				TSLD	123A90-FDL-IN-DG-40014 REV. 1_A			
IO Type	Input	No	Output	Yes	Energy by transmitter	No	Energy by system	Yes	
Marshalling	B400-SIS-001	Terminal	07A/07B		Slot	07	Rack	02	Chanel 07

LOOP TEST

1	Check earth isolation of the loop.					OK
2	Connect loop to terminal					OK
3	Energise Loop (close loop) and record status	Normal	Yes	Alarm/trip	No	OK
4	De-Energise Loop (open loop) and record status	Normal	No	Alarm/trip	Yes	OK
5	Record Fail Safe position	Open	NA	Closed	NA	

LOOP SERVICE

		Action	Alarm / Control			Display	
		Trip	GA	DCS	SOE	DCS	
6	Loop energized	No		Yes		OK	OK
7	Loop not energized	Yes		Yes		OK	OK
8	Checking of line monitoring	No		No		OK	OK
9	Checking of Maintenance Inhibition	NA	NA	NA	NA	NA	NA
10	Associated safety Level / bar						
11	Associated outputs						

LOOP DOCUMENTATION

12	Loop diagram is marked up and attached to this test sheet	OK
13	Cause and effect chart is highlighted accordingly	
14	Any defect is recorded for punch list issuance	

TESTING & MEASUREMENT INSTRUMENT USED

Type	Serial N.	Calibration Certificate	Validity
MULTIMETER FLUKE	AW1/018 17140769	7715/24	10/07/2025

Comments:

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	ROSETTI COMM		
Name	Alejandro Sasia	Giandonato Delmissier	Martin Taylor
Date	2025-03-25	2025-06-05	2025-06-09

PROVERLIS Digitaly signed by Alejandro Sasia 2025-03-25T06:27:34.714Z

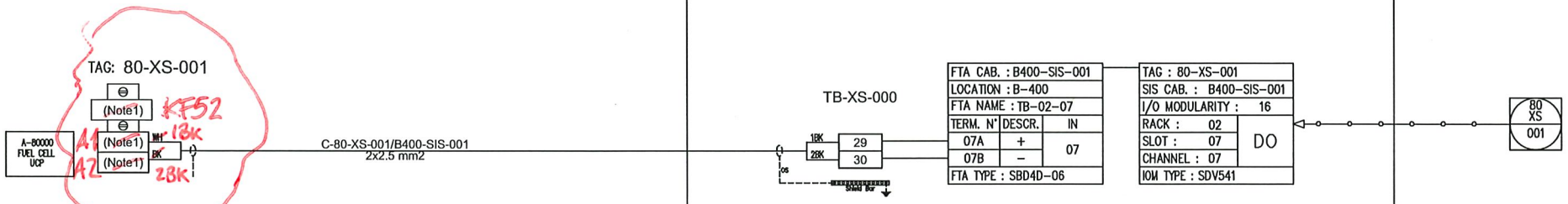
PROVERLIS Digitaly signed by Giandonato Delmissier 2025-06-05T13:46:31.056Z

PROVERLIS Digitaly signed by Martin Taylor 2025-06-09T11:14:09.452Z

Signature			

DRAWING NO. 123A90-DDL-IN-DG-40014 REV. 01

FIELD	ITER – B400	CENTRAL CONTROL ROOM
	SAFETY INSTRUMENTED SYSTEM	OPERATOR CONSOLE



Horizontal
24/03/25

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	06/12/2024	VBA	LCA	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
00	23/10/2024	VBA	LCA	DLO	ISSUE FOR REVIEW (IFR)

VALID FOR CONSTRUCTION
FDL DWG: 123A90-FDL-IN-DG-40014
REV: 1_A | DATE: 20/12/24 | SIGNATURE: C.Pilato
ROSETTI MARINO SpA

CROSSWIND

ROSETTI MARINO

TITLE : INSTRUMENT LOOP DIAGRAM
80-XS-001
SHUT-DOWN A-80000 FUEL CELL PKG

CONTRACT NO./TITLE CONTRACT_NO.			SCALE 1:1
DRAWN: VBA	CHECKED: LCA	APPROVED: DLO	DATE 23/10/2024
A3	DRAWING NO. 123A90-DDL-IN-DG-40014	SHEET 152	REV. 01

File Name : 123A90-DDL-IN-DG-40014_REV.01

ROSETTI MARINO | CROSSWIND

ITEM	Tag	80-XA-001	: A-80000 Fuel cell PKG confirmed gas alarm			Dwg	123A90-DDL-IN-LIS-40089
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	
TASK	code	C10004481	Location	Onshore Activities		User	Rosetti Marino Quality Control
FORM	Process	PRE-COMM	Activity	FTS	Discipline	Instrumental	Form FJ01D	Digital Loop

LOOP DATA

Loop TAG	80-XA-001				TSLD	123A90-FDL-IN-DG-40014 rev.1A			
IO Type	Input	Yes	Output	No	Energy by transmitter	No	Energy by system	Yes	
Marshalling	B400-FGS-001	Terminal	05A/05B		Slot	05	Rack	05	Chanel 05

LOOP TEST

1	Check earth isolation of the loop.					OK
2	Connect loop to terminal					OK
3	Energise Loop (close loop) and record status	Normal	Yes	Alarm/trip	No	OK
4	De-Energise Loop (open loop) and record status	Normal	No	Alarm/trip	Yes	OK
5	Record Fail Safe position	Open	NA	Closed	NA	NA

LOOP SERVICE

		Action	Alarm / Control			Display	
		Trip	GA	DCS	SOE	DCS	
6	Loop energized	No	NA	Yes	NA	OK	OK
7	Loop not energized	Yes	NA	Yes	NA	OK	OK
8	Checking of line monitoring	No	NA	No	NA	OK	OK
9	Checking of Maintenance Inhibition	NA	NA	NA	NA	NA	NA
10	Associated safety Level / bar	ESD-1D					OK
11	Associated outputs						

LOOP DOCUMENTATION

12	Loop diagram is marked up and attached to this test sheet	OK
13	Cause and effect chart is highlighted accordingly	OK
14	Any defect is recorded for punch list issuance	OK

TESTING & MEASUREMENT INSTRUMENT USED

Type	Serial N.	Calibration Certificate	Validity
MULTIMETER FLUKE 175	AW1/018 17140769	7715/24	10/07/2025

Comments:

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CROSSWIND
Name	Laurentiu Grozavu	Giandonato Delmissier	Gerry McCann
Date	2025-03-25	2025-03-25	2025-03-26

PROVERLIS Digitaly signed by Laurentiu Grozavu 2025-03-25T06:29:22.018Z

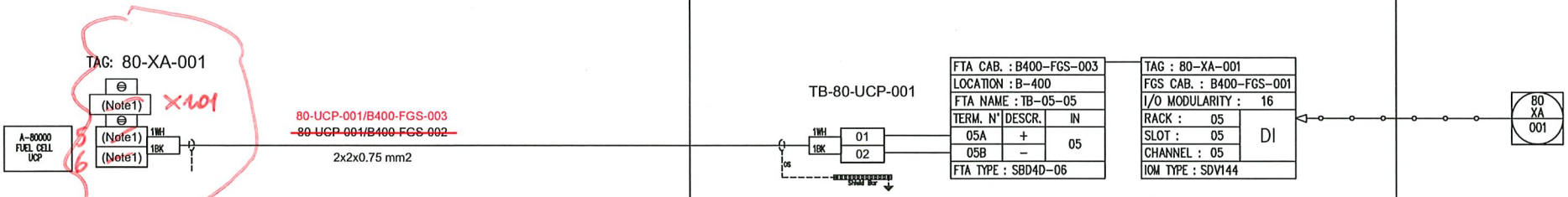
PROVERLIS Digitaly signed by Giandonato Delmissier 2025-03-25T08:04:37.204Z

PROVERLIS Digitaly signed by Gerry McCann 2025-03-26T09:55:15.301Z

Signature			

DRAWING NO.: 123A90-DDL-IN-DG-40014 | REV.: 01

FIELD	ITER – B400	CENTRAL CONTROL ROOM
	FIRE AND GAS SYSTEM	OPERATOR CONSOLE



24/03/25

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	06/12/2024	VBA	LCA	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
00	23/10/2024	VBA	LCA	DLO	ISSUE FOR REVIEW (IFR)

VALID FOR CONSTRUCTION
FDL DWG: 123A90-FDL-IN-DG-40014
REV: 1_A | DATE: 20/12/24 | SIGNATURE: C.Pilato
ROSETTI MARINO SpA

CROSSWIND

ROSETTI MARINO

TITLE : TYPICAL LOOP DIAGRAM
80-XA-001
A-80000 FUEL CELL PKG CONFIRMED GAS ALARM

CONTRACT NO./TITLE CONTRACT_NO.			SCALE 1:1
DRAWN: VBA	CHECKED: LCA	APPROVED: DLO	DATE

A3	DRAWING NO.	SHEET	REV.
	123A90-DDL-IN-DG-40014	300	01

File Name : 123A90-DDL-IN-DG-40014_REV01

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	80-XA-002	: A-80000 Fuel cell PKG confirmed fire alarm			Dwg	123A90-DDL-IN-LIS-40089
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	
TASK	code	C10004482		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	PRE-COMM	Activity FTS	Discipline	Instrumental	Form	FJ01D Digital Loop

LOOP DATA

Loop TAG	80-XA-002				TSLD	123A90-FDL-IN-DG-40014 rev.1A			
IO Type	Input	Yes	Output	No	Energy by transmitter	No	Energy by system	Yes	
Marshalling	B400-FGS-001	Terminal	06A/06B		Slot	05	Rack	05	Chanel 06

LOOP TEST

1	Check earth isolation of the loop.					OK
2	Connect loop to terminal					OK
3	Energise Loop (close loop) and record status	Normal	Yes	Alarm/trip	No	OK
4	De-Energise Loop (open loop) and record status	Normal	No	Alarm/trip	Yes	OK
5	Record Fail Safe position	Open	NA	Closed	NA	NA

LOOP SERVICE

		Action	Alarm / Control			Display	
		Trip	GA	DCS	SOE	DCS	
6	Loop energized	No	NA	Yes	NA	OK	OK
7	Loop not energized	Yes	NA	Yes	NA	OK	OK
8	Checking of line monitoring	No	NA	No	NA	OK	OK
9	Checking of Maintenance Inhibition	NA	NA	NA	NA	NA	NA
10	Associated safety Level / bar	ESD-1D					OK
11	Associated outputs						

LOOP DOCUMENTATION

12	Loop diagram is marked up and attached to this test sheet	OK
13	Cause and effect chart is highlighted accordingly	OK
14	Any defect is recorded for punch list issuance	OK

TESTING & MEASUREMENT INSTRUMENT USED

Type	Serial N.	Calibration Certificate	Validity
MULTIMETER FLUKE 175	AW1/018 17140769	7715/24	10/07/2025

Comments:

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CROSSWIND
Name	Laurentiu Grozavu	Giandonato Delmissier	Gerry McCann
Date	2025-03-25	2025-03-25	2025-03-26

PROVERLIS Digitaly signed by Laurentiu Grozavu 2025-03-25T06:29:37.681Z

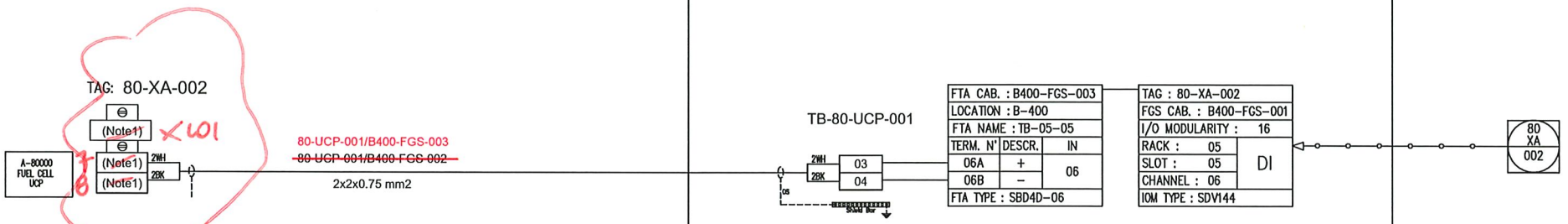
PROVERLIS Digitaly signed by Giandonato Delmissier 2025-03-25T08:05:10.825Z

PROVERLIS Digitaly signed by Gerry McCann 2025-03-26T09:55:54.337Z

Signature			

DRAWING NO. 123A90-DDL-IN-DG-40014 REV. 01

FIELD	ITER – B400	CENTRAL CONTROL ROOM
	FIRE AND GAS SYSTEM	OPERATOR CONSOLE



REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	06/12/2024	VBA	LCA	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
00	23/10/2024	VBA	LCA	DLO	ISSUE FOR REVIEW (IFR)

VALID FOR CONSTRUCTION
FDL DWG: 123A90-FDL-IN-DG-40014
REV: 1_A | DATE: 20/12/24 | SIGNATURE: C.Pilato
ROSETTI MARINO SpA

CROSSWIND

ROSETTI MARINO

TITLE : TYPICAL LOOP DIAGRAM
80-XA-002
A-80000 FUEL CELL PKG CONFIRMED FIRE ALARM

CONTRACT NO./TITLE CONTRACT_NO.			SCALE 1:1
DRAWN: VBA	CHECKED: LCA	APPROVED: DLO	DATE 23/10/2024

A3	DRAWING NO. 123A90-DDL-IN-DG-40014	SHEET 301	REV. 01

File Name : 123A90-DDL-IN-DG-40014_REV.01

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	80-XA-003	: A-80000 Fuel cell PKG UCP fault	Dwg	123A90-DDL-IN-LIS-40089		
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)	Module			
TASK	code	C10004483	Location	Onshore Activities	User	Rosetti Marino Quality Control	
FORM	Process	PRE-COMM	Activity	FTS	Discipline	Instrumental	Form	FJ01D	Digital Loop

LOOP DATA

Loop TAG	80-XA-003			TSLD	123A90-FDL-IN-DG-40014 rev.1A				
IO Type	Input	Yes	Output	No	Energy by transmitter	No	Energy by system	Yes	
Marshalling	B400-SIS-001	Terminal	03A/03B	Slot	01	Rack	03	Chanel	03

LOOP TEST

1	Check earth isolation of the loop.					OK
2	Connect loop to terminal					OK
3	Energise Loop (close loop) and record status	Normal	Yes	Alarm/trip	No	OK
4	De-Energise Loop (open loop) and record status	Normal	No	Alarm/trip	Yes	OK
5	Record Fail Safe position	Open	NA	Closed	NA	NA

LOOP SERVICE

		Action	Alarm / Control			Display	
		Trip	GA	DCS	SOE	DCS	
6	Loop energized	No	NA	Yes	NA	OK	OK
7	Loop not energized	Yes	NA	Yes	NA	OK	OK
8	Checking of line monitoring	No	NA	No	NA	OK	OK
9	Checking of Maintenance Inhibition	NA	NA	NA	NA	NA	NA
10	Associated safety Level / bar						
11	Associated outputs						

LOOP DOCUMENTATION

12	Loop diagram is marked up and attached to this test sheet	OK
13	Cause and effect chart is highlighted accordingly	OK
14	Any defect is recorded for punch list issuance	OK

TESTING & MEASUREMENT INSTRUMENT USED

Type	Serial N.	Calibration Certificate	Validity
MULTIMETER FLUKE 175	AW1/018 17140769	7715/24	10/07/2025

Comments:

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	RM COMM	RM COMM	CROSSWIND
Name	Laurentiu Grozavu	Giandonato Delmissier	Gerry McCann
Date	2025-03-25	2025-03-25	2025-03-26

PROVERLIS Digitaly signed by Laurentiu Grozavu 2025-03-25T06:29:51.511Z

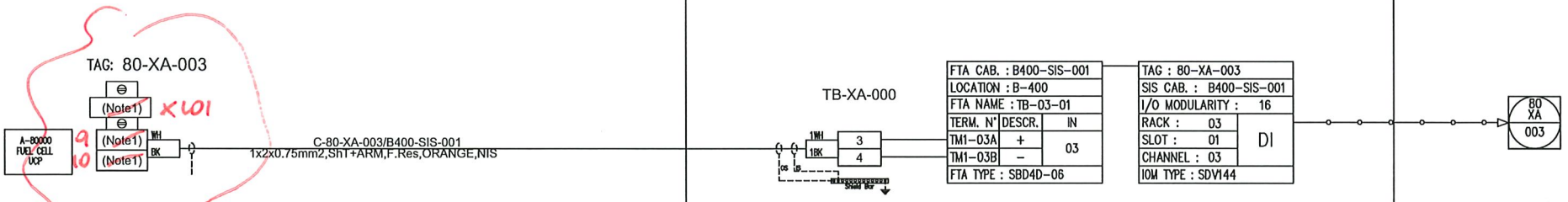
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PROVERLIS Digitaly signed by Gerry McCann 2025-03-26T09:56:55.015Z

Signature			

DRAWING NO. 123A90-DDL-IN-DG-40014 REV. 01

FIELD	ITER – B400	CENTRAL CONTROL ROOM
	SAFETY INSTRUMENTED SYSTEM	OPERATOR CONSOLE



LGarzaro
24/03/25

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	06/12/2024	VBA	LCA	DLO	ACCEPTED FOR CONSTRUCTION (AFC)
00	23/10/2024	VBA	LCA	DLO	ISSUE FOR REVIEW (IFR)

VALID FOR CONSTRUCTION
FDL DWG: 123A90-FDL-IN-DG-40014
REV: 1_A | DATE: 20/12/24 | SIGNATURE: C.Pilato
ROSETTI MARINO SpA

CROSSWIND

ROSETTI MARINO

TITLE : INSTRUMENT LOOP DIAGRAM
80-XA-003
A-80000 FUEL CELL PKG UCP FAULT

CONTRACT NO./TITLE CONTRACT_NO.			SCALE 1:1
DRAWN: VBA	CHECKED: LCA	APPROVED: DLO	DATE 23/10/2024

A3	DRAWING NO. 123A90-DDL-IN-DG-40014	SHEET 138	REV. 01

File Name : 123A90-DDL-IN-DG-40014_REV.01

ITEM	Tag	A-80000	: Fuel Cell			Dwg	123A90-DDL-PR-PID-80012
	S/Sys	80-00	: Hydrogen Fuel Cell Package (A-80000)			Module	UD
TASK	code	C10004886		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	COMM	Activity FTS	Discipline	Instrumental	Form	FJ05 Serial Communication Test

SERIAL COMMUNICATION TEST

Reference document number: Crosswind Modbus Table - Main PLC

Associated subsystems: 80-00

Completion date: 20/03/2025

Comments/Remarks:

	Performed by	☉ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Page 1/1			
Company	Rosetti Marino		
Name	Fabio Sirigu	David Musgrove	
Date	2025-03-20	2025-03-24	
Signature	PROVERLIS Digitaly signed by Fabio Sirigu 2025-03-20T15:03:56.102Z	PROVERLIS Digitaly signed by David Musgrove 2025-03-24T10:28:01.899Z	

Crosswind BLPH FC Package - Main PLC

HOLDING REGISTERS

Allowable Function Codes: FC03;06;16
Read and Write access, if otherwise not specified

Implemented?	Group	Internal - Base	Internal - Offset	Address [Decimal]	Bit	TAG	Pretty Name	Read	Write	Datatype	Scaling	Unit	Comment
	External Control	1000	0	1000		POWER_SP	Export Power Setpoint	VERO	VERO	INT16		0.1 kW	Range 0 to 1200 kW
	External Control	1000	1	1001			Control word						
					0		Wakeup ✓			BOOL			Rising edge triggers wakeup
					1		Sleep ✓			BOOL			Rising edge triggers go to sleep
					2		Start ✓			BOOL			Rising edge triggers start sequence
					3		Stop ✓			BOOL			Rising edge triggers stop sequence
					4		<Spare>			BOOL			Not used
					5		Reset ✓			BOOL			Rising edge triggers fault clear
	External Control	1000	2	1002									
	External Control	1000	3	1003									
	External Control	1000	4	1004									
	External Control	1000	5	1005									
	External Control	1000	6	1006									
	External Control	1000	7	1007									
	External Control	1000	8	1008									
	External Control	1000	9	1009									

Ballard: Peter Bleach - 19/03/2025
BAX ENERGY: SYED ALI - 19/03/2025
CW DAVE MUSKIZOVIC 19/03/2025
RM FABIO SIRIGU

CW DAVE MUSGROVE 20/03/2025
Ballard Peter Black -11-
BAX/YOKO SYED ALI -11-
RM FABIO SRIGH

Crosswind BLPH FC Package - Main PLC

INPUT REGISTERS

Allowable Function Codes: FC04
Read only access

Yellow Fields indicate changes in most recent verstion (Column "B"), notes in Column "P"

Implemented?	Group	Internal - Base	Internal - Offset	Address [Decimal]	Bit	TAG	Pretty Name	Read	Write	Datatype	Scaling	Unit	Comment	Max value
VERO	External Control	1000	0	1000		StateMain	Main FC Package Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	1	1001		FC1_State	Fuel Cell Module #1 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	2	1002		FC2_State	Fuel Cell Module #2 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	3	1003		FC3_State	Fuel Cell Module #3 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	4	1004		FC4_State	Fuel Cell Module #4 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	5	1005		FC5_State	Fuel Cell Module #5 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	6	1006		FC6_State	Fuel Cell Module #6 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	7	1007			<Spare>							
VERO	External Control	1000	8	1008			<Spare>							
VERO	External Control	1000	9	1009			<Spare>							
VERO	External Control	1000	10	1010			<Spare>							
VERO	External Control	1000	11	1011			<Spare>							
VERO	External Control	1000	12	1012			<Spare>							
VERO	External Control	1000	13	1013		P_MAX	Total Capacity of FC Package	VERO	FALSO	INT16	0,1	kW	Range 0 to 1000 kW	
VERO	External Control	1000	14	1014		P_FC	Fuel Cell Power Produced	VERO	FALSO	INT16	0,1	kW	Range 0 to 1200 kW	Change: now contains DC power output from FC
VERO	External Control	1000	15	1015			Spare							
VERO	External Control	1000	16	1016		FCM_RUNNING	Number of Fuel Cell Modules Producing Power	VERO	FALSO	INT16	1	n/a	Range 0 to 6	
VERO	External Control	1000	17	1017			<Spare>							
VERO	External Control	1000	18	1018			<Spare>							
VERO	External Control	1000	19	1019			<Spare>							
VERO	External Control	1000	20	1020			FCWave 1 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	21	1021			FCWave 1 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	22	1022			FCWave 1 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	23	1023			FCWave 2 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	24	1024			FCWave 2 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	25	1025			FCWave 2 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	26	1026			FCWave 3 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	27	1027			FCWave 3 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	28	1028			FCWave 3 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	29	1029			FCWave 4 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	30	1030			FCWave 4 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	31	1031			FCWave 4 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	32	1032			FCWave 5 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	33	1033			FCWave 5 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	34	1034			FCWave 5 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	35	1035			FCWave 6 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	36	1036			FCWave 6 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	37	1037			FCWave 6 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	38	1038			Power Setpoint Readback	VERO		INT16	0,1	kW	Manual or from Customer Modbus	Change: description updated
VERO	External Control	1000	39	1039			Export AC Power	VERO		INT16	0,1	kW	measurement before breaker	
VERO	External Control	1000	40	1040			Nanogrid AC Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	41	1041			Aux AC power	VERO		INT16	0,1	kW		
VERO	External Control	1000	42	1042			<Spare>							
VERO	External Control	1000	43	1043			<Spare>							
VERO	External Control	1000	44	1044			<Spare>							
VERO	External Control	1000	45	1045			<Spare>							
VERO	External Control	1000	46	1046			<Spare>							
VERO	External Control	1000	47	1047			<Spare>							
VERO	External Control	1000	48	1048			<Spare>							
VERO	External Control	1000	49	1049			<Spare>							
VERO	External Control	1000	50	1050			Error Code 1	VERO		INT16	1	n/a	Active Error Code #1	
VERO	External Control	1000	51	1051			Error Code 2	VERO		INT16	1	n/a	Active Error Code #2	
VERO	External Control	1000	52	1052			Error Code 3	VERO		INT16	1	n/a	Active Error Code #3	
VERO	External Control	1000	53	1053			Error Code 4	VERO		INT16	1	n/a	Active Error Code #4	
VERO	External Control	1000	54	1054			Error Code 5	VERO		INT16	1	n/a	Active Error Code #5	
VERO	External Control	1000	55	1055			Error Code 6	VERO		INT16	1	n/a	Active Error Code #6	
VERO	External Control	1000	56	1056			Error Code 7	VERO		INT16	1	n/a	Active Error Code #7	
VERO	External Control	1000	57	1057			Error Code 8	VERO		INT16	1	n/a	Active Error Code #8	
VERO	External Control	1000	58	1058			Error Code 9	VERO		INT16	1	n/a	Active Error Code #9	
VERO	External Control	1000	59	1059			Error Code 10	VERO		INT16	1	n/a	Active Error Code #10	
VERO	External Control	1000	60	1060			Error Code 11	VERO		INT16	1	n/a	Active Error Code #11	
VERO	External Control	1000	61	1061			Error Code 12	VERO		INT16	1	n/a	Active Error Code #12	
VERO	External Control	1000	62	1062			Error Code 13	VERO		INT16	1	n/a	Active Error Code #13	
VERO	External Control	1000	63	1063			Error Code 14	VERO		INT16	1	n/a	Active Error Code #14	
VERO	External Control	1000	64	1064			Error Code 15	VERO		INT16	1	n/a	Active Error Code #15	
VERO	External Control	1000	65	1065			Error Code 16	VERO		INT16	1	n/a	Active Error Code #16	
VERO	External Control	1000	66	1066			Error Code 17	VERO		INT16	1	n/a	Active Error Code #17	
VERO	External Control	1000	67	1067			Error Code 18	VERO		INT16	1	n/a	Active Error Code #18	
VERO	External Control	1000	68	1068			Error Code 19	VERO		INT16	1	n/a	Active Error Code #19	
VERO	External Control	1000	69	1069			Error Code 20	VERO		INT16	1	n/a	Active Error Code #20	
VERO	External Control	1000	70	1070			Error Code 21	VERO		INT16	1	n/a	Active Error Code #21	
VERO	External Control	1000	71	1071			Error Code 22	VERO		INT16	1	n/a	Active Error Code #22	
VERO	External Control	1000	72	1072			Error Code 23	VERO		INT16	1	n/a	Active Error Code #23	
VERO	External Control	1000	73	1073			Error Code 24	VERO		INT16	1	n/a	Active Error Code #24	
VERO	External Control	1000	74	1074			Error Code 25	VERO		INT16	1	n/a	Active Error Code #25	
VERO	External Control	1000	75	1075			Error Code 26	VERO		INT16	1	n/a	Active Error Code #26	
VERO	External Control	1000	76	1076			Error Code 27	VERO		INT16	1	n/a	Active Error Code #27	
VERO	External Control	1000	77	1077			Error Code 28	VERO		INT16	1	n/a	Active Error Code #28	
VERO	External Control	1000	78	1078			Error Code 29	VERO		INT16	1	n/a	Active Error Code #29	
VERO	External Control	1000	79	1079			Error Code 30	VERO		INT16	1	n/a	Active Error Code #30	
VERO	External Control	1000	80	1080			Error Code 31	VERO		INT16	1	n/a	Active Error Code #31	
VERO	External Control	1000	81	1081			Error Code 32	VERO		INT16	1	n/a	Active Error Code #32	
VERO	External Control	1000	82	1082			Error Code 33	VERO		INT16	1	n/a	Active Error Code #33	
VERO	External Control	1000	83	1083			Error Code 34	VERO		INT16	1	n/a	Active Error Code #34	
VERO	External Control	1000	84	1084			Error Code 35	VERO		INT16	1	n/a	Active Error Code #35	
VERO	External Control	1000	85	1085			Error Code 36	VERO		INT16	1	n/a	Active Error Code #36	
VERO	External Control	1000	86	1086			Error Code 37	VERO		INT16	1	n/a	Active Error Code #37	
VERO	External Control	1000	87	1087			Error Code 38	VERO		INT16	1	n/a	Active Error Code #38	
VERO	External Control	1000	88	1088			Error Code 39	VERO		INT16	1	n/a	Active Error Code #39	
VERO	External Control	1000	89	1089			Error Code 40	VERO		INT16	1	n/a	Active Error Code #40	
VERO	External Control	1000	90	1090			Error Code 41	VERO		INT16	1	n/a	Active Error Code #41	

30 ERROR CODES TO ADD YOKOHAMA

ERROR CODE 1-50 CHANGE FROM SIGNED TO UN-SIGNED INT

CW DAVE MUSGROVE 20/03/2025
Ballard Peter Black -11-
DAX/YOKO SYED ALI -11-
RM FABIO SURIGA

VERO	External Control		1000	91	1091		Error Code 42		VERO	INT16	1	n/a	Active Error Code #42	
VERO	External Control		1000	92	1092		Error Code 43		VERO	INT16	1	n/a	Active Error Code #43	
VERO	External Control		1000	93	1093		Error Code 44		VERO	INT16	1	n/a	Active Error Code #44	
VERO	External Control		1000	94	1094		Error Code 45		VERO	INT16	1	n/a	Active Error Code #45	
VERO	External Control		1000	95	1095		Error Code 46		VERO	INT16	1	n/a	Active Error Code #46	
VERO	External Control		1000	96	1096		Error Code 47		VERO	INT16	1	n/a	Active Error Code #47	
VERO	External Control		1000	97	1097		Error Code 48		VERO	INT16	1	n/a	Active Error Code #48	
VERO	External Control		1000	98	1098		Error Code 49		VERO	INT16	1	n/a	Active Error Code #49	
VERO	External Control		1000	99	1099		Error Code 50		VERO	INT16	1	n/a	Active Error Code #50	
VERO	External Information		1100	0	1100	=HE01+DA02-BT01	HT1 - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		HT1 - Coolant Return Temperature [°C]
VERO	External Information		1100	1	1101	=HE01+DA02-BT02	HT1 - Pump Inlet Temperature		VERO	FALSO INT16	0.1	°C		HT1 - Pump Inlet Temperature [°C]
VERO	External Information		1100	2	1102	=HE01+DA02-BF01	HT1 - Flowrate		VERO	FALSO INT16	0.1	m3^h		HT1 - Flowrate [m3^h]
VERO	External Information		1100	3	1103	=HE01+DA02-GP19_RPM	HT1 - Pump RPM		VERO	FALSO INT16	1	rpm		HT1 - Pump RPM [rpm]
VERO	External Information		1100	4	1104	=HE02+DA02-BT01	HT2 - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		HT2 - Coolant Return Temperature [°C]
VERO	External Information		1100	5	1105	=HE02+DA02-BT02	HT2 - Pump Inlet Temperature		VERO	FALSO INT16	0.1	°C		HT2 - Pump Inlet Temperature [°C]
VERO	External Information		1100	6	1106	=HE02+DA02-BF01	HT2 - Flowrate		VERO	FALSO INT16	0.1	m^3/h		HT2 - Flowrate [m^3/h]
VERO	External Information		1100	7	1107	=HE02+DA02-GP29_RPM	HT2 - Pump RPM		VERO	FALSO INT16	1	rpm		HT2 - Pump RPM [rpm]
VERO	External Information		1100	8	1108	=HE03+DA01-BT01	LT - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		LT - Coolant Return Temperature [°C]
VERO	External Information		1100	9	1109	=HE03+DA01-BT02	LT - Coolant Forward Temperature		VERO	FALSO INT16	0.1	°C		LT - Coolant Forward Temperature [°C]
VERO	External Information		1100	10	1110	=HE03+DA01-BF03	LT - Flowrate		VERO	FALSO INT16	0.1	m^3/h		LT - Flowrate [m^3/h]
VERO	External Information		1100	11	1111	=HE03+DA01-GP11_RPM	LT - Pump RPM		VERO	FALSO INT16	1	rpm		LT - Pump RPM [rpm]
VERO	External Information		1100	12	1112	=JA01+DA01-BT01	40ft - Ventilation Intake Temperature		VERO	FALSO INT16	0.1	°C		40ft - Ventilation Intake Temperature [°C]
VERO	External Information		1100	13	1113	=JA01+DA01-BT02	40ft - Container Temperature 2		VERO	FALSO INT16	0.1	°C		40ft - Container Temperature 2 [°C]
VERO	External Information		1100	14	1114	=JA01+DA01-BT03	40ft - Container Temperature 3		VERO	FALSO INT16	0.1	°C		40ft - Container Temperature 3 [°C]
VERO	External Information		1100	15	1115	=JA01+DA01-GQ06_RPM	40ft - Ventilation Fan 1 Speed		VERO	FALSO INT16	1	rpm		40ft - Ventilation Fan 1 Speed [rpm]
VERO	External Information		1100	16	1116	=JA01+DA01-GQ07_RPM	40ft - Ventilation Fan 2 Speed		VERO	FALSO INT16	1	rpm		40ft - Ventilation Fan 2 Speed [rpm]
VERO	External Information		1100	17	1117	=JA01+DA03-BT01	10ft - Container Temperature		VERO	FALSO INT16	0.1	°C		10ft - Container Temperature [°C]
VERO	External Information	PL	1100	18	1118	=JA01+DA03-GQ10_RPM	10ft - Ventilation Fan Speed		VERO	FALSO INT16	1	rpm		10ft - Ventilation Fan Speed [rpm]
VERO	External Information		1100	19	1119		Available Unused Power (AUP)		VERO	FALSO INT16	0,1	kW		Available Unused Power (AUP) [kW]
VERO	External Information		1100	20	1120		Calculated Maximum Power (CMP)		VERO	FALSO INT16	0,1	kW		Calculated Maximum Power (CMP) [kW]
VERO	External Information		1100	21	1121		Operating state		VERO	FALSO INT16	1	n/a	Range 0 to 6	Operating state [n/a]
VERO	External Information		1200	0	1200		<Spare>							
VERO	External Information		1200	1	1201		<Spare>							
VERO	External Information	PL	1200	2	1202		System efficiency			INT16	0,1	%	(DEIF Power + Pack Power) / (SUM'ed H2 flow converted to power) - realtime	
VERO	External Information	PL	1200	3	1203		FC1 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	4	1204		FC2 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	5	1205		FC3 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	6	1206		FC4 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	7	1207		FC5 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	8	1208		FC6 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information		1200	9	1209		FC1 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	11	1211		FC2 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	13	1213		FC3 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	15	1215		FC4 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	17	1217		FC5 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	19	1219		FC6 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information	PL	1200	21	1221		System lifetime produced energy			UINT32	1	kWh - AC	value from ABB breaker	2147GWh = 1.34mio hours @ 1.6MW
VERO	External Information		1200	23	1223		FC1 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	24	1224		FC2 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	25	1225		FC3 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	26	1226		FC4 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	27	1227		FC5 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	28	1228		FC6 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information	PL	1200	29	1229		H2 Consumption Status Word			WORD				
VERO	External Information	PL	1200			0	FC1 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			1	FC2 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			2	FC3 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			3	FC4 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			4	FC5 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			5	FC6 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information		1200			6 to 15	<Spare>			BOOL				
VERO	External Information		1200	30	1230		Ambient Temperature			INT16	0.1	°C		
VERO	External Information		1200	31	1231		Container intake air Temperature			INT16	0.1	°C		
VERO	External Information		1200	32	1232		LT Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	33	1233		LT Cooling Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	34	1234		HT1 Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	35	1235		HT1 Coolant Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	36	1236		HT2 Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	37	1237		HT2 Coolant Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	38	1238		FC1 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	39	1239		FC1 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	40	1240		FC1 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	41	1241		FC2 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	42	1242		FC2 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	43	1243		FC2 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	44	1244		FC3 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	45	1245		FC3 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	46	1246		FC3 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	47	1247		FC4 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	48	1248		FC4 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	49	1249		FC4 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	50	1250		FC5 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	51	1251		FC5 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	52	1252		FC5 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	53	1253		FC6 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	54	1254		FC6 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	55	1255		FC6 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	56	1256		FC1 Stack Current String A			INT16	0.1	A - DC		
VERO	External Information		1200	57	1257		FC1 Stack Current String B			INT16	0.1	A - DC		
VERO	External Information		1200	58	1258		FC1 Stack Voltage String A			INT16	0.1	V - DC		
VERO	External Information		1200	59	1259		FC1 Stack Voltage String B			INT16	0.1	V - DC		
VERO	External Information		1200	60	1260		FC2 Stack Current String A			INT16	0.1	A - DC		
VERO	External Information		1200	61	1261		FC2 Stack Current String B			INT16	0.1	A - DC		
VERO	External Information		1200	62	1262		FC2 Stack Voltage String A			INT16	0.1	V - DC		
VERO	External Information		1200	63	1263		FC2 Stack Voltage String B			INT16	0.1	V - DC		
VERO	External Information		1200	64	1264		FC3 Stack Current String A			INT16	0.1	A - DC		

CW DAVE MUSGROVE 20/03/2025
Ballard Polar Bloch
BAX/DIKO SYED ALI
RM FABIO SURIGN

VERO	External Information		1200	65	1265	FC3 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	66	1266	FC3 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	67	1267	FC3 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	68	1268	FC4 Stack Current String A	INT16	0.1	A - DC		
VERO	External Information		1200	69	1269	FC4 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	70	1270	FC4 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	71	1271	FC4 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	72	1272	FC5 Stack Current String A	INT16	0.1	A - DC		
VERO	External Information		1200	73	1273	FC5 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	74	1274	FC5 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	75	1275	FC5 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	76	1276	FC6 Stack Current String A	INT16	0.1	A - DC	NOT tested	
VERO	External Information		1200	77	1277	FC6 Stack Current String B	INT16	0.1	A - DC	NOT tested	
VERO	External Information		1200	78	1278	FC6 Stack Voltage String A	INT16	0.1	V - DC	NOT tested	
VERO	External Information		1200	79	1279	FC6 Stack Voltage String B	INT16	0.1	V - DC	NOT tested	
NOT TRUE	External Information	PL	1200	80	1280	FC1 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	82	1282	FC2 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	84	1284	FC3 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	86	1286	FC4 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	88	1288	FC5 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	90	1290	FC6 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	92	1292	System ON Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information	PL	1200	94	1294	PLC ON Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
VERO	External Information		1200	96	1296	FC1 start counter	INT16	1	no.		
VERO	External Information		1200	97	1297	FC2 start counter	INT16	1	no.		
VERO	External Information		1200	98	1298	FC3 start counter	INT16	1	no.		
VERO	External Information		1200	99	1299	FC4 start counter	INT16	1	no.		
VERO	External Information		1200	100	1300	FC5 start counter	INT16	1	no.		
VERO	External Information		1200	101	1301	FC6 start counter	INT16	1	no.		
VERO	External Information		1200	102	1302	System start counter	INT16	1	no.		
VERO	External Information		1200	103	1303	FC1 shutdown counter	INT16	1	no.		
VERO	External Information		1200	104	1304	FC2 shutdown counter	INT16	1	no.		
VERO	External Information		1200	105	1305	FC3 shutdown counter	INT16	1	no.		
VERO	External Information		1200	106	1306	FC4 shutdown counter	INT16	1	no.		
VERO	External Information		1200	107	1307	FC5 shutdown counter	INT16	1	no.		
VERO	External Information		1200	108	1308	FC6 shutdown counter	INT16	1	no.		
VERO	External Information	PL	1200	109	1309	System shutdown counter	INT16	1	no.		
VERO	External Information		1200	110	1310	Main Output Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	111	1311	Main Output Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	112	1312	Main Output Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	113	1313	Main Output Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	114	1314	Main Output Voltage L2N	INT16	0.1	V - AC		
VERO	External Information		1200	115	1315	Main Output Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	116	1316	Main Output Current L1	INT16	1	A - AC		
VERO	External Information		1200	117	1317	Main Output Current L2	INT16	1	A - AC		
VERO	External Information		1200	118	1318	Main Output Current L3	INT16	1	A - AC		
VERO	External Information		1200	119	1319	Main Output Power	INT16	0.1	kW - AC		
VERO	External Information		1200	120	1320	Main Output Reactive Power	INT16	0.1	kvar		
VERO	External Information		1200	121	1321	Main Output Apparent Power	INT16	0.1	kVA		
VERO	External Information		1200	122	1322	Main Output Power Factor	INT16	0.001	-		
VERO	External Information		1200	123	1323	Main Busbar Frequency	UINT16	0,001	Hz		
VERO	External Information		1200	124	1324	Main Busbar Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	125	1325	Main Busbar Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	126	1326	Main Busbar Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	127	1327	Main Busbar Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	128	1328	Main Busbar Voltage L2N	INT16	0.1	V - AC		
VERO	External Information	PL	1200	129	1329	Main Busbar Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	130	1330	AUX Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	131	1331	AUX Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	132	1332	AUX Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	133	1333	AUX Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	134	1334	AUX Voltage L2N	INT16	0.1	V - AC		
VERO	External Information		1200	135	1335	AUX Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	136	1336	AUX Current L1	INT16	0.1	A - AC		
VERO	External Information		1200	137	1337	AUX Current L2	INT16	0.1	A - AC		
VERO	External Information		1200	138	1338	AUX Current L3	INT16	0.1	A - AC		
VERO	External Information		1200	139	1339	AUX Power	INT16	0.1	kW - AC		
VERO	External Information		1200	140	1340	AUX Reactive Power	INT16	0.1	kvar		
VERO	External Information		1200	141	1341	AUX Apparent Power	INT16	0.1	kVA		
VERO	External Information		1200	142	1342	AUX Power Factor	INT16	0.001	n/a		
VERO	External Information		1200	143	1343	AUX Frequency	UINT16	0,001	Hz		
VERO	External Information		1200	144	1344	Nanogrid Power	INT16	0.1	kW - DC	Nanogrid Breaker Total Power	

Section 4.4 Instrumentation “As-Commissioned” interconnection diagrams

NOT APPLICABLE

Section 4.5 Telecommunication functional test sheets index

NOT APPLICABLE

Section 4.6 Telecommunication
“As-Commissioned” I.C.D. / TSLD's

NOT APPLICABLE

Section 5 SITE / OPERATIONAL

Section 5.1 Operational Test Procedure

Section 5.2 Operational Test Certificates

CROSSWIND

ROSETTI MARINO

Project CROSSWIND

STATUS INDEX DETAIL

Filtered on subsystem: 80-00

Miscellaneous	80-00 Hydrogen Fuel Cell Package (A-80000)						
ITEM		TASK					
Code	Description	Location	Code	Form	Progress	Date	Certificate
123A90-PML-COM-PRO-03062	OTP – Hydrogen Fuel Cell Package	ONSHORE	C10004619	5300	100	2025-07-28	RFO 4

ITEM	Tag	123A90-PML-COM-PRO-03062 : OTP – Hydrogen Fuel Cell Package				Dwg	123A90-PML-COM-PRO-03062
	S/Sys	80-00 : Hydrogen Fuel Cell Package (A-80000)				Module	
TASK	code	C10004619		Location	Onshore Activities	User	Rosetti Marino Quality Control
FORM	Process	COMM	Activity OTS	Discipline	Miscellaneous Form 5300		Operational Test Procedure

OTP - OPERATIONAL TEST PROCEDURE

Attached procedure number:

Associated subsystems:

Completion date:

Comments/Remarks:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
	COMMISSIONING DISCIPLINE LEAD	RM COMMISSIONING MANAGER	CPY COMMISSIONING MANAGER
Name		Anthony Iveson	Jamie McAllister
Date		2025-07-21	2025-07-28
Signature		PROVERLIS Digitaly signed by Anthony Iveson 2025-07-21T09:24:19.591Z	PROVERLIS Digitaly signed by Jamie McAllister 2025-07-28T14:10:19.143Z

Base Load Power Hub (BLPH)

OTP – Hydrogen Fuel Cell Package

Document Number: 123A90-PML-COM-PRO-03062

Document Class: 2

{ DOCUMENT PREPARED IN COLLABORATION WITH CROSSWIND PMT }

01	30/01/2025	Accepted for Construction (AFC)	G.DELMISSIER	A.IVESON	M.BRUNELLI
00	18/12/2024	Issue for Review (IFR)	G.DELMISSIER	A.IVESON	M.BRUNELLI
Rev.	Date	Description	Prepared	Reviewed	Approved

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Revision / Change Log

Rev.	Description
00	Issue for Review (IFR)
01	Accepted for Construction (AFC)

HOLDS LIST

No.	Description
1	Awaiting details of commissioning spare parts from Ballard
2	
3	

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1 INTRODUCTION

1.1 Project Overview

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.2 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.



Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map



Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile is located on coordinates E 590719.1, N 5841602.3 and is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.3 Project Concept

All components included in the BLPH will be integrated onshore on a topside and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

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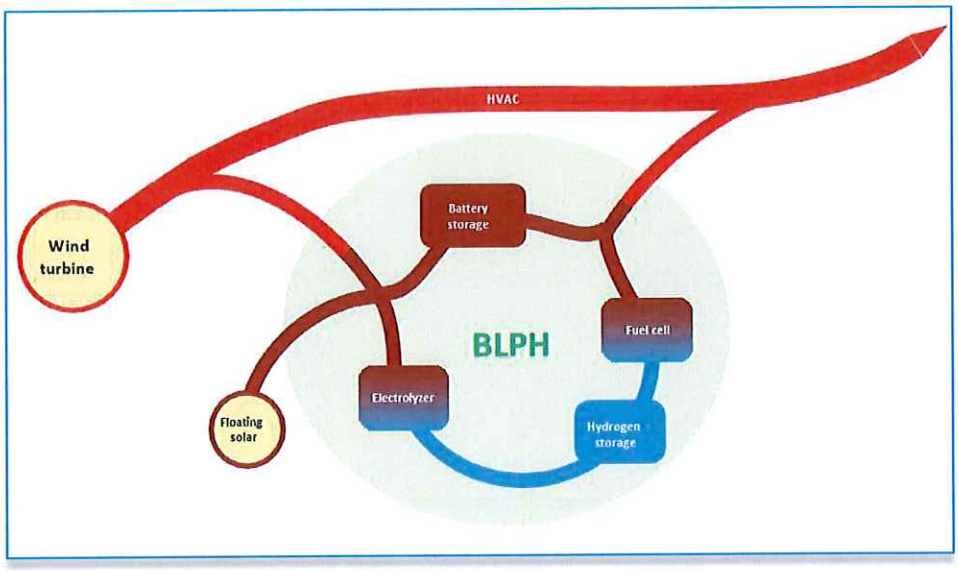


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.
The purpose of the BLPH is to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2 DOCUMENT SCOPE

The purpose of this document is to describe the dedicated Commissioning procedure together with the detailed test steps to be implemented for the preparation and execution of the operation testing of the Hydrogen Fuel Cell Package

The document will cover all related test steps to be performed at both the onshore Worksite construction yard and the offshore SITE.

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3 OTP SUMMARY

3.1 Test Objective

The operating test of the Hydrogen Fuell Cell system is executed to ensure that the system is started up in a safe and controlled manner and to verify the correct operation according to the project requirements.

Aim of this document is to provide the sequence and appropriate actions to verify the safety systems of the system along with ability for the system to produce electrical power.

Please note that Pre-commissioning activities are described in detail in the method statement document K559-2254-CWIWP4202202-J99-009 as well as in the Vendor SAT procedure K559-2254-CWIWP4202202-J99-001. For the sake of completeness, these activities will be mentioned here as part of necessary steps but will not be part of the OTP.

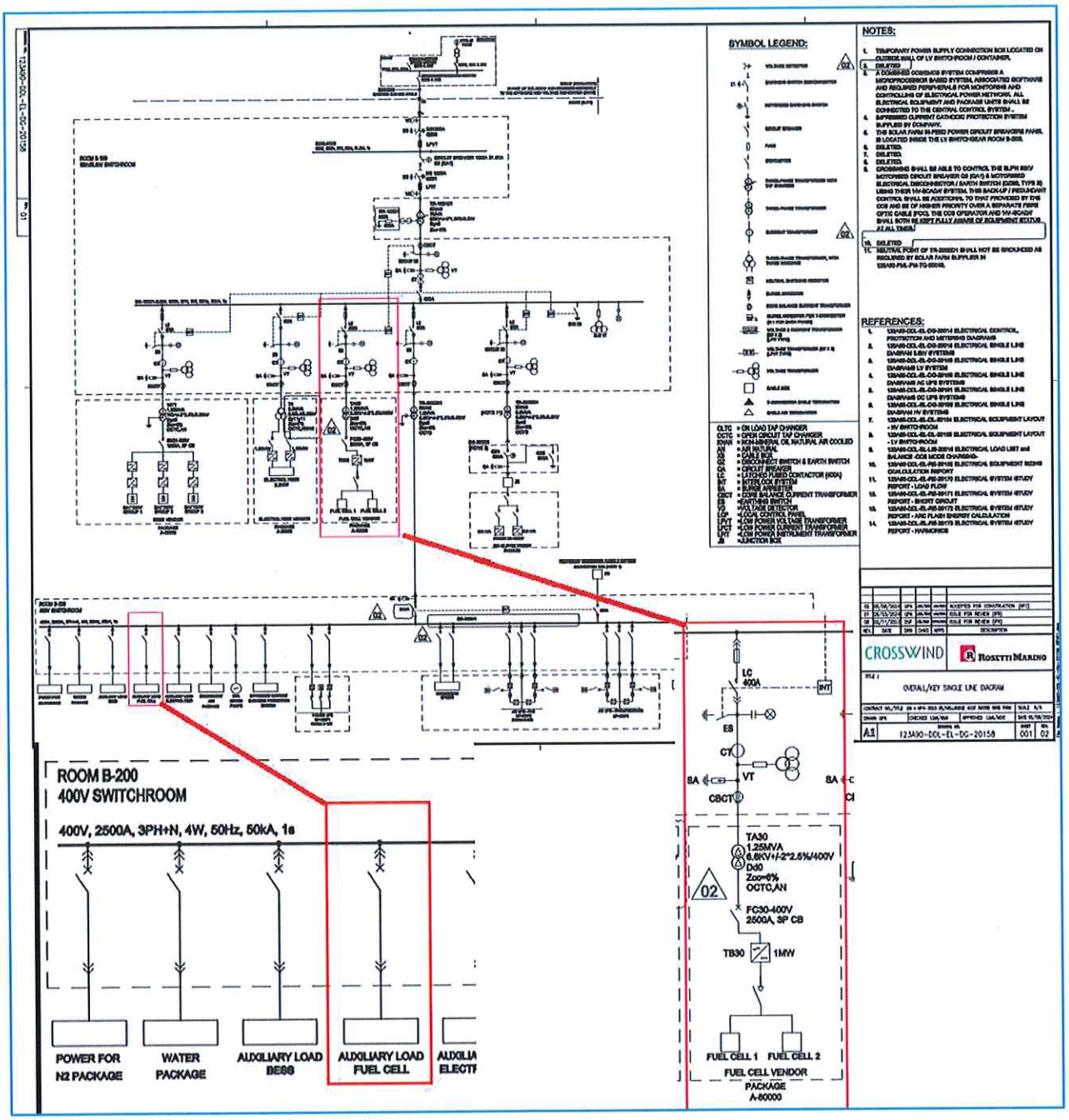
Activities shall be developed as follows:

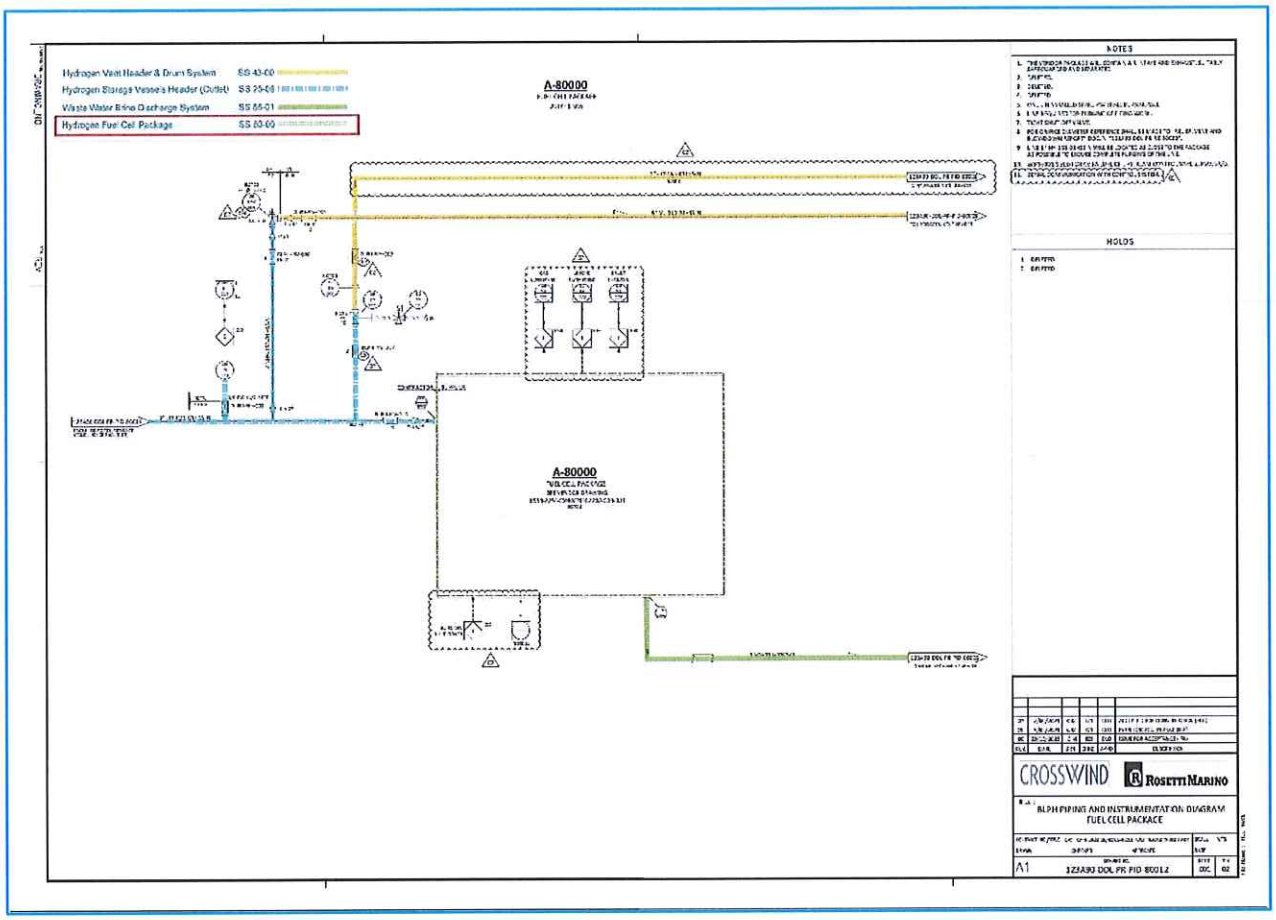
- Onshore pre-commissioning and commissioning activities at Contractor site (WORKSITE)
  - PHASE 1: Pre-commissioning (powered) activities including the following (NOT PART OF THIS OTP):
    - Leak Testing of modified H2 heater manifold assembly and coolant system leak test.
    - Aux first power on
    - Collant System fill and degas
  - PHASE 2: Pre-commissioning (powered) activities including the following (NOT PART OF THIS OTP):
    - IO test (package internal)
    - Platform communication check
    - Testing of 6.6 kV Trafo
    - Software upgrades testing
    - H2 supply check
    - External interface checks
    - Software upgrade testing
  - PHASE 3: Vendor SAT & Integrated function test of Hydrogen Fuel Cell package.
- Offshore commissioning (SITE)
  - PHASE 4: Integrated function test of Hydrogen Fuel Cell package (OFFSHORE).

PHASES 1 – 2 are covered by and contained within the vendor Method Statement. PHASES 3 - 4 are included within this OTP document, and the Vendor SAT procedure.

3.2 System Boundary Limits

See below the interested systems and subsystems on the Overall Single Line Diagram





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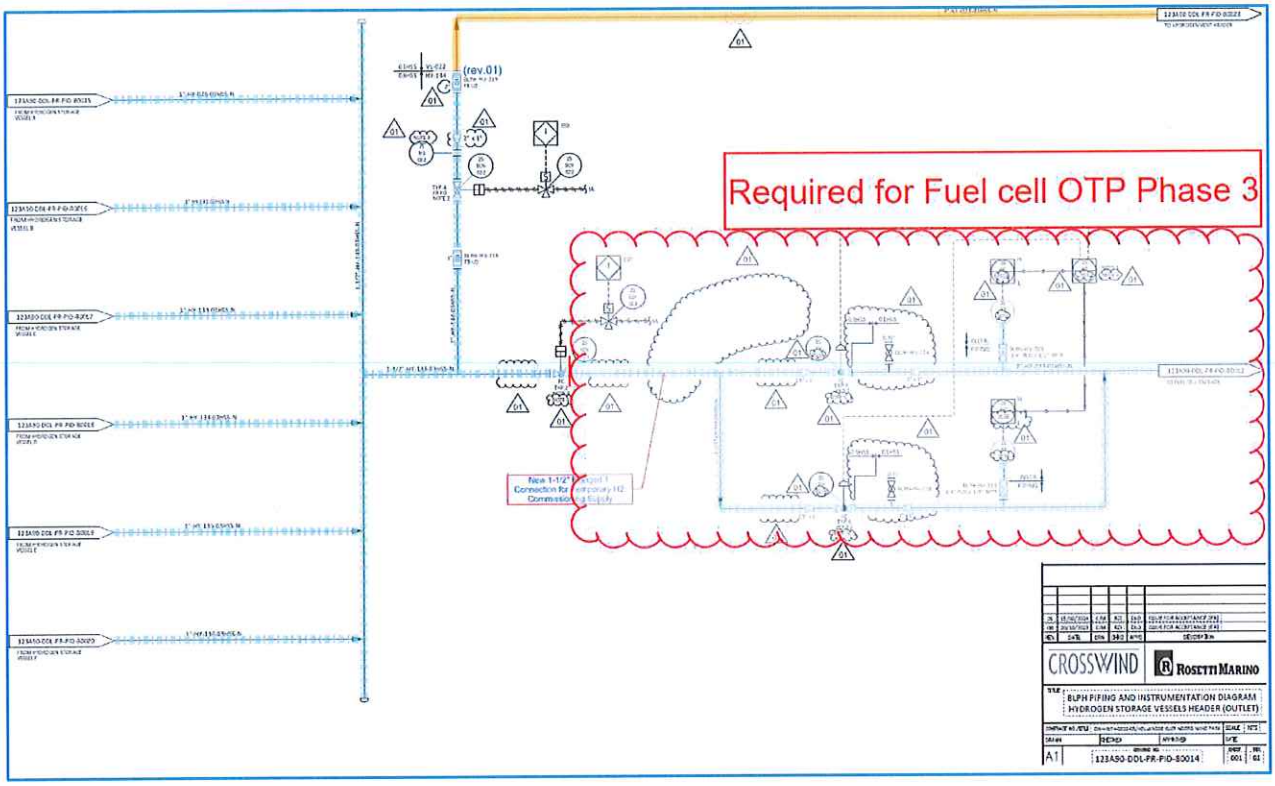


Figure 4 – OTP System Boundary Limits

3.3 Test and System Description

Proceeding with this OTP is confirmation that the following system:

- 80-00 Hydrogen Fuel Cell

That all equipment is installed in accordance with the following vendor documents:

- K559-2254-CG-PHI-001 Commissioning Philosophy
- ELO-INN-PBH-DWG-0005 General Arrangement Drawing
- ELO-ELE-BPH-DWG- 0005 Electrical Single Line Diagram Power Distribution
- ELO-INN-BPH-CKT-0006 Alarm warning list
- ELO-INN-BPH-DWG-0008 Process Flow Diagrams
- K559-2254-EL-ELL-002 BLPH - Electrical Load List (CCS MODE 2(A) 'HOT STANDBY')
- K559-2254-EL-ELL-003 BLPH - Electrical Load List (CCS MODE 3(C) 'DISCHARGING')
- K559-2254-EL-ELL-004 BLPH - Electrical Load List (CCS MODE 4(A) 'COLD STANDBY')
- K559-2254-EL-ELL-005 BLPH - Electrical Load List (CCS MODE 4A(D) 'EMERGENCY MODE (Island))
- K559-2254-EL-ELL-006 BLPH - Electrical Load List (CCS MODE 5(D) 'POWER OUT (Blackout))
- K559-2254-PR-PHI-001 - Main process control philosophy

3.4 Safety Devices

- Appropriate Personnel Protective Equipment (PPE) and safety equipment e.g., safety shoes, hand gloves, helmet, earplugs etc. are available and must be used in line with the site requirements.
- For entry into the 40' container standard PPE as stated above must be worn. Phones are not permitted within the 40' container.
- Access to the 10' transformer container is not permitted during operation and the container is to be double locked, the second lock being controlled by the CONTRACTOR.
  This is in addition to all normal PPE in line with site requirements.
- Warning safety signs are to be posted with restricted access to essential personnel only.
- Adequate firefighting equipment must be present at site.

3.4.1 HSE Management

- All necessary safety precautions must be taken to avoid any risk of personnel injury.
- All personnel involved in this operational test shall be competent for the tasks they will be required to undertake
- Place safety / warning signs and segregate the entire area with barrier tapes (safety barriers) of a colour distinguished (blue and white) from those used for construction activities
- Restrict access into area only to authorized personnel
- Conduct "Toolbox Talk" with all personnel prior to starting test work
- Appropriate Personnel Protective Equipment (PPE) and safety equipment e.g. safety shoes, hand gloves, helmet, earplugs etc. are available and must be used in line with the site requirements. Flame retardant coveralls should be worn.
- ATEX Field radios or Walkie-Talkies will be required for communication during testing.
- Portable gas detectors to be used by all personnel after H2 introduction.
- All activities carried out on the project shall be performed in accordance with the "Permit to Work" system Doc. PRO-HSE-23
- Electrical and mechanical isolations are to be assured as per Doc. PRO-HSE-08 and "Commissioning and start-up operation" procedure.
- Observe and enforce all international codes and regulations to safeguard personnel, plant and environment.
- Ensure that the working area is clean, tidy, well illuminated and that access and escape routes are free from obstructions.

Before starting work on any of the activities in this OTP it is the responsibility of the persons performing the work to:

- Familiarize themselves with the plant/equipment to be worked on
- Ensure they are aware of all other work activities that are taking place, or due to take place
- If necessary, re-plan any situation/activity
- Ensure proper communications between parties involved in the execution of the OTP
- Read the relevant Vendor documentation for the equipment covered by this OTP and observe any special requirements and limitations recommended or imposed by Vendor
- Verify that all personnel involved in the implementation of this procedure are familiar with its content as well as the associated safety requirements (Toolbox Talk)

3.5 Acceptance Criteria

- Before Power ON:

Visual inspection and verification are a crucial step to identify any obvious issues with the installation, such as loose connections, missing components, or damage to the equipment.

Crosschecking the installation with engineering documentation ensures that the installation is done correctly and according to the manufacturer's guidelines. These steps can help identify any missing or incorrect components, and wrong connections - – Refer to Vendor SAT chapters 7.1, through 7.4

All package ITRs to be completed & RFC issued for sub-system 80-00.

Apply padlocks on all necessary Breakers per LoTo Procedure.

Applicable locations:
- AC Power Distribution (BA20+UC50)
- Control System, Container #1 (LA01+UC20)
- Coolant Skid Cabinet, Container #1 (HE01+UC30
- DCDC Cabinets #1-6 (+UC01 to +UC06)
- Control System, Container #2 (LA01+UC31)
- Power Conversion Output, Container #2 (BA30+DA03)

See Ballard produced document "BLPH Project – Electrical Single Line Diagrams" – BPSE-ELE-BPH-DWG-00005

Powering ON the unit is an essential step to verify that the equipment is functioning correctly. Observing if everything is OK and any alarm will help detect possible errors or malfunctions.

Phase 1 (Not in the OTP) will prove correct (NOT PART OF THIS OTP):
- All piping (H2 and cooling) installed correctly.
- All cooling systems are filled correctly.
- Energization of the AUX circuits is successful; all the subsystems are working according to specification.
- All necessary Software updates are performed, and the package internal communication is proven successful.
- The safety critical functions integrated in the Hydrogen Fuel Cell package are working according to specification.

Phase 2 (Not in the OTP) will prove correct (NOT PART OF THIS OTP):
- All necessary Software updates are performed, and the package internal communication is proven successful.
- Functionality checks of the Package VFDs.
- The communication with the EMCS/PCS.
- The installation and functionality of the 6.6kv Trafo.

Phase 3 will prove correct:
- Completion of the Vendor SAT procedure.
- Functionality of the Hydrogen Fuell Cell package in coordination with Required Associated Subsystems packages on BLPH. (ONSHORE)

Phase 4 will prove correct:
- Functionality of the Hydrogen Fuel Cell package in coordination with the other packages on BLPH (OFFSHORE).

Performing the steps in this OTP as per engineering documents is crucial to ensure that the equipment is operating correctly and that it meets the desired design specifications. Observing the results will help identify any issues that may arise during the operation.

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Overall, following these steps shall provide a comprehensive and effective way to verify the equipment installation and functionality.

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4 DOCUMENTS REFERENCES AND ABBREVIATIONS

4.1 Reference Documents

4.1.1 Company Documents and Standards

Document ID	Document Title
[1] K559-2254-CG-PHI-001	Commissioning Philosophy
[2] K559-2254-EL-ELL-002	BLPH Electrical Load List (CCS MODE 2(A) 'HOT STANDBY')
[3] K559-2254-EL-ELL-003	BLPH Electrical Load List (CCS MODE 3(C) 'DISCHARGING')
[4] K559-2254-EL-ELL-004	BLPH Electrical Load List (CCS MODE 4(A) 'COLD STANDBY')
[5] K559-2254-EL-ELL-005	BLPH Electrical Load List (CCS MODE 4A(D) 'EMERGENCY MODE (Island))
[6] K559-2254-EL-ELL-006	BLPH Electrical Load List (CCS MODE 5(D) 'POWER OUT (Blackout))
[7] K559-2254-PR-PHI-001	Main process control philosophy

Table 1: Company Documents and Standards

Note – These documents were produced in FEED and made available to RM for info. They have subsequently been superseded by Detailed Design, similar or same deliverables.

4.1.2 Project Documents

Document ID	Document Title
[1] 123A90-PML-PM-LIS-01001	Master Document Register
[2] 123A90-PML-PM-PL-00001	Project Execution Plan
[3] 123A90-PML-QHSE-PL-00001	Project HSE Plan
[4] 123A90-PRO-HSE-23	RM Yard Permit To Work Procedure
[5] 123A90-PML-COM-PL-03002	Mechanical Completion & Commissioning Exec. Plan
[6] 123A90-PML-COM-PRO-03007	Commissioning Strategy
[7] 123A90-PML-COM-LIS-03011	System/Sub-Systems List
[8] 123A90-PML-COM-LIS-03012	System/Sub-System Boundary Limit Diagrams
[9] 123A90-PML-COM-PRO-03038	Leak Test Procedure
[10]123A90-PML-COM-SP-03032	Pre-Commissioning Functional Test Sheet Template Collection (ITR-B)
[11]123A90-PML-COM-SP-03014	Commissioning TDS - Temporary Equipment & Facilities
[12]123A90-PML-COM-PRO-03019	OTP – Onshore Performance & Integrated Test Procedure
[13]123A90-PML-COM-LIS-03034	Inhibit-Override Register

Document ID	Document Title
[14]123A90-PML-COM-LIS-03035	PSV Calibration Register
[15]123A90-PML-COM-PRO-03036	OTP - Black Start Procedure
[16]123A90-PML-COM-LIS-03024	Commissioning Spare Parts and Consumables List
[17]123A90-PML-COM-PRO-03022	Initial offshore START-UP procedures
[18]123A90-PML-COM-SP-03057	Worksite WEF (Work Execution Flow Scheme)
[19]123A90-PML-COM-SP-03058	Site WEF (Work Execution Flow Scheme)
[20]123A90-PML-COM-RE-03001	Commissioning Final Dossier (ITR-B)
[21]123A90-PML-QHSE-PRO-00116	Flushing and Cleaning Procedures
[22]123A90-PML-QHSE-SP-00118	Mechanical Completion Check Sheet Template Collection (ITR-A)
[23]123A90-PML-QHSE-RE-00115	Mechanical Completion Final Dossier (ITR-A)
[24]123A90-PML-QHSE-PRO-00117	Punch list Management Procedure
[25]123A90-PML-COM-PRO-03041	OTP - Hydrogen Storage & Venting Systems
[26]123A90-PML-COM-PRO-03042	OTP - Sea Water Intake & Fresh Water Treatment Systems
[27]123A90-PML-COM-PRO-03043	OTP - Instrument Air System
[28]123A90-PML-COM-PRO-03055	OTP - Nitrogen Generation System
[29]123A90-PML-COM-PRO-03044	OTP - HVAC Systems
[30]123A90-PML-COM-PRO-03045	OTP - HV Switchgear & 66 kV Transformer Systems
[31]123A90-PML-COM-PRO-03046	OTP - 6.6 kV Switchgear & Transformer Systems
[32]123A90-PML-COM-PRO-03047	OTP - LV Switch Board & LV Distribution Board Systems
[33]123A90-PML-COM-PRO-03048	OTP - Lighting & Small Power Systems
[34]123A90-PML-COM-PRO-03049	OTP - Electrical Heat Tracing Systems
[35]123A90-PML-COM-PRO-03050	OTP - UPS Systems
[36]123A90-PML-COM-PRO-03051	OTP - Data Network Systems
[37]123A90-PML-COM-PRO-03052	OTP - Telecom & Surveillance Systems
[38]123A90-PML-COM-PRO-03053	OTP - Navaid System
[39]123A90-PML-COM-PRO-03054	OTP - F&G and ESD C&E Logics
[40]123A90-PML-QHSE-PRO-00120	Proverlis Management Procedure
[41]123A90-PML-COM-PRO-03056	OTP – Document Template
[42]123A90-DDL-IN-RE-40095	Process Control Logics Description

Table 2: Reference Project Deliverables

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4.1.3 Vendor Documents

Document ID	Document Title
[1] K559-2254-CWIWP4202202-C06-001Rev007	Electrical Single Line Diagram
[2] K559-2254-CWIWP4202202-B01-001Rev009	General Arrangement
[3] K559-2254-CWIWP4202202-N01-001Rev001	Integration Manual
[4] K559-2254-CWIWP4202202-N01-002Rev002	Operators Manual
[5] K559-2254-CWIWP4202202-E03-007Rev001	Electrical Interface Document
[6] K559-2254-CWIWP4202202-K03-001Rev001	Performance Test Results (FAT)
[7] K559-2254-CWIWP4202202-J99-001-Rev003	SAT Procedure
[8] K559-2254-CWIWP4202202-C08-001Rev004	Control Philosophy & Block Logic Diagrams
[9] K559-2254-CWIWP4202202-J99-009	Method Statement

Table 3: Company Key Reference Documentation

4.2 Acronyms and Abbreviations

Acronyms / Abbreviations	Description
BLPH	BaseLoad Power Hub
CO	Carbon monoxide
EMCS	Electrical Monitoring & Control System
ESD	Emergency Stop Devices
FAT	Factory Acceptance Test
FTE	Full Time Employees
F&G	Fire and Gas
PPE	Personal Protective Equipment
ITR	Inspection & Test Record
LOTO	Lock Out Tag Out
OTP	Operational Test Procedure
PCS	Power Conversion System
SAT	Site Acceptance Test
SOC	State Of Charge

Table 1: Acronyms and Abbreviations

5 OTP AT ONSHORE WORKSITE

This chapter refer to the activities on the Contractor worksite (construction yard).

5.1 Planning and Manpower

5.1.1 Planned tasks with estimated manpower

Estimated manpower for the different phases of the OTP are:

- 2 Vendor FTE.
- 1 Commissioning Supervisor from Company
- 1 Commissioning Supervisor from Contractor
- 1 Operator from EMCS vendor
- 1 Operations Engineer from Company.

5.1.2 Pre-Commissioning duration estimate:

- **PHASE 1:** 12 days approx. (Not in the OTP)
- **PHASE 2:** 12 days approx. (Not in the OTP)

5.1.3 Test duration estimate

The test duration should be as follows:

- **PHASE 3:** 3 days approx.
- **PHASE 4:** 2 days approx.

If necessary, the estimated time can be extended in order to complete all required pre-commissioning and commissioning activities.

5.1.4 Vendor Assistance

Vendor Ballard will lead and/or supervise the onshore commissioning activities. For offshore commissioning Ballard will provide remote support.

5.1.5 Summary of interface signals to be tested:

Please refer to the following documents;

- **BPSE-INN-BPH-REG-00006** – Modbus Table
- **BPSE-INN-BPH-OTH-00012** - BLPH - FC Package Modbus Table

5.2 OTP Test Requirements – Onshore WORKSITE

5.2.1 Pre-Commissioning Achievement

Prior to commencement of commissioning activities, the relevant pre-commissioning documentation be fully signed.

5.2.2 Commissioning Achievement

The commissioning achievement will be the full successful operation, functionality and integration of the Hydrogen Fuel Cell package installed on BLPH.

5.2.3 Status of Required Associated Subsystems

- PHASE 3

Subsystems required RFC for Commissioning of the Hydrogen Fuel Cell Package

- 83-00 400V Switchboard SG200N1
- 83-00 Auxiliary power supply
- 83-20 Distribution board
- 88-00: Earthing System
- 83-99: Temporary Yard 400/230V Main and auxiliary power supplies
- 87-00: EMCS
- 87-10: PCS
- 82-00: MV 6.6 kV Switchboard (SG-100D1)
- 82-10: Power Transformer 1.25 MVA
- 82-99: MV 6.6 kV Temporary Yard Supply Integrated Test
- 70-00: F&G Control System
- 79-00: Emergency Shutdown Systems (SIS)
- 25-01 to 25-08 (Partial): Hydrogen Storage Vessels & Header
- 43-00: Hydrogen Vent Header and Drum System
- 55-01: Waste Water Brine Discharge System

- PHASE 4

- Subsystems required RFC for OFFSHORE Commissioning of the Hydrogen Fuel Cell Package
- 83-00 400V Switchboard SG200N1
- 83-00 Auxiliary power supply
- 83-20 Distribution board
- 88-00: Earthing System
- 87-00: EMCS
- 87-10: PCS
- 82-00: MV 6.6 kV Switchboard (SG-100D1)
- 82-10: Power Transformer 1.25 MVA
- 70-00: F&G Control System
- 79-00: Emergency Shutdown Systems (SIS)
- 25-01 to 25-08: Hydrogen Storage Vessels & Header
- 43-00: Hydrogen Vent Header and Drum System
- 55-01: Waste Water Brine Discharge System
- 81-20: Power Transformer 7 MVA (TR-100AD1)
- 81-10: GIS 66 kV (HNA6-AFA70)
- 81-00: 66 kV Subsea Cable

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5.2.4 Special Tools & Test Equipment

The following special tool and Test Equipment are required:

S.No.	DESCRIPTION	QTY
1	General PPE	3
2	Various tools for electrical wiring	1
3	Various tools for mechanical installation	1
4	H2 Sniffer - Sewerin Snooper Mini H2	1
5	Pressure sensor - Fluke 700RG07 500PSIG	1
6	Test gas - Formier gas 5% hydrogen	1
7	Sniffer test station - Sewerin SPE-HG	1
8	Pressure regulator	1
9	Pressure relief valve	1
10	Smoke generator for fire detector test	1
11	H2 test gas for detector test	1
12	Coolant pumping/filling equipment	1
13	CE multitester	1
14	Multimeter	1

- H2 Sniffer - Sewerin Snooper Mini H2, Detection instrument to sniff/locate source of potential leaks.
- Pressure sensor - Fluke 700RG07 500PSIG, measuring device to accurately adjust and monitor gas pressure during leakage test.
- Test gas - Formier gas 5% hydrogen. Test gas for pressurizing pipework where the 5% hydrogen acts as tracer agent for sniffing
- Sniffer test station - Sewerin SPE-HG. Test instrument that emits a reference gas to check the correct function of the Snooper Mini H2 sniffer.
- Pressure regulator, Test gas pressure regulator for pressurizing the DUT.
- Pressure relief valve, Safety valve to ensure safe pipework pressurization during test.

TESTING & MEASUREMENT INSTRUMENT USED			
Type	Serial N.	Calibration certificate	Validity

5.2.5 Commissioning Spare Parts

HOLD 2

5.2.6 Temporary Facilities

Phase 3: Temporary emergency stop and/or fire and gas detection may be required if deemed necessary after suitable risk assessment. This will depend on the availability of interacting sub-systems.

If a temporary H2 connection is provided by Rosetti to ensure testing can progress this will be subject to a separate risk assessment & permit for installation/operation.

5.3 OTP Description – Onshore WORKSITE

5.3.1 OTP Test Preparation

Step	Description	Result	Verified by	Date
1	System Ready for Commissioning Certificate (RFC) is issued and approved.	✓		04.07.25
2	No Mechanical Completion or Pre-commissioning punch list 'A' items are outstanding against the system to be commissioned.	✓		"
3	Factory Acceptance Test Procedure has been carried out successfully (refer to Doc. K559-2254-CWIWP4202202-K03-001Rev001)	✓		"
4	All personnel involved in the implementation of this procedure are familiar with its content as well as with associated safety requirements (Toolbox Talk to be conducted before initiation of activities).	✓		"
5	A final walkdown of the system has been completed, to ensure that the system and the area are ready for commissioning.	✓		"
6	Check that areas are free for work and escape routes are clear of any obstructions.	✓		"
7	All safety barriers and warning signs have been installed.	✓		"
8	Ensure that proper communications have been established between parties involved in the implementation of the procedure.	✓		"
9	Verify availability of test equipment and spares as per section 5.2.	✓		"
10	With reference to Commissioning Temporary equipment & Facilities (refer on Doc. 123A90-PML-COM-SP-03014), check that power is available to any temporary equipment or test equipment (if any).	✓		"
11	System(s) isolations as per LOTO procedure defined within HSSE Permits to Work and Commissioning procedures duly prepared and approved	✓		"
12	All yard personnel have been duly notified by dedicated LUN (Livening Up Notification) that the system(s) is ready for commissioning.	✓		"

Step	Description	Result	Verified by	Date

5.3.2 Electrical Preparation

Step	Description	Result	Verified by	Date
1	Check related punch list 'B' items and confirm acceptability for start of commissioning activities.	✓	G. [illegible]	4-7-25
2	Verify that all relevant associated systems / subsystems are completed.	✓	[illegible]	"
3	Check that grounding and bonding are in accordance with applicable documents.	✓	[illegible]	"
4	Verify and confirm the correct circuit breaker protection settings according to latest protection study revision.	✓	[illegible]	"
5	Verify and confirm the completion of the final connections between the LV 400V Switchboard and the FC, the MV 6.6kV and FC, and the EMCS.	✓	[illegible]	"
6	Assess the need for additional temporary F&G or E-Stop protection during ONSHORE phases and implement necessary changes.	✓	G. [illegible]	"

5.3.3 Mechanical Preparation

Step	Description	Result	Verified by	Date
1	Check the correct flow direction of the valves.	✓	G. [illegible]	4-07-25
2	Confirm leak testing is complete and documented.	✓	G. [illegible]	"
3	Ensure package PSV setpoints are correct for the designed operating pressure.	✓	G. [illegible]	"
4	Ensure all unnecessary isolations are removed and package is ready to receive hydrogen.	✓	G. [illegible]	"

5.3.4 Instrument Preparation

Step	Description	Result	Verified by	Date
1	Check related punch list 'B' items and confirm acceptability for start of commissioning	✓	[illegible]	4-7-25

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Step	Description	Result	Verified by	Date
	activities.			
2	Verify that all relevant associated systems / subsystems are ready.	✓		4-7-25
3	Check Inhibit and Override register has been prepared and validated.	✓		"
4	Verify that relevant equipment/ components are available and in operation for start of commissioning activities.	✓		"
5	Verify availability of test equipment as per section 5.2.4.	✓		"

5.3.5 Piping Preparation

Step	Description	Result	Verified by	Date
1	Ensure Process Water drain connection is correctly connected to the Rosetti system	✓		4-7-25
2	Ensure H2 supply connection is correctly connected from the Rosetti system	✓		4-7-25
3	Review Rosetti flange management and confirm all interface connections have been torqued and leak tested with details recorded and signed for.	✓		4-7-25
4	Ensure Blind flange/ positive isolation is in place at test boundary.	✓		4-7-25

5.3.6 Additional Discipline Preparation

Not applicable.

5.4 Test Steps – Onshore WORKSITE - PHASES 1-2 (NOT PART OF THIS OTP)

The previous chapters must be successfully performed prior to commissioning of the Hydrogen Fuel Cell Package.

Please refer to the following documents for Phase 1-2 pre-commissioning Onshore activities:

- Method Statement, Doc No: K559-2254-CWIWP4202202-J99-009.
- SAT Procedure, Doc No: K559-2254-CWIWP4202202-J99-001

5.4.1 OTP Steps WORKSITE - PHASE 3

It is foreseen that previous sections are successfully performed.

Please refer to SAT document K559-2254-CWIWP4202202-J99-001 ***section 7 and 8*** for Phase 3 commissioning Onshore activities.

5.4.2 OTP Steps WORKSITE - PHASE 4

It is foreseen that previous sections are successfully performed.

In the following steps the functionality of the Hydrogen Fuel Cell package shall be tested for operation in all BLPH operating modes.

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Hydrogen Fuel Cell Integrated Testing ONSHORE

Step	Description	Result	Verified by	Date
Fuel Cell operating modes to be controlled from PCS via ECMS.				
1	Confirm on PCS that CCS operating mode is in "IDLE". Confirm Fuel Cell Package is in sleep mode.	✓	S. M	5-7-25
2	On PCS, change CCS operating mode to "IMPORT". Confirm no change at Fuel Cell package.	✓	"	"
3	On PCS, change CCS operating mode to "HOT STANDBY". Confirm Fuel Cell is now in Standby mode.	✓	"	"
4	Confirm H2 storage is available. This requires a reading of ≥ 20 barg on at least one of the following pressure transmitters: • 25-PT-035 • 25-PT-037 • 25-PT-040 • 25-PT-043 • 25-PT-046 • 25-PT-049	✓	"	"
NOTE: Pressure control via valves 25-PV-055A & 25-PV-055B should already be successfully tested via Hydrogen Venting & Storage OTP 123A90-PML-COM-PRO-03042				
5	On PCS, change CCS operating mode to "EXPORT". Confirm Fuel Cell status changes to running.	✓	"	5-7-25
6	Confirm that power output can be controlled via the EMCS over modbus. Test power output at increments of 0.25MW up to and including 1MW.	✓	"	"
7	On PCS, change CCS operating mode to "COLD STANDBY". Confirm Fuel Cell shuts down and returns to Sleep mode.	✓	"	"
8	On PCS, change CCS operating mode to "EMERGENCY (Island Mode)". Confirm Fuel Cell recommences discharge of power.	✓	"	14-7-25
9	On PCS, change CCS operating mode to "MAINTENANCE". Confirm Fuel Cell can only be operated locally.	✓	"	14-7-25

Step	Description	Result	Verified by	Date
10	On PCS, return CCS operating mode to "EXPORT". Initiate Fuel Cell F&G event via 1 of the 3 hydrogen detectors located inside the container and confirm the following: • Safety trip of all 6 FC Wave modules. • All hydrogen safety valves are closed. • Safe Torque Off of all Power Converters • Safe Torque Off of all Motor Drives	✓		05.7.25
11	On PCS, return CCS operating mode to "EXPORT". Operate the Fuel Cell Package Emergency Stop and confirm the following: • Safety trip of all 6 FC Wave modules. • All hydrogen safety valves are closed. • Safe Torque Off of all Power Converters • Safe Torque Off of all Motor Drives	✓		05.7.25

Full details of the EMCS HMI control graphics can be found in Document Number: 123A90-DDL-EL-SP-20039 Functional and Technical Design Specification, IDS and DDS for Electrical Monitoring and Control System (EMCS)

Hydrogen Fuel Cell Integrated Testing ONSHORE Notes and Remarks

TESTING CARRIED OUT ALONGSIDE OIT OTP. FUEL CELL WAS RAMPED UP FROM 300KW TO 1MW AND THEN BACK DOWN TO 300KW. BEFORE DISCONNECTING.
THE FUEL CELL WAS NOT USED BELOW 300KW DUE TO INSTABILITY OF THE BLPH CONTROL VALVES.
DURING RAMP UP AND DOWN THE FUEL CELL WAS CONTROLLED IN 100KW INCREMENTS.
PLEASE REFER TO THE OIT OTP FOR MORE INFORMATION.

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5.4.2.1 Hydrogen Fuel Cell Integrated Testing ONSHORE - Certifying Authority Table of Attendances

Name and Surname	Certifying Authority	Position	Signature
S. Mackloet			

5.4.2.2 Hydrogen Fuel Cell Integrated Testing ONSHORE - Final Signatures and Company Acceptance

Name and Surname	Company Representative	Position	Signature
S. Mackloet	CW	OPS ENGINEER	
Gedas Paukaysteis	Ballard	Service Tech.	
Anthony Wesson	R.M.	Commissioning MGR.	

5.5 Post-test Conditions

Throughout Phase 1 to 4, AUX power shall be maintained active to ensure monitoring of the package and functionality of its safety features.
All other sub-systems shall be de-energized and, if deemed necessary, LOTO.
No AUX power will be provided during sea transport.

5.6 Reinstatement and Preservation Tasks

Generally, the system/ sub-system shall be reinstated at its initial condition; and the following activities must be carried out as minimum:

- all inhibition performed for the test shall be removed (as per Inhibit / Override List)
- all equipment/devices shall be returned in healthy functional conditions.

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6 OTP AT SITE

6.1 Planning and Manpower

6.1.1 Offshore Site overview

It is expected that all pre-commissioning tests, systems energization and commissioning steps will have been successfully performed during the Onshore Phases.
Consequently, during the offshore SITE phase, the respective systems will be inspected prior to re-energization. No additional test steps will be required on these items of equipment, correct operation and functioning will be verified.

6.1.2 Planned tasks with estimated manpower

Estimated manpower for the entire duration of the Test:

- 1 Operations Engineer from Client
- 1 Commissioning representative from Client
- 1 operator from EMCS vendor
- 1 Supervisor from Contractor

6.1.3 Test duration estimate

The test duration should be as follows:

- 2 days approx.

If necessary, the estimated time can be extended to complete all required pre-commissioning and commissioning activities.

6.1.4 Vendor Assistance

- For offshore commissioning Ballard will provide remote support.

6.1.5 Items Postponed to C&E OTP

- Not Applicable

6.1.6 HOLDS

- Not Applicable

6.2 OTP Test Requirements – Offshore SITE

6.2.1 Pre-Commissioning Achievement

- Not applicable

6.2.2 Commissioning Achievement

The commissioning achievement will be the full successful operation, functionality and integration of the Hydrogen Fuel Cell package installed on BLPH.

The successful commissioning result, achieved during the WORKSITE commissioning phase for the functionality and safeguard of the Hydrogen Fuel Cell Package, will allow for a smoother commissioning phase of the offshore SITE.

- The systems and subsystems involved:
- 83-00 400V Switchboard SG200N1
- 83-00 Auxiliary power supply
- 83-20 Distribution board
- 88-00: Earthing System
- 87-00: EMCS
- 87-10: PCS
- 82-00: MV 6.6 kV Switchboard (SG-100D1)
- 82-10: Power Transformer 1.25 MVA
- 70-00: F&G Control System
- 79-00: Emergency Shutdown Systems (SIS)
- 25-01 to 25-08: Hydrogen Storage Vessels & Header
- 55-01: Waste Water Brine Discharge System
- 81-20: Power Transformer 7 MVA (TR-100AD1)
- 81-10: GIS 66 kV (HNA6-AFA70)
- 81-00: 66 kV Subsea Cable

6.2.3 Status of Required Associated Subsystems

The systems involved has been already energized and commissioned in WORKSITE Phase

6.2.4 Special Tools & Test Equipment

The following special tool and Test Equipment are required:

S.No.	DESCRIPTION	QTY
1	General PPE	3
2	Various tools for electrical wiring	1
3	Various tools for mechanical installation	1
4	H2 Sniffer - Sewerin Snooper Mini H2	1
5	Pressure sensor - Fluke 700RG07 500PSIG	1
6	Test gas - Formier gas 5% hydrogen	1
7	Sniffer test station - Sewerin SPE-HG	1
8	Pressure regulator	1
9	Pressure relief valve	1
10	Smoke generator for fire detector test	1
11	H2 test gas for detector test	1
12	Coolant pumping/filling equipment	1
13	CE multitester	1
14	Multimeter	1

- H2 Sniffer - Sewerin Snooper Mini H2, Detection instrument to sniff/locate source of potential leaks.
- Pressure sensor - Fluke 700RG07 500PSIG, measuring device to accurately adjust and monitor gas pressure during leakage test.
- Test gas - Formier gas 5% hydrogen. Test gas for pressurizing pipework where the 5% hydrogen acts as tracer agent for sniffing
- Sniffer test station - Sewerin SPE-HG. Test instrument the emits a reference gas to check the correct function of the Snooper Mini H2 sniffer.
- Pressure regulator, Test gas pressure regulator for pressurizing the DUT.

- Pressure relief valve, Safety valve to ensure safe pipework pressurization during test.

TESTING & MEASUREMENT INSTRUMENT USED			
Type	Serial N.	Calibration certificate	Validity

6.2.5 Consumable List

- Not applicable

6.2.6 Commissioning Spare Parts

HOLD 2

6.2.7 Temporary Facilities

- Not applicable

6.3 OTP Description – SITE

The SITE test will consist of a repeat of the onshore integration testing with the BLPH now installed situ to it's permanent connections. In the following steps the functionality of the Hydrogen Fuel Cell package shall be tested for operation in all BLPH operating modes.

6.3.1 OTP Test Preparation

Step	Description	Result	Verified by	Date
1	System Ready for Operation (RFO) Certificate is issued and approved.	✓	G. Mll	4-7-25
2	No blocking punch list items are outstanding against the system to be commissioned.	✓	G. Mll	"
3	System(s), (de)isolations as per LOTO procedure enclosed within commissioning Work Permits procedures prepared and approved	✓	G. Mll	"
4	Verify and confirm that all steps performed at WORKSITE of this procedure are completed without any pending issues that would prevent from proceeding with the offshore SITE PROCEDURE	✓	G. Mll	"

Step	Description	Result	Verified by	Date
5	All personnel involved in the implementation of this procedure are familiar with this procedure as well as with associated safety requirements (Toolbox Talk to be conducted before initiation of activities).	✓		4.7.25
6	A final walkdown after hook-up of the system has been completed, any preservation items have been removed and to ensure that the system and the area are ready for energization.	✓		"
7	Check that areas are free for work and escape routes are clear of any obstructions.	✓		"
8	Ensure that proper communications have been established between parties involved in the implementation of the procedure.	✓		"
9	Verify availability of test equipment and consumables as per chapters 6.2.4.	✓		"
10	All personnel have been duly notified during dedicated daily SIMOPS meetings that the system(s) is ready for operation.	✓		"

6.3.2 Electrical Preparation

Step	Description	Result	Verified by	Date
1	No blocking punch list items are outstanding against the system to be commissioned.	✓		4.7.25
2	Review and confirm no changes are required to be performed on existing protection settings.	✓		"

6.3.3 Mechanical Preparation

Step	Description	Result	Verified by	Date
1	No blocking punch list items are outstanding against the system to be commissioned.	✓		4.7.25
2	Ensure Fuel Cell package correctly connected to upstream H2 supply.	✓		"
3	Ensure Fuel Cell package correctly connected to downstream process waste water line.	✓		"

6.3.4 Instrument Preparation

Not applicable.

6.3.5 Piping Preparation

Not applicable

6.3.6 Additional Discipline Preparation

Not applicable.

6.4 OTP Test Steps – Offshore PHASE 4

The previous chapters must be successfully performed prior to final operational test of the Hydrogen Fuel Cell

6.4.1.1 Hydrogen Fuel Cell Integrated Testing OFFSHORE

Step	Description	Result	Verified by	Date
	Hydrogen Fuel Cell operating modes to be controlled from PCS via ECMS.			
1	Confirm on PCS that CCS operating mode is in "IDLE". Confirm Fuel Cell Package is in sleep mode.			
2	On PCS, change CCS operating mode to "IMPORT". Confirm no change at Fuel Cell package.			
3	On PCS, change CCS operating mode to "HOT STANDBY". Confirm Fuel Cell is now in Standby mode.			
4	Confirm H2 storage is available. This requires a reading of ≥ 20 barg on at least one of the following pressure transmitters: • 25-PT-035 • 25-PT-037 • 25-PT-040 • 25-PT-043 • 25-PT-046 • 25-PT-049			
	NOTE: Pressure control via valves 25-PV-055A & 25-PV-055B should already be successfully tested via Hydrogen Venting & Storage OTP 123A90-PML-COM-PRO-03042			
5	On PCS, change CCS operating mode to "EXPORT". Confirm Fuel Cell status changes to running.			
6	Confirm that power output can be controlled via the EMCS over modbus. Test power output at increments of 0.25MW up to and including 1MW.			
7	On PCS, change CCS operating mode to "COLD STANDBY". Confirm Fuel Cell shuts down and returns to Sleep mode.			
8	On PCS, change CCS operating mode to "EMERGENCY (Island Mode)". Confirm Fuel Cell recommences discharge of power.			

Step	Description	Result	Verified by	Date
9	On PCS, change CCS operating mode to "MAINTENANCE". Confirm Fuel Cell can only be operated locally.			
10	On PCS, return CCS operating mode to "EXPORT". Initiate Fuel Cell F&G event via 1 of the 3 hydrogen detectors located inside the container and confirm the following: • Safety trip of all 6 FC Wave modules. • All hydrogen safety valves are closed. • Safe Torque Off of all Power Converters Safe Torque Off of all Motor Drives			
11	On PCS, return CCS operating mode to "EXPORT". Operate the Fuel Cell Package Emergency Stop and confirm the following: • Safety trip of all 6 FC Wave modules. • All hydrogen safety valves are closed. • Safe Torque Off of all Power Converters Safe Torque Off of all Motor Drives			

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6.4.1.2 Hydrogen Fuel Cell Integrated Testing OFFSHORE Notes and Remarks

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6.4.1.3 Hydrogen Fuel Cell Integrated Testing OFFSHORE - Certifying Authority Table of Attendances

Name and Surename	Certifying Authority	Position	Signature

6.4.1.4 Hydrogen Fuel Cell Integrated Testing OFFSHORE - Final Signatures and Company Acceptance

Name and Surname	Company Representative	Position	Signature
Name and Surename	**Certifying Authority**	**Position**	**Signature**

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6.5 Post-test Conditions

After functional tests have been completed, system / sub-systems are left in healthy and safety condition and operational.

6.6 Reinstatement tasks

Generally, the system/ sub-system shall be reinstated at its initial condition; and the following activities must be carried out as minimum:

- all inhibition done for the test shall be removed (as per Inhibit / Override List)
- all equipment/devices shall be returned in healthy functional conditions.

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7 APPENDICES

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7.1 Vendor SAT Procedure

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7.2 Proverlis Summary System Reports

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7.3 Equipment Related Technical Queries

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7.4 As Built Documentation

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7.5 Management of Change – Summary Table of Tasks and Details of Affected Related Documentation

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Short Title	Megablock Site Acceptance Test
Full Title	Megablock Site Acceptance Test
Abstract	*Site acceptance test for verification of full Megablock system*

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Revision Record

Rev #	Description	Revised By	Date (dd-mm-yyyy)
-	Initial Release	RKN	28-05-2024
1	General updates	RKN	28-06-2024
1.1	General updates	TAN	18-09-2024
2	Update prior to release to CW	PBL	16-10-2024
3	Updates based on review with CW	RKN	19-11-2024
4	Updates based on review with CW	RKN	09-01-2025

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1.0 Executive Summary

This document outlines the recommended commissioning activities and site acceptance tests. These tests aim to verify correct installation, and that the system performance onsite matches the performance level shown during FAT. There should be no CAT A items outstanding prior to power up.

2.0 References

- Confirmation of Satisfactory SAT - Signature Page
- PWR008 Ballard commissioning document
- EN 60204 Electrical safety test 10ft
- EN 60204 Electrical safety test 40ft
- EN 60204 Electrical safety test Cng Pltfrm
- F07 & F08, Electrical safety SAT
- F10 Safety checklist
- SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure
- SPC ID 0104 H2 Leak Test Procedure
- SPC ID 0106 Noise Level Measurement Test Procedure
- SPC ID 0204 System pressure decay test template

3.0 Definitions and Acronyms

FC	FCwave™
H2	Hydrogen
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
HT1	High temperature 1050kW cooling system 1
HT2	High temperature 1050kW cooling system 2
LT	Low temperature cooling system

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4.0 Objectives and Background

The tests in the document are based on the test matrix in document J99-02 (Aconex K559-2254-CWIWP4202202-J99-002-Rev002)

This document describes the witnessed Site Acceptance Tests. The tests do not include the internal testing that has been done to secure product maturity, mechanical and electrical connections have been done correctly.

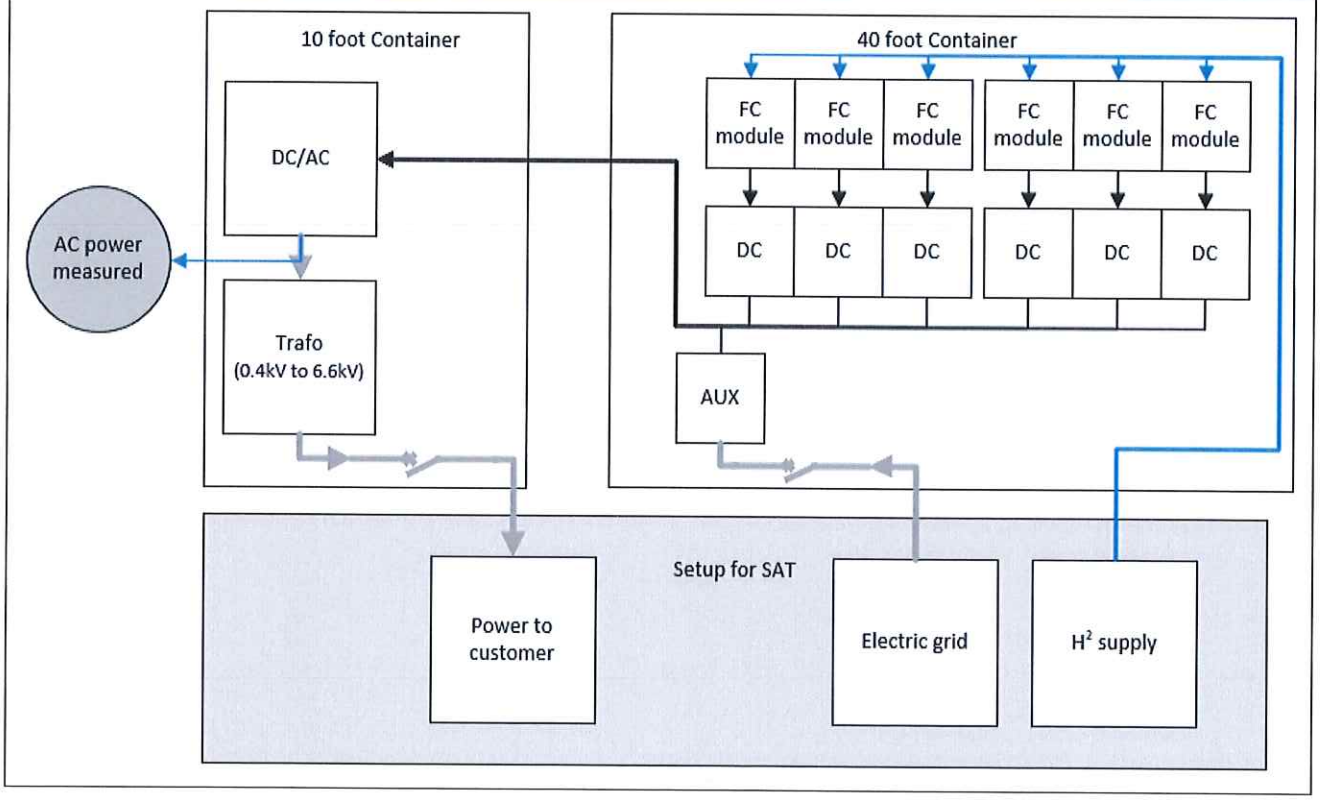
The SAT is not intended to replace an integration test. If third-party features are not yet ready for testing, those specific test cases will be temporarily excluded from the SAT and should be performed during integration testing. This will not affect the overall SAT signoff.

There should be no CAT A items outstanding prior to power up.

The scope of testing is:

- Visual Inspection of the delivered product (Tri-party walkaround)
- Verification of safety systems for the Megablock.
- Production of electrical power to the customer grid to verify performance.

Figure 1: Megablock System test overview



5.0 Note on Power Quality Measurements

The power quality measurements are indicative during SAT, as the measured power quality depends also on the customer load dissipating the produced power. Ballard is also not capable of measuring power quality on the 6.6kV bus, and any measurements are done on the 400V side of the output transformer. This results in lower measurements than on the medium voltage side of the output transformer, as the transformer inductance is an integral part of the harmonic dampening of the FC package.

Power quality measurements have been removed from pass/fail criteria.

6.0 Note on Electrical Load

The electrical load that is to dissipate the power generated by the FC package is not in Ballard scope. During step response tests and full load tests, it is required that it is present and able to absorb the power from the FC package.

7.0 Functional tests

7.1 F02 Visual inspection

7.1.1 Test

The test involves an examination of the paint job through visual inspection, assessing the overall build quality, and checking for any dents. The focus is also on evaluating the assembly quality to ensure compliance with weather resistance.

This test is superseded by the tri party walkaround.

7.1.2 Relevant Standard / document

- No reference

7.1.3 Brief Test Plan

- Visual inspection with customer of full system, meaning inside and outside container solution.
- Take comprehensive pictures of the full system and test setup, including close-ups of vital components, with timestamps for reference.

7.1.4 Pass/Fail criteria.

- Visual inspect with customer to review quality of full system.

7.1.5 Test Result

Table 1: Visual inspection – Test Result

Date tested	Item	Result	Pass/Fail	Notes
04/06/25	40' Container	ok	Pass	Rob Bleth
04/06/25	10' Container	ok	Pass	Peter Bleth
04/06/25	Cooling Skid	ok	Pass	Peter Bleth

Rob Bleth 09/06 '25

7.2 F07 Electrical safety test – 10-foot container

7.2.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.2.2 Relevant Standard / document

- EN 60204 Electrical safety test 10ft
- F07 & F08, Electrical safety SAT

7.2.3 Brief Test Plan

- According to EN 60204-1

7.2.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.2.5 Test Result

Table 2: Electrical safety test - Test results

Date tested	Item	Result	Pass/Fail	Notes
06/02/25	Grounding Continuity	OK	Pass	See test sheet
06/02/25	Isolation resistance	OK	Pass	See test sheet.

Pedro Blanch 04/06/'25

Table 3: Electrical safety test - calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
	086 – 003	2025-06-04	Tests F07 & F08

7.3 F08 Electrical safety test – 40-foot container

7.3.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.3.2 Relevant Standard / document

- EN 60204 Electrical safety test 40ft
- EN 60204 Electrical safety test Cng Pltfrm
- F07 & F08, Electrical safety SAT

7.3.3 Brief Test Plan

- According to EN 60204-1

7.3.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.3.5 Test Result

Table 4: Electrical safety test - Test Result

Date tested	Item	Result	Pass/Fail	Notes
06/02/25	Grounding Continuity	OL	Pass	See test sheet
06/02/25	Isolation Resistance	OL	Pass	See test sheet

Table 5: Electrical safety test - Calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
	086-003	2025-06-04	F08 & F07

Peter Blum
04/06/25

7.4 F10 Safety

7.4.1 Test

Conduct tests of safety inputs and outputs, including emergency stop buttons, smoke detectors, gas detectors and external connections.

7.4.2 Relevant Standard / document

- F10 Safety checklist

7.4.3 Brief Test Plan

- Trigger each safety input according to checklist.
  - Emergency pushbuttons
  - Smoke detectors test
  - H2 sensor test
  - External safety switches
  - External feedback

7.4.4 Pass/Fail criteria.

- Verified according to checklist.
- Each item triggers the correct alarm

7.4.5 Test Result

Table 6: Safety - Test Result

Date tested	Item	Result	Pass/Fail	Notes
19/02/2025	Emergency pushbuttons	✓	PASS	✓
19/02/2025	Smoke detectors	✓	PASS	✓
19/02/2025	H2 sensors	✓	PASS	✓
19/02/2025	External safety switches	✓	PASS	ADDED 120 OHM RESISTOR
19/02/2025	External feedback	✓	PASS	✓

Peter Black
F. SORIGH
ROSETTI MARINO
04/02/25

Table 7: Safety – Calibration/Equipment

Unit	Equipment number	Calibration due date	Equipment used for
—	—	—	—

7.5 F18 H_2 Leakage test

7.5.1 Test procedure

All pipework and H2 instrumentation subassemblies must be inspected, recorded, verified and pass in accordance with the procedure in section 5.4 in *SPC ID 0104 H2 Leak Test Procedure Rev 002* prior to full system SAT.

System H2 leakage test is done system pressure decay test, according to section 5.5 in *SPC ID 0104 H2 Leak Test Procedure Rev 002.*

7.5.2 Pass/Fail criteria.

Pressure decay test with a maximum leakage no greater than specified in test procedure.

Result details are documented in the template *SPC ID 0204 System pressure decay test template*

Parameter	Value	Description
L_A [Nm^3/h]	**2,72 – 3,58 x10^{-3}**	**Maximum allowed pressure decay to pass pressure decay test, where L_A = L_S + L_Mu**
L_S [Nm^3/h]	0	Summarized expected leak rates of all components in the system (per design leak rate).
L_Mu [Nm^3/h]	2,72 – 3,58 x10^{-3}	Calculated accuracy of the measuring system, used to perform the test.
L_C [Nm^3/h]	2,7x10^{-5}	Maximum allowed leak rate for a given pipe section, where integrity/operability of the system may be maintained safely

7.5.3 Test Result

Table 8: H2 leakage - Test Result

Date tested	Item	Leakage rate L_1 [Nm^3/h]	Pass/Fail	Notes
19/2/25	H2 line 1	0	Pass	See test Sheet
19/2/25	H2 line 2	0	Pass	See test sheet
19/2/25	H2 line 3	0	Pass	See test Sheet
19/2/25	H2 line 4	0	Pass	See test sheet
19/2/25	H2 line 5	0	Pass	See test sheet
19/2/25	H2 line 6	0	Pass	See test Sheet

Pass DHell 04/06

8.0 Operational tests

Operations are done using operator HMI or remote HMI in normal operating mode.

8.1 O01 System Start/Stop - Normal low load operation.

8.1.1 Test

Fuel Cell system can start, deliver minimum power and perform controlled stop without faults. This test is based on DC power.

8.1.2 Relevant Standard / document

- No reference

8.1.3 Brief Test Plan

- All FC in standby
- Request 100kW DC
- Delay 120 seconds
- Request zero power
- Repeat with new preferred FC until all tested.

8.1.4 Pass/Fail criteria.

- Fuel Cell Package starts without faults.
- No persistent system alarms.
- Correct available power signal.
- DC Power output within +/-5% and stable in less than 60 seconds
- Fuel Cell Package stops without faults.
- Fuel Cell in stand-by in less than 120 seconds.

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8.1.5 Test Result

Table 9: System Start/Stop – Normal low load operation - Test Result

Date tested	Item	Result	Pass/Fail	Notes
14/6/25	FCwave 1	All pass criteria passed	pass	See below
14/6/25	FCwave 2	"	pass	"
14/6/25	FCwave 3	"	pass	"
14/6/25	FCwave 4	"	pass	"
16/6/25	FCwave 5	"	pass	"
16/6/25	FCwave 6	"	pass	"

Normal low load operation was tested during the conditioning of the modules on Sat June 14th + Monday June 16th.

Each FC module was ramped up from 0 - 200kW output. All 6 modules exceeded 200 kW.

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8.2 *O09 Load Test – step response 0 to ~~35%~~ 40%*

8.2.1 Test

Test step response by adding 35% load in one step from no load while measuring AC power quality.

8.2.2 Relevant Standard / document

- N/A

8.2.3 Brief Test Plan

- All FC in stand-by.
- Apply set point by requesting 350kW AC

8.2.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.2.5 Test Result

Table 10: Load Test - step response 0 to 35% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
04/07/2025	Step response 0-35%	—	Pass	—
	AC power quality		Indicative	

Gedas Paulauskas
Ballard

8.3 *O10 Load Test – step response ~~35~~ 40% to 70%*

8.3.1 Test

Test step response by adding 35% load in one step to reach 70% load while measuring AC power quality.

8.3.2 Relevant Standard / document

- N/A

8.3.3 Brief Test Plan

- 3 FC running delivering 350kW AC steady state.
- 3 FC in stand-by
- Apply set point by requesting 700kW AC power.

8.3.4 Pass/Fail criteria.

- No persistent system alarms.

8.3.5 Test Result

Table 11: Load Test - step response 35% to 70% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
05/04/2025	Step response 35%-70%	—	Pass	—
	AC power quality		Indicative	

Gedas Pocelauskas
Ballard
CW

8.4 O11 Load Test – step response 65% to 100%

8.4.1 Test

Test step response by adding 35% load in one step to reach full load while measuring AC power quality.

8.4.2 Relevant Standard / document

- N/A

8.4.3 Brief Test Plan

- 6 FC running delivering 650kW AC steady state.
- Apply set point by requesting 1000kW AC power.

8.4.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.4.5 Test Result

Table 12: Load Test - step response 65% to 100% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
05/07/2025	Step response 65%-100%	—	Pass	—
	AC power quality		Indicative	

Gedas Paulauskas
Ballard

8.5 O12 Load Test – 100% stability test - 1 hours.

8.5.1 Test

Test steady state at 100% load for 1 hours while measuring power quality.

This test is also dependent on the hydrogen supply for the system.

8.5.2 Relevant Standard / document

- N/A

8.5.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.

8.5.4 Pass/Fail criteria

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.5.5 Test Result

Table 13: Load Test – Steady state 100% load - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3-7-25	Full load test	100kw	Pass	—
	AC power quality		Indicative	

Gedas Paulauskas
Ballard
CW

8.6 O13 Load Test – step response 100% to 50%

8.6.1 Test

Test step response by removing 50% load in one step at full load while measuring power quality.

8.6.2 Relevant Standard / document

- N/A

8.6.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.
- Request 500kW AC.

8.6.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.6.5 Test Result

Table 14: Load Test - step response 100% to 50% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
05/04/2025	Step response 100%-50%	—	Pass	—
	AC power quality		Indicative	

Gedas Paukunkas
Ballard

8.7 O14 Load Test – step response 50% to 0%

8.7.1 Test

Test step response by removing 50% load in one step to no load while measuring AC power quality.

8.7.2 Relevant Standard / document

- N/A

8.7.3 Brief Test Plan

- 3-6 FC running delivering 500kW AC.
- Request 0% and apply set point.

8.7.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.7.5 Test Result

Table 15: Load Test - step response 50% to 0% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
05/04/2025	Step response 50%-0%	—	Pass	—
	AC power quality	n/a	n/a	Unit not producing power

Gedas Paukauskas
Ballard

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft Container, RM Yard, Ravenna
Test performed by	PBL, MKD

Grounding continuity
EN 60204-1:2018 - Section 18.2.2 - Test 1
Test performed with a test current of 10A

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	Busbar to busbar	0,024	Ohm	0,01
	Module 1	0,018	Ohm	0,015
	DC/DC cabinet 1	0,023	Ohm	0,006
	Module 2	0,024	Ohm	0,011
	DC/DC cabinet 2	0,019	Ohm	0,006
	Module 3	0,026	Ohm	0,017
	DC/DC cabinet 3	0,016	Ohm	0,006
	Module 4	0,026	Ohm	0,02
	DC/DC cabinet 4	0,016	Ohm	0,008
	Module 5	0,024	Ohm	0,013
	DC/DC cabinet 5	0,017	Ohm	0,006
	Module 6	0,029	Ohm	0,017
	DC/DC cabinet 6	0,015	Ohm	0,005
	Control cabinet	0,021	Ohm	0,014
	Control cabinet right door	0,032	Ohm	0,048
	Lifting crane track, dolly	0,028	Ohm	0,008
	LT piping	0,031	Ohm	0,022
	Isolation transformer cover	0,039	Ohm	0,015
	Cable tray	0,019	Ohm	0,012

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	Busbar to busbar	0,019	Ohm	0,007
	Main DC/Acpoint 1	0,032	Ohm	0,031
	Main DC/Acpoint 2	0,024	Ohm	0,014
	Main DC/Acpoint 3	0,027	Ohm	0,011
	DC/AC conduncter point 1	0,037	Ohm	0,007
	DC/AC conduncter point 2	0,022	Ohm	0,009
	DC/AC conduncter point 3	0,023	Ohm	0,006
	LT coolant pipe	0,024	Ohm	0,014
	Cable tray	0,02	Ohm	0,007
	Main transforer grounding bolt	0,023	Ohm	0,009
	Main transformer chassis	0,02	Ohm	0,007
	Cable tray MV cables	0,022	Ohm	0,011

Name and date: Abo Bkal June 4th

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft Vontainer, RM Yard, Ravenna
Test performed by	PBL, MKD

Isolation resistance
EN 60204-1:2018 - Section 18.3
Test performed with a test voltage of 1000V

Main location	Location	Measurement FAT	Unit	Measurement SAT
40 ft container	L1-PE	> 999.9	MOhm	> 999.9
	Cooling skid L1	10,01	Mohm	12,11
	Colling skid L2	6,252	Mohm	5,21
	Cooling skid L3	12,81	Mohm	10,12
	AUX supply L1	251	Mohm	316
	AUX supply L2	337	MOhm	364
	AUX supply L3	237	Mohm	248

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	L1+L2+L3-PE on AC circuit	592	Mohm	Transformer connected, RM scope

Name and date: Pablo Blah June 4th

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft container, RM Yard, Ravenna
Test performed by	PBL, MKD

Isolation resistance
EN 60204-1:2018 - Section 18.4
Test performed with a test voltage of 2500VAC

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	PE and L1	0	mA	0,6
	PE and L2	0	mA	0,6
	PE and L3	0	mA	0,6

Main location	Location	Measurement FAT	Unit	Measurement SAT
10 FT container	PE and L1	7,1	mA	Transformer connected, RM scope
	PE and L2	7,1	mA	Transformer connected, RM scope
	PE and L3	7	mA	Transformer connected, RM scope

Name and date: Peter Blell 5 mr, 4th

BALLARD

Ballard Power Systems Europe A/S
Majsmarken 1
DK-9500 Hobro

Confirmation of Satisfactory H2 leakage test

Part No.	601456B-7002362 Incl sub-assemblies 601456B-7002973 601456B-7003716
Product name	FC PowerGen 1000kW
Serial No.	601456B

Ballard Power Systems Europe A/S confirms that the above-listed equipment has satisfactorily with comments undergone and passed the H2 leakage test according to

BLPH Project – SPC ID 0104 H2 Leak Test Procedure rev 02 Max 11,240 BARG < 1 mbar dec

CrossWind C.V. acknowledges that the H2 leakage test for the above-listed equipment was witnessed and confirms that the test was performed satisfactorily with comments, and all agreed-upon specifications have been met.

Signatures

Ballard Power Systems Europe A/S			
Signature:	Preben H 2		
Name:	PREBEN JENSEN		
Title:	SENIOR APPLICATION ENGINEER	Date:	19/2/25
CrossWind C.V.			
Signature:			
Name:			
Title:	Crosswind Commissioning Manager	Date:	
Inspector			
Signature:			
Name:	DAVE MUSGROVE		
Title:	Inspector for Crosswind	Date:	19/02/2025

Note: This document serves as formal confirmation that the H2 leakage test has been successfully completed and witnessed, with both parties in agreement on the satisfactory results. It should be signed by authorized representatives of both parties.

Section 6 PIPING AND VESSEL PREPARATION

Section 6.1 Final Mechanical / Vessel Inspection Checks Index

NOT APPLICABLE

Section 6.2 Leak Test / Drying / Inerting Test Sheets Index

NOT APPLICABLE

Section 6.3 Chemical Loading & First Fill records Index

NOT APPLICABLE

Section 6.4 Chemical Cleaning Reports and Records Index

NOT APPLICABLE

Section 6.5 Lubrication Schedule

NOT APPLICABLE

Section 7 VENDOR

Section 7.1 Vendor Package Summary Index

NOT APPLICABLE

Section 7.2 SAT Procedure with associated punch list and reference (Front Page)

NOT APPLICABLE

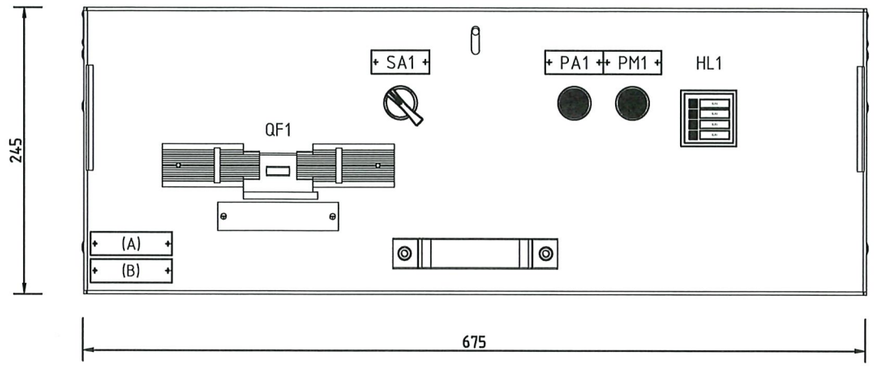
Section 7.3 Vendor Spares & Special Tools lists references

NOT APPLICABLE

Section 7.4 Vendor Data / Operations / Maintenance Manuals References

DOOR FRONT LAY-OUT

TYPICAL : LINE FEEDER "LK1-n"

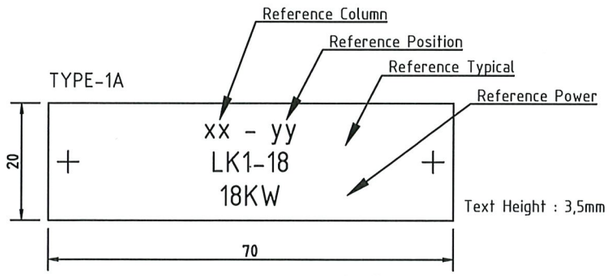


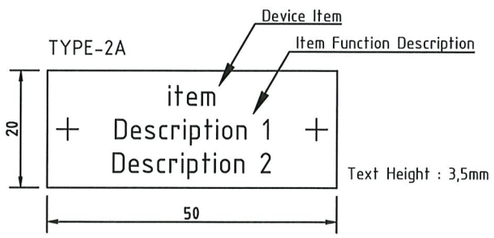
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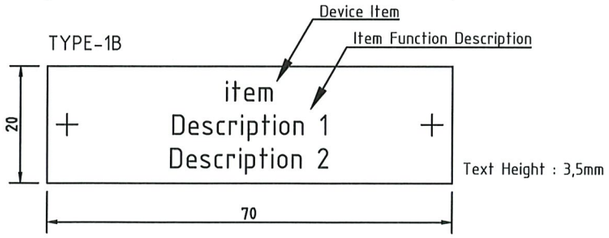
A) IDENTIFICATION name plate (type-1A) , with :
- Drawer position [Column / Position inside SWB]
- Typical name [reference applicability typical used]
- Power [reference applicability typical used]

B) USER name plate (type-1B), with :
- Item User [to see SLD diagrams]
- User Description [to see SLD diagrams]

DEVICES name plate			
ITEM	DESCRIPTION 1	DESCRIPTION 2	NOTE
QF1	Circuit Breaker		NO plate
SA1	LOC-REM	SELECTOR	Type-2A
PA1	STOP	MOTOR	Type-2A
PM1	RUN	MOTOR	Type-2A
HL1	Multiled	Signalling	NO plate







AS COMMISSIONED : NAOWA GIROW
26/3/25
NO MARK UP

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Door Front Lay-Out - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

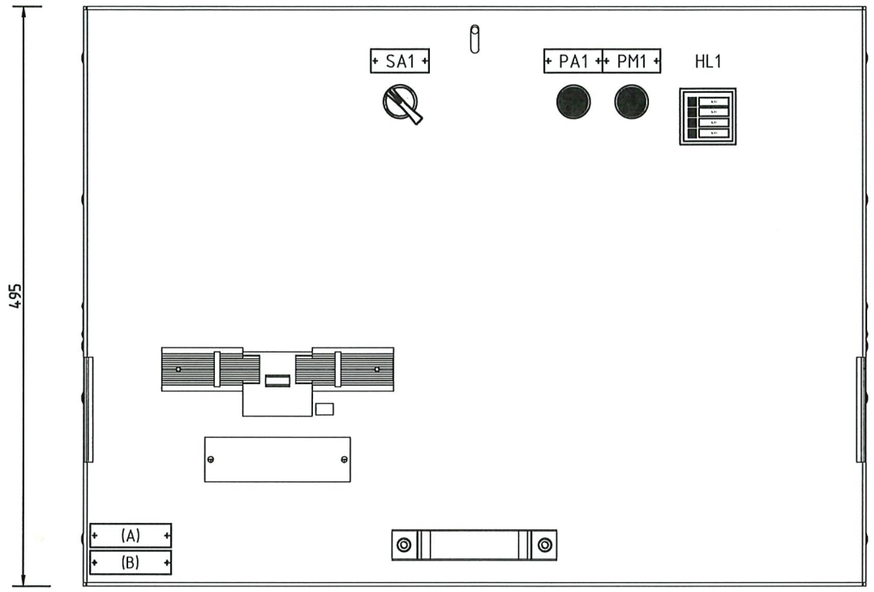
A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 034 | REV. 02

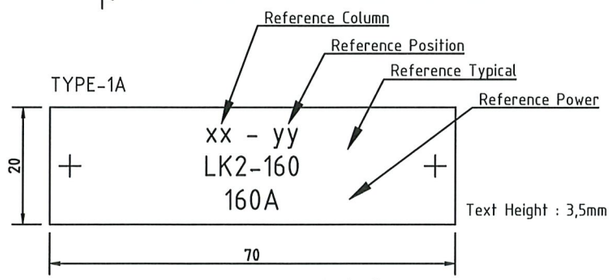
F.to UNI A3: 420mmx297mm

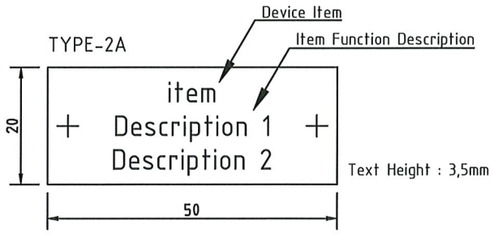
File Name : 1723002197-EL-DG-00031 Rev. 02

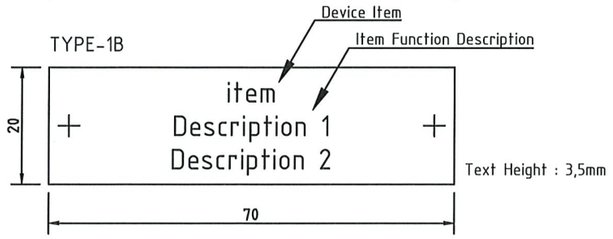
DOOR FRONT LAY-OUT

TYPICAL : LINE FEEDER "LK2-n"









NOTE :

A) IDENTIFICATION name plate (type-1A) , with :
- Drawer position [Column / Position inside SWB]
- Typical name [reference applicability typical used]
- Power [reference applicability typical used]

B) USER name plate (type-1B), with :
- Item User [to see SLD diagrams]
- User Description [to see SLD diagrams]

DEVICES name plate			
ITEM	DESCRIPTION 1	DESCRIPTION 2	NOTE
QF1	Circuit Breaker		NO plate
SA1	LOC-REM	SELECTOR	Type-2A
PA1	STOP	MOTOR	Type-2A
PM1	RUN	MOTOR	Type-2A
HL1	Multiled	Signalling	NO plate

AS COMMISSIONED: MARCIA GIROTTI
24/3/25
NO MARK UP

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
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0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Door Front Lay-Out - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 035 | REV. 02

File Name : 1723002197-EL-DG-00031 Rev. 02

F.to UNI A3: 420mmx297mm

USERS LEGEND

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"

TYPICAL APPLICABILITY					
ITEM	ITEM TAG	DESCRIPTION TAG	REFERENCE POSITION (written on name name plate "type-1A)	REFERENCE NOMINAL CURRENT C.B. TRIP UNIT (written on name name plate "type-1A)	REFERENCE TYPICAL (written on name name plate "type-1A)
1	SPARE	SPARE	A2 / +05	40A	LK1-40
2	SPARE	SPARE	A3 / +02	40A	LK1-40
3	DP-200N1	DB-LIGHTING & SMALL POWER BoP	A3 / +03	100A	LK1-100
4	JB-200E3	CRANE	A3 / +04	63A	LK1-63
5	SPARE	SPARE	A3 / +05	40A	LK1-40
6	JB-500E8	WATER PACKAGE	A3 / +08	160A	LK2-160
7	B100-HSB-001	HVAC PANELS HV ROOM	A4 / +02	40A	LK1-40
8	A-80000	FUELL CELL AUXIALIRY LOAD	A4 / +03	63A	LK1-63
9	CP-850F03	BESS PCS CABINET	A4 / +04	40A	LK1-40
10	SPARE	SPARE	A4 / +05	40A	LK1-40
11	SPARE	SPARE	A4 / +06	40A	LK1-40
12	K-63001-A	INSTRUMENTS AIR PACKAGE 01A	A4 / +08	160A	LK2-160
13	SPARE	SPARE	A5 / +01	40A	LK1-40
14	B200-HSB-001	HVAC PANELS - LV ROOM	A5 / +02	40A	LK1-40
15	B300-HSB-001	HVAC PANELS - UPS ROOM	A5 / +03	63A	LK1-63
16	B400-HSB-001	HVAC PANELS - ITER	A5 / +04	63A	LK1-63
17	CN-200N1	IMPRESSED CURR. CATHODIC PROTECTION (ICCP) SYSTEM	A5 / +05	40A	LK1-40
18	SPARE	SPARE	A5 / +06	40A	LK1-40
19	K-63001-B	INSTRUMENTS AIR PACKAGE 01B	A5 / +08	160A	LK2-160
20	CP-850E1	BESS LV1 CABINAT (+DISTR 1)	A6 / +02	40A	LK1-40
21	CP-850E2	BESS LV2 CABINAT (+DISTR 2)	A6 / +03	40A	LK1-40
22	SPARE	SPARE	A6 / +04	40A	LK1-40

AS COMMISSIONED: NATALIA GINOLI
24/3/25
NO MARK UP

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
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TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Users Legend - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 036 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

ITEMS ACRONYM

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"

Composition of Typical :

LK-x = Common Parts
LK1-"nn" or LK2-"nn"= Specific Parts

Example for Composition of LK1-63:
- to take "LK-x" plus "LK1-63"

Example for Composition of LK2-160:
- to take "LK-x" plus "LK2-160"

	ACRONYM ITEMS (Comun parts)	ACRONYM ITEMS (Specific parts)					
	LK-x	LK1-40 (In=40A) (Current Trip Unit)	LK1-63 (In=63A) (Current Trip Unit)	LK1-100 (In=100A) (Current Trip Unit)	LK2-160 (In=160A) (Current Trip Unit)		
ASSOCIATED TYPICAL	This Item include all devices that are comun for both "Specific Parts" Items	This Items include only devices that are detail for "Specific Parts" Items					
LK1-40	X	X					
LK1-63	X		X				
LK1-100	X			X			
LK2-160	X				X		
-							

AS COMMISSIONED: NATWA GIRGIN
24/3/25
NO MARK UP

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031

REV.:	DATE:	SIGNATURE:
2_A	18/03/25	G.Randi

ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x

DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
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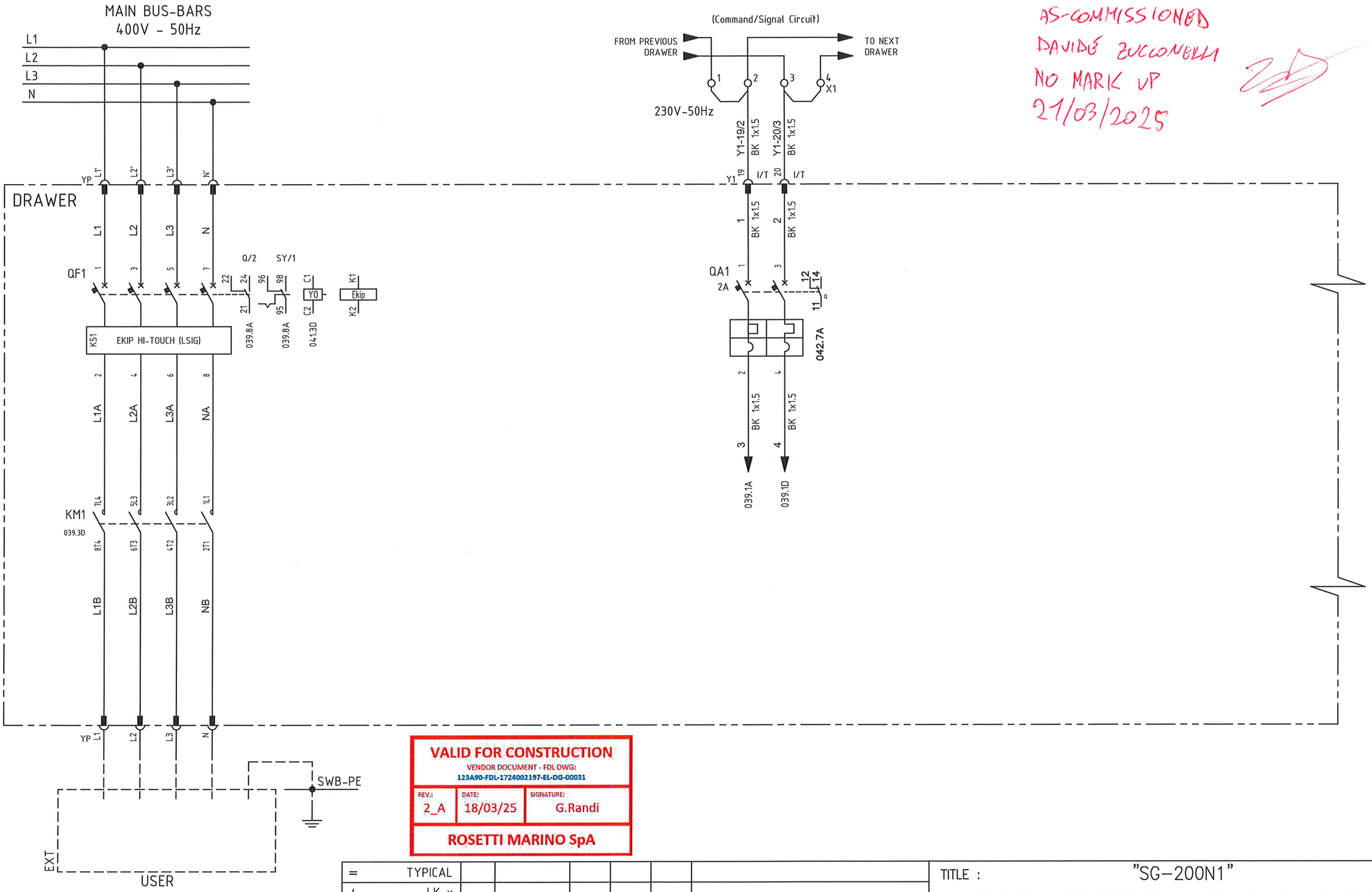
TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Items Acronym - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 037 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02



AS-COMMISSIONED
DAVIDE ZUCCONELLI
NO MARK UP
21/03/2025

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031

REV.:	DATE:	SIGNATURE:
2_A	18/03/25	G.Randi

ROSETTI MARINO SpA

=	TYPICAL
+	LK-x

DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

IMESA ELECTRICAL ENGINEERING

CROSSWIND

ROSETTI MARINO

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK

SCALE : NTS

A3

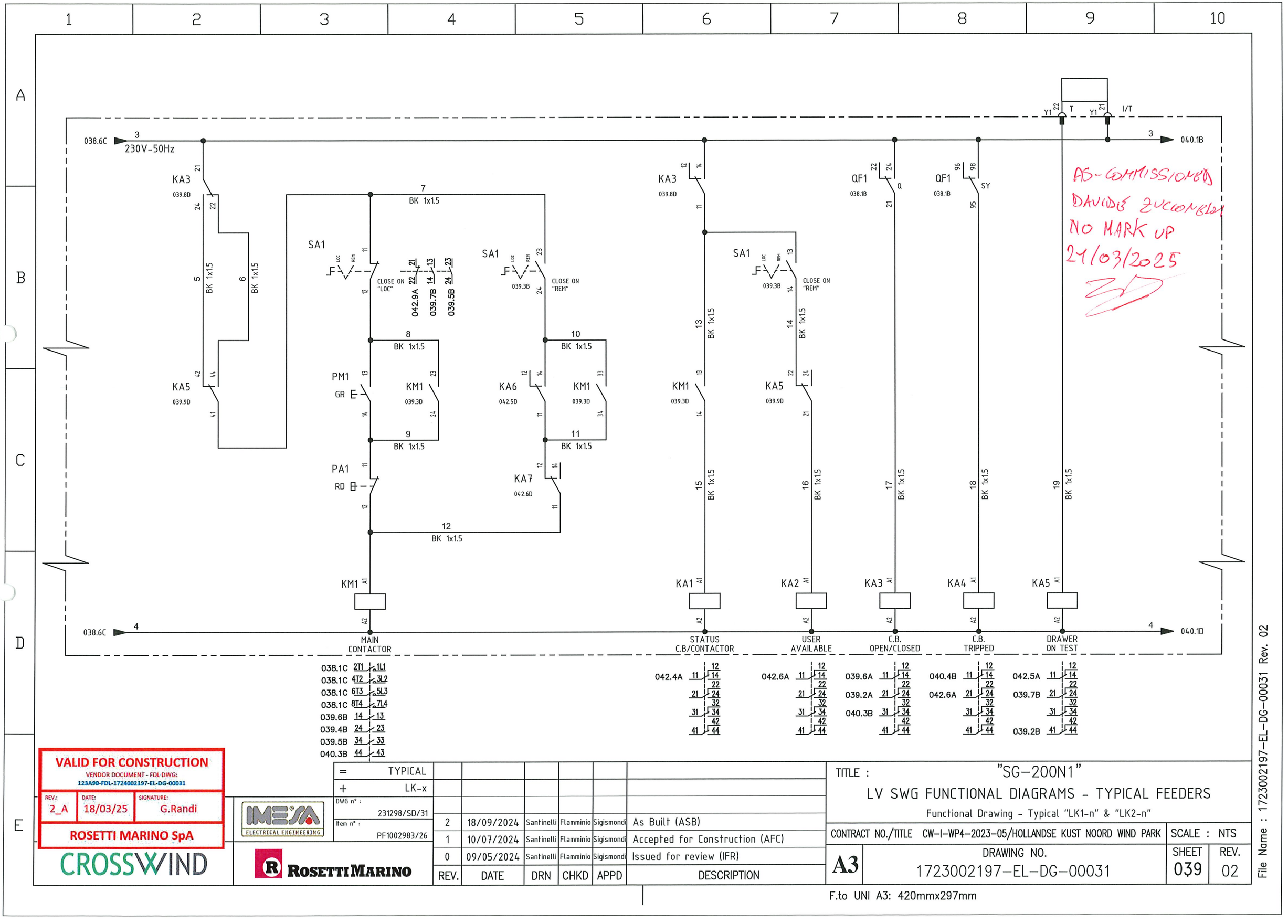
DRAWING NO. 1723002197-EL-DG-00031

SHEET 038

REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02



VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031

REV.:	DATE:	SIGNATURE:
2_A	18/03/25	G.Randi

ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
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0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

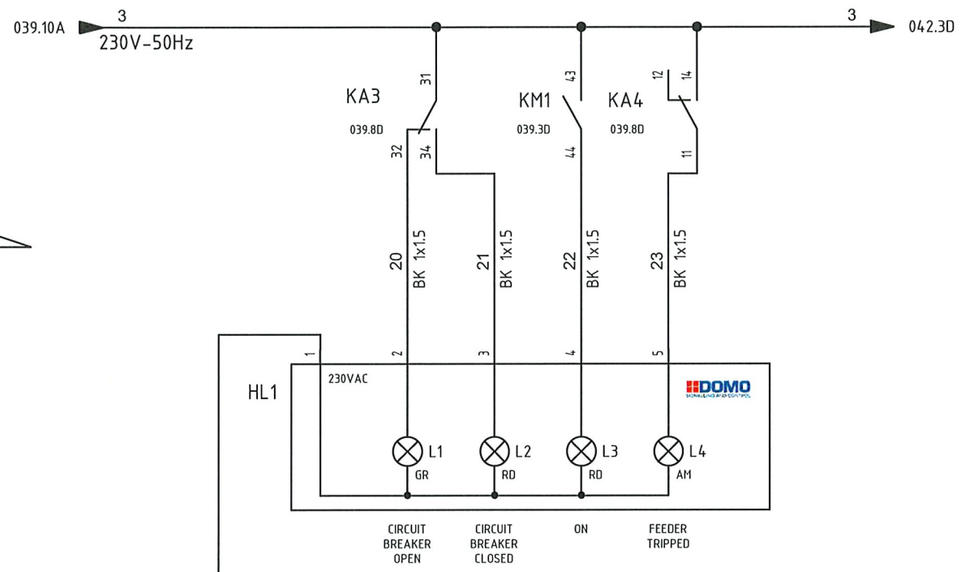
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A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 039 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

AS-COMMISSIONED
DAVIDE ZUCCONELLI
NO MARK UP
27/03/2025



VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031

REV.:	DATE:	SIGNATURE:
2_A	18/03/25	G.Randi

ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

=	TYPICAL
+	LK-x
DWG n° :	231298/SD/31
Item n° :	PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

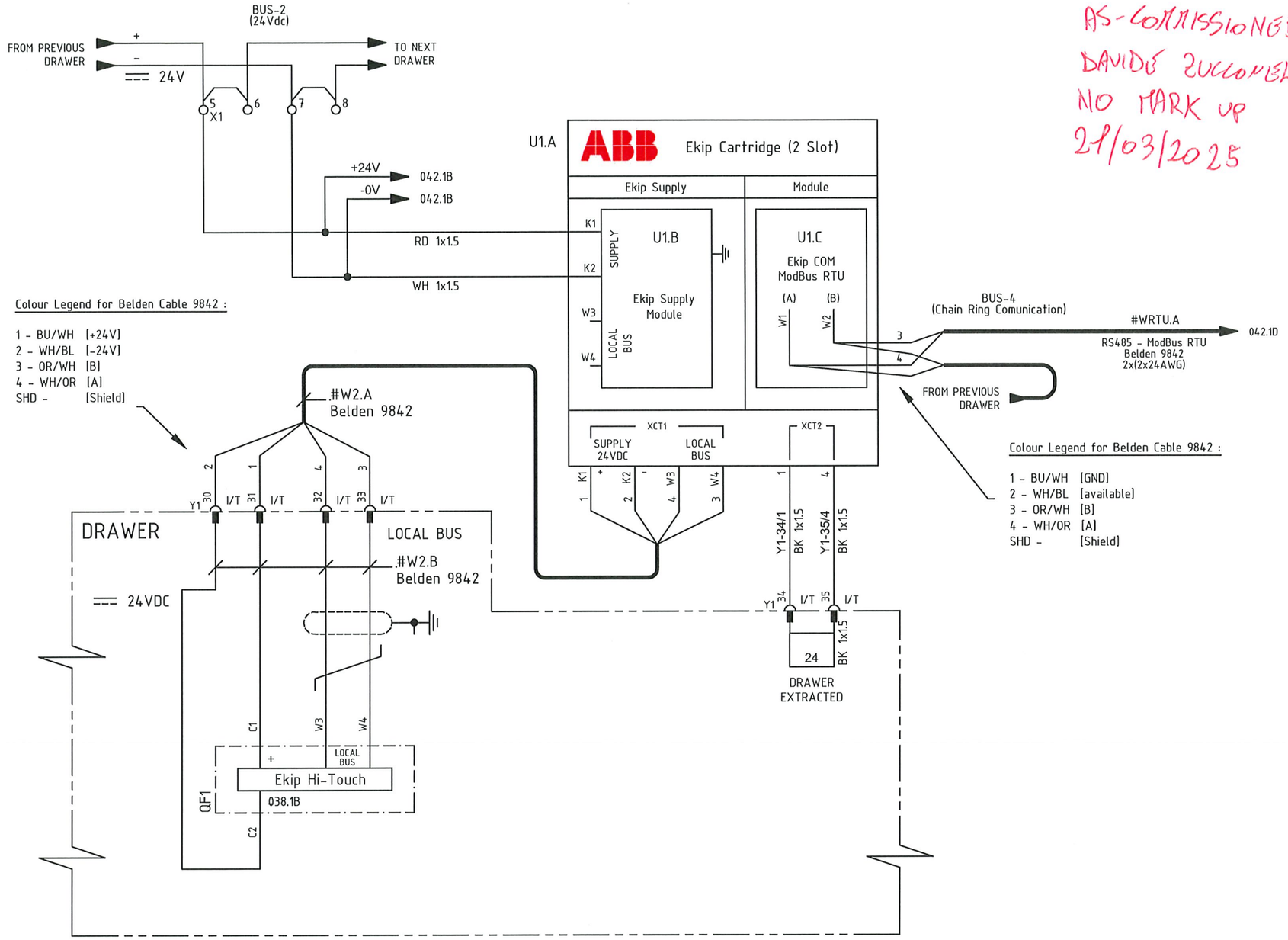
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 040 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

AS-COMMISSIONED
DAVIDE ZUCCONELLI
NO MARK UP
21/03/2025



VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

=	TYPICAL						
+	LK-x						
DWG n° :	231298/SD/31						
Item n° :	PF1002983/26						
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)		
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)		
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)		
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION		

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 041 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

AS-COMMISSIONED
DAVIDE ZUCCOMELLI
NO MARK UP
21/03/2025

DRAWER

C.B. - CONTACTOR CLOSED & INSERTED
C.B. - CONTACTOR OPEN OR DISCONNECTED
CIRCUIT BREAKER TRIPPED
FEEDER AVAILABLE
INTERNAL FAULT
USER ON LOCAL

KA1 039.6D
KA5 039.9D
KA4 039.8D
KA2 039.7D
QA1 038.6B
SA1 039.3B — CLOSE ON "LOC"

+25 RD 1x1.5 … +32 RD 1x1.5 — I/T — E

Y1-14/9 BK 1x1.5
Y1-5/10 BK 1x1.5
Y1-15/11 BK 1x1.5
Y1-16/12 BK 1x1.5
Y1-10/13 BK 1x1.5
Y1-9/14 BK 1x1.5
Y1-36/15 BK 1x1.5
Y1-37/19 BK 1x1.5

AVAILABLE

+103 … +108 RD 1x1.5
+115 … +118 RD 1x1.5

041.4A +24V
041.4A -0V
=== 24V

U2.A
+/L -/N PE
10÷40Vdc - 19÷29Vac SUPPLY
Z-PC-DINAL2-17.5
Modbus RTU RS485
B(-) A(+) GND SHD
B/L A/H GND SHD
041.9B
BUS-4 (Chain Ring Comunication)
TO NEXT DRAWER

U2.B
+16V 0V IN-1 IN-2 IN-3 IN-4 IN-5
INPUT
SENECA AUTOMATION INTERFACES
MODULE I/O
Z-5DI-2DO
ID = 01
OUTPUT
DO-1 DO-2

U2.C
+16V 0V IN-1 IN-2 IN-3 IN-4 IN-5
INPUT
SENECA AUTOMATION INTERFACES
MODULE I/O
Z-5DI-2DO
ID = 02
OUTPUT
DO-1 DO-2

Colour Legend for Belden Cable 9842 :

1 - BU/WH [GND]
2 - WH/BL [available]
3 - OR/WH [B]
4 - WH/OR [A]
SHD - [Shield]

Y1-11/20 BK 1x1.5
Y1-12/21 BK 1x1.5
Y1-13/22 BK 1x1.5
+109 … +114 RD 1x1.5

DRAWER
040.5B 3 230V-50Hz
040.5D 4
KA6 — CONTACTOR CLOSE COMMAND
KA7 — CONTACTOR OPEN COMMAND

KA6 039.5B
KA7 039.5C

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE : NTS
A3
DRAWING NO. 1723002197-EL-DG-00031
SHEET 042
REV. 02

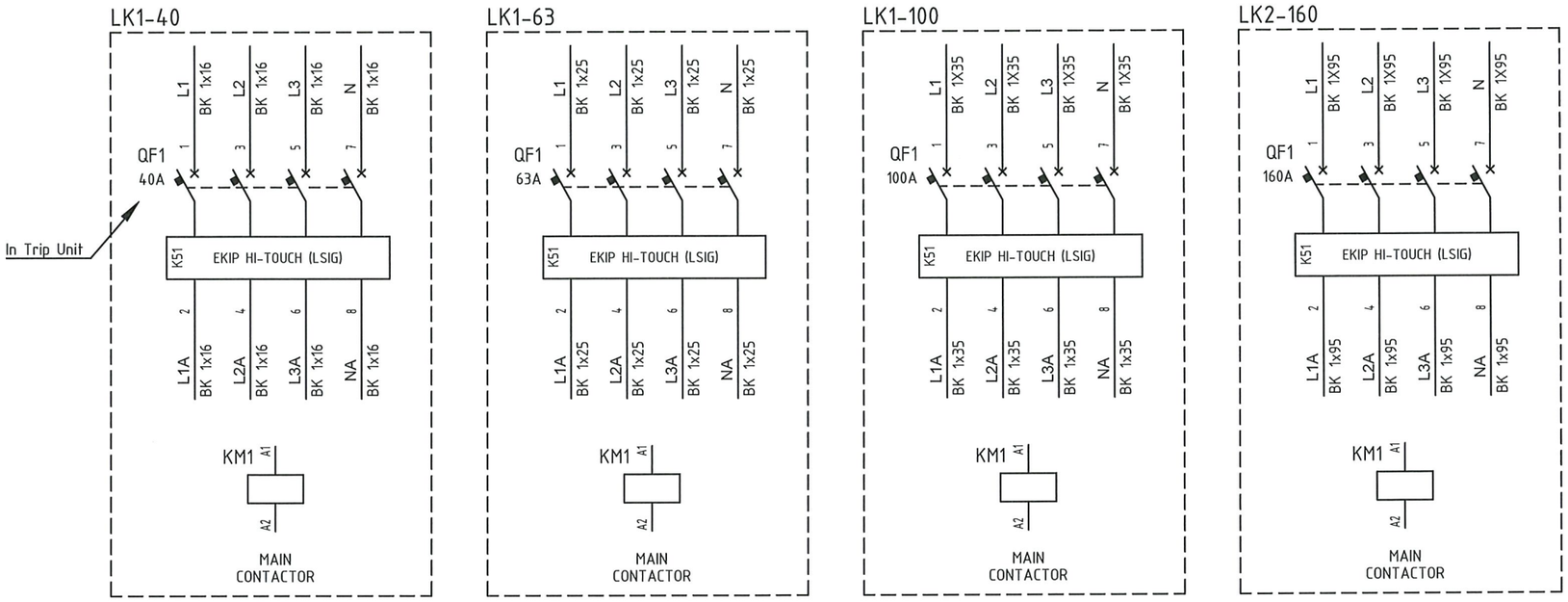
F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

SPECIFIC PARTS

TYPICAL : LINE FEEDER "LK1-n" "LK2-n"

AS-COMMISSIONED
DAVIDE ZUCCONELLI
NO MARK UP
21/03/2025



VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 043 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

TYPICAL - LK-x - Y1

AUXILIARY SOCKET
136450/001 (PF – 2 pcs) + 136458/004 (PM – 2 pcs)

N° PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
JUMP			●	●				●	●																																			
RACKED-OUT			✕	✕				✕	✕																																			
TEST								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RACKED-IN					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PIN USED			042.5B	042.5B	042.4B			042.6B	042.7B	042.6B	042.5D	042.5D	042.6D	042.3B	042.4B	042.6B			038.6A	038.6A	039.9A	039.9A								041.3C	041.3C	041.4C	041.4C	041.6C	041.7C	042.7B	042.9B							

← FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN RACKED-OUT POSITION
← FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN TEST POSITION
← FIELD WHIT "X" - CONTACT CLOSE WHEN DRAWER IS IN RACKED-IN POSITION

← CROS-REFERENCE USED PIN

AS COMMISSIONED
DAVIDE ZUCCONELLI
NO MARK UP
21/03/2025

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 044 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

TYPICAL - LK-x X1					
NumM	Fg.	Sez.	Tipo	Descrizione	Costruttore
			BT003	BT/3 End bracket	Cabur
1	038.5A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
2	038.6A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
3	038.6A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
4	038.6A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
5	041.3A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
6	041.3A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
7	041.4A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
8	041.4A	2.5	HD100GR_	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
			HD101GR	HMD/PT/GR End section - Grey	Cabur
9	042.3B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
10	042.4B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
11	042.4B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
12	042.5B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
13	042.6B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
14	042.7B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
15	042.7B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
16	042.7B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
17	042.8B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
18	042.8B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
19	042.9B	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
20	042.5C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
21	042.5C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
22	042.6C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
23	042.9C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
24	042.9C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
25	042.10C	2.5	HD400GR_	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur
			HD201GR	HMD.1/PT/GR End section - Grey	Cabur
			BT003	BT/3 End bracket	Cabur

AS-COMMISSIONED
DAVIDE ZUCCHINELLI
NO MARK UP
21/03/2025

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 045 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
HL1	040	ML22/484L230STLTTR	1	MULTILED 48x48 - 4 LED - Vaux=230Vac/dc + LAMP TEST + TROP	DOMO	TYPICAL LK-x
KA1	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA2	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA3	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA4	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA5	039	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA6	042	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
KA7	042	ER 592 6	1	CR-M230AC4L SUPPLY 230VAC 4C/O 250V/6A LED	ABB	TYPICAL LK-x
		ER 609 8	1	CR-MH HOLDER FOR CR-M RELAY	ABB	TYPICAL LK-x
		ER 686 6	1	CR-M4SS SOCKET STANDARD X 2/4 C/O(CR-M)	ABB	TYPICAL LK-x
PA1	039	KW 075 2	1	MP1-10R PUSH BUTTON RED WITH BLACK RING	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 571 3	2	MCB-01 CONTACT NC FOR PUSHBUTTOM	ABB	TYPICAL LK-x
PM1	039	KW 076 0	1	MP1-10G PUSH BUTTON GREEN WITH BLACK RING	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 570 5	2	MCB-10 CONTACT NO FOR PUSHBUTTONS	ABB	TYPICAL LK-x
QA1	038	S550239	1	S202M C 2 AUTOMATIC CIRCUIT BREAKER 10KA 2P	ABB	TYPICAL LK-x
		A563819	1	S2-CS/H6R AUXILIARY STATE CONTACT 1CO	ABB	TYPICAL LK-x
SA1	039	KW 329 3	1	M2SS2-10B HANDLE SELECTOR 2P 90° BLACK RING BLACK	ABB	TYPICAL LK-x
		EO 569 7	1	MCBH-00 FIXING SUPPORT 3 CONTACTS	ABB	TYPICAL LK-x
		EO 570 5	2	MCB-10 CONTACT NO FOR PUSHBUTTONS	ABB	TYPICAL LK-x
		EO 571 3	2	MCB-01 CONTACT NC FOR PUSHBUTTOM	ABB	TYPICAL LK-x
U1.2	041	1SDA074173R1	1	MODUL EKIP SUPPLY 24÷48VDC	ABB	TYPICAL LK-x
U1.3	041	1SDA105166R1	1	Module Ekip Com Modbus RS485 Tmax XT	ABB	TYPICAL LK-x
U1.A	041	1SDA105203R1	1	EKIP CARTRIDGE 2SLOT FOR XT2-XT4-XT5	ABB	TYPICAL LK-x
U2.A	042	Z-PC-DINAL2-17.5	1	DIN RAIL 2SLOT WITH HEAD FOR "Z-5DI-2DO"	SENECA	TYPICAL LK-x
U2.B	042	Z-5DI-2DO	1	I/O MODUL 5DI+2DO modbus RS485 Vaux=10÷40Vdc 19÷28Vac	SENECA	TYPICAL LK-x
U2.C	042	Z-5DI-2DO	1	I/O MODUL 5DI+2DO modbus RS485 Vaux=10÷40Vdc 19÷28Vac	SENECA	TYPICAL LK-x
X1		HD100GR_	8	HMD.2/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur	TYPICAL LK-x
		HD400GR_	17	HMD.2N/GR Two-level feed-through Terminal Block - Grey (2.5 mmq) - Spring type	Cabur	TYPICAL LK-x
		BT003	2	BT/3 End bracket	Cabur	TYPICAL LK-x
		HD101GR	1	HMD/PT/GR End section - Grey	Cabur	TYPICAL LK-x

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031
REV.: 2_A | DATE: 18/03/25 | SIGNATURE: G.Randi
ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

= TYPICAL
+ LK-x
DWG n° : 231298/SD/31
Item n° : PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"
LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS
Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 046 | REV. 02

File Name : 1723002197-EL-DG-00031 Rev. 02

AS-COMMISSIONED DAVIDE ZUCCONELLI NO MARK UP 21/03/2025

Fito UNI A3: 420mmx297mm

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
X1		HD201GR	1	HMD.1/PT/GR End section - Grey	Cabur	TYPICAL LK-x

AS-COMMISSIONED
DAVIDE ZUCCOMELLI

NO MARK UP
21/03/2025

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF40400013	1	AF40-40-00-13 CONTACTOR 4P 40A 100-250VAC/DC	ABB	TYPICAL LK1-40
		CA440E	1	CA4-40E AUXILIARY FRONT CONTACT 4NO	ABB	TYPICAL LK1-40
QF1	043	1SDA068169R1	1	XT2S 160 BREAKING PART 4p F F	ABB	TYPICAL LK1-40
		1SDA100162R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=40A XT2 4p	ABB	TYPICAL LK1-40
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK1-40

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF52400013	1	AF52-30-00-13 CONTACTOR 4P 53A(AC3) 100-250VAC/DC	ABB	TYPICAL LK1-63
		CA440E	1	CA4-40E AUXILIARY FRONT CONTACT 4NO	ABB	TYPICAL LK1-63
QF1	043	1SDA068169R1	1	XT2S 160 BREAKING PART 4p F F	ABB	TYPICAL LK1-63
		1SDA100163R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=63A XT2 4p	ABB	TYPICAL LK1-63
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK1-63

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF80400013	1	AF80-30-00-13 CONTACTOR 4P 80A(AC3) 100-250VAC/DC	ABB	TYPICAL LK1-100
		CA440E	1	CA4-40E AUXILIARY FRONT CONTACT 4NO	ABB	TYPICAL LK1-100
QF1	043	1SDA068169R1	1	XT2S 160 BREAKING PART 4p F F	ABB	TYPICAL LK1-100
		1SDA100164R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=100A XT2 4p	ABB	TYPICAL LK1-100
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK1-100

Nome/Item	Fg/Sh	Tipo/Type	Q.ta/Q.ty	Descrizione/Description	Costruttore/Manufacturer	Quadro (descrizione)
KM1	043	AF190401113	1	AF190-40-11-13 CONT 4P 190A AC3 100-250VAC/DC	ABB	TYPICAL LK2-160
		CAL1911	1	CAL19-11 CONTATTO AUSILIARIO 1NA+1NC PER AF116÷AF370	ABB	TYPICAL LK2-160
		CAL1911B	2	CAL19-11B AUXILIARY CONTACT 1NA+1NC PER AF116÷AF370	ABB	TYPICAL LK2-160
QF1	043	1SDA068179R1	1	XT4S 250 BREAKING PART 4p F F	ABB	TYPICAL LK2-160
		1SDA100334R1	1	ELECTRONIC TRIP RELEASE Ekip Hi-Touch LSIG In=160A XT4 4p	ABB	TYPICAL LK2-160
		1SDA066431R1	1	AUX-C 1Q+1SY 250Vac/dc XT1..XT5 F/P	ABB	TYPICAL LK2-160

VALID FOR CONSTRUCTION
VENDOR DOCUMENT - FDL DWG:
123A90-FDL-1724002197-EL-DG-00031

REV.:	DATE:	SIGNATURE:
2_A	18/03/25	G.Randi

ROSETTI MARINO SpA

CROSSWIND

IMESA ELECTRICAL ENGINEERING

ROSETTI MARINO

=	TYPICAL
+	LK-x
DWG n° :	231298/SD/31
Item n° :	PF1002983/26

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
2	18/09/2024	Santinelli	Flamminio	Sigismondi	As Built (ASB)
1	10/07/2024	Santinelli	Flamminio	Sigismondi	Accepted for Construction (AFC)
0	09/05/2024	Santinelli	Flamminio	Sigismondi	Issued for review (IFR)

TITLE : "SG-200N1"

LV SWG FUNCTIONAL DIAGRAMS - TYPICAL FEEDERS

Functional Drawing - Typical "LK1-n" & "LK2-n"

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE : NTS

A3 | DRAWING NO. 1723002197-EL-DG-00031 | SHEET 047 | REV. 02

F.to UNI A3: 420mmx297mm

File Name : 1723002197-EL-DG-00031 Rev. 02

Section 8 LIST OF MODIFICATIONS

NOT APPLICABLE

Section 8.1 List of changes

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft Container, RM Yard, Ravenna
Test performed by	PBL, MKD

Grounding continuity
EN 60204-1:2018 - Section 18.2.2 - Test 1
Test performed with a test current of 10A

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	Busbar to busbar	0,024	Ohm	0,01
	Module 1	0,018	Ohm	0,015
	DC/DC cabinet 1	0,023	Ohm	0,006
	Module 2	0,024	Ohm	0,011
	DC/DC cabinet 2	0,019	Ohm	0,006
	Module 3	0,026	Ohm	0,017
	DC/DC cabinet 3	0,016	Ohm	0,006
	Module 4	0,026	Ohm	0,02
	DC/DC cabinet 4	0,016	Ohm	0,008
	Module 5	0,024	Ohm	0,013
	DC/DC cabinet 5	0,017	Ohm	0,006
	Module 6	0,029	Ohm	0,017
	DC/DC cabinet 6	0,015	Ohm	0,005
	Control cabinet	0,021	Ohm	0,014
	Control cabinet right door	0,032	Ohm	0,048
	Lifting crane track, dolly	0,028	Ohm	0,008
	LT piping	0,031	Ohm	0,022
	Isolation transformer cover	0,039	Ohm	0,015
	Cable tray	0,019	Ohm	0,012

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	Busbar to busbar	0,019	Ohm	0,007
	Main DC/Acpoint 1	0,032	Ohm	0,031
	Main DC/Acpoint 2	0,024	Ohm	0,014
	Main DC/Acpoint 3	0,027	Ohm	0,011
	DC/AC conduncter point 1	0,037	Ohm	0,007
	DC/AC conduncter point 2	0,022	Ohm	0,009
	DC/AC conduncter point 3	0,023	Ohm	0,006
	LT coolant pipe	0,024	Ohm	0,014
	Cable tray	0,02	Ohm	0,007
	Main transforer grounding bolt	0,023	Ohm	0,009
	Main transformer chassis	0,02	Ohm	0,007
	Cable tray MV cables	0,022	Ohm	0,011

Name and date: Abo Obaid June 4th

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft Vontainer, RM Yard, Ravenna
Test performed by	PBL, MKD

Isolation resistance

EN 60204-1:2018 - Section 18.3

Test performed with a test voltage of 1000V

Main location	Location	Measurement FAT	Unit	Measurement SAT
40 ft container	L1-PE	> 999.9	MOhm	> 999.9
	Cooling skid L1	10,01	Mohm	12,11
	Colling skid L2	6,252	Mohm	5,21
	Cooling skid L3	12,81	Mohm	10,12
	AUX supply L1	251	Mohm	316
	AUX supply L2	337	MOhm	364
	AUX supply L3	237	Mohm	248

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	L1+L2+L3-PE on AC circuit	592	Mohm	Transformer connected, RM scope

Name and date: Peter Bloch 4th June

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	06/02/2025
Test location	40ft container, RM Yard, Ravenna
Test performed by	PBL, MKD

Isolation resistance

EN 60204-1:2018 - Section 18.4

Test performed with a test voltage of 2500VAC

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	PE and L1	0	mA	0,6
	PE and L2	0	mA	0,6
	PE and L3	0	mA	0,6

Main location	Location	Measurement FAT	Unit	Measurement SAT
10 FT container	PE and L1	7,1	mA	Transformer connected, RM scope
	PE and L2	7,1	mA	Transformer connected, RM scope
	PE and L3	7	mA	Transformer connected, RM scope

Name and date: Peter Blee June 4th

Ballard Power Systems Europe A/S
Majsmarken 1
DK-9500 Hobro

Confirmation of Satisfactory H2 leakage test

Part No.	601456B-7002362 Incl. sub-assemblies: 601456B-7002973 601456B-7003716
Product name	FC PowerGen 1000kW
Serial No.	601456B

Ballard Power Systems Europe A/S confirms that the above-listed equipment has satisfactorily with comments undergone and passed the H2 leakage test according to

BLPH Project – SPC ID 0104 H2 Leak Test Procedure rev 02 max. 11,240 BARG < 1 mbar dec

CrossWind C.V. acknowledges that the H2 leakage test for the above-listed equipment was witnessed and confirms that the test was performed satisfactorily with comments, and all agreed-upon specifications have been met.

Signatures

Ballard Power Systems Europe A/S			
Signature:	Preben H 2		
Name:	PREBEN JENSEN		
Title:	SENIOR APPLICATION ENGINEER	Date:	19/2/25
CrossWind C.V.			
Signature:			
Name:			
Title:	Crosswind Commissioning Manager	Date:	
Inspector			
Signature:	DM		
Name:	DAVE MUSGROVE		
Title:	Inspector for Crosswind	Date:	19/02/2025

Note: This document serves as formal confirmation that the H2 leakage test has been successfully completed and witnessed, with both parties in agreement on the satisfactory results. It should be signed by authorized representatives of both parties.

5.0 Note on Power Quality Measurements

The power quality measurements are indicative during SAT, as the measured power quality depends also on the customer load dissipating the produced power. Ballard is also not capable of measuring power quality on the 6.6kV bus, and any measurements are done on the 400V side of the output transformer. This results in lower measurements than on the medium voltage side of the output transformer, as the transformer inductance is an integral part of the harmonic dampening of the FC package.

Power quality measurements have been removed from pass/fail criteria.

6.0 Note on Electrical Load

The electrical load that is to dissipate the power generated by the FC package is not in Ballard scope. During step response tests and full load tests, it is required that it is present and able to absorb the power from the FC package.

7.0 Functional tests

7.1 F02 Visual inspection

7.1.1 Test

The test involves an examination of the paint job through visual inspection, assessing the overall build quality, and checking for any dents. The focus is also on evaluating the assembly quality to ensure compliance with weather resistance.

This test is superseded by the tri party walkaround.

7.1.2 Relevant Standard / document

- No reference

7.1.3 Brief Test Plan

- Visual inspection with customer of full system, meaning inside and outside container solution.
- Take comprehensive pictures of the full system and test setup, including close-ups of vital components, with timestamps for reference.

7.1.4 Pass/Fail criteria.

- Visual inspect with customer to review quality of full system.

7.1.5 Test Result

Table 1: Visual inspection – Test Result

Date tested	Item	Result	Pass/Fail	Notes
04/06/25	40' Container	ok	Pass	Peter Bloch
04/06/25	10' Container	ok	Pass	Peter Bloch
04/06/25	Cooling Skid	ok	Pass	Peter Bloch

Peter Bloch 09/06 '25

7.2 F07 Electrical safety test – 10-foot container

7.2.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.2.2 Relevant Standard / document

- EN 60204 Electrical safety test 10ft
- F07 & F08, Electrical safety SAT

7.2.3 Brief Test Plan

- According to EN 60204-1

7.2.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.2.5 Test Result

Table 2: Electrical safety test - Test results

Date tested	Item	Result	Pass/Fail	Notes
06/02/25	Grounding Continuity	OK	Pass	See test sheet
06/02/25	Isolation resistance	OK	Pass	See test sheet.

Pilar Blanch 04/06 '25

Table 3: Electrical safety test - calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
	086 - 003	2025-06-04	Tests F07 & F08

7.3 F08 Electrical safety test – 40-foot container

7.3.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.3.2 Relevant Standard / document

- EN 60204 Electrical safety test 40ft
- EN 60204 Electrical safety test Cng Pltfrm
- F07 & F08, Electrical safety SAT

7.3.3 Brief Test Plan

- According to EN 60204-1

7.3.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.3.5 Test Result

Table 4: Electrical safety test - Test Result

Date tested	Item	Result	Pass/Fail	Notes
06/02/25	Grounding Continuity	OU	Pass	See test sheet
06/02/25	Isolation Resistance	OU	Pass	See test sheet

Table 5: Electrical safety test - Calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
	086-003	2025-06-04	F08 & F07

Peter Blum
04/06/25

7.4 F10 Safety

7.4.1 Test

Conduct tests of safety inputs and outputs, including emergency stop buttons, smoke detectors, gas detectors and external connections.

7.4.2 Relevant Standard / document

- F10 Safety checklist

7.4.3 Brief Test Plan

- Trigger each safety input according to checklist.
  - Emergency pushbuttons
  - Smoke detectors test
  - H2 sensor test
  - External safety switches
  - External feedback

7.4.4 Pass/Fail criteria.

- Verified according to checklist.
- Each item triggers the correct alarm

7.4.5 Test Result

Table 6: Safety - Test Result

Date tested	Item	Result	Pass/Fail	Notes
19/02/2025	Emergency pushbuttons	✓	PASS	✓
19/02/2025	Smoke detectors	✓	PASS	✓
19/02/2025	H2 sensors	✓	PASS	✓
19/02/2025	External safety switches	✓	PASS	ADDED 120 OHM RESISTOR
19/02/2025	External feedback	✓	PASS	✓

Peter Black
F. SIRIGU
ROSETTA MARINO
04/06/25

Table 7: Safety – Calibration/Equipment

Unit	Equipment number	Calibration due date	Equipment used for
—	—	—	—

7.5 F18 H_2 Leakage test

7.5.1 Test procedure

All pipework and H2 instrumentation subassemblies must be inspected, recorded, verified and pass in accordance with the procedure in section 5.4 in *SPC ID 0104 H2 Leak Test Procedure Rev 002* prior to full system SAT.

System H2 leakage test is done system pressure decay test, according to section 5.5 in *SPC ID 0104 H2 Leak Test Procedure Rev 002*.

7.5.2 Pass/Fail criteria.

Pressure decay test with a maximum leakage no greater than specified in test procedure.

Result details are documented in the template *SPC ID 0204 System pressure decay test template*

Parameter	Value	Description
L_A [Nm^3/h]	**2,72 – 3,58 x10^{-3}**	**Maximum allowed pressure decay to pass pressure decay test, where L_A = L_S + L_Mu**
L_S [Nm^3/h]	0	Summarized expected leak rates of all components in the system (per design leak rate).
L_Mu [Nm^3/h]	2,72 – 3,58 x10^{-3}	Calculated accuracy of the measuring system, used to perform the test.
L_C [Nm^3/h]	2,7x10^{-5}	Maximum allowed leak rate for a given pipe section, where integrity/operability of the system may be maintained safely

7.5.3 Test Result

Table 8: H2 leakage - Test Result

Date tested	Item	Leakage rate L_1 [Nm^3/h]	Pass/Fail	Notes
19/2/25	H2 line 1	0	Pass	See test Sheet
19/2/25	H2 line 2	0	Pass	See test sheet
19/2/25	H2 line 3	0	Pass	See test Sheet
19/2/25	H2 line 4	0	Pass	See test Sheet
19/2/25	H2 line 5	0	Pass	See test sheet
19/2/25	H2 line 6	0	Pass	See test Sheet

Pass Ø Hell 04/06

Section 9 SUPPORTING DOCUMENTS

Fuel Cell - RFO

Document Number	Document Name	Revision
1. System Definition & LOSH		
K559-2254-CWIWP4202202-B01-001	General Arrangement	009
K559-2254-CWIWP4202202-C03-001	P&IDs	006
K559-2254-CWIWP4202202-C06-001	SLDs	007
K559-2254-CWIWP4202202-E03-007	Electrical Interface Drawing	003
2. RFO Certificate		
N/A	RFO	000
3. Consolidated PL		
N/A	Consolidated PL	N/A
4. ITRs E&I		
N/A	ATEX ITRs	N/A
N/A	Ballard ITRs	N/A
N/A	Crosswind Modbus Table - Main PLC signed	N/A
5. ITRs P&M		
N/A	Ballard Leak Test 19-2-25	N/A
6. As-Builts E&I		
K559-2254-CWIWP4202202-B05-001	Fire and Gas Detection	001
K559-2254-CWIWP4202202-C06-001	SLDs	007
K559-2254-CWIWP4202202-E03-001	Panel Layout Plan	001
K559-2254-CWIWP4202202-E03-002	Panel Cabinet Layout: UC20 40ft Control Cabinet	001
K559-2254-CWIWP4202202-E03-003	Panel Cabinet Layout: UC30 Coolant Skid Control Cabinet	001
K559-2254-CWIWP4202202-E03-004	Panel Cabinet Layout: UC31 10ft Control Cabinet	001
K559-2254-CWIWP4202202-E03-005	Panel Cabinet Layout: UC41 Coolant Skid VFD Cabinet	001
K559-2254-CWIWP4202202-E03-006	Panel Cabinet Layout: UC50 AC Power Distribution	001
K559-2254-CWIWP4202202-E03-007	Electrical Interface Documentation	003
K559-2254-CWIWP4202202-E03-008	Panel Cabinet Layout: UC42 Ex Barrier Box	001
K559-2254-CWIWP4202202-E03-009	Earthing Layout	002
7. As-Builts P&M		
K559-2254-CWIWP4202202-B01-001	General Arrangement	009
K559-2254-CWIWP4202202-C05-001	Piping Line List and Speciality Item List	002
8. Vendors SOW		
FAT		
K559-2254-CWIWP4202202-K03-001	Performance Test Results (FAT)	001
SAT		
K599-2254-CWIWP4202202-J99-001	Site Acceptance Test (SAT) Procedure	004

K599-2254-CWIWP4202202-J99-003	Confirmation of Satisfactory SAT - Signature Page	001
K599-2254-CWIWP4202202-J99-004	F10, Safety checklist	001
K599-2254-CWIWP4202202-J99-006	EN 60204 Electrical safety test 10ft	001
K599-2254-CWIWP4202202-J99-007	EN 60204 Electrical safety test 40ft	001
K599-2254-CWIWP4202202-J99-008	EN 60204 Electrical safety test Cng Pltfrm	001
	SPC ID0204 System Pressure Decay Test Template	N/A

9. Supporting Documents

ATEX

BPSE-INN-BPH-REG-00007	Atex Register	006
K559-2254-CWIWP4202202-D99-001	ATEX Component datasheets	002
K559-2254-CWIWP4202202-G99-001	IEC60079-10 Analysis	004
K559-2254-CWIWP4202202-G99-002	Intrinsically Safe Calculations	003
K559-2254-CWIWP4202202-K02-001	Equipment Hazardous Area Certificates & Schedule	005
K559-2254-CWIWP4202202-K02-003	ATEX Design Journal	005
K559-2254-CWIWP4202202-Q03-001	ATEX Inspections during Manufacturing	001

Declaration of Conformity

K559-2254-CWIWP4202202-K01-001	Declaration of Conformity (FCwave)	004
K559-2254-CWIWP4202202-K01-002	Declaration of Conformity (Container Solution)	002
K599-2254-CWIWP4202202-K01-003	PED Compliance H2 Manifold addendum	003

Manuals

K559-2254-CWIWP4202202-N01-001	Integration Manual for Container	001
K559-2254-CWIWP4202202-N01-002	Operator Manual for Container	003
K559-2254-CWIWP4202202-N01-003	Service and Maintenance Manual for Container	003
K559-2254-CWIWP4202202-N01-004	ATEX Zone Components Maintenance	002
K559-2254-CWIWP4202202-N01-005	Lockout Tagout Procedure	001
K559-2254-CWIWP4202202-N01-006	Integration Manual for FC Wave	002
K559-2254-CWIWP4202202-N01-007	Fuel Cell Maintenance Manual	001

Risk Assessments

K559-2254-CWIWP4202202-J99-009	Method Statement	006
K599-2254-CWIWP4202202-J99-010	Risk assessment for container solution	001

Type Approval Certificates

K559-2254-CWIWP4202202-K12-001	Type Approval Certificates	002

10. CQ-TQ Documents

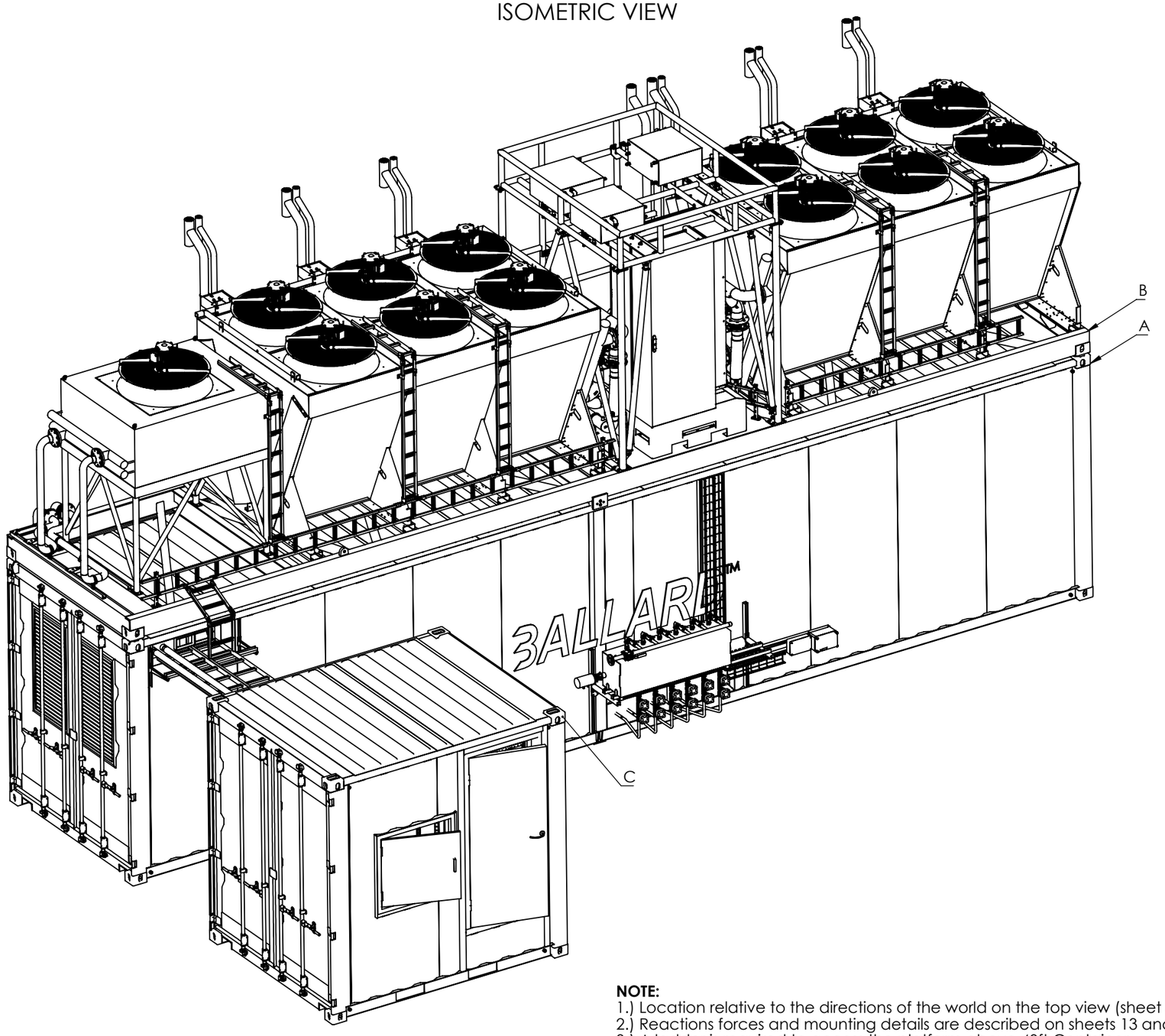
BALL-CW-TQ-0002	Hydrogen Interface	N/A
BLPH-CQ-004	Ballard E-Stop inter-trip Upstream	N/A
CW-BALL-TQ-0009	Lighting and small cable trays fixing on Fuel Cell container	N/A
CW-BALL-TQ-0010	Hydrogen Supply Interface	N/A
CW-ROS-TQ-00016	Design of Hydrogen Supply Pre3ssure Control Valves 25-PV-055 A-B	N/A

Ballard Power Systems Europe A/S
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Denmark

Revision history		
Rev.	**Date.**	**Description**
001	10/02/2023	First Issue
002	24/03/2023	Re-issue according to comments
003	30/05/2023	Re-issue according to comments
004	10/11/2023	Re-issue according to comments
005	24/11/2023	Re-issue according to comments
006	02/04/2024	Re-issue according to comments
007	17/07/2024	Re-issue according to comments
008	05/09/2024	Re-issue (as built)
009	21/11/2024	Re-issue according to comments

Document Title:	**BLPH Project - General Arrangements**
Document Number:	K559-2254-CWIWP4202202-B01-001
Revision:	Rev009
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-B01-001Rev009
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	B01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

ISOMETRIC VIEW



No	Name	Operating Masses	Dry Masses
A	40ft container	21680kg	21320kg
B	40ft fladbed	10060kg	9060kg
C	10ft container	7350kg	7310kg

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

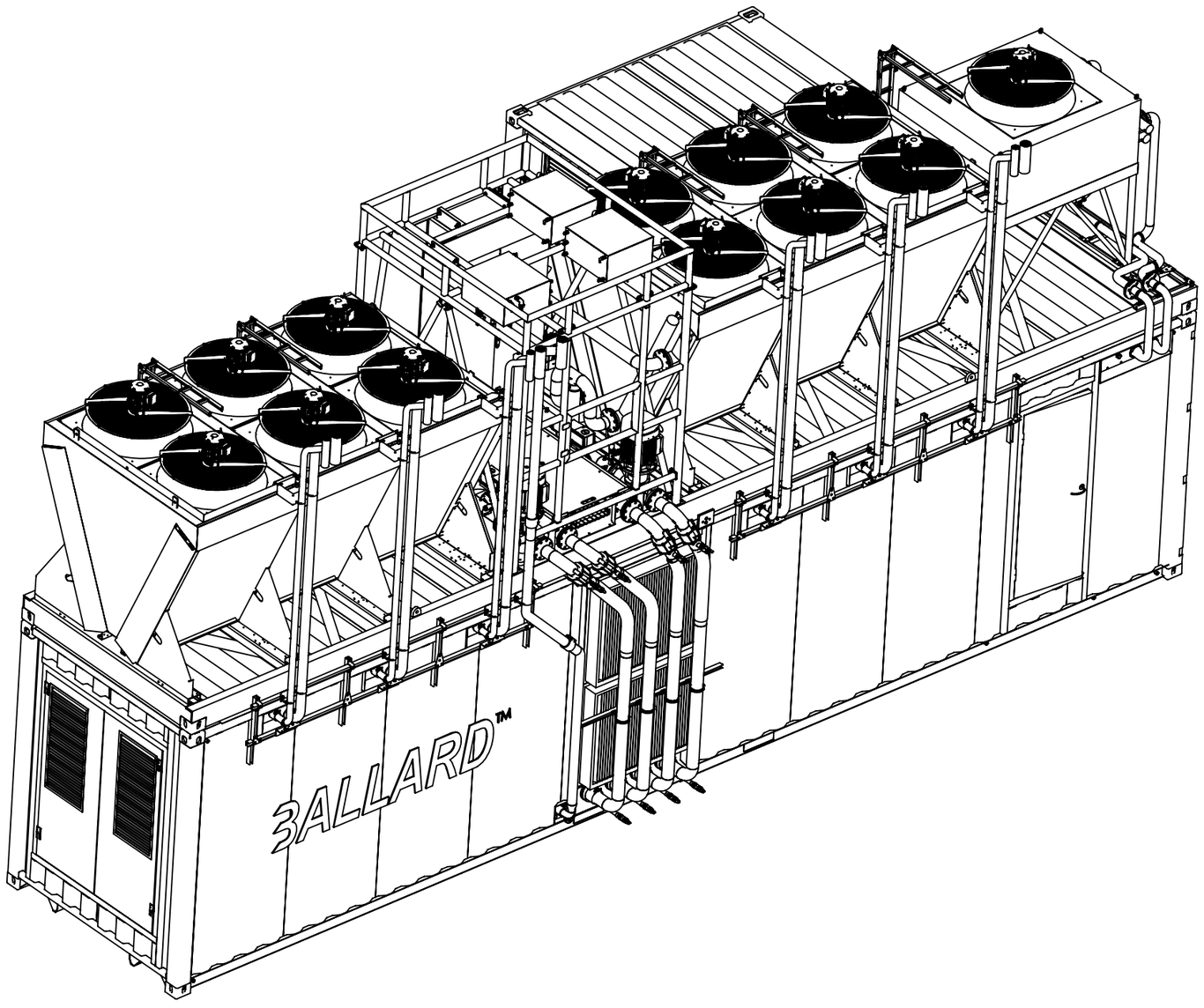
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	1/14	1:50	601456B	9

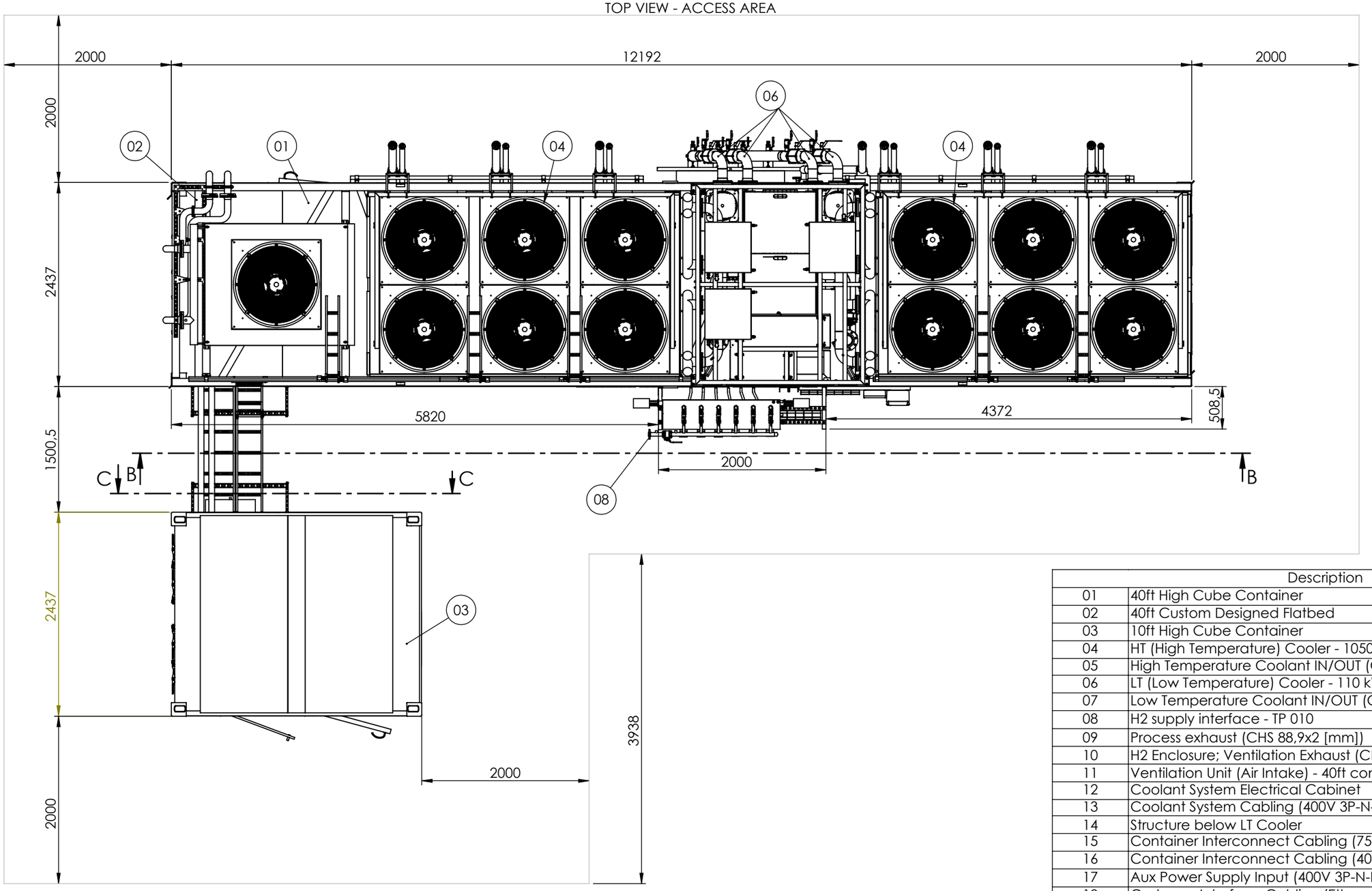
ISOMETRIC VIEW



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)				BALLARD™				
Tolerances for linear and angular dimensions without individual tolerance according to ISO668		By	Date	General arrangement				
	Drawn	ASM	20-02-2024					
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision							
	Released							
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TOP VIEW - ACCESS AREA





	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

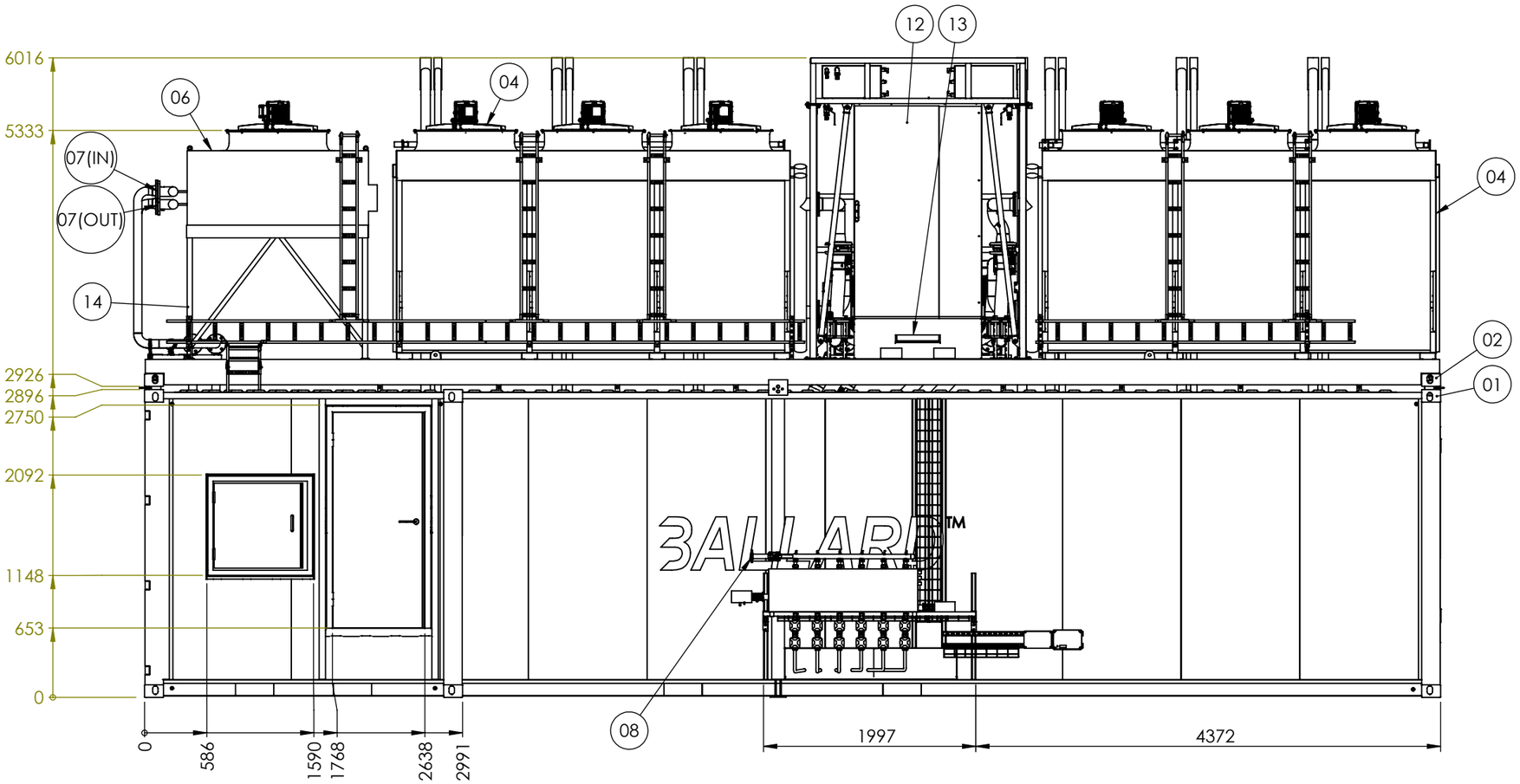
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BALLARD™

General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	3/14	1:50	601456B	9

FRONT VIEW
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

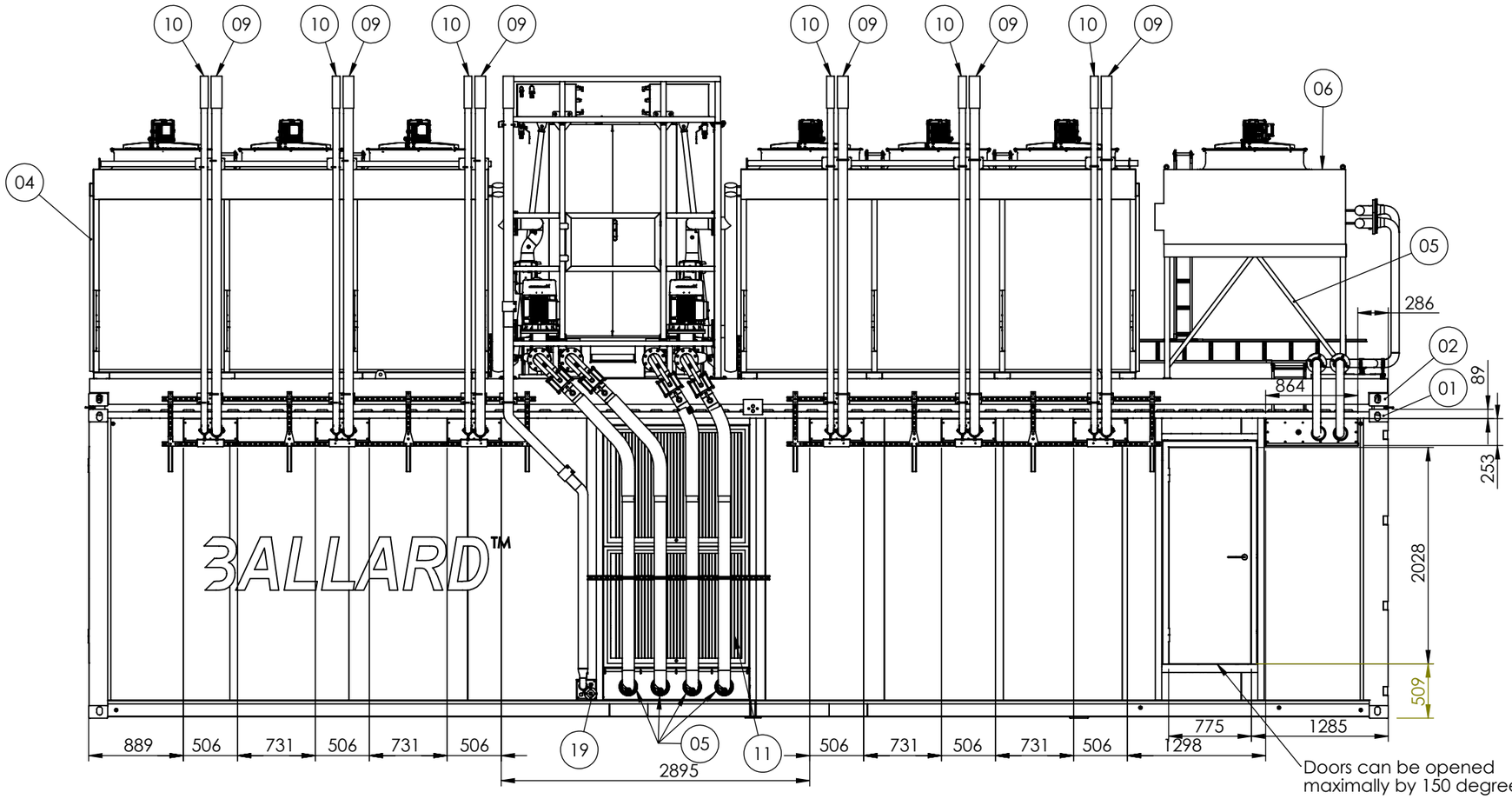
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	4/14	1:50	601456B	9

BACK VIEW
(LOOKING NORTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

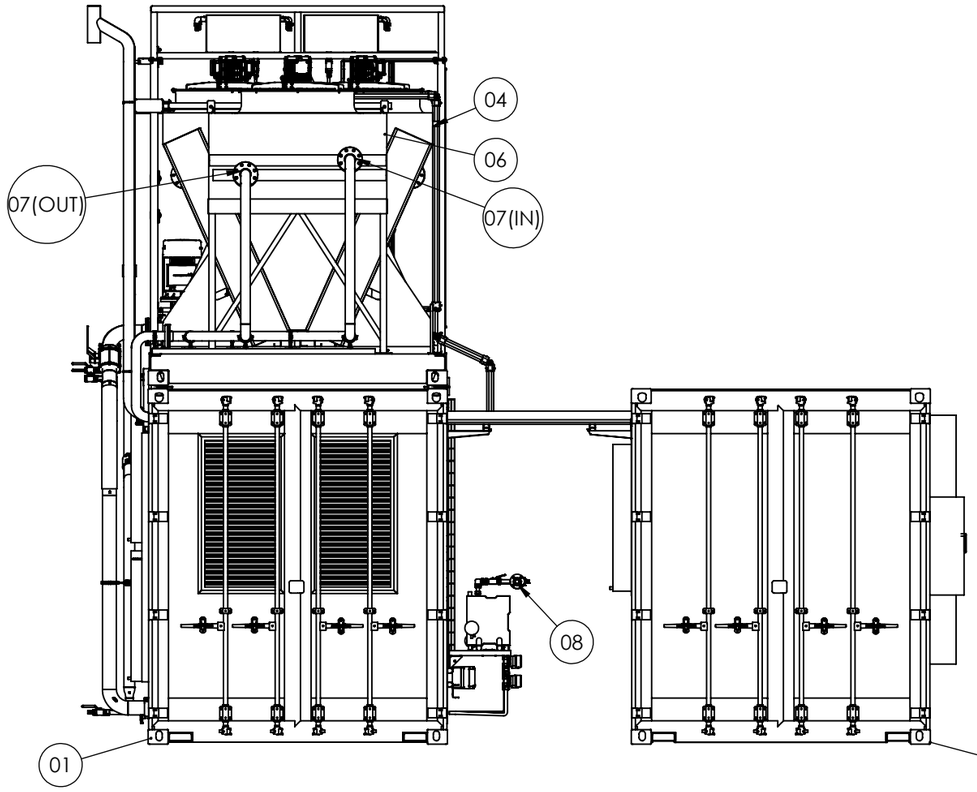
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

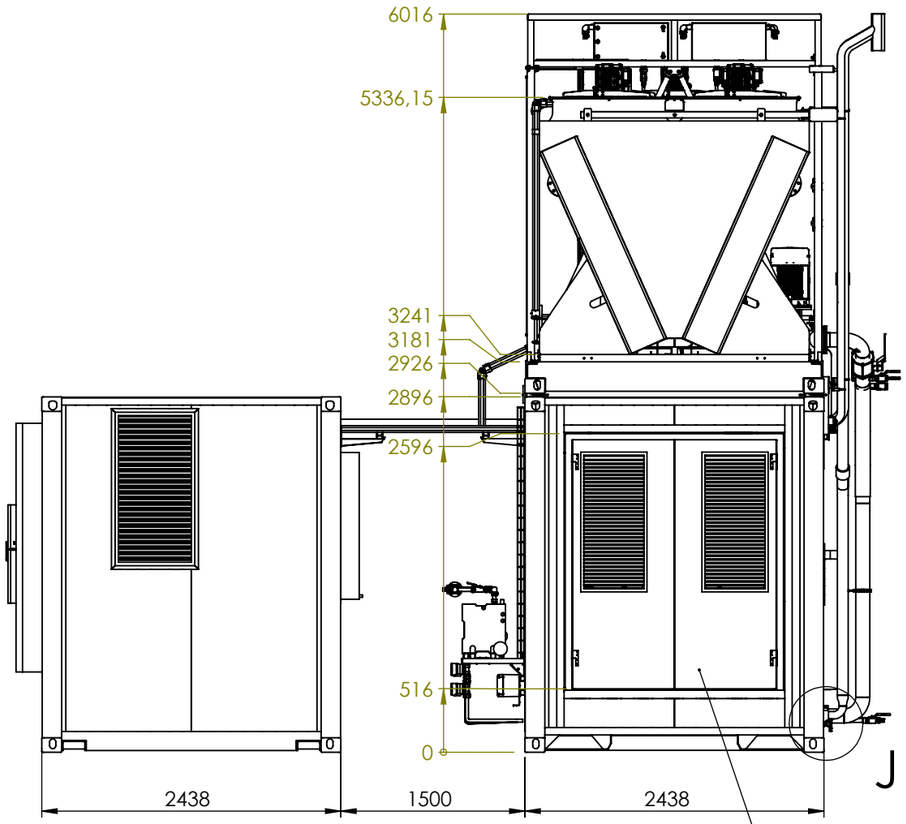
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	5/14	1:50	601456B	9

RIGHT VIEW
(LOOKING WEST)

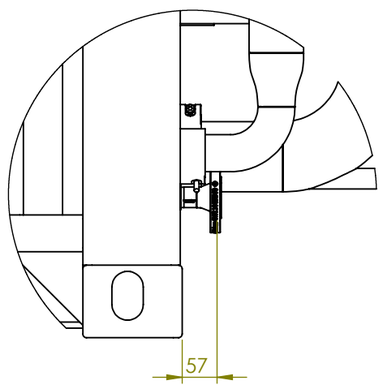


LEFT VIEW
(LOOKING EAST)



Doors can be opened
maximally by 150 degrees

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		



DETAIL J
SCALE 1 : 10

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
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3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

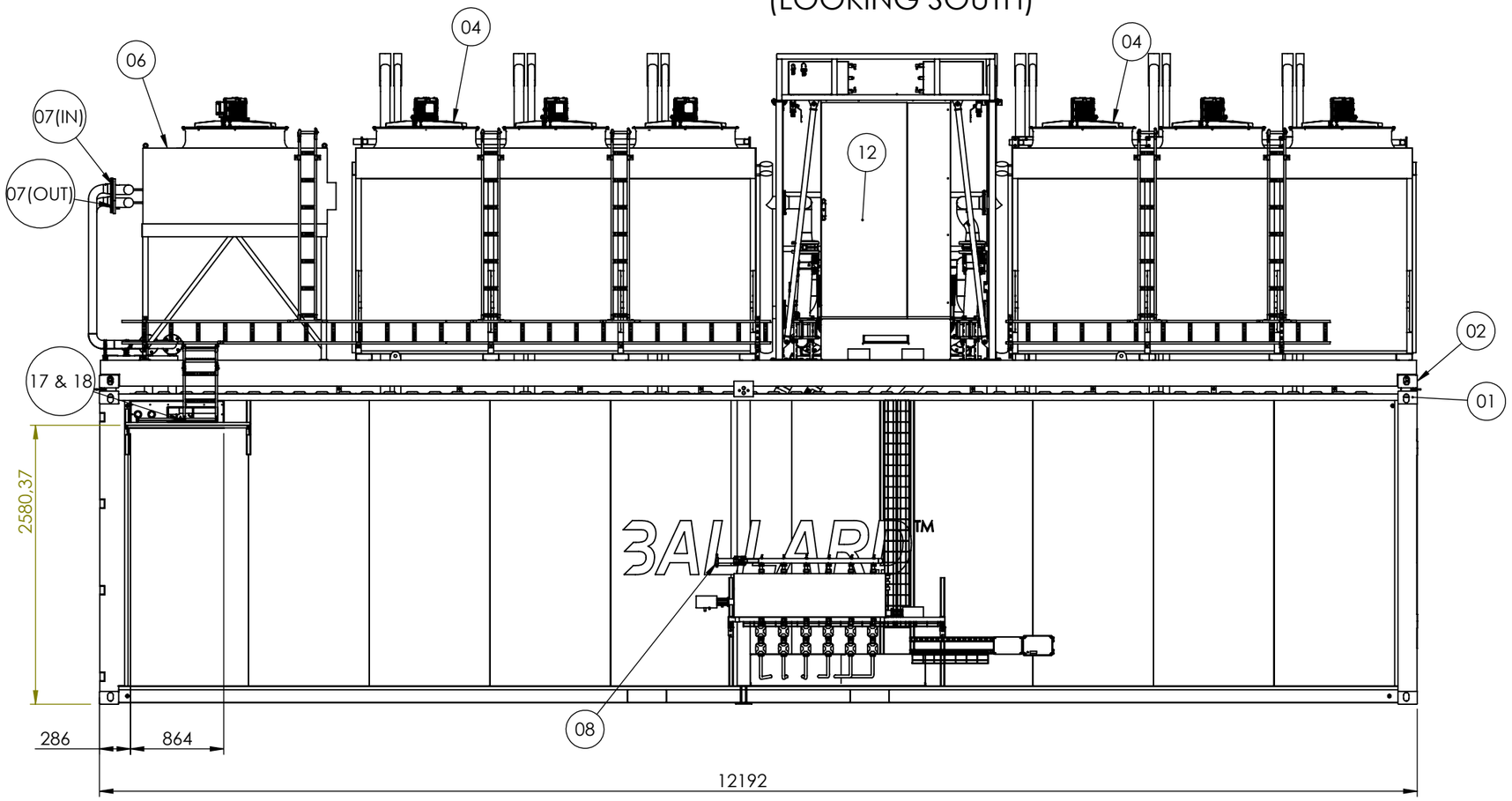
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BALLARD

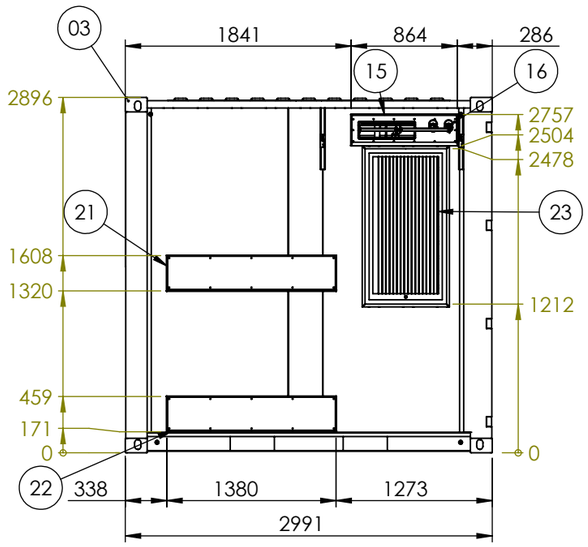
General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	6/14	1:50	601456B	9

FRONT VIEW
(LOOKING SOUTH)



SECTION B-B



SECTION C-C

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

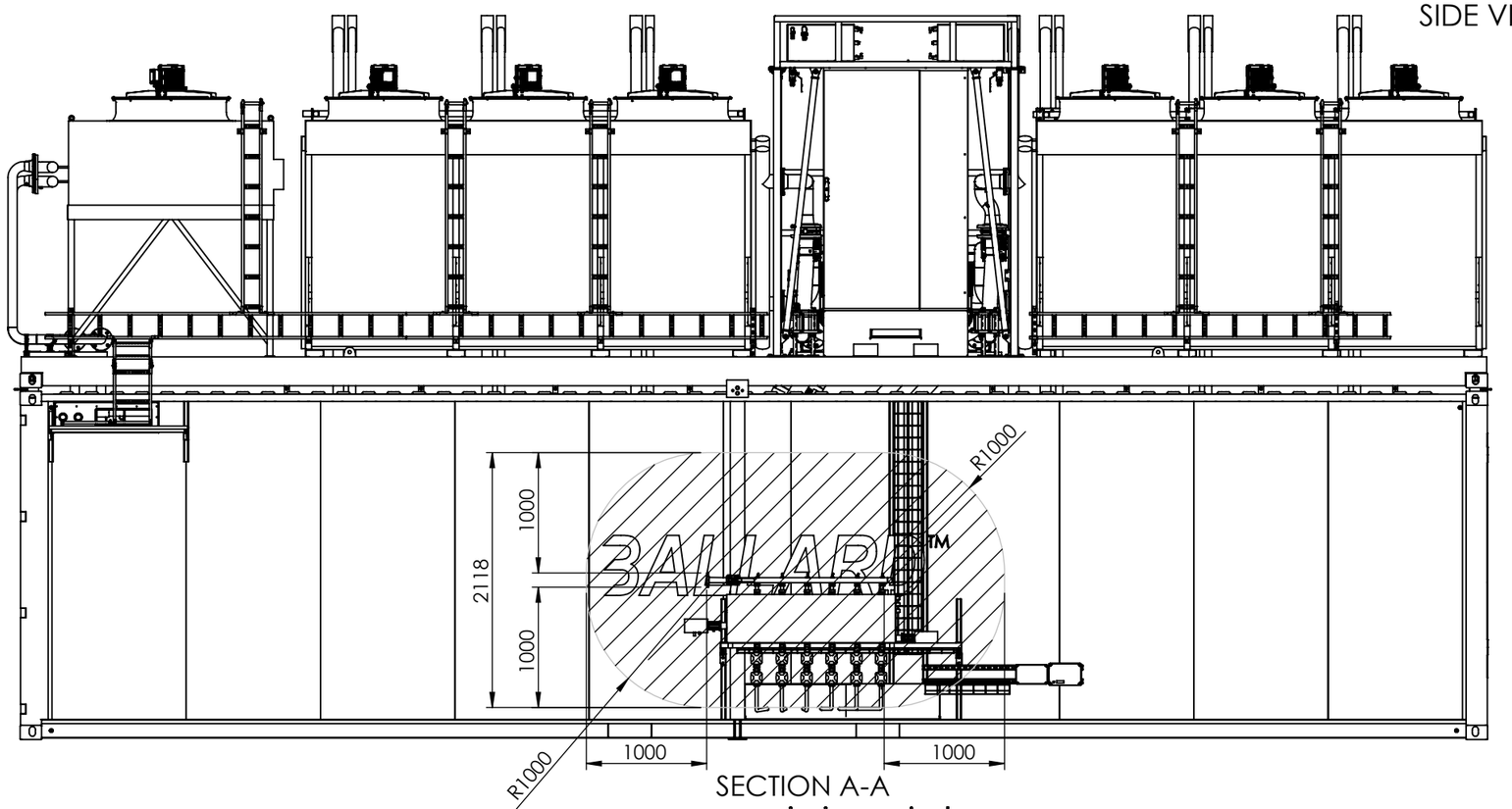
	By	Date
Drawn	ASM	20-02-2024
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Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
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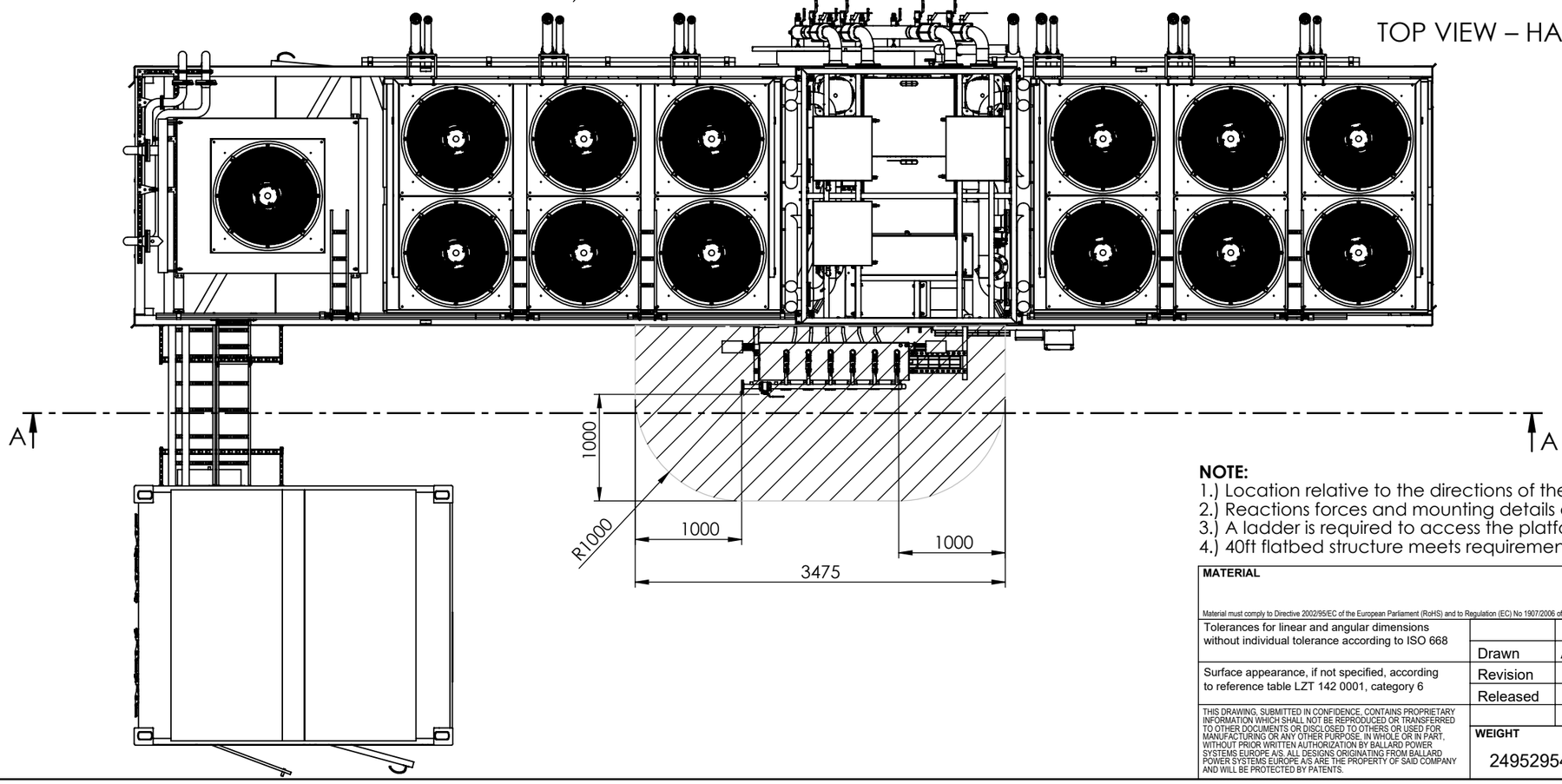
SIDE VIEW - HAZARD AREA



SECTION A-A

Zone 2 Gc IIC T1

TOP VIEW – HAZARD AREA



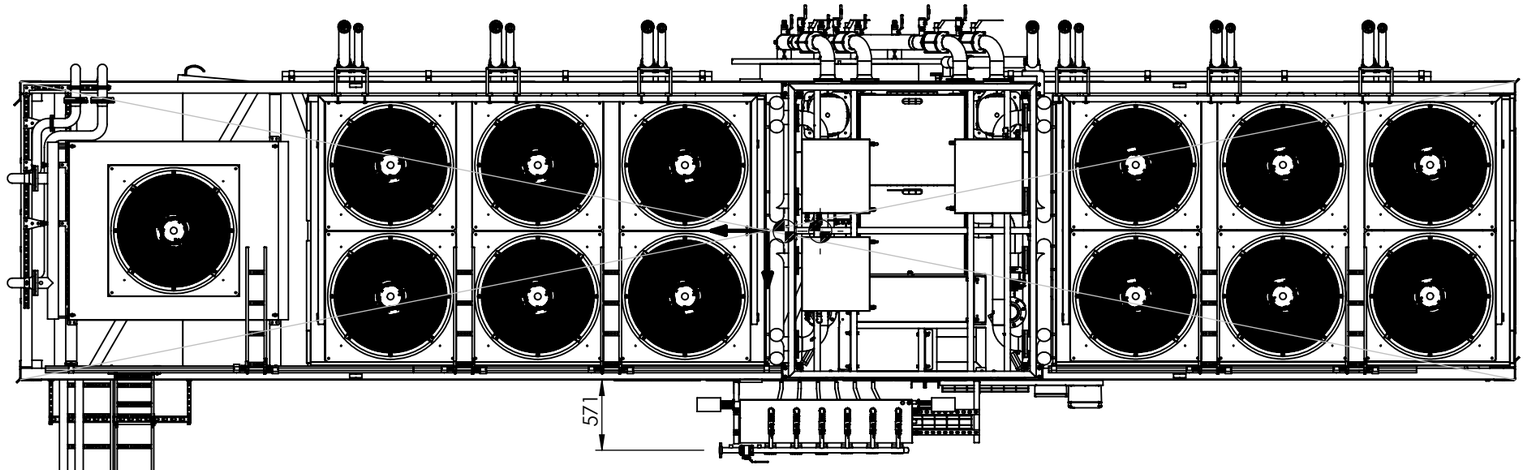
NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

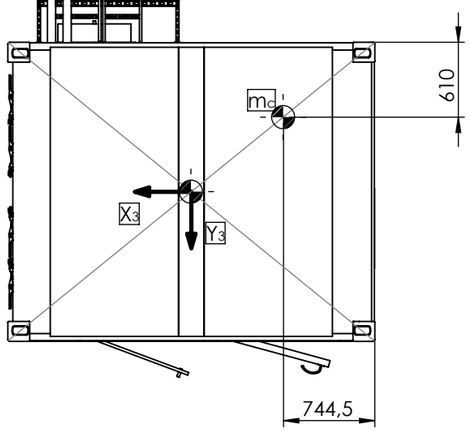
MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)			BALLARD™
Tolerances for linear and angular dimensions without individual tolerance according to ISO 668		By	Date
	Drawn	ASM	20-02-2024
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision		
	Released		
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
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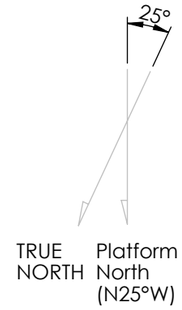
TOP VIEW - Center of Gravity

Access area





Access area



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

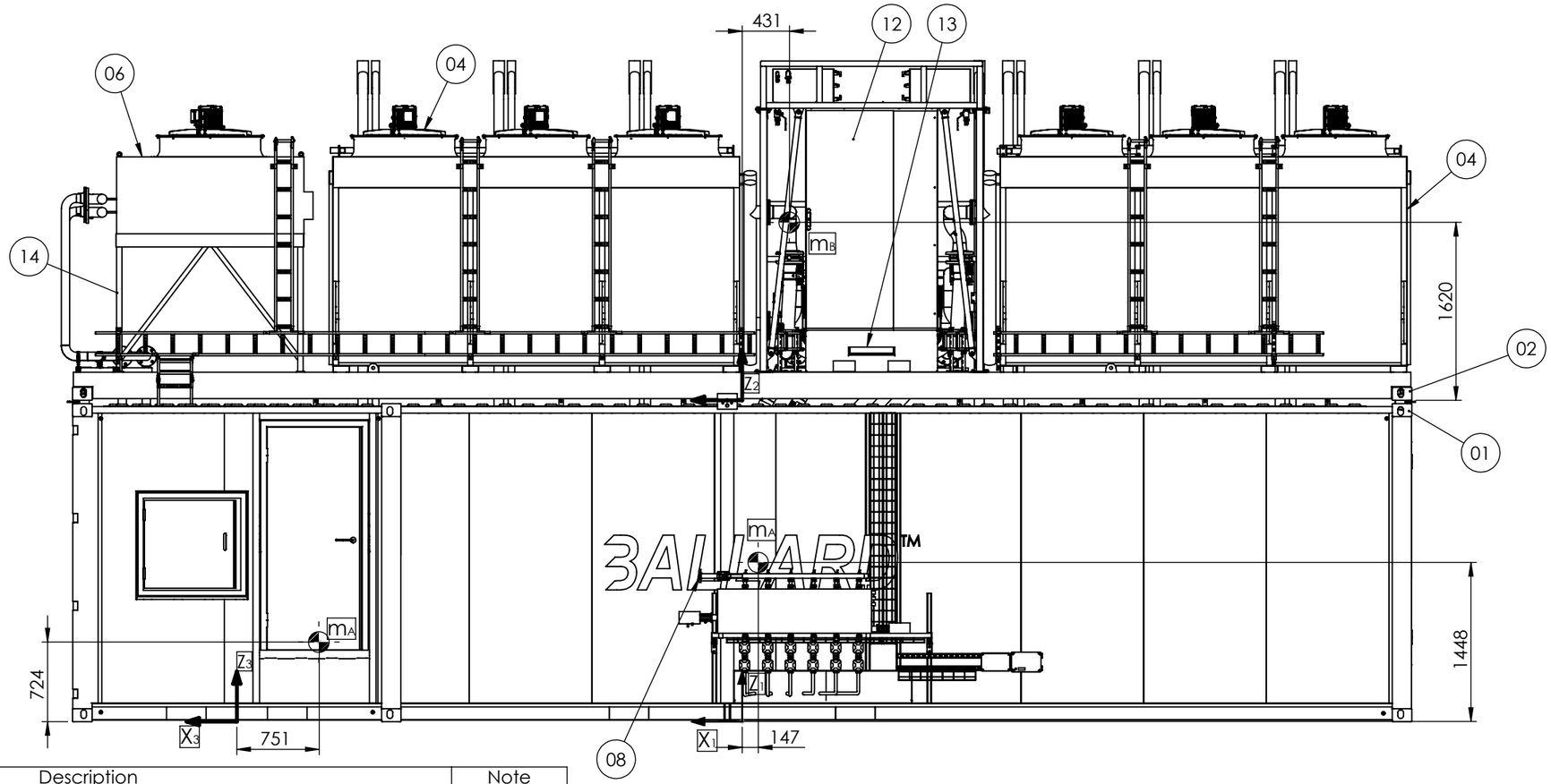
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	9/14	1:50	601456B	9

FRONT VIEW - Center of Gravity
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
	CHS = Circular Hollow Section	
	CIP - Customer Interface Point	

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
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WEIGHT 24952954 g

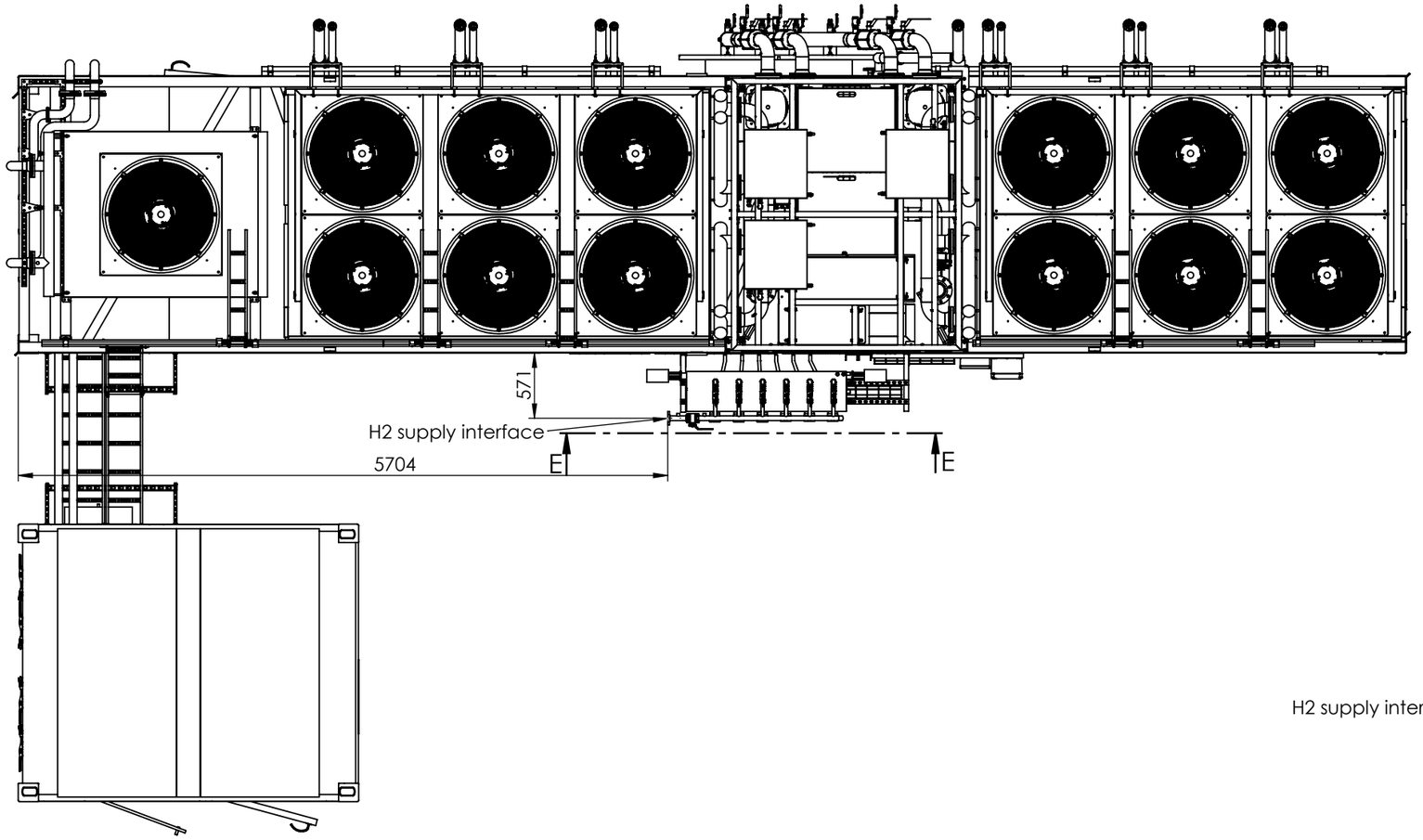
1st angle projection

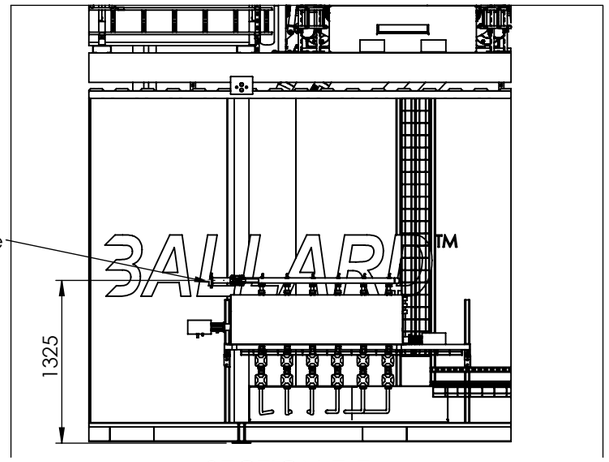
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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	10/14	1:50	601456B	9

TOP VIEW - H2 SUPPLY INTERFACE





SECTION E-E

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
08	H2 supply interface - TP 010	DN32	EN1759-1	300	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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Drawn	ASM	20-02-2024
Revision		
Released		

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WEIGHT 24952954 g

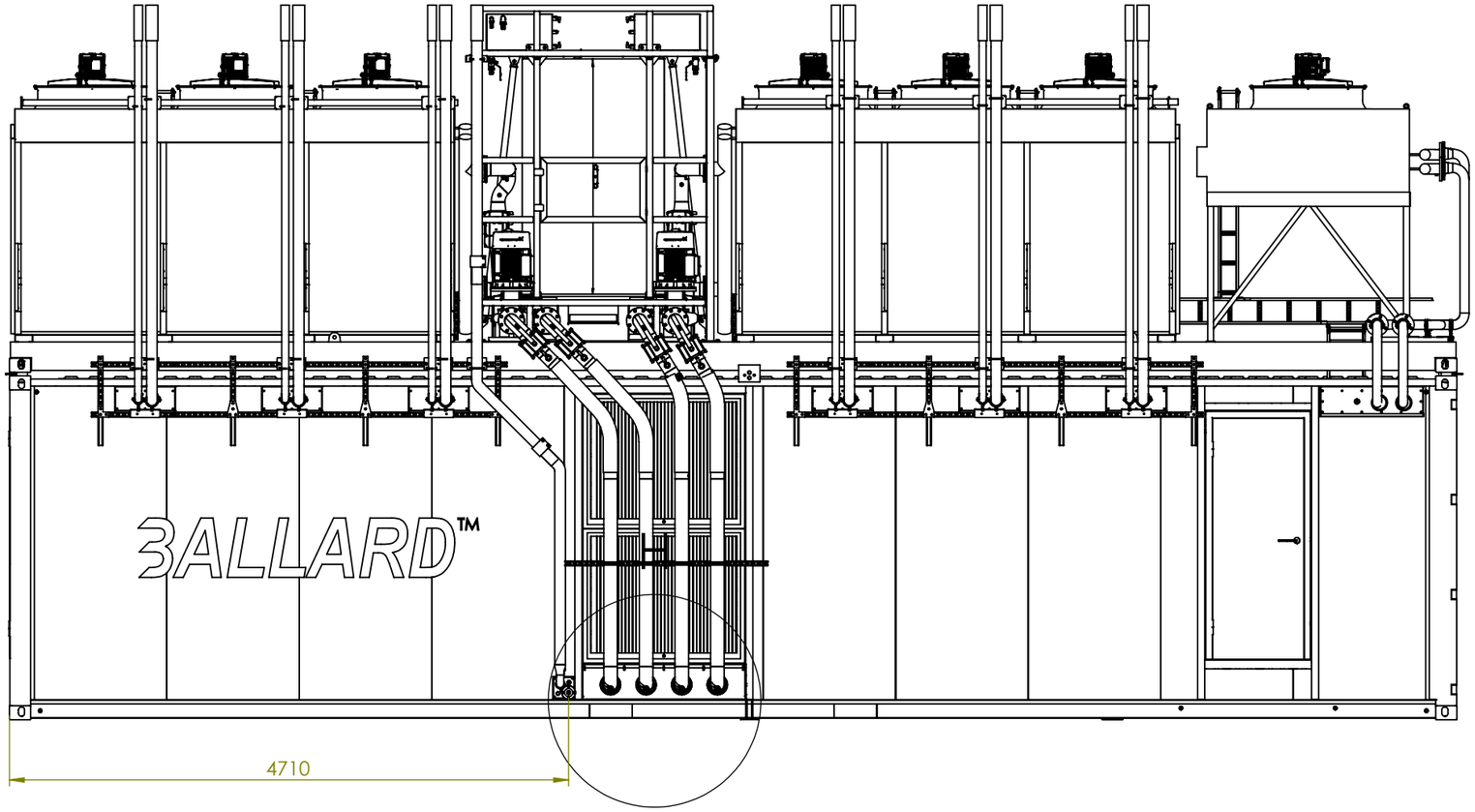
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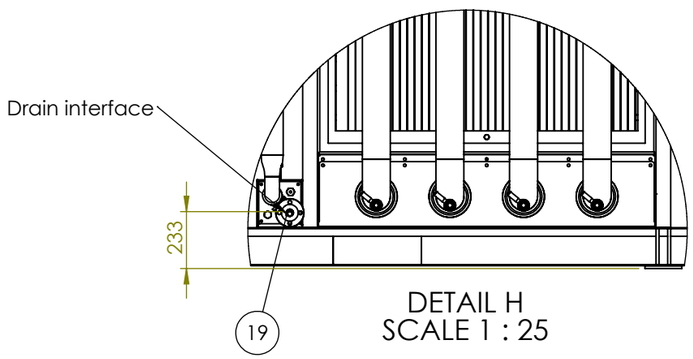
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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	11/14	1:50	601456B	9

FRONT VIEW LOOKING NORTH- DRAIN INTERFACE





DETAIL H
SCALE 1 : 25

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
19	Drain interface - TP 015	1"	ASME B 16.5	150	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

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WEIGHT 24952954 g

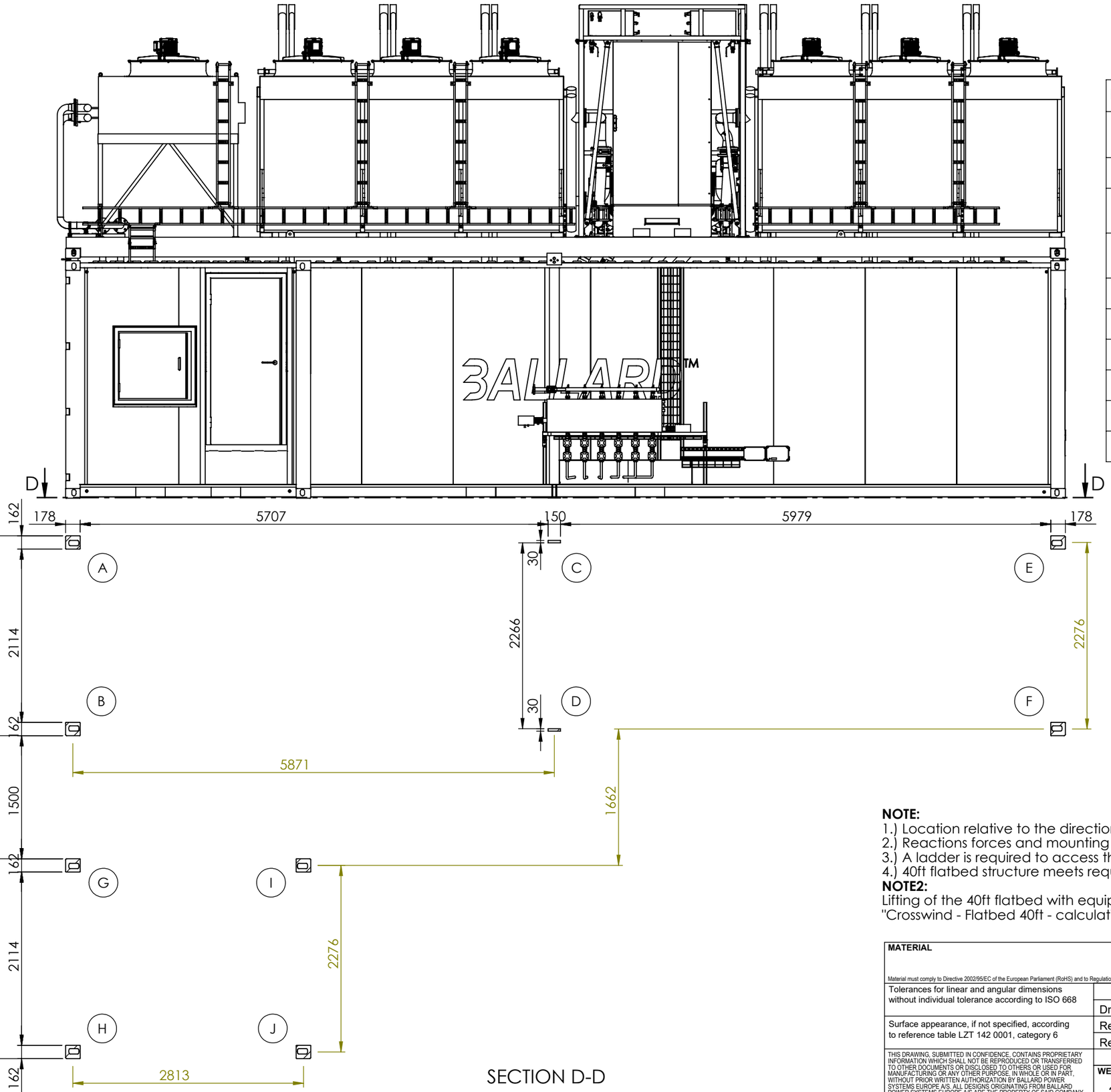
1st angle projection

BALLARD™

General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	12/14	1:50	601456B	9

REACTIONS BOTTOM



SECTION D-D

Pointer	Element description	Required support description
A	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
B	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
C	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
D	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
E	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
F	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
G	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
H	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
I	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
J	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

NOTE2:
Lifting of the 40ft flatbed with equipment in accordance to guidelines specified in structural calculation report: "Crosswind - Flatbed 40ft - calculation report rev_1.pdf"

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

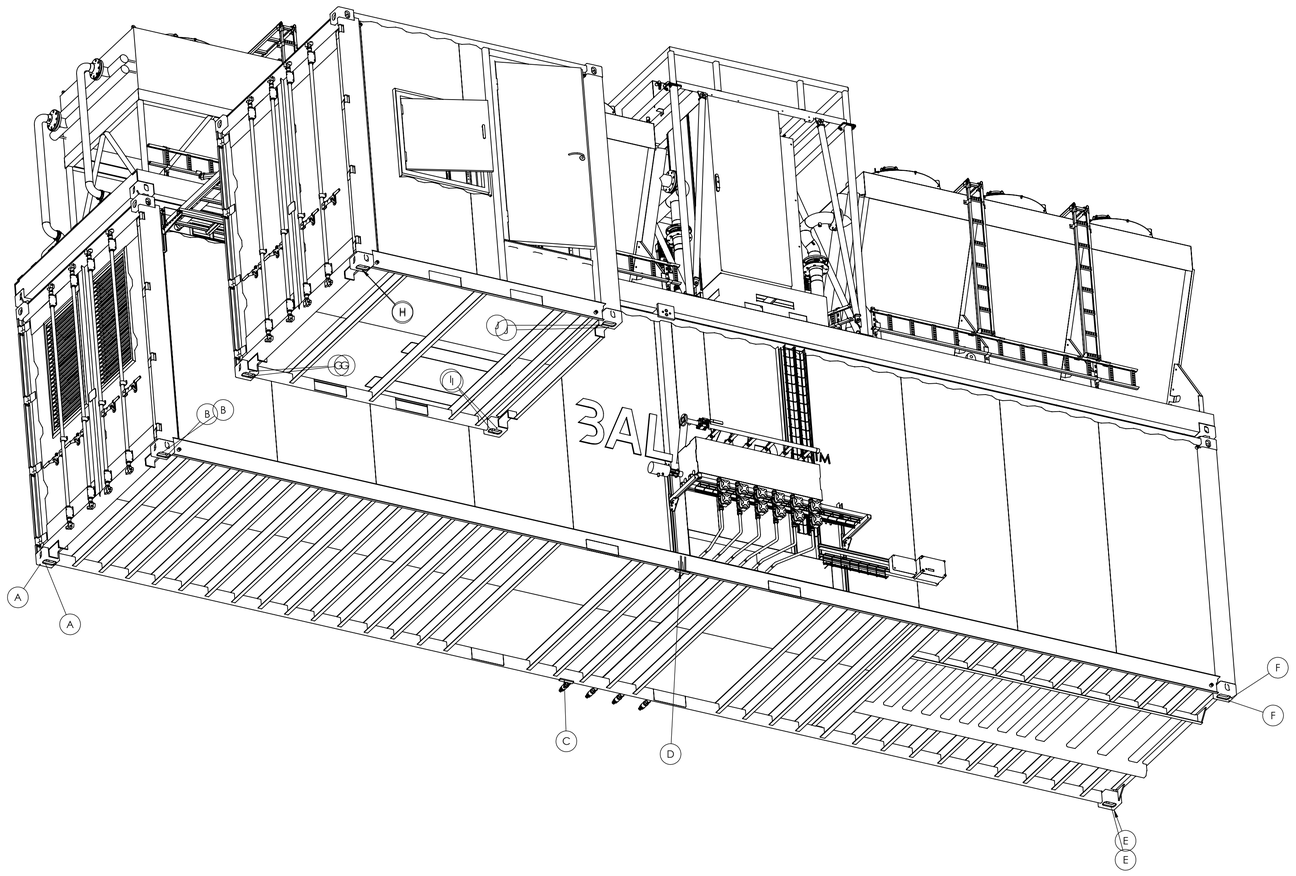
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	13/14	1:50	601456B	9



40ft container							
Ultimate Limit State: LC5 - Lifting of 40ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-	-	126	A	-	-	125
B	-	-	133	B	-	-	134
C	-	-	-	C	-	-	-
D	-	-	-	D	-	-	-
E	-	-	133	E	-	-	134
F	-	-	128	F	-	-	128

40ft container							
Ultimate Limit State: LC5 - Lifting of 10ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-	-	25	G	-	-	25
H	-	-	17	H	-	-	16
I	-	-	100	I	-	-	99
J	-	-	22	J	-	-	23

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
40ft container + 40ft flatbed (max self-weight) LC7 MAX-Sea transport on the barge Head sea, bow down, Y+ [Pitch case 1]				40ft container + 40ft flatbed (min self-weight) LC7 MIN-Sea transport on the barge Head sea, bow down, Y+ [Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	39	-75	-158	A	65	-72	-217
B	-103	-63	300	B	-76	-63	234
C	-	-	113	C	-	-	53
D	-	-	130	D	-	-	24
E	11	-42	27	E	-24	-60	-70
F	53	-83	138	F	35	-67	93
40ft container + 40ft flatbed (max self-weight) LC8 MAX-Sea transport on the barge Quatering sea, bow down, X+ Y+ [Quatering 1]				40ft container + 40ft flatbed (min self-weight) LC8 MIN-Sea transport on the barge Quatering sea, bow down, X+ Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-64	-39	-60	A	-42	-37	-98
B	-153	-49	263	B	-131	-50	207
C	-	-	101	C	-	-	34
D	-	-	127	D	-	-	41
E	-45	-33	30	E	-74	-48	-42
F	-37	-44	85	F	-52	-30	21
40ft container + 40ft flatbed (max self-weight) LC9 MAX-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]				40ft container + 40ft flatbed (min self-weight) LC9 MIN-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-130	9	80	A	-111	10	48
B	-131	-12	141	B	-111	-13	90
C	-	-	99	C	-	-	31
D	-	-	124	D	-	-	47
E	-44	2	70	E	-70	-11	-10
F	-78	2	-4	F	-92	13	-41
40ft container + 40ft flatbed (max self-weight) LC10 MAX-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]				40ft container + 40ft flatbed (min self-weight) LC10 MIN-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-154	51	206	A	-132	53	172
B	-67	31	-6	B	-44	31	-65
C	-	-	105	C	-	-	30
D	-	-	126	D	-	-	49
E	-4	46	127	E	-32	32	61
F	-74	37	-39	F	-90	49	-82
40ft container + 40ft flatbed (max self-weight) LC11 MAX-Sea transport on the barge Head sea, stern down, Y- [Pitch case 2]				40ft container + 40ft flatbed (min self-weight) LC11 MIN-Sea transport on the barge Head sea, stern down, Y- [Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-104	68	265	A	-79	71	225
B	33	65	-126	B	61	64	-164
C	-	-	118	C	-	-	23
D	-	-	130	D	-	-	59
E	77	85	178	E	43	67	101
F	-6	43	-13	F	-26	59	-79
40ft container + 40ft flatbed (max self-weight) LC12 MAX-Sea transport on the barge Quatering sea, stern down, X-Y- [Quatering 3]				40ft container + 40ft flatbed (min self-weight) LC12 MIN-Sea transport on the barge Quatering sea, stern down, X- Y- [Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	0	33	161	A	22	35	129
B	88	51	-101	B	111	51	-166
C	-	-	118	C	-	-	41
D	-	-	120	D	-	-	51
E	129	75	164	E	101	61	99
F	81	6	60	F	66	19	10
40ft container + 40ft flatbed (max self-weight) LC13 MAX-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]				40ft container + 40ft flatbed (min self-weight) LC13 MIN-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	69	-14	19	A	88	-13	-13
B	66	14	9	B	87	13	-31
C	-	-	115	C	-	-	47
D	-	-	117	D	-	-	40
E	126	39	120	E	100	25	60
F	122	-38	120	F	107	-27	83
40ft container + 40ft flatbed (max self-weight) LC14 MAX-Sea transport on the barge Quatering sea, stern down, X-Y+ [Quatering 4]				40ft container + 40ft flatbed (min self-weight) LC14 MIN-Sea transport on the barge Quatering sea, stern down, X- Y+ [Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	92	-57	-108	A	113	-55	-150
B	1	-29	170	B	24	-30	116
C	-	-	113	C	-	-	53
D	-	-	120	D	-	-	35
E	88	-5	70	E	59	-20	-5
F	119	-74	154	F	104	-61	116

10ft container (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
10ft container (max self-weight) LC7 MAX-Sea transport on barge Head sea, bow down, Y+ [Pitch case 1]				10ft container (min self-weight) LC7 MIN-Sea transport on barge Head sea, bow down, Y+ [Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	3	-3	14	G	5	-7	1
H	-17	-19	15	H	-8	-11	5
I	11	-18	63	I	4	-16	7
J	2	-7	24	J	-1	-14	12
10ft container (max self-weight) LC8 MAX-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]				10ft container (min self-weight) LC8 MIN-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	3	24	G	-21	0	13
H	-27	-26	14	H	-20	-19	6
I	-7	-12	52	I	-13	-10	6
J	-7	5	19	J	-10	-1	10
10ft container (max self-weight) LC9 MAX-Sea transport on barge Beam sea, X+ [Roll case 1]				10ft container (min self-weight) LC9 MIN-Sea transport on barge Beam sea, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-33	10	29	G	-32	6	19
H	-27	-23	13	H	-21	-17	5
I	-13	-3	54	I	-19	-1	11
J	-9	16	13	J	-12	11	4
10ft container (max self-weight) LC10 MAX-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]				10ft container (min self-weight) LC10 MIN-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-29	14	28	G	-28	11	17
H	-21	-15	11	H	-13	-8	3
I	-9	7	63	I	-15	9	17
J	-5	25	8	J	-8	20	-2
10ft container (max self-weight) LC11 MAX-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]				10ft container (min self-weight) LC11 MIN-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-8	14	19	G	-6	10	7
H	-6	-2	10	H	3	6	0
I	8	12	80	I	0	14	24
J	5	24	6	J	2	18	-6
10ft container (max self-weight) LC12 MAX-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]				10ft container (min self-weight) LC12 MIN-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	18	7	7	G	20	3	-3
H	6	5	10	H	13	12	1
I	25	7	84	I	19	8	37
J	15	12	9	J	12	6	0
10ft container (max self-weight) LC13 MAX-Sea transport on barge Beam sea, X- [Roll case 2]				10ft container (min self-weight) LC13 MIN-Sea transport on barge Beam sea, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	29	0	3	G	30	-3	8
H	6	3	11	H	13	9	3
I	31	-3	80	I	26	-1	37
J	17	0	15	J	14	-6	6
10ft container (max self-weight) LC14 MAX-Sea transport on barge Quatering sea, stern down, X-Y+ [Quatering 4]				10ft container (min self-weight) LC14 MIN-Sea transport on barge Quatering sea, stern down, X-Y+ [Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	25	-4	4	G	26	-7	7
H	-1	-6	13	H	6	2	5
I	27	-12	73	I	21	-10	26
J	13	-8	21	J	10	14	11

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
40ft container + 40ft flatbed (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-67	2	58	A	-61	3	48
B	-69	-4	99	B	-63	-4	83
C	-	-	84	C	-	-	63
D	-	-	102	D	-	-	78
E	1	10	71	E	-7	6	51
F	-23	-8	20	F	-27	-4	9
40ft container + 40ft flatbed (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	65	-95	-260	A	71	-95	-275
B	-115	-82	362	B	-108	-81	347
C	-	-	103	C	-	-	92
D	-	-	105	D	-	-	80
E	-4	-65	-38	E	-12	-69	-61
F	53	-95	158	F	50	-92	149
40ft container + 40ft flatbed (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	16	-7	26	A	21	-6	17
B	13	6	39	B	19	6	21
C	-	-	97	C	-	-	76
D	-	-	102	D	-	-	78
E	69	24	91	E	61	20	72
F	60	-24	78	F	56	-20	66
40ft container + 40ft flatbed (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-117	90	332	A	-111	91	323
B	60	83	-237	B	67	83	-257
C	-	-	98	C	-	-	76
D	-	-	119	D	-	-	106
E	73	98	189	E	65	94	172
F	-17	66	-72	F	-21	69	-88

10ft container (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
10ft container (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-28	16	32	G	-24	13	28
H	-8	-14	-1	H	-7	-11	-1
I	6	-25	38	I	2	-21	26
J	-7	23	22	J	-8	19	17
10ft container (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-19	0	4	G	-15	-4	0
H	-7	-26	13	H	-6	-23	13
I	21	-30	39	I	16	-26	27
J	6	7	36	J	4	3	31
10ft container (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-4	6	2	G	1	3	-2
H	6	-10	0	H	7	-7	1
I	27	-16	38	I	22	-12	56
J	8	19	21	J	7	15	16
10ft container (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	28	35	G	-18	25	30
H	-2	2	-17	H	-1	5	-17
I	21	-10	60	I	17	-6	48
J	3	29	13	J	2	25	8

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and its Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

WEIGHT 24952954 g

1st angle projection

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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A1	14/14	1:30	601456B	9

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	27/01/2023	First Issue
002	03/03/2023	Modified according to comments
003	17/05/2023	Updated according to comments
004	08/03/2024	Updated according to comments
005	16/10/2024	Updated according to comments and with changed water separator
006	20/11/2024	Updated according to comments

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Purchaser Job:	K559-2254
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Process And Instrumentation Diagrams

Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS

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		3	Symbol List	15-Oct-24
		4	Hydrogen Supply System	20-Nov-24
		5	Hydrogen Supply System - BOM	20-Nov-24
		6	Process Exhaust and Drain	20-Nov-24
		7	HT1 Coolant System - Fuel Cells	20-Nov-24
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		10	LT Coolant System - Fuel Cells	20-Nov-24
		11	LT Coolant System - Power Converters 1/2	20-Nov-24
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		13	LT Coolant System - BOM	20-Nov-24
		13.a	LT Coolant System - BOM	16-Oct-24
		14	Ventilation Air System - 40ft Container	20-Nov-24
		15	Ventilation Air System - 10ft Container	20-Nov-24

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Structure Identifier Overview

Functional Designation

Which function is associated with the components?

Structure identifier overview

Full designation	Labeling	Structure description
=AA01	Function designation	Container Interconnection
=BA01	Function designation	Power Conversion Block 1
=BA02	Function designation	Power Conversion Block 2
=BA20	Function designation	Power Conversion BOP
=BA30	Function designation	Power Conversion Output
=HA01	Function designation	Hydrogen Supply System
=HE01	Function designation	High Temperature Cooling Circuit #1
=HE02	Function designation	High Temperature Cooling System #2
=HE03	Function designation	Low Temperature Cooling Circuit
=JA01	Function designation	Container Ventilation System
=JA02	Function designation	Process Exhaust System
=JA03	Function designation	H2 Enclosure Ventilation
=JB01	Function designation	Condensate Drainage System
=LA01	Function designation	Container Control System
=LB02	Function designation	Container Safety System
=RE01	Function designation	Fuel Cell System 1
=RE02	Function designation	Fuel Cell System 2
=HKN70	Function designation	Baseload Power Hub
=EXT	Function designation	External Connection
=JB02	Function designation	Condensate Drainage System
=LA01.LA01	Function designation	

Location Designation

Where is the component located?

Structure identifier overview

Full designation	Labeling	Structure description
+DA01	Location designation	Container #1 Inside
+DA02	Location designation	Container #1 Outside
+DA03	Location designation	Container #2 Inside
+DA04	Location designation	Container #2 Outside
+GB01	Location designation	FCwave Module #1
+GB02	Location designation	FCwave Module #2
+GB03	Location designation	FCwave Module #3
+GB04	Location designation	FCwave Module #4
+GB05	Location designation	FCwave Module #5
+GB06	Location designation	FCwave Module #6
+UC01	Location designation	DCDC Cabinet #1
+UC02	Location designation	DCDC Cabinet #2
+UC03	Location designation	DCDC Cabinet #3
+UC04	Location designation	DCDC Cabinet #4
+UC05	Location designation	DCDC Cabinet #5
+UC06	Location designation	DCDC Cabinet #6
+UC07	Location designation	Ventilation Cabinet
+UC10	Location designation	DCAC Cabinet Output
+UC20	Location designation	Control Cabinet (40ft)
+UC30	Location designation	Coolant Skid Control Cabinet
+UC31	Location designation	Control Cabinet (10ft)
+UC40	Location designation	Coolant Power Distribution
+UC41	Location designation	HT+LT VFD Cabinet
+UC42	Location designation	EX Barrier Box
+UC50	Location designation	AC Power Distribution
+WZ10	Location designation	Container Interconnect Frame
+H2SS	Location designation	Hydrogen Supply (Ext)
+UC30.UC20	Location designation	

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Symbol List

Process Engineering

Threaded Connection
Dissimilar male and female part
=+-XM00

Valve, Hand-actuated
Typically quarter-turn, lockable in both positions
=+-QM00

Wall-passthough
Penetration through enclosure or container
-XT01

Valve, solenoid-actuated
Electromagnetic shutoff valve, normally closed type
-QM00

Pipe fixed point
Eg pipe end or welding connection
-XM00

Valve, check
One-way flow control valve for gas for fluid
-RM00

Liquid cooling element
Cooling path of liquid cooled power electronics
-TA00

Cooling Tower, with fans
Suction type
=+-EG00

Pump, centrifugal, with motor
Suction type
-GP00

Hose, Flexible
-WP00

Exhaust, to free air
With weather shield
-WM00

Valve, Shut-off, Motorized, Modulating
Motorized Control Valve, gradual between 0-100%
-QN00

Vessel or tank
With volume indicated
=+-CL00
Volume XL

Flow restrictor or orifice
For limiting gas or fluid flow rate
-QN00

Reducer, concentric
With indication of size
-XM00

Ventilation and Heating

Heater, with fans
Space heating element, electric
-EB00

Damper, lamellar
For ventilation purposes
-QM00

Actuator, motor, modulating
For dampers or valves
=+-QM00.MA00

Fan, axial flow
With motor
-GQ00

Fan, radial flow
With motor
-GQ00

Sensor, Room
Sensor for sensing conditions in open space
-BT00

Sensor, Process
Sensor with process connection
-BT00

Filter, for air
Cooling path of liquid cooled power electronics
-FS00

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
= | ++	+ | & B02

REVISION INFORMATION	
DESCRIPTION	
DATE	
15-Oct-24	

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DRAWING	601456B C03 Process and Instrumentation Diagram	REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Symbol List		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1	LANGUAGE EN	SHEET/TOTAL 3 / 16

FRMS103653/08

Hydrogen Supply System - Fuel Cells 1-6

=RE01
Fuel Cell System 1

+GB01
FCwave 1

-XM01
20mm
H2 Supply Inlet

-WP_H2927
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

+GB02
FCwave 2

-XM01
20mm
H2 Supply Inlet

-WP_H2926
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

+GB03
FCwave 3

-XM01
20mm
H2 Supply Inlet

-WP_H2925
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=RE02
Fuel Cell System 2

+GB04
FCwave 4

-XM01
20mm
H2 Supply Inlet

-WP_H2924
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

+GB05
FCwave 5

-XM01
20mm
H2 Supply Inlet

-WP_H2923
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

+GB06
FCwave 6

-XM01
20mm
H2 Supply Inlet

-WP_H2922
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02
Hydorgen Supply System, Container #1 Outside

-XT01
Wall pass-through

-WP_H2917
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.1

=HA01+DA02-QM2.1
DN20
Shut-off Valve

-WP_H2907
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM1.1

=HA01+DA02-QM1.1
DN20
Shut-off Valve

-XT02
Wall pass-through

-WP_H2916
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.2

=HA01+DA02-QM2.2
DN20
Shut-off Valve

-WP_H2906
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM1.2

=HA01+DA02-QM1.2
DN20
Shut-off Valve

-XT03
Wall pass-through

-WP_H2915
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.3

=HA01+DA02-QM2.3
DN20
Shut-off Valve

-WP_H2905
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM1.3

=HA01+DA02-QM1.3
DN20
Shut-off Valve

-XT04
Wall pass-through

-WP_H2914
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.4

=HA01+DA02-QM2.4
DN20
Shut-off Valve

-WP_H2904
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM1.4

=HA01+DA02-QM1.4
DN20
Shut-off Valve

-XT05
Wall pass-through

-WP_H2913
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.5

=HA01+DA02-QM2.5
DN20
Shut-off Valve

-WP_H2903
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM1.5

=HA01+DA02-QM1.5
DN20
Shut-off Valve

-XT06
Wall pass-through

-WP_H2912
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

Y V
QM2.6

=HA01+DA02-QM2.6
DN20
Shut-off Valve

-WP_H2902
Hydrogen
3,5-6,5 barg
-6,4 - 80°C
<4,9 g/s

Y V
QM1.6

=HA01+DA02-QM1.6
DN20
Shut-off Valve

-BL01
SI = 11 mm
Ex Point Liquid Detection

BT01
PT1000 -40...150 °C
Liquid Temperature Sensor

-CM01
SS316, Volume 146L
Hydrogen Heater Vessel

-EA01
3x400V, 9kW, Ex
Heating Element 1

-EA02
3x400V, 9kW, Ex
Heating Element 2

-WP01
DN25, 3000m
Tube Coil

-WP02
DN25, 3000m
Tube Coil

-WP03
DN25, 3000m
Tube Coil

-WP04
DN25, 3000m
Tube Coil

-WP05
DN25, 3000m
Tube Coil

-WP06
DN25, 3000m
Tube Coil

-WP_H2947
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM01
DN25
Isolation Valve, Lockable

-WP_H2946
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM02
DN25
Isolation Valve, Lockable

-WP_H2945
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM03
DN25
Isolation Valve, Lockable

-WP_H2944
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM04
DN25
Isolation Valve, Lockable

-WP_H2943
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM05
DN25
Isolation Valve, Lockable

-WP_H2942
Hydrogen
3,5-6,5 barg
12 - 80°C
<4,9 g/s

=HA01+DA02-QM06
DN25
Isolation Valve, Lockable

=HKN70
Baseload Power Hub, Hydrogen Supply

0,9 - 29,4 g/s
-6,4 - 25°C
4,5 - 6,5 barg
Hydrogen

-XM01
DN32, EN1759-1, RF face
H2 Supply Connection
Flange Fitting

P T
BT01

=HA01+DA02-BP01
0...10 barg
Hydrogen Inlet
Pressure Transmitter

-WP_H2900
Hydrogen
3,5 - 6,5 barg
-6,4 - 80°C
0,9 - 29,4 g/s

=HA01+DA02-QM00
DN32
Manual shutoff valve
Lockable

-WP_H2901
Hydrogen
3,5 - 6,5 barg
-6,4 - 80°C
0,9 - 29,4 g/s

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
= | +	+ & B02

REVISION INFORMATION	
DESCRIPTION	
DATE	
20-Nov-24	

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DRAWING	6014568 C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Hydrogen Supply System
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 4 / 16

FRMS103653/08

Hydrogen Supply System - Fuel Cells 1-6

Bill of Materials / Parts List

Device tag	Qty	Unit	Description	Manufacturer			
				Name	Type Number	Order Number	
-AC01-WG01	2	meter	ÖLFLEX CLASSIC 110 CH 18G0,75	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035051	
-BL01	1	Piece	Electronic level sensor; Operating voltage 18...30 DC V; ATEX; M12 Connector; Gold-plated contacts	IFM Electronic AS	LMACE-A12E-QSKG-I/US/3D/3G	LMT01A	
-BL01-WG01	1	piece	Connecting cable with socket Cable: 25 m, PUR, Halogen-free, black, Ø 4.9 mm; 4 x 0.34 mm² (42 x Ø 0.1 mm) Connector: 1 x M12, angled; coding: IP Electronic AS	IFM Electronic AS	[illegible]	EVC14A	Tightening torque: 1.2...1.5 Nm
-BL01-XG01	0						
-BP01	1	Piece	Pressure Transducer, 0-10 barg, 4-20mA, ATEX, -25 to 85°C Ta, M12 Connector, 10..30 VDC, 2-wire, G1/2 Process Connection, FPM Seal	HUBA Controls AG	Pressure Transducer 520 Series	520930S04M801	
-BP01-WG01	1	piece	Connecting cable with socket Cable: 10 m, PUR, Halogen-free, blue, Ø 4.9 mm; 4 x 0.34 mm² (42 x Ø 0.1 mm) Connector: 1 x M12, straight; coding: IP Electronic AS	IFM Electronic AS	[illegible]	EVC03A	Tightening torque: 1.2...1.5 Nm
-BP01-XG01	0						
-BT01	1	Piece	PT1000 Sensor Element, Ø10mm x 160mm, 4 wire connection, EN60751 Class A	IFM Electronic AS	TT-100KBBD10-...../US/	TT1050	
-BT01-WG01	1	piece	Connecting cable with socket Cable: 10 m, PUR, Halogen-free, blue, Ø 4.9 mm; 4 x 0.34 mm² (42 x Ø 0.1 mm) Connector: 1 x M12, straight; coding: IP Electronic AS	IFM Electronic AS	[illegible]	EVC03A	Tightening torque: 1.2...1.5 Nm
-BT01-XG01	0						
-CM01	1	piece	Hydrogen Heater System, Water bath heat exchanger, SS316L, Volume 146L	Ballard Power Systems Europe			
-CM01-EA01	1	piece	Immersion Heater, 3x400V, 9kW, ATEX, IP66, Screw plug 2", ASTM A182 F316, Element Length 600m	JEVI Heating Elements AS	D-8640	340386	
-CM01-EA01	1	piece	Cable gland, ATEX Group II, grounding ring for amour, tightening guide, Resin/compound barrier with transparant inspection chamber, Unplated brass, M20	Hawke International	ICG 653 UNIV Os M20	653UOsM20	
-CM01-EA02	1	piece	Immersion Heater, 3x400V, 9kW, ATEX, IP66, Screw plug 2", ASTM A182 F316, Element Length 600m	JEVI Heating Elements AS	D-8640	340386	
-CM01-EA02	1	Piece	Cable gland, ATEX Group II, grounding ring for amour, tightening guide, Resin/compound barrier with transparant inspection chamber, Unplated brass, M20	Hawke International	ICG 653 UNIV Os M20	653UOsM20	
-CM01-WP01	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-CM01-WP02	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-CM01-WP03	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-CM01-WP04	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-CM01-WP05	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-CM01-WP06	1		Pipe coil, for H2 heater system. DN25 seamless pipe, 2mm wall, Stainless Steel 316L	Ballard Power Systems Europe			
-EA01-WD01	1	meter	Screened control cable, 4G2.5mm2, LSZH	Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342	
-EA02-WD01	1	meter	Screened control cable, 4G2.5mm2, LSZH	Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342	
-QM00	1	Piece	3-piece premium quater-turn ball valve, full bore, Stainless steel, DN32, CF8M, ATEX, Weld-ends, lockable	Armatec DVCAS	1311 Full Bore	131150032	
-QM1.1	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.1	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.1	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.1-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM1.2	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.2	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.2	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.2-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM1.3	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.3	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.3	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.3-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM1.4	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.4	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.4	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.4-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM1.5	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.5	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.5	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.5-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM1.6	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM1.6	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM1.6	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM1.6-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM01	1	Piece	Quater-turn ball valve, lockable, size 25mm, 25mm Hy-Lok Tube Fitting ends	Hy-Lok Corporation	110 Series Ball Valves	BVH-25M	
-QM2.1	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM2.1	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM2.1	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	
-QM2.1-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-QM2.2	1	Piece	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	Emerson ASCO	NF X E210D488E 24/DC	NF X E210D488E 24/DC	
-QM2.2	1	Piece	Eaton's Crouse-Hinds series Redapt AD-U adaptor End1 size: 1/2", NPT, Male End2 size: M20, Metric, Female	Eaton	AD-U	ADU102904	
-QM2.2	1	Piece	501/421 Cable gland, ATEX Group II, M20, Unplated brass	Hawke International	501/421/O M20	421OM20	

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
=	++ | + | & B02

FRM5103653/08

REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

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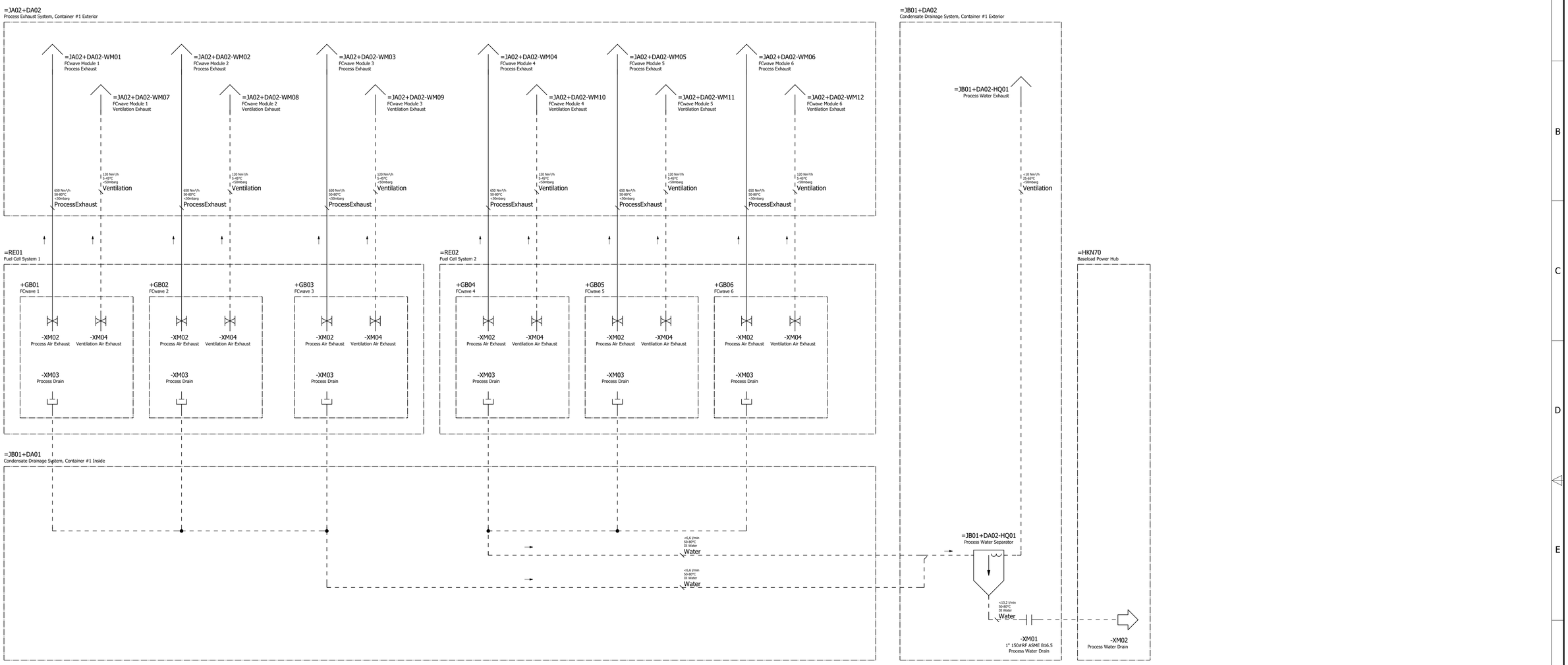
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DRAWING	601456B C03 Process and Instrumentation Diagram	REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Hydrogen Supply System - BOM		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1	LANGUAGE EN	SHEET/TOTAL 5 / 16

Process Exhaust, Ventilation Exhaust, Process Water Drain - Fuel Cells 1-6



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=JB01+DA02-HQ01	0					
=JB01+DA02-HQ01	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM01	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM02	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM03	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM04	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM05	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM06	1		Process Exhaust for FCwave, Megablock, 3" Stainless 316	Ballard Power Systems Europe		7001553
=JA02+DA02-WM07	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM08	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM09	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM10	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM11	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JA02+DA02-WM12	1		Ventilation Exhaust, Megablock, 2", Stainless 316	Ballard Power Systems Europe		7001554
=JB01+DA02-XM01	1		Pipe End, Ø60.3mm, Material 1.4301	Ballard Power Systems Europe		5500231B-2891

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
- ++	+ & B02

FRMS10365J/08

REVISION INFORMATION
DESCRIPTION
DATE
20-Nov-24

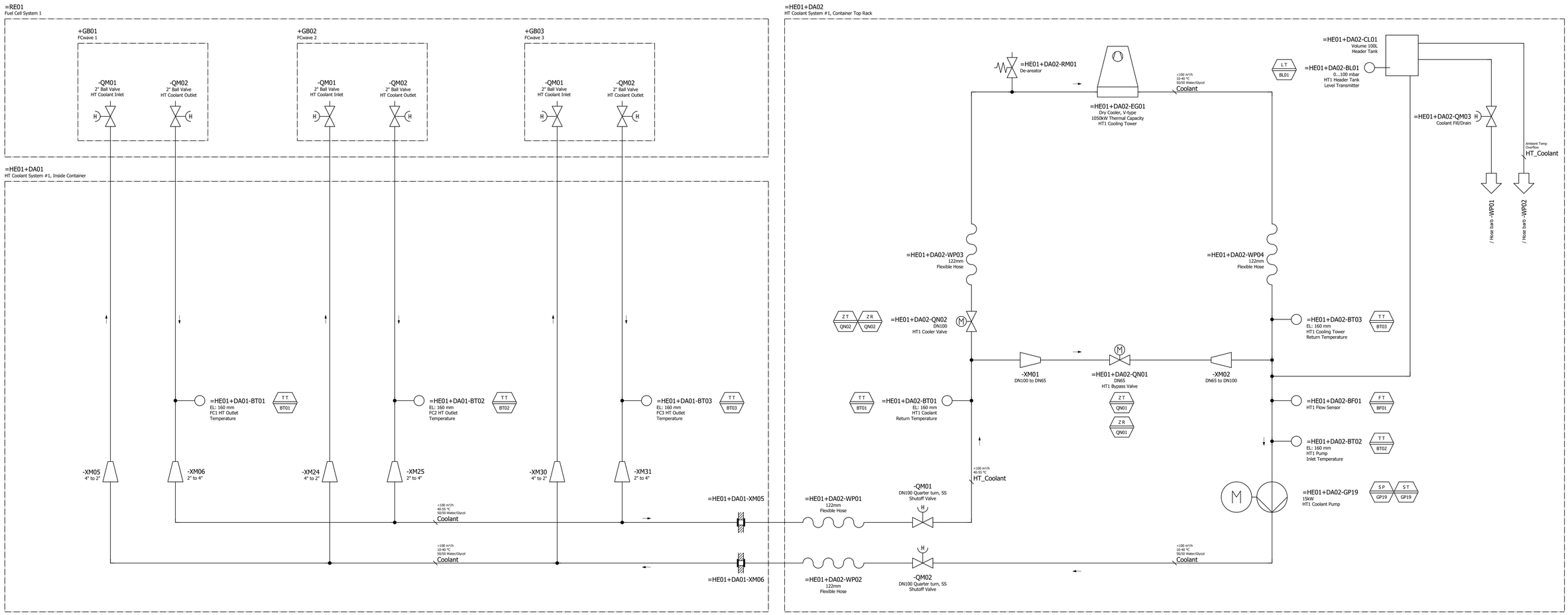
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DRAWING	601456B C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Process Exhaust and Drain
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 6 / 16

High Temperature Cooling System - Fuel Cells 1-3



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=HE01+DA02-BF01	1	Piece	Flow sensor	IFM Electronic AS	SAEXXXXB50KG/US-100	SA4104
=HE01+DA02-BL01	1	Piece	Pressure transmitter with ceramic measuring cell, DC, analogue signal	IFM Electronic AS	PA-,10BRBG14-A-ZVG/US/ /V	PA3589
=HE01+DA01-BT01	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA01-BT02	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA01-BT03	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA02-BT01	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA02-BT02	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA02-BT03	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE01+DA02-CL01	1		Header Tank, Volume 100L, AISI 304	Ballard Power Systems Europe	5500231B-3002	5500231B-3002
=HE01+DA02-EG01	1		Dry Cooler, 1050kW, With Ventilators (Offshore)	EVAPCO Europe A/S	VA091 Series Drycooler	VA091EWHHD-682-IHD-120-2,3-Sp
=HE01+DA02-GP19	1		Centrifugal pump, with electric motor, single-stage close coupled in line.	Grundfos AS	TP 100-310/2 X-F-A-BQQE-OW1	92886729
=HE01+DA02-QM01	1		Ball Valve, Stainless Steel, DN100, Weld Flange	Armatec DVCAS	DVC Type 1311	1311510100
=HE01+DA02-QM02	1		Ball Valve, Stainless Steel, DN100, Weld Flange	Armatec DVCAS	DVC Type 1311	1311510100
=HE01+DA02-QM03	0					
=HE01+DA02-QN01	1	piece	Valve act. 24...230V, 160 Nm, bus, IP66	Belimo Holding AG	PRCA-BAC-S2-T	PRCA-BAC-S2-T
=HE01+DA02-QN02	1	piece	Valve act. 24...230V, 160 Nm, bus, IP66	Belimo Holding AG	PRCA-BAC-S2-T	PRCA-BAC-S2-T
=HE01+DA02-RM01	1		De-aerator, For coolant containing 50% glycol, 21.3mm BSPT thread external	Sanistål	Flexvent 1/2"	
=HE01+DA02-WP01	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE01+DA02-WP02	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE01+DA02-WP03	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE01+DA02-WP04	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

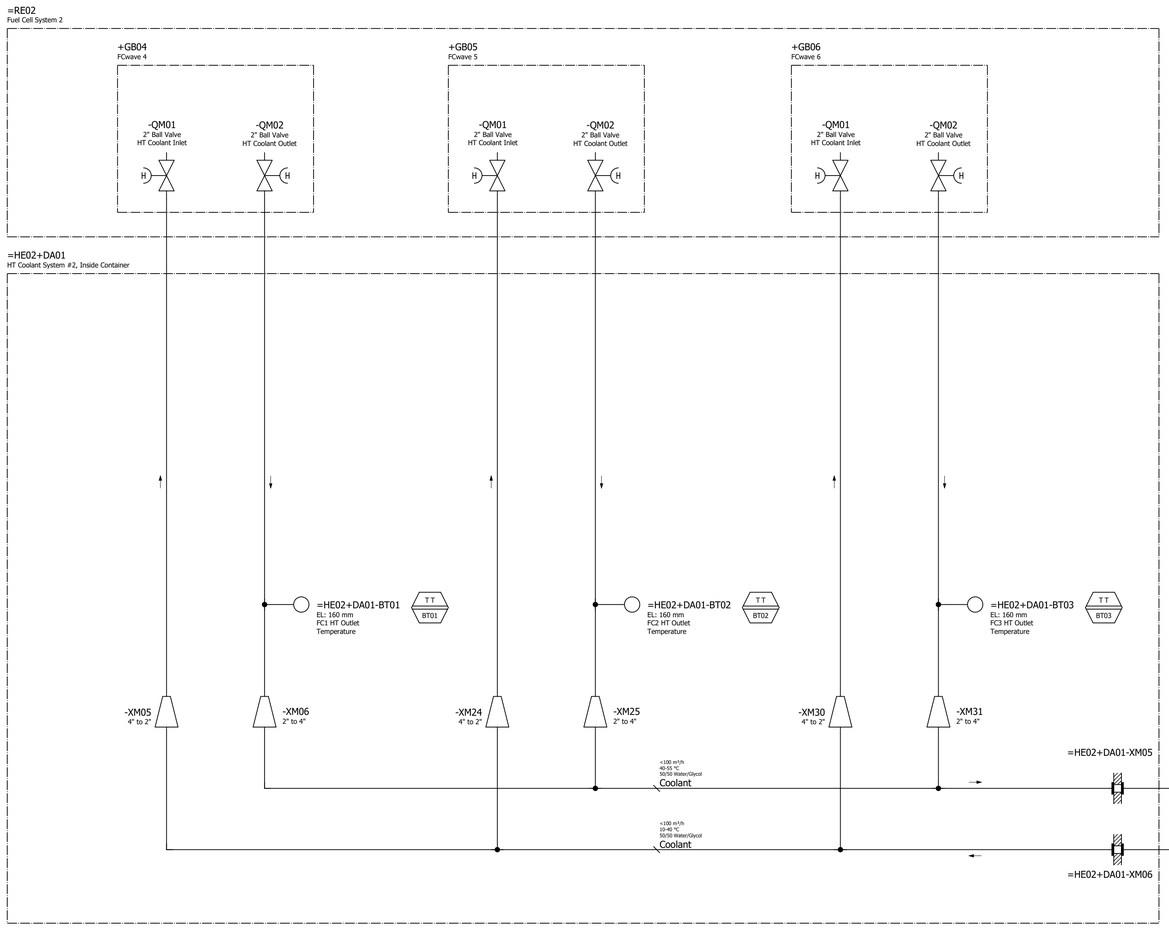
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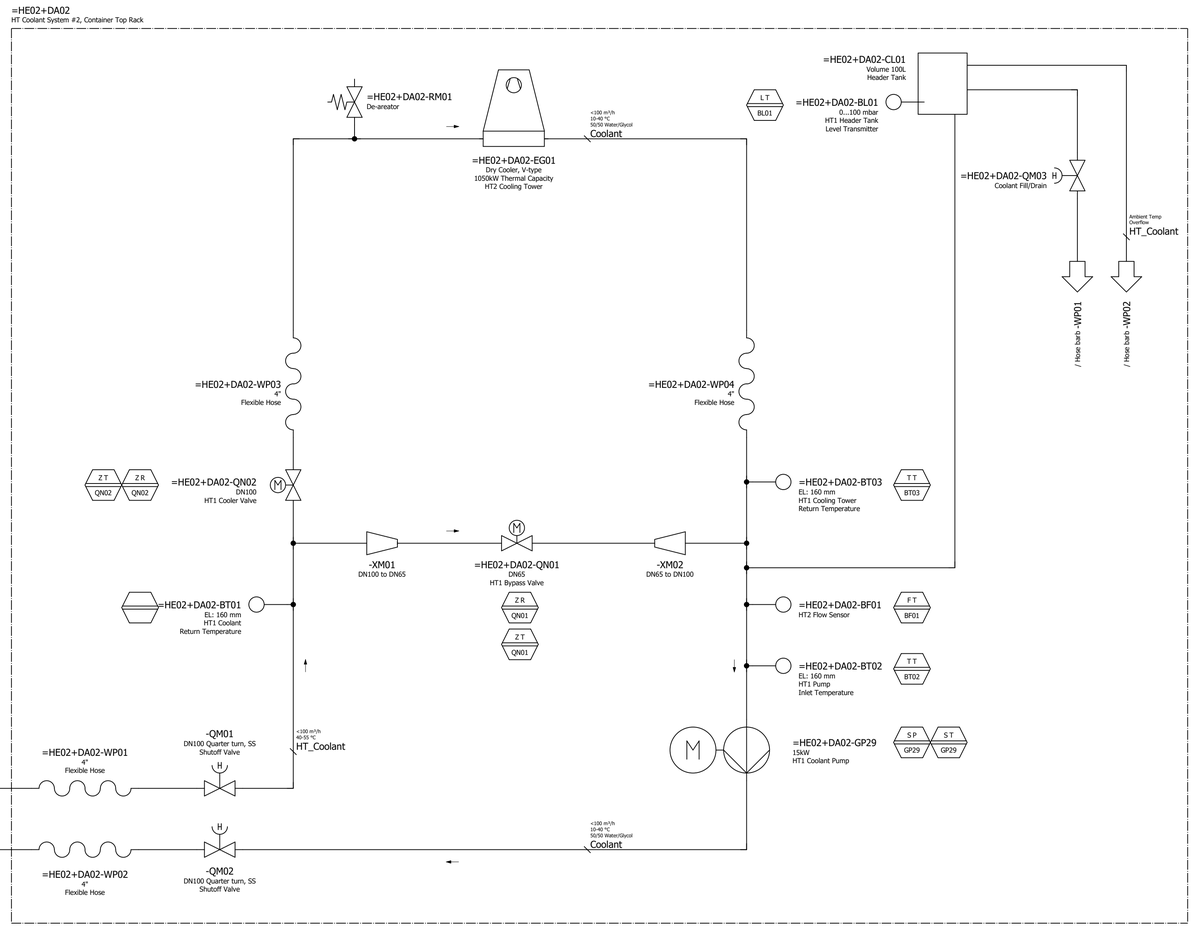
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DRAWING	601456B C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	HT1 Coolant System - Fuel Cells
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 · LANGUAGE EN · SHEET/TOTAL 7 / 16

High Temperature Cooling System - Fuel Cells 4-6





Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=HE02+DA02-BF01	1	Piece	Flow sensor	IFM Electronic AS	SAEXXXXB50KG/US-100	SA4104
=HE02+DA02-BL01	1	Piece	Pressure transmitter with ceramic measuring cell, DC, analogue signal	IFM Electronic AS	PA-,10BRBG14-A-ZVG/US/ /V	PA3589
=HE02+DA01-BT01	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA01-BT02	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA01-BT03	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA02-BT01	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA02-BT02	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA02-BT03	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE02+DA02-CL01	1		Header Tank, Volume 100L, AISI 304	Ballard Power Systems Europe	5500231B-3002	5500231B-3002
=HE02+DA02-EG01	1		Dry Cooler, 1050kW, With Ventilators (Offshore)	EVAPCO Europe A/S	VA091 Series Drycooler	VA091EWHHD-682-IHD-120-2,3-Sp
=HE02+DA02-GP29	1		Centrifugal pump, with electric motor, single-stage close coupled in line.	Grundfos AS	TP 100-310/2 X-F-A-BQQE-OW1	92886729
=HE02+DA02-QM01	1		Ball Valve, Stainless Steel, DN100, Weld Flange	Armatec DVCAS	DVC Type 1311	1311510100
=HE02+DA02-QM02	1		Ball Valve, Stainless Steel, DN100, Weld Flange	Armatec DVCAS	DVC Type 1311	1311510100
=HE02+DA02-QM03	0					
=HE02+DA02-QN01	1	piece	Valve act. 24...230V, 160 Nm, bus, IP66	Belimo Holding AG	PRCA-BAC-S2-T	PRCA-BAC-S2-T
=HE02+DA02-QN02	1	piece	Valve act. 24...230V, 160 Nm, bus, IP66	Belimo Holding AG	PRCA-BAC-S2-T	PRCA-BAC-S2-T
=HE02+DA02-RM01	1		De-aerator, For coolant containing 50% glycol, 21.3mm BSPT thread external	Sanistål	Flexvent 1/2"	
=HE02+DA02-WP01	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE02+DA02-WP02	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE02+DA02-WP03	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122
=HE02+DA02-WP04	1		Coolant Hose, 110x122mm, EPDM, 4barg	Radiacord	5.002.000.01604	NW110-122

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

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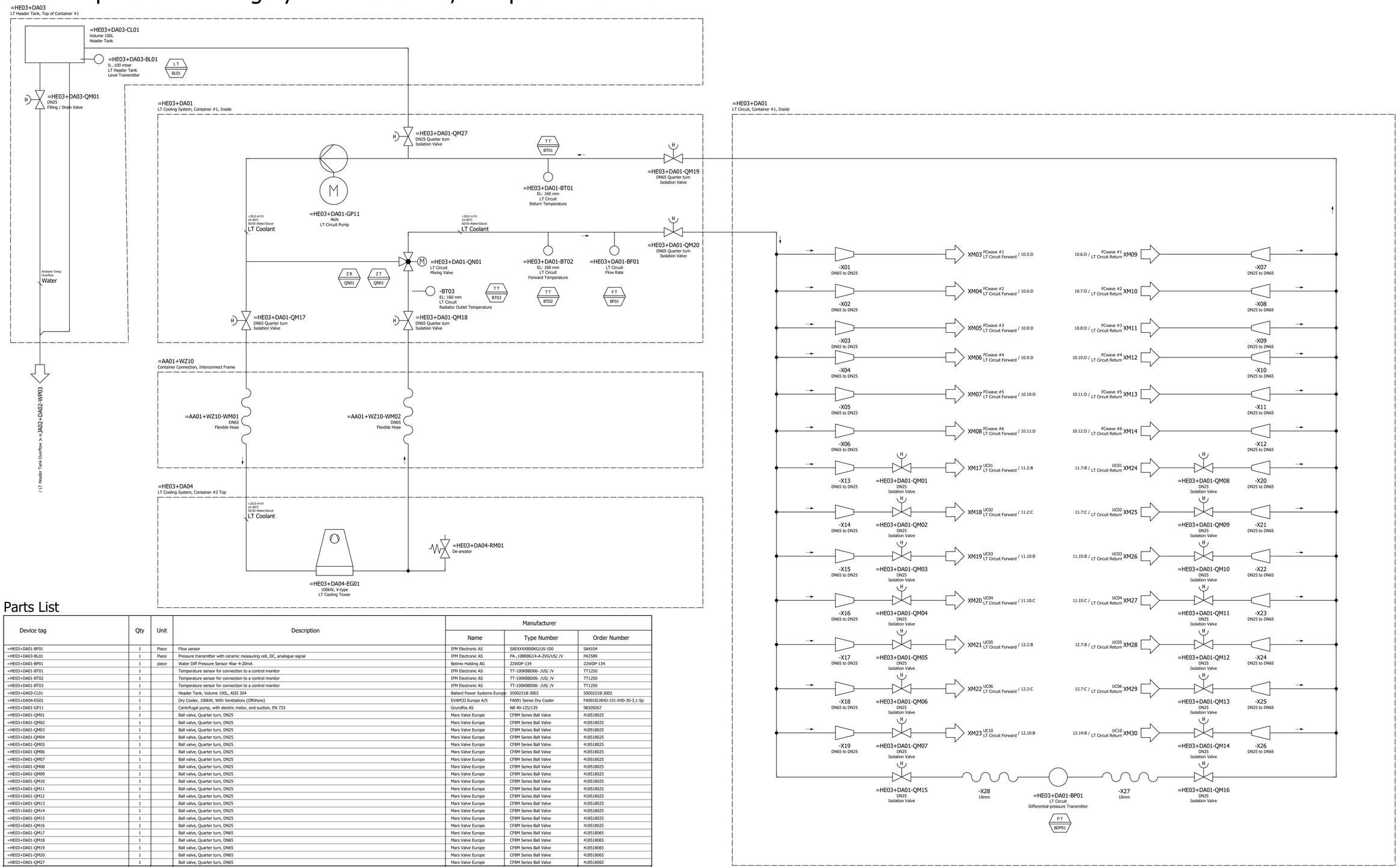
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DRAWING	601456B C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	HT2 Coolant System - Fuel Cells
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 · LANGUAGE EN · SHEET/TOTAL 8 / 16

FRMS103653/0B

Low Temperature Cooling System - Radiator, Pump and Manifold



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=HE03+DA01-BF01	1	Piece	Flow sensor	IFM Electronic AS	SAEXXXXB50KG/US-100	SA4104
=HE03+DA03-BL01	1	Piece	Pressure transmitter with ceramic measuring cell, DC, analogue signal	IFM Electronic AS	PA-,108RBG14-A-ZVG/US/ /V	PA3589
=HE03+DA01-BP01	1	piece	Water Diff Pressure Sensor 4bar 4-20mA	Belimo Holding AG	22WDP-134	22WDP-134
=HE03+DA01-BT01	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE03+DA01-BT02	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE03+DA01-BT03	1		Temperature sensor for connection to a control monitor	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250
=HE03+DA03-CL01	1		Header Tank, Volume 100L, AISI 304	Ballard Power Systems Europe	S500231B-3002	S500231B-3002
=HE03+DA04-EG01	1		Dry Cooler, 100kW, With Ventilators (Offshore)	EVAPCO Europe A/S	FA091 Series Dry Cooler	FA091ELNHD-151-IHD-30-3,1-Sp
=HE03+DA01-GP11	1		Centrifugal pump, with electric motor, end suction, EN 733	Grundfos AS	NB 40-125/139	98309267
=HE03+DA01-QM01	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM02	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM03	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM04	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM05	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM06	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM07	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM08	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM09	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM10	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM11	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM12	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM13	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM14	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM15	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM16	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QM17	1		Ball valve, Quarter turn, DN65	Mars Valve Europe	CF8M Series Ball Valve	418S18065
=HE03+DA01-QM18	1		Ball valve, Quarter turn, DN65	Mars Valve Europe	CF8M Series Ball Valve	418S18065
=HE03+DA01-QM19	1		Ball valve, Quarter turn, DN65	Mars Valve Europe	CF8M Series Ball Valve	418S18065
=HE03+DA01-QM20	1		Ball valve, Quarter turn, DN65	Mars Valve Europe	CF8M Series Ball Valve	418S18065
=HE03+DA01-QM27	1		Ball valve, Quarter turn, DN65	Mars Valve Europe	CF8M Series Ball Valve	418S18065
=HE03+DA03-QM01	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S18025
=HE03+DA01-QN01	1		3-way flow control valve, Stainless steel, Internal thread, DN50, PN25	Belimo Holding AG	H3S Series Globe Valve	H350S-P
=HE03+DA01-QN01.MA01	1		Actuator, for globe valves, modulating, 1500N force	Belimo Holding AG	SVC Series Modulaing Actuators	SVC24A-SR-TPC
=HE03+DA04-RM01	1		De-aerator, Stainless, For coolant containing 50% glycol, 3/8"	Brdr AO Johansen	Aeromat Series	
=HE03+DA01-X27	1		Polyamide Flexible Tubing, Ø10x8,0	Parker Hannifin		100P1000
=HE03+DA01-X28	1		Polyamide Flexible Tubing, Ø10x8,0	Parker Hannifin		100P1000

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

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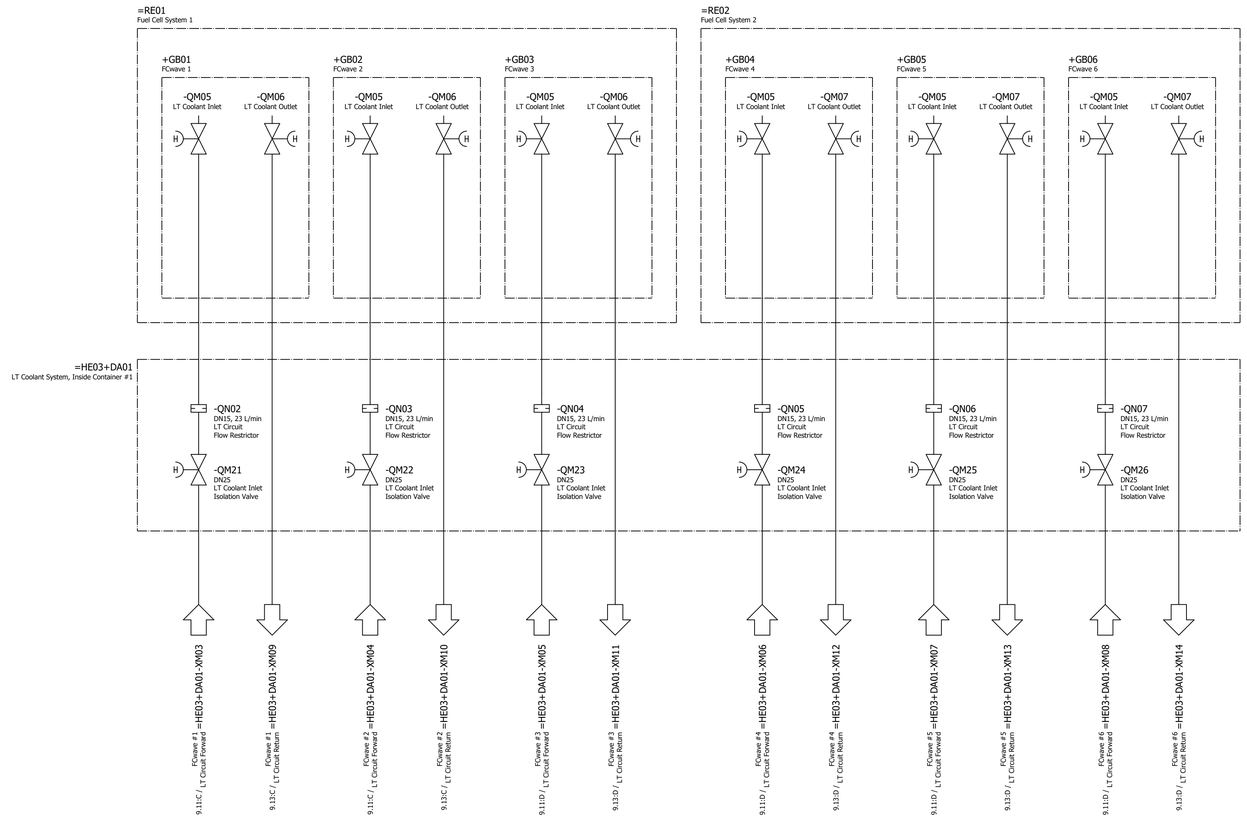
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DRAWING	6014568 C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	LT Coolant System - Overview
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 9 / 16

FRMS103653/08

Low Temperature Cooling System - Fuel Cell Connections



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=HE03+DA01-QM21	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QM22	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QM23	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QM24	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QM25	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QM26	1		Ball valve, Quarter turn, DN25	Mars Valve Europe	CF8M Series Ball Valve	418S1802S
=HE03+DA01-QN02	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=HE03+DA01-QN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=HE03+DA01-QN04	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=HE03+DA01-QN05	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=HE03+DA01-QN06	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=HE03+DA01-QN07	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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FRM510365 3/08

REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

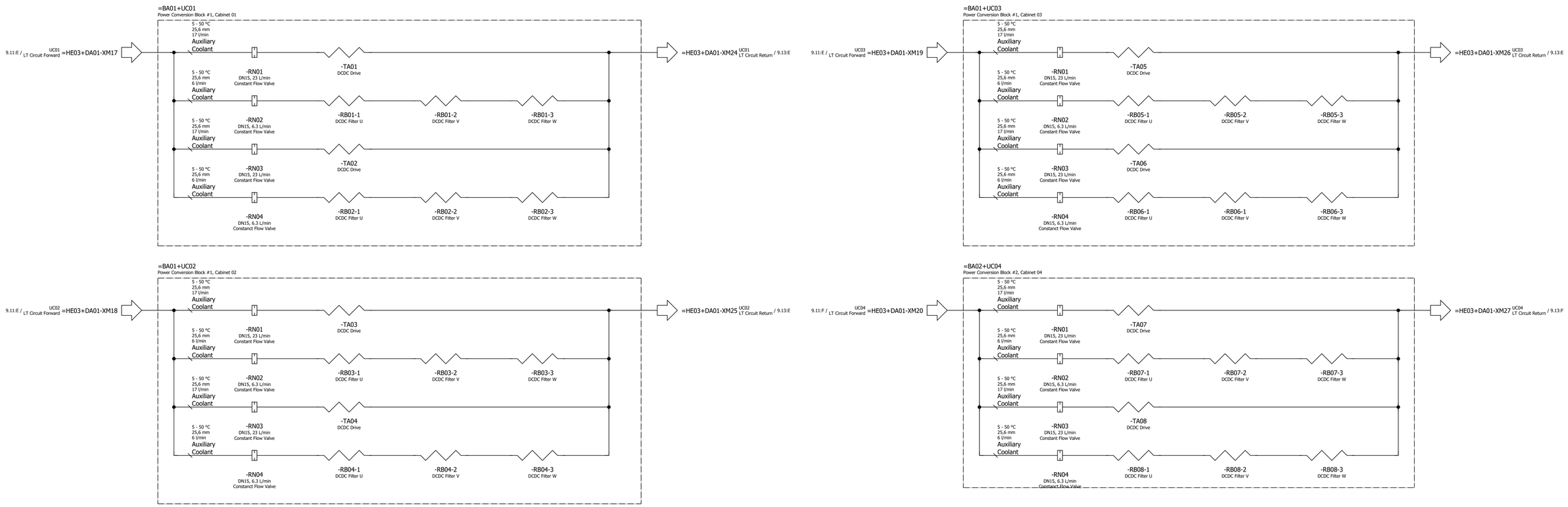
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DRAWING	601456B C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	LT Coolant System - Fuel Cells
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1
LANGUAGE	EN
SHEET/TOTAL	10 / 16

Low Temperature Cooling System - Power Converter Connections 1/2



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=BA01+UC01-RB01-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RB01-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RB01-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RB02-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RB02-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RB02-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB03-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB03-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB03-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB04-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB04-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC02-RB04-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC03-RB05-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC03-RB05-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC03-RB05-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC03-RB06-1	2		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC03-RB06-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA01+UC01-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC01-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC01-RN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC01-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC02-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC02-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC02-RN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC02-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC03-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC03-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC03-RN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA01+UC03-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA01+UC01-TA01	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA01+UC01-TA02	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA01+UC02-TA03	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA01+UC02-TA04	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA01+UC03-TA05	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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REVISION INFORMATION	
DESCRIPTION	
DATE	
20-Nov-24	

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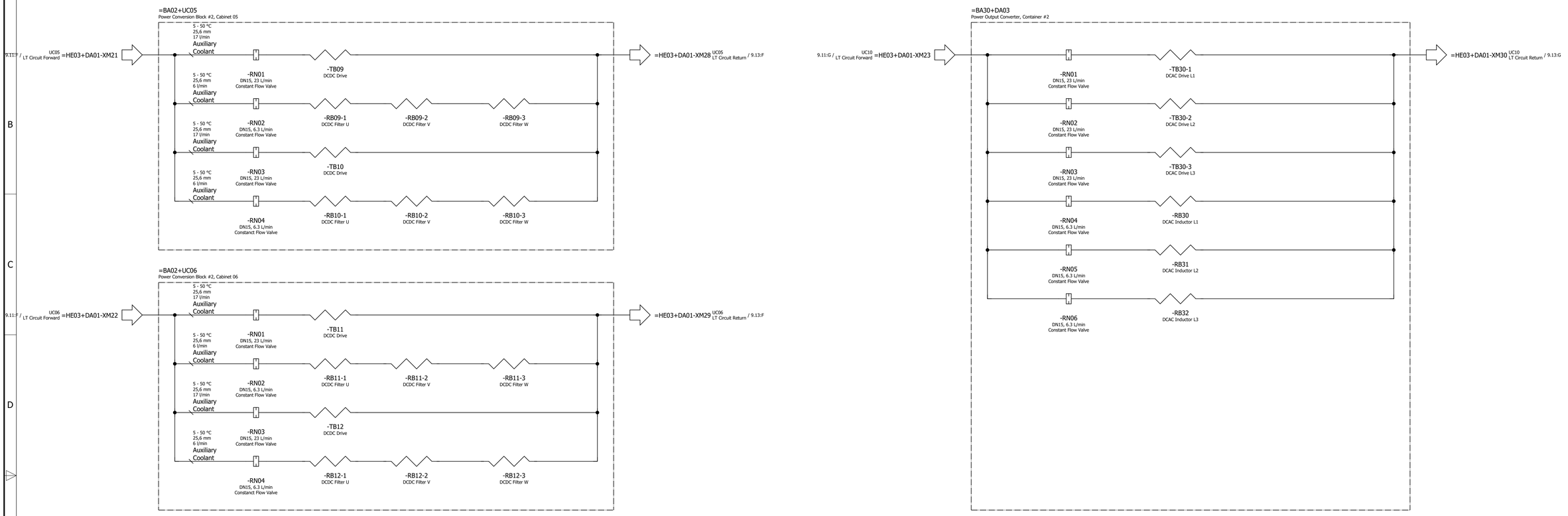
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DRAWING	6014568 C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	LT Coolant System - Power Converters 1/2
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 11 / 16

FRMS103653/08

Low Temperature Cooling System - Power Converter Connections 2/2



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=BA02+UC05-RB09-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC05-RB09-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC05-RB09-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC05-RB10-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC05-RB10-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC05-RB10-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB11-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB11-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB11-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB12-1	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB12-2	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA02+UC06-RB12-3	1		Heat Exchanger, for liquid cooled DC inductors, 168A, 1050V	QA Trafotek Oy	181B5969	
=BA30+DA03-RB30	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905
=BA30+DA03-RB31	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905
=BA30+DA03-RB32	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905
=BA02+UC05-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA02+UC05-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA02+UC05-RN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA02+UC05-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA02+UC06-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA02+UC06-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA02+UC06-RN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA02+UC06-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA30+DA03-RN01	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP
=BA30+DA03-RN02	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA30+DA03-RN03	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA30+DA03-RN04	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA30+DA03-RN05	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA30+DA03-RN06	1		Valve, Constant Flow, DN15, 6.3 L/min	Bertfeld Teknik AB		117115P63LP
=BA02+UC05-TB09	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA02+UC05-TB10	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA02+UC06-TB11	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA02+UC06-TB12	1		Heat exchanger, Frame FR8 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FR08901
=BA30+DA03-TB30-1	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905
=BA30+DA03-TB30-2	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905
=BA30+DA03-TB30-3	1		Heat exchanger, Frame CH64 for NXP series	Danfoss	FR8 Chassis Heat Exhanger	FW64905

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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FRM5103653/0B

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DRAWING	6014568 C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	LT Coolant System - Power Converters 2/2
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 12 / 16

0	1	2	3	4	5	6	7	8

Bill of Materials / Parts List

Device tag	Qty	Unit	Description	Manufacturer			
				Name	Type Number	Order Number	
-BF01	1	Piece	Flow sensor, Connector: 1 x M12; coding: A; Contacts: gold-plated	IFM Electronic AS	SAEXXXXB50KG/US-100	SA4104	
-BF01-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BF01-XD01	0						
-BF01-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BF01-XG01	0						
-BL01-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BL01-XG01	0						
-BL01	1	Piece	Pressure transmitter with ceramic measuring cell, DC, analogue signal	IFM Electronic AS	PA-,10BRBG14-A-ZVG/US/ /V	PA3589	
-BP01	1	piece	Differential Pressure Sensor Water 0...4 bar AC/DC 24 V, Output signal 0...10 V	Belimo Holding AG	22WDP-134	22WDP-134	
-BP01-WG01	1	meter	ÖLFLEX CLASSIC 110 CH 3G1	Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056	
-BP01-XD01	0						
-BP02	0						
-BP02-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP02-XG01	0						
-BP03-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP03-XG01	0						
-BP04	0						
-BP04-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP04-XG01	0						
-BP05	0						
-BP05-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP05-XG01	0						
-BP06	0						
-BP06-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP06-XG01	0						
-BP07	0						
-BP07-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BP07-XG01	0						
-BT01	1		PT1000 Sensor Element, Length 160mm to M12, A code connector. 3/4 wire measurement	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250	
-BT02	1		PT1000 Sensor Element, Length 160mm to M12, A code connector. 3/4 wire measurement	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250	
-BT03	1		PT1000 Sensor Element, Length 160mm to M12, A code connector. 3/4 wire measurement	IFM Electronic AS	TT-100KBBD06- /US/ /V	TT1250	
-BT04-XG01	0						
-BT05-XG01	0						
-BT05-WG01	1	Piece	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end; LSZH	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540	
-BT05-XG01	0						
-CL01	1		Header Tank, Volume 100L, AISI 304	Ballard Power Systems Europe	5500231B-3002	5500231B-3002	
-EG01	1		Dry Cooler, 100kW, With Ventilatiors (Offshore), Tube 316, Fins AlMg/316, Frame 316	EVAPCO Europe A/S	FA091 Series Dry Cooler	FA091ELNHD-151-IHD-30-3,1-Sp	
-GP11	1		Centrifugal pump, with electric motor, end suction, EN 733, Motor: 4kW, 3x380-415D, 50Hz, 7.9A	Grundfos AS	NB 40-125/139	98309267	
-GP11-WG01	1	m	ÖLFLEX CLASSIC 110 Control Line, 3G1.0 Min Bending Radius 90mm, Numbered Conductors	Lapp Group	ÖLFLEX CLASSIC 110	1119 203	
-GP11-WG01	0						
-GP11.WD01	1	meter	Screened control cable, 4G2.5mm2, LSZH	Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342	
-GP11.WD02	1	meter	Screened control cable, 4G2.5mm2, LSZH	Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342	
-GP11.WG02	1	meter		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059	
-GQ31	1		Three-phase asynchronous motor, 4 pole pairs, 4,0kW	Fabrika A/S	Fabrika CX B14 TEAO	CXB14-4	
-GQ31-WD01	1	meter	ÖLFLEX CLASSIC 135 CH BK 0,6/1 kV 4G2,5	Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123478	
-QM01	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM02	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM03	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM04	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM05	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM06	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM07	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM08	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM09	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM10	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM11	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
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DRAWING		REVISION	03.P18
DRAWING TITLE			
SHEET TYPE/DESC	LT Coolant System - BOM		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 /

0	1	2	3	4	5	6	7	8

Bill of Materials / Parts List

Device tag	Qty	Unit	Description	Manufacturer			
				Name	Type Number	Order Number	
-QM12	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM13	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM14	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM15	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM16	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM17	1		Ball valve, Quarter turn, DN65, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518065	
-QM18	1		Ball valve, Quarter turn, DN65, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518065	
-QM19	1		Ball valve, Quarter turn, DN65, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518065	
-QM20	1		Ball valve, Quarter turn, DN65, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518065	
-QM21	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM22	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM23	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM24	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM25	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM26	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QM27	1		Ball valve, Quarter turn, DN65, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518065	
-QM01	1		Ball valve, Quarter turn, DN25, Material body, valve AISI304, gasket and sealing ring PTFE	Mars Valve Europe	CF8M Series Ball Valve	418518025	
-QN01	1		3-way flow control valve, Stainless steel, Internal thread, DN50, PN25	Belimo Holding AG	H3S Series Globe Valve	H350S-P	
-QN01.MA01	1		Actuator, for globe valves, modulating, 1500N force	Belimo Holding AG	SVC Series Modulaing Actuators	SVC24A-SR-TPC	
-QN01.WG01	1	meter		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059	
-QN01.WG02	1	meter		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059	
-QN02	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-QN03	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-QN04	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-QN05	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-QN06	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-QN07	1		Valve, Constant Flow, DN15, 23 L/min	Bertfeld Teknik AB		117115P230LP	
-RM01	1		De-aerator, Stainless, For coolant containing 50% glycol, 3/8"	Brdr AO Johansen	Aeromat Series		
-TA11	2	PIECES	Safe Torque off & ATEX board for VACON® NXP 2DI,1RO(NO/NC), 1RO(NO), 1TI Slot B	Danfoss	OPT-AF	OPT-AF-V	
-TA11	2	pieces	VFD , Input voltage: 3x 380-500 VAC, Output Power: 4 kW	Danfoss	NXP00095-A5H1SSV	NXP00095-A5H1SSV	
-TA11	0						
-TA11	2	pieces	Vacon NX, Ethernet option board with two RJ-45 connectors SLOT: D, E	Danfoss	OPT-E9	OPT-E9-V	
-TF01	1		Signal Converter Voltage/Current, Input 0-10V or (0)4-20mA, Output (0)4-20mA	Belimo Holding AG	Z-UIC	Z-UIC	
-X27	1		Polyamide Flexible Tubing, Ø10x8,0 - OD 10mm, ID 8mm, 50bar, -40 to 100°C	Parker Hannifin		100P1000	
-X28	1		Polyamide Flexible Tubing, Ø10x8,0 - OD 10mm, ID 8mm, 50bar, -40 to 100°C	Parker Hannifin		100P1000	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	03.P18		
EPLAN Project Pages	623		
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REVISION INFORMATION
DESCRIPTION
DATE
16-Oct-24

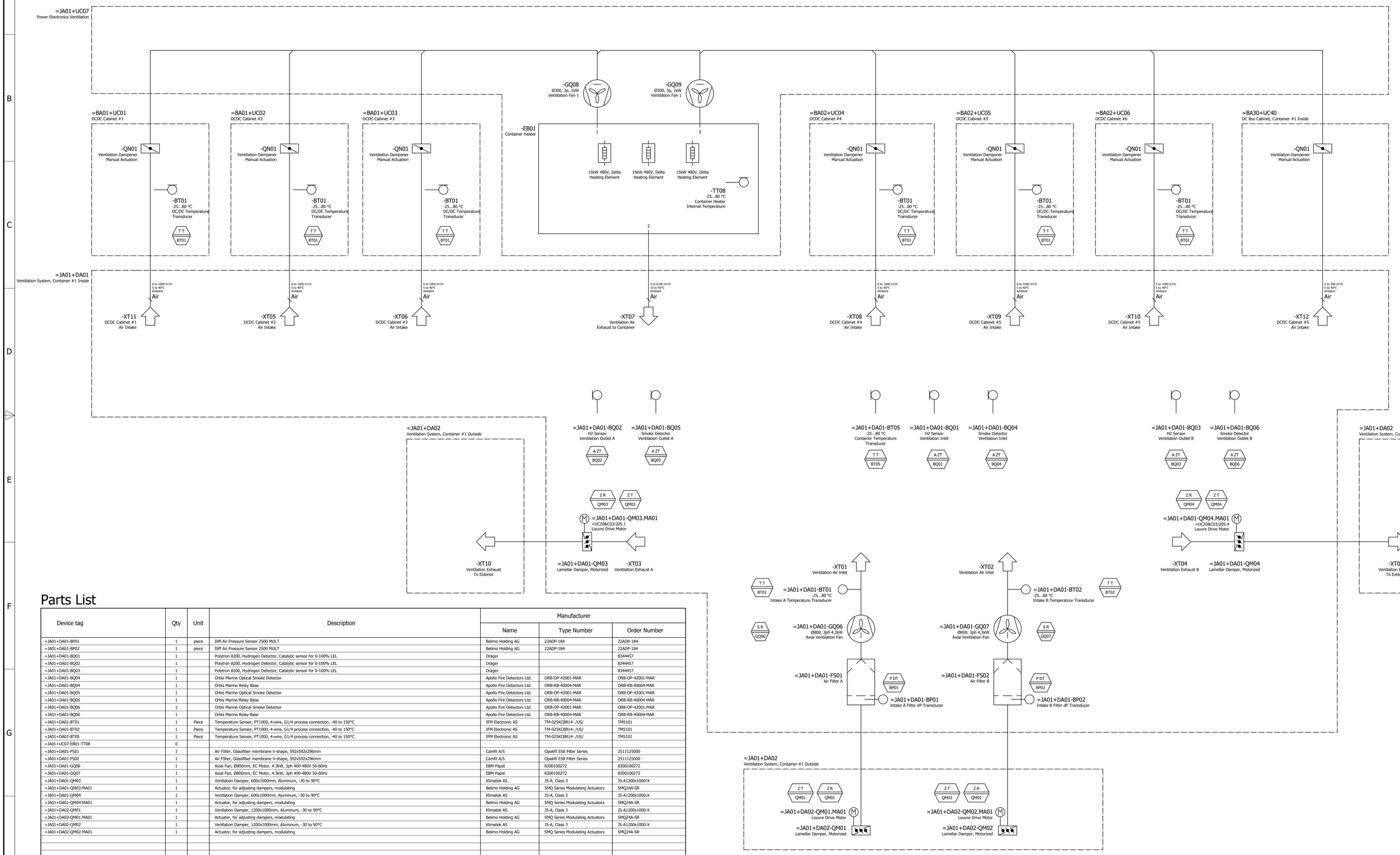
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DRAWING		REVISION	03.P18
DRAWING TITLE			
SHEET TYPE/DESC	LT Coolant System - BOM		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13.a /

Ventilation Air System - 40ft Container



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=JA01+DA01-BP01	1	piece	Diff Air Pressure Sensor 2500 MULT	Belimo Holding AG	22ADP-184	22ADP-184
=JA01+DA01-BP02	1	piece	Diff Air Pressure Sensor 2500 MULT	Belimo Holding AG	22ADP-184	22ADP-184
=JA01+DA01-BQ01	1		Polytron 8200, Hydrogen Detector, Catalytic sensor for 0-100% LEL	Dräger		8344457
=JA01+DA01-BQ02	1		Polytron 8200, Hydrogen Detector, Catalytic sensor for 0-100% LEL	Dräger		8344457
=JA01+DA01-BQ03	1		Polytron 8200, Hydrogen Detector, Catalytic sensor for 0-100% LEL	Dräger		8344457
=JA01+DA01-BQ04	1		Orbis Marine Optical Smoke Detector	Apollo Fire Detectors Ltd.	ORB-OP-42001-MAR	ORB-OP-42001-MAR
=JA01+DA01-BQ04	1		Orbis Marine Relay Base	Apollo Fire Detectors Ltd.	ORB-RB-40004-MAR	ORB-RB-40004-MAR
=JA01+DA01-BQ05	1		Orbis Marine Optical Smoke Detector	Apollo Fire Detectors Ltd.	ORB-OP-42001-MAR	ORB-OP-42001-MAR
=JA01+DA01-BQ05	1		Orbis Marine Relay Base	Apollo Fire Detectors Ltd.	ORB-RB-40004-MAR	ORB-RB-40004-MAR
=JA01+DA01-BQ06	1		Orbis Marine Optical Smoke Detector	Apollo Fire Detectors Ltd.	ORB-OP-42001-MAR	ORB-OP-42001-MAR
=JA01+DA01-BQ06	1		Orbis Marine Relay Base	Apollo Fire Detectors Ltd.	ORB-RB-40004-MAR	ORB-RB-40004-MAR
=JA01+DA01-BT01	1	Piece	Temperature Sensor, PT1000, 4-wire, G1/4 process connection, -40 to 150°C	IFM Electronic AS	TM-025KCBR14- /US/	TM5101
=JA01+DA01-BT02	1	Piece	Temperature Sensor, PT1000, 4-wire, G1/4 process connection, -40 to 150°C	IFM Electronic AS	TM-025KCBR14- /US/	TM5101
=JA01+DA01-BT05	1	Piece	Temperature Sensor, PT1000, 4-wire, G1/4 process connection, -40 to 150°C	IFM Electronic AS	TM-025KCBR14- /US/	TM5101
=JA01+UC07-EB01-TT08	0					
=JA01+DA01-FS01	1		Air Filter, Glassfiber membrane V-shape, 592x592x296mm	Camfil A/S	Opakfil ES8 Filter Series	2511125000
=JA01+DA01-FS02	1		Air Filter, Glassfiber membrane V-shape, 592x592x296mm	Camfil A/S	Opakfil ES8 Filter Series	2511125000
=JA01+DA01-GQ06	1		Axial Fan, Ø800mm, EC Motor, 4.3kW, 3ph 400-480V 50-60Hz	EBM Papst	8300100272	8300100272
=JA01+DA01-GQ07	1		Axial Fan, Ø800mm, EC Motor, 4.3kW, 3ph 400-480V 50-60Hz	EBM Papst	8300100272	8300100272
=JA01+DA01-QM03	1		Ventilation Damper, 600x1000mm, Aluminum, -30 to 90°C	Klimatek AS	JS-A, Class 3	JS-A1200x1000-X
=JA01+DA01-QM03.MA01	1		Actuator, for adjusting dampers, modulating	Belimo Holding AG	SMQ Series Modulating Actuators	SMQ24A-SR
=JA01+DA01-QM04	1		Ventilation Damper, 600x1000mm, Aluminum, -30 to 90°C	Klimatek AS	JS-A, Class 3	JS-A1200x1000-X
=JA01+DA01-QM04.MA01	1		Actuator, for adjusting dampers, modulating	Belimo Holding AG	SMQ Series Modulating Actuators	SMQ24A-SR
=JA01+DA02-QM01	1		Ventilation Damper, 1200x1000mm, Aluminum, -30 to 90°C	Klimatek AS	JS-A, Class 3	JS-A1200x1000-X
=JA01+DA02-QM01.MA01	1		Actuator, for adjusting dampers, modulating	Belimo Holding AG	SMQ Series Modulating Actuators	SMQ24A-SR
=JA01+DA02-QM02	1		Ventilation Damper, 1200x1000mm, Aluminum, -30 to 90°C	Klimatek AS	JS-A, Class 3	JS-A1200x1000-X
=JA01+DA02-QM02.MA01	1		Actuator, for adjusting dampers, modulating	Belimo Holding AG	SMQ Series Modulating Actuators	SMQ24A-SR

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
=	++ + & B02

REVISION INFORMATION	
DESCRIPTION	
DATE	20-Nov-24

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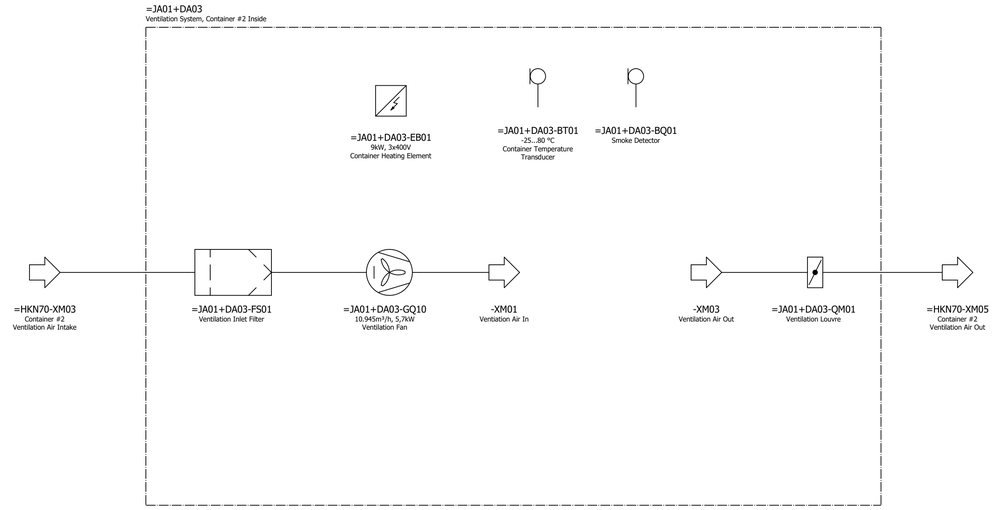
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DRAWING	6014568 C03 Process and Instrumentation Diagram	REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Ventilation Air System - 40ft Container		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1	LANGUAGE EN	SHEET/TOTAL 14 / 16

FRMS103653/08

Ventilation Air System - 10ft Container



Parts List

Device tag	Qty	Unit	Description	Manufacturer		
				Name	Type Number	Order Number
=JA01+DA03-BQ01	1		Orbis Marine Optical Smoke Detector	Apollo Fire Detectors Ltd.	ORB-OP-42001-MAR	ORB-OP-42001-MAR
=JA01+DA03-BQ01	1		Orbis Marine Relay Base	Apollo Fire Detectors Ltd.	ORB-RB-40004-MAR	ORB-RB-40004-MAR
=JA01+DA03-BT01	1	Piece	Temperature Sensor, PT1000, 4-wire, G1/4 process connection, -40 to 150°C	IFM Electronic AS	TM-025KCBR14- /US/	TM5101
=JA01+DA03-EB01	1		Placeholder			
=JA01+DA03-FS01	0					
=JA01+DA03-GQ10	1		Ventilation Fan, Radial, EC Motor, 3ph, 400-480V, 5.7kW			
=JA01+DA03-QM01	0					

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P18
EPLAN Project Pages	623
= | ++ | + | & B02	

REVISION INFORMATION	
DESCRIPTION	
DATE	
20-Nov-24	

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DRAWING	601456B C03 Process and Instrumentation Diagram
REVISION	03.P18
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Ventilation Air System - 10ft Container
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 15 / 16

FRMS103653/08

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	03/02/2023	First Issue
002	17/02/2023	Modified according to comments
003	24/03/2023	Further detailed and expanded
004	18/09/2023	Updated and expanded
005	08/03/2024	Updated according to comments
006	09/04/2024	Exp. to include fan contactors
007	15/10/2024	Updated with changed water separator

Document Title:	**BLPH Project - Electrical Single Line Diagrams**
Document Number:	BPSE-ELE-BPH-DWG-00005
Legacy Number:	K559-2254-CWIWP4202202-C06-001
Revision:	Rev007
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-C06-001Rev007
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	C06
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

AC Distribution - 40ft Container

Crosswind Scope

Ballard Scope

=HKN70-XB01
3p+N+PE 400Vac
20kW

=BA20+UC50
AC Power Distribution

-XB01
AUX Supply Terminals

-SG01
63 A
Switch Disconnector

-FA01
Uc:277V
Iimp: 25 kA
Surge Arrester

-FC06
2A, B curve
MCB

AUX Customer Supply
Voltage Meas
3ph 400V
-BA01

-BC02
+UC508C03/601.1
+UC508C03/601.1
+UC508C03/601.1
3ph 75A
AUX Customer Supply
Current Trafo

-FC02
50A, C curve
MCCB

-FC12
63A, C Curve
MCCB

-FC10
2A, C-curve
MCCB

Nanogrid Internal
Voltage Meas
3ph 400V
-BA02

-FC01
250A, 3p+N
MCCB

-QA02
55A
Isolation Contactor, 4 pole

-QA01
55A
Isolation Contactor, 4 pole

-FC05
32A, B-curve
MCCB

3p+N 400-480V 50/60Hz

-FC04
63A, B Curve
MCCB

=BA20+DA01

Transformer, dry-type
-TA03
0,46/0,4-0,48
Dyn11 160kVA

=AA01+WZ10
Container Interconnect, Between Containers

BP1 AC Supply from Transformer 250A / 6.3:B

BP2 AC Supply to Container #2 - 32A / 6.3:C

-FC04
160A, 3p+N
MCCB Cooling Skid
+UC30

=LA01+UC20
Control System, Container #1 Inside

-QB01
63A, 3ph+N
Switch Disconnector

3p+N 400-480V 50/60Hz

-FC01A
6A, B-curve
MCCB

-FC01B
6A, B-curve
MCCB

-FC01C
6A, B-curve
MCCB

-FC02
4A, B-curve
MCCB

-FC06
10A, B-curve
MCCB

-FC07
10A, B-curve
MCCB

-FC03A
6A, B-curve
MCCB

-FC03B
6A, B-curve
MCCB

-FC04
10A, C-curve
RCD/MCB

-FC08
20A, B-curve
MCCB

-FC09
20A, B-curve
MCCB

-FC10
20A, B-curve
MCCB

-FC11
10A, B-curve
MCCB

-TB01A
24-28V/40ADC
FCwave PSU
with UPS

-TB01B
24-28V/40ADC
FCwave PSU
with UPS

-TB01C
24-28V/40ADC
FCwave PSU
with UPS

-TB02
24-28V/10ADC
Control PSU
with UPS

-QB02
50A, 24V coil
Contactor

-QB03
50A, 24V coil
Contactor

-QA08
25A
Solidstate
Contactor

-QA09
25A
Solidstate
contactor

-QA10
25A
Solidstate
contactor

-GB01A
UPS Battery
24V, XY Ah

-GB01B
UPS Battery
24V, XY Ah

-GB01C
UPS Battery
24V, XY Ah

-GB02
UPS Battery
24V, XY Ah

1/N/PE

-XD04
1P+N+PE, 1kW
Service

=HE01+UC30
Coolant Skid Cabinet, Container #1 Outside

3p+N 400-480V 50/60Hz

-FC01
6A, B-curve
MCCB

-FC02
2A, B-curve
MCCB

-FC19
25A, B-curve
MCCB

-FC11
6A, B-curve
MCCB

-FC12
6A, B-curve
MCCB

-FC13
6A, B-curve
MCCB

-FC14
6A, B-curve
MCCB

-FC15
6A, B-curve
MCCB

-FC16
6A, B-curve
MCCB

-FC40
13A, B-curve
MCCB

-TB01
24-28V/10ADC
PSU with UPS

-BT02
5°C
Temperature Switch

-GB01
24V Backup Battery
24V, XY Ah

-EA02
0,4W
Cabinet Heater

-TA19
15kW
3x 380-500 VAC
HT Pump Drive

=HE01+UC41
HT + LT VFD Cabinet

-TA11
4.0kW
VFD

-TA12
4.0kW
VFD

-TA13
4.0kW
VFD

-TA14
4.0kW
VFD

-TA15
4.0kW
VFD

-TA16
4.0kW
VFD

-EC40
VFD Cabinet Chiller

=HE01+DA02
HT Cooling System #1, Container #1 Outside

-GP19
15kW
HT1
Coolant Pump

-GQ11
4kW
Ventilation Fan

-GQ12
4kW
Ventilation Fan

-GQ13
4kW
Ventilation Fan

-GQ14
4kW
Ventilation Fan

-GQ15
4kW
Ventilation Fan

-GQ16
4kW
Ventilation Fan

=HE01+UC80
Coolant Skid Cabinet, Container #1 Outside

3p+N 400-480V 50/60Hz

-FC41
20A, B-curve
MCCB

-FC42
20A, B-curve
MCCB

-FC03
2A, B-curve
MCCB

-FC29
25A, B-curve
MCCB

-FC21
6A, B-curve
MCCB

-FC22
6A, B-curve
MCCB

-FC23
6A, B-curve
MCCB

-FC24
6A, B-curve
MCCB

-FC25
6A, B-curve
MCCB

-FC26
6A, B-curve
MCCB

-FC31
6A, B-curve
MCCB

-QA41
25A
Solidstate
contactor

-QA42
25A
Solidstate
contactor

-EA03
Container
Lighting

-TA29
15kW
3x 380-500 VAC
HT Pump Drive

=HE01+UC41
HT + LT VFD Cabinet

-TA21
4.0kW
VFD

-TA22
4.0kW
VFD

-TA23
4.0kW
VFD

-TA24
4.0kW
VFD

-TA25
4.0kW
VFD

-TA26
4.0kW
VFD

-TA31
4.0kW
VFD

-EB01
3x480V, 3x15kW
H2 Heater

9kW
Heating Element

9kW
Heating Element

=HE02+DA02
HT Cooling System #2, Container #1 Outside

-GP29
15kW
HT2
Coolant Pump

-GQ21
4kW
Ventilation Fan

-GQ22
4kW
Ventilation Fan

-GQ23
4kW
Ventilation Fan

-GQ24
4kW
Ventilation Fan

-GQ25
4kW
Ventilation Fan

-GQ26
4kW
Ventilation Fan

=HE03+DA02
LT Coolant System Cooler, Container #1 Outside

-GQ31
4kW
Ventilation Fan

=JA01+DA01
Container Ventilation, Inside Container #1

-EA01
Container
Lighting

-GQ06
4,3 kW
Ventilation Fan

-GQ07
4,3 kW
Ventilation Fan

=JA01+UC07
Container Ventilation, Fan/Heater Assembly

-GQ08
1kW
Ventilation Fan

-GQ09
1kW
Ventilation Fan

-EB01
3x480V, 3x15kW
Container Heater

15kW
Heating Element

15kW
Heating Element

15kW
Heating Element

=HE03+DA01
LT Cooling System, Container #1 Inside

-TA11
4kW
3x380-500VAC
LT Pump Drive

-GP11
4kW
LT Circuit Pump

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
~ ++ + & C01	

REVISION INFORMATION	
DESCRIPTION	
DATE	15-Oct-24

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DRAWING	601456B C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 40ft Container AC
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 / LANGUAGE EN / SHEET/TOTAL 4 / 7

FRM510365 3/0B

DC Distribution - 40ft Container

=AA01+WZ10
Container Interconnect, Between Containers

DC1 DC Bus to Container #2 / 6.3:G
DC2 DC Bus to Container #2 / 6.3:G
DC3 DC Bus to Container #2 / 6.3:G
DC4 DC Bus to Container #2 / 6.3:G
DC5 DC Bus to Container #2 / 6.3:G
DC6 DC Bus to Container #2 / 6.3:G

=BA01
Power Conversion Block #1, Container #1 Inside

+UC01
DCDC Cabinet #1, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA01
DCDC Drive

-TA02
DCDC Drive

-RB01
Converter Inductor

-RB02
Converter Inductor

-FC01
315A

-FC02
315A

+UC02
DCDC Cabinet #2, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA03
DCDC Drive

-TA04
DCDC Drive

-RB03
Converter Inductor

-RB04
Converter Inductor

-FC01
315A

-FC02
315A

+UC03
DCDC Cabinet #3, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA05
DCDC Drive

-TA06
DCDC Drive

-RB05
Converter Inductor

-RB06
Converter Inductor

-FC01
315A

-FC02
315A

=BA02
Power Conversion Block #2, Container #1 Inside

+UC04
DCDC Cabinet #4, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA07
DCDC Drive

-TA08
DCDC Drive

-RB07
Converter Inductor

-RB08
Converter Inductor

-FC01
315A

-FC02
315A

+UC05
DCDC Cabinet #5, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA09
DCDC Drive

-TA10
DCDC Drive

-RB09
Converter Inductor

-RB10
Converter Inductor

-FC01
315A

-FC02
315A

+UC06
DCDC Cabinet #6, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA11
DCDC Drive

-TA12
DCDC Drive

-RB11
Converter Inductor

-RB12
Converter Inductor

-FC01
315A

-FC02
315A

=RE01
Fuel Cell Block 1

+GB01
Fuel Cell Module 1

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB02
Fuel Cell Module 2

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB03
Fuel Cell Module 3

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

=RE02
Fuel Cell Block 2

+GB04
Fuel Cell Module 4

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB05
Fuel Cell Module 5

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB06
Fuel Cell Module 6

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
=	++ | + | & C01

REVISION INFORMATION	
DESCRIPTION	
DATE	15-Oct-24

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DRAWING	6014568 C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 40ft Container DC
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 5 / 7

FRMS103653/0B

AC/DC Distribution - 10ft Container

Crosswind Scope

Ballard Scope

=AA01+WZ10
Container Interconnect, Between Containers

4.15:B / 3ph AC Supply to Container #1 - 250A BP1

4.15:B / 3ph+N AC Supply from Container #1 - 32A BP2

3ph 400-480V, 50-60Hz

=LA01+UC31
Control System, Container #2 Inside

-QB01
32A, 3p+N
Switch Disconnector

3ph+N 400-480V, 50-60Hz

-FC01
4A, B-curve
MCCB

-TB33
24-28V/10ADC
PSU with UPS

-GB01
UPS Battery
24V, XY Ah

-FC03
13A, B-curve
MCCB

-QA03
4...32 V DC/48...600 V AC
Solidstate contactor
Container Heating

-FC04
10A, B-curve
MCCB

-FC07
4A, B-curve
MCCB

-EA07
Room Lighting

-FC08
10A, C-curve
RCB/MCB

-XD08
1kW
Service Outlet

=JA01+DA03
Container Ventilation System, Inside Container #2

-EB03
10kW
Container Heating

-GQ10
5,7kW
Ventilation Fan

=BA30+DA03
Power Conversion Output, Inside Container #2

=HKN70-XB02
3ph 6,6 kV

=HKN70-FC01
MV Circuit Breaker

-TA30
1250kVA
400/6600V Transformer
Dry-type

-FC31
250A
250A Breaker

-FC30
2000A
2000A Breaker

-FC40
2.5..4A
Circuit Breaker
for Primary Transformer Protection

-RB30
500V, 840A
0,084mH, 203uF
LC Filter

-RB31
500V, 840A
0,084mH, 203uF
LC Filter

-TA40
0,4/0,4 kV, 2kVA
Isolation Transformer

-TB30
1640 A, 3x 400-500 VAC
Active Front End

-QA40
Precharge Contactor

-TB40
60A
Rectifier, 3ph doide bridge

-RA40
4 pcs 3,3Ω, 1000W
Resistor

-FC29
800A
Fuse

-FC32
800A
Fuse

-FC41
20A

DC Busbar System

-XD01:1 -XD01:7

5.15:B / DC Bus from Fuel Cells DC1

5.15:B / DC Bus from Fuel Cells DC2

5.15:B / DC Bus from Fuel Cells DC3

6x (2x120 mm2)

5.15:B / DC Bus from Fuel Cells DC4

5.15:B / DC Bus from Fuel Cells DC5

5.15:B / DC Bus from Fuel Cells DC6

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
=	++ | + | & C01

FRM5103653/0B

REVISION INFORMATION	
DESCRIPTION	
DATE	15-Oct-24

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DRAWING	6014568 C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 10ft Container
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 6 / 7

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/07/2024	First Issue
002	28/03/2025	Update after Comms Testing
003	28/03/2025	Reupload with cover page

Document Title:	**BLPH Project - Electrical Interface Documentation**
Document Number:	K559-2254-CWIWP4202202-E03-007
Revision:	Rev003
Sequence Number:	007
File Name:	K559-2254-CWIWP4202202-E03-007Rev003
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Electrical Interface Documentation for Rosetti Marino

Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jul-24

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface Documentation Introduction		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 12

Electrical Interface - 6,6kV

Location: 10ft Container, Side Entry

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=BA30+DA03
Power Output, 10ft Container

-TA30
1250kVA
400/6600V Transformer
Dry-type

2W 2V 2U

1U 1V 1W

Ballard Scope
Rosetti Marino Scope

=HKN70
RM Scope

Ballard provides bulkhead plate

-X01
70mm2, M12
Angled Cable Lug

-X02
70mm2, M12
Angled Cable Lug

-X03
70mm2, M12
Angled Cable Lug

-82003-CEM-1-L1
LSZH
1x70
6,6kV

-82003-CEM-1-L2
LSZH
1x70
6,6kV

-82003-CEM-1-L3
LSZH
1x70
6,6kV

-82003-CEM-1-L1
6,6kV MV Power

-82003-CEM-1-L2
6,6kV MV Power

-82003-CEM-1-L3
6,6kV MV Power

SG-100D1

RM Information taken from "123A90-DDL-EL-LIS-20148_CPI"

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + | & B03

REVISION INFORMATION
DESCRIPTION
DATE
29-Nov-24

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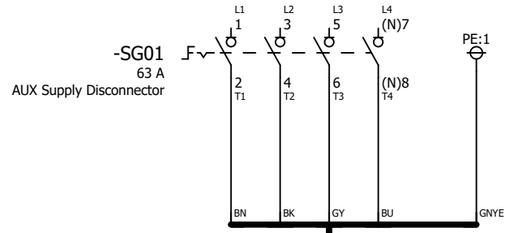
DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - 6,6kV Connection		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 12

Electrical Interface - AUX Connection

Location: 40ft Container, Upper Left Corner

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=BA20+UC50
AC Distribution Cabinet, Inside 40ft Container



Cable length: 12 meters from interface point

Ballard Scope
Rosetti Marino Scope

=HKN70
RM Scope

-83012-CEL
LSZH
5x16
400V
Fuel Cell Auxillary Load

83012-CEL
AUX Power Supply

SG-200N1

RM Information taken from "123A90-DDL-EL-LIS-20148_CPI"

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

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DATE
29-Nov-24

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - AUX Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 12

Electrical Interface - Safety Connections

Location: 40ft Container,Top Side Entry

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=LB02+UC20
Control Cabinet, 40ft Container Inside

To Safety Control System

-KF52
24VDC
Customer Safety Input Relay

A1
A2

-R01
120 Ohm, 0,5W
Wire break
resistor
RM Scope

-KF51
+UC20&C03/55.6
Fire Detection
23
24
5
6

-KF53
+UC20&C03/55.7
Hydrogen Detection
23
24
7
8

-KF50
+UC20&C03/55.5
Safety Status
23
24
33
34
-X101
9
10
11
12

Cable length: 12 meters from interface point

Ballard Scope
Rosetti Marino Scope

>=EXT+
Customer Scope

C-80-XS-001
2x2.5
C-80-XS-001
1 2,5
2 2,5
4.1
4.1

C-80-XS-001 / B400-SIS-001

80-UCP-001
2x2x2.5
80-UCP-001
1 WH 2,5
2 WH 2,5
1 BK 2,5
2 BK 2,5
4.4
4.3
4.4
4.4

80-UCP-001 / B400-FGS-002

C-80-XA-003
1x2x2.5
C-80-XA-002
1 WH 2,5
1 BK 2,5
4.6
4.6

C-80-XA-003 / B400-SES-001

23 — 24 +UC20&C03/55.2
33 — 34 +UC20&C03/55.3

Expected behaviour:
- Conductor 1 24VDC, Conductor 2 0V - Safety OK, Relay ON
- Conductor 1 0V, Conductor 2 0V - Safety NOT OK, Relay OFF

KF51 Indicates Fire detection
KF53 Indicated Gas detection
Implemented with safety rated relay
- De-energized contacts (as shown): No Fire / Gas detection
- Energized contacts (opposite shown): Confirmed Fire/Gas

KF50 Indicates System Emergency Status
Implemented with safety rated relay
- Closed Contacts: FC Package OK
- Open Contacts: FC Package Safety Trip

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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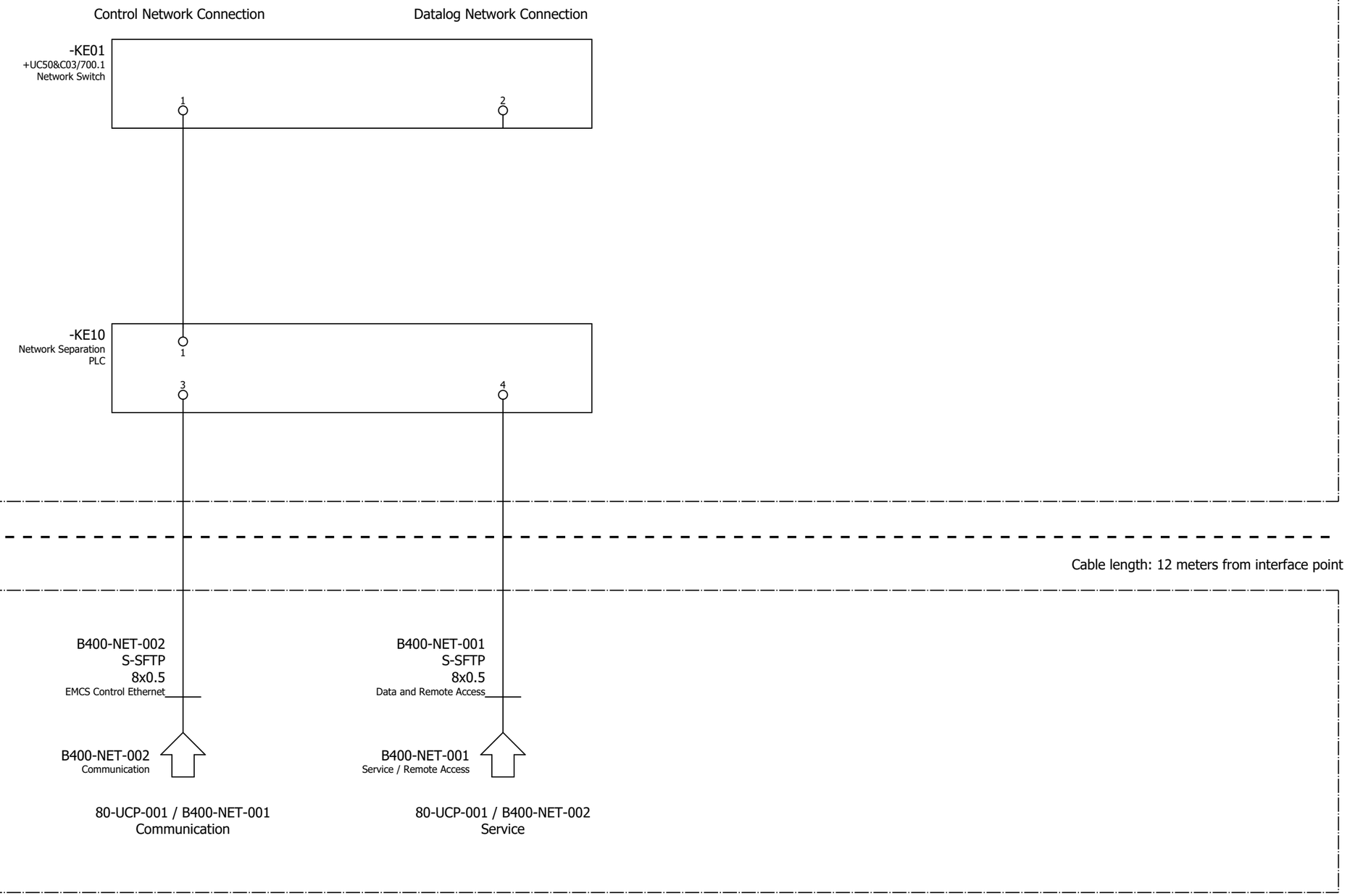
DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 12

Electrical Interface - Network Connections

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

Location: 40ft Container,Top Side Entry

=BA20+UC50
AC Distribution Cabinet, 40ft Container Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - Network		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 12

ROSETTI MARINO	123A90 - HOLLANDSE KUST NOORD WIND PARK BLPH Project	CROSSWIND

Ready For Operation (RFO) Certificate

COMPLETE	Y	PARTIAL	

Revision:	1		Issued on:	XX/XX/25	

System:	80	/	Fuel Cell
SubSystem:	N/A	/	N/A

We hereby confirm that all Mechanical Completion (MC) and Pre-Commissioning/Commissioning (Pre-Comm./Comm.) activities for the above-mentioned System/Sub-System have been successfully completed in accordance with project specifications, relevant standards and contractual requirements. The System/Sub-System has been tested and verified to ensure readiness for operation. Issuance of this Certificate shall not release CONTRACTOR from any of his obligations, responsibilities or liabilities under the CONTRACT.

	Mechanical Completion: All required MC activities have been completed and approved
	Pre-Commissioning & Commissioning: All required Pre-Comm. and Comm. activities and OTPs have been completed and approved (Status Index attached)
	Punch List: All Punch items categorized as A and B have been cleared (PL report attached)
	Documentation: As-built documentation and Commissioning dossier has been completed, reviewed and approved

PUNCH LIST	PENDING POINTS
Note: All Category "A" and "B" Items must be cleared prior to issuance of the Ready For Operation (RFO) Certificate	B

REMARKS:

	CONTRACTOR Commissioning Manager	**COMPANY** Commissioning Lead
Name	_NAME	_NAME
Date	_DATE	_DATE
Signature	_SIGN	_SIGN

#	Item Title	Description	Deadline	Person	Status	Date	Comments
1	Punch List Item 8B - Backup Battery Control Board not shielded.	Backup Battery Control Board not shielded. Ballard to investigate if shielding is required	Prior to SAT	Ballard	Open		PBL confirmed not required per manufacturing guidelines. PBL to send email, then PL can be closed.
2	Punch List Item 9B - External cabinets not shielded from rain during servicing	Rain may enter cabinets if opened during bad weather. Ballard to instruct how to safely carry out maintenance in the external cabinets	Prior to SAT	Ballard	Open		PBL to email confirming the degree of opening. Rain ingress not a risk. Document update only, the PL can be closed.
8	Punch List Item 21B - P&ID tags missing	P&ID tags missing. Valves or other removable/serviceable items should be attached with zip ties while internal non service items can be with stickers. External/outside tags are preferred to be stainless/etched. Existing tag system is appropriate for the environment so the zip tie version will be used 04-09-2024: CW to investigate requirement for SS tags externally. Ballard to investigate plastic tag durability for offshore environment.	Prior to SAT	Ballard	Open		All external tags to be SS as communicated previously. Ballard to confirm Schedule. Ballard have provided specification on current tags used externally, stating they are suitable for the external conditions. CW to review and comment. If SS tags are required Ballard current stance is this is an adder. To be discussed as required.
15	Punch List Item 35B - Ventilation output vent louvers	Concern about the ventilation output louvers not sufficiently shielding against offshore storms/rain showers. To be investigated further by Ballard	Prior to SAT	Ballard	Open		PBL to provide email response regarding the degree of opening and minimal risk. Then can be closed.

PL NUMBER	DEFECT DESCRIPTION	ACTIVITY CODE	ISSUED BY USER	ACTION BY (USER GROUP CODE)	DISCIPLINE CODE	ITEM CODE	ISSUED DATE	VENDOR NAME	Comment	Status
C30000606	40ft Container. Item n.10 Vents (General arrangement K559-2254-CWIWP4202202-B01-001 R.8 sheet 5/14). Two Vents have rust spots on the entire surface of the top side. One image attached as example.	MC	KAlbonetti	VND	M	A-80000	2024-11-19	BALLARD	Ballard to email confirming the source of the rust spots. Residue to be wiped off if possible.	Open
C30000608	Containers' nameplates on both the 40 ft container and the 10 ft one have rust rising from underneath.	MC	KAlbonetti	VND	M	A-80000	2024-11-19	BALLARD	Ballard to email confirming the source of the rust spots. Residue to be wiped off if possible.	Open
C30000609	Several painting touch-ups to be performed. See as example on SHS above anchor points A, B and H (images attached).	MC	KAlbonetti	VND	M	A-80000	2024-11-19	BALLARD	Some touch ups to be complete. Containers to be viewed again.	Open
C30000610	There are discrepancies between the General arrangement document (K559-2254-CWIWP4202202-B01-001 R.8). Sh.12/14. The interface point is different in field compared to the document. Two more in/out-lets exist. In addition there is one vent more originating from the point. See picture n.2 compared to sh.05/14. Finally there is one additional hose going to the Low temperature cooler compared to sh.05/14.	MC	KAlbonetti	VND	M	A-80000	2024-11-19	BALLARD	Vent installed per Rev 009. Drain plate picture to be taken and reviewed against Rev 009 drawing. Rev009 coolant tank hose missing off Rev 009 drawing - drawing to be updated.	Open
C30000686	Bending radius on MCT is not correct. See attached photo.	MC	Gtangianu	VND	E	83012-CEL	2024-11-21	BALLARD	Outstanding - to be modified.	Open
C30001188	Current reading in pct vol. To be changed to pct LEL. 04-09-2024: Will be corrected with next sw release (17C - H2 sensor reading in HMI)	CPY	CPY	VND	E	A-80000	2024-12-03	BALLARD	Outstanding - completed in sw upgrade of next campaign.	Open
C30001191	27C - H2 and smoke detector voting, currently 1/3. CW would like 2/3.	CPY	CPY	VND	E	A-80000	2024-12-03	BALLARD	Outstanding - completed in sw upgrade of next campaign.	Open
C30001193	During shutdown of the FCwave, an intermittent timeout occurs (ca 5% of shutdowns) where the test stalls. Expected to be a software glitch to be corrected by FC wave dev team. (41B - Intermittent timeout of FCwave shutdown test)	CPY	CPY	VND	E	A-80000	2024-12-03	BALLARD	Outstanding - completed in sw upgrade of next campaign.	Open

ITEM	Tag	BL01	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		10000160523			
Manufacturer	IFM Electronic AS			**Model**		LMT01A LMACE-A12E-QSKG-1/US/3D/3G			
Cert No.	8003330			**Equipment Ambient Temp.**					
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex nA	**EPL**	Gc	**Gas group**	IIC	**Temp class**	T4	**IP Rating**	IP67

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	OK	
19	Flameproof components are undamaged	x	NA	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	NA	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	NA	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x		
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x		
50	Cable glands are of the correct type and installed correctly	x		
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x		
52	Flame path are clean and undamaged	x		
53	Flange gap dimensions are within tolerances	x		
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
55	The ventilation airflow is not impeded	x		
56	Insulation resistance (IR) of the motor windings is satisfactory	x		
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
58	Variable voltage/frequency installation complies with documentation	x		
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks				
67	All Terminals are Ex n certified (if required on certificate)	x	OK	
68	Hermetically sealed and enclosed break devices are undamaged	x	OK	
69	Restricted breathing properties satisfactory (conduct vacuum test)	x	NA	
70	Test port, if fitted, is functional (type "nR" only)	x	NA	
71	Breathing operation is satisfactory (type "nR" only)	x	NA	
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x	NA	
73	The ventilation airflow is not impeded	x	NA	
74	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
75	Motor protection devices operate within the permitted tE or tA time limits.	x	NA	
76	Variable voltage/frequency installation complies with documentation	x	NA	
Extra Ex p checks				
77	Pressurization gas is correct type	x		
78	Actual pressure is within maximum and minimum settings for equipment	x		
79	Timers set as per certification documentation	x		
80	Alarms and trip functions operate correctly as per certification documentation	x		
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
82	Automatic electrical protective devices operate within permitted limits	x		
83	Automatic electrical protective devices are set correctly	x		
84	Protective gas inlet temperature is below maximum specified	x		
85	Ducts, pipes and enclosures are in good condition	x		
86	Protective gas is substantially free from contaminants	x		
87	Protective gas pressure and/or flow is adequate	x		
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x		
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x		
90	Specific conditions of use (if applicable) are complied with			
Extra Ex i (Intrinsically Safe – IS) checks				
91	Equipment has adequate circuit identification for 'IS' Installation	x		
92	Cables are installed in accordance with the documentation	x		
93	Segregation is maintained between IS and non-IS Circuits	x		
94	Cable screens are isolated at one end (field side)	x		
95	Cable screens are earthed in accordance with the documentation	x		
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x		
97	Equipment installed is the one specified in the documentation	x		
98	Ambient temperature range of the apparatus is correct for the installation	x		
99	Service temperature range of the apparatus is correct for the installation	x		
100	Installation is clearly labelled	x		
101	Printed circuit boards are clean and undamaged	x		
102	The maximum voltage Um of the associated apparatus is not exceeded	x		
103	Point-to-point connections are all correct	x		
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x		
105	Earth connections maintain the integrity of the type of protection	x		
106	Intrinsically safe circuit earthing is satisfactory	x		
107	Insulation resistance is satisfactory	x		
108	Short-circuit protection of the power supply is in accordance with the documentation	x		

	BARRIER:	**Manufacturer:**		**Model:**		
		Authority:		**Cert No:**		**Type:**

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

Page 3/3	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	CROSSWIND	Crosswind	
Name	GERRY MCCANN	Jamie McAllister	
Date	27/11/2024	02/12/2024	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 16:13:09 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:38:15 +01'00'	

ITEM	Tag	BP01	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**					
Manufacturer	HUBA Controls AG			**Model**		Pressure Transducer 520 Series			
Cert No.	SEV 10 ATEX 0145			**Equipment Ambient Temp.**					
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex ia	**EPL**	Ga/Gb	**Gas group**	IIC	**Temp class**	T4	**IP Rating**	IP67

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	NA	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	NA	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	NA	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x		
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x		
50	Cable glands are of the correct type and installed correctly	x		
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x		
52	Flame path are clean and undamaged	x		
53	Flange gap dimensions are within tolerances	x		
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
55	The ventilation airflow is not impeded	x		
56	Insulation resistance (IR) of the motor windings is satisfactory	x		
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
58	Variable voltage/frequency installation complies with documentation	x		
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

	Extra Ex n (nR, nL) checks				
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type "nR" only)	x			
71	Breathing operation is satisfactory (type "nR" only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
	Extra Ex p checks				
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
	Extra Ex i (Intrinsically Safe – IS) checks				
91	Equipment has adequate circuit identification for 'IS' Installation	x	PL	JB needs to be labelled	
92	Cables are installed in accordance with the documentation	x	OK		
93	Segregation is maintained between IS and non-IS Circuits	x	OK		
94	Cable screens are isolated at one end (field side)	x	NA		
95	Cable screens are earthed in accordance with the documentation	x	NA		
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x	OK		
97	Equipment installed is the one specified in the documentation	x	OK		
98	Ambient temperature range of the apparatus is correct for the installation	x	OK		
99	Service temperature range of the apparatus is correct for the installation	x	OK		
100	Installation is clearly labelled	x	OK		
101	Printed circuit boards are clean and undamaged	x	OK		
102	The maximum voltage Um of the associated apparatus is not exceeded	x	OK		
103	Point-to-point connections are all correct	x	OK		
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x	OK		
105	Earth connections maintain the integrity of the type of protection	x	OK		
106	Intrinsically safe circuit earthing is satisfactory	x	OK		
107	Insulation resistance is satisfactory	x	OK		
108	Short-circuit protection of the power supply is in accordance with the documentation	x	OK		

	BARRIER:	**Manufacturer:**		**Model:**		
		Authority:		**Cert No:**		**Type:**

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	CROSSWIND	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 16:38:14 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:42:12 +01'00'	

ITEM	Tag	EA01	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01

Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		340386-1			
Manufacturer	JEVI Heating Elements AS			**Model**		D-8640			
Cert No.	ISSeP 08 ATEX 008X			**Equipment Ambient Temp.**					
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex d	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T4	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	OK	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	NA	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x	OK	
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x	OK	
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x	OK	
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x	OK	
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x	OK	
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x	OK	
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x	OK	
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x	NA	
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x	NA	
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	CROSSWIND	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 16:50:24 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:43:10 +01'00'	

ITEM	Tag	EA02	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01

Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		340386-2			
Manufacturer	JEVI Heating Elements AS			**Model**		D-8640			
Cert No.	ISSeP 08 ATEX 008X			**Equipment Ambient Temp.**					
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex d	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T4	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	OK	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x	OK	
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x	OK	
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x	OK	
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x	OK	
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x	OK	
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x	OK	
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x	OK	
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x	NA	
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x	NA	
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	CROSSWIND	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 16:59:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:43:54 +01'00'	

ITEM	Tag	QM1.1	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP24068090			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:47:19 +01'00'	

ITEM	Tag	QM1.2	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state “NA”. Comments are required for ‘Failure’ column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex “e” – Ex “n” – Ex “t”)	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:48:04 +01'00'	

ITEM	Tag	QM1.3	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP24068090			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01

Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:49:13 +01'00'	

ITEM	Tag	QM1.4	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

	Extra Ex n (nR, nL) checks				
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
	Extra Ex p checks				
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
	Extra Ex i (Intrinsically Safe – IS) checks				
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:49:39 +01'00'	

ITEM	Tag	QM1.5	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:50:16 +01'00'	

ITEM	Tag	QM1.6	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01

Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:50:45 +01'00'	

ITEM	Tag	QM2.1	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP24068090			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

	Please mark only one box as appropriate
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:51:15 +01'00'	

ITEM	Tag	QM2.2	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:51:46 +01'00'	

ITEM	Tag	QM2.3	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	James McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:52:45 +01'00'	

ITEM	Tag	QM2.4	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline ATEX	Form CJX01		Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ● REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	James McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:53:57 +01'00'	

ITEM	Tag	QM2.5	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state “NA”. Comments are required for ‘Failure’ column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex “e” – Ex “n” – Ex “t”)	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:54:48 +01'00'	

ITEM	Tag	QM2.6	:			Dwg	
	S/Sys	80-00	:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	ATEX	Form	CJX01 Hazardous Area Equipment Detailed Inspection

Schedule Ref. #				**Area Code**					
Area Class Drawing	K559-2254-CWIWP4202202-B01-001			**Serial No.**		ZP23091327			
Manufacturer	Emerson ASCO			**Model**		NF X E210D488E 24/DC			
Cert No.	LCIE 00 ATEX 6008 X			**Equipment Ambient Temp.**		max 40 deg C			
Area Classification	3G	**Zone**	2	**Gas group**	IIC	**Temp class**	T1		
Equipment Protection Type	Ex db	**EPL**	Gb	**Gas group**	IIC	**Temp class**	T2 -T6	**IP Rating**	IP66

Detailed Note:

1) Inspection shall only be performed by competent personnel with competency verified by Total

2) All fields are to be completed. Any non-applicable field shall state "NA". Comments are required for 'Failure' column ONLY.

3) An Inspection Sheet should be completed for EACH individual item of Equipment.

	General Equipment	Detailed	OK/NA/PL	Comments
1	Equipment is appropriate to the EPL / Zone requirements of the area	x	OK	
2	Equipment group is correct	x	OK	
3	Equipment temperature class is correct	x	OK	
4	Degree of IP protection of equipment is appropriate for the level of protection	x	OK	
5	Equipment circuit identification is correct	x	OK	
6	Equipment circuit identification is available	x	OK	
7	Enclosure glass parts and glass-to-metal sealing gaskets and / or compounds are satisfactory	x	NA	
8	There is no damage or unauthorized modifications	x	OK	
9	There is no evidence of unauthorized modifications	x	OK	
10	Bolts, cable entry devices (direct and indirect) & blanking elements are of the correct type, are complete & tight		OK	
	Physical check	x	OK	
11	Threaded covers on enclosures are of the correct type, are tight and secured		OK	
	Physical check	x	OK	
12	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	x	OK	
13	Condition of enclosure gaskets is satisfactory	x	OK	
14	There is no evidence or ingress of water or dust in the enclosure in accordance with the IP rating	x	OK	
15	Electrical connections are tight	x	OK	
16	Bridging links do not reduce creepage / clearance and are allowed	x	NA	
17	Unused terminals are tightened	x	OK	
18	Encapsulated components are undamaged	x	NA	
19	Flameproof components are undamaged	x	OK	
20	Fluorescent lamps are not indicating EOL effects (only for Ex "e" – Ex "n" – Ex "t")	x	NA	
21	HID lamps are not indicating EOL effects	x	NA	
22	Lamp type, rating, pin configuration and position are correct	x	NA	
23	Breathing and drainage devices are satisfactory	x	NA	
24	Type of cable is appropriate	x	OK	
25	There is no obvious damage to the cables	x	OK	
26	Cable glands are the correct type and installed correctly	x	OK	
27	Sealing of trunking, ducts, pipes and or conduits is satisfactory	x	NA	
28	Stopping boxes and cable boxes are corrected filled	x	NA	

ITEM	Tag	:			Dwg		
	S/Sys	:			Module		
TASK	code		Location		User		
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

29	Integrity of conduit system and interface with mixed system maintained	x	NA	
30	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section		OK	
	Physical check	x	OK	
31	Automated electric protective devices operate within permitted limits	x	NA	
32	Special conditions (if applicable) have been complied with.	x	OK	
33	All cable cores are uniquely labeled	x	OK	
34	Cable cores not in use are correctly terminated	x	OK	
35	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	x	OK	
36	No undue accumulation of dust and dirt	x	OK	
37	All equipment housings are clean and dry	x	OK	
38	All moving parts are free and have no mechanical damage	x	OK	
	Applicable for Installation of Heating Systems			
39	Temperature sensors function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
40	Safety cut off devices function according to manufacturer's documents (only applicable for Ex-d e Ex-e)	x		
41	The setting of the safety cut off is sealed (only applicable for Ex-d e Ex-e)	x		
42	Reset of a heating system safety cut off possible with tool only(only applicable for Ex-d e Ex-e)	x		
43	Auto-reset is not possible (only applicable for Ex-d e Ex-e)	x		
44	Reset of a safety cut off under fault conditions is prevented (only applicable for Ex-d e Ex-e)	x		
45	Safety cut off independent from control system (only applicable for Ex-d e Ex-e)	x		
46	Level switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
47	Flow switch is installed and correctly set, if required (only applicable for Ex-d e Ex-e)	x		
	Extra Ex d checks			
48	Obstructions adjacent to flame proof flanged joints are in accordance with IEC 60079-14	x	OK	
49	Ex d conduits seals are fitted to all conduits and satisfactorily sealed	x	NA	
50	Cable glands are of the correct type and installed correctly	x	OK	
51	Adaptors, reducers, stop ends, etc. are all certified Ex d	x	OK	
52	Flame path are clean and undamaged	x	OK	
53	Flange gap dimensions are within tolerances	x	OK	
54	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x	NA	
55	The ventilation airflow is not impeded	x	NA	
56	Insulation resistance (IR) of the motor windings is satisfactory	x	NA	
57	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x	OK	
58	Variable voltage/frequency installation complies with documentation	x	NA	
	Extra Ex e checks			
59	All Equipment is Ex e certified (including components within enclosure)	x		
60	Power conductors are not bunched together causing possible hot spots	x		
61	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks	x		
62	Insulation resistance (IR) of the motor windings is satisfactory	x		
63	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x		
64	The ventilation airflow is not impeded	x		
65	Motor protection devices operate within the permitted tE or tA time limits.	x		
66	Variable voltage/frequency installation complies with documentation	x		

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity	CCK	Discipline	ATEX	Form	CJX01	Hazardous Area Equipment Detailed Inspection

Extra Ex n (nR, nL) checks					
67	All Terminals are Ex n certified (if required on certificate)	x			
68	Hermetically sealed and enclosed break devices are undamaged	x			
69	Restricted breathing properties satisfactory (conduct vacuum test)	x			
70	Test port, if fitted, is functional (type “nR” only)	x			
71	Breathing operation is satisfactory (type “nR” only)	x			
72	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are	x			
73	The ventilation airflow is not impeded	x			
74	Insulation resistance (IR) of the motor windings is satisfactory	x			
75	Motor protection devices operate within the permitted tE or tA time limits.	x			
76	Variable voltage/frequency installation complies with documentation	x			
Extra Ex p checks					
77	Pressurization gas is correct type	x			
78	Actual pressure is within maximum and minimum settings for equipment	x			
79	Timers set as per certification documentation	x			
80	Alarms and trip functions operate correctly as per certification documentation	x			
81	Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	x			
82	Automatic electrical protective devices operate within permitted limits	x			
83	Automatic electrical protective devices are set correctly	x			
84	Protective gas inlet temperature is below maximum specified	x			
85	Ducts, pipes and enclosures are in good condition	x			
86	Protective gas is substantially free from contaminants	x			
87	Protective gas pressure and/or flow is adequate	x			
88	Pressure and/or flow indicators, alarms and interlocks function correctly	x			
89	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	x			
90	Specific conditions of use (if applicable) are complied with				
Extra Ex i (Intrinsically Safe – IS) checks					
91	Equipment has adequate circuit identification for ‘IS’ Installation	x			
92	Cables are installed in accordance with the documentation	x			
93	Segregation is maintained between IS and non-IS Circuits	x			
94	Cable screens are isolated at one end (field side)	x			
95	Cable screens are earthed in accordance with the documentation	x			
96	Safety barrier units, relays and other energy limiting devices are of the approved type, installed in	x			
97	Equipment installed is the one specified in the documentation	x			
98	Ambient temperature range of the apparatus is correct for the installation	x			
99	Service temperature range of the apparatus is correct for the installation	x			
100	Installation is clearly labelled	x			
101	Printed circuit boards are clean and undamaged	x			
102	The maximum voltage Um of the associated apparatus is not exceeded	x			
103	Point-to-point connections are all correct	x			
104	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section)	x			
105	Earth connections maintain the integrity of the type of protection	x			
106	Intrinsically safe circuit earthing is satisfactory	x			
107	Insulation resistance is satisfactory	x			
108	Short-circuit protection of the power supply is in accordance with the documentation	x			

	BARRIER:	**Manufacturer:**		**Model:**			
		Authority:		**Cert No:**		**Type:**	

Remarks: Initial inspection should be detailed and carried out before equipment is brought into service as per IEC 60079-17

Please mark only one box as appropriate	
●	**Passed - Complete**
	Failed

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Crosswind	Crosswind	
Name	Gerry McCann	Jamie McAllister	
Date	27/11/24	02/12/24	
Signature	Gerard Paul McCann Digitally signed by Gerard Paul McCann Date: 2024.12.02 17:13:49 +01'00'	Jamie McAllister Digitally signed by Jamie McAllister Date: 2024.12.03 13:55:55 +01'00'	

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ITEM	Tag	=LA01+UC20-KE03-WG01	:			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Telecom	Form	CIX09 Telecom Cable RJ45

CABLE DATA

Type: Ethernet | Cores/Size mm²: 4*2*28awg | Color: GN

From: UC20 | To: UC30

1	Confirm cable is as specified in project cable schedule	OK
2	Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Confirm cable labelling is in accordance with specifications.	OK
8	Check cable is correctly loomed and segregated in accordance with specification.	OK
9	Check proper fitting of heat shrink sleeves and cable glands (if applicable).	NA
10	Check cores marking are in accordance with termination diagram.	NA
11	Check terminations are in accordance with latest termination diagram.	NA
12	To roll up that measured lenght complies with pulled lenght.	NA
13	To roll up the cable complies with Cat. 5E performance requirements (250 Mhz).	OK
14	Attach LAN tester print out to this test sheet.	OK
15	if required produce Red Line Mark Up for "AS BUILT"	

Comments

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Peter	Rasmus Knudsen	
Date	26/11-2024	26/11-2024	
Signature			

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ITEM	Tag	=LA01+UC30-KE05-WG01	:			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Telecom	Form CIX09	Telecom Cable RJ45

CABLE DATA

Type: Ethernet | Cores/Size mm²: 4*2*28awg | Color: GN

From: UC30 | To: UC31

1	Confirm cable is as specified in project cable schedule	OK
2	Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Confirm cable labelling is in accordance with specifications.	OK
8	Check cable is correctly loomed and segregated in accordance with specification.	OK
9	Check proper fitting of heat shrink sleeves and cable glands (if applicable).	NA
10	Check cores marking are in accordance with termination diagram.	NA
11	Check terminations are in accordance with latest termination diagram.	NA
12	To roll up that measured lenght complies with pulled lenght.	NA
13	To roll up the cable complies with Cat. 5E performance requirements (250 Mhz).	OK
14	Attach LAN tester print out to this test sheet.	OK
15	if required produce Red Line Mark Up for "AS BUILT"	

Comments

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Peter	Rasmus Knudsen	
Date	26/11-2024	26/11-2024	
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=LA01+UC31-KE06-WG01	:			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Telecom	Form	CIX09 Telecom Cable RJ45

CABLE DATA

Type: Ethernet | Cores/Size mm²: 4*2*28awg | Color: GN

From: UC31 | To: UC50

1	Confirm cable is as specified in project cable schedule	OK
2	Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Confirm cable labelling is in accordance with specifications.	OK
8	Check cable is correctly loomed and segregated in accordance with specification.	OK
9	Check proper fitting of heat shrink sleeves and cable glands (if applicable).	NA
10	Check cores marking are in accordance with termination diagram.	NA
11	Check terminations are in accordance with latest termination diagram.	NA
12	To roll up that measured lenght complies with pulled lenght.	NA
13	To roll up the cable complies with Cat. 5E performance requirements (250 Mhz).	OK
14	Attach LAN tester print out to this test sheet.	OK
15	if required produce Red Line Mark Up for "AS BUILT"	

Comments

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Peter	Rasmus Knudsen	
Date	26/11-2024	26/11-2024	
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=HA01+DA02-BT01-WG01	: H2 Heater temperature sensor			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Instrumental	Form	CJX10 Multi/Single-Core Instrument Control Cable

CABLE DATA

Type: Signal cable | Cores/Size mm²: 4x1.0 | Color: GY

From: UC20 | To: UC42 EX box

1	Check cable is as specified in project cable schedule.	OK
2	Check relevant documents are at the latest revision.	OK
3	Check cable is routed in accordance with cable layout drawings.	OK
4	Check cable for any physical damage.	OK
5	Check cable is adequately supported and correctly fixed to rack according to Project specification.	OK
6	Check bending radius is within the specified limits.	OK
7	Check cable is correctly loomed and segregated in accordance with specification.	OK
8	Check cable and core marking are in accordance with specification.	OK
9	Check cable labelling is in accordance with specification.	OK
10	Check that glands, shrouds and earthing are in accordance with specification.	OK
11	Check terminations are in accordance with termination diagram	OK
12	Check gland plate for single core cables is non-ferrous.	OK
13	If required produce Red Line Mark Up for "AS BUILT"	

INSULATION	CORE to EARTH	OL	MΩ
	CORE to CORE	OL	MΩ
	CORE to SCREEN	OL	MΩ
	CORE to ARMr	NA	MΩ
	SCREEN to EARTH	NA	MΩ
	SCREEN to ARMr	NA	MΩ
CONTINUITY	CORES	2.4	Ω
	SCREEN	2.2	Ω
	EARTH	NA	Ω
	ARMr	NA	Ω
	TEST VOLTS	250V	V

TEST ALL CORES AND RECORD LOWEST VALUE

Notes: The lowest value is recorded and must be within project specifications

TESTING INSTRUMENTS USED

TYPE / SERIAL N°: Insulation Tester W8330207 | Calibration date: 7722/24 10/07/2025

Comments: Type/serial N: Multimeter 1405677 Calibration cert. N and date: 1313891 04/26/2025

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Company	Ballard		
Name	Rasmus Knudsen		
Date	29/11-2024		
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=HA01+DA02-BP01-WG01	: H2 Manifold pressure			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Instrumental	Form	CJX10 Multi/Single-Core Instrument Control Cable

CABLE DATA

Type: Signal cable | Cores/Size mm²: 4x1.0 | Color: GY

From: UC30 | To: UC42EX box

1	Check cable is as specified in project cable schedule.	OK
2	Check relevant documents are at the latest revision.	OK
3	Check cable is routed in accordance with cable layout drawings.	OK
4	Check cable for any physical damage.	OK
5	Check cable is adequately supported and correctly fixed to rack according to Project specification.	OK
6	Check bending radius is within the specified limits.	OK
7	Check cable is correctly loomed and segregated in accordance with specification.	OK
8	Check cable and core marking are in accordance with specification.	OK
9	Check cable labelling is in accordance with specification.	OK
10	Check that glands, shrouds and earthing are in accordance with specification.	OK
11	Check terminations are in accordance with termination diagram	OK
12	Check gland plate for single core cables is non-ferrous.	OK
13	If required produce Red Line Mark Up for "AS BUILT"	

INSULATION	CORE to EARTH	OL	MΩ
	CORE to CORE	OL	MΩ
	CORE to SCREEN	OL	MΩ
	CORE to ARMr	NA	MΩ
	SCREEN to EARTH	NA	MΩ
	SCREEN to ARMr	NA	MΩ
CONTINUITY	CORES	2.6	Ω
	SCREEN	2.2	Ω
	EARTH	NA	Ω
	ARMr	NA	Ω
	TEST VOLTS	250V	V

TEST ALL CORES AND RECORD LOWEST VALUE

Notes: The lowest value is recorded and must be within project specifications

TESTING INSTRUMENTS USED

TYPE / SERIAL N°: Insulation Tester W8330207 | Calibration date: 7722/24 10/07/2025

Comments: Type/Serial N: Multimeter 1405677 Calibration cert. N and date: 1313891 04/26/2025

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Company	Ballard		
Name	Rasmus Knudsen		
Date	29/11-2024		
Signature			

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ITEM	Tag	=LB02+UC31-KE20-WG01	: Safety EFI Bus			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Instrumental	Form	CJX10 Multi/Single-Core Instrument Control Cable

CABLE DATA

Type: CanBus | Cores/Size mm²: 2x2x0.5 | Color: PU

From: UC20 To: UC31

1	Check cable is as specified in project cable schedule.	OK
2	Check relevant documents are at the latest revision.	OK
3	Check cable is routed in accordance with cable layout drawings.	OK
4	Check cable for any physical damage.	OK
5	Check cable is adequately supported and correctly fixed to rack according to Project specification.	OK
6	Check bending radius is within the specified limits.	OK
7	Check cable is correctly loomed and segregated in accordance with specification.	OK
8	Check cable and core marking are in accordance with specification.	OK
9	Check cable labelling is in accordance with specification.	OK
10	Check that glands, shrouds and earthing are in accordance with specification.	OK
11	Check terminations are in accordance with termination diagram	OK
12	Check gland plate for single core cables is non-ferrous.	OK
13	If required produce Red Line Mark Up for "AS BUILT"	

INSULATION	CORE to EARTH	OL	MΩ
	CORE to CORE	OL	MΩ
	CORE to SCREEN	NA	MΩ
	CORE to ARMr	NA	MΩ
	SCREEN to EARTH	NA	MΩ
	SCREEN to ARMr	NA	MΩ
CONTINUITY	CORES	2.2	Ω
	SCREEN	NA	Ω
	EARTH	NA	Ω
	ARMr	NA	Ω
	TEST VOLTS	250V	V

TEST ALL CORES AND RECORD LOWEST VALUE

Notes: The lowest value is recorded and must be within project specifications

TESTING INSTRUMENTS USED

TYPE / SERIAL N°: Insulation Tester W8330207 Calibration date: 7722/24 10/07/2025

Comments: Type/serial N: Multimeter 1405677, cal N: 1313891 validity: 04/26/2025

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Company	Ballard	Ballard	
Name	Rasmus Knudsen	Peter Blach	
Date	02/12/2025	02/12/2025	
Signature			

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ITEM	Tag	=HA01+DA02-AC01-WG01	: H2 Valve junction box			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Instrumental	Form	CJX10

Multi/Single-Core Instrument Control Cable

CABLE DATA

Type: Signal cable | Cores/Size mm²: 18x0.75 | Color: GY

From: UC20 | To: H2 Valve junction box

1	Check cable is as specified in project cable schedule.	OK
2	Check relevant documents are at the latest revision.	OK
3	Check cable is routed in accordance with cable layout drawings.	OK
4	Check cable for any physical damage.	OK
5	Check cable is adequately supported and correctly fixed to rack according to Project specification.	OK
6	Check bending radius is within the specified limits.	OK
7	Check cable is correctly loomed and segregated in accordance with specification.	OK
8	Check cable and core marking are in accordance with specification.	OK
9	Check cable labelling is in accordance with specification.	OK
10	Check that glands, shrouds and earthing are in accordance with specification.	OK
11	Check terminations are in accordance with termination diagram	OK
12	Check gland plate for single core cables is non-ferrous.	OK
13	If required produce Red Line Mark Up for "AS BUILT"	

INSULATION	CORE to EARTH	OL	MΩ
	CORE to CORE	OL	MΩ
	CORE to SCREEN	NA	MΩ
	CORE to ARMr	NA	MΩ
	SCREEN to EARTH	NA	MΩ
	SCREEN to ARMr	NA	MΩ
CONTINUITY	CORES	1.4	Ω
	SCREEN	NA	Ω
	EARTH	0.5	Ω
	ARMr	NA	Ω
	TEST VOLTS	250	V

TEST ALL CORES AND RECORD LOWEST VALUE

Notes: The lowest value is recorded and must be within project specifications

TESTING INSTRUMENTS USED

TYPE / SERIAL N°: Insulation Tester W8330207 | Calibration date: 7722/42 10/07/2025

Comments: Type/Serial N: Multimeter 1405677 Calibration N and date: 1313891 04/26/2025

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Peter Blach	
Date	02/12/2024	02/12/2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	UC42	:			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Instrumental	Form CJX31	Junction and Marshalling Box

1	Check equipment is de-energized and safe.	OK
2	Check available documents are at the latest revision.	OK
3	Check nameplate data/certification is in accordance with project data.	OK
4	Check all flange faces are clean and greased with approved lubicants, and that all bolts are fitted and correctly tight (Exd only).	OK
5	Check all gaskets and bolts are fitted in covers and gland plates (where applicable).	OK
6	Check enclosure is correctly tagged as per drawing.	OK
7	Check enclosure is correctly earthed in accordance with project data.	NA
8	Check that all unused entries are plugged with approved blanks.	OK
9	Check that terminals are approved and that the correct numbers are fitted.	OK
10	Check segregation barriers are fitted where necessary.	OK
11	Check enclosure is correctly mounted and easily accessible.	OK
12	If required produce Red Line Mark Up for "AS BUILT"	

Comments:

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Peter Blach	
Date	02/12/2025	02/12/2025	
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=BA20+DA01-TA03	: AC Supply				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type 3p | Cores/Size mm² 70 | Color BK

From 10" | To 40"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form	CPX09 LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.8Ohm	
6		PH 2	0.6Ohm	
7		PH 3	0.5Ohm	
8	ARMOUR CONTINUITY Ω		NA	
9	PROTECTIVE CONDUCTOR CONTINUITY Ω		NA	
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	239MOhm	
11		PH2 / PH1-PH3-A-E	239MOhm	
12		PH3 / PH1-PH2-A-E	239MOhm	
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	● WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Peter Blach	
Date	02/12-2024	02/12-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC01-WD02	: Output- UC01				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type Power Cable Cores/Size mm² 120 Color BK

From UC01 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ω	PH 1	0.5Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
INSULATION				
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	3.75GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

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Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ITEM	Tag	=BA01+UC02-WD02	: Output- UC02			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CABLE DATA

Type Power Cable Cores/Size mm² 120 Color BK

From UC02 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form	CPX09 LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.3Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	842MOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

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ITEM	Tag	=BA01+UC03-WD02	: Output- UC03			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CABLE DATA

Type: Power Cable | Cores/Size mm²: 120 | Color: BK

From: UC03 | To: 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ω	PH 1	0.3Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
INSULATION				
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	2.65GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC04-WD02	: Output- UC04				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type Power Cable Cores/Size mm² 120 Color BK

From UC04 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.2Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	644MOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC05-WD02	: Output- UC05				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type Power cable Cores/Size mm² 120 Color BK

From UC05 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ω	PH 1	0.4Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
INSULATION				
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	5.48GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC06-WD02	: Output- UC06				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type Power cable Cores/Size mm² 120 Color BK

From UC06 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ω	PH 1	0.3Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
INSULATION				
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	4.29GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC01-WB01	: Output+ UC01			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CABLE DATA

Type Power cable Cores/Size mm² 120 Color BK

From UC01 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form	CPX09 LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.4Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	2.94GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC02-WD01	: Output+ UC02			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CABLE DATA

Type Power cable Cores/Size mm² 120 Color BK

From UC02 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.3Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	849MOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ITEM	Tag	=BA01+UC03-WD01	: Output+ UC03			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical Form CPX09		LV Power Cable

CABLE DATA

Type: Power cable Cores/Size mm²: 120 Color: BK

From: UC03 To: 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ώ	PH 1	0.2Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ώ			
9	PROTECTIVE CONDUCTOR CONTINUITY Ώ			
INSULATION				
10	CORES / ARMOUR+EARTH MΏ	PH1 / PH2-PH3-A-E	692MOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO PROVERLIS CROSSWIND

ITEM	Tag	=BA01+UC04-WD01	: Output+ UC04				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type Power cable Cores/Size mm² 120 Color BK

From UC04 To 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.2Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	2.35GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ITEM	Tag	=BA01+UC05-WD01	: Output+ UC05				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type: Power cable Cores/Size mm²: 120 Color: BK

From: UC05 To: 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

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ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.3Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	2.35GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=BA01+UC06-WD01	: Output+ UC06				Dwg	
	S/Sys		:				Module	
TASK	code			Location			User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09		LV Power Cable

CABLE DATA

Type: Power Cable | Cores/Size mm²: 120 | Color: BK

From: UC06 | To: 10"

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	NA
11	Check cores marking are in accordance with termination diagram	NA
12	Check terminations are in accordance with latest termination diagram	NA
13	If required produce Red Line Mark Up for "AS BUILT"	

REFER TO FINAL SHEET FOR ACCEPTANCE

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	:				Dwg	
	S/Sys	:				Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form	CPX09 LV Power Cable

	CONTINUITY			
5	CORE CONTINUITY Ω	PH 1	0.2Ohm	
6		PH 2		
7		PH 3		
8	ARMOUR CONTINUITY Ω			
9	PROTECTIVE CONDUCTOR CONTINUITY Ω			
	INSULATION			
10	CORES / ARMOUR+EARTH MΩ	PH1 / PH2-PH3-A-E	3.76GOhm	
11		PH2 / PH1-PH3-A-E		
12		PH3 / PH1-PH2-A-E		
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ITEM	Tag	=BA20+UC30-WD0	: Supply UC30 Cooling Skid			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical Form CPX09		LV Power Cable

CABLE DATA

Type 3p+N+PE Cores/Size mm² 70 Color BK+GNYE

From UC50 To UC30

1	Confirm cable is as specified in project cable schedule	OK
2	Visual Check cable physical integrity.	OK
3	Check is installed in accordance with layout drawing (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to project specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Confirm cable glands suit for cable type, correctly mounted and tightened.	OK
7	Check gland plate for single core cables is non ferrous (non -magnetic).	OK
8	Confirm cable labelling is in accordance with specifications.	OK
9	Check cable is correctly loomed and segregated in accordance with specification.	OK
10	Check cable earthing against lastest drawings.	OK
11	Check cores marking are in accordance with termination diagram	OK
12	Check terminations are in accordance with latest termination diagram	OK
13	If required produce Red Line Mark Up for "AS BUILT"	

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=BA20+UC30-WD0	:			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX09	LV Power Cable

CONTINUITY				
5	CORE CONTINUITY Ώ	PH 1	0.5Ohm	
6		PH 2	0.4Ohm	
7		PH 3	0.3Ohm	
8	ARMOUR CONTINUITY Ώ		NA	
9	PROTECTIVE CONDUCTOR CONTINUITY Ώ		NA	
INSULATION				
10	CORES / ARMOUR+EARTH MΏ	PH1 / PH2-PH3-A-E	9.4MOhm	
11		PH2 / PH1-PH3-A-E	9.5MOhm	
12		PH3 / PH1-PH2-A-E	9.6MOhm	
13	CABLE IS CORRECTLY RE-CONNECTED.		Yes	

TESTING INSTRUMENTS USED			
TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	Multimeter 1405677
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	1313891 04/26/2025

Comments: Core continuity N = 0.3Ohm
Core continuity PE = 0.3Ohm

Page 2/2	Performed by	● WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard	Ballard	
Name	Rasmus Knudsen	Martin Jørgensen	
Date	28/11-2024	28/11-2024	
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=LA01+CU30-WG01	: Coolant skid E-Stop			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline Electrical	Form CPX10		Multicore Electrical Control Cable

CABLE DATA

Type: Signal cable | Cores/Size mm²: 4x1.0 | Color: GY

From: UC20 | To: UC30

1	Check cable physical integrity	OK
2	Check cable data against latest cable schedule.	OK
3	Check cable routing against latest drawings (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to latest project Specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Check cable and core marking against latest drawings	OK
7	Check cable labelling is in accordance with latest specification.	OK
8	Check cable glands suit for cable type and are in accordance with latest specification.	OK
9	Check terminations are in accordance with latest termination diagram.	OK
10	Check cable earthing against lastest drawings.	OK
11	Check gland plate for single core cables is non magnetic.	OK
12	If required produce Red Line Mark Up for "AS BUILT"	

CONTINUITY	CORE 1 / All cores+screen+armour+earth	2.5Ohm
	CORE 2 / All cores+screen+armour+earth	3.2Ohm
	CORE 3 / All cores+screen+armour+earth	2.4Ohm
	CORE 4 / All cores+screen+armour+earth	2.4Ohm
	CORE 5 / All cores+screen+armour+earth	NA
	CORE 6 / All cores+screen+armour+earth	NA
	CORE 7 / All cores+screen+armour+earth	NA
	CORE 8 / All cores+screen+armour+earth	NA
	CORE 9 / All cores+screen+armour+earth	NA
	CORE 10 / All cores+screen+armour+earth	NA
INSULATION	CORE 1	OL
	CORE 2	OL
	CORE 3	OL
	CORE 4	OL
	CORE 5	NA
	CORE 6	NA
	CORE 7	NA
	CORE 8	NA
	CORE 9	NA
	CORE 10	NA
	SCREEN	NA
	EARTH	NA
	ARMr	NA
	TEST VOLTS	250V

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	
TYPE / SERIAL N° :	Multimeter 1405677	TYPE / SERIAL N° :	
Calibration certificate N° and date:	1313891 04/26/2025	Calibration certificate N° and date:	

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard		
Name	Rasmus Knudsen		
Date	29/11-2024		
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	+LA01+UC30-WG02	: Coolant skid Safety Relay			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline Electrical	Form CPX10		Multicore Electrical Control Cable

CABLE DATA

Type: Signal cable | Cores/Size mm²: 18x0.75 | Color: GY

From: UC20 | To: UC30

1	Check cable physical integrity	OK
2	Check cable data against latest cable schedule.	OK
3	Check cable routing against latest drawings (segregation, distance…).	OK
4	Check cable is supported and fixed to rack according to latest project Specification.	OK
5	Check bending radius is within the specified limits.	OK
6	Check cable and core marking against latest drawings	OK
7	Check cable labelling is in accordance with latest specification.	OK
8	Check cable glands suit for cable type and are in accordance with latest specification.	OK
9	Check terminations are in accordance with latest termination diagram.	OK
10	Check cable earthing against lastest drawings.	OK
11	Check gland plate for single core cables is non magnetic.	OK
12	If required produce Red Line Mark Up for "AS BUILT"	

CONTINUITY	CORE 1 / All cores+screen+armour+earth	2.9Ohm
	CORE 2 / All cores+screen+armour+earth	2.5Ohm
	CORE 3 / All cores+screen+armour+earth	2.4Ohm
	CORE 4 / All cores+screen+armour+earth	2.2Ohm
	CORE 5 / All cores+screen+armour+earth	NA
	CORE 6 / All cores+screen+armour+earth	NA
	CORE 7 / All cores+screen+armour+earth	NA
	CORE 8 / All cores+screen+armour+earth	NA
	CORE 9 / All cores+screen+armour+earth	NA
	CORE 10 / All cores+screen+armour+earth	NA
INSULATION	CORE 1	OL
	CORE 2	OL
	CORE 3	OL
	CORE 4	OL
	CORE 5	NA
	CORE 6	NA
	CORE 7	NA
	CORE 8	NA
	CORE 9	NA
	CORE 10	NA
	SCREEN	NA
	EARTH	NA
	ARMr	NA
	TEST VOLTS	250V

TESTING INSTRUMENTS USED

TYPE / SERIAL N° :	Insulation Tester W8330207	TYPE / SERIAL N° :	
Calibration certificate N° and date:	7722/24 10/07/2025	Calibration certificate N° and date:	
TYPE / SERIAL N° :	Multimeter 1405677	TYPE / SERIAL N° :	
Calibration certificate N° and date:	1313891 04/26/2025	Calibration certificate N° and date:	

Comments:

	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard		
Name	Rasmus Knudsen		
Date	29/11-2024		
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=HA01+DA02-EA01-WD01	: Power H2 Heater element 1			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX20	Heater

1	Check equipment is de-energized and safe.	OK
2	Check nameplate data is correct.	OK
3	Check equipment tagging against drawings.	OK
4	Check earthing and bonding against drawings.	OK
5	Check item are properly fixed on support.	OK
6	Check all bolts are fitted and all unused entries are suitably plugged.	OK
7	Check Supplier's documentation and drawings.	OK
8	If required produce Red Line Mark Up for "AS BUILT"	

NAME PLATE DATA

Manufacturer :	Sinus Jevi		Serial N° :	340386-1	Type:	D8640	
Voltage :	3*400VAC	V	FLC :		Rating :	9	kW
Frequency :		Hz	IP Rating	IP66	Data Sheet :		
Supplied from :			Type of protection :		Specification:		

Testing & measurement instruments used

Type	Serial n°	Calibration certificate	Validity
Insulation Tester	W8330207	7722/24	10/07/2025
Multimeter	1405677	1313891	04/26/2025

TEST RESULTS

INSULATION RESISTANCE — TEST VOLTAGE 1000 V

R/ S-T-EARTH	OL	Mohm
S/ R-T-EARTH	OL	Mohm
T/S-R-EARTH	OL	Mohm

RESISTANCE MEASUREMENT

R1 - R2	1.5	Ohm
S1 - S2	1.3	Ohm
T1 - T2	1.5	Ohm

Comments: PE core continuity = 1.3 Ohm

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard		
Name	Rasmus Knudsen		
Date	02/12-2024		
Signature			

ROSETTI MARINO | PROVERLIS | CROSSWIND

ITEM	Tag	=HA01+DA02-EA02-WD01	: Power H2 Heater element 2			Dwg	
	S/Sys		:			Module	
TASK	code			Location		User	
FORM	Process	MC	Activity CCK	Discipline	Electrical	Form CPX20	Heater

1	Check equipment is de-energized and safe.	OK
2	Check nameplate data is correct.	OK
3	Check equipment tagging against drawings.	OK
4	Check earthing and bonding against drawings.	OK
5	Check item are properly fixed on support.	OK
6	Check all bolts are fitted and all unused entries are suitably plugged.	OK
7	Check Supplier's documentation and drawings.	OK
8	If required produce Red Line Mark Up for "AS BUILT"	

NAME PLATE DATA

Manufacturer :	Sinus Jevi		Serial N° :	340386-2	Type:	D8640	
Voltage :	3*400VAC	V	FLC :		Rating :	9	kW
Frequency :		Hz	IP Rating	IP66	Data Sheet :		
Supplied from :			Type of protection :		Specification:		

Testing & measurement instruments used

Type	Serial n°	Calibration certificate	Validity
Insulation Tester	W8330207	7722/24	10/07/2025
Multimeter	1405677	1313891	04/26/2025

TEST RESULTS

INSULATION RESISTANCE — TEST VOLTAGE 1000 V

R/ S-T-EARTH	OL	Mohm
S/ R-T-EARTH	OL	Mohm
T/S-R-EARTH	OL	Mohm

RESISTANCE MEASUREMENT

R1 - R2	1.5	Ohm
S1 - S2	1.2	Ohm
T1 - T2	1.3	Ohm

Comments: PE core continuity = 1.5 Ohm

Page 1/1	Performed by	☐ WITNESS ☐ REVIEW	☐ WITNESS ☐ REVIEW
Company	Ballard		
Name	Rasmus Knudsen		
Date	02/12-2024		
Signature			

Crosswind BLPH FC Package - Main PLC

HOLDING REGISTERS

Allowable Function Codes: FC03;06;16
Read and Write access, if otherwise not specified

Implemented?	Group	Internal - Base	Internal - Offset	Address [Decimal]	Bit	TAG	Pretty Name	Read	Write	Datatype	Scaling	Unit	Comment
	External Control	1000	0	1000		POWER_SP	Export Power Setpoint	VERO	VERO	INT16		0.1 kW	Range 0 to 1200 kW
	External Control	1000	1	1001			Control word						
					0		Wakeup ✓			BOOL			Rising edge triggers wakeup
					1		Sleep ✓			BOOL			Rising edge triggers go to sleep
					2		Start ✓			BOOL			Rising edge triggers start sequence
					3		Stop ✓			BOOL			Rising edge triggers stop sequence
					4		<Spare>			BOOL			Not used
					5		Reset ✓			BOOL			Rising edge triggers fault clear
	External Control	1000	2	1002									
	External Control	1000	3	1003									
	External Control	1000	4	1004									
	External Control	1000	5	1005									
	External Control	1000	6	1006									
	External Control	1000	7	1007									
	External Control	1000	8	1008									
	External Control	1000	9	1009									

Ballard: Peter Bleach - 19/03/2025
BAX ENERGY: SYED ALI - 19/03/2025
CW DAVE MUSKIZOVIC 19/03/2025
RM FABIO SIRIGU

CW DAVE MUSGROVE 20/03/2025
Ballard Peter Black -11-
BAX/YOKO SYED ALI -11-
RM FABIO SRIGH

Crosswind BLPH FC Package - Main PLC

INPUT REGISTERS

Allowable Function Codes: FC04
Read only access

Yellow Fields indicate changes in most recent verstion (Column "B"), notes in Column "P"

Implemented?	Group	Internal - Base	Internal - Offset	Address [Decimal]	Bit	TAG	Pretty Name	Read	Write	Datatype	Scaling	Unit	Comment	Max value
VERO	External Control	1000	0	1000		StateMain	Main FC Package Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	1	1001		FC1_State	Fuel Cell Module #1 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	2	1002		FC2_State	Fuel Cell Module #2 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	3	1003		FC3_State	Fuel Cell Module #3 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	4	1004		FC4_State	Fuel Cell Module #4 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	5	1005		FC5_State	Fuel Cell Module #5 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	6	1006		FC6_State	Fuel Cell Module #6 Statemachine Index	VERO	FALSO	INT16	1	n/a	Enumeration index attached	
VERO	External Control	1000	7	1007			<Spare>							
VERO	External Control	1000	8	1008			<Spare>							
VERO	External Control	1000	9	1009			<Spare>							
VERO	External Control	1000	10	1010			<Spare>							
VERO	External Control	1000	11	1011			<Spare>							
VERO	External Control	1000	12	1012			<Spare>							
VERO	External Control	1000	13	1013		P_MAX	Total Capacity of FC Package	VERO	FALSO	INT16	0,1	kW	Range 0 to 1000 kW	
VERO	External Control	1000	14	1014		P_FC	Fuel Cell Power Produced	VERO	FALSO	INT16	0,1	kW	Range 0 to 1200 kW	Change: now contains DC power output from FC
VERO	External Control	1000	15	1015			Spare							
VERO	External Control	1000	16	1016		FCM_RUNNING	Number of Fuel Cell Modules Producing Power	VERO	FALSO	INT16	1	n/a	Range 0 to 6	
VERO	External Control	1000	17	1017			<Spare>							
VERO	External Control	1000	18	1018			<Spare>							
VERO	External Control	1000	19	1019			<Spare>							
VERO	External Control	1000	20	1020			FCWave 1 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	21	1021			FCWave 1 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	22	1022			FCWave 1 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	23	1023			FCWave 2 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	24	1024			FCWave 2 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	25	1025			FCWave 2 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	26	1026			FCWave 3 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	27	1027			FCWave 3 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	28	1028			FCWave 3 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	29	1029			FCWave 4 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	30	1030			FCWave 4 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	31	1031			FCWave 4 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	32	1032			FCWave 5 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	33	1033			FCWave 5 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	34	1034			FCWave 5 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	35	1035			FCWave 6 Power Internal	VERO		INT16	0,1	kW		
VERO	External Control	1000	36	1036			FCWave 6 DCDC A Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	37	1037			FCWave 6 DCDC B Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	38	1038			Power Setpoint Readback	VERO		INT16	0,1	kW	Manual or from Customer Modbus	Change: description updated
VERO	External Control	1000	39	1039			Export AC Power	VERO		INT16	0,1	kW	measurement before breaker	
VERO	External Control	1000	40	1040			Nanogrid AC Power	VERO		INT16	0,1	kW		
VERO	External Control	1000	41	1041			Aux AC power	VERO		INT16	0,1	kW		
VERO	External Control	1000	42	1042			<Spare>							
VERO	External Control	1000	43	1043			<Spare>							
VERO	External Control	1000	44	1044			<Spare>							
VERO	External Control	1000	45	1045			<Spare>							
VERO	External Control	1000	46	1046			<Spare>							
VERO	External Control	1000	47	1047			<Spare>							
VERO	External Control	1000	48	1048			<Spare>							
VERO	External Control	1000	49	1049			<Spare>							
VERO	External Control	1000	50	1050			Error Code 1	VERO		INT16	1	n/a	Active Error Code #1	
VERO	External Control	1000	51	1051			Error Code 2	VERO		INT16	1	n/a	Active Error Code #2	
VERO	External Control	1000	52	1052			Error Code 3	VERO		INT16	1	n/a	Active Error Code #3	
VERO	External Control	1000	53	1053			Error Code 4	VERO		INT16	1	n/a	Active Error Code #4	
VERO	External Control	1000	54	1054			Error Code 5	VERO		INT16	1	n/a	Active Error Code #5	
VERO	External Control	1000	55	1055			Error Code 6	VERO		INT16	1	n/a	Active Error Code #6	
VERO	External Control	1000	56	1056			Error Code 7	VERO		INT16	1	n/a	Active Error Code #7	
VERO	External Control	1000	57	1057			Error Code 8	VERO		INT16	1	n/a	Active Error Code #8	
VERO	External Control	1000	58	1058			Error Code 9	VERO		INT16	1	n/a	Active Error Code #9	
VERO	External Control	1000	59	1059			Error Code 10	VERO		INT16	1	n/a	Active Error Code #10	
VERO	External Control	1000	60	1060			Error Code 11	VERO		INT16	1	n/a	Active Error Code #11	
VERO	External Control	1000	61	1061			Error Code 12	VERO		INT16	1	n/a	Active Error Code #12	
VERO	External Control	1000	62	1062			Error Code 13	VERO		INT16	1	n/a	Active Error Code #13	
VERO	External Control	1000	63	1063			Error Code 14	VERO		INT16	1	n/a	Active Error Code #14	
VERO	External Control	1000	64	1064			Error Code 15	VERO		INT16	1	n/a	Active Error Code #15	
VERO	External Control	1000	65	1065			Error Code 16	VERO		INT16	1	n/a	Active Error Code #16	
VERO	External Control	1000	66	1066			Error Code 17	VERO		INT16	1	n/a	Active Error Code #17	
VERO	External Control	1000	67	1067			Error Code 18	VERO		INT16	1	n/a	Active Error Code #18	
VERO	External Control	1000	68	1068			Error Code 19	VERO		INT16	1	n/a	Active Error Code #19	
VERO	External Control	1000	69	1069			Error Code 20	VERO		INT16	1	n/a	Active Error Code #20	
VERO	External Control	1000	70	1070			Error Code 21	VERO		INT16	1	n/a	Active Error Code #21	
VERO	External Control	1000	71	1071			Error Code 22	VERO		INT16	1	n/a	Active Error Code #22	
VERO	External Control	1000	72	1072			Error Code 23	VERO		INT16	1	n/a	Active Error Code #23	
VERO	External Control	1000	73	1073			Error Code 24	VERO		INT16	1	n/a	Active Error Code #24	
VERO	External Control	1000	74	1074			Error Code 25	VERO		INT16	1	n/a	Active Error Code #25	
VERO	External Control	1000	75	1075			Error Code 26	VERO		INT16	1	n/a	Active Error Code #26	
VERO	External Control	1000	76	1076			Error Code 27	VERO		INT16	1	n/a	Active Error Code #27	
VERO	External Control	1000	77	1077			Error Code 28	VERO		INT16	1	n/a	Active Error Code #28	
VERO	External Control	1000	78	1078			Error Code 29	VERO		INT16	1	n/a	Active Error Code #29	
VERO	External Control	1000	79	1079			Error Code 30	VERO		INT16	1	n/a	Active Error Code #30	
VERO	External Control	1000	80	1080			Error Code 31	VERO		INT16	1	n/a	Active Error Code #31	
VERO	External Control	1000	81	1081			Error Code 32	VERO		INT16	1	n/a	Active Error Code #32	
VERO	External Control	1000	82	1082			Error Code 33	VERO		INT16	1	n/a	Active Error Code #33	
VERO	External Control	1000	83	1083			Error Code 34	VERO		INT16	1	n/a	Active Error Code #34	
VERO	External Control	1000	84	1084			Error Code 35	VERO		INT16	1	n/a	Active Error Code #35	
VERO	External Control	1000	85	1085			Error Code 36	VERO		INT16	1	n/a	Active Error Code #36	
VERO	External Control	1000	86	1086			Error Code 37	VERO		INT16	1	n/a	Active Error Code #37	
VERO	External Control	1000	87	1087			Error Code 38	VERO		INT16	1	n/a	Active Error Code #38	
VERO	External Control	1000	88	1088			Error Code 39	VERO		INT16	1	n/a	Active Error Code #39	
VERO	External Control	1000	89	1089			Error Code 40	VERO		INT16	1	n/a	Active Error Code #40	
VERO	External Control	1000	90	1090			Error Code 41	VERO		INT16	1	n/a	Active Error Code #41	

30 ERROR CODES TO ADD YOKOHAMA

ERROR CODE 1-50 CHANGE FROM SIGNED TO UN-SIGNED INT

CW DAVE MUSGROVE 20/03/2025
Ballard Peter Black -11-
DAX/YOKO SYED ALI -11-
RM FABIO SURIGA

VERO	External Control		1000	91	1091		Error Code 42		VERO	INT16	1	n/a	Active Error Code #42	
VERO	External Control		1000	92	1092		Error Code 43		VERO	INT16	1	n/a	Active Error Code #43	
VERO	External Control		1000	93	1093		Error Code 44		VERO	INT16	1	n/a	Active Error Code #44	
VERO	External Control		1000	94	1094		Error Code 45		VERO	INT16	1	n/a	Active Error Code #45	
VERO	External Control		1000	95	1095		Error Code 46		VERO	INT16	1	n/a	Active Error Code #46	
VERO	External Control		1000	96	1096		Error Code 47		VERO	INT16	1	n/a	Active Error Code #47	
VERO	External Control		1000	97	1097		Error Code 48		VERO	INT16	1	n/a	Active Error Code #48	
VERO	External Control		1000	98	1098		Error Code 49		VERO	INT16	1	n/a	Active Error Code #49	
VERO	External Control		1000	99	1099		Error Code 50		VERO	INT16	1	n/a	Active Error Code #50	
VERO	External Information		1100	0	1100	=HE01+DA02-BT01	HT1 - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		HT1 - Coolant Return Temperature [°C]
VERO	External Information		1100	1	1101	=HE01+DA02-BT02	HT1 - Pump Inlet Temperature		VERO	FALSO INT16	0.1	°C		HT1 - Pump Inlet Temperature [°C]
VERO	External Information		1100	2	1102	=HE01+DA02-BF01	HT1 - Flowrate		VERO	FALSO INT16	0.1	m3^h		HT1 - Flowrate [m3^h]
VERO	External Information		1100	3	1103	=HE01+DA02-GP19_RPM	HT1 - Pump RPM		VERO	FALSO INT16	1	rpm		HT1 - Pump RPM [rpm]
VERO	External Information		1100	4	1104	=HE02+DA02-BT01	HT2 - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		HT2 - Coolant Return Temperature [°C]
VERO	External Information		1100	5	1105	=HE02+DA02-BT02	HT2 - Pump Inlet Temperature		VERO	FALSO INT16	0.1	°C		HT2 - Pump Inlet Temperature [°C]
VERO	External Information		1100	6	1106	=HE02+DA02-BF01	HT2 - Flowrate		VERO	FALSO INT16	0.1	m^3/h		HT2 - Flowrate [m^3/h]
VERO	External Information		1100	7	1107	=HE02+DA02-GP29_RPM	HT2 - Pump RPM		VERO	FALSO INT16	1	rpm		HT2 - Pump RPM [rpm]
VERO	External Information		1100	8	1108	=HE03+DA01-BT01	LT - Coolant Return Temperature		VERO	FALSO INT16	0.1	°C		LT - Coolant Return Temperature [°C]
VERO	External Information		1100	9	1109	=HE03+DA01-BT02	LT - Coolant Forward Temperature		VERO	FALSO INT16	0.1	°C		LT - Coolant Forward Temperature [°C]
VERO	External Information		1100	10	1110	=HE03+DA01-BF03	LT - Flowrate		VERO	FALSO INT16	0.1	m^3/h		LT - Flowrate [m^3/h]
VERO	External Information		1100	11	1111	=HE03+DA01-GP11_RPM	LT - Pump RPM		VERO	FALSO INT16	1	rpm		LT - Pump RPM [rpm]
VERO	External Information		1100	12	1112	=JA01+DA01-BT01	40ft - Ventilation Intake Temperature		VERO	FALSO INT16	0.1	°C		40ft - Ventilation Intake Temperature [°C]
VERO	External Information		1100	13	1113	=JA01+DA01-BT02	40ft - Container Temperature 2		VERO	FALSO INT16	0.1	°C		40ft - Container Temperature 2 [°C]
VERO	External Information		1100	14	1114	=JA01+DA01-BT03	40ft - Container Temperature 3		VERO	FALSO INT16	0.1	°C		40ft - Container Temperature 3 [°C]
VERO	External Information		1100	15	1115	=JA01+DA01-GQ06_RPM	40ft - Ventilation Fan 1 Speed		VERO	FALSO INT16	1	rpm		40ft - Ventilation Fan 1 Speed [rpm]
VERO	External Information		1100	16	1116	=JA01+DA01-GQ07_RPM	40ft - Ventilation Fan 2 Speed		VERO	FALSO INT16	1	rpm		40ft - Ventilation Fan 2 Speed [rpm]
VERO	External Information		1100	17	1117	=JA01+DA03-BT01	10ft - Container Temperature		VERO	FALSO INT16	0.1	°C		10ft - Container Temperature [°C]
VERO	External Information	PL	1100	18	1118	=JA01+DA03-GQ10_RPM	10ft - Ventilation Fan Speed		VERO	FALSO INT16	1	rpm		10ft - Ventilation Fan Speed [rpm]
VERO	External Information		1100	19	1119		Available Unused Power (AUP)		VERO	FALSO INT16	0,1	kW		Available Unused Power (AUP) [kW]
VERO	External Information		1100	20	1120		Calculated Maximum Power (CMP)		VERO	FALSO INT16	0,1	kW		Calculated Maximum Power (CMP) [kW]
VERO	External Information		1100	21	1121		Operating state		VERO	FALSO INT16	1	n/a	Range 0 to 6	Operating state [n/a]
VERO	External Information		1200	0	1200		<Spare>							
VERO	External Information		1200	1	1201		<Spare>							
VERO	External Information	PL	1200	2	1202		System efficiency			INT16	0,1	%	(DEIF Power + Pack Power) / (SUM'ed H2 flow converted to power) - realtime	
VERO	External Information	PL	1200	3	1203		FC1 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	4	1204		FC2 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	5	1205		FC3 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	6	1206		FC4 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	7	1207		FC5 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information	PL	1200	8	1208		FC6 + DC/DC efficiency			INT16	0,1	%	Only FCwave Efficiency	
VERO	External Information		1200	9	1209		FC1 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	11	1211		FC2 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	13	1213		FC3 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	15	1215		FC4 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	17	1217		FC5 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information		1200	19	1219		FC6 stack lifetime produced energy			UINT32	0,1	kWh - DC	stack A (voltage*current) + stack B (voltage*current)	214GWh = 1.07mio hours at full load = 30 topswaps@30.000h
VERO	External Information	PL	1200	21	1221		System lifetime produced energy			UINT32	1	kWh - AC	value from ABB breaker	2147GWh = 1.34mio hours @ 1.6MW
VERO	External Information		1200	23	1223		FC1 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	24	1224		FC2 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	25	1225		FC3 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	26	1226		FC4 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	27	1227		FC5 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information		1200	28	1228		FC6 H2 flow rate			INT16	0,01	kg/h		Estimate from Module Current - +/-15% at steady state
VERO	External Information	PL	1200	29	1229		H2 Consumption Status Word			WORD				
VERO	External Information	PL	1200			0	FC1 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			1	FC2 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			2	FC3 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			3	FC4 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			4	FC5 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information	PL	1200			5	FC6 H2 consumption active			BOOL			0 = not active - 1 = active	
VERO	External Information		1200			6 to 15	<Spare>			BOOL				
VERO	External Information		1200	30	1230		Ambient Temperature			INT16	0.1	°C		
VERO	External Information		1200	31	1231		Container intake air Temperature			INT16	0.1	°C		
VERO	External Information		1200	32	1232		LT Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	33	1233		LT Cooling Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	34	1234		HT1 Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	35	1235		HT1 Coolant Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	36	1236		HT2 Coolant Return Temperature			INT16	0.1	°C		
VERO	External Information		1200	37	1237		HT2 Coolant Forward Temperature			INT16	0.1	°C		
VERO	External Information		1200	38	1238		FC1 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	39	1239		FC1 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	40	1240		FC1 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	41	1241		FC2 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	42	1242		FC2 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	43	1243		FC2 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	44	1244		FC3 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	45	1245		FC3 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	46	1246		FC3 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	47	1247		FC4 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	48	1248		FC4 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	49	1249		FC4 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	50	1250		FC5 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	51	1251		FC5 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	52	1252		FC5 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	53	1253		FC6 Stack Power			INT16	0,1	kW - DC		
VERO	External Information		1200	54	1254		FC6 DCDC A Power			INT16	0,1	kW - DC		
VERO	External Information		1200	55	1255		FC6 DCDC B Power			INT16	0,1	kW - DC		
VERO	External Information		1200	56	1256		FC1 Stack Current String A			INT16	0.1	A - DC		
VERO	External Information		1200	57	1257		FC1 Stack Current String B			INT16	0.1	A - DC		
VERO	External Information		1200	58	1258		FC1 Stack Voltage String A			INT16	0.1	V - DC		
VERO	External Information		1200	59	1259		FC1 Stack Voltage String B			INT16	0.1	V - DC		
VERO	External Information		1200	60	1260		FC2 Stack Current String A			INT16	0.1	A - DC		
VERO	External Information		1200	61	1261		FC2 Stack Current String B			INT16	0.1	A - DC		
VERO	External Information		1200	62	1262		FC2 Stack Voltage String A			INT16	0.1	V - DC		
VERO	External Information		1200	63	1263		FC2 Stack Voltage String B			INT16	0.1	V - DC		
VERO	External Information		1200	64	1264		FC3 Stack Current String A			INT16	0.1	A - DC		

CW DAVE MUSGROVE 20/03/2025
Ballard Polar Bloch
BAX/DIKO SYED ALI
RM FABIO SURIGN

VERO	External Information		1200	65	1265	FC3 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	66	1266	FC3 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	67	1267	FC3 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	68	1268	FC4 Stack Current String A	INT16	0.1	A - DC		
VERO	External Information		1200	69	1269	FC4 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	70	1270	FC4 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	71	1271	FC4 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	72	1272	FC5 Stack Current String A	INT16	0.1	A - DC		
VERO	External Information		1200	73	1273	FC5 Stack Current String B	INT16	0.1	A - DC		
VERO	External Information		1200	74	1274	FC5 Stack Voltage String A	INT16	0.1	V - DC		
VERO	External Information		1200	75	1275	FC5 Stack Voltage String B	INT16	0.1	V - DC		
VERO	External Information		1200	76	1276	FC6 Stack Current String A	INT16	0.1	A - DC	NOT tested	
VERO	External Information		1200	77	1277	FC6 Stack Current String B	INT16	0.1	A - DC	NOT tested	
VERO	External Information		1200	78	1278	FC6 Stack Voltage String A	INT16	0.1	V - DC	NOT tested	
VERO	External Information		1200	79	1279	FC6 Stack Voltage String B	INT16	0.1	V - DC	NOT tested	
NOT TRUE	External Information	PL	1200	80	1280	FC1 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	82	1282	FC2 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	84	1284	FC3 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	86	1286	FC4 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	88	1288	FC5 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	90	1290	FC6 Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information		1200	92	1292	System ON Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
NOT TRUE	External Information	PL	1200	94	1294	PLC ON Hour Meter	UINT32	0,01	hrs		21mio hours = 2451 years
VERO	External Information		1200	96	1296	FC1 start counter	INT16	1	no.		
VERO	External Information		1200	97	1297	FC2 start counter	INT16	1	no.		
VERO	External Information		1200	98	1298	FC3 start counter	INT16	1	no.		
VERO	External Information		1200	99	1299	FC4 start counter	INT16	1	no.		
VERO	External Information		1200	100	1300	FC5 start counter	INT16	1	no.		
VERO	External Information		1200	101	1301	FC6 start counter	INT16	1	no.		
VERO	External Information		1200	102	1302	System start counter	INT16	1	no.		
VERO	External Information		1200	103	1303	FC1 shutdown counter	INT16	1	no.		
VERO	External Information		1200	104	1304	FC2 shutdown counter	INT16	1	no.		
VERO	External Information		1200	105	1305	FC3 shutdown counter	INT16	1	no.		
VERO	External Information		1200	106	1306	FC4 shutdown counter	INT16	1	no.		
VERO	External Information		1200	107	1307	FC5 shutdown counter	INT16	1	no.		
VERO	External Information		1200	108	1308	FC6 shutdown counter	INT16	1	no.		
VERO	External Information	PL	1200	109	1309	System shutdown counter	INT16	1	no.		
VERO	External Information		1200	110	1310	Main Output Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	111	1311	Main Output Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	112	1312	Main Output Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	113	1313	Main Output Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	114	1314	Main Output Voltage L2N	INT16	0.1	V - AC		
VERO	External Information		1200	115	1315	Main Output Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	116	1316	Main Output Current L1	INT16	1	A - AC		
VERO	External Information		1200	117	1317	Main Output Current L2	INT16	1	A - AC		
VERO	External Information		1200	118	1318	Main Output Current L3	INT16	1	A - AC		
VERO	External Information		1200	119	1319	Main Output Power	INT16	0.1	kW - AC		
VERO	External Information		1200	120	1320	Main Output Reactive Power	INT16	0.1	kvar		
VERO	External Information		1200	121	1321	Main Output Apparent Power	INT16	0.1	kVA		
VERO	External Information		1200	122	1322	Main Output Power Factor	INT16	0.001	-		
VERO	External Information		1200	123	1323	Main Busbar Frequency	UINT16	0,001	Hz		
VERO	External Information		1200	124	1324	Main Busbar Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	125	1325	Main Busbar Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	126	1326	Main Busbar Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	127	1327	Main Busbar Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	128	1328	Main Busbar Voltage L2N	INT16	0.1	V - AC		
VERO	External Information	PL	1200	129	1329	Main Busbar Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	130	1330	AUX Voltage L1L2	INT16	0.1	V - AC		
VERO	External Information		1200	131	1331	AUX Voltage L2L3	INT16	0.1	V - AC		
VERO	External Information		1200	132	1332	AUX Voltage L3L1	INT16	0.1	V - AC		
VERO	External Information		1200	133	1333	AUX Voltage L1N	INT16	0.1	V - AC		
VERO	External Information		1200	134	1334	AUX Voltage L2N	INT16	0.1	V - AC		
VERO	External Information		1200	135	1335	AUX Voltage L3N	INT16	0.1	V - AC		
VERO	External Information		1200	136	1336	AUX Current L1	INT16	0.1	A - AC		
VERO	External Information		1200	137	1337	AUX Current L2	INT16	0.1	A - AC		
VERO	External Information		1200	138	1338	AUX Current L3	INT16	0.1	A - AC		
VERO	External Information		1200	139	1339	AUX Power	INT16	0.1	kW - AC		
VERO	External Information		1200	140	1340	AUX Reactive Power	INT16	0.1	kvar		
VERO	External Information		1200	141	1341	AUX Apparent Power	INT16	0.1	kVA		
VERO	External Information		1200	142	1342	AUX Power Factor	INT16	0.001	n/a		
VERO	External Information		1200	143	1343	AUX Frequency	UINT16	0,001	Hz		
VERO	External Information		1200	144	1344	Nanogrid Power	INT16	0.1	kW - DC	Nanogrid Breaker Total Power	

Ballard Power Systems Europe A/S
Majsmarken 1
DK-9500 Hobro

Confirmation of Satisfactory H2 leakage test

Part No.	601456B-7002362 Incl. sub-assemblies: 601456B-7002973 601456B-7003716
Product name	FC PowerGen 1000kW
Serial No.	601456B

Ballard Power Systems Europe A/S confirms that the above-listed equipment has satisfactorily with comments undergone and passed the H2 leakage test according to

BLPH Project – SPC ID 0104 H2 Leak Test Procedure rev 02

max. 11,240 BARG <1 mbar dec

CrossWind C.V. acknowledges that the H2 leakage test for the above-listed equipment was witnessed and confirms that the test was performed satisfactorily with comments, and all agreed-upon specifications have been met.

Signatures

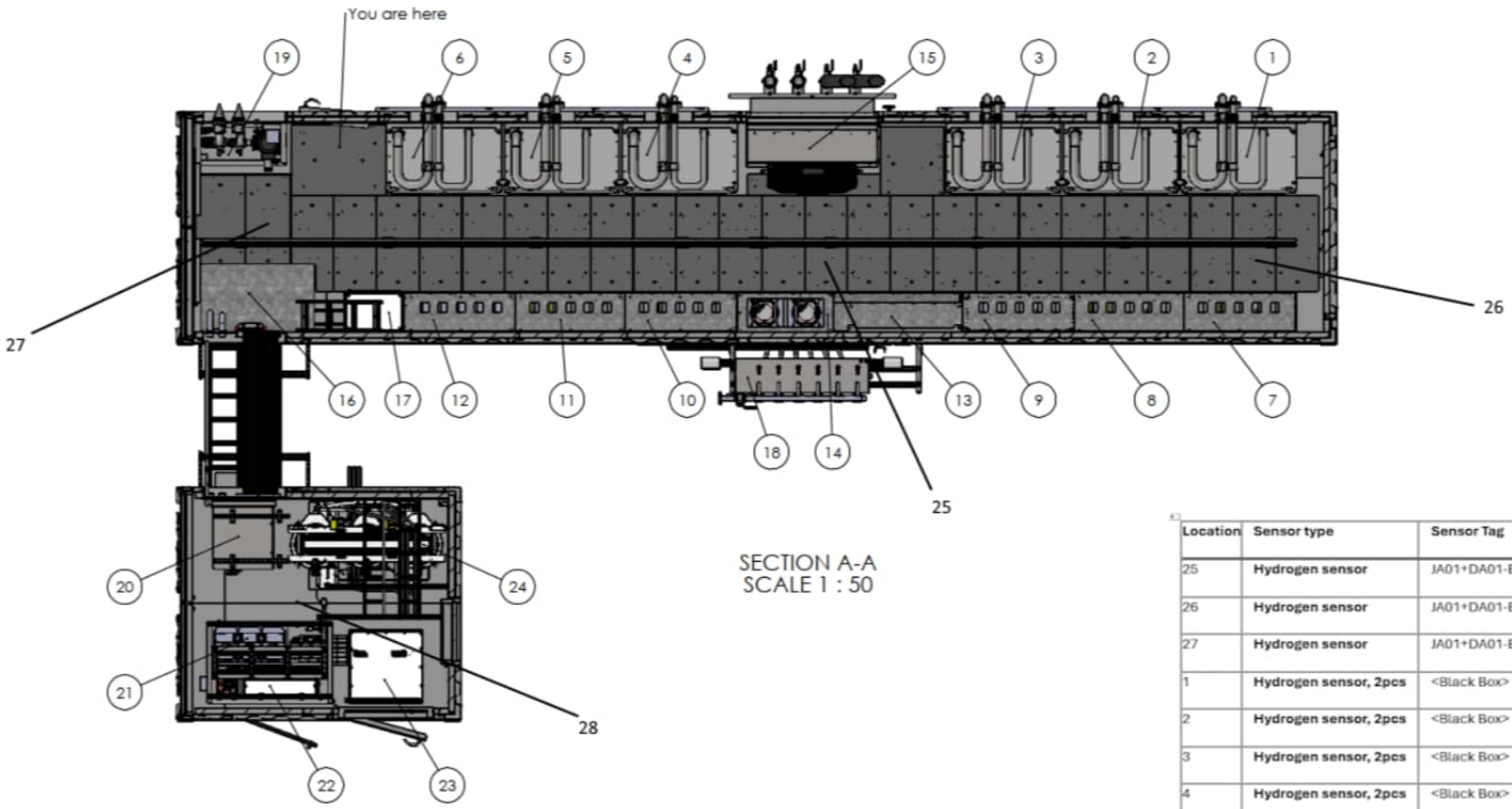
Ballard Power Systems Europe A/S			
Signature:	Preben H Jensen		
Name:	PREBEN JENSEN		
Title:	SENIOR APPLICATION ENGINEER	Date:	19/2/25
CrossWind C.V.			
Signature:			
Name:			
Title:	Crosswind Commissioning Manager	Date:	
Inspector			
Signature:	DM		
Name:	DAVE MUSGROVE		
Title:	Inspector for Crosswind	Date:	19/02/2025

Note: This document serves as formal confirmation that the H2 leakage test has been successfully completed and witnessed, with both parties in agreement on the satisfactory results. It should be signed by authorized representatives of both parties.

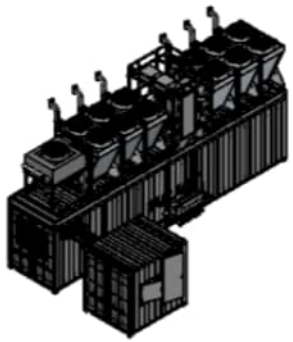
Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

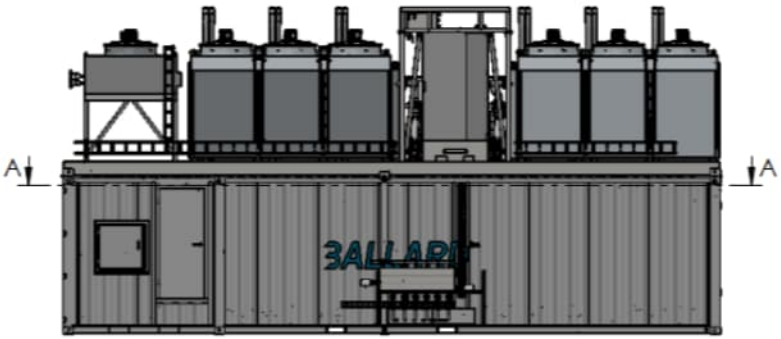
Revision history		
Rev.	**Date.**	**Description**
001	01/05/2025	First Issue

Document Title:	**BLPH Project - Fire and Gas Detection**
Document Number:	K559-2254-CWIWP4202202-B05-
Revision:	Rev001
Sequence Number:	
File Name:	K559-2254-CWIWP4202202-B05-Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	B05
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands



SECTION A-A
SCALE 1 : 50





Location	Sensor type	Sensor Tag	Type
25	**Hydrogen sensor**	JA01+DA01-BQ01	Dräger Polytron 8200 CAT
26	**Hydrogen sensor**	JA01+DA01-BQ02	Dräger Polytron 8200 CAT
27	**Hydrogen sensor**	JA01+DA01-BQ03	Dräger Polytron 8200 CAT
1	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
2	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
3	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
4	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
5	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
6	**Hydrogen sensor, 2pcs**	<Black Box>	Nisha FIS FH2-HY04
25	**Smoke Detector**	JA01+DA01-BQ04	Apollo Orbis ORB-OP-42001-MAR
26	**Smoke Detector**	JA01+DA01-BQ05	Apollo Orbis ORB-OP-42001-MAR
27	**Smoke Detector**	JA01+DA01-BQ06	Apollo Orbis ORB-OP-42001-MAR
1	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
2	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
3	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
4	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
5	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
6	**Smoke Detector**	<Black Box>	Apollo Orbis ORB-OP-42001-MAR
28	**Smoke Detector**	JA01+DA03-BQ01	Apollo Orbis ORB-OP-42001-MAR

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	03/02/2023	First Issue
002	17/02/2023	Modified according to comments
003	24/03/2023	Further detailed and expanded
004	18/09/2023	Updated and expanded
005	08/03/2024	Updated according to comments
006	09/04/2024	Exp. to include fan contactors
007	15/10/2024	Updated with changed water separator

Document Title:	**BLPH Project - Electrical Single Line Diagrams**
Document Number:	BPSE-ELE-BPH-DWG-00005
Legacy Number:	K559-2254-CWIWP4202202-C06-001
Revision:	Rev007
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-C06-001Rev007
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	C06
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

AC Distribution - 40ft Container

Crosswind Scope

Ballard Scope

=HKN70-XB01
3p+N+PE 400Vac
20kW

=BA20+UC50
AC Power Distribution

-XB01
AUX Supply Terminals

-SG01
63 A
Switch Disconnector

-FA01
Uc:277V
Iimp: 25 kA
Surge Arrester

-FC06
2A, B curve
MCB

AUX Customer Supply
Voltage Meas
3ph 400V
-BA01

-BC02
+UC508C03/601.1
+UC508C03/601.1
+UC508C03/601.1
3ph 75A
AUX Customer Supply
Current Trafo

-FC02
50A, C curve
MCCB

-FC12
63A, C Curve
MCCB

-FC10
2A, C-curve
MCCB

Nanogrid Internal
Voltage Meas
3ph 400V
-BA02

-FC01
250A, 3p+N
MCCB

-QA02
55A
Isolation Contactor, 4 pole

-QA01
55A
Isolation Contactor, 4 pole

-FC05
32A, B-curve
MCCB

3p+N 400-480V 50/60Hz

-FC04
63A, B Curve
MCCB

=BA20+DA01

Transformer, dry-type
-TA03
0,46/0,4-0,48
Dyn11 160kVA

=AA01+WZ10
Container Interconnect, Between Containers

BP1 AC Supply from Transformer 250A / 6.3:B

BP2 AC Supply to Container #2 - 32A / 6.3:C

-FC04
160A, 3p+N
MCCB Cooling Skid
+UC30

=LA01+UC20
Control System, Container #1 Inside

-QB01
63A, 3ph+N
Switch Disconnector

3p+N 400-480V 50/60Hz

-FC01A
6A, B-curve
MCCB

-FC01B
6A, B-curve
MCCB

-FC01C
6A, B-curve
MCCB

-FC02
4A, B-curve
MCCB

-FC06
10A, B-curve
MCCB

-FC07
10A, B-curve
MCCB

-FC03A
6A, B-curve
MCCB

-FC03B
6A, B-curve
MCCB

-FC04
10A, C-curve
RCD/MCB

-FC08
20A, B-curve
MCCB

-FC09
20A, B-curve
MCCB

-FC10
20A, B-curve
MCCB

-FC11
10A, B-curve
MCCB

-TB01A
24-28V/40ADC
FCwave PSU
with UPS

-TB01B
24-28V/40ADC
FCwave PSU
with UPS

-TB01C
24-28V/40ADC
FCwave PSU
with UPS

-TB02
24-28V/10ADC
Control PSU
with UPS

-QB02
50A, 24V coil
Contactor

-QB03
50A, 24V coil
Contactor

-QA08
25A
Solidstate
Contactor

-QA09
25A
Solidstate
contactor

-QA10
25A
Solidstate
contactor

-GB01A
UPS Battery
24V, XY Ah

-GB01B
UPS Battery
24V, XY Ah

-GB01C
UPS Battery
24V, XY Ah

-GB02
UPS Battery
24V, XY Ah

1/N/PE

-XD04
1P+N+PE, 1kW
Service

=HE01+UC30
Coolant Skid Cabinet, Container #1 Outside

3p+N 400-480V 50/60Hz

-FC01
6A, B-curve
MCCB

-FC02
2A, B-curve
MCCB

-FC19
25A, B-curve
MCCB

-FC11
6A, B-curve
MCCB

-FC12
6A, B-curve
MCCB

-FC13
6A, B-curve
MCCB

-FC14
6A, B-curve
MCCB

-FC15
6A, B-curve
MCCB

-FC16
6A, B-curve
MCCB

-FC40
13A, B-curve
MCCB

-TB01
24-28V/10ADC
PSU with UPS

-BT02
5°C
Temperature Switch

-GB01
24V Backup Battery
24V, XY Ah

-EA02
0,4W
Cabinet Heater

-TA19
15kW
3x 380-500 VAC
HT Pump Drive

=HE01+UC41
HT + LT VFD Cabinet

-TA11
4.0kW
VFD

-TA12
4.0kW
VFD

-TA13
4.0kW
VFD

-TA14
4.0kW
VFD

-TA15
4.0kW
VFD

-TA16
4.0kW
VFD

-EC40
VFD Cabinet Chiller

=HE01+DA02
HT Cooling System #1, Container #1 Outside

-GP19
15kW
HT1
Coolant Pump

-GQ11
4kW
Ventilation Fan

-GQ12
4kW
Ventilation Fan

-GQ13
4kW
Ventilation Fan

-GQ14
4kW
Ventilation Fan

-GQ15
4kW
Ventilation Fan

-GQ16
4kW
Ventilation Fan

=HE01+UC80
Coolant Skid Cabinet, Container #1 Outside

3p+N 400-480V 50/60Hz

-FC41
20A, B-curve
MCCB

-FC42
20A, B-curve
MCCB

-FC03
2A, B-curve
MCCB

-FC29
25A, B-curve
MCCB

-FC21
6A, B-curve
MCCB

-FC22
6A, B-curve
MCCB

-FC23
6A, B-curve
MCCB

-FC24
6A, B-curve
MCCB

-FC25
6A, B-curve
MCCB

-FC26
6A, B-curve
MCCB

-FC31
6A, B-curve
MCCB

-QA41
25A
Solidstate
contactor

-QA42
25A
Solidstate
contactor

-EA03
Container
Lighting

-TA29
15kW
3x 380-500 VAC
HT Pump Drive

=HE01+UC41
HT + LT VFD Cabinet

-TA21
4.0kW
VFD

-TA22
4.0kW
VFD

-TA23
4.0kW
VFD

-TA24
4.0kW
VFD

-TA25
4.0kW
VFD

-TA26
4.0kW
VFD

-TA31
4.0kW
VFD

-EB01
3x480V, 3x15kW
H2 Heater

9kW
Heating Element

9kW
Heating Element

=HE02+DA02
HT Cooling System #2, Container #1 Outside

-GP29
15kW
HT2
Coolant Pump

-GQ21
4kW
Ventilation Fan

-GQ22
4kW
Ventilation Fan

-GQ23
4kW
Ventilation Fan

-GQ24
4kW
Ventilation Fan

-GQ25
4kW
Ventilation Fan

-GQ26
4kW
Ventilation Fan

=HE03+DA02
LT Coolant System Cooler, Container #1 Outside

-GQ31
4kW
Ventilation Fan

=JA01+DA01
Container Ventilation, Inside Container #1

-EA01
Container
Lighting

-GQ06
4,3 kW
Ventilation Fan

-GQ07
4,3 kW
Ventilation Fan

=JA01+UC07
Container Ventilation, Fan/Heater Assembly

-GQ08
1kW
Ventilation Fan

-GQ09
1kW
Ventilation Fan

-EB01
3x480V, 3x15kW
Container Heater

15kW
Heating Element

15kW
Heating Element

15kW
Heating Element

=HE03+DA01
LT Cooling System, Container #1 Inside

-TA11
4kW
3x380-500VAC
LT Pump Drive

-GP11
4kW
LT Circuit Pump

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
~ ++ + & C01	

REVISION INFORMATION	
DESCRIPTION	
DATE	15-Oct-24

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CONFIDENTIAL

THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM

DRAWING	601456B C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 40ft Container AC
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 / LANGUAGE EN / SHEET/TOTAL 4 / 7

FRM510365 3/0B

DC Distribution - 40ft Container

=AA01+WZ10
Container Interconnect, Between Containers

DC1 DC Bus to Container #2 / 6.3:G
DC2 DC Bus to Container #2 / 6.3:G
DC3 DC Bus to Container #2 / 6.3:G
DC4 DC Bus to Container #2 / 6.3:G
DC5 DC Bus to Container #2 / 6.3:G
DC6 DC Bus to Container #2 / 6.3:G

=BA01
Power Conversion Block #1, Container #1 Inside

+UC01
DCDC Cabinet #1, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA01
DCDC Drive

-TA02
DCDC Drive

-RB01
Converter Inductor

-RB02
Converter Inductor

-FC01
315A

-FC02
315A

+UC02
DCDC Cabinet #2, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA03
DCDC Drive

-TA04
DCDC Drive

-RB03
Converter Inductor

-RB04
Converter Inductor

-FC01
315A

-FC02
315A

+UC03
DCDC Cabinet #3, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA05
DCDC Drive

-TA06
DCDC Drive

-RB05
Converter Inductor

-RB06
Converter Inductor

-FC01
315A

-FC02
315A

=BA02
Power Conversion Block #2, Container #1 Inside

+UC04
DCDC Cabinet #4, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA07
DCDC Drive

-TA08
DCDC Drive

-RB07
Converter Inductor

-RB08
Converter Inductor

-FC01
315A

-FC02
315A

+UC05
DCDC Cabinet #5, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA09
DCDC Drive

-TA10
DCDC Drive

-RB09
Converter Inductor

-RB10
Converter Inductor

-FC01
315A

-FC02
315A

+UC06
DCDC Cabinet #6, Inside Container #1

-QB01
Switch Disconnector

-FC03
215A

-TA11
DCDC Drive

-TA12
DCDC Drive

-RB11
Converter Inductor

-RB12
Converter Inductor

-FC01
315A

-FC02
315A

=RE01
Fuel Cell Block 1

+GB01
Fuel Cell Module 1

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB02
Fuel Cell Module 2

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB03
Fuel Cell Module 3

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

=RE02
Fuel Cell Block 2

+GB04
Fuel Cell Module 4

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB05
Fuel Cell Module 5

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

+GB06
Fuel Cell Module 6

-GB01
720-350V, 0-300A
Fuel Cell Stacks

-GB02
720-350V, 0-300A
Fuel Cell Stacks

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
=	++ | + | & C01

REVISION INFORMATION	
DESCRIPTION	
DATE	15-Oct-24

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DRAWING	6014568 C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 40ft Container DC
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 5 / 7

FRMS103653/0B

AC/DC Distribution - 10ft Container

Crosswind Scope

Ballard Scope

=AA01+WZ10
Container Interconnect, Between Containers

4.15:B / 3ph AC Supply to Container #1 - 250A BP1

4.15:B / 3ph+N AC Supply from Container #1 - 32A BP2

3ph 400-480V, 50-60Hz

=LA01+UC31
Control System, Container #2 Inside

-QB01
32A, 3p+N
Switch Disconnector

3ph+N 400-480V, 50-60Hz

-FC01
4A, B-curve
MCCB

-TB33
24-28V/10ADC
PSU with UPS

-GB01
UPS Battery
24V, XY Ah

-FC03
13A, B-curve
MCCB

-QA03
4...32 V DC/48...600 V AC
Solidstate contactor
Container Heating

-FC04
10A, B-curve
MCCB

-FC07
4A, B-curve
MCCB

-EA07
Room Lighting

-FC08
10A, C-curve
RCB/MCB

-XD08
1kW
Service Outlet

=JA01+DA03
Container Ventilation System, Inside Container #2

-EB03
10kW
Container Heating

-GQ10
5,7kW
Ventilation Fan

=BA30+DA03
Power Conversion Output, Inside Container #2

=HKN70-XB02
3ph 6,6 kV

=HKN70-FC01
MV Circuit Breaker

-TA30
1250kVA
400/6600V Transformer
Dry-type

-FC31
250A
250A Breaker

-FC30
2000A
2000A Breaker

-FC40
2.5..4A
Circuit Breaker
for Primary Transformer Protection

-RB30
500V, 840A
0,084mH, 203uF
LC Filter

-RB31
500V, 840A
0,084mH, 203uF
LC Filter

-TA40
0,4/0,4 kV, 2kVA
Isolation Transformer

-TB30
1640 A, 3x 400-500 VAC
Active Front End

-QA40
Precharge Contactor

-TB40
60A
Rectifier, 3ph doide bridge

-RA40
4 pcs 3,3Ω, 1000W
Resistor

-FC29
800A
Fuse

-FC32
800A
Fuse

-FC41
20A

DC Busbar System

-XD01:1 -XD01:7

5.15:B / DC Bus from Fuel Cells DC1

5.15:B / DC Bus from Fuel Cells DC2

5.15:B / DC Bus from Fuel Cells DC3

6x (2x120 mm2)

5.15:B / DC Bus from Fuel Cells DC4

5.15:B / DC Bus from Fuel Cells DC5

5.15:B / DC Bus from Fuel Cells DC6

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	03.P17
EPLAN Project Pages	595
=	++ | + | & C01

FRM5103653/0B

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DESCRIPTION	
DATE	15-Oct-24

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DRAWING	6014568 C06 Single Line Diagram
REVISION	03.P17
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Single Line Diagram - 10ft Container
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1 | LANGUAGE EN | SHEET/TOTAL 6 / 7

Ballard Power Systems Europe A/S
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Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue

Document Title:	**BLPH Project - Panel Cabinet Layout: Introduction and Overview**
Document Number:	K559-2254-CWIWP4202202-E03-001
Revision:	Rev001
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-E03-001Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Short Title	Electrical Cabinet Documentation Introduction and Overview
Full Title	Crosswind/Baseload Power Hub Fuel Cell Package Electrical Cabinet Documentation Introduction and Overview
Abstract	The purpose of this document is to assist the reader of the E03 series of electrical documentation to understand the context and relation of the individual documents

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Revision Record

Rev #	Description	Revised By	Date
1	Initial Release	PBL	June 2024

Checked by: n/a	Date: n/a
Approved by: n/a	Date: n/a

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1.0 Purpose and Scope 4
2.0 Electrical Cabinets 4
2.1 List of Cabinets 4
3.0 Document contents 5
3.1 Project Information 5
3.2 Controller IO Overview 5
3.3 Multiline Electrical Documentation 5
3.4 Panel Documentation 5

List of Figures

No table of figures entries found.

List of Tables

No table of figures entries found.

1.0 Purpose and Scope

The purpose of this document is to provide the reader of the E03 series of documents with an overview of the electrical cabinets present in the Fuel Cell Package and the documents providing the documentation for each of them.

2.0 Electrical Cabinets

2.1 List of Cabinets

Designation	Description	Physical Location
GB01..GB06	Fuel Cell Modules (FCwave #1..#6)	40ft Container, one side of the container
UC01..UC06	Fuel Cell DCDC Converter Cabinet	40ft container, opposite fuel cells
UC20	40ft Container control Cabinet	40ft container, middle on DCDC side
UC30	Coolant Skid Control Cabinet	On the coolant skid, middle
UC31	10ft Container Control Cabinet	10ft container, behind control panel access hatch
UC41	Coolant Skid VFD Cabinet	On the coolant skid, back-to-back with UC30
UC50	AC Power Distribution	40ft container, facing entrance door

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3.0 Document contents

The documentation for the cabinets follows a standard template as follows:

3.1 Project Information

The section serves as front page and standard compliance requirements.

- Front Page with cabinet DT and name
- Ballard Standard wire color page
- Ballard Tagging Standard page
- Table of Contents

3.2 Controller IO Overview

This section is only present if the cabinet contains PLC racks. The section outlines the construction of the PLC and the cards in the PLC rack(s). For each input/output (DI/DO/AI/AO), the associated control loop is outlined.

3.3 Multiline Electrical Documentation

This section contains the multiline electrical documentation. Reader is expected to be familiar with electrical drawings.

3.4 Panel Documentation

This section contains terminal block listings and layouts for all terminal blocks.

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Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue
002	28/03/2025	Update with RM safety relay

Document Title:	**BLPH Project - Panel Cabinet Layout: UC20 40ft Control Cabinet**
Document Number:	K559-2254-CWIWP4202202-E03-002
Revision:	Rev002
Sequence Number:	002
File Name:	K559-2254-CWIWP4202202-E03-002Rev002
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

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+UC20

Ballard Power Systems Europe - Technology Solutions

Cabinet: 40ft Container Control
Location: 40ft Container, Middle

Vin = 400VAC, 3ph

Ikmax = 6kA - AC Supply

IP20

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& A01

REVISION INFORMATION
DESCRIPTION
DATE
13-Jun-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- .1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	Black (BK)
AC Phase L1	Brown (BN)
AC Phase L2	Black (BK)
AC Phase L3	Grey (GY)
AC Neutral	Light Blue (BU)
Externally supplied circuit	Orange (OG)

DC Wiring Colors

DC Power Circuit	Black (BK)
DC Control Voltage (24V)	Dark Blue (BU)
DC Control Voltage Refence (0V)	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	White (WH)
Signal Wire (AI, AO)	Violet (VT)
Externally supplied circuit	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	Green/Yellow (GNYE)

Conductor Colour Identification

IEC 60757:1983 Designation	Description
BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& A01

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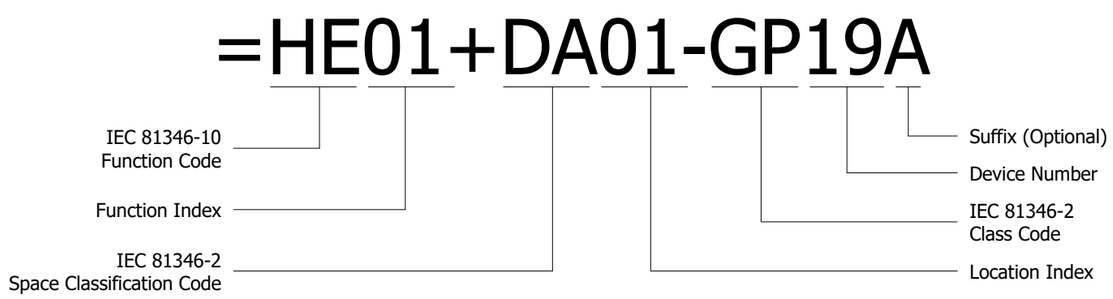
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
= ++	+ UC20 & A01

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DATE
13-Jun-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

0	1	2	3	4	5	6	7	8

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Ballard Power Systems Europe - Technology Solutions

Controller IO Overview Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Controller IO Overview Introduction		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE01
DEIF AMC300
Fuel Cell Genset Controller
Container Control Cabinet

-Slot1
DEIF PSM3.1
Power Supply Module 3.1

PSM3.1

	PE PE		Frame Ground	
	1 12-24V		Supply +	
	2 0V		Supply COM	
	3 R1 COM		Status OK Relay COM	
A1.0	4 DO1	DO1	Status OK Relay	
	5 R2 COM		Relay 2 COM	
A1.1	6 DO2	DO2	Relay 1 Out	
	7 R3 COM		Relay 3 COM	
A1.2	8 DO3	DO3	Relay 3 Out	

EtherCAT Master Ring Topology — EtherCAT +&C01/8.4:C X03 — Ethernet-1 IN

EtherCAT Master Ring Topology — EtherCAT +&C01/8.4:C X03 — Ethernet-2 OUT

Bus Master
Multi-line 300

-Slot2
ACM3.1
Alternating Current Module 3.1

ACM3.1

1 L1	BA20_BA01_L1	AUX Customer Supply - L1 Voltage	
2 L2	BA20_BA01_L2	AUX Customer Supply - L2 Voltage	
3 L3	BA20_BA01_L3	AUX Customer Supply - L3 Voltage	
4 N	BA20_BA01_N	AUX Customer Supply - N Voltage	
5 L1	BA20_BA02_L1	Nanogrid Internal - L1 Voltage	
6 L2	BA20_BA02_L2	Nanogrid Internal - L2 Voltage	
7 L3	BA20_BA02_L3	Nanogrid Internal - L3 Voltage	
8 N	BA20_BA02_N	AUX Customer Supply - N Voltage	
9 L1-S1	BA20_BC01_L1	AUX Customer Supply - L1 Current	
10 L1-S2	CH1-S2	Channel 1 - S2	
11 L2-S1	BA20_BC01_L2	AUX Customer Supply - L2 Current	
12 L2-S2	CH2-S2	Channel 2 - S2	
13 L3-S1	BA20_BC01_L3	AUX Customer Supply - L3 Current	
14 L3-S2	CH3-S2	Channel 3 - S2	
15 4-S1	CH4-S1	Channel 4 - S1	
16 4-S2	CH4-S2	Channel 4 - S2	

-Slot3
&C03/96.3
&C03/77.5
&C03/34.3
&C03/97.8
&C03/24.6
&C03/19.7
&C03/19.7
&C03/19.7
&C03/19.7
IOM3.1
Alternating Current Module 3.1

IOM3.1

3 1 2	1 DO1.1		JS_EA01	Container light 1/3
	2 R1 COM			Relay 1 Common
	3 DO1.2			Relay 1 NC
6 4 5	4 DO2.1		JS_EA02	Container lighting, 40ft 2/2
	5 R2 COM			Relay 2 Common
	6 DO2.2			Relay 2 NC
9 7 8	7 DO3.1	&C03/96.3	JS_EA03	Container light 3/3 UPS Supply
	8 R3 COM	&C03/96.3		Relay 3 Com
	9 DO3.2			Relay 3 NC
12 10 11	10 DO4.1	&C03/77.5	JB01_QB18_EB01	Heatracing drain
	11 R4 COM	&C03/77.5		Relay 4 Com
	12 DO4.2			Relay 4 NC
	13 DIO3	&C03/34.3	UC20_FCXX	400/230VAC Fuse Trip
	14 DIO6	&C03/34.5	UC20_FC101	24VDC Fuse Trip
	15 DIO8	&C03/97.8	DA01_SG100	Light Switch Container
	16 DIO4		UC50_QA01_FB	Container Nanogrid Supply Feedback
	17 DIO5		UC50_QA02_FB	Container AUX Supply Feedback
	18 DIO1	&C03/24.6	UC20_FC210	24VDC light Fuse Trip
	19 DIO7			Spare
	20 DIO9	&C03/19.7	UC20_RB30_RDY	PLC UPS Battery Ready
	21 DIO2	&C03/19.7	UC20_RB30_BAT	PLC UPS Battery Operation
	22 DIO0	&C03/19.7	UC20_RB30_SOH	PLC UPS Battery Low SOH
	23 COM	&C03/19.7		Supply COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Main Rack 1/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE01
DEIF AMC300
Fuel Cell Genset Controller

-Slot4
&C03/56.1
&C03/56.2
&C03/56.3
&C03/56.4
&C03/84.1
&C03/37.4
&C03/37.5
&C03/37.5
&C03/77.2
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM	&C03/56.1		Relay 1 In	
2	DO1	&C03/56.2	FC1_RESET	FC1 Safety PLC Circuit Reset	
3	R2 COM	&C03/56.3		Relay 2 COM	
4	DO2	&C03/56.3	FC2_RESET	FC2 Safety PLC Circuit Reset	
5	R3 COM	&C03/56.4		Relay 3 In	
6	DO3	&C03/56.4	FC3_RESET	FC3 Safety PLC Circuit Reset	
7	R4 COM			Relay 4 In	
8	DO4			Relay 4 Out	
9	AO1	&C03/84.1	JA01_QM01_SP	Ventilation Intake 1 Damper Postion SP	
10	AO1 COM	&C03/84.2		AO1 COM	
11	AO2	&C03/84.4	JA01_QM02_SP	Ventilation Intake 2 Damper Postion SP	
12	AO2 COM	&C03/84.4		AO2 COM	
13	AO3		LT_QN01_SP	LT Mixing Valve Setpoint	
14	AO3 COM			AO3 COM	
15	AO4			Spare	
16	AO4 COM			AO4 COM	
17	DI1	&C03/37.4	VT_GB03	FC3 24V Supply Feedback	
18	DI2	&C03/37.5	VT_GB04	FC4 24V Supply Feedback	
19	DI3			Spare	
20	DI4			Spare	
21	DI1-4 COM	&C03/37.5		DI1-4 COM	
22	AI1	&C03/84.3	JA01_QM01_FB	Ventilation Intake 1 Damper Postion FB	
23	AI1 COM	&C03/84.3		AI1 COM	
24	AI2	&C03/84.5	JA01_QM02_FB	Ventilation Intake 2 Damper Postion FB	
25	AI2 COM	&C03/84.5		AI2 COM	
26	AI3		LT_QN01_FB	LT Mixing Valve Feedback	
27	AI3 COM			AI3 COM	
28	AI4	&C03/77.2	JB01_BL02_LSH	Condensate Drain Tank High Level	
29	AI4 COM			AI4 COM	

-Slot5
&C03/88.1
&C03/88.4
&C03/87.7
&C03/87.2
&C03/93.2
&C03/83.7
IOM3.3
IO Module 3.3

IOM3.3

1	AI1	&C03/88.1	JA01_BT01_TT	Ventilation Intake Temperature	
2	AI1			Spare	
3	AI1			Spare	
4	AI2	&C03/88.4	JA01_BT02_TT	Container Temperature	
5	AI2	&C03/88.4		Spare	
6	AI2	&C03/88.4		Spare	
7	AI3	&C03/88.6	JA01_BT03_TT	Container Temperature	
8	AI3	&C03/88.7		Spare	
9	AI3	&C03/88.7		Spare	
10	AI4		JA01_BP05_TT	Vent. Duct Air Temperature	
11	AI4			Spare	
12	AI4			Spare	
13	AI5			Spare	
14	AI5	&C03/87.7	JA01_BP01_PDT	Ventilation Intake Filter Differential-pressure	
15	AI5	&C03/87.7		Spare	
16	AI6			Spare	
17	AI6	&C03/87.2	JA01_BP02_PDT	Container Indoor/Outdoor Diffential Pressure	
18	AI6	&C03/87.2		COM	
19	AI7			Spare	
20	AI7	&C03/93.2	HE03_DA01_BP01	LT Circuit Differential-pressure	
21	AI7	&C03/93.2		COM	
22	AI8	&C03/83.7	JA01_EB01_TT	Container Heater Internal Temperature	
23	AI8			Spare	
24	AI8			Spare	
25	AI9			Spare	
26	AI9			Spare	
27	AI9			Spare	
28	AI10			Spare	
29	AI10			Spare	
30	AI10			Spare	

-Slot6
&C03/91.3
&C03/92.3
IOM3.3
IO Module 3.3

IOM3.3

1	AI1			Spare
2	AI1		LT_BF01_FT	LT Coolant Flow
3	AI1			-
4	AI2			Spare
5	AI2	&C03/91.3	HE03_DA01_BP02	LT feed pressure FC1
6	AI2	&C03/91.3		-
7	AI3			Spare
8	AI3	&C03/91.4	HE03_DA01_BP03	LT feed pressure FC2
9	AI3	&C03/91.4		-
10	AI4			Spare
11	AI4	&C03/91.6	HE03_DA01_BP04	LT feed pressure FC3
12	AI4	&C03/91.6		-
13	AI5			Spare
14	AI5	&C03/92.3	HE03_DA01_BP05	LT feed pressure FC4
15	AI5	&C03/92.3		-
16	AI6			Spare
17	AI6	&C03/92.4	HE03_DA01_BP06	LT feed pressure FC5
18	AI6	&C03/92.4		-
19	AI7			Spare
20	AI7	&C03/92.6	HE03_DA01_BP07	LT feed pressure FC6
21	AI7			-
22	AI8		LT_BT04_TT	LT Return Temperature
23	AI8			Spare
24	AI8			Spare
25	AI9		LT_BT05_TT	LT Radiator Return Temperature
26	AI9			Spare
27	AI9			Spare
28	AI10		LT_BT06_TT	LT Forward Temperature
29	AI10			Spare
30	AI10			Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DATE
13-Jun-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Main Rack 2/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE01
DEIF AMC300
Fuel Cell Genset Controller

-Slot7
DEIF PCM3.1
Processor and
Communication
Module 3.1

PCM3.1

CAN-A H
1
Other bus systems X01
CAN-A SH
2
Other bus systems X01
CAN-A L
3
Other bus systems X01
CAN-B H
4
Other bus systems X01
CAN-B SH
5
Other bus systems X01
CAN-B L
6
Other bus systems X01

SD Card

Ethernet-3
1
ETH1 Other bus systems X02

Ethernet-4
1
AGI Screen Connection Other bus systems X03

Ethernet-5
1
ETH04 Other bus systems X04

CPU
Multi-line 300

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DESCRIPTION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Main Rack 3/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE02
DEIF AMC300
Fuel Cell Genset Controller - Extension Rack

-Slot1
DEIF PSM3.2
Power Supply Module 3.2

PSM3.2

	PE PE			Frame Ground
	1 12-24V			Supply +
	2 0V			Supply COM
	3 R1 COM			Status OK Relay COM
A52.4	4 DO1	DO1		Status OK Relay
	5 R2 COM			Relay 2 COM
A52.5	6 DO2	DO2		Relay 1 Out
	7 R3 COM			Relay 3 COM
A52.6	8 DO3	DO3		Relay 3 Out

Ethernet-1 IN
EtherCAT Follower Ring Topology — EtherCAT +&C01/8.6:C X03

Ethernet-2 OUT
EtherCAT Follower Ring Topology — EtherCAT +&C01/8.7:C X03

Bus Follower
Multi-line 300

-Slot02
IOM3.3
IO Module 3.3

IOM3.3

1 AI1		Spare
2 AI2		Spare
3 AI3		Spare
4 AI4		Spare
5 AI5		Spare
6 AI6		Spare
7 AI7		Spare
8 AI3		Spare
9 AI9		Spare
10 AI10		Spare
11 AI11		Spare
12 AI12		Spare
13 AI13		Spare
14 AI14		Spare
15 AI15		Spare
16 AI16		Spare
17 AI17		Spare
18 AI18		Spare
19 AI19		Spare
20 AI20		Spare
21 AI21		Spare
22 AI22		Spare
23 AI23		Spare
24 AI24		Spare
25 AI25		Spare
26 AI26		Spare
27 AI27		Spare
28 AI28		Spare
29 AI29		Spare
30 AI30		Spare

-Slot03
&C03/83.2
&C03/35.2
&C03/35.1
&C03/25.7
&C03/25.7
&C03/25.7
&C03/25.7
&C03/28.7
&C03/25.7
&C03/28.7
&C03/28.7
&C03/28.7
&C03/31.7
&C03/31.7
&C03/31.7
&C03/31.7
&C03/31.7
IOM3.4
IO Module 3.4

IOM3.4

	1 12-24V		Supply +
	2 DO &C03/83.2	JA01_EB01_1	Heating element 1 ON
	3 DO &C03/83.4	JA01_EB01_2	Heating element 2 ON
	4 DO &C03/83.5	JA01_EB01_3	Heating element 3 ON
A3.1	5 DO04	DO04	Digital Out 04
	6 DO &C03/35.2	UC20_KF20.2	FC1 24V Toggle
	7 DO &C03/35.3	UC20_KF20.4	FC2 24V Toggle
	8 DO &C03/35.4	UC20_KF21.2	FC3 24V Toggle
	9 DO &C03/35.5	UC20_KF21.4	FC4 24V Toggle
	10 DO &C03/35.6	UC20_KF22.2	FC5 24V Toggle
	11 DO &C03/35.7	UC20_KF22.4	FC6 24V Toggle
A4.0	12 DO11	DO11	Digital Out 11
A4.1	13 DO12	DO12	Digital Out 12
	14 COM &C03/35.1		Supply COM
E6.5	15 DI01	DI01	Digital In 01
E6.6	16 DI02	DI02	Digital In 02
E6.7	17 DI03	DI03	Digital In 03
	18 DI &C03/25.7	UC20_RB01_RDY	FC1+2 UPS Battery Ready
	19 DI &C03/25.7	UC20_RB01_BAT	FC1+2 UPS Battery Operation
	20 DI &C03/25.7	UC20_RB01_SOH	FC1+2 UPS Battery Low SOH
	21 DI &C03/25.7	UC20_RB01_DIS	FC1+2 UPS Battery Discharged
	22 DI &C03/28.7	UC20_RB02_RDY	FC3+4 UPS Battery Ready
	23 COM &C03/25.7		Supply COM
	24 DI &C03/28.7	UC20_RB02_BAT	FC3+4 UPS Battery Operation
	25 DI &C03/28.7	UC20_RB02_SOH	FC3+4 UPS Battery Low SOH
	26 DI &C03/28.7	UC20_RB02_DIS	FC3+4 UPS Battery Discharged
	27 DI &C03/31.7	UC20_RB03_RDY	FC5+6 UPS Battery Ready
	28 DI &C03/31.7	UC20_RB03_BAT	FC5+6 UPS Battery Operation
	29 DI &C03/31.7	UC20_RB03_SOH	FC5+6 UPS Battery Low SOH
	30 DI &C03/31.7	UC20_RB03_DIS	FC5+6 UPS Battery Discharged
E8.4	31 DI16	DI16	Digital In 16
	32 COM &C03/31.7		Supply COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Extension Rack 1/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE02
DEIF AMC300
Fuel Cell Genset Controller - Extension Rack

-Slot04

&C03/58.5
&C03/61.5
&C03/59.1
IOM3.4
IO Module 3.4

IOM3.4

1	12-24V			Supply +
2	DO01	&C03/58.5	GB01_MD_ENABLE	MD_Enable Signal
3	DO02	&C03/61.5	GB02_MD_ENABLE	MD_Enable Signal
4	DO03			SPARE
5	DO04			SPARE
6	DO05			SPARE
7	DO06			SPARE
8	DO07			SPARE
9	DO08			SPARE
10	DO09			SPARE
11	DO10			SPARE
12	DO11			SPARE
13	DO12			SPARE
14	COM			Supply COM
15	DI1	&C03/59.1	GB01_SAFE_FIRE	SAFE_FIRE Safety Signal
16	DI2	&C03/59.2	GB01_SAFE_H2CONC	SAFE_H2CONC Safety Signal
17	DI3	&C03/59.3	GB01_SAFE_VENT	SAFE_VENT Safety Signal
18	DI4	&C03/59.4	GB01_SAFE_WD	SAFE_WD Safety Signal
19	DI7	&C03/59.7	GB01_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
20	DI8	&C03/59.8	GB01_SAFE_EXTERN	SAFE_EXTERN Safety Signal
21	DI13	&C03/58.3	GB01_FCM_OK	Fuel Cell Module OK
22	DI14	&C03/62.1	GB02_SAFE_FIRE	SAFE_FIRE Safety Signal
23	COM			Supply COM
24	DI5	&C03/62.2	GB02_SAFE_H2CONC	SAFE_H2CONC Safety Signal
25	DI6	&C03/62.3	GB02_SAFE_VENT	SAFE_VENT Safety Signal
26	DI9	&C03/62.4	GB02_SAFE_WD	SAFE_WD Safety Signal
27	DI10	&C03/62.7	GB02_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
28	DI11	&C03/62.8	GB02_SAFE_EXTERN	SAFE_EXTERN Safety Signal
29	DI12	&C03/61.3	GB02_FCM_OK	Fuel Cell Module OK
30	DI15			SPARE
31	DI16			SPARE
32	COM			Supply COM

=RE01+GB01-KE02-Slot04:

-Slot05

&C03/65.1
&C03/65.7
&C03/65.8
&C03/64.3
&C03/68.1
&C03/68.7
&C03/68.8
&C03/67.3
IOM3.4
IO Module 3.4

IOM3.4

1	12-24V			Supply +
2	DO01	&C03/64.5	GB03_MD_ENABLE	MD_Enable Signal
3	DO02	&C03/67.5	GB04_MD_ENABLE	MD_Enable Signal
4	DO03			SPARE
5	DO04			SPARE
6	DO05			SPARE
7	DO06			SPARE
8	DO07			SPARE
9	DO08			SPARE
10	DO09			SPARE
11	DO10			SPARE
12	DO11			SPARE
13	DO12			SPARE
14	COM			Supply COM
15	DI1	&C03/65.1	GB03_SAFE_FIRE	SAFE_FIRE Safety Signal
16	DI2	&C03/65.2	GB03_SAFE_H2CONC	SAFE_H2CONC Safety Signal
17	DI3	&C03/65.3	GB03_SAFE_VENT	SAFE_VENT Safety Signal
18	DI4	&C03/65.4	GB03_SAFE_WD	SAFE_WD Safety Signal
19	DI7	&C03/65.7	GB03_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
20	DI8	&C03/65.8	GB03_SAFE_EXTERN	SAFE_EXTERN Safety Signal
21	DI13	&C03/64.3	GB03_FCM_OK	Fuel Cell Module OK
22	DI14	&C03/68.1	GB04_SAFE_FIRE	SAFE_FIRE Safety Signal
23	COM			Supply COM
24	DI5	&C03/68.2	GB04_SAFE_H2CONC	SAFE_H2CONC Safety Signal
25	DI6	&C03/68.3	GB04_SAFE_VENT	SAFE_VENT Safety Signal
26	DI9	&C03/68.4	GB04_SAFE_WD	SAFE_WD Safety Signal
27	DI10	&C03/68.7	GB04_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
28	DI11	&C03/68.8	GB04_SAFE_EXTERN	SAFE_EXTERN Safety Signal
29	DI12	&C03/67.3	GB04_FCM_OK	Fuel Cell Module OK
30	DI15			SPARE
31	DI16			SPARE
32	COM			Supply COM

-Slot06

&C03/71.1
&C03/71.7
&C03/71.8
&C03/70.3
&C03/74.1
&C03/74.7
&C03/74.8
&C03/73.3
IOM3.4
IO Module 3.4

IOM3.4

1	12-24V			Supply +
2	DO01	&C03/70.5	GB05_MD_ENABLE	MD_Enable Signal
3	DO02	&C03/73.5	GB06_MD_ENABLE	MD_Enable Signal
4	DO03			SPARE
5	DO04			SPARE
6	DO05			SPARE
7	DO06			SPARE
8	DO07			SPARE
9	DO08			SPARE
10	DO09			SPARE
11	DO10			SPARE
12	DO11			SPARE
13	DO12			SPARE
14	COM			Supply COM
15	DI1	&C03/71.1	GB05_SAFE_FIRE	SAFE_FIRE Safety Signal
16	DI2	&C03/71.2	GB05_SAFE_H2CONC	SAFE_H2CONC Safety Signal
17	DI3	&C03/71.3	GB05_SAFE_VENT	SAFE_VENT Safety Signal
18	DI4	&C03/71.4	GB05_SAFE_WD	SAFE_WD Safety Signal
19	DI7	&C03/71.7	GB05_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
20	DI8	&C03/71.8	GB05_SAFE_EXTERN	SAFE_EXTERN Safety Signal
21	DI13	&C03/70.3	GB05_FCM_OK	Fuel Cell Module OK
22	DI14	&C03/74.1	GB06_SAFE_FIRE	SAFE_FIRE Safety Signal
23	COM			Supply COM
24	DI5	&C03/74.2	GB06_SAFE_H2CONC	SAFE_H2CONC Safety Signal
25	DI6	&C03/74.3	GB06_SAFE_VENT	SAFE_VENT Safety Signal
26	DI9	&C03/74.4	GB06_SAFE_WD	SAFE_WD Safety Signal
27	DI10	&C03/74.7	GB06_SAFE_FIREMALF	SAFE_FIREMALF Safety Signal
28	DI11	&C03/74.8	GB06_SAFE_EXTERN	SAFE_EXTERN Safety Signal
29	DI12	&C03/73.3	GB06_FCM_OK	Fuel Cell Module OK
30	DI15	DI15	DI15	Digital In 15
31	DI16	DI16	DI16	Digital In 16
32	COM			Supply COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Extension Rack 2/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 6 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE02
DEIF AMC300
Fuel Cell Genset Controller - Extension Rack

-Slot07
&C03/56.5
&C03/56.5
&C03/56.6
&C03/85.1
&C03/86.1
&C03/37.6
&C03/37.8
&C03/85.2
&C03/86.2
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM	&C03/56.5		Relay 1 In
2	DO1	&C03/56.5	FC4_RESET	FC4 Safety PLC Circuit Reset
3	R2 COM	&C03/56.6		Relay 2 COM
4	DO2	&C03/56.6	FC5_RESET	FC5 Safety PLC Circuit Reset
5	R3 COM			Relay 3 In
6	DO3		FC6_RESET	FC6 Safety PLC Circuit Reset
7	R4 COM			Relay 4 In
8	DO4			Relay 4 Out
9	AO1	&C03/85.1 &C03/86.1	JA01_QM03_SP	Ventilation Outlet A Damper Postion SP
10	AO1 COM	&C03/85.2 &C03/86.2		AO1 COM
11	AO2	&C03/85.6 &C03/86.6	JA01_QM04_SP	Ventilation Outlet B Damper Postion SP
12	AO2 COM	&C03/85.6 &C03/86.6		AO2 COM
13	AO3			Ventilation Outlet C Damper Postion SP
14	AO3 COM			AO3 COM
15	AO4			Ventilation Intake D Damper Postion SP
16	AO4 COM			AO4 COM
17	DI1			FC4 24V Supply Feedback
18	DI2	&C03/37.6	VT_GB05	FC5 24V Supply Feedback
19	DI3	&C03/37.7	VT_GB06	FC6 24V Supply Feedback
20	DI4			Spare
21	DI1-4 COM	&C03/37.8		DI1-4 COM
22	AI1	&C03/85.2 &C03/86.2	JA01_QM03_FB	Ventilation Outlet A Damper Postion FB
23	AI1 COM	&C03/85.3 &C03/86.3		AI1 COM
24	AI2	&C03/85.5 &C03/86.5	JA01_QM04_FB	Ventilation Outlet B Damper Postion FB
25	AI2 COM	&C03/85.5 &C03/86.5		AI2 COM
26	AI3			Ventilation Outlet C Damper Postion FB
27	AI3 COM			AI3 COM
28	AI4			Ventilation Intake D Damper Postion FB
29	AI4 COM			AI4 COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Extension Rack 3/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE03
DEIF AMC300
Fuel Cell Genset Controller - Extension Rack 2

-Slot1
&C03/36.6
&C03/36.7
PSM3.2
Power Supply
Module 3.2

PSM3.2

1	12-24V		Frame Ground
2	0V		Supply +
PE	PE		Supply COM
7	R1 COM	&C03/36.6	Status OK Relay COM
8	DO1	&C03/36.7 FC5_24VON	FC5 24V Supply On Signal
3	R2 COM		Relay 2 COM
4	DO1	DO2	<Reserved>
5	R3 COM		Relay 3 COM
6	DO2	DO3	Relay 3 Out

Ethernet-1 IN
Rack Connection IN EtherCAT +&C01/8.8:C X03

Ethernet-2 OUT
Rack Connection OUT EtherCAT +&C01/8.9:C X03

Bus Slave
Multi-line 300

-Slot2
&C03/36.1
&C03/36.1
&C03/36.2
&C03/36.2
&C03/36.4
&C03/36.4
&C03/36.5
&C03/36.5
&C03/37.1
&C03/37.3
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM	&C03/36.1	Relay 1 In
2	DO1	&C03/36.1 FC1_24VON	FC1 24V Supply On Signal
3	R2 COM	&C03/36.2	Relay 2 COM
4	DO1	&C03/36.2 FC2_24VON	FC2 24V Supply On Signal
5	R3 COM	&C03/36.4	Relay 3 In
6	DO2	&C03/36.4 FC3_24VON	FC3 24V Supply On Signal
7	R4 COM	&C03/36.5	Relay 4 In
8	DO2	&C03/36.5 FC4_24VON	FC4 24V Supply On Signal
9	AO1		Spare
10	AO1 COM		AO1 COM
11	AO2		Spare
12	AO2 COM		AO2 COM
13	AO3		Spare
14	AO3 COM		AO3 COM
15	AO4		Spare
16	AO4 COM		AO4 COM
17	DI1	&C03/37.1 VT_GB01	FC1 24V Supply Feedback
18	DI2	&C03/37.2 VT_GB02	FC2 24V Supply Feedback
19	DI3		FC3 24V Supply Feedback
20	DI4		Spare
21	DI COM	&C03/37.3	DI1-4 COM
22	AI1		Spare
23	AI1 COM		AI1 COM
24	AI2		Spare
25	AI2 COM		AI2 COM
26	AI3		Spare
27	AI3 COM		AI3 COM
28	AI4		Spare
29	AI4 COM		AI4 COM

-Slot3
&C03/94.1
&C03/94.3
IOM3.3
IO Module 3.3

IOM3.3

1	AI1		H2_BT01_TT	FC1 Hydrogen Supply Pipe Temperature
2	AI2			Spare
3	AI3			Spare
4	AI4		H2_BT02_TT	FC2 Hydrogen Supply Pipe Temperature
5	AI5			Spare
6	AI6			Spare
7	AI7		H2_BT03_TT	FC3 Hydrogen Supply Pipe Temperature
8	AI3			Spare
9	AI9			Spare
10	AI10		H2_BT04_TT	FC4 Hydrogen Supply Pipe Temperature
11	AI11			Spare
12	AI12			Spare
13	AI13		H2_BT05_TT	FC5 Hydrogen Supply Pipe Temperature
14	AI14			Spare
15	AI15			Spare
16	AI16			FC6 Hydrogen Supply Pipe Temperature
17	AI17			Spare
18	AI18			Spare
19	AI	&C03/94.1	HE03_DA01_BT01	FC1 HT Coolant Outlet Temperature
20	AI	&C03/94.1		Spare
21	AI	&C03/94.1		Spare
22	AI	&C03/94.3	HE03_DA01_BT02	FC2 HT Coolant Outlet Temperature
23	AI	&C03/94.3		Spare
24	AI	&C03/94.3		Spare
25	AI	&C03/94.4	HE03_DA01_BT03	FC3 HT Coolant Outlet Temperature
26	AI	&C03/94.4		Spare
27	AI	&C03/94.5		Spare
28	AI28			Spare
29	AI29			Spare
30	AI30			Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

REVISION INFORMATION
DESCRIPTION
DATE
13-Jun-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Extension Rack 2 1/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 8 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20-KE03
DEIF AMC300
Fuel Cell Genset Controller - Extension Rack 2

Slot4
&C03/78.1
&C03/78.4
&C03/79.1
&C03/95.1
IOM3.3
IO Module 3.3

IOM3.3

1	AI &C03/78.1	UC01_BT01_TT	Cabinet temperature UC01
2	AI &C03/78.1		Spare
3	AI &C03/78.1		Spare
4	AI &C03/78.4	UC02_BT01_TT	Cabinet temperature UC02
5	AI &C03/78.4		Spare
6	AI &C03/78.4		Spare
7	AI &C03/78.7	UC03_BT01_TT	Cabinet temperature UC03
8	AI &C03/78.7		Spare
9	AI &C03/78.7		Spare
10	AI &C03/79.1	UC04_BT01_TT	Cabinet temperature UC04
11	AI &C03/79.1		Spare
12	AI &C03/79.1		Spare
13	AI &C03/79.4	UC05_BT01_TT	Cabinet temperature UC05
14	AI &C03/79.4		Spare
15	AI &C03/79.4		Spare
16	AI &C03/79.7	UC06_BT01_TT	Cabinet temperature UC06
17	AI &C03/79.7		Spare
18	AI &C03/79.7		Spare
19	AI &C03/95.1	HE03_DA01_BT04	FC4 HT Coolant Outlet Temperature
20	AI &C03/95.1		Spare
21	AI &C03/95.1		Spare
22	AI &C03/95.3	HE03_DA01_BT05	FC5 HT Coolant Outlet Temperature
23	AI &C03/95.3		Spare
24	AI &C03/95.3		Spare
25	AI &C03/95.4	2HE03_DA01_BT06	FC6 HT Coolant Outlet Temperature
26	AI26		Spare
27	AI27		Spare
28	AI28		Spare
29	AI29		Spare
30	AI30		Spare

-Slot5
&C03/89.3
IOM3.3
IO Module 3.3

IOM3.3

1	AI1		Spare
2	AI &C03/89.3	JA01_BU01_TT	Container Ambient Temperature - Center
3	AI &C03/89.4		Spare
4	AI4		Spare
5	AI &C03/89.4	JA01_BU01_RH	Container Relative Humidity
6	AI &C03/89.4		Spare
7	AI7		Spare
8	AI &C03/89.5	JA01_BU01_CO2	Container CO2 Concentration
9	AI &C03/89.5		Spare
10	AI10		Spare
11	AI &C03/89.6	JA01_BU01_VOC	Container Ambient VOC Concentration
12	AI &C03/89.6		Spare
13	AI13		Spare
14	AI14		Spare
15	AI15		Spare
16	AI16		Spare
17	AI17		Spare
18	AI18		Spare
19	AI19		Spare
20	AI20		Spare
21	AI21		Spare
22	AI22		Spare
23	AI23		Spare
24	AI24		Spare
25	AI25		Spare
26	AI26		Spare
27	AI27		Spare
28	AI28		Spare
29	AI29		Spare
30	AI30		Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, Extension Rack 2 2/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet

-KE10
24 VDC
Safety PLC, PLC

+ A1
- A2
X03 BUS
<CANbus>
BUS
EFI1_A &C03/38.1
BUS
EFI1_B &C03/38.1
BUS
EFI2_A &C03/38.1

EFI bus Master

-KE11
24 VDC
Safety PLC, Modbus Gateway

PORT 1
1
-X1
Other bus systems
Safety PLC

Other bus systems
-X2
2
PORT 2

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 40ft Container 1/5		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 16 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet

-KE12
&C03/38.2
&C03/39.1
&C03/39.2
&C03/39.5
&C03/51.5
&C03/51.3
&C03/39.6
&C03/49.2
&C03/51.4
&C03/17.1
8DI, 4DO
Safe Digital Input/Output Module

Flexi Soft, expansion module, I/O module, FX3-XTIO

X1		&C03/17.1	KE12PULSE01	KE12 Test pulse output CH1
X2		&C03/17.2	KE12PULSE02	KE12 Test pulse output CH2
+	A1			
-	A2			
I1		&C03/39.1	UC20_SG10_CH1	E-stop UC20 CH01
I2		&C03/39.2	UC20_SG10_CH2	E-stop UC20 CH02
I3		&C03/39.5	UC20_SG11.S	Reset Button E-Stop
I4			UC20_KF17_FB	KF17 Feedback safety relay
I5		&C03/51.5	UC30_SG20-1	Coolant Skid ESTOP CH1
I6		&C03/51.6	UC30_SG20-2	Coolant Skid ESTOP CH2
I7		&C03/51.3	UC30_KF10_FB	Coolant Skid Safety Relay FB
I8			UC21_KF108	Feedback safety relay UC21
Q1		&C03/39.6	UC20_SG11.P	Reset Button E-Stop Light
Q2		&C03/49.2	UC20_KF17	KF17 Safety Relay Coil
Q3		&C03/51.4	UC30_KF10_Q	Coolant Skid Safety Relay Coil
Q4				Spare

SICK.1044125

-KE13
&C03/38.3
&C03/56.2
&C03/40.3
&C03/41.3
&C03/17.2
8DI, 4DO
Safe Digital Input/Output Module

Flexi Soft, expansion module, I/O module, FX3-XTIO

X1		&C03/17.2	KE13PULSE01	KE13 Test pulse output CH1
X2		&C03/17.3	KE13PULSE02	KE13 Test pulse output CH2
+	A1			
-	A2			
I1		&C03/40.4	UC20_KF100	Feedback Safety Relay GB01 & UC01
I2			GB01	SAFE_Main GB01
I3		&C03/41.4	UC20_KF101	Feedback Safety Relay GB02 & UC02
I4			GB02	SAFE_Main GB02
I5		&C03/56.2	FC1_RESET_IN	FC1 Safety PLC Circuit Reset
I6				SPARE
I7		&C03/56.3	FC2_RESET_IN	FC2 Safety PLC Circuit Reset
I8				SPARE
Q1		&C03/40.3	UC20_KF100	Coil Safety relay GB01 & UC01
Q2			GB01	SAFE_In GB01
Q3		&C03/41.3	UC20_KF101	Coil Safety relay GB02 & UC02
Q4			GB02	SAFE_In GB02

SICK.1044125

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 40ft Container 2/5		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 17 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet

-KE14
&C03/38.5
&C03/56.4
&C03/42.3
&C03/43.3
&C03/17.4
8DI, 4DO
Safe Digital Input/Output Module

Flexi Soft, expansion module, I/O module, FX3-XTIO

X1	&C03/17.4	KE14PULSE01	KE14 Test pulse output CH1	
X2	&C03/17.5	KE14PULSE02	KE14 Test pulse output CH2	
+ A1				
- A2				
I1	&C03/42.4	UC20_KF102	Feedback Safety Relay GB03 & UC03	
I2		GB03	SAFE_Main GB03	
I3	&C03/43.4	UC20_KF103	Feedback Safety Relay GB04 & UC04	
I4		GB04	SAFE_Main GB04	
I5	&C03/56.4	FC3_RESET_IN	FC3 Safety PLC Circuit Reset	
I6				
I7	&C03/56.5	FC4_RESET_IN	FC4 Safety PLC Circuit Reset	
I8				
Q1	&C03/42.3	UC20_KF102	Coil Safety relay GB03 & UC03	
Q2		GB03	SAFE_In GB03	
Q3	&C03/43.3	UC20_KF103	Coil Safety relay GB04 & UC04	
Q4		GB04	SAFE_In GB04	

SICK.1044125

-KE15
8DI, 4DO
FC6 Safety PLC Circuit Reset

Flexi Soft, expansion module, I/O module, FX3-XTIO

X1	&C03/17.6	KE15PULSE01	KE15 Test pulse output CH1
X2	&C03/17.7	KE15PULSE02	KE15 Test pulse output CH2
+ A1			
- A2			
I1	&C03/44.4	UC20_KF104	Feedback Safety Relay GB05 & UC05
I2		GB05	SAFE_Main GB05
I3	&C03/45.4	UC20_KF105	Feedback Safety Relay GB06 & UC06
I4		GB06	SAFE_Main GB06
I5	&C03/56.6	FC5_RESET_IN	FC5 Safety PLC Circuit Reset
I6			
I7	&C03/56.8	FC6_RESET_IN	FC6 Safety PLC Circuit Reset
I8			
Q1	&C03/44.3	UC20_KF104	Coil Safety relay GB05 & UC05
Q2		GB05	SAFE_In GB05
Q3	&C03/45.3	UC20_KF105	Coil Safety relay GB06 & UC06
Q4		GB06	SAFE_In GB06

SICK.1044125

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + UC20 | & C02

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 40ft Container 3/5		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3 | LANGUAGE EN	SHEET/TOTAL	18 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet

-KE16
&C03/38.7
&C03/54.4
&C03/55.5
&C03/55.6
&C03/49.3
&C03/48.2
&C03/18.1
Safety Digital
Input/Output Module

Flexi Soft, expansion module, I/O module, FX3-XTIO

X1		&C03/18.1	KE16PULSE01	KE16 Test pulse output CH1
X2		&C03/18.2	KE16PULSE02	KE16 Test pulse output CH2
+	A1			
-	A2			
I1		&C03/49.3	+UC20-KF16	Coil Safety Relay Nanogrid DC/AC
I2			JA01_BQ04_ASZ	Smoke Detector Ventilation Inlet
I3			JA01_BQ05_ASZ	Smoke Detector Ventilation Outlet A
I4			JA01_BQ06_ASZ	Smoke Detector Ventilation Outlet B
I5				ESTOP - 40ft Container Door CH1
I6				ESTOP - 40ft Container Door CH2
I7		&C03/54.4	SG23_CH1	ESTOP - 40ft Container Door CH1
I8		&C03/54.5	SG23_CH2	ESTOP - 40ft Container Door CH2
Q1		&C03/48.2 &C03/48.3	+UC20-KF16	Coil Safety Relay Nanogrid DC/AC
Q2		&C03/55.7	UC20_KF53	Customer Gas Status
Q3		&C03/55.5	UC20_KF50	Customer Safety Status
Q4		&C03/55.6	UC20_KF51	Customer Fire Status

SICK.1044125

-KE17
1 AI
Safe Analog Input Module

Flexi Soft Analog input module, FX3-ANA0

AI+	AI1+	JA01_BQ01_AZT	H2 Sensor Ventilation Inlet
AI1-	AI1-		
AI+	AI2+		
AI2-	AI2-		

SICK.1051134

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

REVISION INFORMATION
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28-Mar-25

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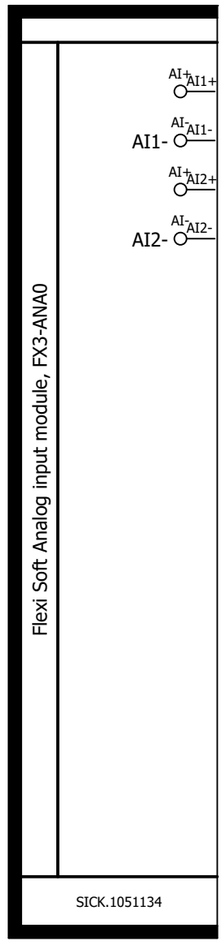
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 40ft Container 4/5		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 19 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet

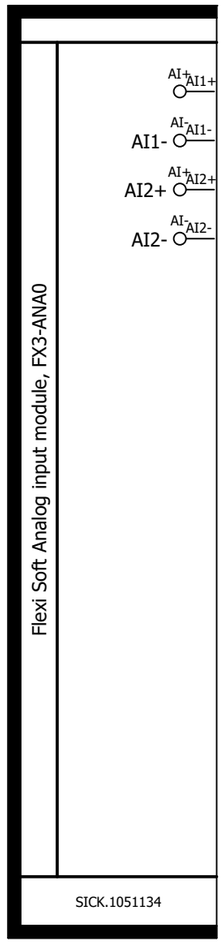
-KE18
1 AI
Safe Analog Input Module



JA01_BQ02_AZT

H2 Sensor Ventilation Outlet A

-KE19
1 AI
Safe Analog Input Module



JA01_BQ03_AZT

H2 Sensor Ventilation Outlet B

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C02

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DESCRIPTION
DATE
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DRAWING	601456B UC20 40ft Control Cabinet			REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet				
SHEET TYPE/DESC	Safety Controller, 40ft Container 5/5				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	20 / 18	

0	1	2	3	4	5	6	7	8

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Ballard Power Systems Europe - Technology Solutions

Multiline Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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26-Mar-25

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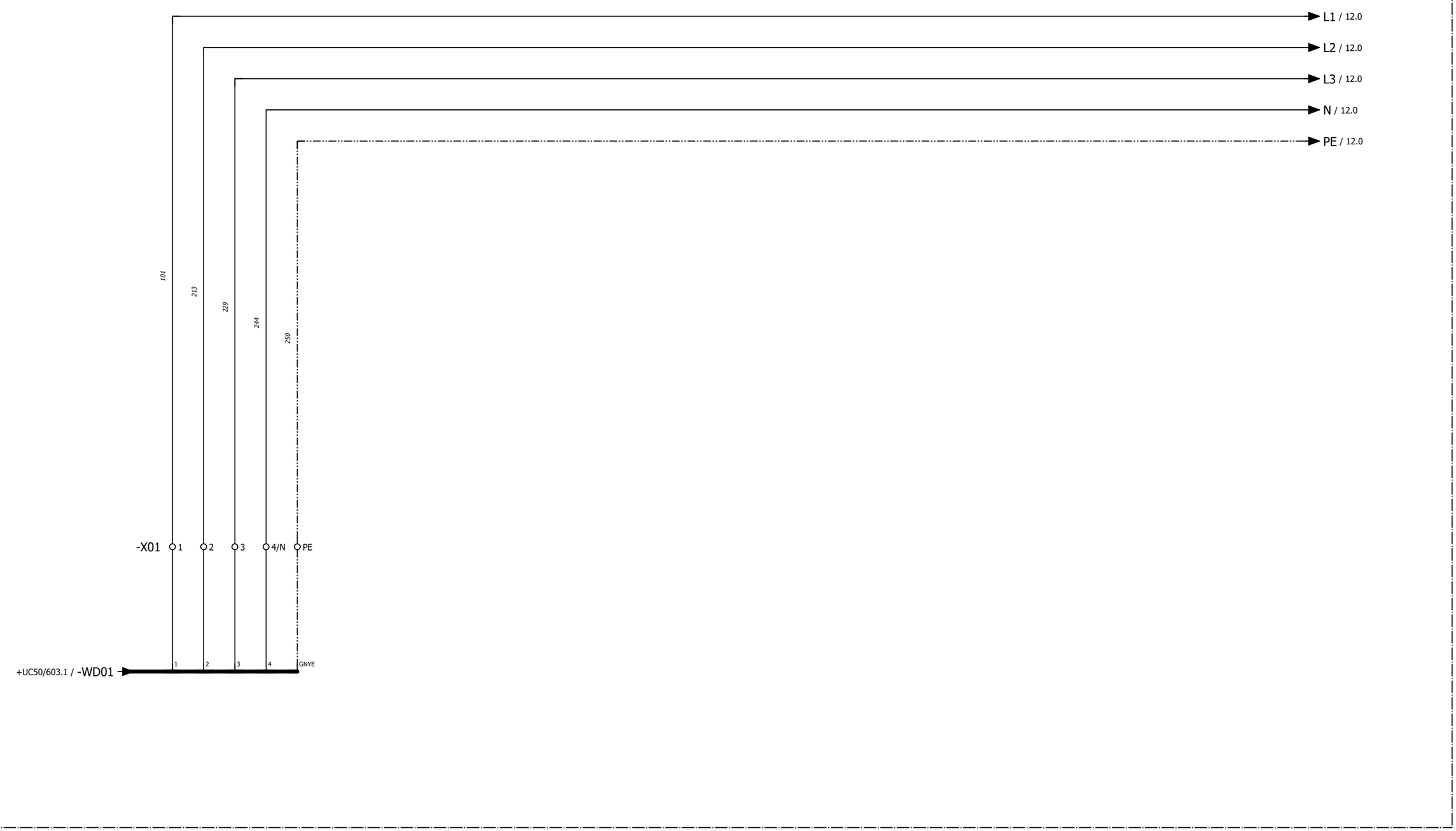
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Multiline Documentation Intro		

ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
DESCRIPTION
DATE
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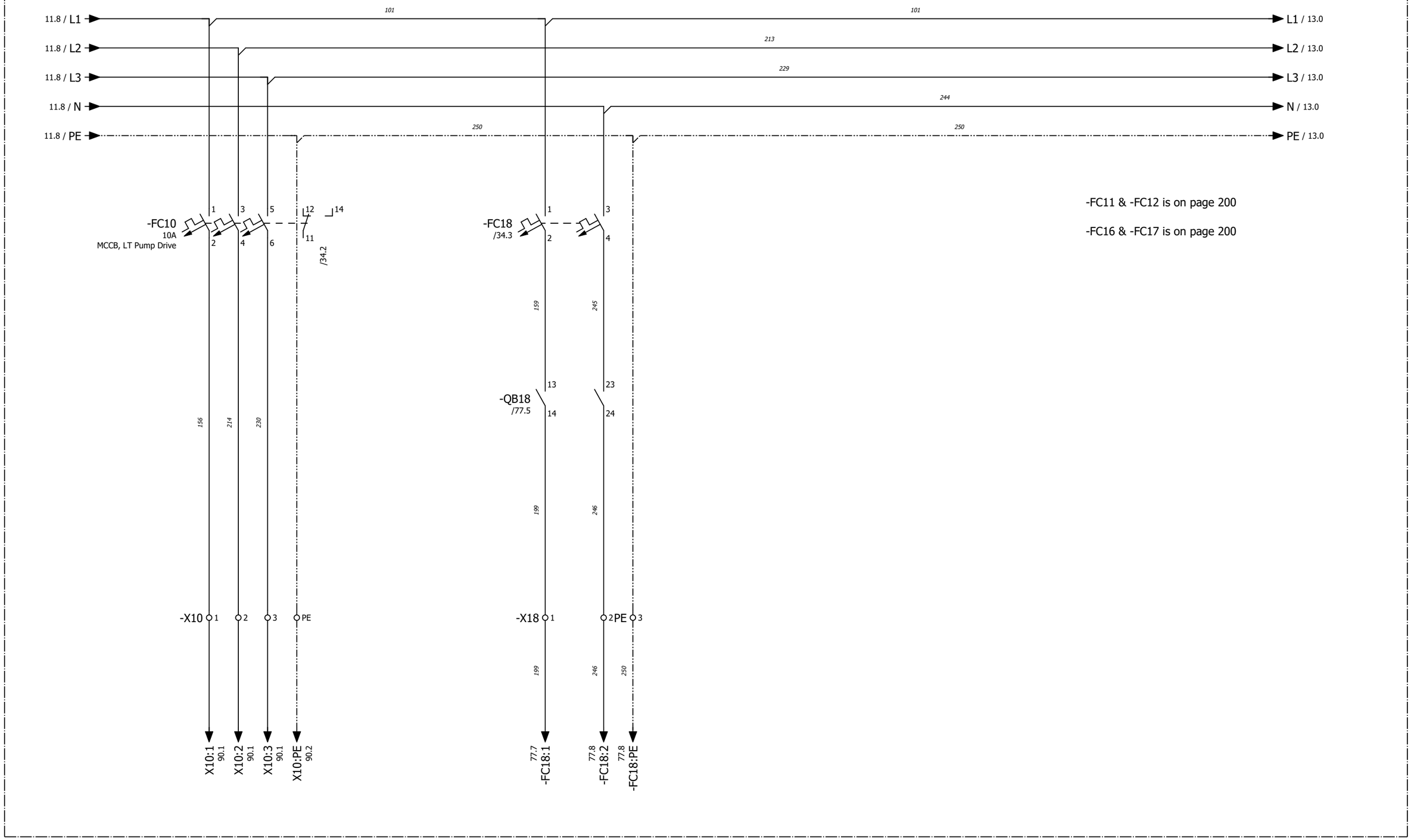
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container MCU Power supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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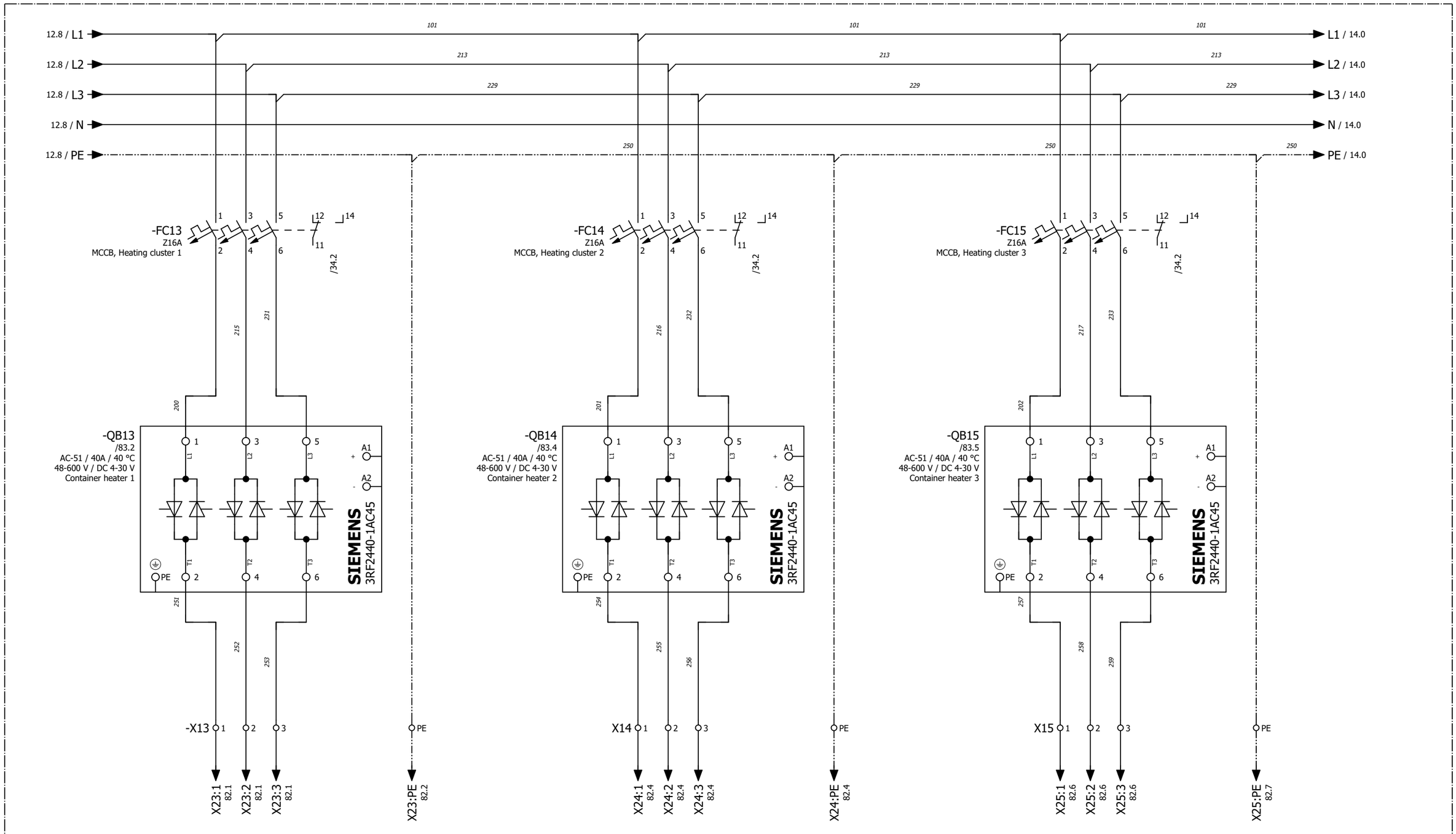
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container MCU Power supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 12 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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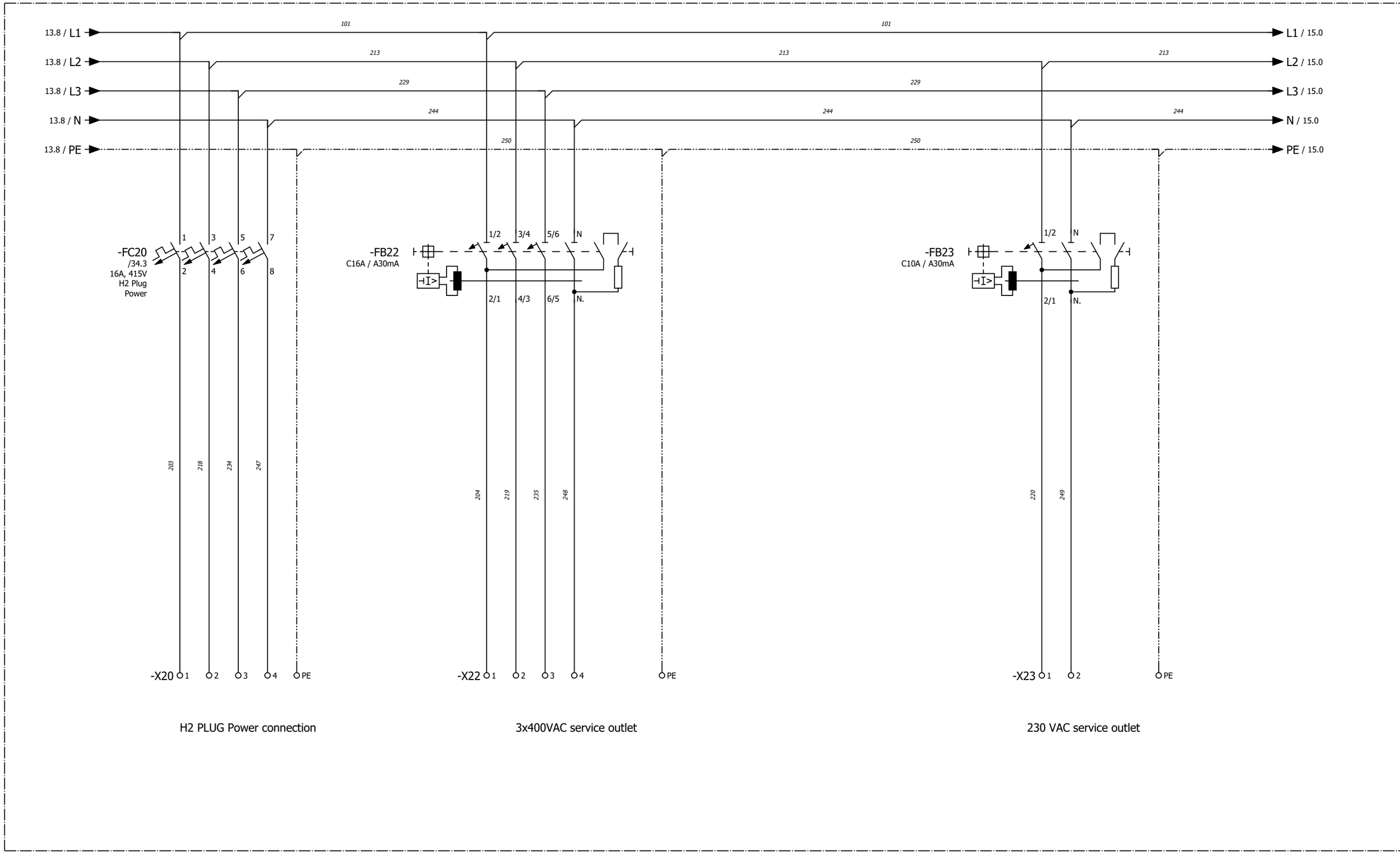
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container Heater control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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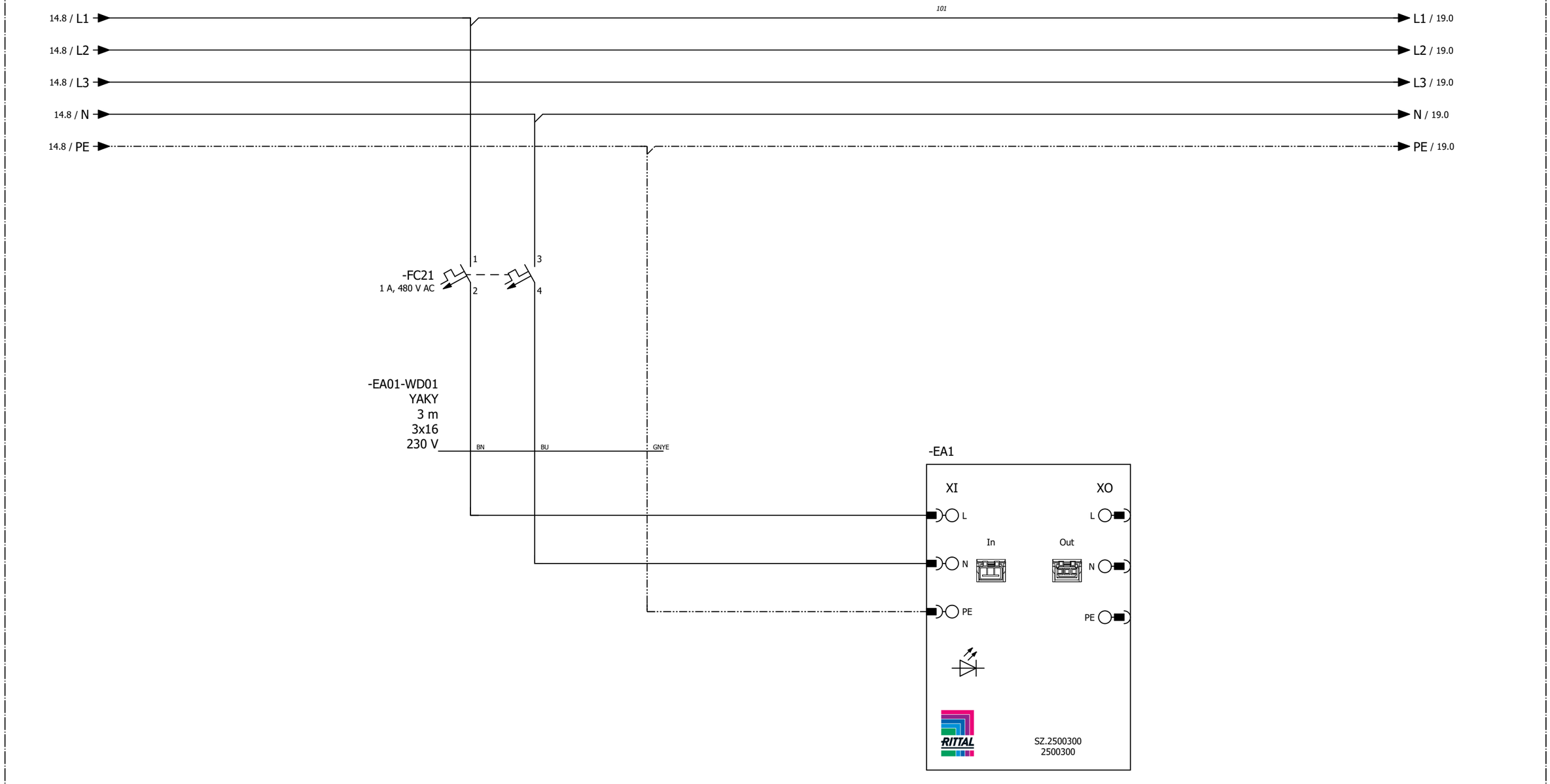
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container Service outlets		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 14 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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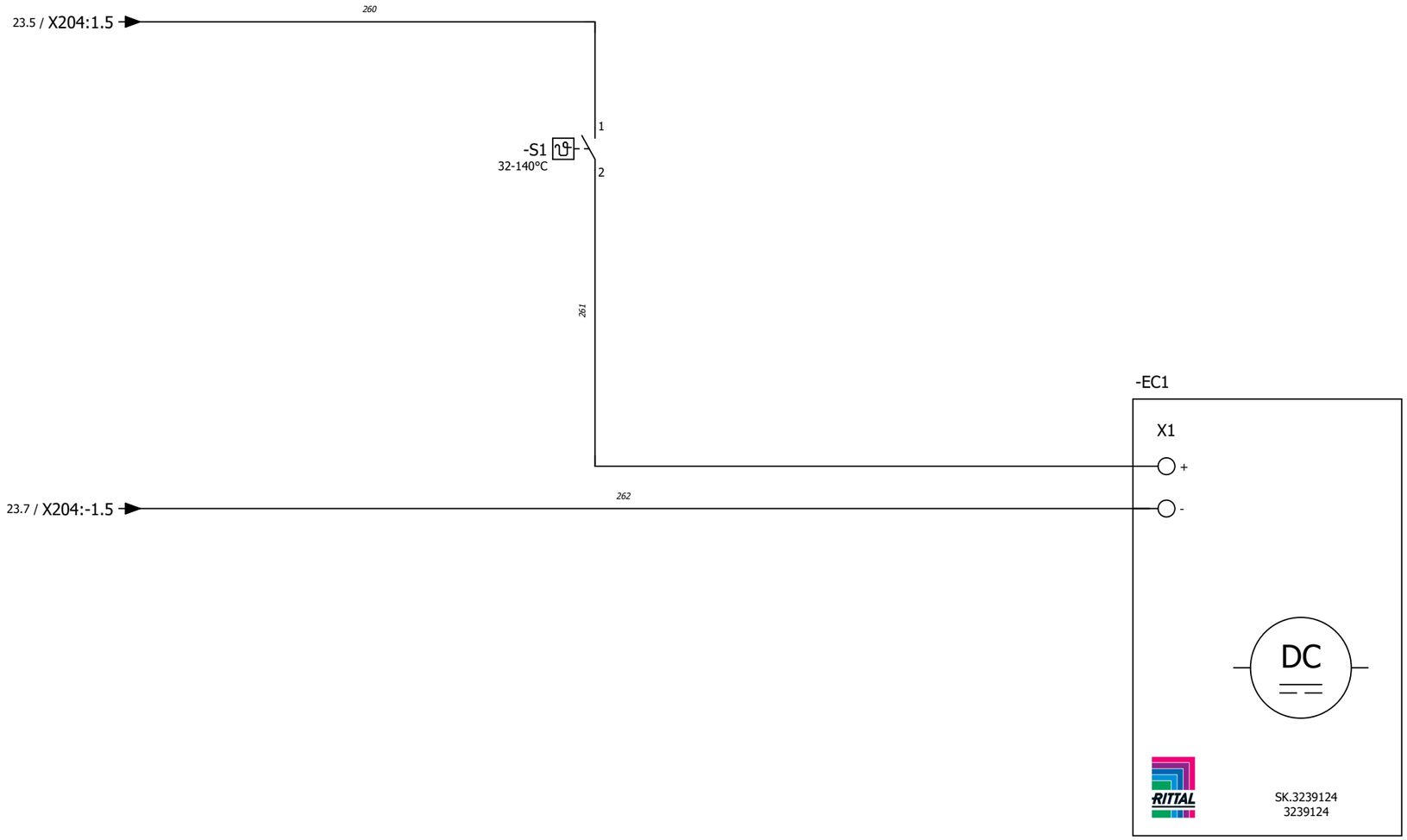
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DRAWING	601456B UC20 40ft Control Cabinet		REVISION	06	
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet				
SHEET TYPE/DESC	40ft container Cabinet light				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	15 / 2	

=LA01+UC20
Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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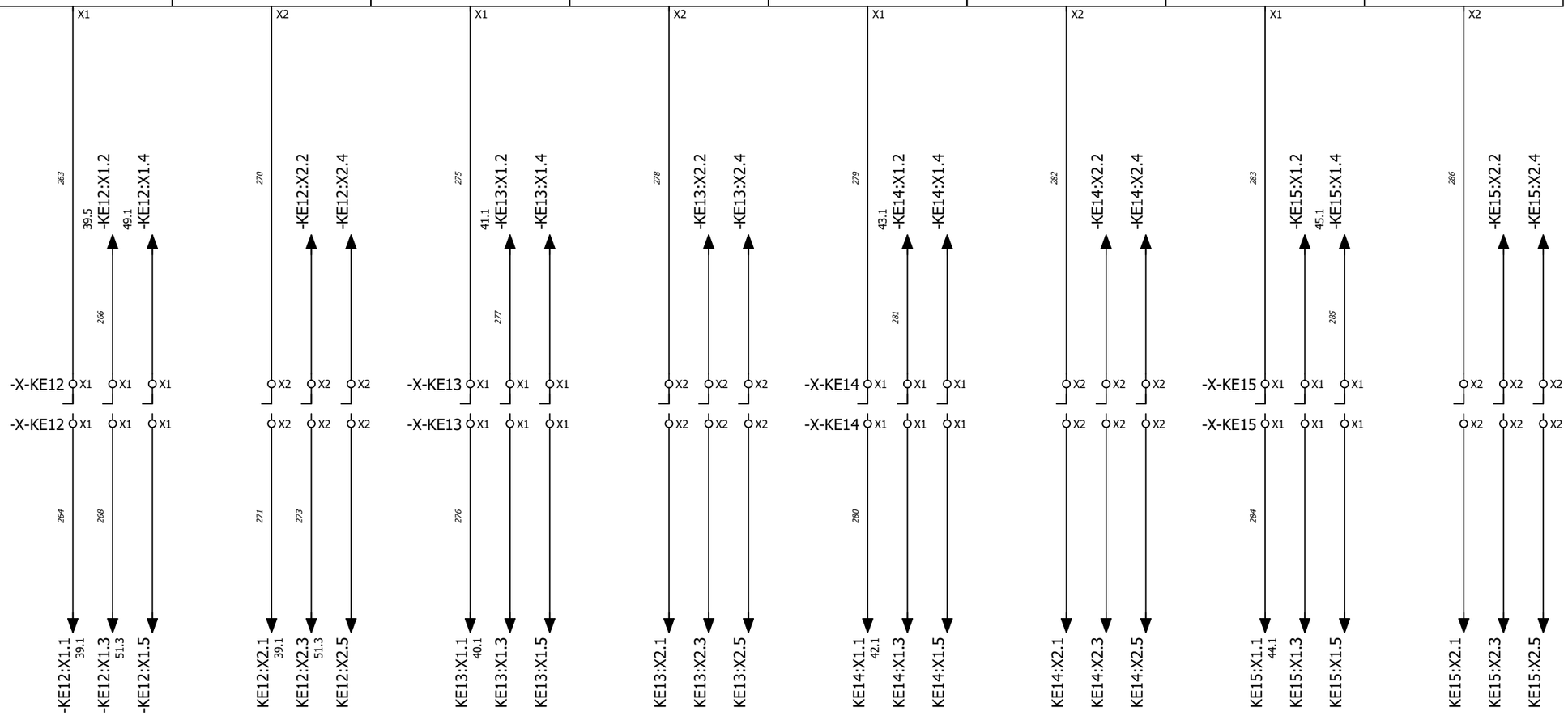
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container Cabinet fan		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 16 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet 40 ft

KE12 Test pulse output CH1	KE12 Test pulse output CH2	KE13 Test pulse output CH1	KE13 Test pulse output CH2	KE14 Test pulse output CH1	KE14 Test pulse output CH2	KE15 Test pulse output CH1	KE15 Test pulse output CH2
KE12PULSE01	KE12PULSE02	KE13PULSE01	KE13PULSE02	KE14PULSE01	KE14PULSE02	KE15PULSE01	KE15PULSE02
&C02/17.1	&C02/17.1	&C02/17.5	&C02/17.5	&C02/18.1	&C02/18.1	&C02/18.4	&C02/18.4
-KE12		KE13		KE14		-KE15	



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Pulse generator		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 17 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Pulse generator		

ALL SHEETS ARE THE SAME REVISION STATUS | SIZE A3 | LANGUAGE EN | SHEET/TOTAL 18 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

15.8 / L1 → L1 / 25.0 (101)
15.8 / L2 → L2 / 25.0 (213)
15.8 / L3 → L3 / 25.0 (229)
15.8 / N → N / 25.0
15.8 / PE → PE / 25.0 (250)

-FC30
6 A
1 3 5
2 4 6

205 221 236

-TB30
/34.5
L1 L2 L3 PE
3AC 380-480V

PULS
Power Supply
QT20.241
24-28V
DC-OK
Overload

DC 24V, 20A, 480W/720W
Out + Out +' Out - Out -' 13 14
DC-OK

292 293 294 295

24.2 -TB30:24V+
24.1 -TB30:24V-

-RB30
In + In - In -'
DC 24V

PULS
DC-UPS Control Unit, 24V, 20A
UB20.241

PE
RB30_Pos / 20.2
RB30_Neg / 20.2
RB30_11 / 20.3
RB30_12 / 20.3
Bat. + Bat. -
11 12 13
PT100 Temp. Sensor
PT100 Temp. Sensor
Battery Center Tap

DC 24V 20A
Out + Out -
296 297
-RB30+ 21.1
-RB30- 21.1

Ready 1 Ready 2 Buffering 3 Buffering 4 Repl. Bat. 5 Repl. Bat. 6 Inhibit + 7 Inhibit - 8
298 299 298 300 298 301

22.4 / -X202:1.1

X02 22 DIO10
>=LA01-KE01-Slot3
&C02/2.6
UC20_RB30_SOH
PLC UPS Battery Low SOH

X02 21 DIO9
>=LA01-KE01-Slot3
&C02/2.6
UC20_RB30_BAT
PLC UPS Battery Operation

X02 20 DIO8
>=LA01-KE01-Slot3
&C02/2.6
UC20_RB30_RDY
PLC UPS Battery Ready

COM 23
>=LA01-KE01-Slot3: &C02/2.6 Supply COM
302
22.6 / -X202:-1.1

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24V Supply and UPS		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 19 / 2

0	1	2	3	4	5	6	7	8

=LA01+DA01

-CA30

PULS

Battery Module, 24V, 12Ah
UZK24.121

DC 24V
Out + Out -

PT100 Temp. Sensor 11
PT100 Temp. Sensor 12
Battery Center Tap 13

-CA30-WD01
ÖLFLEX CLASSIC 100 H
3G2,5
450 V
Battery supply RB30 1 2

-CA30-WG01
ÖLFLEX® CLASSIC 130 H
3G1
300/500 V
1 2 Temp sensor CA30

19.4 / >+UC20-RB30_Pos
19.4 / >+UC20-RB30_Neg
19.5 / >+UC20-RB30_11
19.5 / >+UC20-RB30_12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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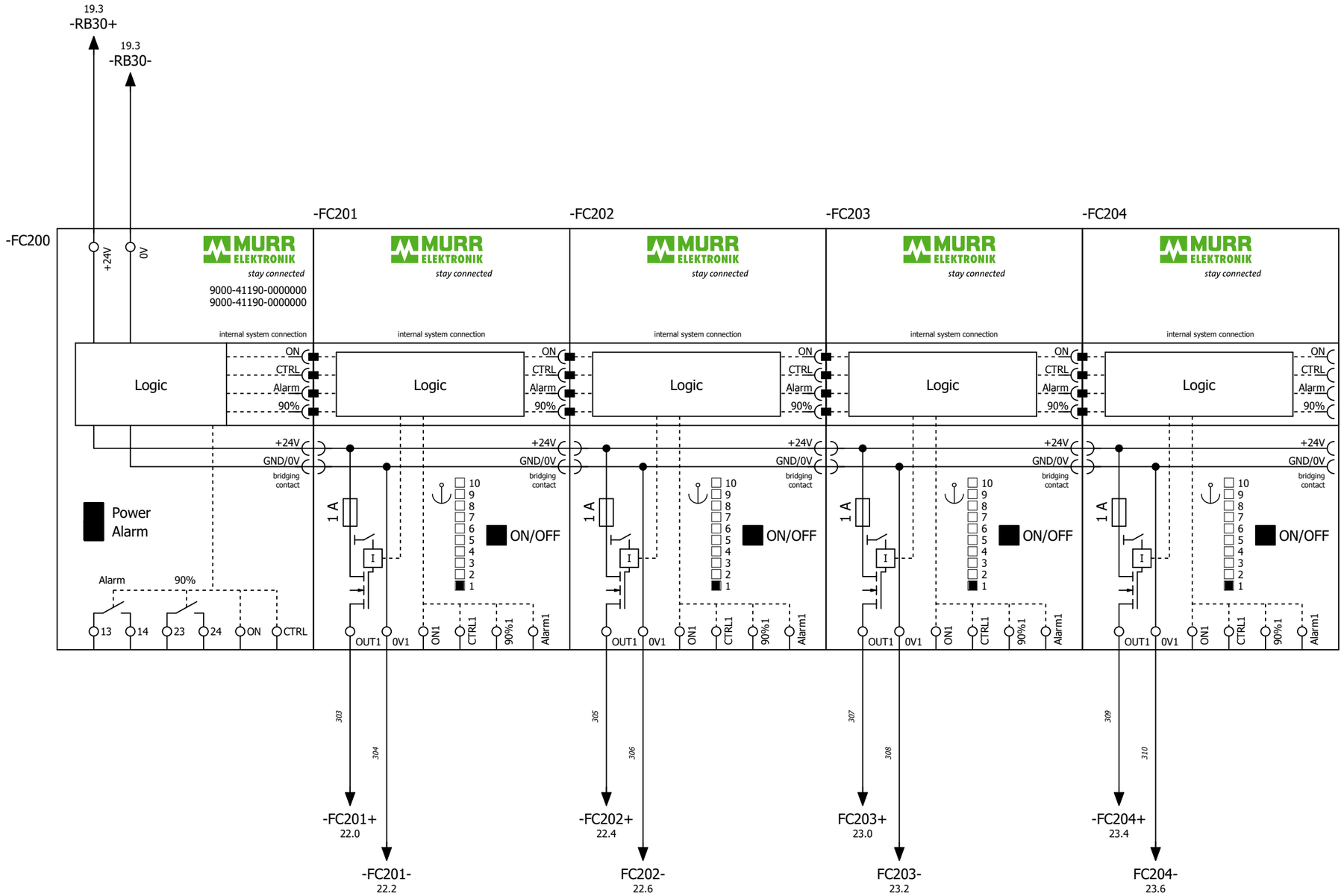
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24V Backup Battery		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 20 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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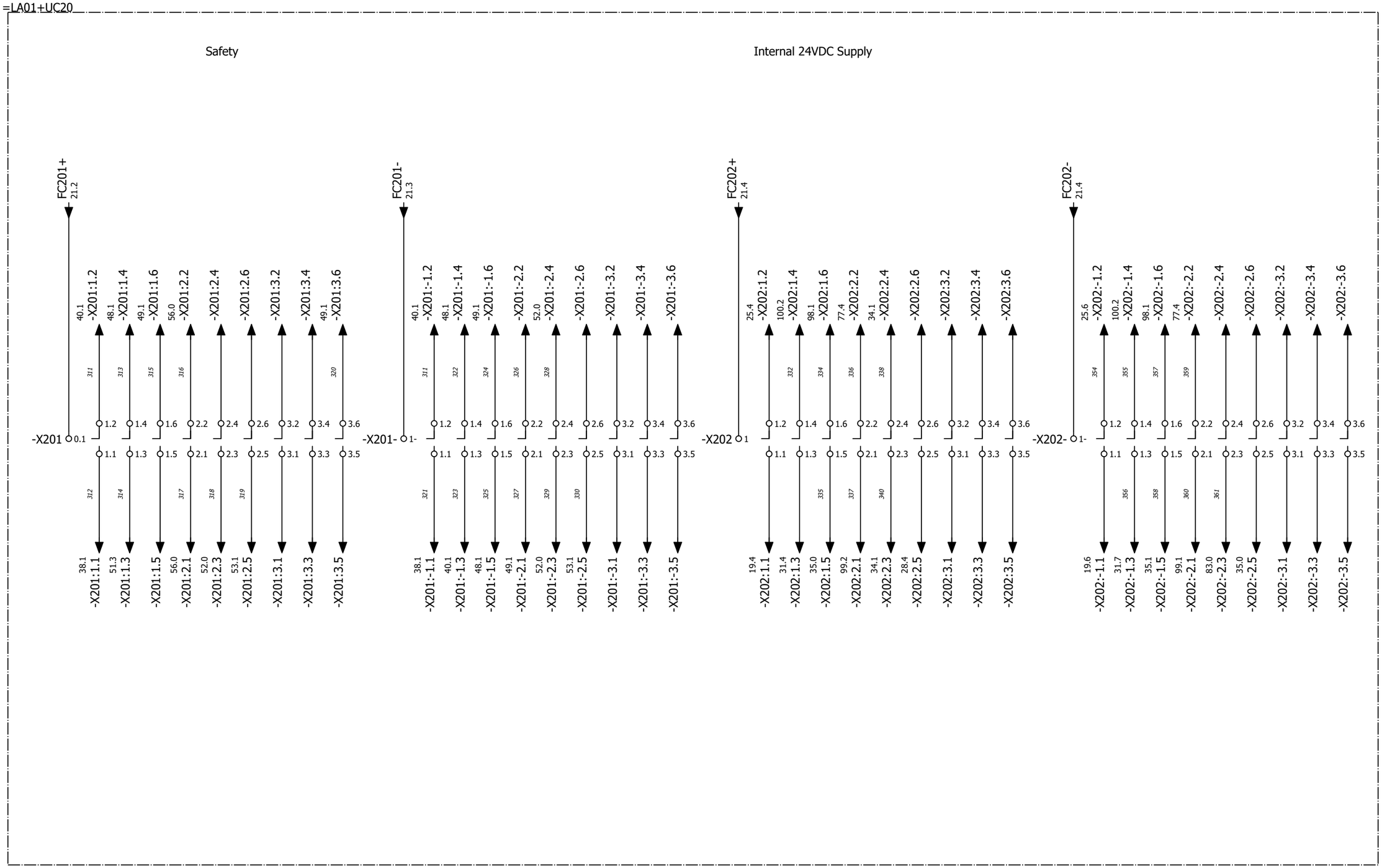
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24 VDC Supply Fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 21 / 2

=LA01+UC20

Safety

Internal 24VDC Supply



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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=	++	+ UC20	& C03

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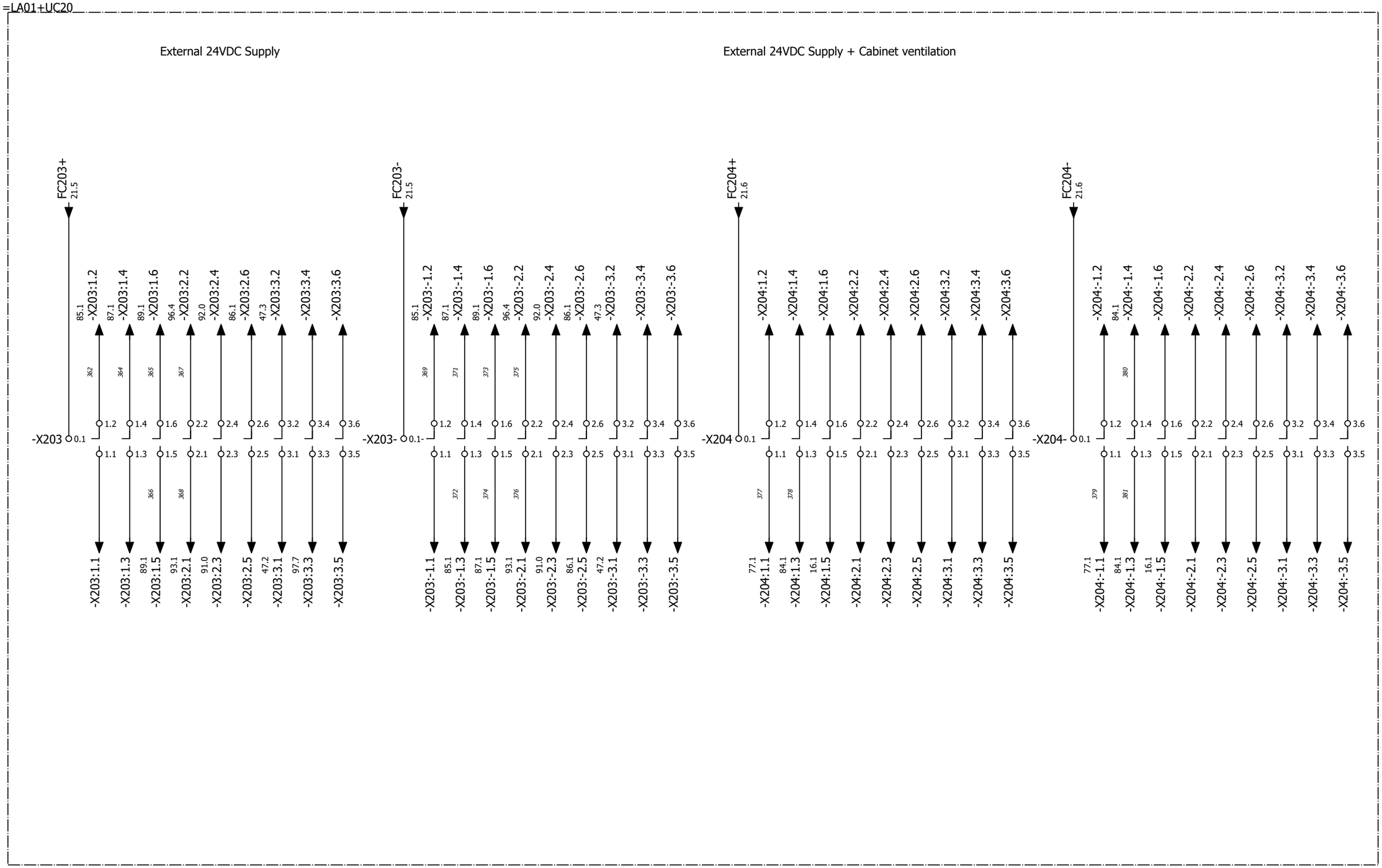
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24 VDC Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

External 24VDC Supply

External 24VDC Supply + Cabinet ventilation



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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=	++	+ UC20	& C03

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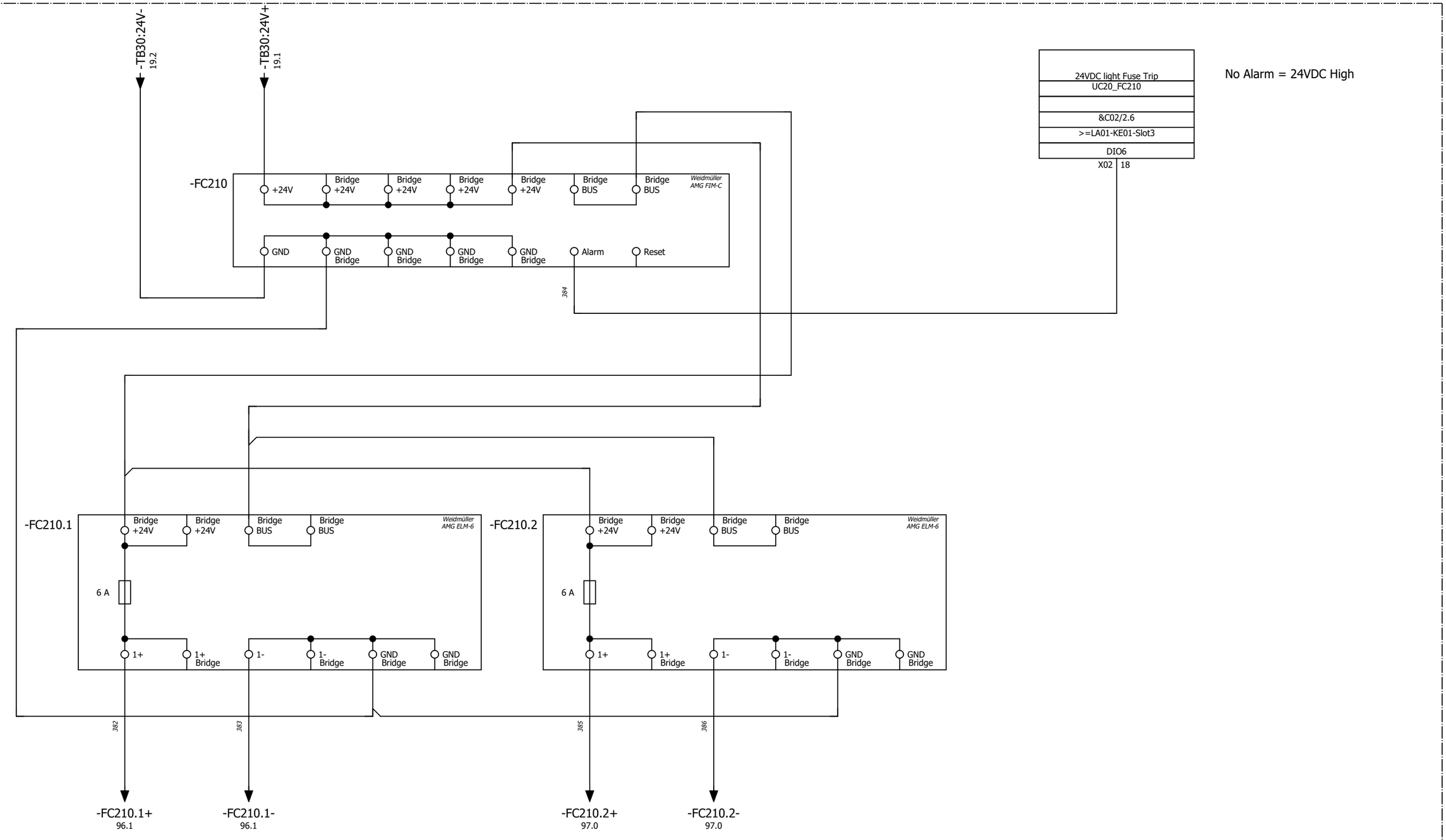
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24 VDC Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 23 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - 24 VDC Supply Container light		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 24 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

19.7 / L1 → L1 / 28.0 (101)
19.7 / L2 → L2 / 28.0 (213)
19.7 / L3 → L3 / 28.0 (229)
19.7 / N → N / 28.0
19.7 / PE → PE / 28.0 (250)

-FC31
6 A
1 3 5
2 4 6

206 222 237

-TB01
L1 L2 L3 PE
3AC 380-480V

PULS
Power Supply
QT40.241
24-28V
DC-OK
Overload
Single/Parallel Mode
DC 24V, 40A, 960W/1440W
Out + Out +' Out - Out -' 13 14 15 16
DC-OK Shut-Down

387 388

PE

>=LA01+DA01-RB01-WG01
UNITRONIC®-FD CP (TP) PLUS
4x0,5
500 V
Temp Sensor CA01 WH BN

RB01_11 / 26.2
RB01_12 / 26.3

>=LA01+DA01-RB01-WD01
ÖLFLEX® CLASSIC 110 CH
3x2,5
300/500 V
Battery Supply RB01 1 2

RB01_Pos / 26.1
RB01_Neg / 26.2

-RB01
FC1+2 24V UPS Module
IN + - BAT_MON 11 12 BAT + 13 -

PULS
UB40.241
DC-UPS CONTROL UNIT

Inhibit + Inhibit - Rdy Rdy Buffer Buffer BAT. Replace BAT. Replace Low BAT. Low BAT.

OUT + - 7 8 1 2 3 4 5 6 14 15 PE

331 331 331 331

389 390 391 392 393 394

-RB01+
27.0
-RB01-
27.0

22.4 / -X202:1.2

X02 18 DI04
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB01_RDY
FC1+2 UPS Battery Ready

X02 19 DI05
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB01_BAT
FC1+2 UPS Battery Operation

X02 20 DI06
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB01_SOH
FC1+2 UPS Battery Low SOH

X02 21 DI07
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB01_DIS
FC1+2 UPS Battery Discharged

COM 23
>=LA01-KE02-Slot03: &C02/5.6 Supply COM

22.6
-X202:-1.2

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1+2 24V Supply and UPS		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 25 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+DA01

-CA01

PULS

Battery Module, 24V, 12Ah
UZK24.121

DC 24V
Out + Out -

PT100 Temp. Sensor 11
PT100 Temp. Sensor 12
Battery Center Tap 13

25.4 / >+UC20-RB01_Pos
25.4 / >+UC20-RB01_Neg
25.4 / >+UC20-RB01_11
25.4 / >+UC20-RB01_12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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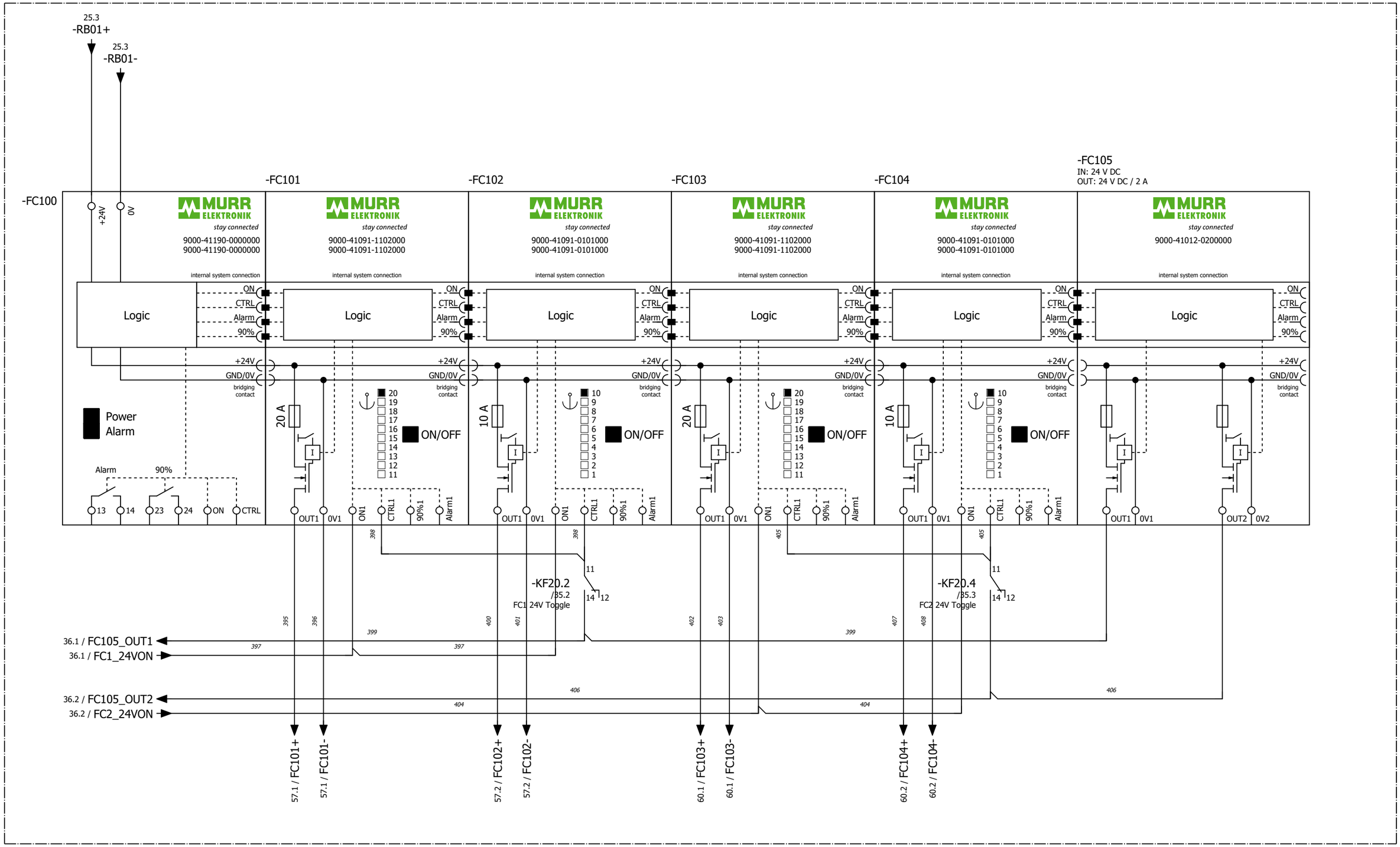
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1+2 24V Backup Battery		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 26 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1+2 24V Fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 27 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

25.7 / L1 → 101 → L1 / 31.0
25.7 / L2 → 213 → L2 / 31.0
25.7 / L3 → 229 → L3 / 31.0
25.7 / N → N / 31.0
25.7 / PE → 250 → PE / 31.0

-FC32
6 A
1 3 5
2 4 6

207 223 238

-TB02
L1 L2 L3 PE
3AC 380-480V

PULS
Power Supply
QT40.241
24-28V
DC-OK
Overload
Single/Parallel Mode

DC 24V, 40A, 960W/1440W
Out + Out +' Out - Out -' 13 14 15 16
DC-OK Shut-Down

409 410

PE

>=LA01+DA01-RB02-WG01
UNITRONIC®-FD CP (TP) PLUS
4x0,5
500 V
Temp Sensor CA02
WH BN

RB02_11 / 29.3
RB02_12 / 29.3

>=LA01+DA01-RB02-WD01
ÖLFLEX® CLASSIC 110 CH
3x2,5
300/500 V
Battery Supply RB02
1 2

RB02_Pos / 29.2
RB02_Neg / 29.2

-RB02
IN + - BAT_MON 11 12 BAT + 13 -

PULS
UB40.241
DC-UPS CONTROL UNIT

Inhibit + Inhibit - Rdy Rdy Buffer Buffer BAT. Replace BAT. Replace Low BAT. Low BAT.

OUT + - 7 8 1 2 3 4 5 6 14 15 PE

358
353 353 353
411 412 413 414 415 416

-RB02+
30.0
-RB02-
30.0

-X202:2.5
22.5

X02 22 → DI08
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB02_RDY
FC3+4 UPS Battery Ready

X03 24 → DI09
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB02_BAT
FC3+4 UPS Battery Operation

X03 25 → DI10
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB02_SOH
FC3+4 UPS Battery Low SOH

X03 26 → DI11
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB02_DIS
FC3+4 UPS Battery Discharged

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3+4 Supply and UPS		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 28 / 2

0	1	2	3	4	5	6	7	8

=LA01+DA01

-CA02

PULS

Battery Module, 24V, 12Ah
UZK24.121

DC 24V
Out + Out -

PT100 Temp. Sensor 11
PT100 Temp. Sensor 12
Battery Center Tap 13

28.4 / >+UC20-RB02_Pos
28.4 / >+UC20-RB02_Neg
28.4 / >+UC20-RB02_11
28.4 / >+UC20-RB02_12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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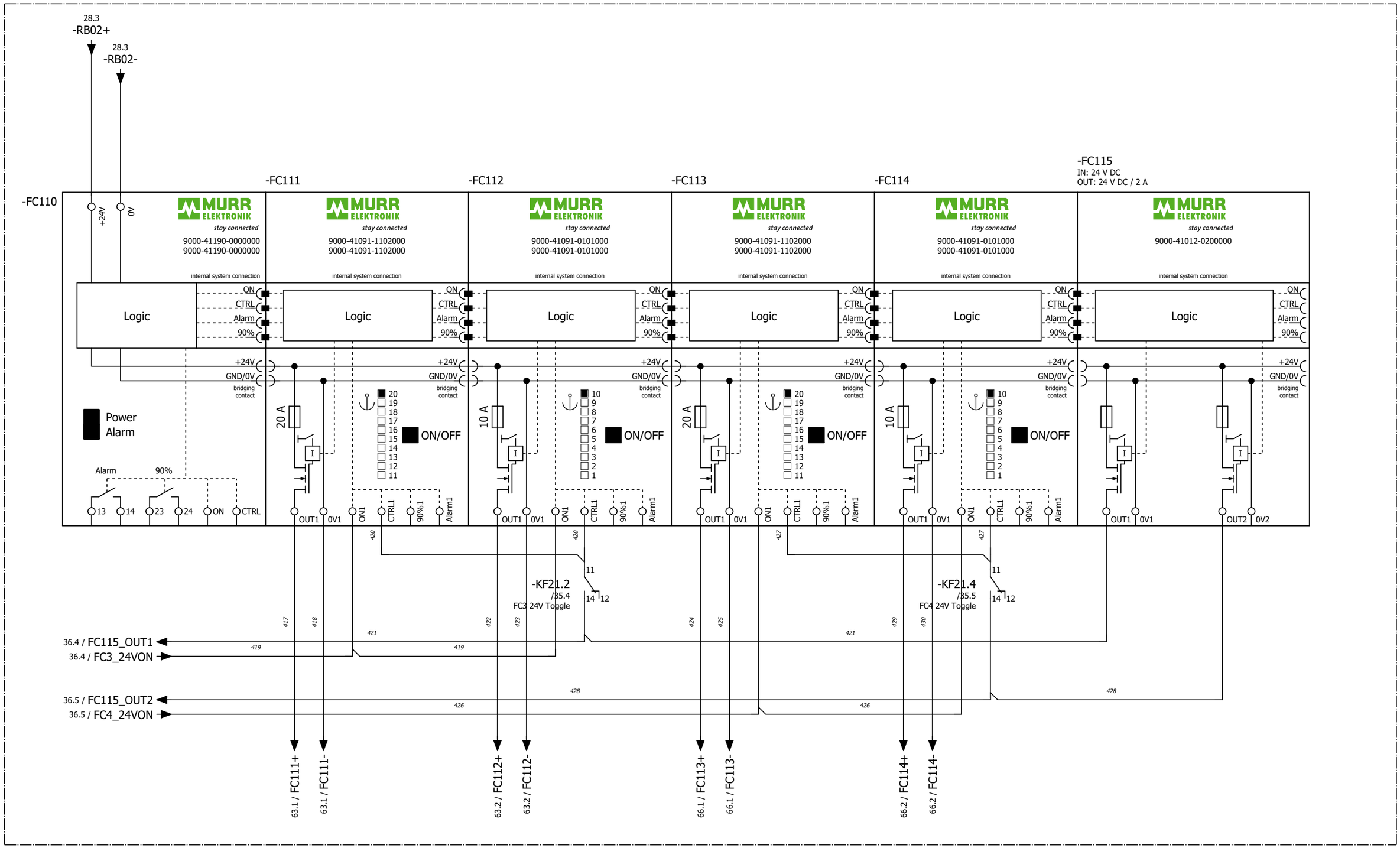
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3+4 24V Backup Battery		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 29 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3+4 24V Fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 30 / 2

=LA01+UC20

28.7 / L1 → 101 → L1 / 80.0
28.7 / L2 → 213 → L2 / 80.0
28.7 / L3 → 229 → L3 / 80.0
28.7 / N → N /
28.7 / PE → 250 → PE / 80.0

-FC33
6 A
1 3 5
2 4 6

208 224 239

-TB03
L1 L2 L3 PE
3AC 380-480V

PULS
Power Supply
QT40.241
24-28V
DC-OK
Overload
Single/Parallel Mode

DC 24V, 40A, 960W/1440W
Out + Out +' Out - Out -' 13 14 15 16
DC-OK Shut-Down

431 432

PE

>=LA01+DA01-RB03-WG01
UNITRONIC®-FD CP (TP) PLUS
4x0,5
500 V
Temp Sensor CA03
WH BN

RB03_11 / 32.3
RB03_12 / 32.3
RB03_Pos / 32.2
RB03_Neg / 32.2

>=LA01+DA01-RB03-WD01
ÖLFLEX® CLASSIC 110 CH
3x2,5
300/500 V
Battery Supply RB03
1 2

-RB03
IN + - BAT_MON 11 12 BAT + 13 -

PULS
UB40.241
DC-UPS CONTROL UNIT

Inhibit + Inhibit - Rdy Rdy Buffer Buffer BAT. Replace BAT. Replace Low BAT. Low BAT.

OUT + - 7 8 1 2 3 4 5 6 14 15 PE

333 333 333

433 434 435 436 437 438

-RB03+
33.0

-RB03-
33.0

-X202:1.3
22.5

X03 27 — DI12
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB03_RDY
FC5+6 UPS Battery Ready

X03 28 — DI13
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB03_BAT
FC5+6 UPS Battery Operation

X03 29 — DI14
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB03_SOH
FC5+6 UPS Battery Low SOH

X03 30 — DI15
>=LA01-KE02-Slot03
&C02/5.6
UC20_RB03_DIS
FC5+6 UPS Battery Discharged

COM 32
>=LA01-KE02-Slot03: &C02/5.6 Supply COM

-X202:-1.3
22.7

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5+6 24V Supply and UPS		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 / 2

0	1	2	3	4	5	6	7	8

=LA01+DA01

-CA03

PULS

Battery Module, 24V, 12Ah
UZK24.121

DC 24V
Out + Out -

PT100 Temp. Sensor 11
PT100 Temp. Sensor 12
Battery Center Tap 13

31.4 / >=LA01+UC20-RB03_Pos
31.4 / >=LA01+UC20-RB03_Neg
31.4 / >=LA01+UC20-RB03_11
31.4 / >=LA01+UC20-RB03_12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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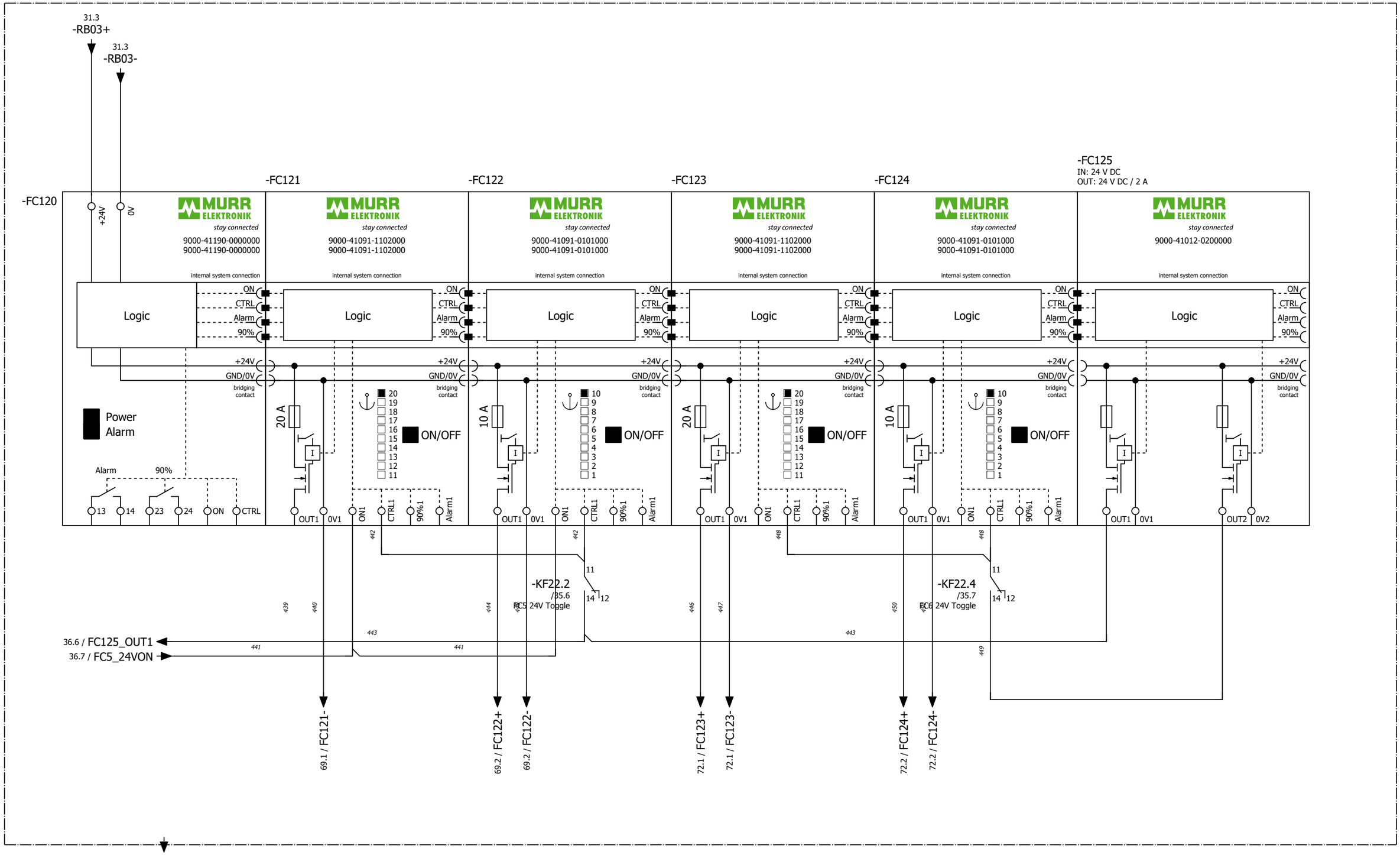
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5+6 Backup Battery		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 32 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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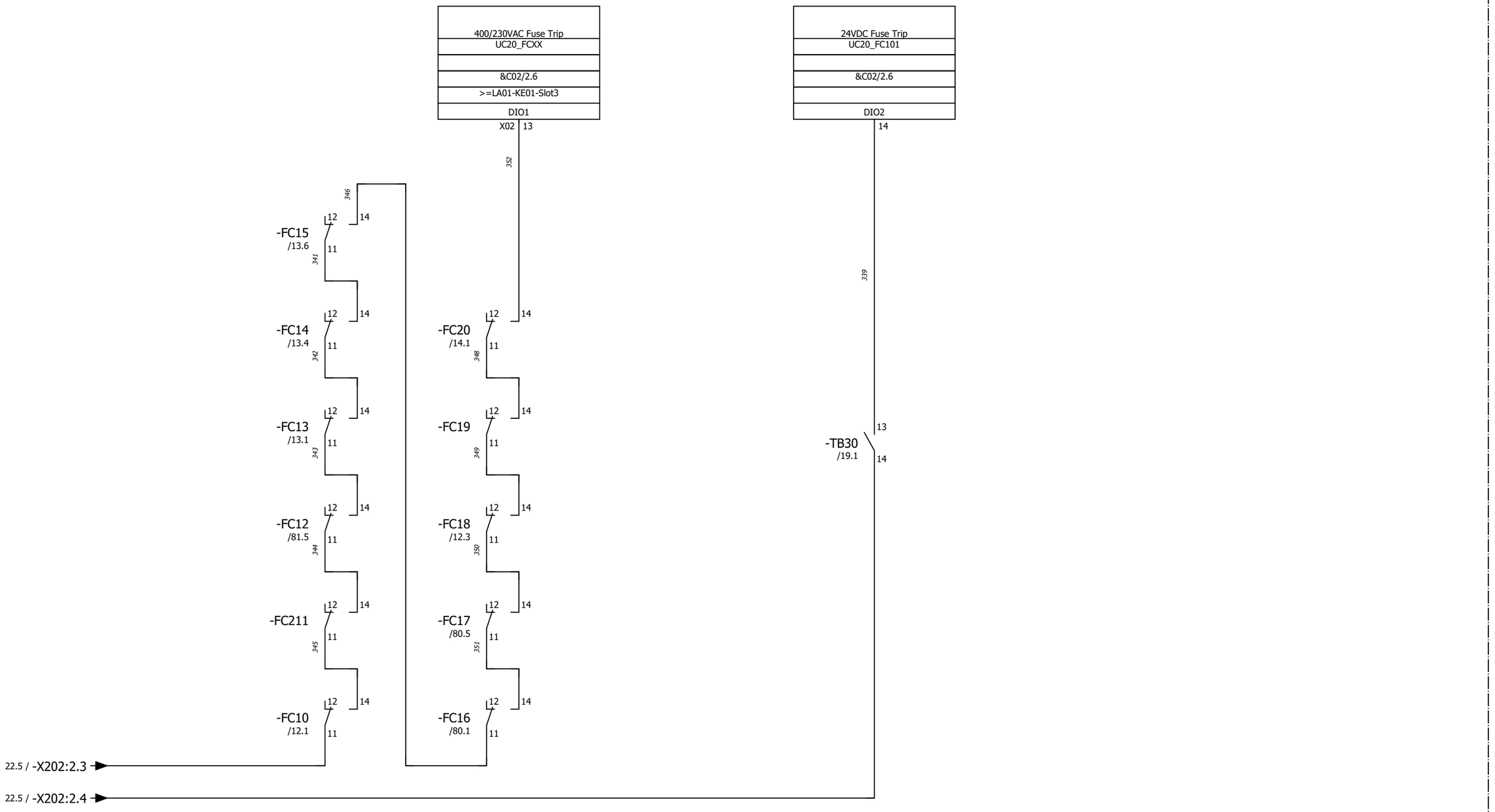
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5+6 24V Fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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=	++	+ UC20	& C03

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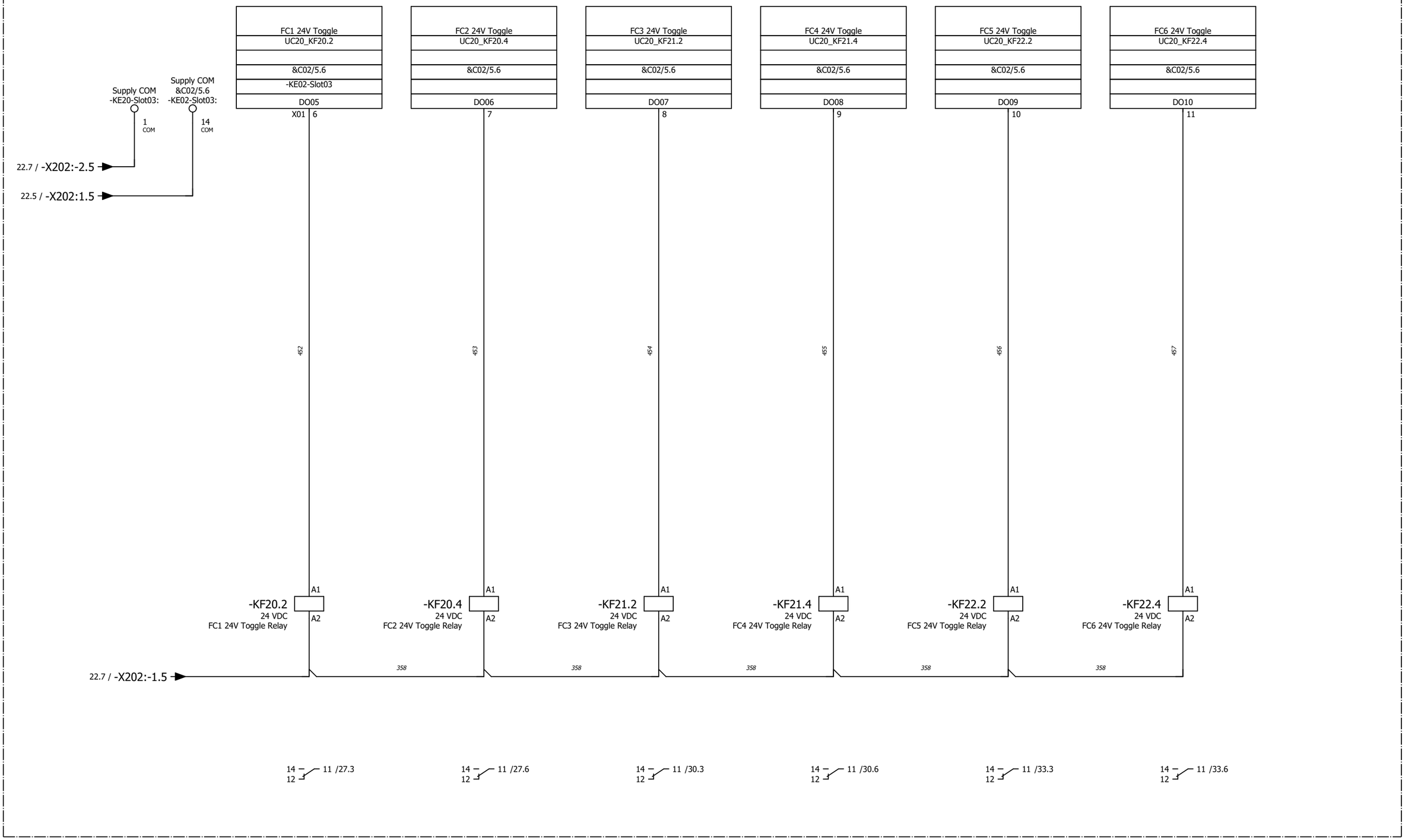
DRAWING	601456B UC20 40ft Control Cabinet		REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet			
SHEET TYPE/DESC	40ft container MCU Fuse trip feed back			
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	34 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Control System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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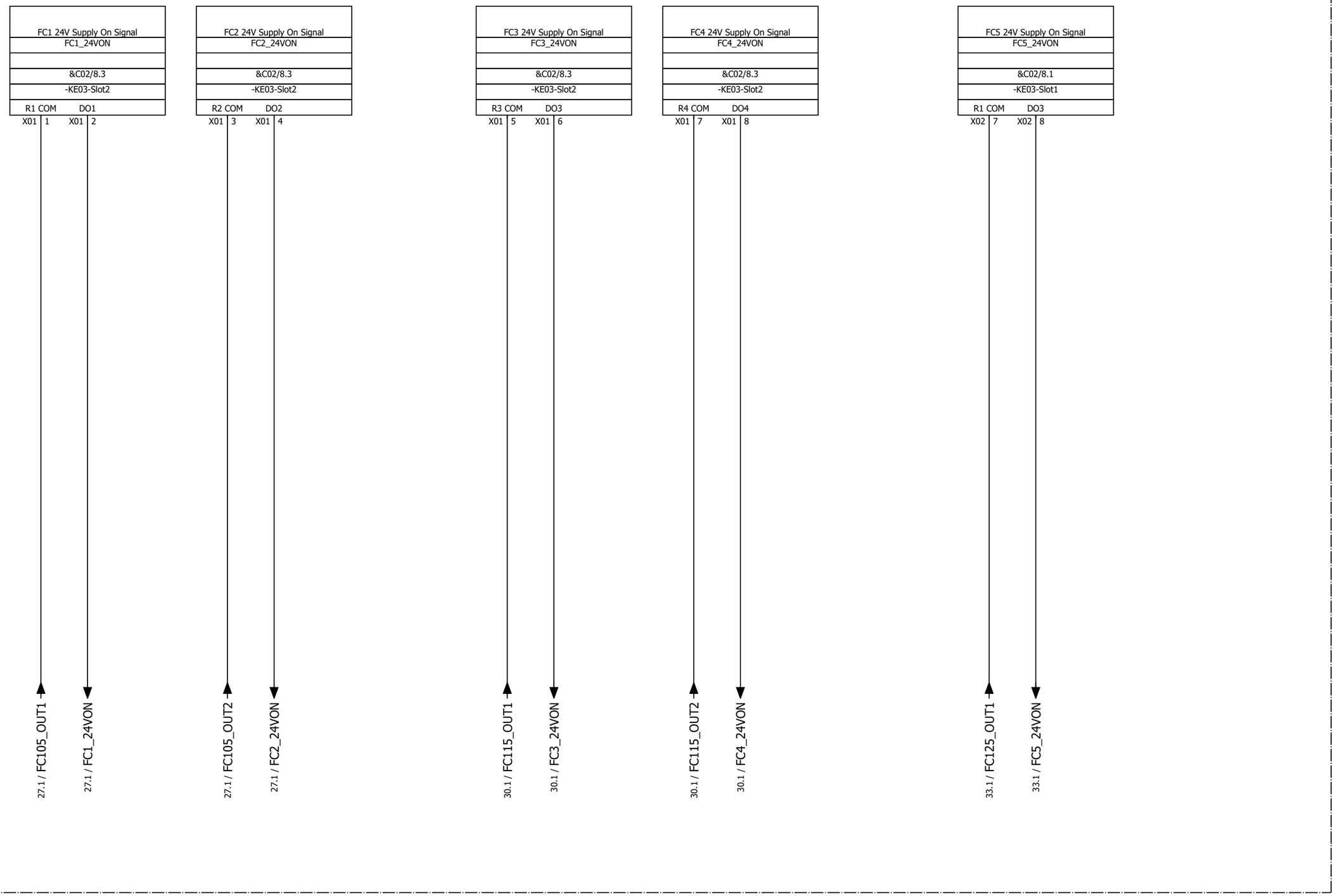
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1-6 24V Toggle		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Control System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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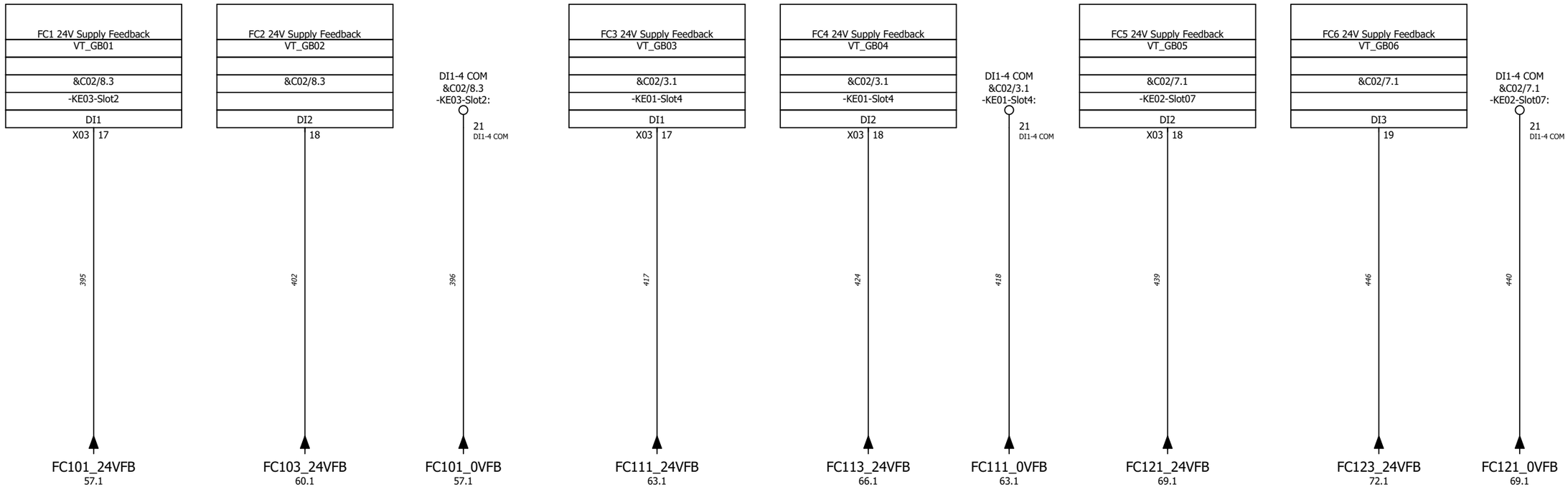
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1-6 24V Toggle On		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 36 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container Control System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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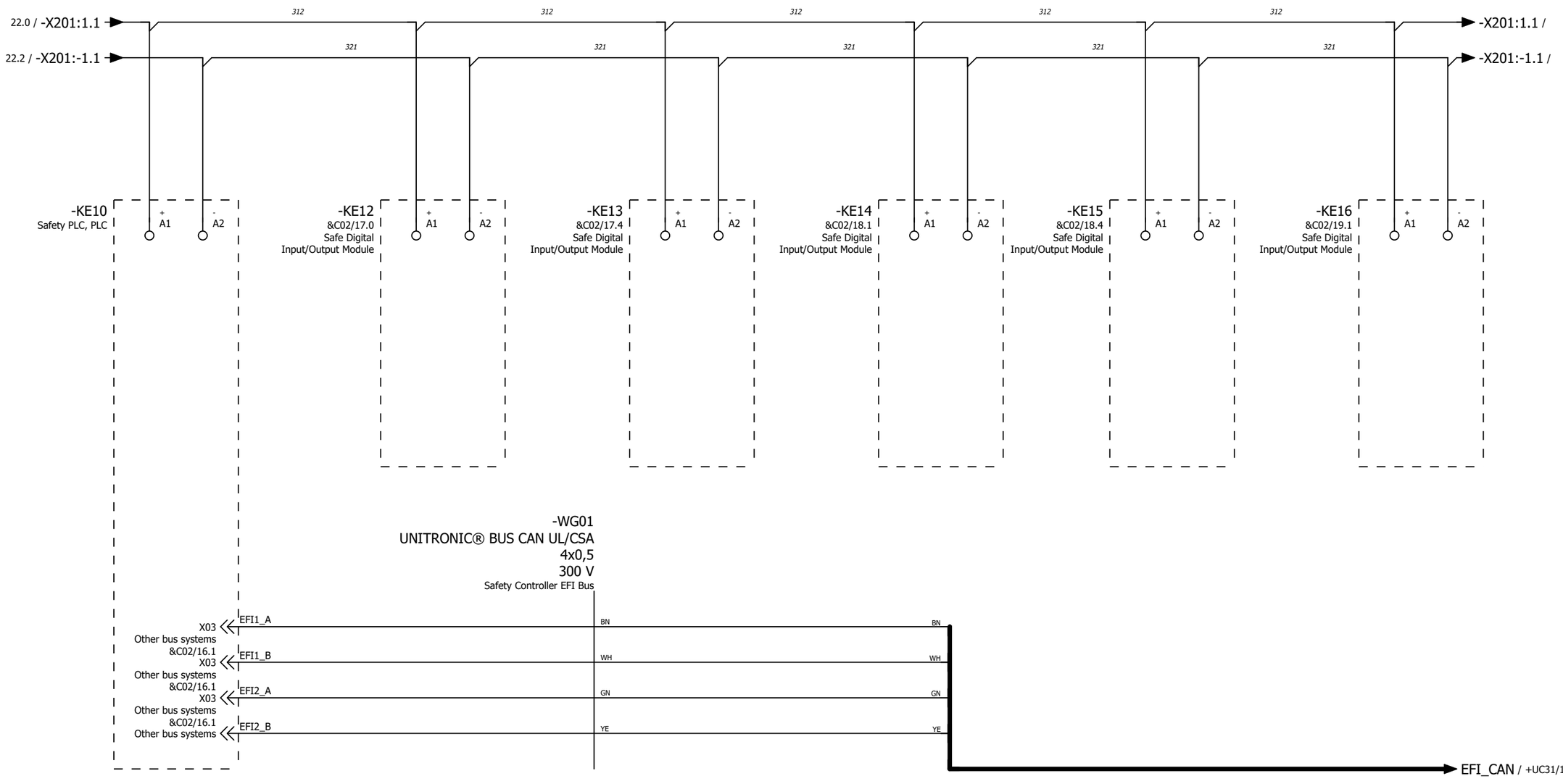
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1-6 24V Feedback		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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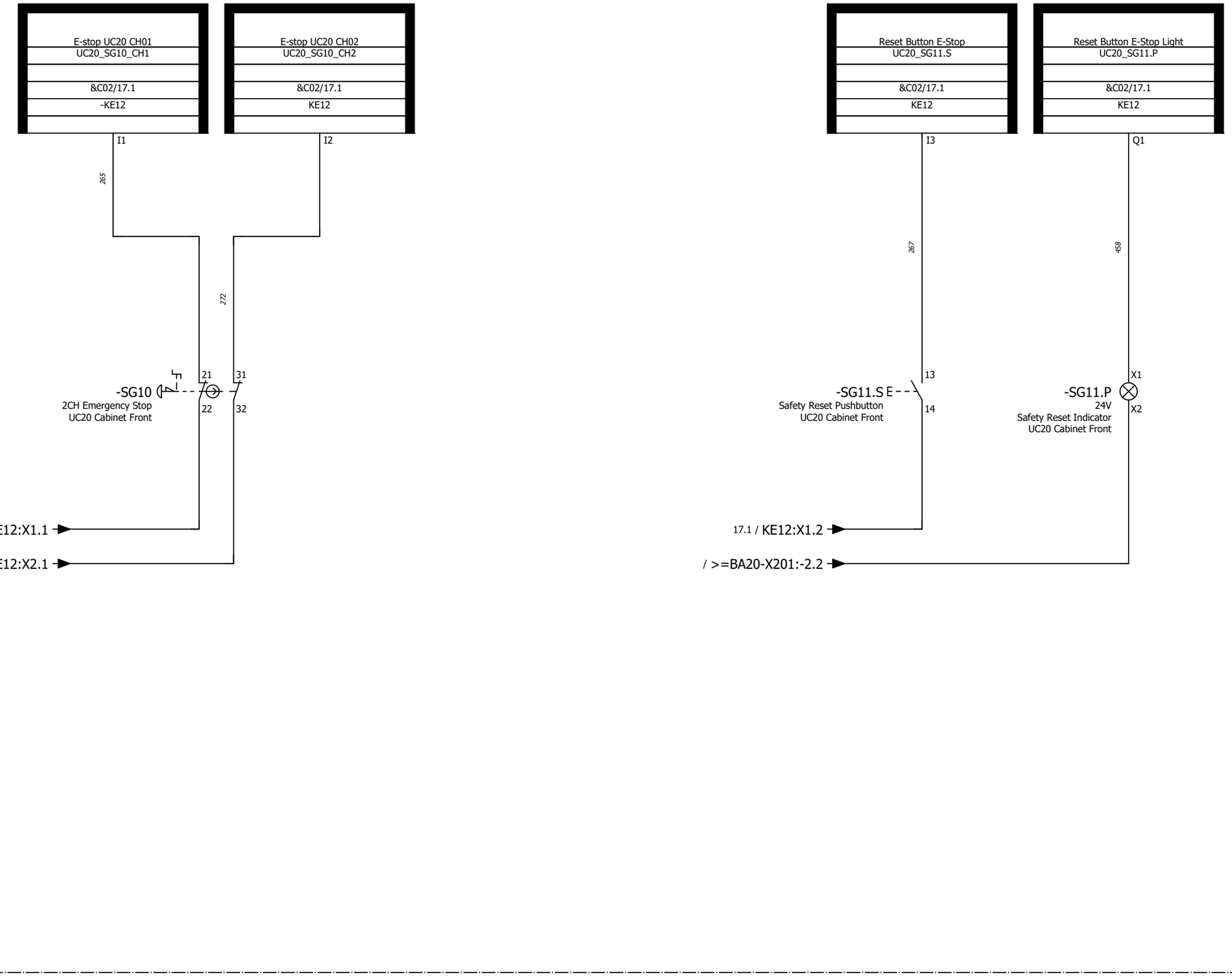
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet - Safety PLC 24V Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 38 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
DESCRIPTION
DATE
26-Mar-25

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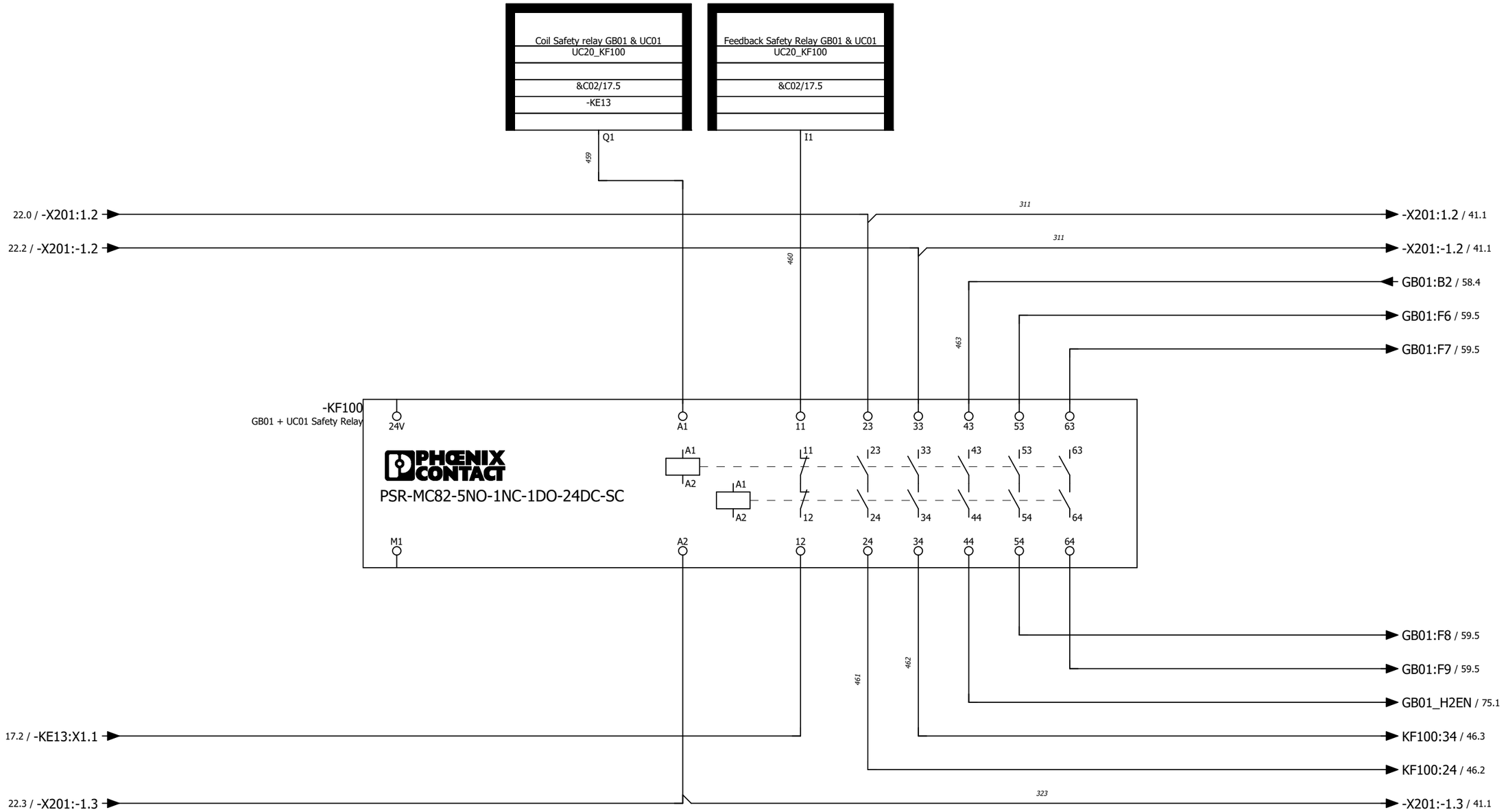
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet - Emergency stop button		

ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	39 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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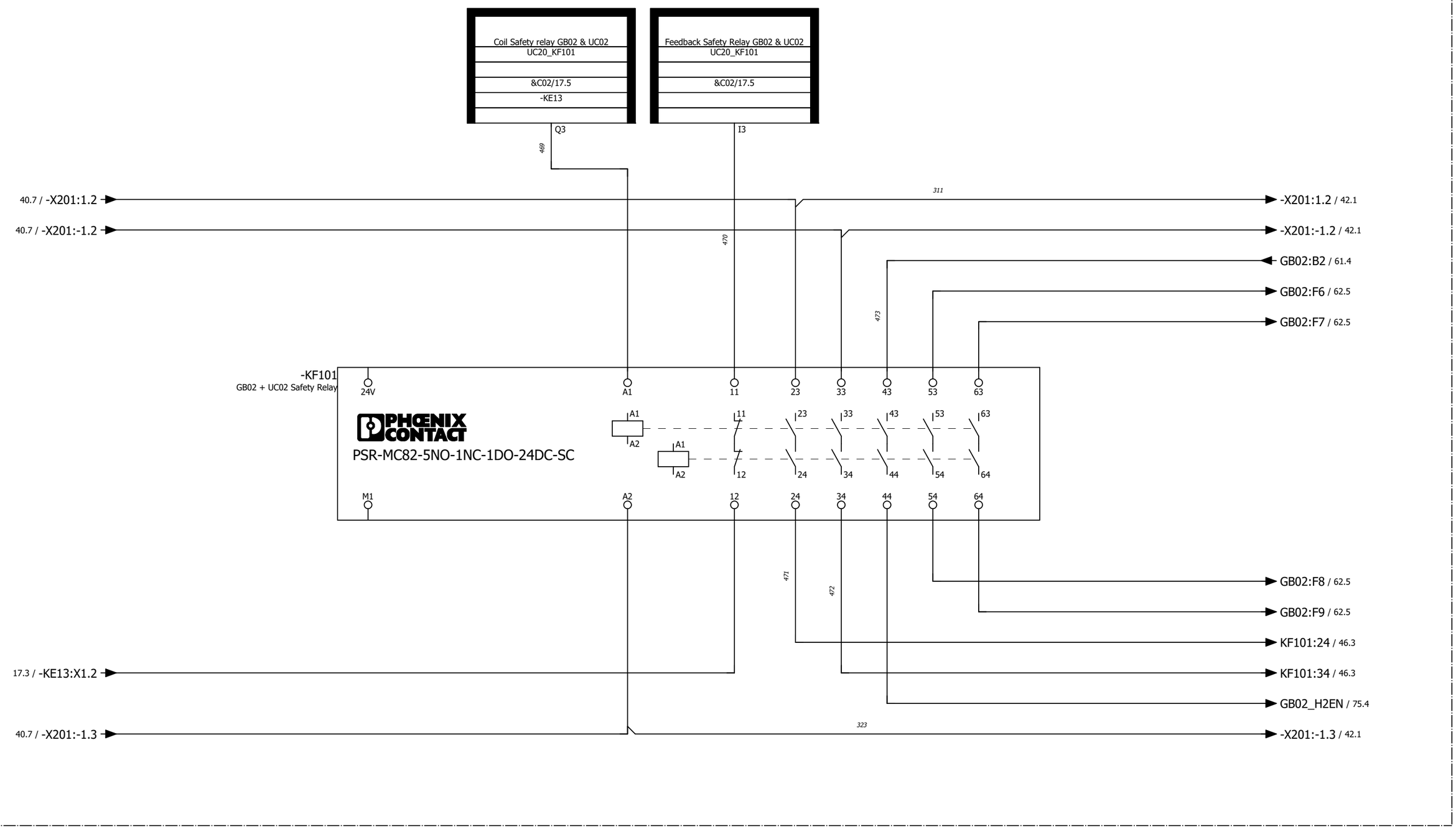
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB01 + UC01 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 40 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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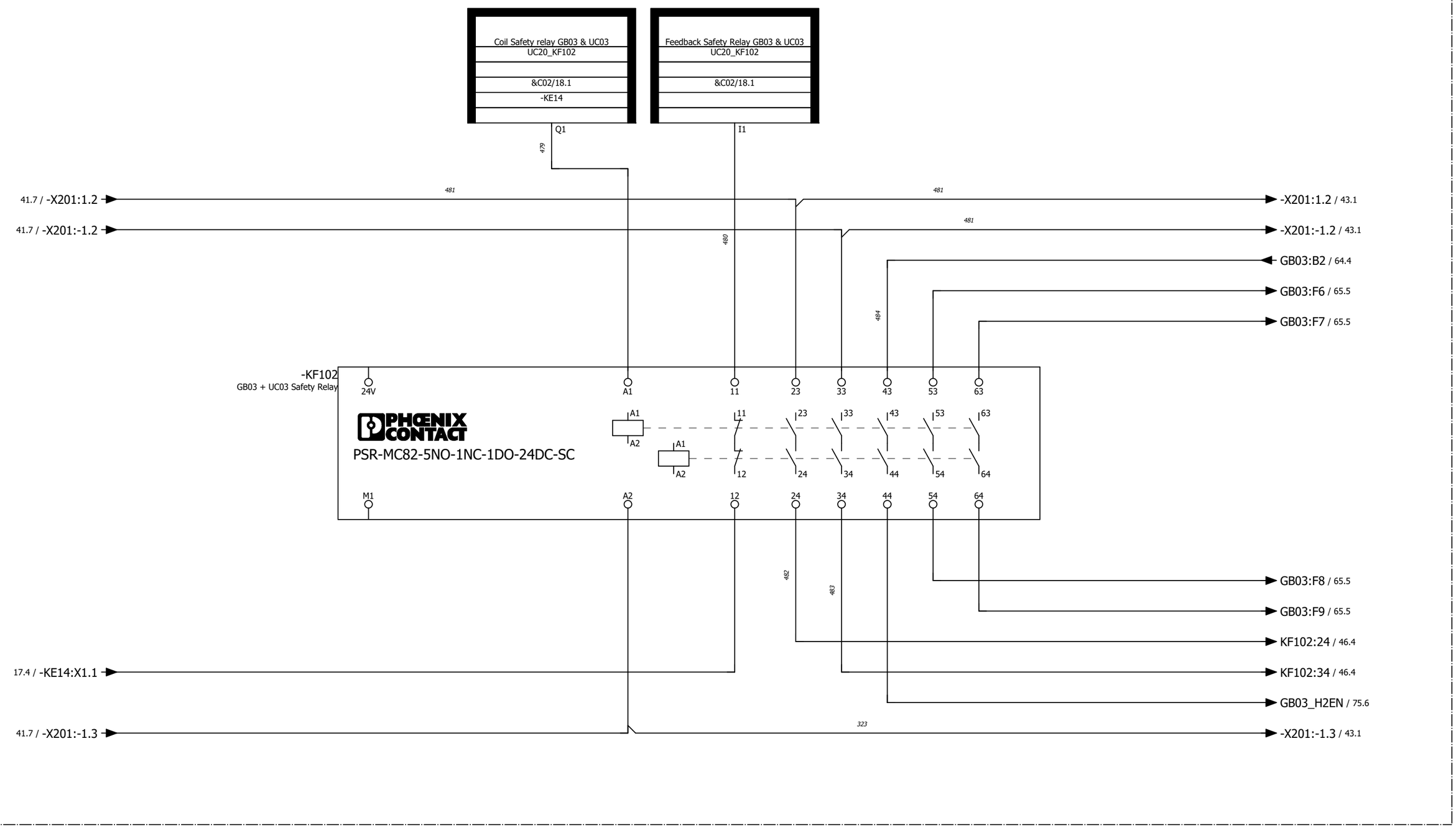
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB02 + UC02 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 41 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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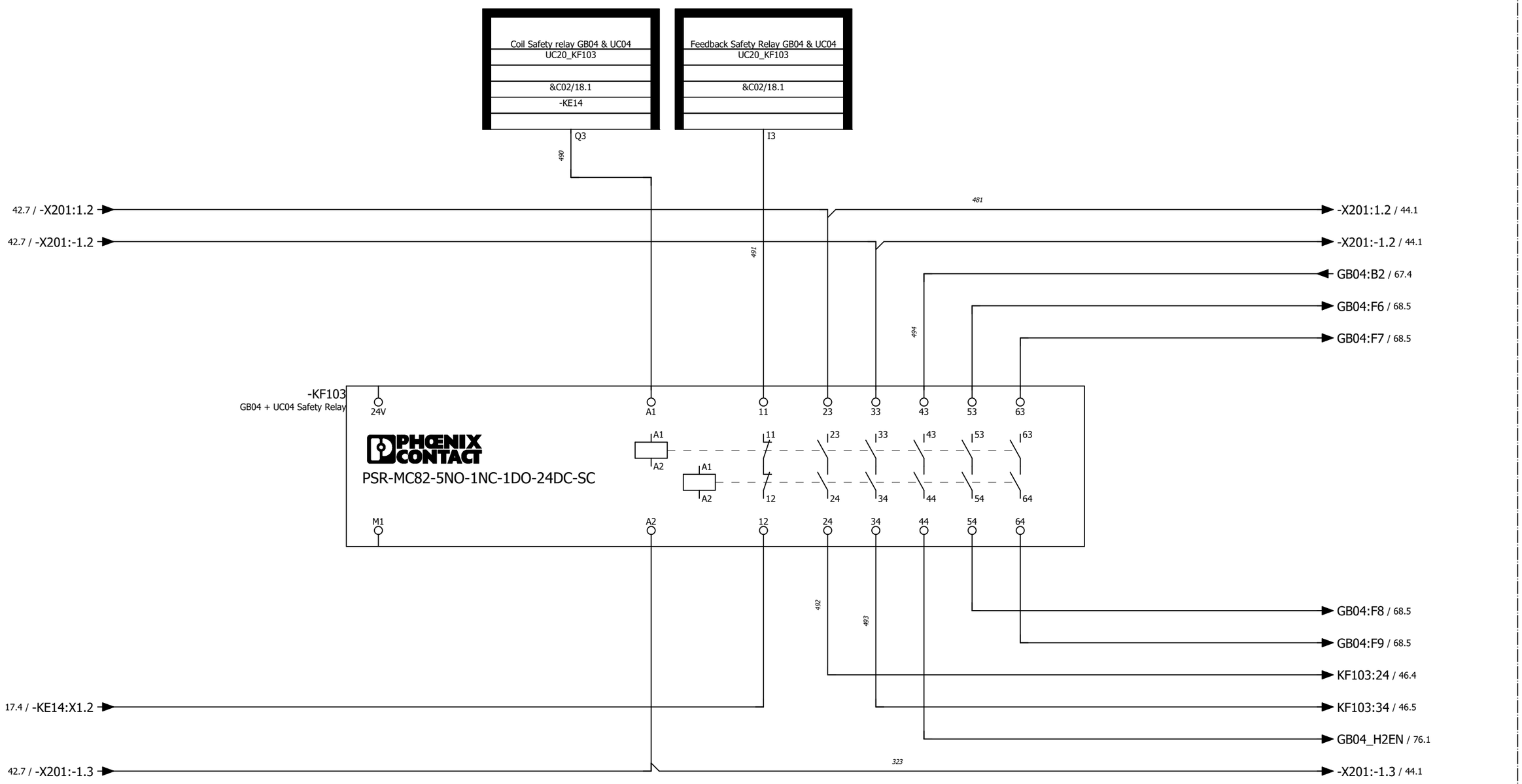
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB03 + UC03 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 42 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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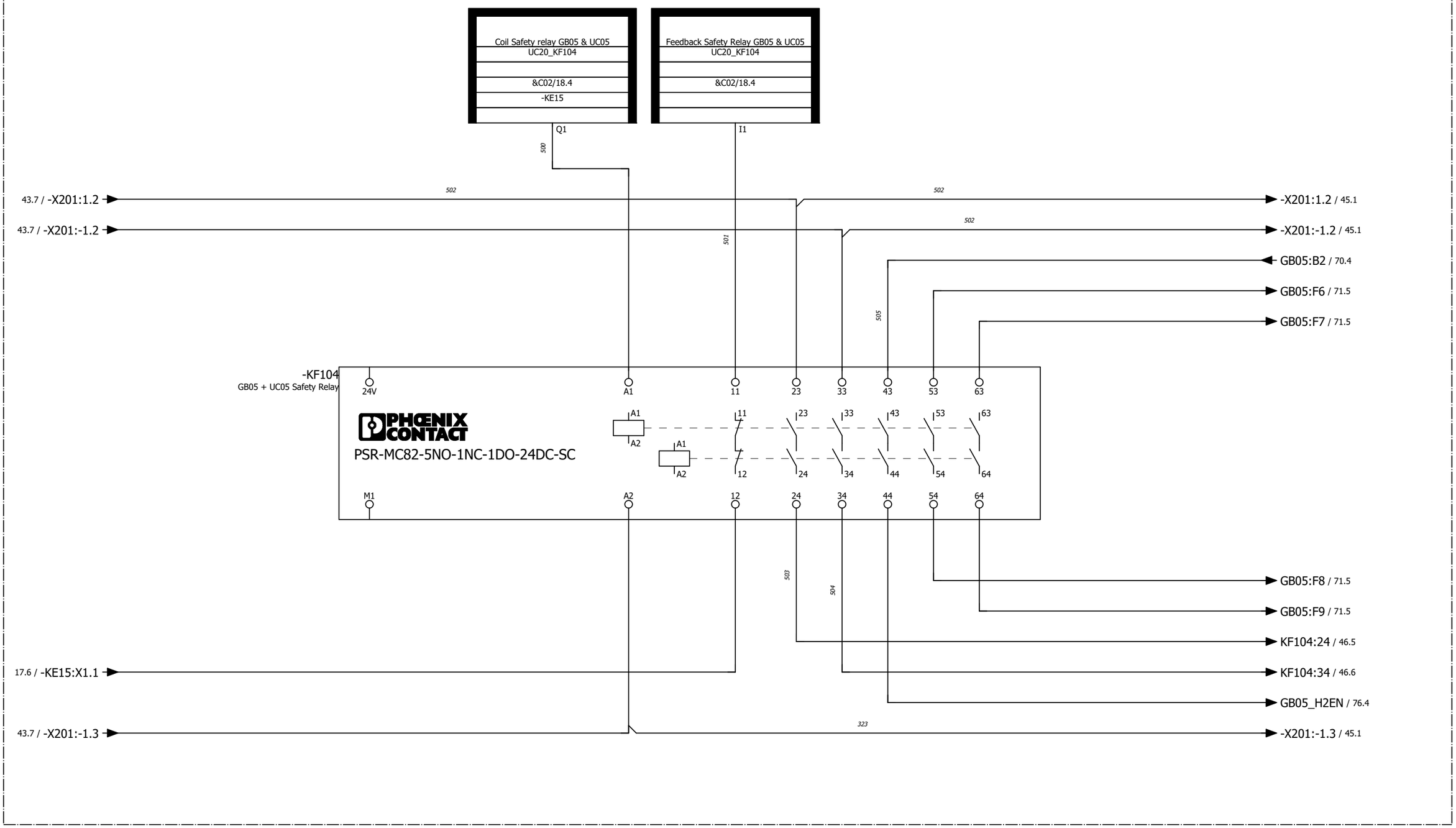
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB04 + UC04 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 43 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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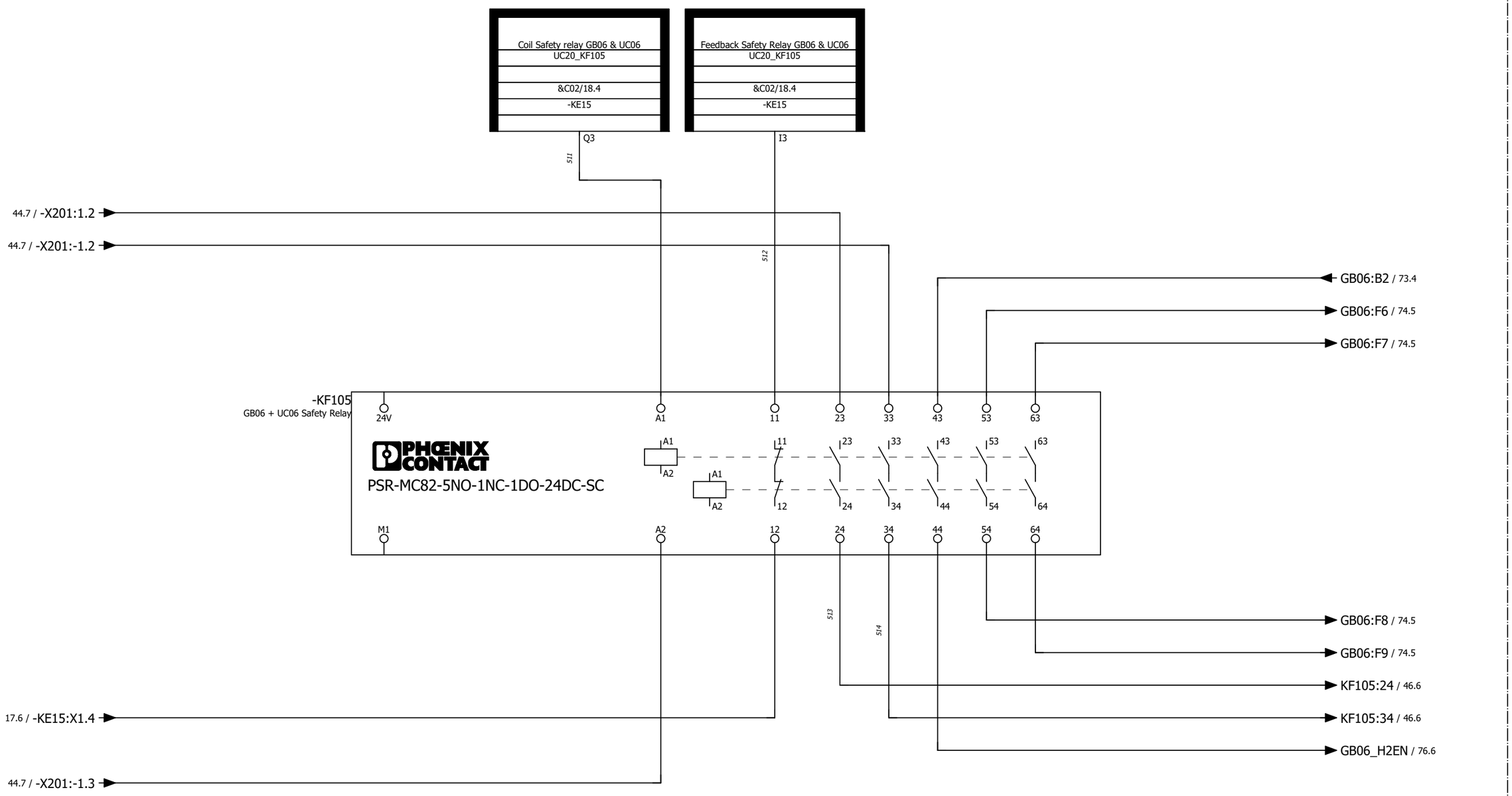
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB05 + UC05 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 44 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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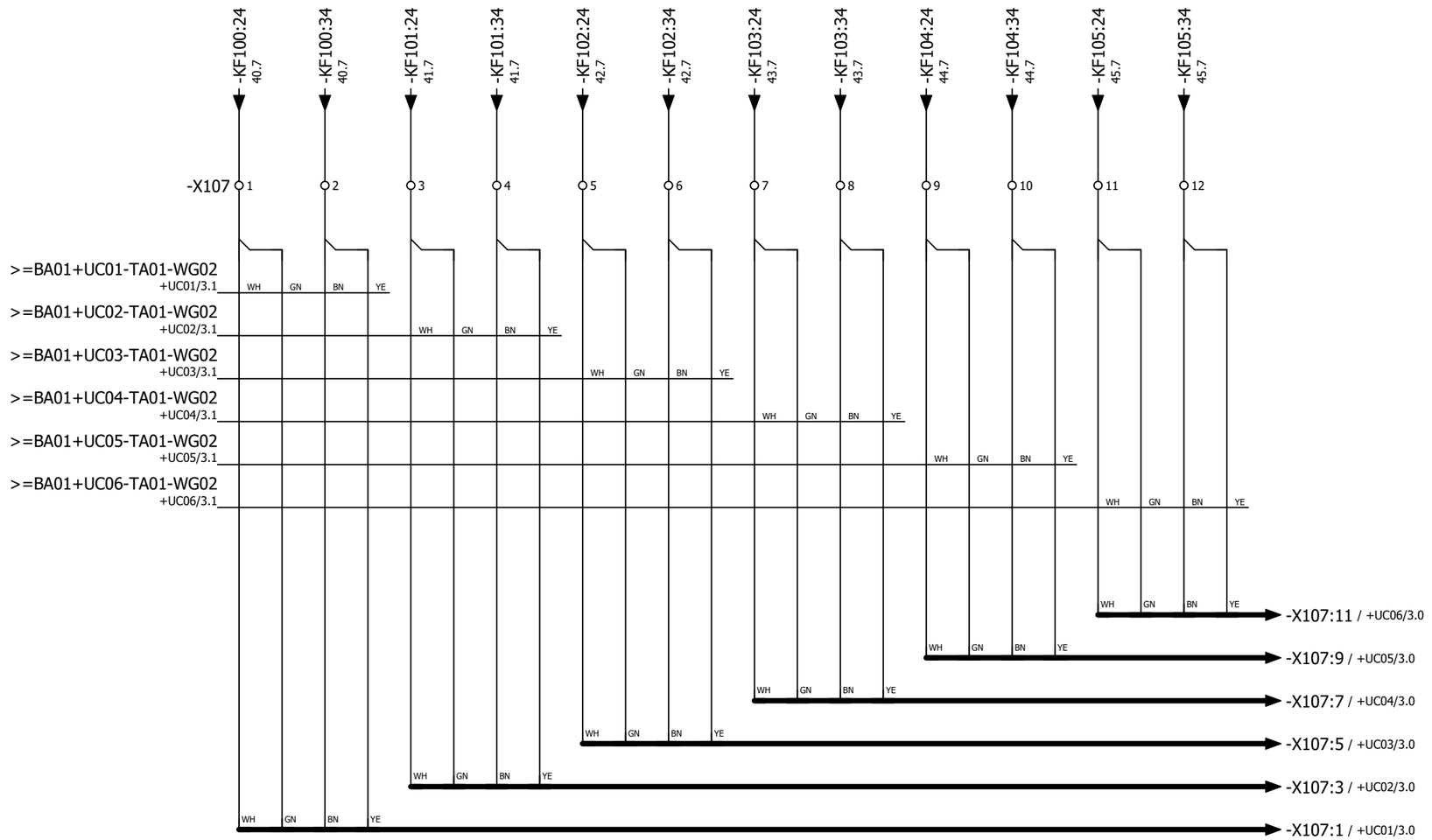
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, GB06 + UC06 Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 45 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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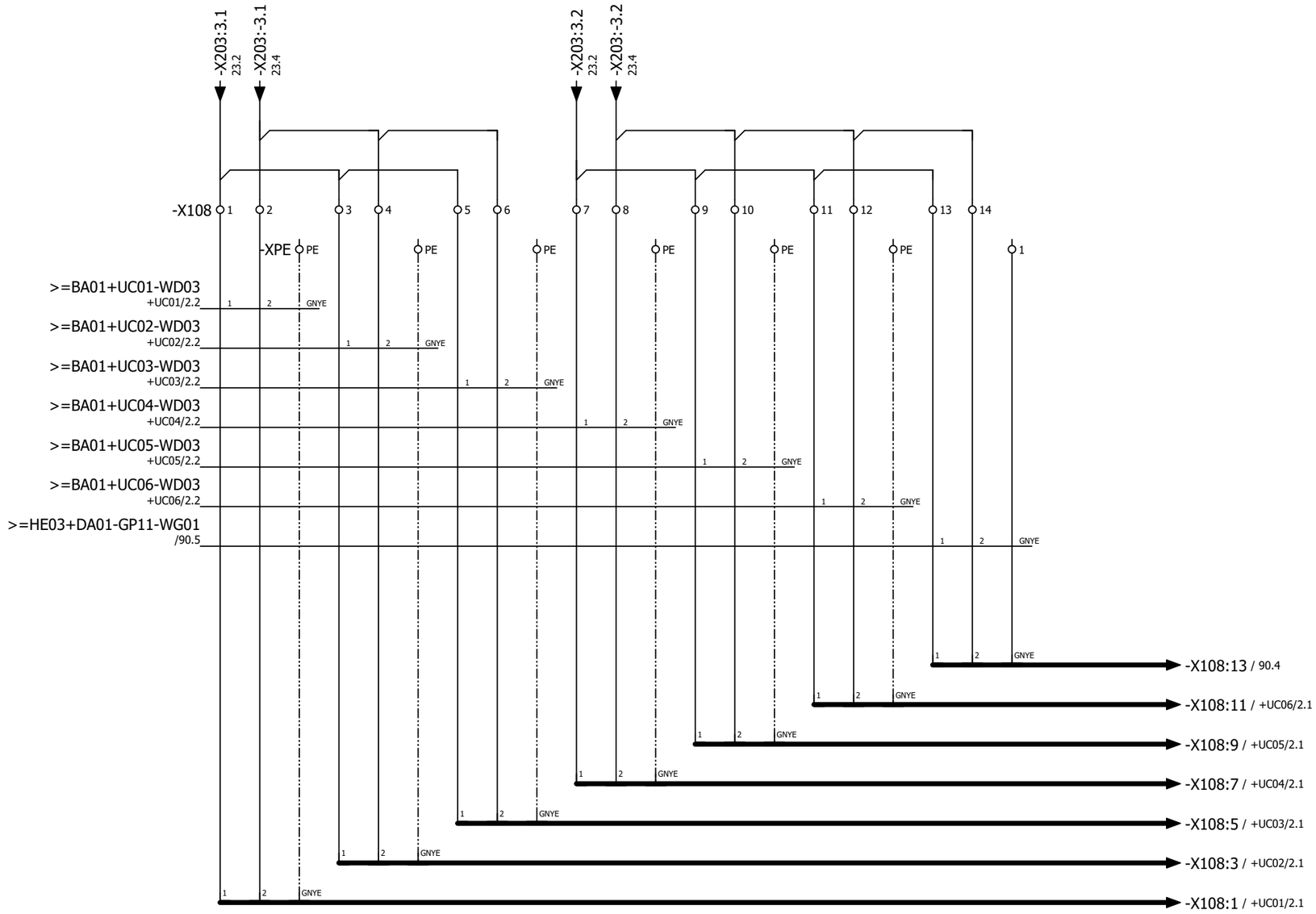
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, -X107 STO Connections UC01 - UC06		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 46 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, -X108 24VDC Connections UC01 - UC06		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 47 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

=LA01+UC20

Coil Safety Relay Nanogrid DC/AC
&C02/19.1
-KE16
Q1

Coil Safety Relay Nanogrid DC/AC
+UC20-KF16
&C02/19.1
Q1

520
521
522
523
524
525

-X101 1 2 3 4

-KF106
Safety Relay, Nanogrid

PHOENIX CONTACT
PSR-MC82-5NO-1NC-1DO-24DC-SC

24V A1 11 23 33 43 53 63
A1 A2 11 12 23 24 33 34 43 44 53 54 63 64
M1 A2 12 24 34 44 54 64

18.1 / KE16:X1.1
22.3 / -X201:-1.5
22.1 / -X201:1.4
22.3 / -X201:-1.4

313
322

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, Safety Relay Nanogrid		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 48 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

KF17 Safety Relay Coil
UC20_KF17
&C02/17.1
-KE12

Coil Safety Relay Nanogrid DC/AC
+UC20-KF16
&C02/19.1
-KE16

Q2
I1

527
528
531
532
533
534

-KF107
Safety Relay, +UC20

24V A1 11 23 33 43 53 63

PHOENIX CONTACT
PSR-MC82-5NO-1NC-1DO-24DC-SC

A1 11 23 33 43 53 63
A2 12 24 34 44 54 64

M1 A2 12 24 34 44 54 64

-X102 1 2 3 4

-KF107:23 50.1
-KF107:33 50.1
-KF107:43 50.1
-KF107:53 50.1

17.1 / KE12:X1.4
22.3 / -X201:-2.1
22.1 / -X201:1.6
22.3 / -X201:-1.6
22.2 / -X201:3.6

529
315
324

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, LT Pump		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 49 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=HE03+DA01
Control System

49.6 / >=LA01+UC20-KF107:23
49.6 / >=LA01+UC20-KF107:33
49.6 / >=LA01+UC20-KF107:43
49.7 / >=LA01+UC20-KF107:53

-GP11.WG02
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
STO LT Pump

-TA11
/90.1
/90.4
/90.4

535

1	2	3	4	21	22	23	25	26	28	29
SD1+	SD1-	SD2+	SD2-	RO1 NC	RO1 CO	RO1 NO	RO2 CO	RO2 NO	TI1+	TI1-

VACON

VACON NX

STO board

OPT-AF

X10 OFF

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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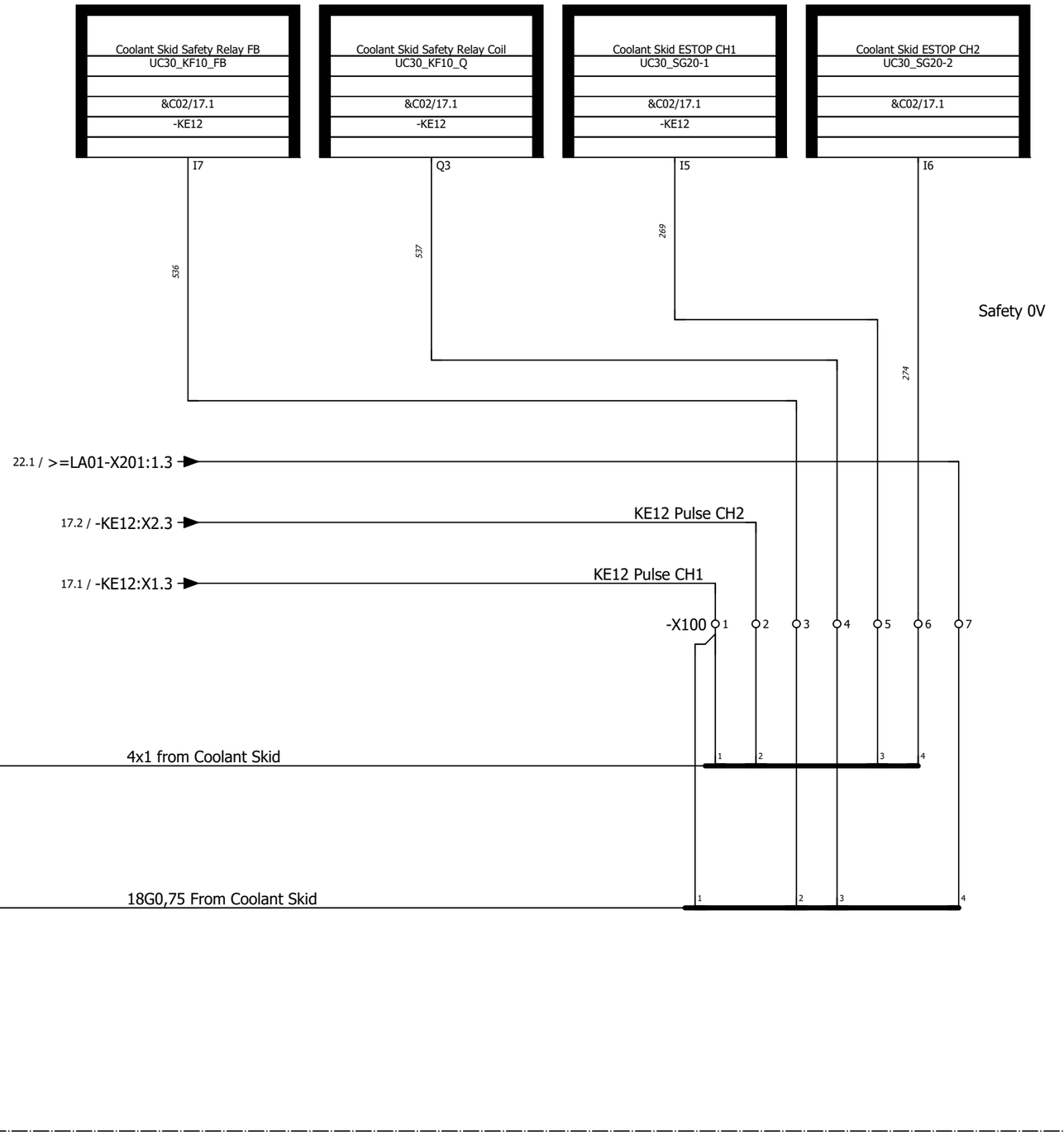
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, STO LT pump		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 50 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
Control Cabinet, Coolant Skid

=HA01+DA02
Exterior location, hydrogen supply

=LA01+UC20
Control Cabinet, 40ft Container



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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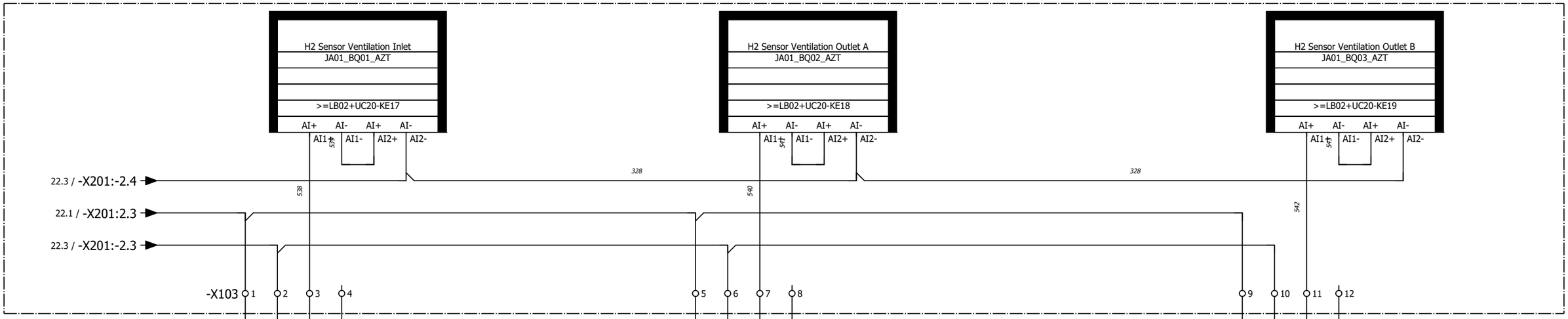
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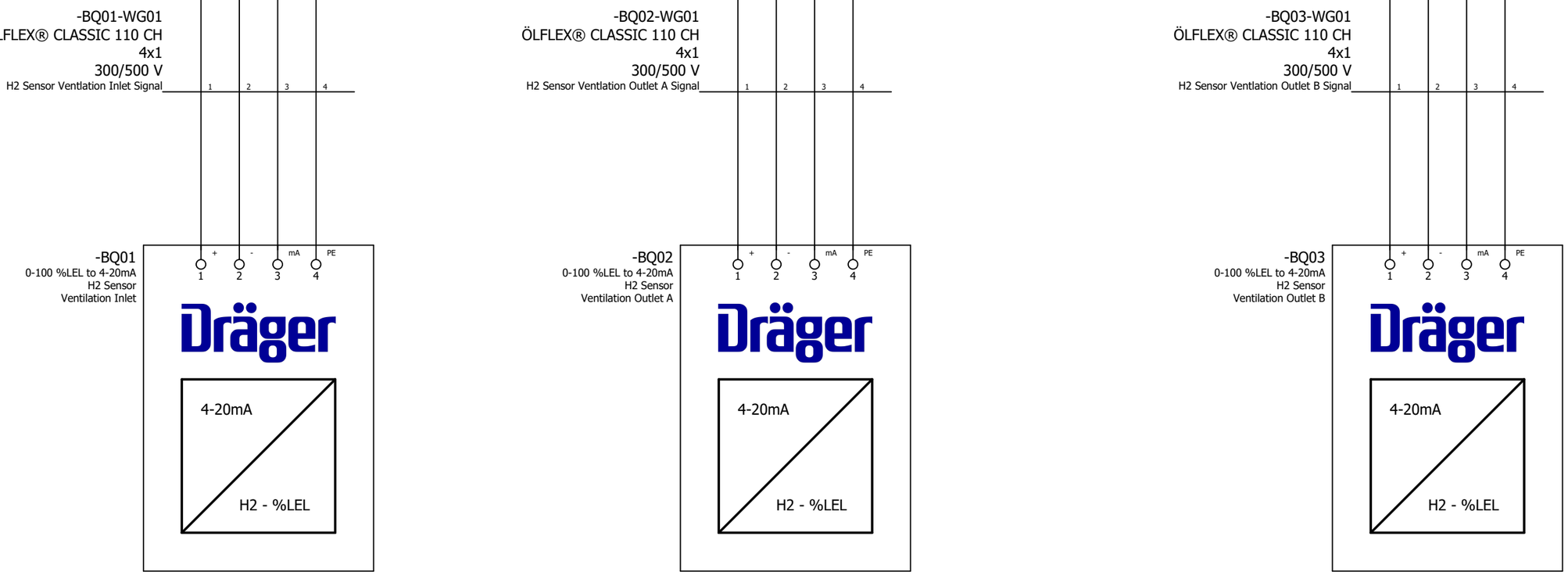
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet, Safety Coolant Skid		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 51 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



=JA01+DA01



Reference Item Number	Ballard Part # TBD		
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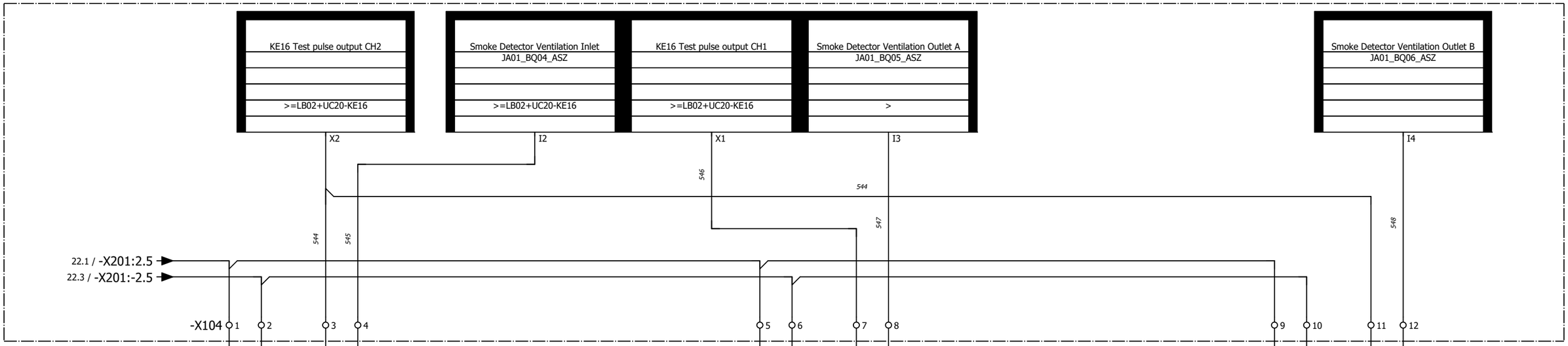
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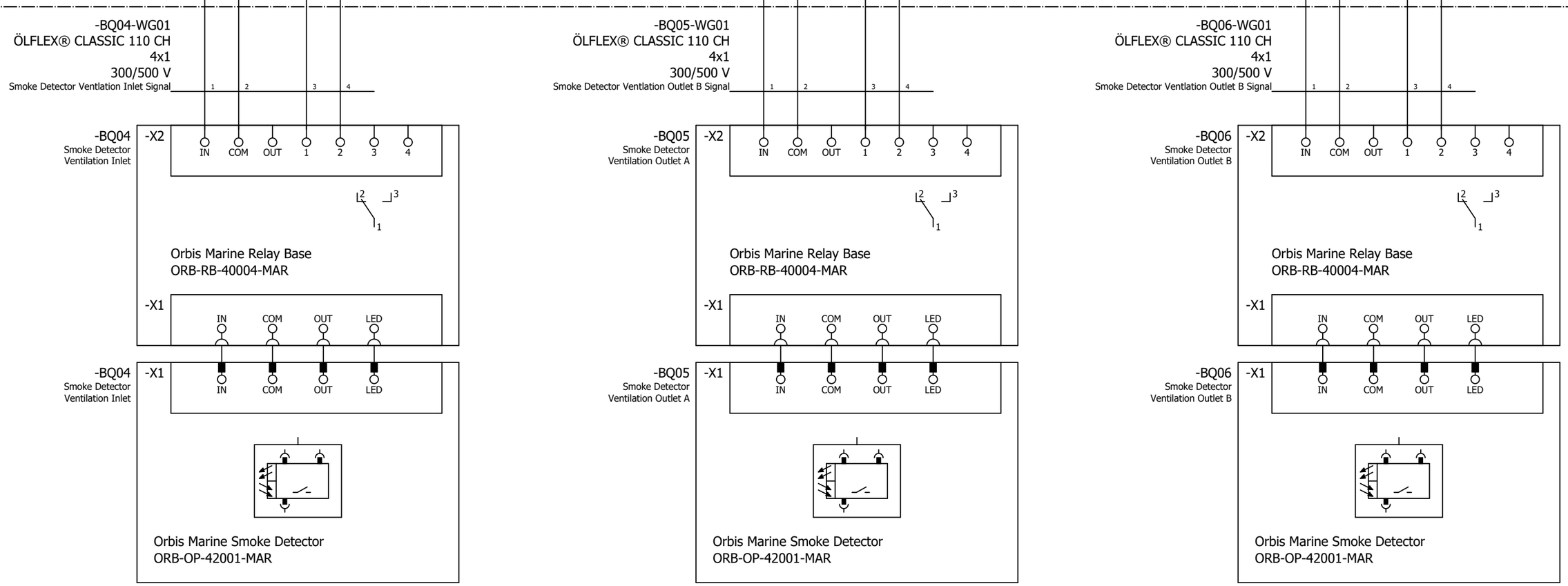
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Safety, Hydrogen Sensors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 52 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



=JA01+DA01



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EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Safety, Smoke Detectors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 53 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01
Control Cabinet, 40ft Container Inside

ESTOP - 40ft Container Door CH1
SG23_CH1
&C02/19.1
-KE16

ESTOP - 40ft Container Door CH2
SG23_CH2
&C02/19.1

I7
I8
KE16:X1.1
18.2
KE16:X2.1
530
291
-X105 1 2 3 4

=LB02+DA01
40ft Container Inside

-SG23-WG01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
ESTOP Container Door
1 2 3 4

-SG23 11 21 12 22
ESTOP
40ft Container Door

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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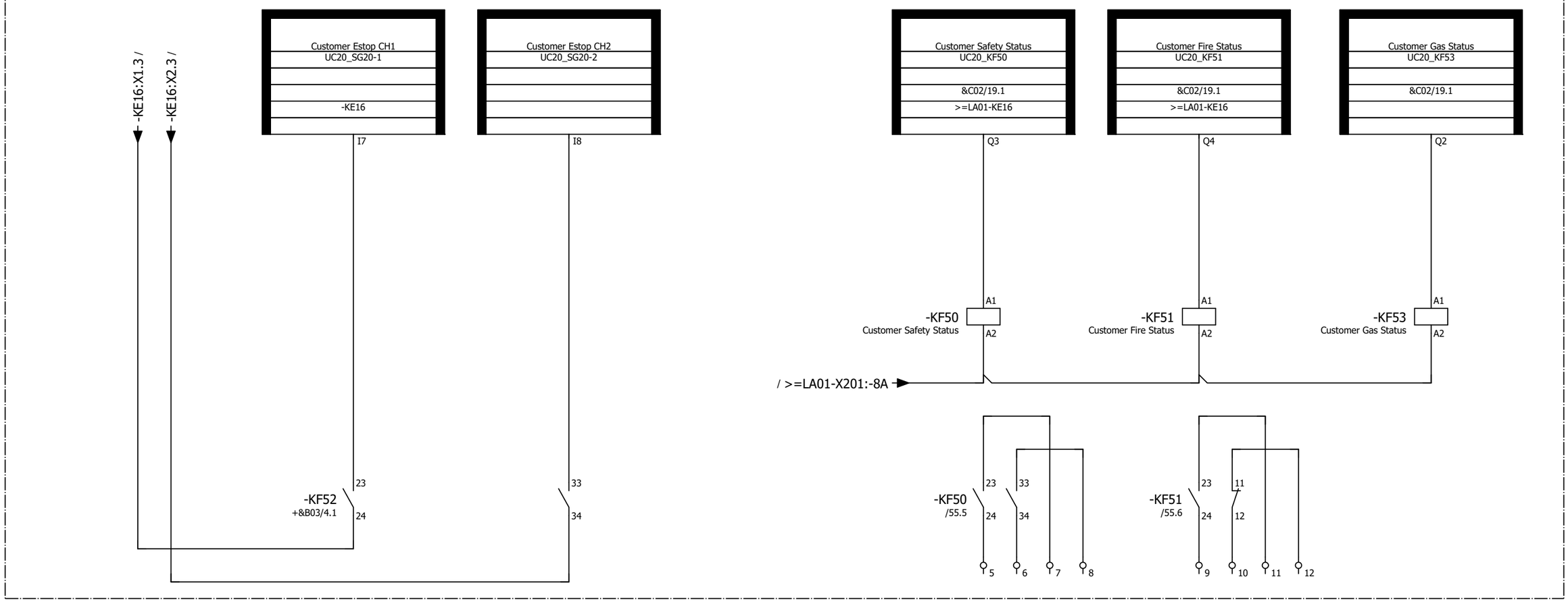
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Safety, ESTOP Container Door		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 54 / 2

0	1	2	3	4	5	6	7	8

=LB02
Control Cabinet, 40ft Container Inside



>=EXT+
Customer Scope

23 — 24 /55.5
23 — 24 +&B03/4.6
33 — 34 /55.5
33 — 34 +&B03/4.6

11 — 12 /55.6
23 — 24 /55.6
23 — 24 +&B03/4.3

23 — 24 +&B03/4.4

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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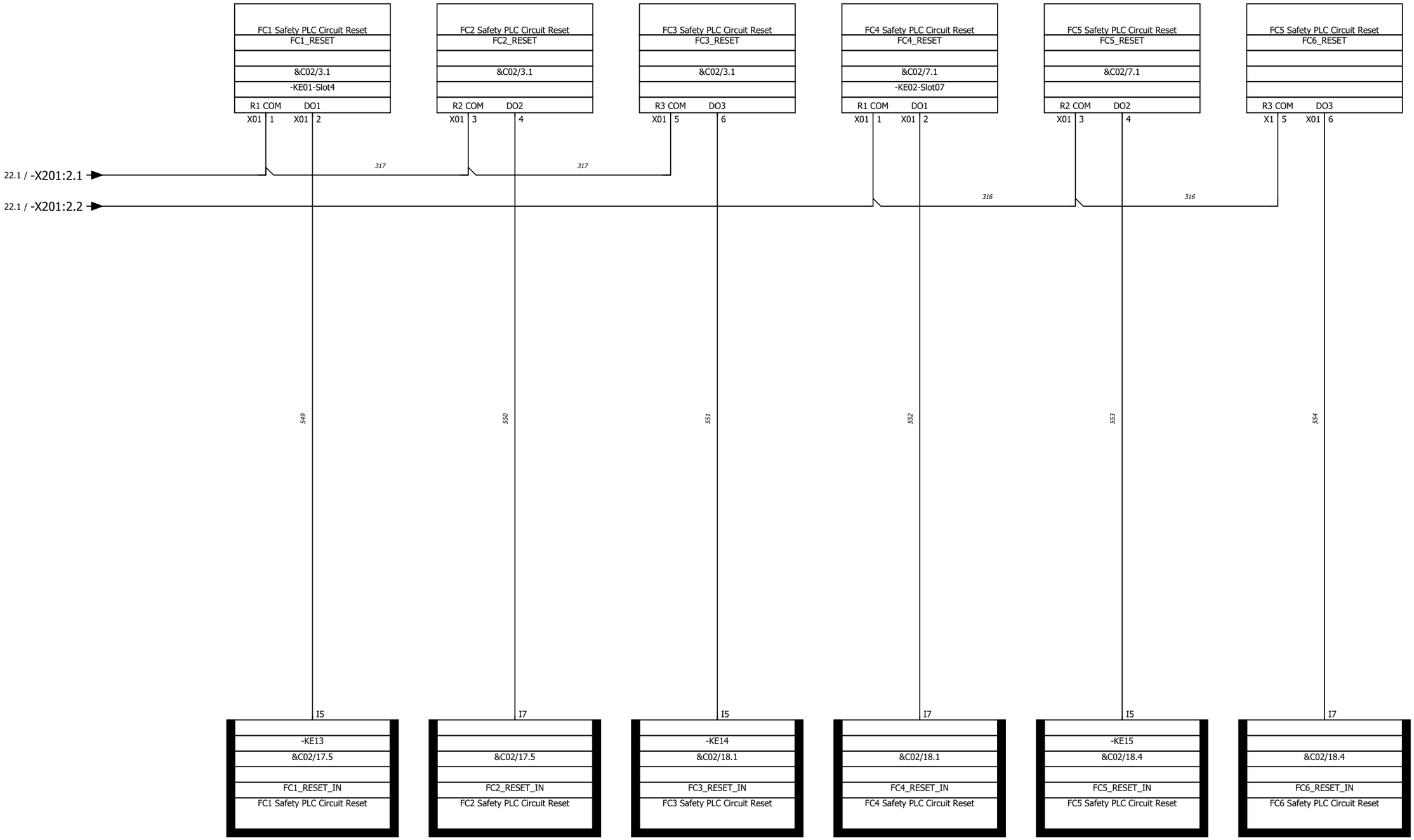
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DRAWING	5500232B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Customer Interface Diagram, ???		
SHEET TYPE/DESC	40ft Container - Safety, Customer Interface		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 55 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet - FC1-6 Safety Circuit Reset		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 56 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
2
Port 2

FC101_24VFB / 37.1
-FC101+ / 27.2
FC101- / 27.2
FC101_0VFB / 37.3
FC102+ / 27.3
FC102- / 27.3
-X50:4 / 75.1

>=RE01+GB01-GB01-XG01
/72.3
Cat 6A
FC1 Ethernet

-X_PE 1
-X50 1 2 3 4

=RE01+GB01
FCwave #1

-GB01-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB01-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/58.0
/59.0
FCwave #2 Control
Connector
-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB01-X_E01
/58.0
/59.0
FCwave #1
Control Connector
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 57 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB01_FCM_OK
&C02/6.1
>=RE01+GB01-KE02-Slot04
DI07
X02 21

MD_Enable Signal
GB01_MD_ENABLE
&C02/6.1
-KE02-Slot04
DO01
X01 2

40.7
GB01:B2

555 VT 0,5 mm²

556 VT 0,5 mm²

-X60 13 14 15

=RE01+GB01
FCwave #1

-GB01-WG02
/59.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals
13 14 15

FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/57.0
FCwave #2 Control
Connector
-SlotB
1 2 3

GB01-X_E01
/57.0
/59.0
FCwave #1
Control Connector
-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 58 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB01 | GB01 | >=LB02-KE13 | I2 | 557 VT 0,5 mm²

SAFE_FIRE Safety Signal | GB01_SAFE_FIRE | &C02/6.1 | -KE02-Slot04 | DI01 | X02 15 | 558 VT 0,5 mm²

SAFE_H2CONC Safety Signal | GB01_SAFE_H2CONC | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI02 | X02 16 | 559 VT 0,5 mm²

SAFE_VENT Safety Signal | GB01_SAFE_VENT | &C02/6.1 | DI03 | 17 | 560 VT 0,5 mm²

SAFE_WD Safety Signal | GB01_SAFE_WD | &C02/6.1 | DI04 | 18 | 561 VT 0,5 mm²

GB01:F6 / 40.7 | 465 OG 0,5 mm²

GB01:F7 / 40.7 | 467 OG 0,5 mm²

GB01:F8 / 40.7 | 466 OG 0,5 mm²

GB01:F9 / 40.7 | 468 OG 0,5 mm²

SAFE_In GB01 | GB01 | >=LB02-KE02-KE13 | Q2 | 562 VT 0,5 mm²

SAFE_FIREMALF Safety Signal | GB01_SAFE_FIREMALF | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI05 | X02 19 | 563 VT 0,5 mm²

SAFE_EXTERN Safety Signal | GB01_SAFE_EXTERN | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI06 | X02 20 | 564 VT 0,5 mm²

-X60 1 2 3 4 5 6 7 8 9 10 11 12

=RE01+GB01
FCwave #1

-GB01-WG02
/58.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

1 FC1_SAFE_MAIN
2 FC1_SAFE_FIRE
3 FC1_SAFE_H2
4 FC1_SAFE_VENT
5 FC1_SAFE_WD
6 FC1_ESTOP_OUT1
7 FC1_ESTOP_OUT2
8 FC1_ESTOP_IN1
9 FC1_ESTOP_IN2
10 FC1_SAFE_IN
11 FC1_SAFE_FIREMALF
12 FC1_SAFE_EXTERN

-XZ01
/57.0
FCwave #2 Control Connector
-SlotF 1 2 3 4 5 6 7 8 9 10 11 12

GB01-X_E01
/57.0
/58.0
FCwave #1
Control Connector
-SlotF 1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC1: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 59 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
3
Port 3

FC103_24VFB / 37.2
-FC103+ / 27.4
FC103- / 27.4
FC104+ / 27.5
FC104- / 27.5
-X51:4 / 75.3

>=RE01+GB02-GB02-XG01
Cat 6A
FC1 Ethernet
1

-X_PE 1
-X51 1 2 3 4

=RE01+GB02
FCwave #2

-GB02-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB02-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/61.0
/62.0
FCwave #2 Control
Connector

-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB02-X_E01
/61.0
/62.0
FCwave #1
Control Connector

-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC2: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 60 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB02_FCM_OK
&C02/6.1
>=RE01+GB01-KE02-Slot04
DI14
X03 29

MD_Enable Signal
GB02_MD_ENABLE
&C02/6.1
-KE02-Slot04
DO02
X01 3

41.7
GB02:B2

565 VT 0,5 mm²
566 VT 0,5 mm²

-X61 13 14 15

=RE01+GB02
FCwave #2

-GB02-WG02
/62.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals
13 14 15

FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/60.0
FCwave #2 Control
Connector
-SlotB
1 2 3

GB02-X_E01
/60.0
/62.0
FCwave #1
Control Connector
-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC2: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 61 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB02 | GB02 | >=LB02-KE13 | I4
SAFE_FIRE Safety Signal | GB02_SAFE_FIRE | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI08 | X02 | 22
SAFE_H2CONC Safety Signal | GB02_SAFE_H2CONC | &C02/6.1 | DI09 | X03 | 24
SAFE_VENT Safety Signal | GB02_SAFE_VENT | &C02/6.1 | DI10 | 25
SAFE_WD Safety Signal | GB02_SAFE_WD | &C02/6.1 | DI11 | 26
SAFE_In GB02 | GB02 | >=LB02-KE02-KE13 | Q4
SAFE_FIREMALF Safety Signal | GB02_SAFE_FIREMALF | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI12 | X03 | 27
SAFE_EXTERN Safety Signal | GB02_SAFE_EXTERN | &C02/6.1 | >=RE01+GB01-KE02-Slot04 | DI13 | X03 | 28

567 VT 0,5 mm² -X61 1
568 VT 0,5 mm² 2
569 VT 0,5 mm² 3
570 VT 0,5 mm² 4
571 VT 0,5 mm² 5
475 OG 0,5 mm² GB02:F6 / 41.7 6
477 OG 0,5 mm² GB02:F7 / 41.7 7
476 OG 0,5 mm² GB02:F8 / 41.7 8
478 OG 0,5 mm² GB02:F9 / 41.7 9
572 VT 0,5 mm² 10
573 VT 0,5 mm² 11
574 VT 0,5 mm² 12

=RE01+GB02
FCwave #2

-GB02-WG02
/61.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

1 FC1_SAFE_MAIN
2 FC1_SAFE_FIRE
3 FC1_SAFE_H2
4 FC1_SAFE_VENT
5 FC1_SAFE_WD
6 FC1_ESTOP_OUT1
7 FC1_ESTOP_OUT2
8 FC1_ESTOP_IN1
9 FC1_ESTOP_IN2
10 FC1_SAFE_IN
11 FC1_SAFE_FIREMALF
12 FC1_SAFE_EXTERN

-XZ01
/60.0
FCwave #2 Control Connector
-SlotF 1 2 3 4 5 6 7 8 9 10 11 12

GB02-X_E01
/60.0
/61.0
FCwave #1 Control Connector
-SlotF 1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC2: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 62 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
4
Port 4

FC111_24VFB / 37.4
-FC111+ / 30.2
FC111- / 30.2
FC111_0VFB / 37.5
FC112+ / 30.3
FC112- / 30.3
-X52:4 / 75.6

>=RE01+GB03-GB03-XG01
Cat 6A
FC1 Ethernet
1

-X_PE 1
-X52 1 2 3 4

=RE01+GB03
FCwave #3

-GB03-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB03-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/64.0
/65.0
FCwave #2 Control
Connector

-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB03-X_E01
/64.0
/65.0
FCwave #1
Control Connector

-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 63 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB03_FCM_OK
&C02/6.4
-KE02-Slot05
DI07
X02 21

MD_Enable Signal
GB03_MD_ENABLE
&C02/6.4
DO01
X01 2

42.7
GB03:B2

575 VT 0,5 mm²

576 VT 0,5 mm²

-X62 13 14 15

=RE01+GB03
FCwave #3

-GB03-WG02
/65.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

13 14 15

FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/63.0
FCwave #2 Control
Connector

-SlotB
1 2 3

GB03-X_E01
/63.0
/65.0
FCwave #1
Control Connector

-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 64 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB03 | GB03 | >=LB02-KE14 | I2
SAFE_FIRE Safety Signal | GB03_SAFE_FIRE | &C02/6.4 | -KE02-Slot05 | DI01 | X02 15
SAFE_H2CONC Safety Signal | GB03_SAFE_H2CONC | &C02/6.4 | DI02 | 16
SAFE_VENT Safety Signal | GB03_SAFE_VENT | &C02/6.4 | DI03 | 17
SAFE_WD Safety Signal | GB03_SAFE_WD | &C02/6.4 | DI04 | 18
SAFE_In GB03 | GB03 | >=LB02-KE14 | Q2
SAFE_FIREMALF Safety Signal | GB03_SAFE_FIREMALF | &C02/6.4 | -KE02-Slot05 | DI05 | X02 19
SAFE_EXTERN Safety Signal | GB03_SAFE_EXTERN | &C02/6.4 | -KE02-Slot05 | DI06 | X02 20

577 VT 0,5 mm² | 578 VT 0,5 mm² | 579 VT 0,5 mm² | 580 VT 0,5 mm² | 581 VT 0,5 mm²
GB03:F6 / 42.7 — 486 OG 0,5 mm²
GB03:F7 / 42.7 — 488 OG 0,5 mm²
GB03:F8 / 42.7 — 487 OG 0,5 mm²
GB03:F9 / 42.7 — 489 OG 0,5 mm²
582 VT 0,5 mm² | 583 VT 0,5 mm² | 584 VT 0,5 mm²

-X62 1 2 3 4 5 6 7 8 9 10 11 12

=RE01+GB03
FCwave #3

-GB03-WG02
/64.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals
1 2 3 4 5 6 7 8 9 10 11 12
FC1_SAFE_MAIN | FC1_SAFE_FIRE | FC1_SAFE_H2 | FC1_SAFE_VENT | FC1_SAFE_WD | FC1_ESTOP_OUT1 | FC1_ESTOP_OUT2 | FC1_ESTOP_IN1 | FC1_ESTOP_IN2 | FC1_SAFE_IN | FC1_SAFE_FIREMALF | FC1_SAFE_EXTERN

-XZ01
/63.0
FCwave #2 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

GB03-X_E01
/63.0
/64.0
FCwave #1 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC3: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 65 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
5
Port 5

>=RE01+GB04-GB04-XG01
Cat 6A
FC1 Ethernet

1

FC113_24VFB / 37.5
-FC113+ / 30.4
FC113- / 30.4
FC114+ / 30.5
FC114- / 30.5
-X53:4 / 76.1

-X_PE 1
-X53 1 2 3 4

=RE02+GB04
FCwave #4

-GB04-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB04-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/67.0
/68.0
FCwave #2 Control
Connector

-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB04-X_E01
/67.0
/68.0
FCwave #1
Control Connector

-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC4: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 66 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB04_FCM_OK
&C02/6.4
-KE02-Slot05
DI14
X03 29

MD_Enable Signal
GB04_MD_ENABLE
&C02/6.4
DO02
X01 3

43.7
GB04:B2

585 VT 0,5 mm²
586 VT 0,5 mm²

-X63 13 14 15

=RE02+GB04
FCwave #4

-GB04-WG02
/68.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

13 14 15
FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/66.0
FCwave #2 Control
Connector
-SlotB
1 2 3

GB04-X_E01
/66.0
/68.0
FCwave #1
Control Connector
-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC4: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 67 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB04 | GB04 | >=LB02-KE14 | I4
SAFE_FIRE Safety Signal | GB04_SAFE_FIRE | &C02/6.4 | -KE02-Slot05 | DI08 | X02 22
SAFE_H2CONC Safety Signal | GB04_SAFE_H2CONC | &C02/6.4 | DI09 | X03 24
SAFE_VENT Safety Signal | GB04_SAFE_VENT | &C02/6.4 | DI10 | 25
SAFE_WD Safety Signal | GB04_SAFE_WD | &C02/6.4 | DI11 | 26
SAFE_In GB04 | GB04 | >=LB02-KE14 | Q4
SAFE_FIREMALF Safety Signal | GB04_SAFE_FIREMALF | &C02/6.4 | -KE02-Slot05 | DI12 | X03 27
SAFE_EXTERN Safety Signal | GB04_SAFE_EXTERN | &C02/6.4 | -KE02-Slot05 | DI13 | X03 28

587 VT 0,5 mm² → -X63 1
588 VT 0,5 mm² → 2
589 VT 0,5 mm² → 3
590 VT 0,5 mm² → 4
591 VT 0,5 mm² → 5
496 OG 0,5 mm² → GB04:F6 / 43.7 → 6
498 OG 0,5 mm² → GB04:F7 / 43.7 → 7
497 OG 0,5 mm² → GB04:F8 / 43.7 → 8
499 OG 0,5 mm² → GB04:F9 / 43.7 → 9
592 VT 0,5 mm² → 10
593 VT 0,5 mm² → 11
594 VT 0,5 mm² → 12

=RE02+GB04
FCwave #4

-GB04-WG02
/67.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

1 FC1_SAFE_MAIN
2 FC1_SAFE_FIRE
3 FC1_SAFE_H2
4 FC1_SAFE_VENT
5 FC1_SAFE_WD
6 FC1_ESTOP_OUT1
7 FC1_ESTOP_OUT2
8 FC1_ESTOP_IN1
9 FC1_ESTOP_IN2
10 FC1_SAFE_IN
11 FC1_SAFE_FIREMALF
12 FC1_SAFE_EXTERN

-XZ01
/66.0
FCwave #2 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

GB04-X_E01
/66.0
/67.0
FCwave #1 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC4: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 68 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
6
Port 6

>=RE01+GB05-GB05-XG01
Cat 6A
FC1 Ethernet

FC121_24VFB / 37.6
-FC121+ / 33.1
FC121- / 33.2
FC121_0VFB / 37.8
FC122+ / 33.3
FC122- / 33.3
-X54:4 / 76.3

-X_PE 1
-X54 1 2 3 4

=RE02+GB05
FCwave #5

-GB05-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB05-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/70.0
/71.0
FCwave #2 Control
Connector
-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB05-X_E01
/70.0
/71.0
FCwave #1
Control Connector
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 69 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB05_FCM_OK
&C02/6.6
-KE02-Slot06
DI07
X02 21

MD_Enable Signal
GB05_MD_ENABLE
&C02/6.6
DO01
X01 2

44.7
GB05:B2

595 VT 0,5 mm²

596 VT 0,5 mm²

-X64 13 14 15

=RE02+GB05
FCwave #5

-GB05-WG02
/71.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

13 14 15

FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/69.0
FCwave #2 Control
Connector

-SlotB
1 2 3

GB05-X_E01
/69.0
/71.0
FCwave #1
Control Connector

-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 70 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB05 | GB05 | >=LB02-KE15 | I2
SAFE_FIRE Safety Signal | GB05_SAFE_FIRE | &C02/6.6 | -KE02-Slot06 | DI01 | X02 15
SAFE_H2CONC Safety Signal | GB05_SAFE_H2CONC | &C02/6.6 | DI02 | 16
SAFE_VENT Safety Signal | GB05_SAFE_VENT | &C02/6.6 | DI03 | 17
SAFE_WD Safety Signal | GB05_SAFE_WD | &C02/6.6 | DI04 | 18
SAFE_In GB05 | GB05 | >=LB02-KE15 | Q2
SAFE_FIREMALF Safety Signal | GB05_SAFE_FIREMALF | &C02/6.6 | -KE02-Slot06 | DI05 | X02 19
SAFE_EXTERN Safety Signal | GB05_SAFE_EXTERN | &C02/6.6 | -KE02-Slot06 | DI06 | X02 20

597 VT 0,5 mm² | 598 VT 0,5 mm² | 599 VT 0,5 mm² | 600 VT 0,5 mm² | 601 VT 0,5 mm²
507 OG 0,5 mm² GB05:F6 / 44.7
509 OG 0,5 mm² GB05:F7 / 44.7
508 OG 0,5 mm² GB05:F8 / 44.7
510 OG 0,5 mm² GB05:F9 / 44.7
602 VT 0,5 mm² | 603 VT 0,5 mm² | 604 VT 0,5 mm²

-X64 1 2 3 4 5 6 7 8 9 10 11 12

=RE02+GB05
FCwave #5

-GB05-WG02
/70.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

1 FC1_SAFE_MAIN | 2 FC1_SAFE_FIRE | 3 FC1_SAFE_H2 | 4 FC1_SAFE_VENT | 5 FC1_SAFE_WD | 6 FC1_ESTOP_OUT1 | 7 FC1_ESTOP_OUT2 | 8 FC1_ESTOP_IN1 | 9 FC1_ESTOP_IN2 | 10 FC1_SAFE_IN | 11 FC1_SAFE_FIREMALF | 12 FC1_SAFE_EXTERN

-XZ01
/69.0
FCwave #2 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

GB05-X_E01
/69.0
/70.0
FCwave #1 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC5: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 71 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

-KF201
16 port
100/10 Ethernet Switch

Ethernet
7
Port 7

FC123_24VFB / 37.7
-FC123+ / 33.4
-FC123- / 33.4
-FC124+ / 33.5
-FC124- / 33.5
-X55:4 / 76.6

>=RE01+GB01-GB01-XG01
/57.3
Cat 6A
FC1 Ethernet

-X_PE 1
-X55 1 2 3 4

=RE02+GB06
FCwave #6

-GB06-WD05
CLASSIC 110 CH
5x6
300/500 V
FCwave #1 24V Supply
GNYE 1 2 3 4

-GB06-WG01
Cat.6A PUR
8x24
300 V
FCwave #1 Ethernet

-XZ01
/73.0
/74.0
FCwave #2 Control
Connector
-PE
PE
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD
Not Connected

GB06-X_E01
/73.0
/74.0
FCwave #1
Control Connector
-SlotA 1 2
-SlotE 1 2
-SlotC 1-8
-SlotD

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC6: 24V and Ethernet		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 72 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

Fuel Cell Module OK
GB06_FCM_OK
&C02/6.6
-KE02-Slot06
DI14
X03 29

MD_Enable Signal
GB06_MD_ENABLE
&C02/6.6
DO02
X01 3

45.7
GB06:B2

605 VT 0,5 mm²

606 VT 0,5 mm²

-X65 13 14 15

=RE02+GB06
FCwave #6

-GB06-WG02
/74.0
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

13 14 15

FC1_FCM_OK
FC1_H2_EN
FC1_MD_EN

-XZ01
/72.0
FCwave #2 Control
Connector

-SlotB
1 2 3

GB06-X_E01
/72.0
/74.0
FCwave #1
Control Connector

-SlotB
1 2 3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC6: Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 73 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
40ft Container, Control Cabinet

SAFE_Main GB06 | GB06 | >=LB02-KE15 | I4
SAFE_FIRE Safety Signal | GB06_SAFE_FIRE | &C02/6.6 | -KE02-Slot06 | DI08 | X02 22
SAFE_H2CONC Safety Signal | GB06_SAFE_H2CONC | &C02/6.6 | DI09 | X03 24
SAFE_VENT Safety Signal | GB06_SAFE_VENT | &C02/6.6 | DI10 | 25
SAFE_WD Safety Signal | GB06_SAFE_WD | &C02/6.6 | DI11 | 26
SAFE_In GB06 | GB06 | >=LB02-KE15 | Q4
SAFE_FIREMALF Safety Signal | GB06_SAFE_FIREMALF | &C02/6.6 | -KE02-Slot06 | DI12 | X03 27
SAFE_EXTERN Safety Signal | GB06_SAFE_EXTERN | &C02/6.6 | -KE02-Slot06 | DI13 | X03 28

607 VT 0,5 mm² | 608 VT 0,5 mm² | 609 VT 0,5 mm² | 610 VT 0,5 mm² | 611 VT 0,5 mm² | 516 OG 0,5 mm² GB06:F6 / 45.7 | 518 OG 0,5 mm² GB06:F7 / 45.7 | 517 OG 0,5 mm² GB06:F8 / 45.7 | 519 OG 0,5 mm² GB06:F9 / 45.7 | 612 VT 0,5 mm² | 613 VT 0,5 mm² | 614 VT 0,5 mm²

-X65 ○ 1 2 3 4 5 6 7 8 9 10 11 12

=RE02+GB06
FCwave #6

-GB06-WG02
/73.4
CLASSIC 110 CH
18x0,75
300/500 V
Fcwave #1 24V Signals

1 FC1_SAFE_MAIN | 2 FC1_SAFE_FIRE | 3 FC1_SAFE_H2 | 4 FC1_SAFE_VENT | 5 FC1_SAFE_WD | 6 FC1_ESTOP_OUT1 | 7 FC1_ESTOP_OUT2 | 8 FC1_ESTOP_IN1 | 9 FC1_ESTOP_IN2 | 10 FC1_SAFE_IN | 11 FC1_SAFE_FIREMALF | 12 FC1_SAFE_EXTERN

-XZ01
/72.0
FCwave #2 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

GB06-X_E01
/72.0
/73.0
FCwave #1 Control Connector
-SlotF
1 2 3 4 5 6 7 8 9 10 11 12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - FC6: Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 74 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft

-X50:4 / 57.2
GB01_H2EN / 40.7
-X51:4 / 60.2
GB02_H2EN / 41.7
-X52:4 / 63.2
GB03_H2EN / 42.7

615 WH 0,5 mm²
464 WH 0,5 mm²
616 WH 0,5 mm²
474 WH 0,5 mm²
617 WH 0,5 mm²
485 WH 0,5 mm²

-X106 1 2 3 4 5 6

X106 / 76.1

=HA01+DA02-AC01
Hydrogen Supply System - Non EX Box

-XT07
EX Cable gland
Wall pass-through

AC01-WG01
H2 Valve Connections
300/500 V
18x0,75
6 m
ÖLFLEX® CLASSIC 110 CH
/76.1

XD01 / 76.1

-XD01 1 2 3 4 5 6

=HA01+DA02
Hydrogen Supply System

-QM1.1-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM1.1 x1 x2

-QM2.1-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM2.1 x1 x2

-QM1.2-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM1.2 x1 x2

-QM2.2-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM2.2 x1 x2

-QM1.3-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM1.3 x1 x2

-QM2.3-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
-QM2.3 x1 x2

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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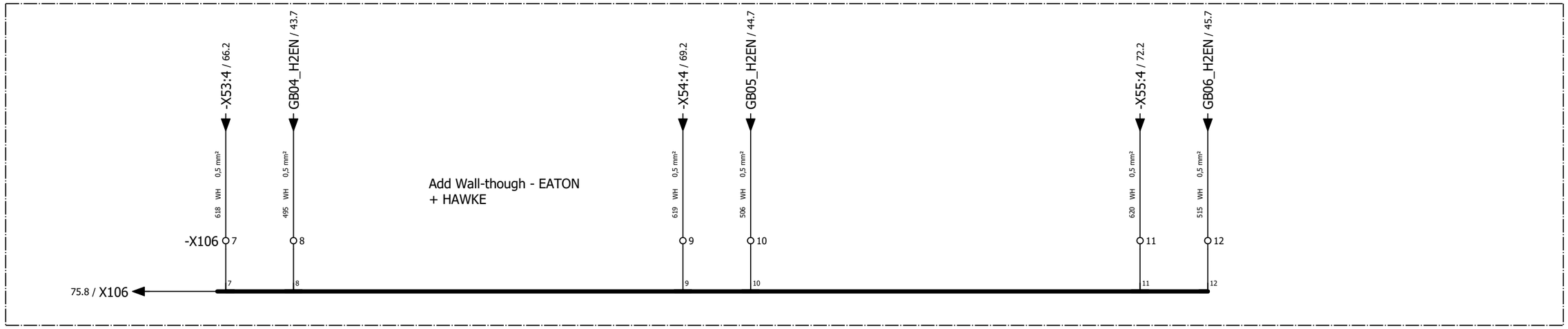
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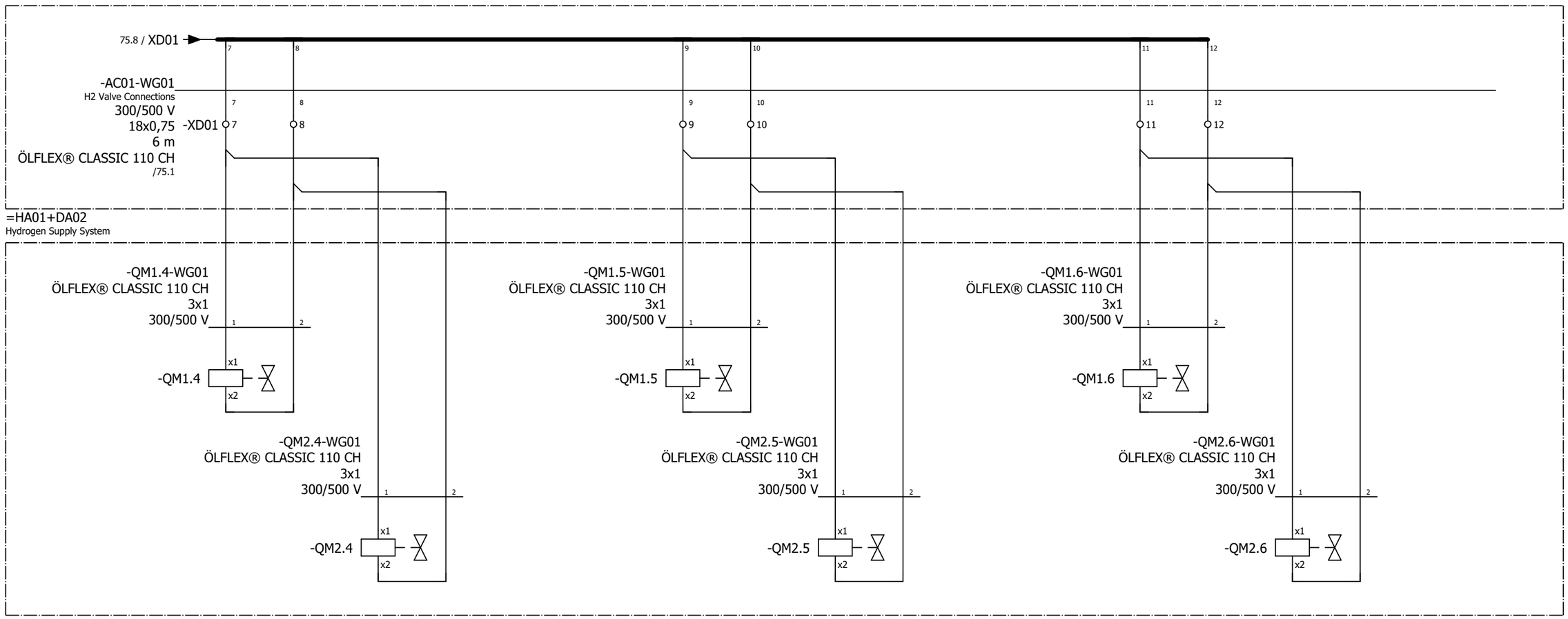
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Hydrogen Valve Cable FC1 - FC3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 75 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft



=HA01+DA02-AC01
Hydrogen Supply System - Non-EX Box



=HA01+DA02
Hydrogen Supply System

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Hydrogen Valve Cable FC4 -FC6		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 76 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft Container

Condensate Drain Tank High Level
JB01_BL02_LSH
&C02/3.1
-KE01-Slot4
AI4
X03 | 28

Heatracing drain
JB01_QB18_EB01
&C02/2.6
-KE01-Slot3
DO4.1
X01 | 10 | 11

622

22.5 / -X202:2.2

A1
-QB18
A2

22.7 / -X202:-2.2

621

23.4 / -X204:1.1

23.6 / -X204:-1.1

-X110 ○1 ○2 ○3 ○4

12.3 -FC18:1

12.3 -FC18:2

12.4 -FC18:PE

=JA01+DA01
Condensate Drain System, Inside 40ft Container

-BL02-WG01
PUR
10 m
4x0,34
50/60 V
Process Drain Tank Level Signal
BN BU BK WH

-BL01-XG01
M12 F
1 2 3 4

-BL02
Process Water
Catchment Tank
Level Transmitter
1 L+
3 L-
V
4 Out 1/ IO-Link
2 Out 2

-EB01
/82.0
Heatracing drain line
L
PE
N

1 ▽ 2
R3 ▽ R4
R5 ▽ R6
7 ▽ 8
13 — 14 /12.3
23 — 24 /12.3

Reference Item Number	Ballard Part # TBD		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Fuel Cell Drain line		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 77 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control Cabinet

Cabinet temperature UC01
UC01_BT01_TT
&C02/9.1
-KE03-Slot4
AI1 AI20 AI21
X01 1 2 3
623 624 625

Cabinet temperature UC02
UC02_BT01_TT
&C02/9.1
-KE03-Slot4
AI4 AI23 AI24
X02 4 5 6
626 627 628

Cabinet temperature UC03
UC03_BT01_TT
&C02/9.1
AI7 AI26 AI27
X03 7 8 9
629 630 631

-X120 1 2 3 4 5 6 7 8 9 10 11 12

=BA01+UC01
DC/DC cabinet 1

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
PT1000
M12

=BA01+UC02
DC/DC cabinet 2

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
PT1000
M12

=BA01+UC03
DC/DC cabinet 3

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
PT1000
M12

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container -DC/DC cab 1 - 3 Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 78 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control Cabinet

Cabinet temperature UC04
UC04_BT01_TT
&C02/9.1
-KE03-Slot4
AI10 AI20 AI21
X04 10 11 12
632 633 634
-X120 13 14 15 16

Cabinet temperature UC05
UC05_BT01_TT
&C02/9.1
AI13 AI23 AI24
X05 13 14 15
635 636 637
17 18 19 20

Cabinet temperature UC06
UC06_BT01_TT
&C02/9.1
AI16 AI23 AI24
X06 16 17 18
638 639 640
21 22 23 24

=BA02+UC04
DC/DC cabinet 4

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
1 2 3 4
PT1000
M12

=BA02+UC05
DC/DC cabinet 5

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
1 2 3 4
PT1000
M12

=BA02+UC06
DC/DC cabinet 6

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet
Temperature
1 2 3 4
PT1000
M12

Reference Item Number	Ballard Part # TBD		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - DC/DC cab 4 - 6 Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 79 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft Container

31.7 / L1
31.7 / L2
31.7 / L3
31.7 / PE

101
213
229
250

L1 / 81.0
L2 / 81.0
L3 / 81.0
PE / 81.0

-FC16
/34.3
6A, B-curve
MCCB, DCDC Cooling Fan A

-FC17
/34.3
6A, B-curve
MCCB, DCDC Cooling Fan B

209
225
240
210
226
241

-X16 PE 1 2 3
-X17 PE 1 2 3

100.7
>=LA01-WG206
BN WH
641
643

=JA01+DA01
Power Converters Cooling 40ft Container

-GQ08-WD01
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV
4x2,5
0,6/1,0 kV
GNYE 1 2 3

-GQ09-WD01
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV
4x2,5
0,6/1,0 kV
GNYE 1 2 3

-AC07-WG01
/100.5
BUS CAN FD P
2x0,5
300 V
Ventilation (Upper) Signal
BN WH

-AC08
93x93mm
Junction Box

-AC07
93x93mm
Junction Box

-RE01
643
641
120 Ω
1 2 3 4

-GQ08-WD02
0,6/1 kV
4x2,5
0,6/1,0 kV
DCDC Cooling Fan A Power
GNYE BN BK GY

-GQ08-WG01
2x0,5
300 V
DCDC Cooling Fan B Signal
BN
WH

-GQ09-WD02
0,6/1 kV
4x2,5
0,6/1,0 kV
DCDC Cooling Fan B Power
GNYE BN BK GY

-GQ09-WG01
2x0,5
300 V
DCDC Cooling Fan A Signal
BN WH

-GQ08
1kW
DCDC Cooling Fan A
PE PE L1 L2 L3 NC COM 0-10V RSB RSA GND 10V
1 2 3 4 5 6 7 8 10 11 12 13
M 3~
PE

-GQ09
1kW
DCDC Cooling Fan B
PE PE L1 L2 L3 NC COM 0-10V RSB RSA GND 10V
1 2 3 4 5 6 7 8 10 11 12 13
M 3~
PE

Reference Item Number	Ballard Part # TBD		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - DCDC Ventilation Fans		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 80 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft Container

80.8 / L1 → 101 → L1 /
80.8 / L2 → 213 → L2 /
80.8 / L3 → 229 → L3 /
80.8 / PE → 250 → PE /

-FC11
6A, B-curve
MCCB, Ventiation Fan A
1 3 5 / 2 4 6
211 227 242

-FC12
/34.2
6A, B-curve
MCCB, Ventilation Fan B
1 3 5 / 2 4 6
212 228 243

100.7
>=LA01-WG202
WH OR SH

-X11 1 2 3 PE
-X12 1 2 3 PE

=JA01+DA01
Container Ventilation System 40ft Container Inside

-GQ06-WD01
/81.0
0,6/1 kV
4x2,5
0,6/1,0 kV
Ventilation (Upper) Supply
BK 1 BK 2 BK 3 GNYE

-GQ06-WG01
/100.4
BUS CAN FD P
2x0,5
300 V
Ventilation (Upper) Signal
WH OR SH

WH BN

-GQ07-WD01
/81.5
0,6/1 kV
4x2,5
0,6/1,0 kV
Ventilation (Lower) Supply
BK 1 BK 2 BK 3 GNYE

-GQ07-WG01
BUS CAN FD P
2x0,5
300 V
Ventilation (Upper) Signal
WH BN SH
WH BN

-GQ06-WD01
/81.1
1 2 3 PE

-GQ06-XD01
4x2,5
1 2 3 PE
211 227 242 250

-GQ06
4,3 kW
Container Ventilation Fan
(Upper)
L1 L2 L3 PE
GND IO1 IO2 IO3 Vout GND RSA RSB RSA RSB
-CON1
-CON2
M
3~

-GQ07-WD01
/81.5
1 2 3 4

-GQ07-XD01
4x2,5
1 2 3 PE
212 228 243 250

-GQ07
4,3 kW
Container Ventilation Fan
(Lower)
L1 L2 L3 PE
GND IO1 IO2 IO3 Vout GND RSA RSB RSA RSB
-CON1
-CON2
M
3~

644 642
-GQ07-RA01
120Ω
RS485 Termination
Resistor

Reference Item Number	Ballard Part # TBD		
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=	++	+ UC20	& C03

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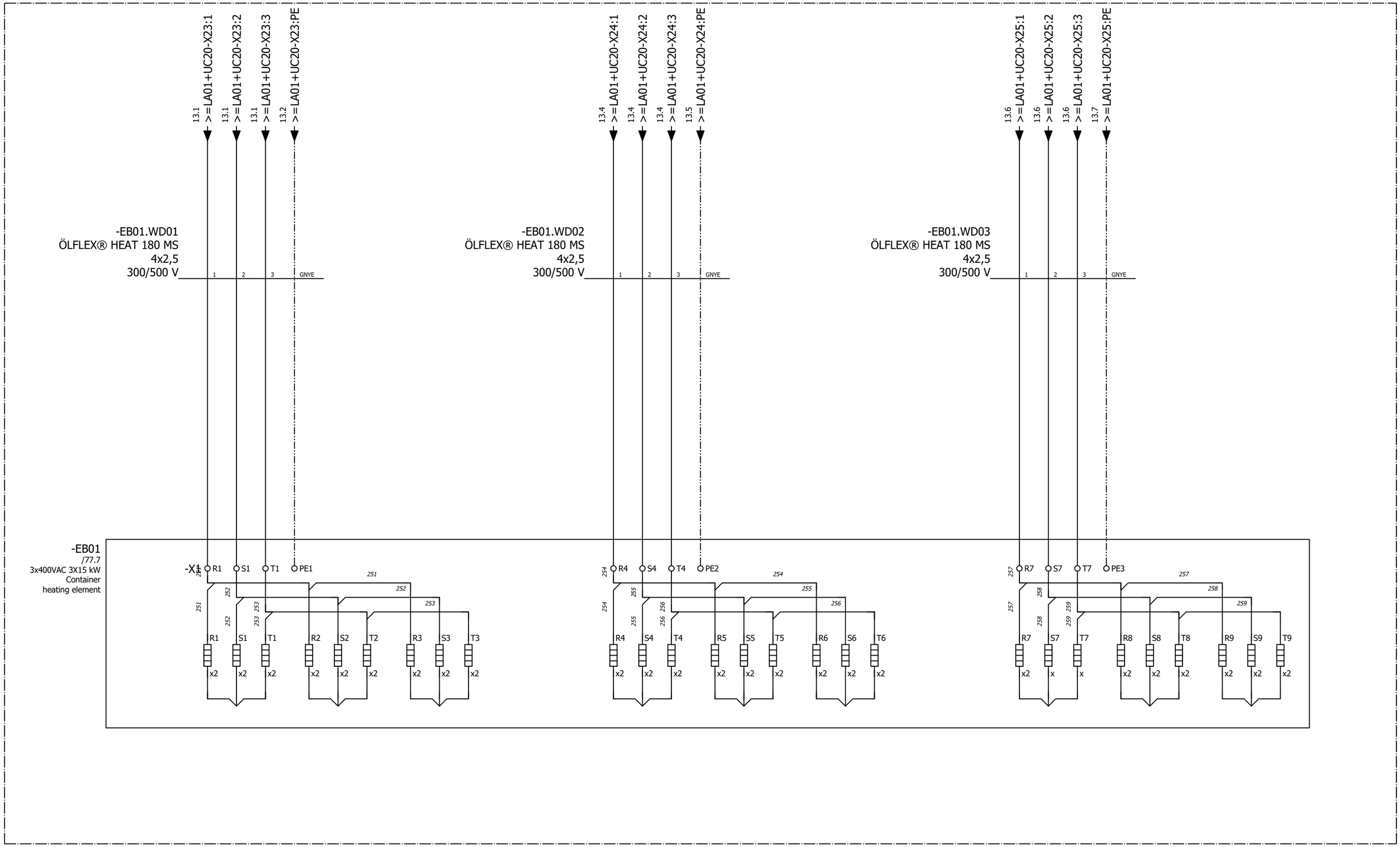
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Ventilation Intake Fans		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 81 / 2

0	1	2	3	4	5	6	7	8

=JA01+DA01

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
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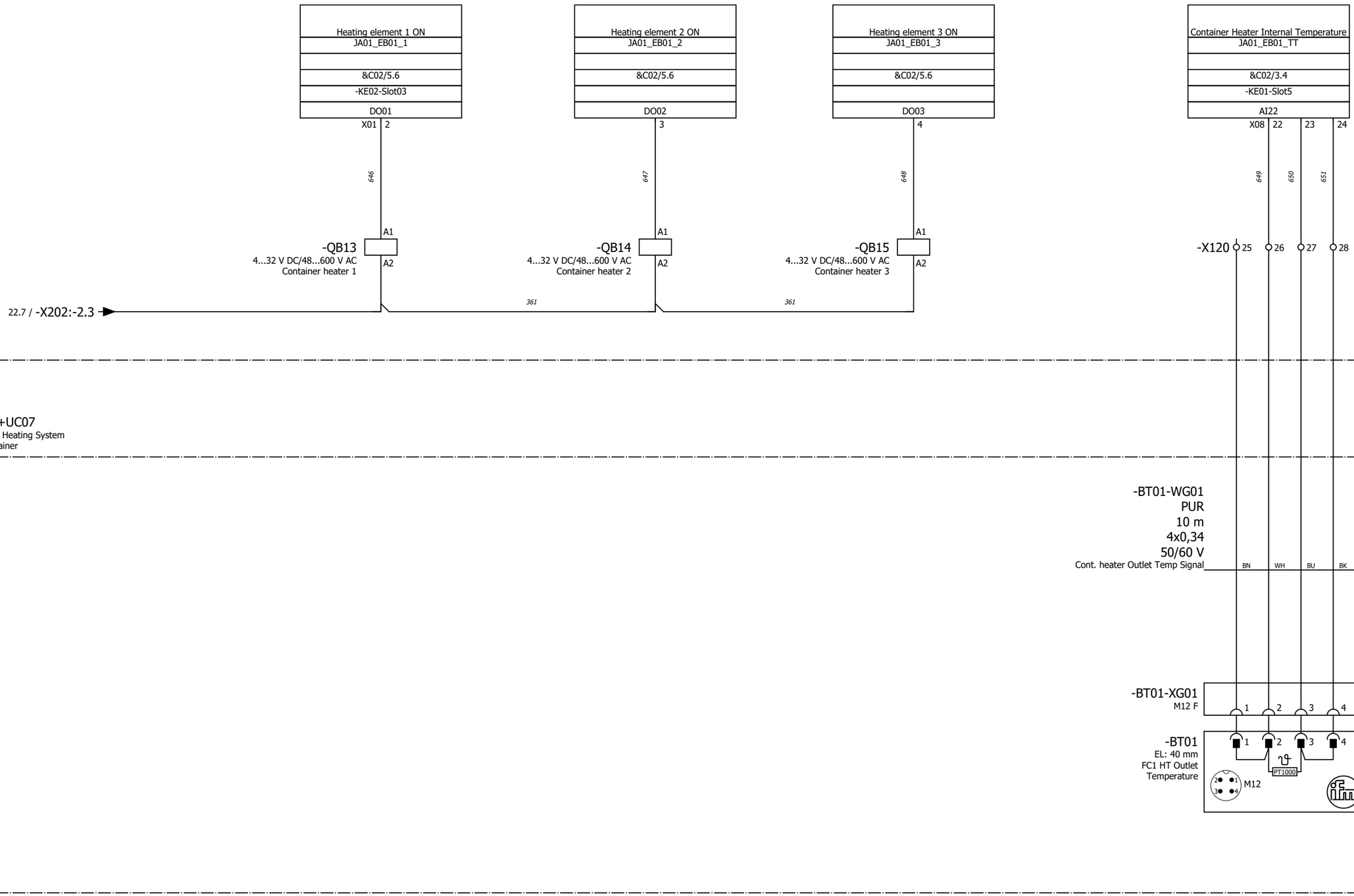
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container heater		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 82 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



=JA01+UC07
Container Heating System
40ft Container

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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=	++	+ UC20	& C03

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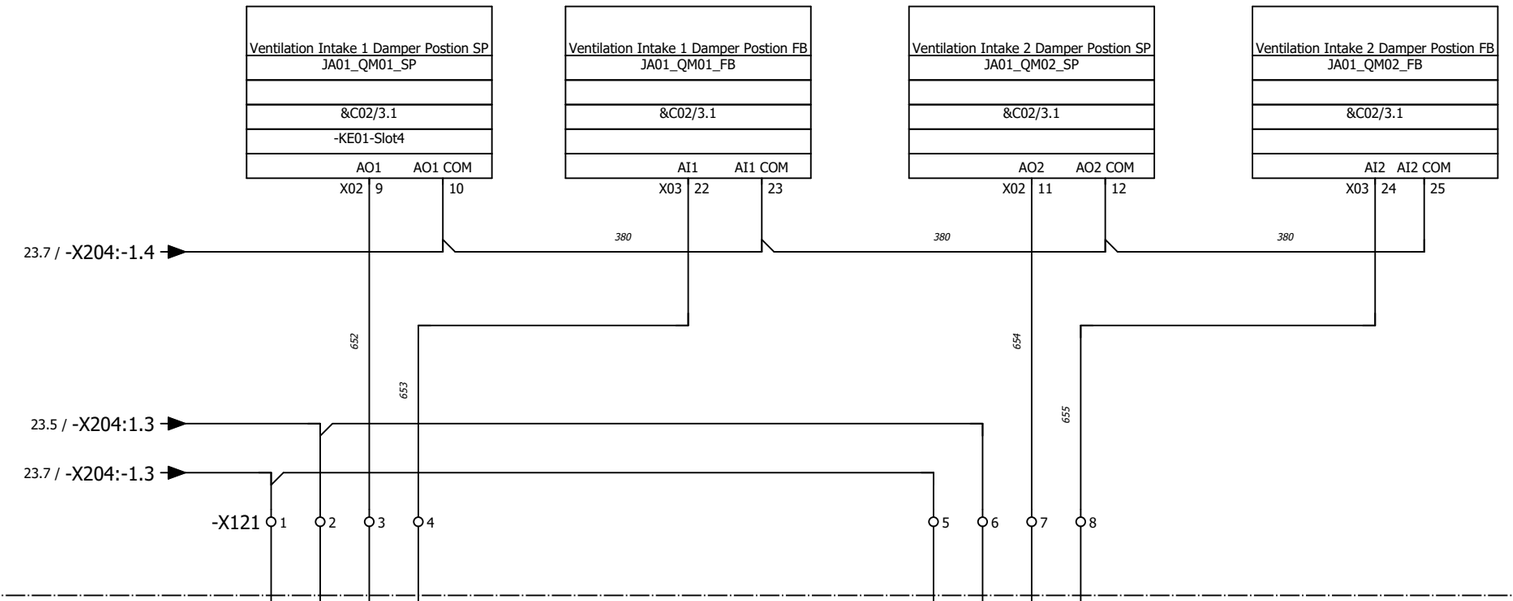
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Heating Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 83 / 2

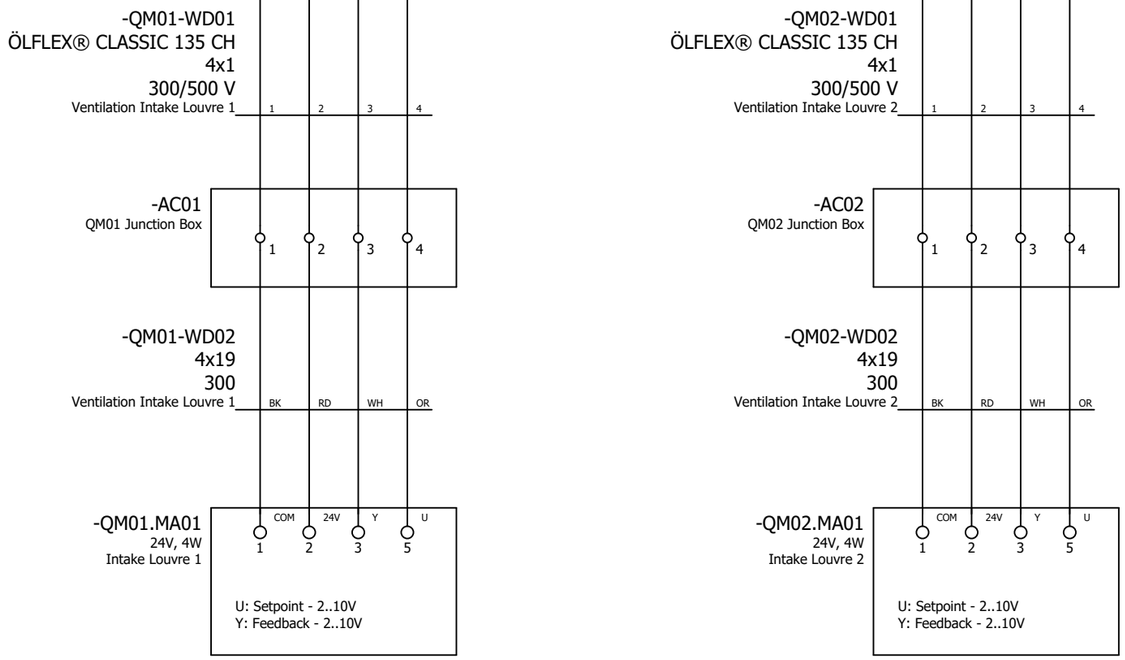
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System, Container #1 Inside



=JA01+DA01
Ventilation System, Container #1 Inside



Reference Item Number	Ballard Part # TBD		
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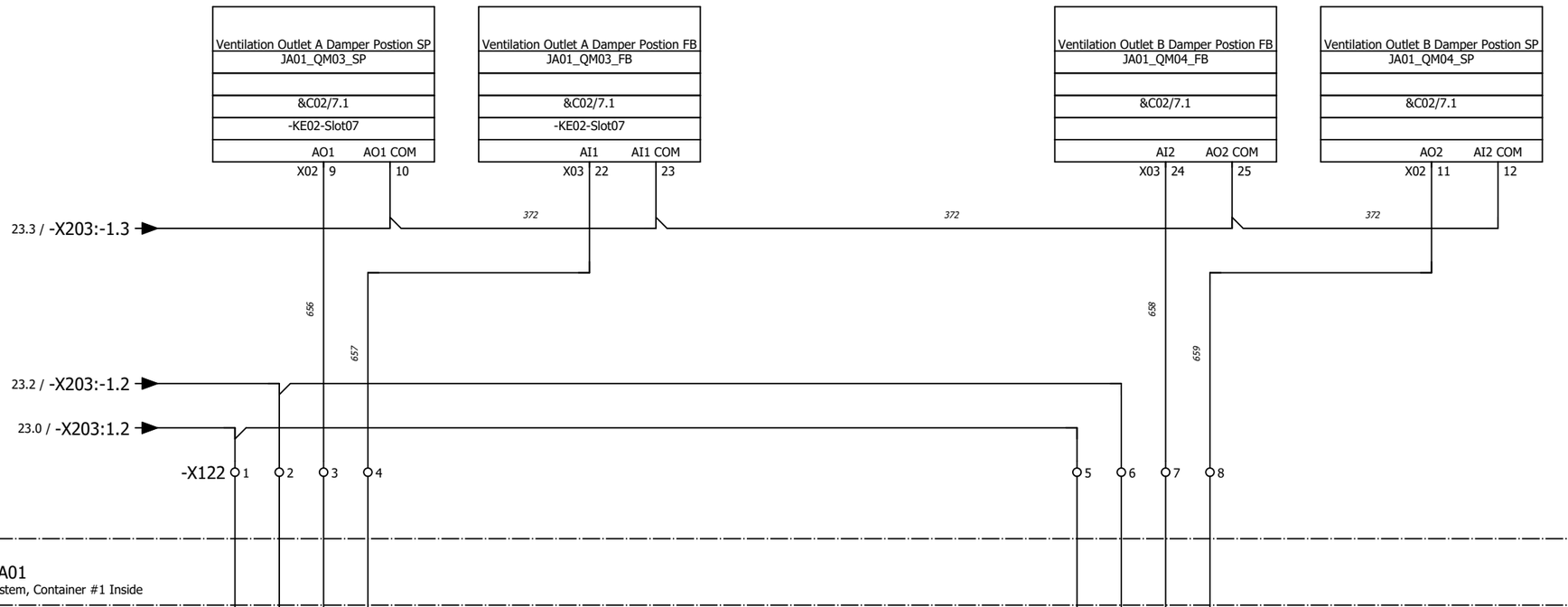
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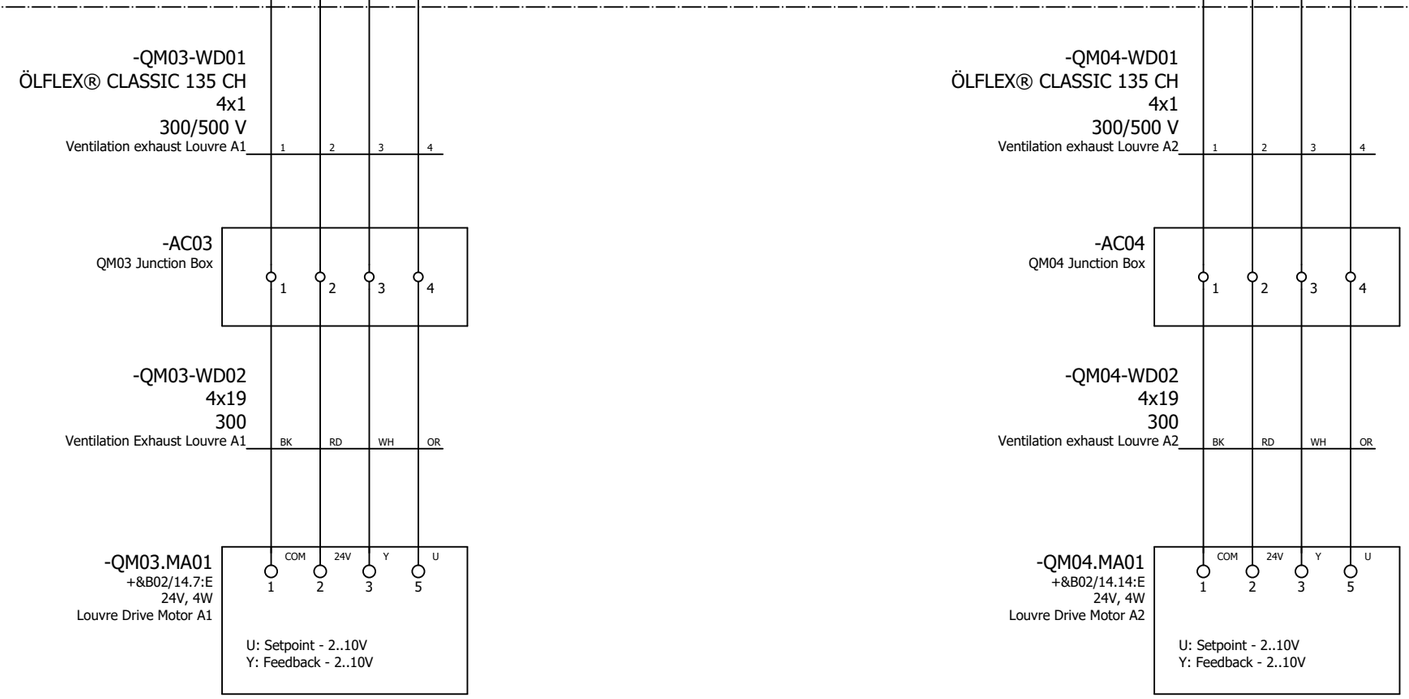
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Intake Louvres		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 84 / 2

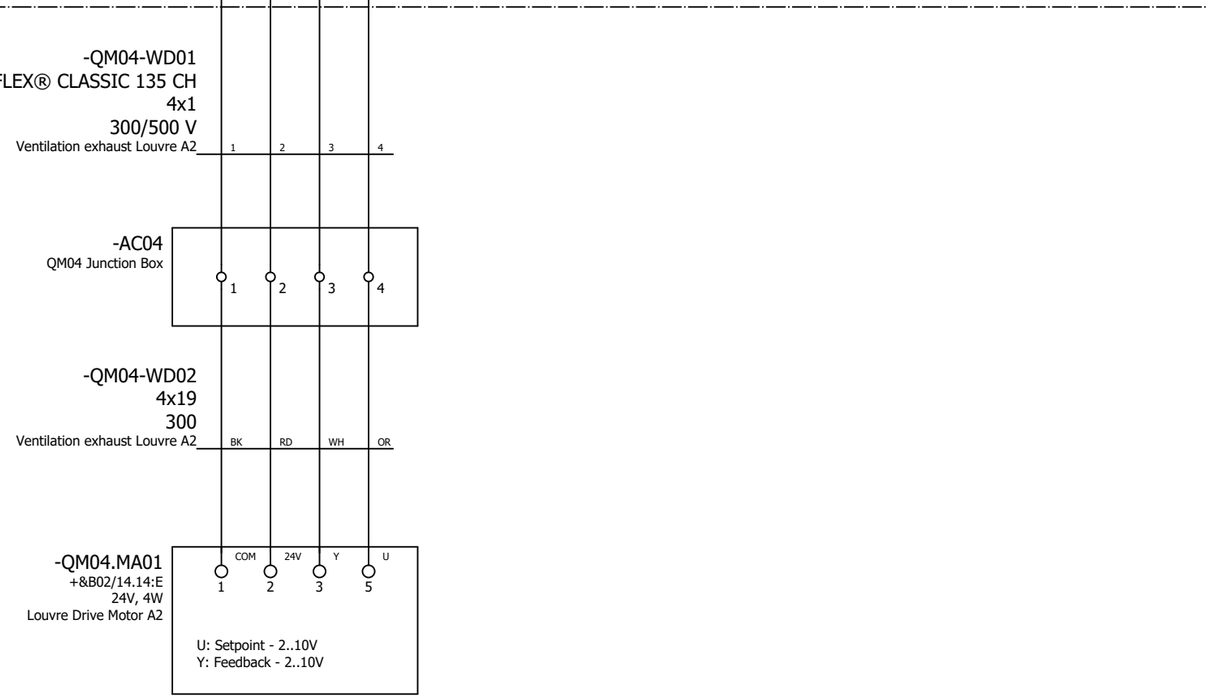
0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System, Container #1 Inside



=JA01+DA01
Ventilation System, Container #1 Inside





Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DESCRIPTION
DATE
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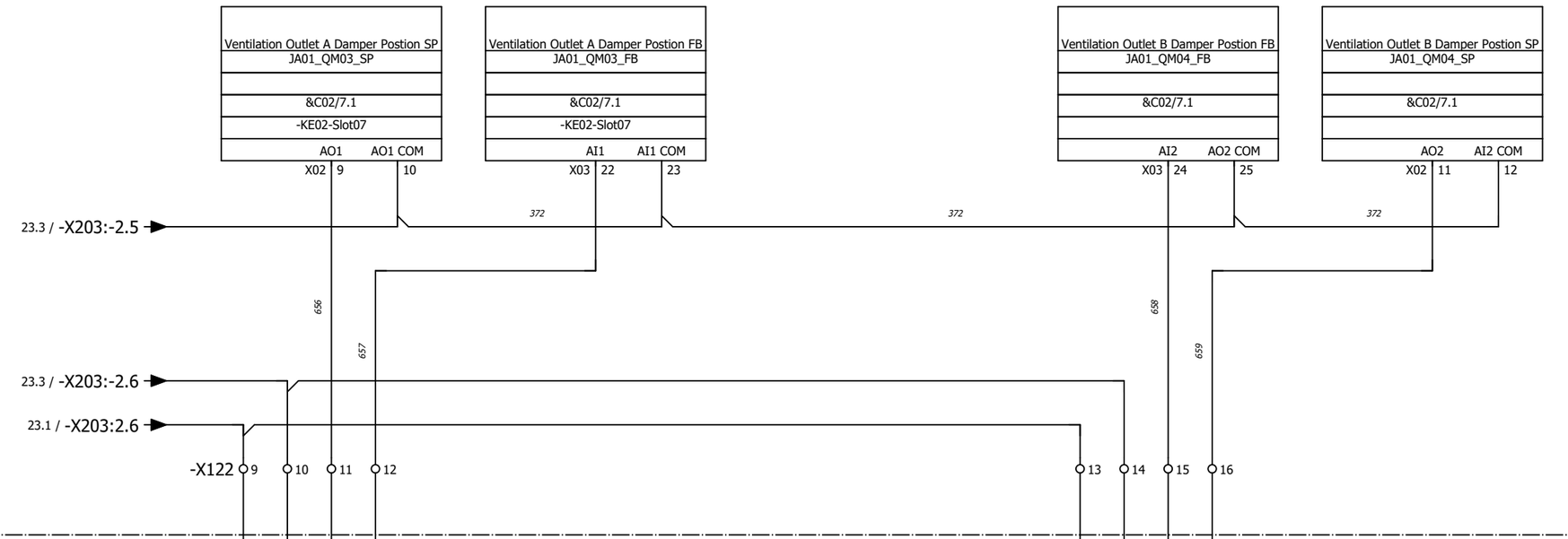
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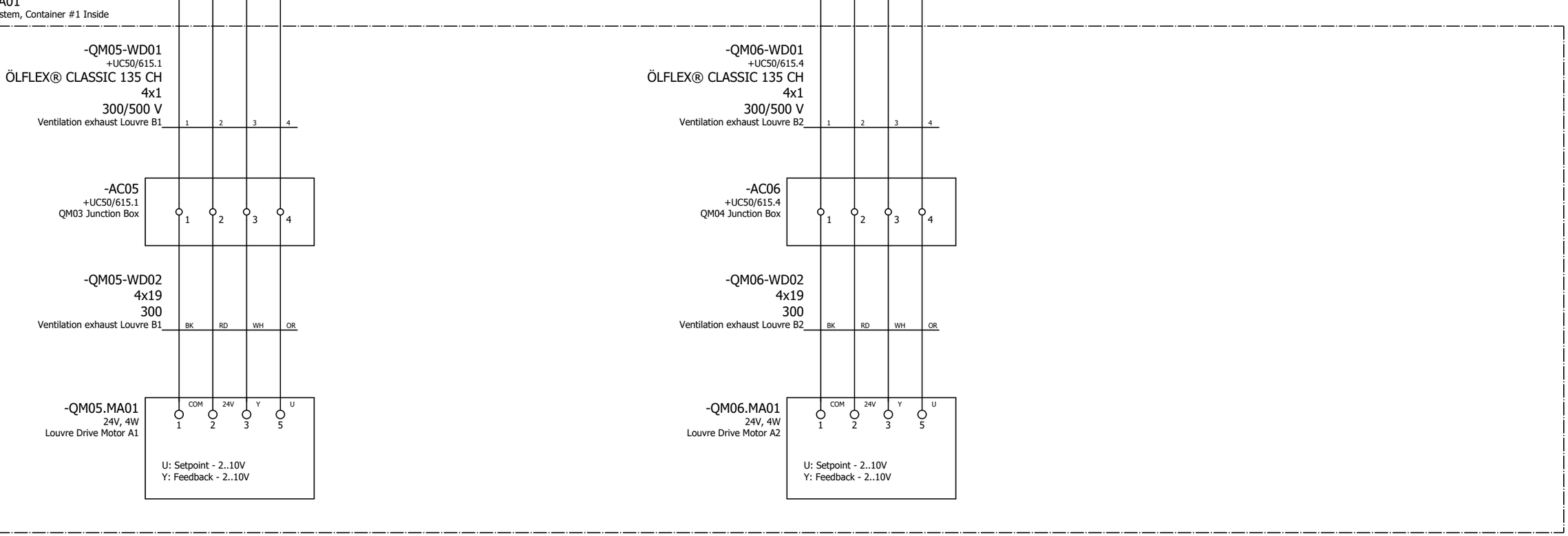
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Exhaust Louvre A		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 85 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System, Container #1 Inside



=JA01+DA01
Ventilation System, Container #1 Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Exhaust Louvre B		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 86 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System, Container #1 Inside

Container Indoor/Outdoor Diffential Pressure
JA01_BP02_PDT
&C02/3.4
-KE01-Slot5
AI6 AI6
X06 17 18

Ventilation Intake Filter Differential-pressure
JA01_BP01_PDT
&C02/3.4
-KE01-Slot5
AI5 AI5
X05 14 15

23.3 / -X203:-1.5

374

660

661

23.1 / -X203:1.4

23.3 / -X203:-1.4

-X123 1 2 3 4 5 6

=JA01+DA01
Ventilation System, Container #1 Inside

-BP02-WD01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
In/Out dP Sensor 1 2 3

-BP02
Container Indoor/Outdoor Diffential Pressure Sensor

UB+ GND AOU1 AOI1
AC/DC 24 V | DC 0...5/10V | DC 4...20mA
ON 1 2 3 4 5 6
Setting: -100 to 100 Pa

-BP01-WD01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
Intake dP Sensor 1 2 3

-BP01
Intake dP Transducer

UB+ GND AOU1 AOI1
AC/DC 24 V | DC 0...5/10V | DC 4...20mA
ON 1 2 3 4 5 6
Setting: 0 to 500 Pa

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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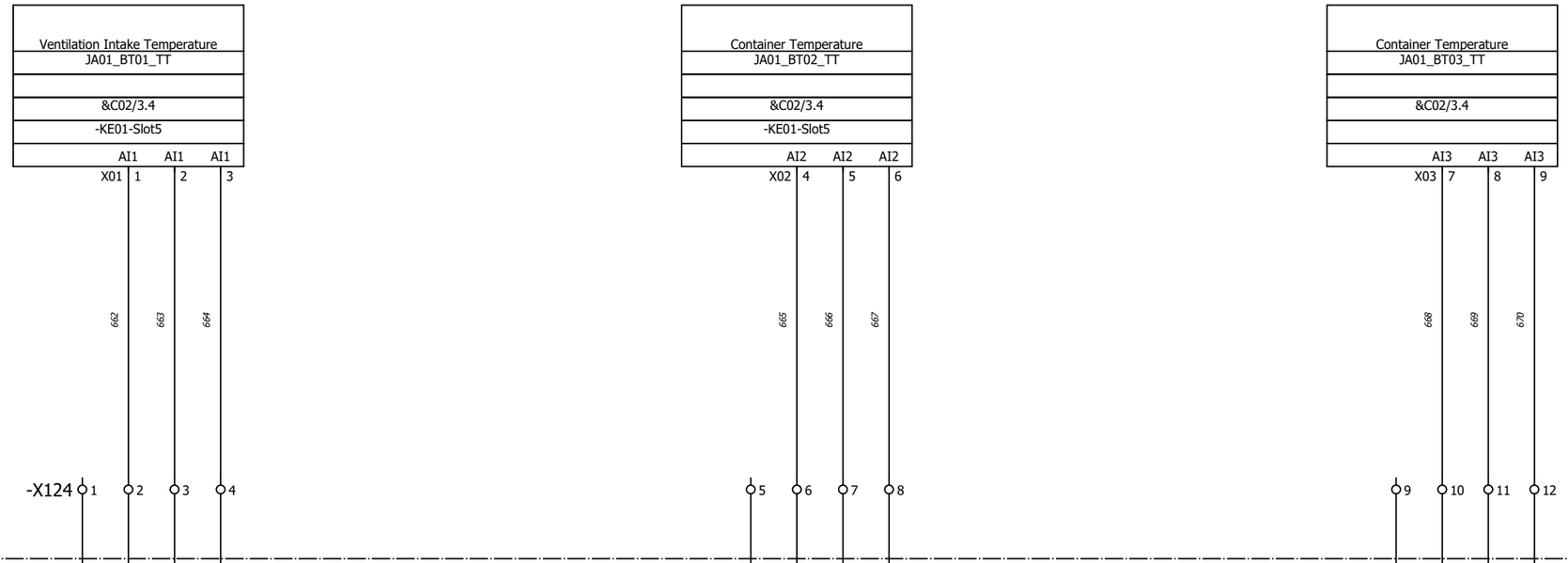
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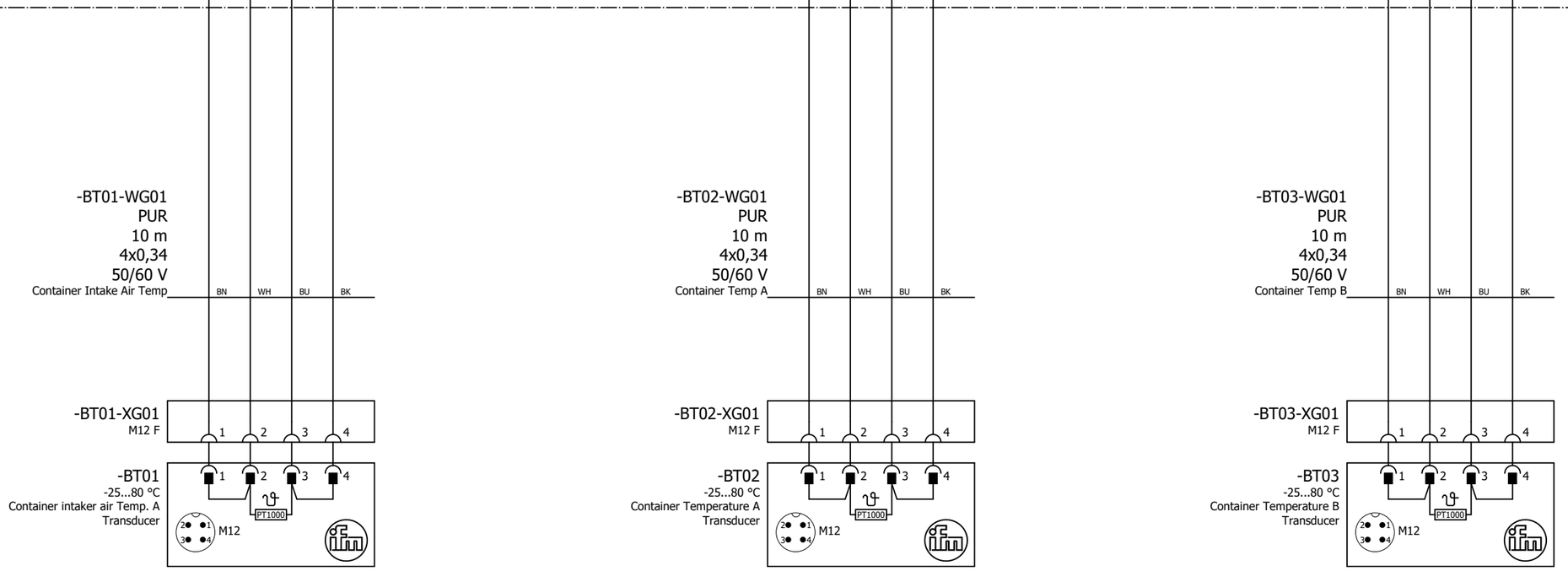
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container In/Out and Filter Diff Pressure		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 87 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System, Container #1 Inside



=JA01+DA01
Ventilation System, Container #1 Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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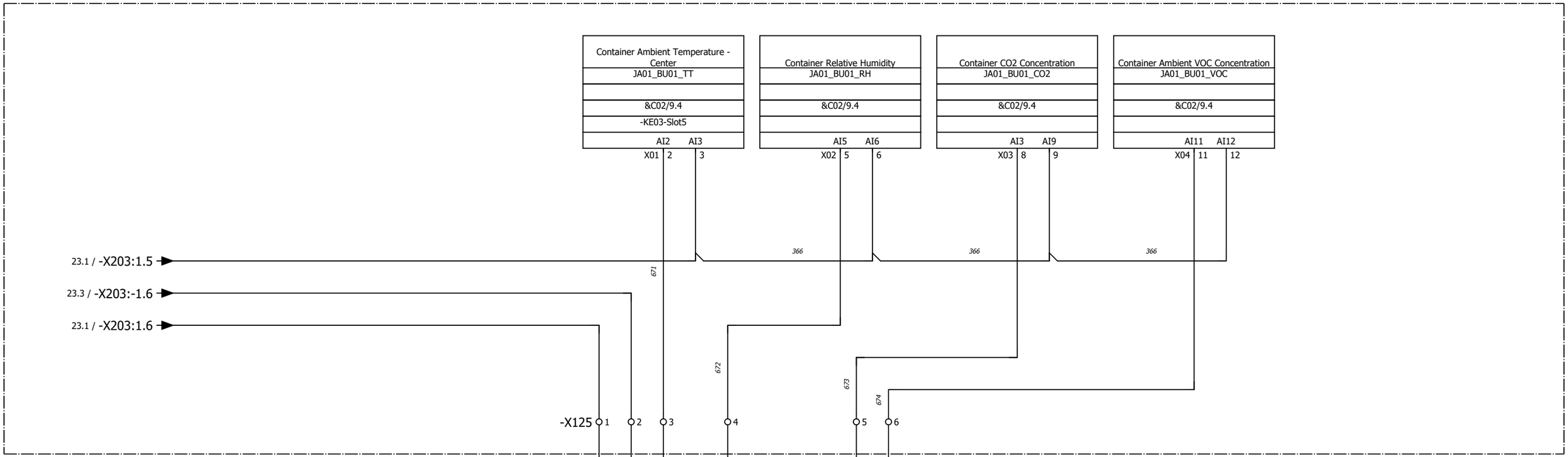
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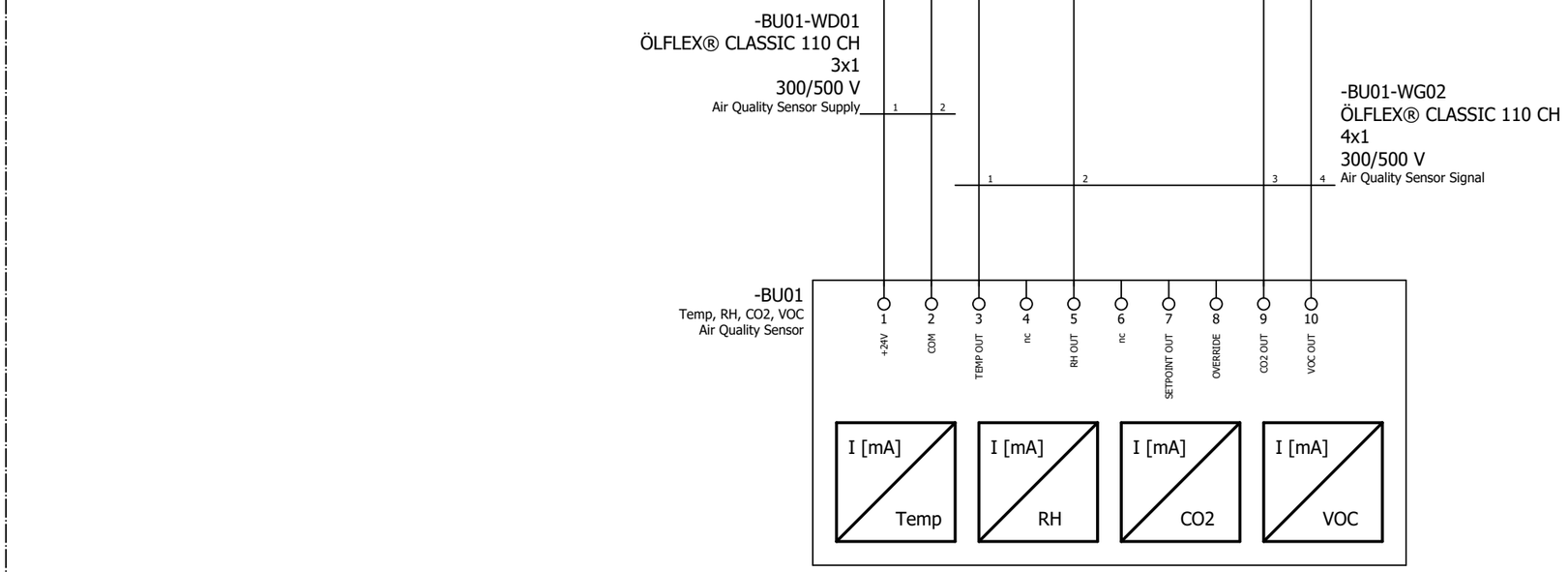
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Temp Sensors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 88 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control Cabinet, 40ft Container



=JA01+DA01
40ft Container, Ventilation System



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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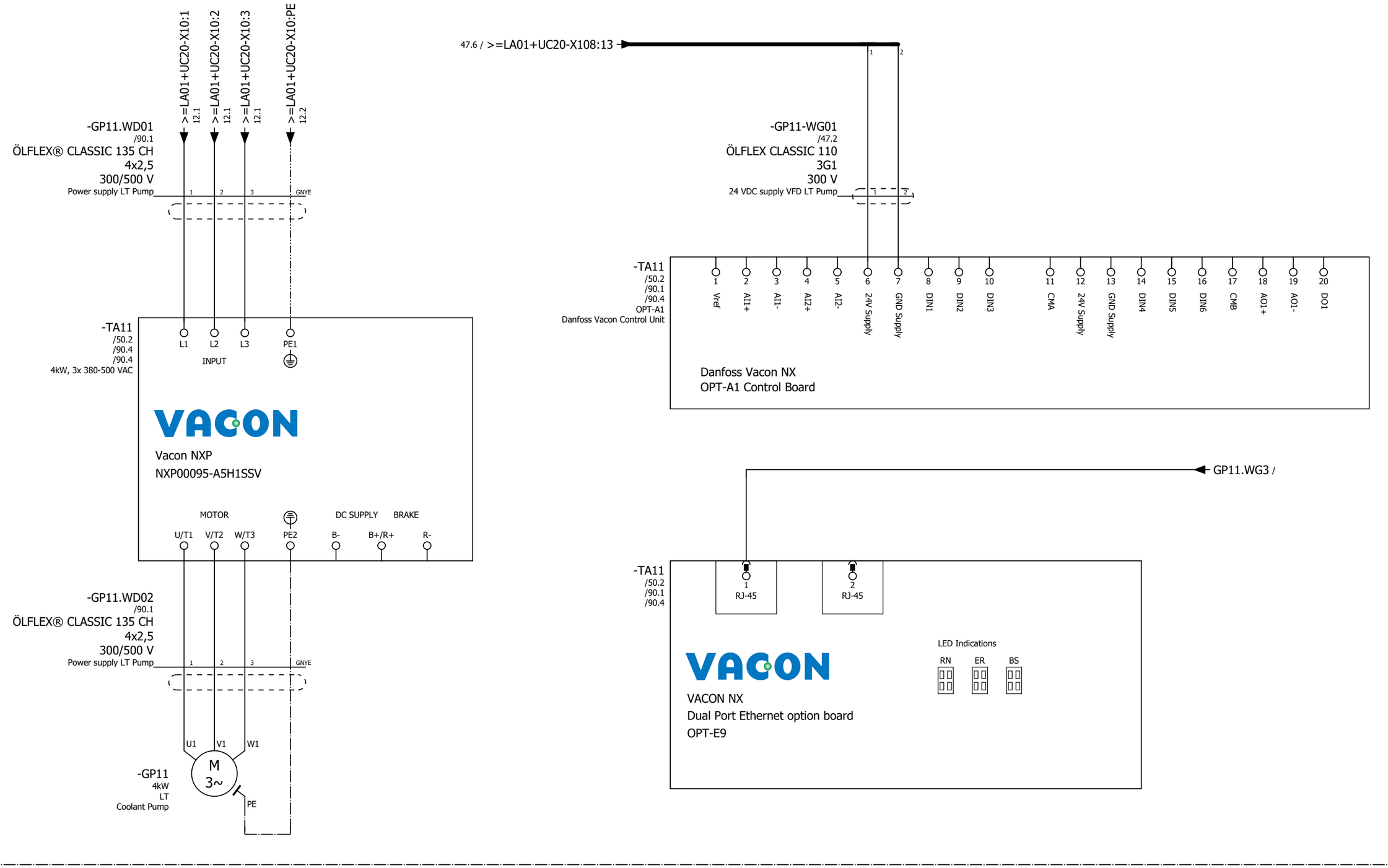
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Container Air Quality Sensor		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 89 / 2

0	1	2	3	4	5	6	7	8

=HE03+DA01

Container Safety System, Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
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=	++	+ UC20	& C03

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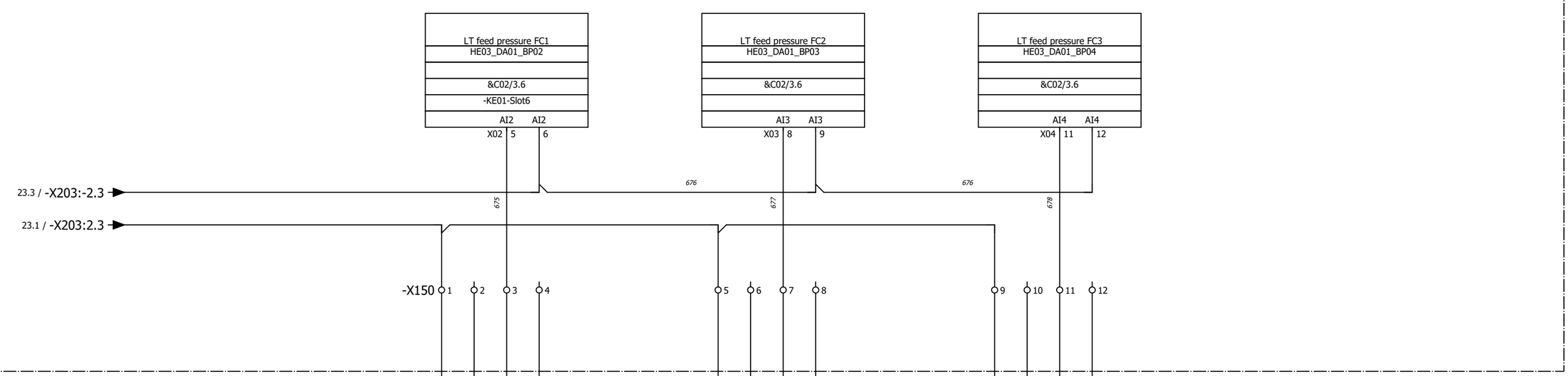
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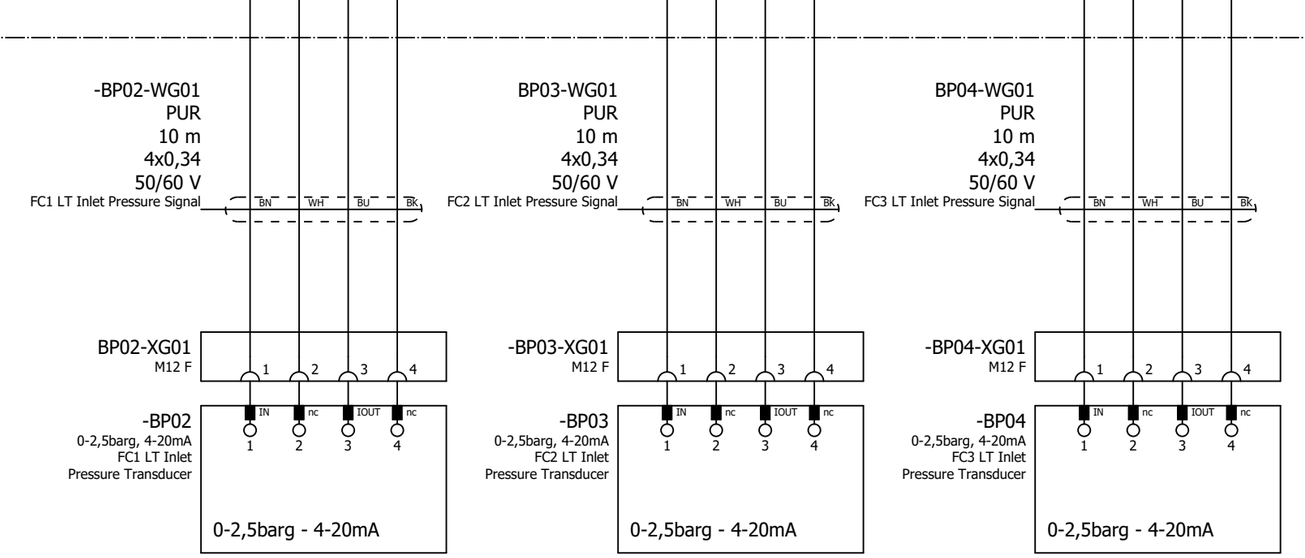
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft container - LT Pump Power Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 90 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



=HE03+DA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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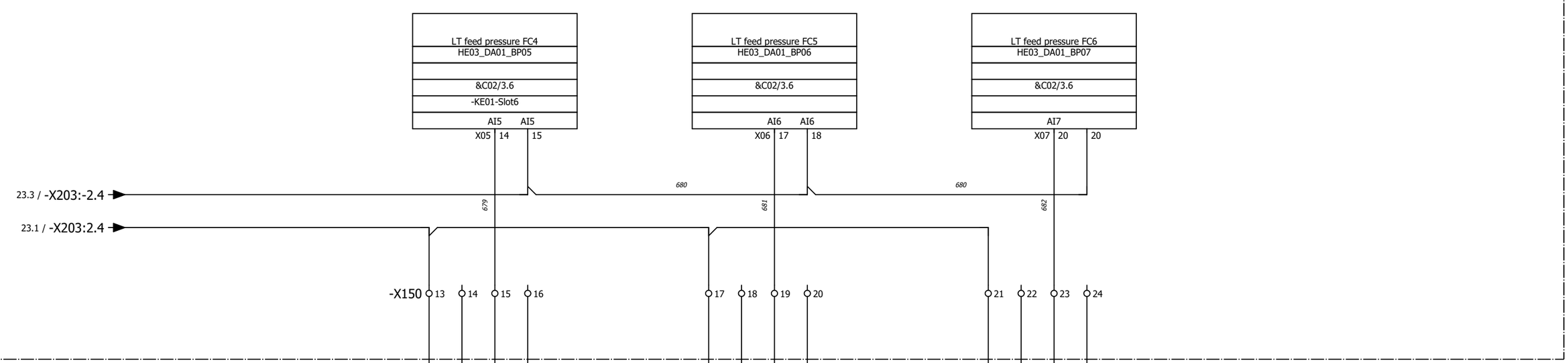
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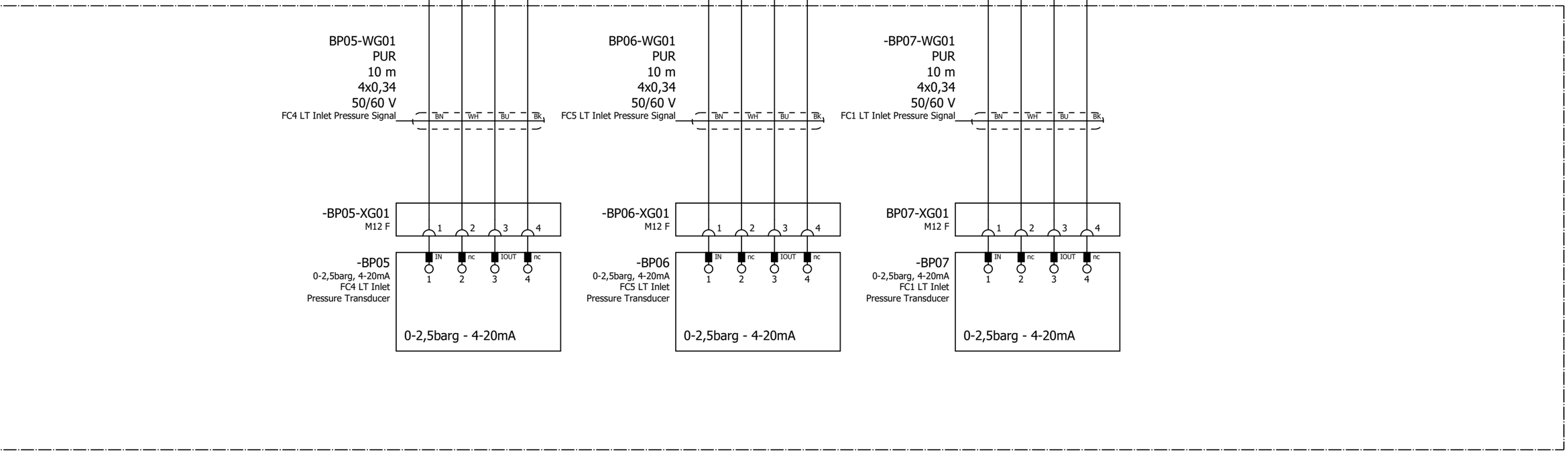
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - LT Cooling System		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 91 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20



=HE03+DA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - LT Cooling System		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 92 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

LT Circuit Differential-pressure
HE03_DA01_BP01
&C02/3.4
-KE01-Slot5
AI7 AI7
X07 20 21

23.3 / -X203:-2.1

683

23.1 / -X203:2.1

-X150 25 26 PE

=HE03+DA01

-BP01-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
LT Circuit dP Signal
1 2 3

-BP01-XD01
DIN 43650 Form A
Valve Plug
1 2 3 PE

-BP01
LT Circuit
Differential-pressure
Transmitter
UB+ nc AOU1 PE
AC/DC
24 V
DC
4..20mA
0..4 barg
BELIMO

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - LT Cooling System		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 93 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control Cabinet

FC1 HT Coolant Outlet Temperature
HE03_DA01_BT01
&C02/8.6
-KE03-Slot3
AI19 AI20 AI21
X07 19 20 21

FC2 HT Coolant Outlet Temperature
HE03_DA01_BT02
&C02/8.6
-KE03-Slot3
AI22 AI23 AI24
X08 22 23 24

FC3 HT Coolant Outlet Temperature
HE03_DA01_BT03
&C02/8.6
AI25 AI26 AI27
X09 25 26 27

684 685 686 687 688 689 690 691 692

-X160 1 2 3 4 5 6 7 8 9 10 11 12

=HE01+DA01
HT Coolant System #1, Inside 40ft Container

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
FC1 HT Outlet Temp Signal
BN WH BU BK

-BT02-WG01
PUR
10 m
4x0,34
50/60 V
FC2 HT Outlet Temp Signal
BN WH BU BK

-BT03-WG01
PUR
10 m
4x0,34
50/60 V
FC3 HT Outlet Temp Signal
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT02-XG01
M12 F
1 2 3 4

-BT03-XG01
M12 F
1 2 3 4

-BT01
EL: 160 mm
FC1 HT Outlet Temperature
1 2 3 4
PT1000
M12 2 1 3 4

-BT02
EL: 160 mm
FC2 HT Outlet Temperature
1 2 3 4
PT1000
M12 2 1 3 4

-BT03
EL: 160 mm
FC3 HT Outlet Temperature
1 2 3 4
PT1000
M12 2 1 3 4

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - HT #1/2 Module Outlet Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 94 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20
Control Cabinet

FC4 HT Coolant Outlet Temperature
HE03_DA01_BT04
&C02/9.1
-KE03-Slot4
AI19 AI20 AI21
X07 19 20 21
693 694 695

FC5 HT Coolant Outlet Temperature
HE03_DA01_BT05
&C02/9.1
AI22 AI23 AI24
X08 22 23 24
696 697 698

FC6 HT Coolant Outlet Temperature
2HE03_DA01_BT06
&C02/9.1
AI25 AI23 AI24
X09 25 23 24
699 700 701

-X160 13 14 15 16 17 18 19 20 21 22 23 24

=HE02+DA01
HT Coolant System #2, Inside 40ft Container

-BT04-WG01
PUR
10 m
4x0,34
50/60 V
FC4 HT Outlet Temp Signal
BN WH BU BK

-BT05-WG01
PUR
10 m
4x0,34
50/60 V
FC5 HT Outlet Temp Signal
BN WH BU BK

-BT06-WG01
PUR
10 m
4x0,34
50/60 V
FC5 HT Outlet Temp Signal
BN WH BU BK

-BT04-XG01
M12 F
1 2 3 4

-BT05-XG01
M12 F
1 2 3 4

-BT06-XG01
M12 F
1 2 3 4

-BT04
EL: 160 mm
FC4 HT Outlet Temperature
1 2 3 4
PT1000
M12 (2 1 3 4)

-BT05
EL: 160 mm
FC5 HT Outlet Temperature
1 2 3 4
PT1000
M12 (2 1 3 4)

-BT06
EL: 160 mm
FC5 HT Outlet Temperature
1 2 3 4
PT1000
M12 (2 1 3 4)

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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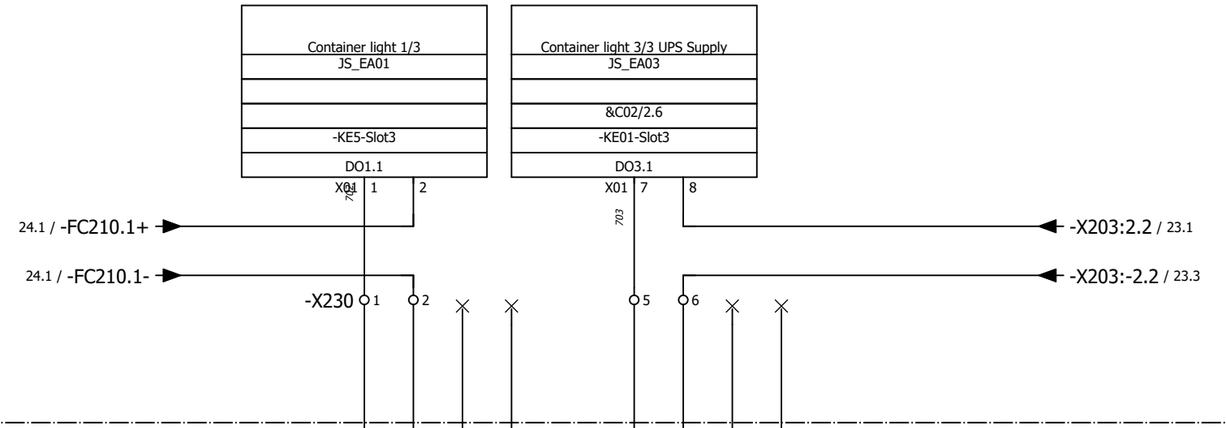
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - HT #2/2 Module Outlet Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 95 / 2

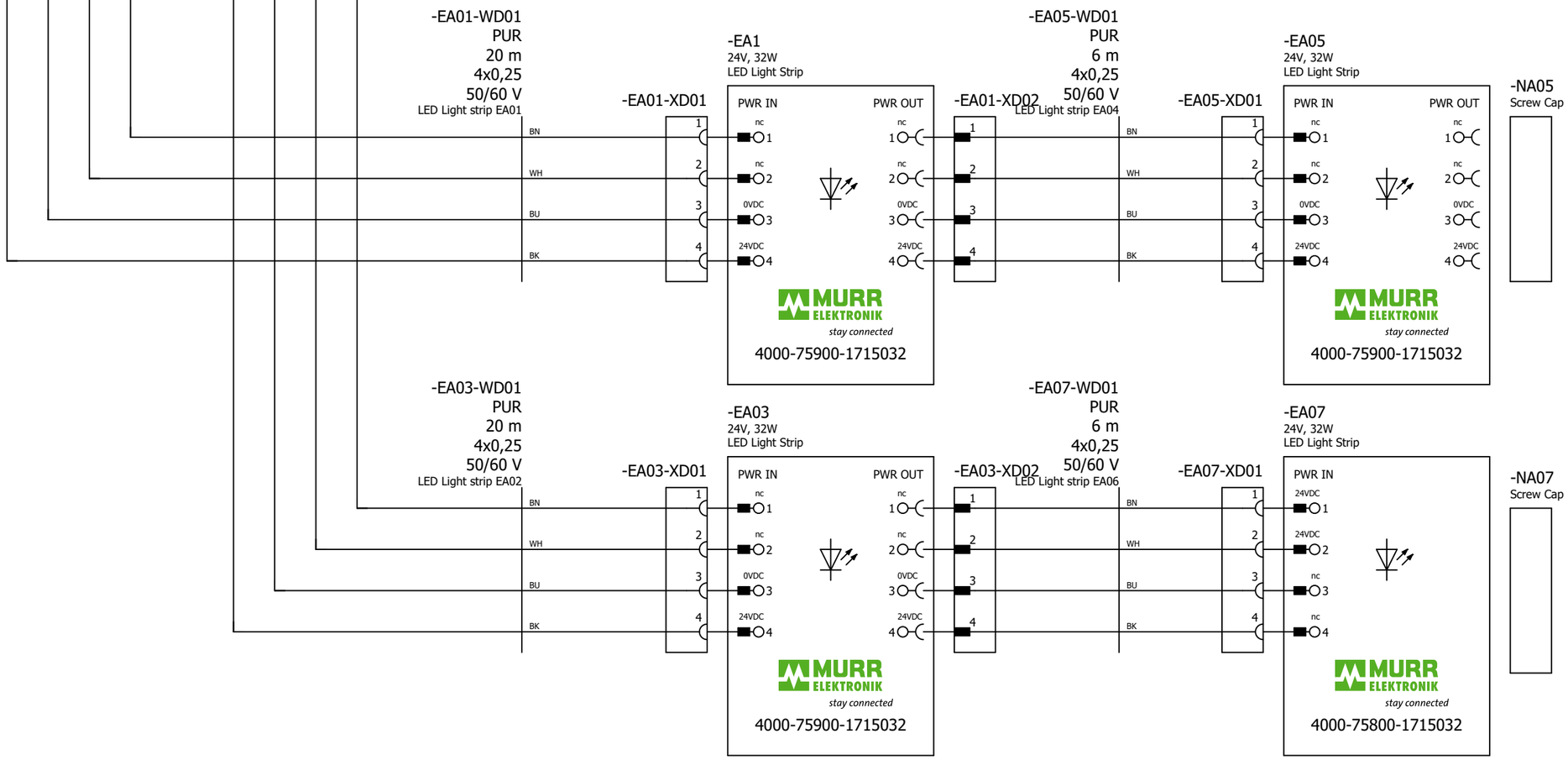
0	1	2	3	4	5	6	7	8

=LA01+UC20



=JA01+DA01

Container Ventilation, Inside Container #1



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
DESCRIPTION
DATE
26-Mar-25

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Lighting 1/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 96 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

Container light 2/3
JS_EA02
-KE5-Slot3
DO2.1
X01 4 5

24.3 / -FC210.2+
24.4 / -FC210.2-
-X230 3 4

Light Switch Container
DA01_SG100
&C02/2.6
-KE01-Slot3
DIO3
X02 15

23.2 / -X203:3.3
7 8

=JA01+DA01
Container Ventilation, Inside Container #1

-EA02-WD01
PUR
20 m
4x0,25
50/60 V
LED Light strip EA05

-EA02
24V, 32W
LED Light Strip
-EA02-XD01
PWR IN
PWR OUT
BN
WH
BU
BK
nc
0VDC
24VDC
MURR ELEKTRONIK
stay connected
4000-75900-1715032

-EA02-XD02

-EA06-WD01
PUR
6 m
4x0,25
50/60 V
LED Light strip EA06

-EA06
24V, 32W
LED Light Strip
-EA06-XD01
PWR IN
PWR OUT
BN
WH
BK
BU
nc
0VDC
24VDC
MURR ELEKTRONIK
stay connected
4000-75900-1715032

-SG01-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
1 2

-SG01 E
13
14

-EA04-WD01
PUR
20 m
4x0,25
50/60 V
LED Light strip EA07

-EA04
24V, 32W
LED Light Strip
-EA04-XD01
PWR IN
PWR OUT
BN
WH
BU
BK
nc
0VDC
24VDC
MURR ELEKTRONIK
stay connected
4000-75900-1715032

-EA04-XD02

-EA08-WD01
PUR
6 m
4x0,25
50/60 V
LED Light strip EA08

-EA08
24V, 32W
LED Light Strip
-EA08-XD01
PWR IN
PWR OUT
BN
WH
BK
BU
nc
0VDC
24VDC
MURR ELEKTRONIK
stay connected
4000-75900-1715032

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
DESCRIPTION
DATE
26-Mar-25

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Lighting 2/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 97 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC20

=HA01+DA02
Exterior location, hydrogen supply

Placed Top right side of cabinet

-X202:-1.6
22.7

-X202:1.6
22.5

-KF200-XD01
1 2 3 4 5 6

-KF200
16 port switch
V1- V1+ COM NO V2- V2+
-U1:1 2 3 4 5 6
PWR1 FAULT PWR2

-U2
Chassis
CHA

Other bus systems
1 2 3 4 5 6 7 8

Other bus systems
9 10 11 12 13 14

Other bus systems
15 16

-KF200-WG01
Cat.6
STP 1
/ KE01-Slot7:P1
Deif Ethernet Port 1

-KF200-WG02
Cat.6
STP
100.4 / -KF210:1

-KF200-WG16
-KF200-WG15
Cat.6
4x2x
STP 1
-KF200:16 / 99.1

-KF200:15 / Cooling skid

-XT11
EX Cable gland
Wall pass-through

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
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DATE
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet - Ethernet switch 1		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 98 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20

Placed bottom right side of cabinet

-X202:-2.1
22.7

-X202:2.1
22.5

-KF201-XD01

1 2 3 4 5 6

-KF201
16 port switch

V1- V1+ COM NO V2- V2+

-U1:1 2 3 4 5 6

PWR1 FAULT PWR2

-U2
Chassis
CHA

Other bus systems 1 2 3 4 5 6 7 8

Other bus systems 9 10 11 12 13 14

Other bus systems 15 16

98.6 / -KF200:16

-KF201:16 /

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
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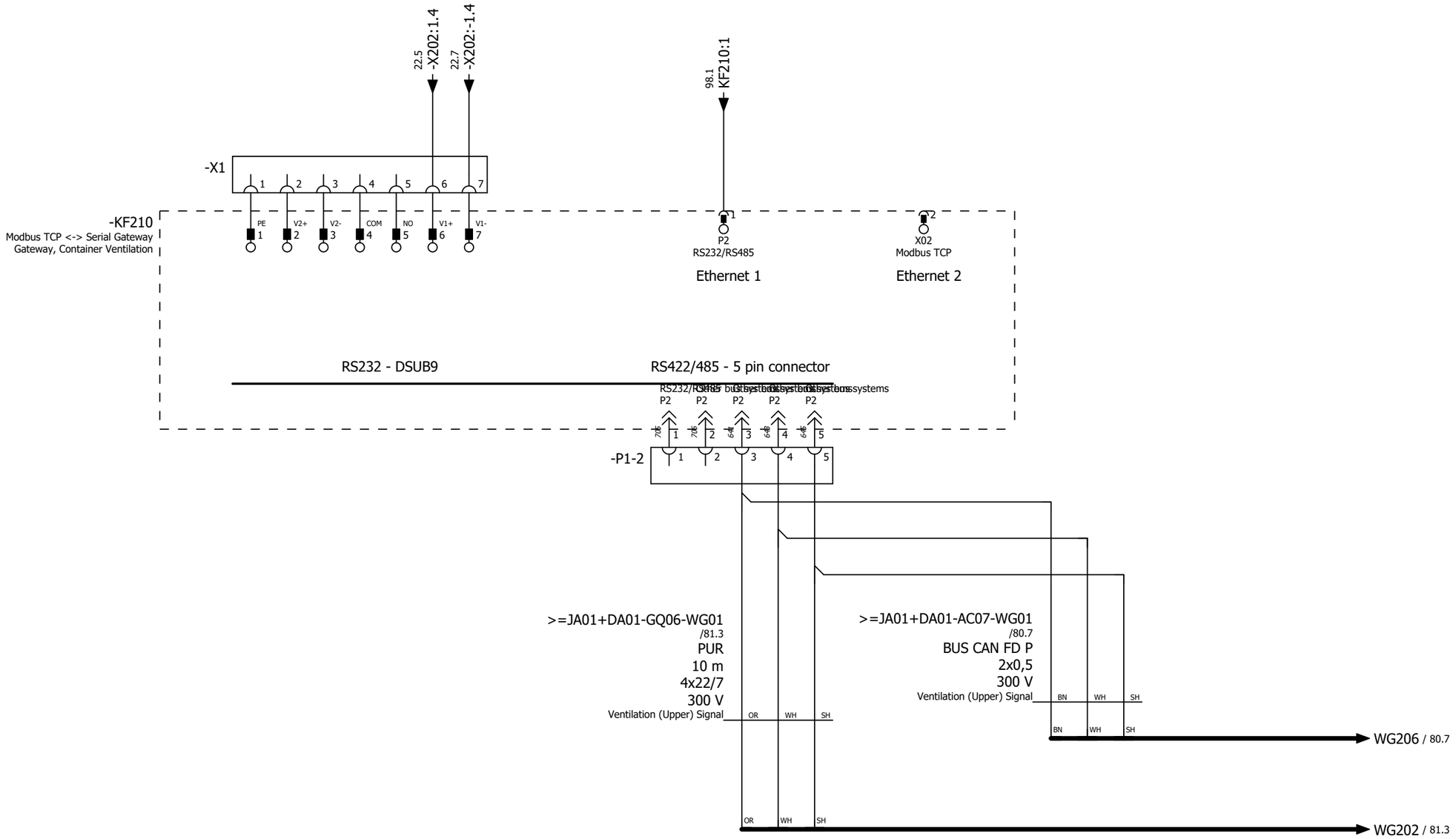
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Control Cabinet - Ethernet switch 2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 99 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC20
Container Control System
Control Cabinet 40 ft



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C03

REVISION INFORMATION
DESCRIPTION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	40ft Container - Modbus Converter		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 100 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

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Ballard Power Systems Europe - Technology Solutions

Panel Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06		
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet				
SHEET TYPE/DESC	Panel Documentation and Layout				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	1 / 18	

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=BA20-XB01		1	1	0	0	1	
=LA01-PE		3	3	0	0	1	
=LA01-X-KE12		X1	X2	0	0	12	
=LA01-X-KE13		X1	X2	0	0	12	
=LA01-X-KE14		X1	X2	0	0	12	
=LA01-X-KE15		X1	X2	0	0	12	
=LA01-X-KE16		X1	X2	0	0	12	
=LA01-X01		1	PE	0	0	5	
=LA01-X10		1	PE	0	0	4	
=LA01-X11		1	3	1	0	4	
=LA01-X12		1	3	1	0	4	
=LA01-X13		1	PE	0	0	4	
=LA01-X14		1	PE	0	0	4	
=LA01-X15		1	PE	0	0	4	
=LA01-X16		1	3	1	0	4	
=LA01-X17		1	3	1	0	4	
=LA01-X18		1	2	0	0	2	
=LA01-X20		1	PE	0	0	5	
=LA01-X22		1	PE	0	0	5	
=LA01-X23		1	PE	0	0	3	
=LA01-X50		1	4	0	0	4	
=LA01-X51		1	4	0	0	4	
=LA01-X52		1	4	0	0	4	
=LA01-X53		1	4	0	0	4	
=LA01-X54		1	4	0	0	4	
=LA01-X55		1	4	0	0	4	
=LA01-X60		1	15	0	0	15	
=LA01-X61		1	15	0	0	15	
=LA01-X62		1	15	0	0	15	
=LA01-X63		1	15	0	0	15	
=LA01-X64		1	15	0	0	15	
=LA01-X65		1	15	0	0	15	
=LA01-X100		1	7	0	0	7	
=LA01-X101		1	4	0	0	4	
=LA01-X102		1	4	0	0	6	
=LA01-X103		1	12	0	0	12	
=LA01-X104		1	12	0	0	12	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =BA20+UC20-XB01 - =LA01+UC20-X104		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 /

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=LA01-X105		1	4	0	0	4	
=LA01-X106		1	12	0	0	12	
=LA01-X107		1	12	0	0	12	
=LA01-X108		1	14	0	0	14	
=LA01-X110		1	4	0	0	6	
=LA01-X120		1	28	0	0	31	
=LA01-X121		1	8	0	0	10	
=LA01-X122		3	16	0	0	18	
=LA01-X123		1	6	0	0	8	
=LA01-X124		11	12	0	0	13	
=LA01-X125		1	6	0	0	6	
=LA01-X150		1	PE	0	0	30	
=LA01-X160		1	24	0	0	26	
=LA01-X201		0.1	0.1	0	0	1	
=LA01-X201-		1-	1-	0	0	1	
=LA01-X202		1	1	0	0	1	
=LA01-X202-		1-	1-	0	0	1	
=LA01-X203		0.1	0.1	0	0	1	
=LA01-X203-		0.1-	0.1-	0	0	1	
=LA01-X204		0.1	0.1	0	0	1	
=LA01-X204-		0.1	0.1	0	0	1	
=LA01-X230		1	8	0	0	8	
=LA01-XPE		1	PE	0	0	7	
=LA01-X_PE		1	1	0	0	6	
=LB02-X101		9	12	0	0	4	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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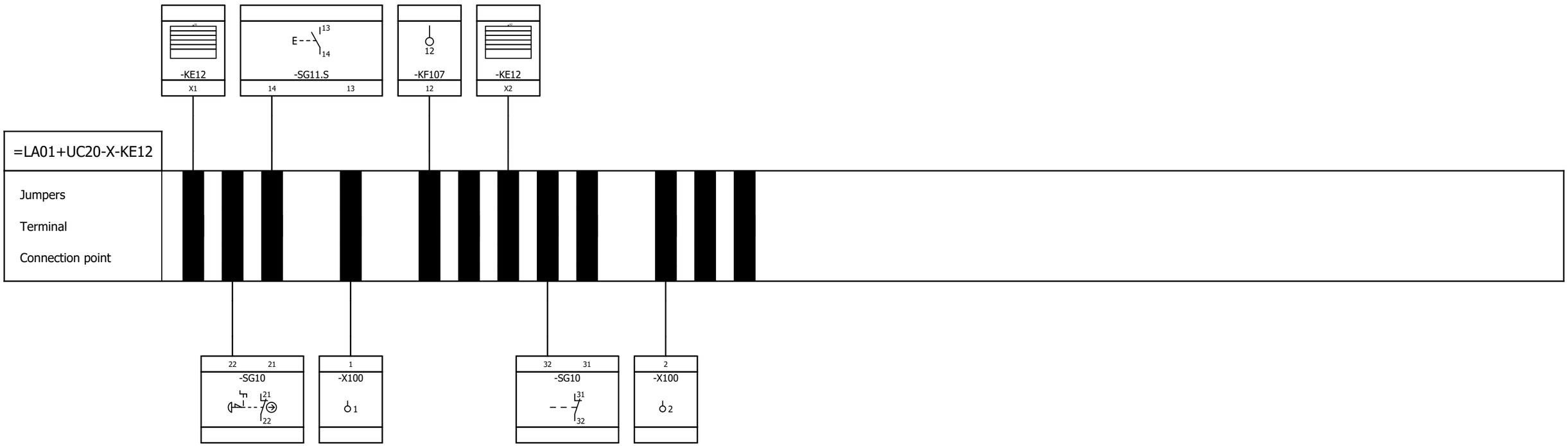
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =LA01+UC20-X105 - =LB02+UC20-X101		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2.a /

Terminal-connection diagram

F11_001
PBL 20-Nov-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
20-Nov-24

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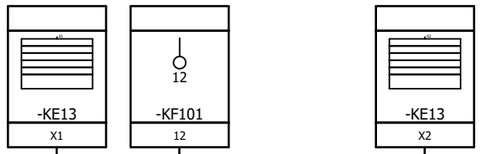
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X-KE12		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

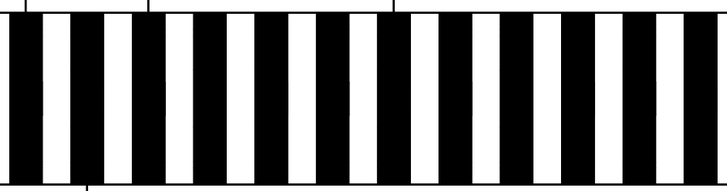


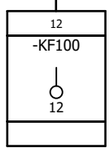
=LA01+UC20-X-KE13

Jumpers

Terminal

Connection point





External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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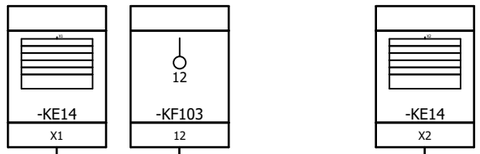
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X-KE13		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

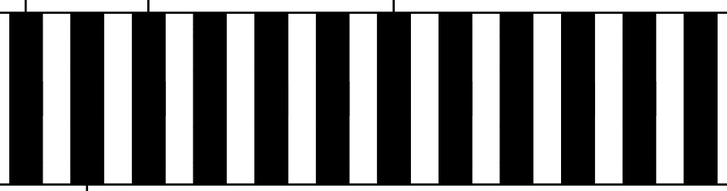


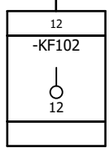
=LA01+UC20-X-KE14

Jumpers

Terminal

Connection point





External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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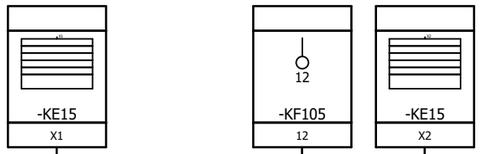
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X-KE14		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

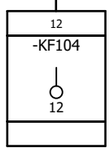


=LA01+UC20-X-KE15

Jumpers

Terminal

Connection point



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DRAWING	601456B UC20 40ft Control Cabinet			REVISION	06
DRAWING TITLE					
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X-KE15				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	6 /	

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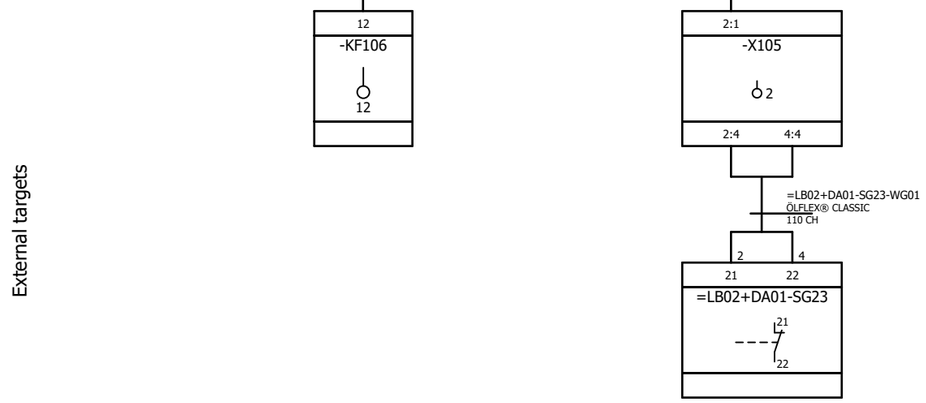
Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
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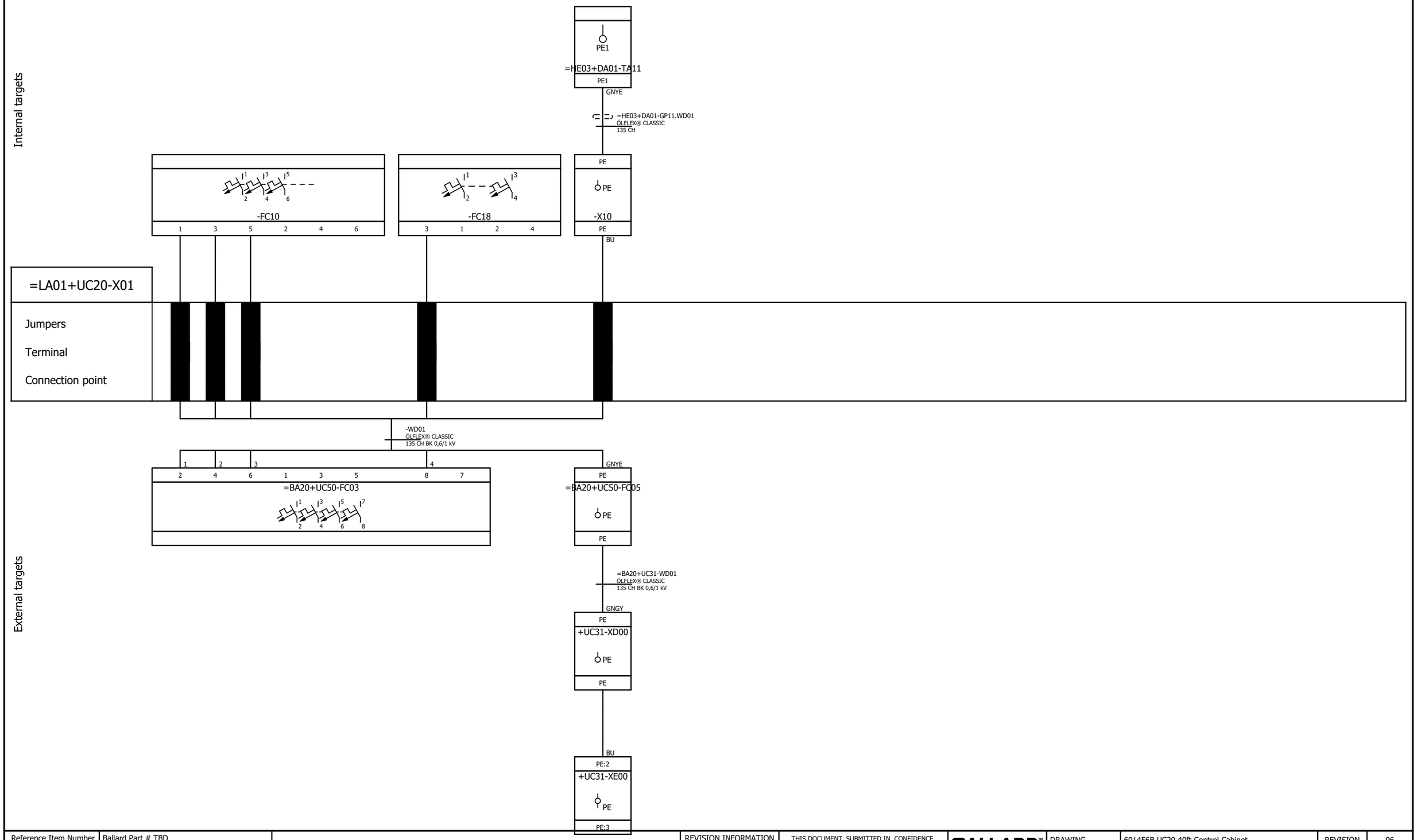
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X-KE16		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



External targets

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + UC20 | & C04

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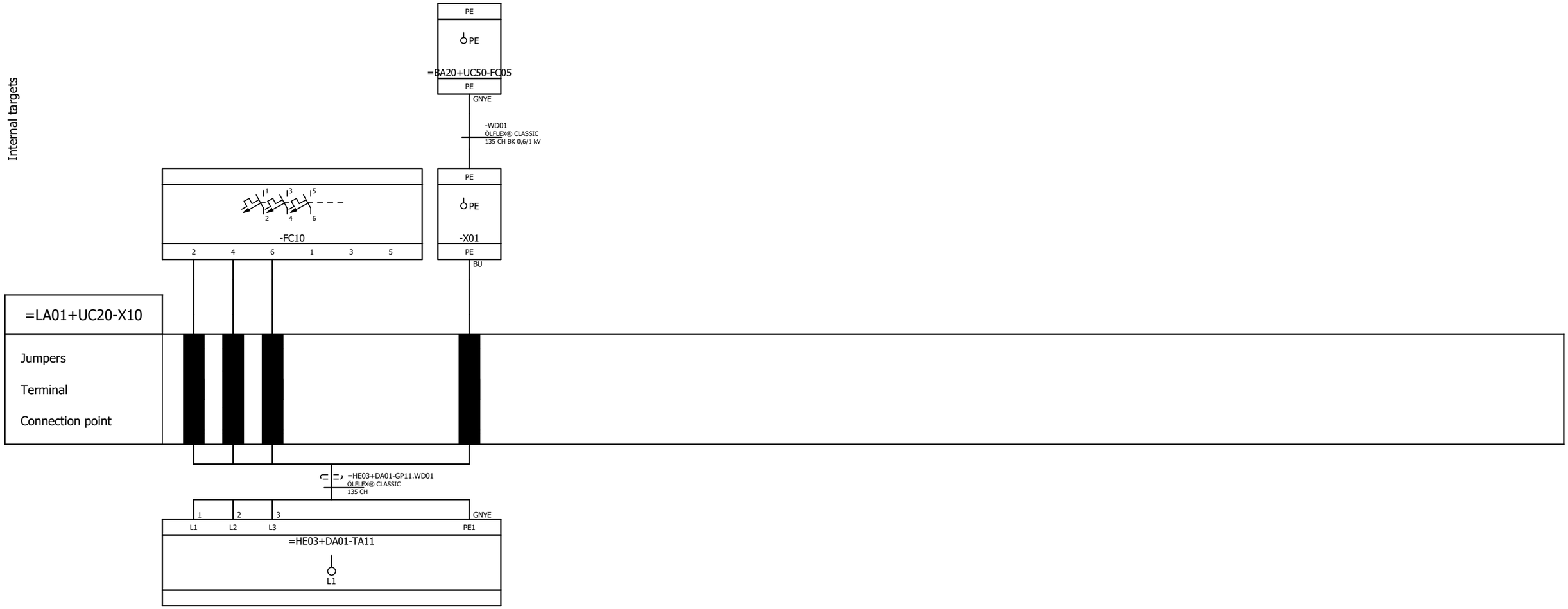
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 8 /

Terminal-connection diagram

F11_001
PBL 16-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
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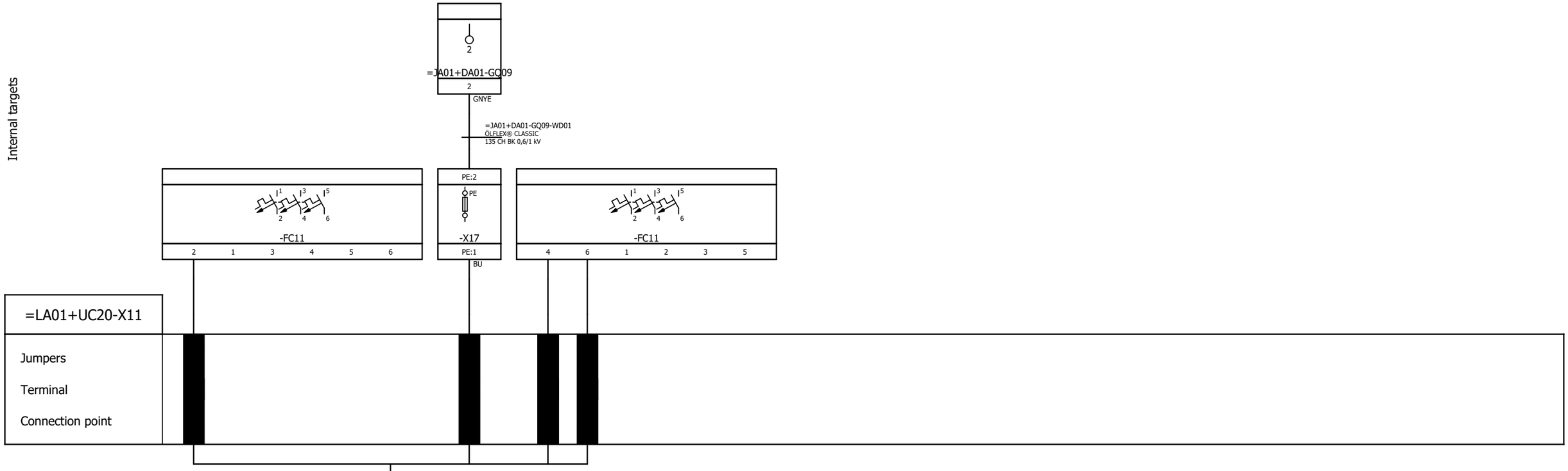
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X10		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DESCRIPTION
DATE
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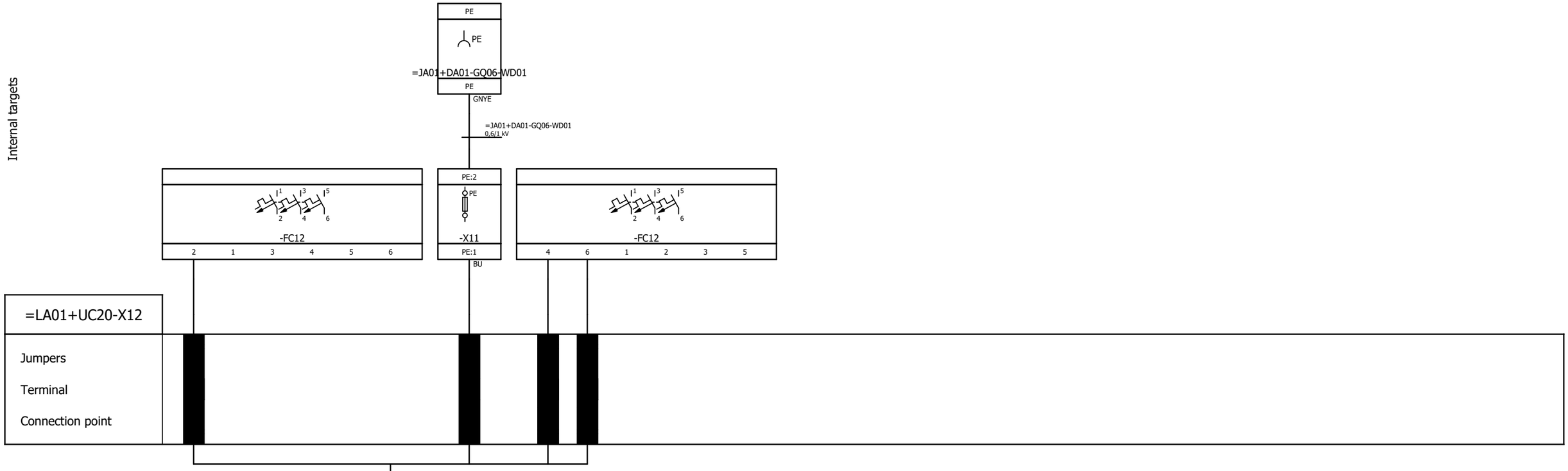
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DRAWING TITLE					
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	10 /	

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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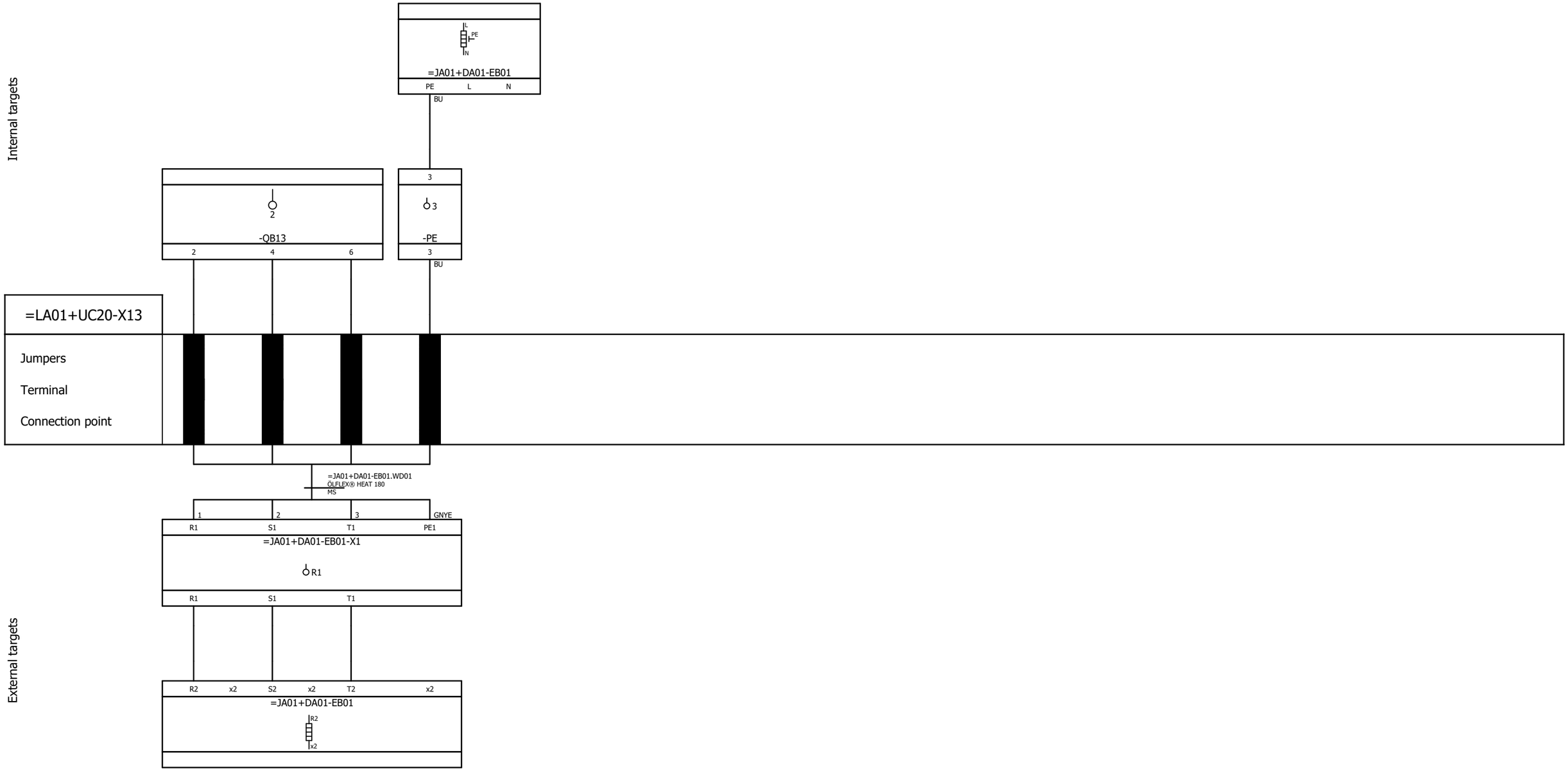
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 /

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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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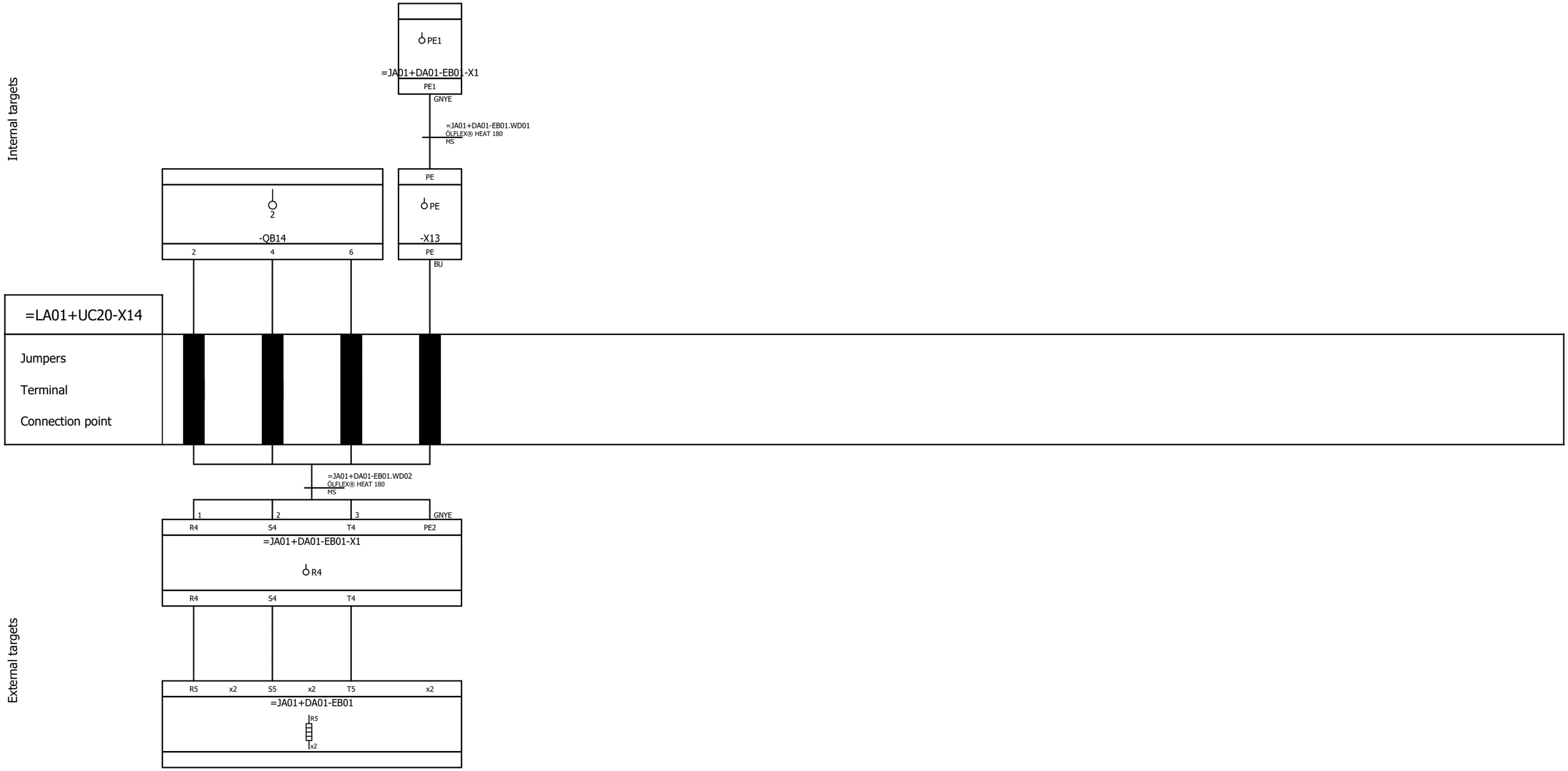
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 12 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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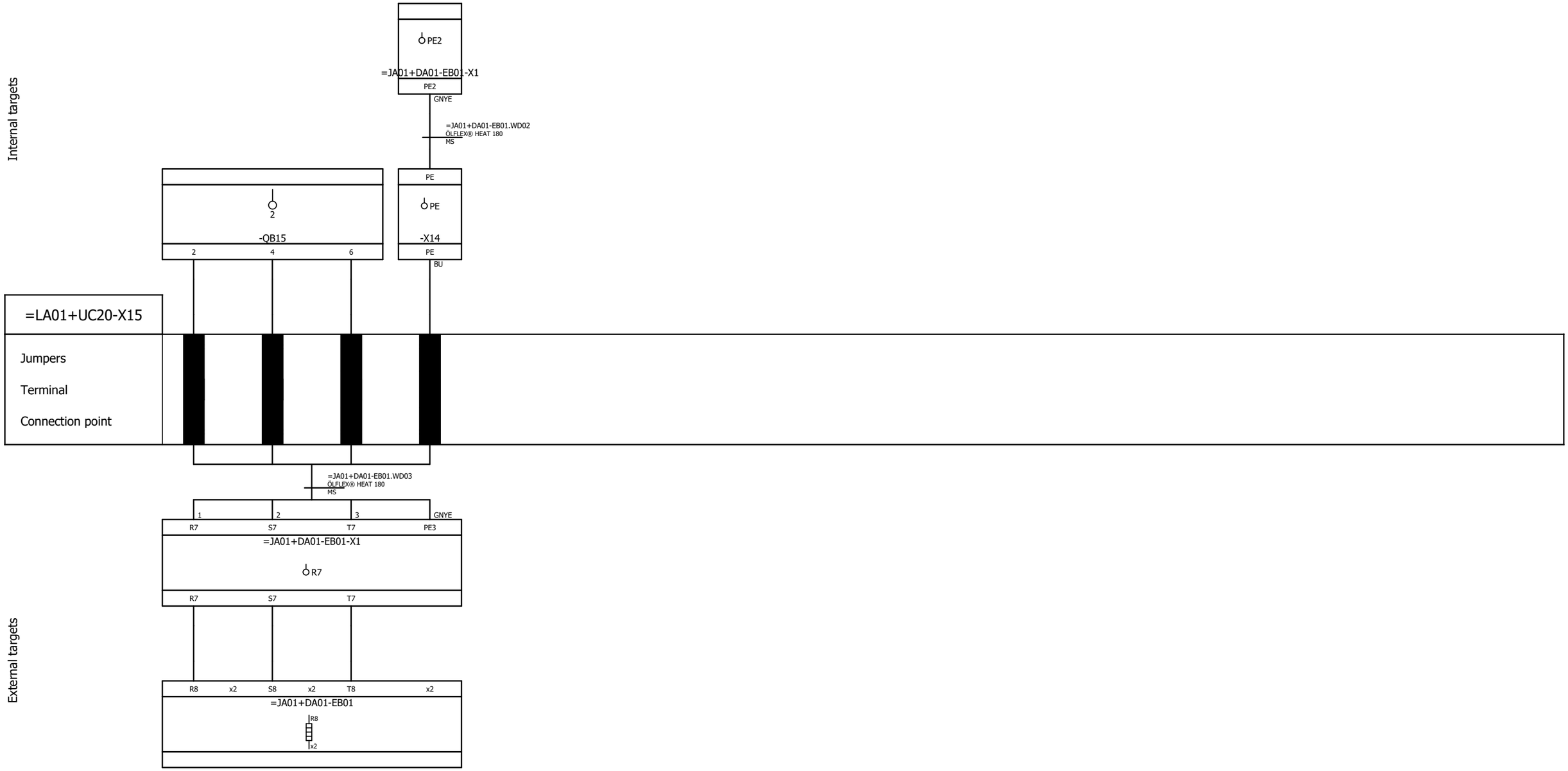
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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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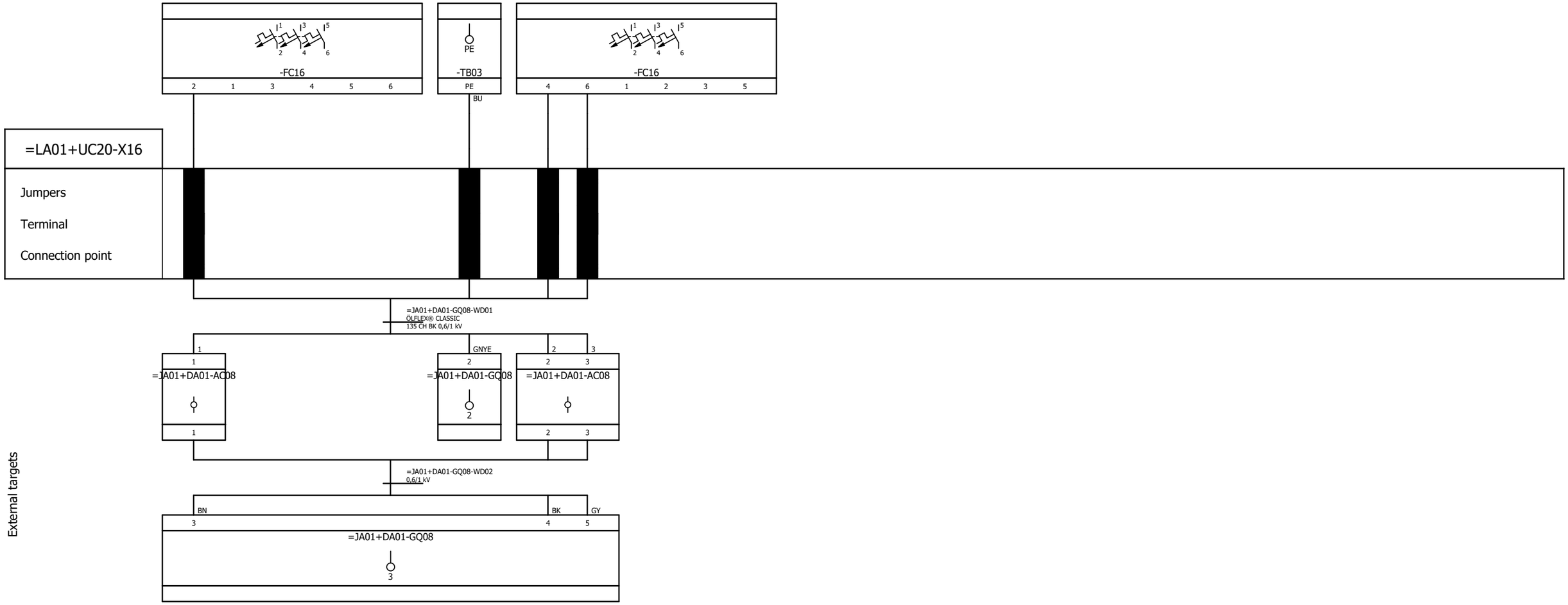
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Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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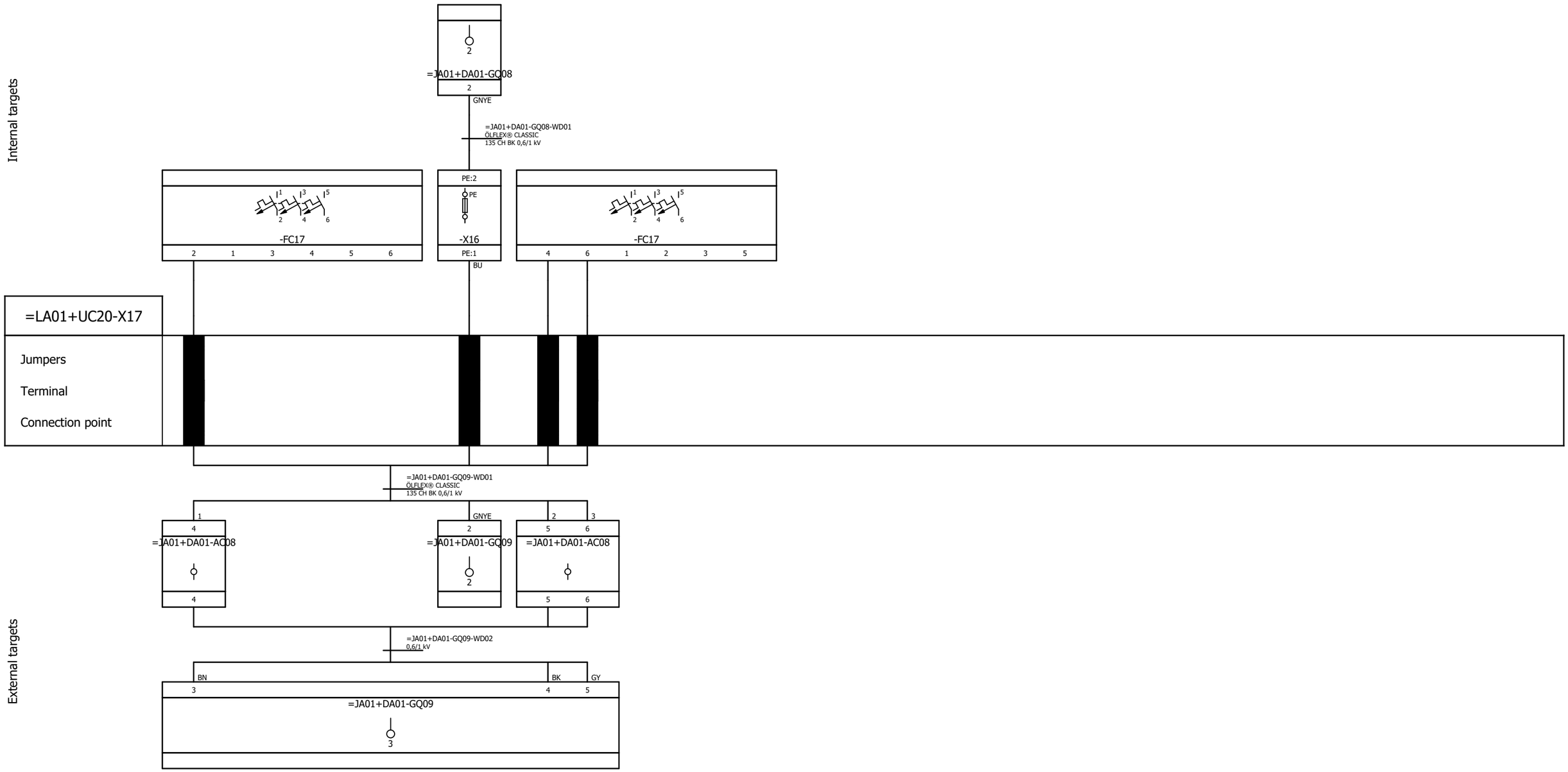
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DRAWING TITLE			
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Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DESCRIPTION
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28-Mar-25

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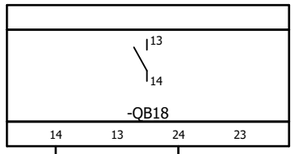
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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

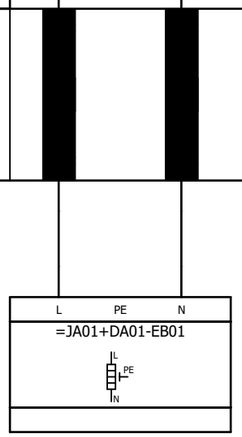


=LA01+UC20-X18

Jumpers

Terminal

Connection point



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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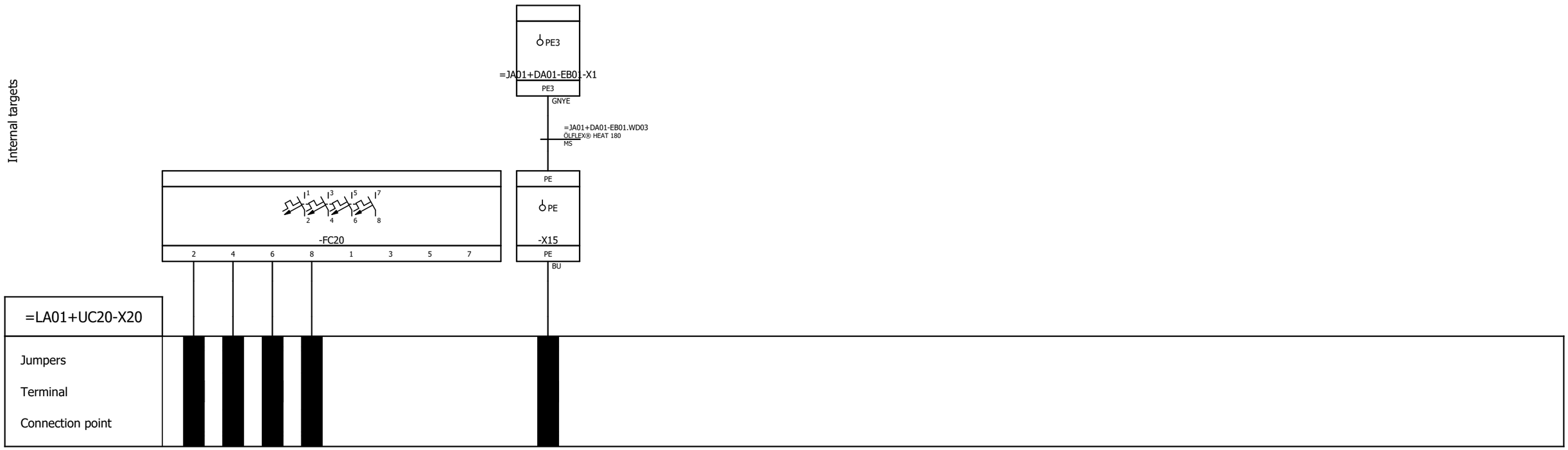
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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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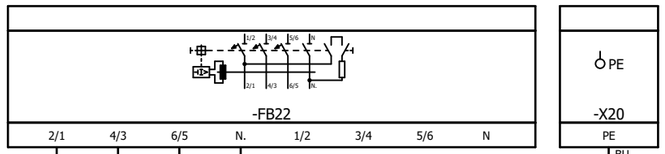
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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X22

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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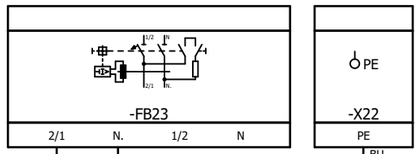
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 19 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X23

Jumpers	
Terminal	
Connection point	

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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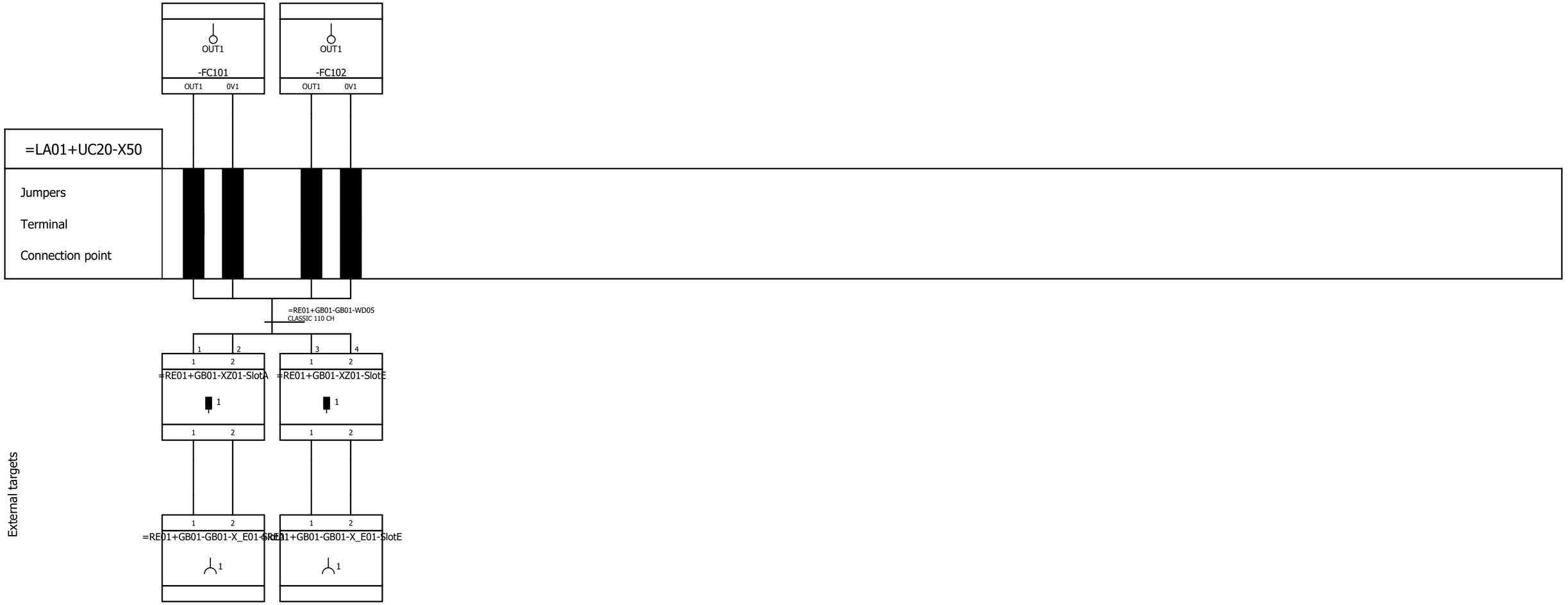
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DRAWING TITLE			
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Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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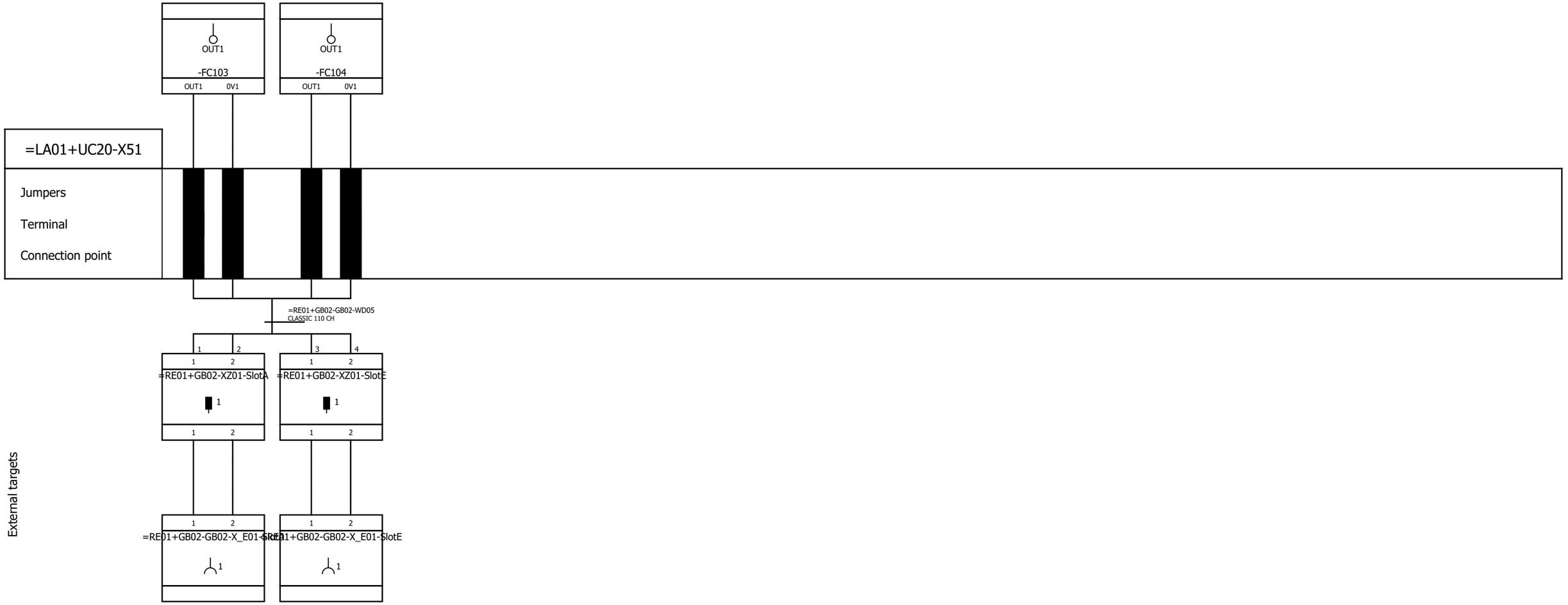
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 21 /

Terminal-connection diagram

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PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DATE
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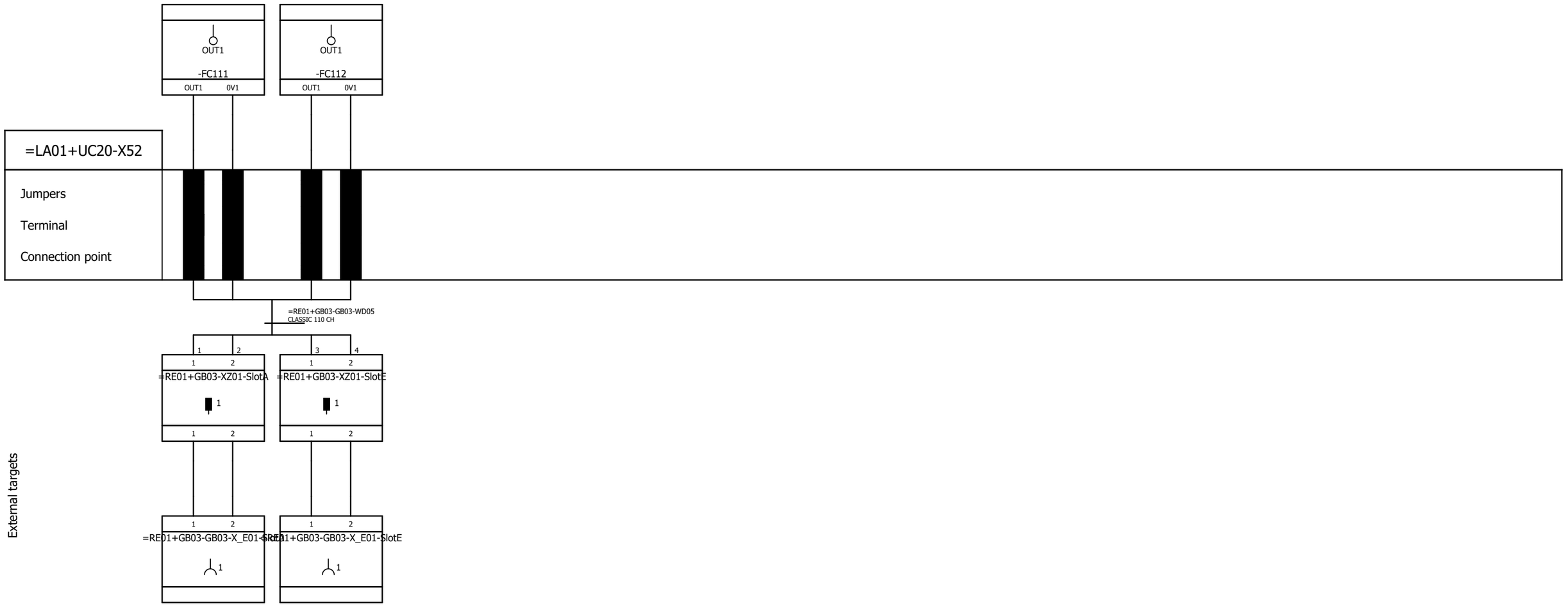
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X51		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 /

Terminal-connection diagram

F11_001
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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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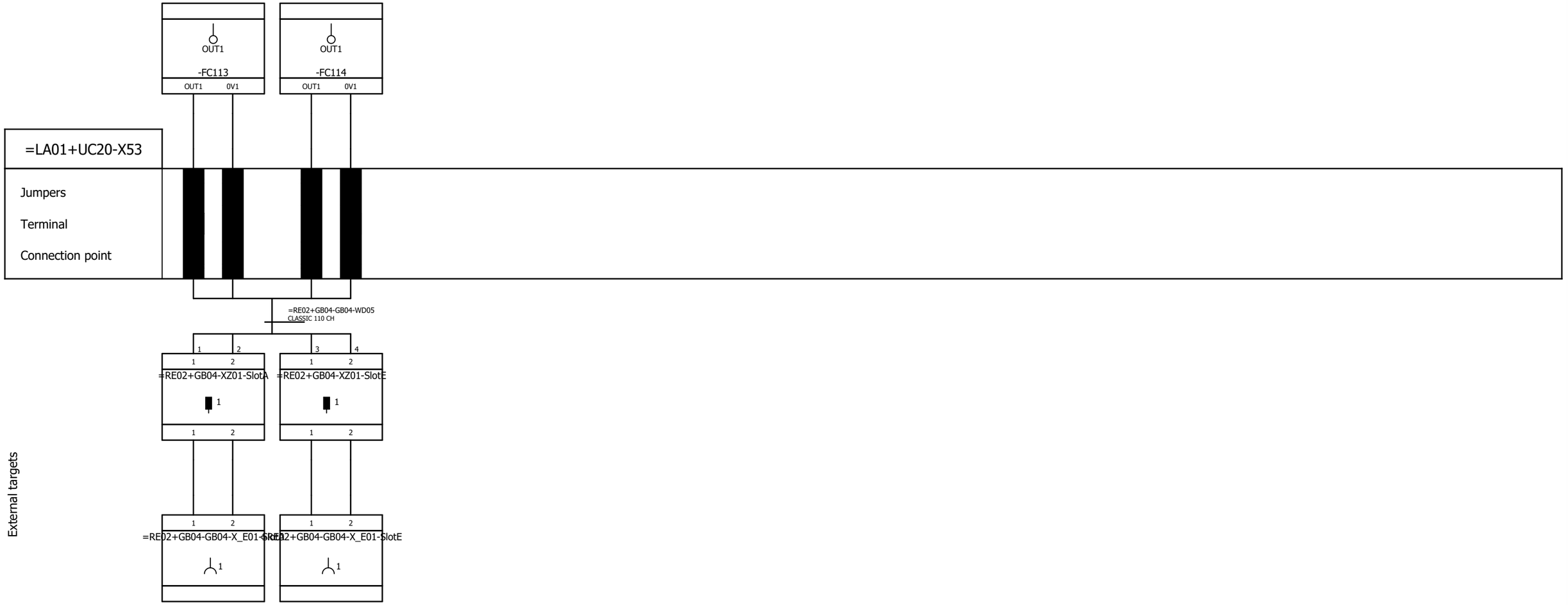
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X52		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 23 /

Terminal-connection diagram

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PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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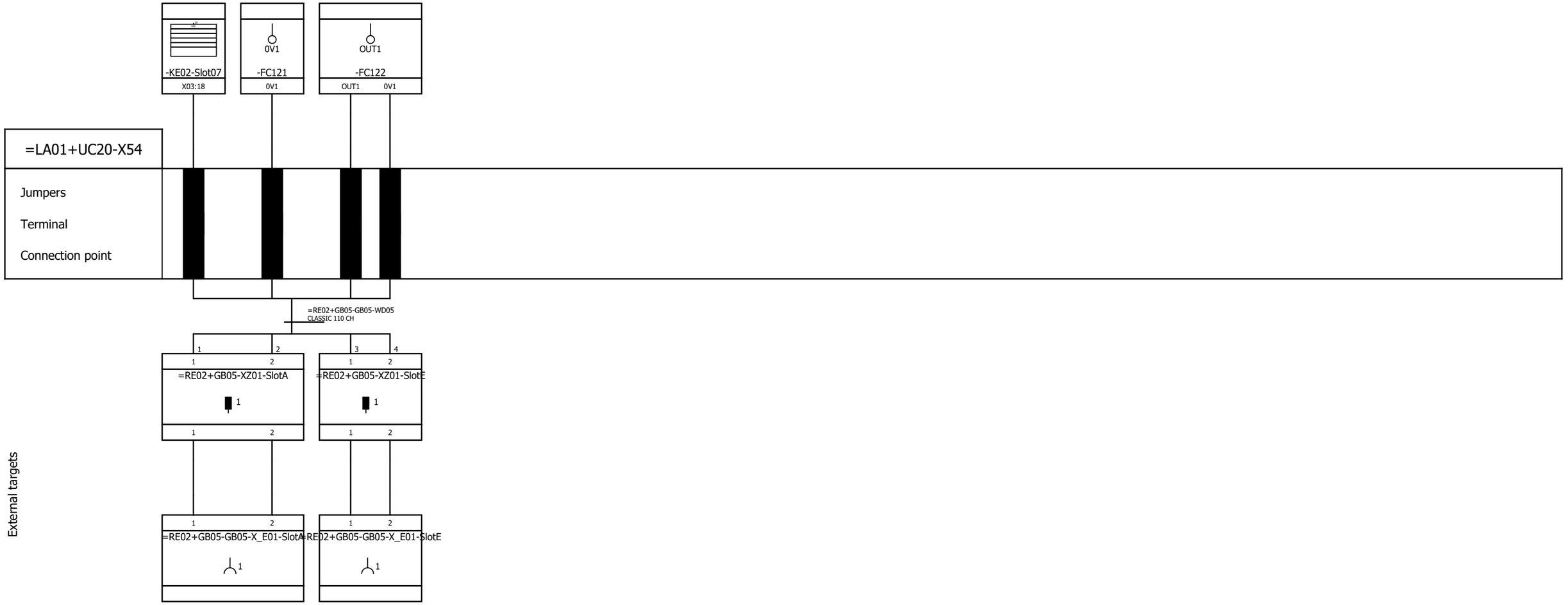
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X53		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 24 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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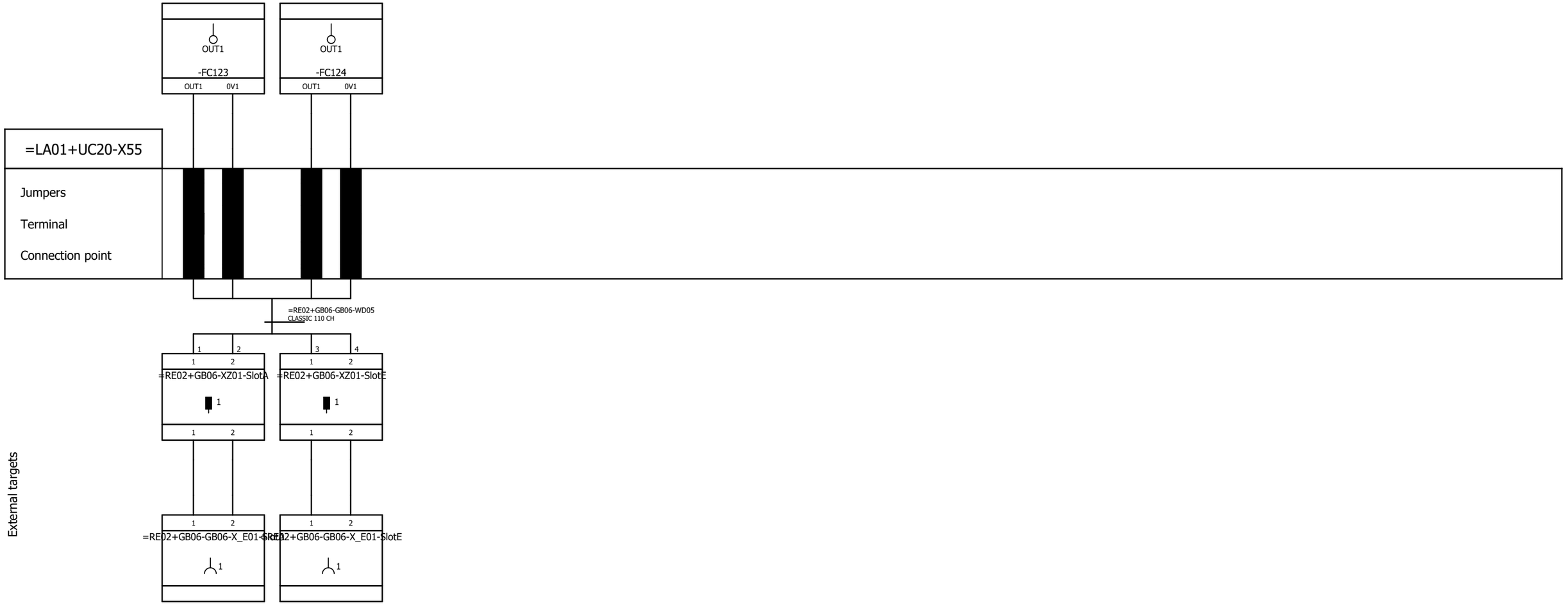
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X54		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 25 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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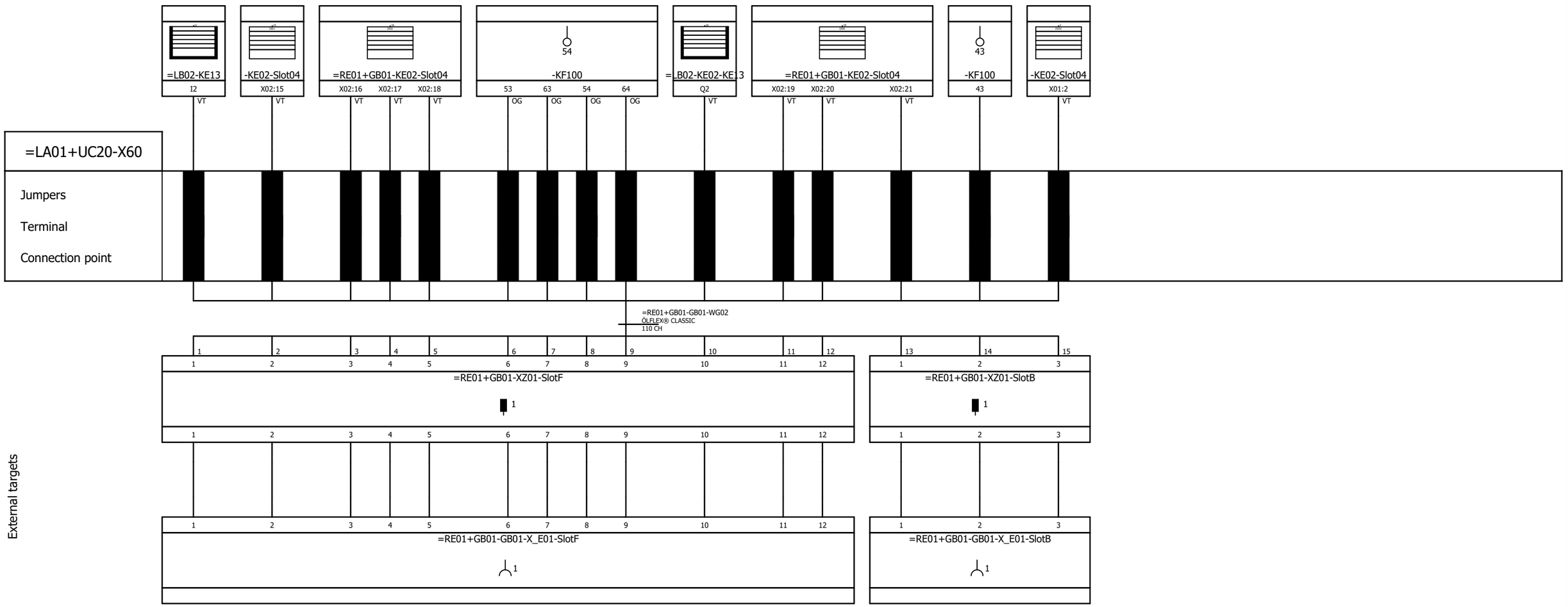
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X55		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 26 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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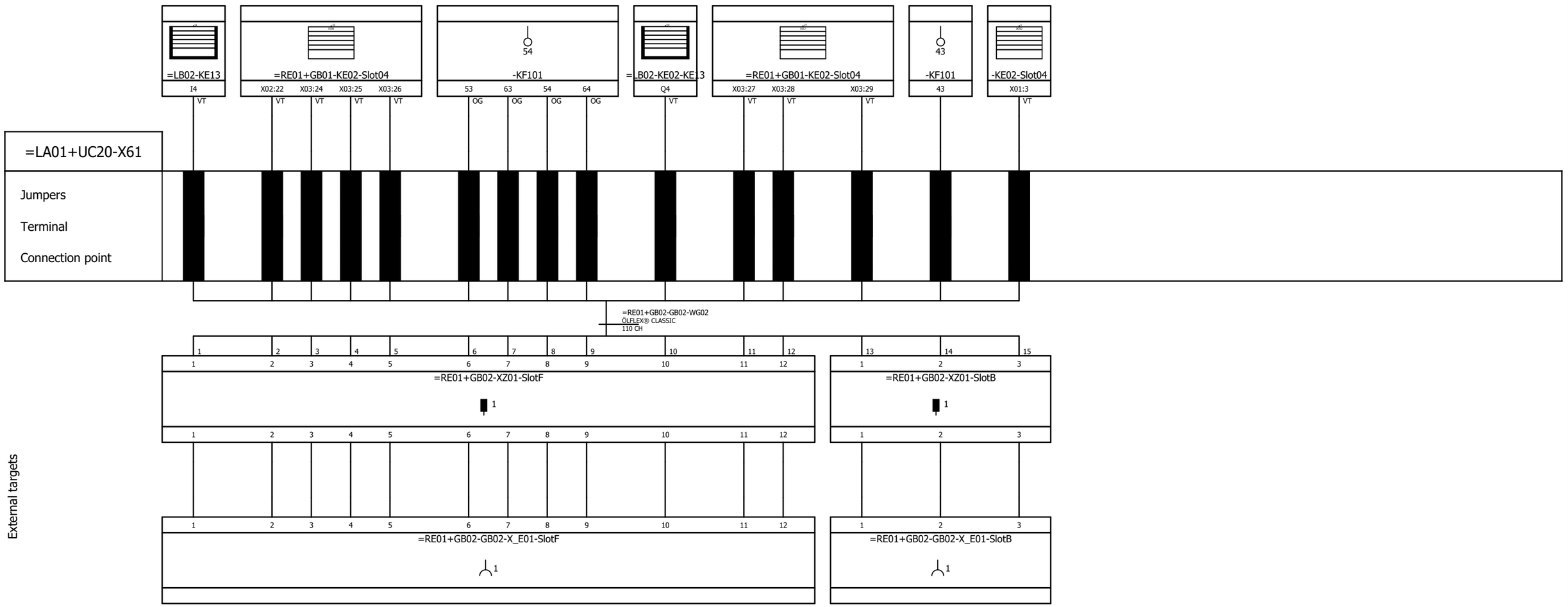
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X60		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 27 /

Terminal-connection diagram

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Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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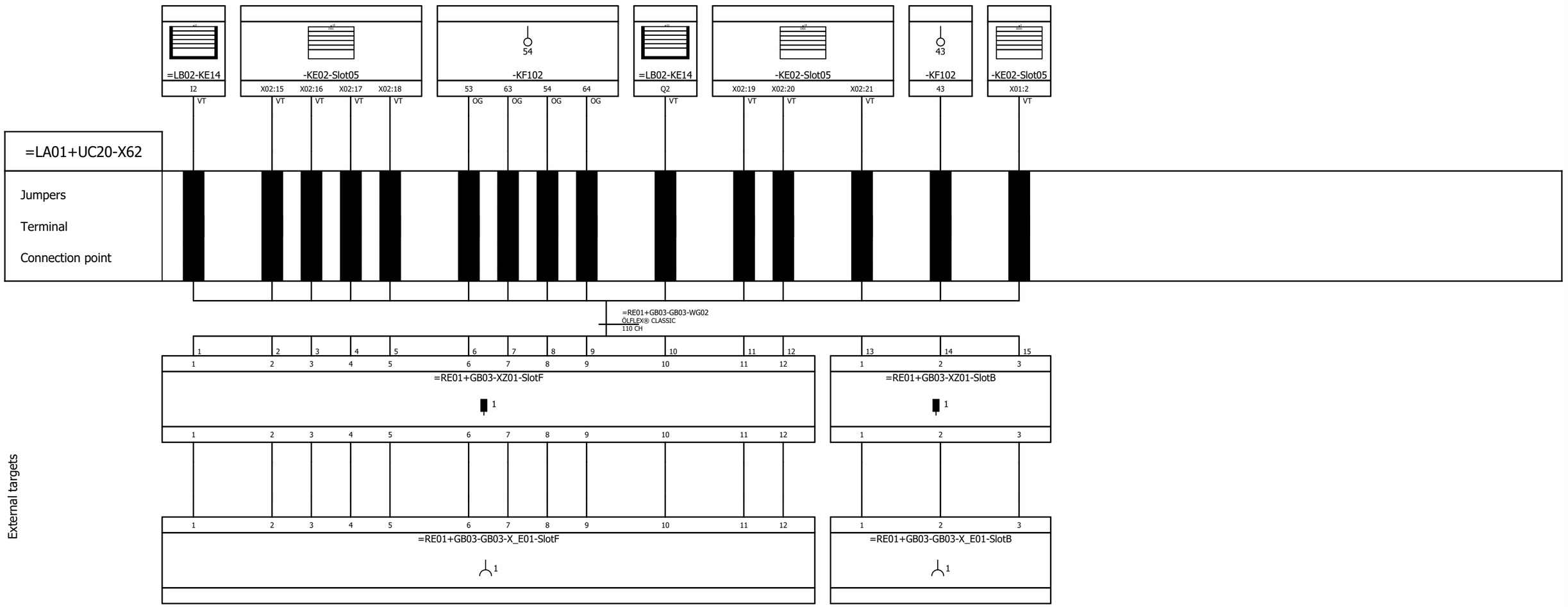
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X61		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 28 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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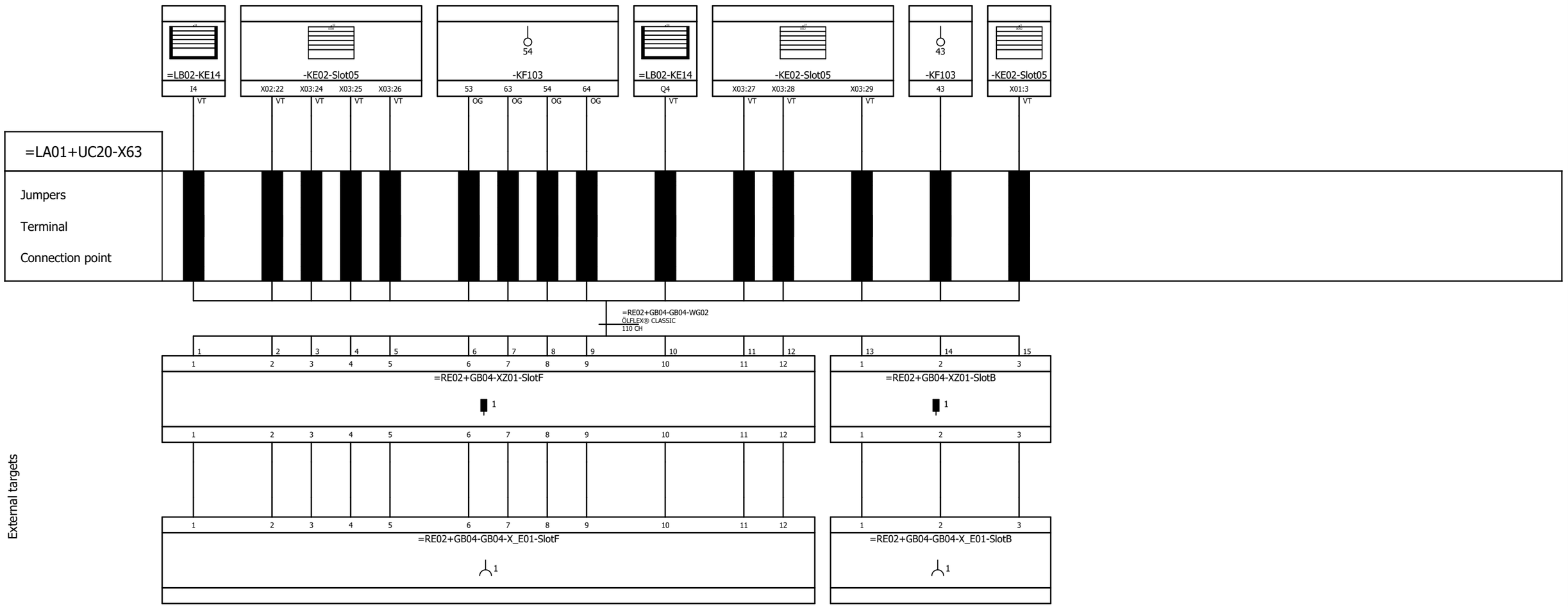
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X62		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 29 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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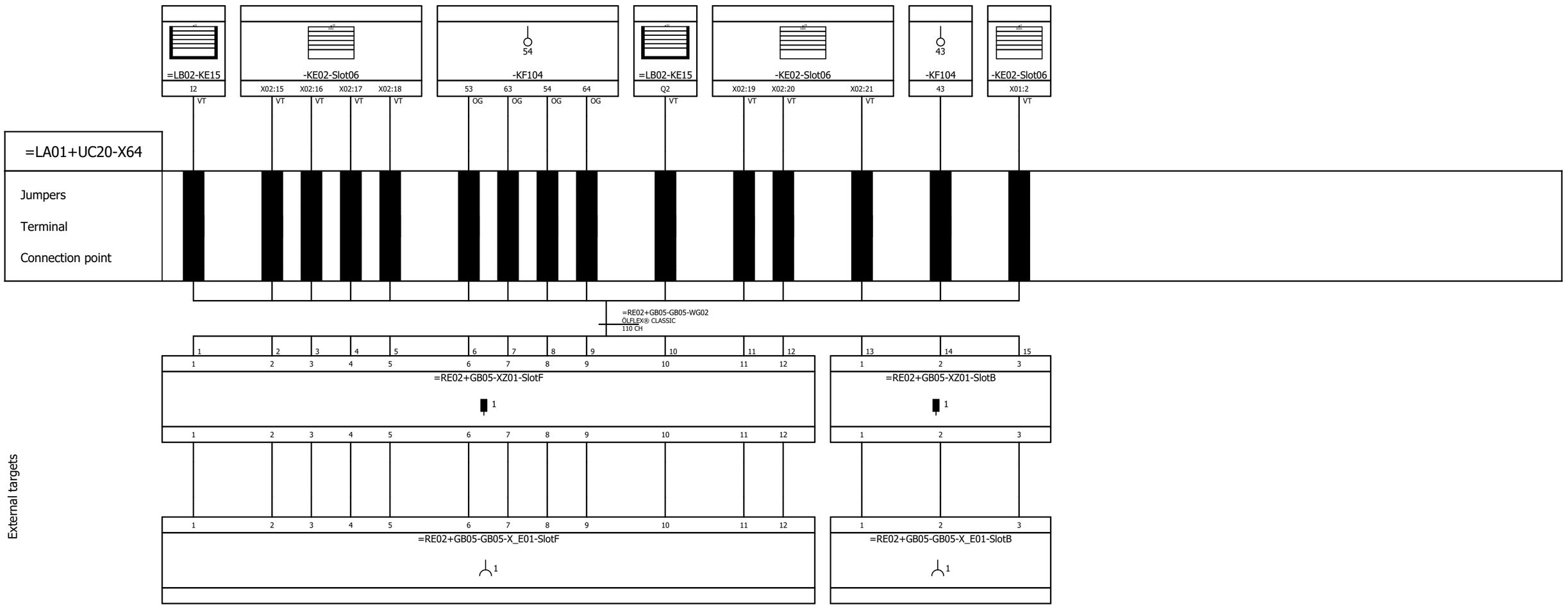
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X63		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 30 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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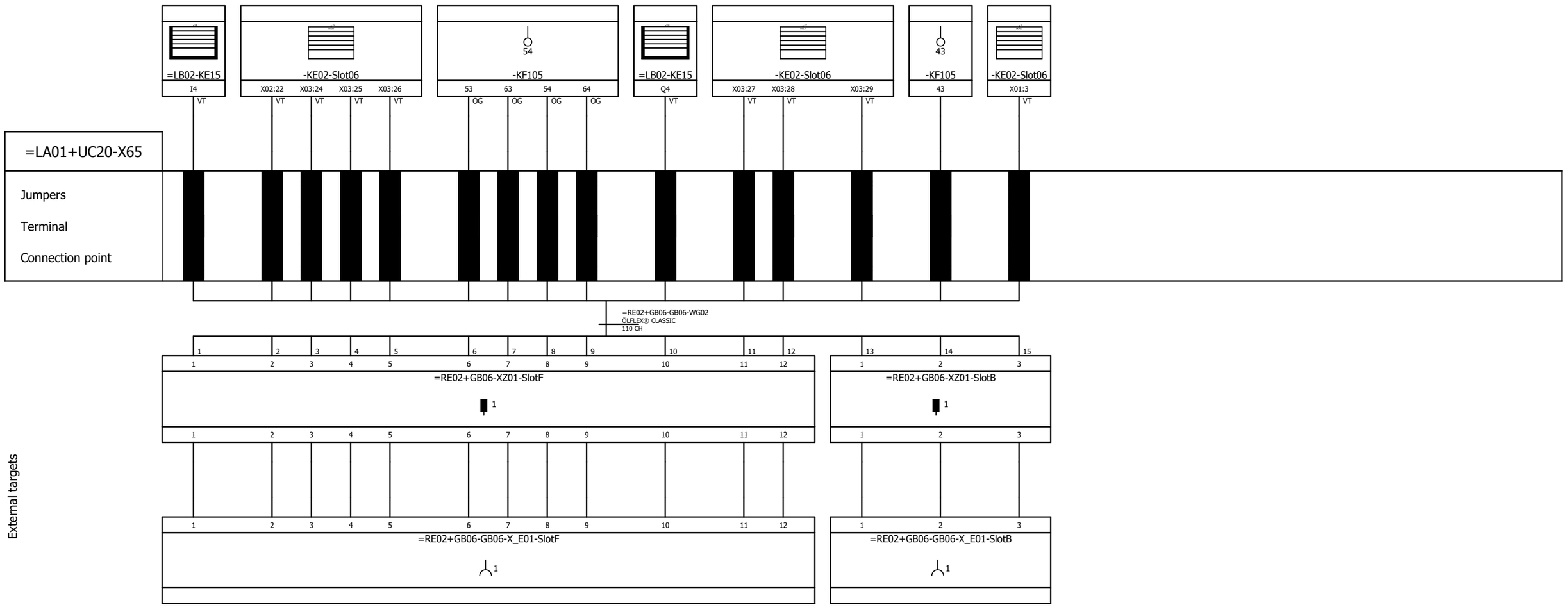
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X64		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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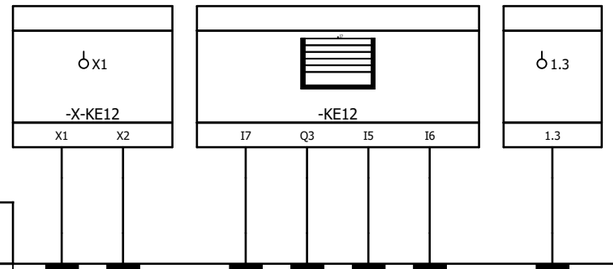
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X65		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 32 /

Terminal-connection diagram

F11_001
PBL 20-Nov-24

Internal targets



=LA01+UC20-X100

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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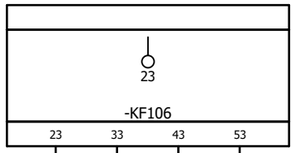
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X100		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X101

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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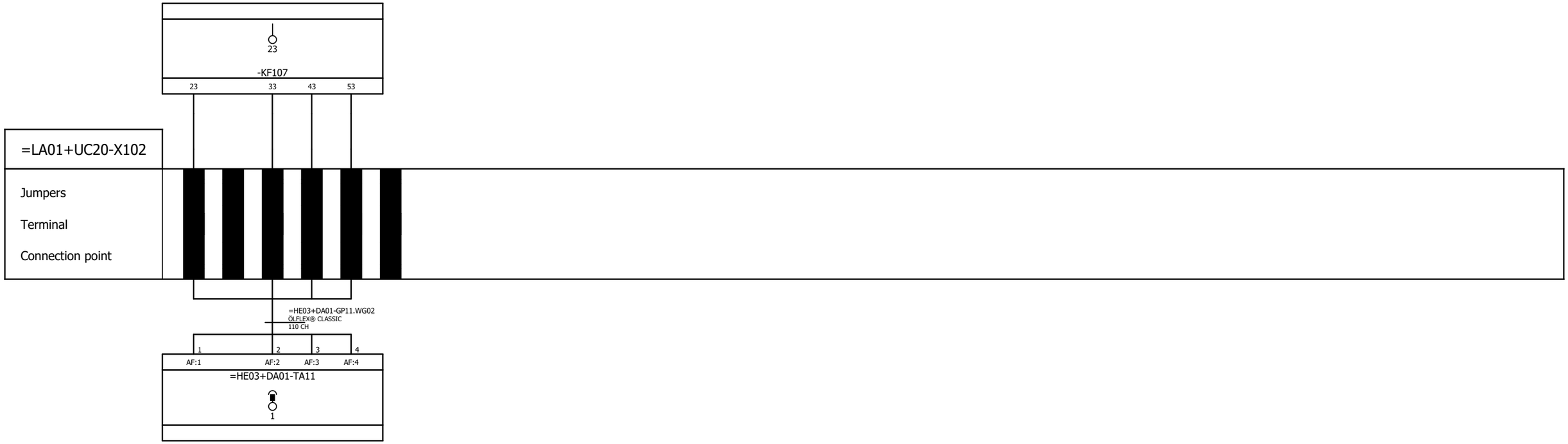
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X101		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 34 /

Terminal-connection diagram

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PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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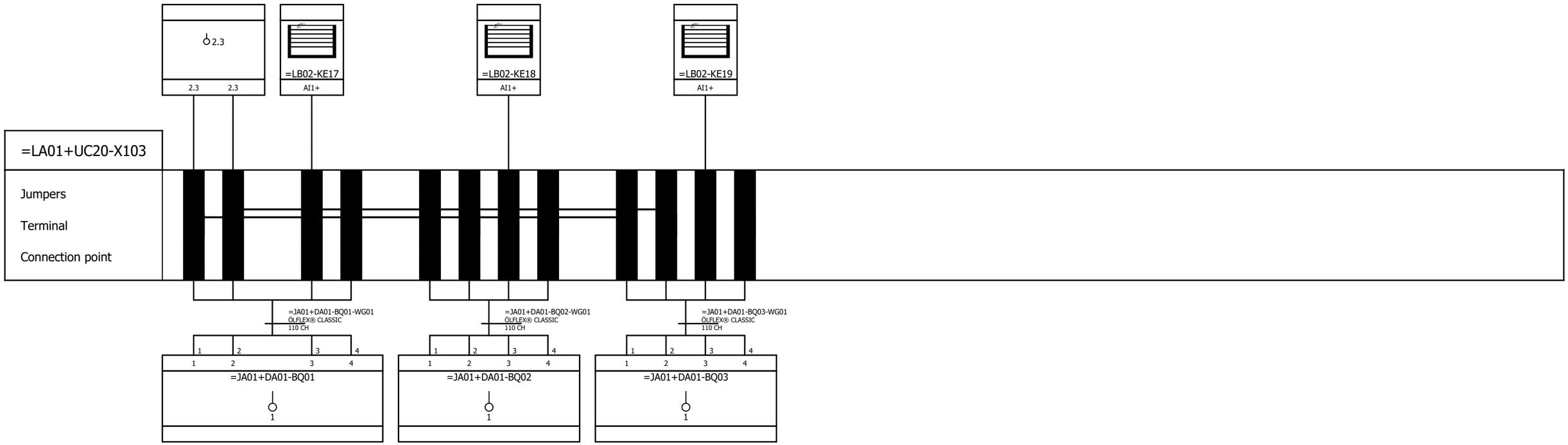
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X102		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 /

Terminal-connection diagram

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PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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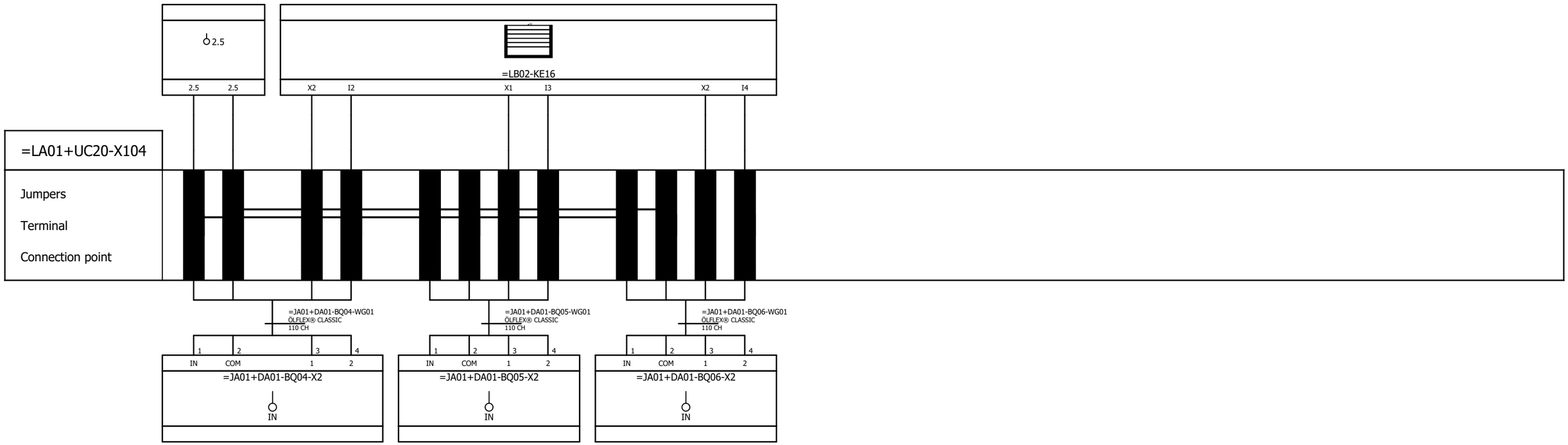
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X103		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 36 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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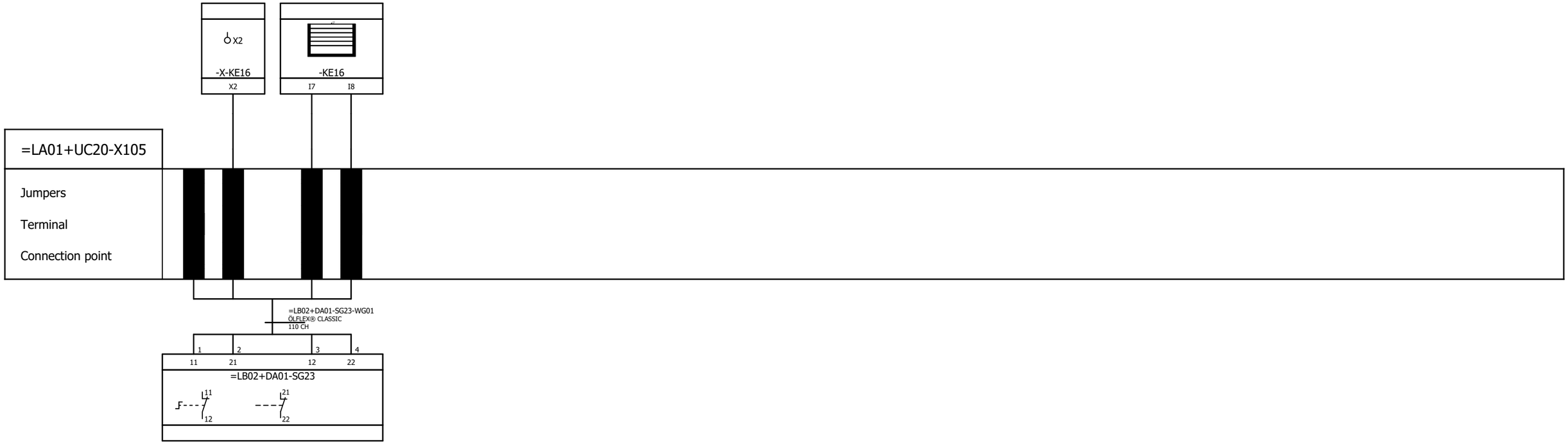
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DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X104		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 38 /

Terminal-connection diagram

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PBL 20-Nov-24

Internal targets

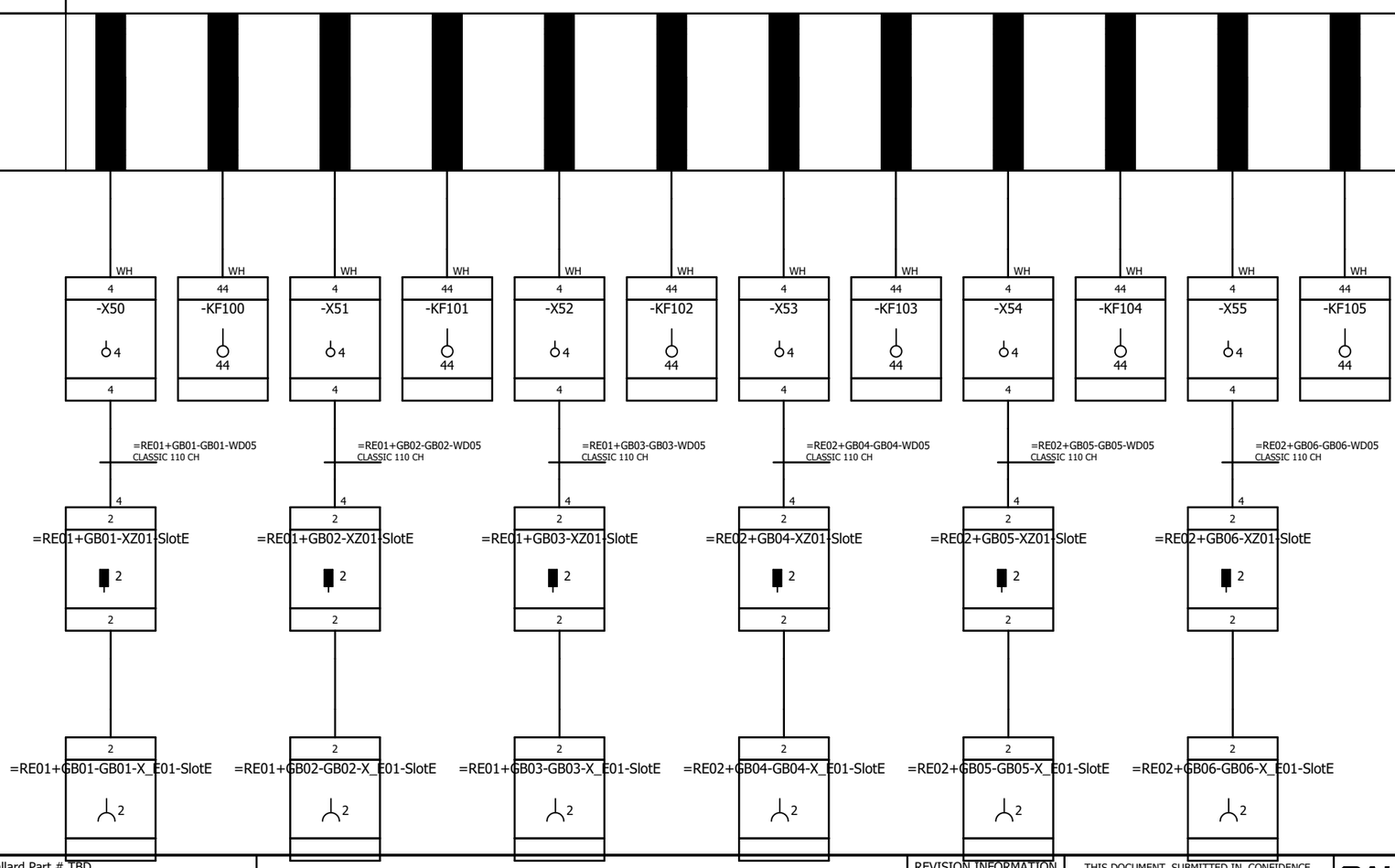
External targets

=LA01+UC20-X106

Jumpers

Terminal

Connection point



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
20-Nov-24

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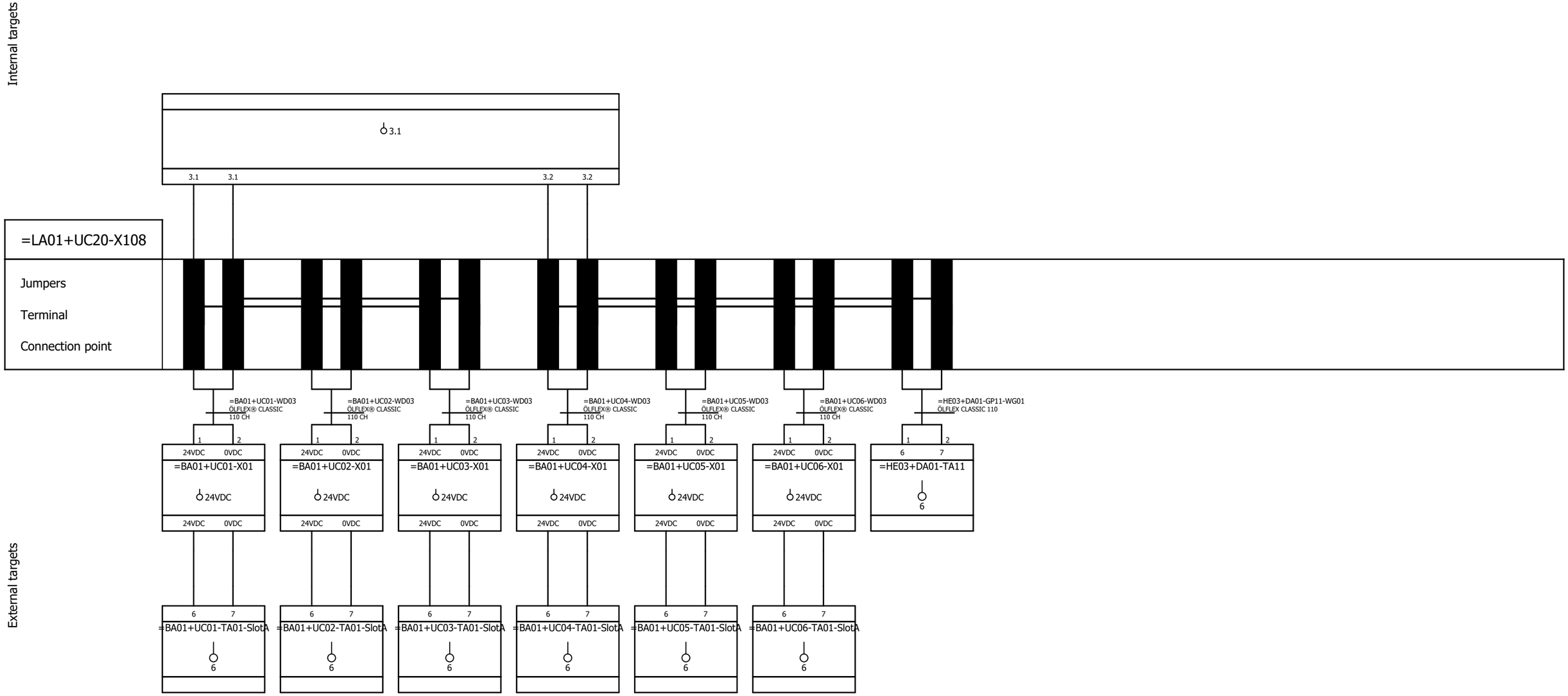
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X106		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 39 /

Terminal-connection diagram

F11_001
PBL 16-Oct-24



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
16-Oct-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X108		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 40 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X110		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 41 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

External targets

=LA01+UC20-X120

Jumpers

Terminal

Connection point

-KE03-Slot4

X01:1 X01:2 X01:3 X02:4 X02:5 X02:6 X03:7 X03:8 X03:9 X04:10 X04:11 X04:12 X05:13 X05:14 X05:15 X06:16

AI20 2

=BA01+UC01-BT01-WG01 PUR BN WH
=BA01+UC01-BT01-XG01 1 2
=BA01+UC01-BT01 1 2

=BA02+UC04-BT01-WG01 PUR BN
=BA02+UC04-BT01-XG01 1
=BA02+UC04-BT01 1

=BA01+UC01-BT01-WG01 PUR BU BK
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=BA01+UC01-BT01 3

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=BA02+UC05-BT01-XG01 1 2 3 4
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=BA02+UC06-BT01 1

=JA01+UC07-BT01-WG01 PUR BN
=JA01+UC07-BT01-XG01 1
=JA01+UC07-BT01 1

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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REVISION INFORMATION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X120		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 42 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

=LA01+UC20-X120

Jumpers

Terminal

Connection point

-KE03-Slot4 X06:17 — 17 AI23

-KE01-Slot5 X08:22

-KE03-Slot4 X06:18 — 18 AI24

-KE01-Slot5 X08:23 X08:24 — 23

=BA02+UC06-BT01-WG01 PUR BU 3

=JA01+UC07-BT01-WG01 PUR WH 2

=BA02+UC06-BT01-WG01 PUR BK 4

=JA01+UC07-BT01-WG01 PUR BU BK 3 4

=BA02+UC06-BT01-XG01 3 3

=JA01+UC07-BT01-XG01 2 2

=BA02+UC06-BT01-XG01 4 4

=JA01+UC07-BT01-XG01 3 3 4

External targets

=BA02+UC06-BT01 3 3

=JA01+UC07-BT01 2 2

=BA02+UC06-BT01 4 4

=JA01+UC07-BT01 3 3 4

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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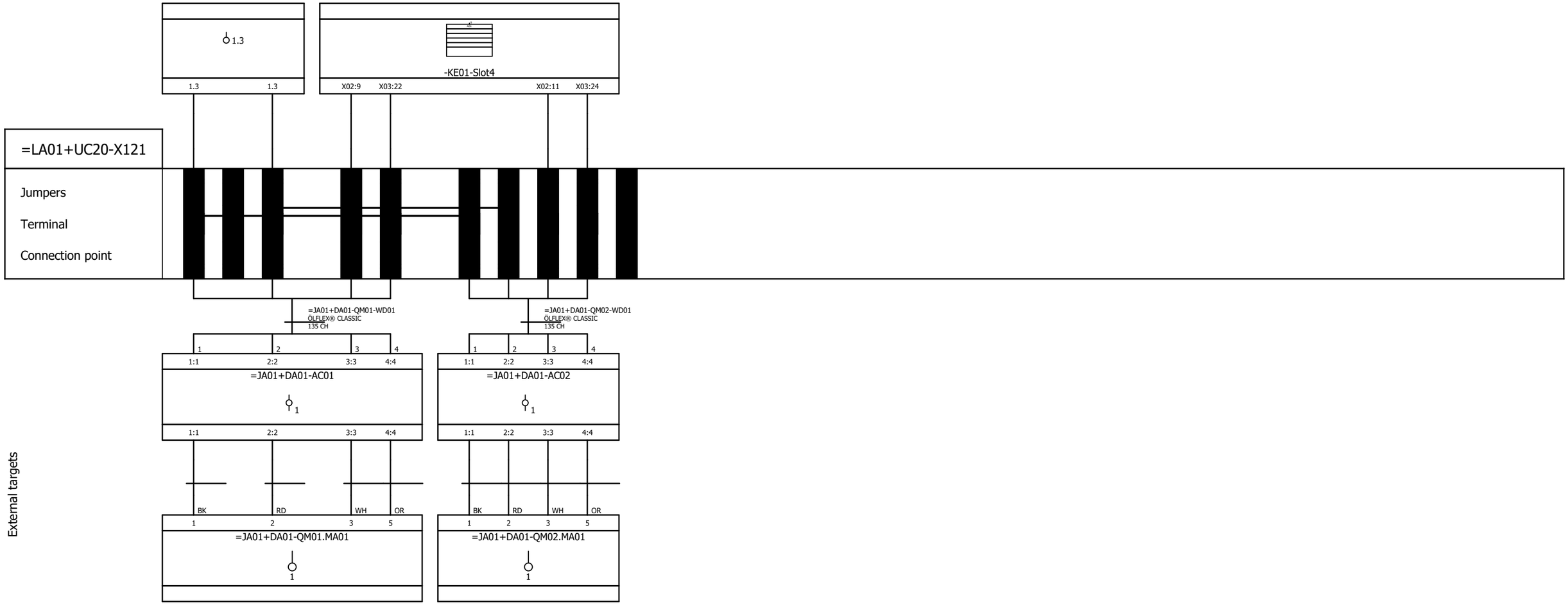
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X120		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 43 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X121		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 44 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets

External targets

=LA01+UC20-X122

Jumpers

Terminal

Connection point

-KE02-Slot07 X02:9 X02:9

1.2 1.2 1.2 2.6 2.6

-KE02-Slot07 X03:22 X03:22 X03:24 X03:24 X02:11 X02:11

=JA01+DA01-QM03-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM05-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM03-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM05-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM03-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM04-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM05-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM06-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM04-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM06-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM04-WD01 ÖLFLEX® CLASSIC 135 CH
=JA01+DA01-QM06-WD01 ÖLFLEX® CLASSIC 135 CH

3 3 1 2 1 2 4 1 4 1 2 3 2 3 4 4

3:3 3:3 1:1 2:2 1:1 2:2 4:4 1:1 4:4 1:1 2:2 3:3 2:2 3:3 4:4 4:4

=JA01+DA01-AC03 =JA01+DA01-AC05 =JA01+DA01-AC03 =JA01+DA01-AC05 =JA01+DA01-AC03 =JA01+DA01-AC04 =JA01+DA01-AC05 =JA01+DA01-AC06 =JA01+DA01-AC04 =JA01+DA01-AC06 =JA01+DA01-AC04 =JA01+DA01-AC06

3 3 1 1 4 1 4 1 2 2 4 4

3:3 3:3 1:1 2:2 1:1 2:2 4:4 1:1 4:4 1:1 2:2 3:3 2:2 3:3 4:4 4:4

WH WH BK RD BK RD OR BK OR BK RD WH RD WH OR OR

3 3 1 2 1 2 5 1 5 1 2 3 2 3 5 5

=JA01+DA01-QM03.MA01 =JA01+DA01-QM05.MA01 =JA01+DA01-QM03.MA01 =JA01+DA01-QM05.MA01 =JA01+DA01-QM03.MA01 =JA01+DA01-QM04.MA01 =JA01+DA01-QM05.MA01 =JA01+DA01-QM06.MA01 =JA01+DA01-QM04.MA01 =JA01+DA01-QM06.MA01 =JA01+DA01-QM04.MA01 =JA01+DA01-QM06.MA01

3 3 1 1 5 1 5 1 2 2 5 5

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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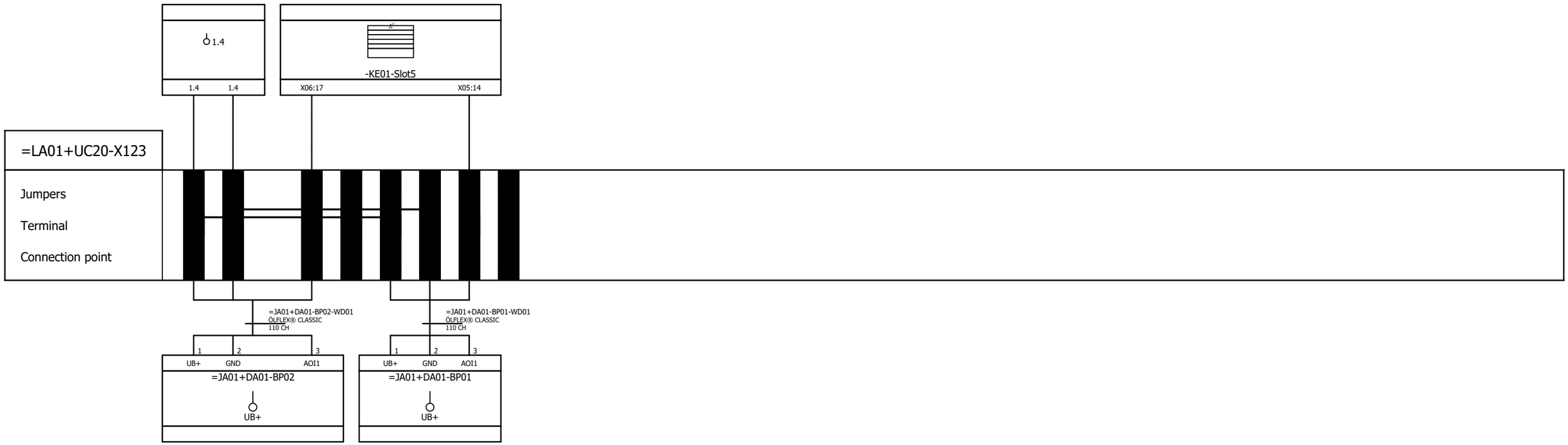
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X122		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 45 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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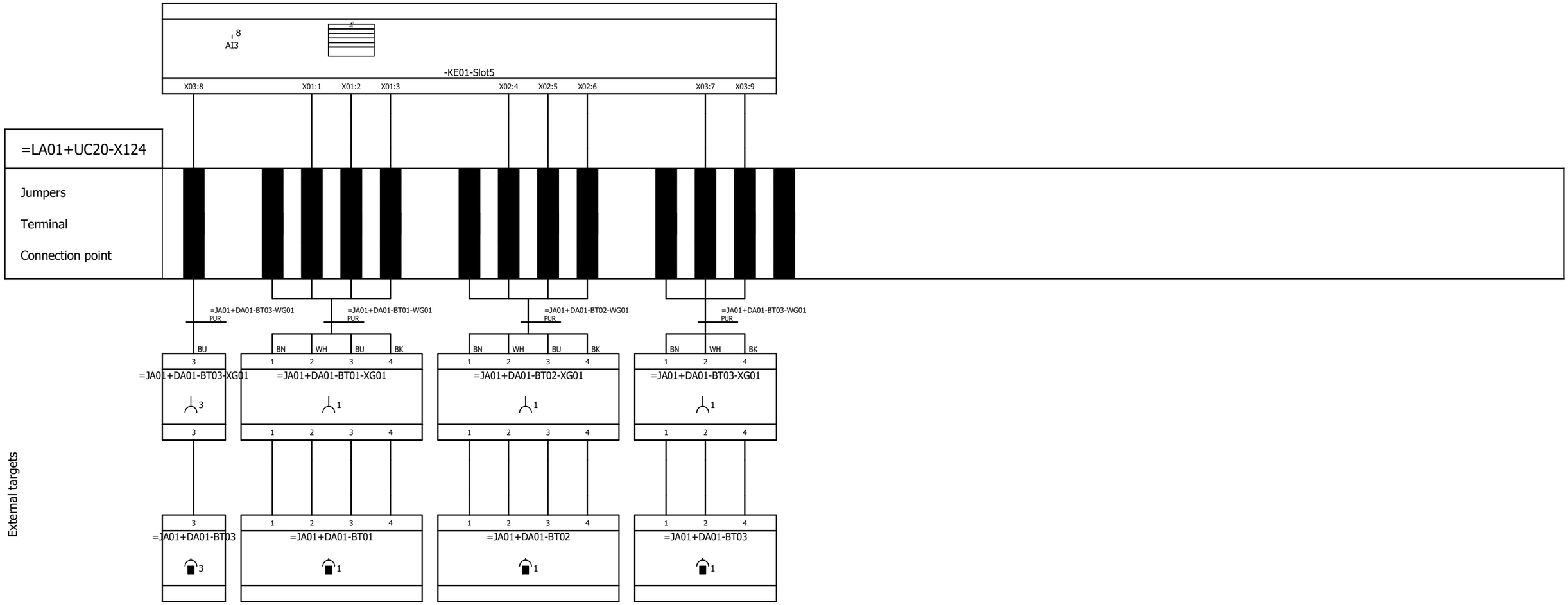
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X123		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 46 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X124		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 47 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DRAWING	601456B UC20 40ft Control Cabinet			REVISION	06
DRAWING TITLE					
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X125				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 48 /		

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

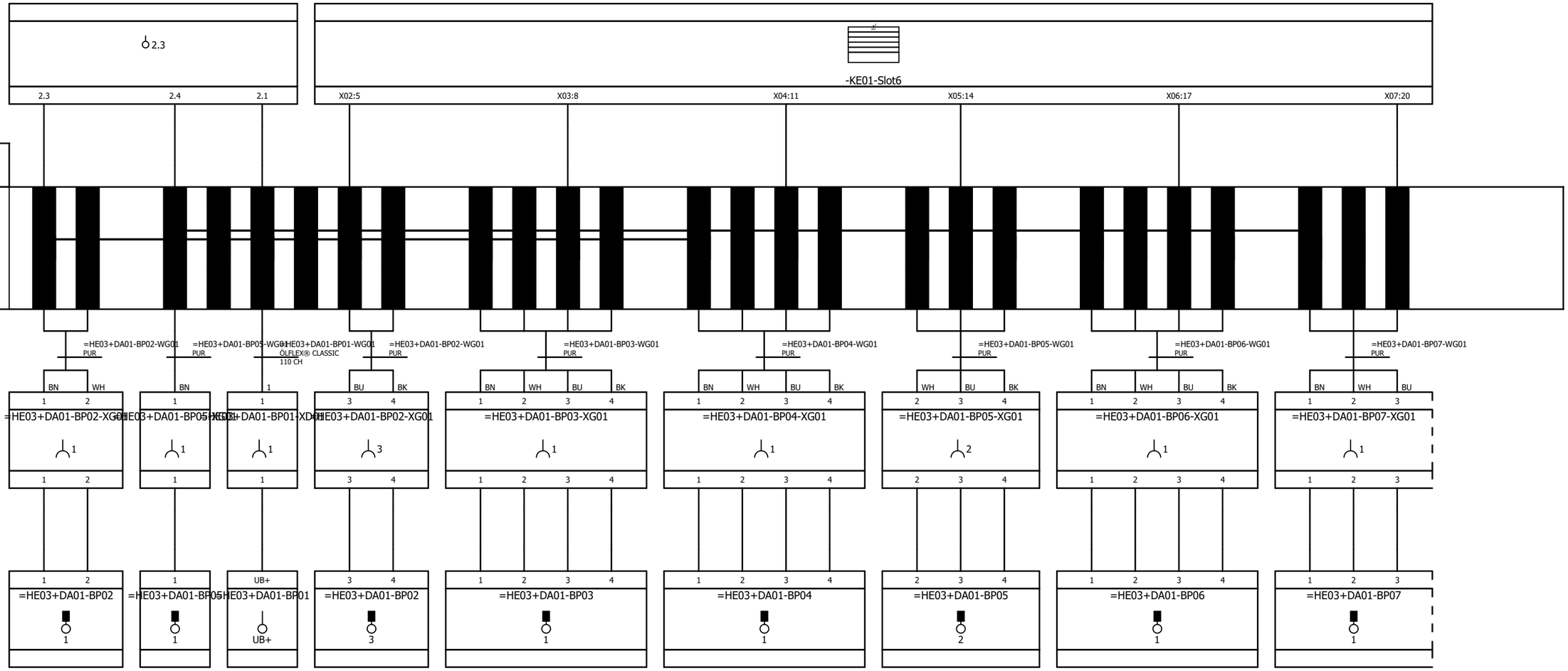
External targets

=LA01+UC20-X150

Jumpers

Terminal

Connection point



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X150		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 49 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

-KE01-Slot5
X07:20

=LA01+UC20-X150

Jumpers

Terminal

Connection point

=HE03+DA01-BP07-WG01
PUR
BK
4
=HE03+DA01-BP07-XG01
4
4
=HE03+DA01-BP07
4

=HE03+DA01-BP01-WG01
ÖLFLEX® CLASSIC
110 CH
2
3
3
PE
=HE03+DA01-BP01-XD01
3
3
PE
AOU1
PE
=HE03+DA01-BP01
AOU1

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X150		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 50 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets

External targets

=LA01+UC20-X160

Jumpers

Terminal

Connection point

-KE03-Slot3

AI20

X07:19 X07:20 X07:21 X08:22 X08:23 X08:24 X09:25 X09:26 X09:27

-KE03-Slot4

AI20

X07:19 X07:20 X07:21 X08:22 X08:23 X08:24 X09:25 X09:23 X09:24

=HE01+DA01-BT01-WG01 PUR	=HE02+DA01-BT04-WG01 PUR	=HE01+DA01-BT01-WG01 PUR	=HE01+DA01-BT02-WG01 PUR	=HE01+DA01-BT03-WG01 PUR	=HE02+DA01-BT04-WG01 PUR	=HE02+DA01-BT05-WG01 PUR	=HE02+DA01-BT06-WG01 PUR
BN WH	BN	BU BK	BN WH BU BK	BN WH BU BK	WH BU BK	BN WH BU BK	BN WH BU BK
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Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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EPLAN Project Pages	628		
=	++	+ UC20	& C04

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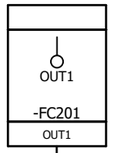
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DRAWING	601456B UC20 40ft Control Cabinet		REVISION	06
DRAWING TITLE				
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X160			
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	51 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X201

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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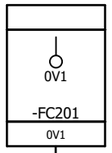
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X201		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 52 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X201-

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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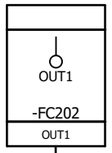
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X201-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 53 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X202

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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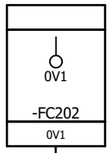
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X202		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 54 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X202-

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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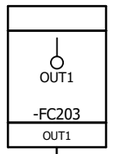
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X202-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 55 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X203

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
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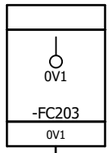
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X203		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 56 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X203-

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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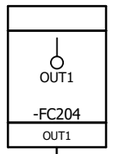
DRAWING	601456B UC20 40ft Control Cabinet			REVISION	06
DRAWING TITLE					
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X203-				
ALL SHEETS ARE THE SAME REVISION STATUS		SIZE A3	LANGUAGE EN	SHEET/TOTAL	57 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X204

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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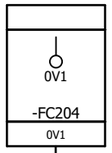
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DRAWING	601456B UC20 40ft Control Cabinet		REVISION	06
DRAWING TITLE				
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X204			
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	58 /

Terminal-connection diagram

F11_001
PBL 15-Oct-24

Internal targets



=LA01+UC20-X204-

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X204-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 59 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 16-Oct-24

Internal targets

=LA01+UC20-X230

Jumpers

Terminal

Connection point

-KE5-Slot3 X01:1
-FC210.1 1-
-KE5-Slot3 X01:4
-FC210.2 1-
-KE01-Slot3 X01:7
2.2 2.2 3.3
-KE01-Slot3 X02:15

=JA01+DA01-EA01-WD01 PUR BK BU
=JA01+DA01-EA02-WD01 PUR BK BU
=JA01+DA01-EA03-WD01 PUR BK BU
=JA01+DA01-SG01-WG01 ÖLFLEX® CLASSIC 110 CH 1 2

4 3 =JA01+DA01-EA01-XD01 4 4 3
4 3 =JA01+DA01-EA02-XD01 4 4 3
4 3 =JA01+DA01-EA03-XD01 4 4 3
13 14 =JA01+DA01-SG01 E 13 14

4 3 =JA01+DA01-EA1 4
4 3 =JA01+DA01-EA02 4
4 3 =JA01+DA01-EA03 4

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& C04

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC20-X230		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 60 /

Cable Overview / Cable Schedule

F10_001_Ballard

Cable Name	Function Text	Source (From)	Target (To)	Cable Type	All Conductors	Cross-Section [Unit]	Length [Unit]	Manufacturer	Type Number	Order Number
=HE01+DA01-BT01-WG01	FC1 HT Outlet Temp Signal	=HE01+DA01-BT01-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE01+DA01-BT02-WG01	FC2 HT Outlet Temp Signal	=HE01+DA01-BT02-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE01+DA01-BT03-WG01	FC3 HT Outlet Temp Signal	=HE01+DA01-BT03-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE02+DA01-BT04-WG01	FC4 HT Outlet Temp Signal	=HE02+DA01-BT04-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE02+DA01-BT05-WG01	FC5 HT Outlet Temp Signal	=HE02+DA01-BT05-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE02+DA01-BT06-WG01	=	=HE02+DA01-BT06-XG01	=LA01-X160	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BF01-WG01	LT Circuit Flow Signal	=BA20+UC50-X10	=HE03+DA01-BF01-XD01	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP01-WG01	LT Circuit dP Signal	=HE03+DA01-BP01-XD01	=LA01-X150	ÖLFLEX® CLASSIC 110 CH	3	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056
=HE03+DA01-BP02-WG01	FC1 LT Inlet Pressure Signal	=HE03+DA01-BP02-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP03-WG01	FC2 LT Inlet Pressure Signal	=HE03+DA01-BP03-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP04-WG01	FC3 LT Inlet Pressure Signal	=HE03+DA01-BP04-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP05-WG01	FC4 LT Inlet Pressure Signal	=HE03+DA01-BP05-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP06-WG01	FC5 LT Inlet Pressure Signal	=HE03+DA01-BP06-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BP07-WG01	FC1 LT Inlet Pressure Signal	=HE03+DA01-BP07-XG01	=LA01-X150	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=HE03+DA01-BT04-WG01	LT Return Temp Signal	=BA20+UC50-X10	=HE03+DA01-BT04-XG01	PUR	4	0,34 mm²	15 m	IFM Electronic AS	ADOAH040MSS0015K04	EVC698
=HE03+DA01-BT05-WG01	LT Radiator Outlet Signal	=BA20+UC50-X10	=HE03+DA01-BT05-XG01	PUR	4	0,34 mm²	15 m	IFM Electronic AS	ADOAH040MSS0015K04	EVC698
=HE03+DA01-GP11-WG01	24 VDC supply VFD LT Pump	=LA01-X108	=HE03+DA01-TA11	ÖLFLEX CLASSIC 110	3G	1 mm²		Lapp Group	ÖLFLEX CLASSIC 110	1119 203
=HE03+DA01-GP11.WD01	Power supply LT Pump	=LA01-X10	=HE03+DA01-TA11	ÖLFLEX® CLASSIC 135 CH	4	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342
=HE03+DA01-GP11.WD02	=	=HE03+DA01-GP11	=HE03+DA01-TA11	ÖLFLEX® CLASSIC 135 CH	4	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123342
=HE03+DA01-GP11.WG02	STO LT Pump	=LA01-X102	=HE03+DA01-TA11	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=HE03+DA01-QN01.WG01	LT Mixing Valve Supply and Signal	=BA20+UC50-X10	=HE03+DA01-TF01	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=HE03+DA01-QN01.WG02	=	=HE03+DA01-QN01.MA01	=HE03+DA01-TF01	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-AC07-WG01	Ventilation (Upper) Signal	=JA01+DA01-AC07	=LA01-P1-2	BUS CAN FD P	2	0,5 mm²		Lapp Group	UNITRONIC® BUS CAN FD P	2170278
								Lapp Group	UNITRONIC® BUS CAN FD P	2170278
=JA01+DA01-BL02-WG01	Process Drain Tank Level Signal	=JA01+DA01-BL01-XG01	=LA01-X110	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=JA01+DA01-BP01-WD01	Intake dP Sensor	=LA01-X123	=JA01+DA01-BP01	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BP02-WD01	In/Out dP Sensor	=LA01-X123	=JA01+DA01-BP02	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ01-WG01	H2 Sensor Ventlation Inlet Signal	=LA01-X103	=JA01+DA01-BQ01	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ02-WG01	H2 Sensor Ventlation Outlet A Signal	=LA01-X103	=JA01+DA01-BQ02	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ03-WG01	H2 Sensor Ventlation Outlet B Signal	=LA01-X103	=JA01+DA01-BQ03	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ04-WG01	Smoke Detector Ventlation Inlet Signal	=LA01-X104	=JA01+DA01-BQ04-X2	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ05-WG01	Smoke Detector Ventlation Outlet B Signal	=LA01-X104	=JA01+DA01-BQ05-X2	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BQ06-WG01	=	=LA01-X104	=JA01+DA01-BQ06-X2	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-BT01-WG01	Container Intake Air Temp	=JA01+DA01-BT01-XG01	=LA01-X124	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=JA01+DA01-BT02-WG01	Container Temp A	=JA01+DA01-BT02-XG01	=LA01-X124	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=JA01+DA01-BT03-WG01	Container Temp B	=JA01+DA01-BT03-XG01	=LA01-X124	PUR	4	0,34 mm²	10 m	IFM Electronic AS	ADOGH040VAT0025H04/3G/2D	EVC540
=JA01+DA01-BU01-WD01	Air Quality Sensor Supply	=LA01-X125	=JA01+DA01-BU01	ÖLFLEX® CLASSIC 110 CH	3	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056
=JA01+DA01-BU01-WG02	Air Quality Sensor Signal	=LA01-X125	=JA01+DA01-BU01	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059
=JA01+DA01-EA01-WD01	LED Light strip EA01	=JA01+DA01-EA01-XD01		PUR	4	0,25 mm²	20 m			
			=LA01-X230							
=JA01+DA01-EA02-WD01	LED Light strip EA05	=JA01+DA01-EA02-XD01		PUR	4	0,25 mm²	20 m			
			=LA01-X230							
			=JA01+DA01-EA04-XD01							
=JA01+DA01-EA03-WD01	LED Light strip EA02	=JA01+DA01-EA03-XD01		PUR	4	0,25 mm²	20 m			
			=LA01-X230							
=JA01+DA01-EA04-WD01	LED Light strip EA07	=JA01+DA01-EA04-XD01		PUR	4	0,25 mm²	20 m			

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + UC20 | & D01

REVISION INFORMATION
DESCRIPTION
DATE
20-Nov-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable overview : =HE01+DA01-BT01-WG01 - =JA01+DA01-EA04-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 /

Cable Overview / Cable Schedule

F10_001_Ballard

Cable Name	Function Text	Source (From)	Target (To)	Cable Type	All Conductors	Cross-Section [Unit]	Length [Unit]	Manufacturer	Type Number	Order Number
=JA01+DA01-EA05-WD01	LED Light strip EA04	=JA01+DA01-EA01-XD02	=JA01+DA01-EA05-XD01	PUR	4	0,25 mm²	6 m			
=JA01+DA01-EA06-WD01	LED Light strip EA06	=JA01+DA01-EA02-XD02	=JA01+DA01-EA06-XD01	PUR	4	0,25 mm²	6 m			
=JA01+DA01-EA07-WD01	=	=JA01+DA01-EA03-XD02	=JA01+DA01-EA07-XD01	PUR	4	0,25 mm²	6 m			
=JA01+DA01-EA08-WD01	LED Light strip EA08	=JA01+DA01-EA04-XD02	=JA01+DA01-EA08-XD01	PUR	4	0,25 mm²	6 m			
=JA01+DA01-EB01.WD01		=JA01+DA01-EB01-X1	=LA01-X13	ÖLFLEX® HEAT 180 MS	4	2,5 mm²		Lapp Group	ÖLFLEX® HEAT 180 MS	00466303
=JA01+DA01-EB01.WD02		=JA01+DA01-EB01-X1	=LA01-X14	ÖLFLEX® HEAT 180 MS	4	2,5 mm²		Lapp Group	ÖLFLEX® HEAT 180 MS	00466303
=JA01+DA01-EB01.WD03		=JA01+DA01-EB01-X1	=LA01-X15	ÖLFLEX® HEAT 180 MS	4	2,5 mm²		Lapp Group	ÖLFLEX® HEAT 180 MS	00466303
=JA01+DA01-GQ06-WD01	Ventilation (Upper) Supply	=JA01+DA01-GQ06-WD01	=LA01-X11	0,6/1 kV	4	2,5 mm²		Murrelektronik	MQ15 Female 0° to open cable, 10m	7000-P8221-P361000
=JA01+DA01-GQ06-WG01	Ventilation (Upper) Signal	=LA01-P1-2	=JA01+DA01-GQ06-CON2	BUS CAN FD P	2	0,5 mm²		Lapp Group	UNITRONIC® BUS CAN FD P	2170278
								Murrelektronik	7000-14541-7981000	7000-14541-7981000
=JA01+DA01-GQ07-WD01	Ventilation (Lower) Supply	=JA01+DA01-GQ07-WD01	=LA01-X12	0,6/1 kV	4	2,5 mm²		Murrelektronik	MQ15 Female 0° to open cable, 10m	7000-P8221-P361000
=JA01+DA01-GQ07-WG01	Ventilation (Upper) Signal	=JA01+DA01-GQ06-CON2	=JA01+DA01-GQ07-CON2	BUS CAN FD P	2	0,5 mm²		Lapp Group	UNITRONIC® BUS CAN FD P	2170278
=JA01+DA01-GQ08-WD01		=LA01-X16	=JA01+DA01-AC08	ÖLFLEX® CLASSIC 135 CH	BK 0,6/1 kV	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123478
			=JA01+DA01-GQ08							
=JA01+DA01-GQ08-WD02	DCDC Cooling Fan A Power	=JA01+DA01-AC08	=JA01+DA01-GQ08	0,6/1 kV	4	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123478
=JA01+DA01-GQ08-WG01	DCDC Cooling Fan B Signal	=JA01+DA01-AC07	=JA01+DA01-GQ08		2	0,5 mm²		Lapp Group	UNITRONIC® BUS CAN FD P	2170278
=JA01+DA01-GQ09-WD01		=LA01-X17	=JA01+DA01-AC08	ÖLFLEX® CLASSIC 135 CH	BK 0,6/1 kV	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123478
			=JA01+DA01-GQ09							
=JA01+DA01-GQ09-WD02	DCDC Cooling Fan B Power	=JA01+DA01-AC08	=JA01+DA01-GQ09	0,6/1 kV	4	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123478
=JA01+DA01-GQ09-WG01	DCDC Cooling Fan A Signal	=JA01+DA01-AC07	=JA01+DA01-GQ09		2	0,5 mm²		Lapp Group	UNITRONIC® BUS CAN FD P	2170278
=JA01+DA01-QM01-WD01	Ventilation Intake Louvre 1	=JA01+DA01-AC01	=LA01-X121	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-QM02-WD01	Ventilation Intake Louvre 2	=JA01+DA01-AC02	=LA01-X121	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-QM03-WD01	Ventilation exhaust Louvre A1	=JA01+DA01-AC03	=LA01-X122	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-QM04-WD01	Ventilation exhaust Louvre A2	=JA01+DA01-AC04	=LA01-X122	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-QM05-WD01	Ventilation exhaust Louvre B1	=JA01+DA01-AC05	=LA01-X122	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
			=BA20+UC50-X11					Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-QM06-WD01	Ventilation exhaust Louvre B2	=JA01+DA01-AC06	=LA01-X122	ÖLFLEX® CLASSIC 135 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
			=BA20+UC50-X11					Lapp Group	ÖLFLEX® CLASSIC 135 CH	1123270
=JA01+DA01-SG01-WG01		=LA01-X230	=JA01+DA01-SG01	ÖLFLEX® CLASSIC 110 CH	3	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035056
=LA01+DA01-CA30-WD01	Battery supply RB30	=LA01+DA01-CA30	=LA01-RB30	ÖLFLEX CLASSIC 100 H	3G	2,5 mm²		Lapp Group	ÖLFLEX CLASSIC 100 H	0014 103
=LA01+DA01-CA30-WG01	Temp sensor CA30	=LA01+DA01-CA30	=LA01-RB30	ÖLFLEX® CLASSIC 130 H	3G	1 mm		Lapp Group	ÖLFLEX® CLASSIC 130 H	1123067
=LA01+DA01-RB01-WD01	Battery Supply RB01	=LA01+DA01-CA01	=LA01-RB01	ÖLFLEX® CLASSIC 110 CH	3	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035089
=LA01+DA01-RB01-WG01	Temp Sensor CA01	=LA01+DA01-CA01	=LA01-RB01	UNITRONIC®-FD CP (TP) PLUS	4	0,5 mm²		Lapp Group	UNITRONIC®-FD CP (TP) PLUS	0030937
=LA01+DA01-RB02-WD01	Battery Supply RB02	=LA01+DA01-CA02	=LA01-RB02	ÖLFLEX® CLASSIC 110 CH	3	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035089
=LA01+DA01-RB02-WG01	Temp Sensor CA02	=LA01+DA01-CA02	=LA01-RB02	UNITRONIC®-FD CP (TP) PLUS	4	0,5 mm²		Lapp Group	UNITRONIC®-FD CP (TP) PLUS	0030937
=LA01+DA01-RB03-WD01	Battery Supply RB03	=LA01+DA01-CA03	=LA01-RB03	ÖLFLEX® CLASSIC 110 CH	3	2,5 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035089
=LA01+DA01-RB03-WG01	Temp Sensor CA03	=LA01+DA01-CA03	=LA01-RB03	UNITRONIC®-FD CP (TP) PLUS	4	0,5 mm²		Lapp Group	UNITRONIC®-FD CP (TP) PLUS	0030937
=LA01-EA01-WD01		=LA01-X23	=LA01-EA1	YAKY	3	16 AWG	3 m	Rittal	SZ.2500500	2500500
		=LA01-FC21								
		=LA01-TB30								
=LA01-KE01-WG01		=LA01-KE01-Slot1	=LA01-KE02-Slot1					Lapp Group	IE-6A-RJ45-L0.5-P-4-26-7-RJ45	2172363
=LA01-KE02-WG01		=LA01-KE02-Slot1	=LA01-KE03-Slot1					Lapp Group	IE-6A-RJ45-L0.5-P-4-26-7-RJ45	2172363
=LA01-KE03-WG01		=HA01+DA02-XT10	=LA01-KE03-Slot1	Profinet 4pair cabling Cat.6A FRNC flexi	8	23 mm²		Lapp Group	Profinet 4pair cabling Cat.6A FRNC flexible	2170931
=LA01-KF200-WG01	STP			Cat.6						
=LA01-KF200-WG02	=	=LA01-KF200	=LA01-KF210	Cat.6						
=LA01-KF200-WG15	=	=HA01+DA02-XT11	=LA01-KF200	Cat.6	4x2					

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
20-Nov-24

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable overview : =JA01+DA01-EA05-WD01 - =LA01+UC20-KF200-WG15		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1.a /

0	1	2	3	4	5	6	7	8

Cable Overview / Cable Schedule

F10_001_Ballard

Cable Name	Function Text	Source (From)	Target (To)	Cable Type	All Conductors	Cross-Section [Unit]	Length [Unit]	Manufacturer	Type Number	Order Number
=LA01-KF200-WG16	STP	=LA01-KF200	=LA01-KF201	Cat.6	4x2					
=LA01-WD01	Supply UC20 MCU cabinet	=LA01-X01	=BA20+UC50-FC03	ÖLFLEX® CLASSIC 135 CH	BK 0,6/1 kV	16 mm²		Lapp Group	ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV	1123493
			=BA20+UC50-FC05							
=LB02+DA01-SG23-WG01	ESTOP Container Door	=LA01-X105	=LB02+DA01-SG23	ÖLFLEX® CLASSIC 110 CH	4	1 mm²		Lapp Group	ÖLFLEX® CLASSIC 110 CH	10035059

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
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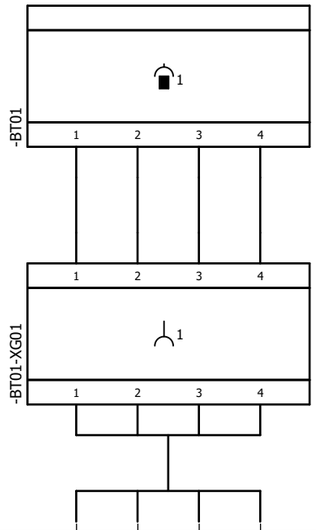
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DRAWING		REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable overview : =LA01+UC20-KF200-WG16 - =LB02+DA01-SG23-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1.b /

Cable connection diagram

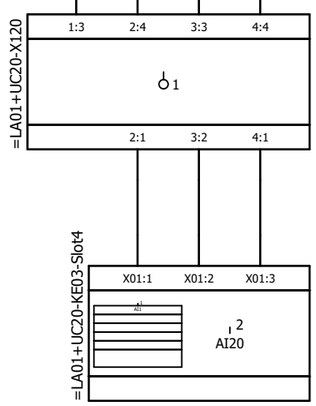
F07_001
PBL 28-Mar-25

Internal targets



=BA01+UC01-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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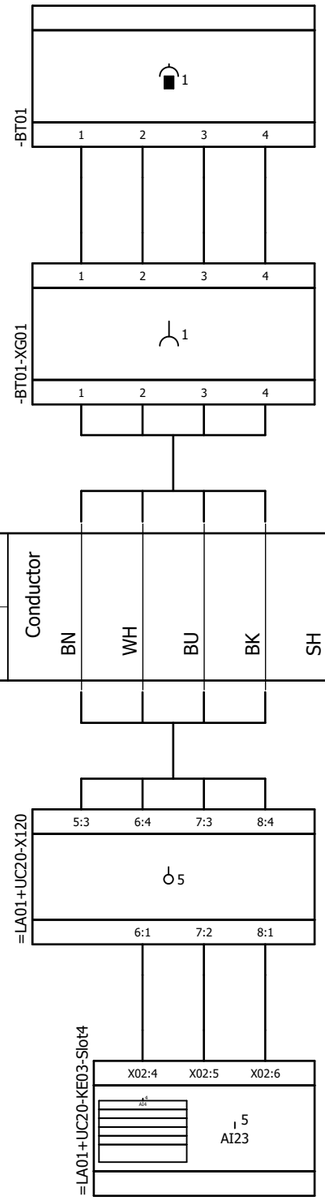
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA01+UC01-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=BA01+UC02-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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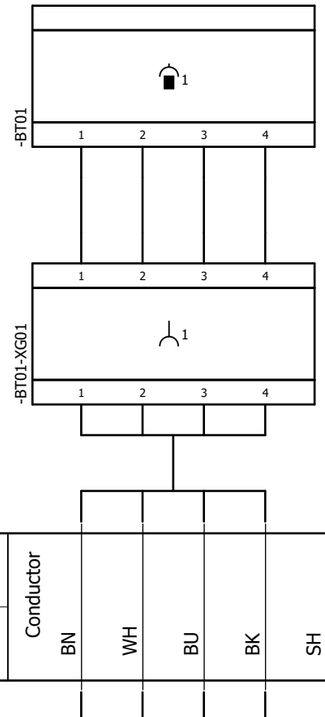
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA01+UC02-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 /

Cable connection diagram

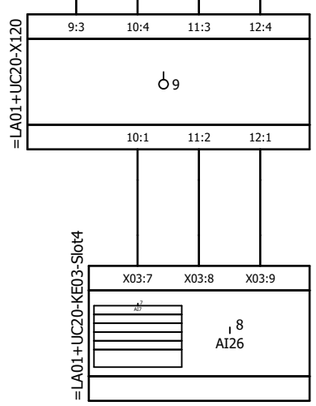
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Internal targets



=BA01+UC03-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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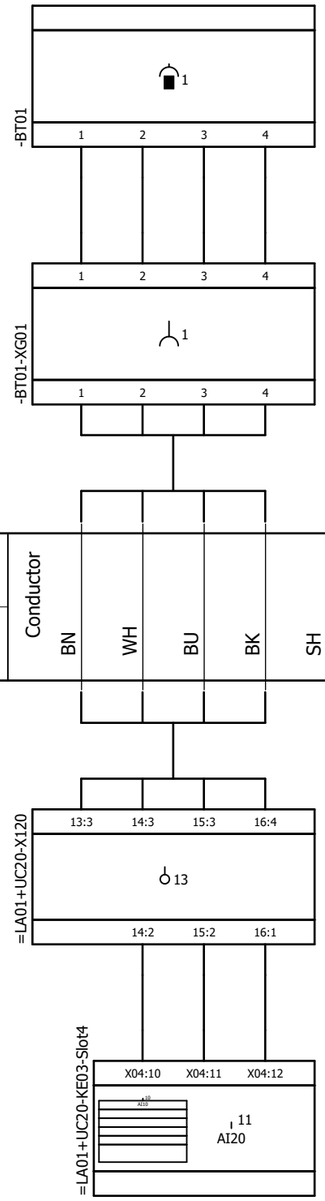
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA01+UC03-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=BA02+UC04-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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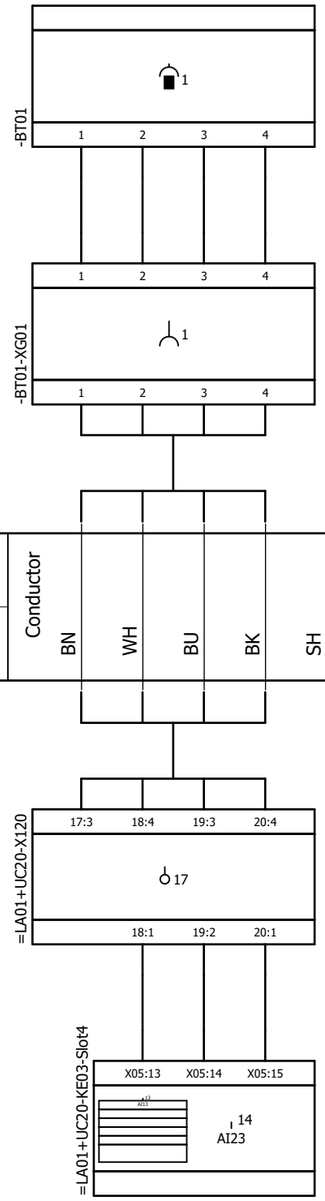
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA02+UC04-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=BA02+UC05-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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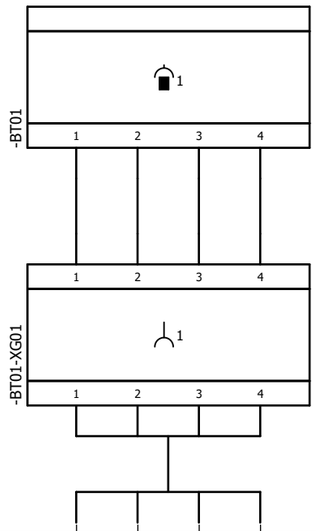
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA02+UC05-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 6 /

Cable connection diagram

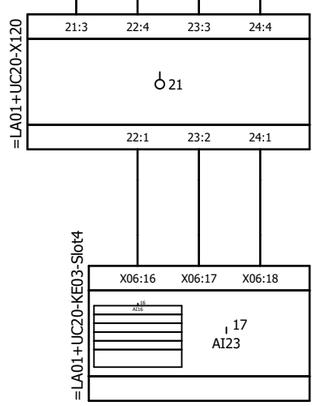
F07_001
PBL 28-Mar-25

Internal targets



=BA02+UC06-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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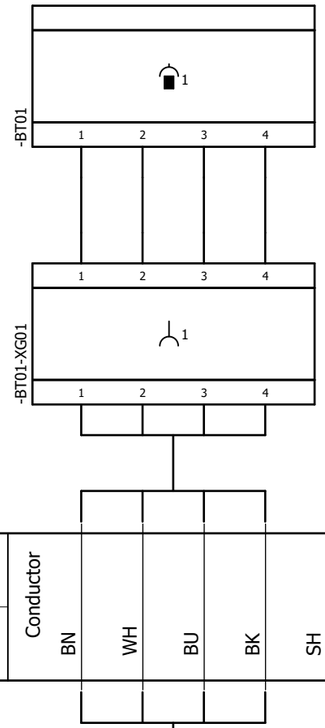
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =BA02+UC06-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 /

Cable connection diagram

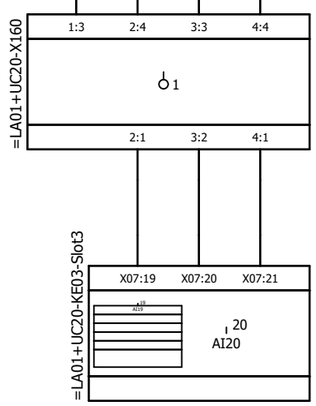
F07_001
PBL 28-Mar-25

Internal targets



=HE01+DA01-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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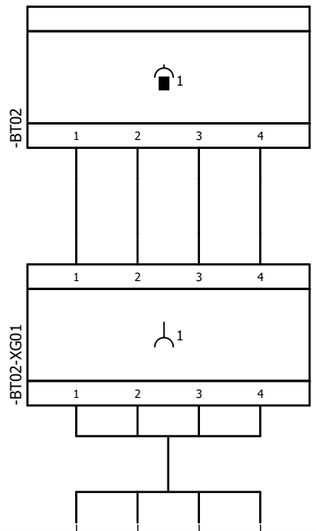
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE01+DA01-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 /

Cable connection diagram

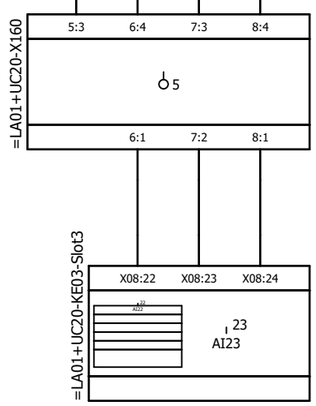
F07_001
PBL 28-Mar-25

Internal targets



=HE01+DA01-BT02-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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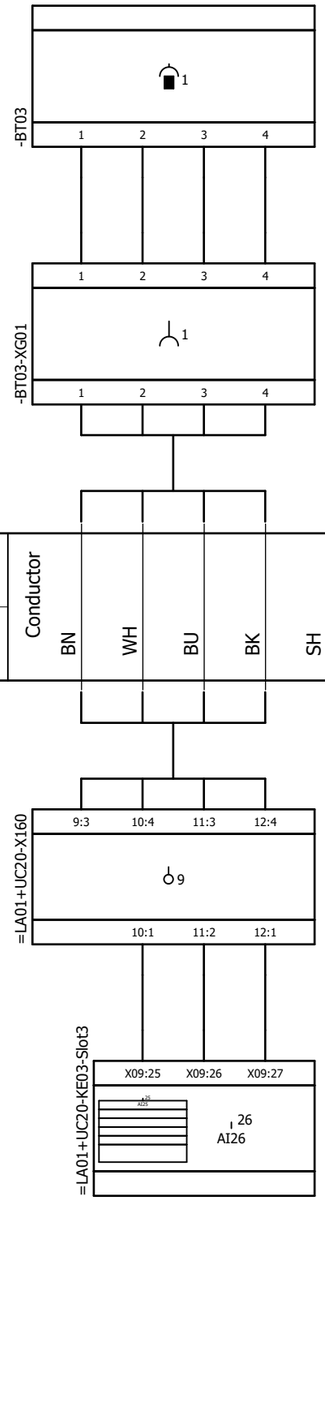
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE01+DA01-BT02-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=HE01+DA01-BT03-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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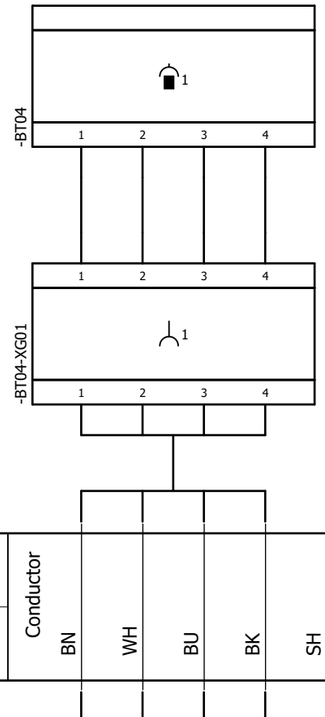
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE01+DA01-BT03-WG01		
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Cable connection diagram

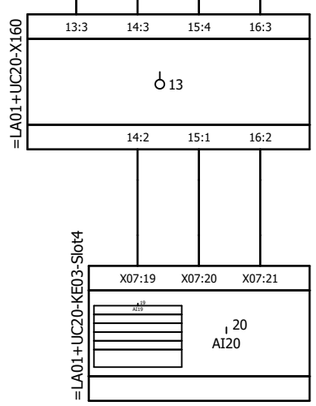
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Internal targets



=HE02+DA01-BT04-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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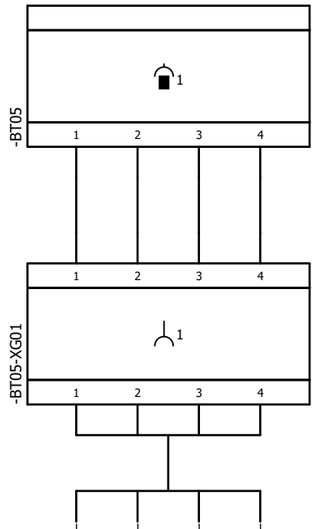
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE02+DA01-BT04-WG01		
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Cable connection diagram

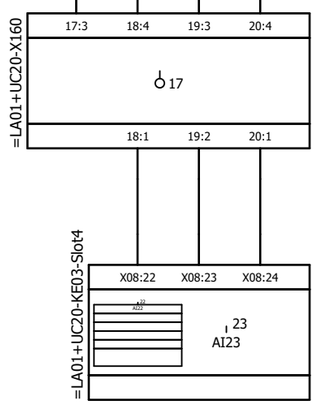
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Internal targets



=HE02+DA01-BT05-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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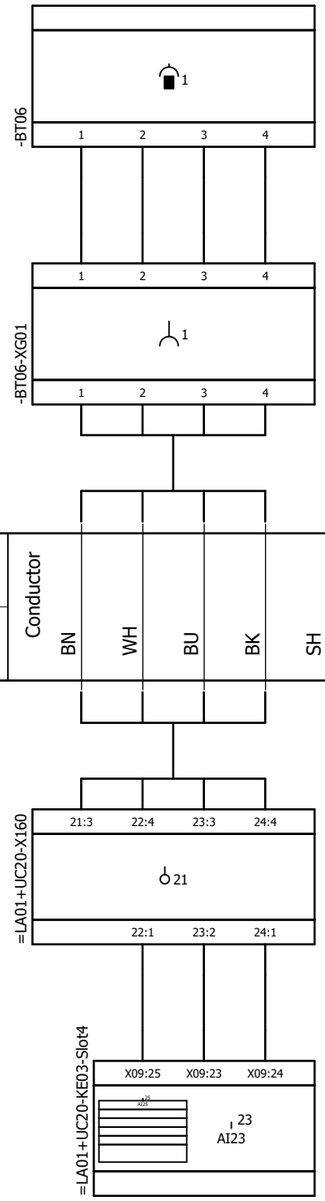
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE02+DA01-BT05-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 /

Cable connection diagram

F07_001
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Internal targets



=HE02+DA01-BT06-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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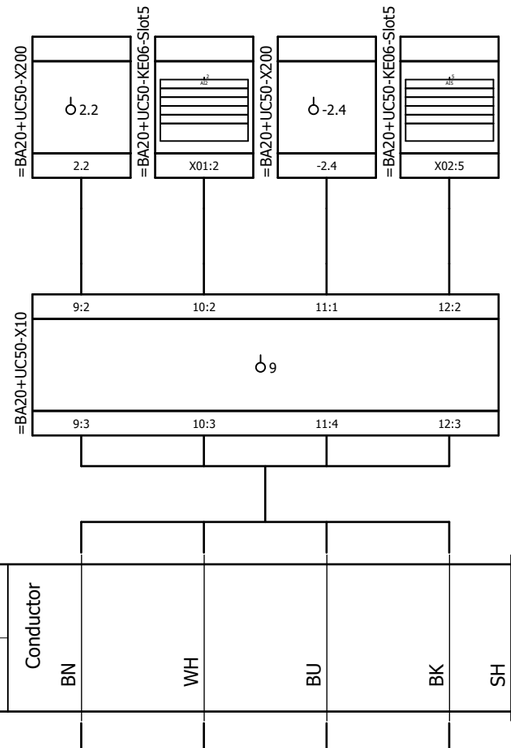
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Cable connection diagram

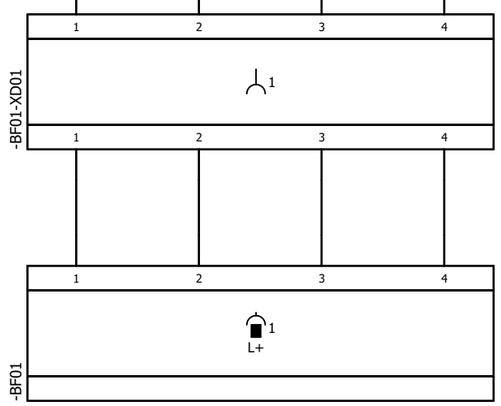
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Internal targets



=HE03+DA01-BF01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
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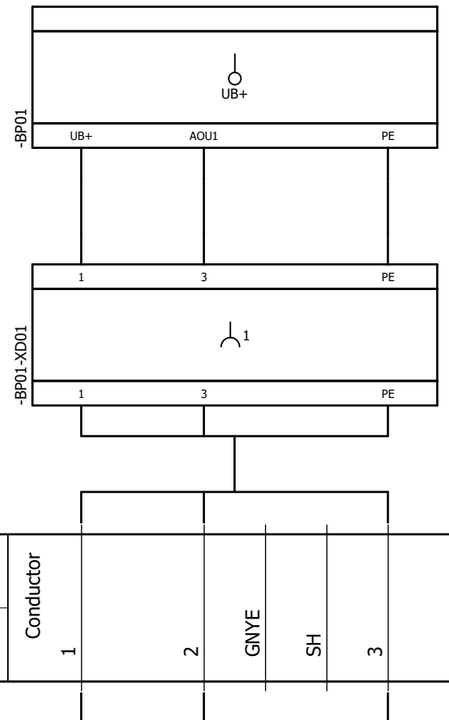
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-BF01-WG01		
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Cable connection diagram

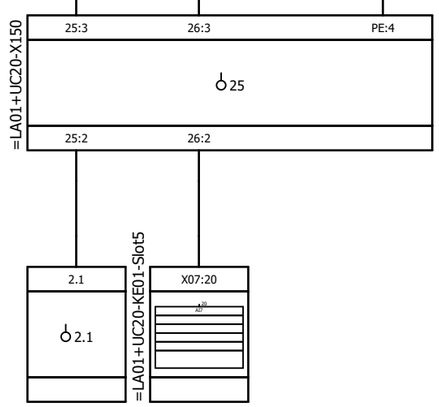
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Internal targets



=HE03+DA01-BP01-WG01	Conductor	1	2	GNYE	SH	3
ÖLFLEX® CLASSIC 110 CH						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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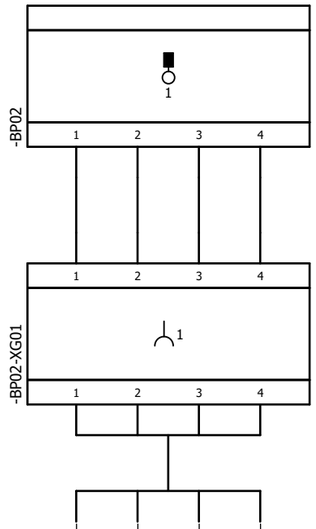
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DRAWING TITLE			
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Cable connection diagram

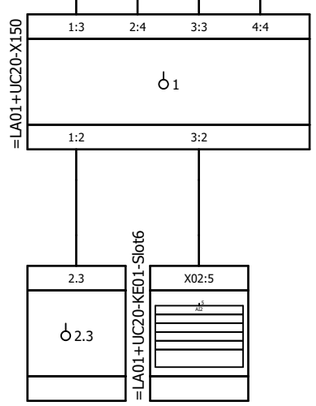
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Internal targets



=HE03+DA01-BP02-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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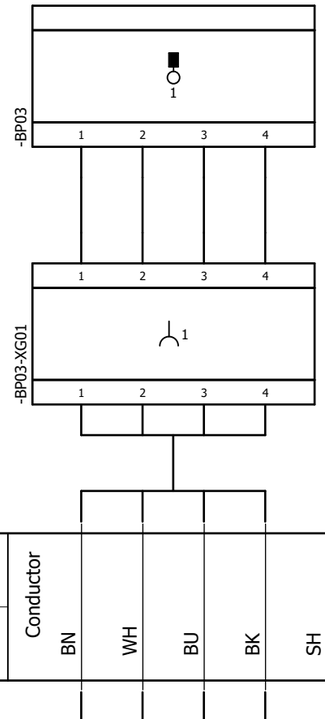
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DRAWING TITLE			
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Cable connection diagram

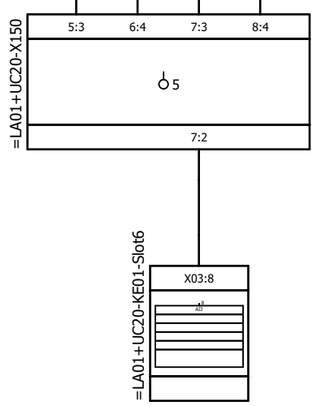
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Internal targets



=HE03+DA01-BP03-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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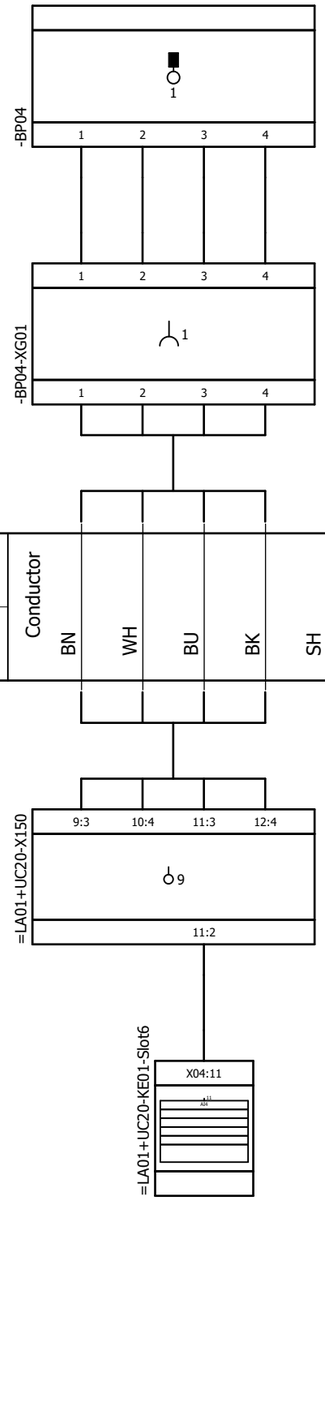
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-BP03-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 18 /

Cable connection diagram

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PBL 28-Mar-25

Internal targets



=HE03+DA01-BP04-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
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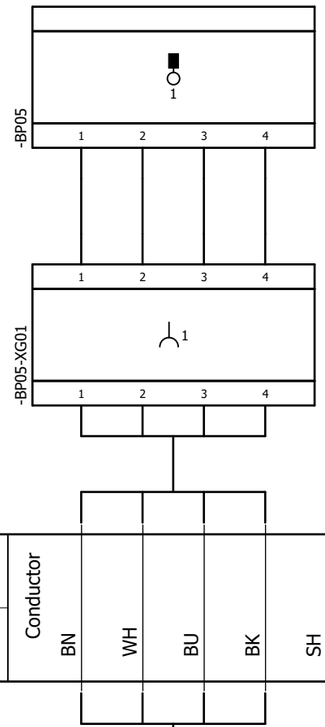
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
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Cable connection diagram

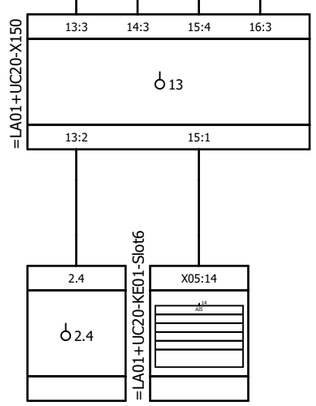
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Internal targets



=HE03+DA01-BP05-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



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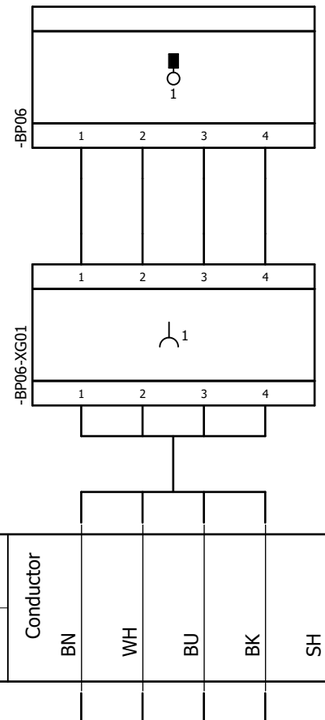
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DRAWING TITLE			
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Cable connection diagram

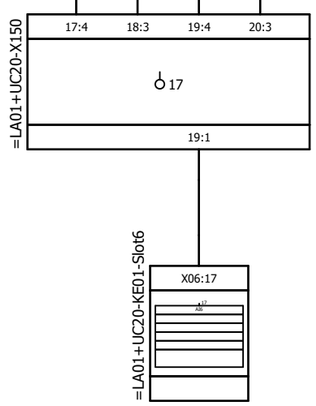
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PBL 28-Mar-25

Internal targets



=HE03+DA01-BP06-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



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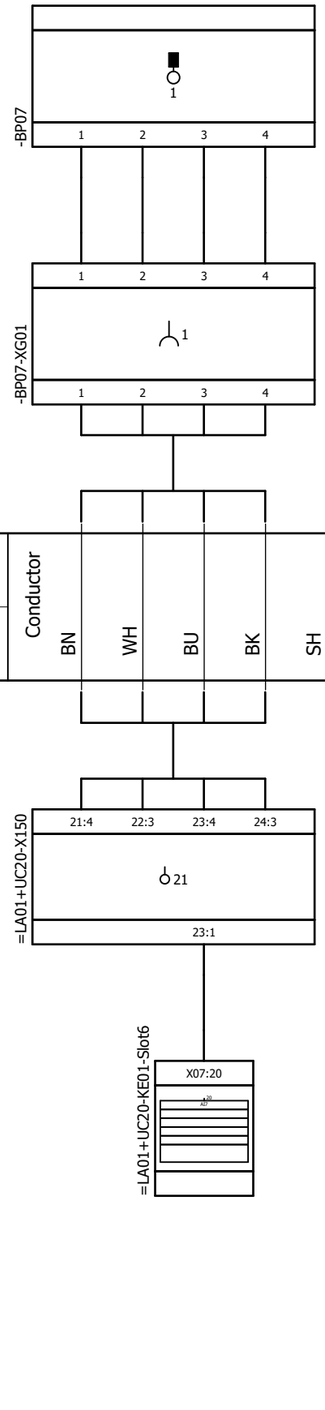
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 21 /

Cable connection diagram

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Internal targets



Reference Item Number	Ballard Part # TBD		
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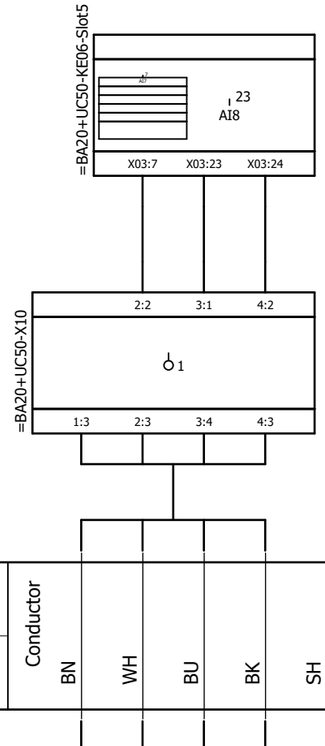
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-BP07-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 /

Cable connection diagram

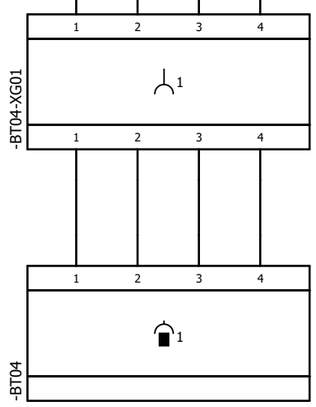
F07_001
PBL 28-Mar-25

Internal targets



=HE03+DA01-BT04-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
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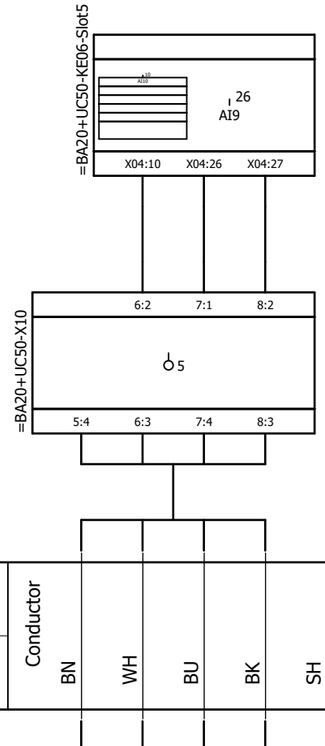
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-BT04-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 23 /

Cable connection diagram

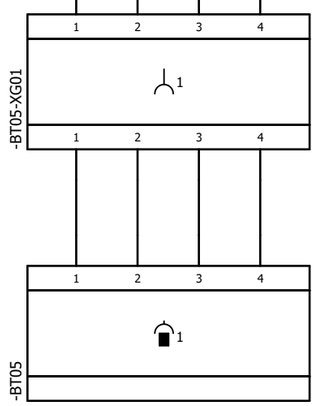
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PBL 28-Mar-25

Internal targets



=HE03+DA01-BT05-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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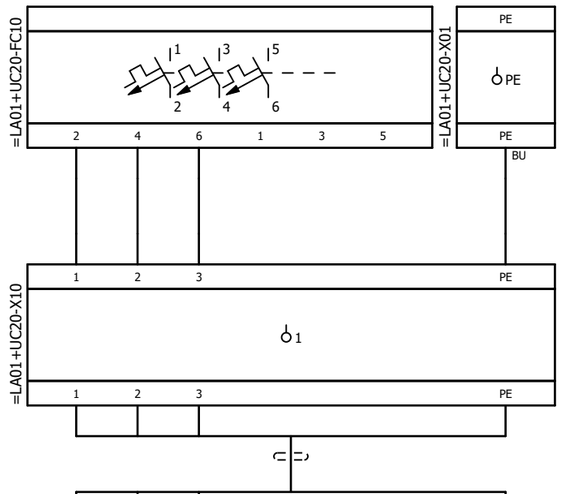
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-BT05-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 24 /

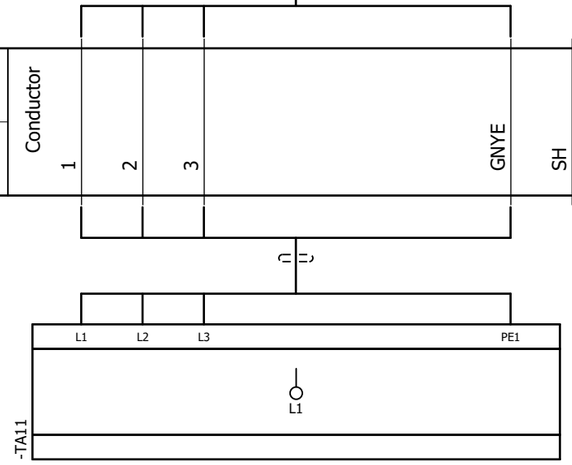
Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets



=HE03+DA01-GP11.WD01	Conductor	1	2	3	GNYE	SH
ÖLFLEX® CLASSIC 135 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
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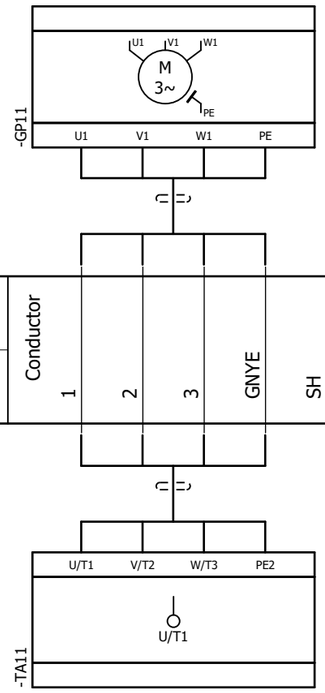
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-GP11.WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 25 /

Cable connection diagram

Internal targets



=HE03+DA01-GP11.WD02	Conductor	1	2	3	GNYE	SH
ÖLFLEX® CLASSIC 135 CH						

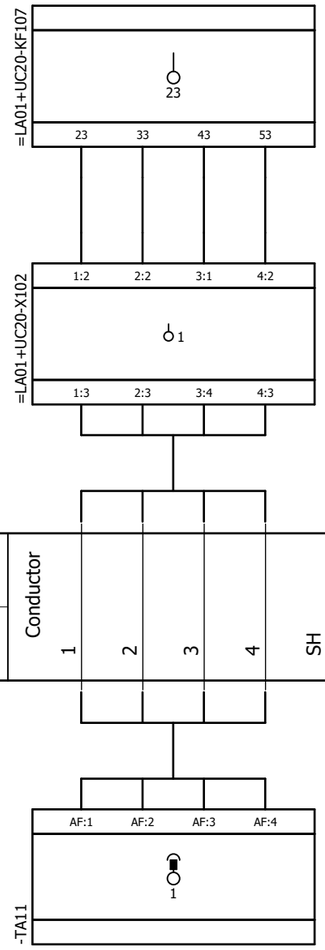
External targets

Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE			
EPLAN Revision	06					THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	SHEET TYPE/DESC	Cable-connection diagram =HE03+DA01-GP11.WD02		
EPLAN Project Pages	628			DATE			ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 26 /
=	++	+ UC20	& D01	15-Oct-24						

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=HE03+DA01-GP11.WG02	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
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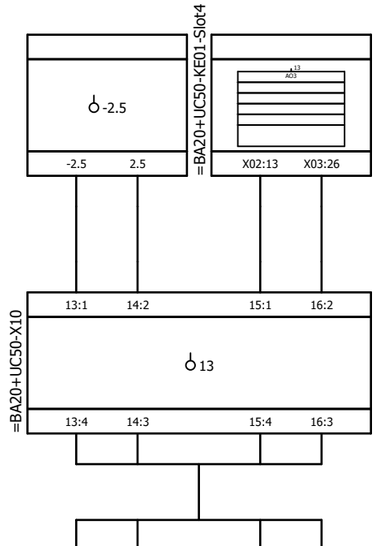
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
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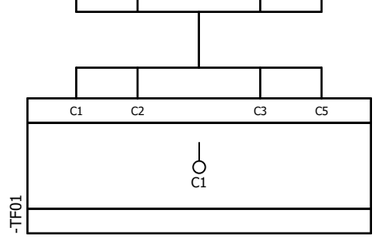
Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=HE03+DA01-QN01.WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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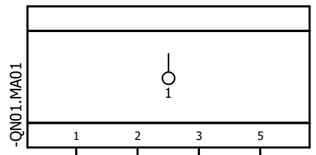
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DRAWING TITLE			
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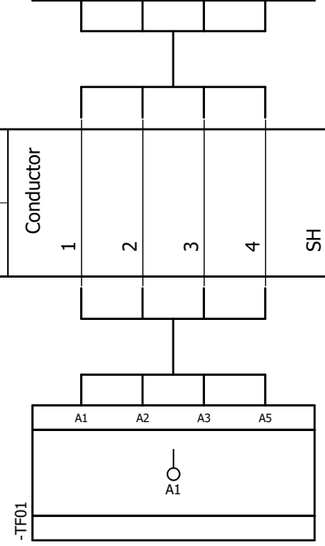
Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets



=HE03+DA01-QN01.WG02	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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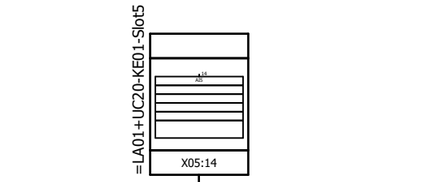
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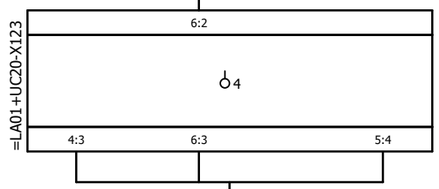
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Cable connection diagram

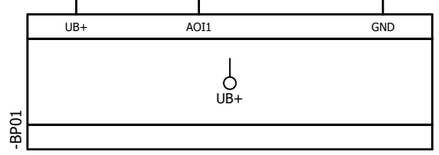
F07_001
PBL 28-Mar-25

Internal targets





=JA01+DA01-BP01-WD01	Conductor						
ÖLFLEX® CLASSIC 110 CH	1	2	3	4	SH	2	



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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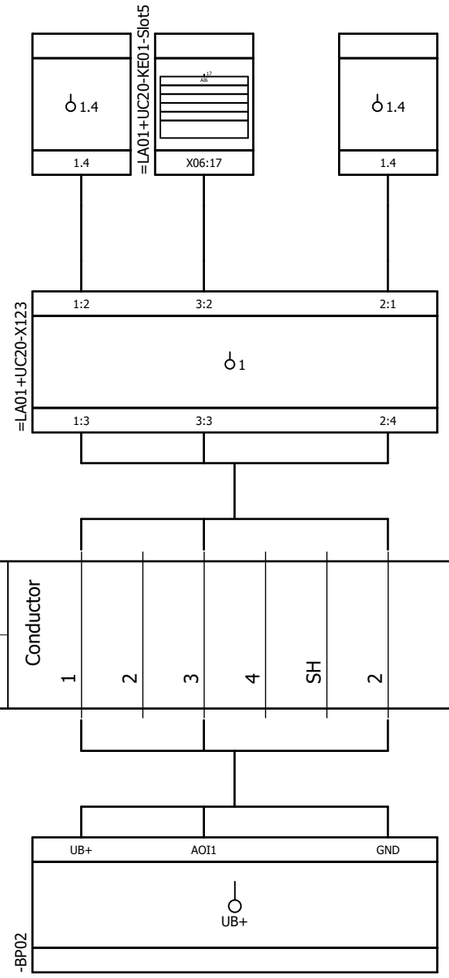
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BP01-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 /

Cable connection diagram

Internal targets



=JA01+DA01-BP02-WD01	Conductor	1	2	3	4	SH	2
ÖLFLEX® CLASSIC 110 CH							

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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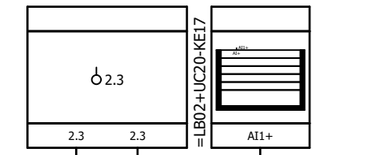
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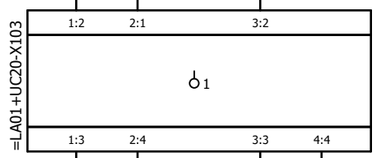
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Cable connection diagram

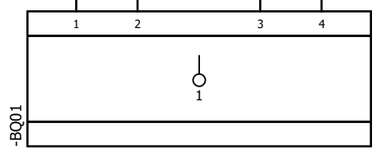
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Internal targets





=JA01+DA01-BQ01-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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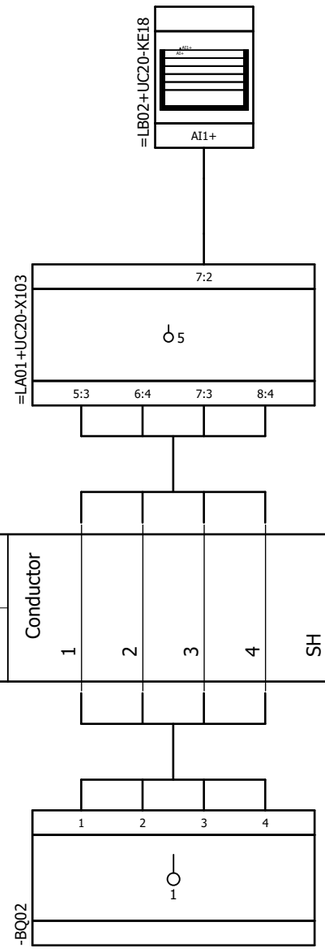
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BQ01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BQ02-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
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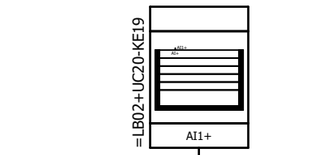
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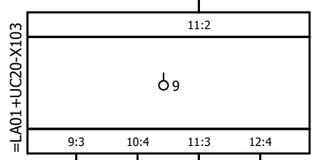
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 34 /

Cable connection diagram

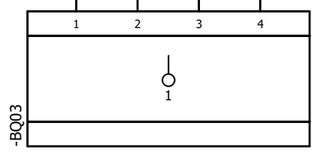
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PBL 28-Mar-25

Internal targets





=JA01+DA01-BQ03-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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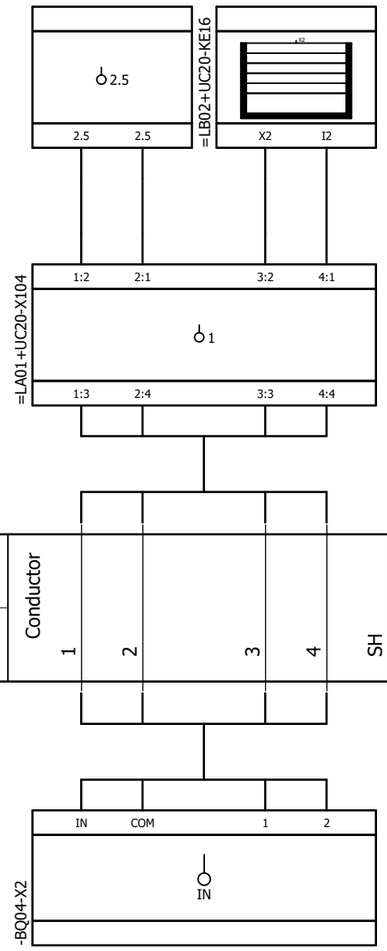
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 /

FRM5103656/0B

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BQ04-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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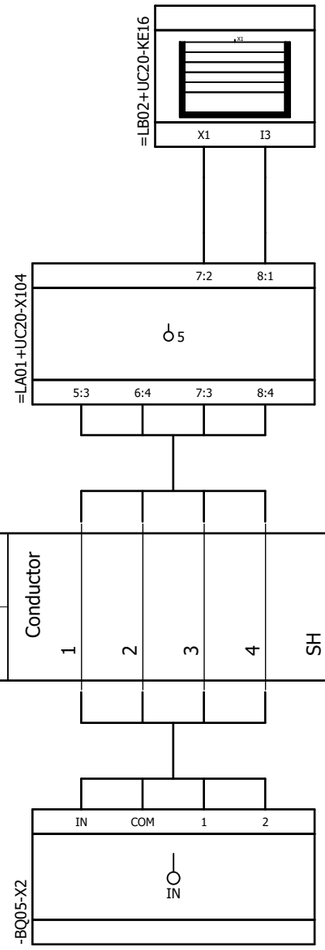
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BQ04-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 36 /

FRM5103656/0B

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BQ05-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

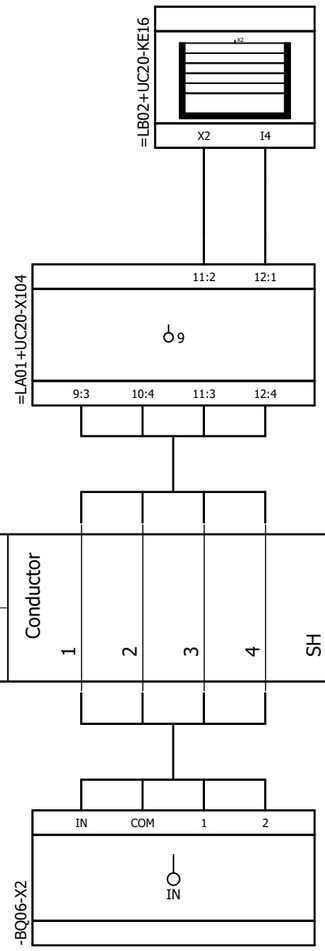
Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE			
EPLAN Revision	06						SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BQ05-WG01		
EPLAN Project Pages	628			DATE		THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 /
=	++	+ UC20	& D01	28-Mar-25						

FRM5103656/0B

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BQ06-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
DATE
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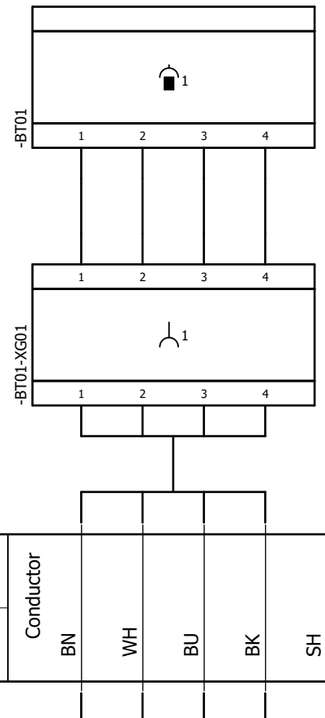
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BQ06-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 38 /

Cable connection diagram

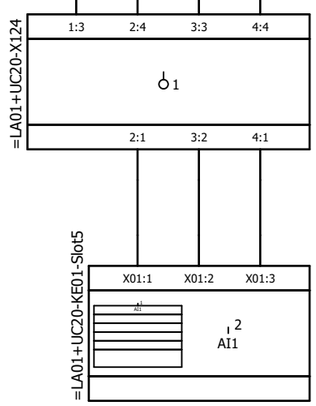
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BT01-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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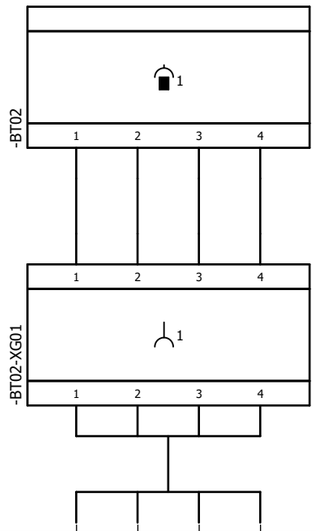
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BT01-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 39 /

Cable connection diagram

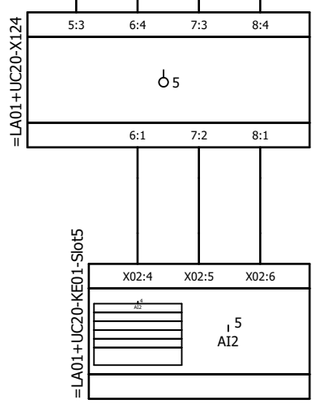
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BT02-WG01	Conductor	BN	WH	BU	BK	SH
PUR						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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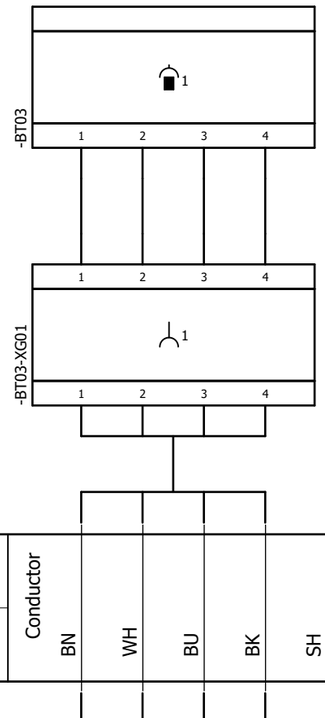
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BT02-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 40 /

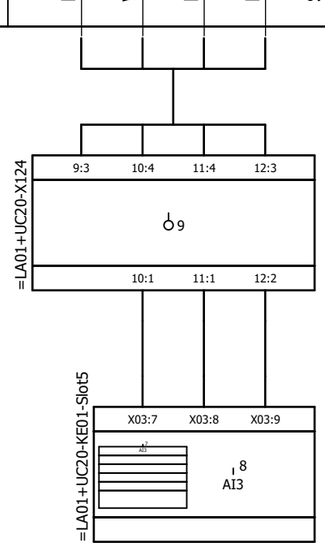
Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BT03-WG01	Conductor	BN	WH	BU	BK	SH
PUR						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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28-Mar-25

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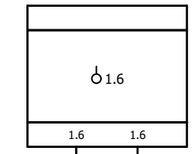
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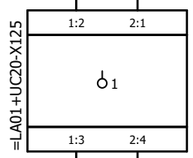
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BT03-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 41 /

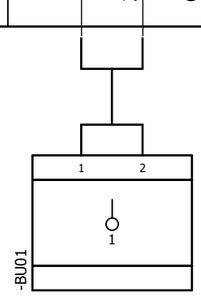
Cable connection diagram

Internal targets





=JA01+DA01-BU01-WD01	Conductor	1	2	GNYE	SH
ÖLFLEX® CLASSIC 110 CH					



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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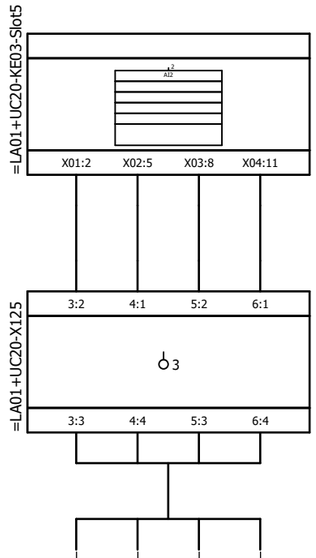
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BU01-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 42 /

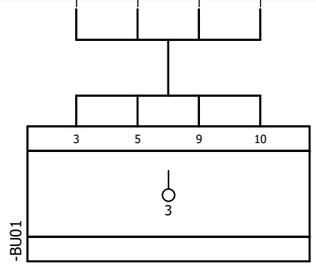
Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-BU01-WG02	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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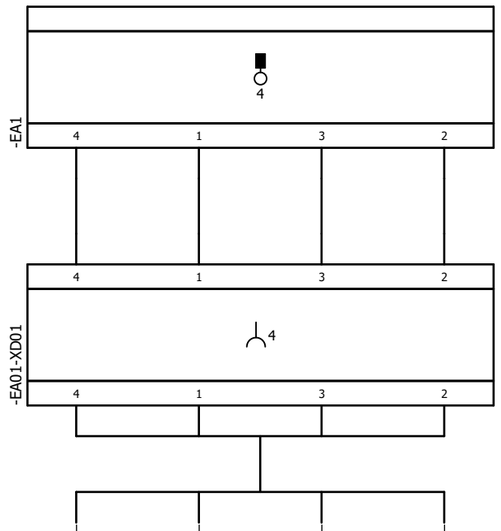
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-BU01-WG02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 43 /

Cable connection diagram

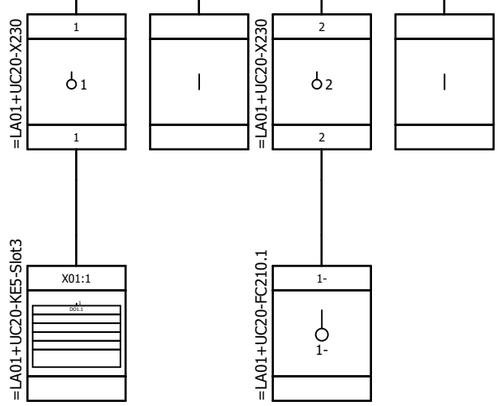
F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA01-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
DATE
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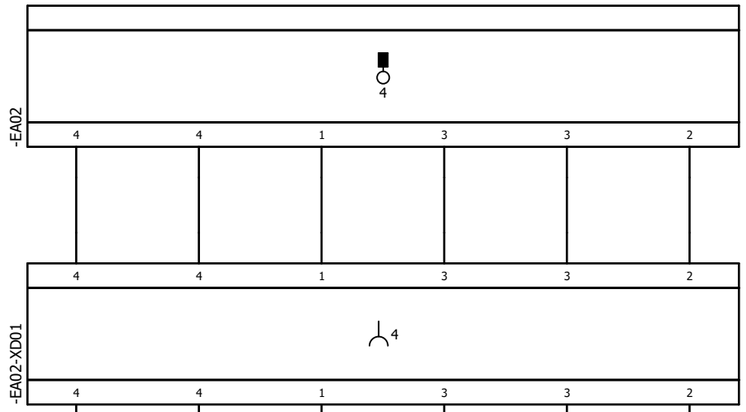
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
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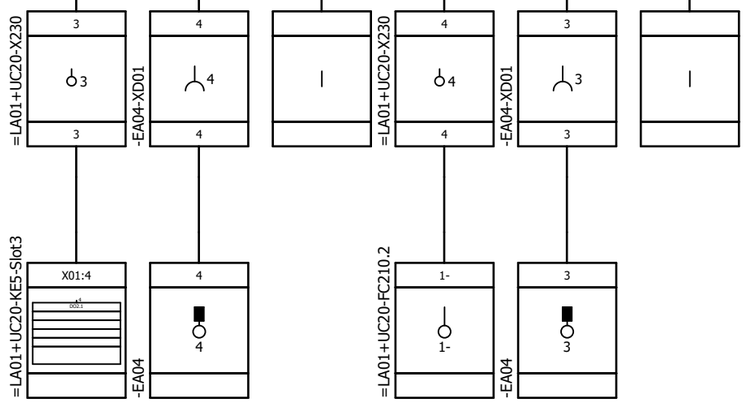
Cable connection diagram

Internal targets



=JA01+DA01-EA02-WD01	Conductor	BK	BK	BN	BU	BU	WH
PUR							

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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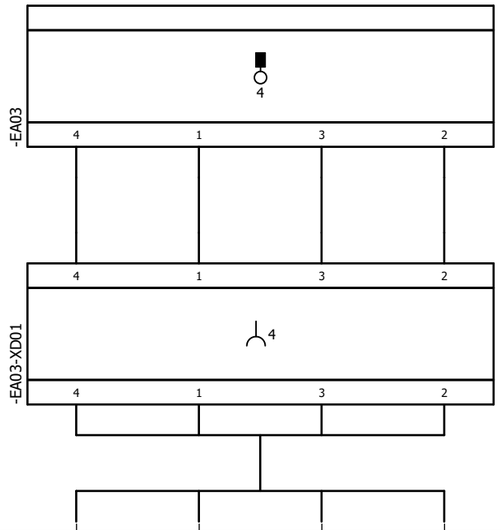
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA02-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 45 /

Cable connection diagram

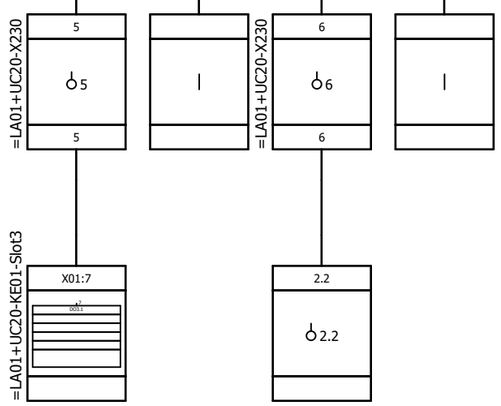
F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA03-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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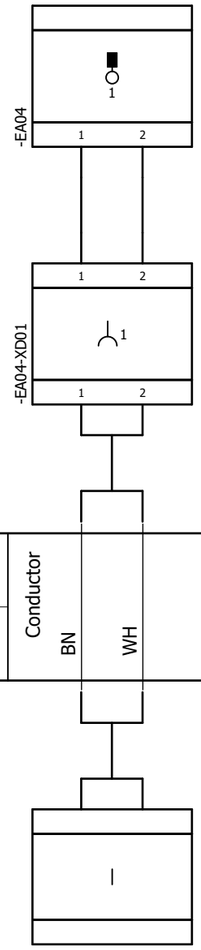
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA03-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 46 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA04-WD01	Conductor	BN	WH
PUR			

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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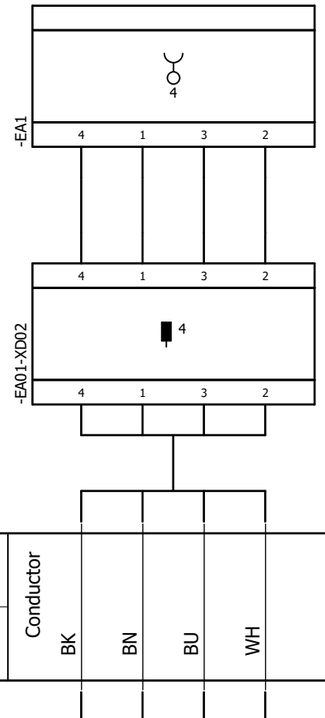
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA04-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 47 /

Cable connection diagram

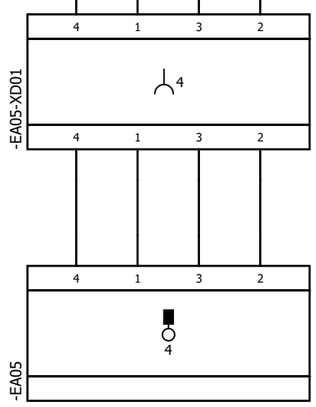
F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA05-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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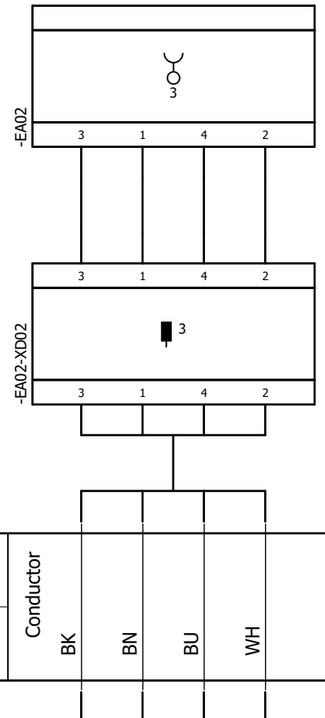
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA05-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 48 /

Cable connection diagram

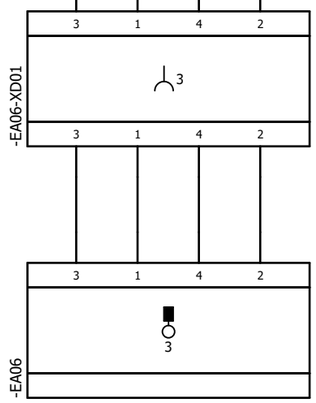
F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA06-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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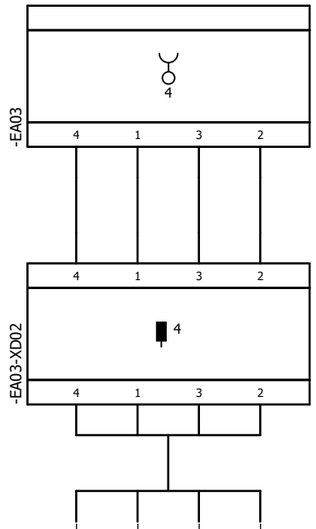
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA06-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 49 /

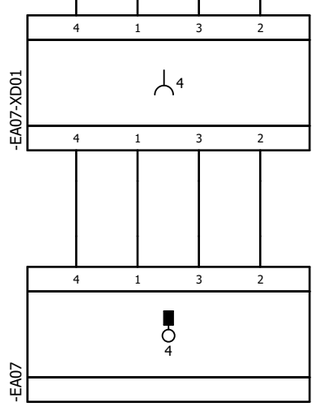
Cable connection diagram

Internal targets



=JA01+DA01-EA07-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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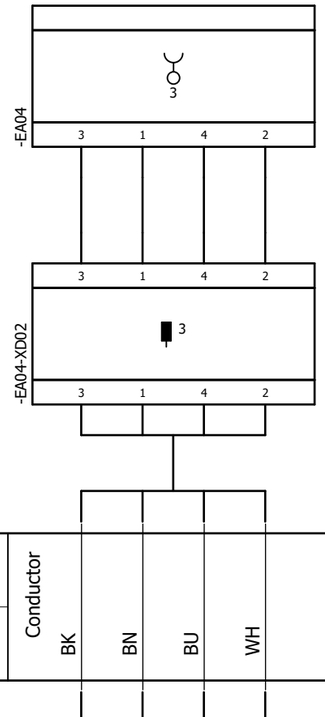
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA07-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 50 /

Cable connection diagram

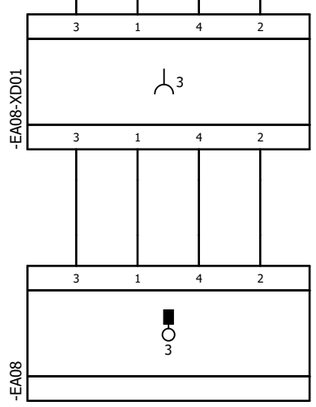
F07_001
PBL 15-Oct-24

Internal targets



=JA01+DA01-EA08-WD01	Conductor	BK	BN	BU	WH
PUR					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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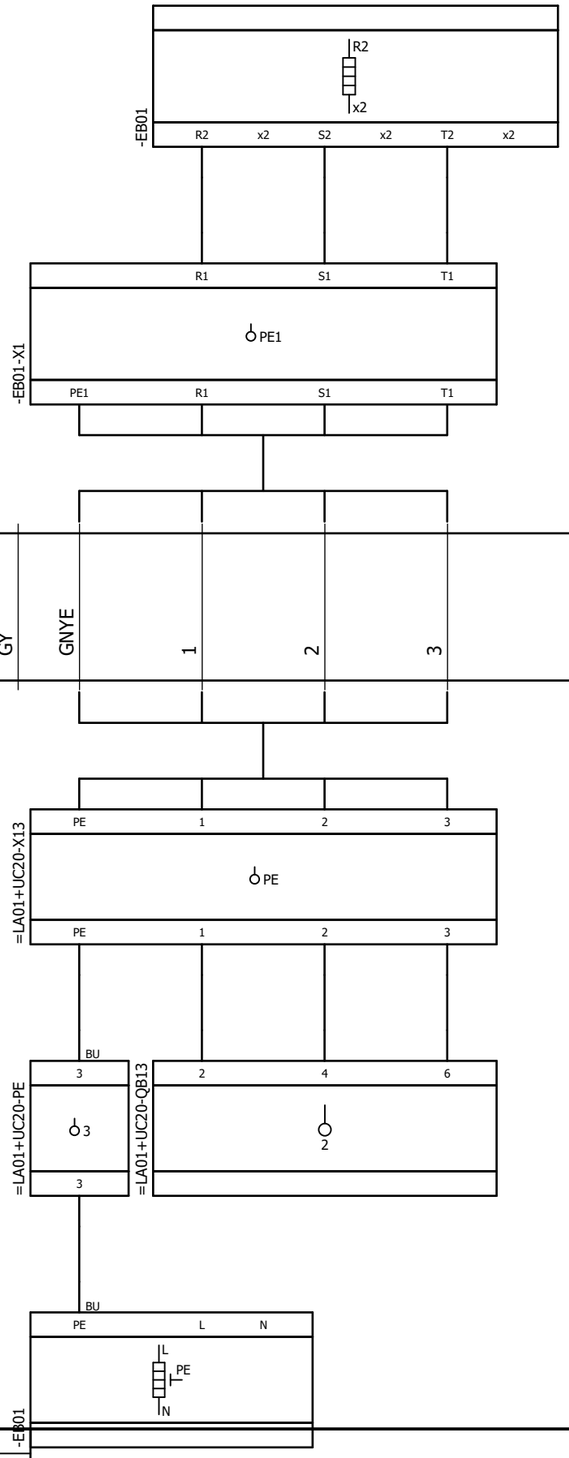
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EA08-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 51 /

0	1	2	3	4	5	6	7	8

Cable connection diagram

F07_001
PBL 16-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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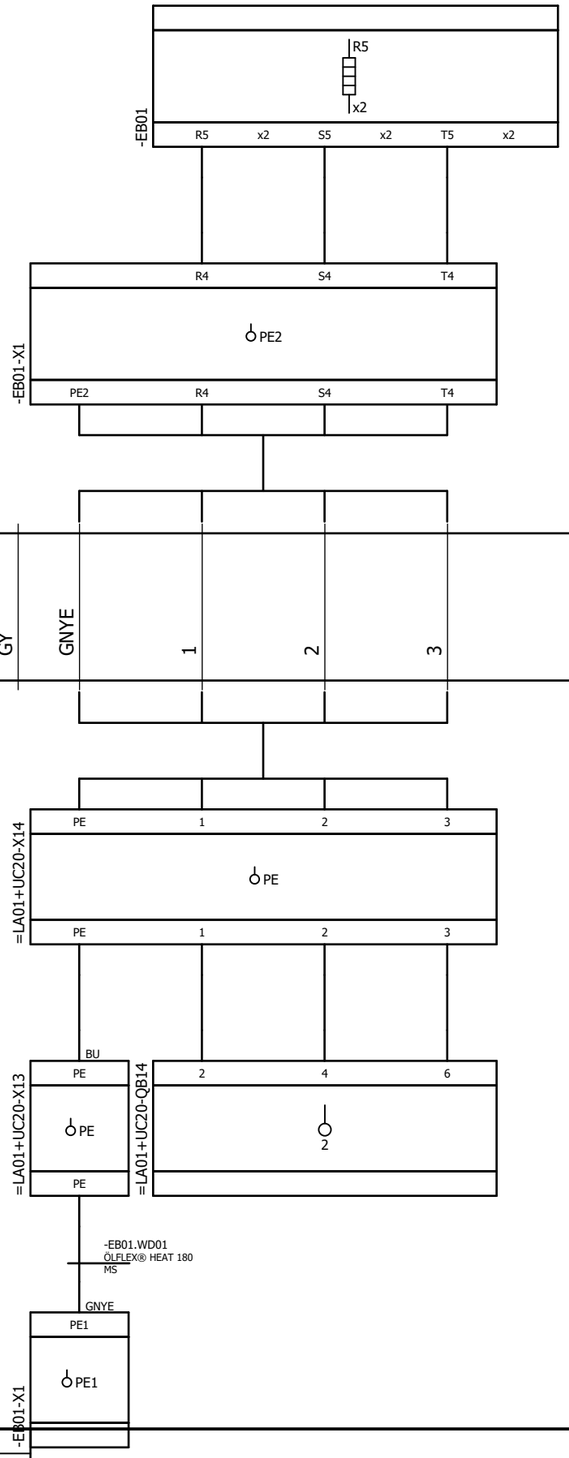
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EB01.WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 52 /

FRM5103656/0B

Cable connection diagram

F07_001
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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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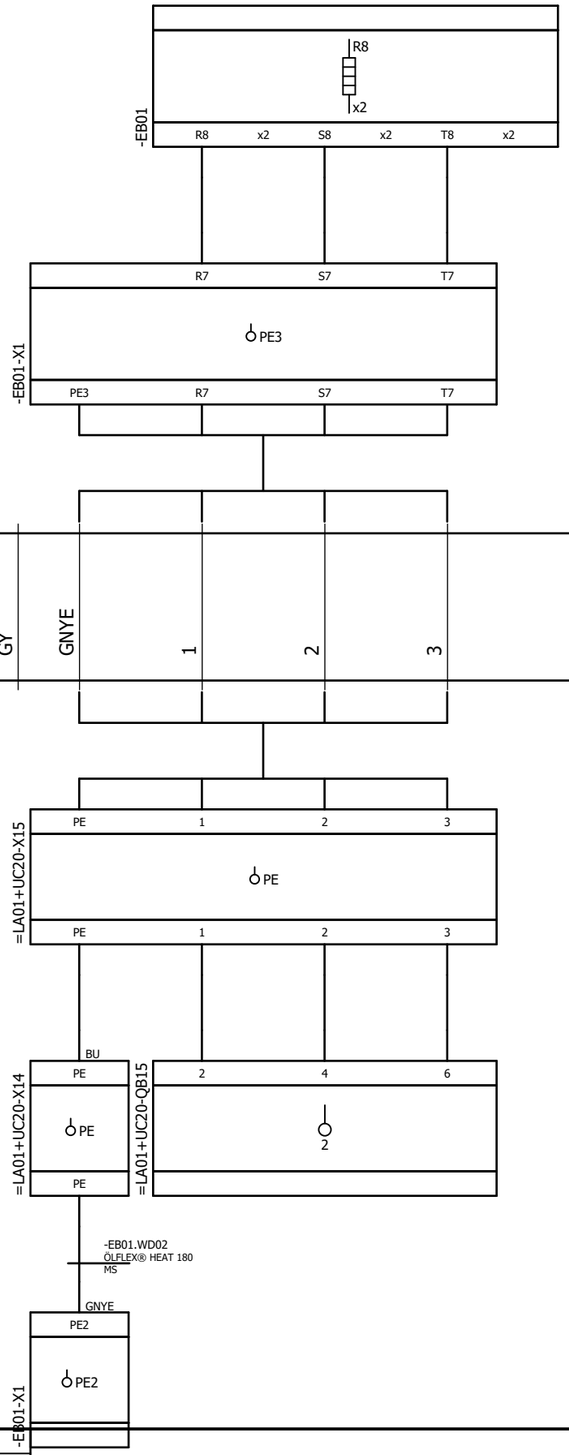
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EB01.WD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 53 /

Cable connection diagram

F07_001
PBL 16-Oct-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DATE
16-Oct-24

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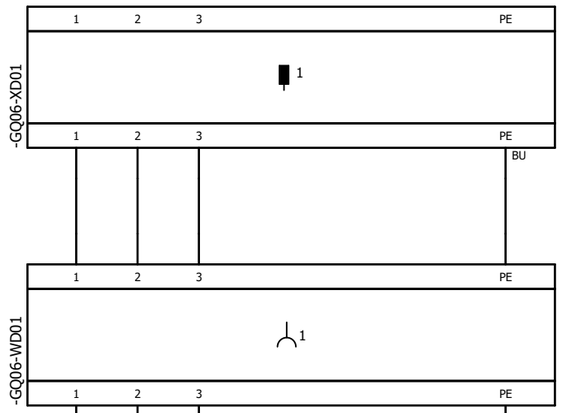
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-EB01.WD03		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 54 /

0	1	2	3	4	5	6	7	8

Cable connection diagram

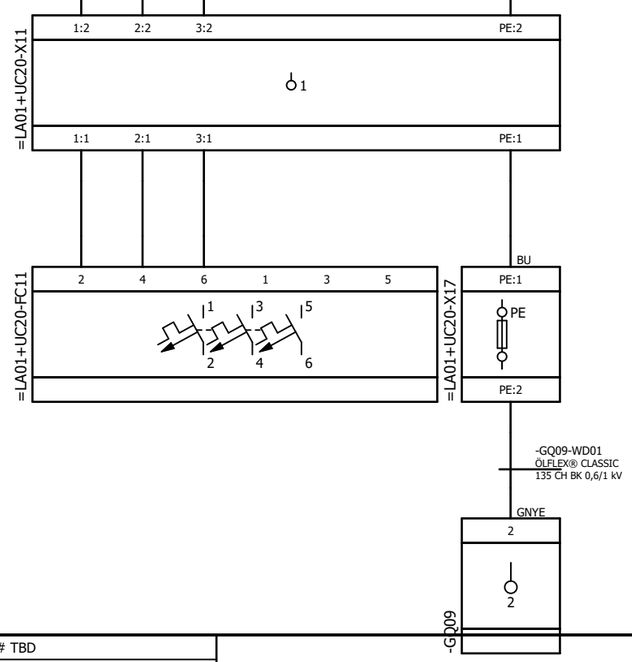
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-GQ06-WD01	Conductor	BK 1	BK 2	BK 3	GNYE
0,6/1 kV					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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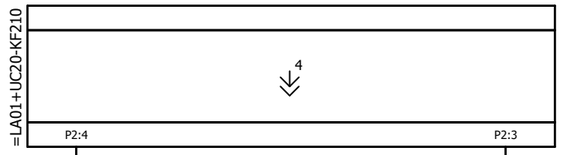
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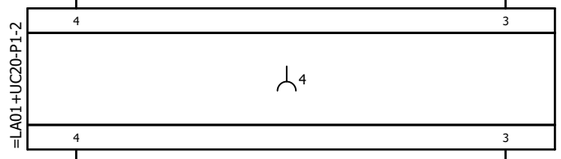
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ06-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 55 /

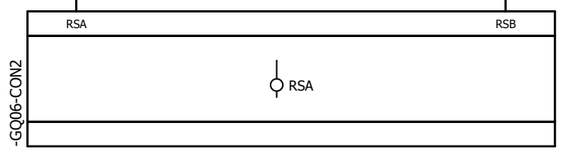
Cable connection diagram

Internal targets





=JA01+DA01-GQ06-WG01	Conductor	WH	BN	SH	WH	BU	YE	OG	OR
BUS CAN FD P									



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
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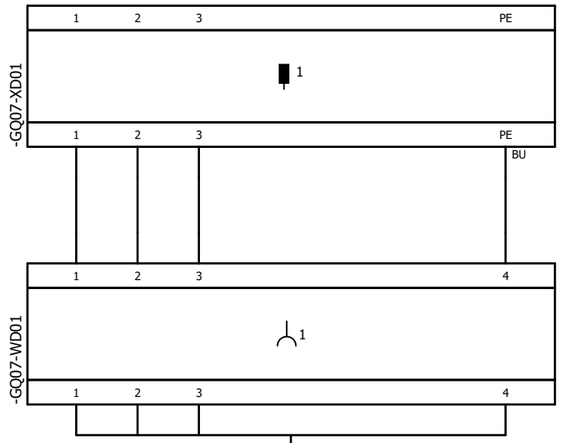
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ06-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 56 /

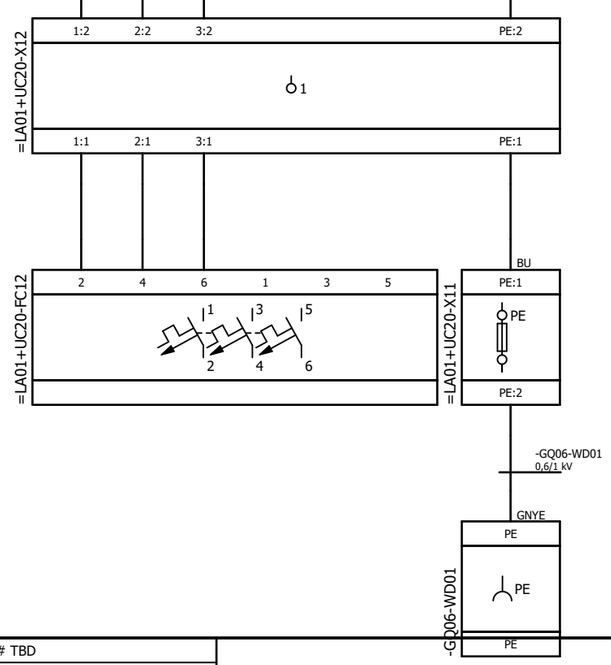
Cable connection diagram

Internal targets



=JA01+DA01-GQ07-WD01	Conductor	BK 1	BK 2	BK 3	GNYE
0,6/1 kV					

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
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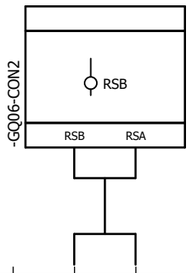
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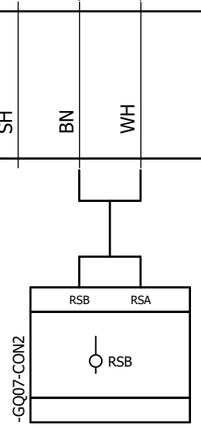
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ07-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 57 /

Cable connection diagram

Internal targets



=JA01+DA01-GQ07-WG01	Conductor	WH	BN	SH	BN	WH
BUS CAN FD P						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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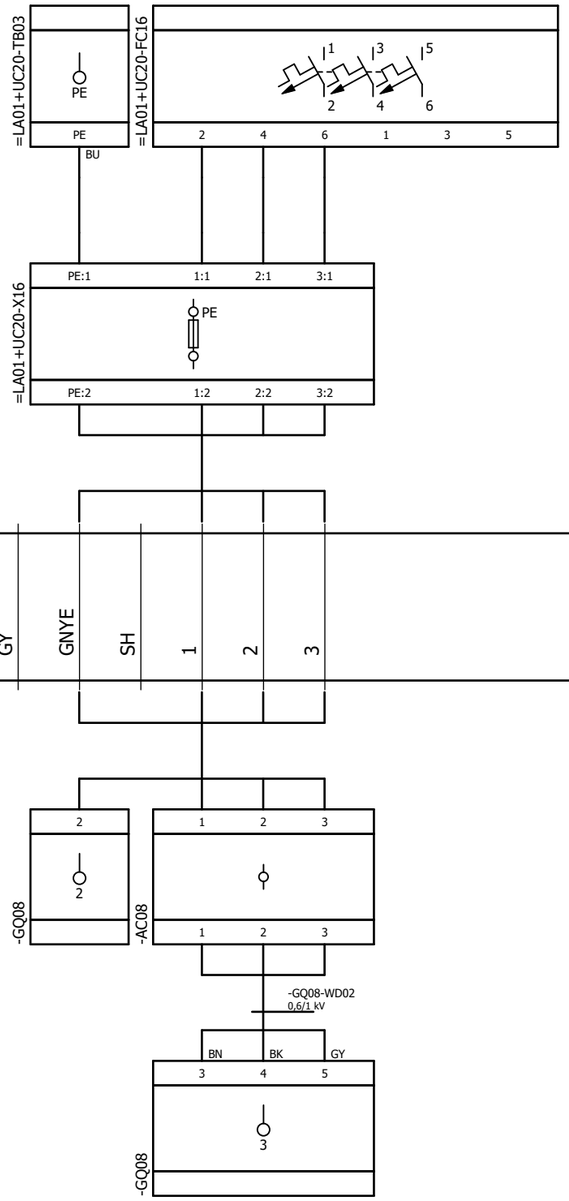
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ07-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 58 /

Cable connection diagram

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PBL 28-Mar-25

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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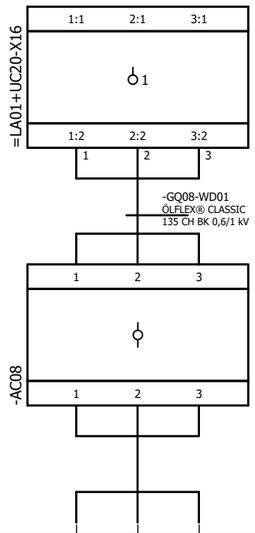
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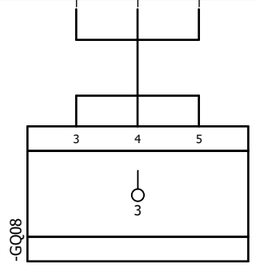
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ08-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 59 /

Cable connection diagram

Internal targets



=JA01+DA01-GQ08-WD02	Conductor	BN	BK	GY	GNYE	SH
0,6/1 kV						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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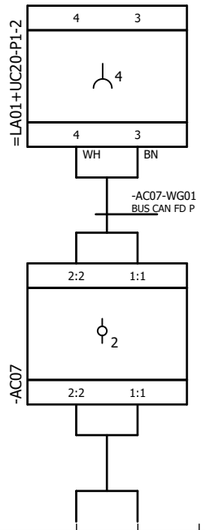
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 60 /

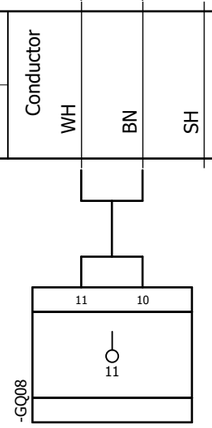
Cable connection diagram

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PBL 28-Mar-25

Internal targets



=JA01+DA01-GQ08-WG01	Conductor	WH	BN	SH



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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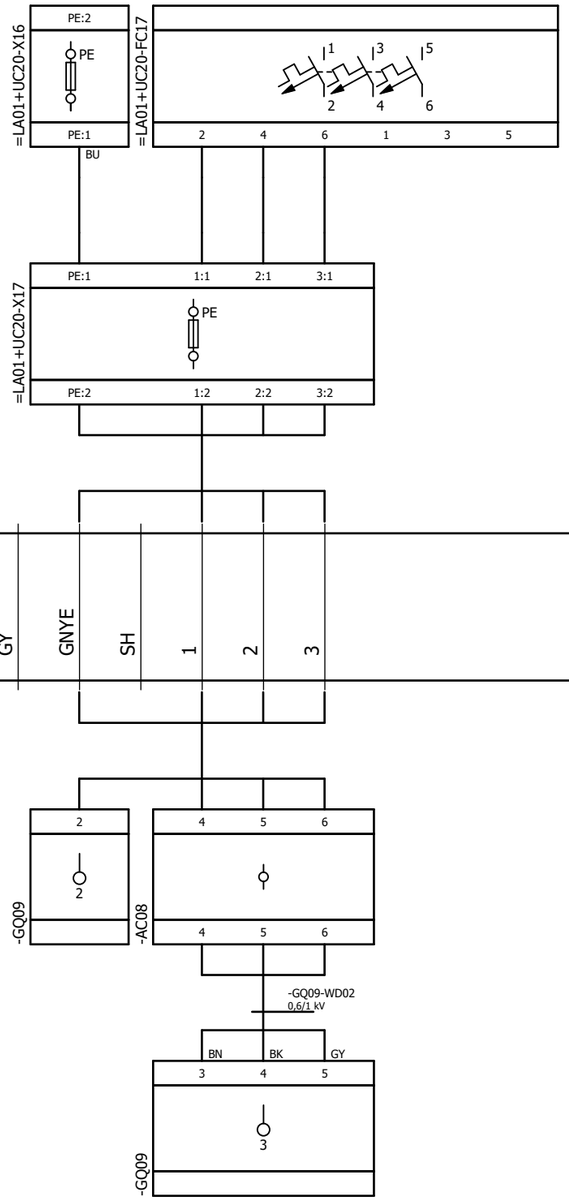
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ08-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 61 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DATE
28-Mar-25

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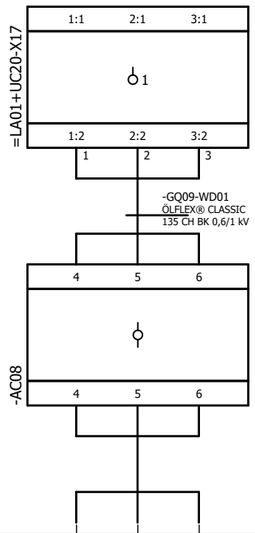
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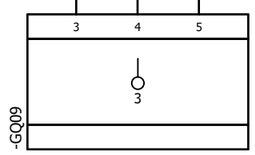
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ09-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 62 /

Cable connection diagram

Internal targets



=JA01+DA01-GQ09-WD02	Conductor	BN	BK	GY	GNYE	SH
0,6/1 kV						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
DATE
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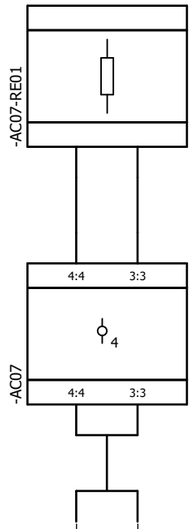
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ09-WD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 63 /

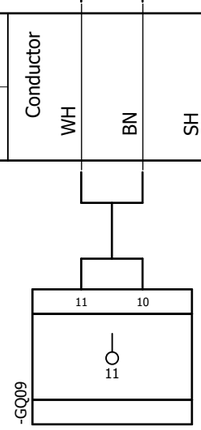
Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-GQ09-WG01	Conductor	WH	BN	SH



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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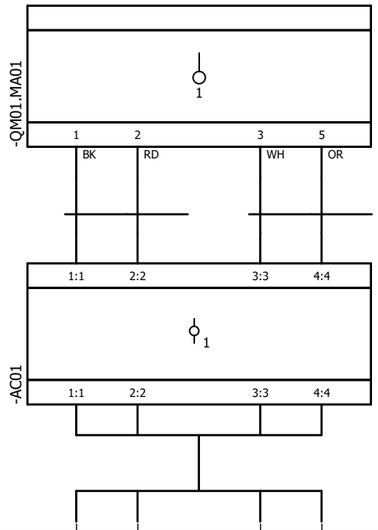
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-GQ09-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 64 /

Cable connection diagram

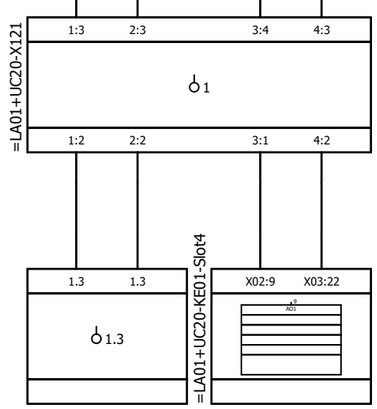
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-QM01-WD01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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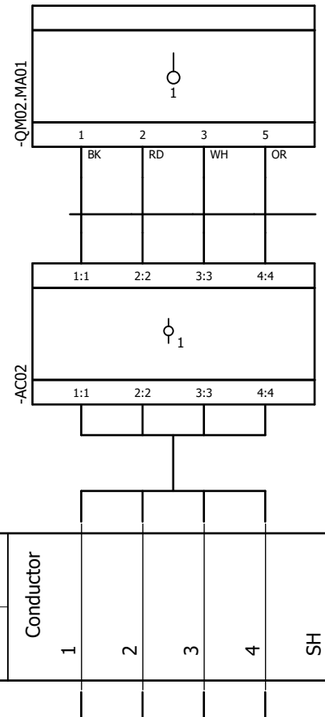
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-QM01-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 65 /

Cable connection diagram

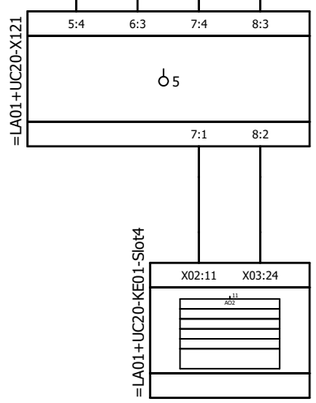
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-QM02-WD01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DESCRIPTION
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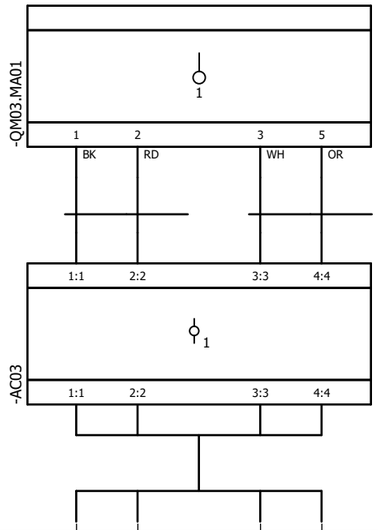
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-QM02-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 66 /

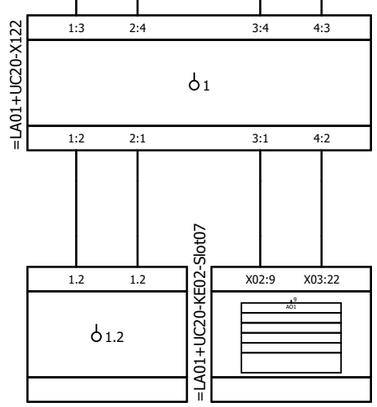
Cable connection diagram

Internal targets



=JA01+DA01-QM03-WD01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH						

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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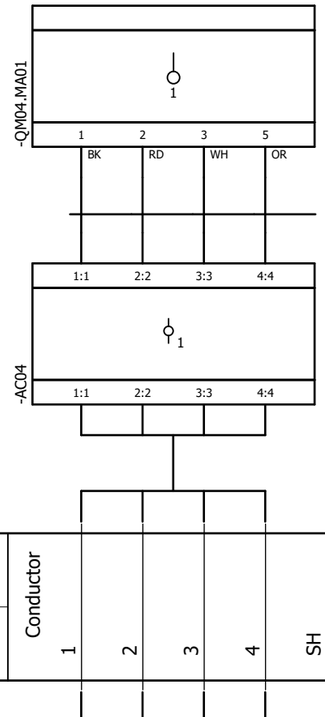
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-QM03-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 67 /

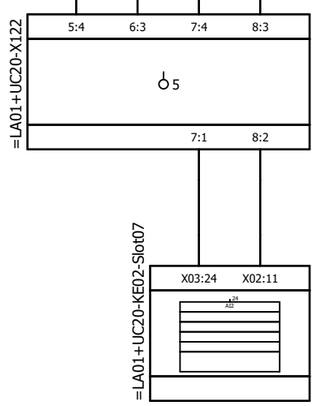
Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-QM04-WD01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH						



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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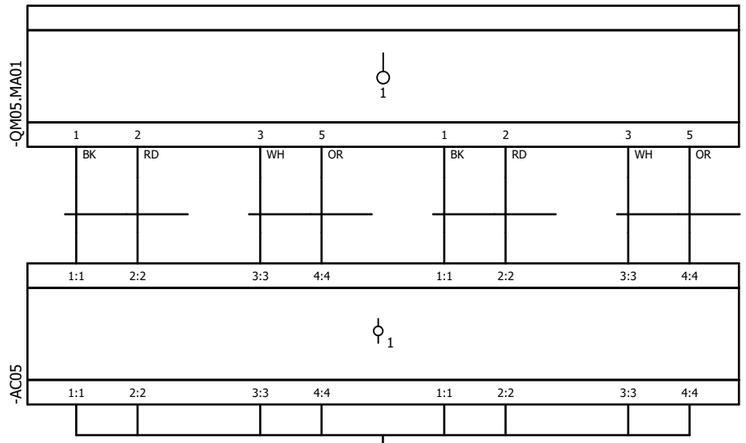
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-QM04-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 68 /

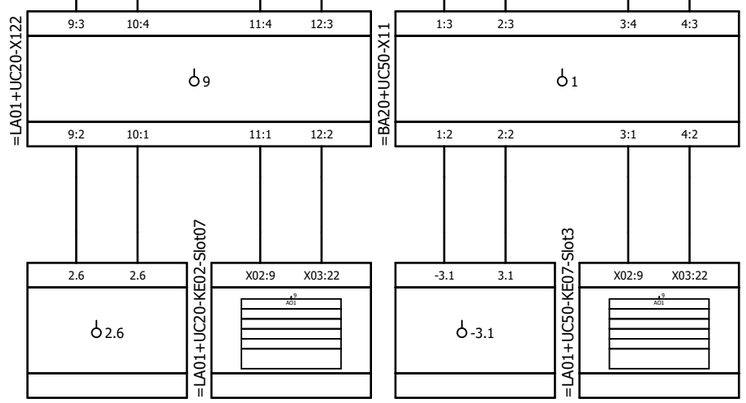
Cable connection diagram

Internal targets



=JA01+DA01-QM05-WD01	Conductor	1	2	3	4	SH	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH											

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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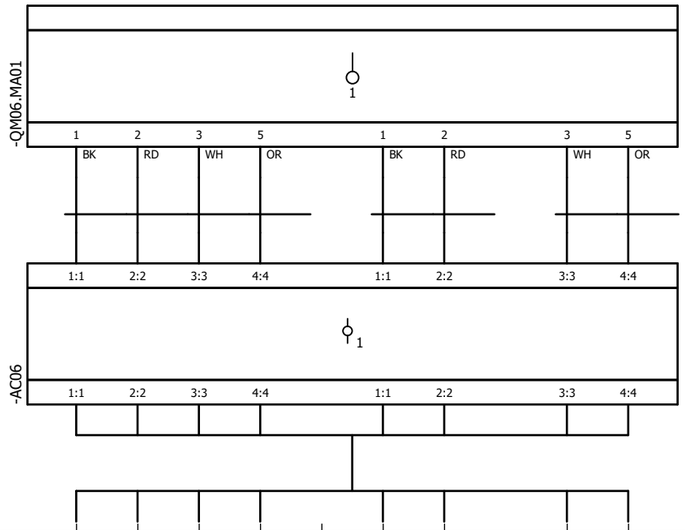
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =JA01+DA01-QM05-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 69 /

Cable connection diagram

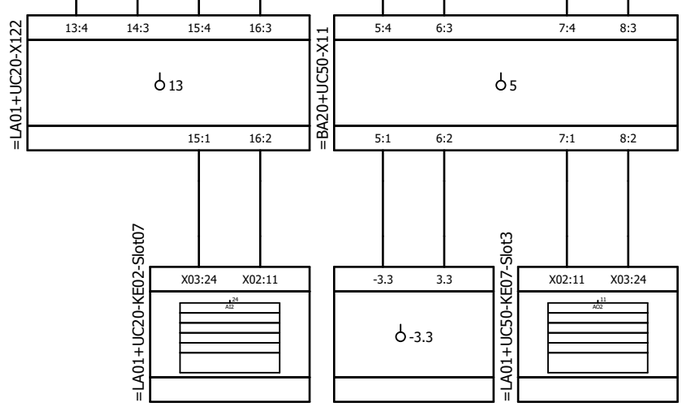
F07_001
PBL 28-Mar-25

Internal targets



=JA01+DA01-QM06-WD01	Conductor	1	2	3	4	SH	1	2	3	4	SH
ÖLFLEX® CLASSIC 135 CH											

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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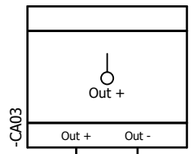
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DRAWING TITLE			
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 70 /

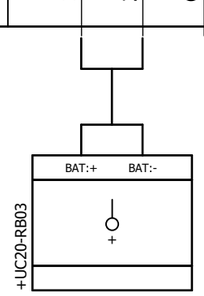
Cable connection diagram

F07_001
PBL 16-Oct-24

Internal targets



=LA01+DA01-RB03-WD01	Conductor	1	2	GNYE	SH
ÖLFLEX® CLASSIC 110 CH					



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =LA01+DA01-RB03-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 72 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets

=LA01+UC20-KE03-WG01	Conductor	WHBU	BU	WHOG	OG	WHGN	GN	WHBN	BN	SH
Profinet 4pair cabling Cat.6A FRNC flexi										

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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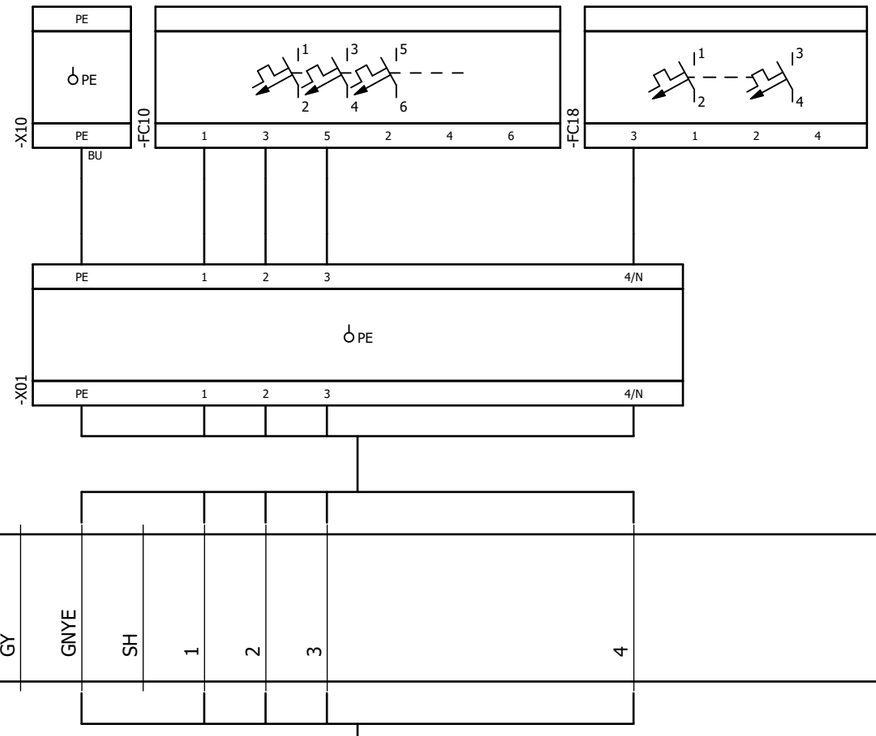
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =LA01+UC20-KE03-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 73 /

0	1	2	3	4	5	6	7	8

Cable connection diagram

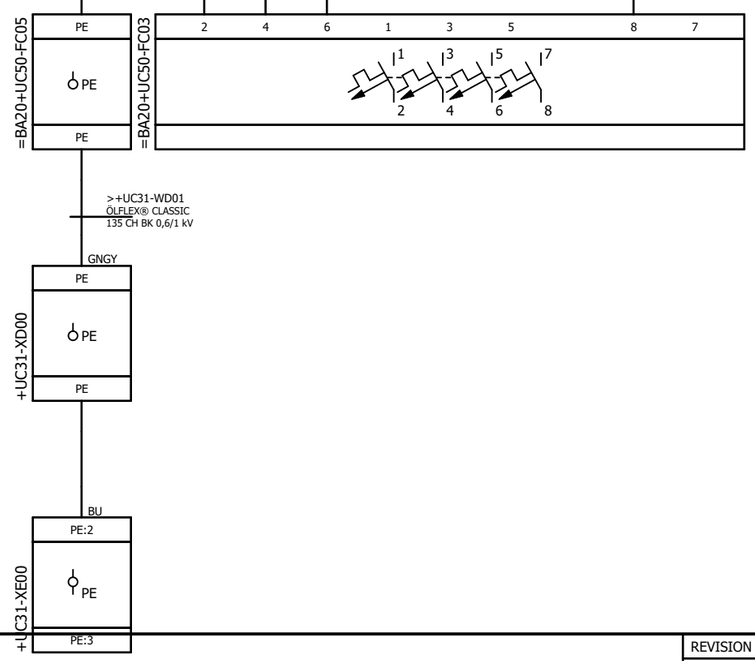
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Internal targets



=LA01+UC20-WD01	Conductor	BU	BN	BK	GY	GNYE	SH	1	2	3	4
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV											

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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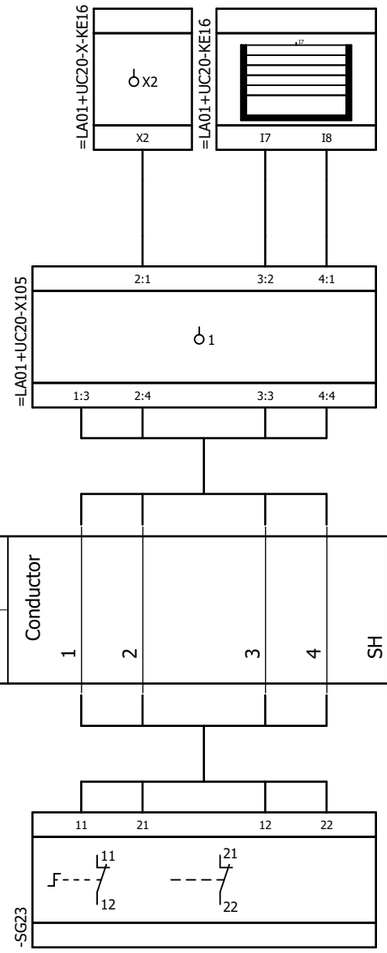
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =LA01+UC20-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 76 /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets



=LB02+DA01-SG23-WG01	Conductor	1	2	3	4	SH
ÖLFLEX® CLASSIC 110 CH						

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
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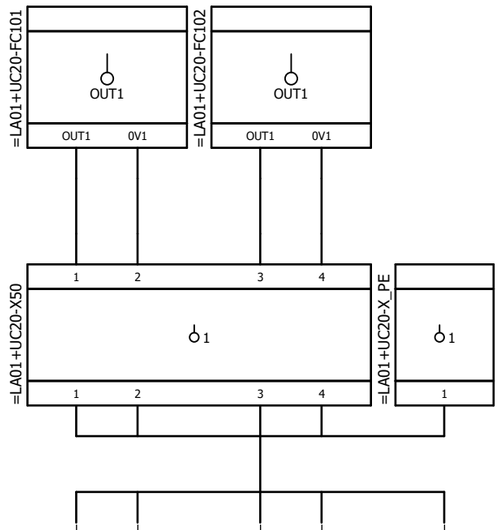
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =LB02+DA01-SG23-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 77 /

Cable connection diagram

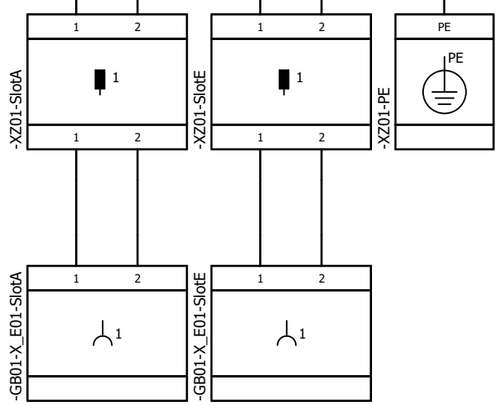
F07_001
PBL 15-Oct-24

Internal targets



=RE01+GB01-GB01-WD05	Conductor	1	2	3	4	GNYE	SH
CLASSIC 110 CH							

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
15-Oct-24

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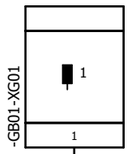
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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB01-GB01-WD05		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 78 /

Cable connection diagram

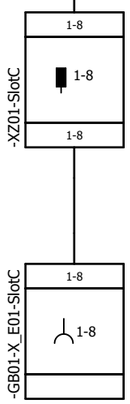
F07_001
PBL 15-Oct-24

Internal targets



=RE01+GB01-GB01-WG01	Conductor	WHBU	BU	WHOG	OG	WHGN	GN	WHBN	BN	SH
Cat.6A PUR										

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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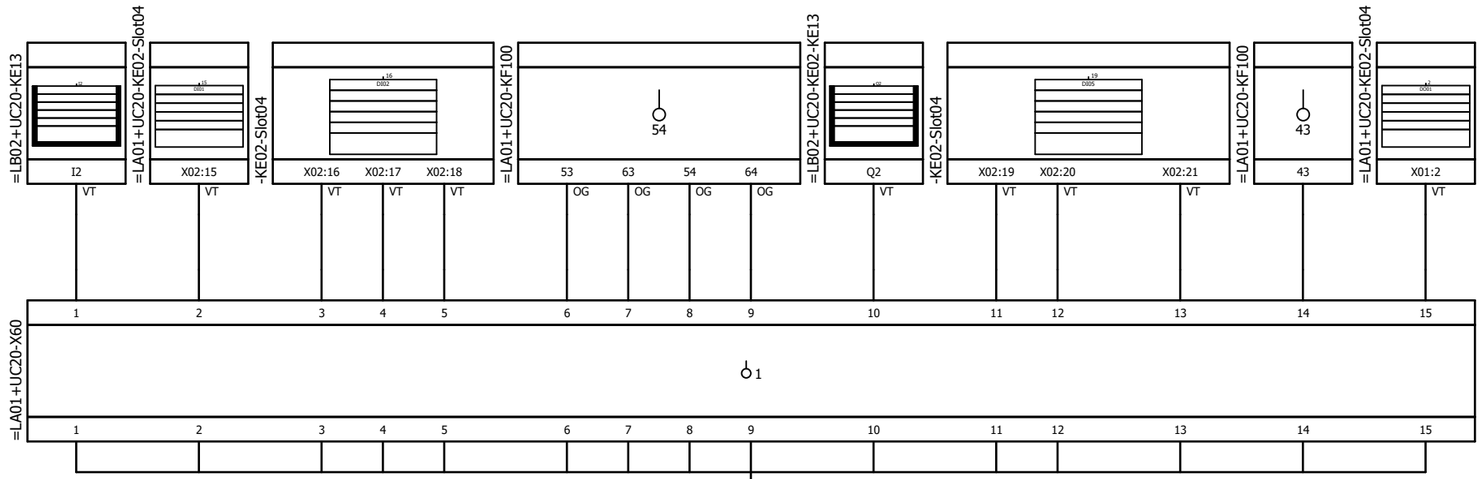
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB01-GB01-WG01		
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Cable connection diagram

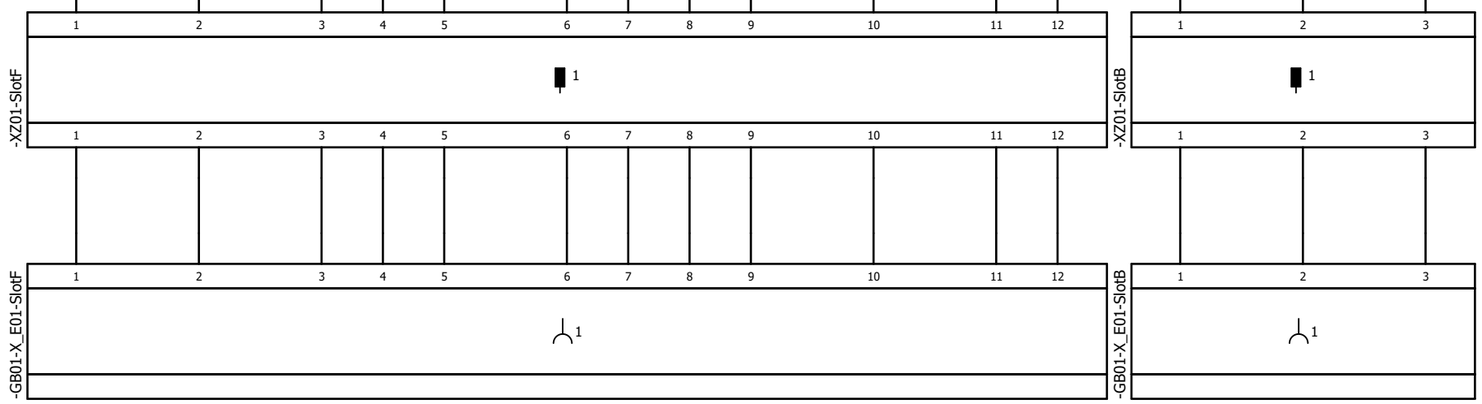
F07_001
PBL 15-Oct-24

Internal targets



=RE01+GB01-GB01-WG02	Conductor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	GNYE	SH	1	2	3	4	5
ÖLFLEX® CLASSIC 110 CH																									

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB01-GB01-WG02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 80 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets

=RE01+GB01-GB01-WG02	Conductor	6	7	8	9	10	11	12	13	14	15	16	17	GNYE	SH
ÖLFLEX® CLASSIC 110 CH															

External targets

Reference Item Number	Ballard Part # TBD		
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EPLAN Revision	06		
EPLAN Project Pages	628		
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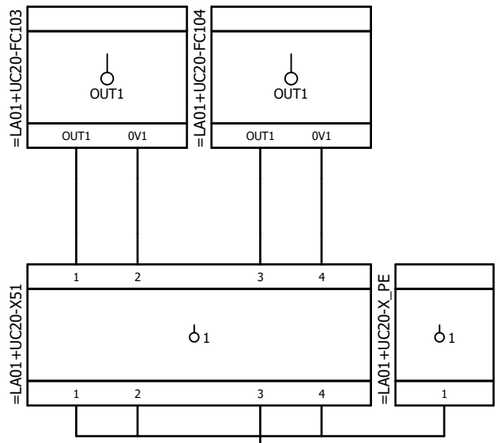
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB01-GB01-WG02		
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Cable connection diagram

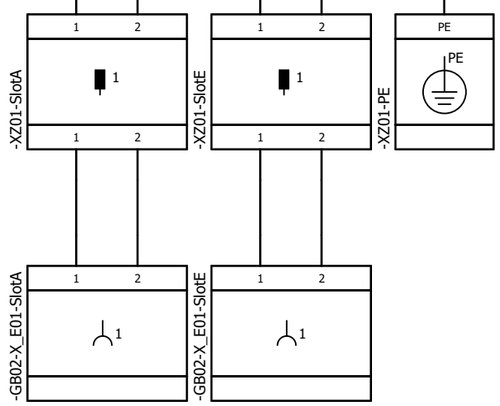
F07_001
PBL 15-Oct-24

Internal targets



=RE01+GB02-GB02-WD05	Conductor	1	2	3	4	GNYE	SH
CLASSIC 110 CH							

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
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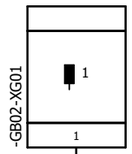
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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-GB02-WD05		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 81 /

Cable connection diagram

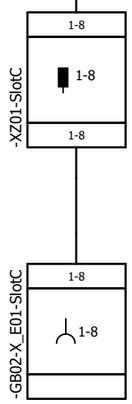
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Internal targets



=RE01+GB02-GB02-WG01	Conductor	WHBU	BU	WHOG	OG	WHGN	GN	WHBN	BN	SH
Cat.6A PUR										

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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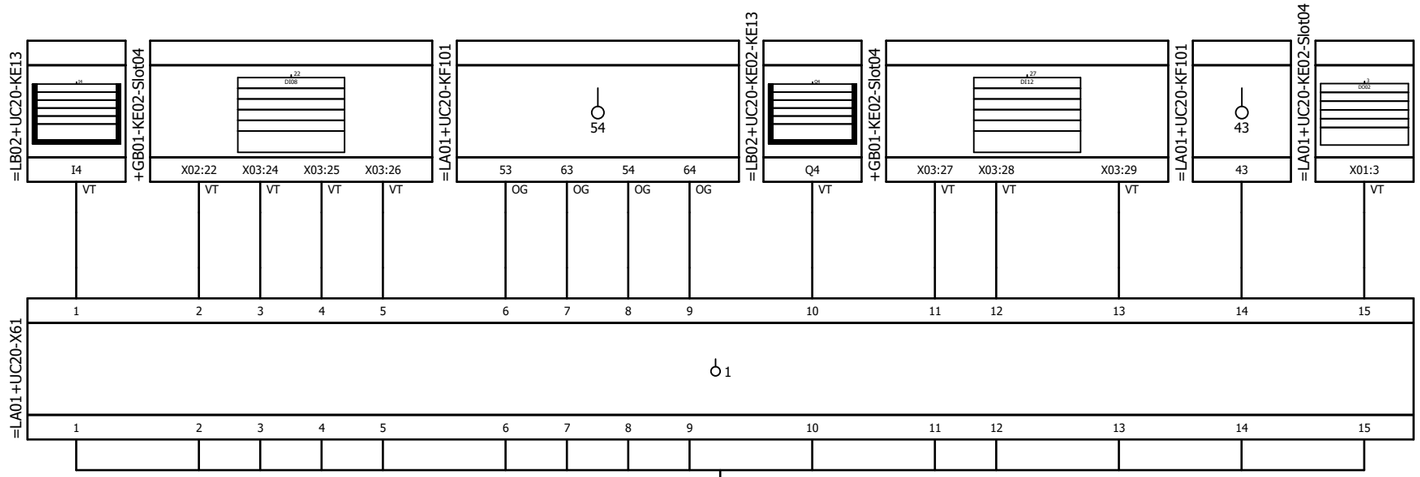
DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-GB02-WG01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 82 /

FRM5103656/0B

Cable connection diagram

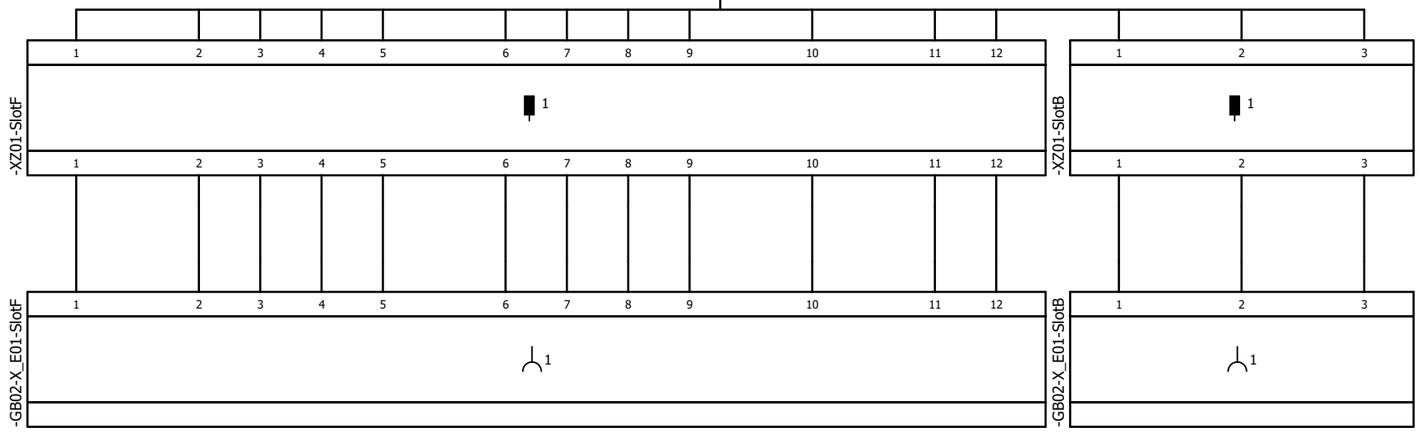
F07_001
PBL 15-Oct-24

Internal targets



=RE01+GB02-GB02-WG02	Conductor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	GNYE	SH	1	2	3	4	5	6
ÖLFLEX® CLASSIC 110 CH																										

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-GB02-WG02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 83 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets

=RE01+GB02-GB02-WG02	Conductor	7	8	9	10	11	12	13	14	15	16	17	GNYE	SH
ÖLFLEX® CLASSIC 110 CH														

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-GB02-WG02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 83.a /

Cable connection diagram

F07_001
PBL 28-Mar-25

Internal targets

=BA01+UC02-X02
1
1

=RE01+GB02-WD01	Conductor	BK	SH
ÖLFLEX® FD 90 CP			

External targets

-XB01
1
1
1

-GB02-X_HV
1:A+
1

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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DRAWING	601456B UC20 40ft Control Cabinet	REVISION	06
DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-WD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 84 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets

=BA01+UC02-X02
2
2

=RE01+GB02-WD02	Conductor	
ÖLFLEX® FD 90 CP	BK	SH

External targets

-XB02
1
1
1

-GB02-X_HV
3
3

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-WD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 85 /

Cable connection diagram

F07_001
PBL 15-Oct-24

Internal targets

=BA01+UC02-X02
3
3

=RE01+GB02-WD03	Conductor	BK	SH
ÖLFLEX® FD 90 CP			

External targets

-XB03
1
1
1

-GB02-X_HV
2
2

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-WD03		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 86 /

Cable connection diagram

Internal targets

=BA01+UC02-X02
4
4

=RE01+GB02-WD04	Conductor	BK	SH
ÖLFLEX® FD 90 CP			

External targets

-XB04
1
1
1

-GB02-X_HV
4
4

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC20	& D01

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DRAWING TITLE			
SHEET TYPE/DESC	Cable-connection diagram =RE01+GB02-WD04		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 87 /

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue

Document Title:	**BLPH Project - Panel Cabinet Layout: UC30 Coolant Skid Control Cabinet**
Document Number:	K559-2254-CWIWP4202202-E03-003
Revision:	Rev001
Sequence Number:	003
File Name:	K559-2254-CWIWP4202202-E03-003Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

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+UC30

Ballard Power Systems Europe - Technology Solutions

Cabinet: Coolant Skid Control Cabinet
Location: Coolant Skid, Middle

Cabinet Supply:
- Vin = 400VAC, 3P+N+PE
- IKmax = 10kA
- I max = 160A
- IP 55x

Control circuit
- AC 230V
- DC 24V

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- 1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	Black (BK)
AC Phase L1	Brown (BN)
AC Phase L2	Black (BK)
AC Phase L3	Grey (GY)
AC Neutral	Light Blue (BU)
Externally supplied circuit	Orange (OG)

DC Wiring Colors

DC Power Circuit	Black (BK)
DC Control Voltage (24V)	Dark Blue (BU)
DC Control Voltage Refence (0V)	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	White (WH)
Signal Wire (AI, AO)	Violet (VT)
Externally supplied circuit	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	Green/Yellow (GNYE)

Conductor Colour Identification

IEC 60757:1983 Designation	Description
BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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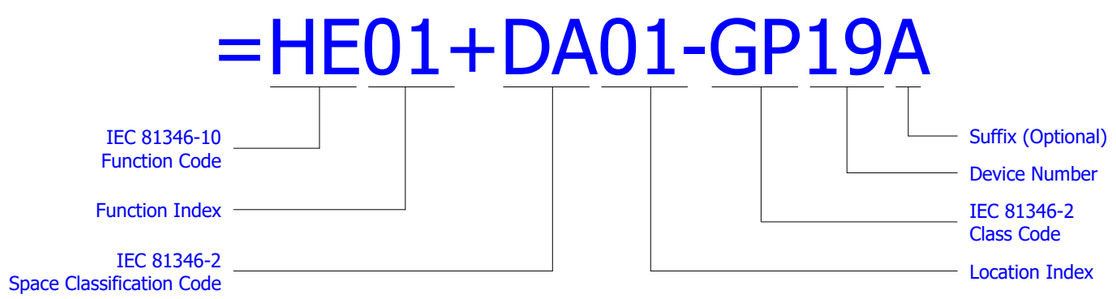
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ + UC30 & A01

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

FRM5103656/0B

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	UC30	1	Front Page	05-Jun-24
	UC30	2	Standard Wire Colors	05-Jun-24
	UC30	3	Tagging Standard	05-Jun-24
	UC30	4	Table of contents : +UC30&A01/1 - +UC30&C03/342	05-Jun-24
	UC30	4.a	Table of contents : +UC30&C03/350 - +UC30&C04/9	05-Jun-24
	UC30	4.b	Table of contents : +UC30&C04/10 - +UC30&C04/37	05-Jun-24
	UC30	1	Controller IO Overview Introduction	05-Jun-24
	UC30	10	Container Controller, Coolant Rack 1/4	05-Jun-24
	UC30	11	Container Controller, Coolant Rack 2/4	05-Jun-24
	UC30	12	Container Controller, Coolant Rack 3/4	05-Jun-24
	UC30	13	Container Controller, Coolant Rack 4/4	05-Jun-24
	UC30	1	Multiline Documentation Intro	05-Jun-24
	UC30	300	40ft Coolant Skid - Control Cabinet Supply	05-Jun-24
	UC30	301	40ft Coolant Skid - HT pump supply	05-Jun-24
	UC30	302	40ft Coolant Skid - Cabinet light and heater	05-Jun-24
	UC30	308	40ft Coolant skid - 24 VDC Supply	05-Jun-24
	UC30	308B	40ft Coolant skid - 24 VDC Supply - Back up battery	05-Jun-24
	UC30	309	40ft Coolant skid - 24 VDC Supply - fuses	05-Jun-24
	UC30	310	40ft Coolant skid - 24 VDC Supply - Distribution	05-Jun-24
	UC30	311	40ft Coolant skid - 24 VDC Supply - Distribution	05-Jun-24
	UC30	314	40ft Coolant skid - MCCB Trip Indication 24V	05-Jun-24
	UC30	315	40ft Coolant skid - MCCB Trip Indication HT1+2	05-Jun-24
	UC30	320	40ft Coolant Skid - Safety circuit	05-Jun-24
	UC30	321	40ft Coolant Skid - Safety circuit	05-Jun-24
	UC30	340	40ft Coolant Skid - HT #1 Sensors	05-Jun-24
	UC30	341	40ft Coolant Skid - HT #1 Coolant Pump	05-Jun-24
	UC30	341B	40ft Coolant Skid - HT #1 Coolant Pump VFD Interface	05-Jun-24
	UC30	342	40ft Coolant Skid - HT #1 Mixing Valves	05-Jun-24

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	UC30	351	40ft Coolant Skid - HT #2 Coolant Pump	05-Jun-24
	UC30	351B	40ft Coolant Skid - HT #2 Coolant Pump VFD Interface	05-Jun-24
	UC30	352	40ft Coolant Skid - HT #2 Mixing Valves	05-Jun-24
	UC30	355	40ft Coolant Skid - LT Header Tank	05-Jun-24
	UC30	356	40ft Coolant Skid - Exterior Temperature	05-Jun-24
	UC30	360	40ft Coolant Skid - HT Cooler #1 Fan Power 1/2	05-Jun-24
	UC30	361	40ft Coolant Skid - HT Cooler #1 Fan Power 2/2	05-Jun-24
	UC30	362	40ft Coolant Skid - HT Cooler #2 Fan Power 1/2	05-Jun-24
	UC30	363	40ft Coolant Skid - HT Cooler #2 Fan Power 2/2	05-Jun-24
	UC30	364	40ft Coolant Skid - LT Cooler Fan Power	05-Jun-24
	UC30	365	40ft Coolant Skid - VFD Cabinet Airconditioning	05-Jun-24
	UC30	368	40ft Coolant Skid - Hydrogen Heater Power	05-Jun-24
	UC30	369	40ft Coolant Skid - Hydrogen Heater Control	05-Jun-24
	UC30	370	40ft Coolant Skid - Hydrogen Heater Control Level	05-Jun-24
	UC30	371	40ft Coolant Skid - Hydrogen Heater Control Temperature	05-Jun-24
	UC30	372	40ft Coolant Skid - Hydrogen Manifold pressure	05-Jun-24
	UC30	500	40ft Coolant Skid - Newtwork switch	05-Jun-24
	UC30	501	40ft Coolant Skid - Secomea	05-Jun-24
	UC30	1	Panel Documentation and Layout	05-Jun-24
	UC30	2	Terminal-strip overview : =LA01+UC30-14 - =LB02+UC30-XD03	05-Jun-24
	UC30	3	Terminal-connection diagram =LA01+UC30-14	05-Jun-24
	UC30	4	Terminal-connection diagram =LA01+UC30-X1	05-Jun-24
	UC30	5	Terminal-connection diagram =LA01+UC30-X02	05-Jun-24
	UC30	6	Terminal-connection diagram =LA01+UC30-X11	05-Jun-24
	UC30	7	Terminal-connection diagram =LA01+UC30-X12	05-Jun-24
	UC30	8	Terminal-connection diagram =LA01+UC30-X13	05-Jun-24
	UC30	9	Terminal-connection diagram =LA01+UC30-X15	05-Jun-24

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ | + UC30 | & A01

REVISION INFORMATION	
DESCRIPTION	
DATE	05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Table of contents : +UC30&C03/350 - +UC30&C04/9		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4.a /

Table of Contents

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Higher-Level Function	Mounting Location	Page	Page Description	Last Modified Date
	UC30	10	Terminal-connection diagram =LA01+UC30-X16	05-Jun-24
	UC30	11	Terminal-connection diagram =LA01+UC30-X21	05-Jun-24
	UC30	12	Terminal-connection diagram =LA01+UC30-X22	05-Jun-24
	UC30	13	Terminal-connection diagram =LA01+UC30-X23	05-Jun-24
	UC30	14	Terminal-connection diagram =LA01+UC30-X24	05-Jun-24
	UC30	15	Terminal-connection diagram =LA01+UC30-X25	05-Jun-24
	UC30	16	Terminal-connection diagram =LA01+UC30-X26	05-Jun-24
	UC30	17	Terminal-connection diagram =LA01+UC30-X31	05-Jun-24
	UC30	18	Terminal-connection diagram =LA01+UC30-X40	05-Jun-24
	UC30	19	Terminal-connection diagram =LA01+UC30-X41	05-Jun-24
	UC30	20	Terminal-connection diagram =LA01+UC30-X42	05-Jun-24
	UC30	21	Terminal-connection diagram =LA01+UC30-X100	05-Jun-24
	UC30	22	Terminal-connection diagram =LA01+UC30-X110	05-Jun-24
	UC30	23	Terminal-connection diagram =LA01+UC30-X111	05-Jun-24
	UC30	24	Terminal-connection diagram =LA01+UC30-X112	05-Jun-24
	UC30	25	Terminal-connection diagram =LA01+UC30-X113	05-Jun-24
	UC30	26	Terminal-connection diagram =LA01+UC30-X114	05-Jun-24
	UC30	27	Terminal-connection diagram =LA01+UC30-X115	05-Jun-24
	UC30	28	Terminal-connection diagram =LA01+UC30-X201	05-Jun-24
	UC30	29	Terminal-connection diagram =LA01+UC30-X201-	05-Jun-24
	UC30	30	Terminal-connection diagram =LA01+UC30-X202	05-Jun-24
	UC30	31	Terminal-connection diagram =LA01+UC30-X202	05-Jun-24
	UC30	32	Terminal-connection diagram =LA01+UC30-X203	05-Jun-24
	UC30	33	Terminal-connection diagram =LA01+UC30-X203-	05-Jun-24
	UC30	34	Terminal-connection diagram =LA01+UC30-X204	05-Jun-24
	UC30	35	Terminal-connection diagram =LA01+UC30-X204-	05-Jun-24
	UC30	36	Terminal-connection diagram =LA01+UC30-X206	05-Jun-24
	UC30	37	Terminal-connection diagram =LB02+UC30-XD03	05-Jun-24

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ | + UC30 | & A01

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Table of contents : +UC30&C04/10 - +UC30&C04/37		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4.b /

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Ballard Power Systems Europe - Technology Solutions

Controller IO Overview Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Controller IO Overview Introduction		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC30-KE04
DEIF AMC300
Controller Extension Rack

-Slot1
DEIF PSM3.2
Power Supply Module 3.2

PSM3.2

	PE PE		Frame Ground	
	1 12-24V		Supply +	
	2 0V		Supply COM	
	3 R1 COM		Status OK Relay COM	
A52.4	4 DO1	DO1	Status OK Relay	
	5 R2 COM		Relay 2 COM	
A52.5	6 DO2	DO2	Relay 1 Out	
	7 R3 COM		Relay 3 COM	
A52.6	8 DO3	DO3	Relay 3 Out	

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.4:E X03 — Ethernet-1 IN

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.4:E X03 — Ethernet-2 OUT

Bus Follower
Multi-line 300

-Slot2
ACM3.1
Alternating Current Module 3.1

ACM3.1

1 L1			Source - L1
2 L2			Source - L2
3 L3			Source - L3
4 N			Source - N
5 L1	BA20-UC30-L1		Coolant Skid Supply Voltage - L1
6 L2	BA20-UC30-L2		Coolant Skid Supply Voltage - L2
7 L3	BA20-UC30-L3		Coolant Skid Supply Voltage - L3
8 N	BA20-UC30-N		Coolant Skid Supply Voltage - N
9 L1-S1	=BA20+UC30-BC01		Current transformer L1 - S1
10 L1-S2	CH1-S2		Channel 1 - S2
11 L2-S1	=BA20+UC30-BC02		Current transformer L2 - S1
12 L2-S2	CH2-S2		Channel 2 - S2
13 L3-S1	=BA20+UC30-BC03		Current transformer L3 - S1
14 L3-S2	CH3-S2		Channel 3 - S2
15 4-S1	CH4-S1		Channel 4 - S1
16 4-S2	CH4-S2		Channel 4 - S2

-Slot3
&C03/340.4
&C03/350.4
IOM3.2
IO Module 3.2

IOM3.2

1 R1 COM			Relay 1 In
2 DO1			Relay 1 out
3 R2 COM			Relay 2 COM
4 DO2			Relay 2 Out
5 R3 COM			Relay 3 In
6 DO3			Relay 3 Out
7 R4 COM			Relay 4 In
8 DO4			Relay 4 Out
9 AO1			Spare
10 AO1 COM			AO1 COM
11 AO2			Spare
12 AO2 COM			AO2 COM
13 AO3			Spare
14 AO3 COM			AO3 COM
15 AO4			Spare
16 AO4 COM			AO4 COM
17 DI1		IAH_FC4X	Fuse trip indication H2 Heat
18 DI2			Spare
19 DI3			Spare
20 DI4			Spare
21 DI1-4 COM			DI1-4 COM
22 AI1			HT1 Coolant Flow
23 AI1 COM			AI1 COM
24 AI2	&C03/340.4	HE01_BL01_LT	HT1 Level header tank
25 AI2 COM	&C03/340.4		AI2 COM
26 AI3			HT2 Coolant Flow
27 AI3 COM			AI3 COM
28 AI4	&C03/350.4	HE02_BL01_LT	HT2 Header Tank Level
29 AI4 COM	&C03/350.4		AI4 COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 1/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30-KE04

DEIF AMC300
Controller Extension Rack

-Slot4

&C03/342.3
&C03/352.3
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM			Relay 1 In
2	DO1			Spare
3	R2 COM			Relay 2 COM
4	DO2			Spare
5	R3 COM			Relay 3 In
6	DO3			Relay 3 Out
7	R4 COM			Relay 4 In
8	DO4			Relay 4 Out
9	AO1	&C03/342.3	HE01_QN01_SP	HT1 Bypass Valve Setpoint
10	AO1 COM	&C03/342.3		AO1 COM
11	AO2	&C03/342.6	HE01_QN02_SP	HT1 Cooler Valve Setpoint
12	AO2 COM	&C03/342.6		AO2 COM
13	AO3	&C03/352.3	HE02_QN01_SP	HT2 Bypass Valve Setpoint
14	AO3 COM	&C03/352.3		AO3 COM
15	AO4	&C03/352.6	HE02_QN02_SP	HT2 Cooler Valve Setpoint
16	AO4 COM	&C03/352.6		AO4 COM
17	DI1			Spare
18	DI2			Spare
19	DI3			Spare
20	DI4			Spare
21	DI1-4 COM			DI1-4 COM
22	AI1	&C03/342.4	HE01_QN01_FB	HT1 Bypass Valve Feedback
23	AI1 COM	&C03/342.4		AI1 COM
24	AI2	&C03/342.7	HE01_QN02_FB	HT1 Cooler Valve Feedback
25	AI2 COM	&C03/342.8		AI2 COM
26	AI3	&C03/352.4	HE02_QN01_FB	HT2 Bypass Valve Feedback
27	AI3 COM	&C03/352.4		AI3 COM
28	AI4	&C03/352.7	HE02_QN02_FB	HT2 Cooler Valve Feedback
29	AI4 COM	&C03/352.8		AI4 COM

-Slot5

&C03/340.3
&C03/340.1
&C03/340.6
&C03/350.3
&C03/350.1
&C03/350.6
&C03/355.4
&C03/356.1
IOM3.3
IO Module 3.3

IOM3.3

1	AI1			Spare
2	AI2	&C03/340.3	HE01_BF01_TT	Main HT Coolant Return Temperature
3	AI3	&C03/340.3		Spare
4	AI4			Spare
5	AI5	&C03/340.1	HE01_BF01_FT	HT1 Coolant Flow
6	AI6			Spare
7	AI7	&C03/340.6	HE01_BT05_TT	HT1 Cooling Tower Return Temperature
8	AI8	&C03/340.6		Spare
9	AI9	&C03/340.6		Spare
10	AI10	&C03/340.7	HE01_BT06_TT	HT1 Pump Inlet Temperature
11	AI11	&C03/340.7		Spare
12	AI12	&C03/340.8		Spare
13	AI13			Spare
14	AI14	&C03/350.3	HE02_BF01_TT	Main HT Coolant Return Temperature
15	AI15			Spare
16	AI16			Spare
17	AI17	&C03/350.1	HE02_BF01_FT	HT2 Coolant Flow
18	AI18			Spare
19	AI19	&C03/350.6	HE02_BT05_TT	HT2 Cooling Tower Return Temperature
20	AI20			Spare
21	AI21			Spare
22	AI22	&C03/350.7	HE02_BT06_TT	HT2 Pump Inlet Temperature
23	AI23			Spare
24	AI24			Spare
25	AI25	&C03/355.4	HE03_BL01_PT	LT Coolant System Header Tank Level
26	AI26			Spare
27	AI27	&C03/355.4		Spare
28	AI28	&C03/356.1	JA01_BT04_TT	Exterior Temperature
29	AI29	&C03/356.1		Spare
30	AI30	&C03/356.2		Spare

-Slot6

IOM3.4
IO Module 3.4

IOM3.4

1	12-24V		Supply +
2	DO01	HA01_EA01	Hydrogen Heater 1
3	DO02	HA01_EA02	Hydrogen Heater 2
4	DO03	DO03	Digital Out 03
5	DO04	DO04	Digital Out 04
6	DO05	DO05	Digital Out 05
7	DO06	DO06	Digital Out 06
8	DO07	DO07	Digital Out 07
9	DO08	DO08	Digital Out 08
10	DO09	DO09	Digital Out 09
11	DO10	DO10	Digital Out 10
12	DO11	DO11	Digital Out 11
13	DO12	DO12	Digital Out 12
14	COM		Supply COM
15	DI03	IAH_FC3X	Fuse Trip Indication HT2
16	DI02	IAH_FC20X	Fuse Trip Indication 24V
17	DI03	IAH_FC2X	Fuse Trip Indication HT1
18	DI04	IAH_FC1X	Fuse Trip Indication LT
19	DI05	JT_RB30_BAT	UPS Battery Operation
20	DI06	JT_RB30_RDY	UPS Battery Ready
21	DI07	JT_RB30_SOH	UPS Battery Low SOH
22	DI08	HA01_BL01	Hydrogen Heater Level Swich
23	COM		Supply COM
24	DI09	DI09	Digital In 09
25	DI10	DI10	Digital In 10
26	DI11	DI11	Digital In 11
27	DI12	DI12	Digital In 12
28	DI13	DI13	Digital In 13
29	DI14	DI14	Digital In 14
30	DI15	DI15	Digital In 15
31	DI16	DI16	Digital In 16
32	COM		Supply COM

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 2/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC30-KE05
DEIF AMC300
Controller Extension Rack

-Slot1
DEIF PSM3.2
Power Supply
Module 3.2

PSM3.2

	PE PE			Frame Ground
	1 12-24V			Supply +
	2 0V			Supply COM
	3 R1 COM			Status OK Relay COM
A52.4	4 DO1		DO1	Status OK Relay
	5 R2 COM			Relay 2 COM
A52.5	6 DO2		DO2	Relay 1 Out
	7 R3 COM			Relay 3 COM
A52.6	8 DO3		DO3	Relay 3 Out

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.5:E X03 — Ethernet-1 IN

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.6:E X03 — Ethernet-2 OUT

Bus Slave
Multi-line 300

-Slot2
&C03/371.4
&C03/371.4
IOM3.3
IO Module 3.3

IOM3.3

1 AI1			Spare
2 AI2		=DA01+DA02+BP01	Hydrogen Inlet Pressure
3 AI3			Spare
4 AI4	&C03/371.4	HE01_DA02_BT01	Hydrogen heater temperature
5 AI5	&C03/371.4		Spare
6 AI6			Spare
7 AI7			Spare
8 AI3			Spare
9 AI9			Spare
10 AI10			Spare
11 AI11			Spare
12 AI12			Spare
13 AI13			Spare
14 AI14			Spare
15 AI15			Spare
16 AI16			Spare
17 AI17			Spare
18 AI18			Spare
19 AI19			Spare
20 AI20			Spare
21 AI21			Spare
22 AI22			Spare
23 AI23			Spare
24 AI24			Spare
25 AI25			Spare
26 AI26			Spare
27 AI27			Spare
28 AI28			Spare
29 AI29			Spare
30 AI30			Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C02

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 3/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 12 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC40-KE04
DEIF AMC300
Controller Extension Rack

Reserved

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C02

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 4/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 / 18

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Ballard Power Systems Europe - Technology Solutions

Multiline Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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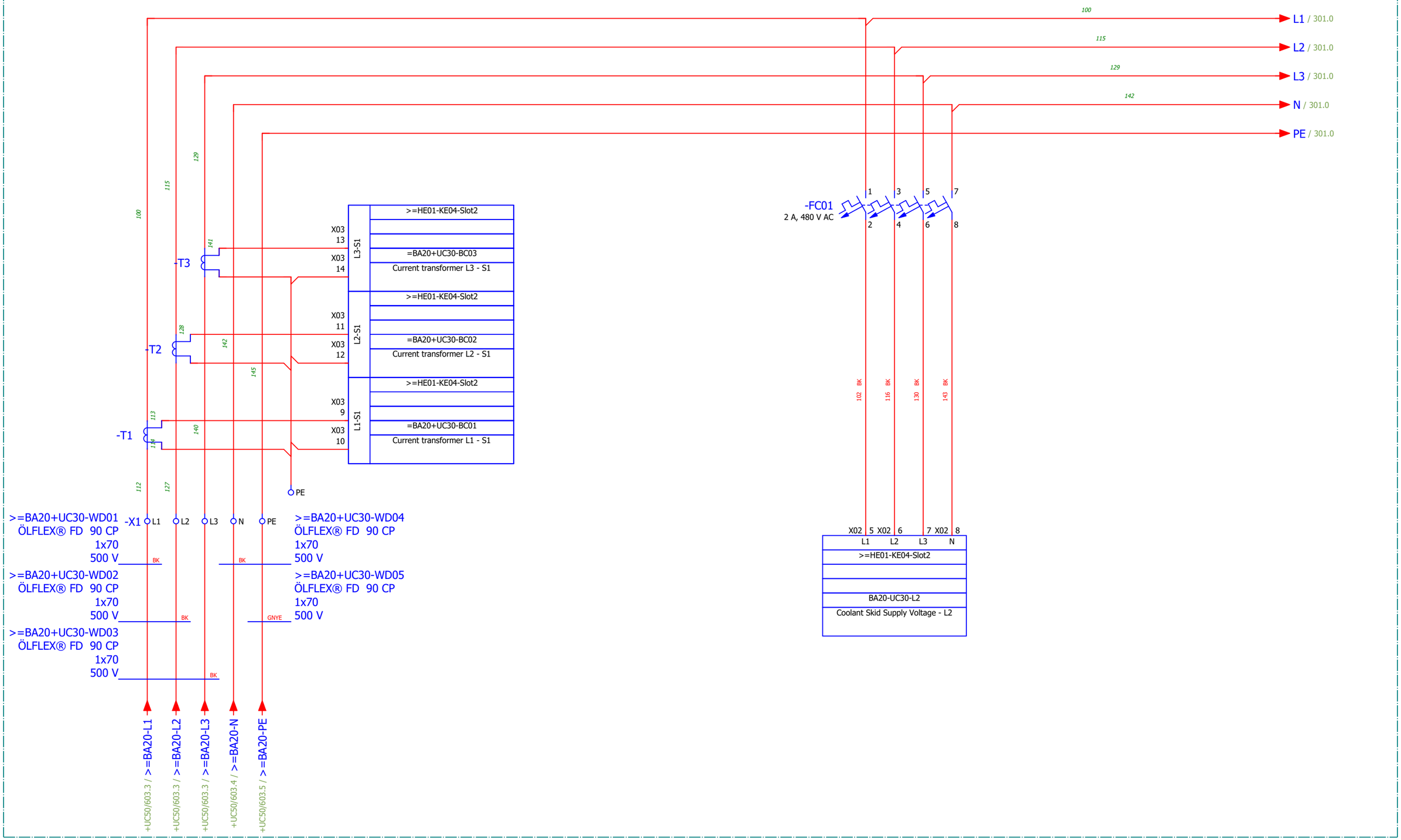
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Multiline Documentation Intro		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

Power conversion BOP Cooling skid cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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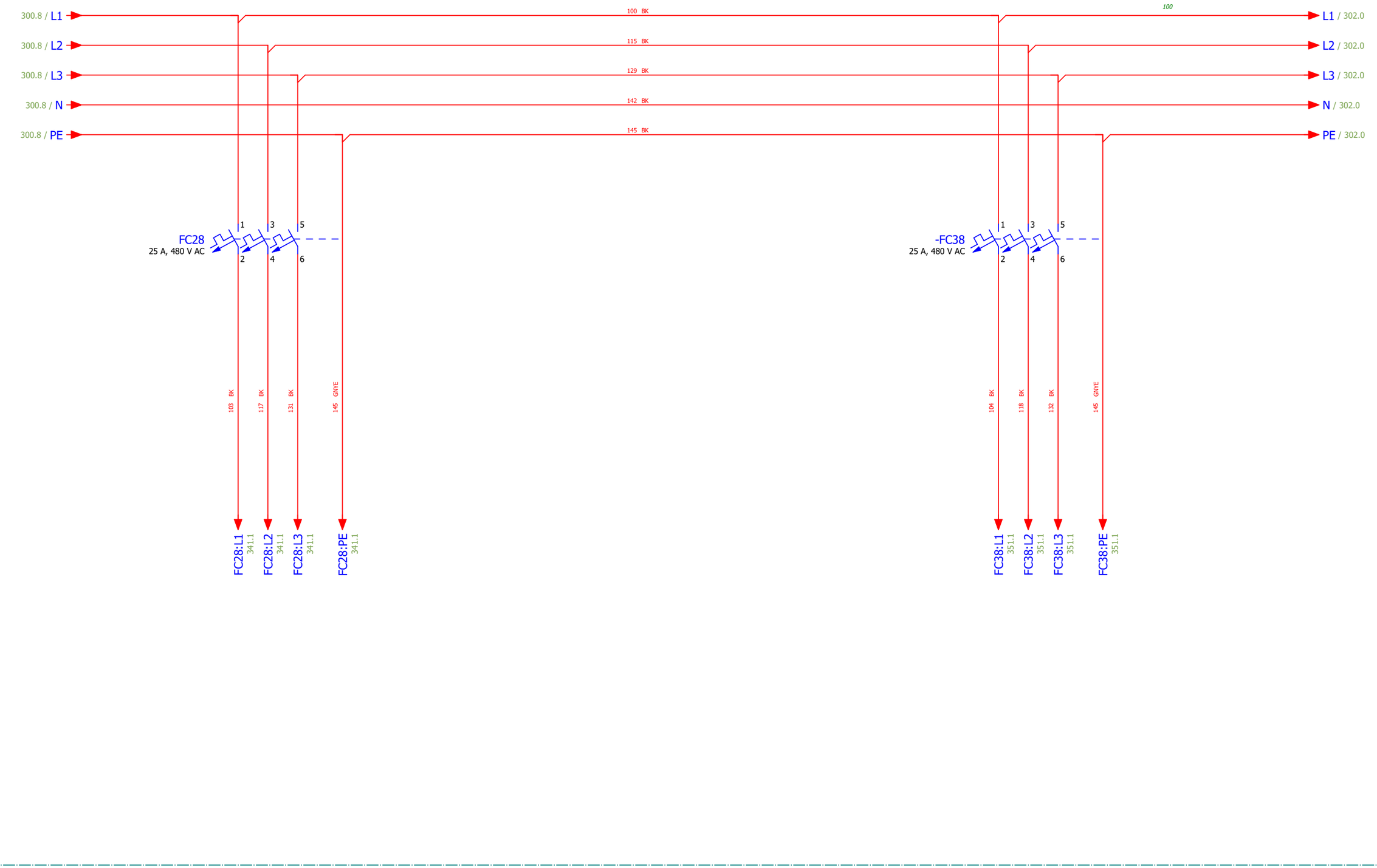
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Control Cabinet Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 300 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

Power conversion BOP Cooling skid cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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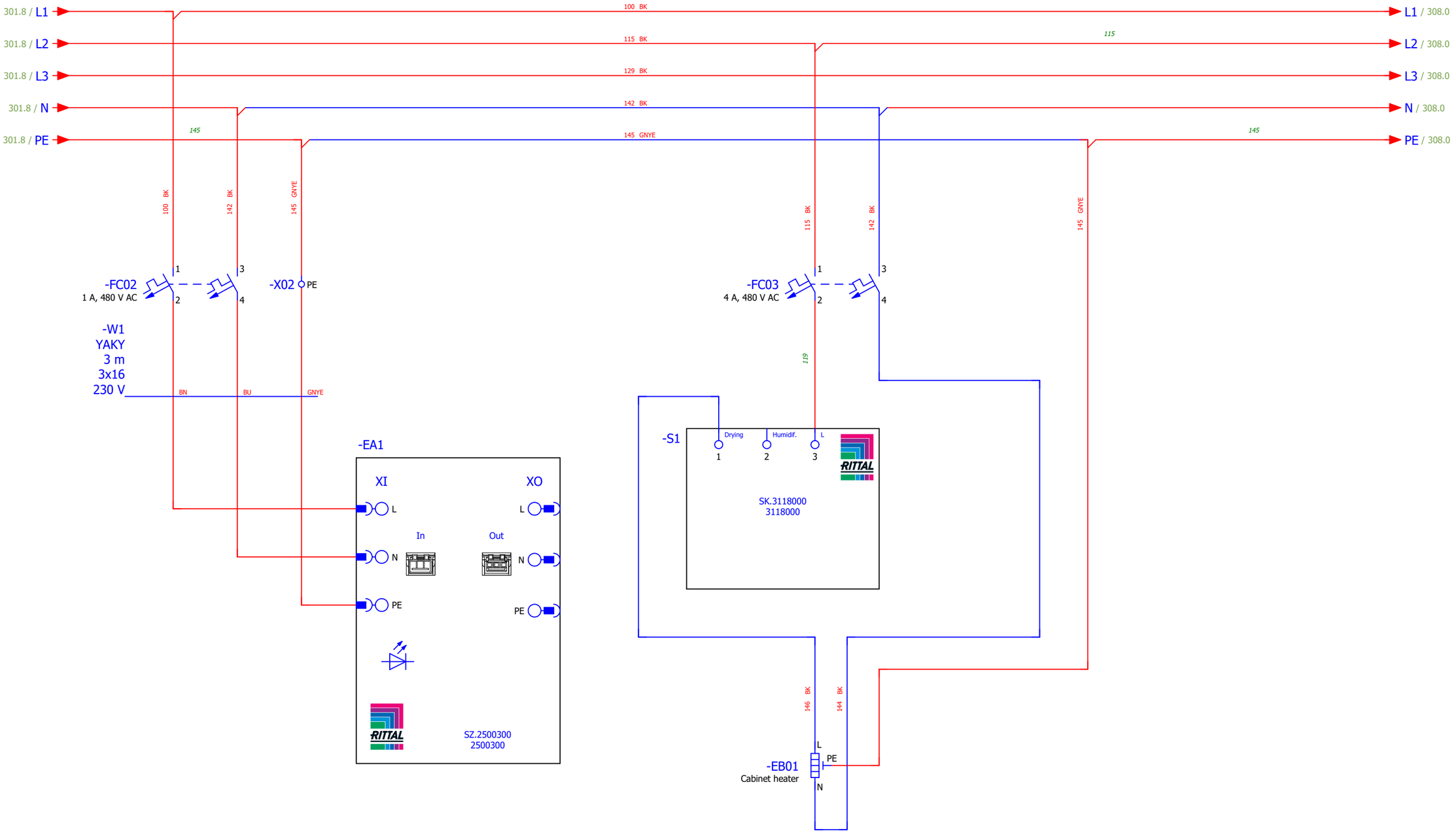
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT pump supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 301 / 2

=LA01+UC30

Power conversion BOP Cooling skid cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Cabinet light and heater		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 302 / 2

=LA01+UC30

302.8 / L1 → 100 → L1 / 360.0
302.8 / L2 → 115 → L2 / 360.0
302.8 / L3 → 129 → L3 / 360.0
302.8 / N → 46 → N /
302.8 / PE → 145 → PE / 360.0

-FC100
6 A
1 3 5
2 4 6

105 BK
120 BK
133 BK
145 GNYE

-TB30
24V, 20A
PSU
L1 L2 L3 PE
3AC 380-480V

PULS
Power
Supply
QT20.241
24-28V
DC-OK
Overload

DC 24V, 20A, 480W/720W
Out + Out +' Out - Out -' 13 14
DC-OK

148
149
149
PE

-RB30
24V, 20A
UPS Module
In + In - In -'
DC 24V
Bat. + Bat. -
11 12 13
PT100 Temp. Sensor
PT100 Temp. Sensor
Battery Center Tap

PULS
DC-UPS Control Unit, 24V, 20A
UB20.25

DC 24V 20A
Out + Out -
Ready 1 Ready 2 Buffering 3 Buffering 4 Repl. Bat. 5 Repl. Bat. 6 Inhibit + 7 Inhibit - 8

153 153 153 153
310.5 / -X202:4B

-RB30+
309.0
-RB30-
309.1

152 → RB30:Bat+ / 308B.0
154 → RB30:Bat- / 308B.0

UPS Battery Ready
JT_RB30_RDY
>=HE01-KE04-Slot6
DI06
X02 20

UPS Battery Operation
JT_RB30_BAT
DI05
19

UPS Battery Low SOH
JT_RB30_SOH
DI07
21

155
157
158

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - 24 VDC Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 308 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

308.7 / RB30:Bat+

308.7 / RB30:Bat-

-CA30

PULS

Battery Module, 24V, 12Ah
UZK24.121

DC 24V
Out + Out -

152

154

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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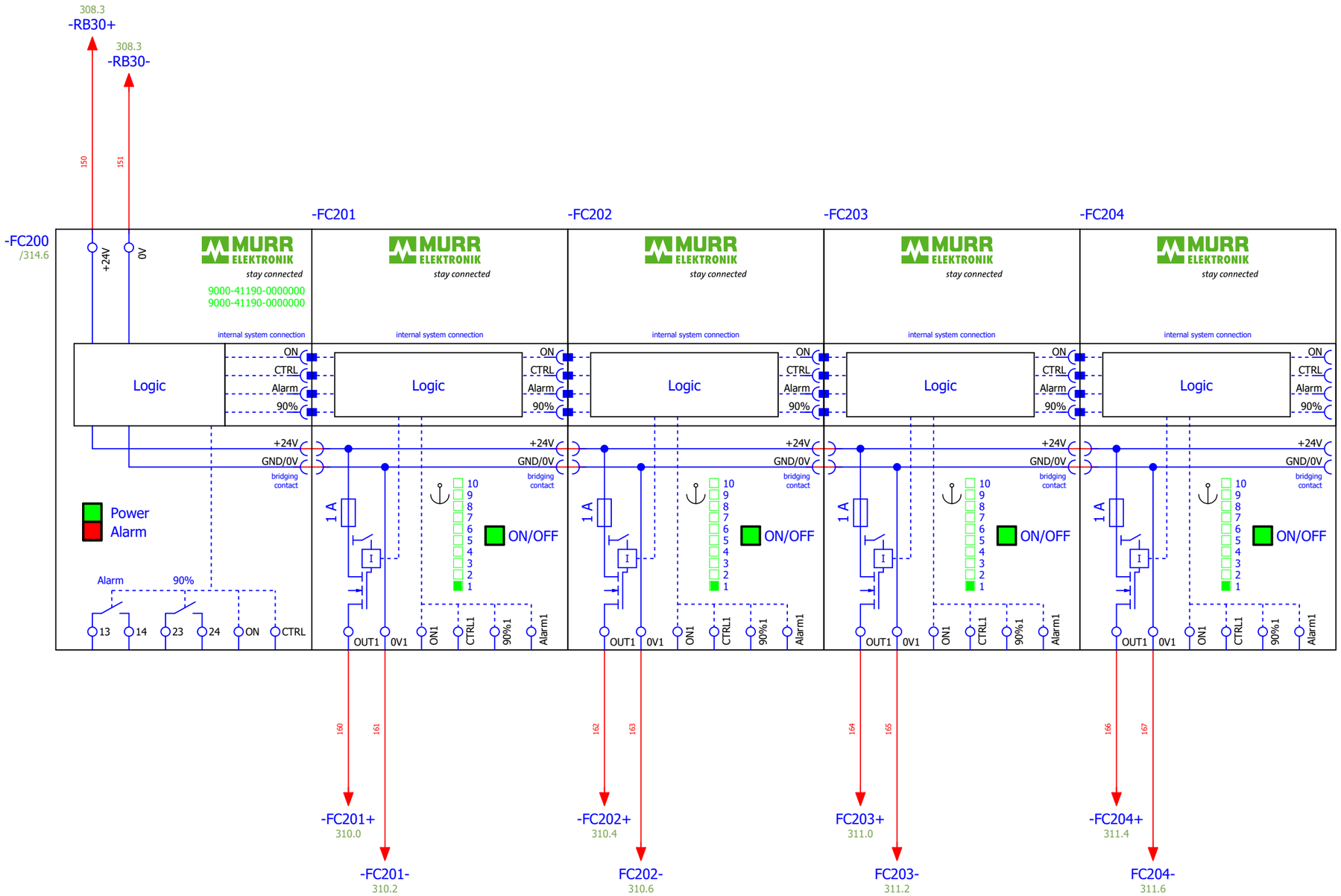
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - 24 VDC Supply - Back up battery		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 308B / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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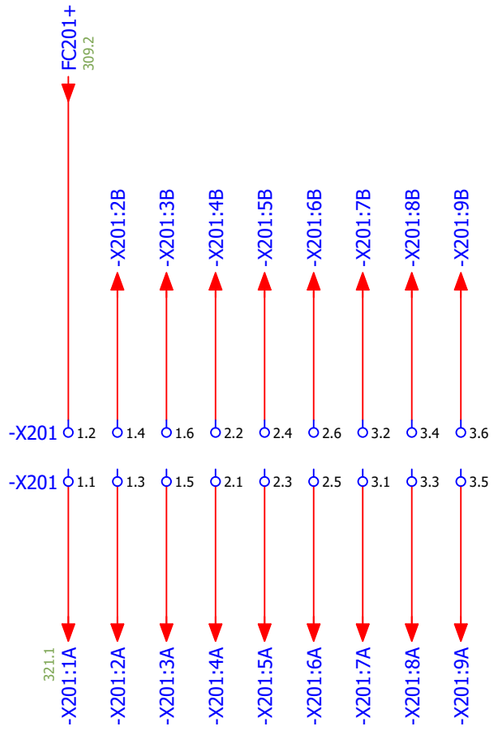
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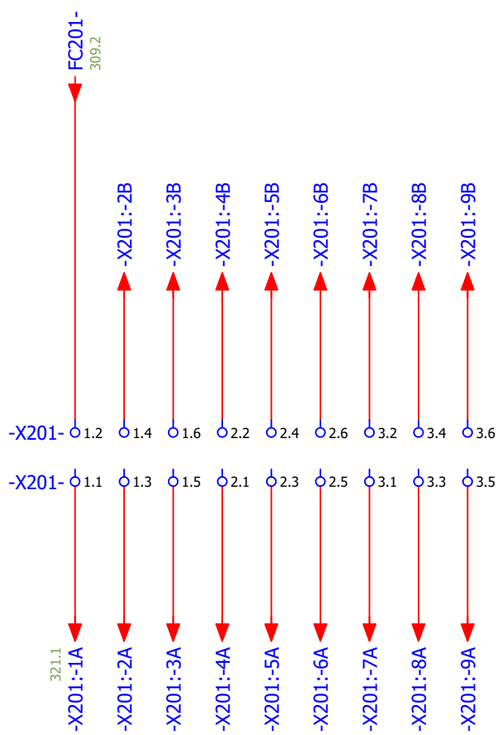
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - 24 VDC Supply - fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 309 / 2

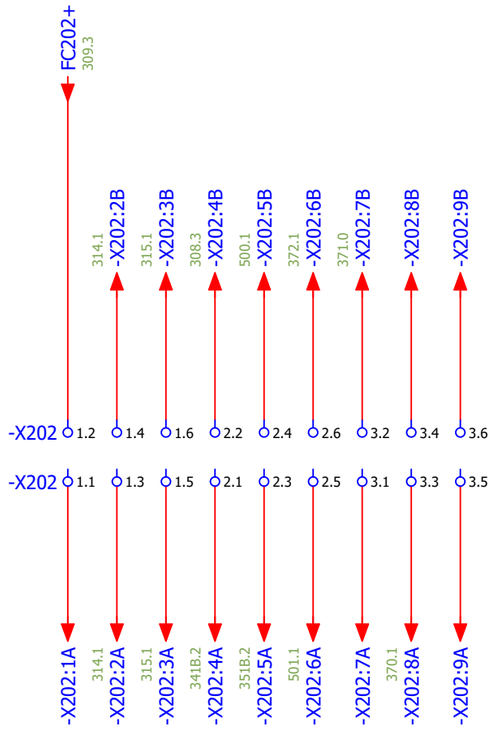
=LA01+UC30

Safety





Internal 24VDC Supply





Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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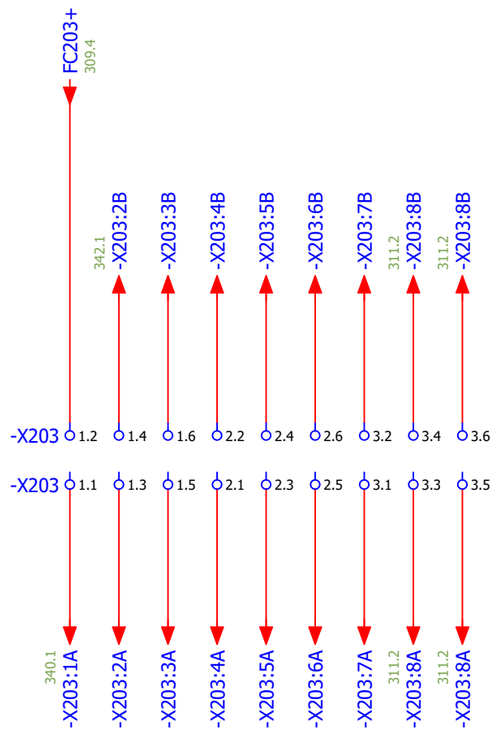
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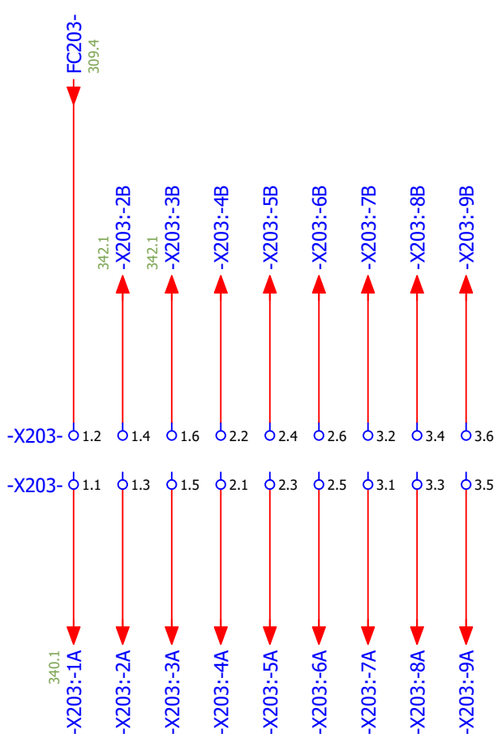
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - 24 VDC Supply - Distribution		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 310 / 2

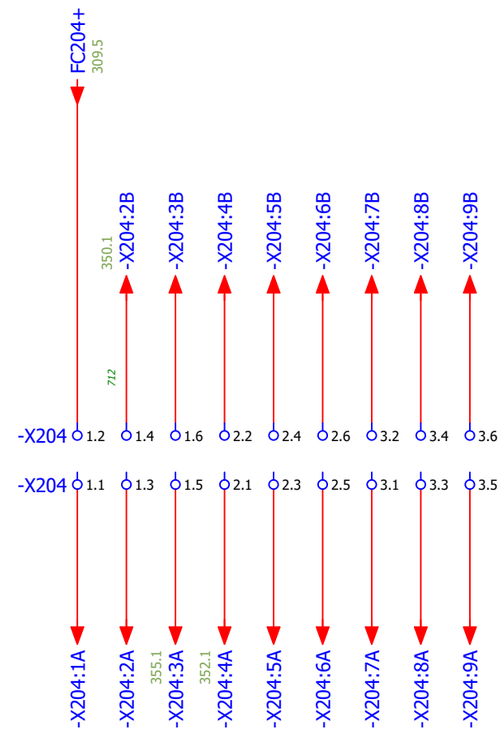
=LA01+UC30

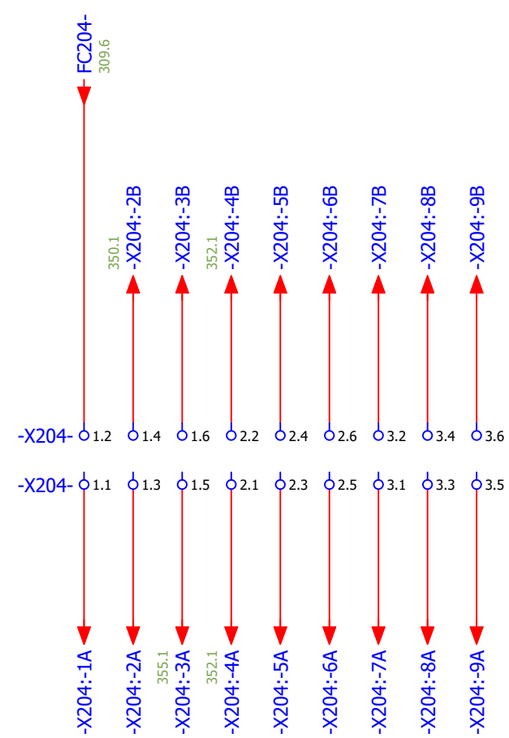
External 24VDC Supply





External 24VDC Supply





Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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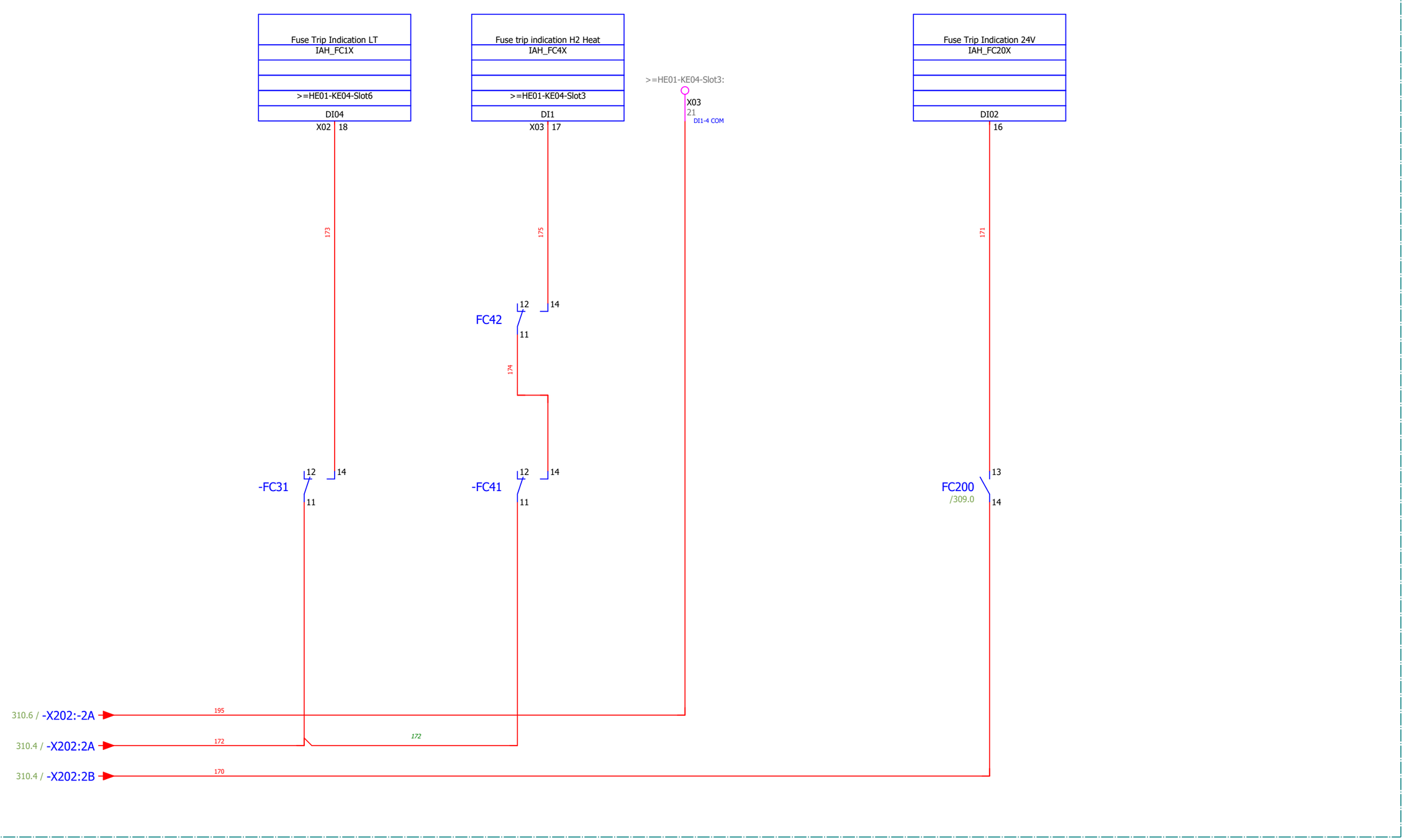
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - 24 VDC Supply - Distribution		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 311 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

Power conversion BOP Cooling skid cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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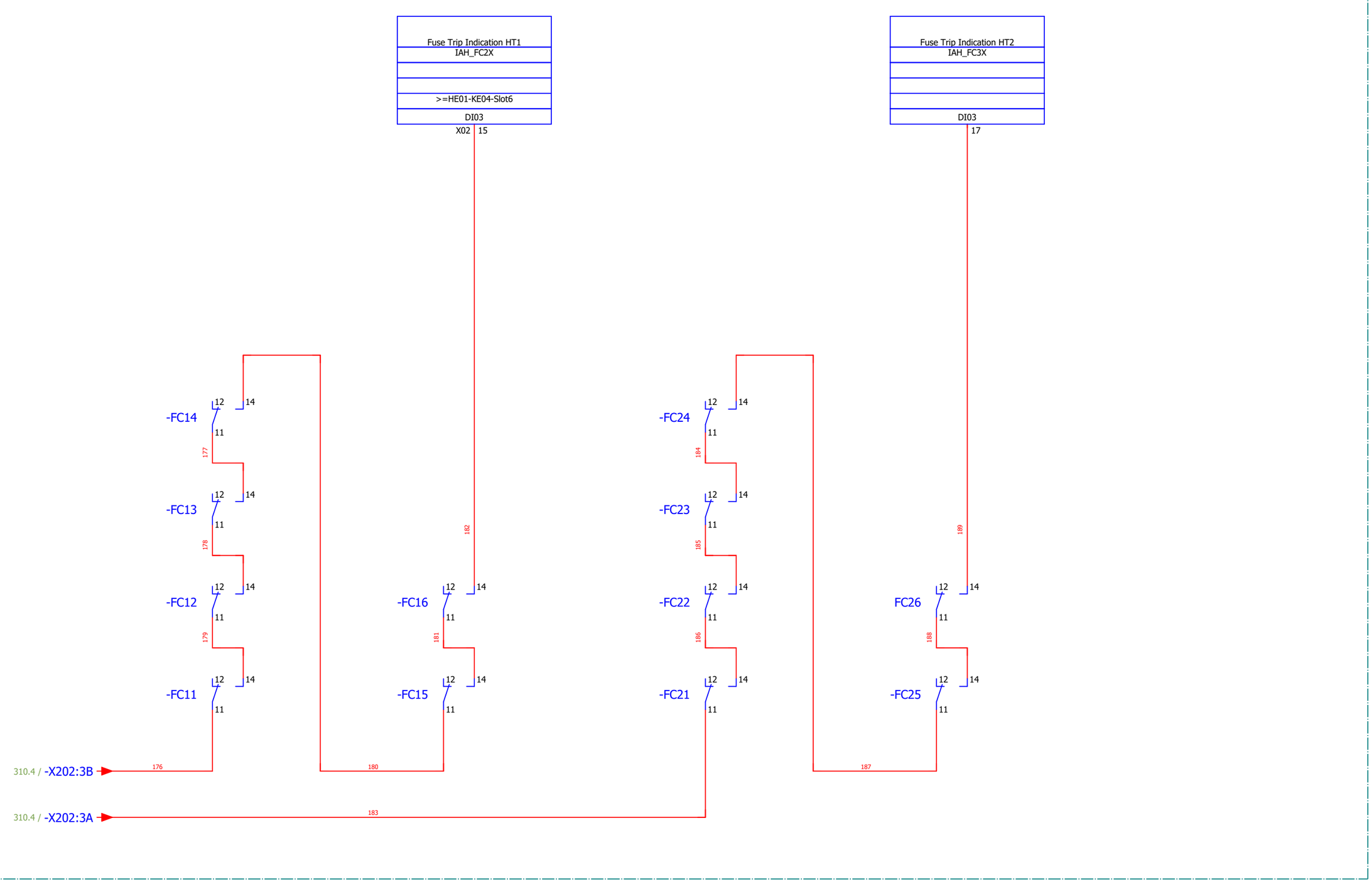
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - MCCB Trip Indication 24V		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 314 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

Power conversion BOP Cooling skid cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant skid - MCCB Trip Indication HT1+2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 315 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside

=LB02+DA04
Coolant System Power Distribution, Container #1 Outside

719
721
720
722

-SG01
Cabinet ESTOP
11 21
12 22

-S1
11 21
12 22

-WG01
Emergency stop
1 2 3 4

719 → KE12:X1 / 321.1
723 → KE12:3 / 321.1
724 → KE12:4 / 321.1
725 → KE12:7 / 321.1

-X100 X1 1 2 3 4 5 6 7 3' 4'

KF10 FB Forward
ESD CH1 Forward
ESD CH2 Forward
KF10 FB Return
KF10 Coil
ESD CH1 Return
ESD CH2 Return
KF10 DCCOM

-WG01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
Coolant Skid ESTOP

-WG02
ÖLFLEX® CLASSIC 110 CH
18x0,75
300/500 V
Coolant Skid Safety Relay

-WG01
+UC20/50.1

-WG02
+UC20/50.1

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ | + UC30 | & C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Safety circuit		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 320 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

Coolant System Power Distribution, Container #1 Outside

320.5 / KE12:X1 → 719

320.5 / KE12:4 → 724

726 → KF10:23 / 341B.5

727 → KF10:33 / 341B.5

KF10

PHOENIX CONTACT

PSR-MC82-5NO-1NC-1DO-24DC-SC

24V, A1, 11, 23, 33, 43, 53, 63

A1, A2, 11, 12, 23, 24, 33, 34, 43, 44, 53, 54, 63, 64

M1, A2, 12, 24, 34, 44, 54, 64

310.0 / -X201:1A → 168

310.2 / -X201:-1A → 169

320.5 / KE12:7 → 725

320.5 / KE12:3 → 723

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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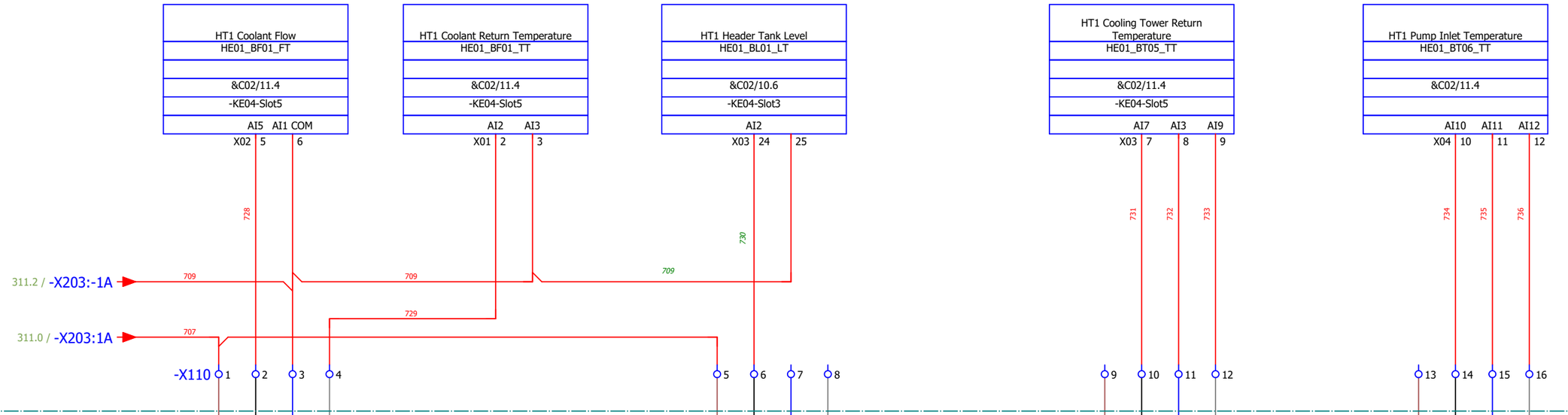
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Safety circuit		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 321 / 2

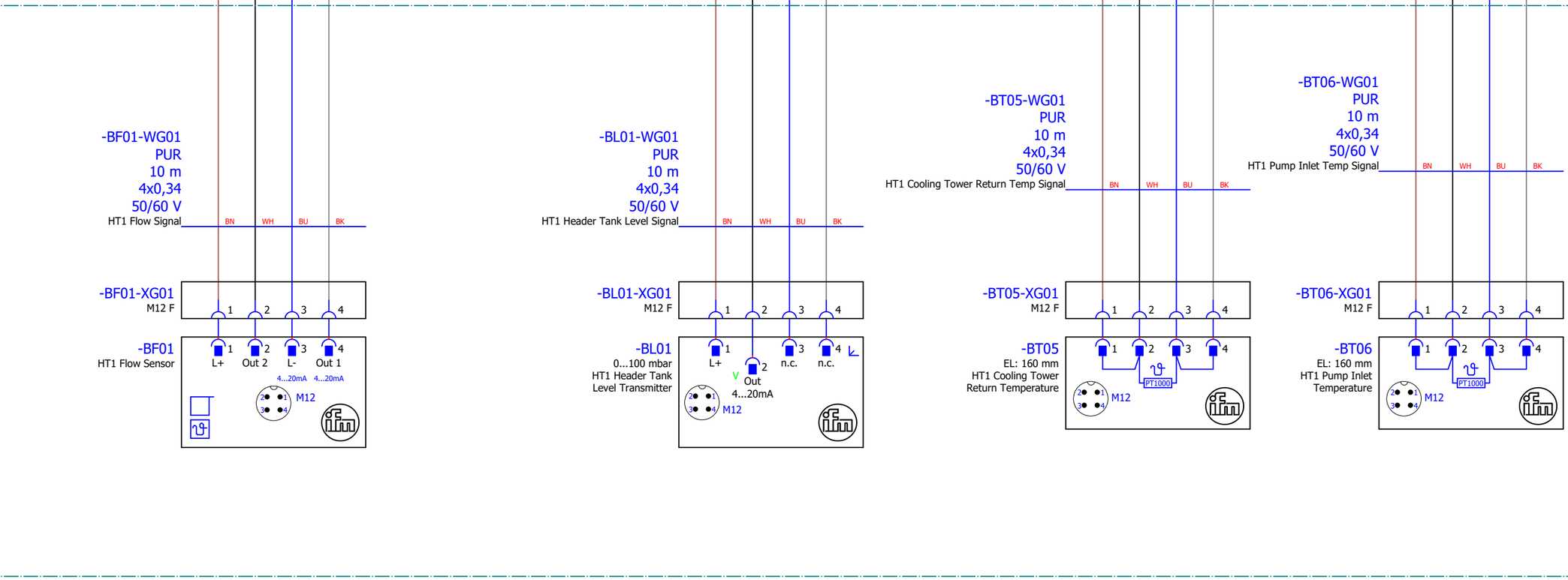
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE01+DA02
HT#1 Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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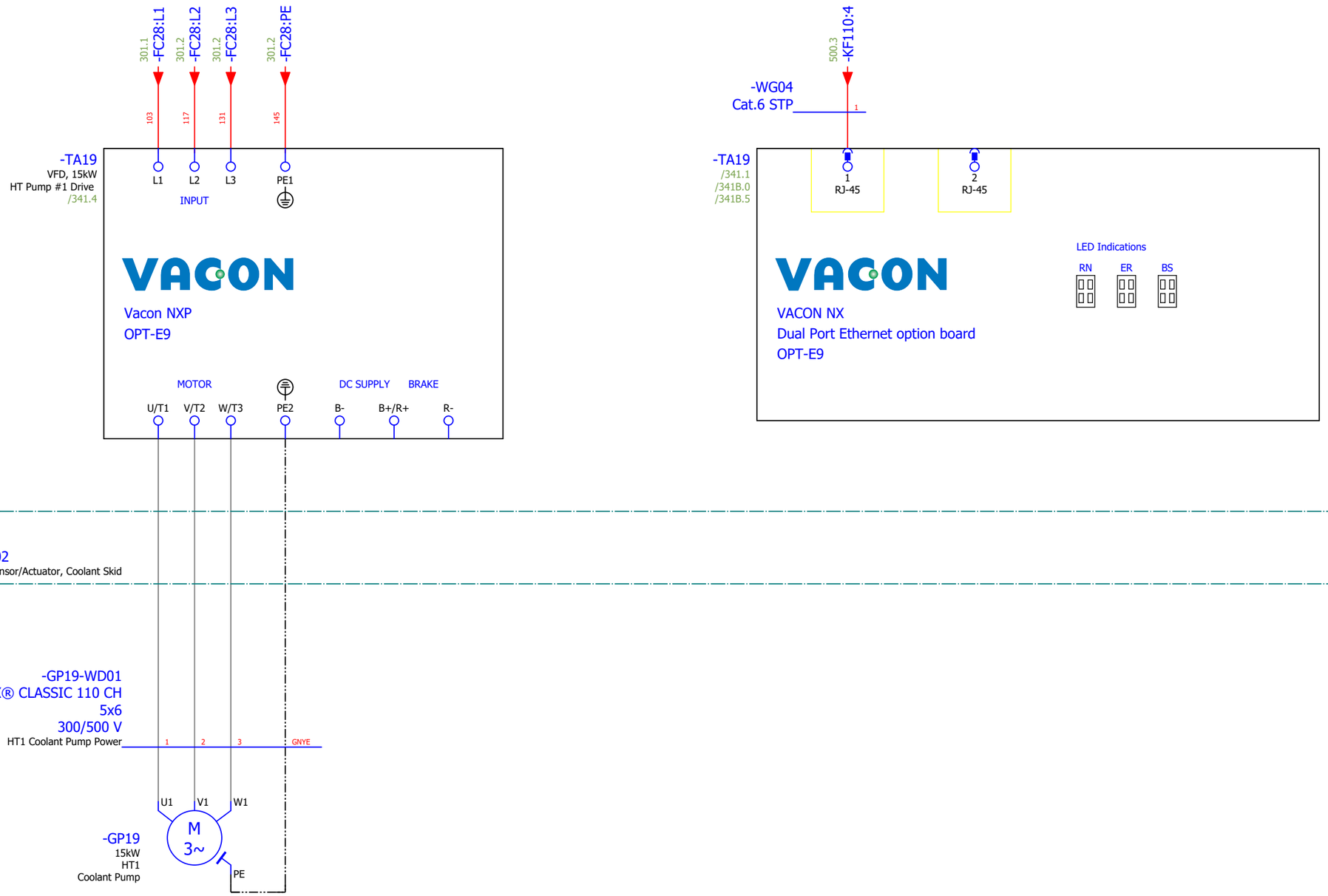
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #1 Sensors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 340 / 2

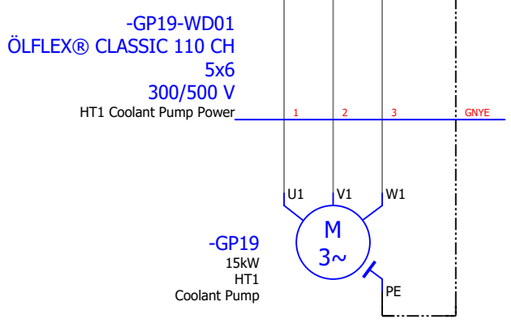
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE01+DA02
HT#1 Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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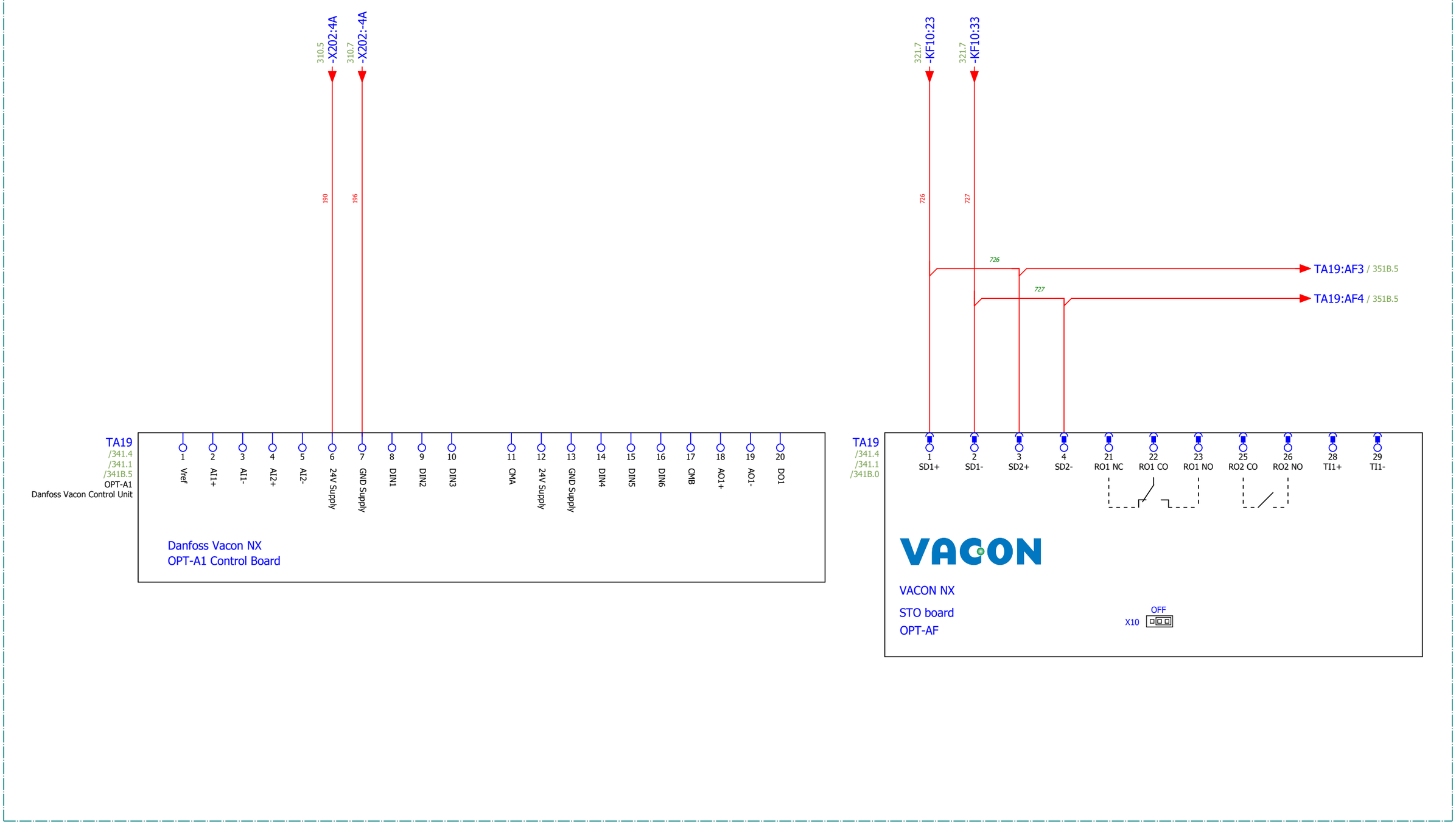
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #1 Coolant Pump		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 341 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

Coolant System Power Distribution, Container #1 Outside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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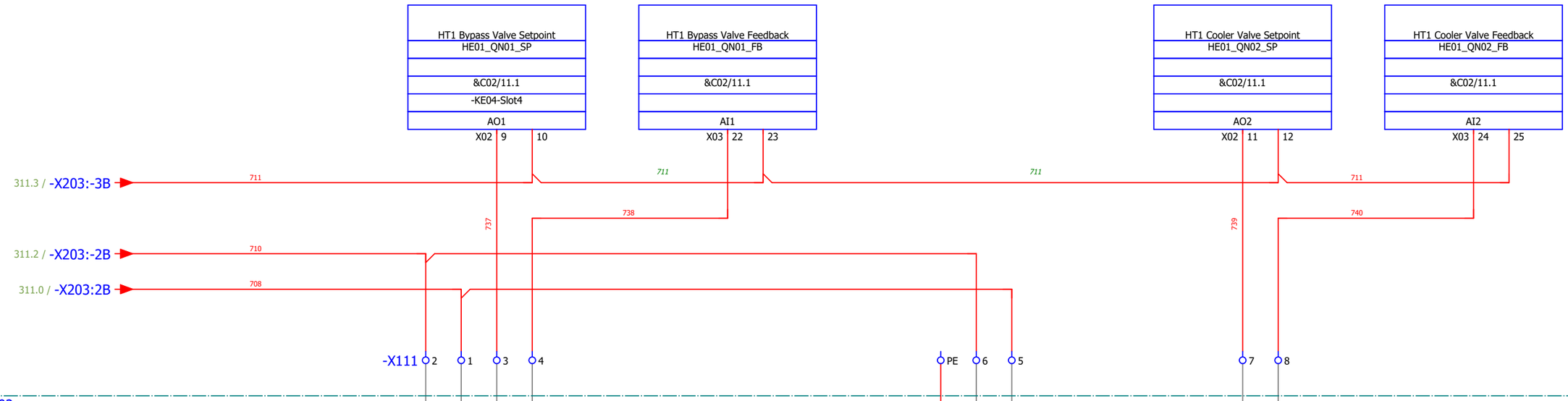
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #1 Coolant Pump VFD Interface		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 341B / 2

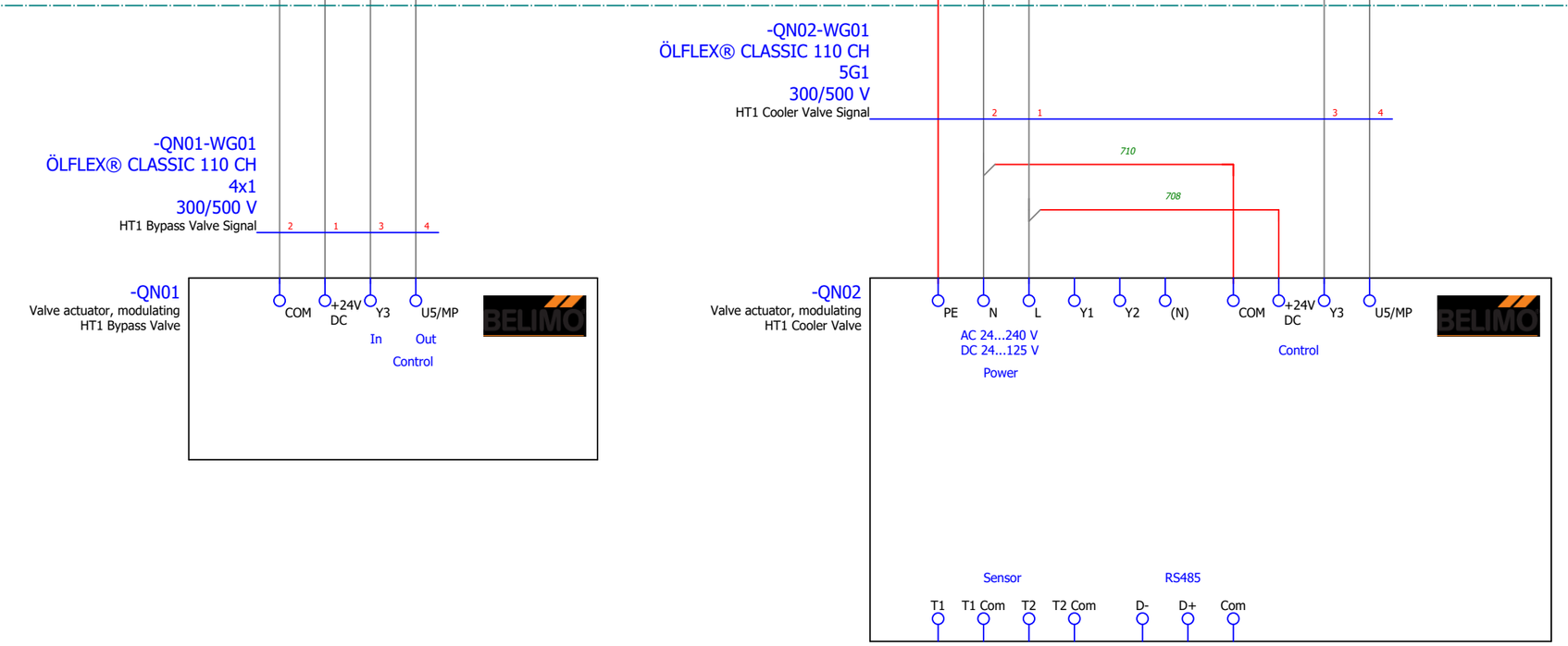
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE01+DA02
HT#1 Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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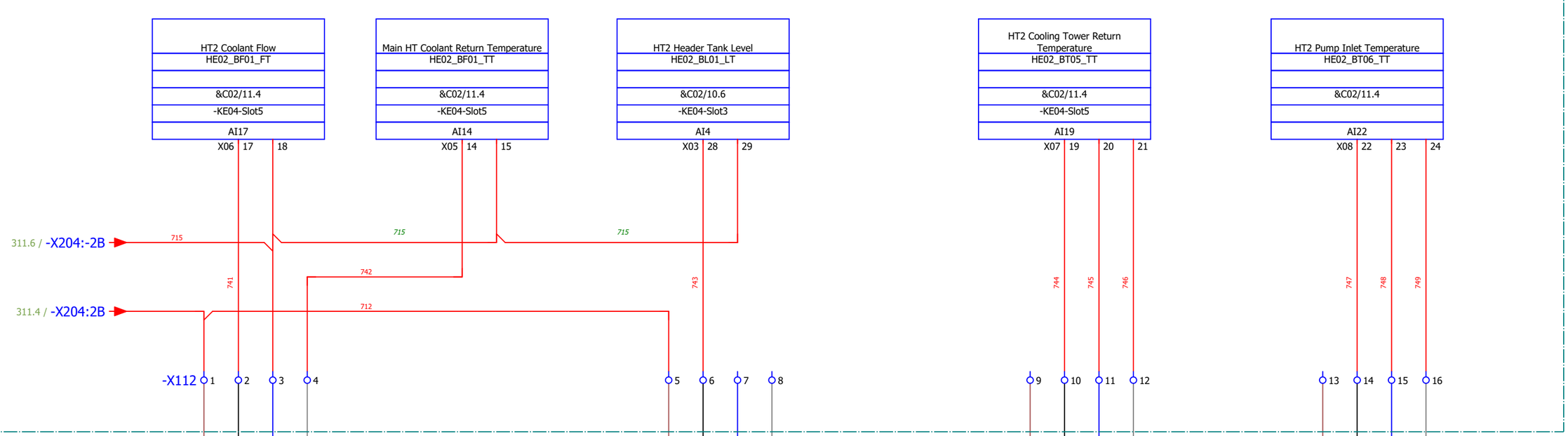
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #1 Mixing Valves		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 342 / 2

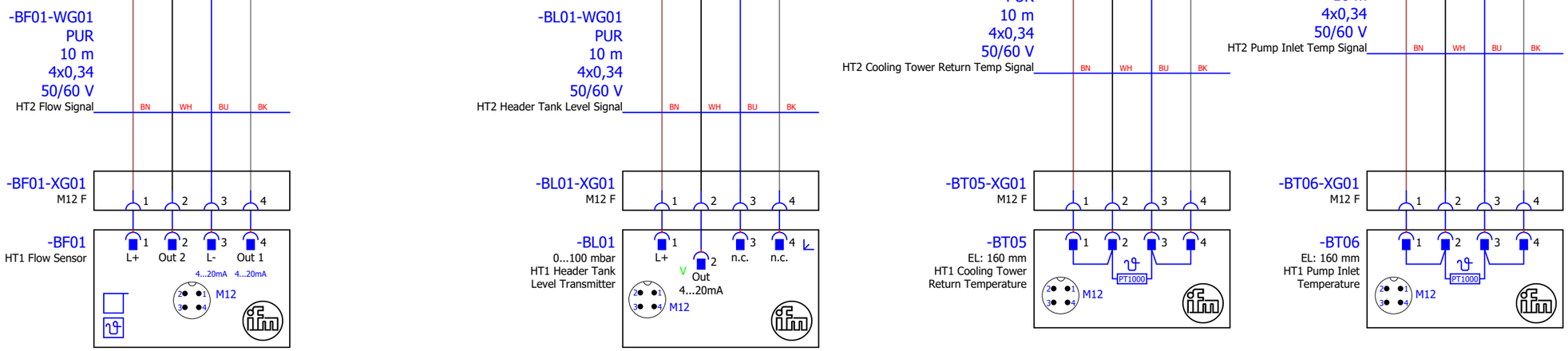
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE02+DA02
HT#2 Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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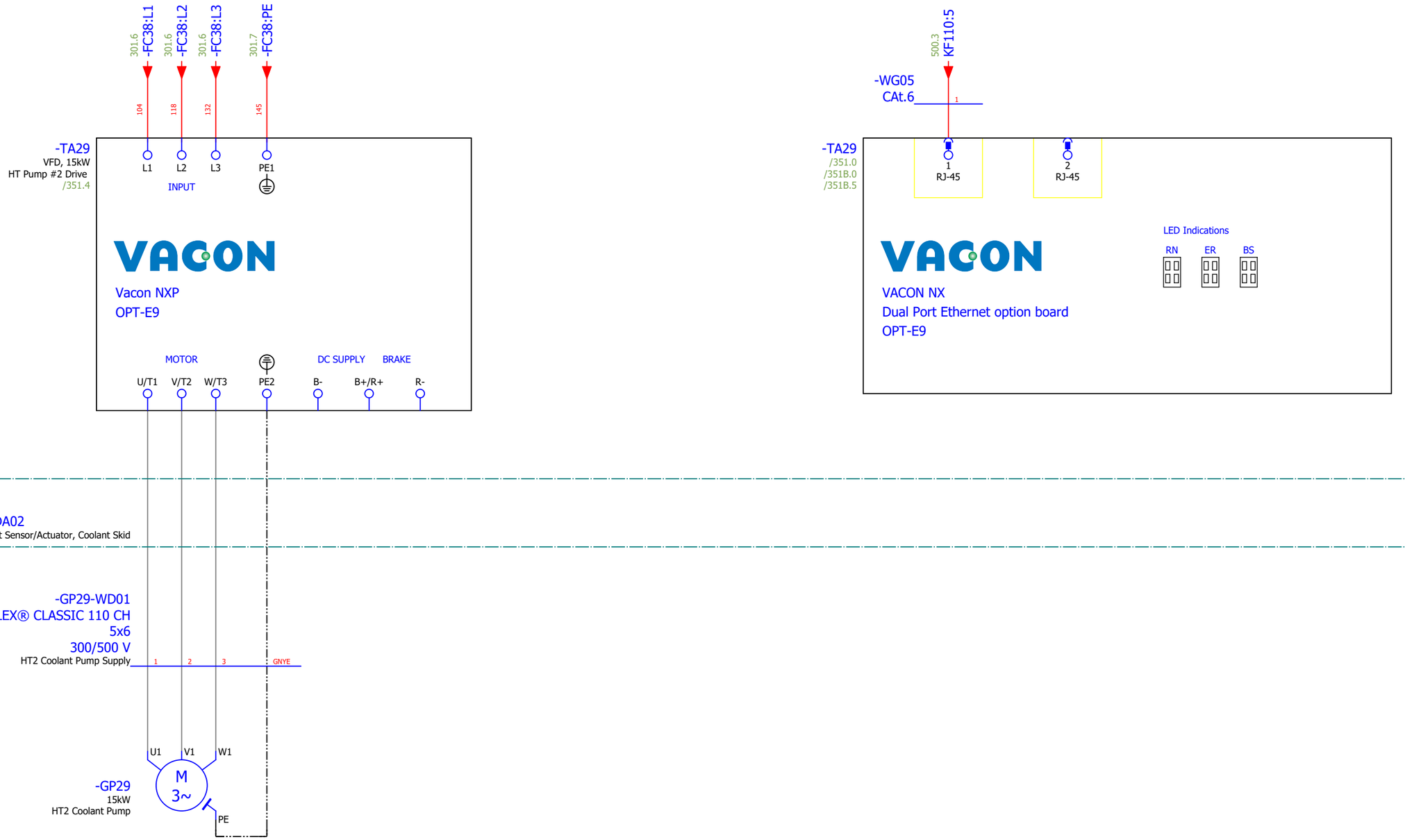
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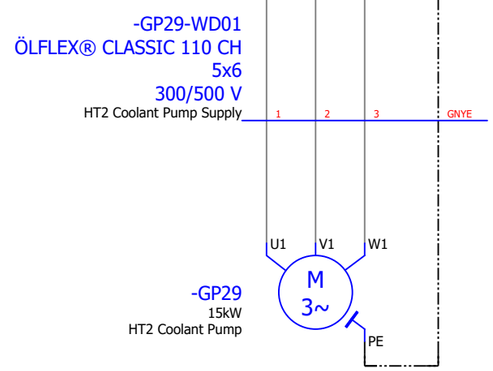
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #2 Sensors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 350 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE02+DA02
HT#2 Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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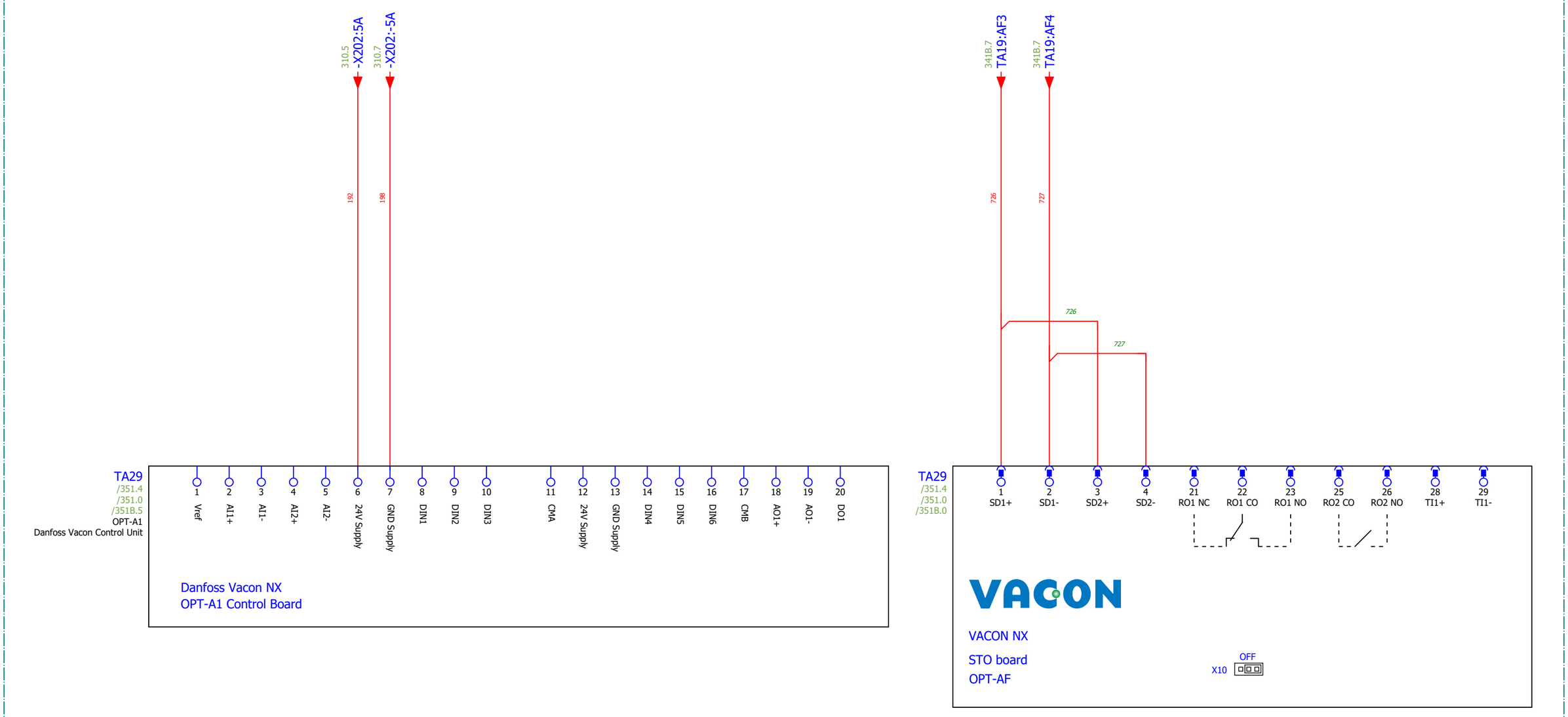
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #2 Coolant Pump		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 351 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

Coolant System Power Distribution, Container #1 Outside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #2 Coolant Pump VFD Interface		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 351B / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside

HT2 Bypass Valve Setpoint
HE02_QN01_SP
&C02/11.1
>+UC30-KE04-Slot4
AO3
X02 13 14

HT2 Bypass Valve Feedback
HE02_QN01_FB
&C02/11.1
AI3
X03 26 27

HT2 Cooler Valve Setpoint
HE02_QN02_SP
&C02/11.1
AO4
X02 15 16

HT2 Cooler Valve Feedback
HE02_QN02_FB
&C02/11.1
AI4
X03 28 29

311.7 / -X204:-4A
311.5 / -X204:4A
311.7 / -X204:-4B

718 718 718 718
751 753
750 752
714
717

-X113 2 1 3 4 PE 6 5 7 8

=HE02+DA02
HT#2 Coolant Sensor/Actuator, Coolant Skid

-QN01-WG01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
HT2 Bypass Valve Signal
2 1 3 4

-QN01
Valve actuator, modulating
HT1 Bypass Valve
COM +24V DC Y3 U5/MP
In Out
Control

-QN02-WG01
ÖLFLEX® CLASSIC 110 CH
5G1
300/500 V
HT2 Cooler Valve Signal
2 1 3 4

717
714

-QN02
Valve actuator, modulating
HT2 Cooler Valve
PE N L Y1 Y2 (N) COM +24V DC Y3 U5/MP
AC 24...240 V
DC 24...125 V
Power
Control

Sensor
T1 T1 Com T2 T2 Com
RS485
D- D+ Com

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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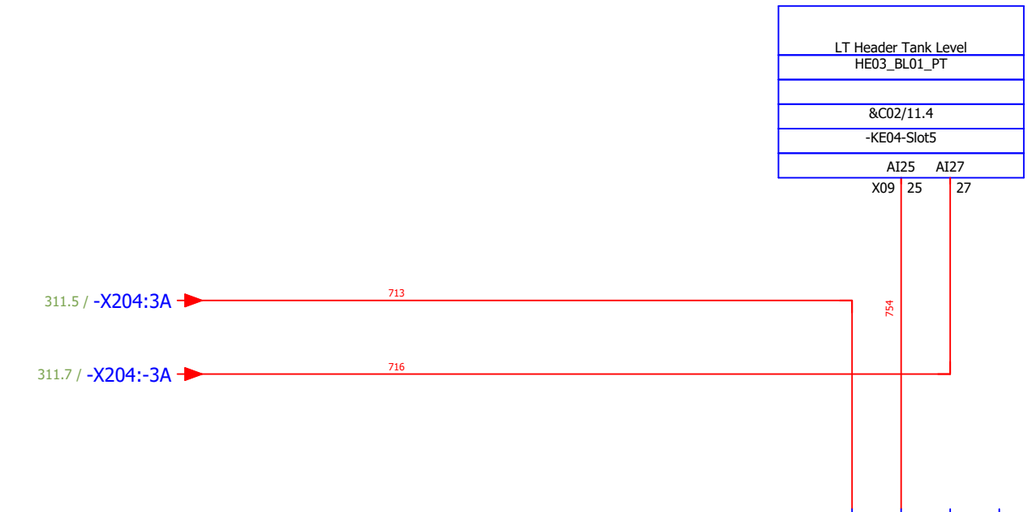
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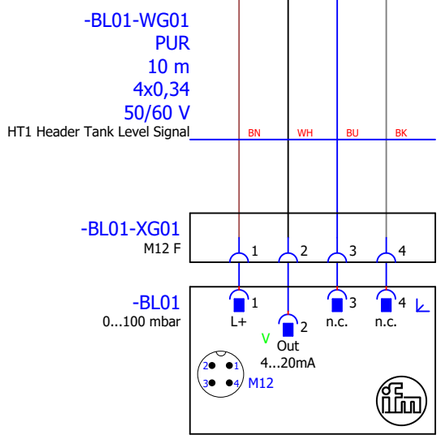
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT #2 Mixing Valves		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 352 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=HE03+DA02
LT Header Tank Coolant Sensor/Actuator, Coolant Skid



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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=	++	+ UC30	& C03

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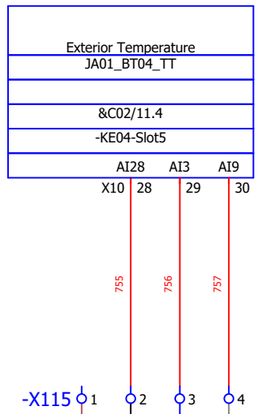
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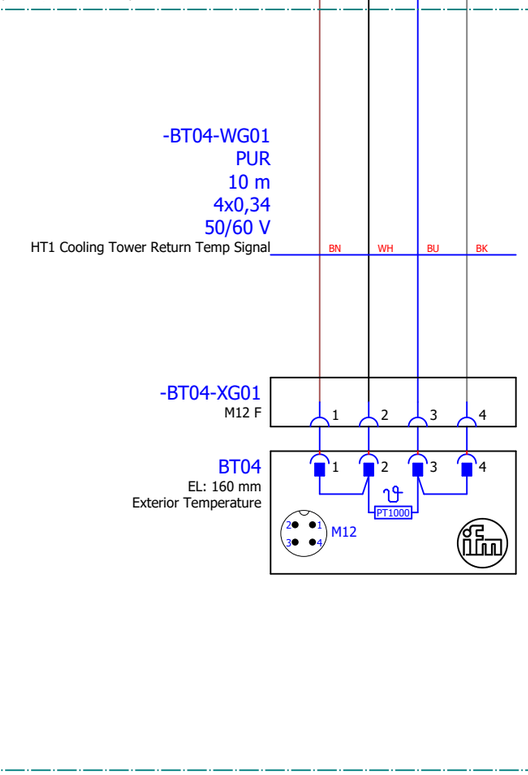
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - LT Header Tank		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 355 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
Coolant System Power Distribution, Container #1 Outside



=JA01+DA02
Ventilation systerm, Exterior Temperature



Reference Item Number	Ballard Part # TBD		
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=	++	+ UC30	& C03

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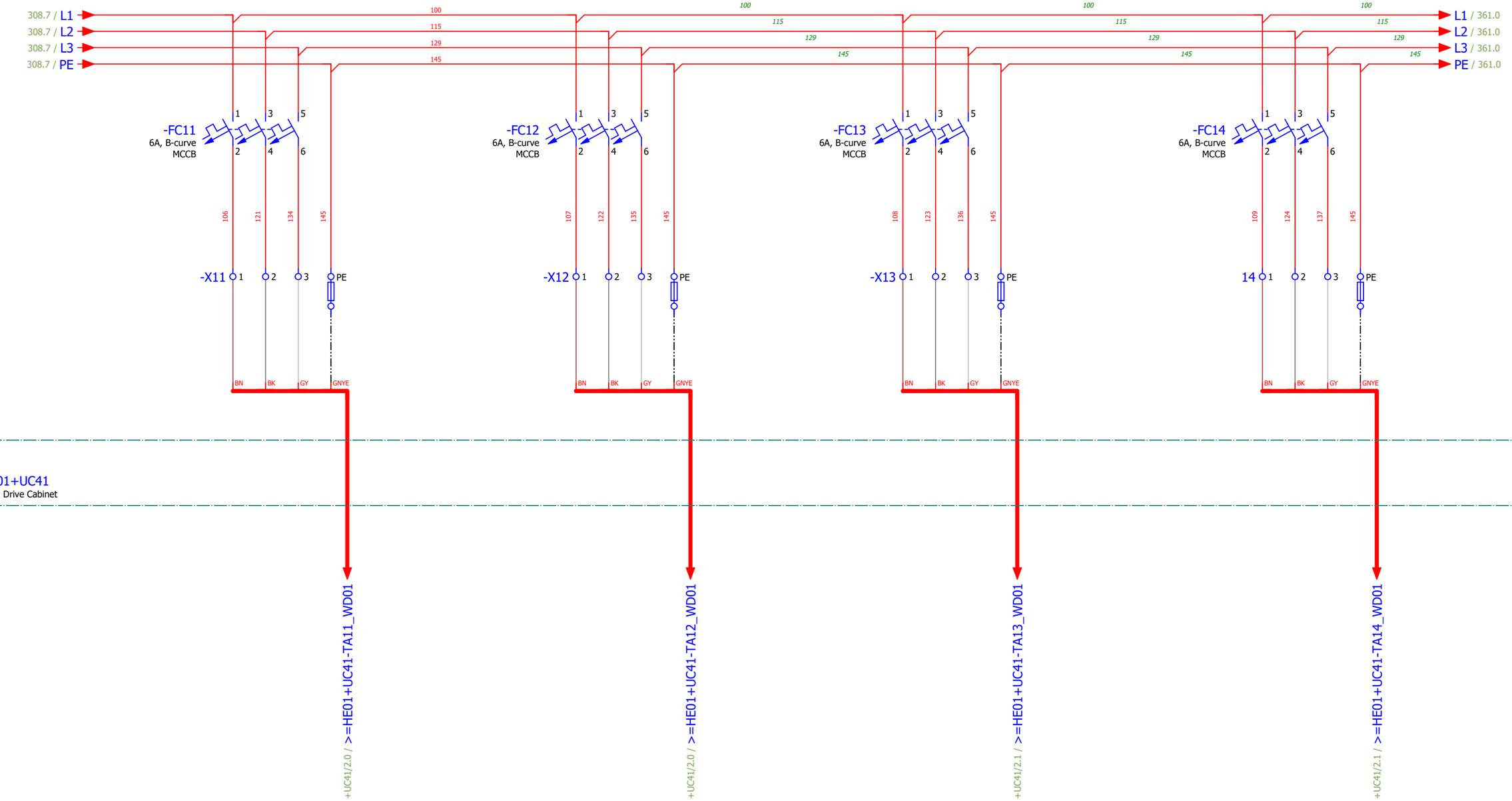
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Exterior Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 356 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

40ft Coolant Skid - Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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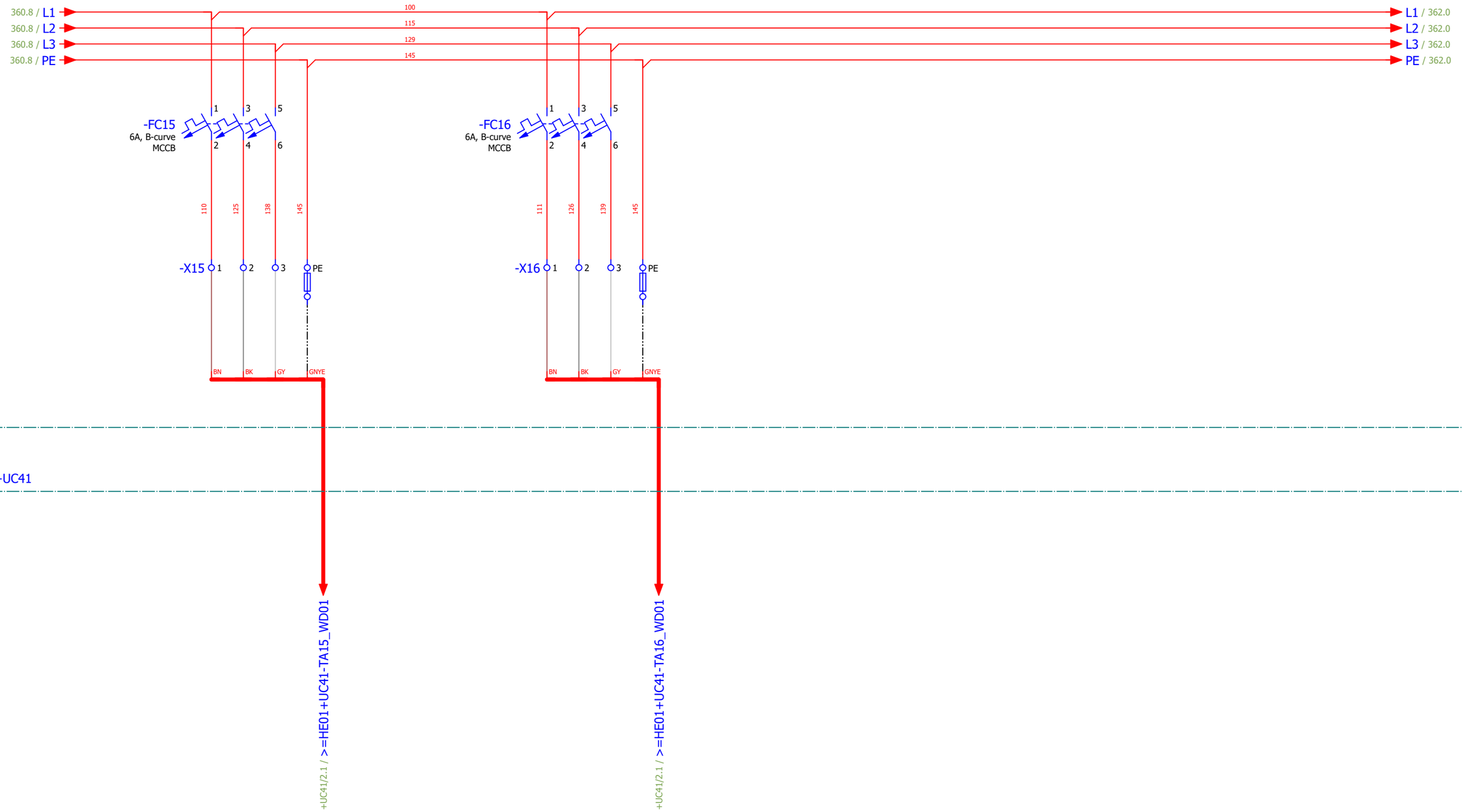
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT Cooler #1 Fan Power 1/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 360 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30

40ft Coolant Skid - Control Cabinet



=HE01+UC41

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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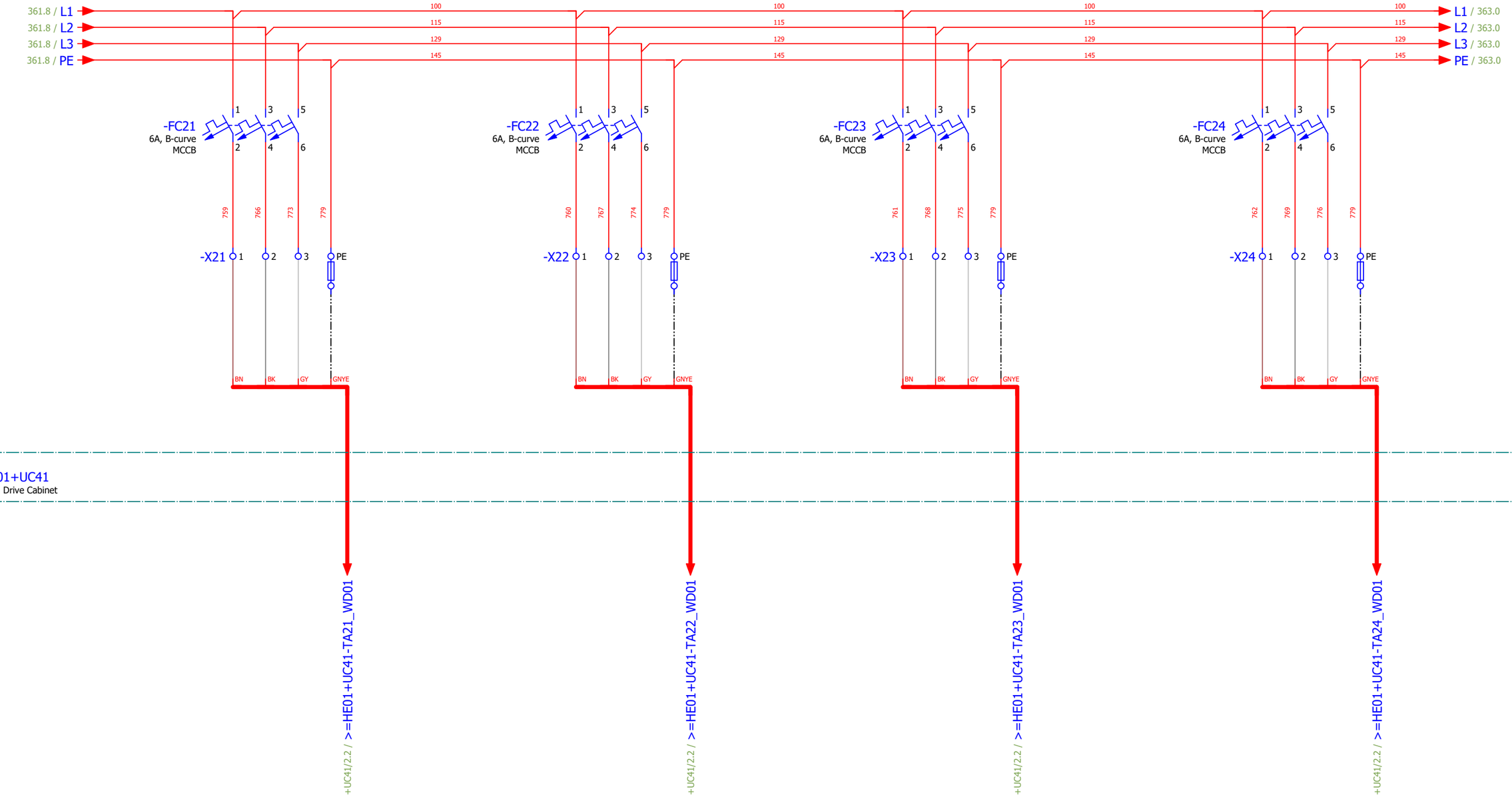
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT Cooler #1 Fan Power 2/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 361 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HE01+UC41
HT Fan Drive Cabinet

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

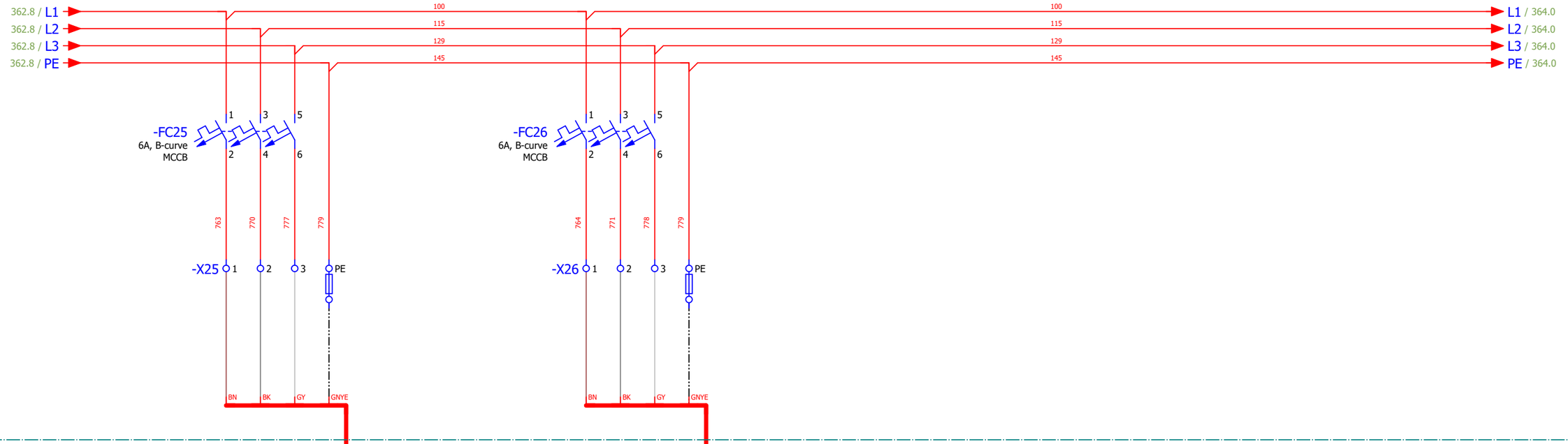
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT Cooler #2 Fan Power 1/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 362 / 2

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HE01+UC41
HT Fan Drive Cabinet

+UC41/2.2 / >=HE01+UC41-TA25_WD01

+UC41/2.2 / >=HE01+UC41-TA26_WD01

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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05-Jun-24	

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - HT Cooler #2 Fan Power 2/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 363 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HE01+UC41
HT Fan Drive Cabinet

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - LT Cooler Fan Power		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 364 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HE01+UC41
HT Fan Drive Cabinet

+UC41/2.3 / >=HE01+UC41-EA40_WD01

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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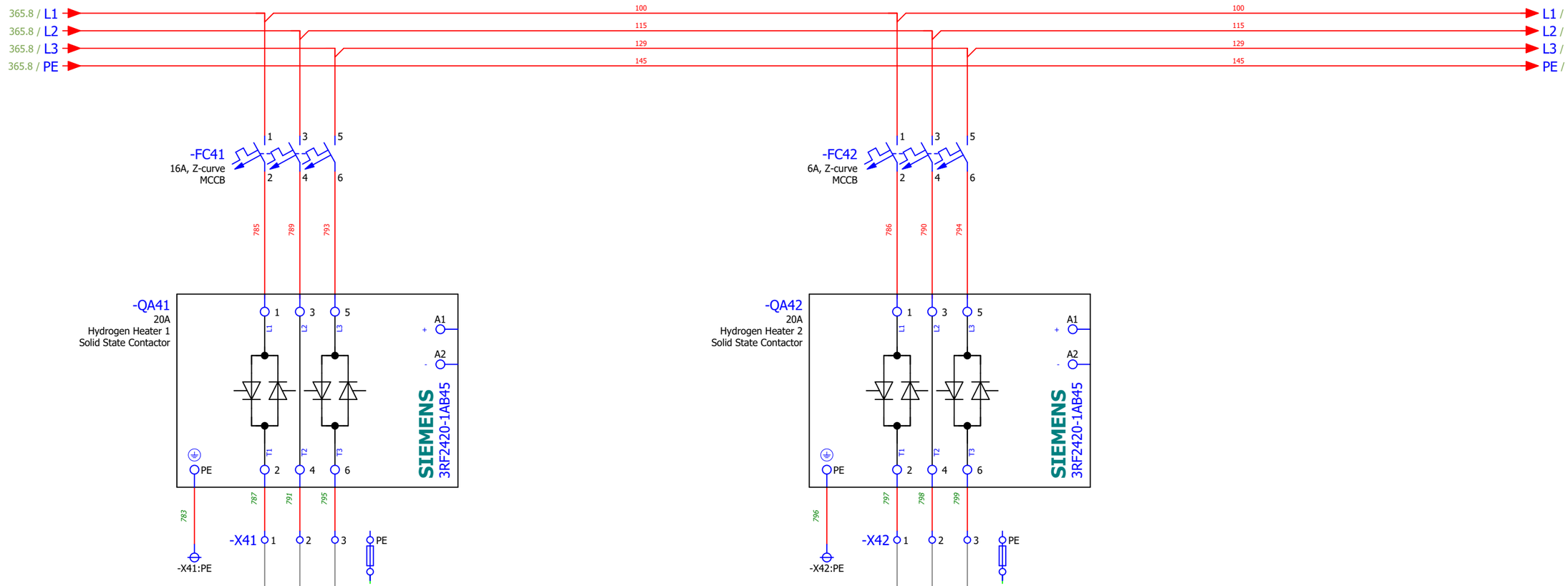
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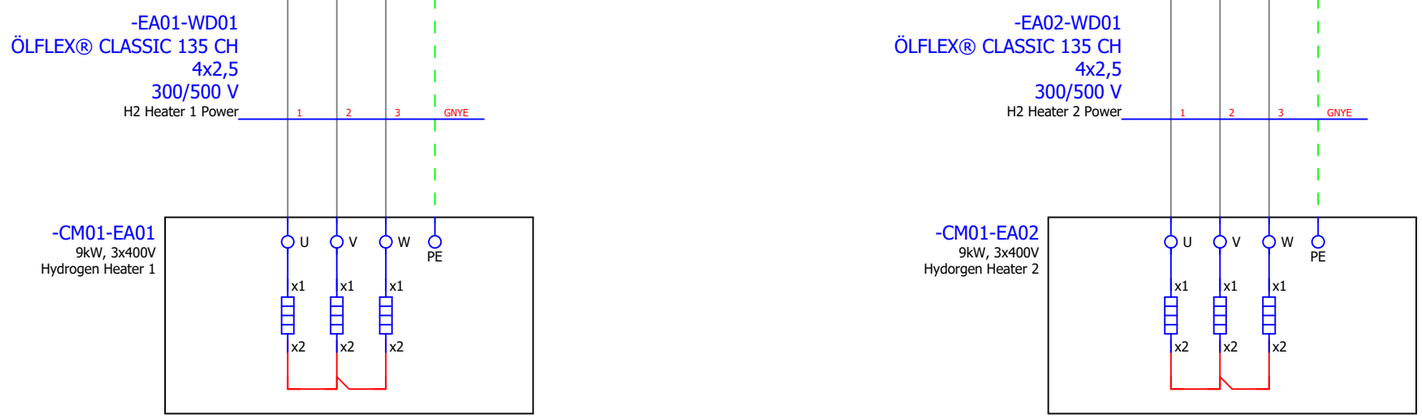
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - VFD Cabinet Airconditioning		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 365 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HA01+DA02
Hydrogen Supply System, Outside Container #1



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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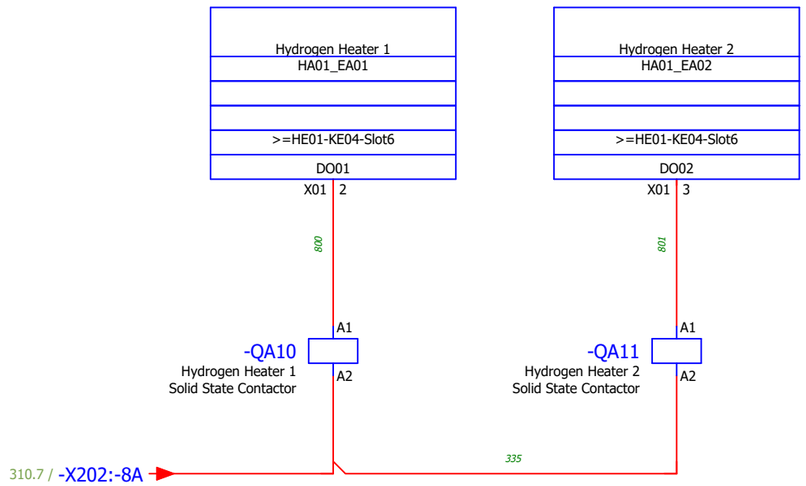
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Hydrogen Heater Power		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 368 / 2

FRM5103656/0B

=LA01+UC30
40ft Coolant Skid - Control Cabinet



=HA01+DA02
Hydrogen Heater

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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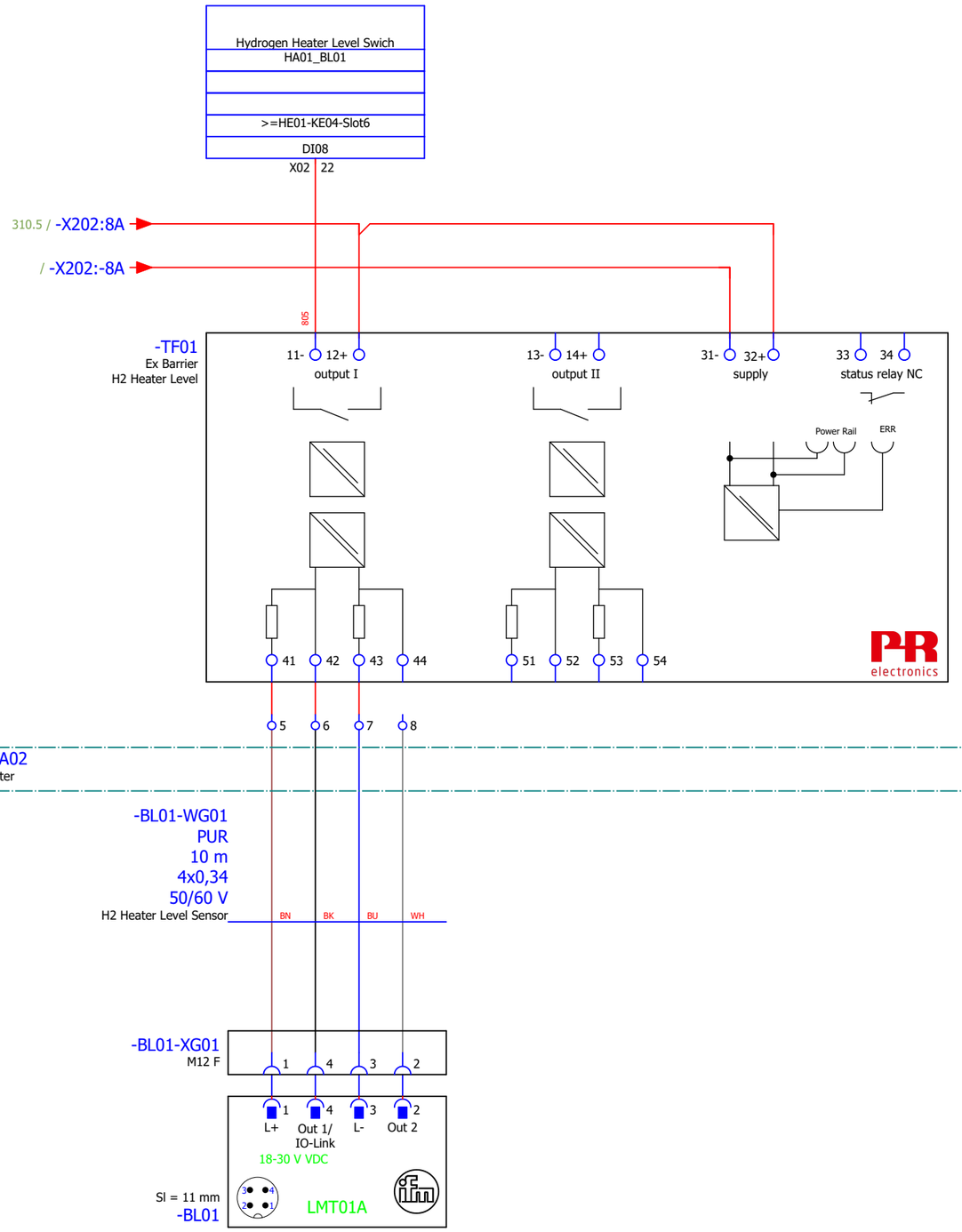
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Hydrogen Heater Control		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 369 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

40ft Coolant Skid - Control Cabinet



335

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Hydrogen Heater Control Level		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 370 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet

Hydrogen heater temperature
HE01_DA02_BT01
&C02/12.4
-KE05-Slot2
AI5 AI4
X02 5 4

310.5 / -X202:7B
310.7 / -X202:-7B

-TF02
Ex Barrier
H2 Heater Temperature

11- 12+ output I
13- 14+ output II
31- 32+ supply
33 34 status relay NC

Power Rail
ERR

Configuration:
RTD 3-wire
-20...100°C -> 4..20mA

input I
41 42 43 44
input II
51 52 53 54

P+R electronics

802 803 804
-X206 1 2 3 4

=HA01+DA02
Hydrogen Heater

-BT02-WG01
PUR
10 m
4x0,34
50/60 V
H2 Heater Temperature
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
PT1000
Hydrogen Heater
Temperature
1 2 3 4
PT1000
M12
2 1 3 4

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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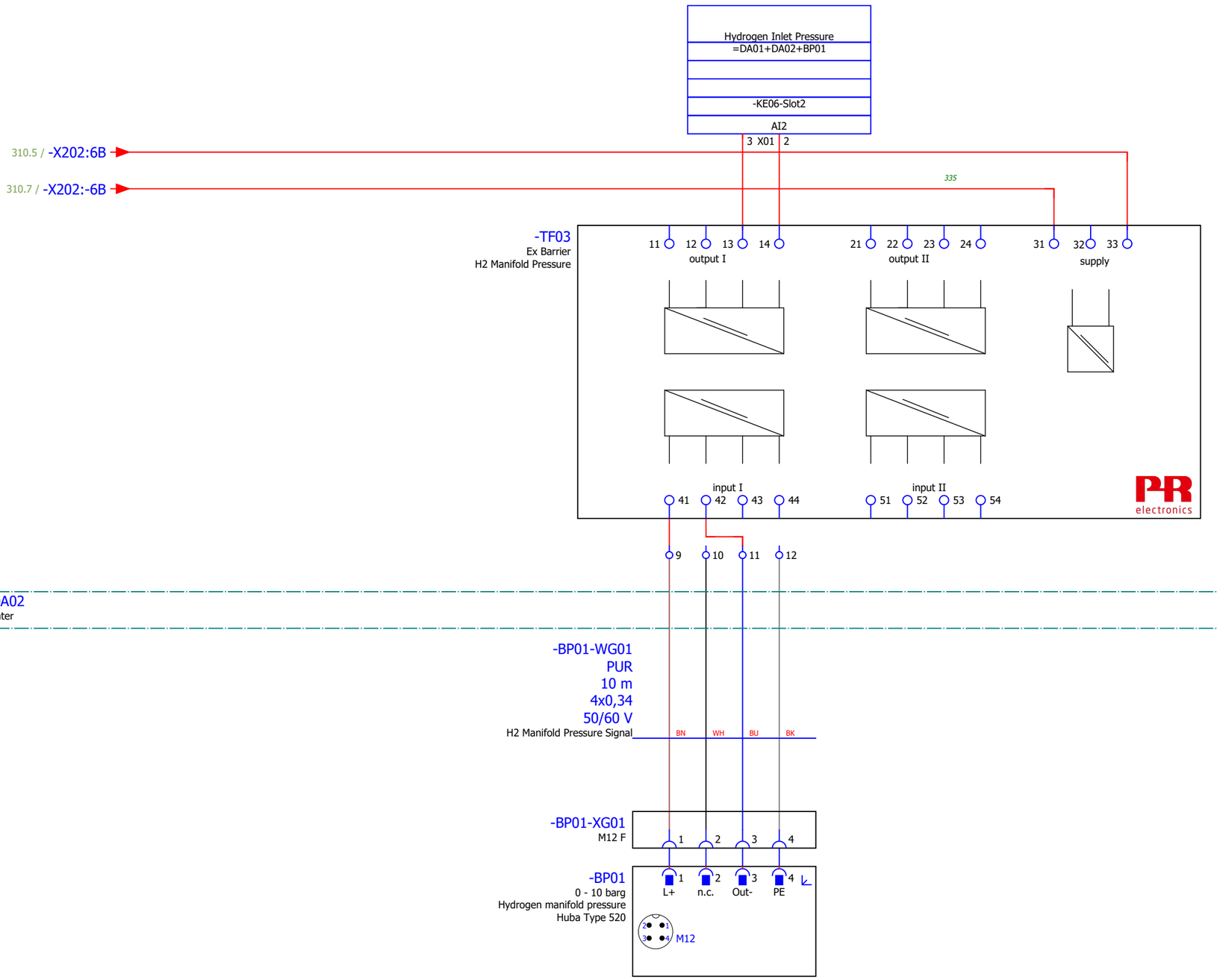
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Hydrogen Heater Control Temperature		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 371 / 2

0	1	2	3	4	5	6	7	8

=LA01+UC30
40ft Coolant Skid - Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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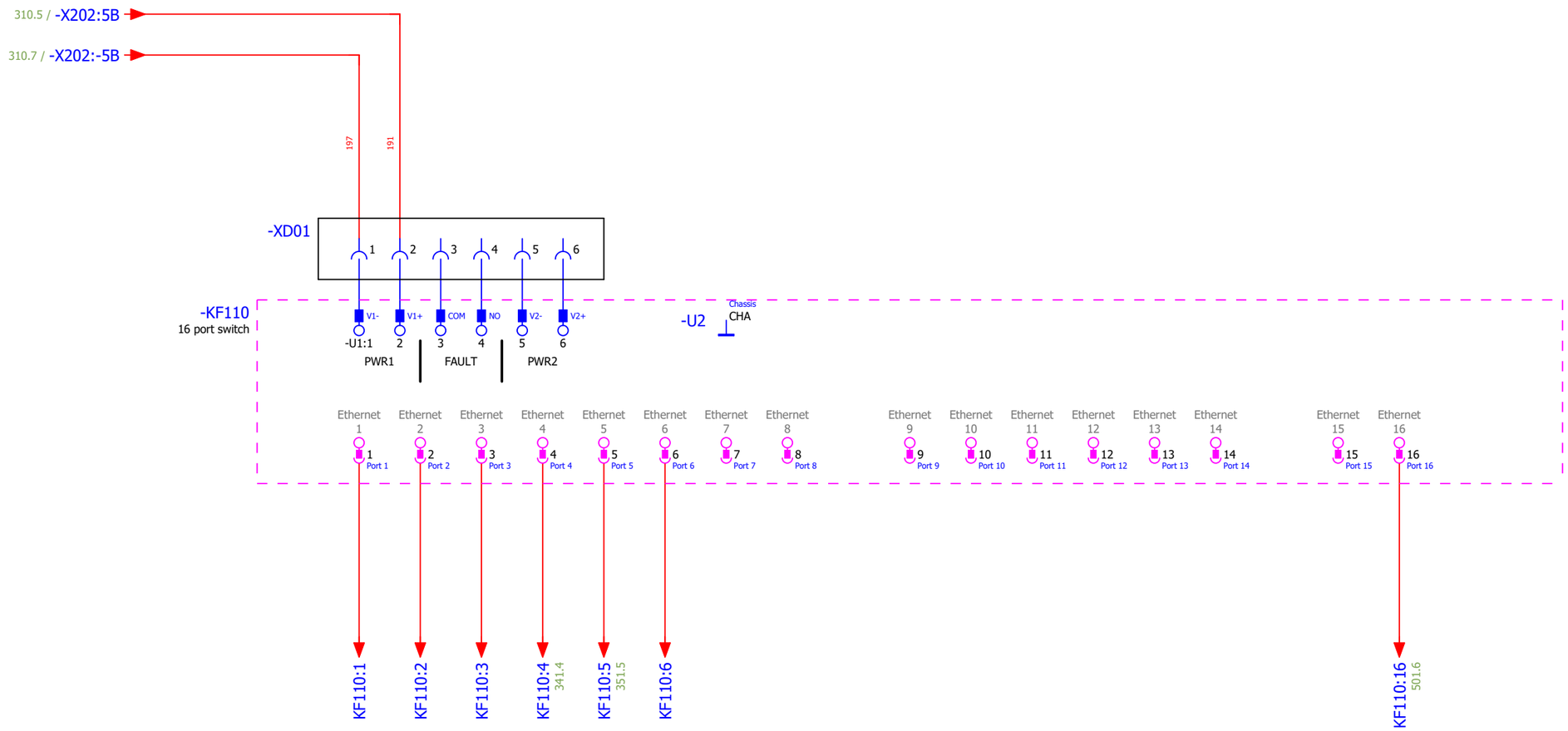
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Hydrogen Manifold pressure		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 372 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

40ft Coolant Skid - Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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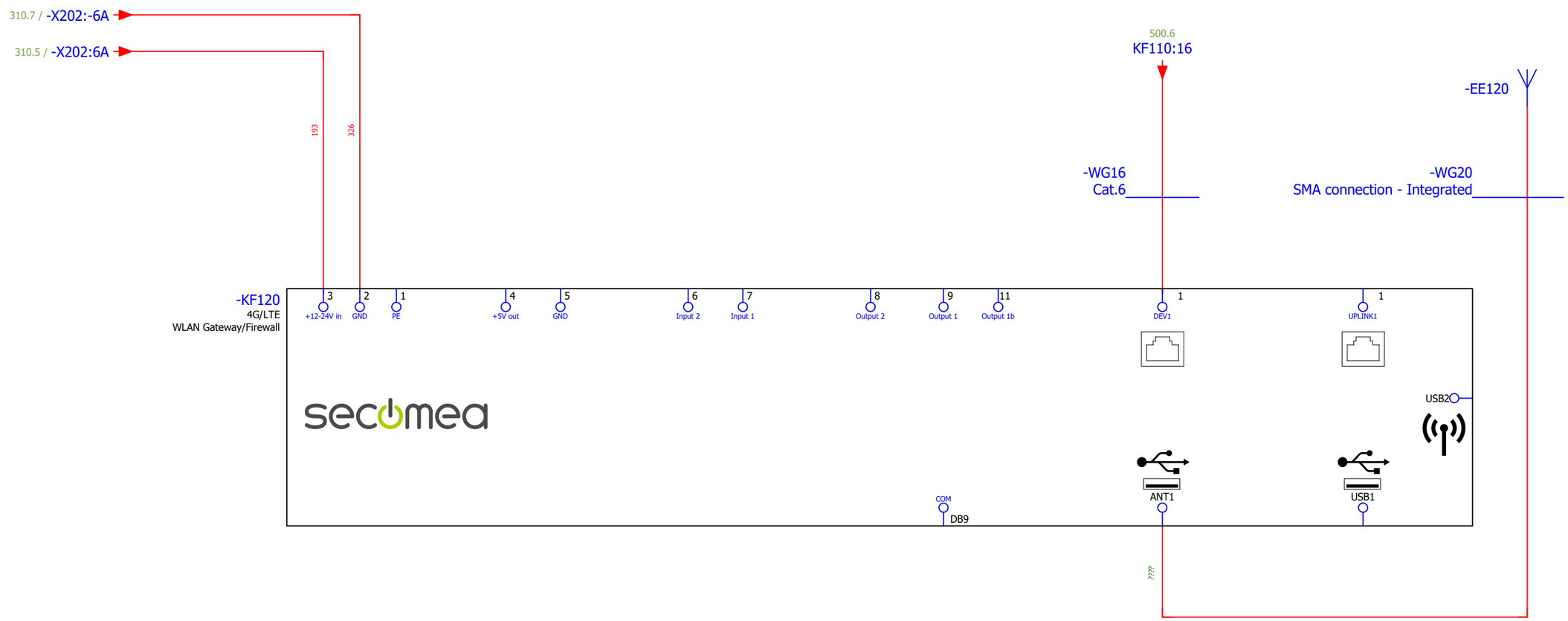
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Newtwork switch		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 500 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01+UC30

40ft Coolant Skid - Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C03

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	40ft Coolant Skid - Secomea		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 501 / 2

FRM5103656/0B

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Ballard Power Systems Europe - Technology Solutions

Panel Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Panel Documentation and Layout		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=LA01-14		1	PE	1	0	4	
=LA01-X1		L1	PE	0	0	5	
=LA01-X02		PE	PE	0	0	1	
=LA01-X11		1	PE	1	0	4	
=LA01-X12		1	PE	1	0	4	
=LA01-X13		1	PE	1	0	4	
=LA01-X15		1	PE	1	0	4	
=LA01-X16		1	PE	1	0	4	
=LA01-X21		1	PE	1	0	4	
=LA01-X22		1	PE	1	0	4	
=LA01-X23		1	PE	1	0	4	
=LA01-X24		1	PE	1	0	4	
=LA01-X25		1	PE	1	0	4	
=LA01-X26		1	PE	1	0	4	
=LA01-X31		1	PE	1	0	4	
=LA01-X40		1	PE	1	0	4	
=LA01-X41		1	PE	1	0	4	
=LA01-X42		1	PE	1	0	4	
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=LA01-X110		1	16	0	0	16	
=LA01-X111		PE	8	0	0	9	
=LA01-X112		1	16	0	0	16	
=LA01-X113		PE	8	0	0	9	
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=LA01-X115		1	4	0	0	4	
=LA01-X201		1.1	3.6	0	0	18	
=LA01-X201-		1.1	3.6	0	0	18	
=LA01-X202		1.1	3.6	0	0	36	
=LA01-X203		1.1	3.6	0	0	18	
=LA01-X203-		1.1	3.6	0	0	18	
=LA01-X204		1.1	3.6	0	0	18	
=LA01-X204-		1.1	3.6	0	0	18	
=LA01-X206		1	4	0	0	4	
=LB02-XD03		1	1	0	0	1	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =LA01+UC30-14 - =LB02+UC30-XD03		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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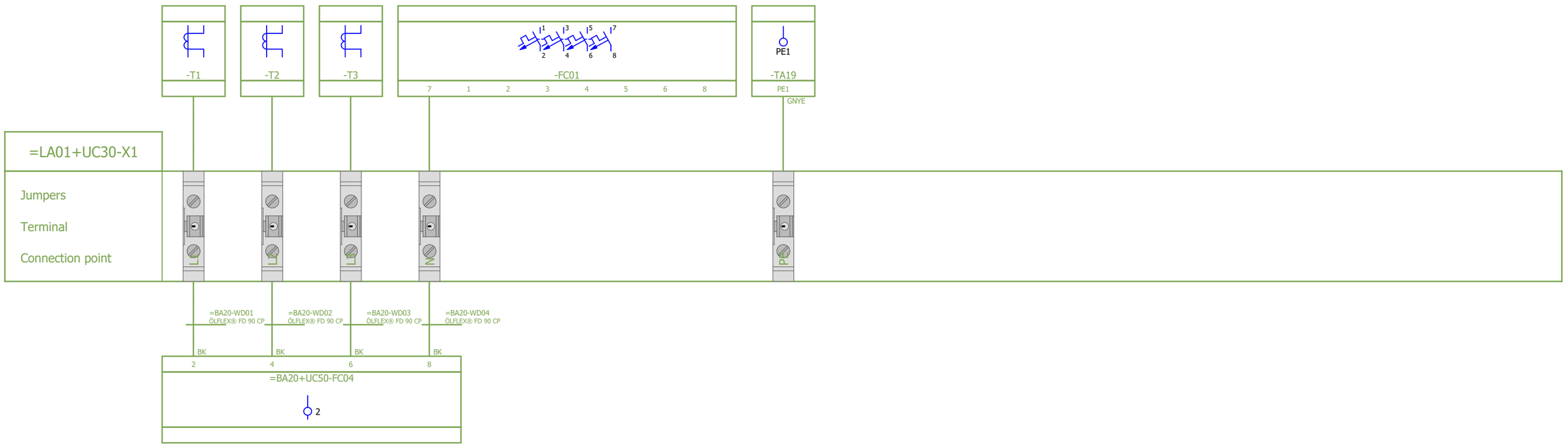
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-14		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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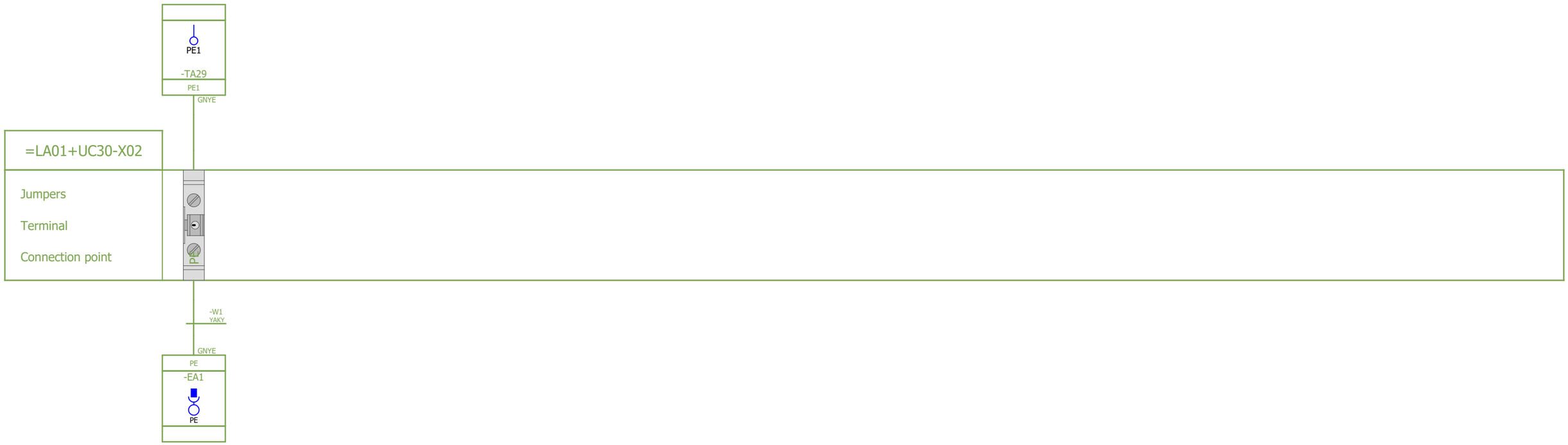
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X1		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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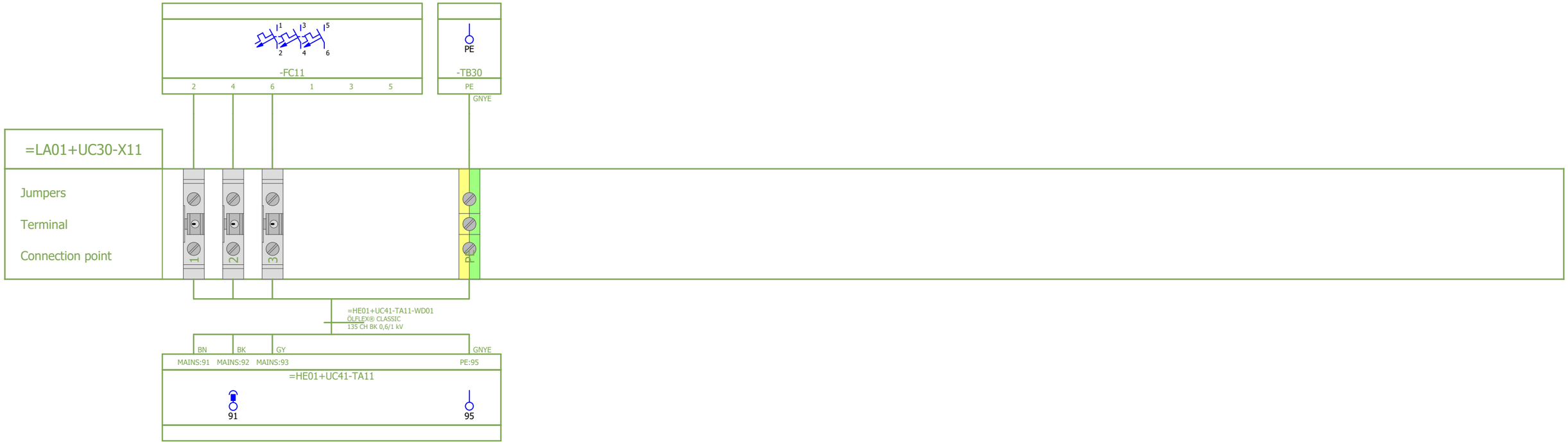
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 /

FRM5103656/0B

Terminal-connection diagram

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Internal targets



External targets

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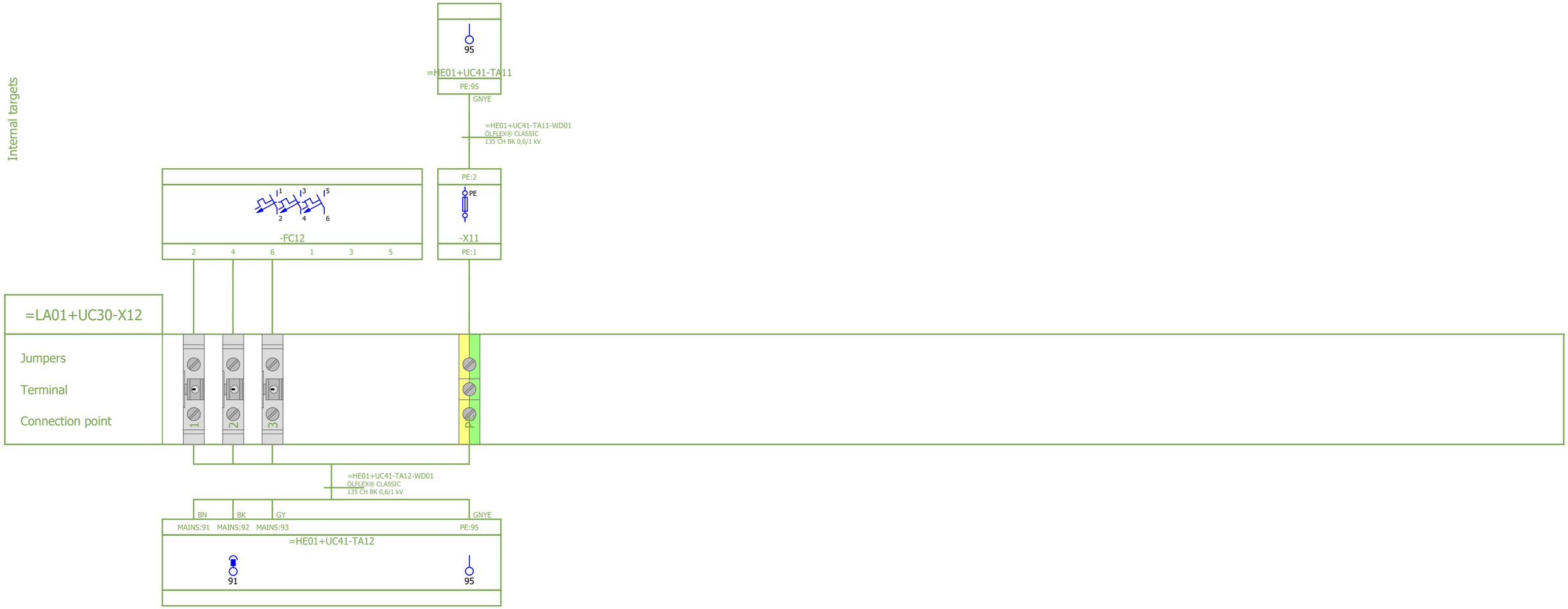
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X11		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 6 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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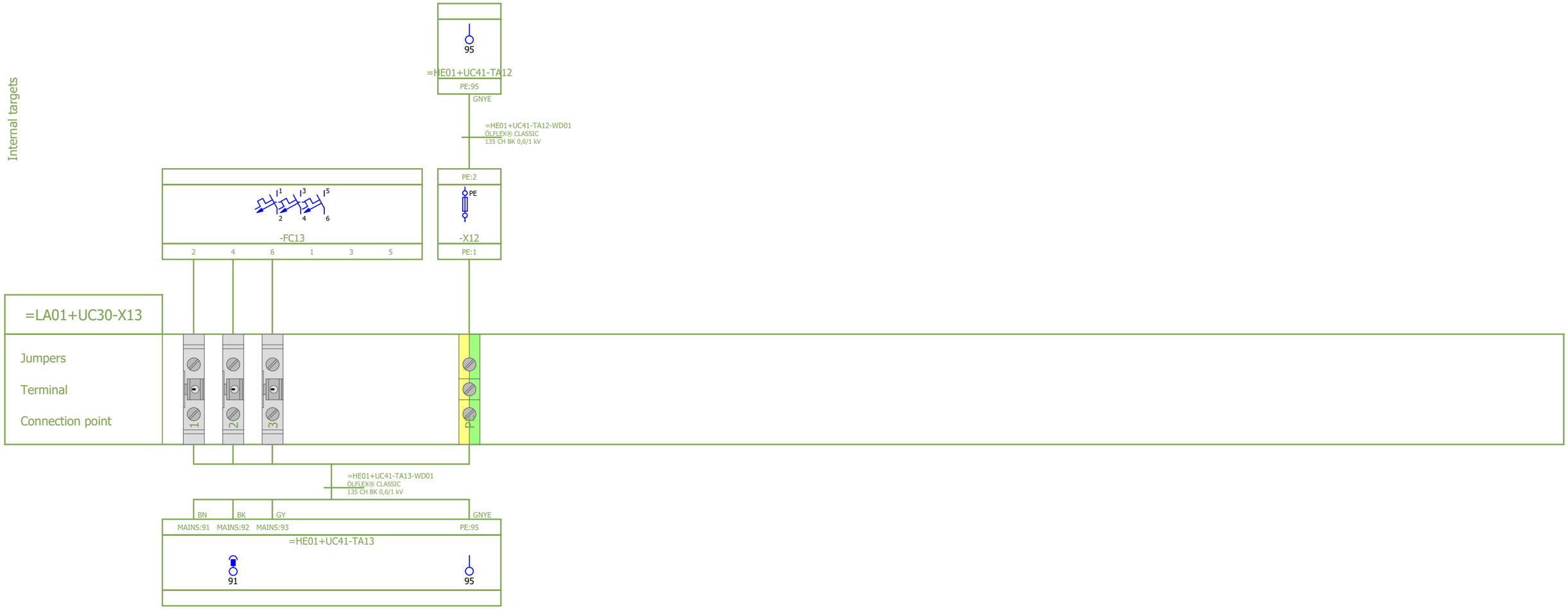
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X12		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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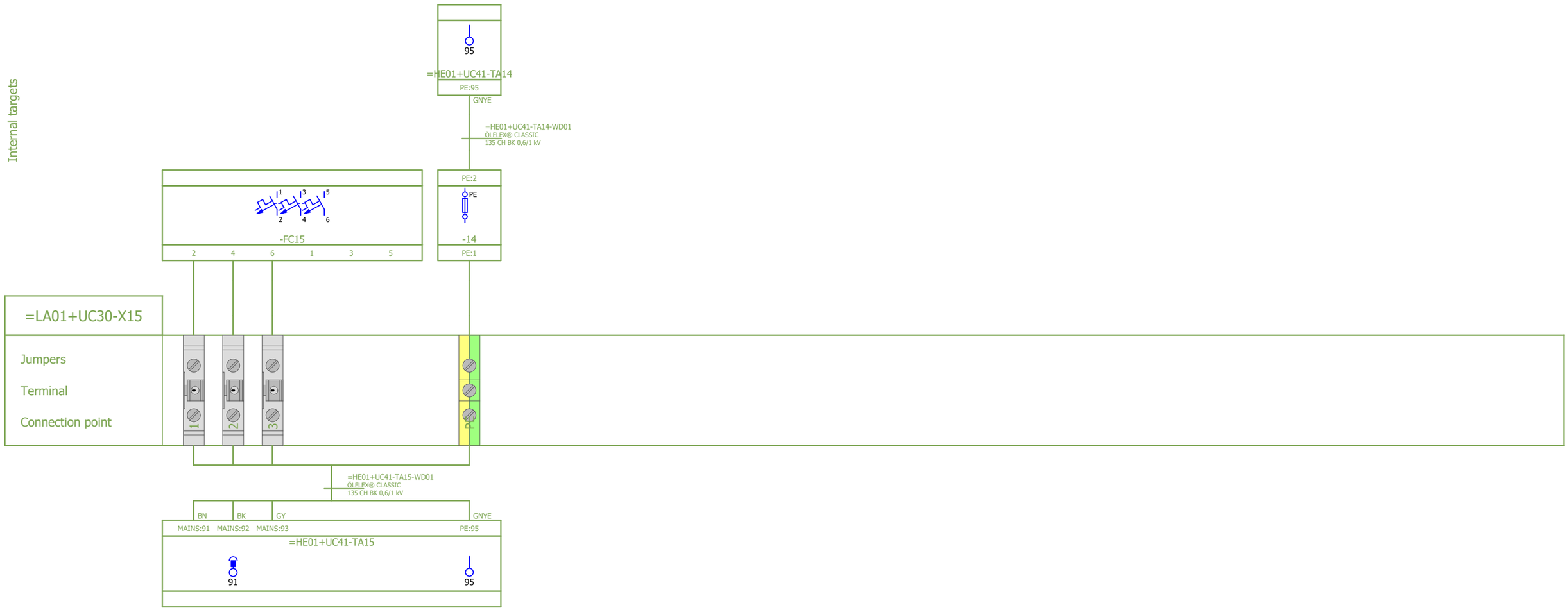
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X13		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 8 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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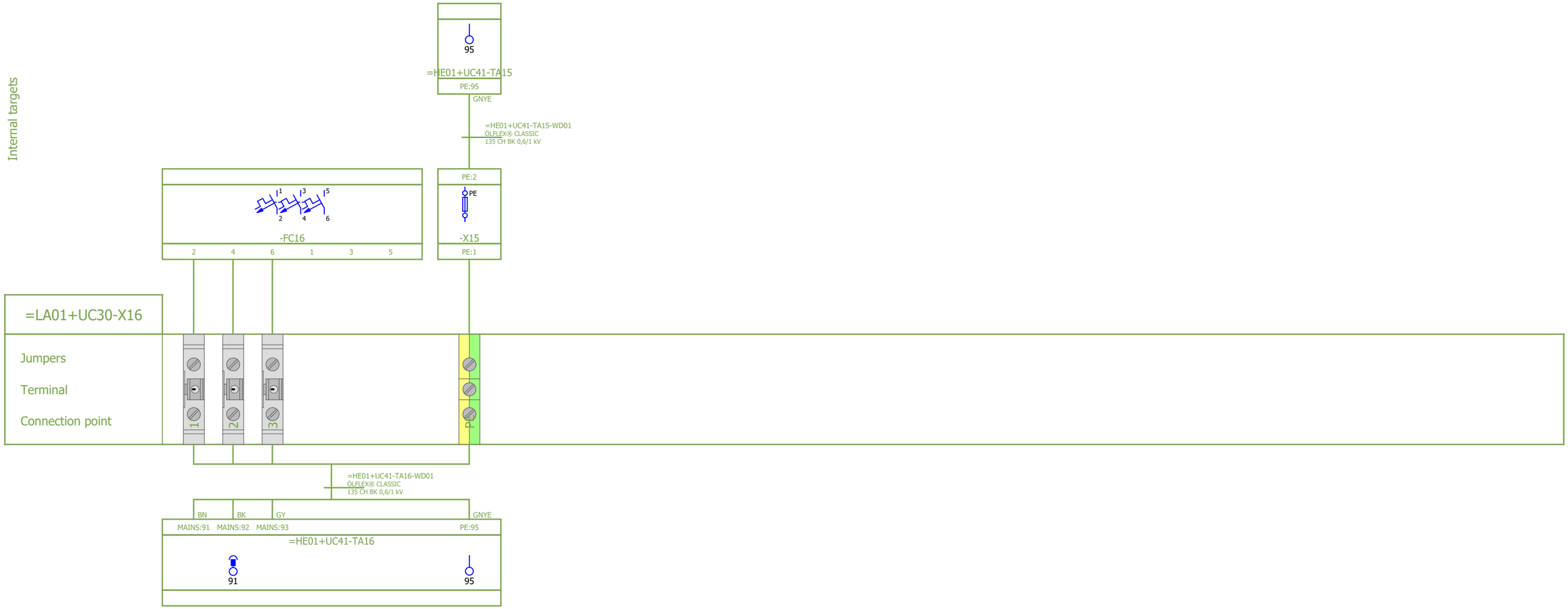
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 /

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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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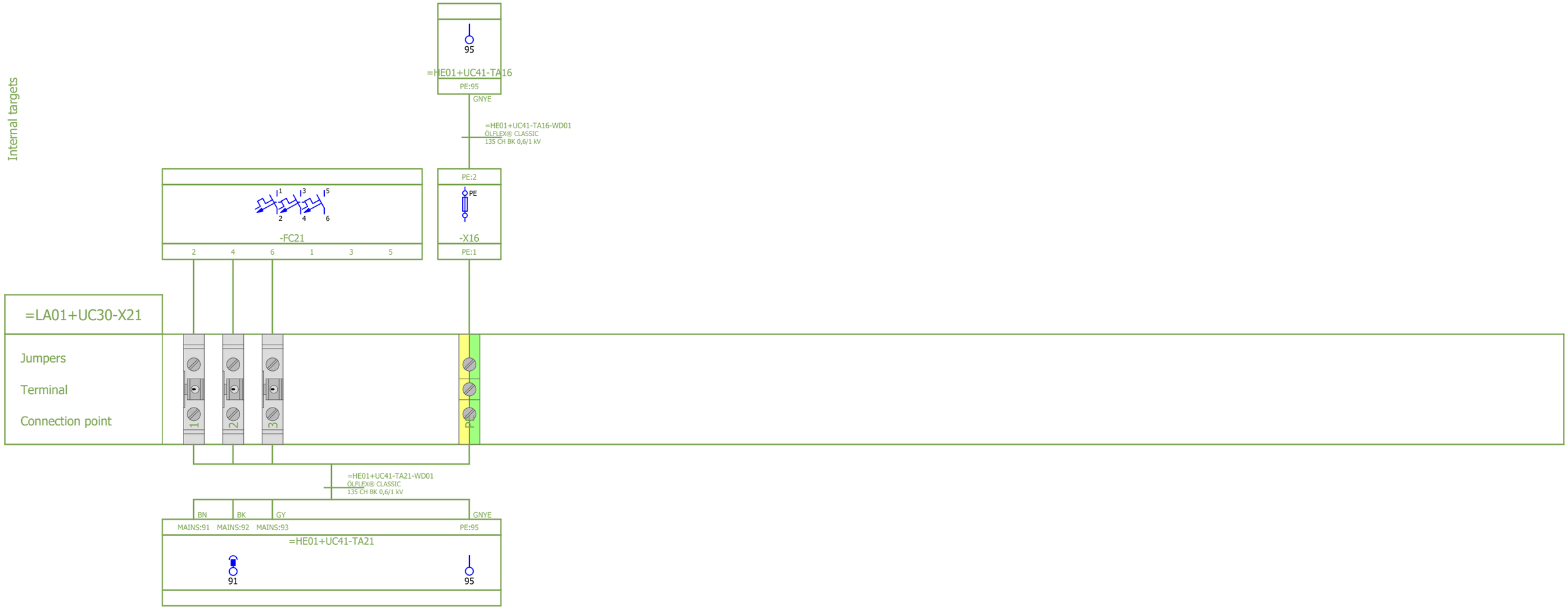
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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 /

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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
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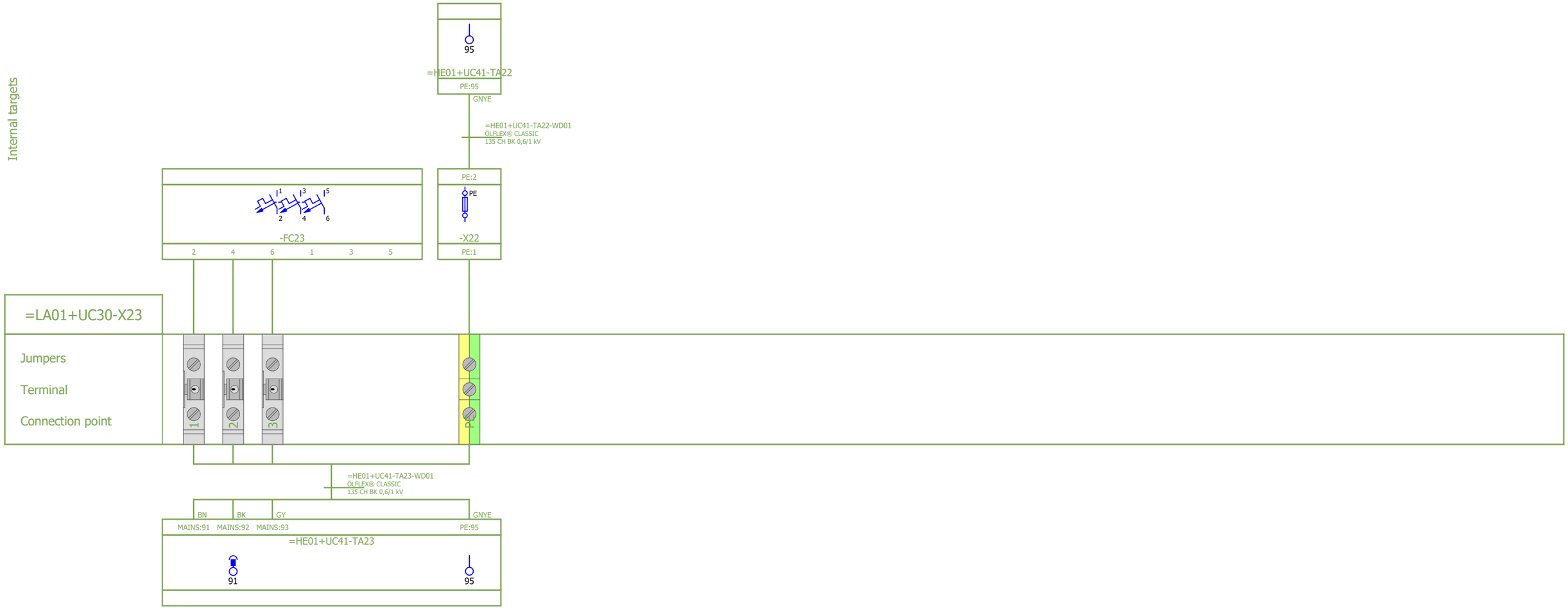
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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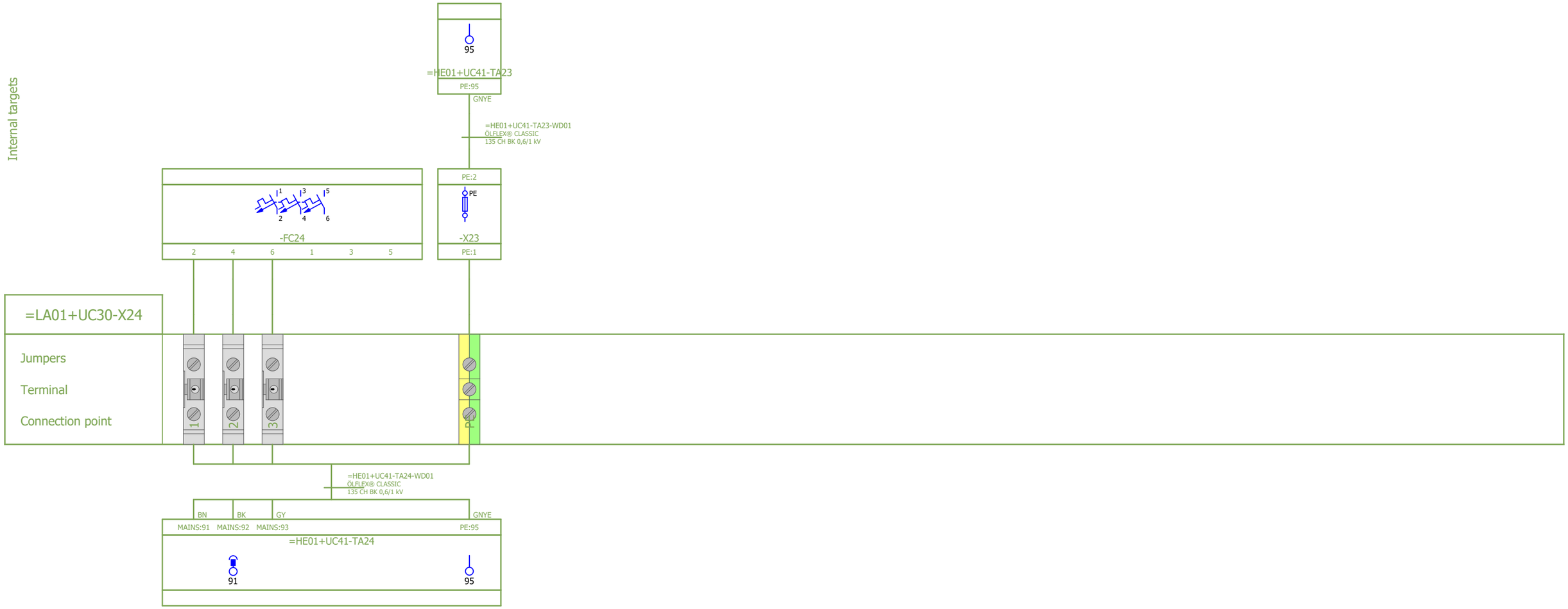
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ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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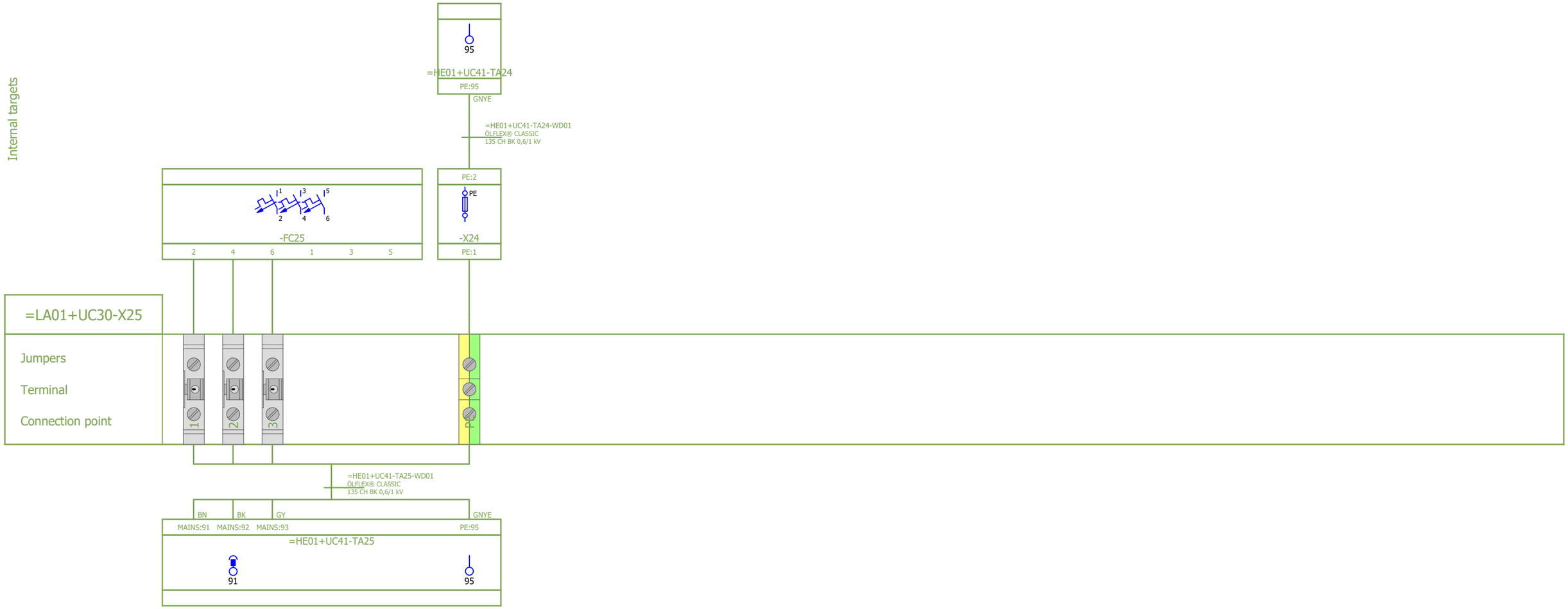
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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
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EPLAN Project Pages	478		
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Terminal-connection diagram

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PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
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Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X31		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 17 /

Terminal-connection diagram

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Internal targets

95
=HE01+UC41-TA31
PE:95
GNYE
=HE01+UC41-TA31-WD01
ÖLFLEX® CLASSIC
135 CH BK 0,6/1 kV

PE:2
PE
-X31
PE:1

1 3 5
2 4 6
-FC40
2 4 6 1 3 5

=LA01+UC30-X40

Jumpers
Terminal
Connection point

1 2 3 PE

=HE01+UC41-EA40-WD01
ÖLFLEX® CLASSIC
135 CH BK 0,6/1 kV

BN BK GY GNYE
1:2 2:1 3:2 PE:2
=HE01+UC41-XD40
1
1:3 2:5 3:3 PE:3

External targets

L1 L2 L3 PE
=HE01+UC41-EA40
L1

Reference Item Number	Ballard Part # TBD		
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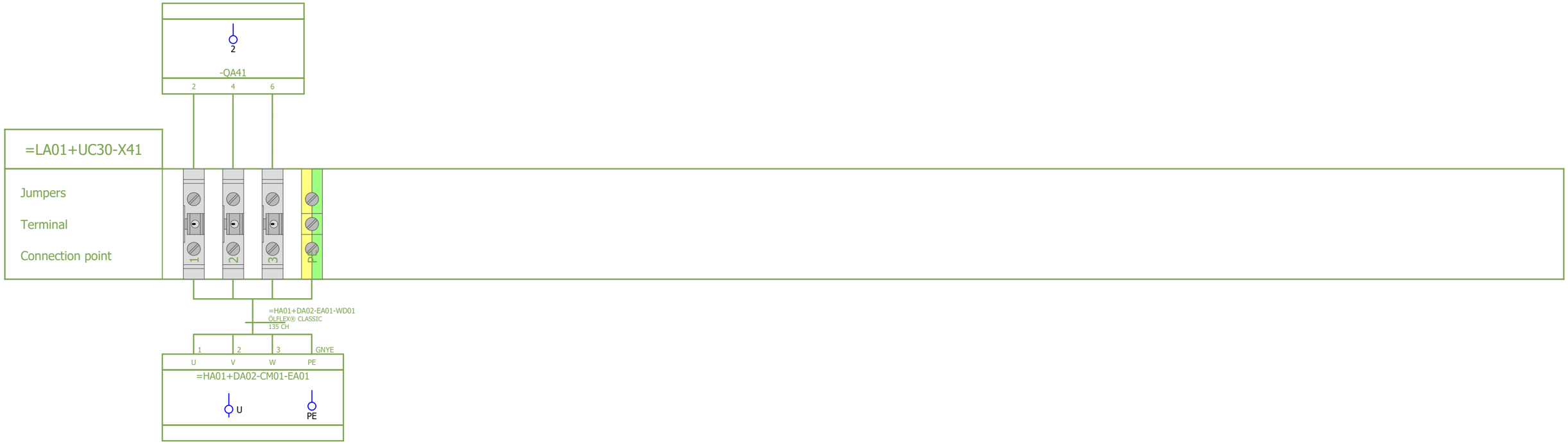
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FRM5103656/0B

Terminal-connection diagram

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Internal targets



External targets

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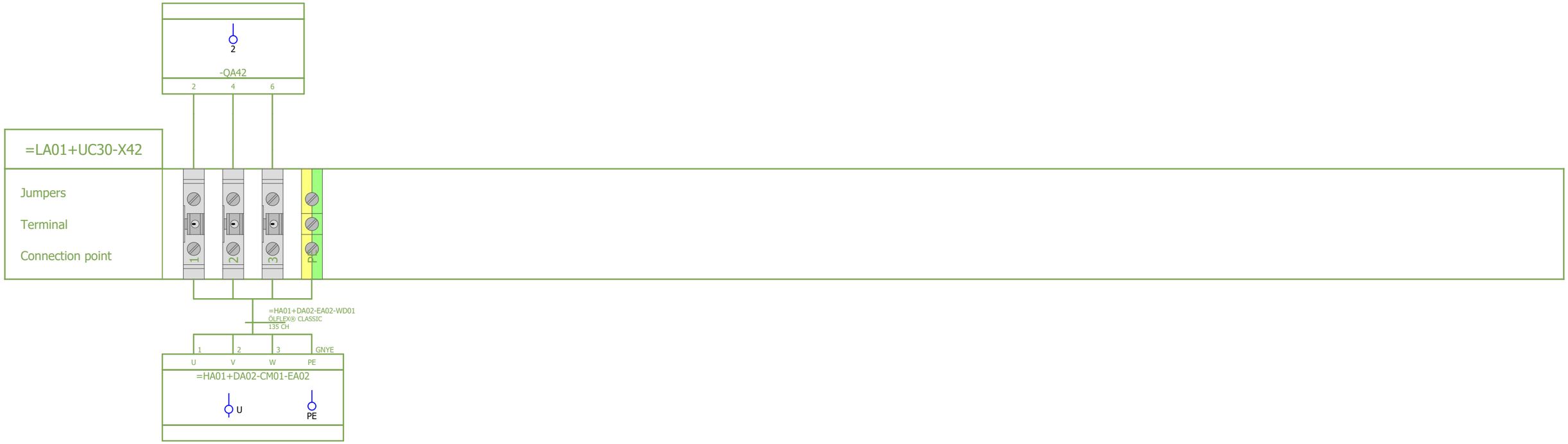
THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM

DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X41		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 19 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X42		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 20 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

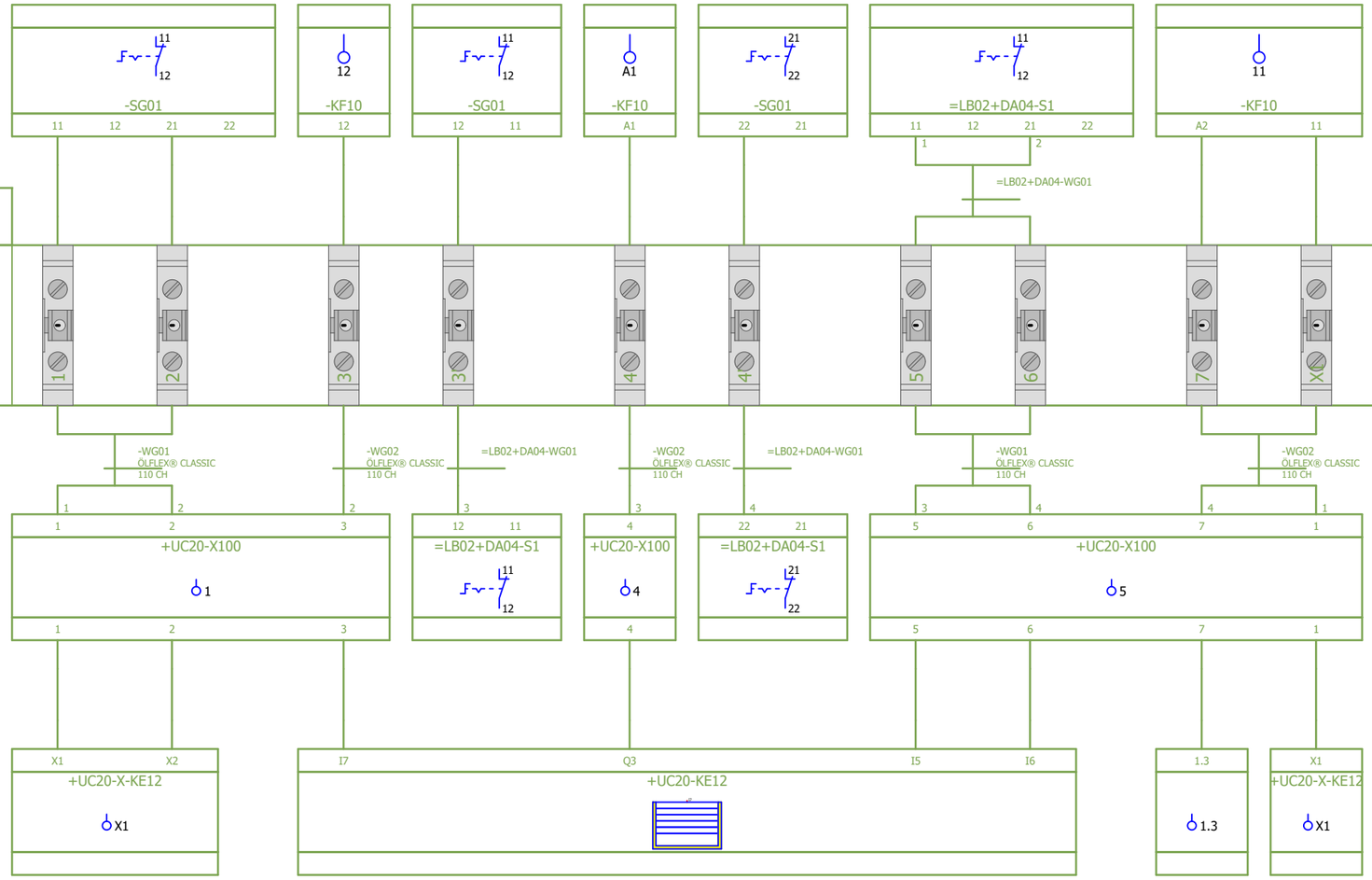
External targets

=LA01+UC30-X100

Jumpers

Terminal

Connection point



Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ | + UC30 | & C04

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DESCRIPTION
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X100		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 21 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

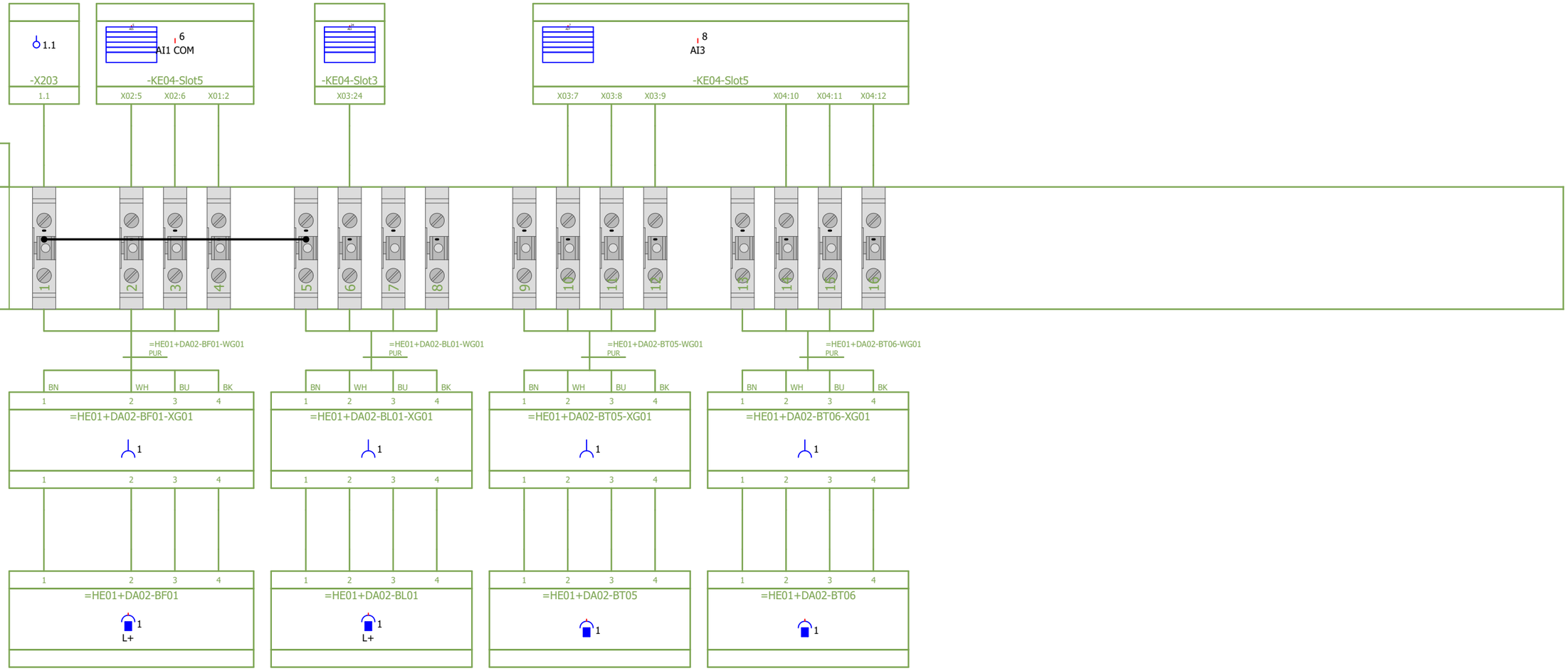
External targets

=LA01+UC30-X110

Jumpers

Terminal

Connection point



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION
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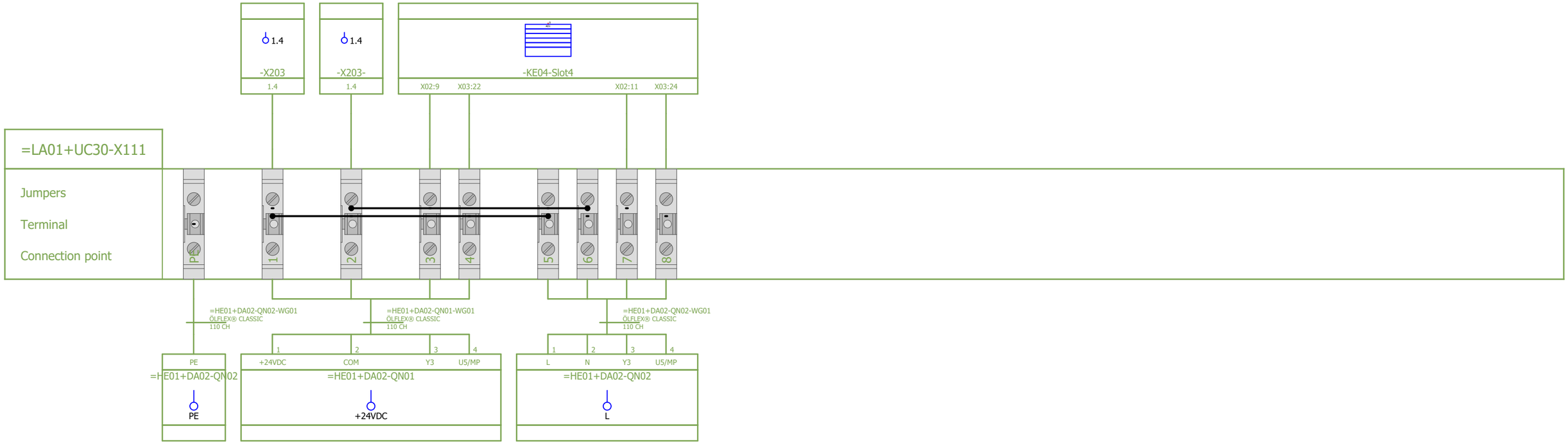
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X110		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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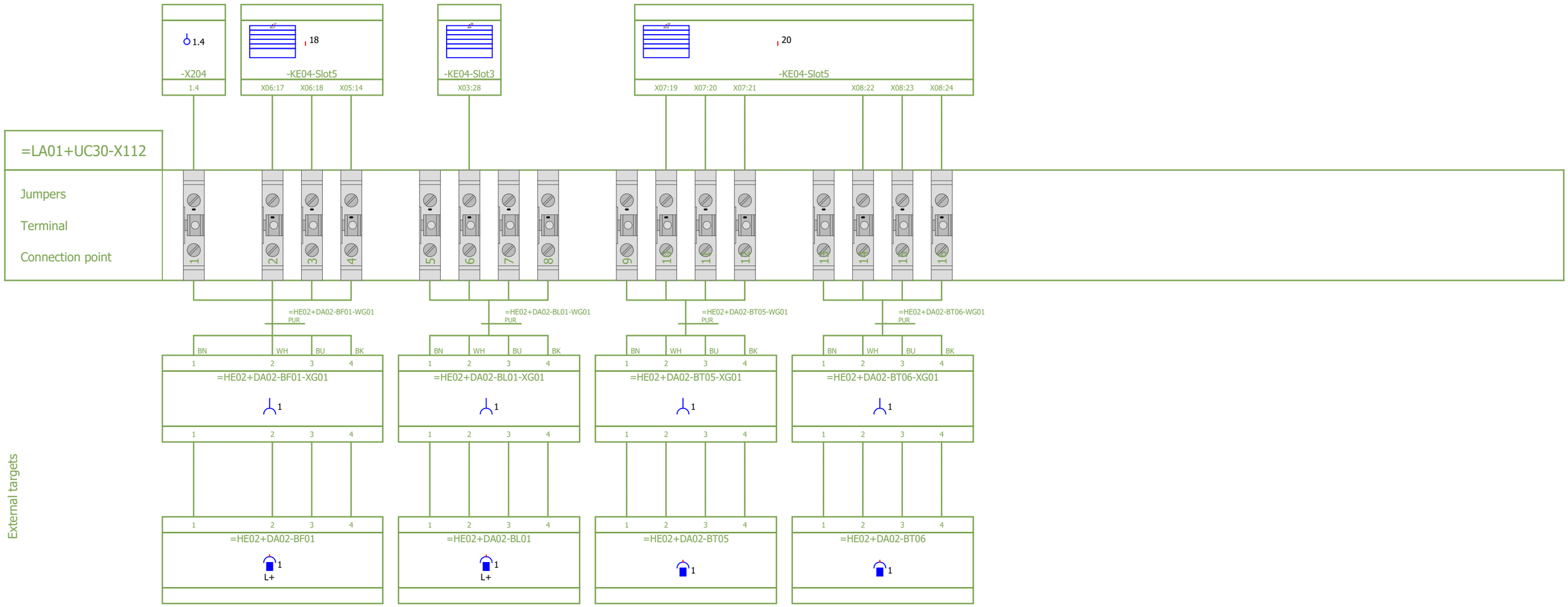
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X111		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 23 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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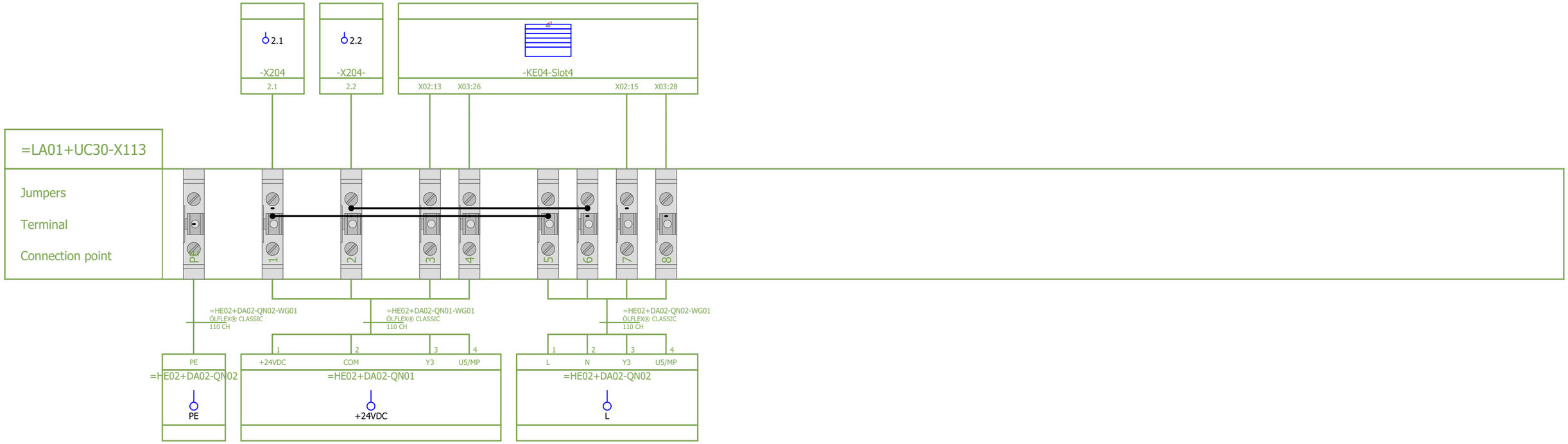
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X112		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 24 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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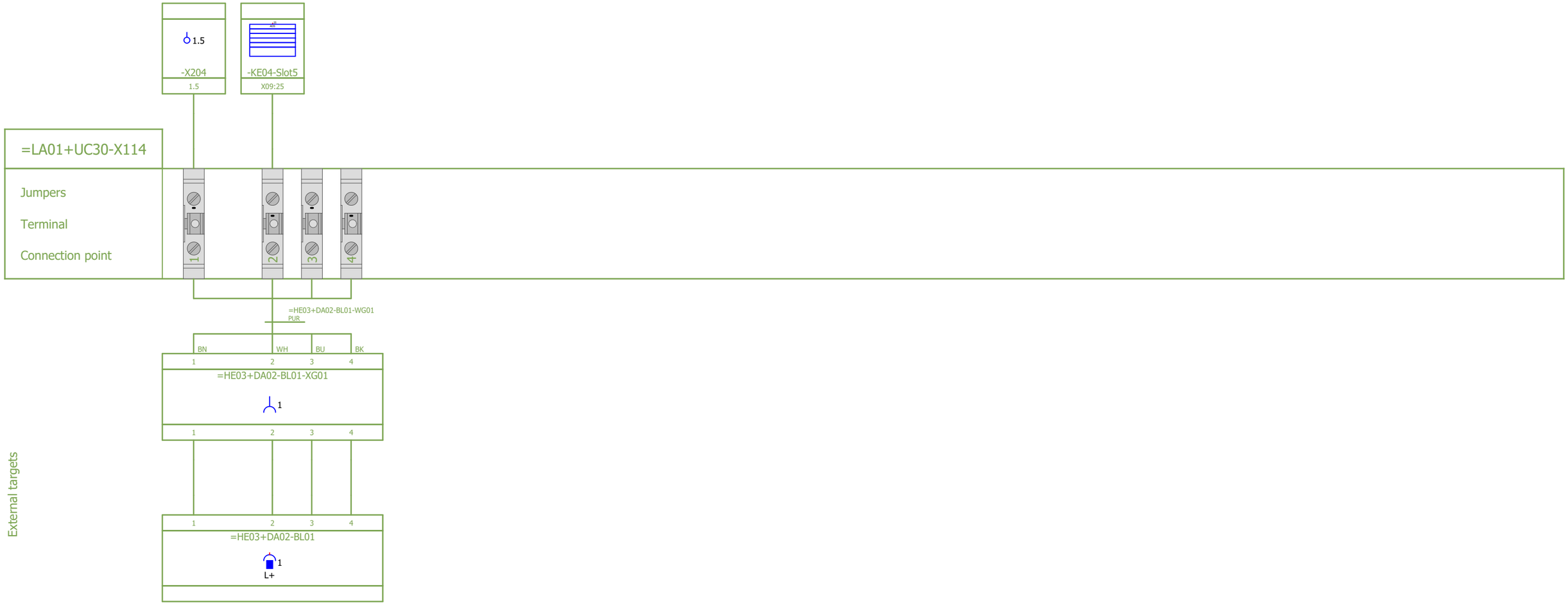
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X113		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 25 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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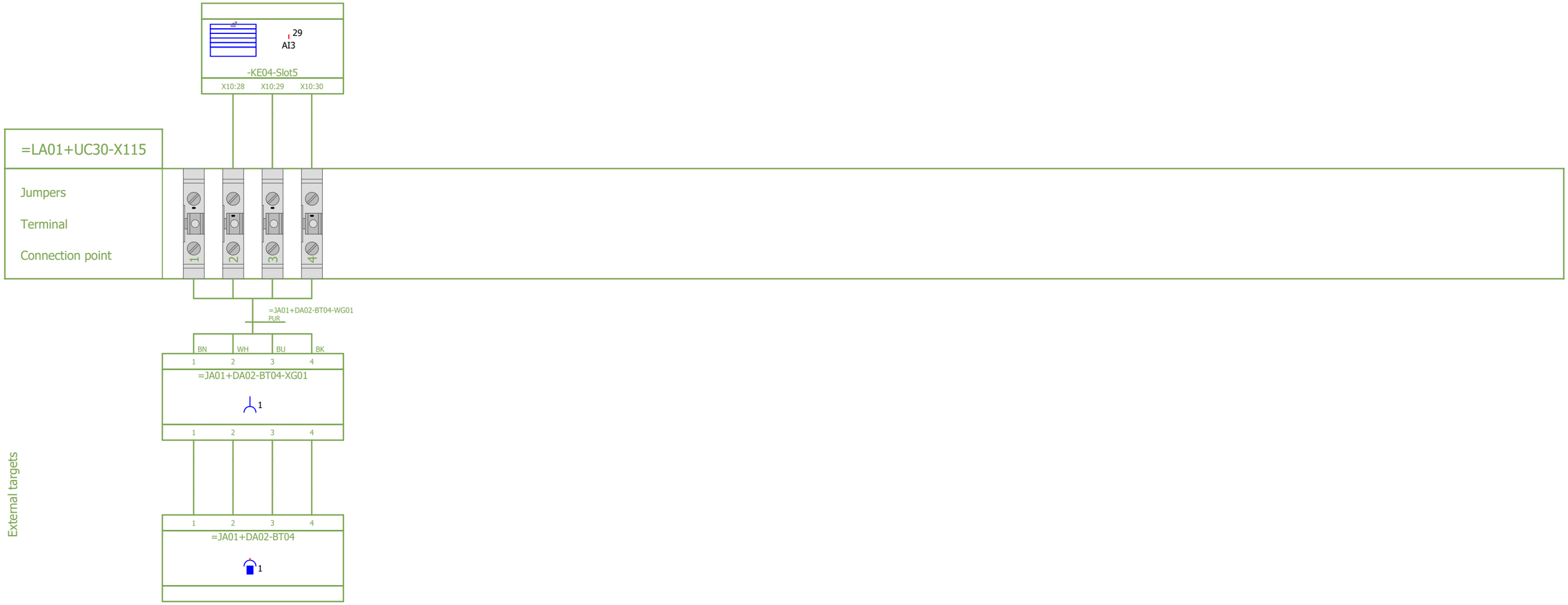
THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM

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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X114		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 26 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X115		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 27 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

OUT1
-FC201
OUT1

=LA01+UC30-X201

Jumpers
Terminal
Connection point



24
-KF10
24

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X201		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 28 /

FRM5103656/0B

Terminal-connection diagram

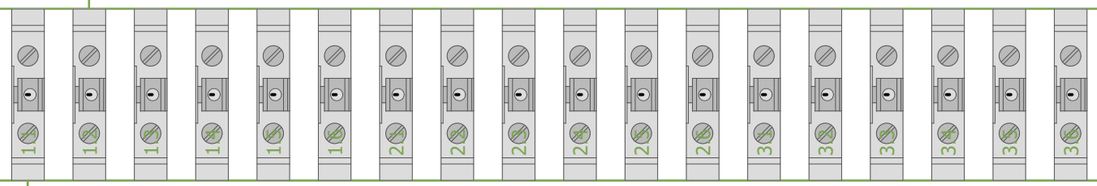
F11_001
PBL 05-Jun-24

Internal targets

0V1
-FC201
0V1

=LA01+UC30-X201-

Jumpers
Terminal
Connection point



34
-KF10
34

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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05-Jun-24	

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X201-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 29 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

=LA01+UC30-X202

Jumpers

Terminal

Connection point

-FC202 (OUT1 / 0V1)

-FC200 (14 / 13)

-FC11 (11 / 12 / 14)

-RB30 (1)

-KF110-U1 (U1:2 / U1:1)

-XD01 (2:V1+ / 1:V1-)

-TF03 (33 / 31)

-TF02 (32+ / 31-)

External targets

-FC31 (11 / 12 / 14)

=HE01-KE04-Slot3 (X03:21)

-FC21 (11 / 12 / 14)

-TA19 (6 / 7)

-TA29 (6 / 7)

-KF120 (X01:3 / X01:2)

-TF01 (12+)

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X202		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 30 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

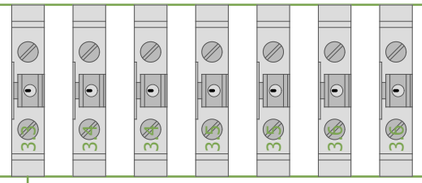
Internal targets

=LA01+UC30-X202

Jumpers

Terminal

Connection point



A2 A1

-QA10

A1

A2

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X202		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

+24VDC
=HE01+DA02-QN01
+24VDC
1

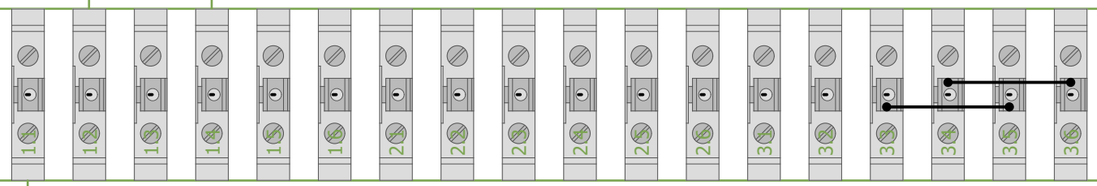
=HE01+DA02-QN01-WG01
ÖLFLEX® CLASSIC
110 CH

OUT1
-FC203
OUT1

1:3
1
-X111
1:2

=LA01+UC30-X203

Jumpers
Terminal
Connection point



External targets

1:2
-X110
1
1:3

=HE01+DA02-BF01-WG01
PUR
BN

1
=HE01+DA02-BF01-XG01
1
1

1
=HE01+DA02-BF01
1
L+

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

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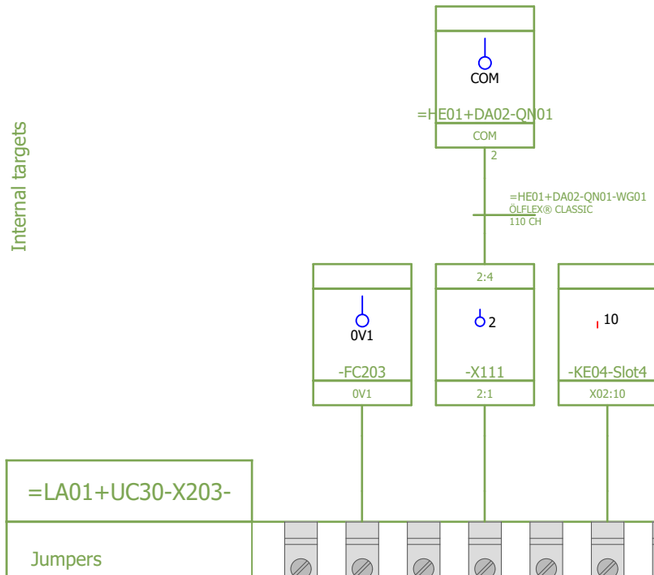
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X203		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 32 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC30-X203-

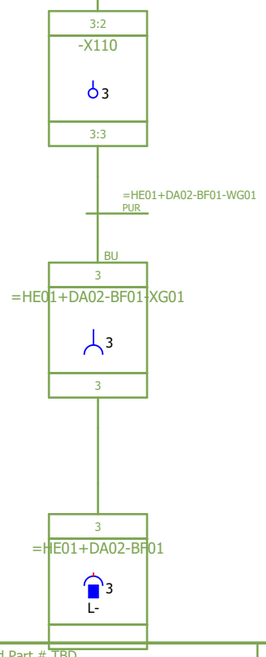
Jumpers

Terminal

Connection point



External targets



Reference Item Number	Ballard Part # TBD		
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EPLAN Revision	01.P15		
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DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X203-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

1
1
=HE02+DA02-BF01-XG01
1
BN
=HE02+DA02-BF01-WG01
PUR

1
OUT1
-FC204
OUT1

1:3
1
-X112
1:2

=LA01+UC30-X204

Jumpers
Terminal
Connection point

1:2
-X114
1
1:3

1:2
-X113
1
1:3

External targets

=HE03+DA02-BL01-WG01
PUR
=HE02+DA02-QN01-WG01
ÖLFLEX® CLASSIC
110 CH

BN
1
=HE03+DA02-BL01-XG01
1
1

1
+24VDC
=HE02+DA02-QN01
+24VDC

1
=HE03+DA02-BL01
1
L+

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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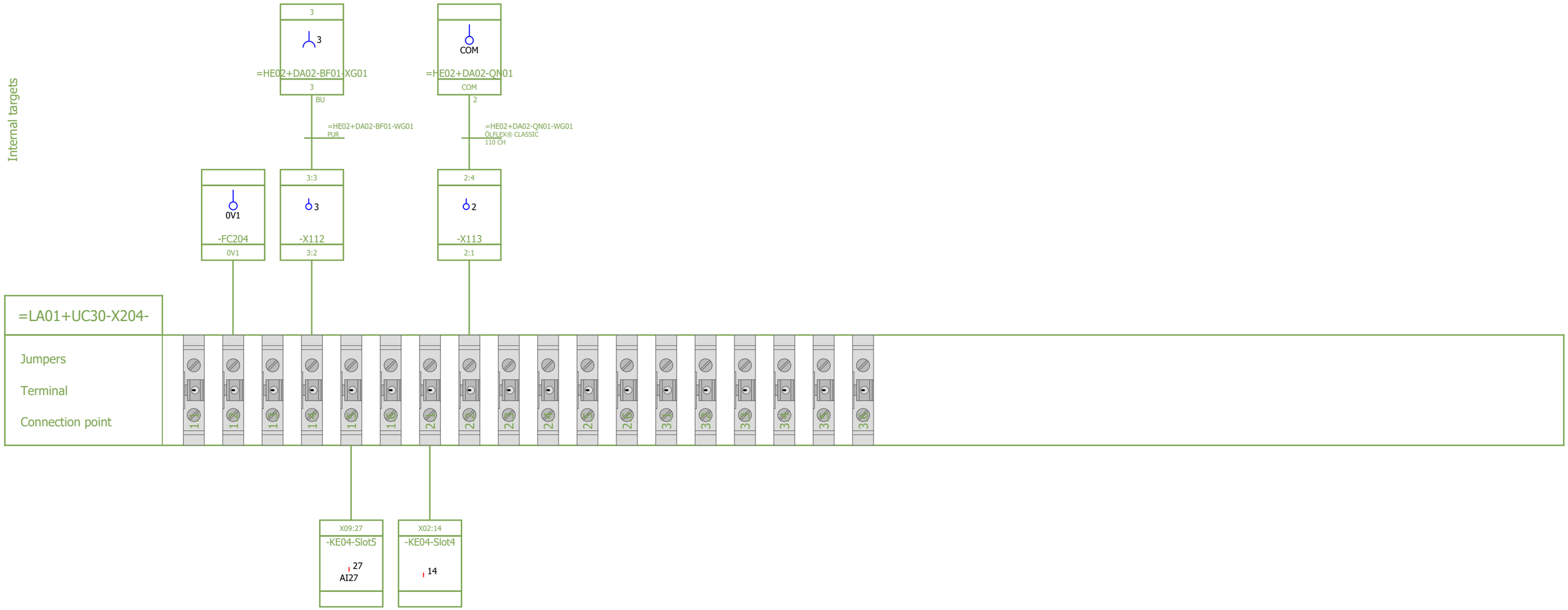
DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X204		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 34 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION	
DESCRIPTION	
DATE	
05-Jun-24	

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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X204-		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 /

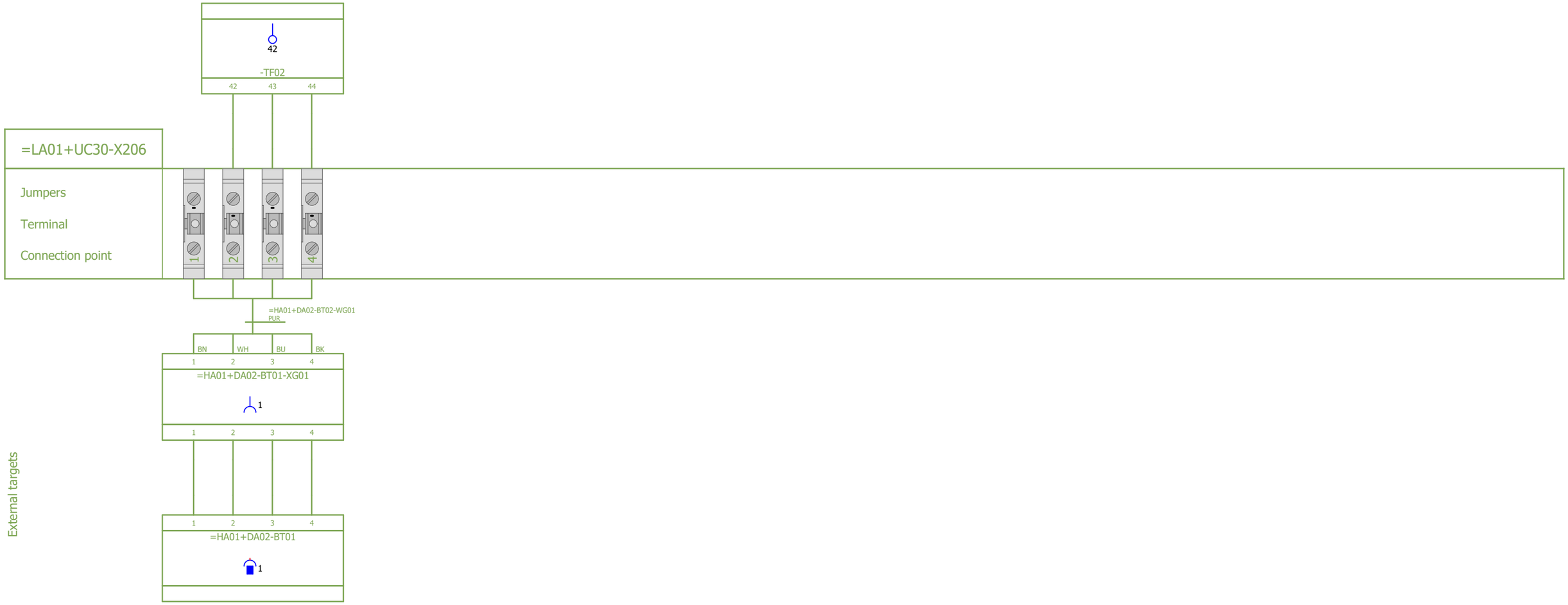
FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC30	& C04

REVISION INFORMATION
DESCRIPTION
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DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC30-X206		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 36 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=HKN70-WG03

=LB02+UC30-XD03

Jumpers	
Terminal	
Connection point	1

External targets

Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC30 Coolant Skid Control Cabinet	REVISION	01.P15
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE	Crosswind UC30 Coolant Skid Control Cabinet		
EPLAN Revision	01.P15					THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	SHEET TYPE/DESC	Terminal-connection diagram =LB02+UC30-XD03		
EPLAN Project Pages	478			DATE			ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 /
=	++	+ UC30	& C04	05-Jun-24						

FRM5103656/0B

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue

Document Title:	**BLPH Project - Panel Cabinet Layout: UC31 10ft Control Cabinet**
Document Number:	K559-2254-CWIWP4202202-E03-004
Revision:	Rev001
Sequence Number:	004
File Name:	K559-2254-CWIWP4202202-E03-004Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8

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+UC31

Ballard Power Systems Europe - Technology Solutions

Cabinet: 10ft Container Control
Location: 10ft Container, Behind access hatch

Cabinet Supply:
Vin = 400VAC, 3P+N+PE
IKmax = 10kA
IP20

AC / DC Sense:
AC: Vin = 400VAC, 3ph
AC: IKmax = 25kA

DC: Vin = 750VDC
DC: IKmax = 10kA

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& A01

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

FRM5103656/0B

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- 1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	Black (BK)
AC Phase L1	Brown (BN)
AC Phase L2	Black (BK)
AC Phase L3	Grey (GY)
AC Neutral	Light Blue (BU)
Externally supplied circuit	Orange (OG)

DC Wiring Colors

DC Power Circuit	Black (BK)
DC Control Voltage (24V)	Dark Blue (BU)
DC Control Voltage Refence (0V)	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	White (WH)
Signal Wire (AI, AO)	Violet (VT)
Externally supplied circuit	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	Green/Yellow (GNYE)

Wire Color Abbreviations

BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& A01

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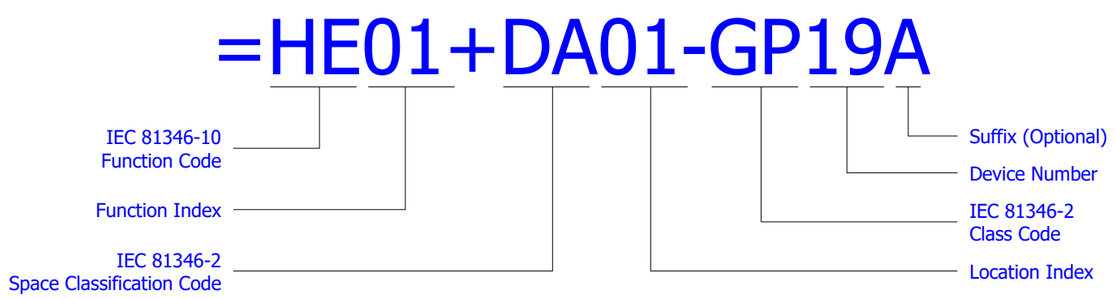
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

FRM5103656/0B

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
= ++ + UC31 & A01	

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

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Higher-Level Function	Mounting Location	Page	Page Description	Last Modified Date
	UC31	1	Front Page	05-Jun-24
	UC31	2	Standard Wire Colors	05-Jun-24
	UC31	3	Tagging Standard	05-Jun-24
	UC31	4	Table of contents : +UC31&A01/1 - +UC31&C03/16	05-Jun-24
	UC31	4.a	Table of contents : +UC31&C03/17 - +UC31&C04/3	05-Jun-24
	UC31	4.b	Table of contents : +UC31&C04/22 - +UC31&C04/51	05-Jun-24
	UC31	1	Container Controller, 20ft Rack 1/3	05-Jun-24
	UC31	2	Container Controller, 20ft Rack 1/3	05-Jun-24
	UC31	3	Container Controller, 20ft Rack 2/3	05-Jun-24
	UC31	4	Container Controller, 20ft Rack 3/3	05-Jun-24
	UC31	5	Safety Controller, 20ft Container 1/2	05-Jun-24
	UC31	6	Safety Controller, 20ft Container 2/2	05-Jun-24
	UC31	1	Multiline Documentation Intro	05-Jun-24
	UC31	2	AC Input	05-Jun-24
	UC31	3	PE Distribution	05-Jun-24
	UC31	4	AC - 24V Power Supplies	05-Jun-24
	UC31	5	AC - Container Heating	05-Jun-24
	UC31	6	AC - LT Fans	05-Jun-24
	UC31	7	AC - Precharge	05-Jun-24
	UC31	8	AC - Precharge	05-Jun-24
	UC31	9	AC - Sensing	05-Jun-24
	UC31	10	10A UPS Module	05-Jun-24
	UC31	11	40A UPS Module	05-Jun-24
	UC31	12	24V Fusing - FC100	05-Jun-24
	UC31	13	24V Fusing and Distribution - FC101	05-Jun-24
	UC31	14	24V Fusing and Distribution - FC102	05-Jun-24
	UC31	15	24V Fusing and Distribution - FC103	05-Jun-24
	UC31	16	24V Fusing and Distribution - FC104	05-Jun-24

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Table of contents : +UC31&A01/1 - +UC31&C03/16		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

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F06_002_Ballard

Higher-Level Function	Mounting Location	Page	Page Description	Last Modified Date
	UC31	17	PLC - 24V	05-Jun-24
	UC31	18	Safety PLC - 24V	05-Jun-24
	UC31	19	FC30 Breaker 24V	05-Jun-24
	UC31	20	FC30 Breaker DI DO	05-Jun-24
	UC31	21	MCCB Trip Indicators	05-Jun-24
	UC31	22	20ft Heating IO	05-Jun-24
	UC31	23	AC - Precharge IO	05-Jun-24
	UC31	24	Safety ESTOP	05-Jun-24
	UC31	25	Safety Relay KF31	05-Jun-24
	UC31	26	Safety Relay	05-Jun-24
	UC31	27	Safety Door Switches	05-Jun-24
	UC31	28	Safety Door Lock	05-Jun-24
	UC31	29	Safety Isolation Monitor	05-Jun-24
	UC31	30	Safety Smoke Detector	05-Jun-24
	UC31	31	Safety Battery Pack Inputs	05-Jun-24
	UC31	32	Safety Battery Pack Outputs	05-Jun-24
	UC31	33	Ventilation Damper IO	05-Jun-24
	UC31	34	Modbus Converter	05-Jun-24
	UC31	35	Network Switch	05-Jun-24
	UC31	36	LT Measurements	05-Jun-24
	UC31	37	Cont. Temp and Diff. Pressure	05-Jun-24
	UC31	38	Transformer Temperature Measurements	05-Jun-24
	UC31	39	Container ventilation and heating	05-Jun-24
	UC31	40	Container Lighting	05-Jun-24
	UC31	41	Main output breaker	05-Jun-24
	UC31	1	Panel Documentation and Layout	05-Jun-24
	UC31	2	Panel Layout	05-Jun-24
	UC31	3	Enclosure Legend	05-Jun-24

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
=	++ | + UC31 | & A01

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Table of contents : +UC31&C03/17 - +UC31&C04/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4.a /

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F06_002_Ballard

Higher-Level Function	Mounting Location	Page	Page Description	Last Modified Date
	UC31	22	Terminal-strip overview : =LA01+UC31-FC101-1 - =LA01+UC31-XE00	05-Jun-24
	UC31	30	Terminal-connection diagram =LA01+UC31-XD01	05-Jun-24
	UC31	31	Terminal-connection diagram =LA01+UC31-XD02	05-Jun-24
	UC31	32	Terminal-connection diagram =LA01+UC31-XD03	05-Jun-24
	UC31	33	Terminal-connection diagram =LA01+UC31-XD04	05-Jun-24
	UC31	34	Terminal-connection diagram =LA01+UC31-XD06	05-Jun-24
	UC31	35	Terminal-connection diagram =LA01+UC31-XD09	05-Jun-24
	UC31	36	Terminal-connection diagram =LA01+UC31-XD10	05-Jun-24
	UC31	37	Terminal-connection diagram =LA01+UC31-XD11	05-Jun-24
	UC31	38	Terminal-connection diagram =LA01+UC31-XD20	05-Jun-24
	UC31	39	Terminal-connection diagram =LA01+UC31-XD20	05-Jun-24
	UC31	40	Terminal-connection diagram =LA01+UC31-XD21	05-Jun-24
	UC31	41	Terminal-connection diagram =LA01+UC31-XD02	05-Jun-24
	UC31	42	Terminal-connection diagram =LA01+UC31-XD20	05-Jun-24
	UC31	43	Terminal-connection diagram =LA01+UC31-XD20	05-Jun-24
	UC31	47	Terminal-connection diagram =LA01+UC31-XE00	05-Jun-24
	UC31	48	Terminal-connection diagram =LA01+UC31-XD02	05-Jun-24
	UC31	49	Terminal-connection diagram =LA01+UC31-XD09	05-Jun-24
	UC31	50	Terminal-connection diagram =LA01+UC31-XD09	05-Jun-24
	UC31	51	Terminal-connection diagram =LA01+UC31-XD02	05-Jun-24

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& A01

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Table of contents : +UC31&C04/22 - +UC31&C04/51		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4.b /

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Ballard Power Systems Europe - Technology Solutions

Controller IO Overview

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C02

REVISION INFORMATION	
DESCRIPTION	
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05-Jun-24	

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, 20ft Rack 1/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC31-KE06
DEIF AMC300
Controller Extension Rack

-Slot1
DEIF PSM3.2
Power Supply
Module 3.2

PSM3.2

	PE	PE &C03/17.1		Frame Ground
	1	12/24V &C03/17.1		Supply +
	2	0V &C03/17.1		Supply COM
	3	R1 COM		Status OK Relay COM
A52.4	4	DO1	DO1	Status OK Relay
	5	R2 COM		Relay 2 COM
A52.5	6	DO2	DO2	Relay 1 Out
	7	R3 COM		Relay 3 COM
A52.6	8	DO3	DO3	Relay 3 Out

EtherCAT Follower Ring Topology — EtherCAT — +&C01/8.a.5:C +&C01/8.8:E — X03 — Ethernet-1 IN

EtherCAT Follower Ring Topology — EtherCAT — +&C01/8.a.6:C +&C01/8.8:E — X03 — Ethernet-2 OUT

Bus Follower
Multi-line 300

-Slot2
&C03/9.1
&C03/9.2
ACM3.1
Alternating Current Module 3.1

ACM3.1

1	L1 &C03/9.1	BA30_BA01_L1	Main Output (Busbar) - L1 Voltage	
2	L2 &C03/9.1	BA30_BA01_L2	Main Output (Busbar) - L2 Voltage	
3	L3 &C03/9.1	BA30_BA01_L3	Main Output (Busbar) - L3 Voltage	
4	N &C03/9.2	BA30_BA01_N	Main Output (Busbar) - N Voltage	
5	L1 &C03/9.3	BA30_BA02_L1	Main Output (Customer) - L1 Voltage	
6	L2 &C03/9.3	BA30_BA02_L2	Main Output (Customer) - L2 Voltage	
7	L3 &C03/9.3	BA30_BA02_L3	Main Output (Customer) - L3 Voltage	
8	N &C03/9.4	BA30_BA02_N	Main Output (Customer) - N Voltage	
9	L1 &C03/9.5	BA30_BC01_L1	Main Output (Busbar) - L1 Current	
10	L1 &C03/9.5	CH1-S2	Channel 1 - S2	
11	L2 &C03/9.6	BA30_BC01_L2	Main Output (Busbar) - L2 Current	
12	L2 &C03/9.6	CH2-S2	Channel 2 - S2	
13	L3 &C03/9.7	BA30_BC01_L3	Main Output (Busbar) - L3 Current	
14	L3 &C03/9.8	CH3-S2	Channel 3 - S2	
15	4-S1	CH4-S1	Channel 4 - S1	
16	4-S2	CH4-S2	Channel 4 - S2	

-Slot3
&C03/23.2
&C03/40.2
&C03/10.3
&C03/10.2
&C03/11.2
IOM3.1
Input Output Module 3.1

IOM3.1

1	DO1.1 &C03/23.2	UC31_QA40_O	Precharge contactor coil	
2	R1 COM &C03/23.2		Relay 1 Common	
3	DO1.2		Relay 1 NC	
4	DO2.1 &C03/40.2	DA03_EA01	Container lighting	
5	R2 COM &C03/40.2		Relay 2 Common	
6	DO2.2		Relay 2 NC	
7	DO3.1		Relay 3 NO	
8	R3 COM		Relay 3 Common	
9	DO3.2		Relay 3 NC	
10	DO4.1		Relay 4 NO	
11	R4 COM		Relay 4 Common	
12	DO4.2		Relay 4 NC	
13	DIO1 &C03/10.3	UC31_RB01_BAT	20ft PLC UPS Battery Operation	
14	DIO2 &C03/10.2	UC31_RB01_DIS	20ft PLC UPS Battery Discharged	
15	DIO3 &C03/10.4	UC31_RB01_RDY	20ft PLC UPS Battery Ready	
16	DIO4 &C03/11.3	UC31_RB02_BAT	20ft Breaker UPS Battery Operation	
17	DIO5 &C03/11.2	UC31_RB02_DIS	20ft Breaker UPS Battery Discharged	
18	DIO6 &C03/11.4	UC31_RB02_RDY	20ft Breaker UPS Battery Ready	
19	DIO7 &C03/23.6	UC31_FC40_I	Precharge MCCB feedback	
20	DIO8 &C03/23.5	UC31_QA40_I	Precharge contactor feedback	
21	DIO9		Spare	
22	DIO10		Spare	
23	COM &C03/17.3		Supply COM	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C02

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DESCRIPTION
DATE
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, 20ft Rack 1/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC31-KE06
DEIF AMC300
Controller Extension Rack

-Slot4
&C03/20.1
&C03/33.3
&C03/33.4
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM	&C03/17.4		Relay 1 In
2	DO1	&C03/20.1	FC30_YO	Breaker FC30 Opening Coil
3	R2 COM	&C03/17.4		Relay 2 COM
4	DO2	&C03/20.2	FC30_YC	Breaker FC30 Closing Coil
5	R3 COM	&C03/17.4		Relay 3 In
6	DO3	&C03/20.3	FC30_RY	Breaker FC30 Trip Reset Coil
7	R4 COM	&C03/17.4		Relay 4 In
8	DO4	&C03/20.4	FC30_UR	Breaker FC30 Undervoltage Coil
9	AO1	&C03/33.3	JA01_QM07_SP	Intake Damper Position Setpoint
10	AO1 COM	&C03/33.3		AO1 COM
11	AO2	&C03/33.5	JA01_QM08_SP	Outlet Damper Position Setpoint
12	AO2 COM	&C03/33.5		AO2 COM
13	AO3			Spare
14	AO3 COM			AO3 COM
15	AO4			Spare
16	AO4 COM			AO4 COM
17	DI1	&C03/20.5	FC30_SPR	Breaker Sping Charge FB
18	DI2	&C03/20.6	FC30_Q1	Breaker Auxillary Contact Q1
19	DI3	&C03/20.7	FC30_Q2	Breaker Auxillary Contact Q2
20	DI4			Spare
21	DI1-4 COM	&C03/17.4		DI1-4 COM
22	AI1	&C03/33.4	JA01_QM07_FB	Damper Position Feedback
23	AI1 COM	&C03/33.4		AI1 COM
24	AI2	&C03/33.6	JA01_QM08_FB	Outlet Damper Position Feedback
25	AI2 COM	&C03/33.6		AI2 COM
26	AI3			Spare
27	AI3 COM			AI3 COM
28	AI4			Spare
29	AI4 COM			AI4 COM

-Slot5
&C03/22.2
&C03/21.8
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM	&C03/17.6		Relay 1 In
2	DO1	&C03/22.2	UC31_EA01_FAN	20ft Heater Fan Enable
3	R2 COM	&C03/17.6		Relay 2 COM
4	DO2	&C03/22.4	UC31_EA01_HTR	20ft Heater Enable
5	R3 COM			Relay 3 In
6	DO3			Breaker FC30 Trip Reset Coil
7	R4 COM			Relay 4 In
8	DO4			Battery Simulator Enable
9	AO1			Spare
10	AO1 COM			AO1 COM
11	AO2			Spare
12	AO2 COM			AO2 COM
13	AO3			Spare
14	AO3 COM			AO3 COM
15	AO4			Spare
16	AO4 COM			AO4 COM
17	DI1	&C03/21.8	IAH_05	MCCB Trip Indication AC Customer
18	DI2			Breaker Auxillary Contact Q1
19	DI3			Breaker Auxillary Contact Q2
20	DI4			Spare
21	DI1-4 COM			DI1-4 COM
22	AI1			Spare
23	AI1 COM			AI1 COM
24	AI2			Spare
25	AI2 COM			AI2 COM
26	AI3			Spare
27	AI3 COM			AI3 COM
28	AI4			Spare
29	AI4 COM			AI4 COM

-Slot6
&C03/21.1
IOM3.2
IO Module 3.2

IOM3.2

1	R1 COM			Relay 1 In
2	DO1			Relay 1 out
3	R2 COM			Relay 2 COM
4	DO2			Relay 2 Out
5	R3 COM			Relay 3 In
6	DO3			Relay 3 Out
7	R4 COM			Relay 4 In
8	DO4			Relay 4 Out
9	AO1			Spare
10	AO1 COM			AO1 COM
11	AO2			Spare
12	AO2 COM			AO2 COM
13	AO3			Spare
14	AO3 COM			AO3 COM
15	AO4			Spare
16	AO4 COM			AO4 COM
17	DI1	&C03/21.1	IAH_01	MCCB Trip Indication PSU
18	DI2	&C03/21.3	IAH_02	MCCB Trip Indication Heating
19	DI3	&C03/21.5	IAH_03	MCCB Trip Indication Battery
20	DI4	&C03/21.6	IAH_04	MCCB Trip Indication AC Busbar
21	DI1-4 COM	&C03/17.7		DI1-4 COM
22	AI1			Spare
23	AI1 COM			AI1 COM
24	AI2			Spare
25	AI2 COM			AI2 COM
26	AI3			Spare
27	AI3 COM			AI3 COM
28	AI4			Spare
29	AI4 COM			AI4 COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DESCRIPTION	
DATE	05-Jun-24

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, 20ft Rack 2/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC31-KE06
DEIF AMC300
Controller Extension Rack

-Slot7
&C03/36.2
&C03/37.1
&C03/37.5
IOM3.3
IO Module 3.3

IOM3.3

1	AI1			Spare
2	AI2	&C03/36.2	HE03_BF02_FT	LT Coolant Flow Auxillary Sensor
3	AI3	&C03/36.2		Spare
4	AI4			Spare
5	AI5	&C03/36.3	HE03_BF02_TT	LT Coolant 20ft Temperature
6	AI6	&C03/36.3		Spare
7	AI7	&C03/36.4	HE03_BT07_TT	LT Coolant 20ft Forward
8	AI8	&C03/36.4		LT Coolant 20ft Forward
9	AI9	&C03/36.4		Spare
10	AI10	&C03/37.1	DA03_BT01	Container temperature
11	AI11	&C03/37.1		Spare
12	AI12	&C03/37.1		Spare
13	AI13		TA30_U_TT	TA30 U Primary Temp
14	AI14			Spare
15	AI15			Spare
16	AI16		TA30_V_TT	TA30 V Primary Temp
17	AI17			Spare
18	AI18			Spare
19	AI19		TA30_W_TT	TA30 W Primary Temp
20	AI20			Spare
21	AI21			Spare
22	AI22			Spare
23	AI23	&C03/37.5	DA03_BP01	Container Diff. Pressure
24	AI24	&C03/37.5		Spare
25	AI25			Spare
26	AI26			Spare
27	AI27			Spare
28	AI28			Spare
29	AI29			Spare
30	AI30			Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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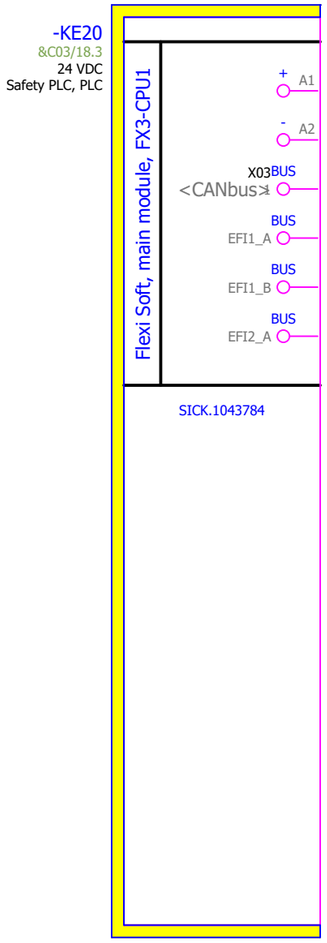
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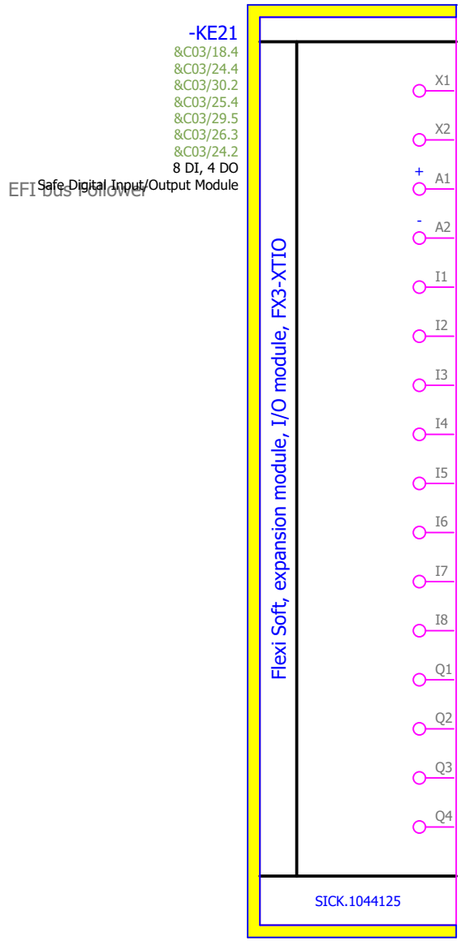
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container Controller, 20ft Rack 3/3		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 18

0	1	2	3	4	5	6	7	8

=LB02+UC31
Container Safety System, Control Cabinet 20 ft





X1	&C03/24.2	KE21PULSE01	KE21 Test pulse output CH1
X2	&C03/24.3	KE21PULSE02	KE21 Test pulse output CH2
I1	&C03/24.4	LB02_SG03_CH1	ESTOP SG03-CH1
I2	&C03/24.5	LB02_SG03_CH2	ESTOP SG03-CH21
I3	&C03/30.2	LB02_BQ07	Smoke Detector, 20ft Container 1/3
I4	&C03/30.4	LB02_BQ08	Smoke Detector, 20ft Container 2/3
I5	&C03/30.7	LB02_BQ09	Smoke Detector, 20ft Container 3/3
I6	&C03/25.4	LB02_KF30_FB	Safety Relay KF30 Feedback
I7	&C03/29.5	BB01_WARN	Isolation Monitor Value Warn
I8	&C03/29.6	BB01_ALARM	Isolation Monitor Value Alarm
Q1	&C03/26.3	LB02_KF30_Q	Safety Relay KF30 Coil

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
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=	++ | + UC31 | & C02

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 20ft Container 1/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 18

0	1	2	3	4	5	6	7	8

=LB02+UC31

Container Safety System, Control Cabinet 20 ft

-KE22

&C03/18.5
&C03/28.1
&C03/24.7
&C03/27.2
&C03/24.6

8 DI, 4 DO

Safe Digital Input/Output Module

Flexi Soft, expansion module, I/O module, FX3-XTIO

SICK.1044125

X1		KE22PULSE01	KE22 Test pulse output CH1
X2	&C03/24.6	KE22PULSE02	KE22 Test pulse output CH2
+ A1			
- A2			
I1	&C03/28.3	LB02_RL01_CH1	Door Lock Feedback CH1
I2	&C03/28.4	LB02_RL01_CH2	Door Lock Feedback CH2
I3	&C03/28.1	LB02_RL01_AUX	Door Lock Possible
I4	&C03/24.7	LB02_SG04	Safety System Reset
I5	&C03/27.2	LB02_BG01_CH1	Safety Door Sensor, Door A - CH1
I6	&C03/27.3	LB02_BG01_CH2	Safety Door Sensor, Door A - CH2
I7	&C03/27.5	LB02_BG02_CH1	Safety Door Sensor, Door B - CH1
I8	&C03/27.6	LB02_BG02_CH2	Safety Door Sensor, Door B - CH2
Q1	&C03/28.2	LB02_RL01_LOCK	Door Lock Command
Q2			
Q3			
Q4			

Safety IO - Battery Pack

-KE23

&C03/18.6
&C03/31.1
&C03/32.1

Flexi Soft, expansion module, I/O module, FX3-XTIO

SICK.1044125

X1	&C03/32.1
X2	&C03/32.2
+ A1	
- A2	
I1	&C03/31.1
I2	&C03/31.2
I3	&C03/31.3
I4	&C03/31.4
I5	&C03/31.4
I6	&C03/31.5
I7	&C03/31.6
I8	&C03/31.7
Q1	&C03/32.4
Q2	&C03/32.5
Q3	&C03/32.6
Q4	&C03/32.7

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Controller, 20ft Container 2/2		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3 | LANGUAGE EN	SHEET/TOTAL	6 / 18

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Ballard Power Systems Europe - Technology Solutions

Multiline Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DESCRIPTION	
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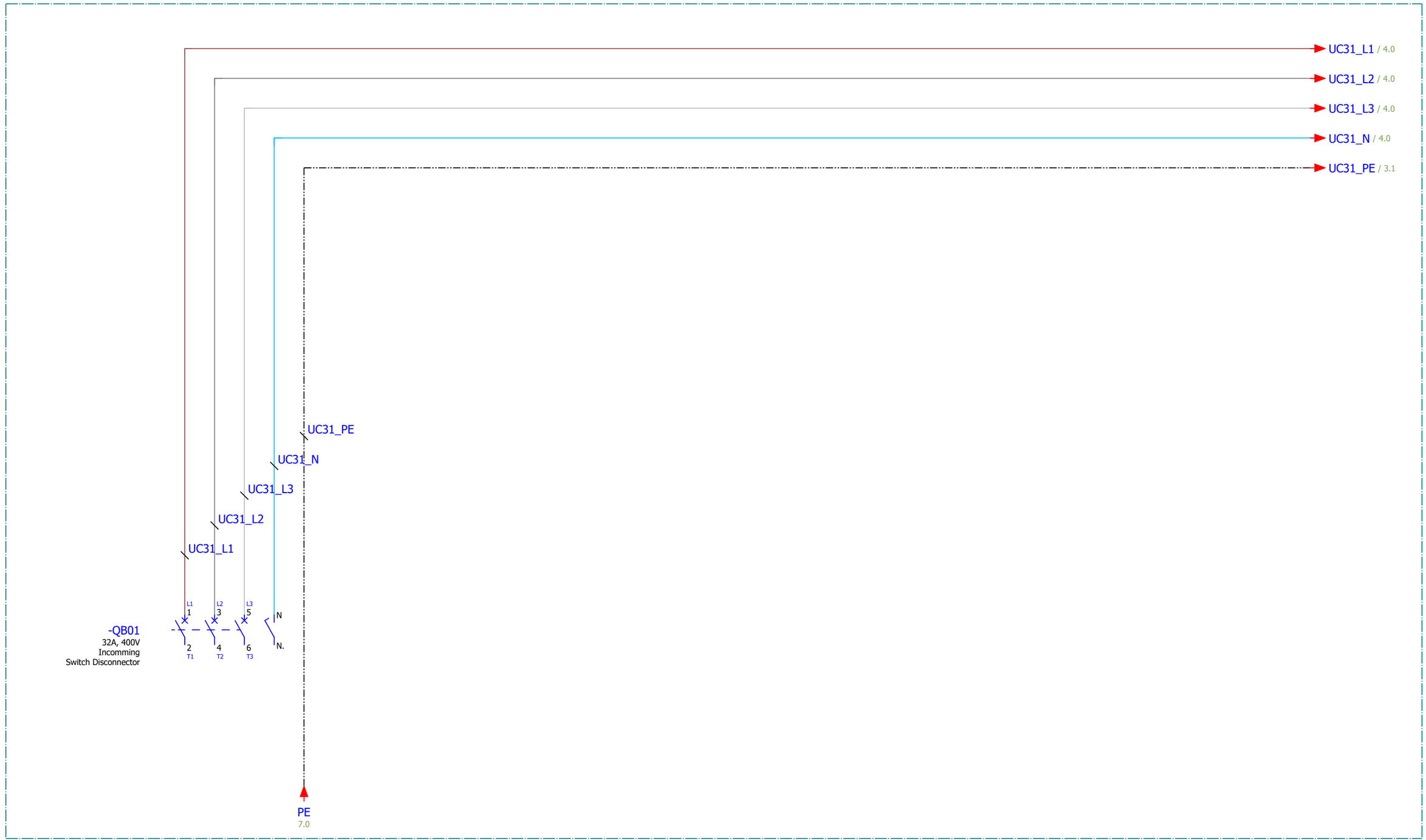
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Multiline Documentation Intro		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 2

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DATE
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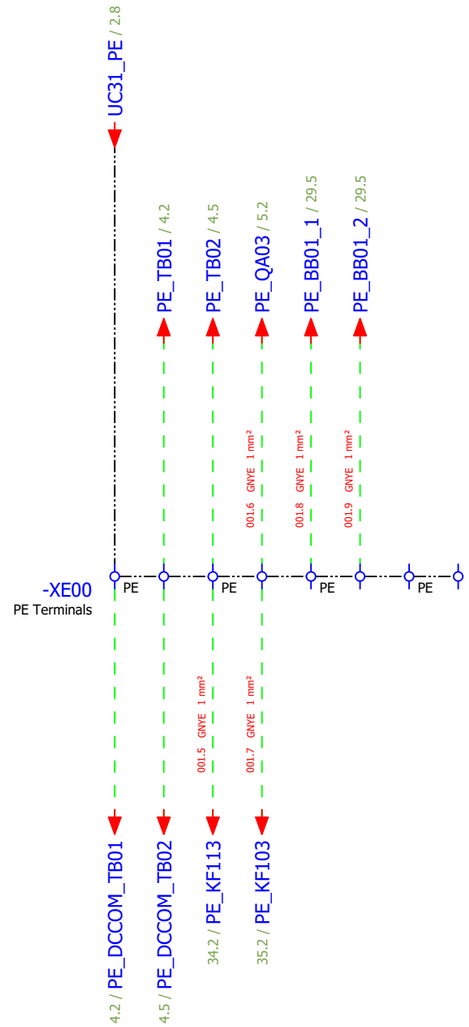
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC Input		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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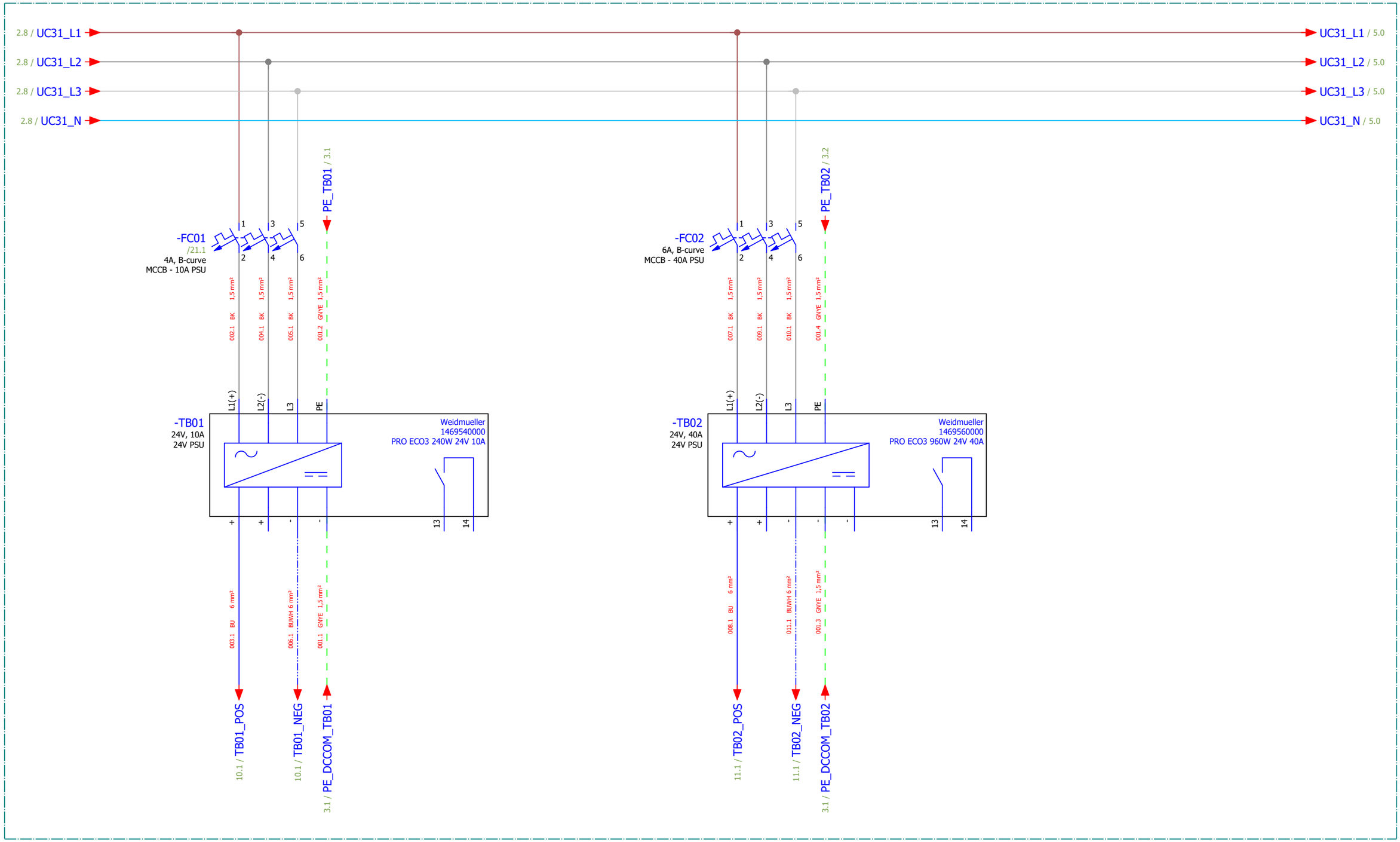
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DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	PE Distribution		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

=LA01



Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
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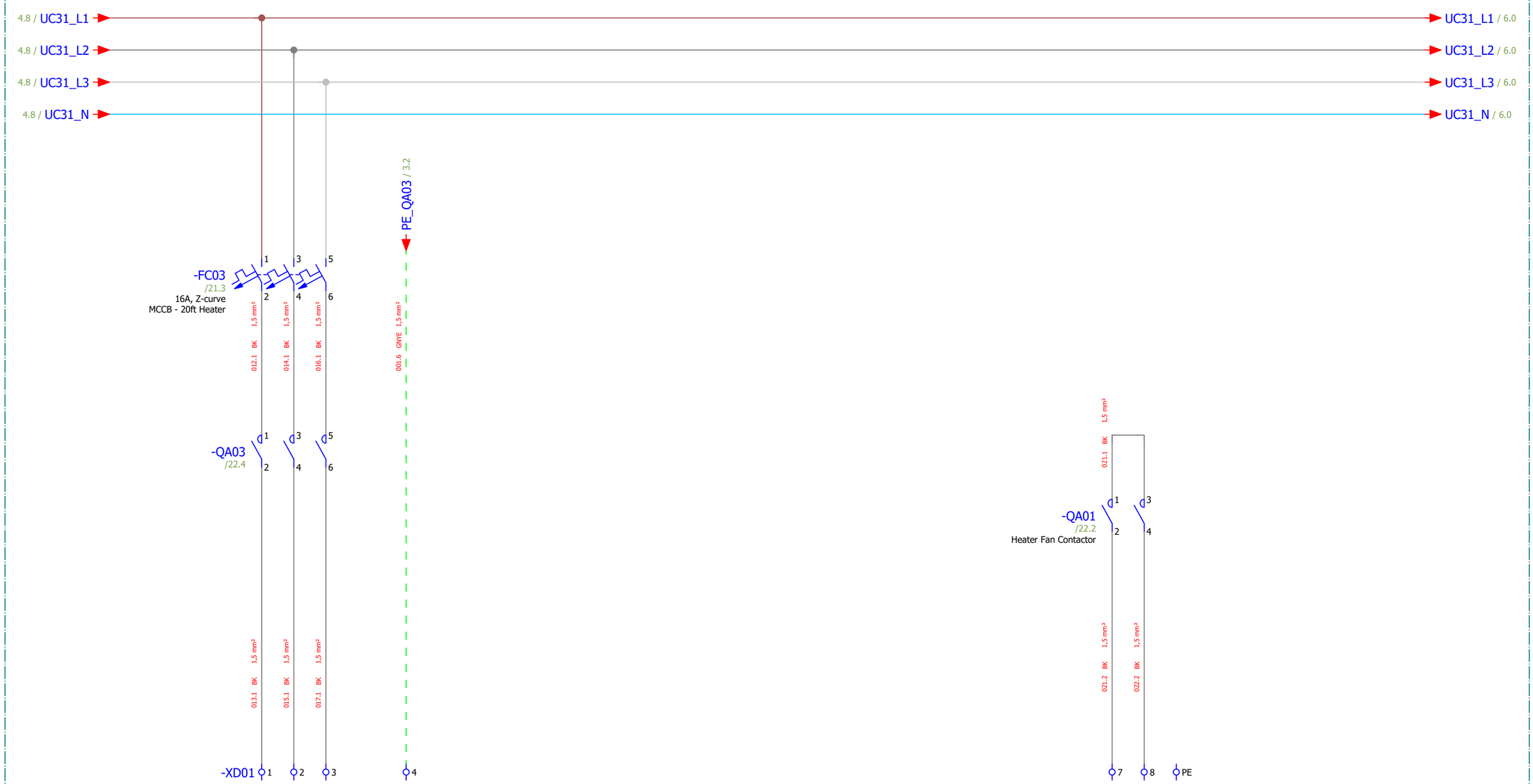
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - 24V Power Supplies		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 18

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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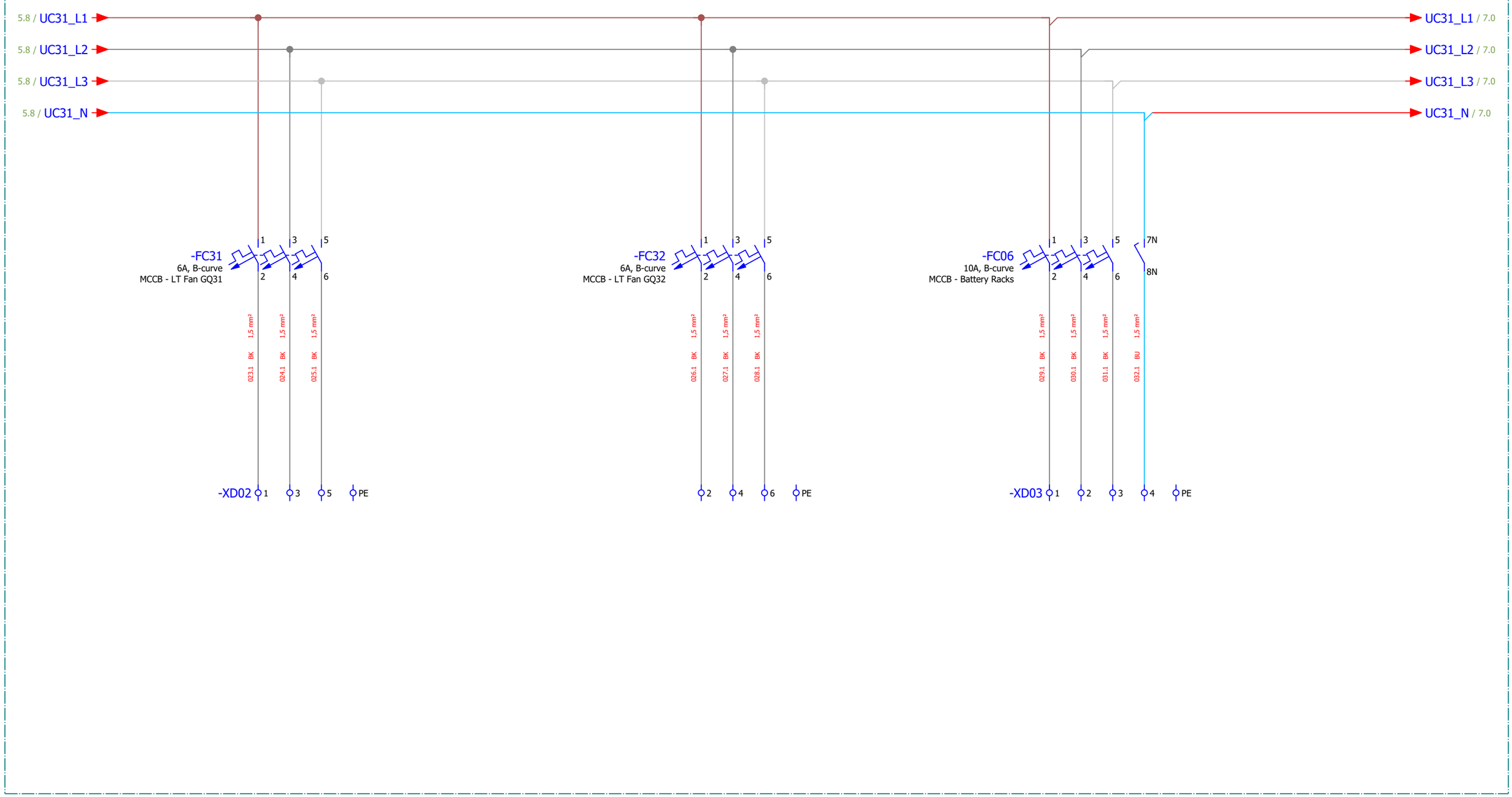
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - Container Heating		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 18

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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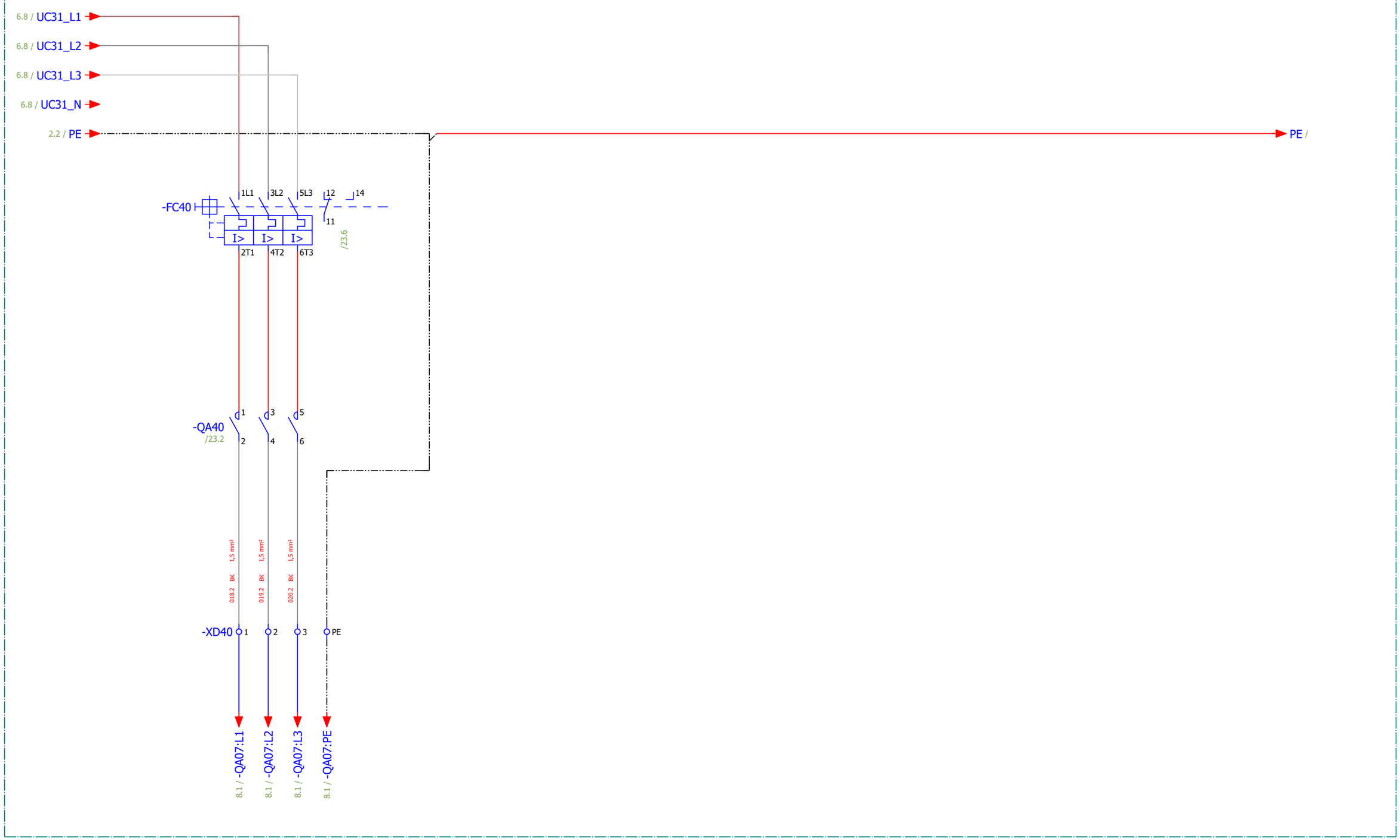
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - LT Fans		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 6 / 18

FRM5103656/0B

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - Precharge		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 / 18

0	1	2	3	4	5	6	7	8

=BA30+

7.1 / >=LA01+UC31-QA07:L1

7.1 / >=LA01+UC31-QA07:L2

7.2 / >=LA01+UC31-QA07:L3

7.2 / >=LA01+UC31-QA07:PE

-TA40

U V W PE

PRI

BLOCK

TT3 2,5-4-4

SEC

380U 380V 380W 400U 400V 400W 420U 420V 420W N

+DA30.TA40-WD01
ÖLFLEX® CLASSIC 130 H BK 0,6/1 kV
4x2,5
0,6/1,0 kV
Precharge supply

BN BK GY

BN BK GY

-TB40

BN BK GY

\- +

-RA40.1
3.3Ω, 1000W

-RA40.2
3.3Ω, 1000W

-XD41 1 2

-RA40.3
3.3Ω, 1000W

-RA40.4
3.3Ω, 1000W

-FC41
20 A

1 1

>=BA20+DA03-WD01:1

>=BA20+DA03-WD01:2

>=BA20+DA03-L+ / 29.7

>=BA20+DA03-L- / 29.8

+BA20-WD02
ÖLFLEX® CLASSIC 130 H BK 0,6/1 kV
4x2,5
0,6/1,0 kV
Isolation monitoring

BN BK

-FC42
2 A

1 1

3

4

=BA20+
DC Bus

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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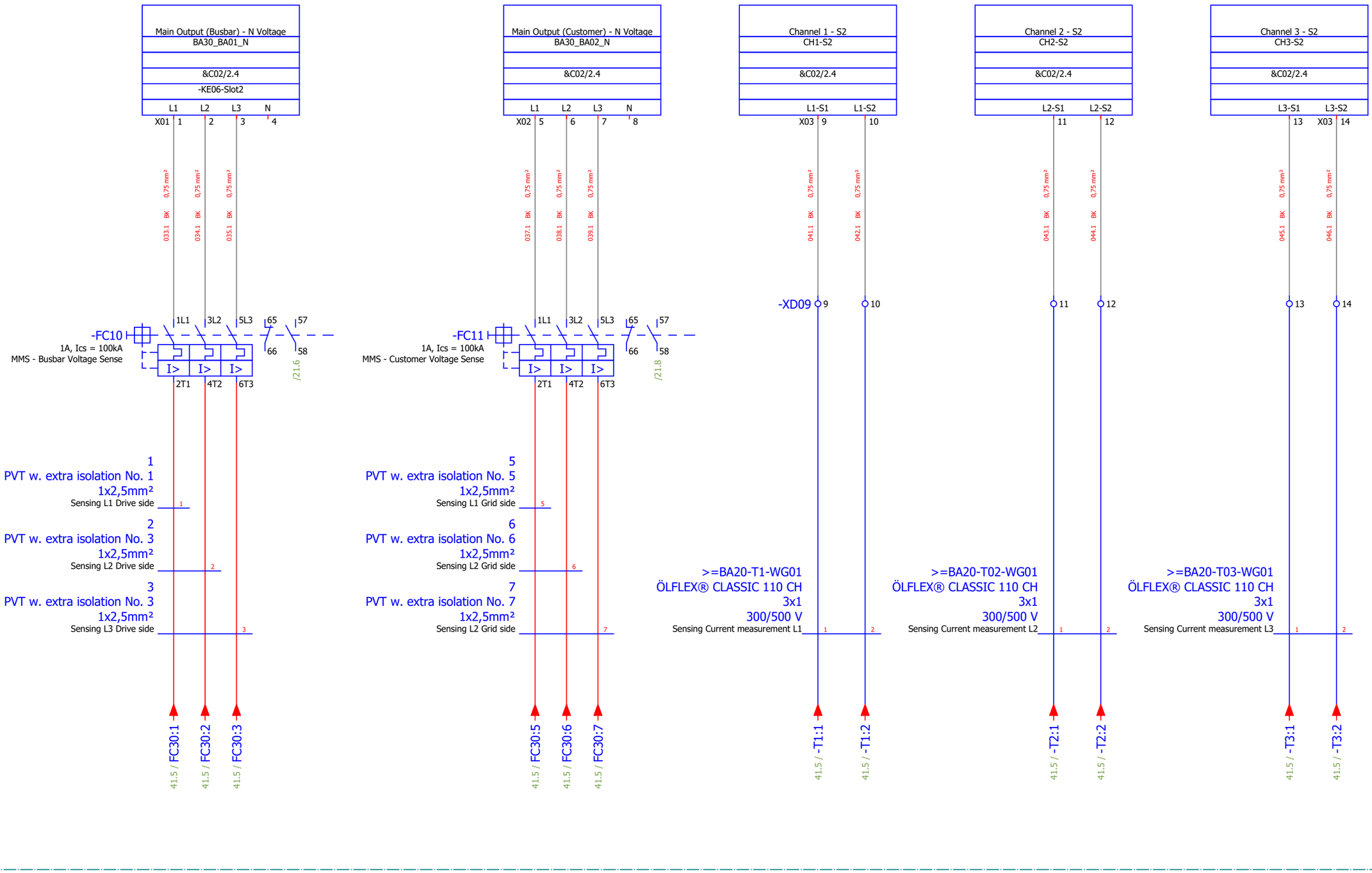
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - Precharge		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 8 / 18

FRM5103656/0B

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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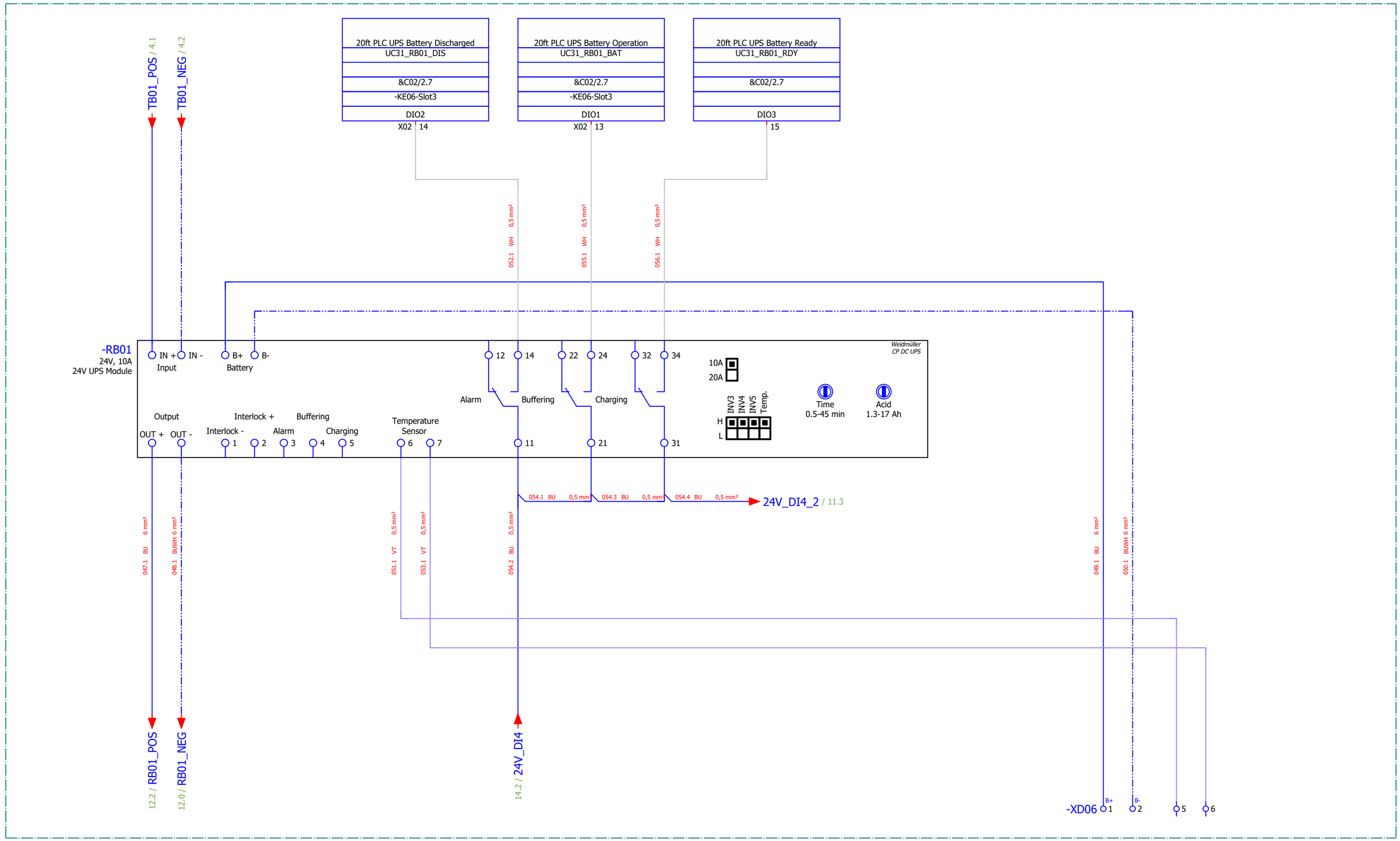
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - Sensing		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 / 18

0	1	2	3	4	5	6	7	8

=LA01

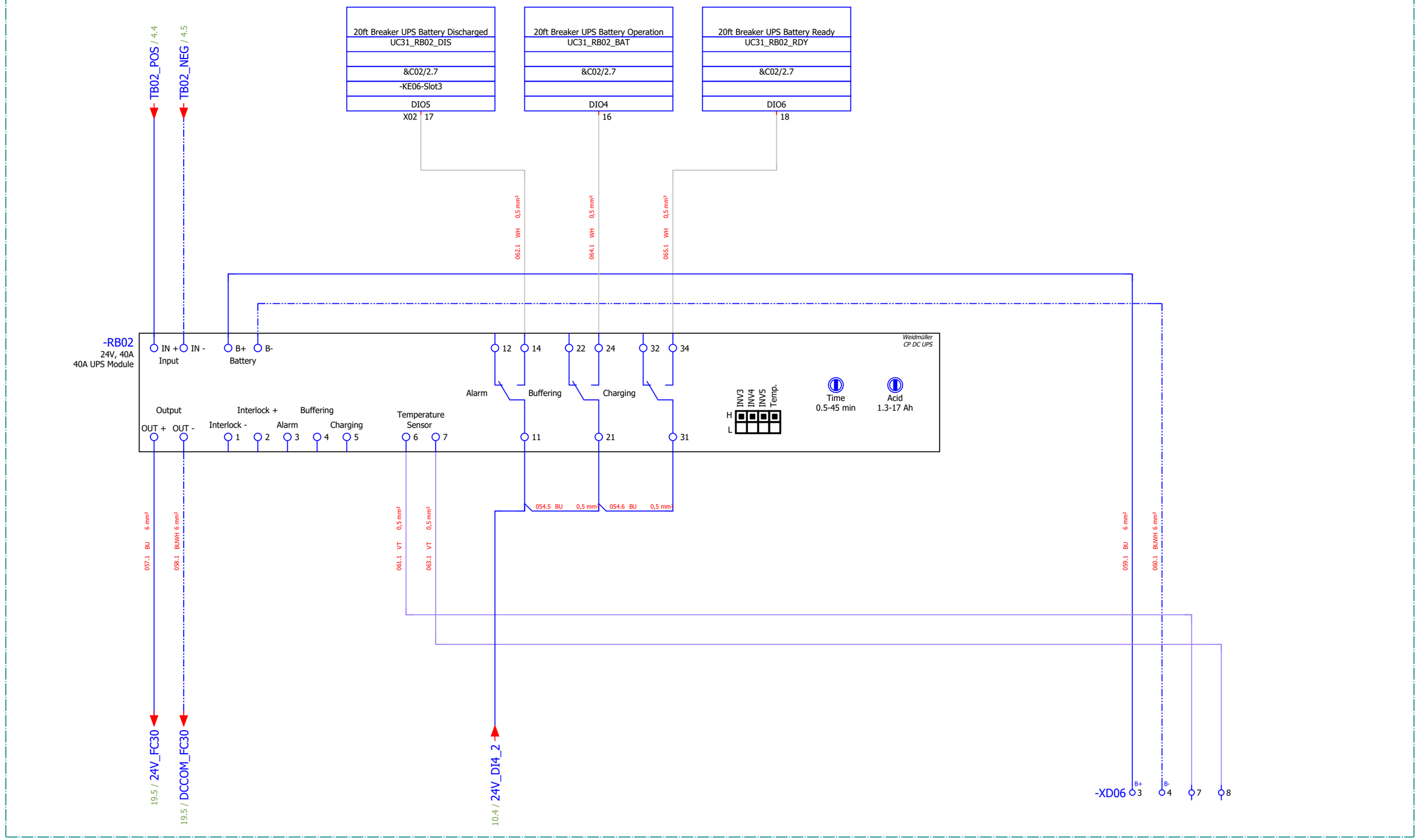


Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
EPLAN Revision	01.P15						SHEET TYPE/DESC	10A UPS Module		
EPLAN Project Pages	478			DATE		THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 / 18
=	++	+ UC31	& C03	05-Jun-24						

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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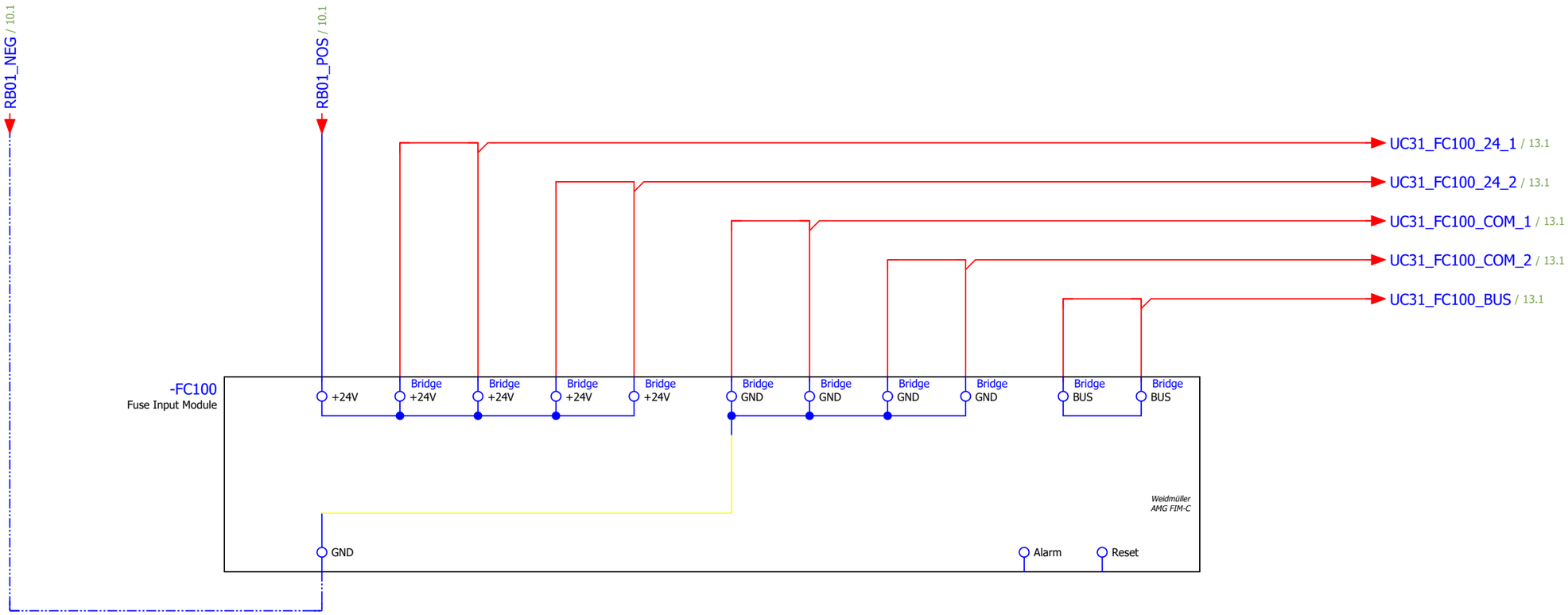
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	40A UPS Module		

ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 / 18

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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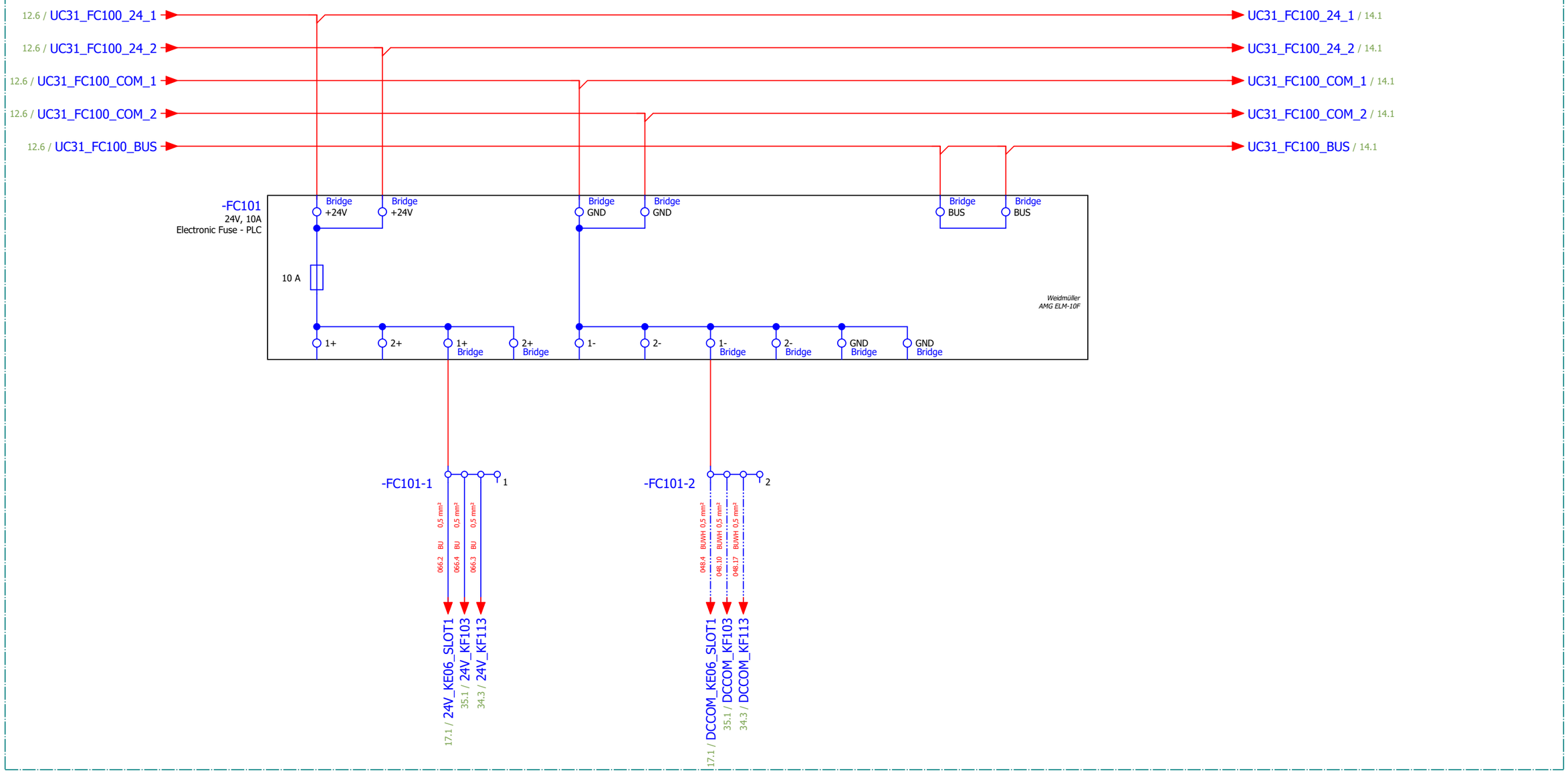
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	24V Fusing - FC100		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 12 / 18

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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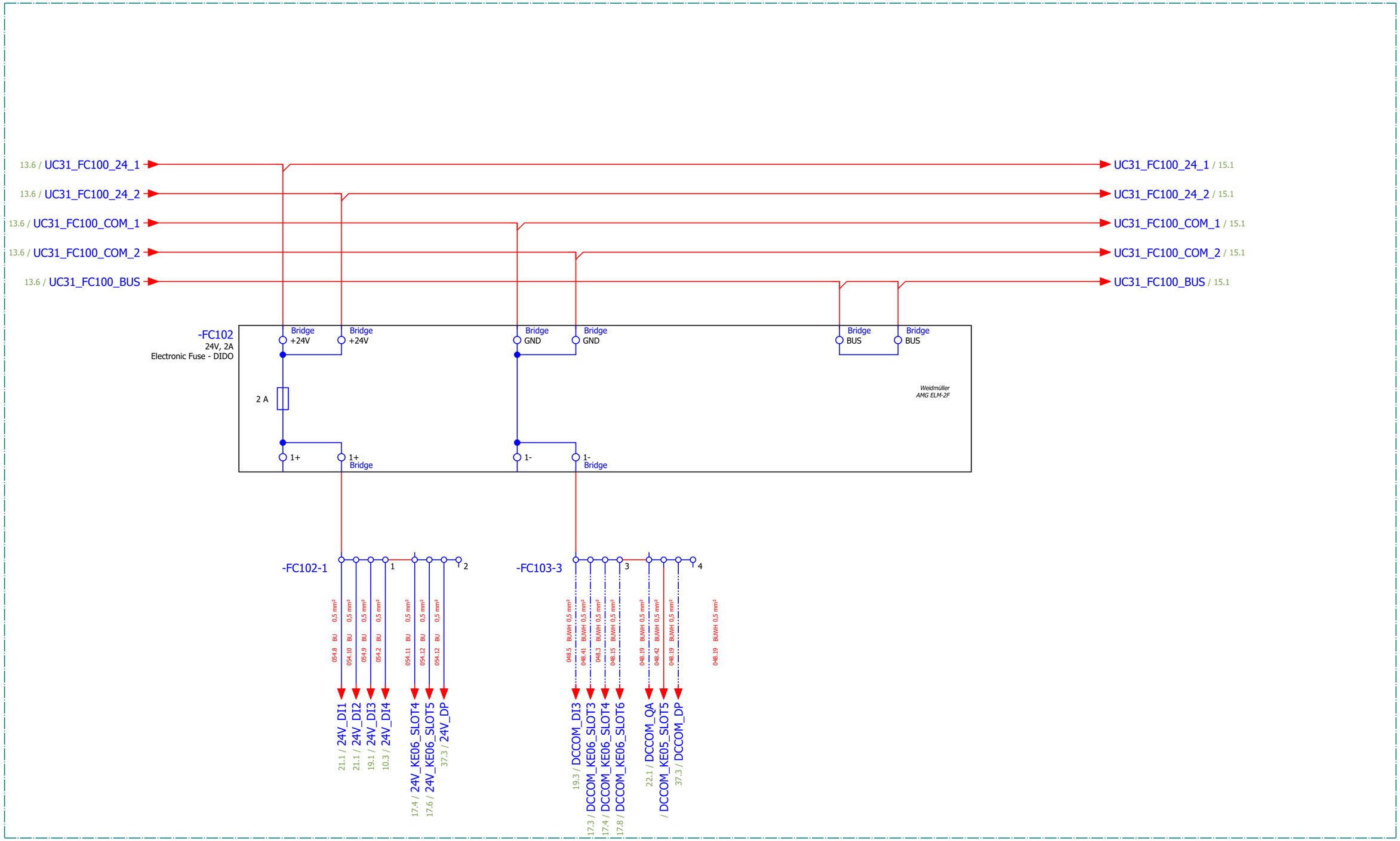
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	24V Fusing and Distribution - FC101		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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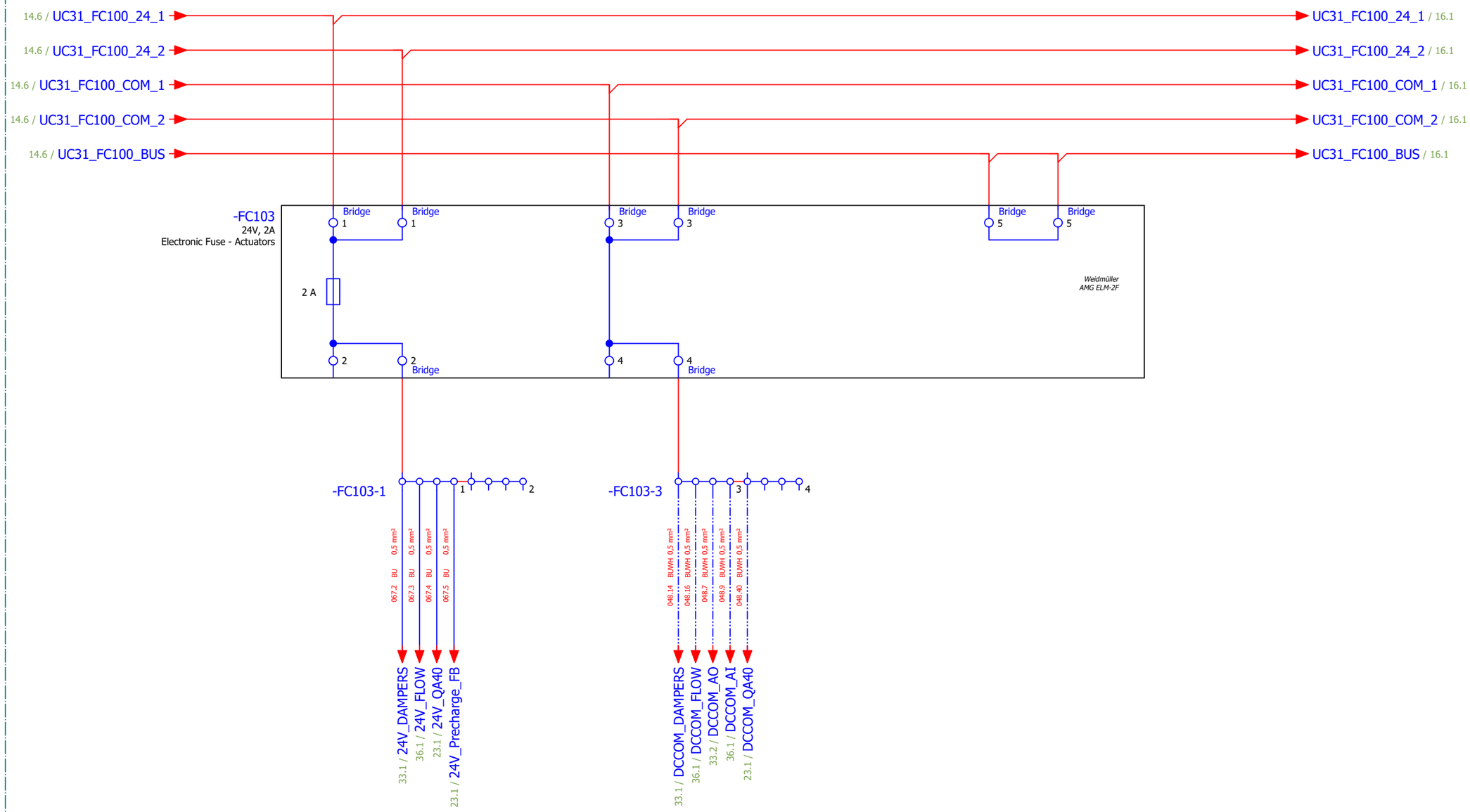
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	24V Fusing and Distribution - FC102		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 14 / 18

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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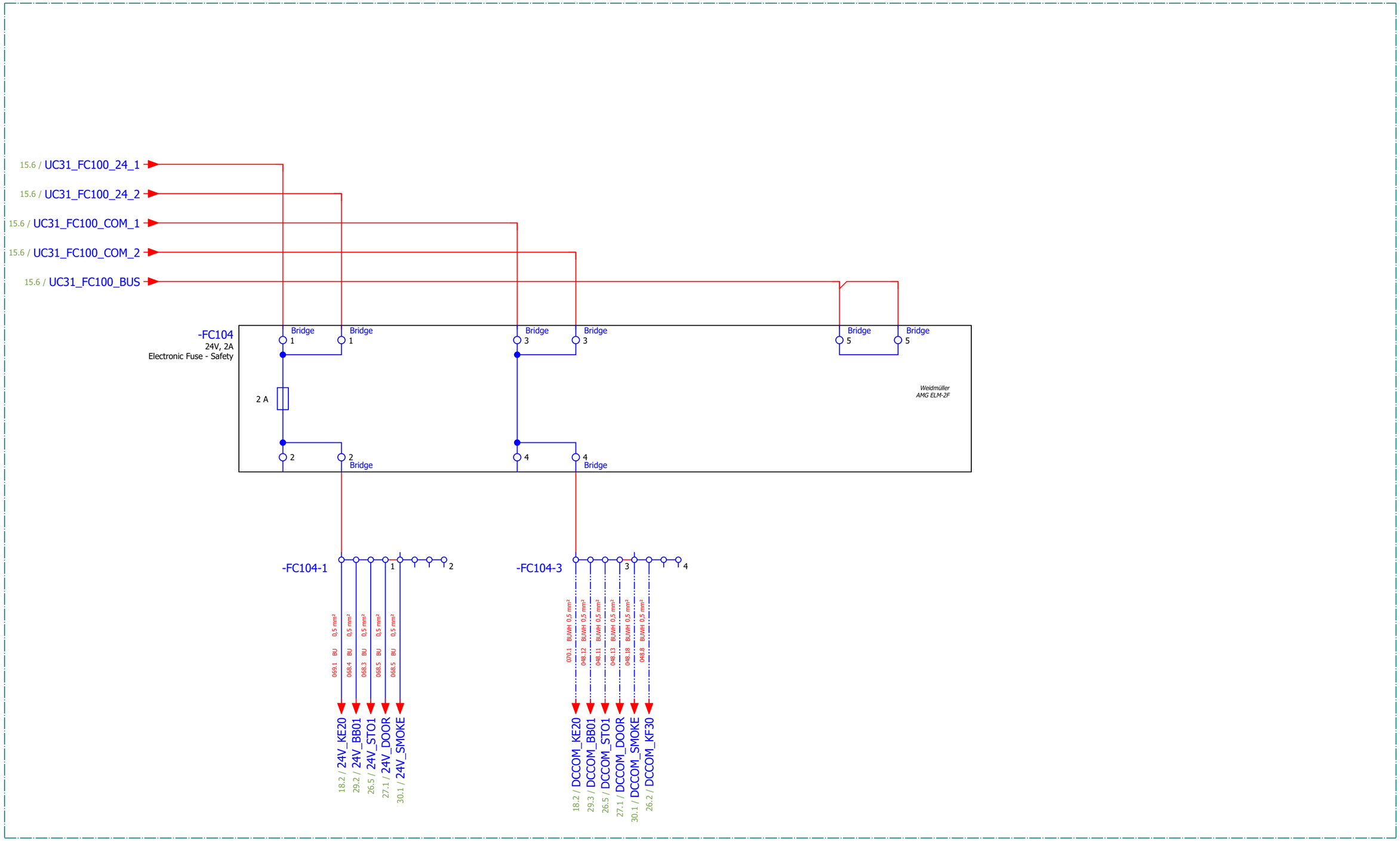
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	24V Fusing and Distribution - FC103		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 15 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	24V Fusing and Distribution - FC104		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 16 / 18

0	1	2	3	4	5	6	7	8

=LA01

-KE06
DEIF AMC300
Controller Extension Rack

-Slot1
DEIF PSM3.2

PE
PE
&C02/2.1

12-24V
1
&C02/2.1

0V
2
&C02/2.1

-Slot3

-Slot4

R1 COM
1
Relay 1 In &C02/3.1

R2 COM
3
Relay 2 COM &C02/3.1

R3 COM
5
Relay 3 In &C02/3.1

R4 COM
7
Relay 4 In &C02/3.1

DI1-4 COM
21
DI1-4 COM &C02/3.1

-Slot5

R1 COM
1
Relay 1 In &C02/3.4

R2 COM
3
Relay 2 COM &C02/3.4

-Slot6

DI1-4 COM
21
DI1-4 COM &C02/3.6

COM
23
Supply COM &C02/2.7

13.4 / DCCOM_KE06_SLOT1

13.2 / 24V_KE06_SLOT1

14.3 / DCCOM_KE06_SLOT3

14.2 / 24V_KE06_SLOT4

14.3 / DCCOM_KE06_SLOT4

14.2 / 24V_KE06_SLOT5

14.4 / DCCOM_KE06_SLOT6

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	PLC - 24V		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 17 / 18

0	1	2	3	4	5	6	7	8

=AA01+WZ10
From 40ft Container

=LB02+UC31
Safety System, 20ft Control Cabinet

16.2 / >=LA01-24V_KE20
16.3 / >=LA01-DCCOM_KE20

-KE20
&C02/5.0
24 VDC
Safety PLC, PLC
+ A1
- A2

-KE21
&C02/5.3
Safe Digital
Input/Output Module
+ A1
- A2
068.8 BU 0,5 mm²
048.21 BUWH 0,5 mm²

-KE22
&C02/6.1
Safe Digital
Input/Output Module
+ A1
- A2
068.9 BU 0,5 mm²
048.22 BUWH 0,5 mm²

-KE23
&C02/6.5
Safe Digital
Input/Output Module
+ A1
- A2
068.9 BU 0,5 mm²
048.22 BUWH 0,5 mm²

+UC20/39.8 / EFI_CAN

BN 1 X03 Other bus systems
WH 2 X03 Other bus systems
GN 3 X03 Other bus systems
YE EFI2_B Other bus systems

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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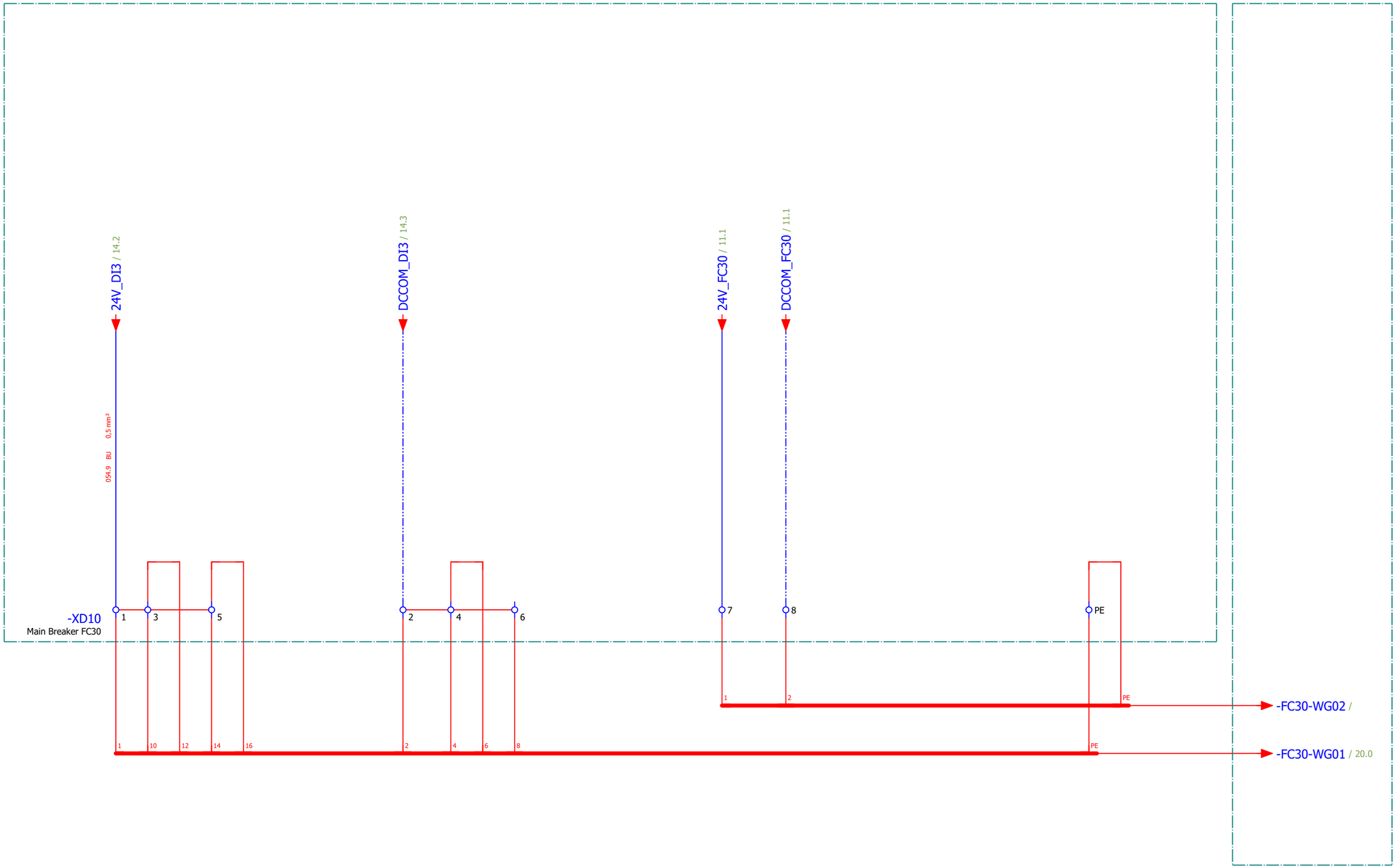
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety PLC - 24V		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 18 / 18



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC31 10ft Control Cabinet			REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet				
SHEET TYPE/DESC	FC30 Breaker 24V				
ALL SHEETS ARE THE SAME REVISION STATUS		SIZE A3	LANGUAGE EN	SHEET/TOTAL	19 / 18

FRM5103656/0B

=BA30+DA01-LA01
AC Power Output, 20ft Container Inside

=BA30+DA03
AC Power Output, 20ft Container Inside

Breaker FC30 Opening Coil	Breaker FC30 Closing Coil	Breaker FC30 Trip Reset Coil	Breaker FC30 Undervoltage Coil	Breaker Sping Charge FB	Breaker Auxillary Contact Q1	Breaker Auxillary Contact Q2
FC30_YO	FC30_YC	FC30_RY	FC30_UR	FC30_SPR	FC30_Q1	FC30_Q2
&C02/3.1	&C02/3.1	&C02/3.1	&C02/3.1	&C02/3.1	&C02/3.1	&C02/3.1
-KE06-Slot4						
DO1	DO2	DO3	DO4	DI1	DI2	DI3
X01 2	4	6	X01 8	X03 17	18	19

0,5 mm² WH 072.1

FC30_UR_1
26.6

26.6
FC30_UR_2

0,5 mm² WH 074.1

0,5 mm² WH 069.1
0,5 mm² WH 070.1
0,5 mm² WH 071.1
0,5 mm² WH 075.1
0,5 mm² WH 076.1
0,5 mm² WH 077.1

-XD10 10 11 12 13 14 15 16 17 18

19.8 / -FC30-WG01 → 3 5 7 17 9 11 → -FC30-WG01 /

1 2 → -TA30-WG0X /

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DESCRIPTION
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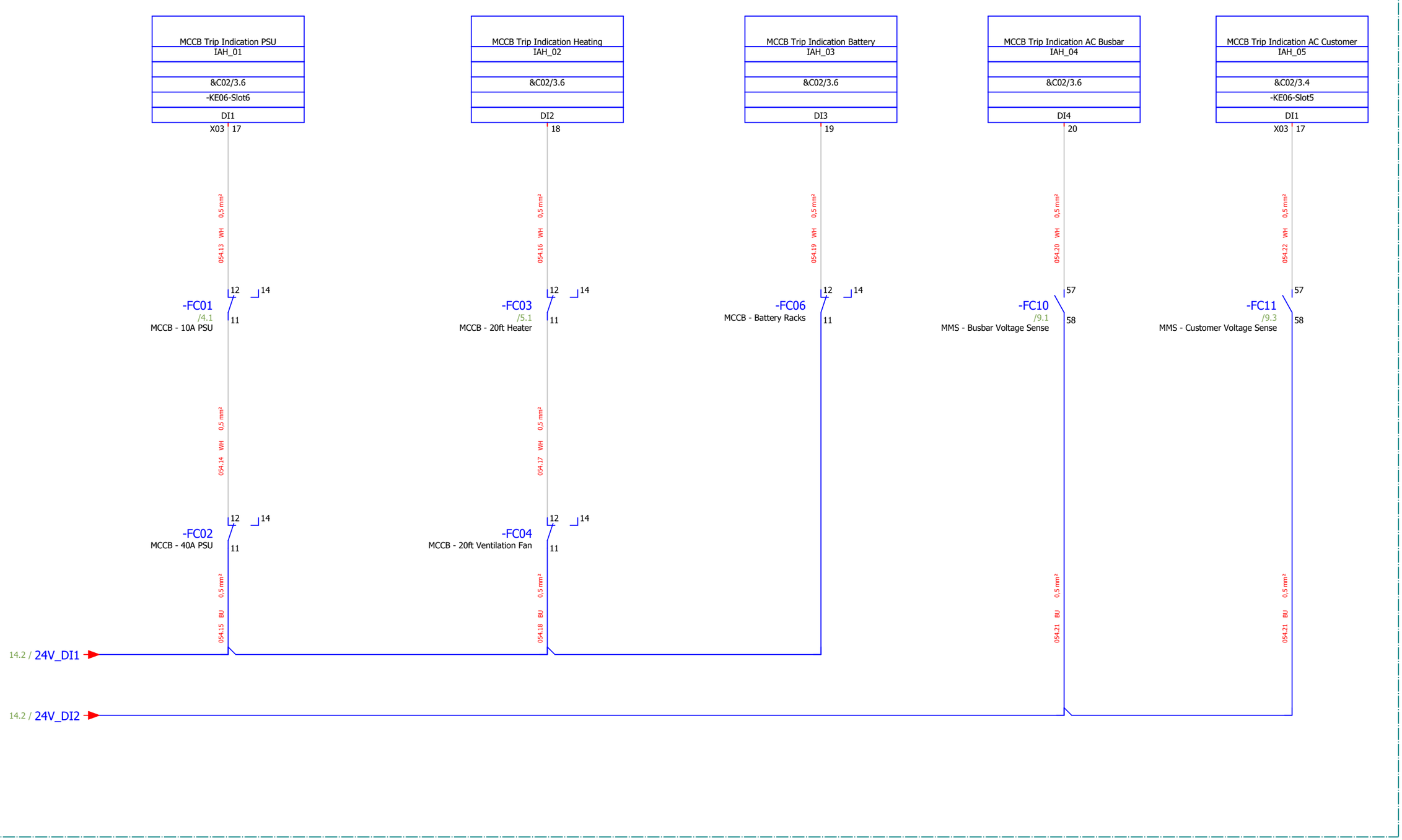
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	FC30 Breaker DI DO		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 20 / 18

FRM5103656/0B

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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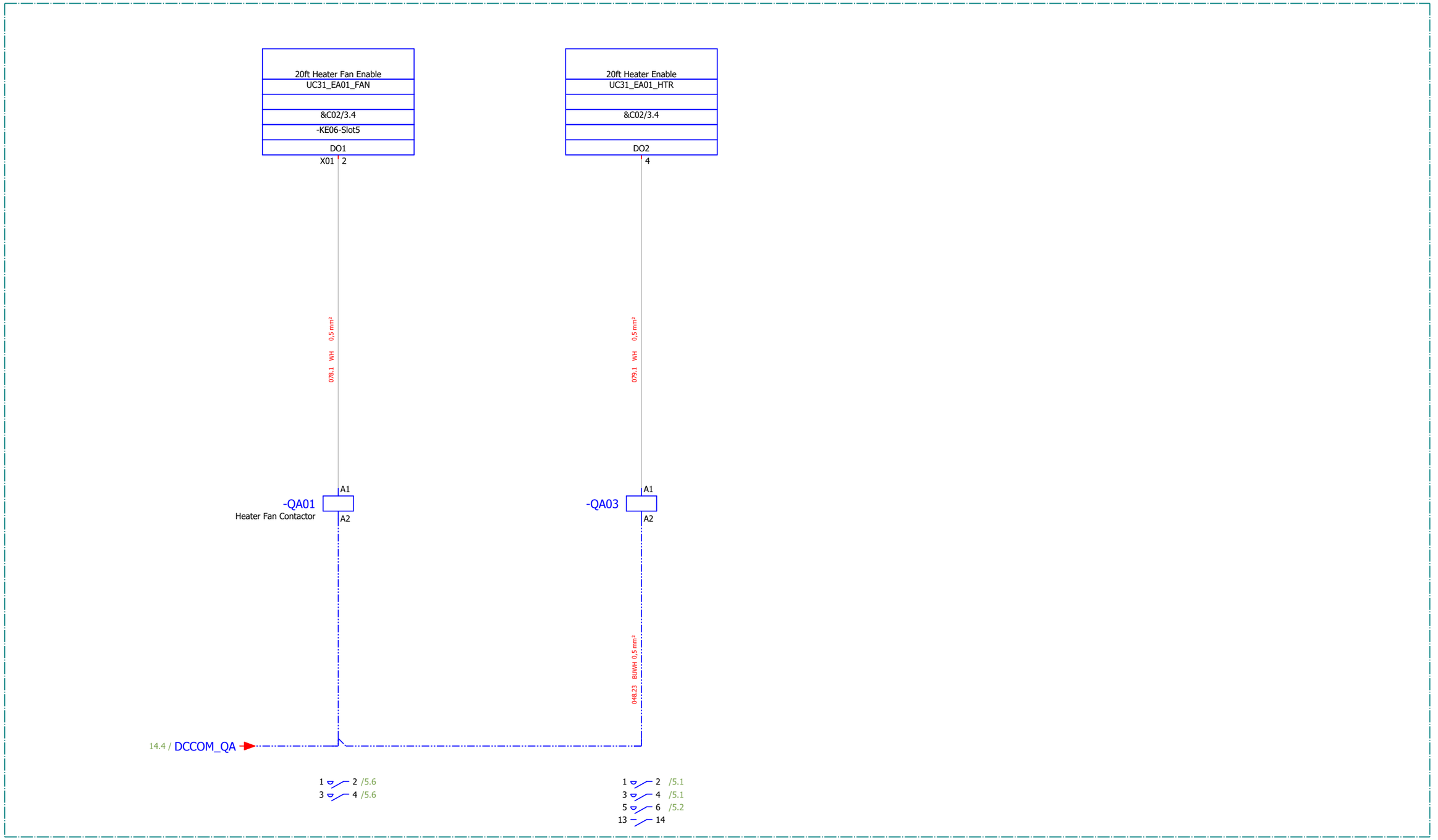
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	MCCB Trip Indicators		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 21 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01
Control System, 20ft Container



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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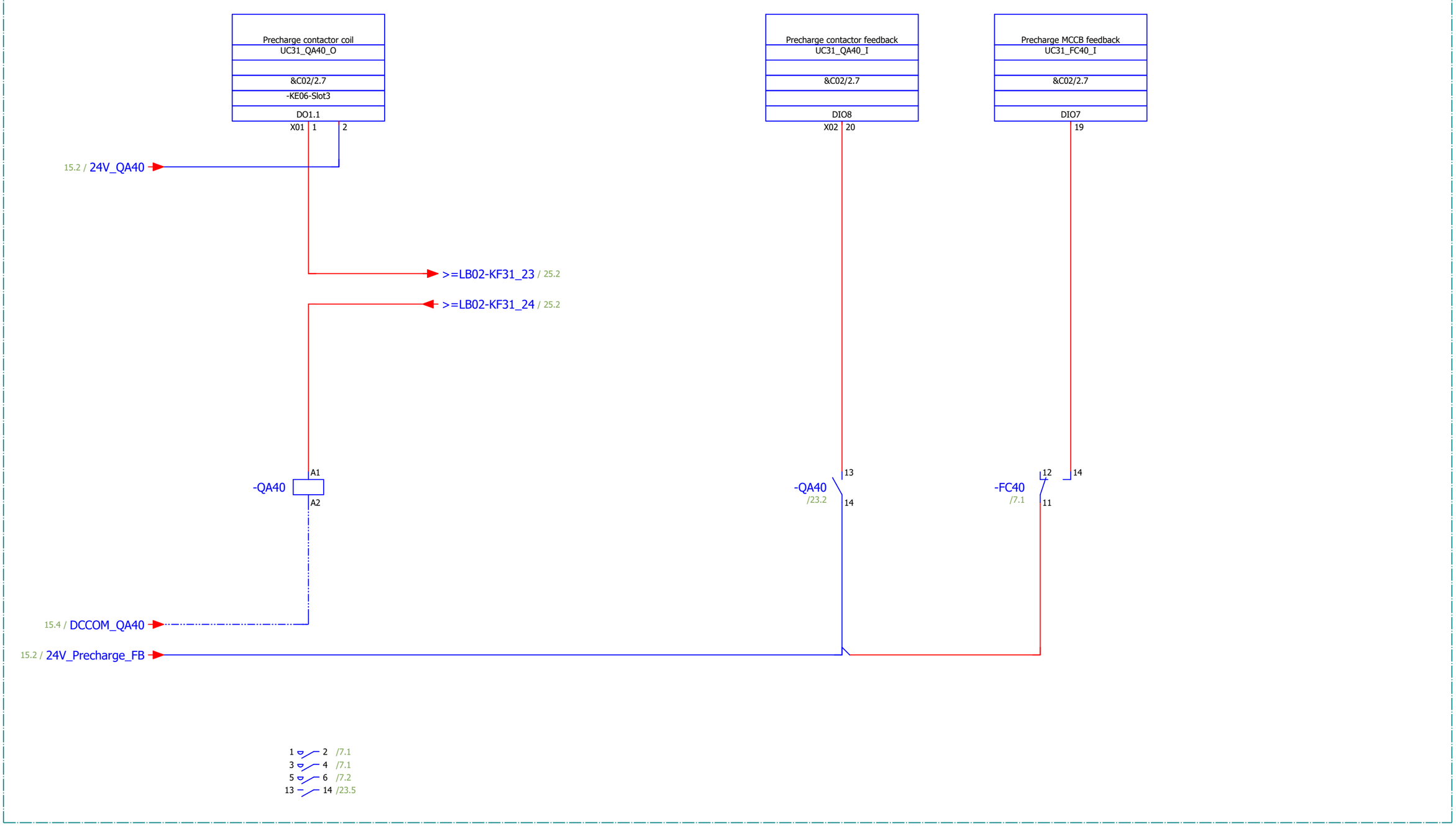
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	20ft Heating IO		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 / 18

0	1	2	3	4	5	6	7	8

=LA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DESCRIPTION	
DATE	05-Jun-24

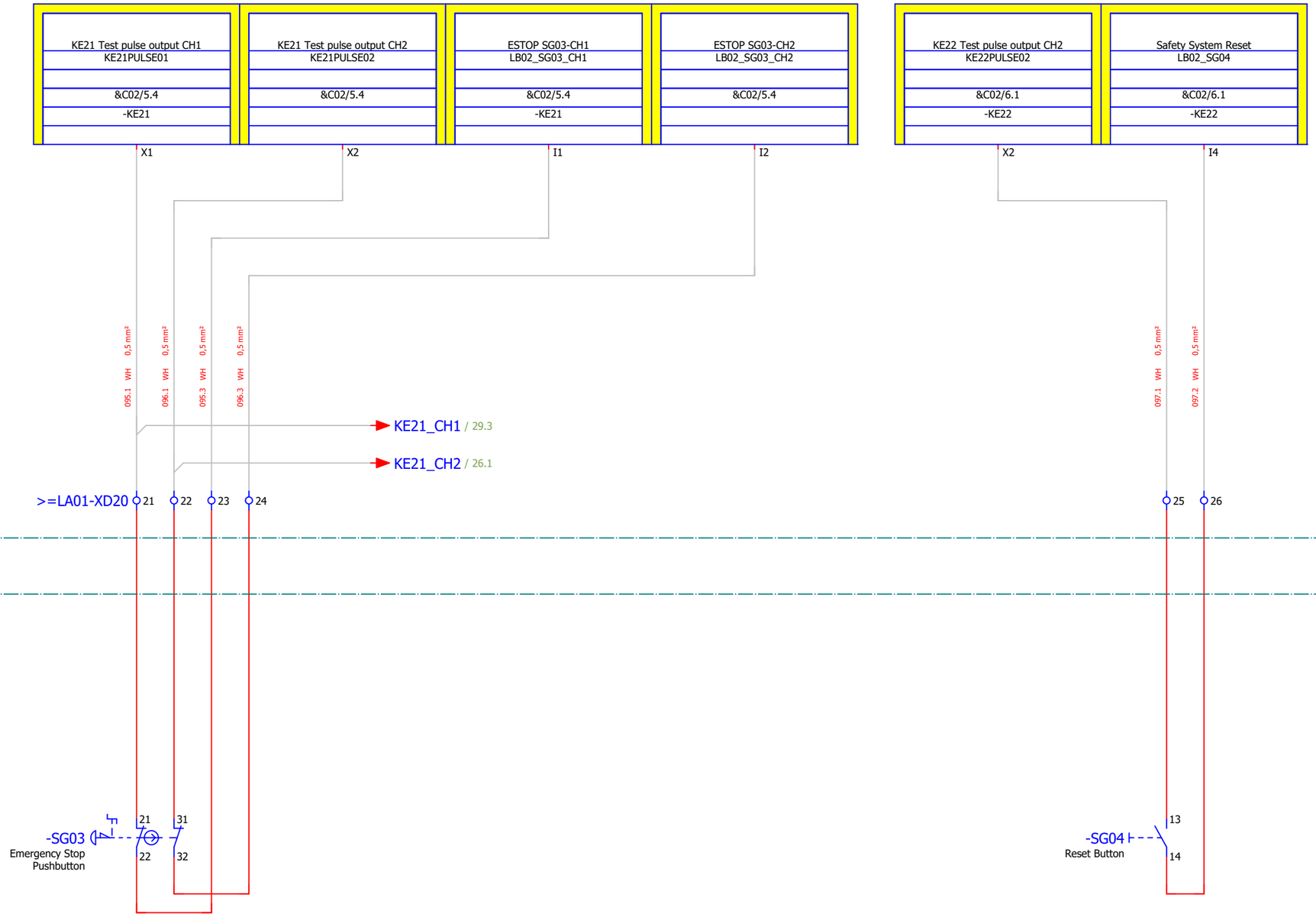
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	AC - Precharge IO		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 23 / 18

=LB02+UC31
Safety System, 20ft Control Cabinet



=LB02+DA03
Safety System, 20ft Container, Breaker Panel Front



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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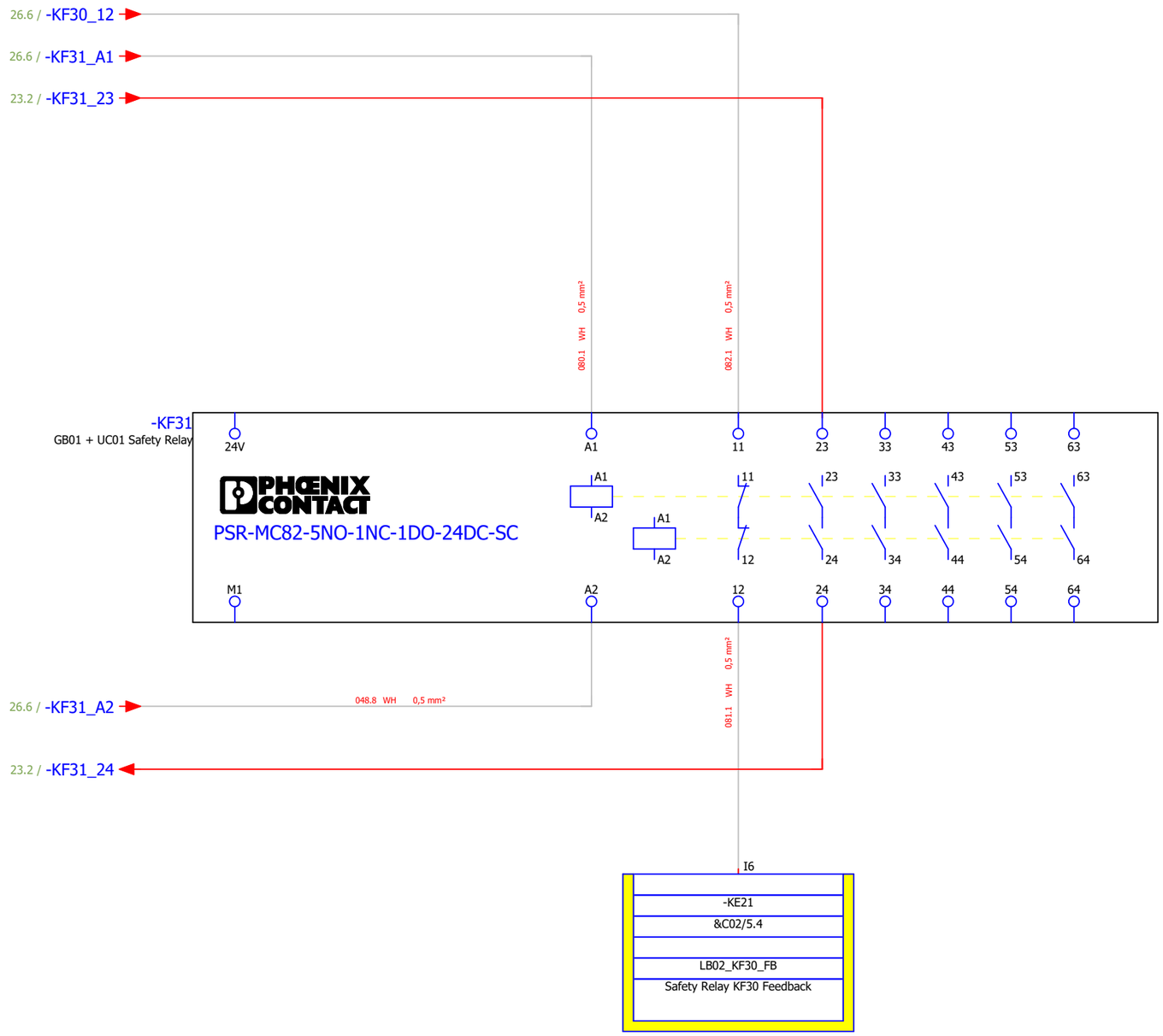
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety ESTOP		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 24 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LB02+UC31
Safety System, 20ft Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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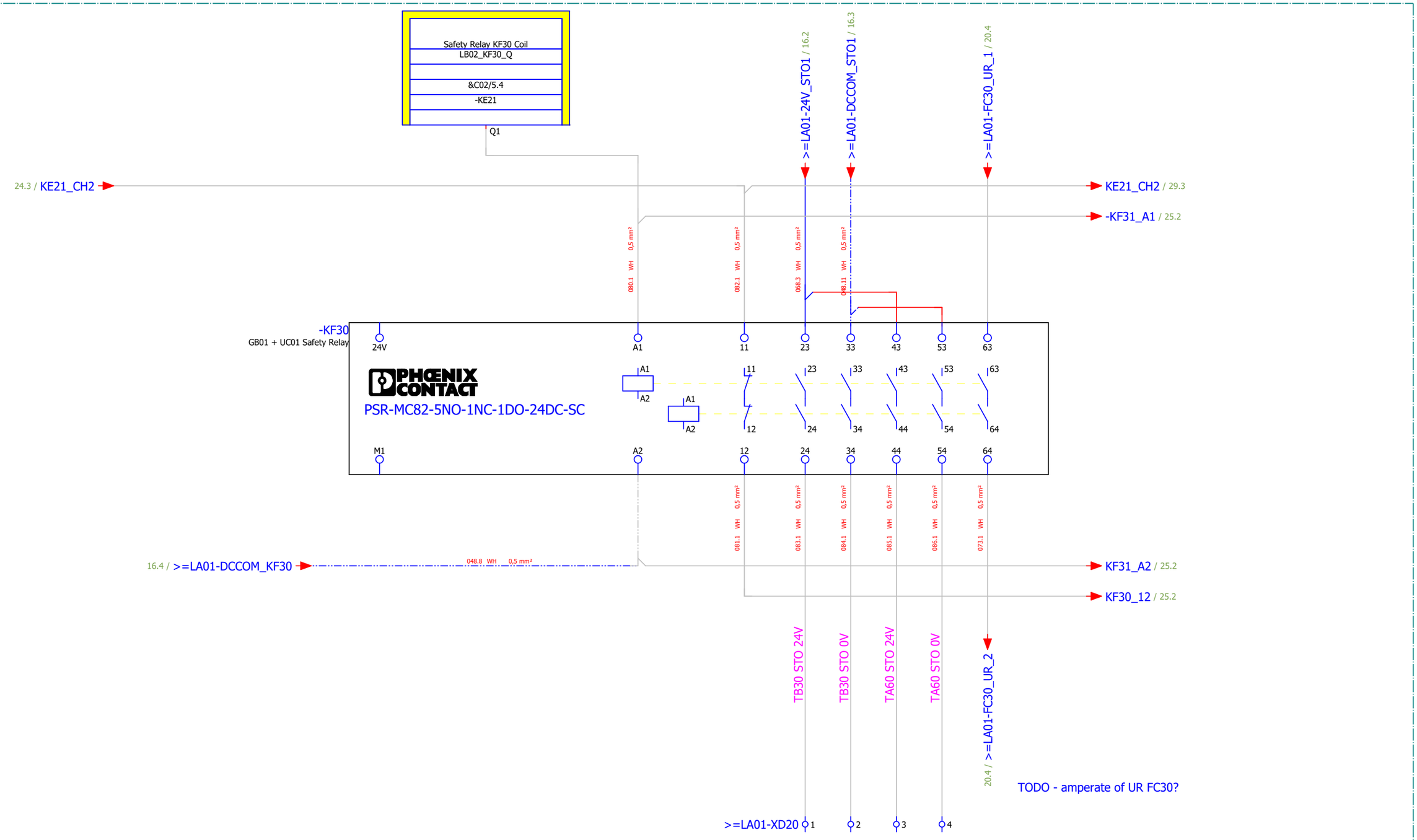
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Relay KF31		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 25 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LB02+UC31
Safety System, 20ft Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Relay		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 26 / 18

=LB02+UC31
Safety System, 20ft Control Cabinet

Safety Door Sensor, Door A - CH1
LB02_BG01_CH1
&C02/6.1
-KE22
I5

Safety Door Sensor, Door A - CH2
LB02_BG01_CH2
&C02/6.1
I6

Safety Door Sensor, Door B - CH1
LB02_BG02_CH1
&C02/6.1
I7

Safety Door Sensor, Door B - CH2
LB02_BG02_CH2
&C02/6.1
I8

16.2 / >=LA01-24V_DOOR → >=LA01-24V_DOOR / 28.1

16.4 / >=LA01-DCCOM_DOOR → >=LA01-DCCOM_DOOR / 28.1

087.1 WH 0,5 mm²
088.1 WH 0,5 mm²
088.11 BU 0,5 mm²
089.1 WH 0,5 mm²
048.25 BUWH 0,5 mm²
090.1 WH 0,5 mm²

>=LA01-XD20 5 6 7 8 9 10 11 12

=LB02+DA03
Safety System, 20ft Container, Inside

-BG01.WG01
20 m
4x0.25
300
Transformer Door Sensor
BN WH BU BK

-BG01
SICK.1069563
Door Sensor
Above door at transformer
+24V 1 | Out A 2 | 0V 3 | Out B 4 | Out Aux 5

-BG02.WG01
20 m
4x0.25
300
Battery Door Sensor
BN WH BU BK

-BG02
SICK.1069563
Door Sensor
Above door at batteries
+24V 1 | Out A 2 | 0V 3 | Out B 4 | Out Aux 5

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Door Switches		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 27 / 18

=LB02+UC31
Safety System, 20ft Control Cabinet

Door Lock Possible
LB02_RL01_AUX
&C02/6.1
-KE22
I3

Door Lock Command
LB02_RL01_LOCK
&C02/6.1
Q1

Door Lock Feedback CH1
LB02_RL01_CH1
&C02/6.1
I1

Door Lock Feedback CH2
LB02_RL01_CH2
&C02/6.1
I2

27.7 / >=LA01-24V_DOOR

27.7 / >=LA01-DCCOM_DOOR

091.1 WH 0,5 mm²
068.11 BU 0,5 mm²
092.1 WH 0,5 mm²
093.1 WH 0,5 mm²
094.1 WH 0,5 mm²
048.25 BUWH 0,5 mm²

>=LA01-XD20 13 14 15 16 17 18 19 20

Not applicable

=LB02+DA03
Safety System, 20ft Container, Inside

-RL01.WG01
PUR
10 m
8x0,25 mm²
300
Safety Door Lock
WH BN GN YE GY PK BK RD

-RL01.XG01
1 2 3 4 5 6 7 8

-RL01
SICK.1101321
FXL1-SPBMSA00
Safety Door Lock
20ft Container Door
Data sheet (DE)

1	2	3	4	5	6	7	8
OutAux	24VDC	LOCK	In2	OSSD1	OSSD2	0V	In1

M12 male

ImageVisible
Yes

SICK

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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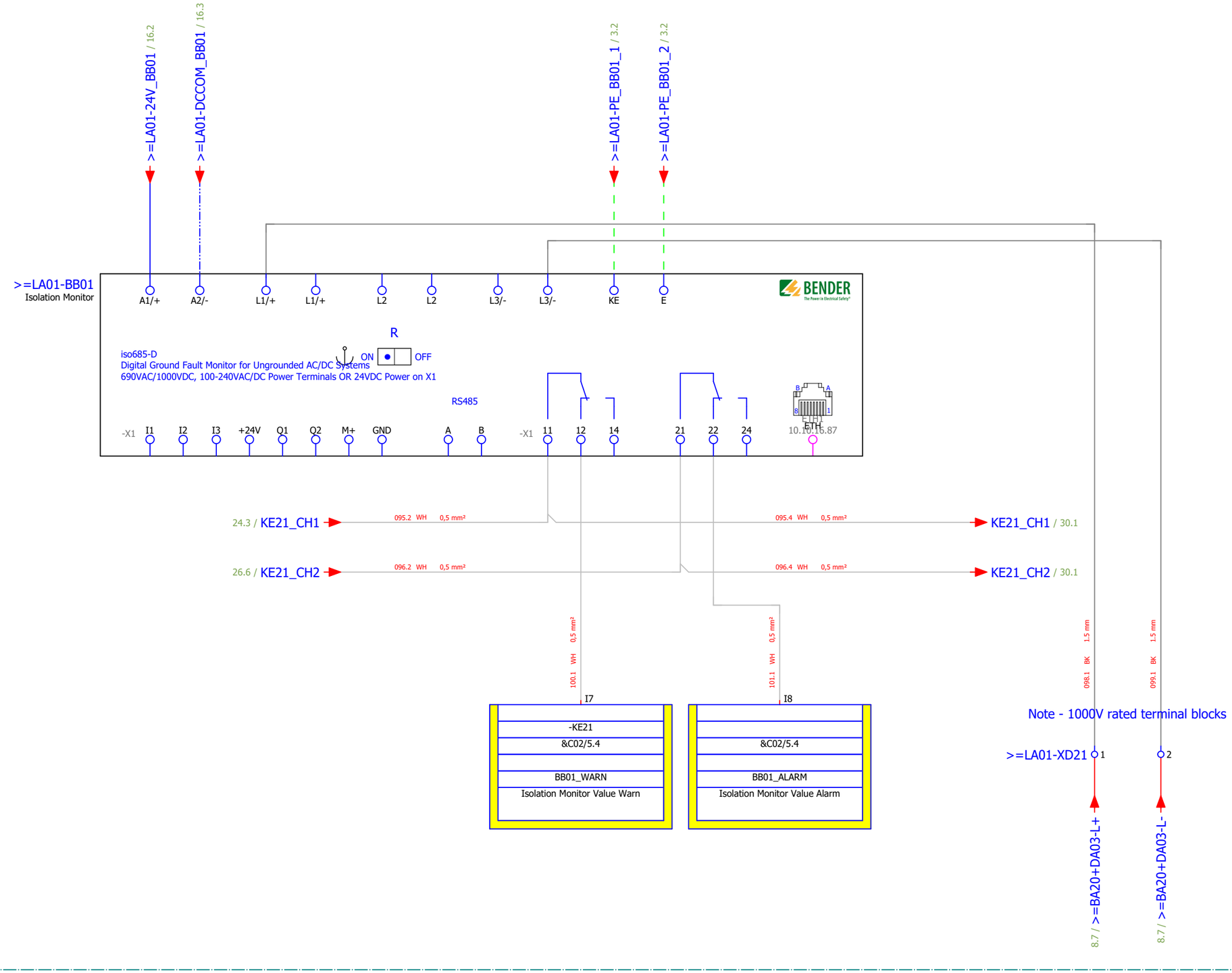
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Door Lock		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 28 / 18

FRM5103656/0B

=LB02+UC31
Safety System, 20ft Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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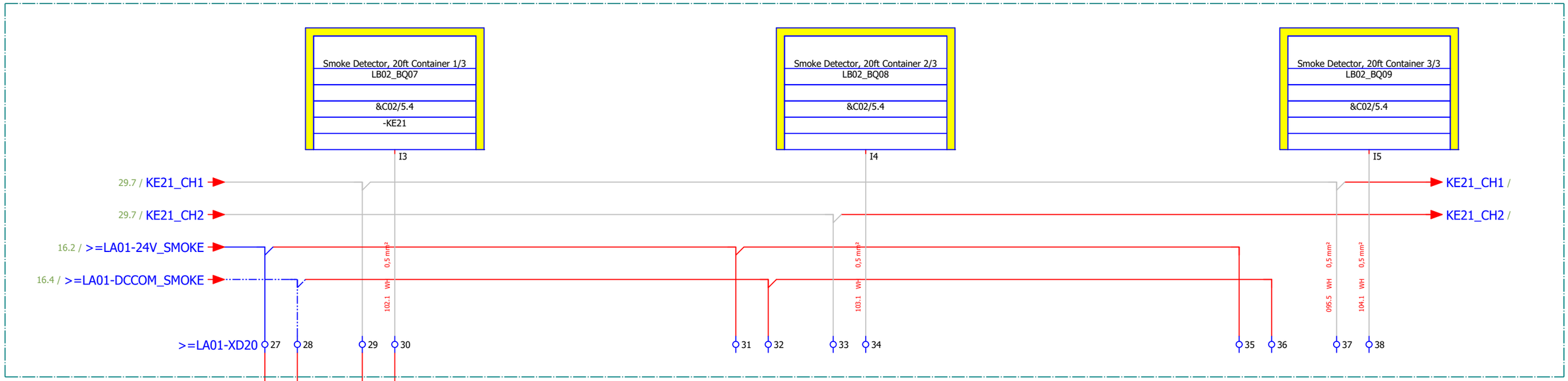
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Isolation Monitor		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 29 / 18

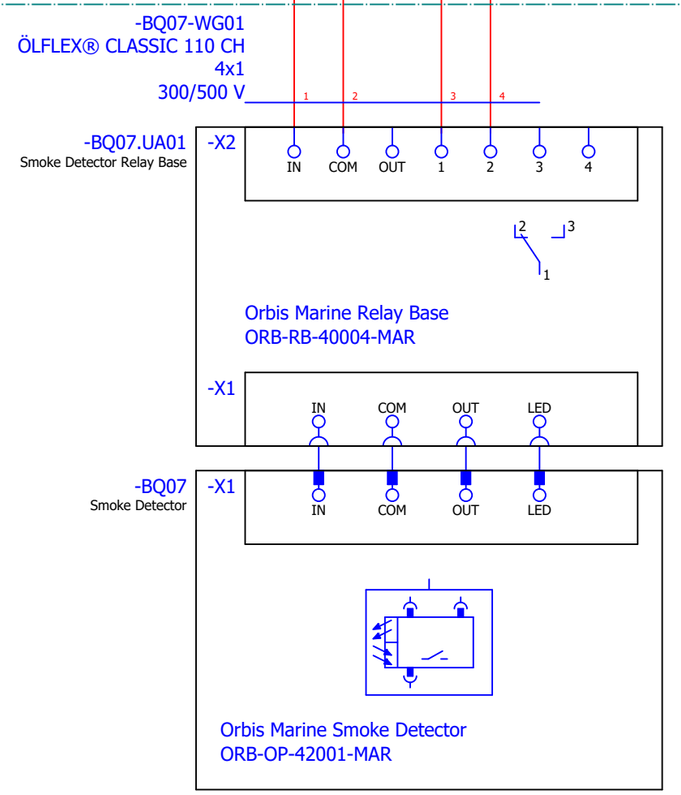
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LB02+UC31
Safety System, 20ft Control Cabinet



=LB02+DA03
Safety System, 20ft Container, Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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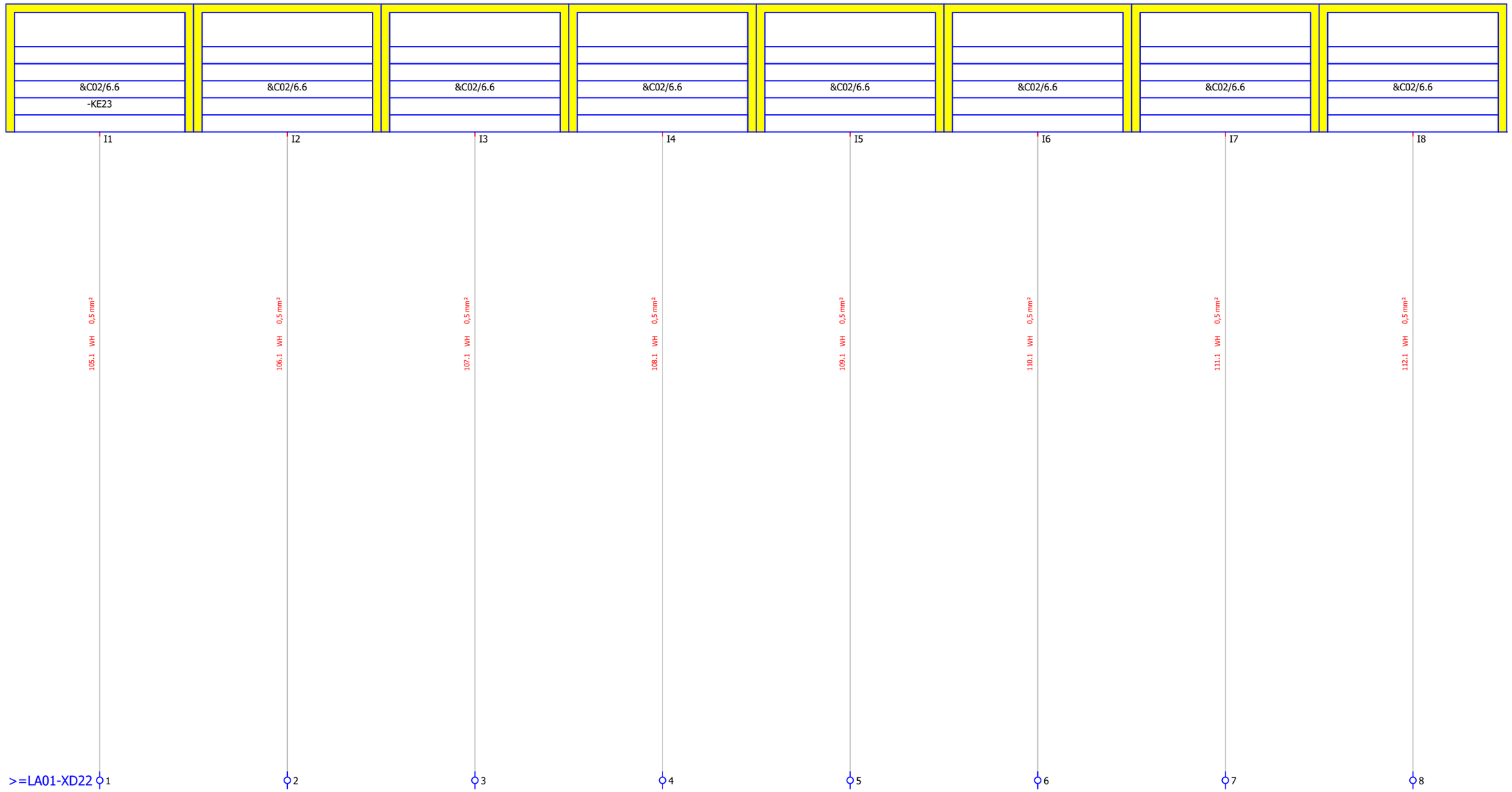
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Smoke Detector		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 30 / 18

=LB02+UC31

Safety System, 20ft Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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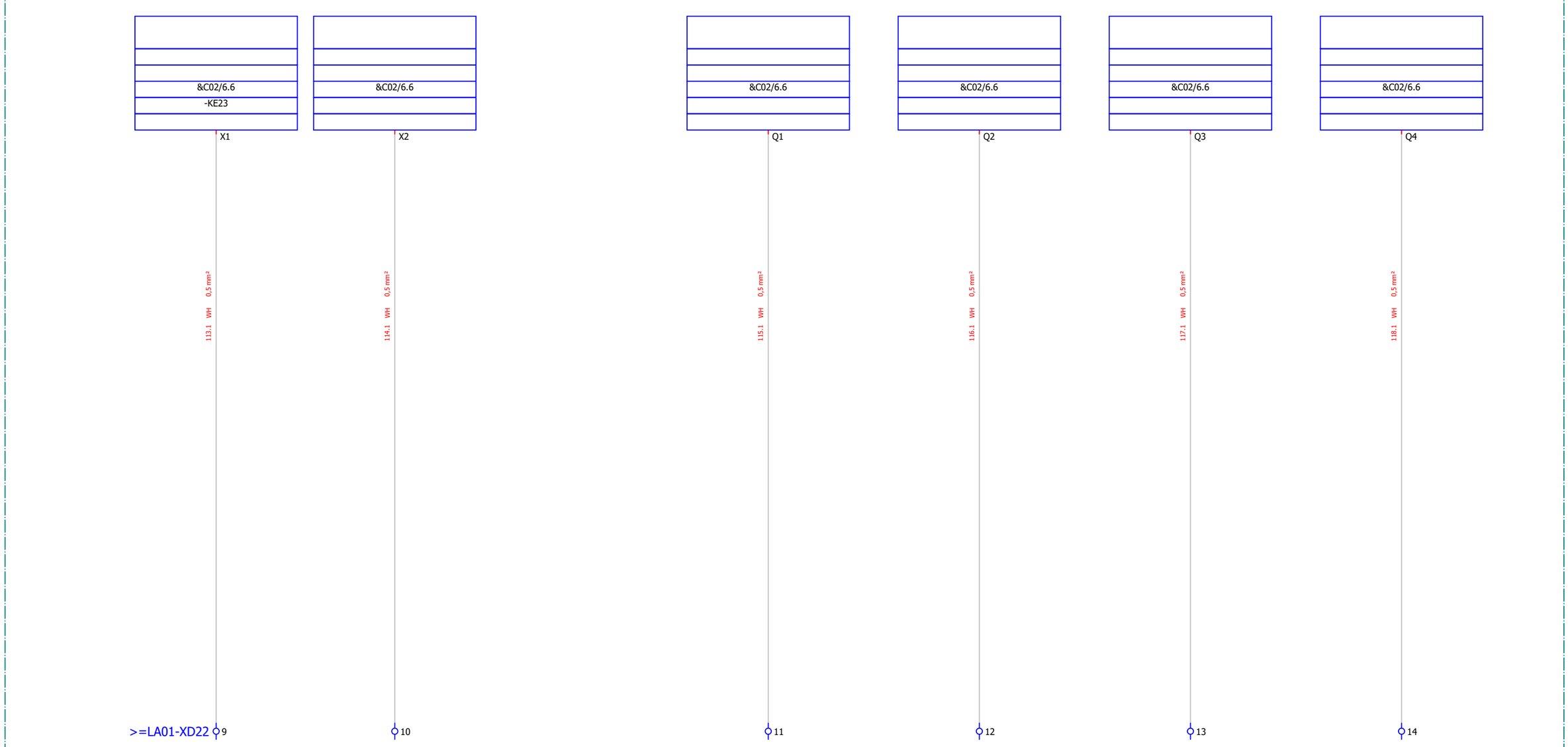
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Battery Pack Inputs		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 / 18

=LB02+UC31

Safety System, 20ft Control Cabinet



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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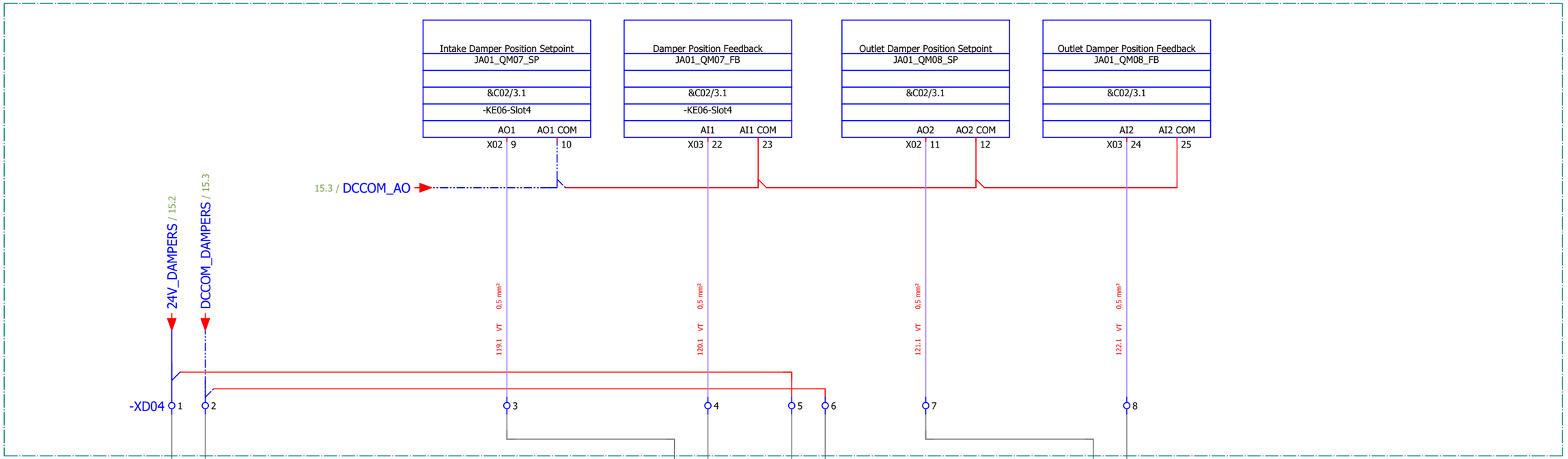
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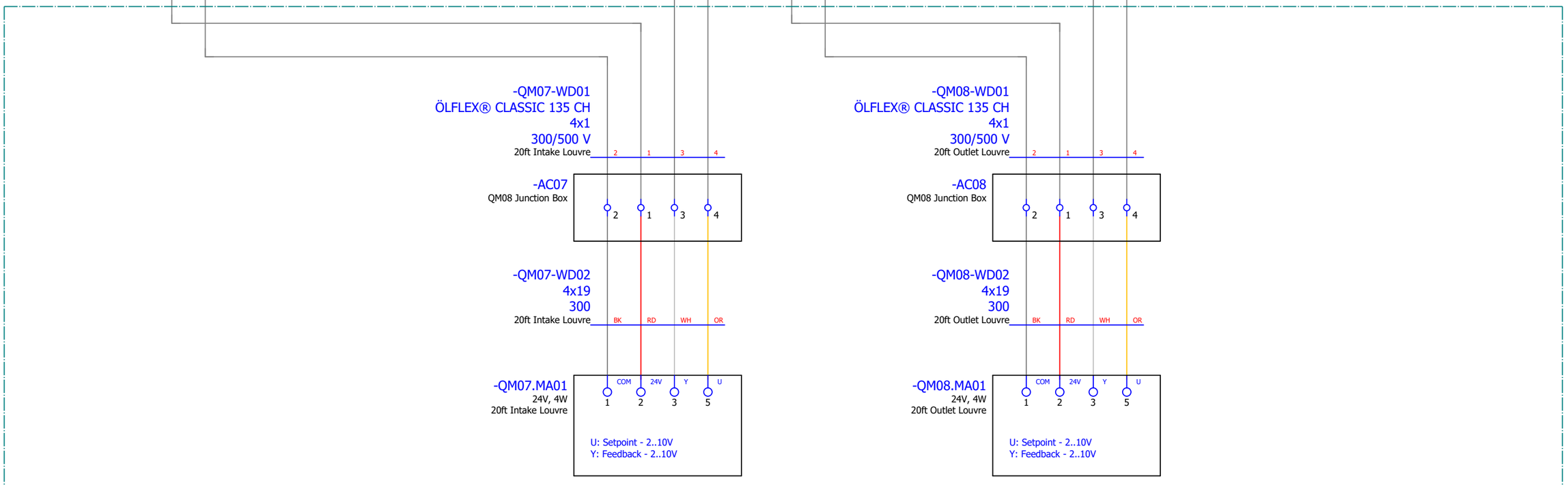
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Safety Battery Pack Outputs		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 32 / 18

=LA01
Control System, 20ft Container



=JA01+DA03



Reference Item Number	Ballard Part # TBD
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=	++ + UC31 & C03

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DATE
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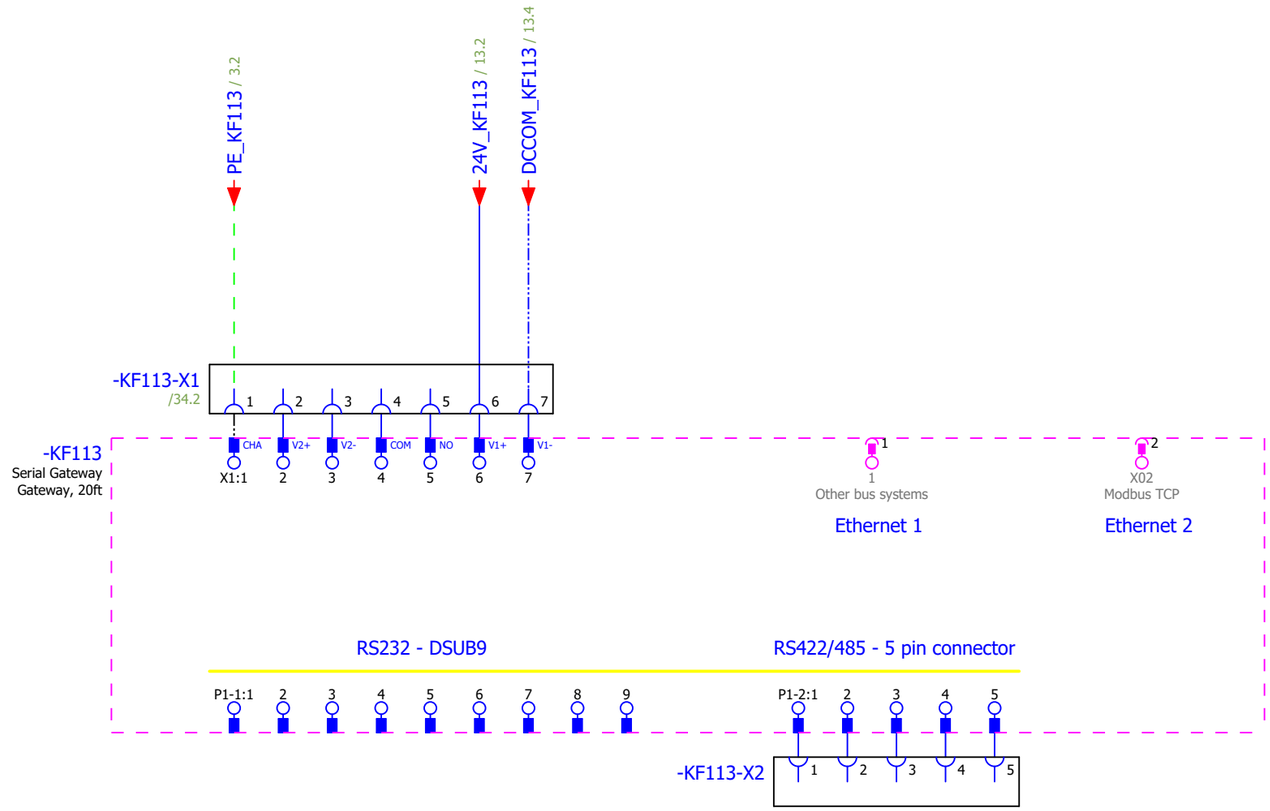
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Ventilation Damper IO		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 / 18

FRM5103656/0B

=LA01
Control System, 20ft Container



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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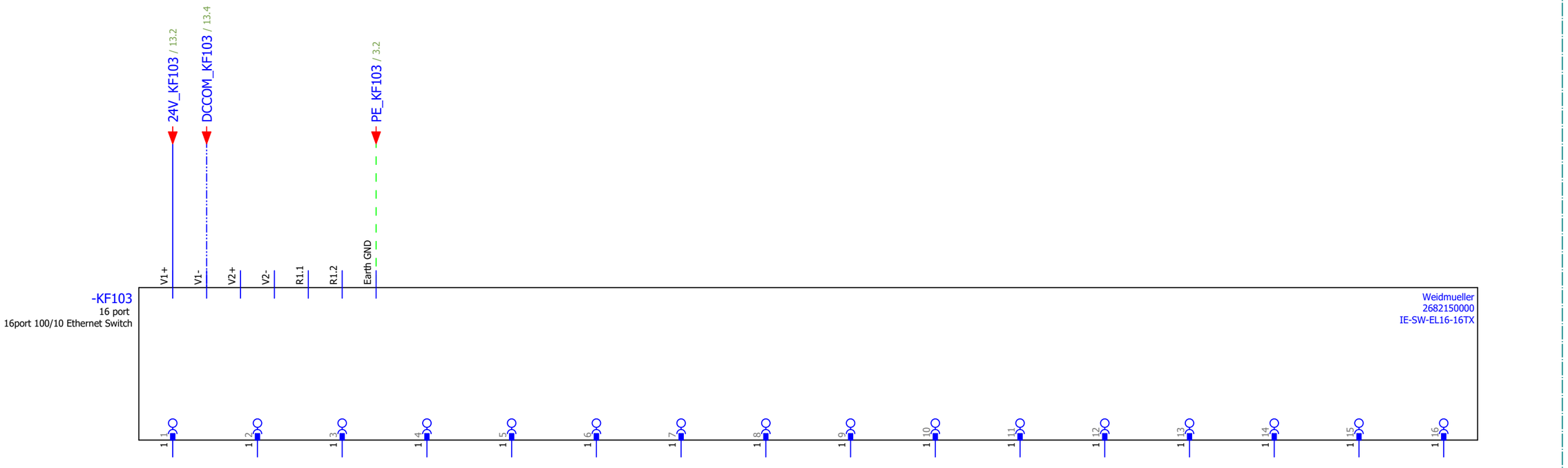
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Modbus Converter		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 34 / 18

FRM5103656/0B

=LA01
Control System, 20ft Container

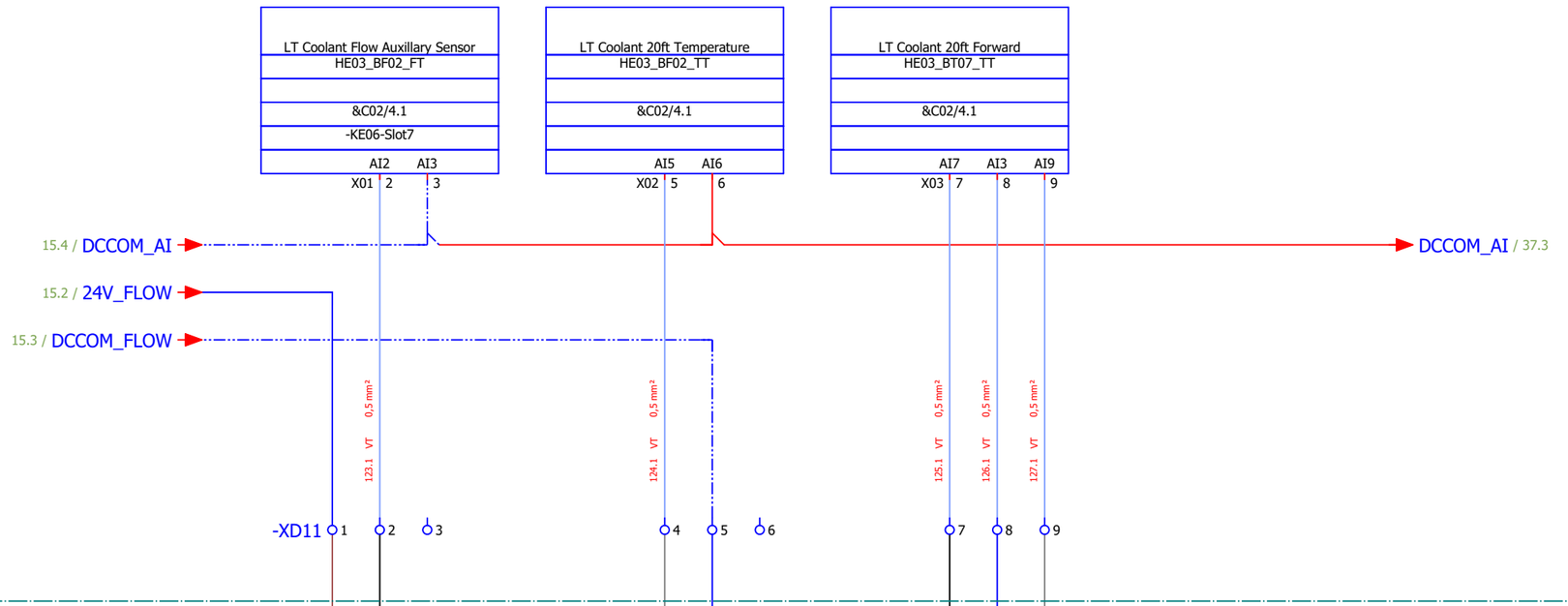


Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
EPLAN Revision	01.P15					THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	SHEET TYPE/DESC	Network Switch		
EPLAN Project Pages	478			DATE			ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 / 18
=	++	+ UC31	& C03	05-Jun-24						

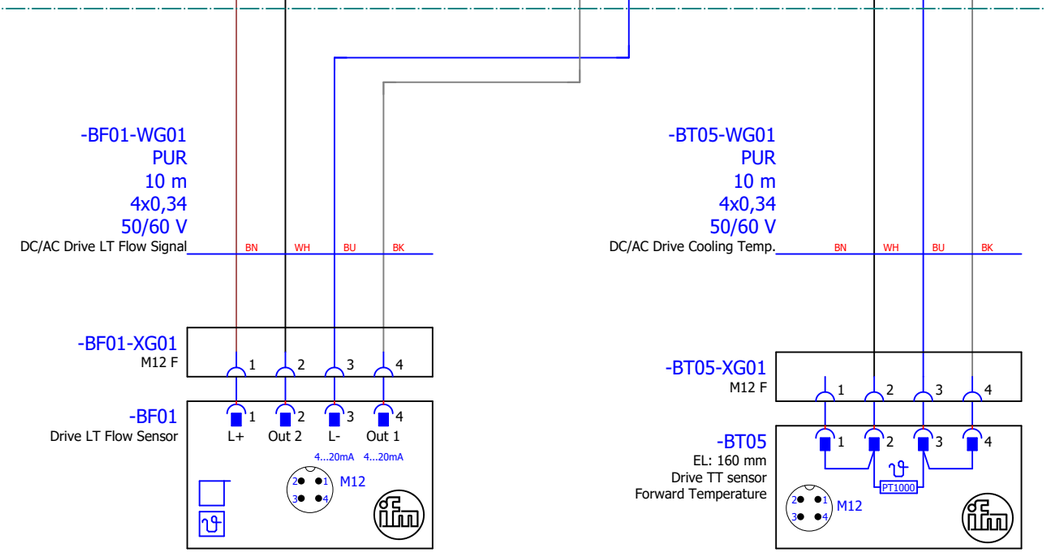
FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01
Control System, 20ft Container



=HE03+DA03
Tempereature and flow sensors. Drive cooling



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15		
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet				
SHEET TYPE/DESC	LT Measurements				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	36 / 18	

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=LA01
Control System, 20ft Container

Container temperature
DA03_BT01
&C02/4.1
-KE06-Slot7
AI10 AI11 AI12
X04 10 11 12

Container Diff. Pressure
DA03_BP01
&C02/4.1
-KE06-Slot7
AI23
X08 23 24

36.6 / DCCOM_AI
14.4 / DCCOM_DP
14.2 / 24V_DP

0,5 mm² VT 128.1
0,5 mm² VT 129.1
0,5 mm² VT 130.1

-XD11 10 11 12
-XD11 22 23 24

Klemmer skal monteres

=JA01+DA03
Control System, 20ft Container

-BT01-WG01
PUR
10 m
4x0,34
50/60 V
Container Temperature
BN WH BU BK

-BT01-XG01
M12 F
1 2 3 4

-BT01
-25...80 °C
Container Temperature B
Transducer
1 2 3 4
PT1000
M12

-BP01.WG01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
Differential-pressure intake filter
1 2 3

-BP01
Container Indoor/Outdoor
Diffential Pressure Sensor
UB+ GND AOU1 AOI1
AC/DC 24 V
DC 0...5/10V
DC 4...20mA
ON 1 2 3 4 5 6
Setting: 0 to 500 Pa

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

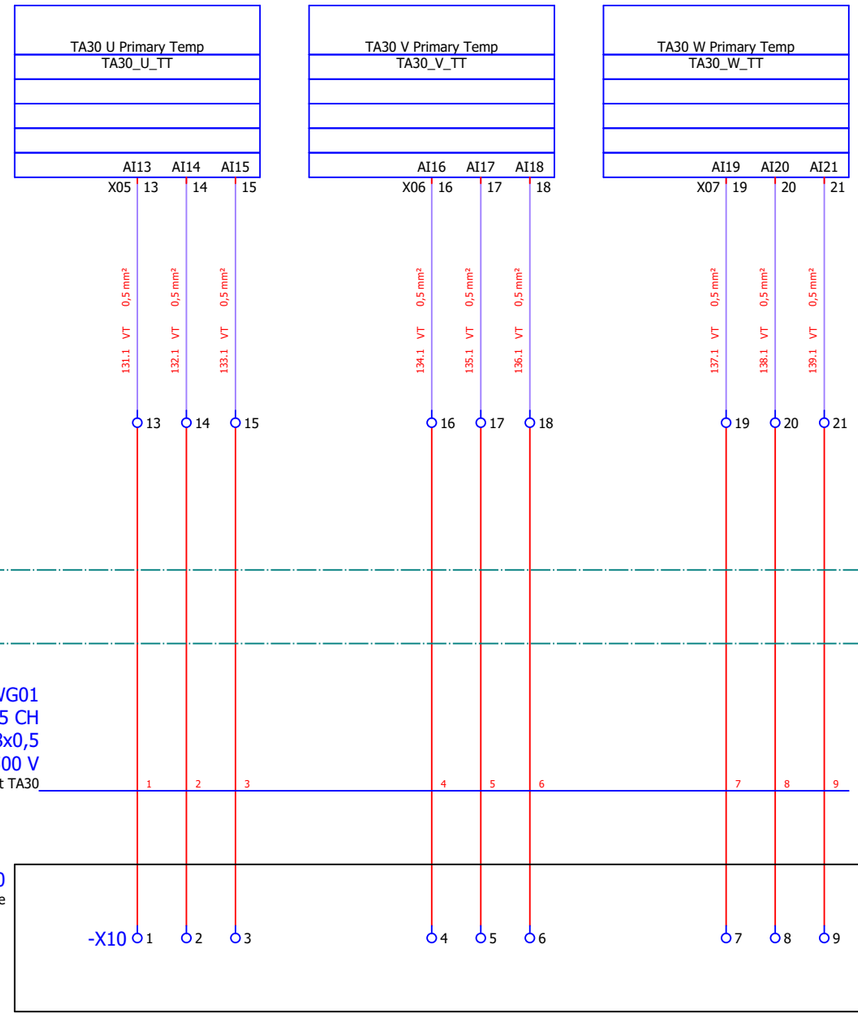
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DESCRIPTION
DATE
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Cont. Temp and Diff. Pressure		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 / 18

=LA01
Control System, 20ft Container



=BA20+DA03.TA30
Control System, 20ft Container

-WG01
ÖLFLEX® CLASSIC 135 CH
18x0,5
300/500 V
Temperature measurement TA30

-AC10
Transformer temperature

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Transformer Temperature Measurements		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 38 / 18

FRM5103656/0B

=JA01+DA03
Container ventilation fan

/ >+UC31-XD01:2
/ >+UC31-XD01:4
/ >+UC31-XD01:6
/ >+UC31-XD01:PE2

-GQ01.WD01
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV
4x2,5
0,6/1,0 kV
Container fan supply
GN/YE 1 2 3

-GQ01.WG01
UNITRONIC® BUS CAN FD P
2x0,5
300 V
Container fan Modbus
BN WH

BN WH >=LA01+UC31-MB01 /

-GQ01-R01
120Ohm

-GQ01
1kW
Container ventilation fan

PE	PE	L1	L2	L3	NC	COM	0-10V	RSB	RSA	GND	10V
1	2	3	4	5	6	7	8	10	11	12	13

M
3~
PE

>=LA01+UC31-XD01:1 /
>=LA01+UC31-XD01:3 /
>=LA01+UC31-XD01:5 /
>=LA01+UC31-XD01:N /
>=LA01+UC31-XD01:PE /

-EB02-WD01
ÖLFLEX® CLASSIC 110 CH
5x2,5
300/500 V
Container heater supply
1 2 3 4 GNYE

>=LA01+UC31-XD01:7 /
>=LA01+UC31-XD01:8 /

-EB02-WG01
ÖLFLEX® CLASSIC 110 CH
3x1
300/500 V
Container heater thermostat
1 2

-EB02
Container heating unit

L1	L2	L3	N	PE	T1	T2
1	2	3	4	5	6	7

11 kW Heater fan

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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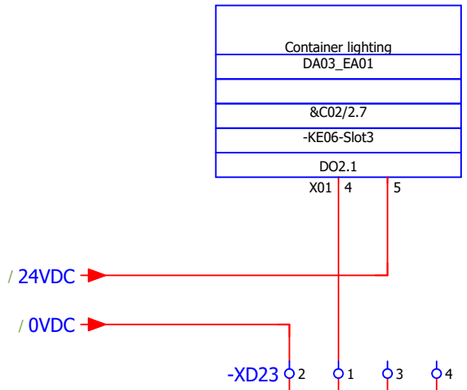
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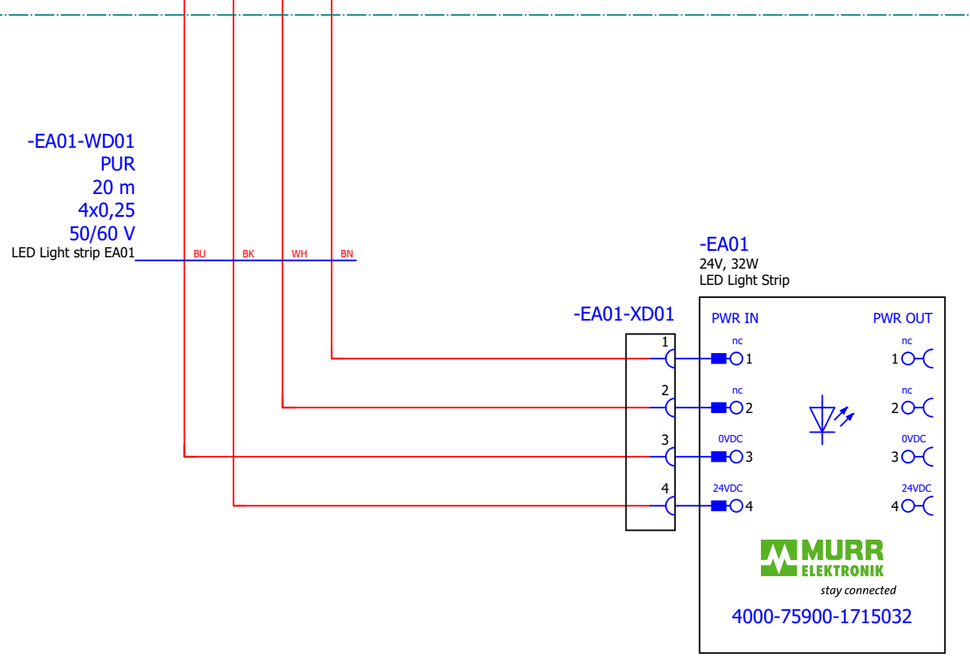
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container ventilation and heating		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 39 / 18

=LA01+UC31
Container AUX control



=JA01+DA03
Container Lighting



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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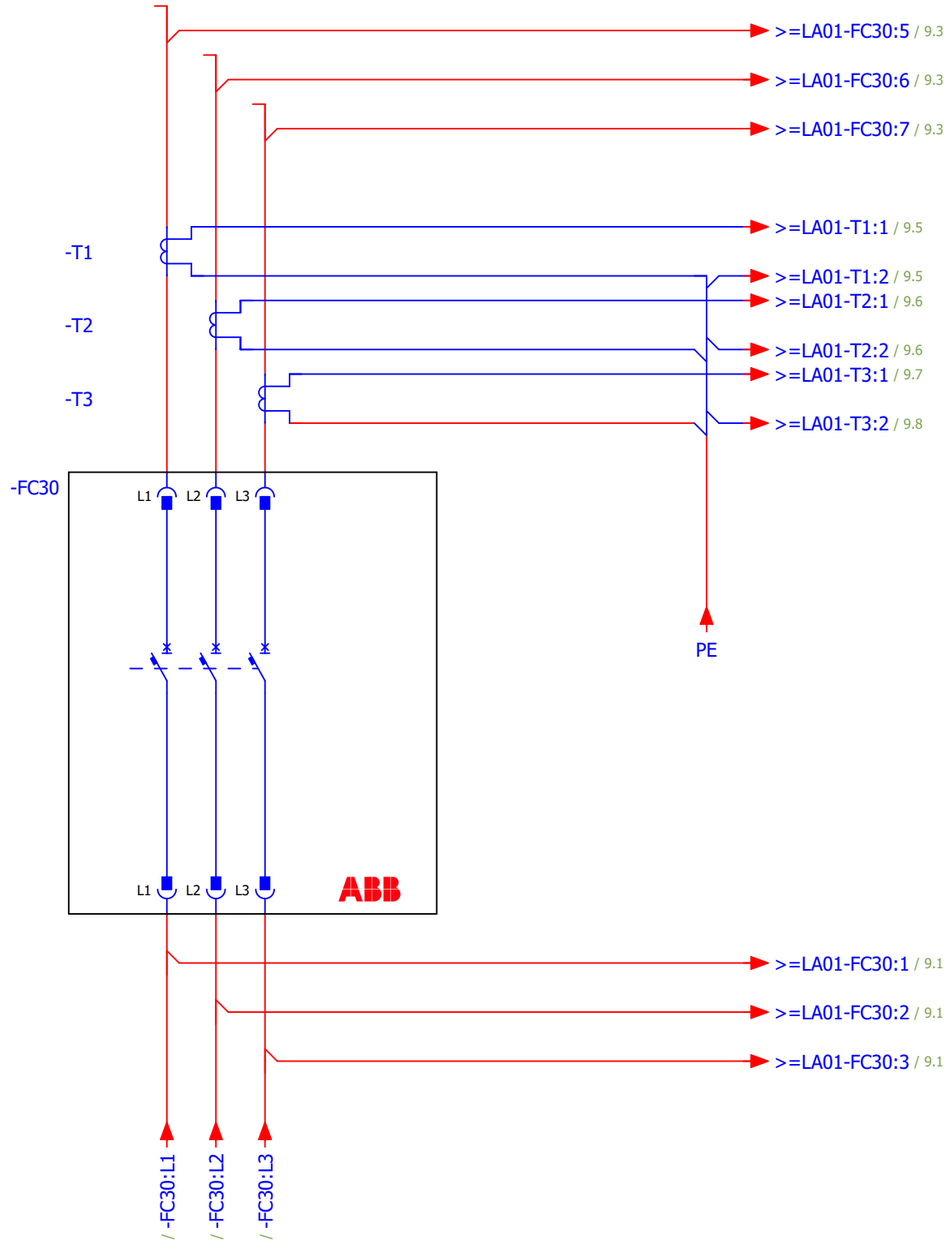
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Container Lighting		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 40 / 18

0	1	2	3	4	5	6	7	8

=BA30
Output Breaker



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C03

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Main output breaker		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 41 / 18

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Ballard Power Systems Europe - Technology Solutions

Panel Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

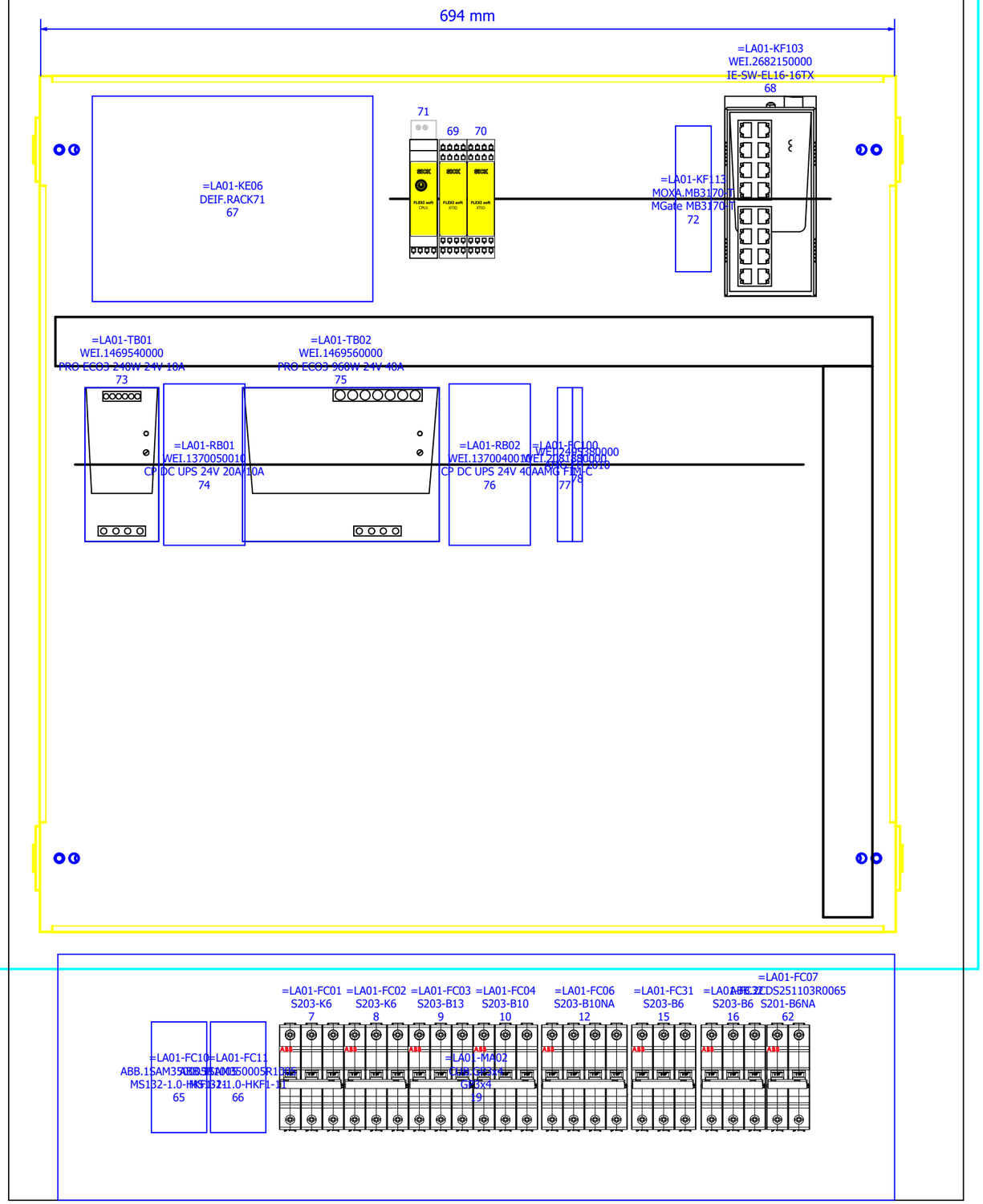
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Panel Documentation and Layout		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Panel Layout		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Enclosure legend

Item number	Device tag	Type number	Part number	Manufacturer	Function text
7	FC01	S203-K6	ABB.2CDS253001R0377	ABB	
8	FC02	S203-K6	ABB.2CDS253001R0377	ABB	
9	FC03	S203-B13	ABB.2CDS253001R0135	ABB	
10	FC04	S203-B10	ABB.2CDS253001R0105	ABB	
12	FC06	S203-B10NA	ABB.2CDS253103R0105	ABB	
15	FC31	S203-B6	ABB.2CDS253001R0065	ABB	
16	FC32	S203-B6	ABB.2CDS253001R0065	ABB	
19	MA02	GP3x4	CUB.GP3x4	CUB	
62	FC07	S201-B6NA	ABB.2CDS251103R0065	ABB	
65	FC10	MS132-1.0-HKF1-11	ABB.1SAM350005R1005	ABB	MMS - Busbar Voltage Sense
66	FC11	MS132-1.0-HKF1-11	ABB.1SAM350005R1005	ABB	MMS - Customer Voltage Sense
67	KE06		DEIF.RACK71	DEIF	Controller Extension Rack
68	KF103	IE-SW-EL16-16TX	WEI.2682150000	WEI	16port 100/10 Ethernet Switch
69	KE21	FX3-XTIO84002	SICK.1044125	SICK	Safe Digital Input/Output Module
70	KE22	FX3-XTIO84002	SICK.1044125	SICK	=
71	KE20	FX3-CPU130002	SICK.1043784	SICK	Safety PLC, PLC
72	KF113	MGate MB3170-T	MOXA.MB3170-T	MOXA	Gateway, 20ft
73	TB01	PRO ECO3 240W 24V 10A	WEI.1469540000	WEI	24V PSU
74	RB01	CP DC UPS 24V 20A/10A	WEI.1370050010	WEI	24V UPS Module
75	TB02	PRO ECO3 960W 24V 40A	WEI.1469560000	WEI	24V PSU
76	RB02	CP DC UPS 24V 40A	WEI.1370040010	WEI	40A UPS Module

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Enclosure Legend		

ALL SHEETS ARE THE SAME REVISION STATUS | SIZE A3 | LANGUAGE EN | SHEET/TOTAL 3 / 18

FRM5103656/0B

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=LA01-FC101-1		1	1	0	0	1	
=LA01-FC101-2		2	2	0	0	1	
=LA01-FC102-1		1	2	0	0	2	
=LA01-FC103-1		1	2	0	0	2	
=LA01-FC103-3		3	4	0	0	4	
=LA01-FC104-1		1	2	0	0	2	
=LA01-FC104-3		3	4	0	0	2	
=LA01-XD01		1	PE	5	0	16	
=LA01-XD02		1	PE	2	0	8	
=LA01-XD03		1	PE	2	0	6	
=LA01-XD04		1	8	0	0	8	
=LA01-XD06		1	8	0	0	8	
=LA01-XD09		9	14	0	0	6	
=LA01-XD10		1	18	2	0	20	
=LA01-XD11		1	24	0	0	15	
=LA01-XD20		1	38	0	0	38	
=LA01-XD21		1	2	0	0	2	
=LA01-XD22		1	14	0	0	14	
=LA01-XD23		1	4	0	0	4	
=LA01-XD40		1	PE	3	0	12	
=LA01-XE00		PE		8	0	8	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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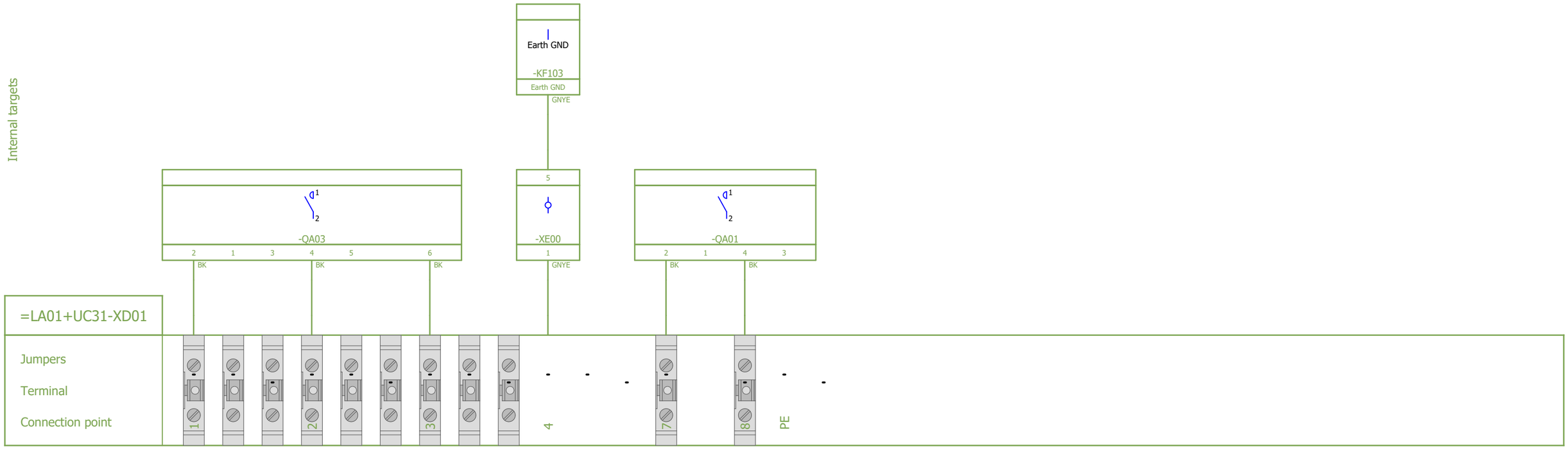
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =LA01+UC31-FC101-1 - =LA01+UC31-XE00		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 22 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DATE
05-Jun-24

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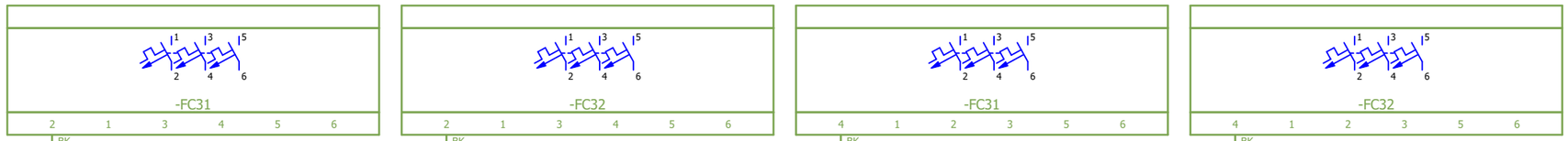
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 30 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC31-XD02

Jumpers

Terminal

Connection point

1 2 3 4

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DESCRIPTION	
DATE	
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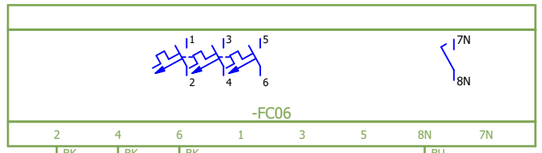
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 31 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC31-XD03

Jumpers

Terminal

Connection point



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DESCRIPTION	
DATE	
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD03		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 32 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

-FC103 (2) — 2 — 4

1 — -FC103-1 (1) — 1 — BU

3 — -FC103-3 (3) — 3 — BUWH

-KE06-Slot4 — X02:9 VT — X03:22 VT — X02:11 VT — X03:24 VT

=LA01+UC31-XD04

Jumpers

Terminal

Connection point

1 5 2 6 3 4 7 8

	=JA01+DA03-QM07-WD01	=JA01+DA03-QM08-WD01	=JA01+DA03-QM07-WD01	=JA01+DA03-QM08-WD01	=JA01+DA03-QM07-WD01	=JA01+DA03-QM08-WD01
	ÖLFLEX® CLASSIC 135 CH	ÖLFLEX® CLASSIC 135 CH	ÖLFLEX® CLASSIC 135 CH	ÖLFLEX® CLASSIC 135 CH	ÖLFLEX® CLASSIC 135 CH	ÖLFLEX® CLASSIC 135 CH
	1	1	2	2	3 4	3 4
	1:2	1:2	2:1	2:1	3:3 4:4	3:3 4:4
	=JA01+DA03-AC07	=JA01+DA03-AC08	=JA01+DA03-AC07	=JA01+DA03-AC08	=JA01+DA03-AC07	=JA01+DA03-AC08
	1	1	2	2	3	3
	1:2	1:2	2:1	2:1	3:3 4:4	3:3 4:4
	RD	RD	BK	BK	WH OR	WH OR
	2	2	1	1	3 5	3 5
	=JA01+DA03-QM07.MA01	=JA01+DA03-QM08.MA01	=JA01+DA03-QM07.MA01	=JA01+DA03-QM08.MA01	=JA01+DA03-QM07.MA01	=JA01+DA03-QM08.MA01
	2	2	1	1	3	3

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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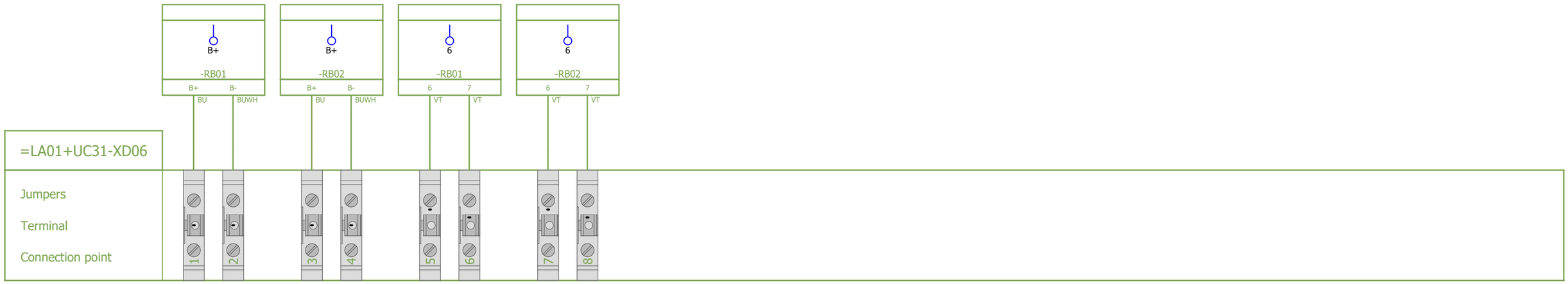
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD04		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 33 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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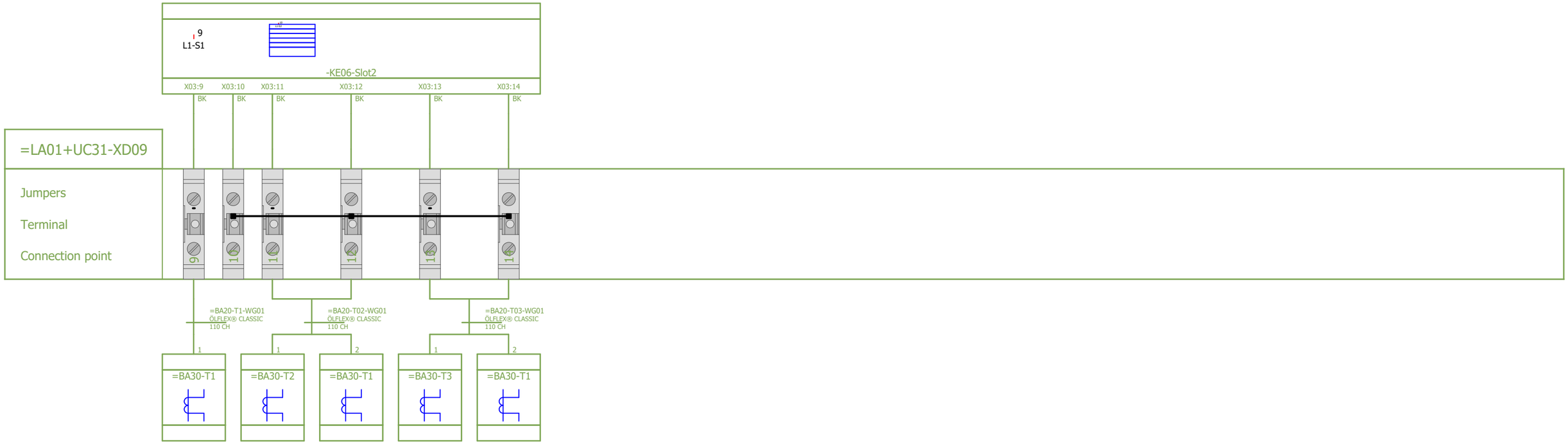
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD06		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 34 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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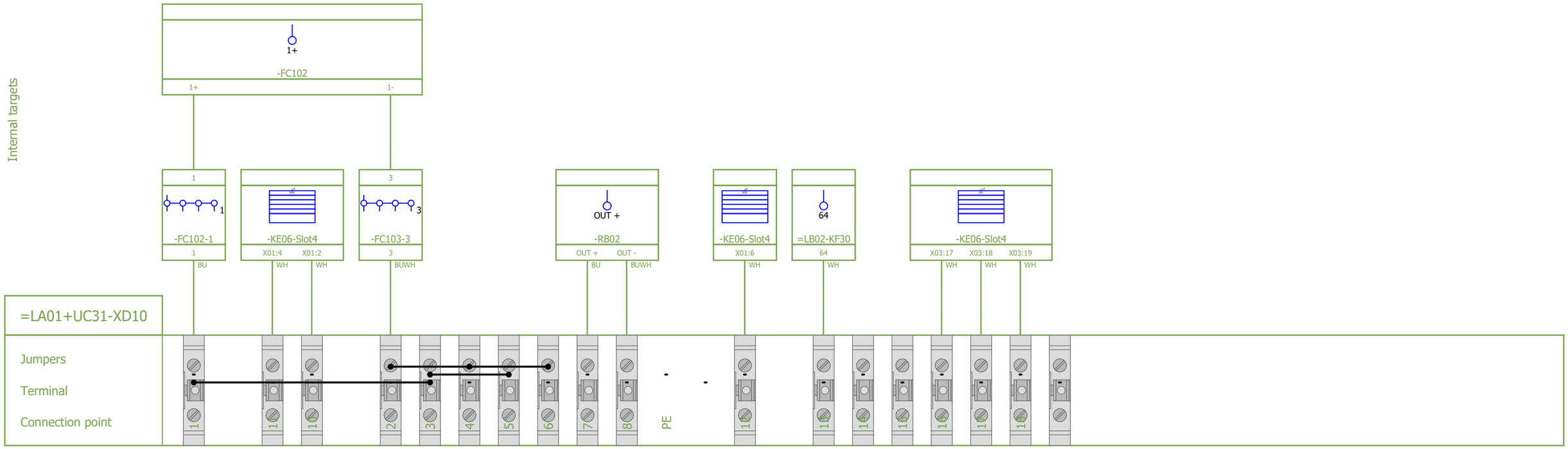
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DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD09		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 35 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD10		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 36 /

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0	1	2	3	4	5	6	7	8

Terminal-connection diagram

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Internal targets

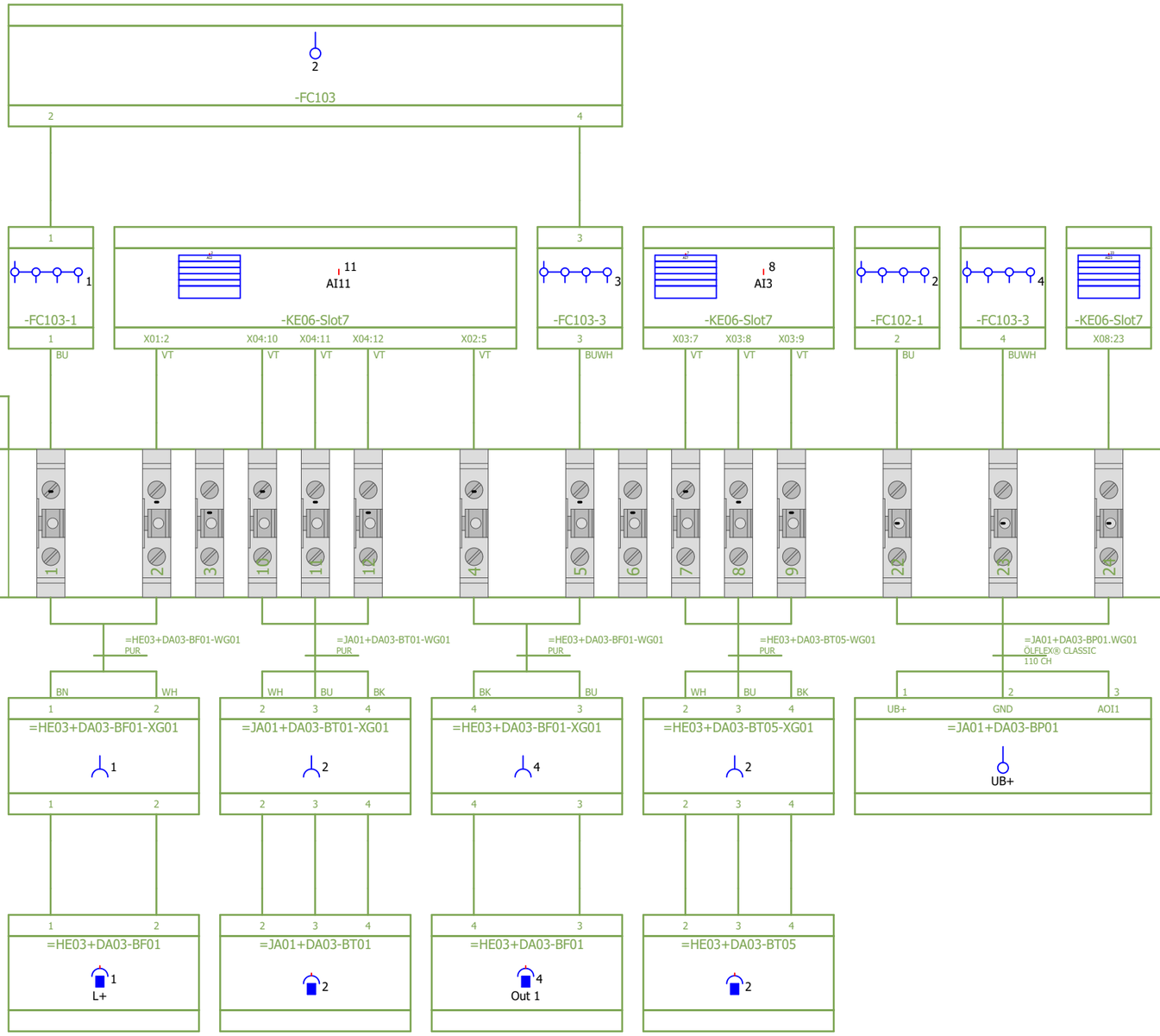
External targets

=LA01+UC31-XD11

Jumpers

Terminal

Connection point



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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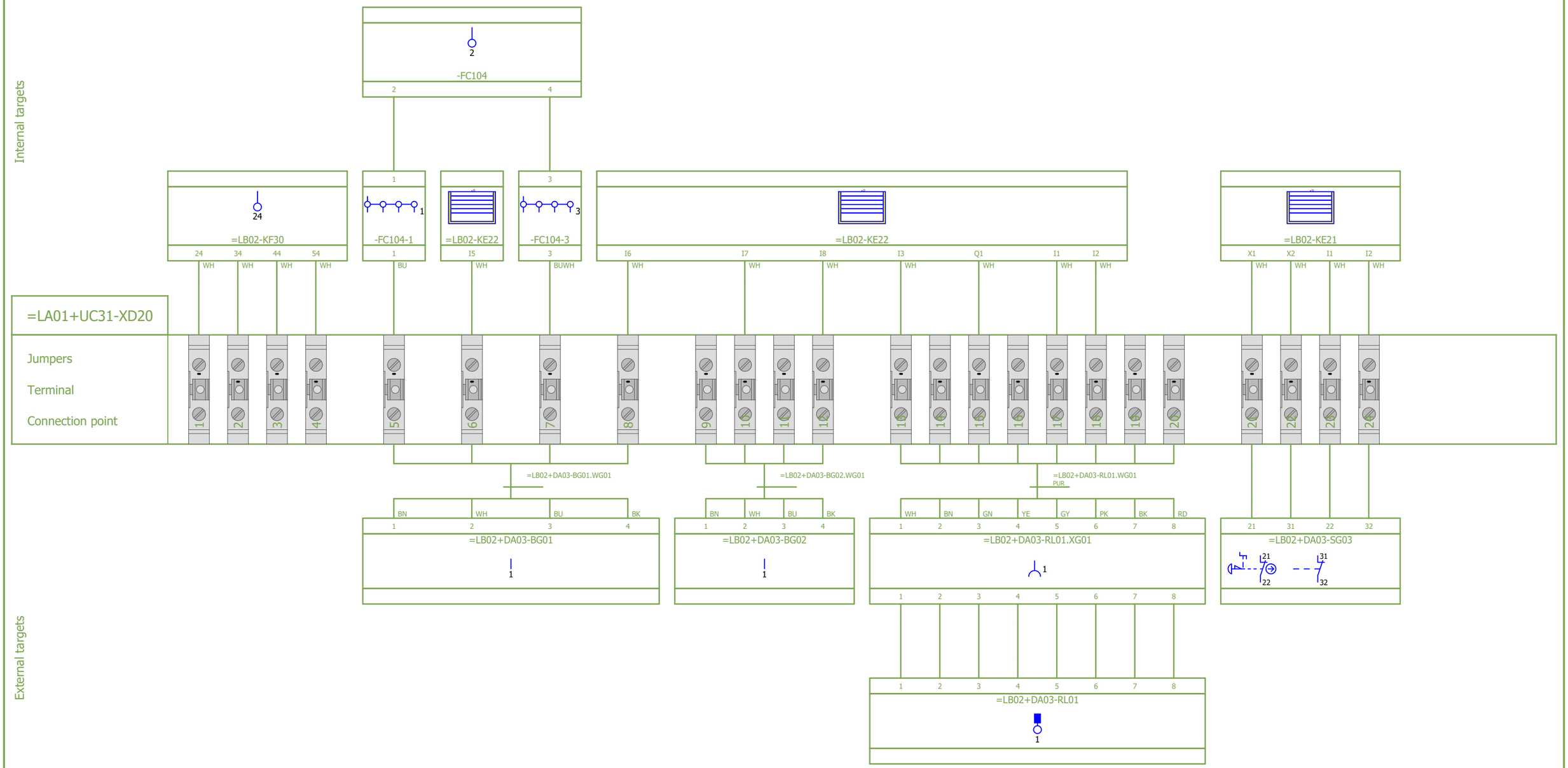
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD11		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 37 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD20		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 38 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets

External targets

=LA01+UC31-XD20

Jumpers

Terminal

Connection point

-FC104

=LB02-KF30

-FC104-1

=LB02-KE22

-FC104-3

=LB02-KE22

=LB02-KE21

=LB02+DA03-BG01.WG01

=LB02+DA03-BG02.WG01

=LB02+DA03-RL01.WG01

=LB02+DA03-BG01

=LB02+DA03-BG02

=LB02+DA03-RL01.XG01

=LB02+DA03-SG03

=LB02+DA03-RL01

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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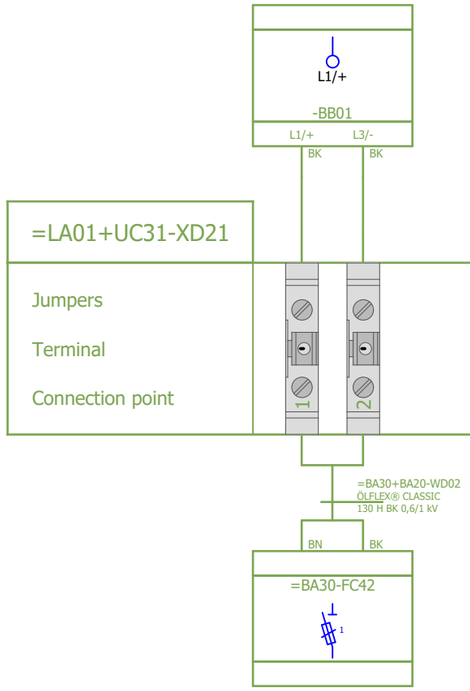
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD20		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 39 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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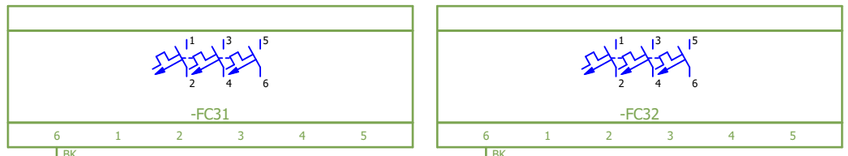
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD21		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 40 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC31-XD02

Jumpers		
Terminal	5	6
Connection point		PE PE

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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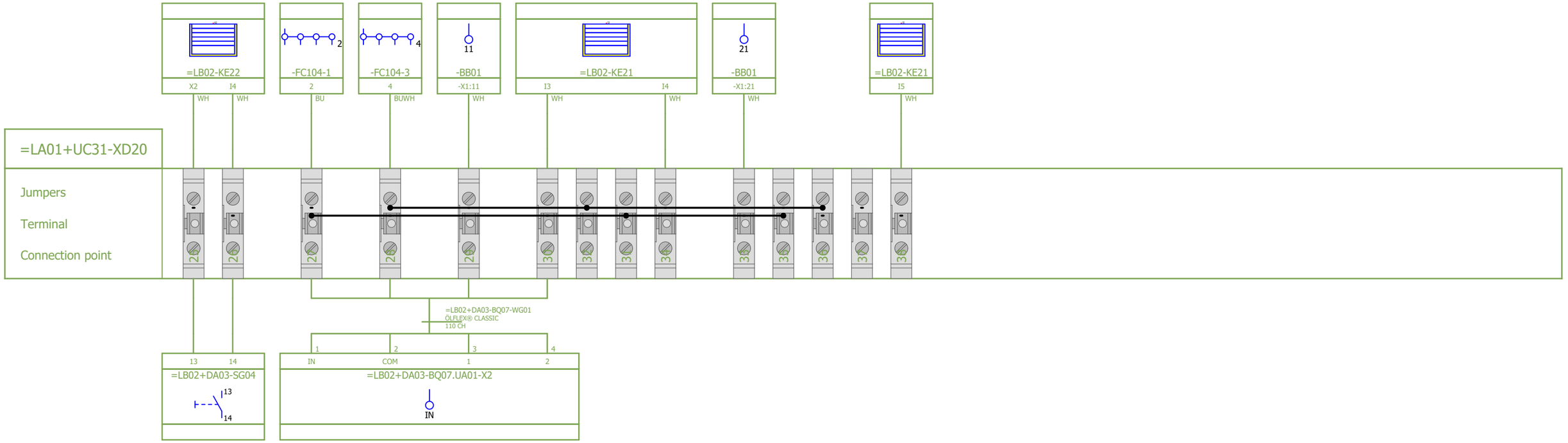
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 41 /

Terminal-connection diagram

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Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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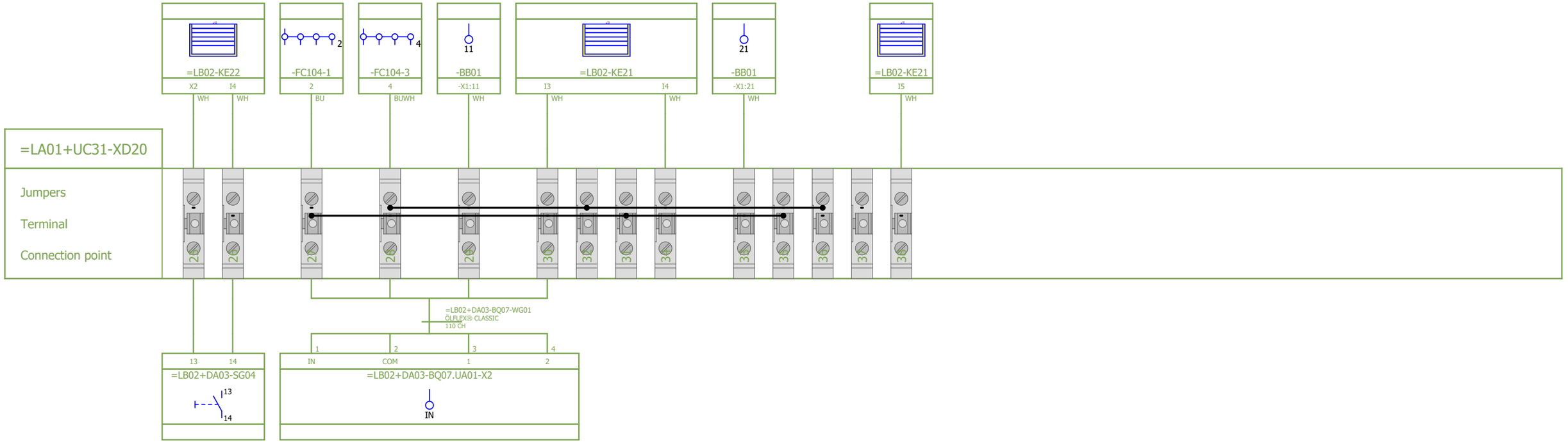
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD20		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 42 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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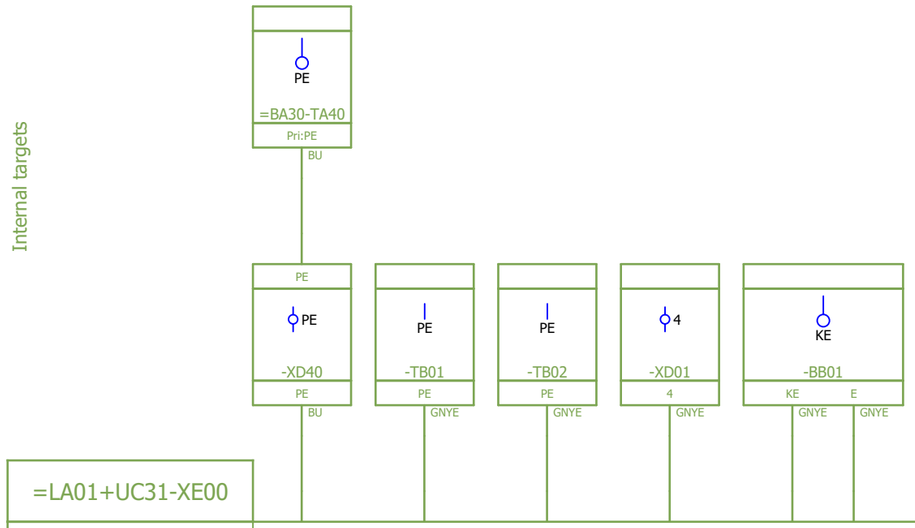
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD20		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 43 /

Terminal-connection diagram

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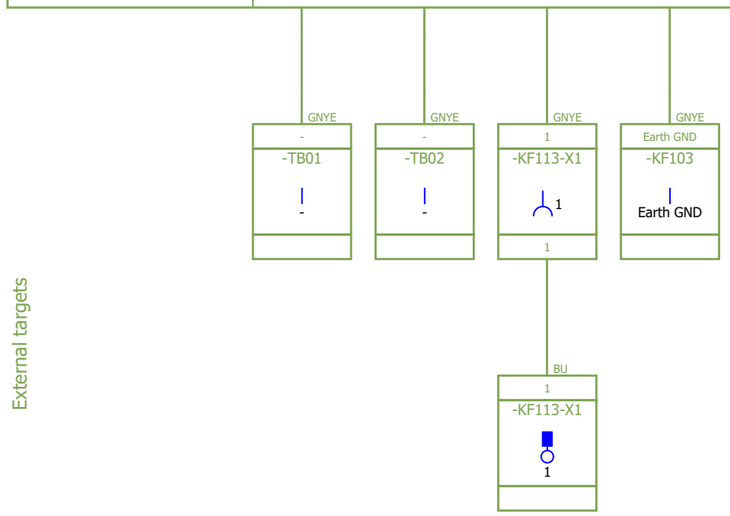
Internal targets



=LA01+UC31-XE00

Jumpers	-	-	-	-	-	-	-	-
Terminal								
Connection point	PE		PE		PE		PE	

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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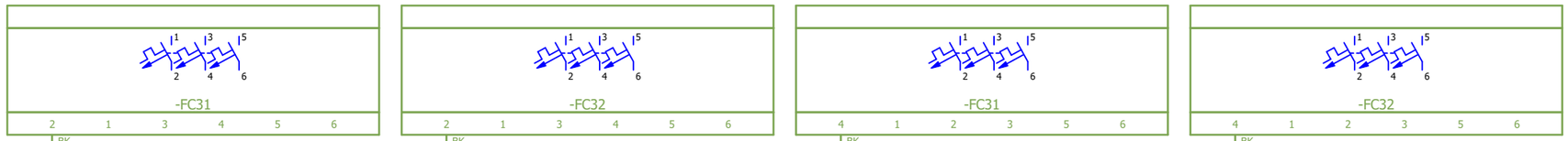
DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XE00		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 47

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC31-XD02

Jumpers

Terminal

Connection point

1 2 3 4

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

REVISION INFORMATION	
DESCRIPTION	
DATE	
05-Jun-24	

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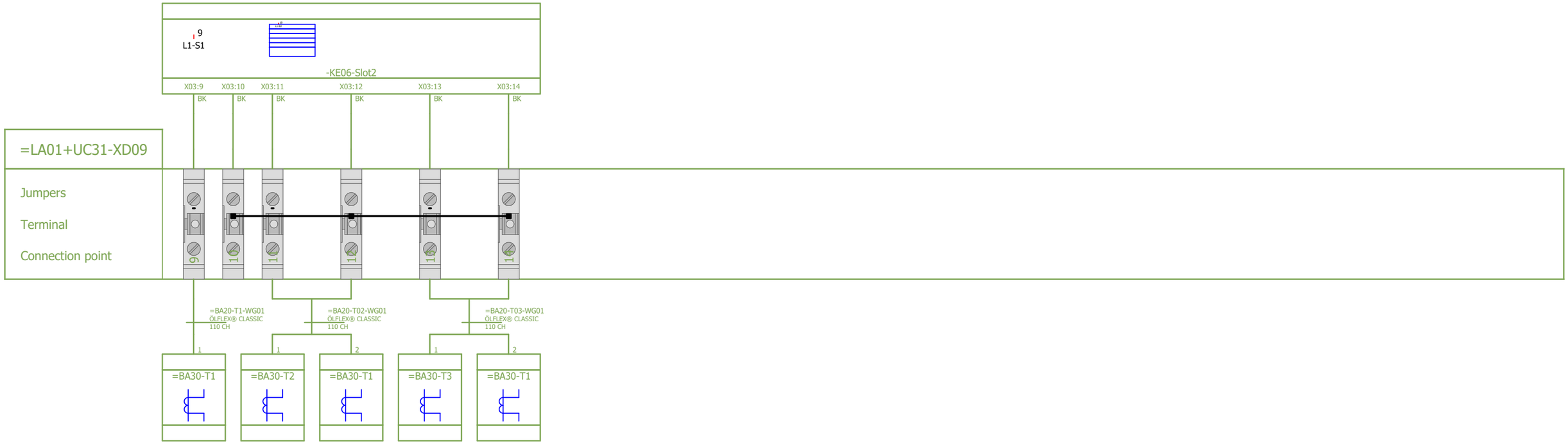
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 48 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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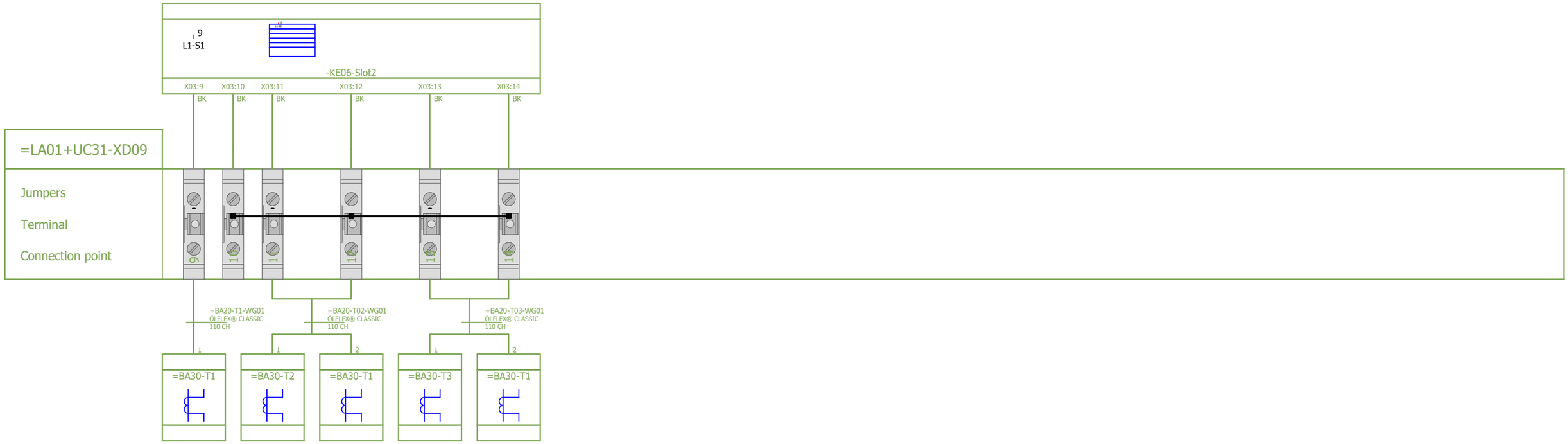
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD09		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 49 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC31	& C04

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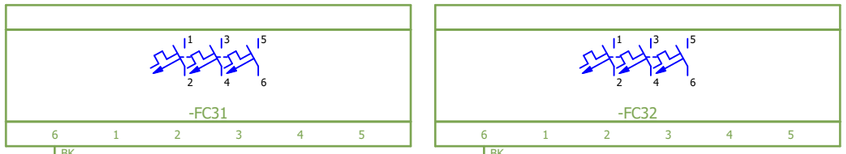
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DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD09		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 50 /

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



=LA01+UC31-XD02

Jumpers	-	-
Terminal	-	-
Connection point	5	6 PE PE

External targets

Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC31 10ft Control Cabinet	REVISION	01.P15
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE	Crosswind UC31 10ft Control Cabinet		
EPLAN Revision	01.P15					THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	SHEET TYPE/DESC	Terminal-connection diagram =LA01+UC31-XD02		
EPLAN Project Pages	478						ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 51 /
=	++	+ UC31	& C04	DATE 05-Jun-24						

FRM5103656/0B

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue

Document Title:	**BLPH Project - Panel Cabinet Layout: UC41 Coolant Skid VFD Cabinet**
Document Number:	K559-2254-CWIWP4202202-E03-005
Revision:	Rev001
Sequence Number:	005
File Name:	K559-2254-CWIWP4202202-E03-005Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

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+UC41

Ballard Power Systems Europe - Technology Solutions

Cabinet: Coolant Skid Inverter Cabinet
Location: Coolant Skid, Middle Rear

Vin = 400VAC, 3ph

Ikmax = 6kA - AC Supply

IP56

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& A01

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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- 1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	Black (BK)
AC Phase L1	Brown (BN)
AC Phase L2	Black (BK)
AC Phase L3	Grey (GY)
AC Neutral	Light Blue (BU)
Externally supplied circuit	Orange (OG)

DC Wiring Colors

DC Power Circuit	Black (BK)
DC Control Voltage (24V)	Dark Blue (BU)
DC Control Voltage Refence (0V)	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	White (WH)
Signal Wire (AI, AO)	Violet (VT)
Externally supplied circuit	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	Green/Yellow (GNYE)

Conductor Colour Identification

IEC 60757:1983 Designation	Description
BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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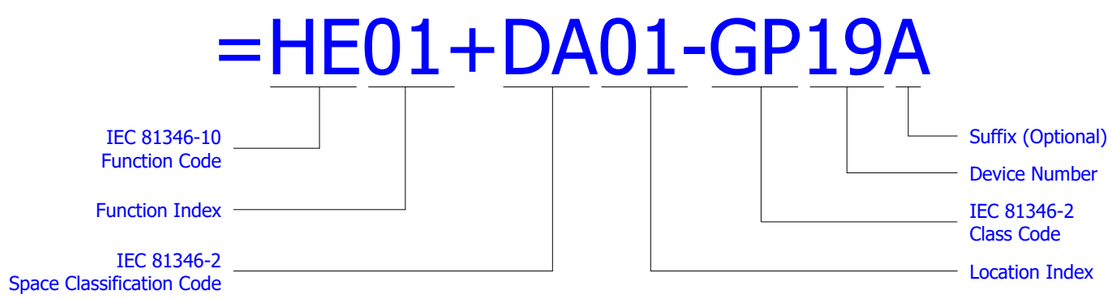
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
= ++ + UC41 & A01	

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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

FRM5103656/0B

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F06_002_Ballard

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	UC41	2	Standard Wire Colors	05-Jun-24
	UC41	3	Tagging Standard	05-Jun-24
	UC41	4	Table of contents : +UC41&A01/1 - +UC41&C04/5	05-Jun-24
	UC41	1	Multiline Documentation Intro	05-Jun-24
	UC41	2	AC Power - Incomming	05-Jun-24
	UC41	3	DC Supply - Incomming	05-Jun-24
	UC41	4	Network - Incomming	05-Jun-24
	UC41	5	Network - Switch	05-Jun-24
	UC41	6	AC Power - TA11	05-Jun-24
	UC41	7	AC Power - TA12	05-Jun-24
	UC41	8	AC Power - TA13	05-Jun-24
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	UC41	13	AC Power - TA22	05-Jun-24
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	UC41	2	Fan Overview	05-Jun-24
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	UC41	4	Terminal-connection diagram =HE01+UC41-X01	05-Jun-24
	UC41	5	Terminal-connection diagram =HE01+UC41-XD40	05-Jun-24

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	01.P15
EPLAN Project Pages	478
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DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Table of contents : +UC41&A01/1 - +UC41&C04/5		
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Multiline Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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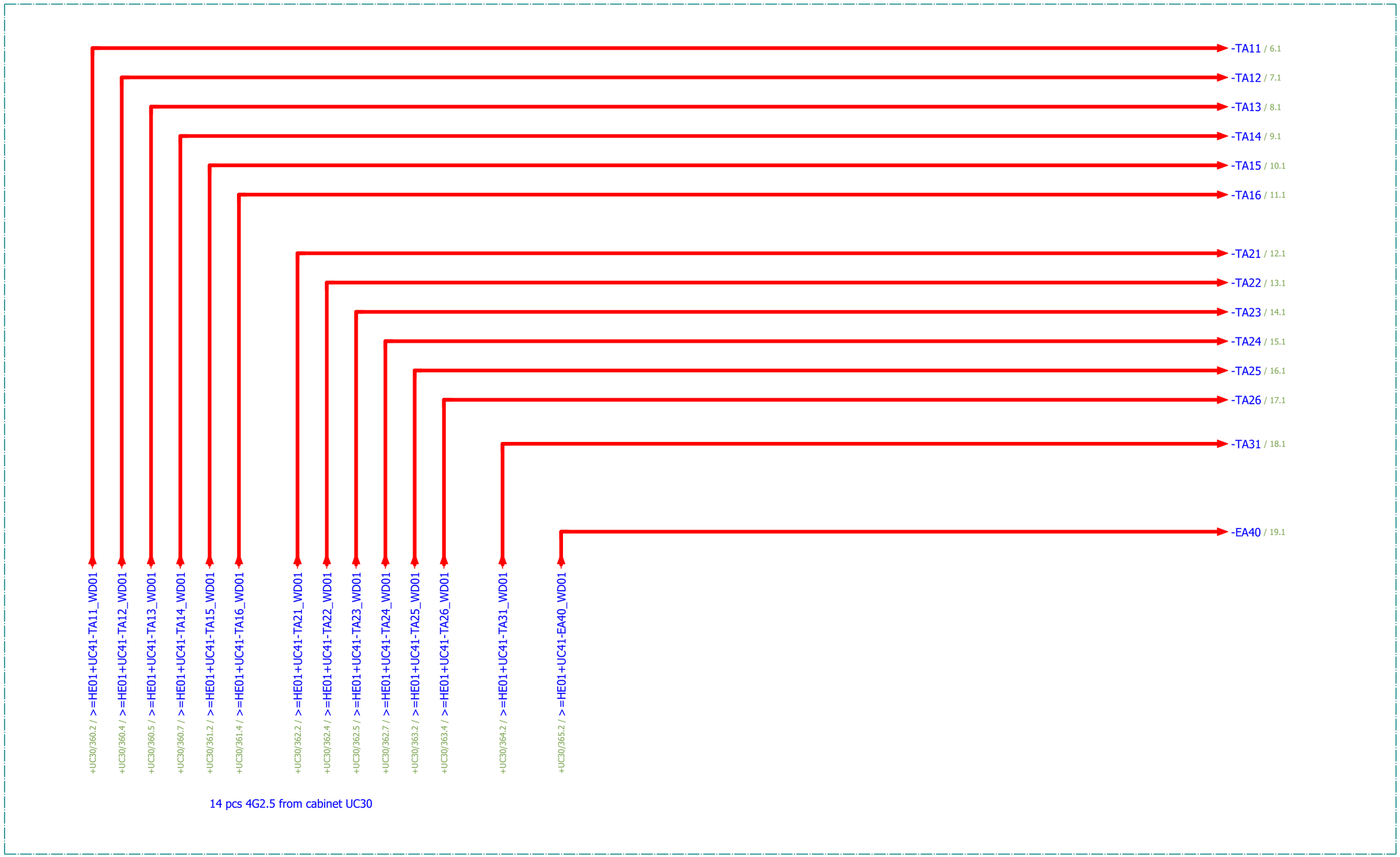
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DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Multiline Documentation Intro		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 2

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
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EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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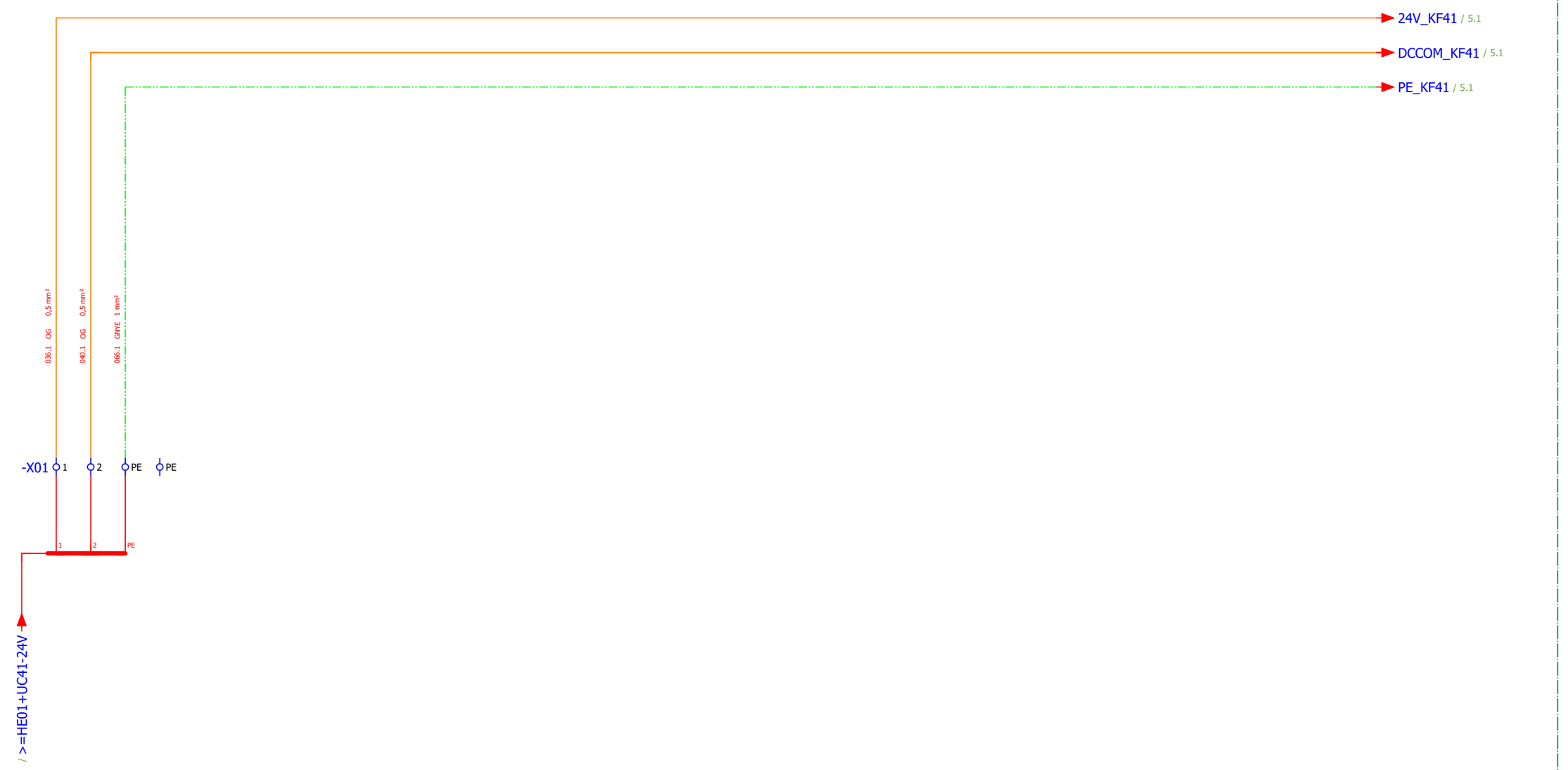
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DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - Incomming		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

=HE01



From Coolant Skid Control Cabinet (UC30)
3G1 - 24V Supply

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	DC Supply - Incomming		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

=HE01

-KF41_WG01 / 5.1

-EA40_WG01 / 19.1

-KF41-WG01
Cat.6A PUR
8x24
300 V
VFD Control Net

-EA40-WG01
UNITRONIC® BUS CAN UL/CSA
4x0,5
300 V
Air Chiller RS485 Bus

> =HE01+UC41-WG01 /

> =HE01+UC41-WG02 /

From Coolant Skid Control Cabinet (UC30)
1 pcs Ethernet
1 pcs RS485

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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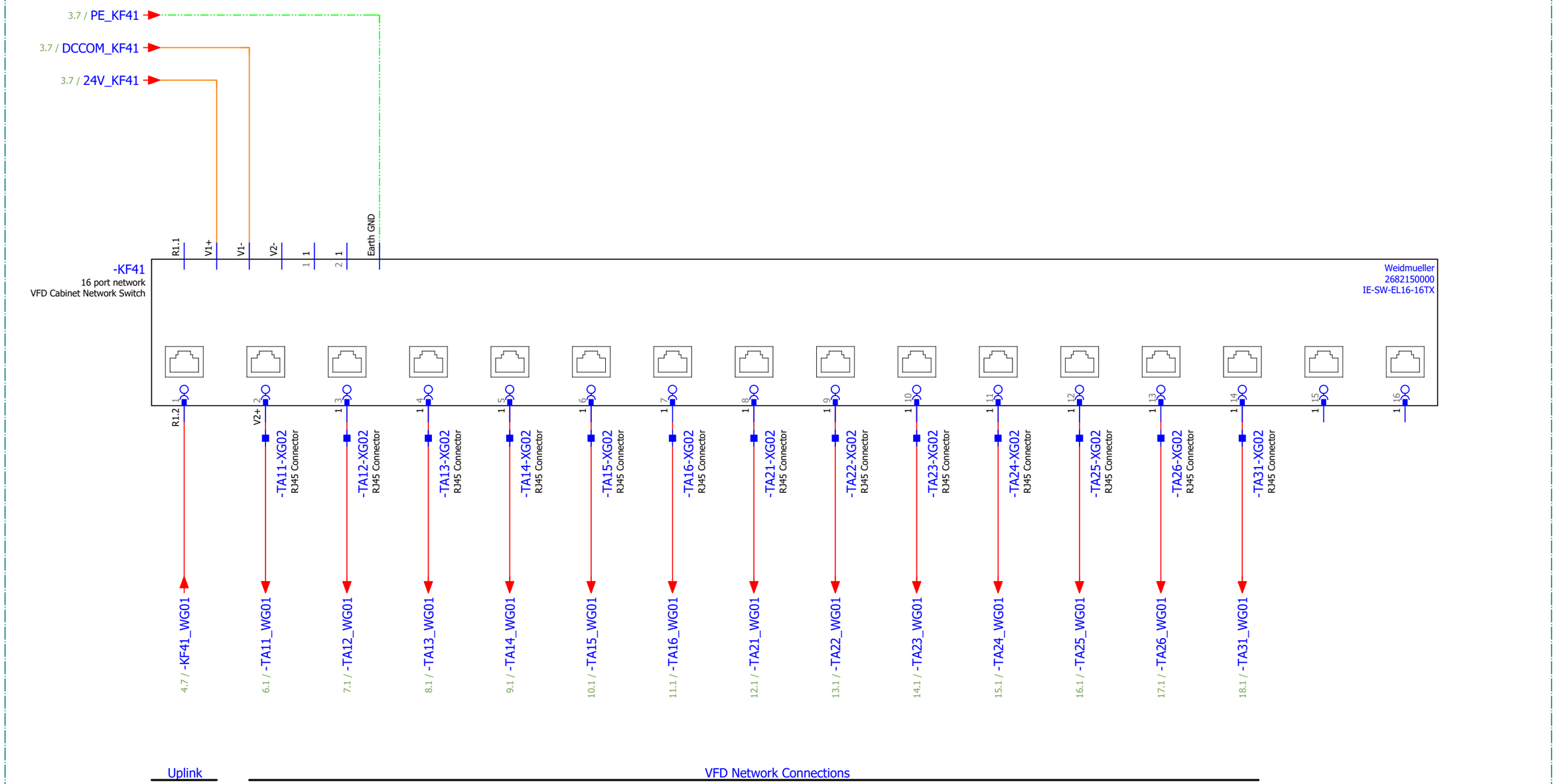
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Network - Incomming		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 18

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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DESCRIPTION	
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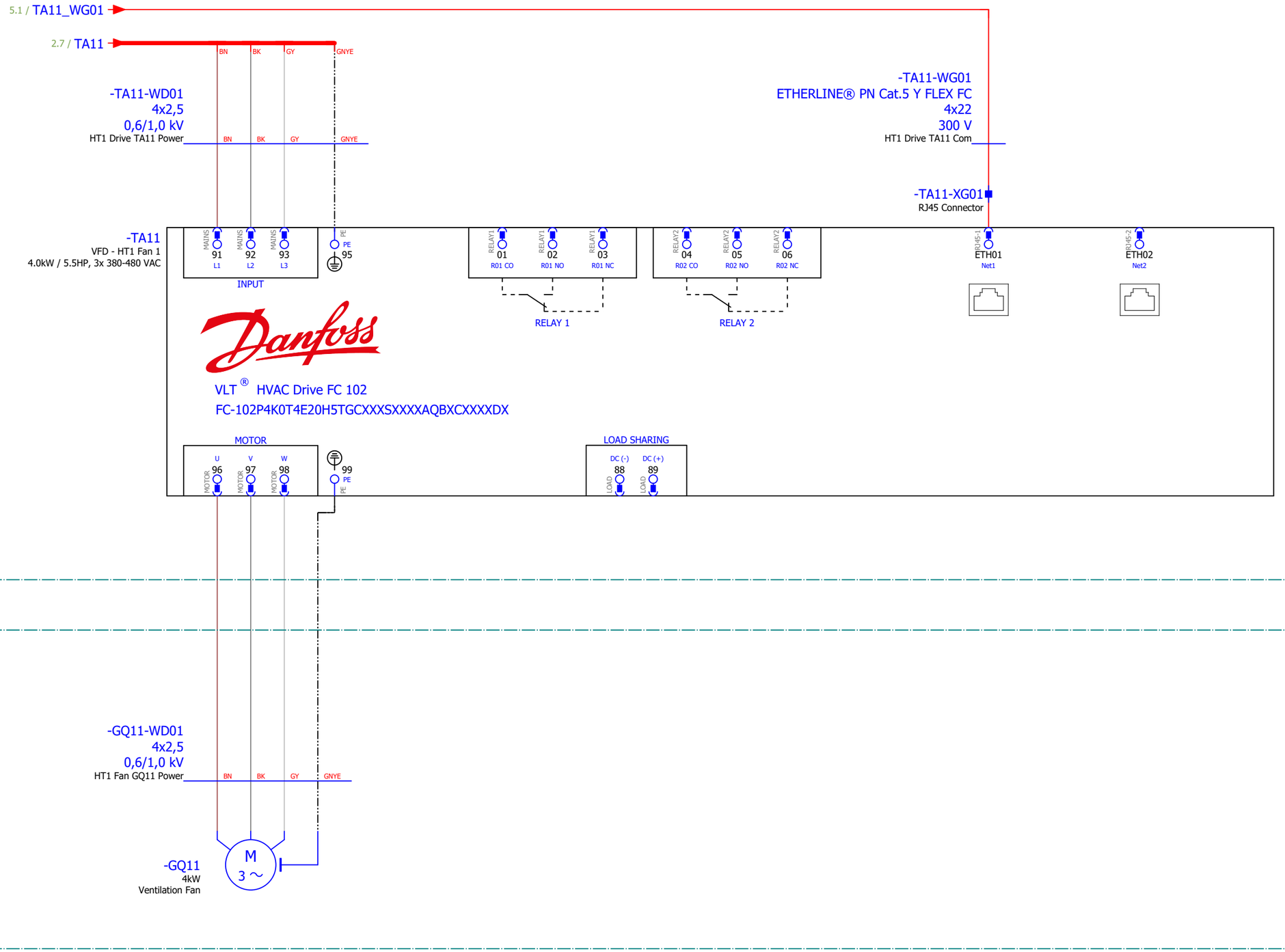
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Network - Switch		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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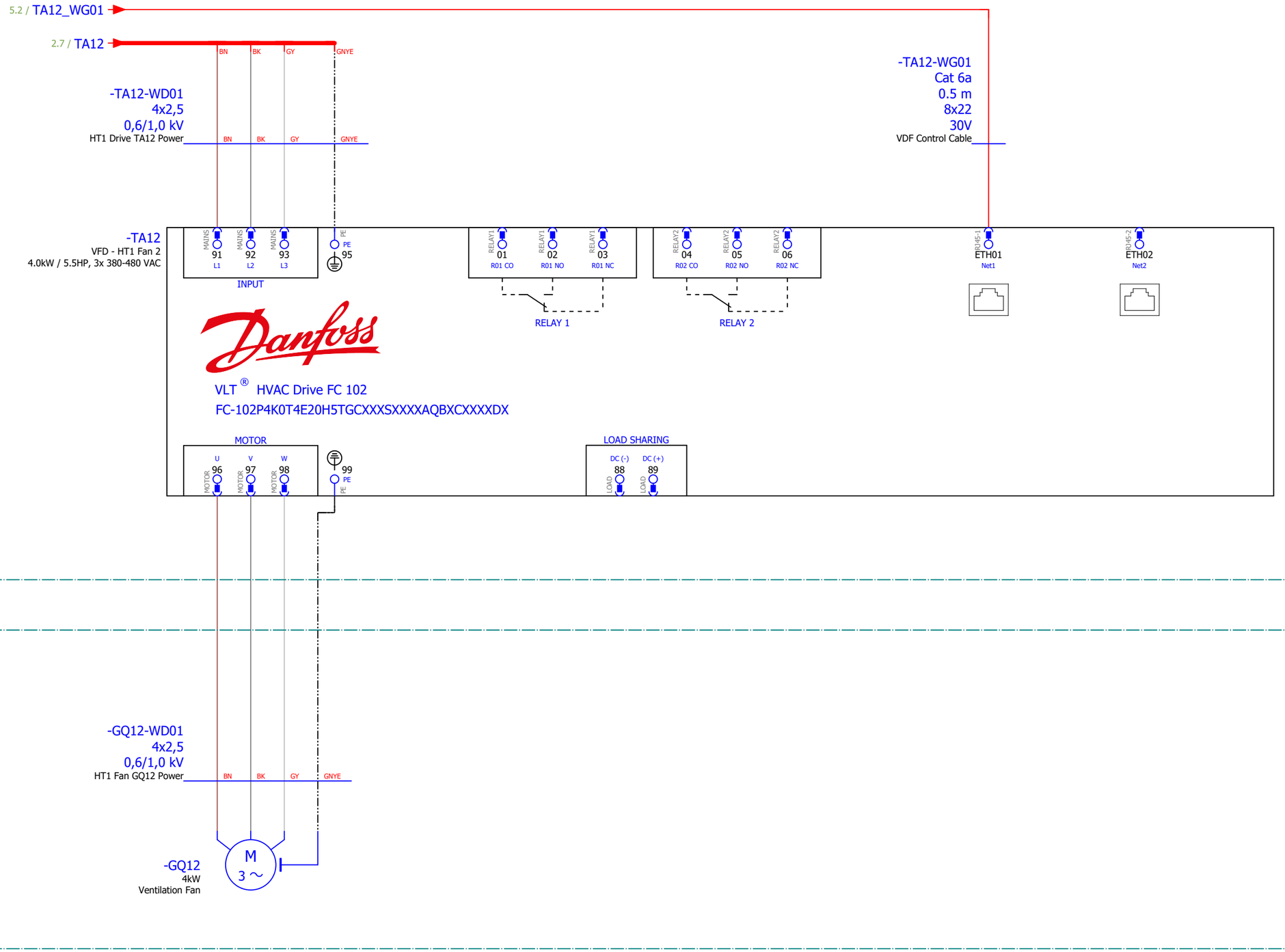
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA11		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 6 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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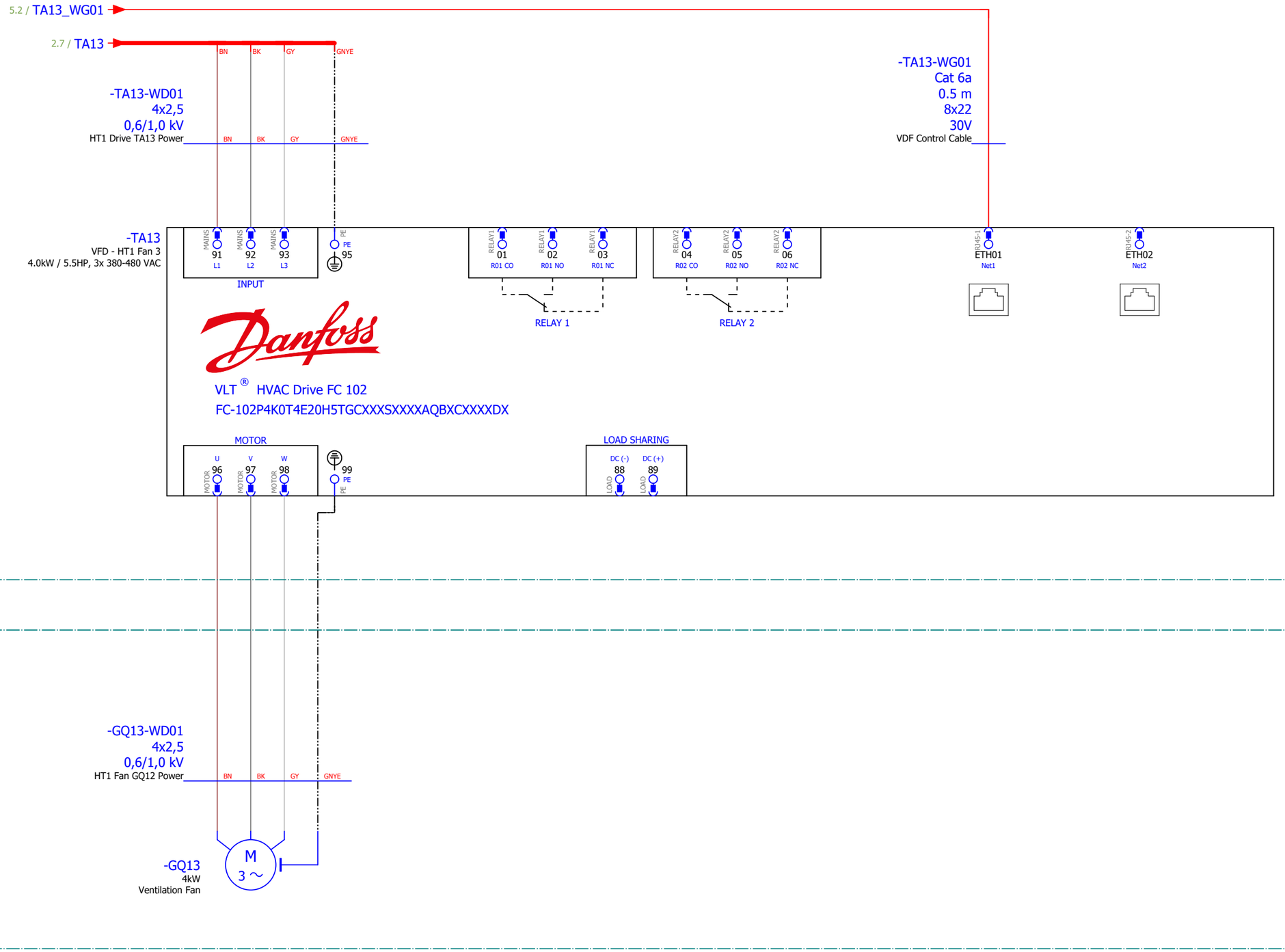
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA12		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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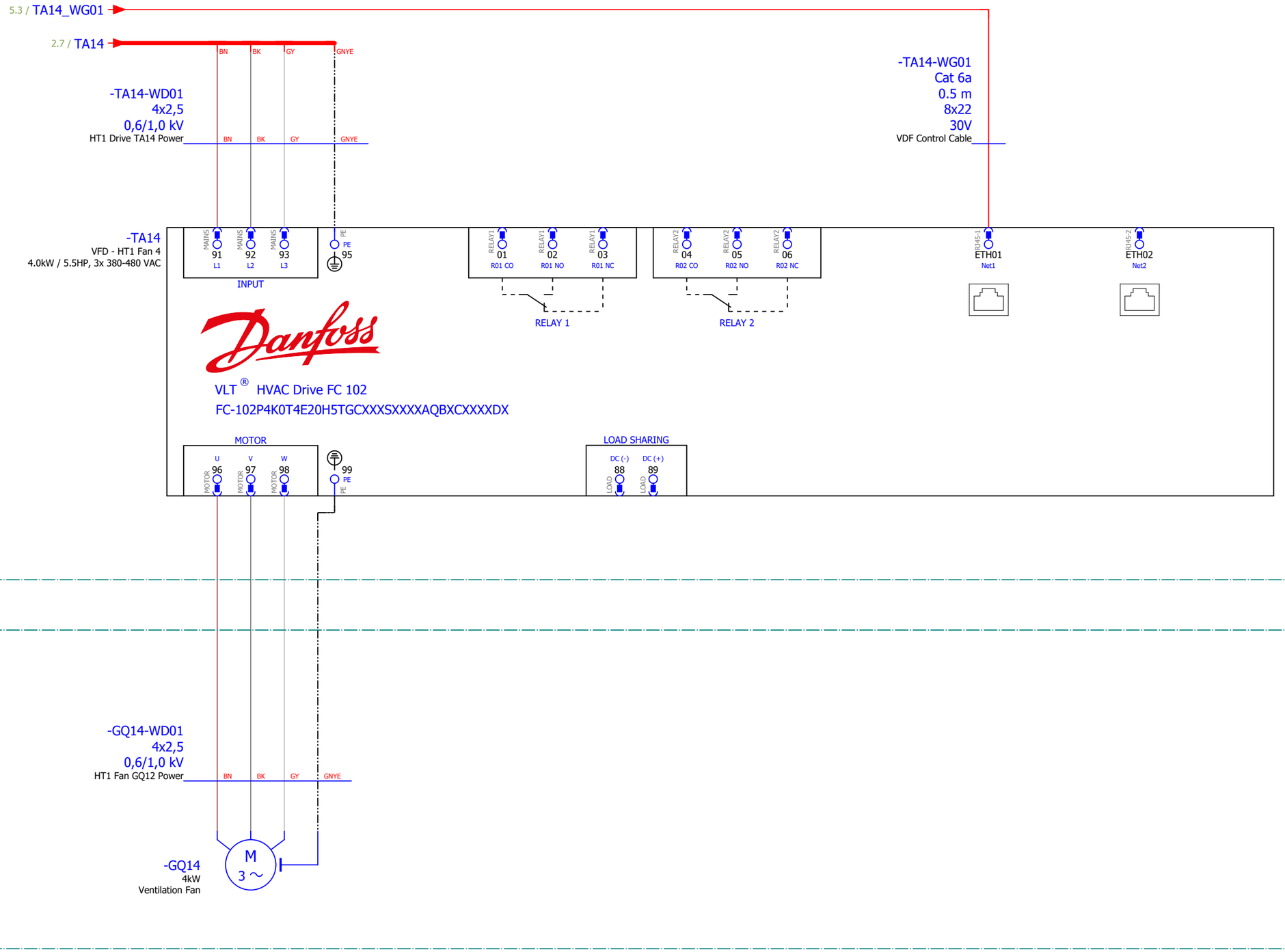
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet		REVISION	01.P15	
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet				
SHEET TYPE/DESC	AC Power - TA13				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	8 / 18	

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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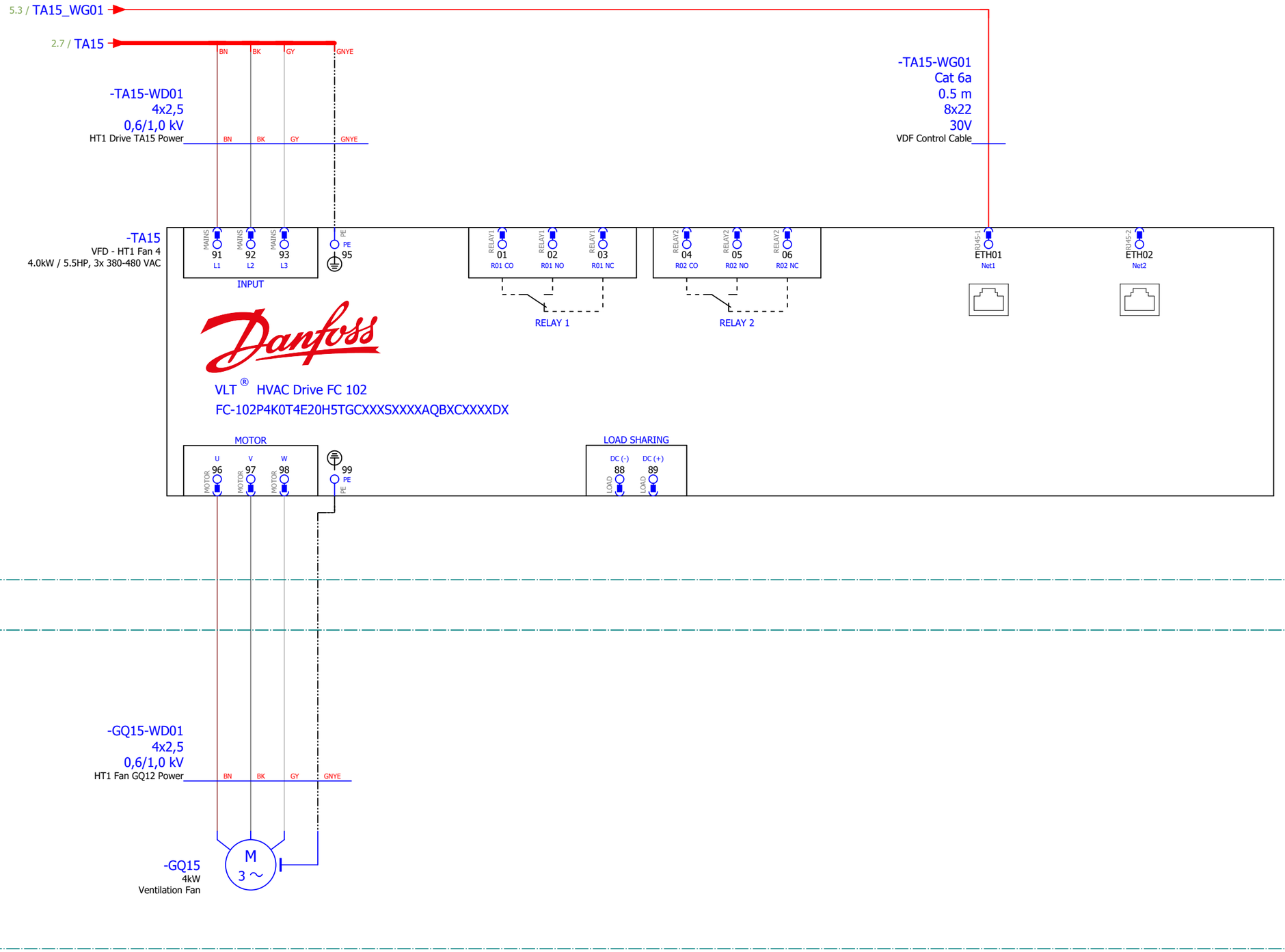
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA14		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 9 / 18

0	1	2	3	4	5	6	7	8

=HE01



=HE01+DA02
HT1 Cooler

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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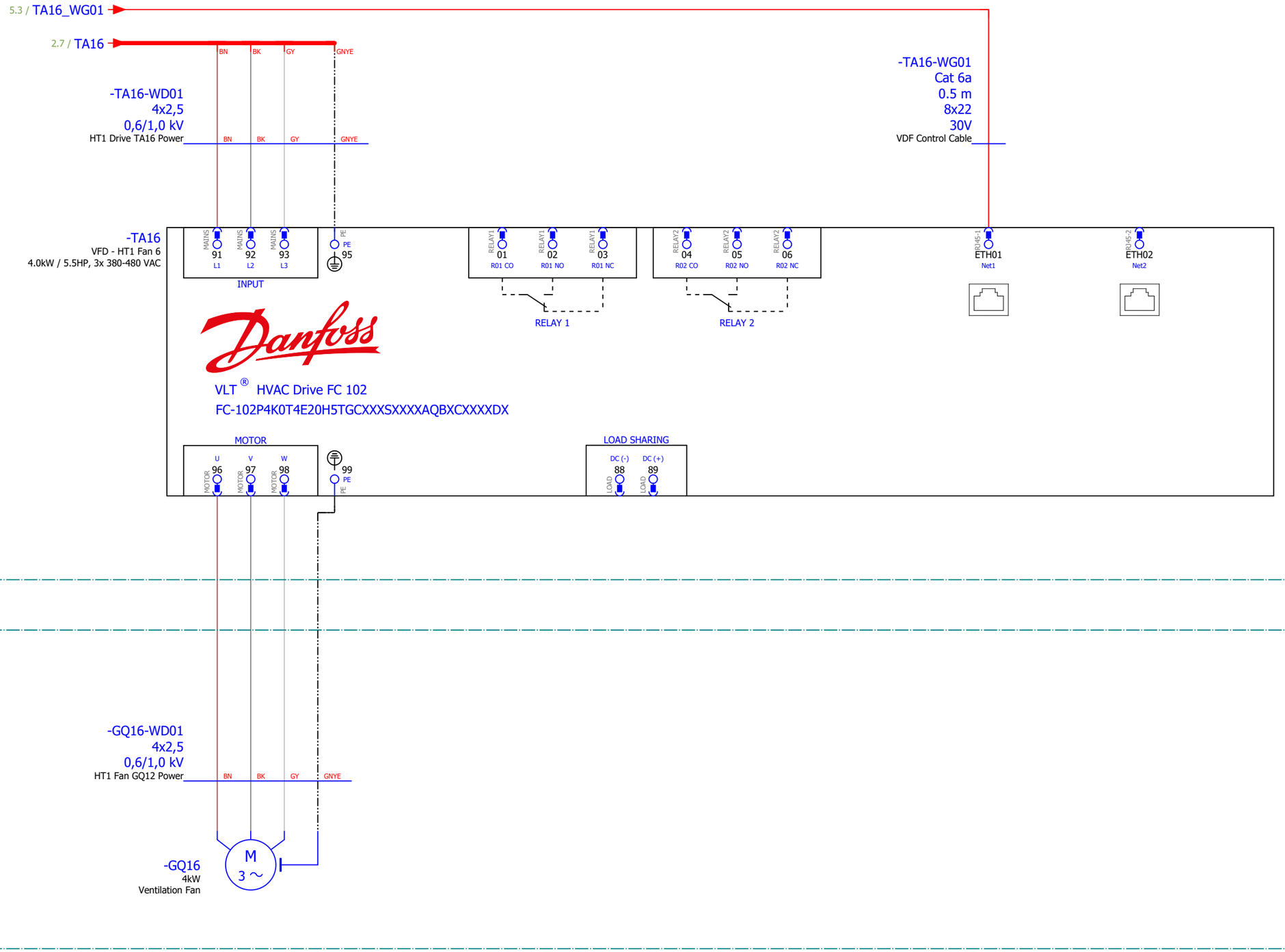
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA15		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 / 18

0	1	2	3	4	5	6	7	8

=HE01



=HE01+DA02
HT1 Cooler

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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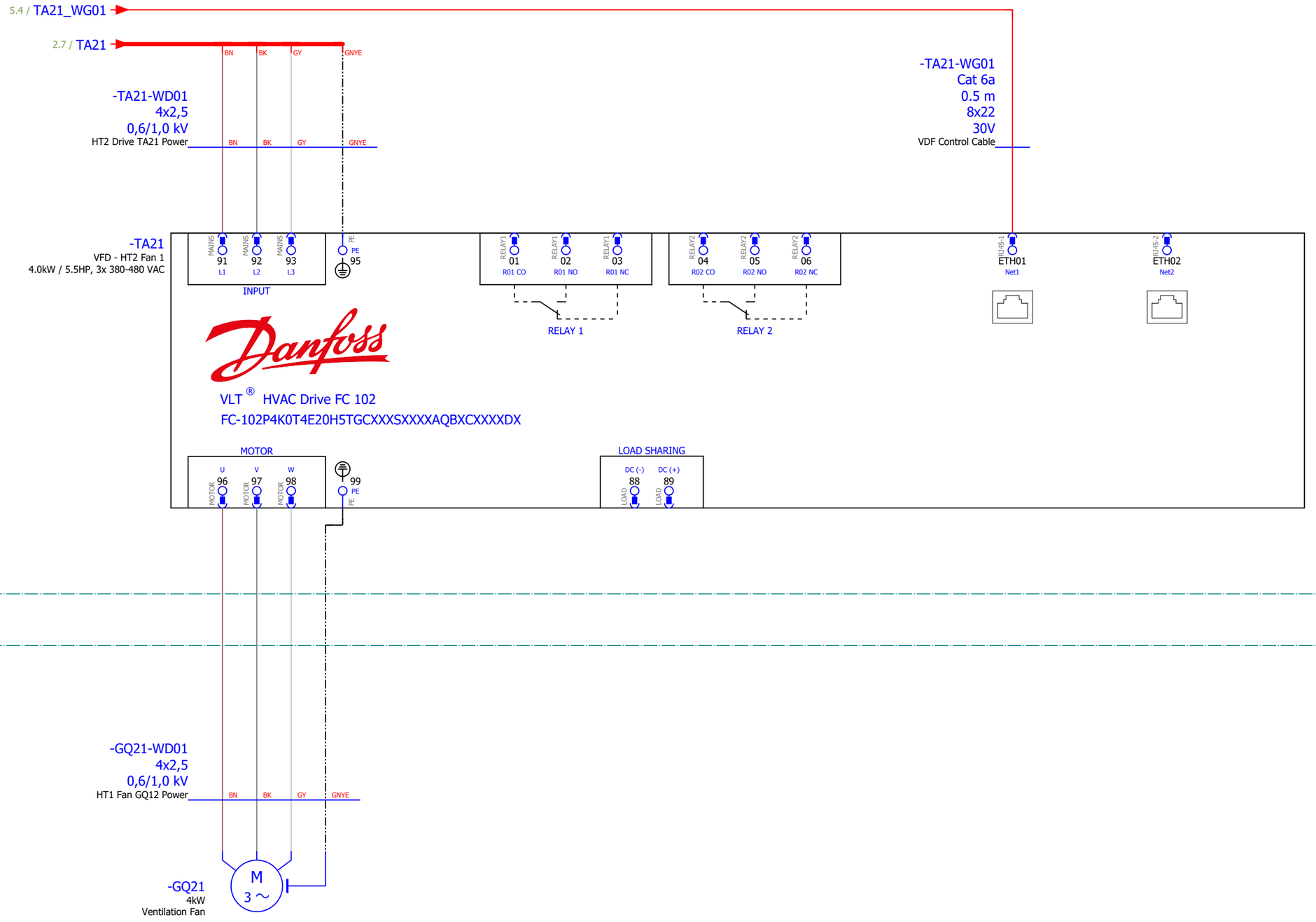
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA16		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

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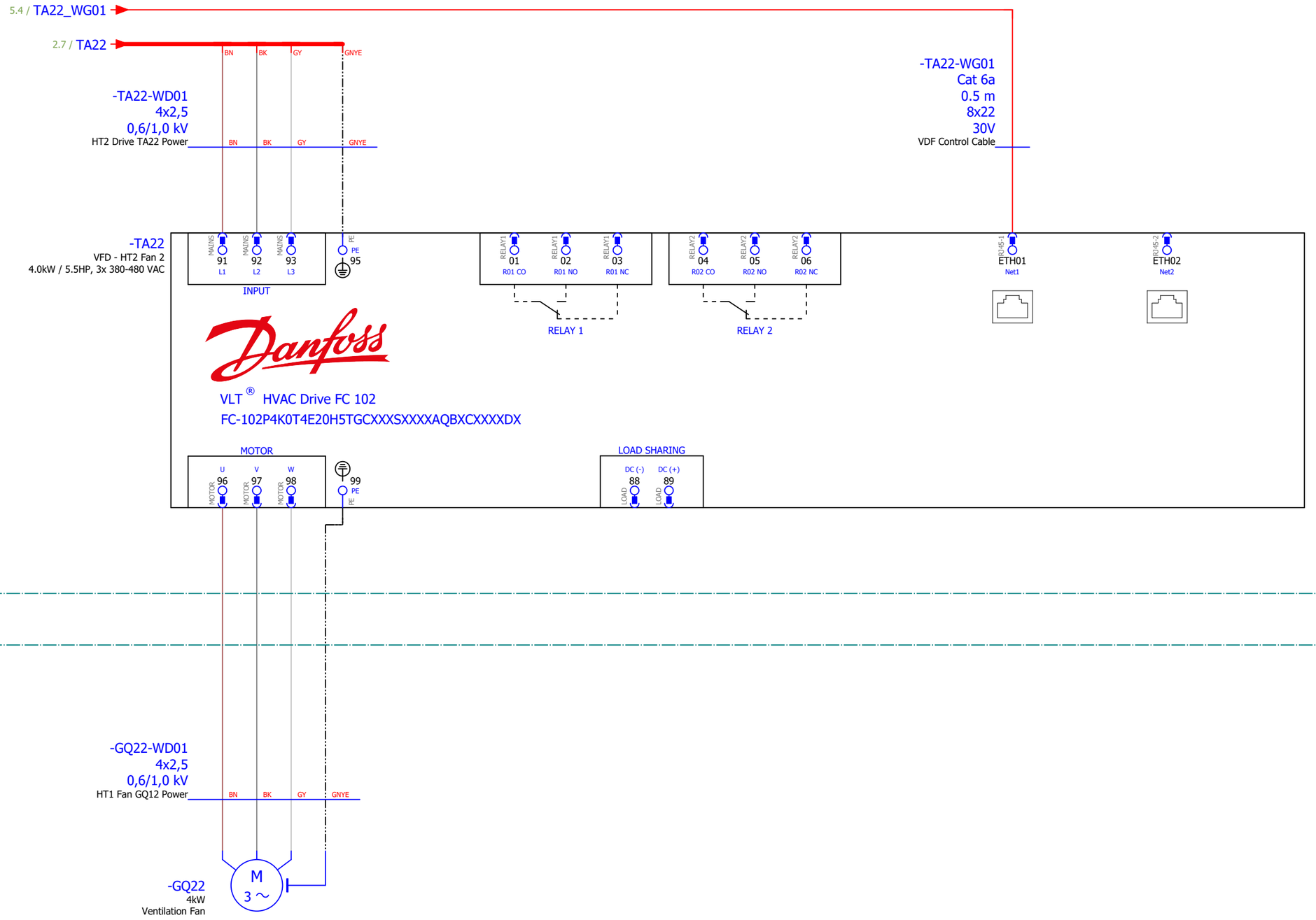
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet		REVISION	01.P15	
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet				
SHEET TYPE/DESC	AC Power - TA21				
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL	12 / 18	

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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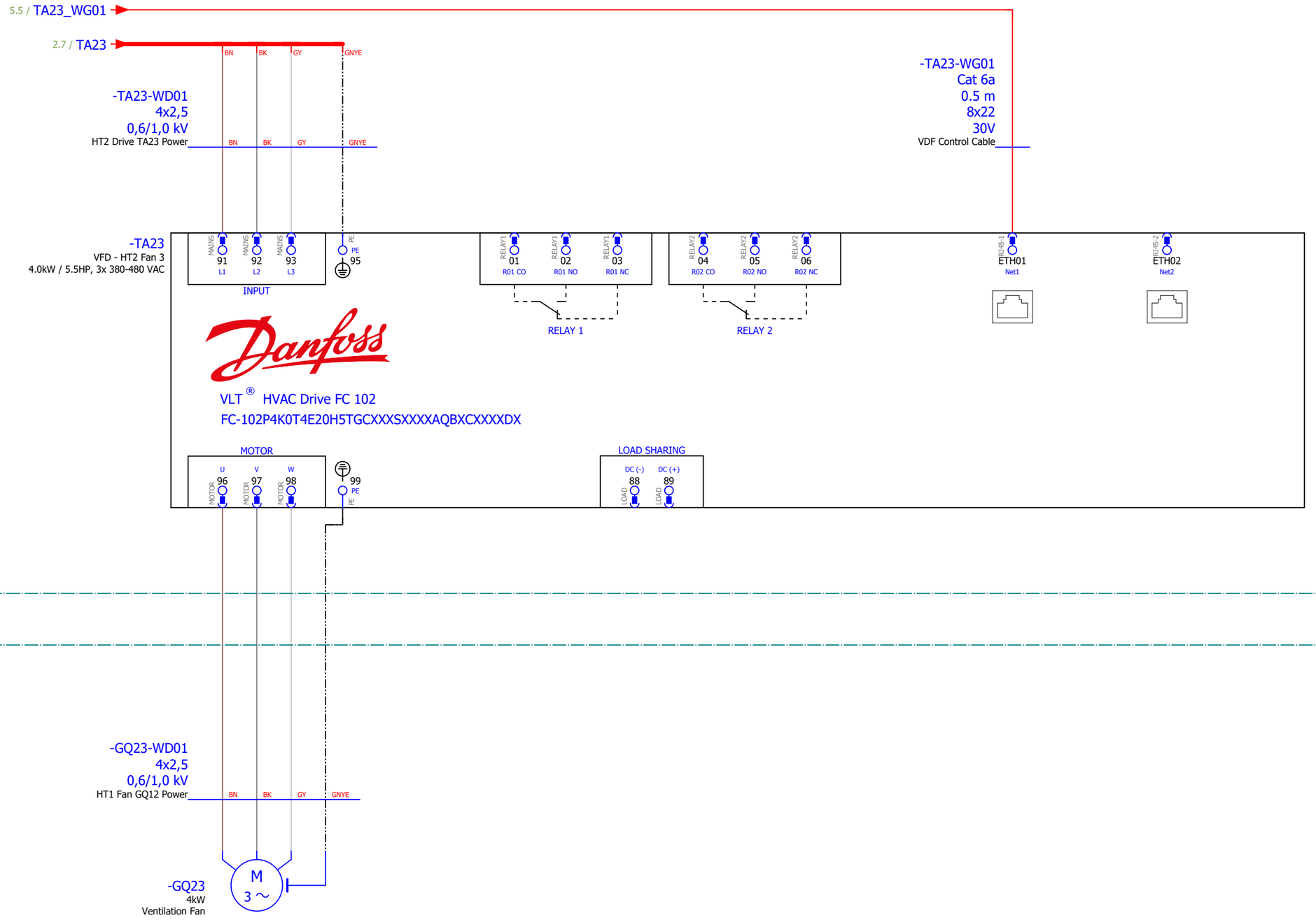
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA22		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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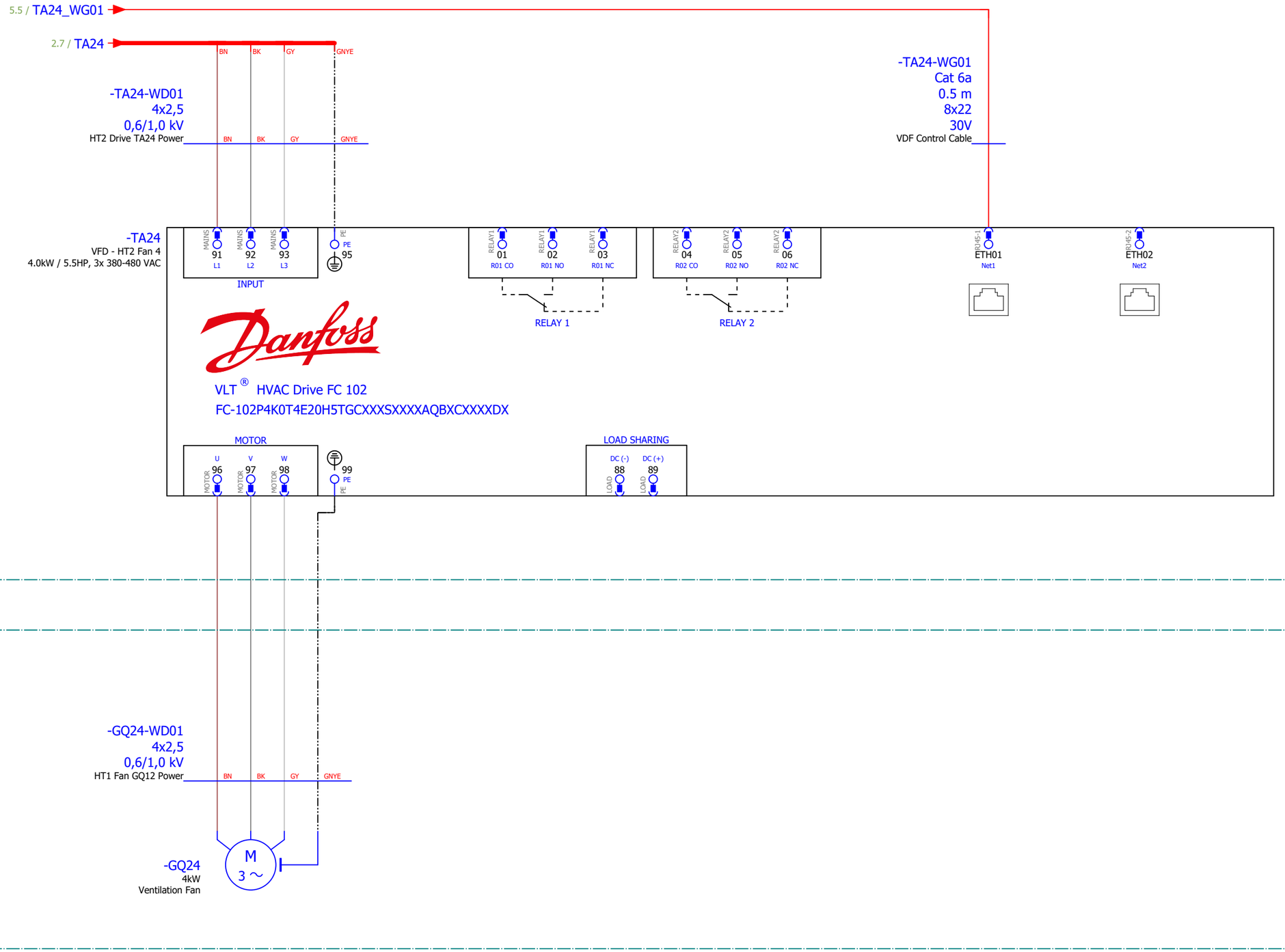
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA23		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 14 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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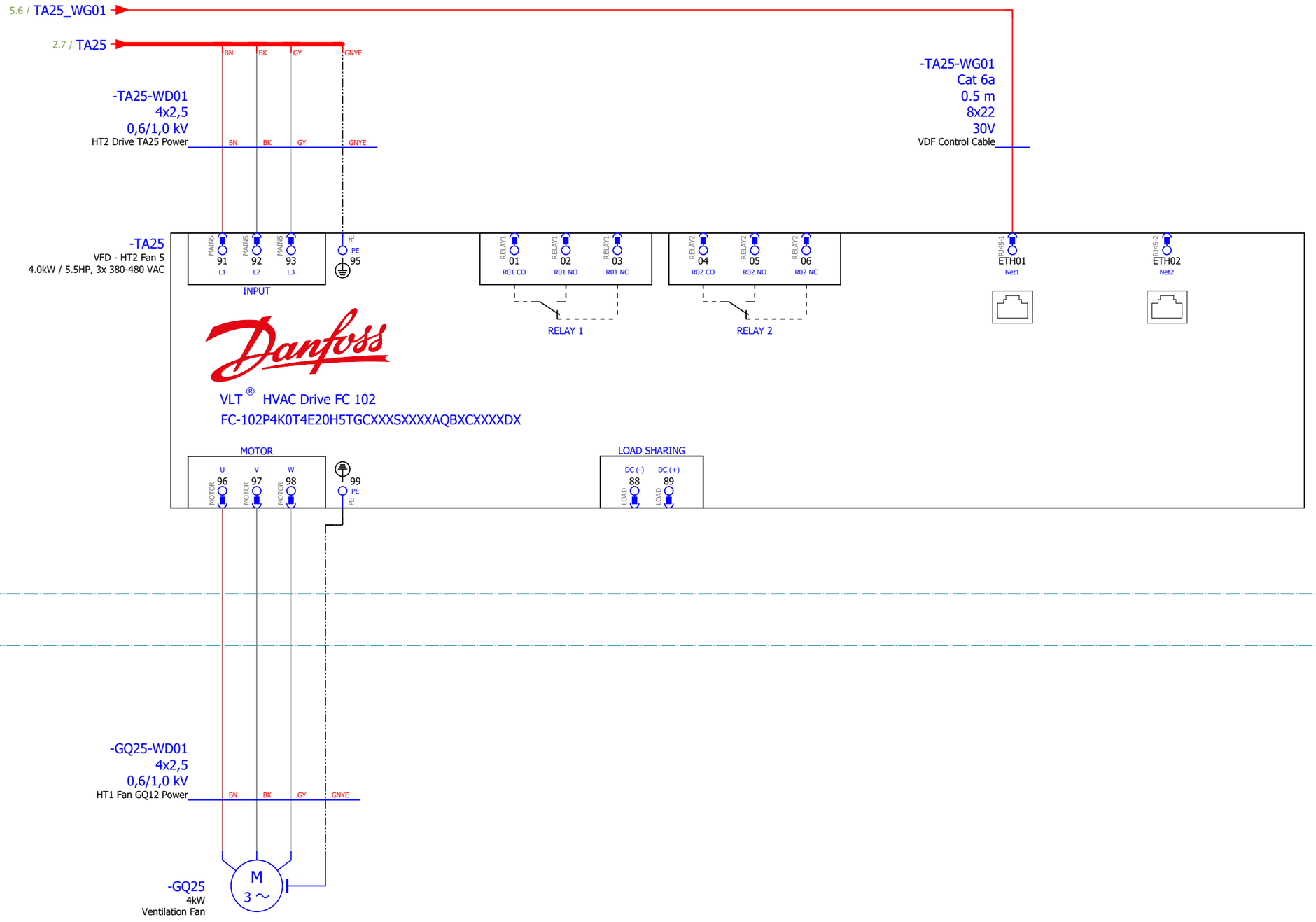
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA24		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 15 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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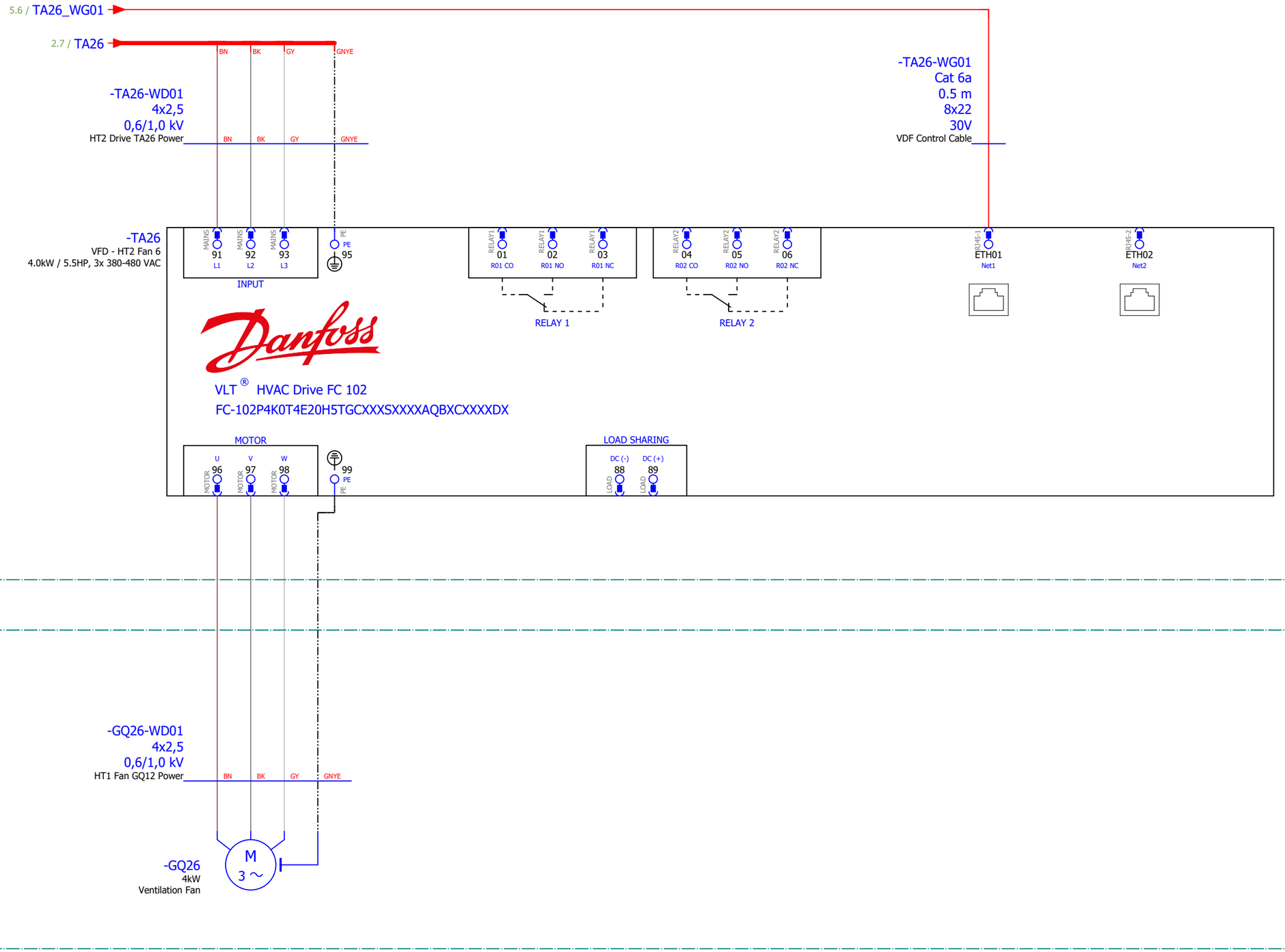
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA25		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 16 / 18

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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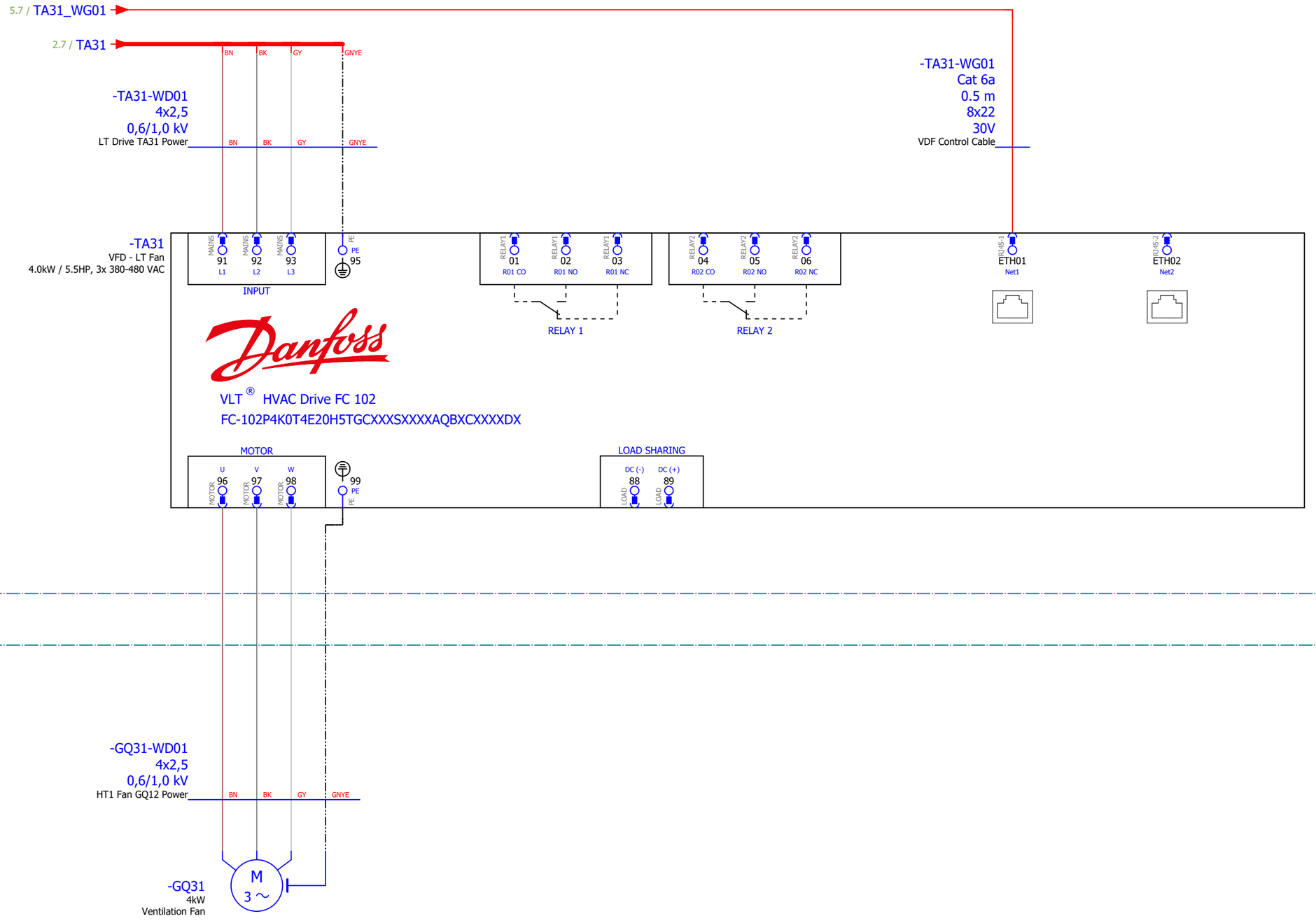
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA26		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 17 / 18

0	1	2	3	4	5	6	7	8

=HE01



=HE03+DA02
LT Cooler

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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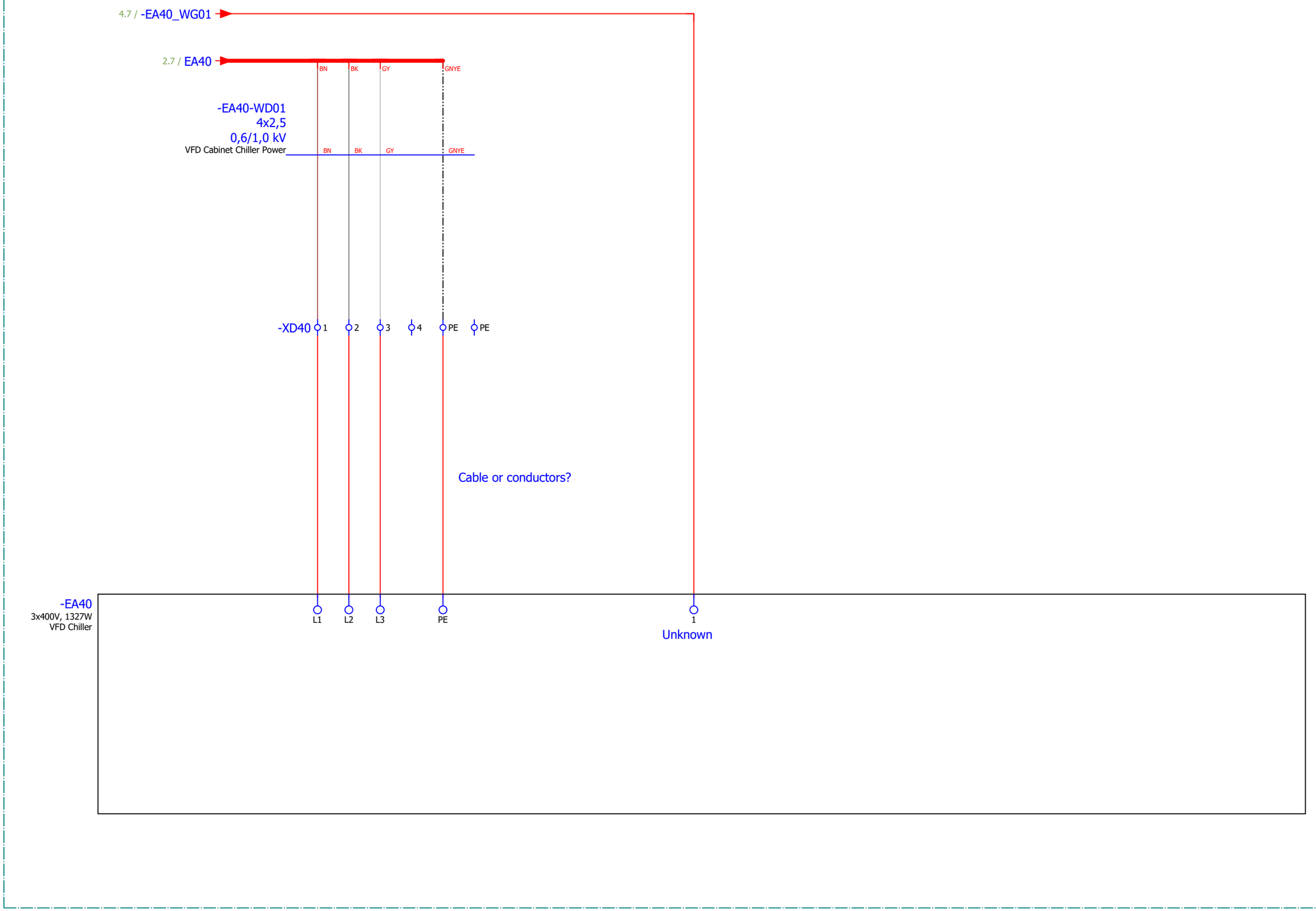
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - TA31		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 18 / 18

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=HE01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C03

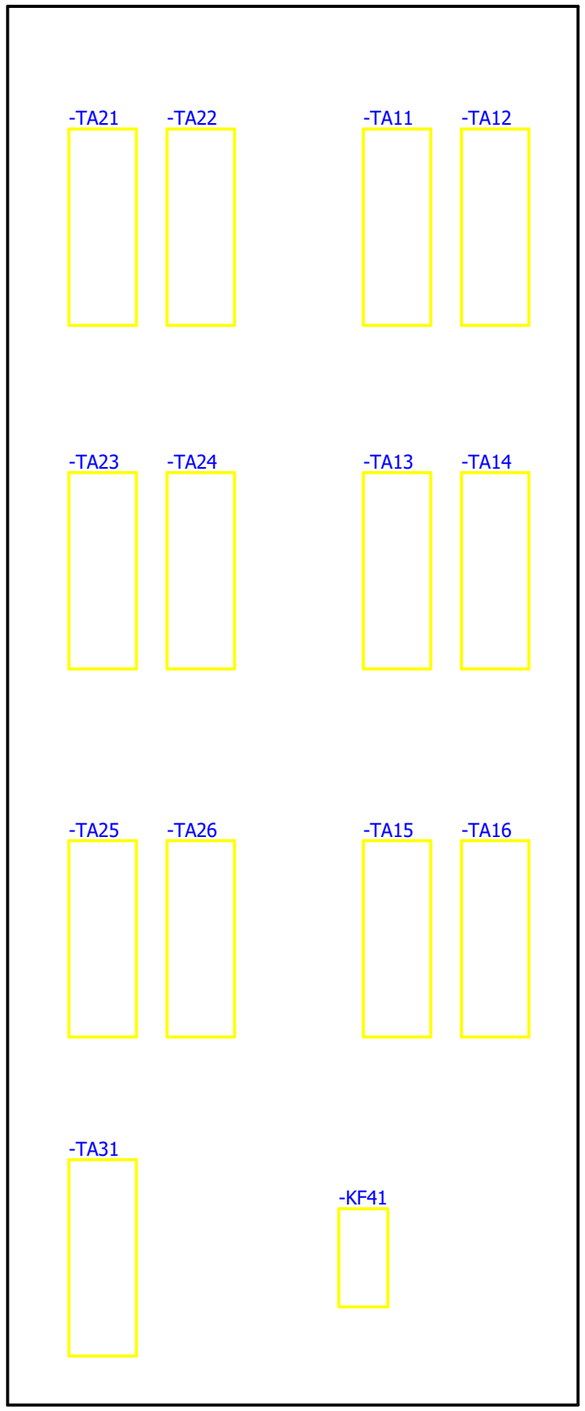
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	AC Power - Chiller		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 19 / 18



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C04

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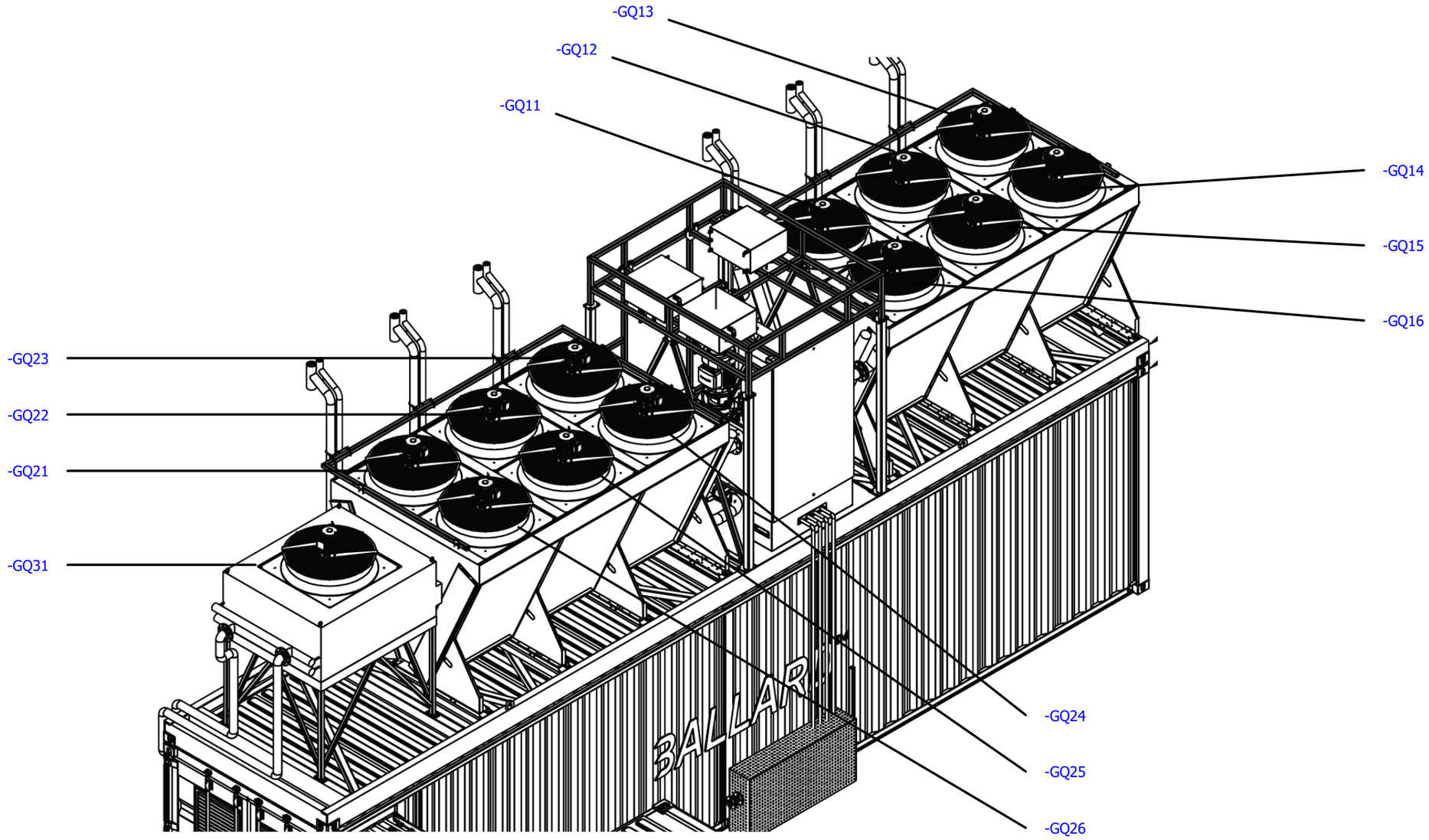
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

FRM5103656/0B



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Fan Overview		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=HE01-X01		1	PE	2	0	4	
=HE01-XD40		1	PE	2	0	6	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C04

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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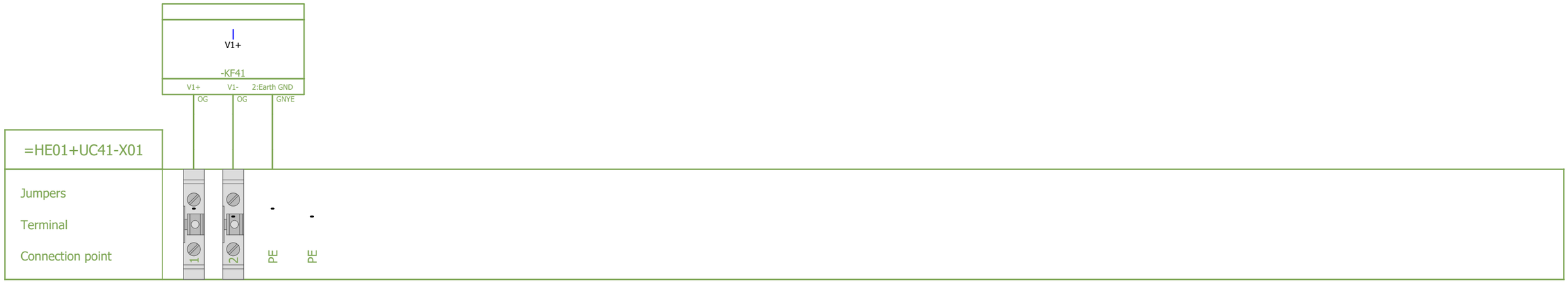
DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =HE01+UC41-X01 - =HE01+UC41-XD40		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C04

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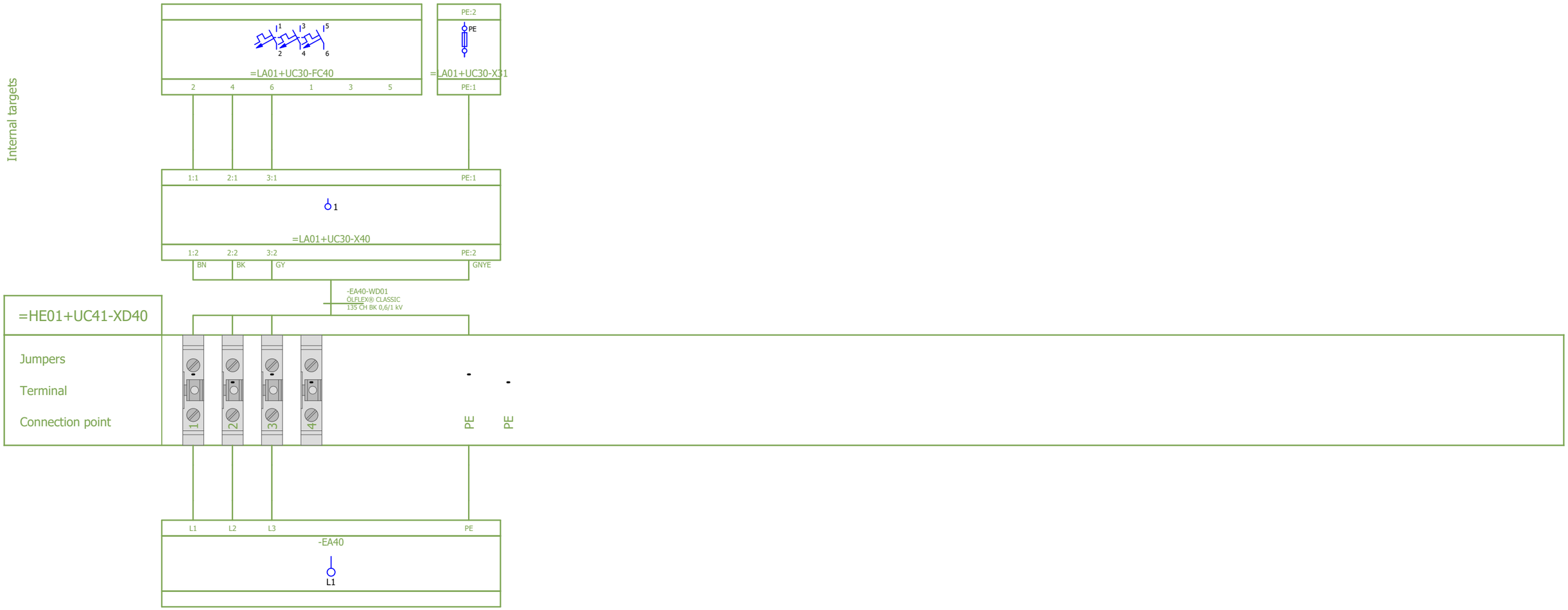
DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =HE01+UC41-X01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 05-Jun-24

Internal targets



External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	01.P15		
EPLAN Project Pages	478		
=	++	+ UC41	& C04

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DESCRIPTION
DATE
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DRAWING	601456B UC41 Coolant Skid VFD Cabinet	REVISION	01.P15
DRAWING TITLE	Crosswind UC41 Coolant Skid VFD Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =HE01+UC41-XD40		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 /

FRM5103656/0B

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/06/2024	First Issue
002	28/03/2025	Update with network gateway PLC

Document Title:	**BLPH Project - Panel Cabinet Layout: UC50 AC Power Distribution**
Document Number:	K559-2254-CWIWP4202202-E03-006
Revision:	Rev002
Sequence Number:	006
File Name:	K559-2254-CWIWP4202202-E03-006Rev002
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

BALLARD™

+UC50

Ballard Power Systems Europe - Technology Solutions

Cabinet: 40ft Container AC Distribution
Location: 40ft Container, next to access door

Vin = 400VAC, 3ph
Ikmax = 6kA - AC Supply
Ikmax

IP56

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& A01

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- 1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	———	Black (BK)
AC Phase L1	———	Brown (BN)
AC Phase L2	———	Black (BK)
AC Phase L3	———	Grey (GY)
AC Neutral	———	Light Blue (BU)
Externally supplied circuit	———	Orange (OG)

DC Wiring Colors

DC Power Circuit	———	Black (BK)
DC Control Voltage (24V)	———	Dark Blue (BU)
DC Control Voltage Refence (0V)	-·-·-·-	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	———	White (WH)
Signal Wire (AI, AO)	———	Violet (VT)
Externally supplied circuit	———	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	- - - - - - -	Green/Yellow (GNYE)

Conductor Colour Identification

IEC 60757:1983 Designation	Description
BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& A01

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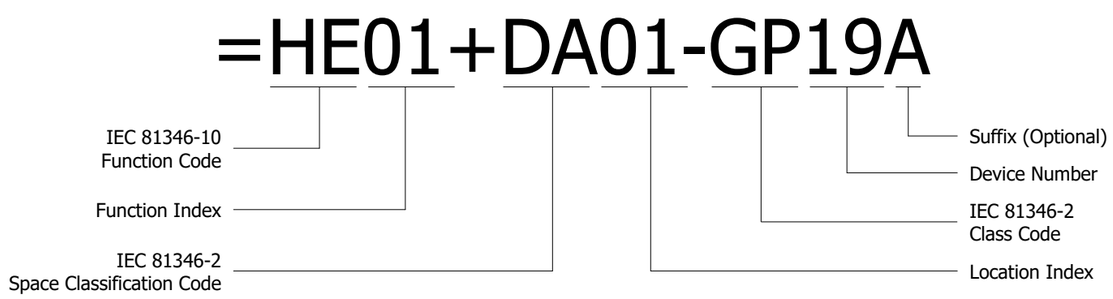
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
= ++ + UC50 & A01	

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC50-KE07
DEIF AMC300
Controller Extension Rack

-Slot1
DEIF PSM3.2
Power Supply Module 3.2

PSM3.2

	PE PE		Frame Ground					
	1 12-24V		Supply +					
	2 0V		Supply COM					
	3 R1 COM		Status OK Relay COM					
A52.4	4 DO1	DO1	Status OK Relay					
	5 R2 COM		Relay 2 COM					
A52.5	6 DO2	DO2	Relay 1 Out					
	7 R3 COM		Relay 3 COM					
A52.6	8 DO3	DO3	Relay 3 Out					

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.10:E X03 — Ethernet-1 IN

EtherCAT Follower Ring Topology — EtherCAT +&C01/8.11:E X03 — Ethernet-2 OUT

Bus Follower
Multi-line 300

-Slot2
ACM3.1
Alternating Current Module 3.1

ACM3.1

1 L1	UC50_L1	Voltage measurement Nanogrid L1	
2 L2	UC50_L2	Voltage measurement Nanogrid L2	
3 L3	UC50_L3	Voltage measurement Nanogrid L3	
4 N	UC50_N	Voltage measurement Nanogrid N	
5 L1	UC50_L1'	Voltage measurement AUX L1	
6 L2	UC50_L2'	Voltage measurement AUX L2	
7 L3	UC50_L3'	Voltage measurement AUX L3	
8 N	UC50_N'	Voltage measurement AUX N	
9 L1-S1	UC50_BC01	Current measurement AUX L1	
10 L1-S2	CH1-S2	Channel 1 - S2	
11 L2-S1	UC50_BC02	Current measurement AUX L2	
12 L2-S2	CH2-S2	Channel 2 - S2	
13 L3-S1	UC50_BC03	Current measurement AUX L3	
14 L3-S2	CH3-S2	Channel 3 - S2	
15 4-S1	CH4-S1	Channel 4 - S1	
16 4-S2	CH4-S2	Channel 4 - S2	

-Slot3
&C03/615.1
IOM3.2
IO Module 3.2

IOM3.2

1 R1 COM			Relay 1 In
2 DO1			Relay 1 out
3 R2 COM			Relay 2 COM
4 DO2			Relay 2 Out
5 R3 COM			Relay 3 In
6 DO3			Relay 3 Out
7 R4 COM			Relay 4 In
8 DO4			Relay 4 Out
9 AO1	&C03/615.1	JA01_QM05.SP	Ventilation Outlet C Damper Postion SP
10 AO1 COM			AO1 COM
11 AO2	&C03/615.5	JA01_QM06.SP	Ventilation Outlet D Damper Postion SP
12 AO2 COM			AO2 COM
13 AO3		HE03_QN01.SP	LT Mixing valve SP
14 AO3 COM	&C03/615.2		AO3 COM
15 AO4			Spare
16 AO4 COM	&C03/615.5		AO4 COM
17 DI1			Spare
18 DI2			Spare
19 DI3			Spare
20 DI4			Spare
21 DI1-4 COM			DI1-4 COM
22 AI1	&C03/615.2	JA01_QM05.FB	Ventilation Outlet C Damper Postion FB
23 AI1 COM			AI1 COM
24 AI2	&C03/615.6	JA01_QM06.FB	Ventilation Outlet D Damper Postion FB
25 AI2 COM			AI2 COM
26 AI3			Spare
27 AI3 COM		HE03_QN01.FB	LT Mixing valve feedback
28 AI4			Spare
29 AI4 COM	&C08/615.6		AI4 COM

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C02

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 1/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 10 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC50-KE07
DEIF AMC300
Controller Extension Rack

-Slot4
IOM3.4
IO Module 3.4

IOM3.4

	1 12-24V			Supply +
	2 DO01	+CU50_KF01	Control Nanogrid supply	
	3 DO02	+CU50_KF02	AUX Nanogrid supply	
A3.0	4 DO03	DO03	Digital Out 03	
A3.1	5 DO04	DO04	Digital Out 04	
A3.2	6 DO05	DO05	Digital Out 05	
A3.3	7 DO06	DO06	Digital Out 06	
A3.4	8 DO07	DO07	Digital Out 07	
A3.5	9 DO08	DO08	Digital Out 08	
A3.6	10 DO09	DO09	Digital Out 09	
A3.7	11 DO10	DO10	Digital Out 10	
A4.0	12 DO11	DO11	Digital Out 11	
A4.1	13 DO12	DO12	Digital Out 12	
	14 COM		Supply COM	
	15 DI01	+UC50_FC01	Nanogrid MCCB feedback	
	16 DI02	+UC50_FC02	AUX Supply MCCB feedback	
	17 DI03	+UC50_QA01	Nanogrid contactor QA01 feedback	
	18 DI04	+UC50_QA02	AUX Contactor QA02 feedback	
	19 DI05	+UC50_FC03 - 05	Distribution MCB feedback	
	20 DI06	+UC50_13 - 14	Control MCB feedback	
	21 DI07	+UC50_FC10	Nanogrid measurement MCB feedback	
	22 DI08	+UC50_FC11	AUX measurement MCB feedback	
	23 COM		Supply COM	
	24 DI09	+UC50_FC12	Surge protection MCB feedback	
	25 DI10	+UC50_FA	Surge protection feedback	
E7.7	26 DI11	DI11	Digital In 11	
E8.0	27 DI12	DI12	Digital In 12	
E8.1	28 DI13	DI13	Digital In 13	
E8.2	29 DI14	DI14	Digital In 14	
E8.3	30 DI15	DI15	Digital In 15	
E8.4	31 DI16	DI16	Digital In 16	
	32 COM		Supply COM	

-Slot5
IOM3.3
IO Module 3.3

IOM3.3

1 AI1			Spare
2 AI2	HE03_FT01	LT Cooling Circuit Flow Rate	
3 AI3			Spare
4 AI4			Spare
5 AI5	HE03_TT02	LT Circuit Forward Temperature	
6 AI6			Spare
7 AI7	HE03_TT01	LT Circuit Return Temperature	
8 AI3			Spare
9 AI9			Spare
10 AI10	HE03_TT03	LT Circuit Radiator Outlet Temperature	
11 AI11			Spare
12 AI12			Spare
13 AI13			Spare
14 AI14			Spare
15 AI15			Spare
16 AI16			Spare
17 AI17			Spare
18 AI18			Spare
19 AI19			Spare
20 AI20			Spare
21 AI21			Spare
22 AI22			Spare
23 AI23			Spare
24 AI24			Spare
25 AI25			Spare
26 AI26			Spare
27 AI27			Spare
28 AI28			Spare
29 AI29			Spare
30 AI30			Spare

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C02

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 2/4		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 11 / 18

0	1	2	3	4	5	6	7	8

=LA01+UC50-KE07
DEIF AMC300
Controller Extension Rack

Reserved

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C02

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Container Controller, Coolant Rack 3/4		

ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 12 / 18

0	1	2	3	4	5	6	7	8

=LA01-KE10
DEIF AMC300
Network Separation PLC

-Slot1
DEIF PSM3.1
Power Supply
Module 3.1

PSM3.1

PE PE &C03/701.1 — Frame Ground
1 12/24V &C03/701.1 — Supply +
2 0V &C03/701.1 — Supply COM

3 R1 COM — Status OK Relay COM
A1.0 4 DO1 — DO1 — Status OK Relay

5 R2 COM — Relay 2 COM
A1.1 6 DO2 — DO2 — Relay 1 Out

7 R3 COM — Relay 3 COM
A1.2 8 DO3 — DO3 — Relay 3 Out

Note: Slot 2 and 3: Blanking plates

EtherCAT Master Ring Topology — Other bus systems X03 — Ethernet-1 IN
EtherCAT Master Ring Topology — Other bus systems X03 — Ethernet-2 OUT

Bus Master
Multi-line 300

-Slot4
DEIF PCM3.3
Processor and
Communication
Module 3.3
&C03/701.3

PCM3.3

X01 RS-483/232 — 1 2 3 4 5 6 7 8
X02 CAN-A / CAN-B — 9 10 11 12 13 14
X03 CAN-C / CAN-D — 15 16 17 18 19 20

ETH1 Other bus systems X04 — Ethernet-1 1
ETH1 Other bus systems &C03/701.4 X02 — Ethernet-3 1
ETH1 Other bus systems &C03/701.4 X02 — Ethernet-3 1
AGI Screen Connection Other bus systems X03 — Ethernet-4 1
ETH04 Other bus systems X04 — Ethernet-5 1

CPU
Multi-line 300

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C02

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DESCRIPTION
DATE
28-Mar-25

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Network Gateway, Rack 1/1		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 13 / 18

0	1	2	3	4	5	6	7	8

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Ballard Power Systems Europe - Technology Solutions

Multiline Documentation

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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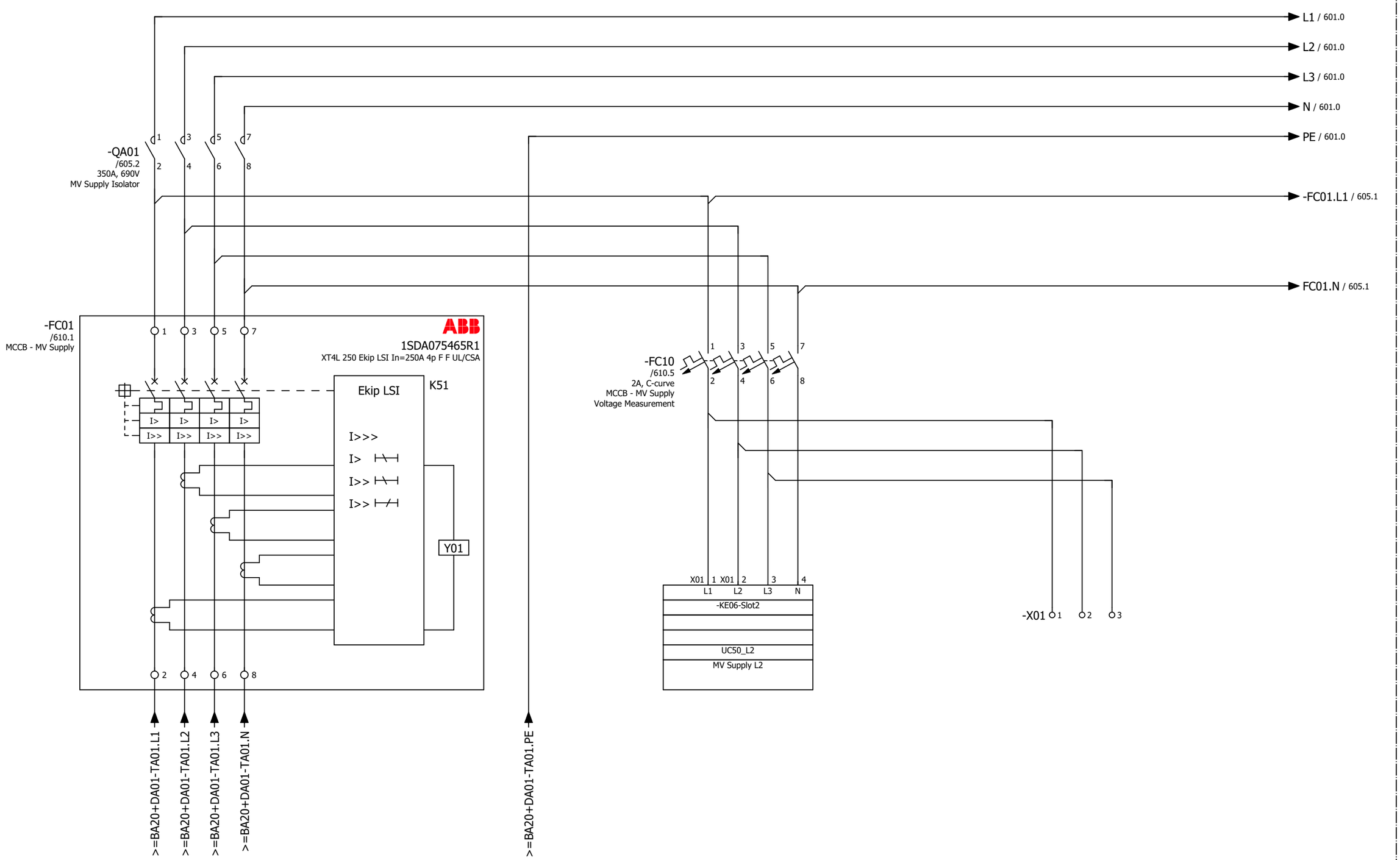
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Multiline Documentation Intro		

ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 2

0	1	2	3	4	5	6	7	8

=BA20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
DESCRIPTION
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Nanogrid supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 600 / 2

0	1	2	3	4	5	6	7	8

=BA20

600.8 / L1 → L1 / 603.0
600.8 / L2 → L2 / 603.0
600.8 / L3 → L3 / 603.0
600.8 / N → N / 603.0
600.8 / PE → PE / 602.0

-QA02
/605.4
55A, 4-pole
AUX Isolation Contactor

-FC02.L1 / 605.4
FC02.N / 605.4

-BC01
/601.1
/601.1

-BC02
+&C01/4.3:B

-BC03
/601.1
/601.1

X03 9	L1-S1	-KE06-Slot2
		UC50_BC01
10	L1-S2	Current measurement AUX L1
		-KE06-Slot2
X03 11	L2-S1	
		UC50_BC02
12	L2-S2	Current measurement AUX L2
		-KE06-Slot2
X03 13	L3-S1	
		UC50_BC03
14	L3-S2	Current measurement AUX L3

-FC11
/610.6
2A, C-curve
MCCB - Aux Voltage Measurement

X02 5 6 7 8
L1 L2 L3 N

-KE06-Slot2
UC50_L2'
Voltage measurement AUX L2

-FC02
/610.2
63A, C-curve
MCCB - Aux Supply

PE

EXT-L1 EXT-L2 EXT-L3 EXT-N

-SG01
63 A
AUX Supply Disconnector

L1 1 → 2 T1
L2 3 → 4 T2
L3 5 → 6 T3
L4 (N)7 → (N)8 T4

EXT-L1 EXT-L2 EXT-L3 EXT-N EXT-PE

EXT-L1 EXT-L2 EXT-L3 EXT-N

2L1 / 602.0
2L2 / 602.0
2L3 / 602.0
2N / 602.0

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Nanogrid supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 601 / 2

FRM5103656/0B

0	1	2	3	4	5	6	7	8

=BA20

601.8 / 2L1
601.8 / 2L2
601.8 / 2L3
601.8 / 2N
601.8 / PE

-FA01
Surge Arrester

L1 L2 L3 N

PE' PE

ABB

-XPE:1

2

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
DESCRIPTION
DATE
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Surge Protection		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 602 / 2

0	1	2	3	4	5	6	7	8

=BA20

601.8 / L1
601.8 / L2
601.8 / L3
601.8 / N
603.8 / PE

L1 /
L2 /
L3 /
N /
PE / 603.0

-FC04
/610.3
160A, Trip Curve
MCCB Cooling Skid
+UC30

1 3 5 7

Ekip LSI
K51
I>
I>>
I>>>
I>
I>>
I>>
Y01

2 4 6 8

-FC03
/610.3
63A, B-curve
MCCB Control Cabinet
+UC20

1 3 5 7
2 4 6 8

>=LA01+UC20-WD01
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV
5x16
0,6/1,0 kV
Supply UC20 MCU cabinet

1 2 3 4 GNYE
1 2 3 4 GNYE

+UC20/11.1 / >=LA01+UC20-WD01

-FC05
/610.3
32A, B-curve
MCCB - 10ft Container

1 3 5 7
2 4 6 8
PE

>+UC31-WD01
ÖLFLEX® CLASSIC 135 CH BK 0,6/1 kV
5x6
0,6/1,0 kV
Supply +UC31 10ft Cabinet

1 2 3 4 GNGY
1 2 3 4 GNYE

>=LA01+UC31-WD01 / +UC31/2.0

+UC30/300.1 / >=BA20+UC30-L1
+UC30/300.1 / >=BA20+UC30-L2
+UC30/300.1 / >=BA20+UC30-L3
+UC30/300.1 / >=BA20+UC30-N
+UC30/300.1 / >=BA20+UC30-PE

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Nanogrid		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 603 / 2

0	1	2	3	4	5	6	7	8

=BA20

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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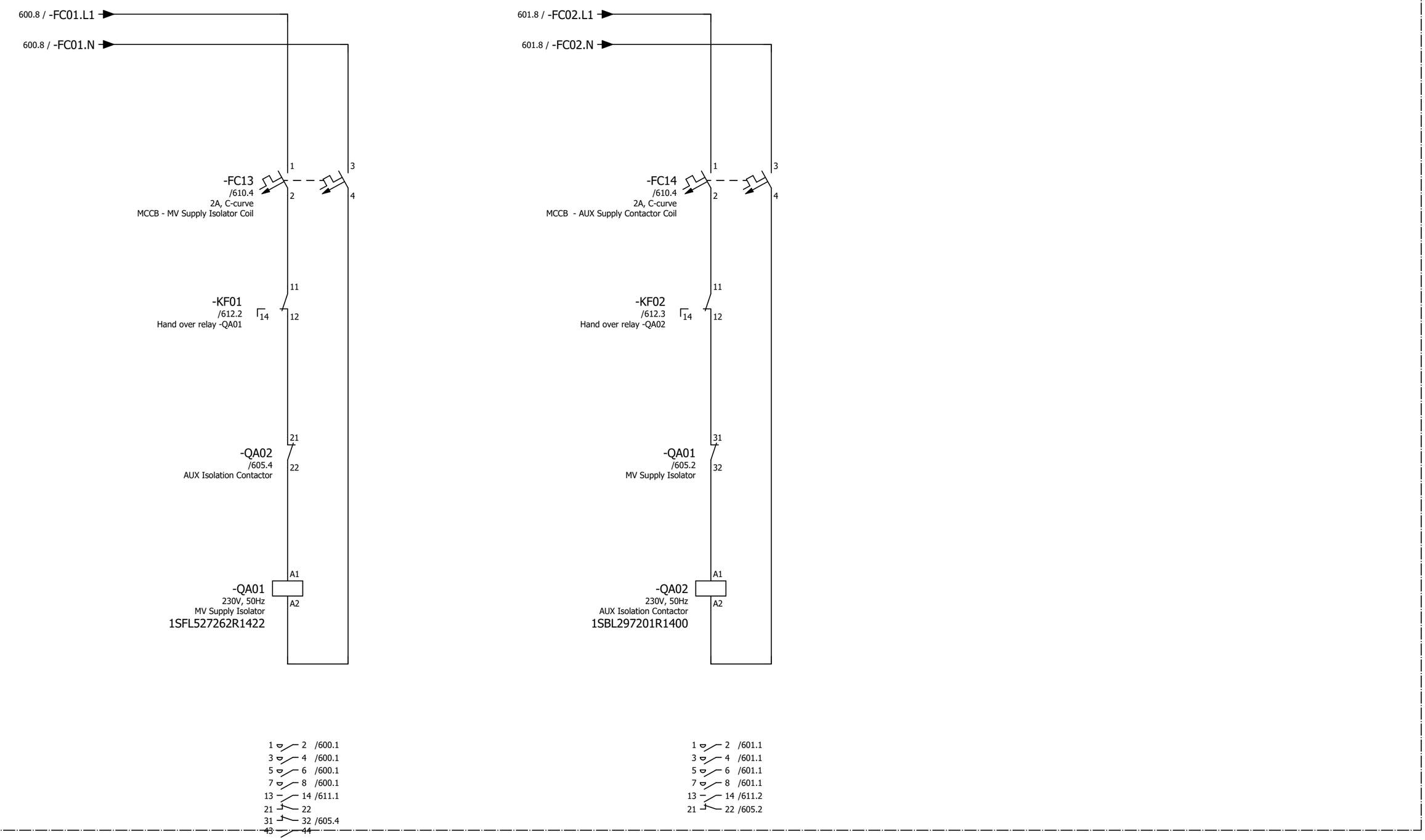
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Control fuses		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 604 / 2

0	1	2	3	4	5	6	7	8

=BA20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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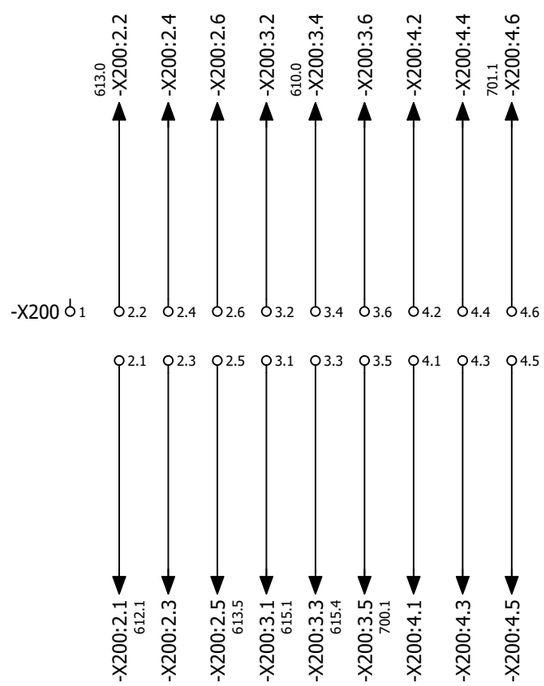
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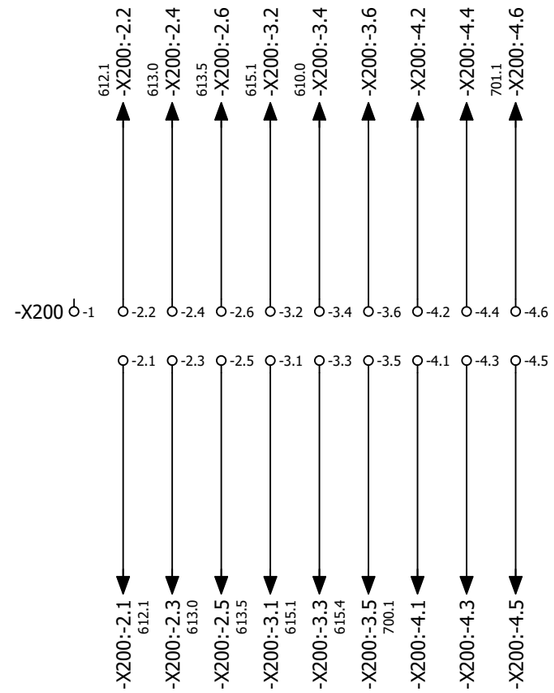
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distrbution Control -QA01 & -QA02		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 605 / 2

0	1	2	3	4	5	6	7	8

=BA20





Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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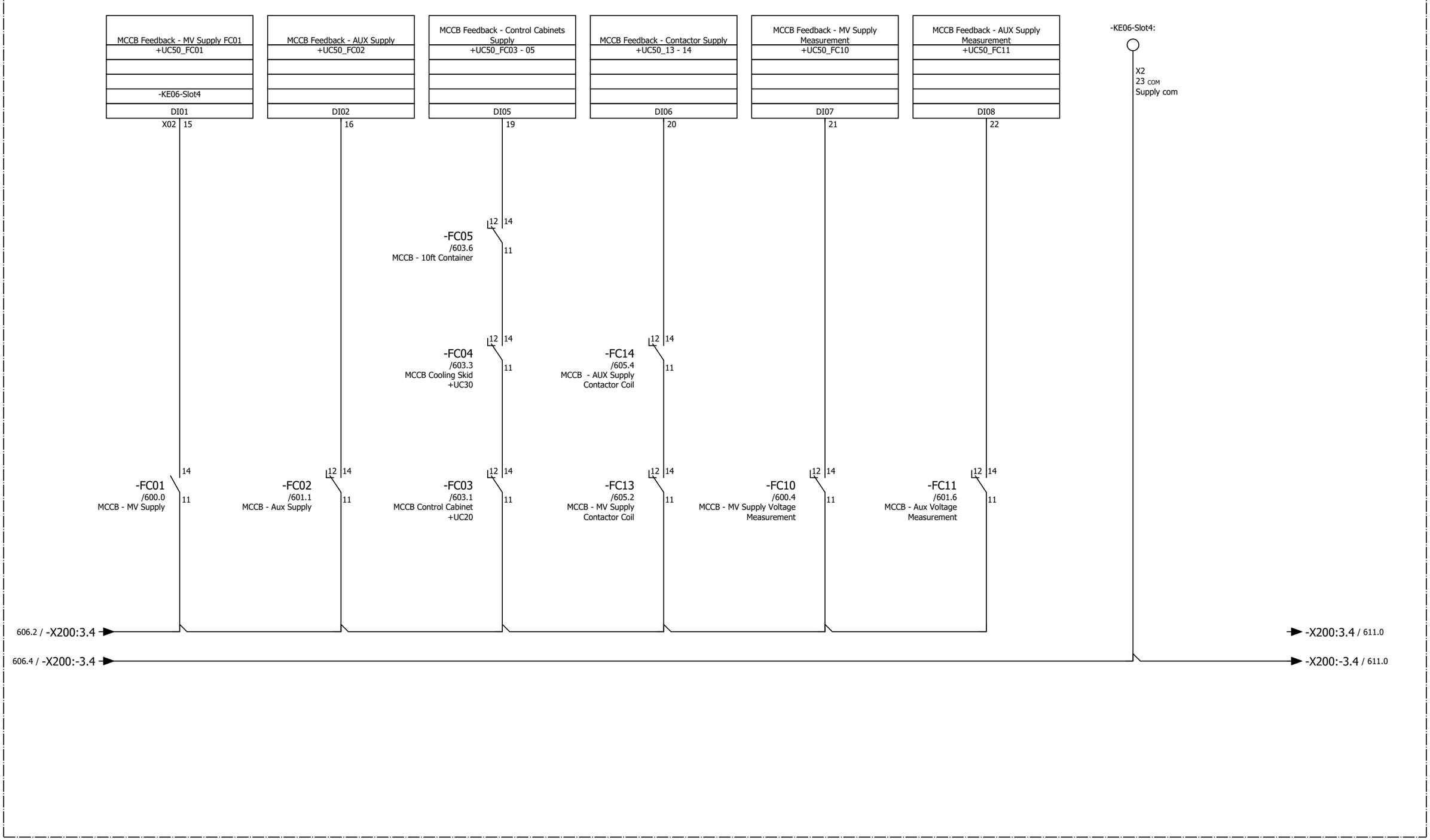
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - AC distribution - 24VDC		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 606 / 2

0	1	2	3	4	5	6	7	8

=BA20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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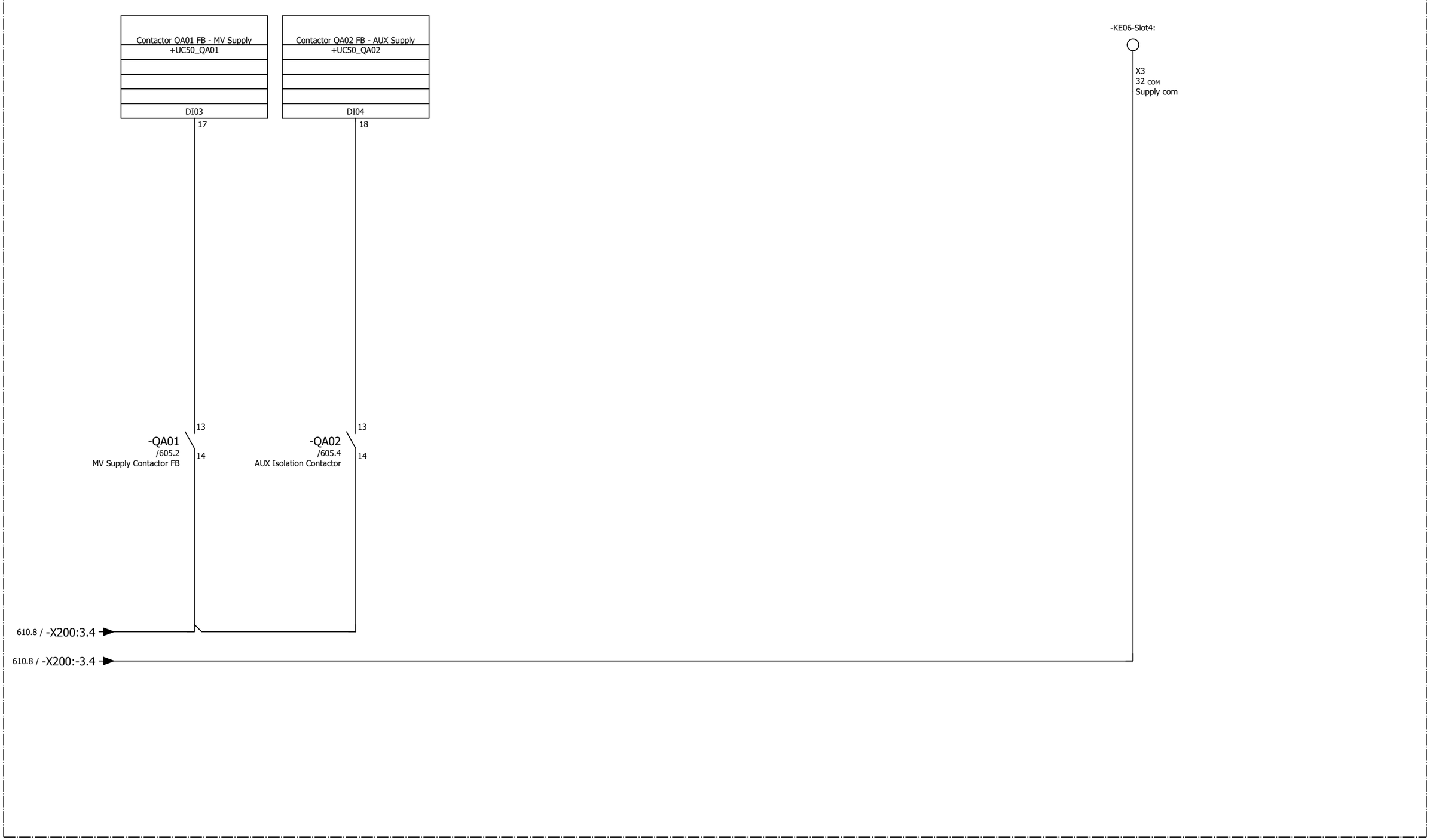
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - MCCB Feedback		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 610 / 2

0	1	2	3	4	5	6	7	8

=BA20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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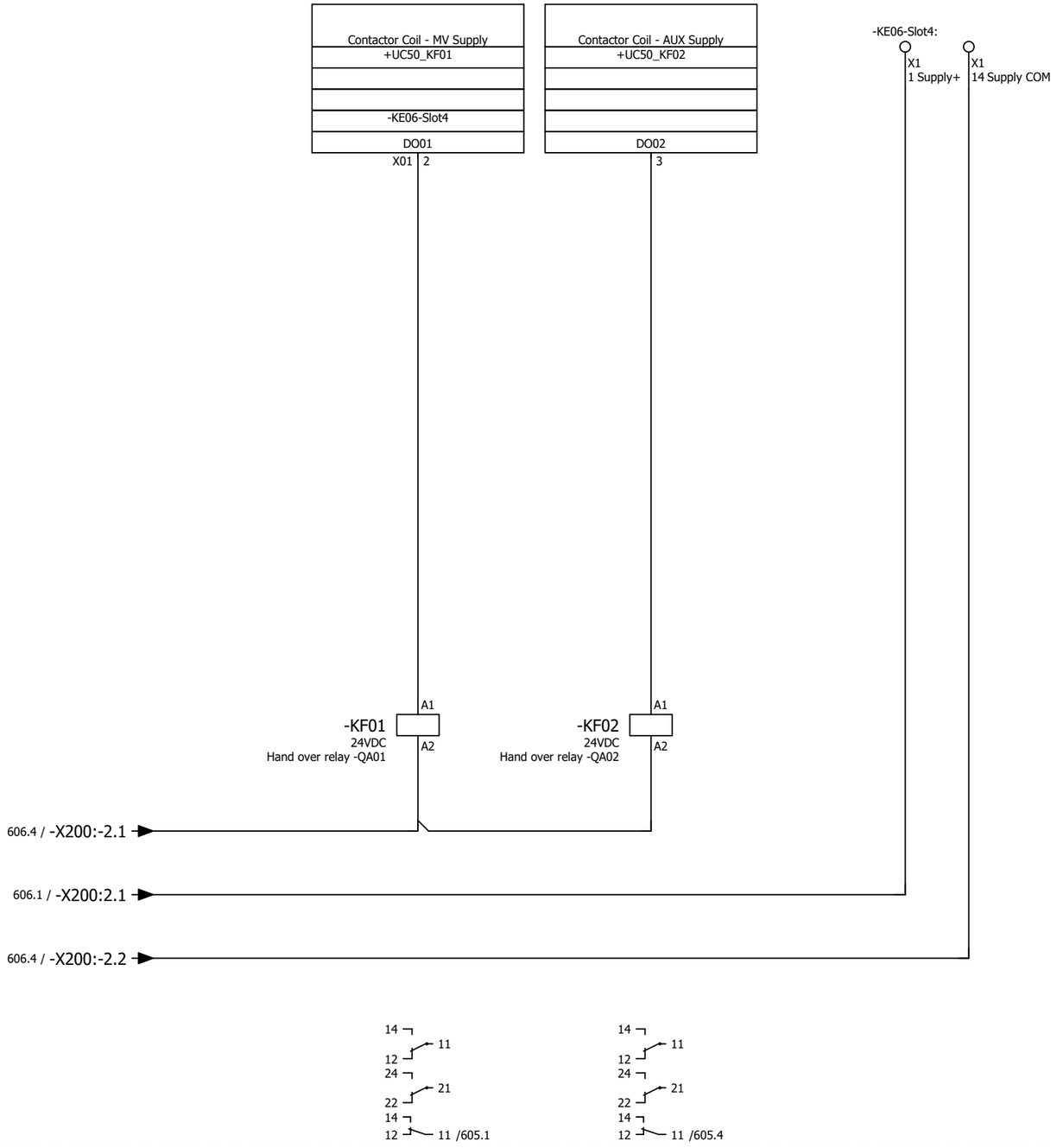
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - Contactor Feedback		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 611 / 2

0	1	2	3	4	5	6	7	8

=BA20



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - Contactor Coils		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 612 / 2

0	1	2	3	4	5	6	7	8

=BA20

LT Cooling Circuit Flow Rate
HE03_FT01
-KE06-Slot5
AI2 AI1
X01 2 3

LT Circuit Forward Temperature
HE03_TT02
AI5
X02 5 6

LT Mixing Valve Setpoint
LT_QN01_SP
-KE01-Slot4
AO3 AO3 COM
X02 13 14

LT Mixing Valve Feedback
LT_QN01_FB
AI3 AI3 COM
X03 26 27

606.4 / -X200:-2.3
606.4 / -X200:-2.4
606.1 / -X200:2.2
606.4 / -X200:-2.6
606.2 / -X200:2.5
606.4 / -X200:-2.5

-X10 9 10 11 12 13 14 15 16

=HE03+DA01

-BF01-WG01
PUR
10 m
4x0,34
50/60 V
LT Circuit Flow Signal
BN WH BU Bk

-BF01-XD01
M12 F
1 2 3 4

-BF01
LT Circuit
Flow Rate
1 L+ 2 Out 2 3 L- 4 Out 1
4...20mA 4...20mA
M12
2 1 3 4

-QN01.WG01
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
LT Mixing Valve Supply and Signal
1 2 3 4

TF01
LT Coolant
Mixing Valve
Signal Converter
- + 0-20mA 0-20mA
C1 C2 C3 C5
Jumper "J" must be installed
A1 A2 A3 A5
- + Y U

-QN01.WG02
ÖLFLEX® CLASSIC 110 CH
4x1
300/500 V
LT Mixing Valve Supply and Signal
1 2 3 4

-QN01.MA01
+&B02/9.5:C
24V, 4W
LT Coolant Mixing
Valve Drive Motor
COM 24V Y U
1 2 3 5
U: Setpoint - 2..10V
Y: Feedback - 2..10V

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

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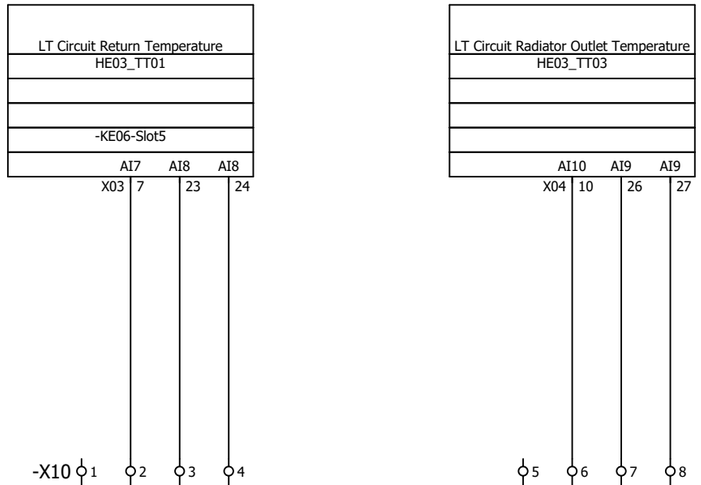
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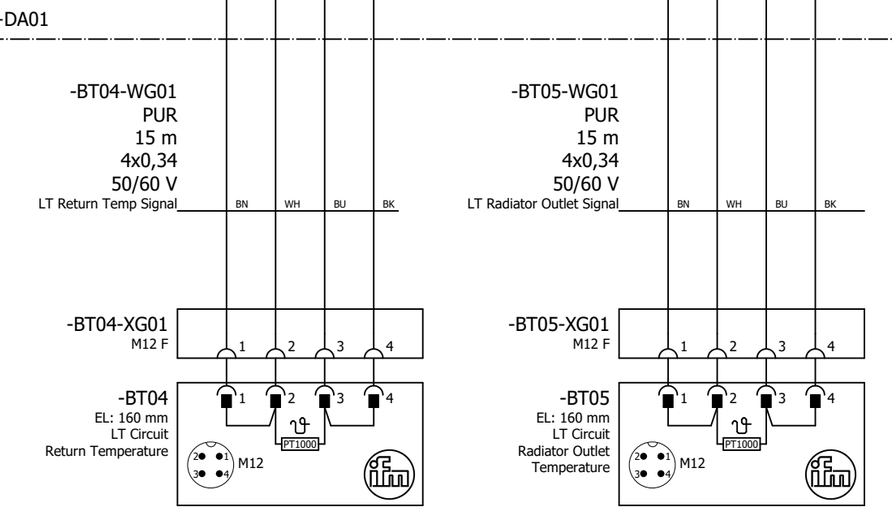
DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - LT Cooling System		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 613 / 2

0	1	2	3	4	5	6	7	8

=BA20



=HE03+DA01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
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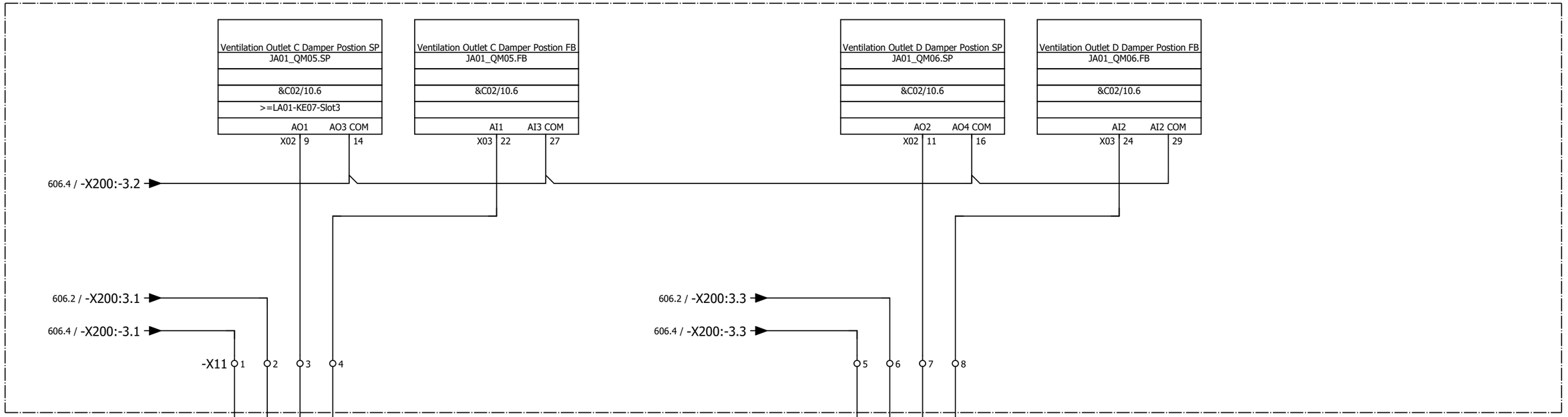
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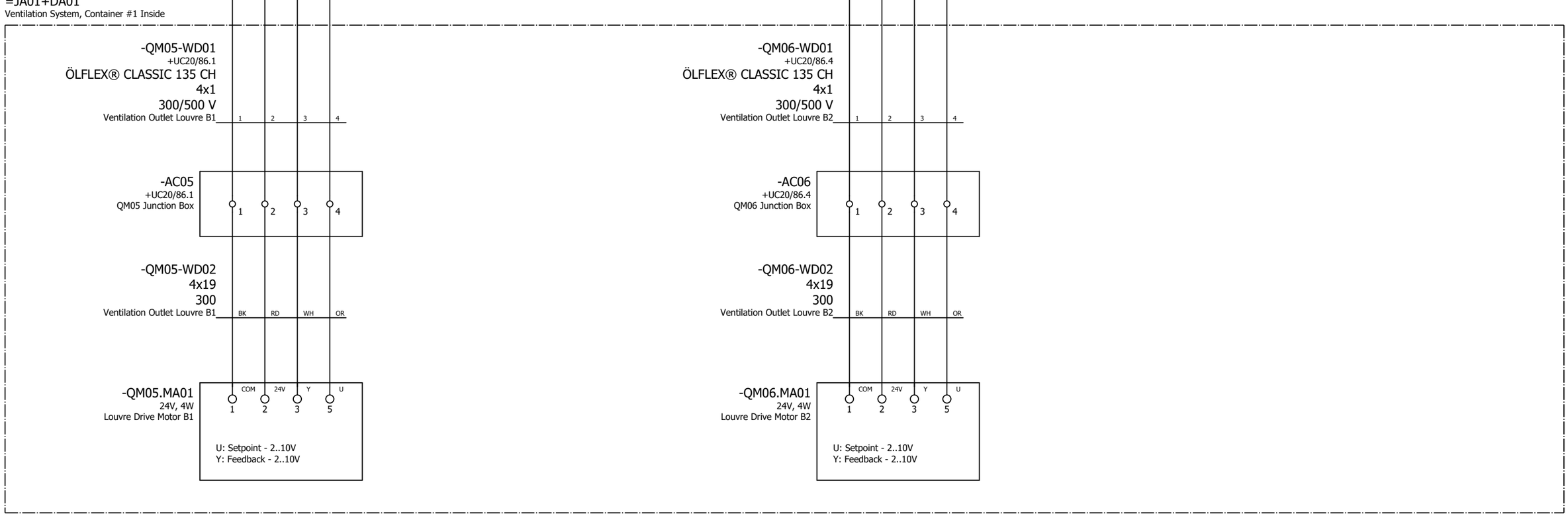
DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - LT Cooling System		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 614 / 2

0	1	2	3	4	5	6	7	8

=BA20
Container Control System, Container #1 Inside



=JA01+DA01
Ventilation System, Container #1 Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
DESCRIPTION
DATE
05-Jun-24

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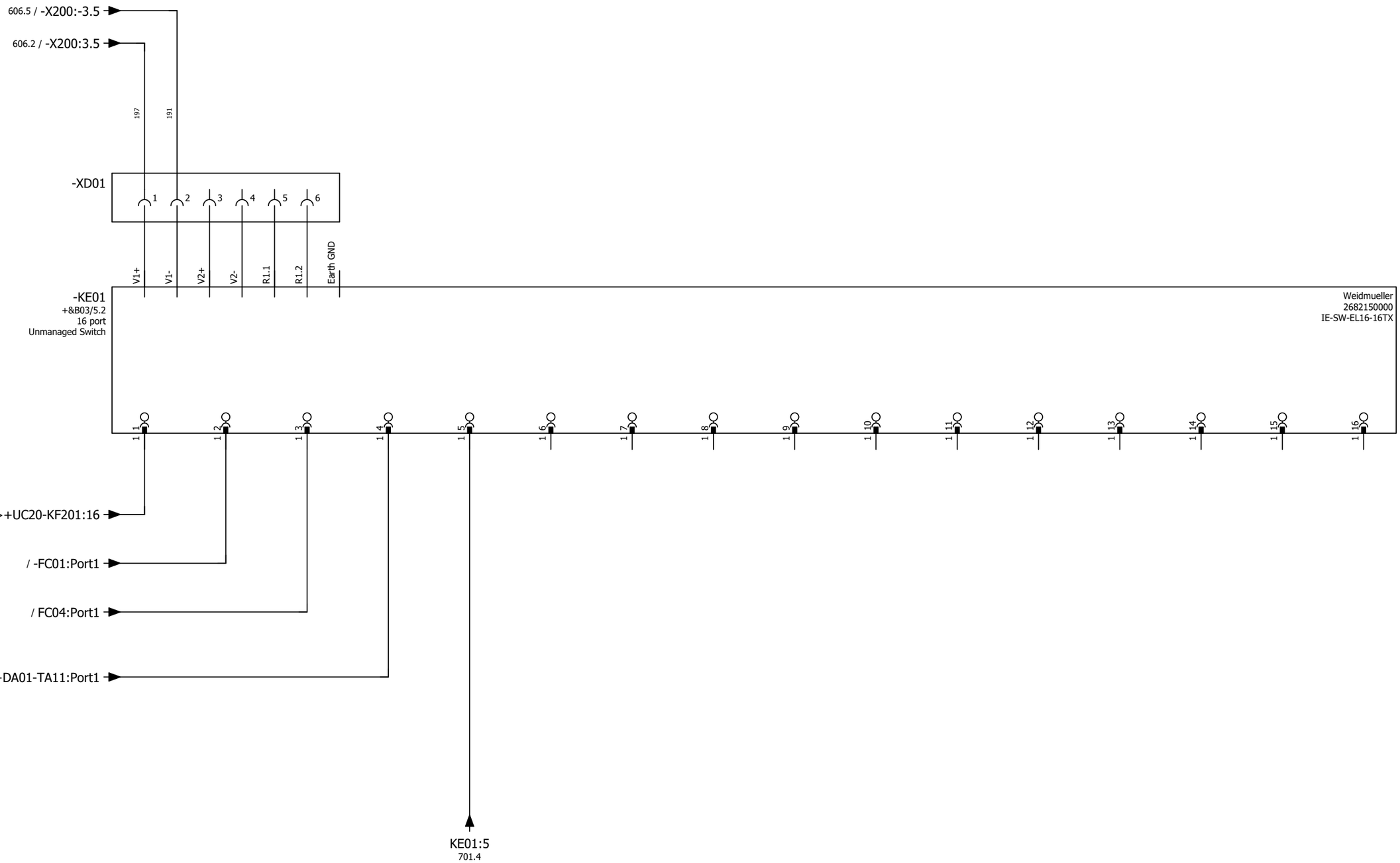
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - Container Exhaust Louvre B		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 615 / 2

0	1	2	3	4	5	6	7	8

=BA20
40ft Container - AUX distribution



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

REVISION INFORMATION
DESCRIPTION
DATE
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container AUX distribution - Newtwork switch		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 700 / 2

0	1	2	3	4	5	6	7	8

=BA20
40ft Container - AUX distribution

700.3
KE01:5

>=LA01-KE10-Slot1
DEIF PSM3.1
Power Supply
Module 3.1

Supply +
&C02/13.1
1
12-24V

Supply COM
&C02/13.1
2
0V

Frame Ground
&C02/13.1
PE
PE

606.3
-X200:4.6

606.5
-X200:-4.6

>=LA01-KE10-Slot4
&C02/13.5
DEIF PCM3.3
Processor and
Communication
Module 3.3

1
Top side of card
X02
Other bus systems
&C02/13.5
&C02/13.5

Other bus systems
X03
Bottom side of card
3

Connected to RM network cable - See sheet &B03:5

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C03

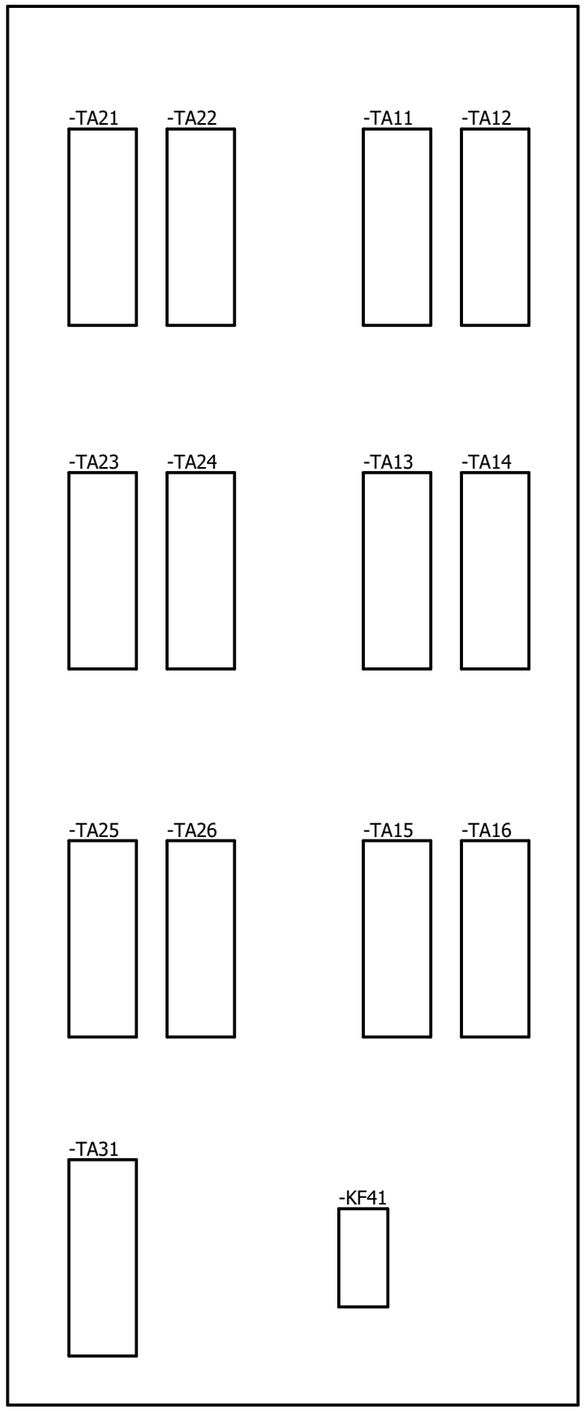
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DESCRIPTION
DATE
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	40ft Container - Gateway PLC		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 701 / 2



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C04

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DESCRIPTION
DATE
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Front Page		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 18

Terminal-strip overview

F14_001

Terminal strip	Terminal strip definition text	Terminals					Graphical page of terminal diagrams
		first	last	Total PE	Total N	Total number	
=BA20-X01		1	3	0	0	3	
=BA20-X10		1	16	0	0	20	
=BA20-X11		1	8	0	0	10	
=BA20-X200		1	4.6	0	0	22	
=BA20-XB01		1	1	0	0	1	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C04

REVISION INFORMATION
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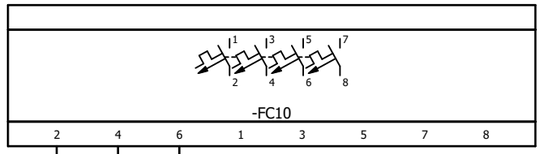
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Terminal-strip overview : =BA20+UC50-X01 - =BA20+UC50-XB01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 /

Terminal-connection diagram

F11_001
PBL 13-Jun-24

Internal targets



=BA20+UC50-X01

Jumpers

Terminal

Connection point

External targets

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C04

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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =BA20+UC50-X01		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 /

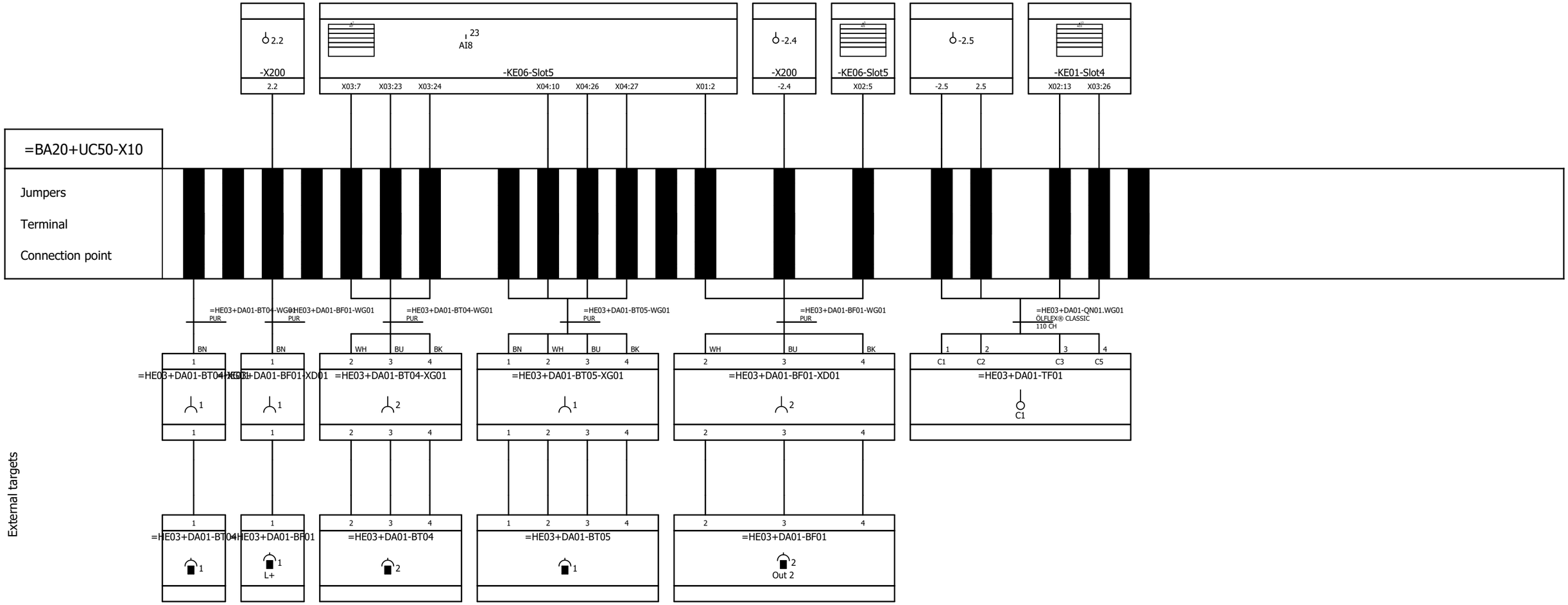
FRM5103656/0B

Terminal-connection diagram

F11_001
PBL 13-Jun-24

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C04

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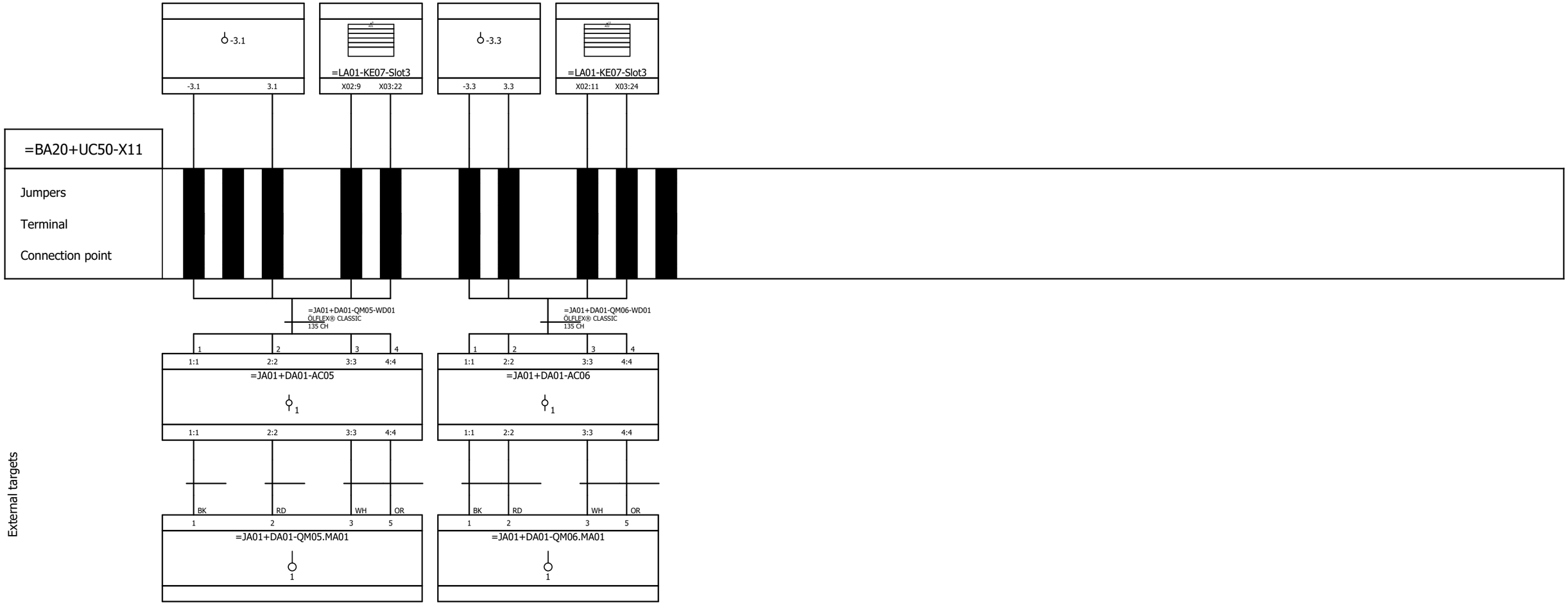
DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =BA20+UC50-X10		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets

External targets



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC50	& C04

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DATE
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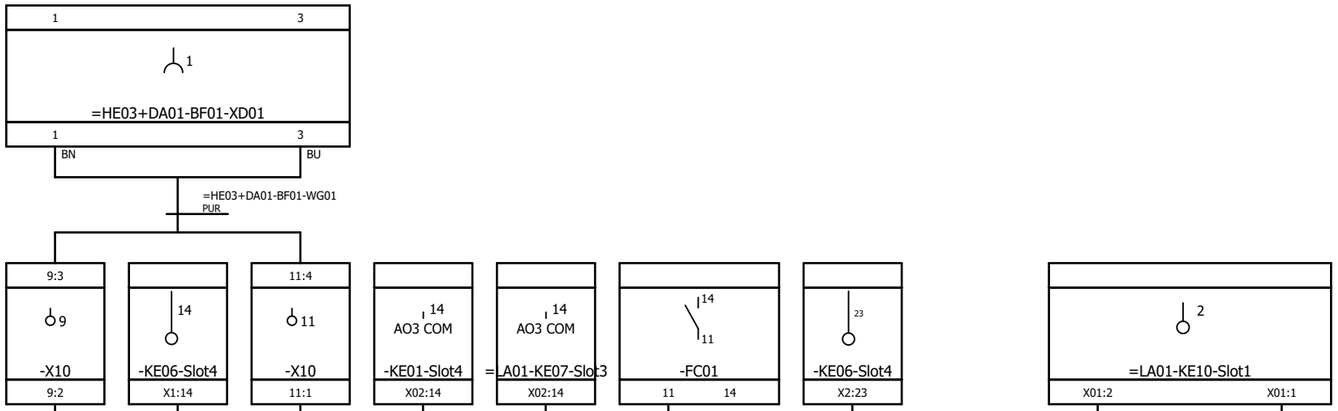
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DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
SHEET TYPE/DESC	Terminal-connection diagram =BA20+UC50-X11		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 /

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



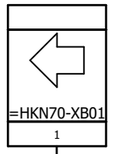
=BA20+UC50-X200

| | | |

Terminal-connection diagram

F11_001
PBL 28-Mar-25

Internal targets



=BA20+UC50-XB01	
Jumpers	
Terminal	
Connection point	1

External targets

Reference Item Number	Ballard Part # TBD			REVISION INFORMATION	THIS DOCUMENT, SUBMITTED IN CONFIDENCE, CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR DISCLOSED TO OTHERS OR USED FOR MANUFACTURING OR ANY OTHER PURPOSE WITHOUT PRIOR WRITTEN PERMISSION OF BALLARD POWER SYSTEMS INC. OR A RELATED WHOLLY-OWNED SUBSIDIARY OR AFFILIATE.	BALLARD™ CONFIDENTIAL	DRAWING	601456B UC50 AC Distribution Cabinet	REVISION	06
EPLAN Project Name	601456B - Shell Baseload Power Hub			DESCRIPTION			DRAWING TITLE	Crosswind UC50 AC Distribution Cabinet		
EPLAN Revision	06					THIS DOCUMENT'S APPROVAL IS MANAGED BY E-SIGNATURE ON FILE IN BALLARD POWER SYSTEMS' PLM SYSTEM	SHEET TYPE/DESC	Terminal-connection diagram =BA20+UC50-XB01		
EPLAN Project Pages	628			DATE			ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 7 /
=	++	+ UC50	& C04	28-Mar-25						

FRM5103656/0B

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	05/07/2024	First Issue
002	28/03/2025	Update after Comms Testing
003	28/03/2025	Reupload with cover page

Document Title:	**BLPH Project - Electrical Interface Documentation**
Document Number:	K559-2254-CWIWP4202202-E03-007
Revision:	Rev003
Sequence Number:	007
File Name:	K559-2254-CWIWP4202202-E03-007Rev003
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Electrical Interface Documentation for Rosetti Marino

Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface Documentation Introduction		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 12

Electrical Interface - 6,6kV

Location: 10ft Container, Side Entry

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=BA30+DA03
Power Output, 10ft Container

-TA30
1250kVA
400/6600V Transformer
Dry-type

2W 2V 2U

1U 1V 1W

Ballard Scope
Rosetti Marino Scope

=HKN70
RM Scope

Ballard provides bulkhead plate

-X01
70mm2, M12
Angled Cable Lug

-X02
70mm2, M12
Angled Cable Lug

-X03
70mm2, M12
Angled Cable Lug

-82003-CEM-1-L1
LSZH
1x70
6,6kV

-82003-CEM-1-L2
LSZH
1x70
6,6kV

-82003-CEM-1-L3
LSZH
1x70
6,6kV

-82003-CEM-1-L1
6,6kV MV Power

-82003-CEM-1-L2
6,6kV MV Power

-82003-CEM-1-L3
6,6kV MV Power

SG-100D1

RM Information taken from "123A90-DDL-EL-LIS-20148_CPI"

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + | & B03

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DESCRIPTION
DATE
29-Nov-24

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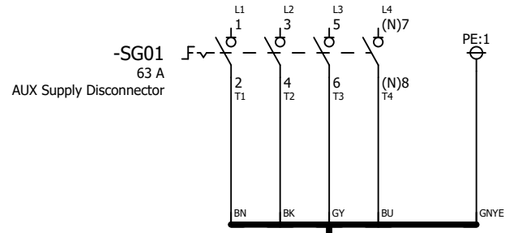
DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - 6,6kV Connection		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 12

Electrical Interface - AUX Connection

Location: 40ft Container, Upper Left Corner

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=BA20+UC50
AC Distribution Cabinet, Inside 40ft Container



Cable length: 12 meters from interface point

Ballard Scope
Rosetti Marino Scope

=HKN70
RM Scope

-83012-CEL
LSZH
5x16
400V
Fuel Cell Auxillary Load

83012-CEL
AUX Power Supply

SG-200N1

RM Information taken from "123A90-DDL-EL-LIS-20148_CPI"

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - AUX Supply		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 12

Electrical Interface - Safety Connections

Location: 40ft Container,Top Side Entry

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

=LB02+UC20
Control Cabinet, 40ft Container Inside

To Safety Control System

-KF52
24VDC
Customer Safety Input Relay

A1
A2

-R01
120 Ohm, 0,5W
Wire break
resistor
RM Scope

-KF51
+UC20&C03/55.6
Fire Detection
23
24
5
6

-KF53
+UC20&C03/55.7
Hydrogen Detection
23
24
7
8

-KF50
+UC20&C03/55.5
Safety Status
23
24
33
34
-X101
9
10
11
12

Cable length: 12 meters from interface point

Ballard Scope
Rosetti Marino Scope

>=EXT+
Customer Scope

C-80-XS-001
2x2.5
C-80-XS-001
1 2,5
2 2,5
4.1
4.1

C-80-XS-001 / B400-SIS-001

80-UCP-001
2x2x2.5
80-UCP-001
1 WH 2,5
2 WH 2,5
1 BK 2,5
2 BK 2,5
4.4
4.3
4.4
4.4

80-UCP-001 / B400-FGS-002

C-80-XA-003
1x2x2.5
C-80-XA-002
1 WH 2,5
1 BK 2,5
4.6
4.6

C-80-XA-003 / B400-SES-001

23 — 24 +UC20&C03/55.2
33 — 34 +UC20&C03/55.3

Expected behaviour:
- Conductor 1 24VDC, Conductor 2 0V - Safety OK, Relay ON
- Conductor 1 0V, Conductor 2 0V - Safety NOT OK, Relay OFF

KF51 Indicates Fire detection
KF53 Indicated Gas detection
Implemented with safety rated relay
- De-energized contacts (as shown): No Fire / Gas detection
- Energized contacts (opposite shown): Confirmed Fire/Gas

KF50 Indicates System Emergency Status
Implemented with safety rated relay
- Closed Contacts: FC Package OK
- Open Contacts: FC Package Safety Trip

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

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28-Mar-25

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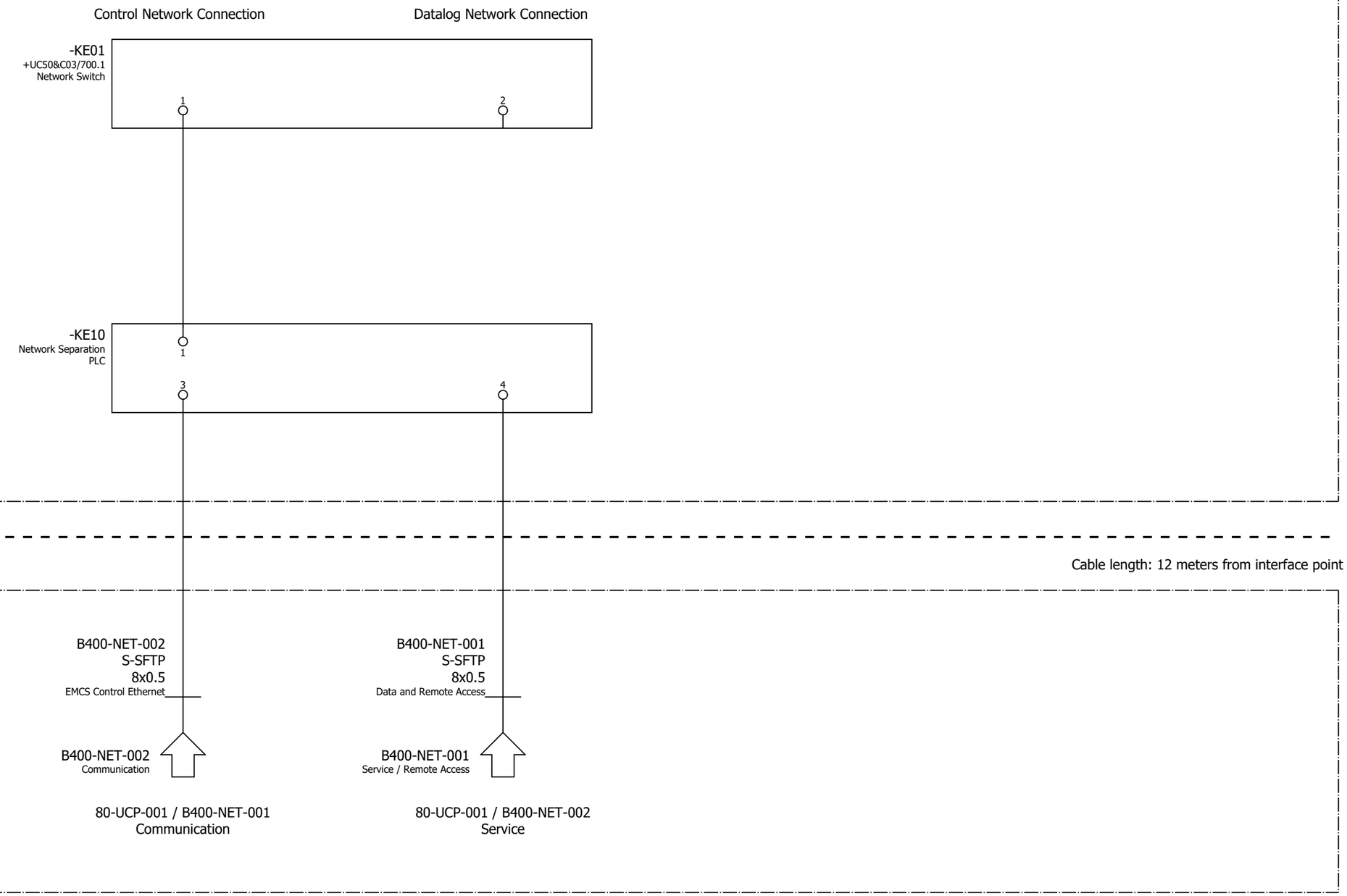
DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - Safety		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 4 / 12

Electrical Interface - Network Connections

Responsibility matrix: K559-2254-SWIWP4202202-E99-003Rev001

Location: 40ft Container,Top Side Entry

=BA20+UC50
AC Distribution Cabinet, 40ft Container Inside



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+	& B03

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DRAWING	E03-007 Electrical Interfaces to RM	REVISION	06
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS		
SHEET TYPE/DESC	Electrical Interface - Network		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 5 / 12

Ballard Power Systems Europe A/S
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9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	01/04/2025	First Issue

Document Title:	**BLPH Project - Panel Cabinet Layout: UC42 Ex Barrier Box**
Document Number:	K559-2254-CWIWP4202202-E03-008
Revision:	Rev001
Sequence Number:	008
File Name:	K559-2254-CWIWP4202202-E03-008Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

0	1	2	3	4	5	6	7	8

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+UC42

Ballard Power Systems Europe - Technology Solutions

Cabinet: Ex Barrier Box
Location: Outside 40ft Container, Right of H2 Manifold

Refer to K559-2254-CWIWP4202202-K02-003 ATEX Design Journal for ATEX Information

Vin = 24VDC

IP65

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC42	& A01

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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DRAWING	601456B UC42 Ex Barrier Box			REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet				
SHEET TYPE/DESC	Front Page				
ALL SHEETS ARE THE SAME REVISION STATUS		SIZE A3	LANGUAGE EN	SHEET/TOTAL	1 / 18

Ballard Power Systems Europe - Technology Solutions, Cabinet Wiring Colors

Standard Basis: EN 61439

Required wire standard compliance:

Required: IEC Wire
Required: UL Recognized
Required: CSA/UL

Wire Numbering:

- Wires inside panels are to be numbered
- Wire number system is perferably "potential oriented with subnumber"
- All wires of the same potential (e.g. DC Common) have the same main number, with sequential subnumber.
- Potential numbers with fewer digits may be leading zero padded (e.g. 19 -> 019)
- Separator between main and subnumber is "."

Example: 019.1 BUWH 0.75mm²

- 019 — Wire potential number
- 1 — Wire sequential subnumber with separator
- BUWH — Wire color code (Dark Blue with White stripe)
- 0.75mm² — Wire dimension

AC Wiring Colors

AC Power Circuit (Generic)	———	Black (BK)
AC Phase L1	———	Brown (BN)
AC Phase L2	———	Black (BK)
AC Phase L3	———	Grey (GY)
AC Neutral	———	Light Blue (BU)
Externally supplied circuit	———	Orange (OG)

DC Wiring Colors

DC Power Circuit	———	Black (BK)
DC Control Voltage (24V)	———	Dark Blue (BU)
DC Control Voltage Refence (0V)	-·-·-·-	Dark Blue with White Stripe (BUWH)
Signal Wire (DI, DO)	———	White (WH)
Signal Wire (AI, AO)	———	Violet (VT)
Externally supplied circuit	———	Orange (OG)

PE Wiring Colors

Protective Earth (PE)	- - - - - - -	Green/Yellow (GNYE)

Conductor Colour Identification

IEC 60757:1983 Designation	Description
BK	Black
BN	Brown
RD	Red
OG	Orange
YE	Yellow
GN	Green
BU	Blue
VT	Violet
GY	Gray
WH	White
PK	Pink
GD	Gold
TQ	Turquoise
SR	Silver
GNYE	Green/Yellow
SH	Shield

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
=	++ | + UC42 | & A01

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28-Mar-25

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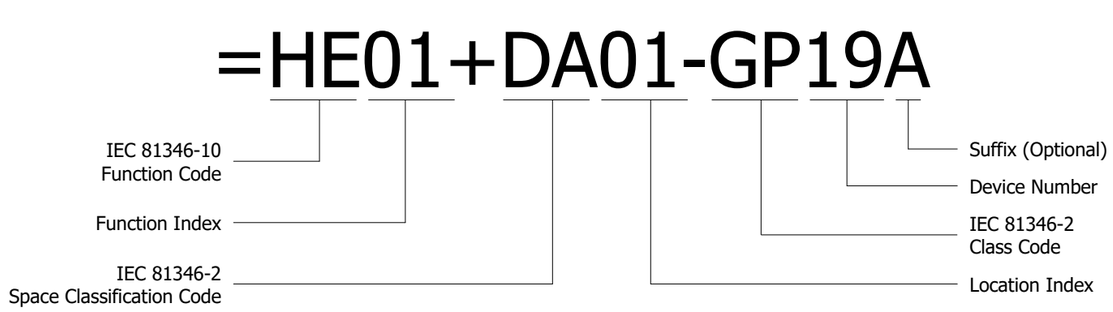
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DRAWING	601456B UC42 Ex Barrier Box	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Standard Wire Colors		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 2 / 18

Ballard Power Systems Europe - Technology Solutions Device Tag Process

A Ballard Device Tagname consists of three parts:
- A function designation (=)
  - According to IEC81346-10, Table B.1 and B2.
  - Always two letters followed by two digits
- A location designation (+)
  - According to IEC81346-2, Table 4
  - Always two letters followed by two digits
- A class code (-)
  - According to IEC81346-2, Table 2
  - Always two letters followed by two or three digits plus optional suffix

Sample fully qualified Device Tag (DT) for a Coolant Pump



IEC81346-10 Function Examples

IEC 81346-10 Table B.1 and B.2 provide a class definition system, which provides a two letter code for the functional description
Table B.1 is used for power supply systems and table B.2 for other systems

IEC 81346-10 Table B.1 / B.2	Function Codes (Example)
=AA	Structural System, Load support (Frame)
=BA	Transporting Electrical Energy (Power Converters)
=HA	Supply System, Gaseous Matter (Gas Piping)
=HE	Supply System, Heating/Cooling (Radiator)
=JA	Distribution System, Gaseous Matter (Gas Handling Unit)
=JB	Distribution System, Liquid Matter (Fluid Drain)
=LA	Control System, Process (PLC, SCADA)
=LB	Control System, Safety (Safety PLC)
=QA	Storage System, Gaseous Matter (Gas Storage)
=RE	Energy Conversion System, Chemical to Electricity (Fuel cells, Batteries)

IEC81346-2 Space Classification

IEC 81346-2 Table 4 provide a classification scheme for spaces, which provides a two and three letter code for the space (location) classification.
Class code "1" and "1" is used for the location scheme

IEC 81346-2 Table 4	Location Codes (Example)
+GB	Space for power generation, Chemical (Fuel Cells)
+DA	Space for active technical equipment
+UC	Space for electrical equipment (Electrical Cabinet)

IEC81346-2 Class Code

IEC 81346-2 Class Codes is a scheme for defined objects for reference designations according to their inherent function

IEC 81346-2 Table 2	Class Codes (Example)
-BA	Sensing, electrical potential (Voltage Transducer)
-BC	Sensing, electrical current (Current Transducer)
-BP	Sensing, pressure (Pressure Transducer)
-BT	Sensing, temperature (Temperature Transducer)
-EA	Emitting, light (Light Fixture)
-FC	Protecting, overcurrent (Fuse, MCCB)
-GB	Generating, Chemical Reaction (Fuel Cell)
-GP	Generating, Liquid Flow (Pump)
-GQ	Generating, Gas Flow (Van, Ventilator)
-KE	Processing, Electrical signals (PLC)
-KF	Processing, Information (Network Switch)
-MA	Driving, Torque (AC Motor)
-QA	Controlling, Electric Current (Contactor, Motor Starter)
-QB	Controlling, Electric Separation (Disconnector)
-QM	Controlling, Fluid On/Off (Valve)
-QN	Controlling, Fluid Regulation (Damper, Gas Control Valve)
-WD	Guiding, Low Voltage Electric Energy (AC or DC power Cable)
-WE	Guiding, Reference Potential (Grounding Wire/Cable)
-WG	Guiding, Electric Signals (Control, Network Cable)

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	601456B - Shell Baseload Power Hub
EPLAN Revision	06
EPLAN Project Pages	628
= ++ + UC42 & A01	

REVISION INFORMATION
DESCRIPTION
DATE
28-Mar-25

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DRAWING	601456B UC42 Ex Barrier Box	REVISION	06
DRAWING TITLE	Crosswind UC20 40ft Control Cabinet		
SHEET TYPE/DESC	Tagging Standard		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 18

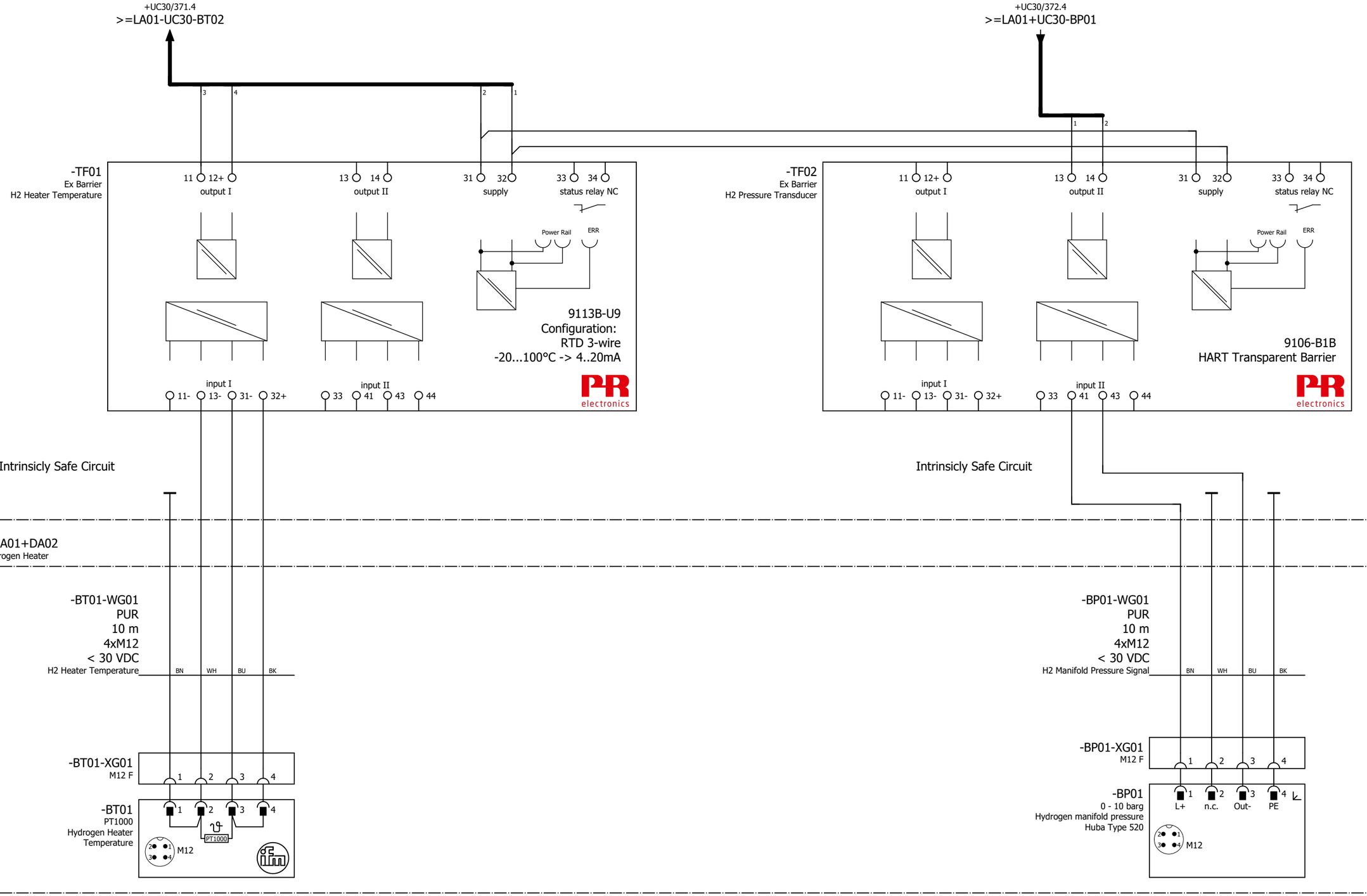
0	1	2	3	4	5	6	7	8

Refer to K559-2254-CWIWP4202202-K02-003 ATEX Design Journal for ATEX Information

=LA01
Ex Barrier Box

+UC30/371.4
>=LA01-UC30-BT02

+UC30/372.4
>=LA01+UC30-BP01



Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	06		
EPLAN Project Pages	628		
=	++	+ UC42	& C03

REVISION INFORMATION
DESCRIPTION
DATE
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DRAWING	601456B UC42 Ex Barrier Box	REVISION	06
DRAWING TITLE	40ft Container - DCDC Cabinets		
SHEET TYPE/DESC	EX Barrier Box		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 1 / 2

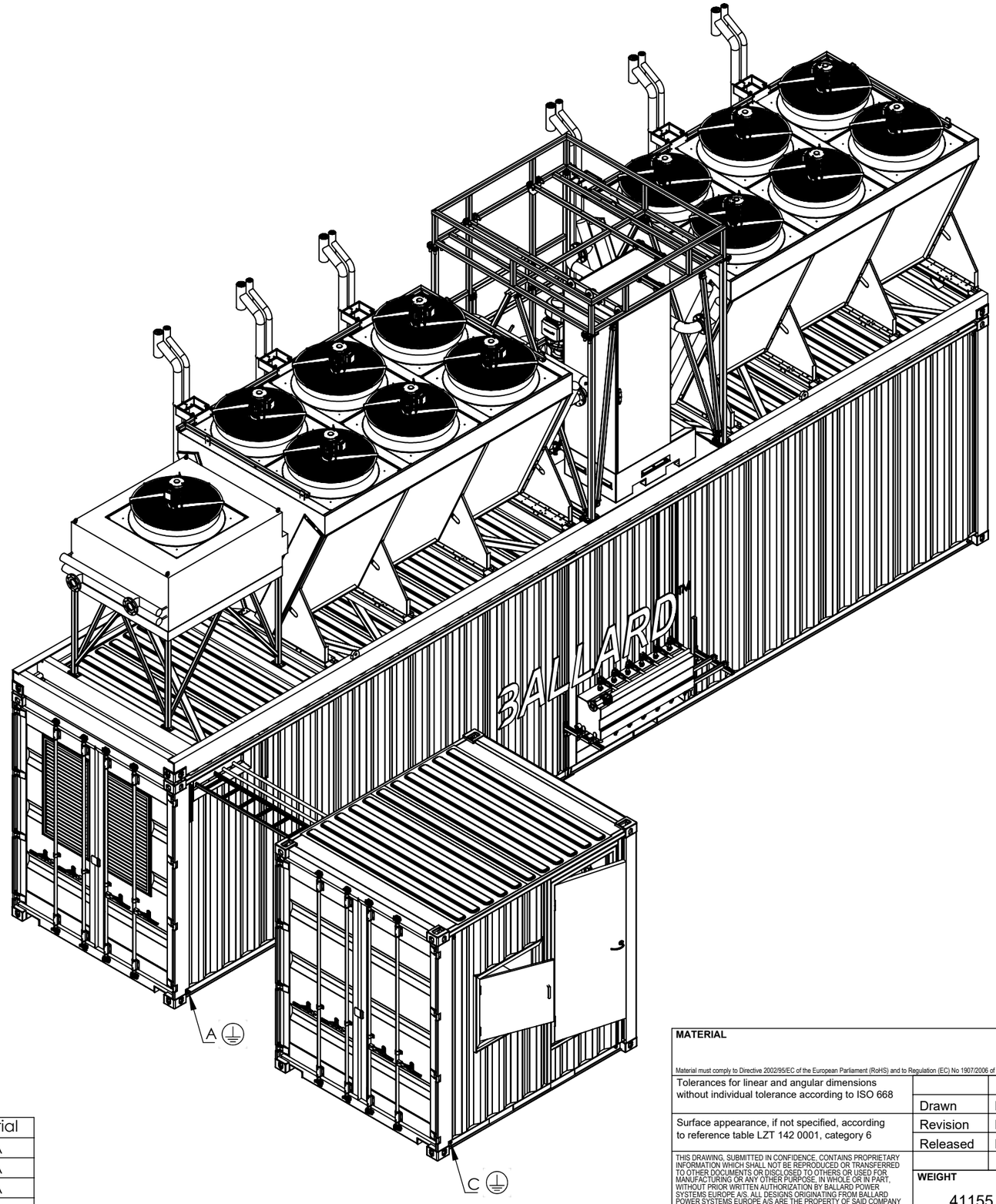
Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	03/03/2023	First Issue
002	11/04/2024	Updated/modified acc. to comments

Document Title:	**BLPH Project - Specials: Earthing Layout**
Document Number:	K559-2254-CWIWP4202202-E99-004
Revision:	Rev002
Sequence Number:	004
File Name:	K559-2254-CWIWP4202202-E99-004Rev002
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	E99
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

ISOMETRIC VIEW

Revision Table				
ZONE	REV.	DESCRIPTION	DATE	REV. BY
0	0	RELEASE	09/04/2024	PSZ



Point	Bolt size	Bolt length	Torque	Material
A	M12x1.5	25 mm	65 Nm	V2A
B	M12x1.5	25 mm	65 Nm	V2A
C	M12x1.5	25 mm	65 Nm	V2A
D	M12x1.5	25 mm	65 Nm	V2A

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

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WEIGHT 41155 kg

1st angle projection

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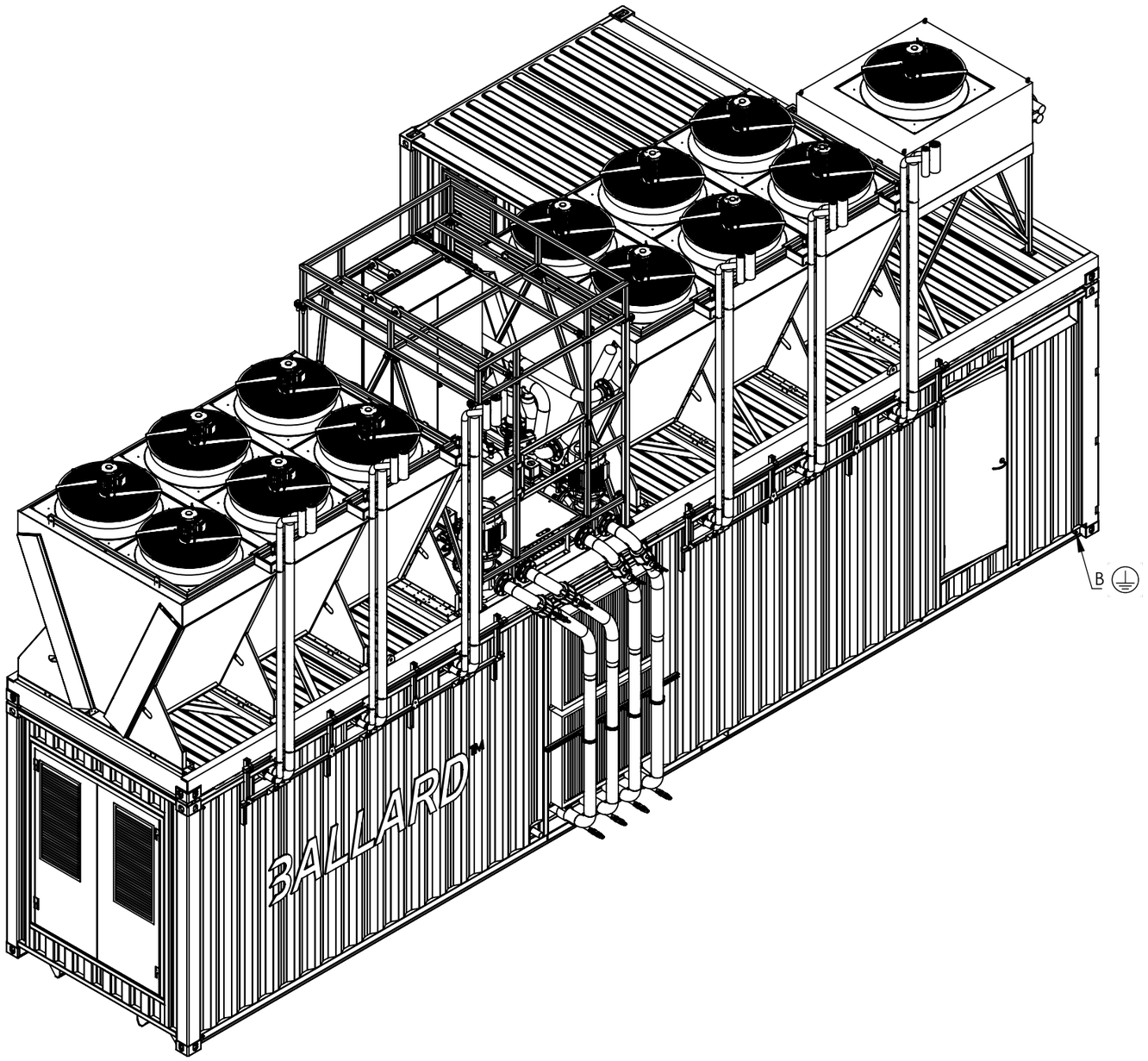
Ballard hydrogen system

ISOMETRIC VIEW

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	1/6	1:50	E99-004	0

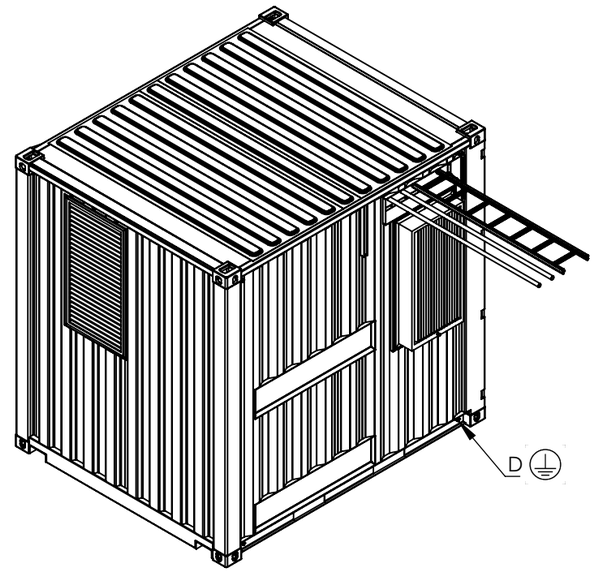
Revision Table				
ZONE	REV.	DESCRIPTION	DATE	REV. BY
0	0	RELEASE	09/04/2024	PSZ

ISOMETRIC VIEW - 40FT CONTAINER



ISOMETRIC VIEW - 10FT CONTAINER

(40ft container hidden)



Point	Bolt size	Bolt length	Torque	Material
A	M12x1.5	25 mm	65 Nm	V2A
B	M12x1.5	25 mm	65 Nm	V2A
C	M12x1.5	25 mm	65 Nm	V2A
D	M12x1.5	25 mm	65 Nm	V2A

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

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WEIGHT 41155 kg

1st angle projection

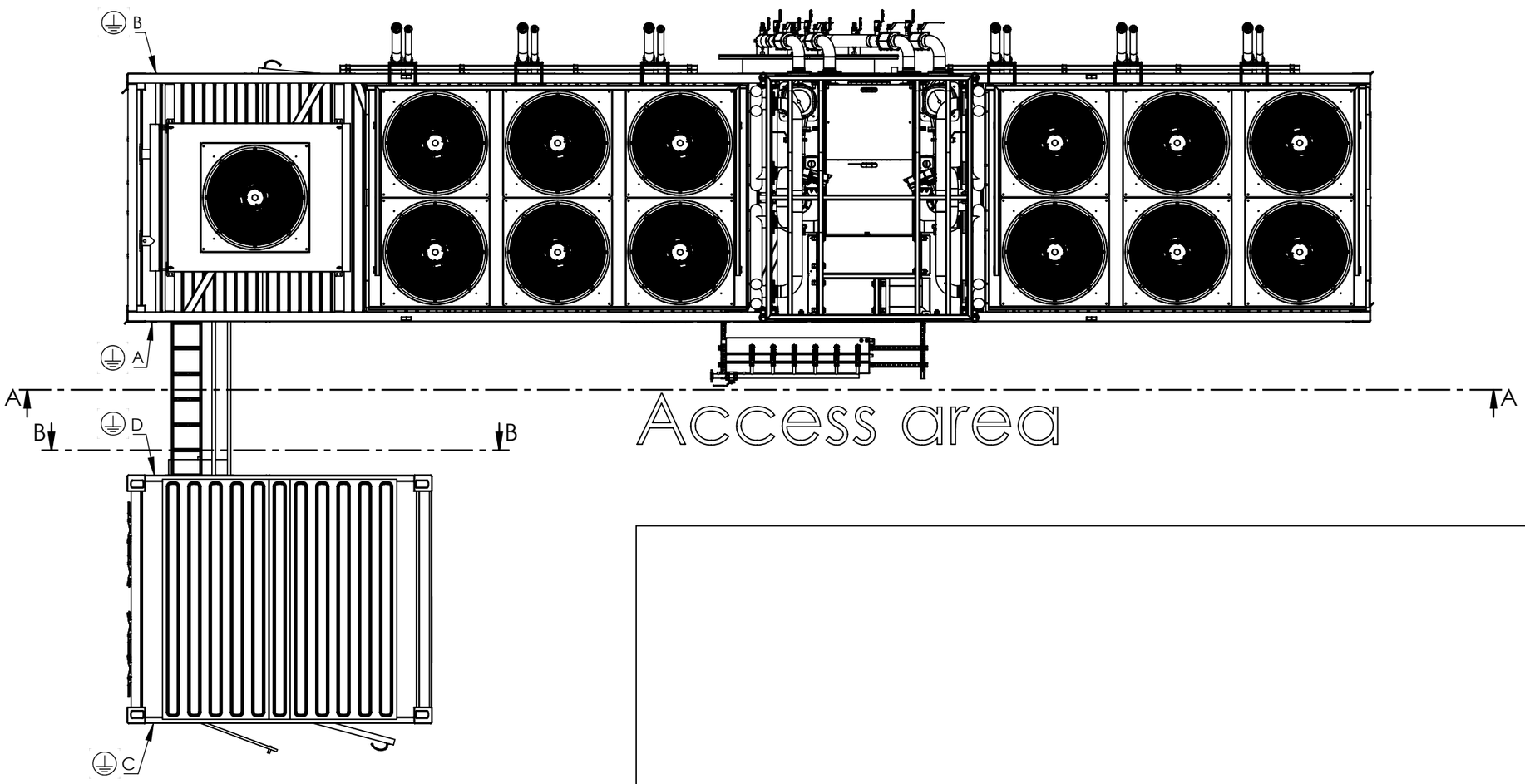
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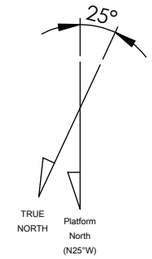
Ballard hydrogen system

ISOMETRIC VIEW - Back

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	2/6	1:50	E99-004	0

TOP VIEW - ACCESS AREA





Point	Bolt size	Bolt length	Torque	Material
A	M12x1.5	25 mm	65 Nm	V2A
B	M12x1.5	25 mm	65 Nm	V2A
C	M12x1.5	25 mm	65 Nm	V2A
D	M12x1.5	25 mm	65 Nm	V2A

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

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WEIGHT 41155 kg

1st angle projection

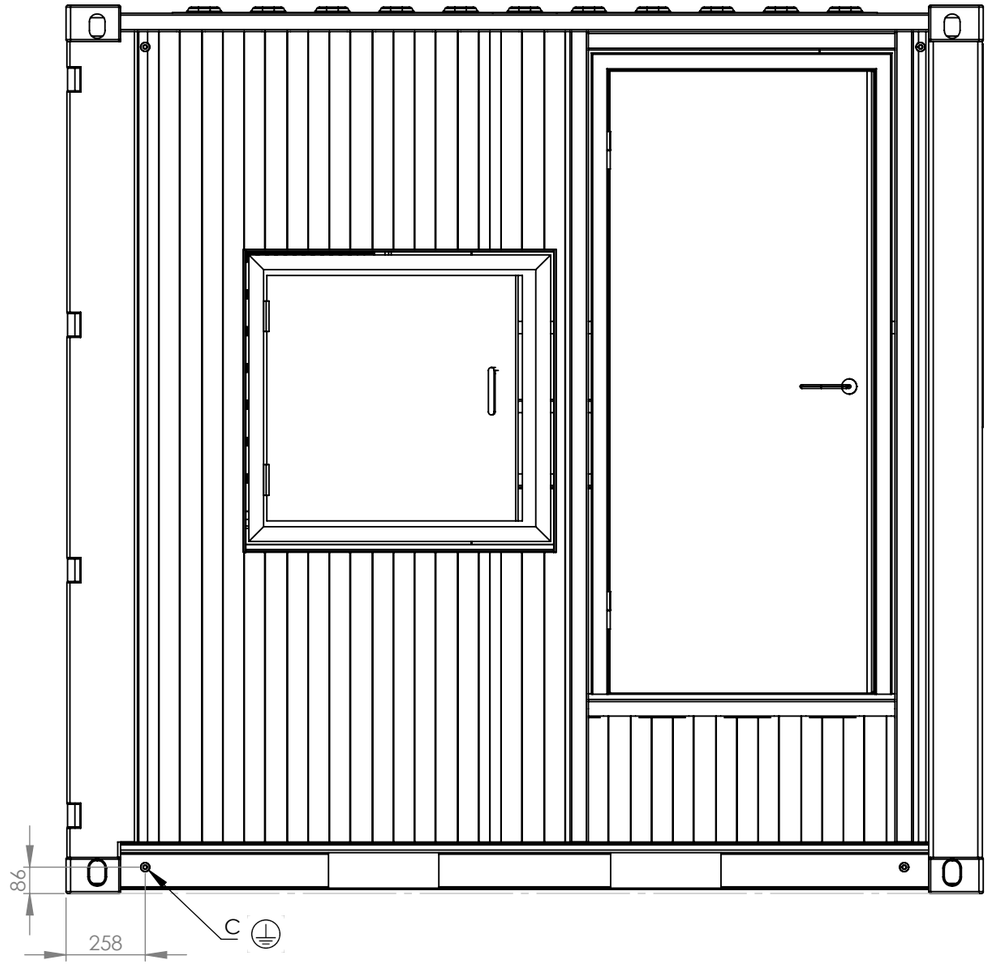
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Ballard hydrogen system

Top - Access area

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	3/6	1:50	E99-004	0

FRONT VIEW - 10FT CONTAINER
(LOOKING SOUTH)



Point	Bolt size	Bolt length	Torque	Material
A	M12x1.5	25 mm	65 Nm	V2A
B	M12x1.5	25 mm	65 Nm	V2A
C	M12x1.5	25 mm	65 Nm	V2A
D	M12x1.5	25 mm	65 Nm	V2A

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

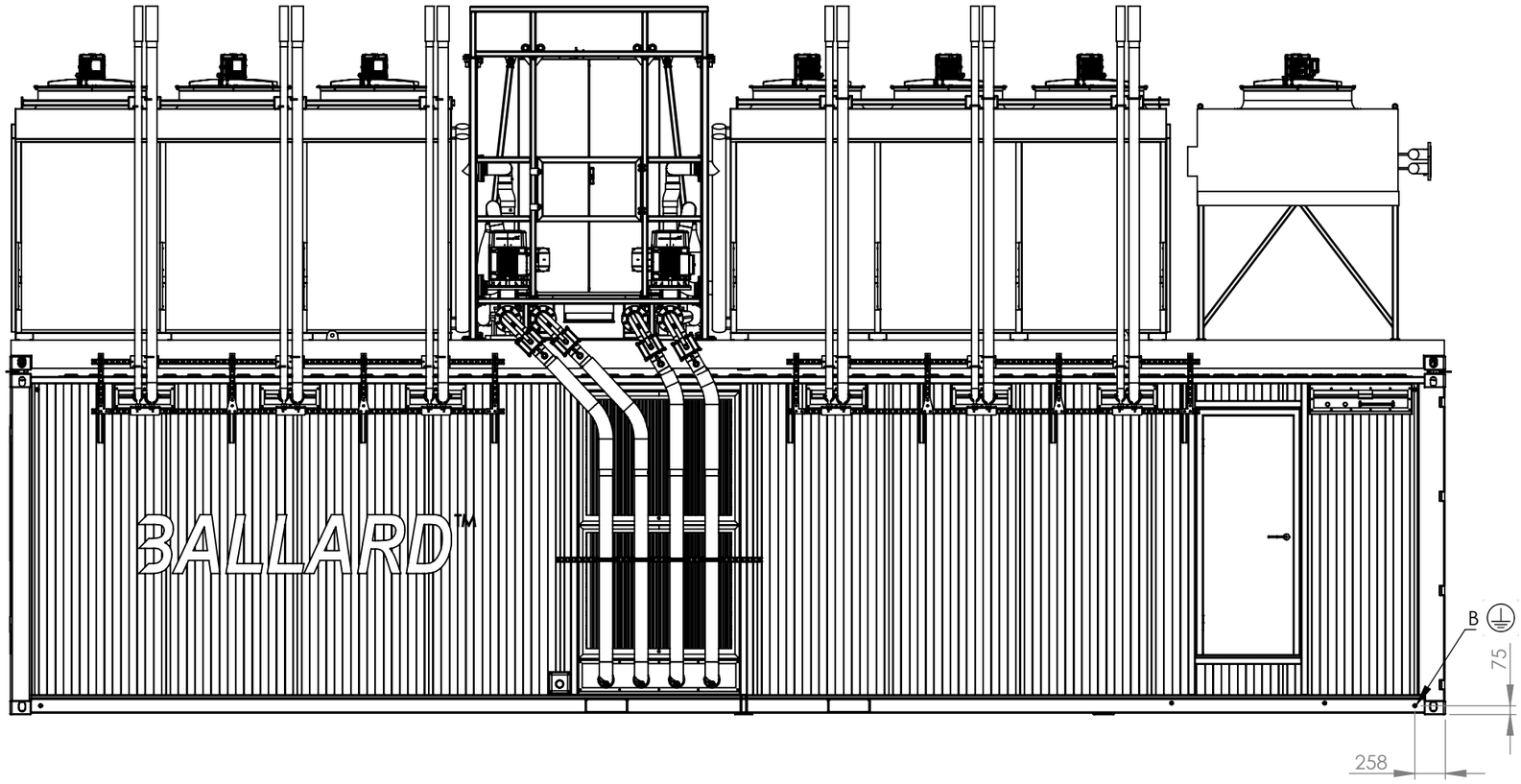
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Ballard hydrogen system
FRONT

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
41155 kg	1st angle projection	A3	4/6	1:20	E99-004	0

BACK VIEW - 40FT CONTAINER
(LOOKING NORTH)



Point	Bolt size	Bolt length	Torque	Material
A	M12x1.5	25 mm	65 Nm	V2A
B	M12x1.5	25 mm	65 Nm	V2A
C	M12x1.5	25 mm	65 Nm	V2A
D	M12x1.5	25 mm	65 Nm	V2A

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

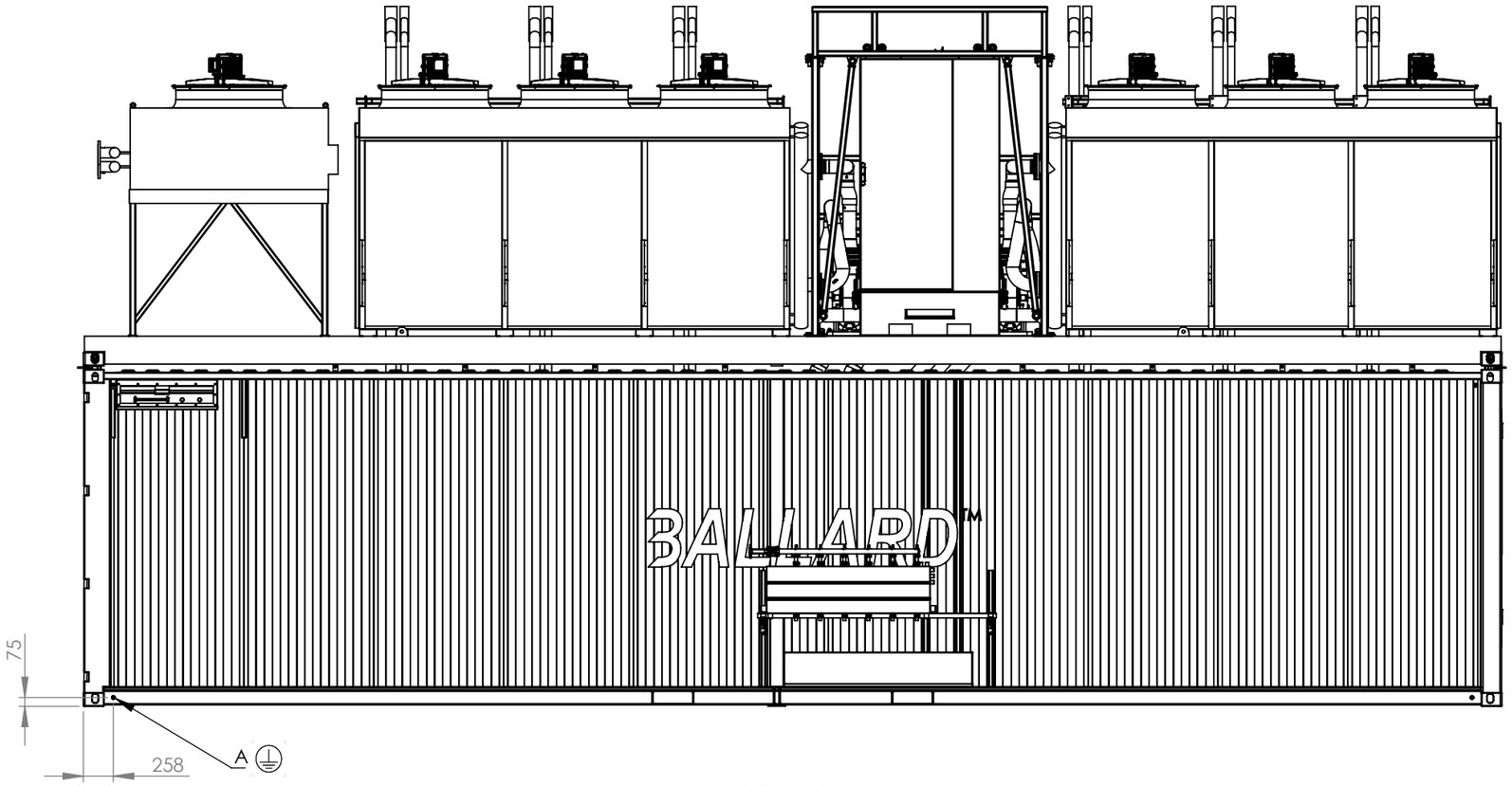
	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

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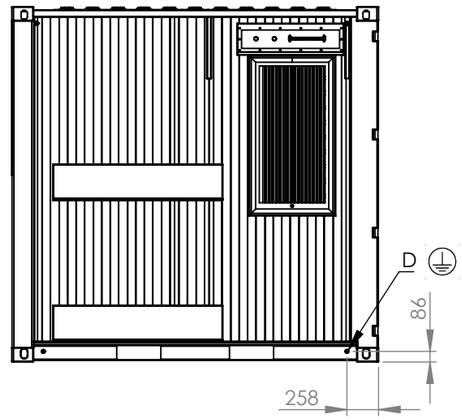
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Ballard hydrogen system
BACK

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
41155 kg	1st angle projection	A3	5/6	1:50	E99-004	0



SECTION A-A



SECTION B-B

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	PSZ	09-04-2024
Revision	PSZ	09-04-2024
Released	PSZ	09-04-2024

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Ballard hydrogen system

Cross sections

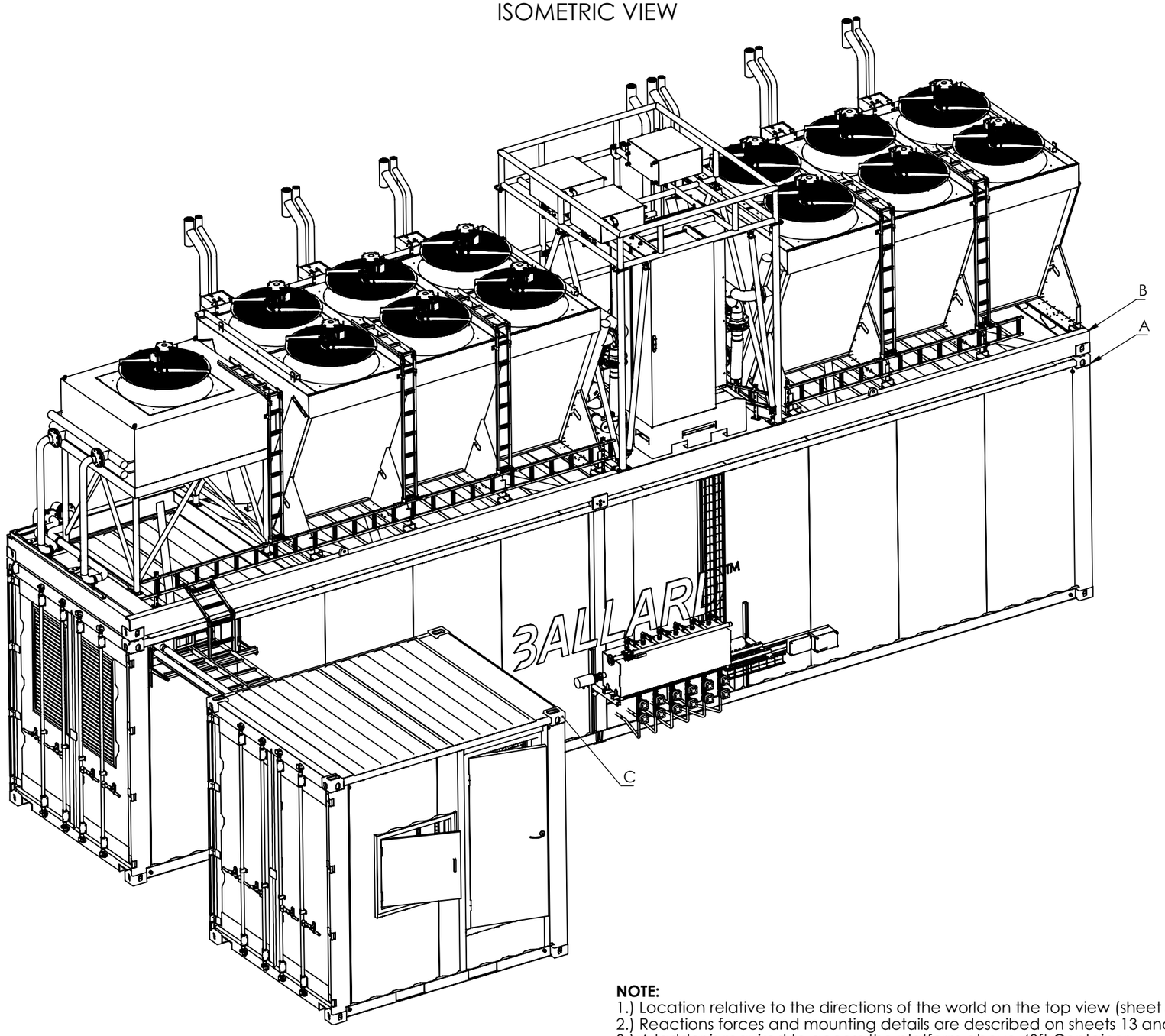
WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
41155 kg	1st angle projection	A3	6/6	1:50	E99-004	0

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	10/02/2023	First Issue
002	24/03/2023	Re-issue according to comments
003	30/05/2023	Re-issue according to comments
004	10/11/2023	Re-issue according to comments
005	24/11/2023	Re-issue according to comments
006	02/04/2024	Re-issue according to comments
007	17/07/2024	Re-issue according to comments
008	05/09/2024	Re-issue (as built)
009	21/11/2024	Re-issue according to comments

Document Title:	**BLPH Project - General Arrangements**
Document Number:	K559-2254-CWIWP4202202-B01-001
Revision:	Rev009
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-B01-001Rev009
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	B01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

ISOMETRIC VIEW



No	Name	Operating Masses	Dry Masses
A	40ft container	21680kg	21320kg
B	40ft fladbed	10060kg	9060kg
C	10ft container	7350kg	7310kg

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

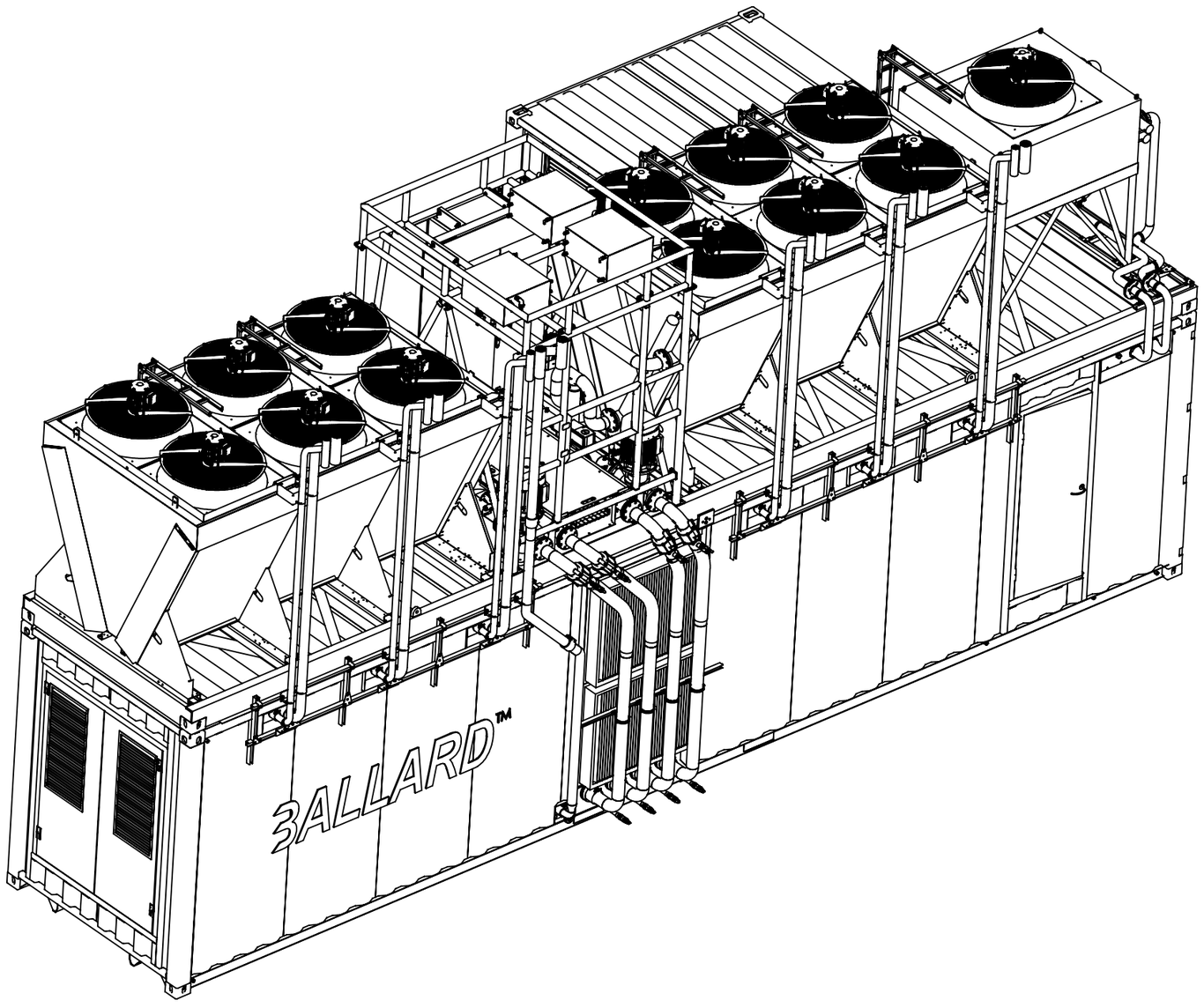
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	1/14	1:50	601456B	9

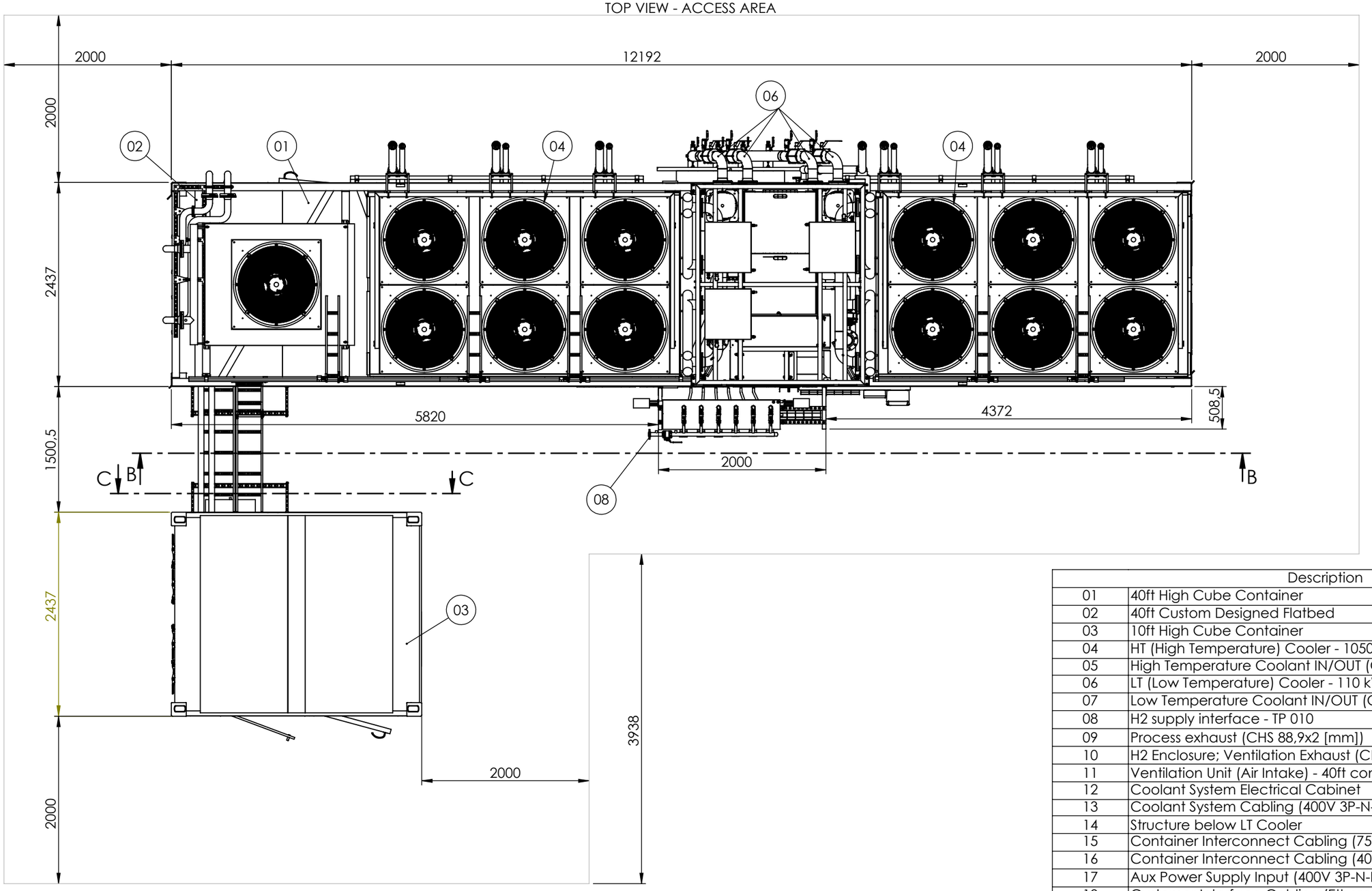
ISOMETRIC VIEW



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)				BALLARD™				
Tolerances for linear and angular dimensions without individual tolerance according to ISO668		By	Date	General arrangement				
	Drawn	ASM	20-02-2024					
Surface appearance, if not specified, according to reference table LZT 142 0001, category 6	Revision							
	Released							
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TOP VIEW - ACCESS AREA





	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

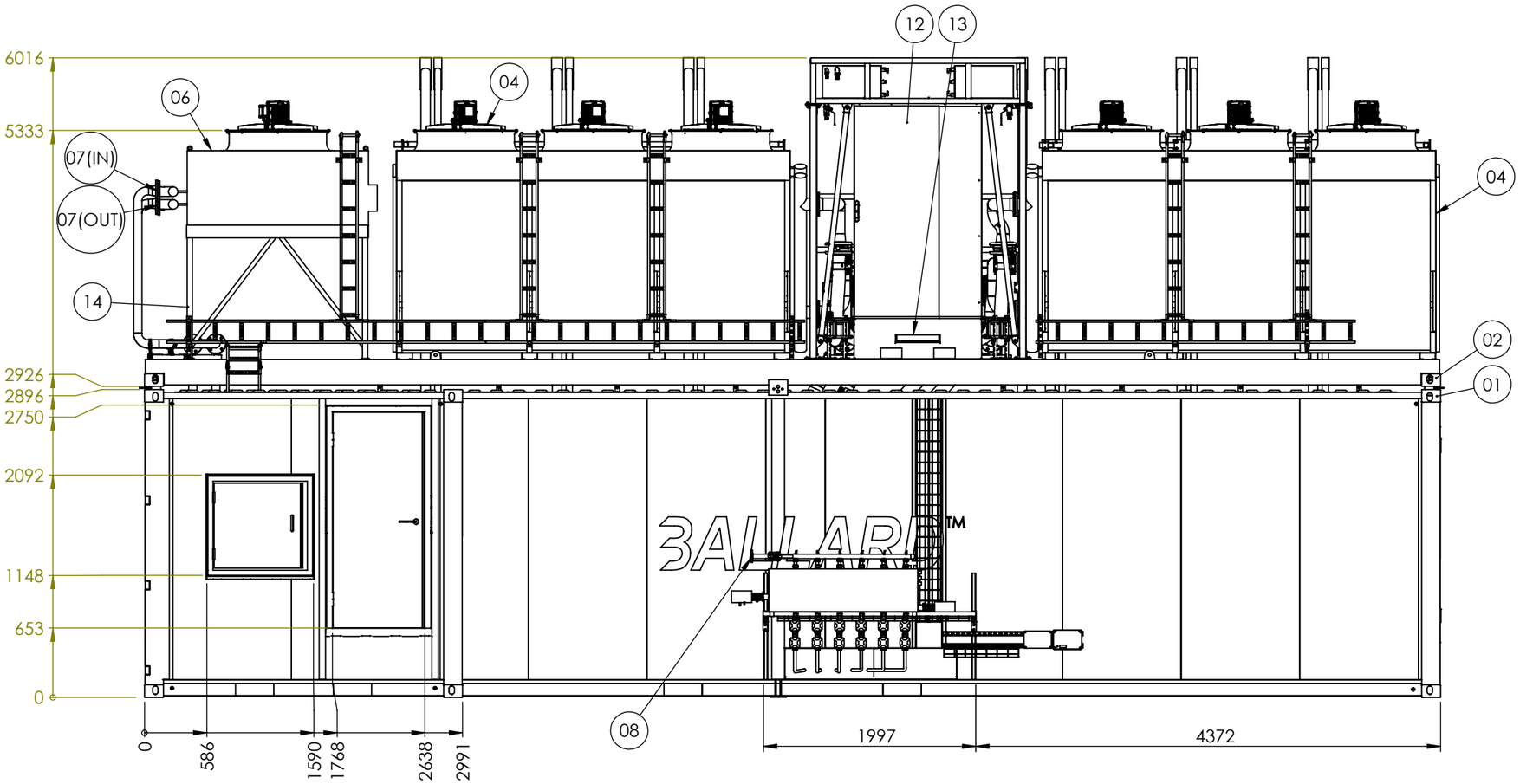
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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	3/14	1:50	601456B	9

FRONT VIEW
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

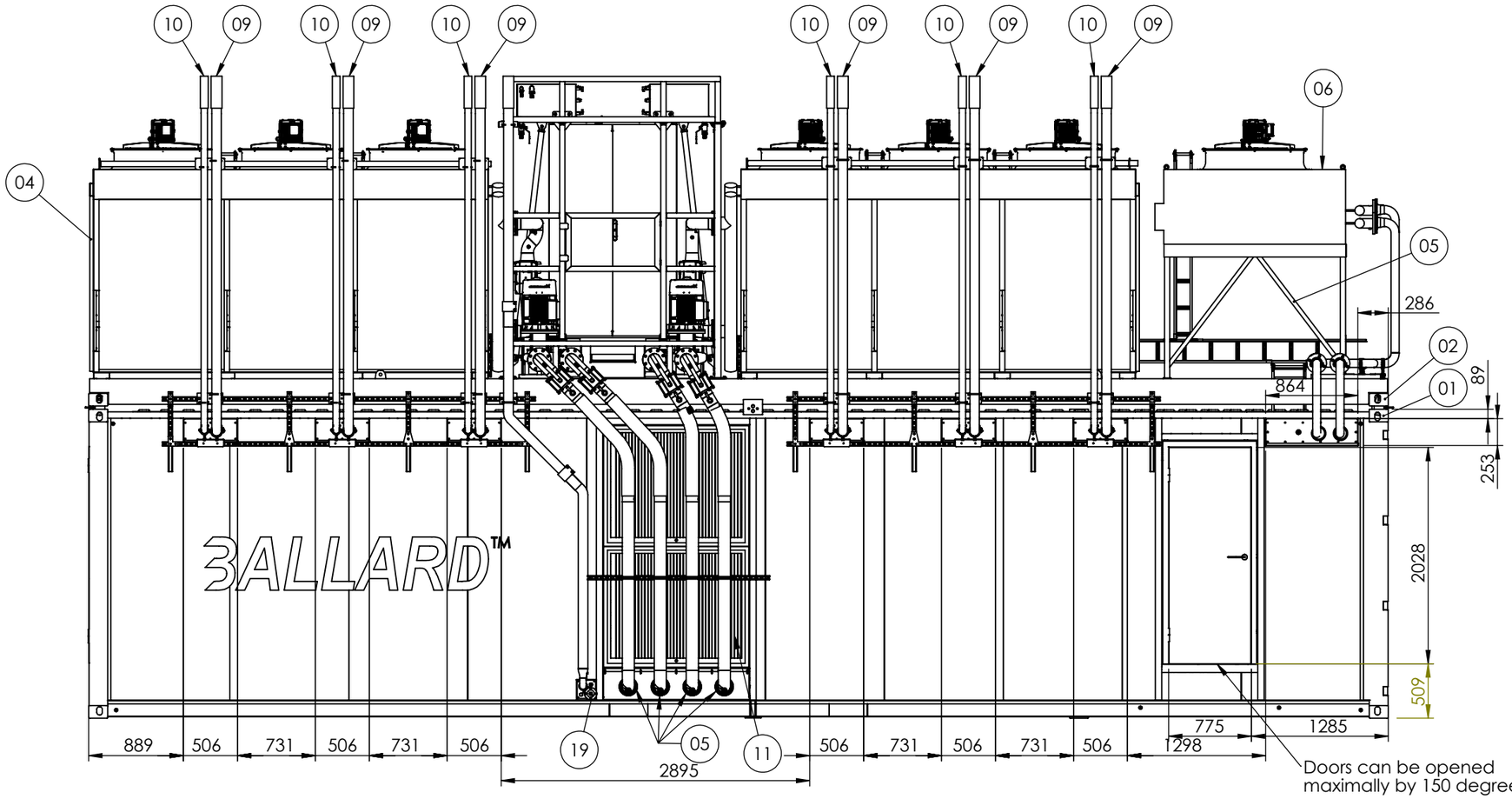
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	4/14	1:50	601456B	9

BACK VIEW
(LOOKING NORTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

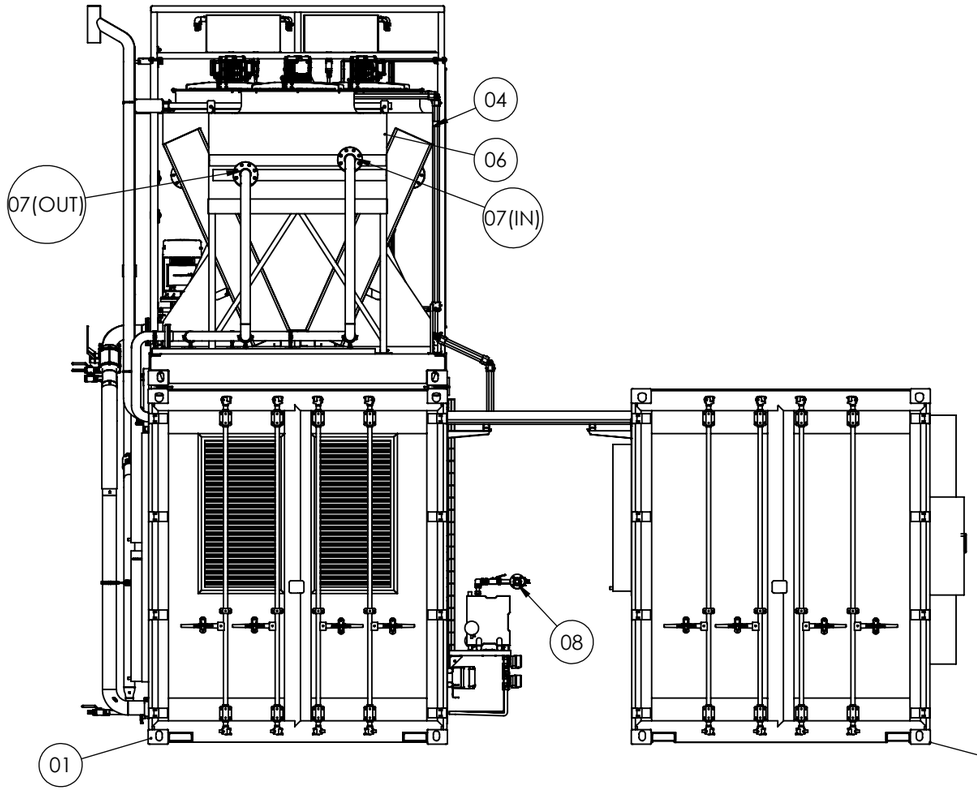
	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

General arrangement

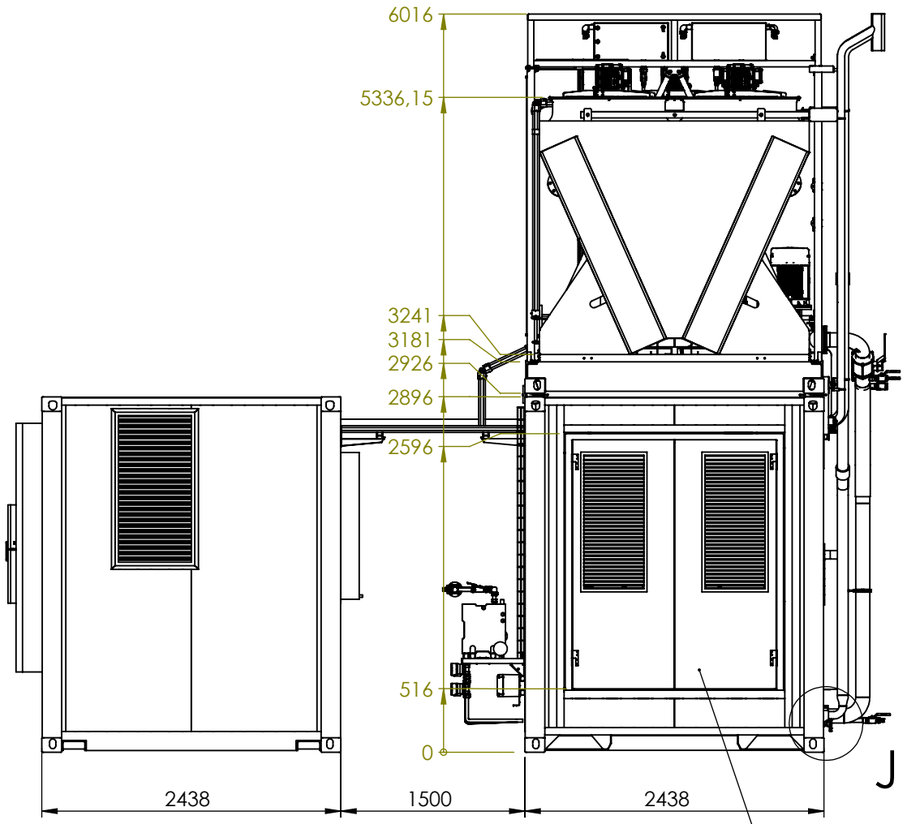
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	5/14	1:50	601456B	9

RIGHT VIEW
(LOOKING WEST)

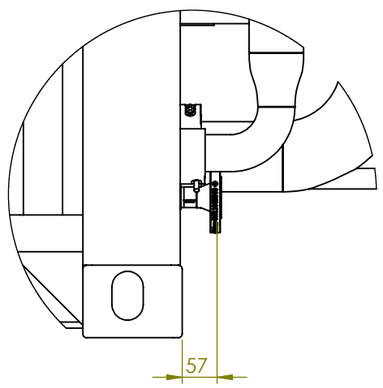


LEFT VIEW
(LOOKING EAST)



Doors can be opened
maximally by 150 degrees

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		



DETAIL J
SCALE 1 : 10

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

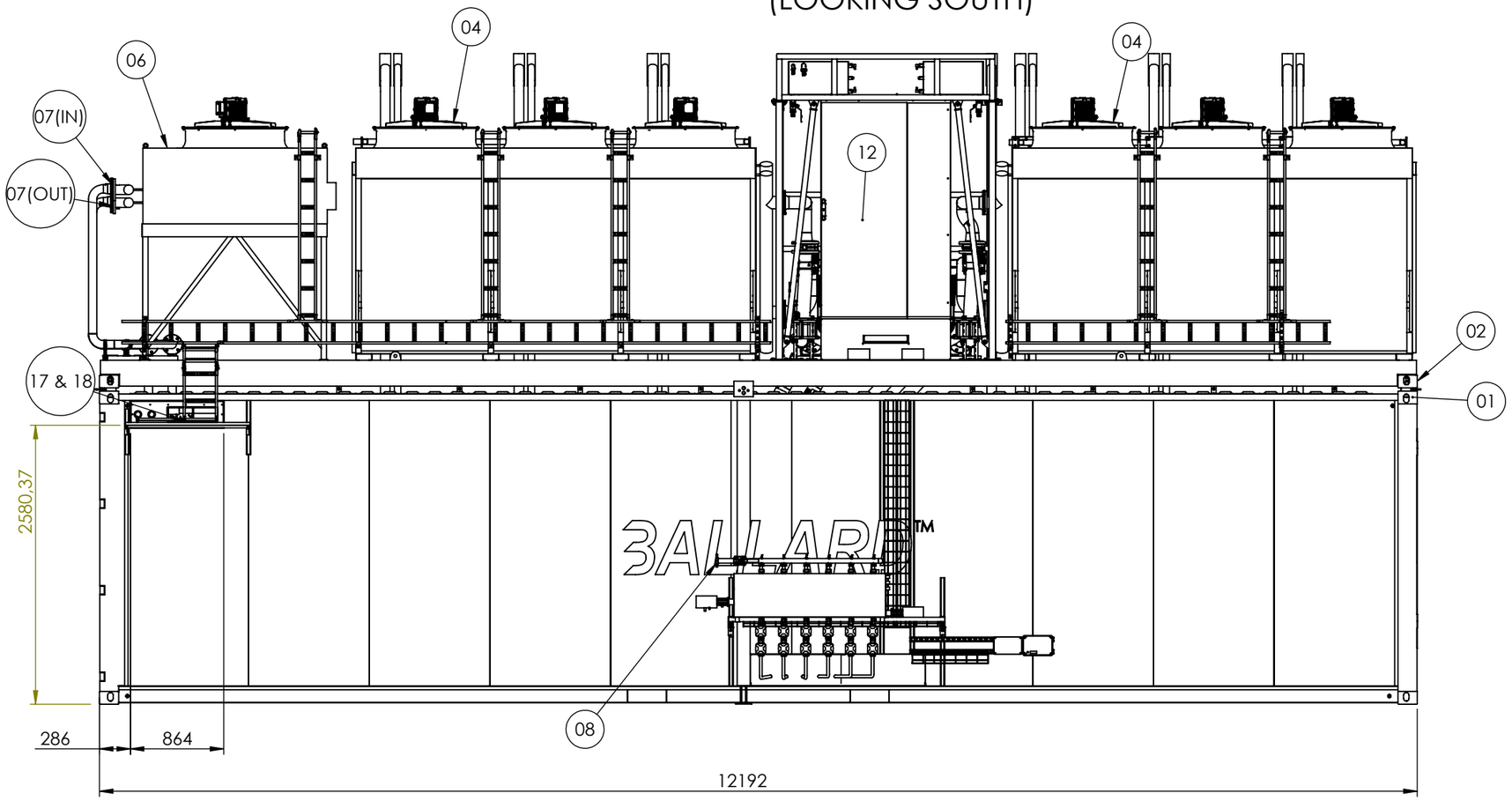
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BALLARD

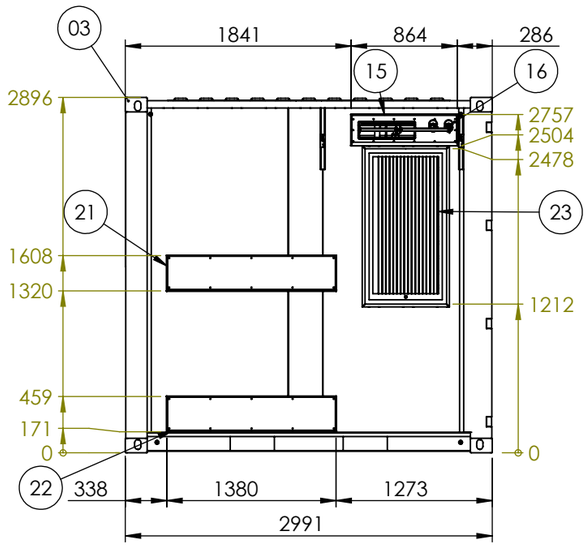
General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	6/14	1:50	601456B	9

FRONT VIEW
(LOOKING SOUTH)



SECTION B-B



SECTION C-C

	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
CHS = Circular Hollow Section		
CIP - Customer Interface Point		

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

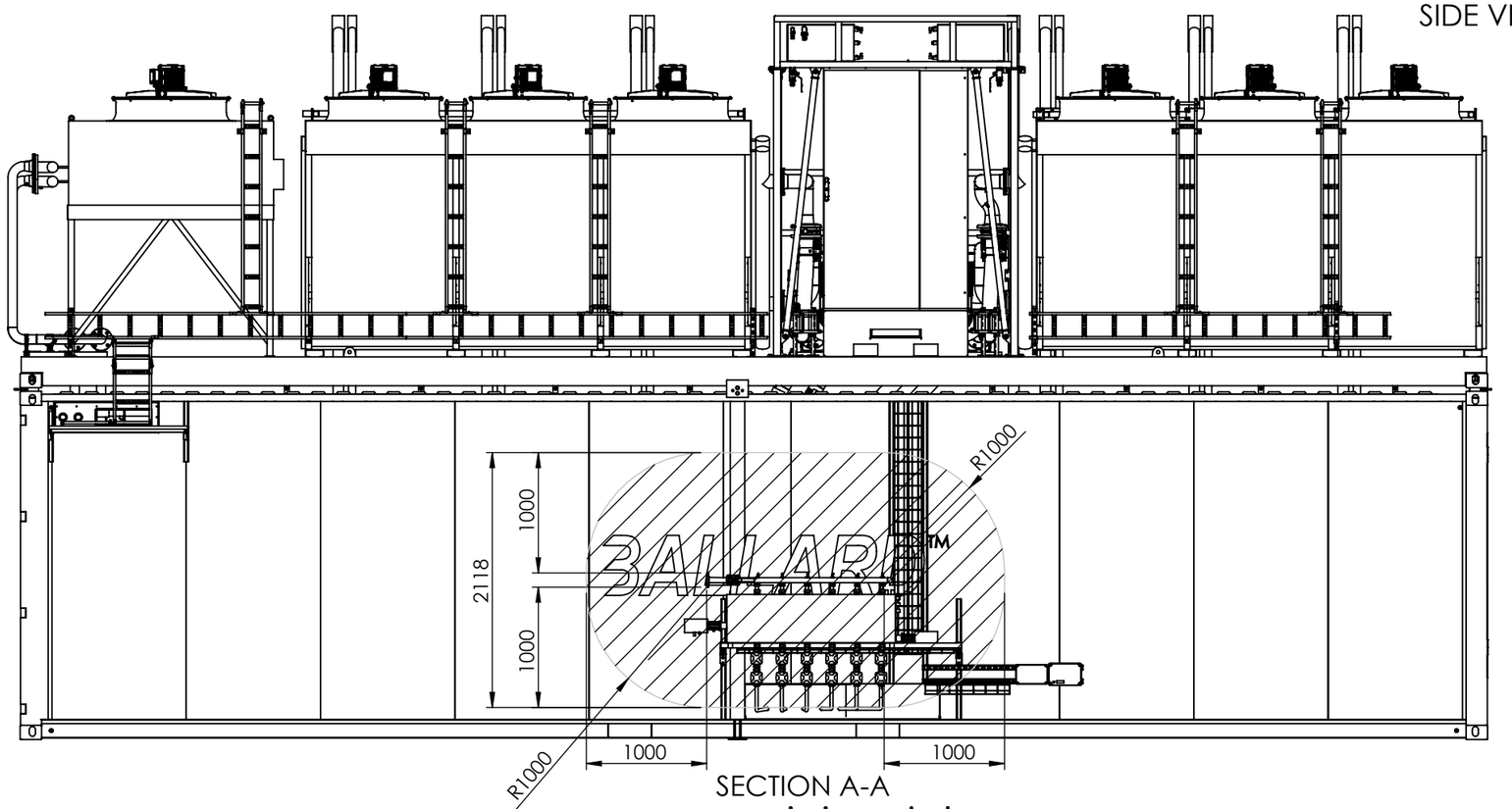
	By	Date
Drawn	ASM	20-02-2024
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Released		

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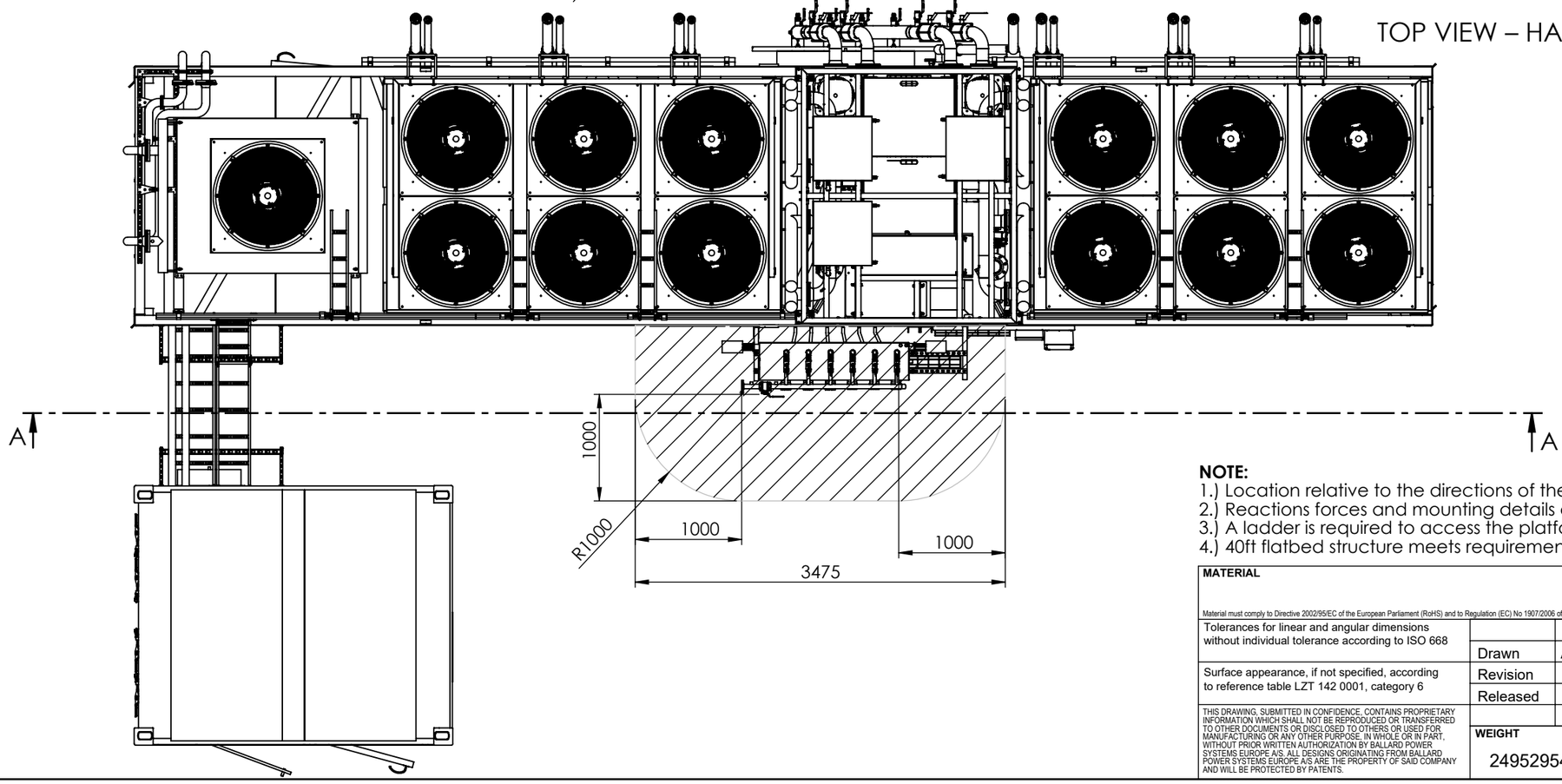
SIDE VIEW - HAZARD AREA



SECTION A-A

Zone 2 Gc IIC T1

TOP VIEW – HAZARD AREA



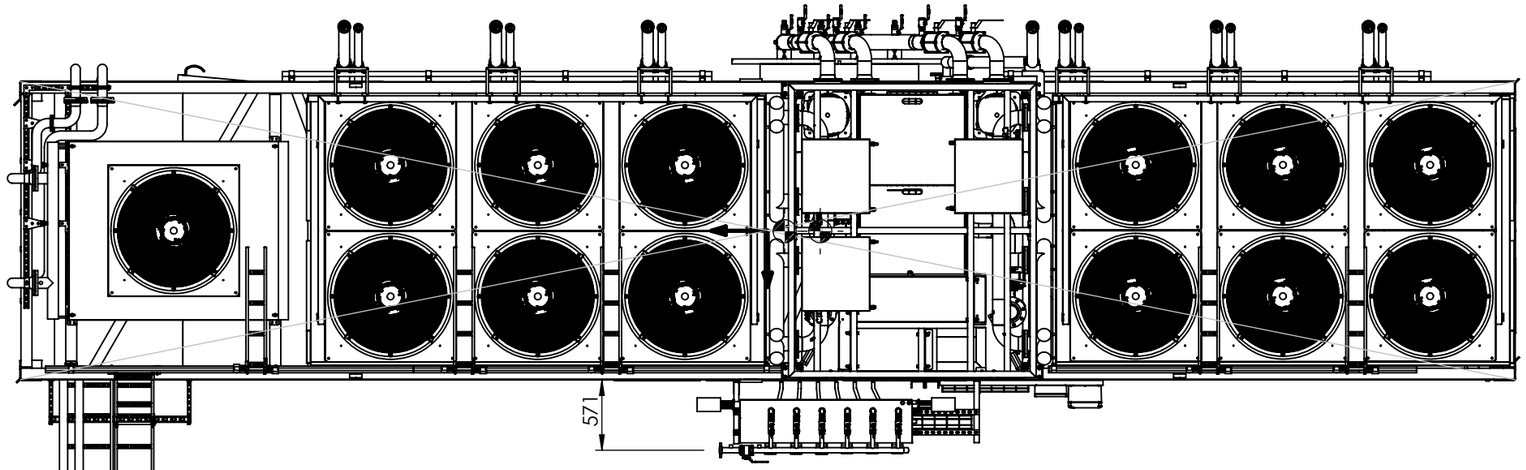
NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

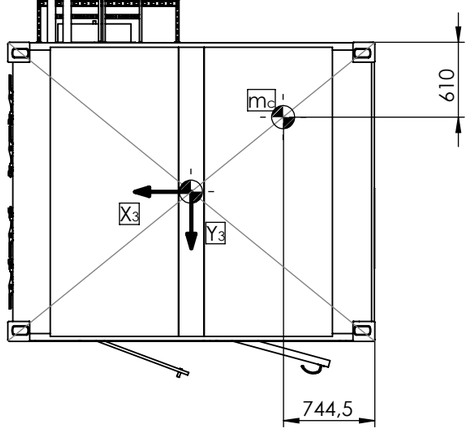
MATERIAL Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)			BALLARD™
Tolerances for linear and angular dimensions without individual tolerance according to ISO 668		By	Date
	Drawn	ASM	20-02-2024
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	8/14	1:50	601456B	9

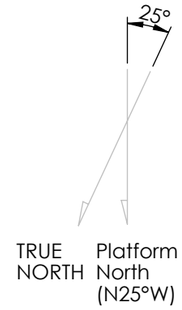
TOP VIEW - Center of Gravity

Access area





Access area



NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

BALLARD™

Tolerances for linear and angular dimensions without individual tolerance according to

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

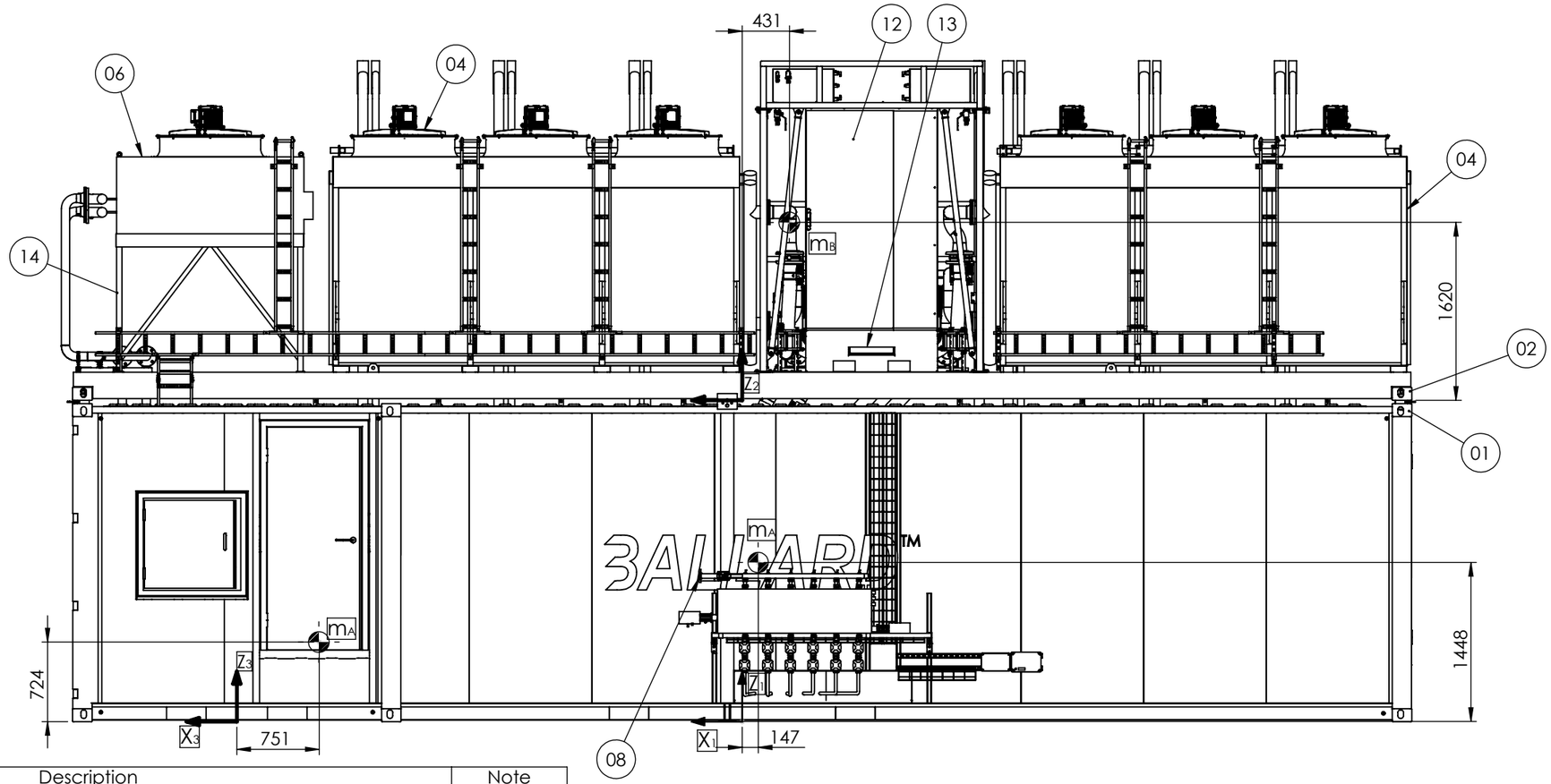
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Drawn	ASM	20-02-2024
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WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	9/14	1:50	601456B	9

FRONT VIEW - Center of Gravity
(LOOKING SOUTH)



	Description	Note
01	40ft High Cube Container	
02	40ft Custom Designed Flatbed	
03	10ft High Cube Container	
04	HT (High Temperature) Cooler - 1050kW (Evapco)	
05	High Temperature Coolant IN/OUT (CHS 114,3x3 [mm])	
06	LT (Low Temperature) Cooler - 110 kW (Evapco)	
07	Low Temperature Coolant IN/OUT (CHS 88,9x3 [mm])	
08	H2 supply interface - TP 010	CIP
09	Process exhaust (CHS 88,9x2 [mm])	
10	H2 Enclosure; Ventilation Exhaust (CHS 60,3x2 [mm])	
11	Ventilation Unit (Air Intake) - 40ft container	
12	Coolant System Electrical Cabinet	
13	Coolant System Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
14	Structure below LT Cooler	
15	Container Interconnect Cabling (750V DC)	
16	Container Interconnect Cabling (400V 3P-N-PE, Ethernet, Hardwired)	
17	Aux Power Supply Input (400V 3P-N-PE, 32A)	CIP
18	Customer Interface Cabling (Ethernet, Hardwired)	CIP
19	Drain interface - TP 015	CIP
20	~~Cover of hydrogen manifold~~	Optional
21	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
22	Customer MV Connection (6,6kV AC 3P, 92A)	CIP
23	Ventilation Unit (Air Intake) - 10ft container	
	CHS = Circular Hollow Section	
	CIP - Customer Interface Point	

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

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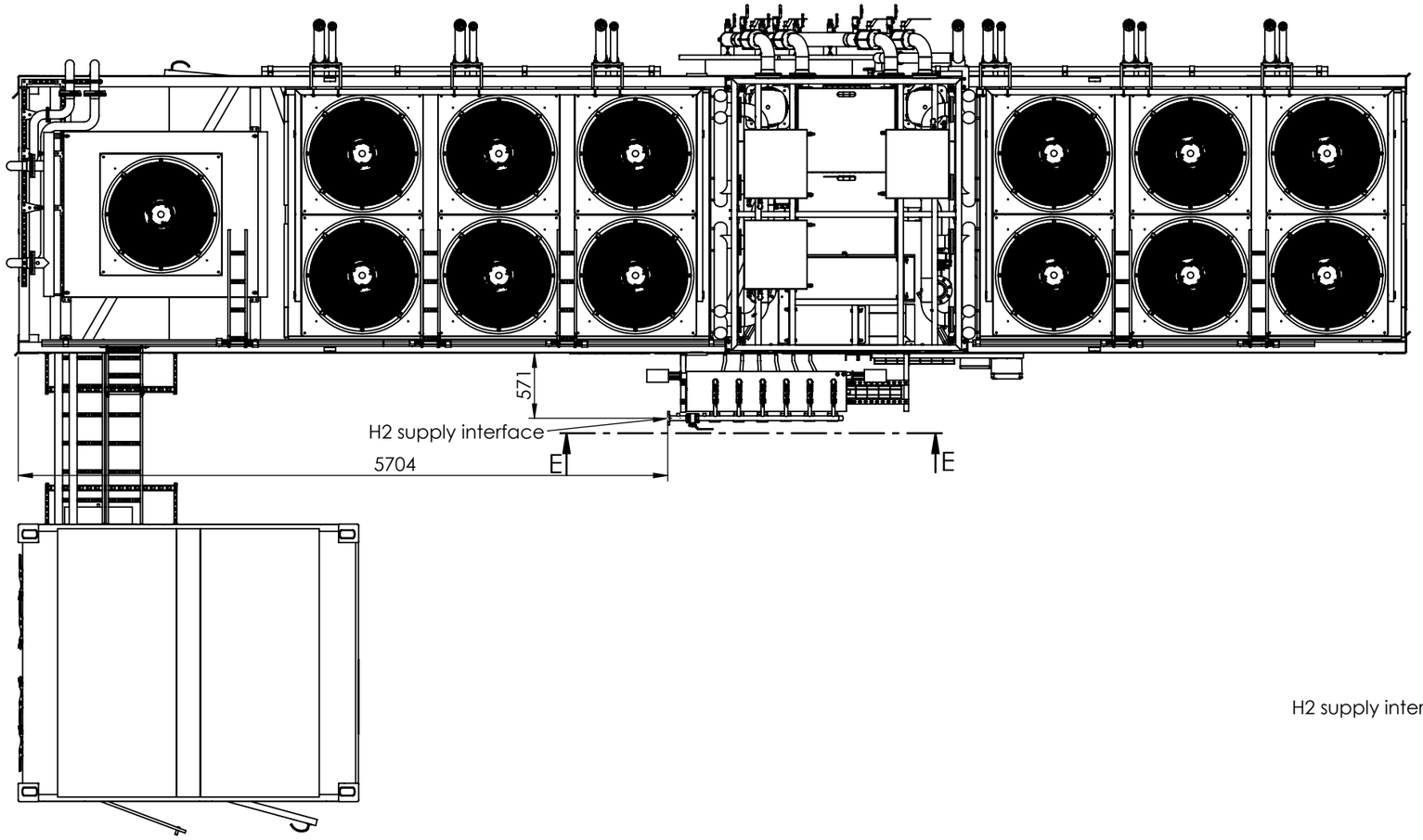
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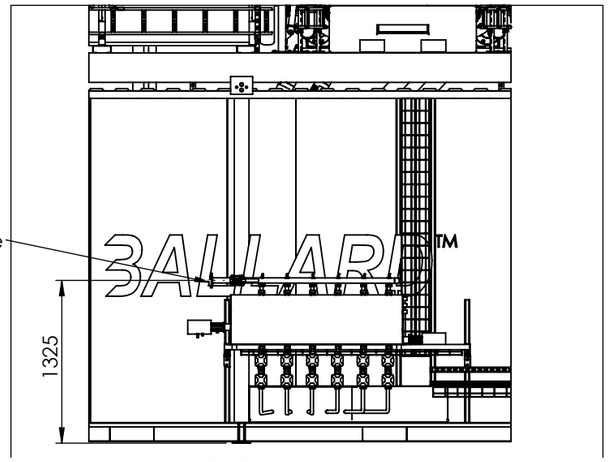
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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	10/14	1:50	601456B	9

TOP VIEW - H2 SUPPLY INTERFACE





SECTION E-E

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
08	H2 supply interface - TP 010	DN32	EN1759-1	300	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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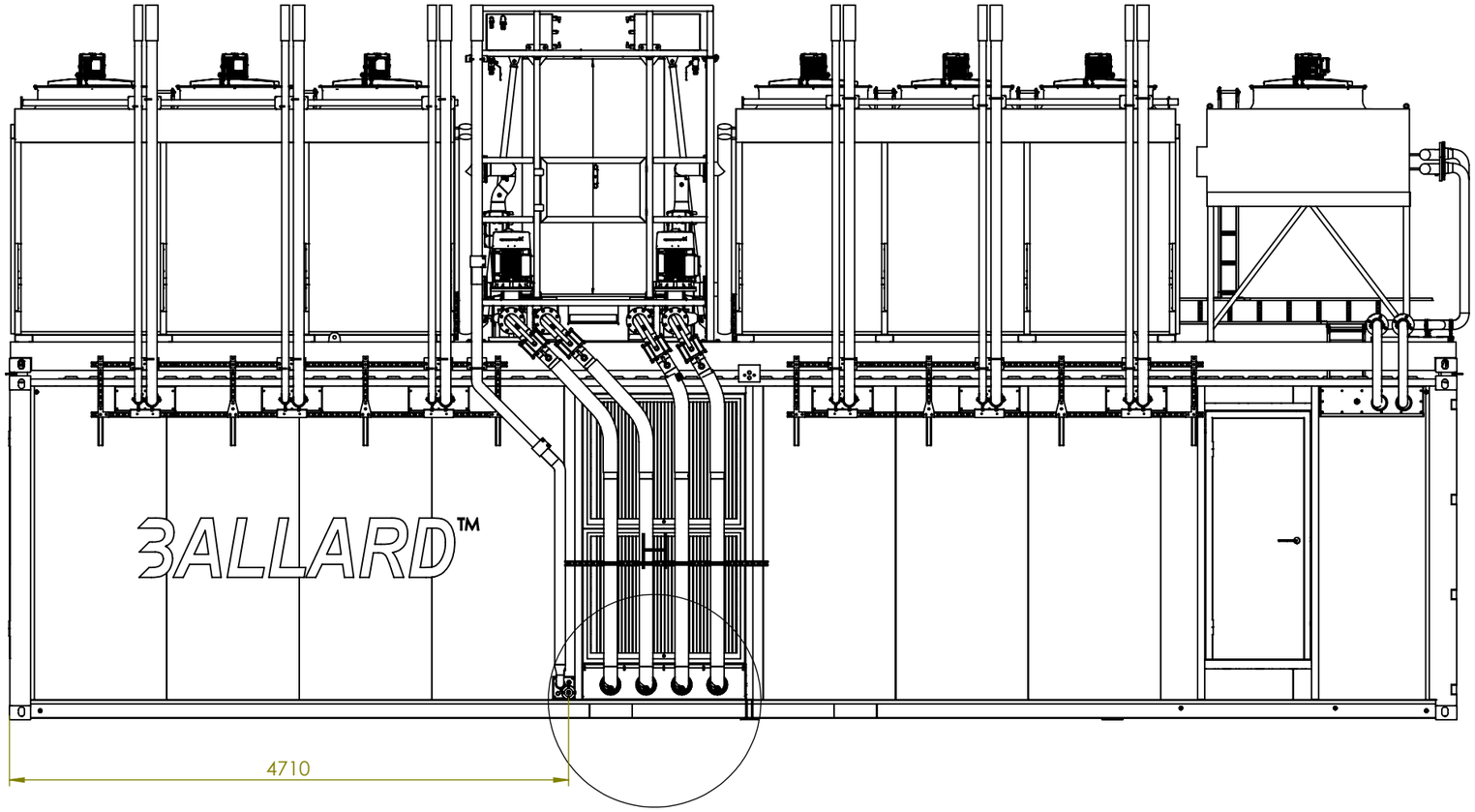
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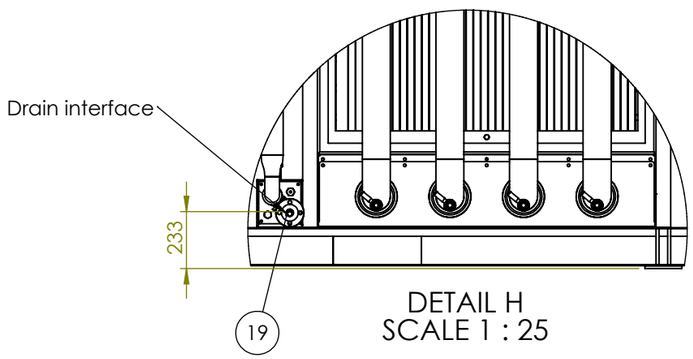
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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	11/14	1:50	601456B	9

FRONT VIEW LOOKING NORTH- DRAIN INTERFACE





DETAIL H
SCALE 1 : 25

Reference	Interface	Dimension	Flange Standard	Pressure class	Flange face	Material	Allowable nozzle loads
19	Drain interface - TP 015	1"	ASME B 16.5	150	RF	ANSI 316	50N*
* All interfacing flanges/connections must be fully supported and compensated for loads and moments.							

MATERIAL

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Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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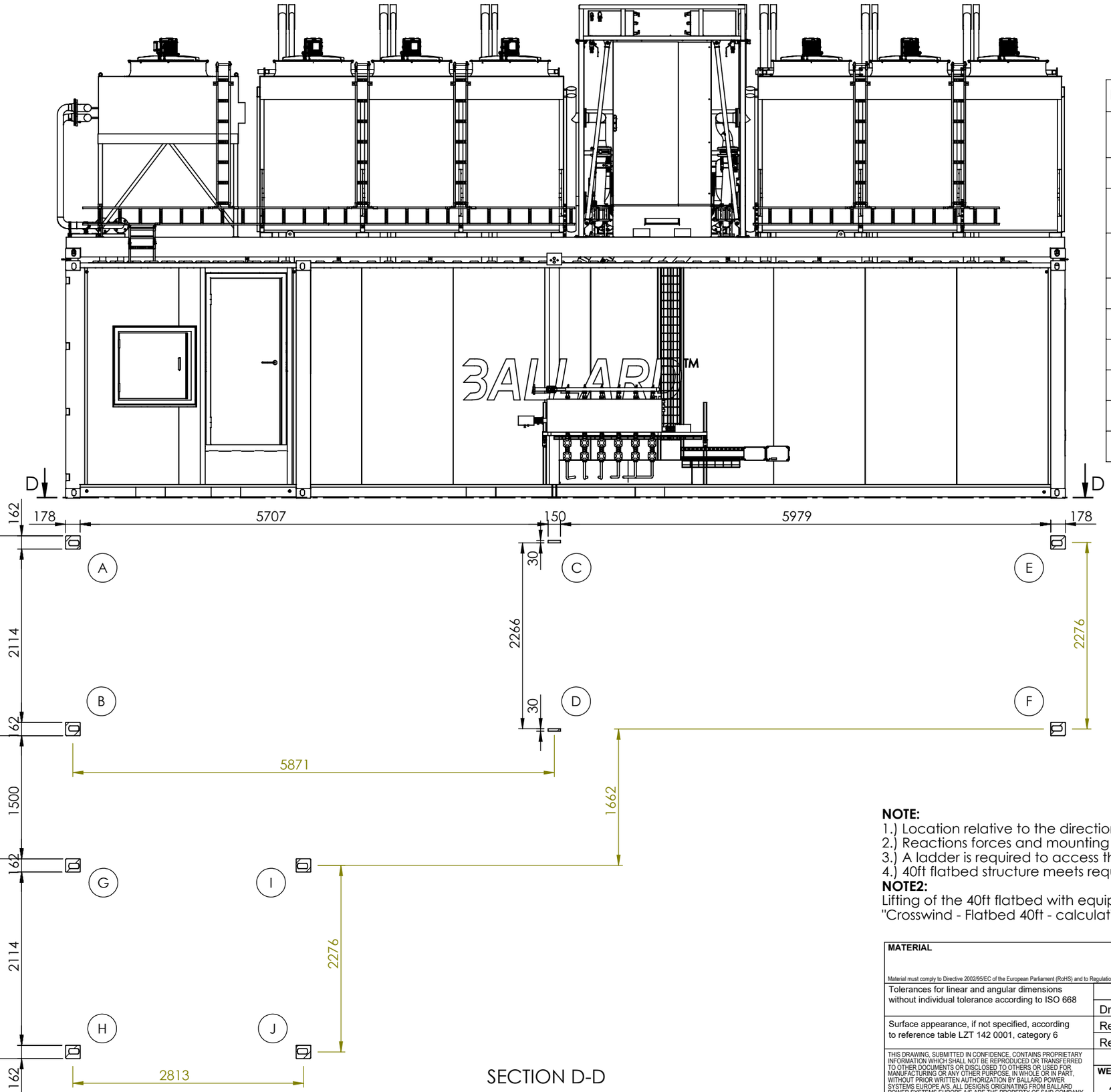
1st angle projection

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General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A3	12/14	1:50	601456B	9

REACTIONS BOTTOM



SECTION D-D

Pointer	Element description	Required support description
A	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
B	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
C	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
D	Support plate 12x30x150	Supporting plate 30x150 (blocked movement in direction Z) (no bolts, only compression reaction force)
E	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
F	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
G	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
H	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
I	Bottom right corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)
J	Bottom left corner - ISO1161	Standard Container Twist-Lock (blocked movement in directions X, Y, Z)

NOTE:
1.) Location relative to the directions of the world on the top view (sheet 3/14)
2.) Reactions forces and mounting details are described on sheets 13 and 14
3.) A ladder is required to access the platform above 40ft Container
4.) 40ft flatbed structure meets requirements of EN1090-2 - Execution class: EXC2.

NOTE2:
Lifting of the 40ft flatbed with equipment in accordance to guidelines specified in structural calculation report: "Crosswind - Flatbed 40ft - calculation report rev_1.pdf"

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and to Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

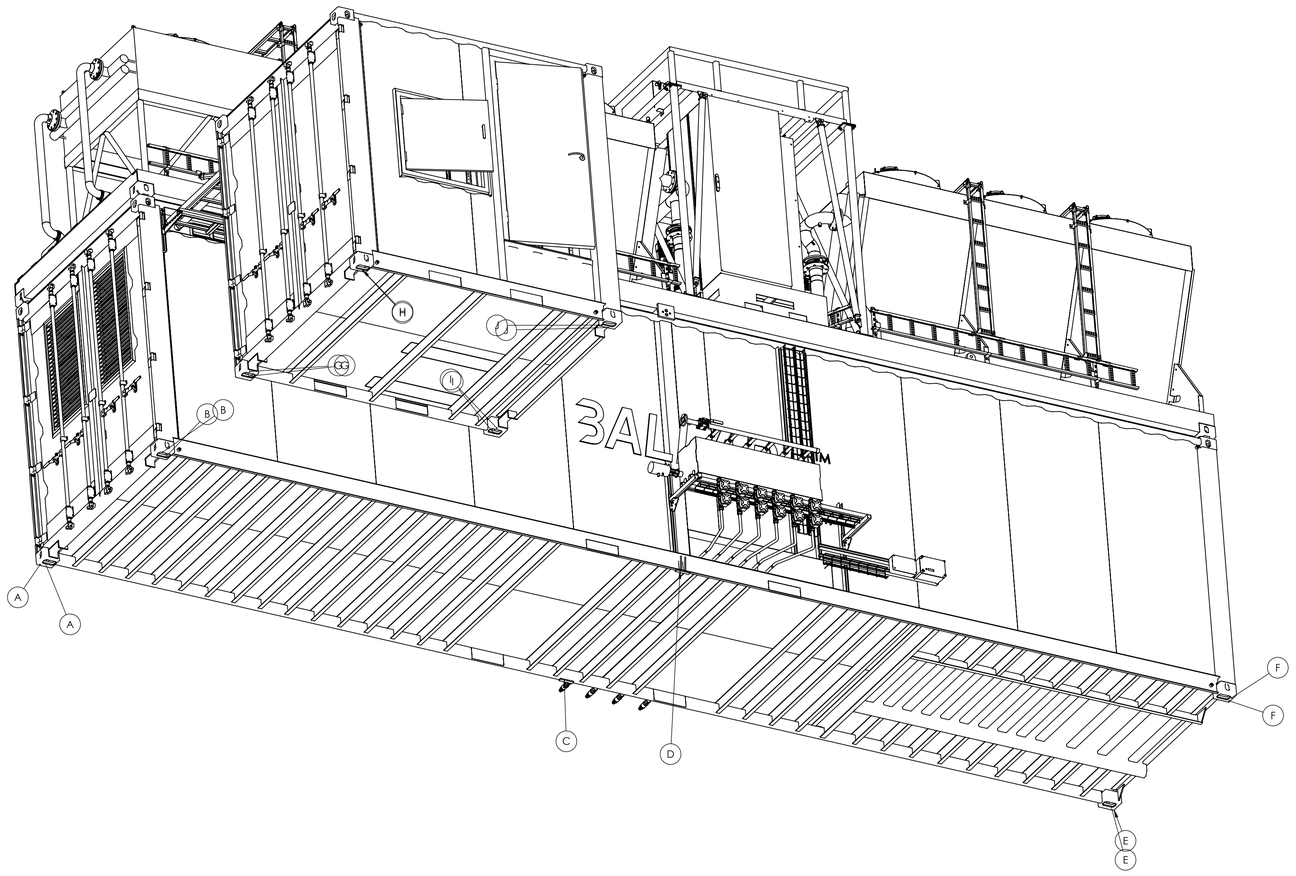
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Drawn	ASM	20-02-2024
Revision		
Released		

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General arrangement

WEIGHT		SIZE	SHEET	SCALE	PART NUMBER:	REVISION
24952954 g	1st angle projection	A3	13/14	1:50	601456B	9



40ft container							
Ultimate Limit State: LC5 - Lifting of 40ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-	-	126	A	-	-	125
B	-	-	133	B	-	-	134
C	-	-	-	C	-	-	-
D	-	-	-	D	-	-	-
E	-	-	133	E	-	-	134
F	-	-	128	F	-	-	128

40ft container							
Ultimate Limit State: LC5 - Lifting of 10ft container with full equipment							
LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]				LC5 - Lifting offshore vertical by 4 bottom ISO 1161 Corners (only 40ft container), [SF=2,34]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-	-	25	G	-	-	25
H	-	-	17	H	-	-	16
I	-	-	100	I	-	-	99
J	-	-	22	J	-	-	23

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
40ft container + 40ft flatbed (max self-weight) LC7 MAX-Sea transport on the barge Head sea, bow down, Y+ [Pitch case 1]				40ft container + 40ft flatbed (min self-weight) LC7 MIN-Sea transport on the barge Head sea, bow down, Y+ [Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	39	-75	-158	A	65	-72	-217
B	-103	-63	300	B	-76	-63	234
C	-	-	113	C	-	-	53
D	-	-	130	D	-	-	24
E	11	-42	27	E	-24	-60	-70
F	53	-83	138	F	35	-67	93
40ft container + 40ft flatbed (max self-weight) LC8 MAX-Sea transport on the barge Quatering sea, bow down, X+ Y+ [Quatering 1]				40ft container + 40ft flatbed (min self-weight) LC8 MIN-Sea transport on the barge Quatering sea, bow down, X+ Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-64	-39	-60	A	-42	-37	-98
B	-153	-49	263	B	-131	-50	207
C	-	-	101	C	-	-	34
D	-	-	127	D	-	-	41
E	-45	-33	30	E	-74	-48	-42
F	-37	-44	85	F	-52	-30	21
40ft container + 40ft flatbed (max self-weight) LC9 MAX-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]				40ft container + 40ft flatbed (min self-weight) LC9 MIN-Sea transport on the barge Beam sea, bow down, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-130	9	80	A	-111	10	48
B	-131	-12	141	B	-111	-13	90
C	-	-	99	C	-	-	31
D	-	-	124	D	-	-	47
E	-44	2	70	E	-70	-11	-10
F	-78	2	-4	F	-92	13	-41
40ft container + 40ft flatbed (max self-weight) LC10 MAX-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]				40ft container + 40ft flatbed (min self-weight) LC10 MIN-Sea transport on the barge Quatering sea, stern down, X+ Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-154	51	206	A	-132	53	172
B	-67	31	-6	B	-44	31	-65
C	-	-	105	C	-	-	30
D	-	-	126	D	-	-	49
E	-4	46	127	E	-32	32	61
F	-74	37	-39	F	-90	49	-82
40ft container + 40ft flatbed (max self-weight) LC11 MAX-Sea transport on the barge Head sea, stern down, Y- [Pitch case 2]				40ft container + 40ft flatbed (min self-weight) LC11 MIN-Sea transport on the barge Head sea, stern down, Y- [Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-104	68	265	A	-79	71	225
B	33	65	-126	B	61	64	-164
C	-	-	118	C	-	-	23
D	-	-	130	D	-	-	59
E	77	85	178	E	43	67	101
F	-6	43	-13	F	-26	59	-79
40ft container + 40ft flatbed (max self-weight) LC12 MAX-Sea transport on the barge Quatering sea, stern down, X-Y- [Quatering 3]				40ft container + 40ft flatbed (min self-weight) LC12 MIN-Sea transport on the barge Quatering sea, stern down, X- Y- [Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	0	33	161	A	22	35	129
B	88	51	-101	B	111	51	-166
C	-	-	118	C	-	-	41
D	-	-	120	D	-	-	51
E	129	75	164	E	101	61	99
F	81	6	60	F	66	19	10
40ft container + 40ft flatbed (max self-weight) LC13 MAX-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]				40ft container + 40ft flatbed (min self-weight) LC13 MIN-Sea transport on the barge Beam sea, bow down, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	69	-14	19	A	88	-13	-13
B	66	14	9	B	87	13	-31
C	-	-	115	C	-	-	47
D	-	-	117	D	-	-	40
E	126	39	120	E	100	25	60
F	122	-38	120	F	107	-27	83
40ft container + 40ft flatbed (max self-weight) LC14 MAX-Sea transport on the barge Quatering sea, stern down, X-Y+ [Quatering 4]				40ft container + 40ft flatbed (min self-weight) LC14 MIN-Sea transport on the barge Quatering sea, stern down, X- Y+ [Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	92	-57	-108	A	113	-55	-150
B	1	-29	170	B	24	-30	116
C	-	-	113	C	-	-	53
D	-	-	120	D	-	-	35
E	88	-5	70	E	59	-20	-5
F	119	-74	154	F	104	-61	116

10ft container (CROSSWIND)							
Ultimate Limit State: LC7-LC14 - Sea transport on barge							
10ft container (max self-weight) LC7 MAX-Sea transport on barge Head sea, bow down, Y+ [Pitch case 1]				10ft container (min self-weight) LC7 MIN-Sea transport on barge Head sea, bow down, Y+ [Pitch case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	3	-3	14	G	5	-7	1
H	-17	-19	15	H	-8	-11	5
I	11	-18	63	I	4	-16	7
J	2	-7	24	J	-1	-14	12
10ft container (max self-weight) LC8 MAX-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]				10ft container (min self-weight) LC8 MIN-Sea transport on barge Quatering sea, bow down, X+Y+ [Quatering 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	3	24	G	-21	0	13
H	-27	-26	14	H	-20	-19	6
I	-7	-12	52	I	-13	-10	6
J	-7	5	19	J	-10	-1	10
10ft container (max self-weight) LC9 MAX-Sea transport on barge Beam sea, X+ [Roll case 1]				10ft container (min self-weight) LC9 MIN-Sea transport on barge Beam sea, X+ [Roll case 1]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-33	10	29	G	-32	6	19
H	-27	-23	13	H	-21	-17	5
I	-13	-3	54	I	-19	-1	11
J	-9	16	13	J	-12	11	4
10ft container (max self-weight) LC10 MAX-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]				10ft container (min self-weight) LC10 MIN-Sea transport on barge Quatering sea, stern down, X+Y+ [Quatering 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-29	14	28	G	-28	11	17
H	-21	-15	11	H	-13	-8	3
I	-9	7	63	I	-15	9	17
J	-5	25	8	J	-8	20	-2
10ft container (max self-weight) LC11 MAX-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]				10ft container (min self-weight) LC11 MIN-Sea transport on barge Head sea, stern down, Y- [Pitch case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-8	14	19	G	-6	10	7
H	-6	-2	10	H	3	6	0
I	8	12	80	I	0	14	24
J	5	24	6	J	2	18	-6
10ft container (max self-weight) LC12 MAX-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]				10ft container (min self-weight) LC12 MIN-Sea transport on barge Quatering sea, stern down, X-Y- [Quatering 3]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	18	7	7	G	20	3	-3
H	6	5	10	H	13	12	1
I	25	7	84	I	19	8	37
J	15	12	9	J	12	6	0
10ft container (max self-weight) LC13 MAX-Sea transport on barge Beam sea, X- [Roll case 2]				10ft container (min self-weight) LC13 MIN-Sea transport on barge Beam sea, X- [Roll case 2]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	29	0	3	G	30	-3	8
H	6	3	11	H	13	9	3
I	31	-3	80	I	26	-1	37
J	17	0	15	J	14	-6	6
10ft container (max self-weight) LC14 MAX-Sea transport on barge Quatering sea, stern down, X-Y+ [Quatering 4]				10ft container (min self-weight) LC14 MIN-Sea transport on barge Quatering sea, stern down, X-Y+ [Quatering 4]			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	25	-4	4	G	26	-7	7
H	-1	-6	13	H	6	2	5
I	27	-12	73	I	21	-10	26
J	13	-8	21	J	10	14	11

40ft container + 40ft flatbed (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
40ft container + 40ft flatbed (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-67	2	58	A	-61	3	48
B	-69	-4	99	B	-63	-4	83
C	-	-	84	C	-	-	63
D	-	-	102	D	-	-	78
E	1	10	71	E	-7	6	51
F	-23	-8	20	F	-27	-4	9
40ft container + 40ft flatbed (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	65	-95	-260	A	71	-95	-275
B	-115	-82	362	B	-108	-81	347
C	-	-	103	C	-	-	92
D	-	-	105	D	-	-	80
E	-4	-65	-38	E	-12	-69	-61
F	53	-95	158	F	50	-92	149
40ft container + 40ft flatbed (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				40ft container + 40ft flatbed (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	16	-7	26	A	21	-6	17
B	13	6	39	B	19	6	21
C	-	-	97	C	-	-	76
D	-	-	102	D	-	-	78
E	69	24	91	E	61	20	72
F	60	-24	78	F	56	-20	66
40ft container + 40ft flatbed (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				40ft container + 40ft flatbed (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
A	-117	90	332	A	-111	91	323
B	60	83	-237	B	67	83	-257
C	-	-	98	C	-	-	76
D	-	-	119	D	-	-	106
E	73	98	189	E	65	94	172
F	-17	66	-72	F	-21	69	-88

10ft container (CROSSWIND)							
Ultimate Limit State: LC15-LC18 - destination place (Offshore)							
10ft container (max self-weight) LC15 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC15 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-28	16	32	G	-24	13	28
H	-8	-14	-1	H	-7	-11	-1
I	6	-25	38	I	2	-21	26
J	-7	23	22	J	-8	19	17
10ft container (max self-weight) LC16 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC16 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-19	0	4	G	-15	-4	0
H	-7	-26	13	H	-6	-23	13
I	21	-30	39	I	16	-26	27
J	6	7	36	J	4	3	31
10ft container (max self-weight) LC17 MAX-Destination place - Offshore Wind X+				10ft container (min self-weight) LC17 MIN-Destination place - Offshore Wind X+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-4	6	2	G	1	3	-2
H	6	-10	0	H	7	-7	1
I	27	-16	38	I	22	-12	56
J	8	19	21	J	7	15	16
10ft container (max self-weight) LC18 MAX-Destination place - Offshore Wind Y+				10ft container (min self-weight) LC18 MIN-Destination place - Offshore Wind Y+			
Reactions	X [kN]	Y [kN]	Z [kN]	Reactions	X [kN]	Y [kN]	Z [kN]
G	-23	28	35	G	-18	25	30
H	-2	2	-17	H	-1	5	-17
I	21	-10	60	I	17	-6	48
J	3	29	13	J	2	25	8

MATERIAL

Material must comply to Directive 2002/95/EC of the European Parliament (RoHS) and its Regulation (EC) No 1907/2006 of the European Parliament (Reach)

Tolerances for linear and angular dimensions without individual tolerance according to ISO 668

Surface appearance, if not specified, according to reference table LZT 142 0001, category 6

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	By	Date
Drawn	ASM	20-02-2024
Revision		
Released		

WEIGHT 24952954 g

1st angle projection

BALLARD™

General arrangement

SIZE	SHEET	SCALE	PART NUMBER:	REVISION
A1	14/14	1:30	601456B	9

Ballard Power Systems Europe A/S
Majsmarken 1
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Revision history		
Rev.	**Date.**	**Description**
001	30/05/2023	First Issue

KBR
ACCEPTANCE
FOR ENGINEERING USE

THIS DOCUMENT IS:

ACCEPTED	(Code 1)
ACCEPTED WITH COMMENTS	(Code 2)
NOT ACCEPTED	(Code 3)
NOT REVIEWED	(Code 4)

ACCEPTANCE DOES NOT RELIEVE SUPPLIER FROM FURNISHING MATERIAL IN CONFORMANCE WITH ORDER. REFER TO SDR-1 FOR FULL DEFINITION OF ACCEPTANCE CONDITIONS.

DISCIPLINE _____ BY _____
DATE _____

Document Title:	**BLPH Project - Piping Line List and Speciality Item List**
Document Number:	K559-2254-CWIWP4202202-C05-001
Revision:	Rev001
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-C05-001Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	C05
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Piping Class Overivew and Piping Line List

Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS

Table of Contents

Higher-Level Function	Mounting Location	Page	Page Description	Last Modified Date
		1	Document C05 Introduction	24-May-23
		2	Pre-planning: Pipe class overview : CustomerScope - DN32-PIPE	24-May-23
		3	P&I diagram: Piping overview : Hydrogen - Hydrogen	24-May-23

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	--.P09		
EPLAN Project Pages	49		
=	++	+	& D01

REVISION INFORMATION
DESCRIPTION
CO???????
DATE
24-May-23

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DRAWING	601456B-C05	REVISION	--.P09
DRAWING TITLE	EPLAN P8 Project, ???????		
SHEET TYPE/DESC	Document C05 Introduction		

ALL SHEETS ARE THE SAME REVISION STATUS | SIZE A3 | LANGUAGE EN | SHEET/TOTAL 1 / 3

Pre-planning: Pipe class overview

Pipe class		Description	Standard	Nominal pressure level	Material
1	CustomerScope	Piping is within Customer Scope	Customer Scope	Customer Scope	AISI 316 Suggested
2	DN25-PIPE	Seamless hydraulic pipe, acid-resistant	EN 10216-5, ASTM A269/A213	166 bar dynamic, 194 static (DIN2421)	AISI 316
3	DN32-PIPE	Seamless hydraulic pipe, acid-resistant	EN 10216-5, ASTM A269/A213	166 bar dynamic, 194 static (DIN2421)	AISI 316

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P&I diagram: Piping overview

F37_001-BPSE

Piping Name	From (Source)	To (Target)	Pipe Class	Length	Substance (Contents)	Pressure	Flow	Temperature	
-HKN70_H2	=HKN70-C01	=HA01+DA02-XM01	CustomerScope		Hydrogen	3,5 - 6,5 barg	0,9 - 29,4 g/s	-8,4 - 80°C	
-WP_H2900	=HA01+DA02-XM01	=HA01+DA02-QM00	DN32-PIPE		Hydrogen	3,5 - 6,5 barg	0,9 - 29,4 g/s	-8,4 - 80°C	
-WP_H2901	=HA01+DA02-QM04	=HA01+DA02-QM00	DN32-PIPE		Hydrogen	3,5 - 6,5 barg	0,9 - 29,4 g/s	-8,4 - 80°C	
-WP_H2902	=HA01+DA02-QM16	=HA01+DA02-QM26	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2903	=HA01+DA02-QM15	=HA01+DA02-QM25	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2904	=HA01+DA02-QM14	=HA01+DA02-QM24	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2905	=HA01+DA02-QM13	=HA01+DA02-QM23	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2906	=HA01+DA02-QM12	=HA01+DA02-QM22	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2907	=HA01+DA02-QM11	=HA01+DA02-QM21	DN25-PIPE	220 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2912	=HA01+DA02-QM26	=HA01+DA02-XT06	DN25-PIPE	5477 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2913	=HA01+DA02-QM25	=HA01+DA02-XT05	DN25-PIPE	4390 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2914	=HA01+DA02-QM24	=HA01+DA02-XT04	DN25-PIPE	3303 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2915	=HA01+DA02-QM23	=HA01+DA02-XT03	DN25-PIPE	3462 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2916	=HA01+DA02-QM22	=HA01+DA02-XT02	DN25-PIPE	4547 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2917	=HA01+DA02-QM21	=HA01+DA02-XT01	DN25-PIPE	5637 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2922	=HA01+DA02-XT06	=RE02+GB06-XM01	DN25-PIPE	5477 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2923	=HA01+DA02-XT05	=RE02+GB05-XM01	DN25-PIPE	4390 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2924	=HA01+DA02-XT04	=RE02+GB04-XM01	DN25-PIPE	3303 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2925	=HA01+DA02-XT03	=RE01+GB03-XM01	DN25-PIPE	3462 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2926	=HA01+DA02-XT02	=RE01+GB02-XM01	DN25-PIPE	4547 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2927	=HA01+DA02-XT01	=RE01+GB01-XM01	DN25-PIPE	5637 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2942	=HA01+DA02-QM16	=HA01+DA02-QM06	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2943	=HA01+DA02-QM15	=HA01+DA02-QM05	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2944	=HA01+DA02-QM14	=HA01+DA02-QM04	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2945	=HA01+DA02-QM13	=HA01+DA02-QM03	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2946	=HA01+DA02-QM12	=HA01+DA02-QM02	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	
-WP_H2947	=HA01+DA02-QM01	=HA01+DA02-QM11	DN25-PIPE	190 mm	Hydrogen	3,5-6,5 barg	<4,9 g/s	-8,4 - 80°C	

Reference Item Number	Ballard Part # TBD		
EPLAN Project Name	601456B - Shell Baseload Power Hub		
EPLAN Revision	--.P09		
EPLAN Project Pages	49		
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REVISION INFORMATION
DESCRIPTION
DATE
24-May-23

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DRAWING	601456B-C05	REVISION	--.P09
DRAWING TITLE			
SHEET TYPE/DESC	P&I diagram: Piping overview : Hydrogen - Hydrogen		
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A3	LANGUAGE EN	SHEET/TOTAL 3 / 3

Ballard Power Systems Europe A/S
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Revision history		
Rev.	**Date.**	**Description**
001	17/09/2024	First Issue

Document Title:	**BLPH Project - Performance Test Results (FAT)**
Document Number:	K559-2254-CWIWP4202202-K03-001
Revision:	Rev001
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-K03-001Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	K03
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Ballard Power Systems Europe A/S
Majsmarken 1
DK-9500 Hobro
K559-2254-CWIWP4202202-J08-002

Confirmation of Satisfactory FAT

Part No.	601456B-7002362 Incl. sub-assemblies: 601456B-7002973 601456B-7003716
Product name	FC PowerGen 1000kW
Serial No.	601456B

Ballard Power Systems Europe A/S confirms that the above-listed equipment has satisfactorily with comments undergone and passed the Factory Acceptance Test (FAT) according to

BLPH Project – Acceptance Test Procedure (FAT) [K559-2254-CWIWP4202202-J08-001]

BLPH Project - Test Matrix for FAT and SAT [K559-2254-CWIWP4202202-J99-002]

601456B Crosswind BLPH FAT punch list [K559-2254-CWIWP4202202-J08-003]

prior to the shipment.

CrossWind C.V. acknowledges that the Factory Acceptance Test (FAT) for the above-listed equipment was witnessed and confirms that the test was performed satisfactorily with comments, and all agreed-upon specifications have been met.

Signatures

Ballard Power Systems Europe A/S			
Signature:			
Name:	Mads Hjorth Andersen		
Title:	Project Manager	Date:	04-09-2024
CrossWind C.V.			
Signature:			
Name:	Martin Taylor		
Title:	Crosswind Commissioning Manager	Date:	04-09-2024
Inspector			
Signature:			
Name:	Luigi Pignatelli		
Title:	Inspector for Crosswind	Date:	04-09-2024

Note: This document serves as formal confirmation that the FAT has been successfully completed and witnessed, with both parties in agreement on the satisfactory results. It should be signed by authorized representatives of both parties.

Short Title	Megablock Witnessed Factory Acceptance Test - CrossWind
Full Title	Megablock Witnessed Factory Acceptance Test - CrossWind
Abstract	*A selection of the Factory Acceptance Tests of the CrossWind Megablock system with witnesses from the CrossWind, Shell, Rosetti Marino and a surveyor from Fulkrum (CrossWind).*

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Revision Record

Rev #	Description	Revised By	Date (dd-mm-yyyy)
-	Initial Release	RKN	27-02-2024
1	General updates	RKN	17-06-2024
1a	Updated with results	TAN	20/8-2024
2	Updated leak test procedure	TAN	30-08-2024
2a	Updated with results	TAN	30-08-2024
2b	Updated with leakage rates	MHA	02-09-2024

Luigi Signarelli
ON BEHALF OF CrossWind
DATE 4/9/2024 WR

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1.0 Executive Summary

This document outlines the tests to be included in the witnessed Factory Acceptance Test. These tests aim to show the overall functionality of the fuel cell-based power plant. The verification should show the capability of delivering the expected AC power and that the product is ready to be delivered and installed on site.

When the delegations from CrossWind, Shell, Rosetti Marino and the surveyor from Fulkrum (CrossWind) were at Ballard Europe, Hobro to witness the selection of Factory Acceptance Tests 4/12 tests were performed and passed. The remaining eight tests are to be performed later are the following:

- F18 H2 leakage test
- O01 System Start/stop
- O09 Load Test – Step response 0 to 35%
- O10 Load Test – step response 35% to 70%
- O11 Load Test – Step response 65 to 100%
- O12 Load Test – 100% stability test – 3 hours
- O13 Load Test – Step response 100% to 50%
- O14 Load Test – step response 50% to 0%

2.0 References

- PWR008 Ballard commissioning document
- EN 60204-1
- SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure
- SPC ID 0104 H2 Leak Test Procedure

3.0 Definitions and Acronyms

FC	FCwave™
H2	Hydrogen
FAT	Factory Acceptance Test
HT1	High temperature 1050kW cooling system
HT2	High temperature 1050kW cooling system
LT	Low temperature cooling system

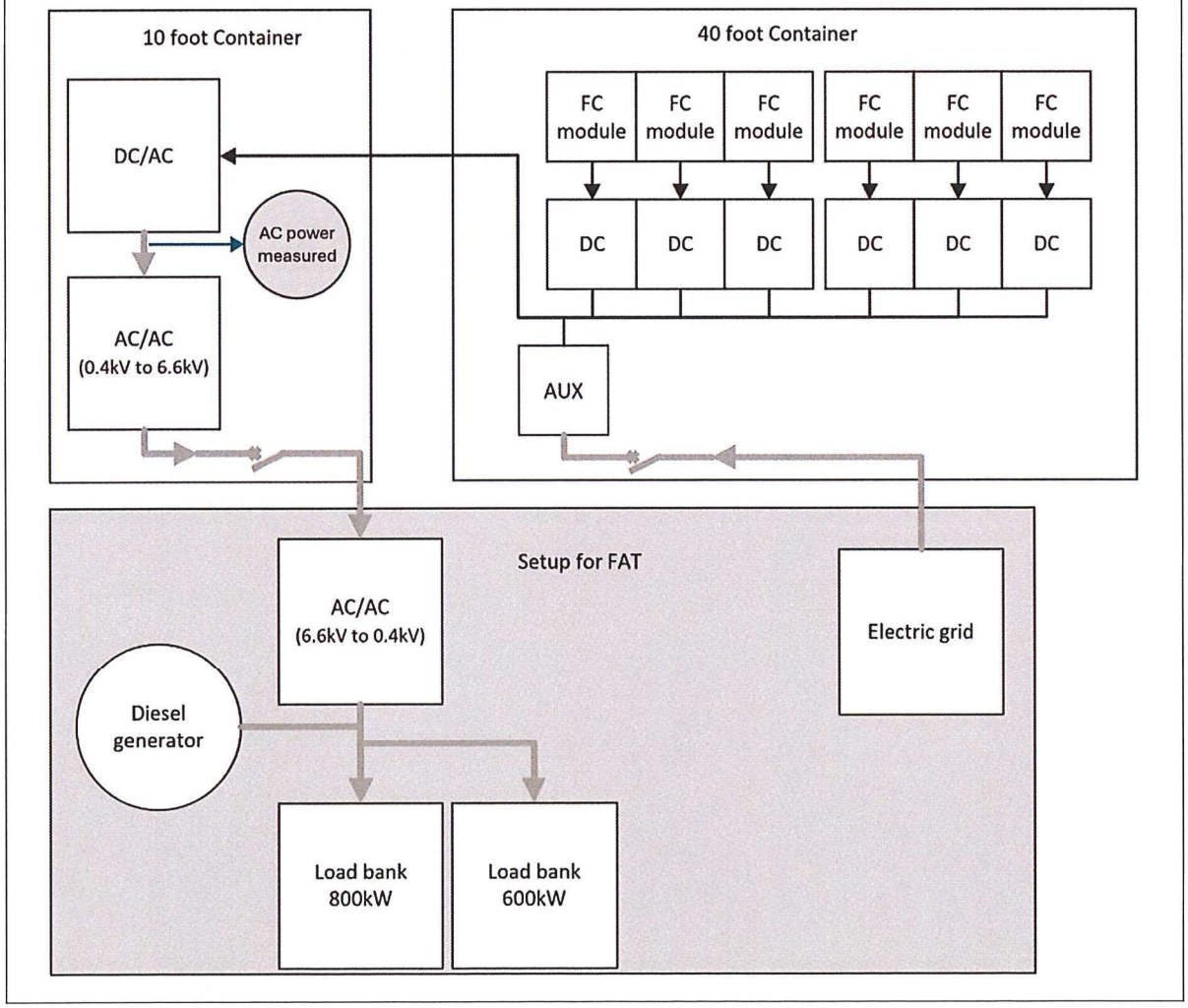
4.0 Objectives and Background

This document describes the witnessed Factory Acceptance Tests. The tests do not include the internal testing that has been done to secure product maturity, mechanical and electrical connections have been done correctly.

The scope of testing is:

- Go through the Megablock with the customer to find defects that needs to be corrected
- Safety systems are functioning correctly in a complete Megablock with coolers.
- Megablock produces AC current, and the tests shall verify the capability to produce AC current following the demand.

Figure 1: Megablock System test overview



5.0 Functional tests

5.1 F02 Visual inspection

5.1.1 Test

The test involves an examination of the paint job through visual inspection, assessing the overall build quality, and checking for any dents. The focus is also on evaluating the assembly quality to ensure compliance with weather resistance.

5.1.2 Relevant Standard / document

- No reference

5.1.3 Brief Test Plan

- Visual inspection with customer of full system meaning inside and outside container solution.
- Take comprehensive pictures of the full system and test setup, including close-ups of vital components, with timestamps for reference.

5.1.4 Pass/Fail criteria.

- Visual inspect with customer to review quality of full system.

5.1.5 Test Result

Table 1: Visual inspection – Test Result

Date tested	Item	Result	Pass/Fail	Notes
13/8-2024	Inspection of paint	Accepted	Pass	See item list for further elaboration
13/8-2024	Assessing build quality	Accepted	Pass	See item list for further elaboration
13/8-2024	Check for dents	Accepted	Pass	See item list for further elaboration

5.2 F07 Electrical safety test – 10-foot container

5.2.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

5.2.2 Relevant Standard / document

- EN 60204-1

5.2.3 Brief Test Plan

- According to EN 60204-1

5.2.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

5.2.5 Test Result

Table 2: Electrical safety test - Test results

Date tested	Item	Result	Pass/Fail	Notes
13/8-2024	Grounding Continuity	Accepted	Pass	-
13/8-2024	High Potential	Accepted	Pass	-

Table 3: Electrical safety test - calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
Metrel CE-Multitester	086-003	19/1-2025	Grounding Continuity and High Potential

5.3 F08 Electrical safety test – 40-foot container

5.3.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

5.3.2 Relevant Standard / document

- EN 60204-1

5.3.3 Brief Test Plan

- According to EN 60204-1

5.3.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

5.3.5 Test Result

Table 4: Electrical safety test - Test Result

Date tested	Item	Result	Pass/Fail	Notes
13/8-2024	Grounding Continuity	Accepted	Pass	-
13/8-2024	High Potential	Accepted	Pass	-

Table 5: Electrical safety test - Calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for
Metrel CE-Multitester	086-003	19/1-2025	Grounding Continuity and High Potential

5.4 F10 Safety

5.4.1 Test

Conduct tests of safety inputs and outputs, including emergency stop buttons, smoke detectors, gas detectors and external connections.

5.4.2 Relevant Standard / document

- Safety input checklist according to EN/ISO 13849-2 procedure

5.4.3 Brief Test Plan

- Trigger each safety input according to checklist.
  - Emergency pushbuttons
  - Smoke detectors test
  - H2 sensor test
  - External safety switches
  - External feedback

5.4.4 Pass/Fail criteria.

- Verified according to checklist.
- Each item triggers the correct alarm

5.4.5 Test Result

Table 6: Safety - Test Result

Date tested	Item	Result	Pass/Fail	Notes
13/8-2024	Emergency pushbuttons	OK	Pass	-
13/8-2024	Smoke detectors	OK	Pass	3 sensors in 40ft container and 1 sensor in 10 ft container
13/8-2024	H2 sensors	OK	Pass	3 sensors in 40ft container
13/8-2024	External safety switches	OK	Pass	-
13/8-2024	External feedback	OK	Pass	-

Table 7: Safety - Calibration Equipment

Unit	Equipment number	Calibration due date	Equipment used for
Dräger calibration gas, 2% Hydrogen	Cylinder No: 955-657732	Valid until 10/1-2029	H2 sensors

5.5 F18 H_2 Leakage test

5.5.1 Test procedure

All pipework and H2 instrumentation subassemblies must be inspected, recorded, verified and pass in accordance with the procedure in section 5.4 in *SPC ID 0104 H2 Leak Test Procedure Rev 002* prior to full system FAT.

System H2 leakage test is done system pressure decay test, according to section 5.5 in *SPC ID 0104 H2 Leak Test Procedure Rev 002.*

5.5.2 Pass/Fail criteria.

Pressure decay test with a maximum leakage no greater than specified in test procedure.

Result details are documented in the template *SPC ID 0204 System pressure decay test template*

Parameter	Value	Description
L_A [Nm^3/h]	**2,72 – 3,58 x10^{-3}**	**Maximum allowed pressure decay to pass pressure decay test, where L_A = L_S + L_Mu**
L_S [Nm^3/h]	0	Summarized expected leak rates of all components in the system (per design leak rate).
L_Mu [Nm^3/h]	2,72 – 3,58 x10^{-3}	Calculated accuracy of the measuring system, used to perform the test.
L_C [Nm^3/h]	2,7x10^{-5}	Maximum allowed leak rate for a given pipe section, where integrity/operability of the system may be maintained safely

5.5.3 Test Result

Table 8: H2 leakage - Test Result

Date tested	Item	Leakage rate L_1 [Nm^3/h]	Pass/Fail	Notes
3/9-2024	H2 line 1	4.03E-05	Pass	-
3/9-2024	H2 line 2	8.06E-05	Pass	-
3/9-2024	H2 line 3	0.00E+00	Pass	-
3/9-2024	H2 line 4	1.60E-04	Pass	-
3/9-2024	H2 line 5	7.27E-05	Pass	-
3/9-2024	H2 line 6	-8.16E-05	Pass	-

6.0 Operational tests

Operations are done using operator HMI or remote HMI in normal operating mode.

6.1 O01 System Start/Stop - Normal low load operation.

6.1.1 Test

Fuel Cell system can start, deliver minimum power and perform controlled stop without faults. This test is based on DC power.

6.1.2 Relevant Standard / document

- No reference

6.1.3 Brief Test Plan

- All FC in standby
- Request 100kW DC
- Delay 120 seconds
- Request zero power
- Repeat with new preferred FC until all tested.

6.1.4 Pass/Fail criteria.

- Fuel Cell Package starts without faults.
- No persistent system alarms.
- Correct available power signal.
- DC Power output within +/-5% and stable in less than 60 seconds
- Fuel Cell Package stops without faults.
- FC in stand-by in less than 30 seconds.

6.1.5 Test Result

Table 9: System Start/Stop – Normal low load operation - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3/9-2024	FCwave 1	All pass criterias passed except time to standby	Pass with note	Shut down to standby longer than 30 seconds
3/9-2024	FCwave 2	All pass criterias passed except time to standby	Pass with note	Shut down to standby took 58 seconds. Power output dipped to 82 kW during the test.
3/9-2024	FCwave 3	All pass criterias passed except time to standby	Pass with note	Shut down to standby took 55 seconds.
3/9-2024	FCwave 4	All pass criterias passed except time to standby	Pass with note	Shut down to standby took 59 seconds.
3/9-2024	FCwave 5	All pass criterias passed except time to standby	Pass with note	Shut down to standby took 57 seconds.
3/9-2024	FCwave 6	All pass criterias passed except time to standby	Pass with note	Shut down to standby took 1 minute 3 seconds.

6.2 O09 Load Test – step response 0 to 35%

6.2.1 Test

Test step response by adding 35% load in one step from no load while measuring AC power quality.

6.2.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.2.3 Brief Test Plan

- All FC in stand-by.
- Apply set point by requesting 350kW AC

6.2.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Startup time < curve+5 seconds at any FC.
- AC power quality within SPC ID 107
- No persistent system alarms.

6.2.5 Test Result

Table 10: Load Test - step response 0 to 35% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3/9-2024	Step response 0-35%	45 seconds for start-up 0-350kW AC. Slight overshoot on 30 kW AC	Pass	With reference to document C08 it is estimated that a ramp time to 500 kW is 75 seconds.
3/9-2024	AC power quality	2,8-2,9% VAC THD 2-50 No alarms	Pass	

6.3 O10 Load Test – step response 35% to 70%

6.3.1 Test

Test step response by adding 35% load in one step to reach 70% load while measuring AC power quality.

6.3.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.3.3 Brief Test Plan

- 3 FC running delivering 350kW AC steady state.
- 2 FC in stand-by
- Apply set point by requesting 700kW AC power.

6.3.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Startup time < curve+5 seconds at any FC
- AC power quality within SPC ID 107
- No persistent system alarms.

6.3.5 Test Result

Table 11: Load Test - step response 35% to 70% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3/9-2024	Step response 35%-70%	All 3 started up. 23 seconds startup time	Pass	With reference to document C08 it is estimated that a ramp time from 250 kW to 750 kW is 45 seconds.
3/9-2024	AC power quality	2,8-3,0 % VAC THD 2-50 No alarms	Pass	

6.4 O11 Load Test – step response 65% to 100%

6.4.1 Test

Test step response by adding 35% load in one step to reach full load while measuring AC power quality.

6.4.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.4.3 Brief Test Plan

- 6 FC running delivering 650kW AC steady state.
- Apply set point by requesting 1000kW AC power.

6.4.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Startup time < curve+5 seconds at any FC.
- AC power quality within SPC ID 107
- No persistent system alarms.

6.4.5 Test Result

Table 12: Load Test - step response 65% to 100% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3/9-2024	Step response 65%-100%	18 seconds startup time	Pass	With reference to document C08 it is estimated that a ramp time from 250 kW to 750 kW is 45 seconds.
3/9-2024	AC power quality	3,0-3,1 % VAC THD 2-50 No alarms	Pass	

6.5 O12 Load Test – 100% stability test - 3 hours.

6.5.1 Test

Test steady state at 100% load for 3 hours while measuring power quality.

6.5.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.5.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.

6.5.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Shutdown time < curve+5 seconds at any FC.
- AC power quality within SPC ID 107
- No persistent system alarms.

6.5.5 Test Result

Table 13: Load Test – Steady state 100% load - Test Result

Date tested	Item	Result	Pass/Fail	Notes
04-09-24	Full load test	1000 kW for 3 hours	Pass	See below
04-09-24	AC power quality	2.3-3.6 % VAC THD 2-50 No alarms	Pass	

- Following added to document 05/09/2024
- In agreement with customer, after half elapsed time of the test, BOP load was increased to maximum by the following:
  - All HT fans forced to 100%
  - HT Coolant pumps forced to 70%
  - Ventilation (40ft+10ft) increased to 100%
- No impact on power delivery was observed.

6.6 O13 Load Test – step response 100% to 50%

6.6.1 Test

Test step response by removing 50% load in one step at full load while measuring power quality.

6.6.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.6.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.
- Request 500kW AC.

6.6.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Shutdown time < curve+5 seconds at any FC.
- AC power quality within SPC ID 107
- No persistent system alarms.

6.6.5 Test Result

Table 14: Load Test - step response 100% to 50% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
3/9-2024	Step response 100%-50%	Ramp down in 15 seconds	Pass	Wit reference to document C08 it is estimated that a ramp down time from 800 kW to 200 kW is 15 seconds.
3/9-2024	AC power quality	3,0-2,6 % VAC THD 2-50 No alarms	Pass	

6.7 O14 Load Test – step response 50% to 0%

6.7.1 Test

Test step response by removing 50% load in one step to no load while measuring AC power quality.

6.7.2 Relevant Standard / document

- SPC ID 0107 Power Quality Measurement Test Procedure

6.7.3 Brief Test Plan

- 3 FC running delivering 500kW AC.
- Request 0% and apply set point.

6.7.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- FC: Shutdown time < curve+5 seconds at any FC.
- AC power quality within SPC ID 107
- No persistent system alarms.

6.7.5 Test Result

Table 15: Load Test - step response 50% to 0% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
03-09-2024	Step response 50%-0%		Pass	Test is executed with 6 FC instead of 3 as the plan describes
—	AC power quality	NA	NA	Not applicable due to the unit not producing power

ON BEHALF OF Ballard
DATE 6/9/2024 WR

SPC ID 0203 Pipework inspection and leakage test check sheet

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Checked by: MHA	Date: 29/08-2024
Approved by: MHA	Date: 30/08-2024

Project	601456B Crosswind BLPH
Date	30-08-2024
Identification of piping system (photo or P&ID) [✓ or -]	✓
Inspected by	MKD
Document Approved by	MFO
Filing date	02-09-2024

Follow the procedure in section 5.4 of *SPC ID 0104 Leakage Test Procedure*

*=Pass criteria according to inspection tool user instruction

**=Calculated value based on allowable leakage rate plus sniffing tool uncertainty

*** Not applicable due to refitting/preswaging of joint/Not a ferrule fitting

		Visual inspection	Gauge Inspection*	Auditorial inspection	Sniffing inspection		Overall result
Item type	**Item ID**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass criteria** [PPM]**	**[Pass/fail]**
H2 heater, String 1	1-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 1	1-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 3	3-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 5	5-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CUA-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater string 1,2,3 Inlet

M: Manifold
H: Heater
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.





H2 Heater string 4,5,6 Inlet



H2 Heater string 1,2,3,4,5,6 Shut-off Valve & Pipes

M: Manifold
H: Heater
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.





SPC ID 0203 Pipework inspection and leakage test check sheet

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Revision Record

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-	Initial Draft	TAN	21-08-2024
1	Released	TAN	30-8-2024

Checked by: MHA	Date: 29/08-2024
Approved by: MHA	Date: 30/08-2024

Project	601456B Crosswind BLPH
Date	30-08-2024
Identification of piping system (photo or P&ID) [✓ or -]	✓
Inspected by	MKD
Document Approved by	MFO
Filing date	02-09-2024

Follow the procedure in section 5.4 of *SPC ID 0104 Leakage Test Procedure*

*=Pass criteria according to inspection tool user instruction

**=Calculated value based on expected leakage rate plus sniffing tool uncertainty

*** Not applicable due to refitting/preswaging of joint/Not a ferrule fitting

		Visual inspection	Gauge Inspection*	Auditorial inspection	Sniffing inspection		Overall result
Item type	**Item ID**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass criteria** [PPM]**	**[Pass/fail]**
H2 Heater+Container, String 1	1-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 1	1-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 2	2-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 2	2-C-CUR-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater+Container, String 3	3-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 3	3-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 4	4-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 4	4-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 5	5-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 5	5-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 6	6-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 6	6-C-CUR-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater+Container string 1,2,3,4,5,6



M: Manifold
H: Heater
C: Container
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.

H2 Container pipe to FCwave



M: Manifold
H: Heater
C: Container
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.

SPC ID 0204 System Pressure Decay Test Template

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-	Initial Draft	TAN	21-08-2024
1	Released	TAN	30-08-2024
2	Updated	TAN	09-09-2024

Purpose	Pressure decay test template for recording tightness and evaluating system pipework integrity
Reference procedure	SPC ID 0104 rev 002 H2 Leak Test Procedure

Checked by	MHA	Date: 09/09-2024
Approved by	MHA	Date: 09/09-2024

Title	System Pressure Decay, Complete Assembly, Crosswind
Project	601456B Crosswind BLPH
Test date	03-09-2024
Identification of piping system (photo or P&ID) [✓ or -]	✓ see Sheet "P&ID"

Test volume	String 1 HA01+DA02-QM01 to YV_H30 solenoid valve in FCwave 1. Similar valves for string 2-6.
Test fluid/gas	Hydrogen
Test location	Crosswind Container, Majsmarken 1, 9500 Hobro Denmark
Test performed by	TAN
Results approved by	MHA
Filing date	09-09-2024

L_S - Expected leak rate for pipework system							
Ferrule fittings tightness tolerance	< 0		bar				
Bonded seal tightness tolerance	< 0		bar				
L_S total*	= 0		bar				
L_S total	=	0	NM3/h				
L_Mu - Measuring system uncertainty							
pressure gauge uncertainty							
transmitter FS (full scale)	=	16	barg				
Linearity	<	0.2	% of FS	=	<	32	mbar
Non-repeatability	<	0.1	% of FS	=	<	16	mbar
Analogue input	±	10	microA	=		10	mbar/10 minutes
Accuracy ±0.25% actual reading	±	32.5	microA		=	32.5	mbar
Temperature uncertainty (3 Kelvin)				=	±	82	mbar/10 minutes
L_Mu total					=	172.5	mbar
*=All joints and valves are considered to be classified "enhanced tightness". Hence zero allowable leak rate							

Calculation of L_Mu, measuring system uncertainty

	V	T0	T1	T2	P0	P1	P2	Pa1	Pa2	t	L_Mu
	M3	°C	°C	°C	kPa	barg	barg	kPa	kPa	minutes	NM3/h
String 1	3.46E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	3.53E-03
String 2	3.05E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	3.12E-03

String 3	2.67E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	2.72E-03
String 4	2.74E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	2.80E-03
String 5	3.12E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	3.19E-03
String 6	3.50E-03	15	15	15	101.325	7.150	6.978	101.325	101.325	10	3.58E-03

Calculation of L_A, max evaluated leak rate for pipework system acceptance

	L_S	L_Mu		L_A
	NM3/h	NM3/h		NM3/h
String 1	0	3.53E-03	=	3.53E-03
String 2	0	3.12E-03	=	3.12E-03
String 3	0	2.72E-03	=	2.72E-03
String 4	0	2.80E-03	=	2.80E-03
String 5	0	3.19E-03	=	3.19E-03
String 6	0	3.58E-03	=	3.58E-03

Procedure

Fill in design pressure =	6.5	barg
The Test Pressure is 1.1 times design pressure or above =	7.15	barg
If the system previosly has been leakage tested with formier gas, this test can also use the used gas for operation		
To perform the test follow "Sequence" paragraph 5.5.3 in SPC 0104 H2 Leak Test Procedure		

Calculation of L1, actual leak rate

	V	T0	T1	T2	P0	P1	P2	Pa1	Pa2	t	L1 (gas leakage rate)
	M3	°C	°C	°C	kPa	barg	barg	kPa	kPa	minutes	NM3/h
String 1	0.003458573	15	19.7	19.7	101.325	7.494	7.492	1015	1015	10	4.03E-05
String 2	0.003458573	15	19.7	19.7	101.325	7.578	7.574	1015	1015	10	8.06E-05
String 3	0.002666793	15	19.7	19.7	101.325	7.95	7.95	1015	1015	10	0.00E+00
String 4	0.002741607	15	19.7	19.7	101.325	7.552	7.542	1015	1015	10	1.60E-04
String 5	0.003120525	15	19.7	19.7	101.325	7.452	7.448	1015	1015	10	7.27E-05
String 6	0.003500483	15	19.7	19.7	101.325	7.28	7.284	1015	1015	10	-8.16E-05

Sensor	Sensor placement
Temperature sensor T1 & T2	BT01 Sensor in H2 heater
Pressure sensor P1 & P2	FCwave pressure inlet sensor
Atmospheric pressure Pa1 & Pa2	Data from https://www.dmi.dk/maalinger/show/DK/2620167/Hobro/

Result of test

	L1	<	L_A	Pass (Below acceptance criteria L_A)
	NM3/h		NM3/h	Pass/Fail
String 1	4.03E-05	<	3.53E-03	Pass
String 2	8.06E-05	<	3.12E-03	Pass
String 3	0.00E+00	<	2.72E-03	Pass
String 4	1.60E-04	<	2.80E-03	Pass
String 5	7.27E-05	<	3.19E-03	Pass
String 6	-8.16E-05	<	3.58E-03	Pass

Title: System Pressure Decay, Complete Assembly, CrossWind
P&ID of Hydrogen Supply system

SPC ID: 0204
Revision: 2

Printed on: 09-09-2024

Hydrogen Supply System - Fuel Cells 1-6

=RE01
Fuel Cell System 1

+GB01
FCwave 1

-XM01
20mm
H2 Supply Inlet

-WP_H2927
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

+GB02
FCwave 2

-XM01
20mm
H2 Supply Inlet

-WP_H2926
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

+GB03
FCwave 3

-XM01
20mm
H2 Supply Inlet

-WP_H2925
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

=RE02
Fuel Cell System 2

+GB04
FCwave 4

-XM01
20mm
H2 Supply Inlet

-WP_H2924
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

+GB05
FCwave 5

-XM01
20mm
H2 Supply Inlet

-WP_H2923
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

+GB06
FCwave 6

-XM01
20mm
H2 Supply Inlet

-WP_H2922
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

=HA01+DA02
Hydrogen Supply System, Container #1 Outside

-XT01
Wall pass-through

-WP_H2917
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-XT02
Wall pass-through

-WP_H2916
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-XT03
Wall pass-through

-WP_H2915
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-XT04
Wall pass-through

-WP_H2914
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-XT05
Wall pass-through

-WP_H2913
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-XT06
Wall pass-through

-WP_H2912
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

Y V
QM21

=HA01+DA02-QM21
DN20
Shut-off valve

Y V
QM22

=HA01+DA02-QM22
DN20
Shut-off valve

Y V
QM23

=HA01+DA02-QM23
DN20
Shut-off valve

Y V
QM24

=HA01+DA02-QM24
DN20
Shut-off valve

Y V
QM25

=HA01+DA02-QM25
DN20
Shut-off valve

Y V
QM26

=HA01+DA02-QM26
DN20
Shut-off valve

-WP_H2907
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2906
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2905
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2904
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2903
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2902
Hydrogen
3.5-4.5 barg
-5.4 - 80°C
<4.9 g/s

Y V
QM11

=HA01+DA02-QM11
DN20
Shut-off Valve

Y V
QM12

=HA01+DA02-QM12
DN20
Shut-off Valve

Y V
QM13

=HA01+DA02-QM13
DN20
Shut-off Valve

Y V
QM14

=HA01+DA02-QM14
DN20
Shut-off Valve

Y V
QM15

=HA01+DA02-QM15
DN20
Shut-off Valve

Y V
QM16

=HA01+DA02-QM16
DN20
Shut-off Valve

-BL01
SI = 11 mm
Ex Point Liquid Detection

BT01
PT1000 -40...150 °C
Liquid Temperature Sensor

-CM01
SS316, Volume 146L
Hydrogen Heater Vessel

-WP01
DN25, 3000m
Tube Coil

-WP02
DN25, 3000m
Tube Coil

-WP03
DN25, 3000m
Tube Coil

-WP04
DN25, 3000m
Tube Coil

-WP05
DN25, 3000m
Tube Coil

-WP06
DN25, 3000m
Tube Coil

-EA01
3x400V, 9kW, Ex
Heating Element 1

-EA02
3x400V, 9kW, Ex
Heating Element 2

-WP_H2947
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2946
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2945
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2944
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2943
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

-WP_H2942
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
<4.9 g/s

H

=HA01+DA02-QM01
DN25
Isolation Valve, Lockable

H

=HA01+DA02-QM02
DN25
Isolation Valve, Lockable

H

=HA01+DA02-QM03
DN25
Isolation Valve, Lockable

H

=HA01+DA02-QM04
DN25
Isolation Valve, Lockable

H

=HA01+DA02-QM05
DN25
Isolation Valve, Lockable

H

=HA01+DA02-QM06
DN25
Isolation Valve, Lockable

=HKN70
Baseload Power Hub, Hydrogen Supply

0.5 - 25.4 g/s
-5.4 - 80°C
3.5 - 4.5 barg
Hydrogen

=HA01+DA02-XM01
DN32 ASME B16.5
H2 Supply Connection

P T
BT01

=HA01+DA02-BP01
0...10 barg
Hydrogen Inlet
Pressure Transmitter

-WP_H2900
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
0.5 - 25.4 g/s

H

=HA01+DA02-QM00
DN32
Manual shutoff valve
Lockable

-WP_H2901
Hydrogen
3.5 - 4.5 barg
-5.4 - 80°C
0.5 - 25.4 g/s

Reference Item Number	Ballard Part # TBD
EPLAN Project Name	6014568 - Shell Baseload Power Hub
EPLAN Revision	-.P13
EPLAN Project Pages	319
=	+ + + & 802

REVISION INFORMATION	
DESCRIPTION	
DATE	08-Mar-24

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DRAWING	6014568 C03 Process and Instrumentation Diagram
REVISION	-.P13
DRAWING TITLE	Crosswind/Shell Baseload Power Hub, Fuel Cell Container 1MW, no BESS
SHEET TYPE/DESC	Hydrogen Supply System
ALL SHEETS ARE THE SAME REVISION STATUS	SIZE A1
LANGUAGE EN	SHEET/TOTAL 4 / 14

FRMS110653/08

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	13-08-2024
Test location	Crosswind Containers, Majsmarken 1, 9500 Hobro, Denmark
Test performed by	PBL & TAN

Grounding continuity

EN 60204-1:2018 - Section 18.2.2 - Test 1

Test performed with a test current of 10A

Main location	Location	Measurement	Unit
40ft container	Busbar to busbar	0.024	Ohm
	Module 1	0.018	Ohm
	DC/DC cabinet 1	0.023	Ohm
	Module 2	0.024	Ohm
	DC/DC cabinet 2	0.019	Ohm
	Module 3	0.026	Ohm
	DC/DC cabinet 3	0.016	Ohm
	Module 4	0.026	Ohm
	DC/DC cabinet 4	0.016	Ohm
	Module 5	0.024	Ohm
	DC/DC cabinet 5	0.017	Ohm
	Module 6	0.029	Ohm
	DC/DC cabinet 6	0.015	Ohm
	Control cabinet	0.021	Ohm
	Control cabinet right door	0.032	Ohm
	Lifting crane track, dolly	0.028	Ohm
	LT piping	0.031	Ohm
	Isolation transformer cover	0.039	Ohm
	Cable tray	0.019	Ohm

Main location	Location	Measurement	Unit
10ft container	Busbar to busbar	0.019	Ohm
	Main DC/Acpoint 1	0.032	Ohm
	Main DC/Acpoint 2	0.024	Ohm
	Main DC/Acpoint 3	0.027	Ohm
	DC/AC conduncter point 1	0.037	Ohm
	DC/AC conduncter point 2	0.022	Ohm
	DC/AC conduncter point 3	0.023	Ohm
	LT coolant pipe	0.024	Ohm
	Cable tray	0.02	Ohm
	Main transforer grounding bolt	0.023	Ohm
	Main transformer chassis	0.02	Ohm
	Cable tray	0.022	Ohm

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	13-08-2024
Test location	Crosswind Containers, Majsmarken 1, 9500
Test performed by	PBL & TAN

Isolation resistance
EN 60204-1:2018 - Section 18.3
Test performed with a test voltage of 1000V

Main location	Location	Measurement	Unit
40 ft container	L1-PE	> 999.9	MOhm
	Cooling skid L1	10.01	Mohm
	Colling skid L2	6.252	Mohm
	Cooling skid L3	12.81	Mohm
	AUX supply L1	251	Mohm
	AUX supply L2	337	MOhm
	AUX supply L3	237	Mohm

Main location	Location	Measurement	Unit
10ft container	L1+L2+L3-PE on AC circuit	592	Mohm

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	13-08-2024
Test location	Crosswind Containers, Majsmarken 1, 9500
Test performed by	PBL & TAN

Isolation resistance

EN 60204-1:2018 - Section 18.4

Test performed with a test voltage of 2500VAC

Main location	Location	Measurement	Unit	Notes
40ft container	PE and L1	0	mA	The surge arrestor has been bypassed to allow the test to be conducted
	PE and L2	0	mA	
	PE and L3	0	mA	

Main location	Location	Measurement	Unit	Notes
10 FT container	PE and L1	7.1	mA	
	PE and L2	7.1	mA	
	PE and L3	7	mA	

Date: 2024-09-11

Author: PBL, TAN

Ballard Power Systems Europe

Summary:

Thermographic report from Crosswind FAT2, 2024-09-04.

System is operating at 100% (1MW) and have been at full power for >1 hour with the cooling and ventilation system operating at 100%.

Test start at 8:55

The first few images are the system from a distance.

First half of the report shows thermal images from inside the 40ft container, with focus on DC power cables, pumps and fans and process exhaust pipes.

Second half of the report shows the system test equipment and outside the system.

There are no items of concern.

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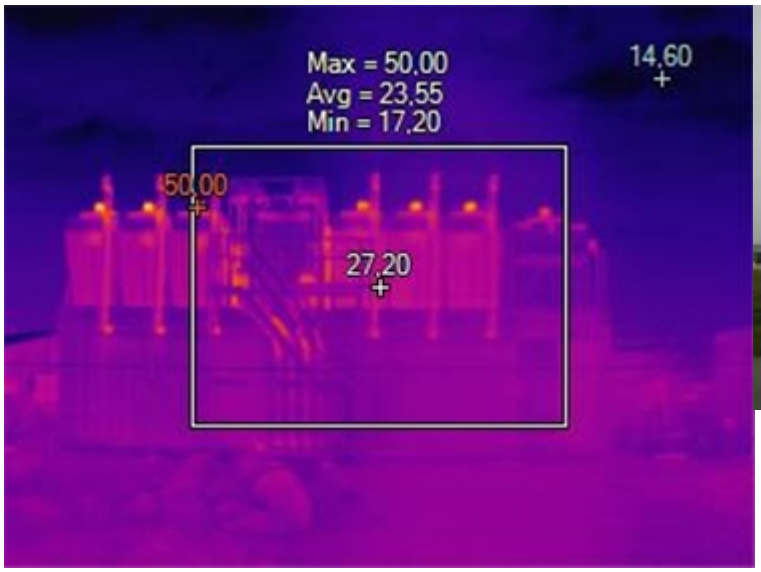




Image Info

Name	IR_00252.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	14,60 °C to 50,00 °C
Image Time	04/09/2024 11:45:17 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27,2 °C	27,2 °C	27,2 °C	0,95	22,0 °C	0,00	
Centerbox	50,0 °C	17,2 °C	23,6 °C	0,95	22,0 °C	2,67	
Hot	50,0 °C	50,0 °C	50,0 °C	0,95	22,0 °C	0,00	
Cold	14,6 °C	14,6 °C	14,6 °C	0,95	22,0 °C	0,00	

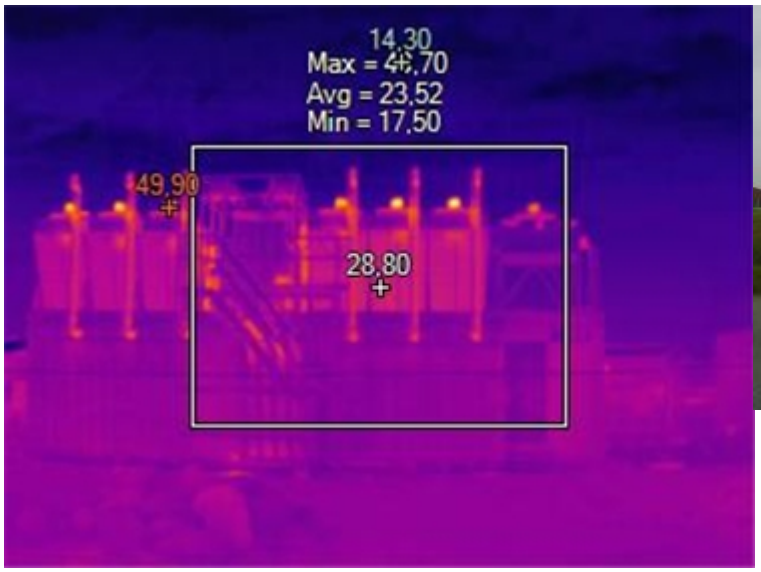


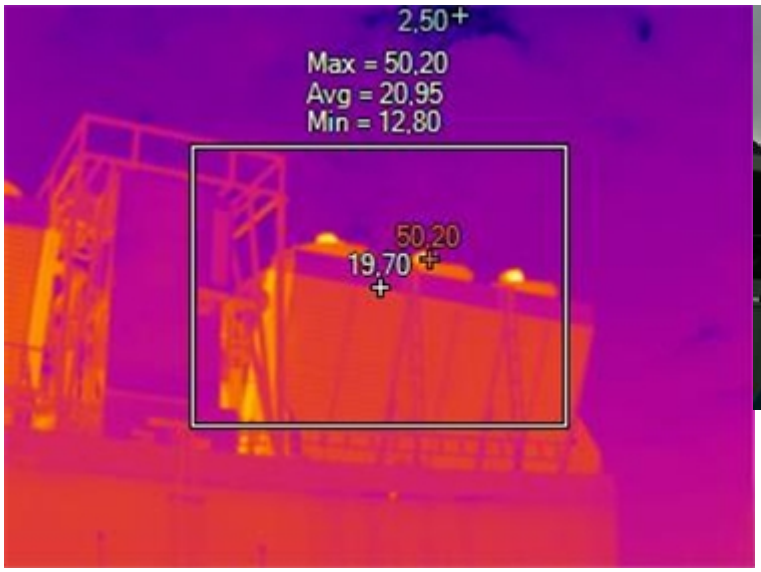


Image Info

Name	IR_00251.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	14,30 °C to 49,90 °C
Image Time	04/09/2024 11:45:00 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28,8 °C	28,8 °C	28,8 °C	0,95	22,0 °C	0,00	
Centerbox	49,7 °C	17,5 °C	23,5 °C	0,95	22,0 °C	3,28	
Hot	49,9 °C	49,9 °C	49,9 °C	0,95	22,0 °C	0,00	
Cold	14,3 °C	14,3 °C	14,3 °C	0,95	22,0 °C	0,00	



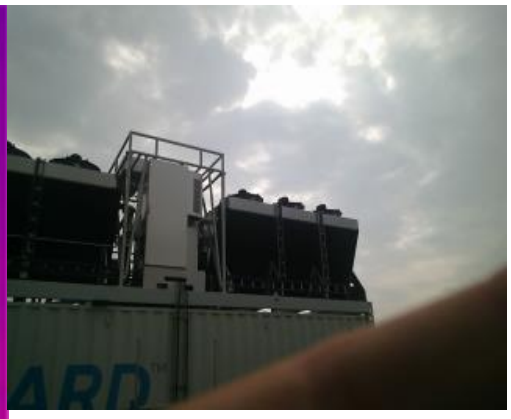


Image Info

Name	IR_00250.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	2,50 °C to 50,20 °C
Image Time	04/09/2024 11:43:56 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	19,7 °C	19,7 °C	19,7 °C	0,95	22,0 °C	0,00	
Centerbox	50,2 °C	12,8 °C	20,9 °C	0,95	22,0 °C	5,34	
Hot	50,2 °C	50,2 °C	50,2 °C	0,95	22,0 °C	0,00	
Cold	2,5 °C	2,5 °C	2,5 °C	0,95	22,0 °C	0,00	

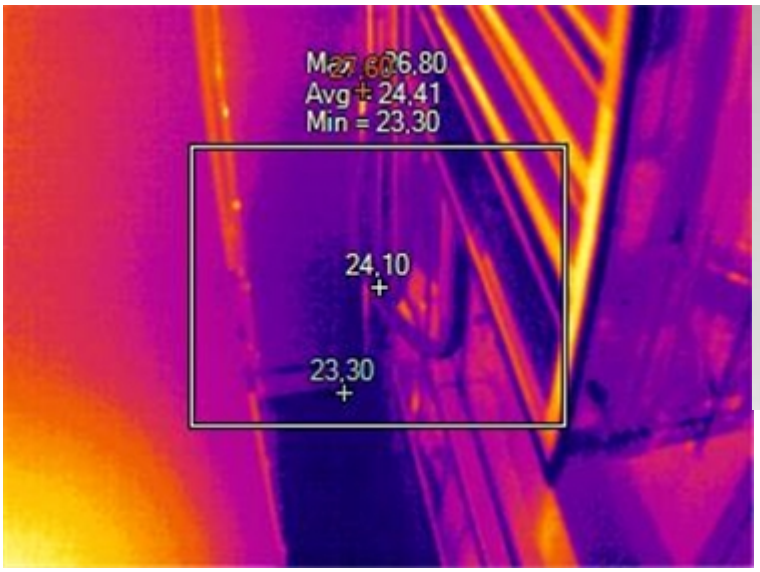




Image Info

Name	IR_00248.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	23,30 °C to 27,60 °C
Image Time	04/09/2024 11:31:07 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24,1 °C	24,1 °C	24,1 °C	0,95	22,0 °C	0,00	
Centerbox	26,8 °C	23,3 °C	24,4 °C	0,95	22,0 °C	0,56	
Hot	27,6 °C	27,6 °C	27,6 °C	0,95	22,0 °C	0,00	
Cold	23,3 °C	23,3 °C	23,3 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00247.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	23.10 °C to 28.60 °C
Image Time	04/09/2024 11:31:00 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.7 °C	23.7 °C	23.7 °C	0.95	22.0 °C	0.00	
Centerbox	28.6 °C	23.2 °C	23.9 °C	0.95	22.0 °C	0.55	
Hot	28.6 °C	28.6 °C	28.6 °C	0.95	22.0 °C	0.00	
Cold	23.1 °C	23.1 °C	23.1 °C	0.95	22.0 °C	0.00	

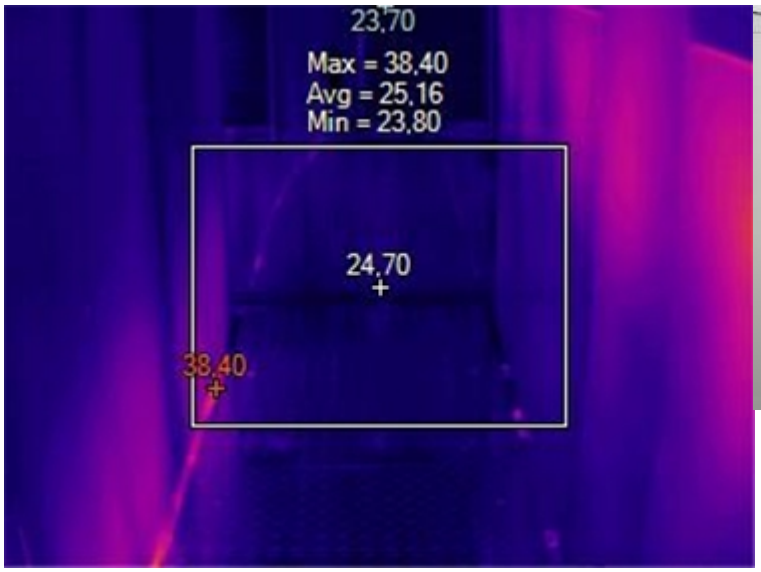




Image Info

Name	IR_00246.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	23,70 °C to 38,40 °C
Image Time	04/09/2024 11:30:47 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24,7 °C	24,7 °C	24,7 °C	0,95	22,0 °C	0,00	
Centerbox	38,4 °C	23,8 °C	25,2 °C	0,95	22,0 °C	0,71	
Hot	38,4 °C	38,4 °C	38,4 °C	0,95	22,0 °C	0,00	
Cold	23,7 °C	23,7 °C	23,7 °C	0,95	22,0 °C	0,00	

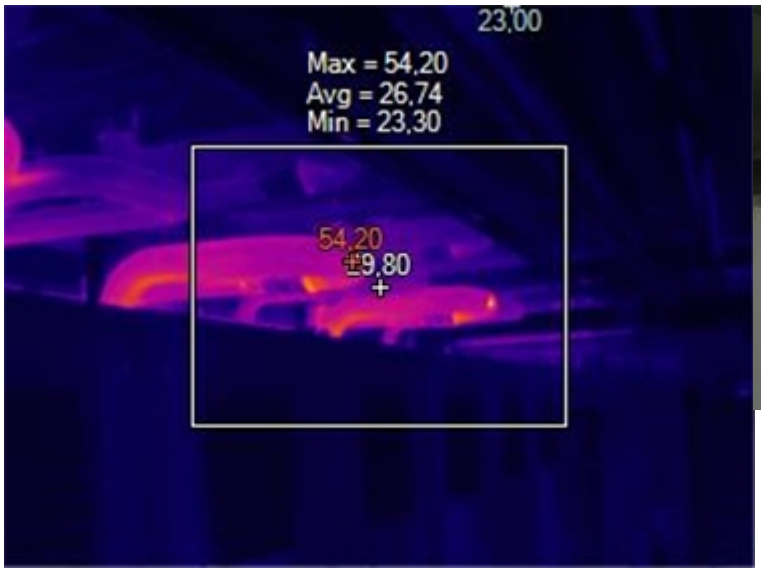




Image Info

Name	IR_00245.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	23,00 °C to 54,20 °C
Image Time	04/09/2024 11:30:41 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,8 °C	29,8 °C	29,8 °C	0,95	22,0 °C	0,00	
Centerbox	54,2 °C	23,3 °C	26,7 °C	0,95	22,0 °C	3,47	
Hot	54,2 °C	54,2 °C	54,2 °C	0,95	22,0 °C	0,00	
Cold	23,0 °C	23,0 °C	23,0 °C	0,95	22,0 °C	0,00	

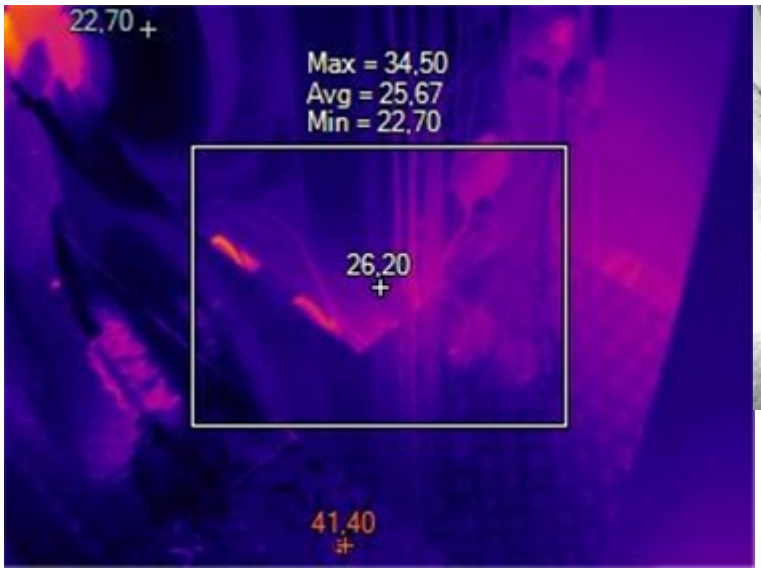




Image Info

Name	IR_00244.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,70 °C to 41,40 °C
Image Time	04/09/2024 11:30:33 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	26,2 °C	26,2 °C	26,2 °C	0,95	22,0 °C	0,00	
Centerbox	34,5 °C	22,7 °C	25,7 °C	0,95	22,0 °C	1,26	
Hot	41,4 °C	41,4 °C	41,4 °C	0,95	22,0 °C	0,00	
Cold	22,7 °C	22,7 °C	22,7 °C	0,95	22,0 °C	0,00	

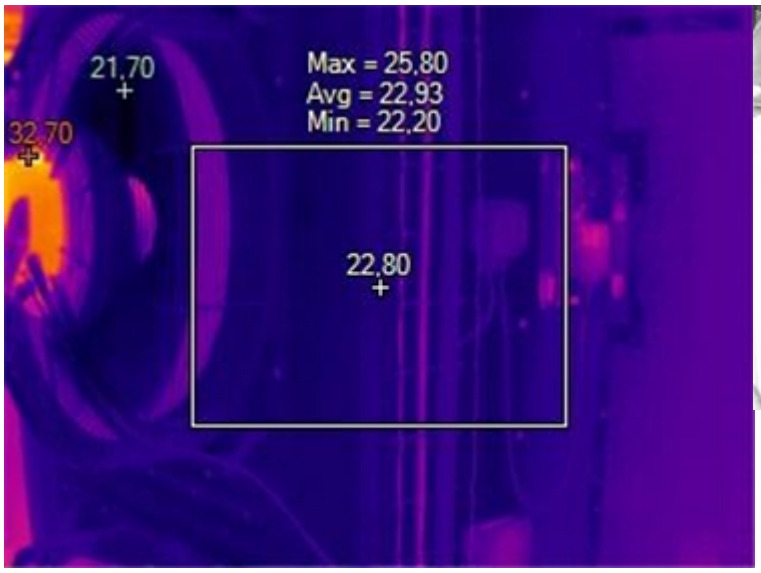




Image Info

Name	IR_00243.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,70 °C to 32,70 °C
Image Time	04/09/2024 11:30:27 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22,8 °C	22,8 °C	22,8 °C	0,95	22,0 °C	0,00	
Centerbox	25,8 °C	22,2 °C	22,9 °C	0,95	22,0 °C	0,44	
Hot	32,7 °C	32,7 °C	32,7 °C	0,95	22,0 °C	0,00	
Cold	21,7 °C	21,7 °C	21,7 °C	0,95	22,0 °C	0,00	

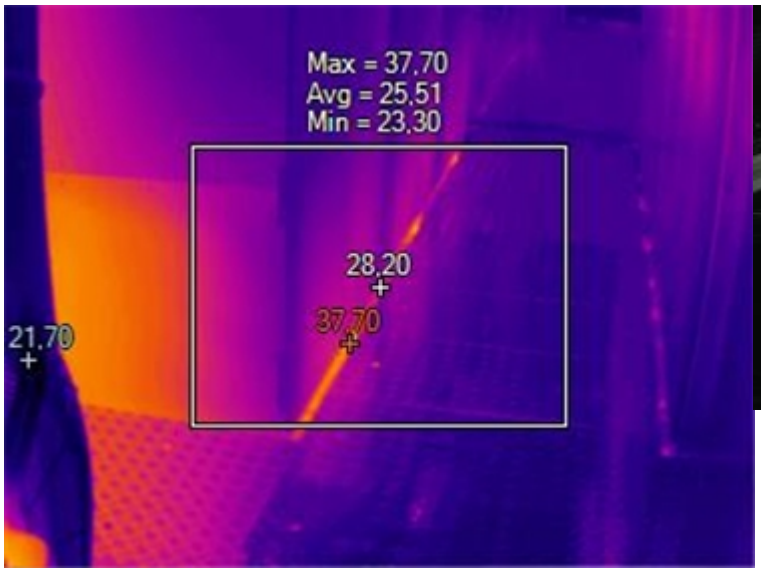




Image Info

Name	IR_00242.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,70 °C to 37,70 °C
Image Time	04/09/2024 11:30:17 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28,2 °C	28,2 °C	28,2 °C	0,95	22,0 °C	0,00	
Centerbox	37,7 °C	23,3 °C	25,5 °C	0,95	22,0 °C	1,49	
Hot	37,7 °C	37,7 °C	37,7 °C	0,95	22,0 °C	0,00	
Cold	21,7 °C	21,7 °C	21,7 °C	0,95	22,0 °C	0,00	

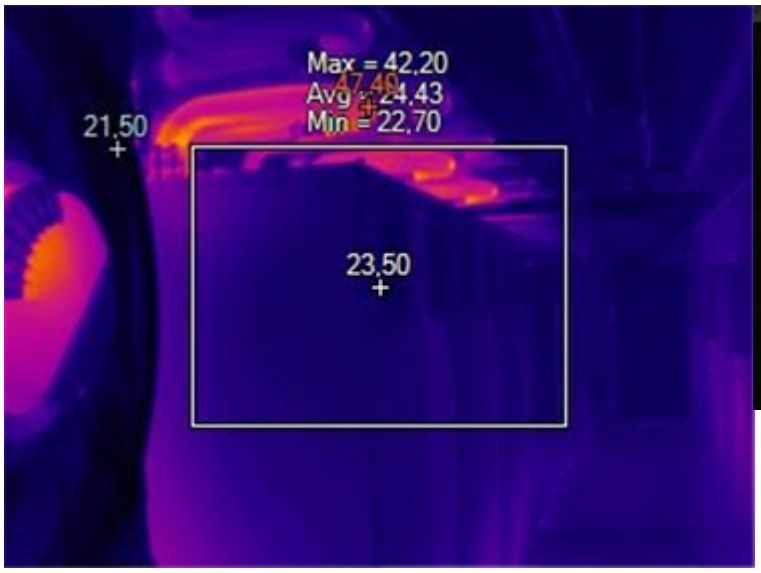




Image Info

Name	IR_00241.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,50 °C to 47,40 °C
Image Time	04/09/2024 11:30:12 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,5 °C	23,5 °C	23,5 °C	0,95	22,0 °C	0,00	
Centerbox	42,2 °C	22,7 °C	24,4 °C	0,95	22,0 °C	1,92	
Hot	47,4 °C	47,4 °C	47,4 °C	0,95	22,0 °C	0,00	
Cold	21,5 °C	21,5 °C	21,5 °C	0,95	22,0 °C	0,00	

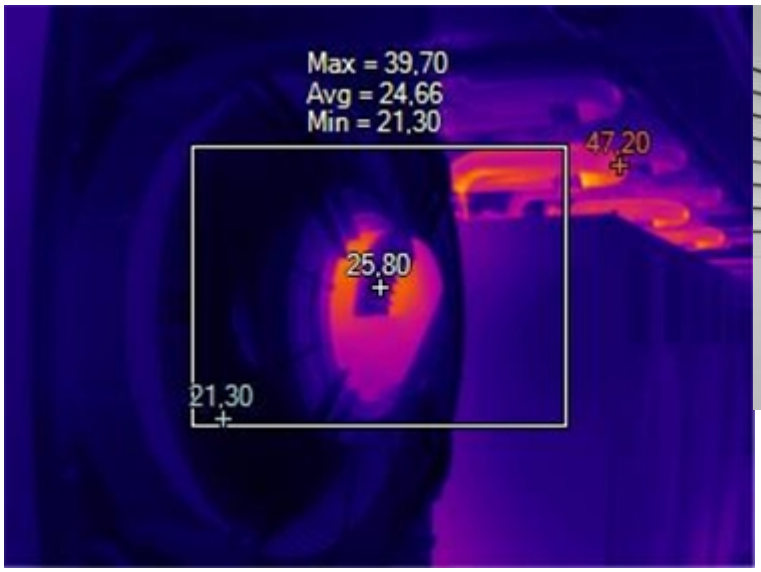




Image Info

Name	IR_00240.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,30 °C to 47,20 °C
Image Time	04/09/2024 11:29:44 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25,8 °C	25,8 °C	25,8 °C	0,95	22,0 °C	0,00	
Centerbox	39,7 °C	21,3 °C	24,7 °C	0,95	22,0 °C	3,44	
Hot	47,2 °C	47,2 °C	47,2 °C	0,95	22,0 °C	0,00	
Cold	21,3 °C	21,3 °C	21,3 °C	0,95	22,0 °C	0,00	

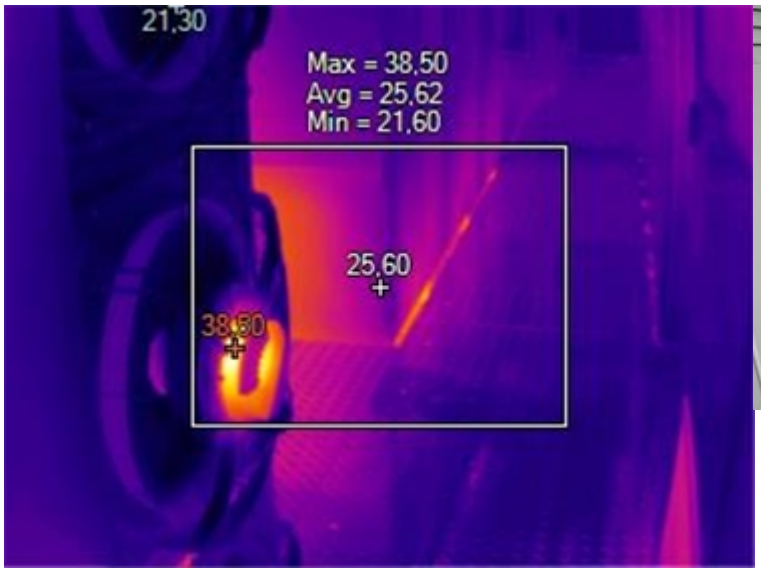




Image Info

Name	IR_00239.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,30 °C to 38,50 °C
Image Time	04/09/2024 11:29:27 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25,6 °C	25,6 °C	25,6 °C	0,95	22,0 °C	0,00	
Centerbox	38,5 °C	21,6 °C	25,6 °C	0,95	22,0 °C	2,50	
Hot	38,5 °C	38,5 °C	38,5 °C	0,95	22,0 °C	0,00	
Cold	21,3 °C	21,3 °C	21,3 °C	0,95	22,0 °C	0,00	

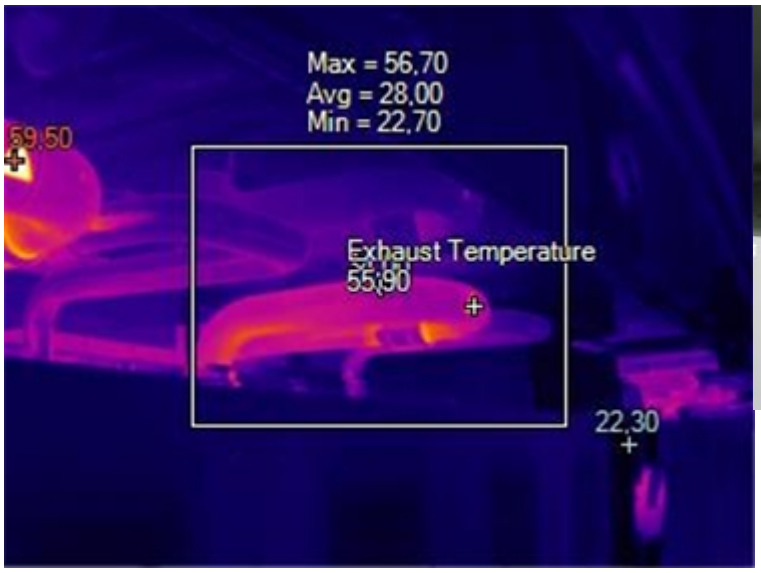




Image Info

Name	IR_00238.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,30 °C to 59,50 °C
Image Time	04/09/2024 11:29:09 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	34,0 °C	34,0 °C	34,0 °C	0,95	22,0 °C	0,00	
Centerbox	56,7 °C	22,7 °C	28,0 °C	0,95	22,0 °C	4,18	
Hot	59,5 °C	59,5 °C	59,5 °C	0,95	22,0 °C	0,00	
Cold	22,3 °C	22,3 °C	22,3 °C	0,95	22,0 °C	0,00	
Exhaust Temperature	55,9 °C	55,9 °C	55,9 °C	0,95	22,0 °C	0,00	

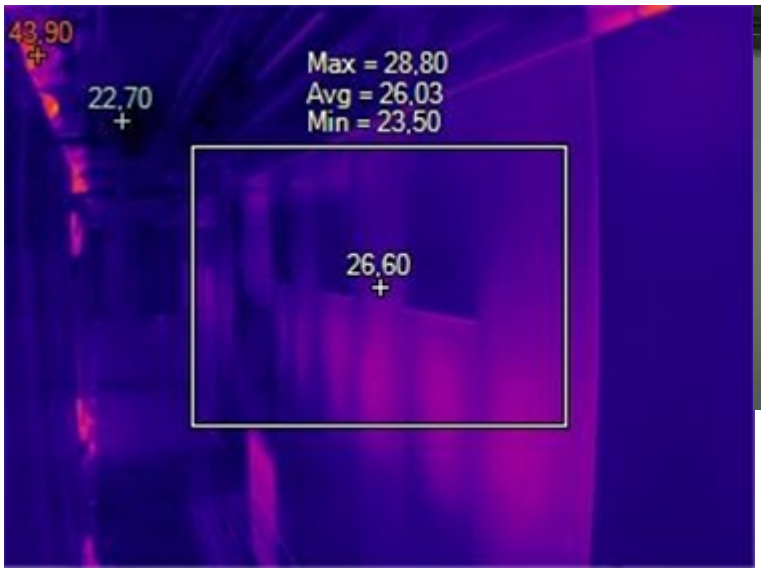




Image Info

Name	IR_00237.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,70 °C to 43,90 °C
Image Time	04/09/2024 11:29:01 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	26,6 °C	26,6 °C	26,6 °C	0,95	22,0 °C	0,00	
Centerbox	28,8 °C	23,5 °C	26,0 °C	0,95	22,0 °C	1,08	
Hot	43,9 °C	43,9 °C	43,9 °C	0,95	22,0 °C	0,00	
Cold	22,7 °C	22,7 °C	22,7 °C	0,95	22,0 °C	0,00	

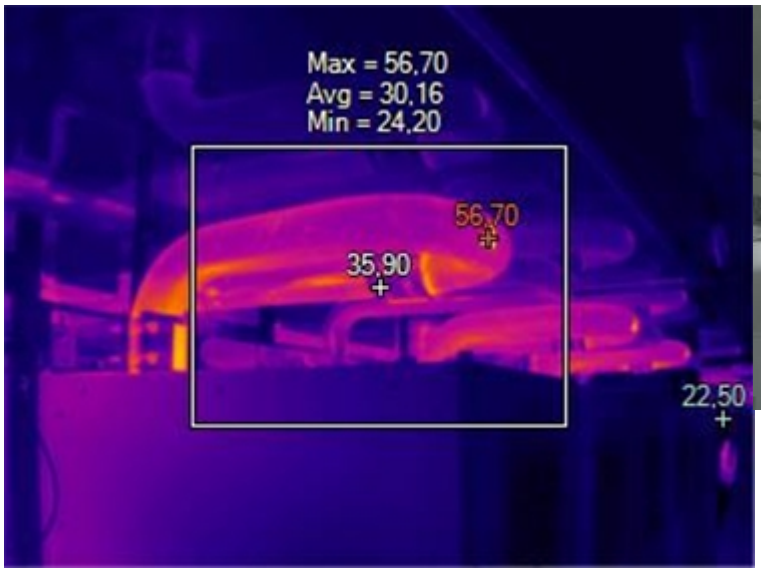




Image Info

Name	IR_00236.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,50 °C to 56,70 °C
Image Time	04/09/2024 11:28:50 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	35,9 °C	35,9 °C	35,9 °C	0,95	22,0 °C	0,00	
Centerbox	56,7 °C	24,2 °C	30,2 °C	0,95	22,0 °C	4,12	
Hot	56,7 °C	56,7 °C	56,7 °C	0,95	22,0 °C	0,00	
Cold	22,5 °C	22,5 °C	22,5 °C	0,95	22,0 °C	0,00	

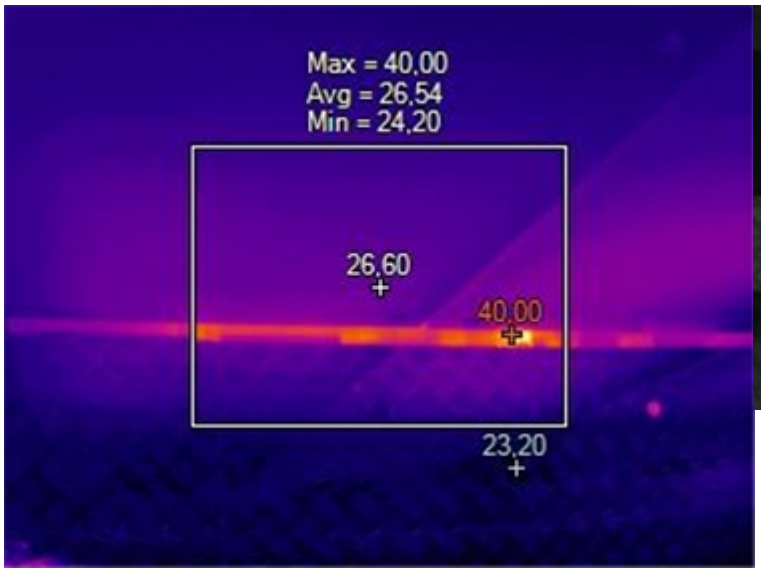




Image Info

Name	IR_00235.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	23,20 °C to 40,00 °C
Image Time	04/09/2024 11:28:41 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	26,6 °C	26,6 °C	26,6 °C	0,95	22,0 °C	0,00	
Centerbox	40,0 °C	24,2 °C	26,5 °C	0,95	22,0 °C	1,49	
Hot	40,0 °C	40,0 °C	40,0 °C	0,95	22,0 °C	0,00	
Cold	23,2 °C	23,2 °C	23,2 °C	0,95	22,0 °C	0,00	

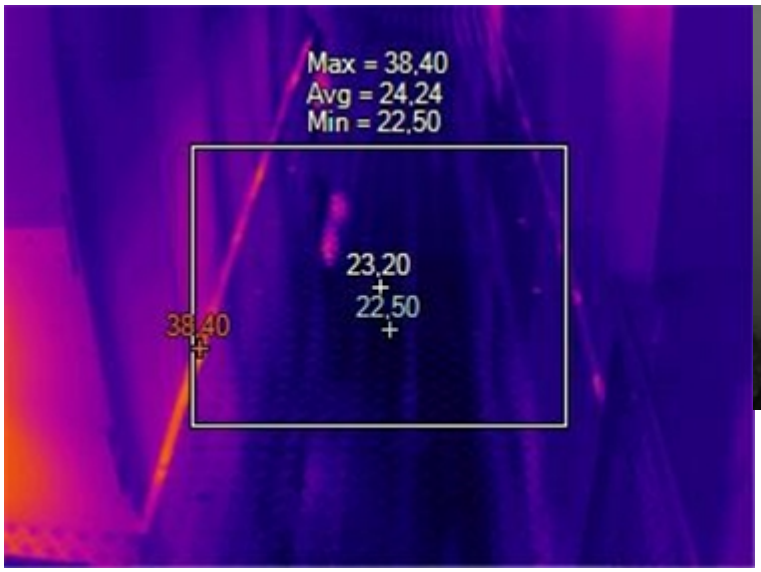




Image Info

Name	IR_00234.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,50 °C to 38,40 °C
Image Time	04/09/2024 11:28:29 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,2 °C	23,2 °C	23,2 °C	0,95	22,0 °C	0,00	
Centerbox	38,4 °C	22,5 °C	24,2 °C	0,95	22,0 °C	1,21	
Hot	38,4 °C	38,4 °C	38,4 °C	0,95	22,0 °C	0,00	
Cold	22,5 °C	22,5 °C	22,5 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00233.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	21,10 °C to 30,70 °C
Image Time	04/09/2024 11:28:14 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,8 °C	23,8 °C	23,8 °C	0,95	22,0 °C	0,00	
Centerbox	30,7 °C	23,2 °C	25,4 °C	0,95	22,0 °C	1,64	
Hot	30,7 °C	30,7 °C	30,7 °C	0,95	22,0 °C	0,00	
Cold	21,1 °C	21,1 °C	21,1 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00232.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	22,20 °C to 37,00 °C
Image Time	04/09/2024 11:28:09 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,2 °C	23,2 °C	23,2 °C	0,95	22,0 °C	0,00	
Centerbox	34,0 °C	22,8 °C	24,6 °C	0,95	22,0 °C	1,91	
Hot	37,0 °C	37,0 °C	37,0 °C	0,95	22,0 °C	0,00	
Cold	22,2 °C	22,2 °C	22,2 °C	0,95	22,0 °C	0,00	

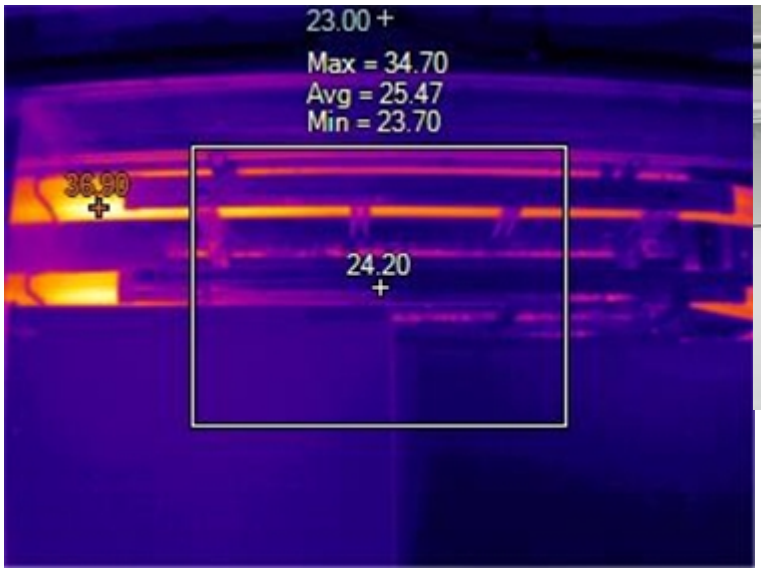




Image Info

Name	IR_00231.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	23.00 °C to 36.90 °C
Image Time	04/09/2024 11:27:56 AM
Asset Name	UC50 Aux AC Cabinet

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24.2 °C	24.2 °C	24.2 °C	0.95	22.0 °C	0.00	
Centerbox	34.7 °C	23.7 °C	25.5 °C	0.95	22.0 °C	1.52	
Hot	36.9 °C	36.9 °C	36.9 °C	0.95	22.0 °C	0.00	
Cold	23.0 °C	23.0 °C	23.0 °C	0.95	22.0 °C	0.00	

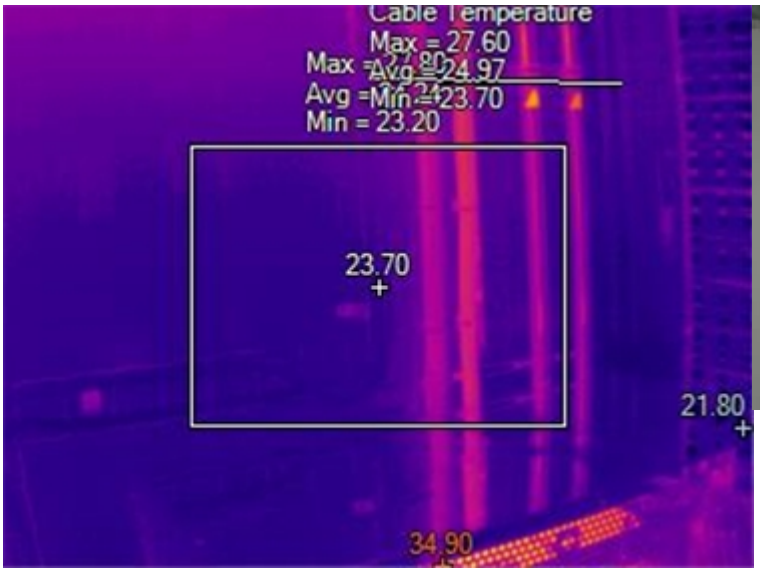




Image Info

Name	IR_00230.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	21.80 °C to 34.90 °C
Image Time	04/09/2024 11:27:50 AM
Asset Name	UC50 Aux AC Cabinet

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.7 °C	23.7 °C	23.7 °C	0.95	22.0 °C	0.00	
Centerbox	27.8 °C	23.2 °C	24.2 °C	0.95	22.0 °C	0.90	
Hot	34.9 °C	34.9 °C	34.9 °C	0.95	22.0 °C	0.00	
Cold	21.8 °C	21.8 °C	21.8 °C	0.95	22.0 °C	0.00	
Cable Temperature	27.6 °C	23.7 °C	25.0 °C	0.95	22.0 °C	0.94	

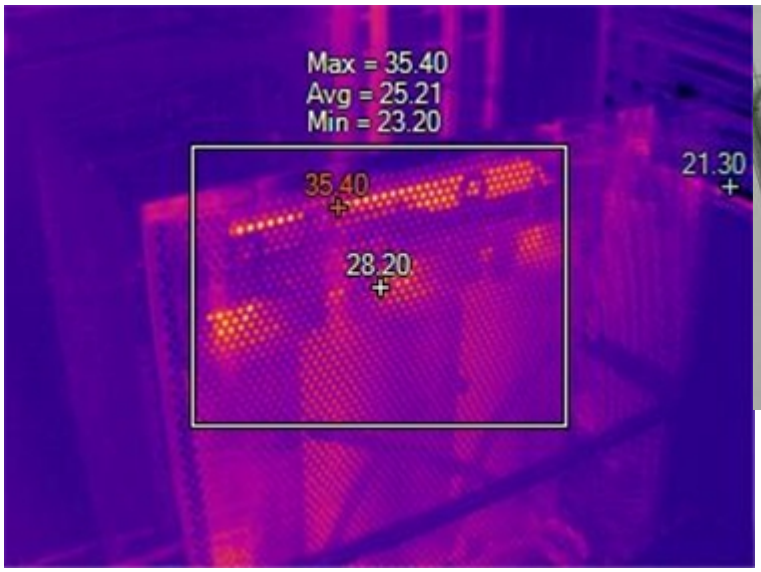




Image Info

Name	IR_00229.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	21.30 °C to 35.40 °C
Image Time	04/09/2024 11:27:38 AM
Asset Name	UC50 Aux AC Cabinet

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.2 °C	28.2 °C	28.2 °C	0.95	22.0 °C	0.00	
Centerbox	35.4 °C	23.2 °C	25.2 °C	0.95	22.0 °C	1.37	
Hot	35.4 °C	35.4 °C	35.4 °C	0.95	22.0 °C	0.00	
Cold	21.3 °C	21.3 °C	21.3 °C	0.95	22.0 °C	0.00	

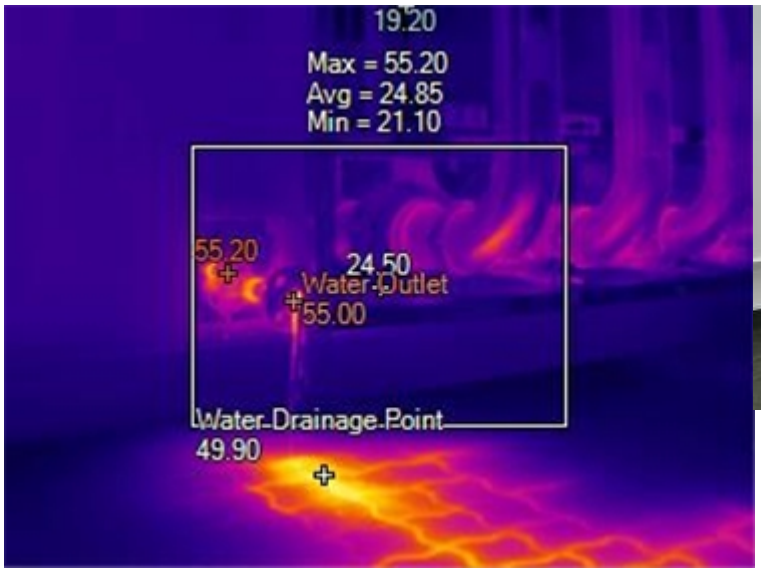




Image Info

Name	IR_00228.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	19.20 °C to 55.20 °C
Image Time	04/09/2024 11:26:59 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24.5 °C	24.5 °C	24.5 °C	0.95	22.0 °C	0.00	
Centerbox	55.2 °C	21.1 °C	24.8 °C	0.95	22.0 °C	3.00	
Hot	55.2 °C	55.2 °C	55.2 °C	0.95	22.0 °C	0.00	
Cold	19.2 °C	19.2 °C	19.2 °C	0.95	22.0 °C	0.00	
Water Outlet	55.0 °C	55.0 °C	55.0 °C	0.95	22.0 °C	0.00	
Water Drainage Point	49.9 °C	49.9 °C	49.9 °C	0.95	22.0 °C	0.00	

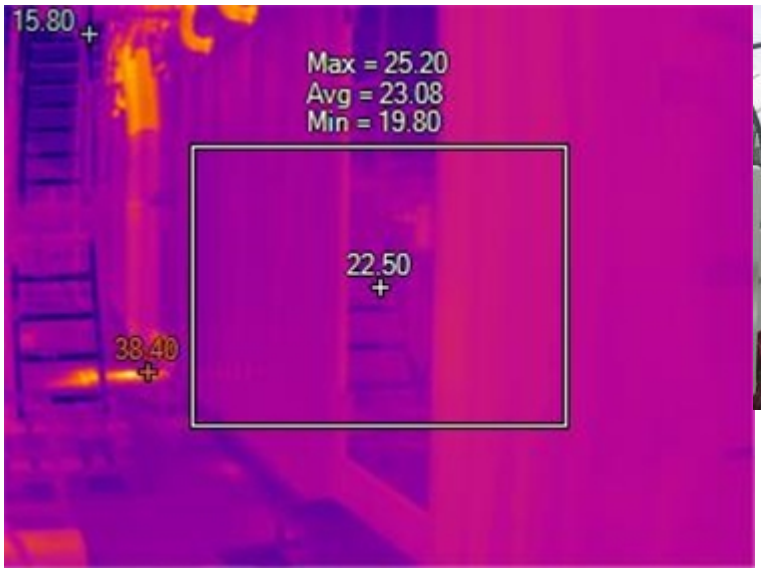




Image Info

Name	IR_00227.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	15.80 °C to 38.40 °C
Image Time	04/09/2024 11:26:38 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22.5 °C	22.5 °C	22.5 °C	0.95	22.0 °C	0.00	
Centerbox	25.2 °C	19.8 °C	23.1 °C	0.95	22.0 °C	1.06	
Hot	38.4 °C	38.4 °C	38.4 °C	0.95	22.0 °C	0.00	
Cold	15.8 °C	15.8 °C	15.8 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00226.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	18,20 °C to 54,70 °C
Image Time	04/09/2024 11:25:55 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	37,9 °C	37,9 °C	37,9 °C	0,95	22,0 °C	0,00	
Centerbox	50,7 °C	21,1 °C	26,1 °C	0,95	22,0 °C	5,37	
Hot	54,7 °C	54,7 °C	54,7 °C	0,95	22,0 °C	0,00	
Cold	18,2 °C	18,2 °C	18,2 °C	0,95	22,0 °C	0,00	

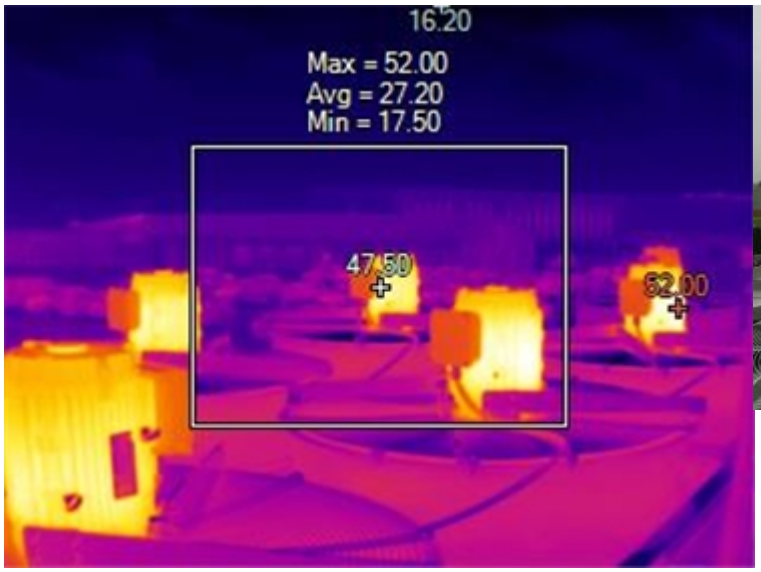




Image Info

Name	IR_00225.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	16.20 °C to 52.00 °C
Image Time	04/09/2024 11:25:34 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	47.5 °C	47.5 °C	47.5 °C	0.95	22.0 °C	0.00	
Centerbox	52.0 °C	17.5 °C	27.2 °C	0.95	22.0 °C	7.80	
Hot	52.0 °C	52.0 °C	52.0 °C	0.95	22.0 °C	0.00	
Cold	16.2 °C	16.2 °C	16.2 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00224.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	20.70 °C to 39.50 °C
Image Time	04/09/2024 11:24:49 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.5 °C	28.5 °C	28.5 °C	0.95	22.0 °C	0.00	
Centerbox	39.5 °C	22.5 °C	30.9 °C	0.95	22.0 °C	4.68	
Hot	39.5 °C	39.5 °C	39.5 °C	0.95	22.0 °C	0.00	
Cold	20.7 °C	20.7 °C	20.7 °C	0.95	22.0 °C	0.00	

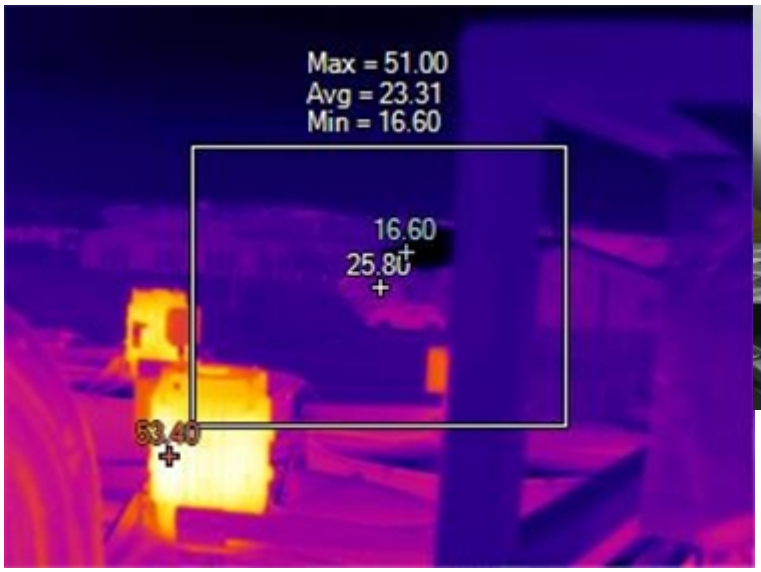




Image Info

Name	IR_00222.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	16.60 °C to 53.40 °C
Image Time	04/09/2024 11:23:50 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25.8 °C	25.8 °C	25.8 °C	0.95	22.0 °C	0.00	
Centerbox	51.0 °C	16.6 °C	23.3 °C	0.95	22.0 °C	5.36	
Hot	53.4 °C	53.4 °C	53.4 °C	0.95	22.0 °C	0.00	
Cold	16.6 °C	16.6 °C	16.6 °C	0.95	22.0 °C	0.00	

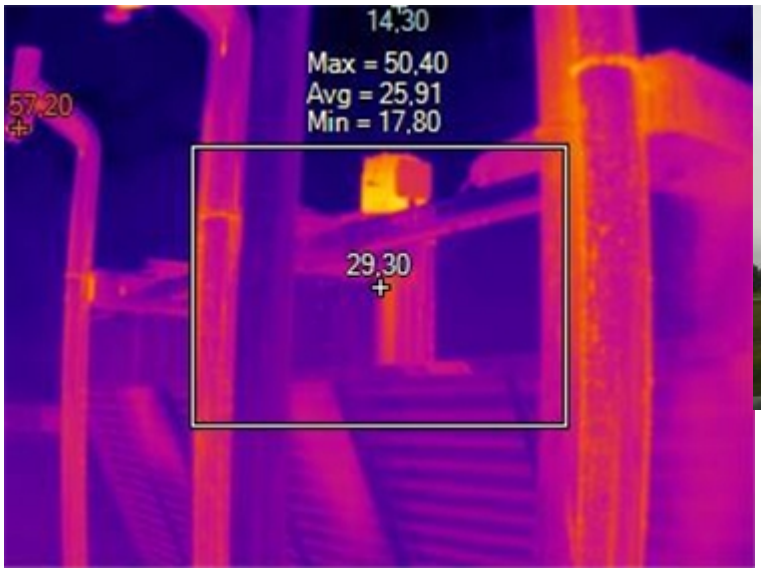




Image Info

Name	IR_00221.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	14,30 °C to 57,20 °C
Image Time	04/09/2024 11:23:38 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,3 °C	29,3 °C	29,3 °C	0,95	22,0 °C	0,00	
Centerbox	50,4 °C	17,8 °C	25,9 °C	0,95	22,0 °C	5,31	
Hot	57,2 °C	57,2 °C	57,2 °C	0,95	22,0 °C	0,00	
Cold	14,3 °C	14,3 °C	14,3 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00220.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	13,10 °C to 36,20 °C
Image Time	04/09/2024 11:22:30 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27,1 °C	27,1 °C	27,1 °C	0,95	22,0 °C	0,00	
Centerbox	34,2 °C	18,2 °C	25,2 °C	0,95	22,0 °C	2,26	
Hot	36,2 °C	36,2 °C	36,2 °C	0,95	22,0 °C	0,00	
Cold	13,1 °C	13,1 °C	13,1 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00219.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	14.30 °C to 39.70 °C
Image Time	04/09/2024 11:22:14 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.5 °C	28.5 °C	28.5 °C	0.95	22.0 °C	0.00	
Centerbox	32.7 °C	15.3 °C	22.2 °C	0.95	22.0 °C	2.54	
Hot	39.7 °C	39.7 °C	39.7 °C	0.95	22.0 °C	0.00	
Cold	14.3 °C	14.3 °C	14.3 °C	0.95	22.0 °C	0.00	

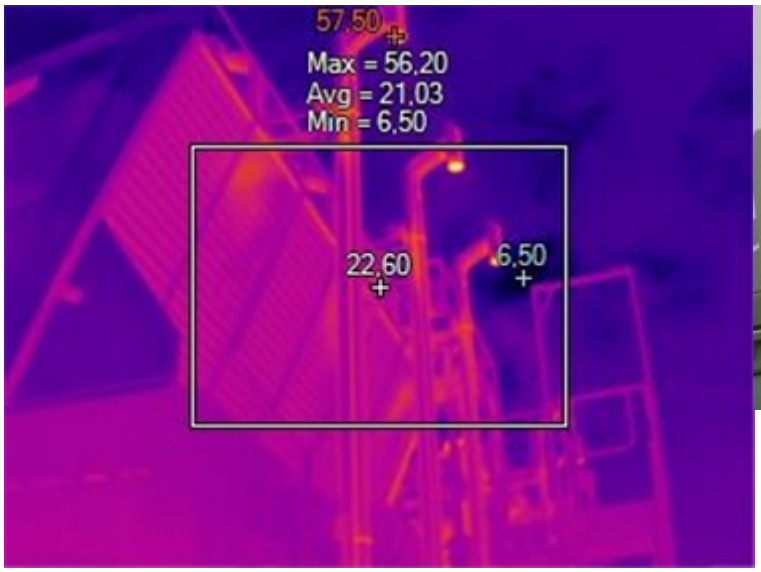




Image Info

Name	IR_00218.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	6,50 °C to 57,50 °C
Image Time	04/09/2024 11:21:25 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22,6 °C	22,6 °C	22,6 °C	0,95	22,0 °C	0,00	
Centerbox	56,2 °C	6,5 °C	21,0 °C	0,95	22,0 °C	5,14	
Hot	57,5 °C	57,5 °C	57,5 °C	0,95	22,0 °C	0,00	
Cold	6,5 °C	6,5 °C	6,5 °C	0,95	22,0 °C	0,00	

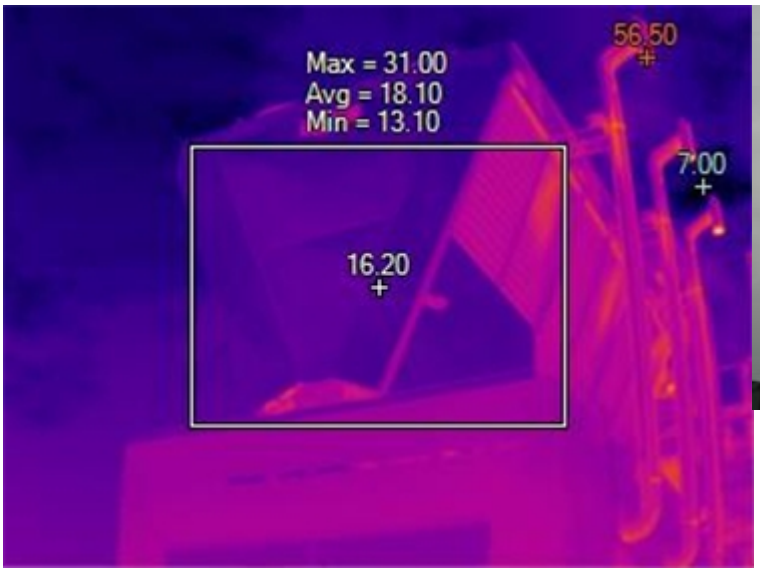




Image Info

Name	IR_00217.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	7.00 °C to 56.50 °C
Image Time	04/09/2024 11:21:15 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	16.2 °C	16.2 °C	16.2 °C	0.95	22.0 °C	0.00	
Centerbox	31.0 °C	13.1 °C	18.1 °C	0.95	22.0 °C	3.33	
Hot	56.5 °C	56.5 °C	56.5 °C	0.95	22.0 °C	0.00	
Cold	7.0 °C	7.0 °C	7.0 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00216.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	18.20 °C to 144.30 °C
Image Time	04/09/2024 11:20:35 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	21.2 °C	21.2 °C	21.2 °C	0.95	22.0 °C	0.00	
Centerbox	23.7 °C	18.6 °C	21.9 °C	0.95	22.0 °C	0.96	
Hot	144.3 °C	144.3 °C	144.3 °C	0.95	22.0 °C	0.00	
Cold	18.2 °C	18.2 °C	18.2 °C	0.95	22.0 °C	0.00	

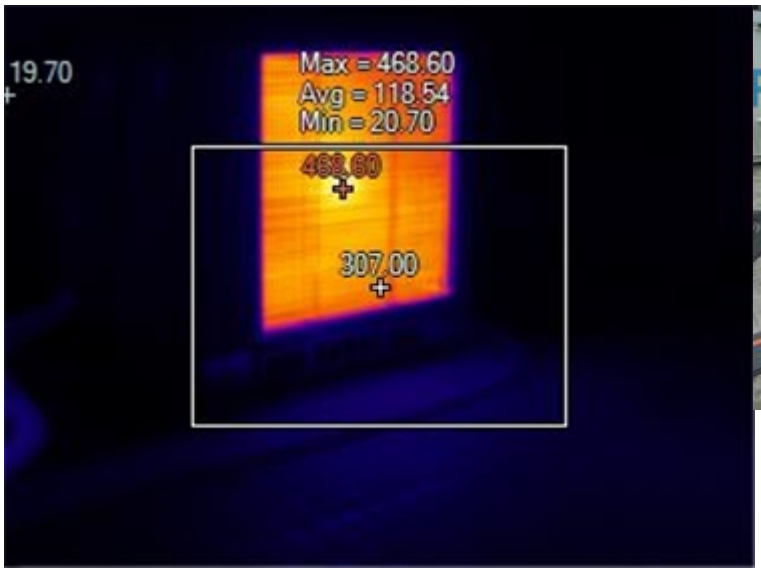




Image Info

Name	IR_00215.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	19.70 °C to 468.60 °C
Image Time	04/09/2024 11:19:20 AM
Asset Name	Test Equipemnt

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	307.0 °C	307.0 °C	307.0 °C	0.95	22.0 °C	0.00	
Centerbox	468.6 °C	20.7 °C	118.5 °C	0.95	22.0 °C	129.65	
Hot	468.6 °C	468.6 °C	468.6 °C	0.95	22.0 °C	0.00	
Cold	19.7 °C	19.7 °C	19.7 °C	0.95	22.0 °C	0.00	

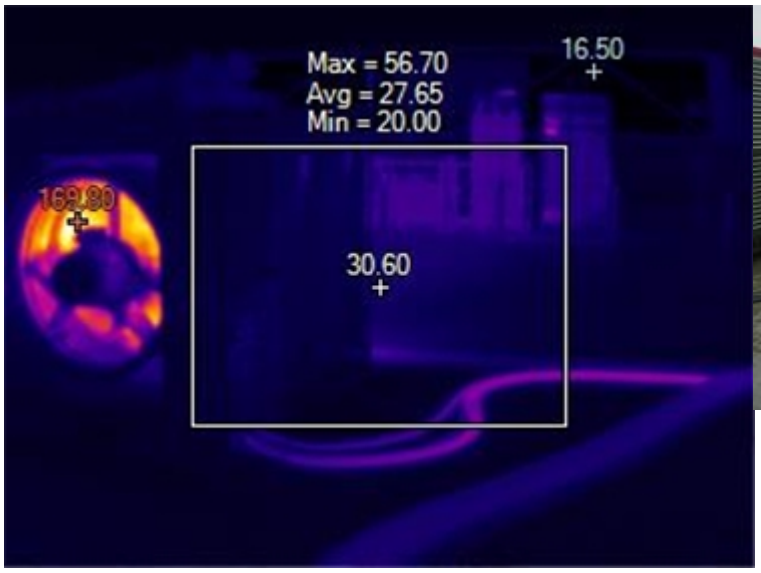




Image Info

Name	IR_00214.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	16.50 °C to 169.80 °C
Image Time	04/09/2024 11:18:48 AM
Asset Name	Test Equipemnt

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	30.6 °C	30.6 °C	30.6 °C	0.95	22.0 °C	0.00	
Centerbox	56.7 °C	20.0 °C	27.6 °C	0.95	22.0 °C	6.06	
Hot	169.8 °C	169.8 °C	169.8 °C	0.95	22.0 °C	0.00	
Cold	16.5 °C	16.5 °C	16.5 °C	0.95	22.0 °C	0.00	

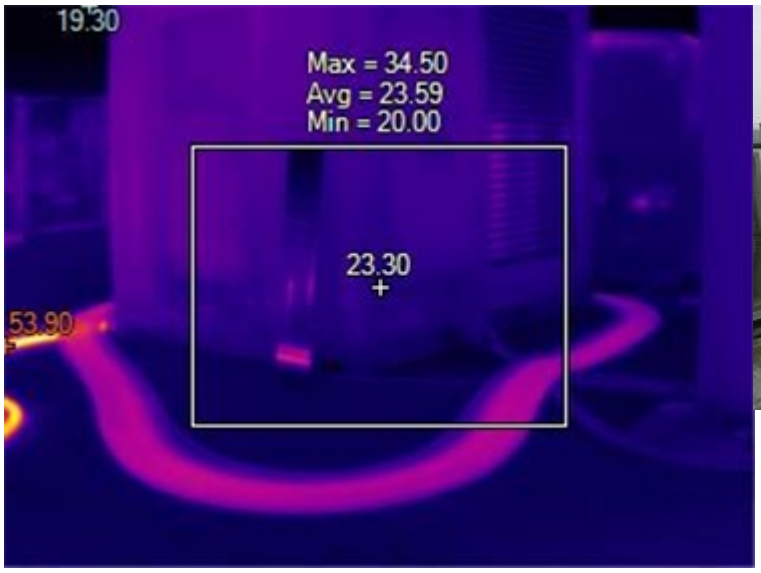




Image Info

Name	IR_00213.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	19.30 °C to 53.90 °C
Image Time	04/09/2024 11:18:26 AM
Asset Name	Test Equipemnt

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.3 °C	23.3 °C	23.3 °C	0.95	22.0 °C	0.00	
Centerbox	34.5 °C	20.0 °C	23.6 °C	0.95	22.0 °C	1.81	
Hot	53.9 °C	53.9 °C	53.9 °C	0.95	22.0 °C	0.00	
Cold	19.3 °C	19.3 °C	19.3 °C	0.95	22.0 °C	0.00	

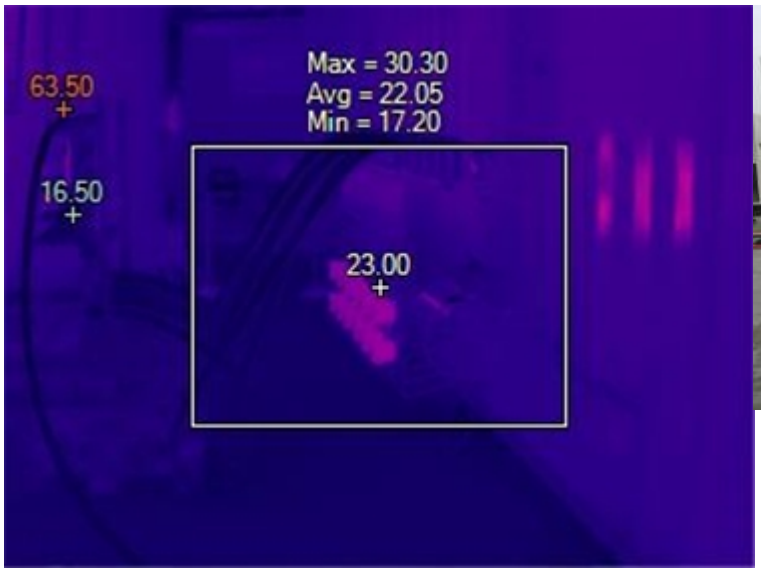




Image Info

Name	IR_00212.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	16.50 °C to 63.50 °C
Image Time	04/09/2024 11:18:08 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.0 °C	23.0 °C	23.0 °C	0.95	22.0 °C	0.00	
Centerbox	30.3 °C	17.2 °C	22.1 °C	0.95	22.0 °C	1.74	
Hot	63.5 °C	63.5 °C	63.5 °C	0.95	22.0 °C	0.00	
Cold	16.5 °C	16.5 °C	16.5 °C	0.95	22.0 °C	0.00	

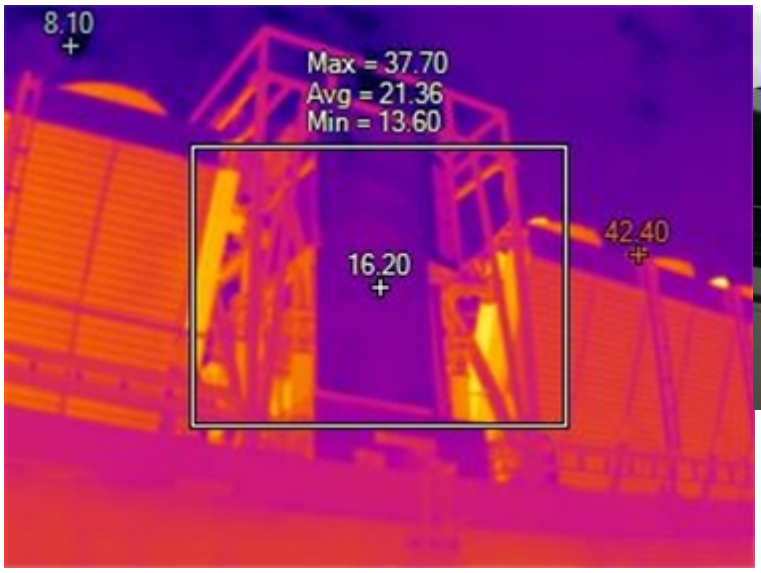




Image Info

Name	IR_00209.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	8.10 °C to 42.40 °C
Image Time	04/09/2024 11:17:23 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	16.2 °C	16.2 °C	16.2 °C	0.95	22.0 °C	0.00	
Centerbox	37.7 °C	13.6 °C	21.4 °C	0.95	22.0 °C	5.11	
Hot	42.4 °C	42.4 °C	42.4 °C	0.95	22.0 °C	0.00	
Cold	8.1 °C	8.1 °C	8.1 °C	0.95	22.0 °C	0.00	

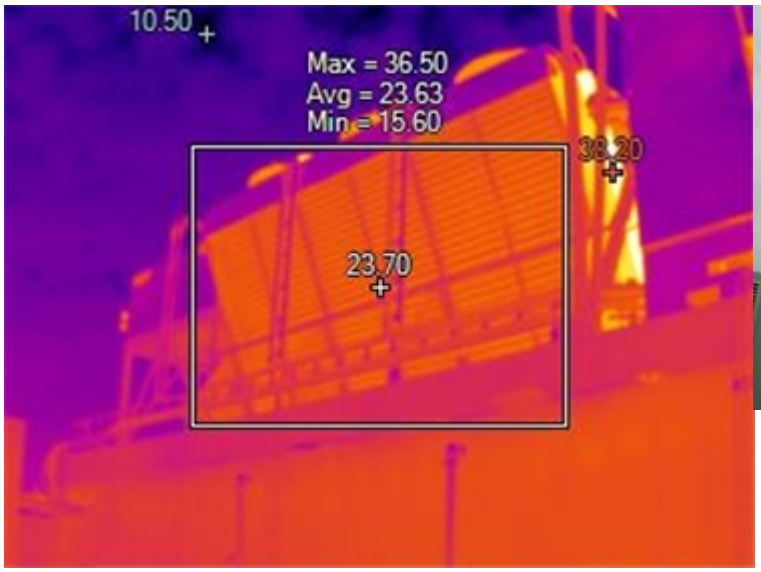




Image Info

Name	IR_00208.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	10.50 °C to 38.20 °C
Image Time	04/09/2024 11:16:35 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.7 °C	23.7 °C	23.7 °C	0.95	22.0 °C	0.00	
Centerbox	36.5 °C	15.6 °C	23.6 °C	0.95	22.0 °C	2.30	
Hot	38.2 °C	38.2 °C	38.2 °C	0.95	22.0 °C	0.00	
Cold	10.5 °C	10.5 °C	10.5 °C	0.95	22.0 °C	0.00	

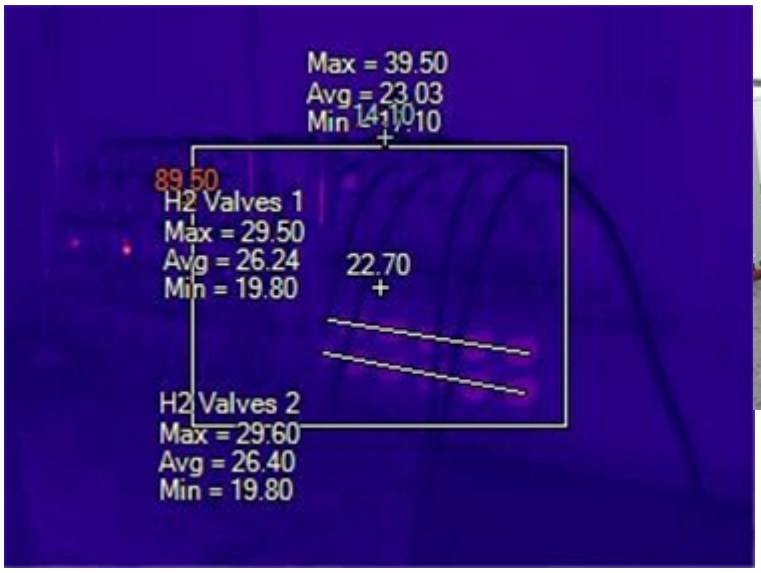




Image Info

Name	IR_00207.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	14.10 °C to 89.50 °C
Image Time	04/09/2024 11:16:21 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22.7 °C	22.7 °C	22.7 °C	0.95	22.0 °C	0.00	
Centerbox	39.5 °C	17.1 °C	23.0 °C	0.95	22.0 °C	1.82	
Hot	89.5 °C	89.5 °C	89.5 °C	0.95	22.0 °C	0.00	
Cold	14.1 °C	14.1 °C	14.1 °C	0.95	22.0 °C	0.00	
H2 Valves 1	29.5 °C	19.8 °C	26.2 °C	0.95	22.0 °C	2.45	
H2 Valves 2	29.6 °C	19.8 °C	26.4 °C	0.95	22.0 °C	2.53	

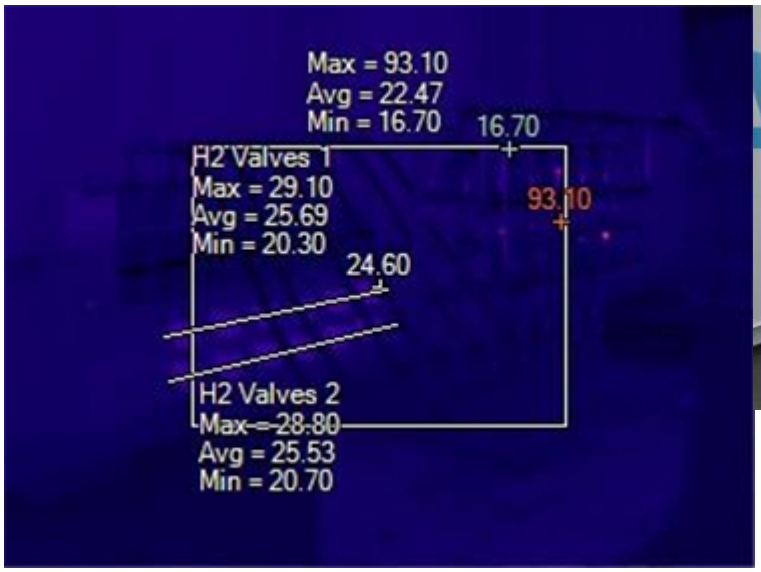




Image Info

Name	IR_00206.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	16.70 °C to 93.10 °C
Image Time	04/09/2024 11:16:09 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24.6 °C	24.6 °C	24.6 °C	0.95	22.0 °C	0.00	
Centerbox	93.1 °C	16.7 °C	22.5 °C	0.95	22.0 °C	1.81	
Hot	93.1 °C	93.1 °C	93.1 °C	0.95	22.0 °C	0.00	
Cold	16.7 °C	16.7 °C	16.7 °C	0.95	22.0 °C	0.00	
H2 Valves 1	29.1 °C	20.3 °C	25.7 °C	0.95	22.0 °C	2.39	
H2 Valves 2	28.8 °C	20.7 °C	25.5 °C	0.95	22.0 °C	2.28	

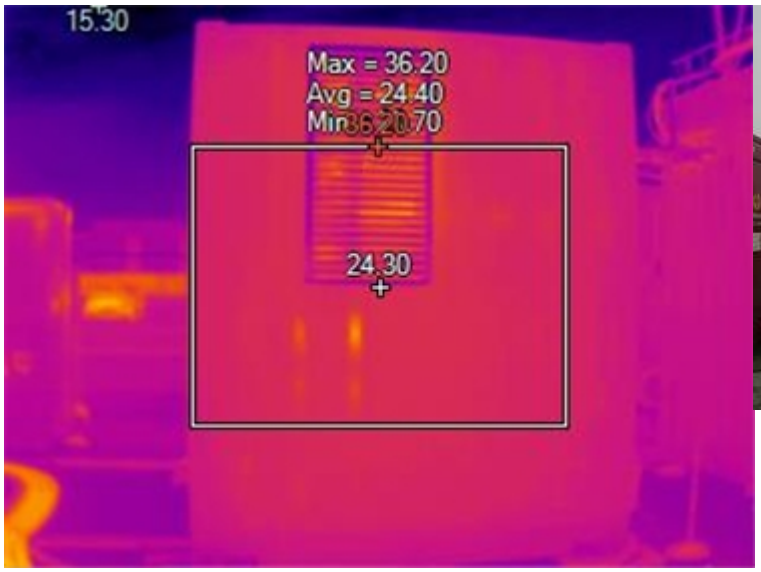




Image Info

Name	IR_00205.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	15.30 °C to 36.20 °C
Image Time	04/09/2024 11:15:41 AM
Asset Name	10ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	24.3 °C	24.3 °C	24.3 °C	0.95	22.0 °C	0.00	
Centerbox	36.2 °C	20.7 °C	24.4 °C	0.95	22.0 °C	0.71	
Hot	36.2 °C	36.2 °C	36.2 °C	0.95	22.0 °C	0.00	
Cold	15.3 °C	15.3 °C	15.3 °C	0.95	22.0 °C	0.00	

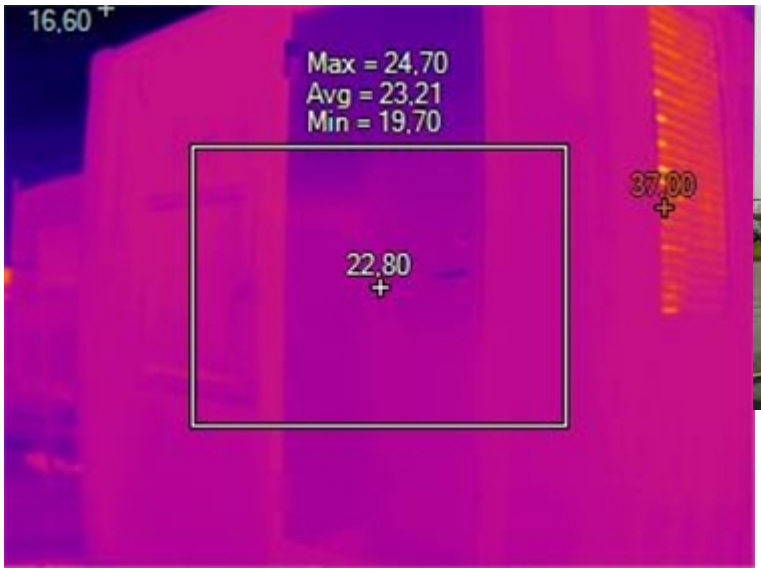




Image Info

Name	IR_00204.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	16,60 °C to 37,00 °C
Image Time	04/09/2024 11:15:27 AM
Asset Name	10ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22,8 °C	22,8 °C	22,8 °C	0,95	22,0 °C	0,00	
Centerbox	24,7 °C	19,7 °C	23,2 °C	0,95	22,0 °C	0,67	
Hot	37,0 °C	37,0 °C	37,0 °C	0,95	22,0 °C	0,00	
Cold	16,6 °C	16,6 °C	16,6 °C	0,95	22,0 °C	0,00	

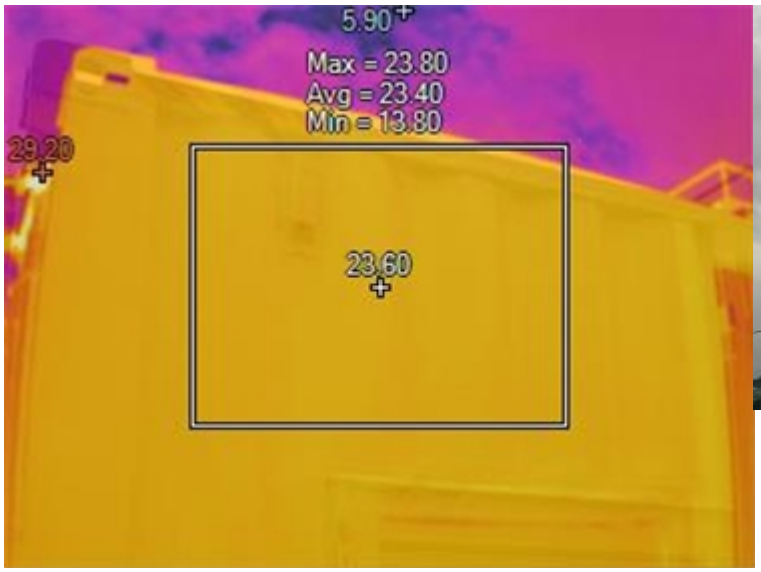




Image Info

Name	IR_00203.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	5.90 °C to 29.20 °C
Image Time	04/09/2024 11:15:10 AM
Asset Name	10ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.6 °C	23.6 °C	23.6 °C	0.95	22.0 °C	0.00	
Centerbox	23.8 °C	13.8 °C	23.4 °C	0.95	22.0 °C	0.74	
Hot	29.2 °C	29.2 °C	29.2 °C	0.95	22.0 °C	0.00	
Cold	5.9 °C	5.9 °C	5.9 °C	0.95	22.0 °C	0.00	

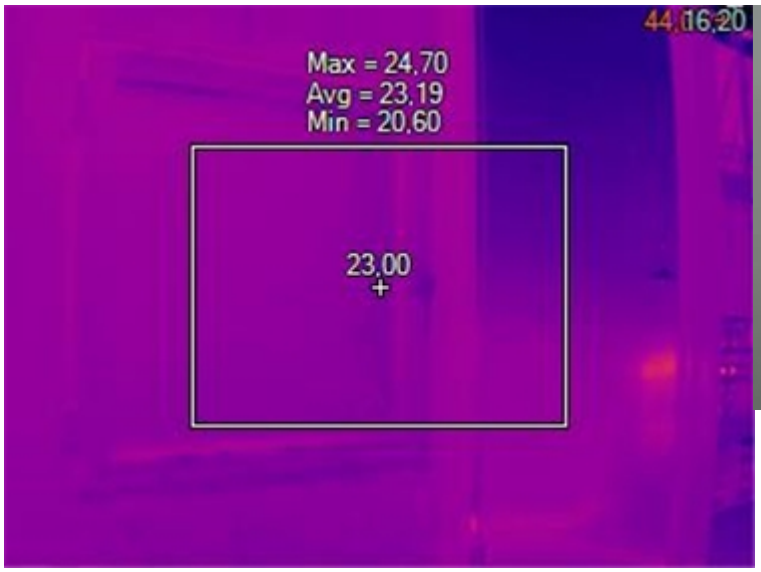




Image Info

Name	IR_00202.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	16,20 °C to 44,00 °C
Image Time	04/09/2024 11:15:01 AM
Asset Name	10ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,0 °C	23,0 °C	23,0 °C	0,95	22,0 °C	0,00	
Centerbox	24,7 °C	20,6 °C	23,2 °C	0,95	22,0 °C	0,73	
Hot	44,0 °C	44,0 °C	44,0 °C	0,95	22,0 °C	0,00	
Cold	16,2 °C	16,2 °C	16,2 °C	0,95	22,0 °C	0,00	

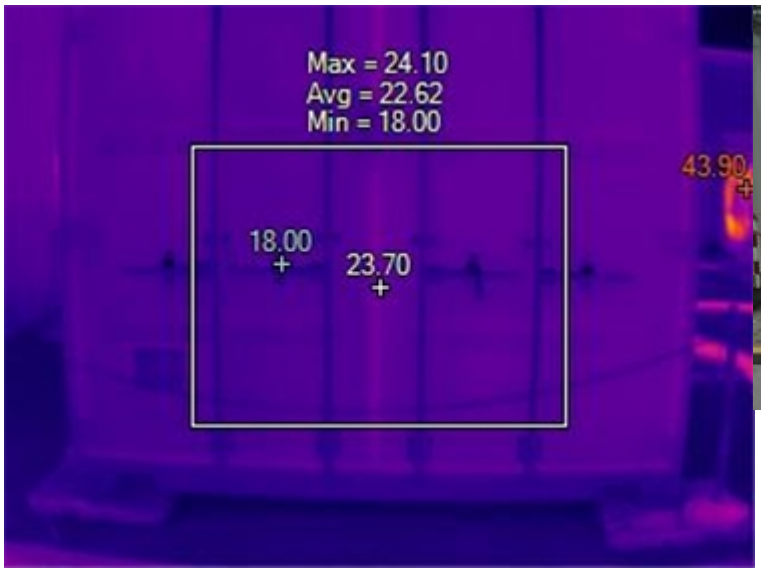




Image Info

Name	IR_00201.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	18.00 °C to 43.90 °C
Image Time	04/09/2024 11:14:23 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23.7 °C	23.7 °C	23.7 °C	0.95	22.0 °C	0.00	
Centerbox	24.1 °C	18.0 °C	22.6 °C	0.95	22.0 °C	0.46	
Hot	43.9 °C	43.9 °C	43.9 °C	0.95	22.0 °C	0.00	
Cold	18.0 °C	18.0 °C	18.0 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00200.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	9.80 °C to 35.70 °C
Image Time	04/09/2024 11:14:05 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	32.9 °C	32.9 °C	32.9 °C	0.95	22.0 °C	0.00	
Centerbox	35.7 °C	13.3 °C	21.7 °C	0.95	22.0 °C	5.19	
Hot	35.7 °C	35.7 °C	35.7 °C	0.95	22.0 °C	0.00	
Cold	9.8 °C	9.8 °C	9.8 °C	0.95	22.0 °C	0.00	

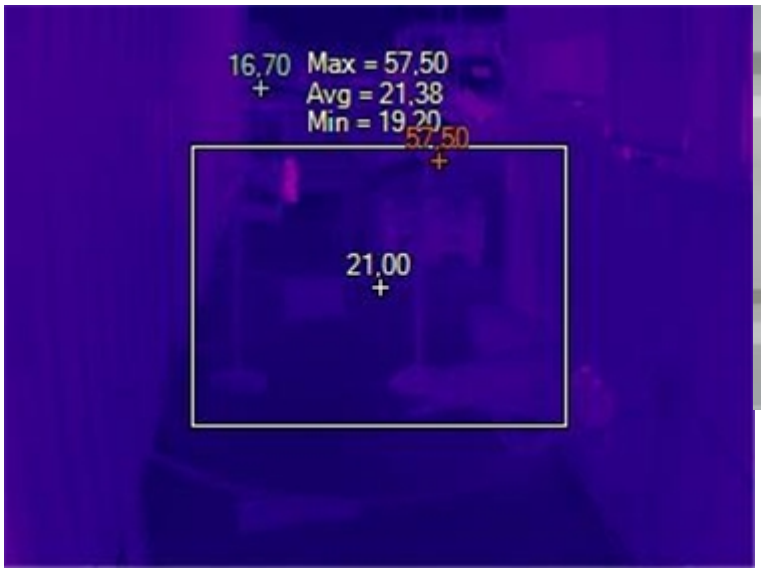




Image Info

Name	IR_00199.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	16,70 °C to 57,50 °C
Image Time	04/09/2024 11:13:51 AM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	21,0 °C	21,0 °C	21,0 °C	0,95	22,0 °C	0,00	
Centerbox	57,5 °C	19,2 °C	21,4 °C	0,95	22,0 °C	1,03	
Hot	57,5 °C	57,5 °C	57,5 °C	0,95	22,0 °C	0,00	
Cold	16,7 °C	16,7 °C	16,7 °C	0,95	22,0 °C	0,00	

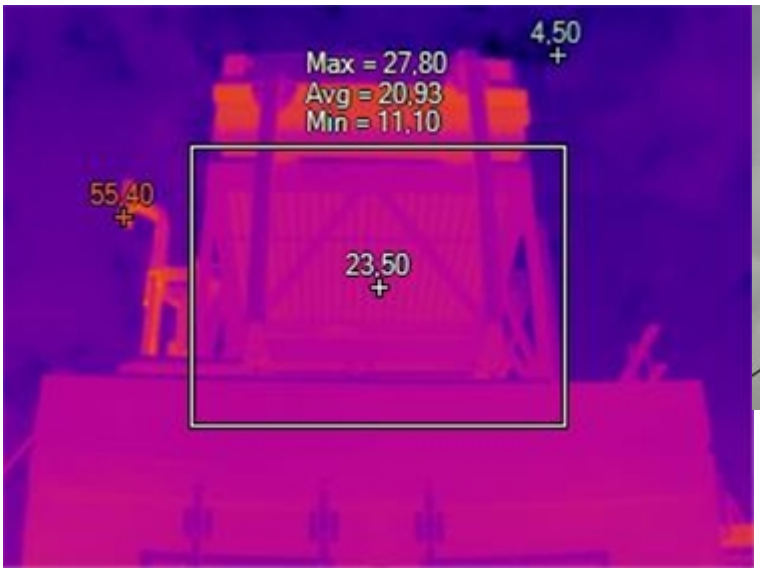




Image Info

Name	IR_00198.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Calibration Range	-10,00 °C to 550,00 °C
Image Range	4,50 °C to 55,40 °C
Image Time	04/09/2024 11:13:37 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	23,5 °C	23,5 °C	23,5 °C	0,95	22,0 °C	0,00	
Centerbox	27,8 °C	11,1 °C	20,9 °C	0,95	22,0 °C	2,73	
Hot	55,4 °C	55,4 °C	55,4 °C	0,95	22,0 °C	0,00	
Cold	4,5 °C	4,5 °C	4,5 °C	0,95	22,0 °C	0,00	

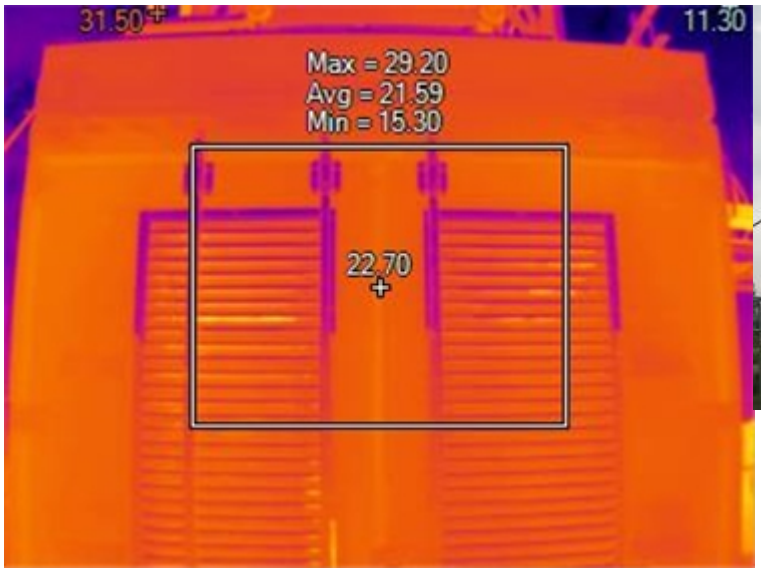




Image Info

Name	IR_00197.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Calibration Range	-10.00 °C to 550.00 °C
Image Range	11.30 °C to 31.50 °C
Image Time	04/09/2024 11:13:10 AM
Asset Name	40ft Container Exterior

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	22.7 °C	22.7 °C	22.7 °C	0.95	22.0 °C	0.00	
Centerbox	29.2 °C	15.3 °C	21.6 °C	0.95	22.0 °C	1.48	
Hot	31.5 °C	31.5 °C	31.5 °C	0.95	22.0 °C	0.00	
Cold	11.3 °C	11.3 °C	11.3 °C	0.95	22.0 °C	0.00	

Summary:

Date: 09/08/2024

Author: PBL

Ballard Power Systems Europe

Summary:

Thermograhic test of the Crosswind BLPH 1MW system

Entire power train included, from Fuel DCDC converters to AC output transformer.

Hottest item found is DC fuses at 70-75 degrees, which is within expected range.

No items found with elevated temperatures

Some images of test setup is included, but not inside Crosswind scope.

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Image Info

Name	IR_00190.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	14.50 °C to 53.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:39:16 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	36.0 °C	36.0 °C	36.0 °C	0.95	22.0 °C	0.00	
Centerbox	53.5 °C	19.5 °C	31.1 °C	0.95	22.0 °C	4.48	
Hot	53.5 °C	53.5 °C	53.5 °C	0.95	22.0 °C	0.00	
Cold	14.5 °C	14.5 °C	14.5 °C	0.95	22.0 °C	0.00	

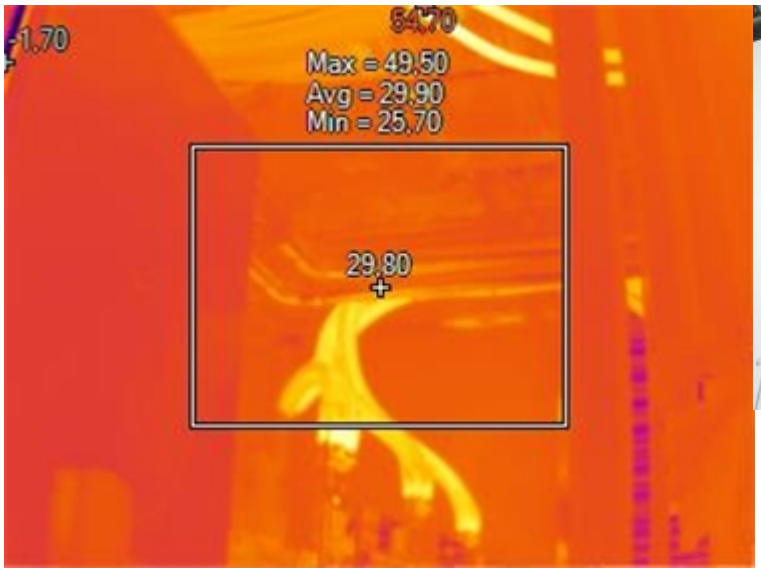




Image Info

Name	IR_00189.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	-1,70 °C to 54,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:39:07 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,8 °C	29,8 °C	29,8 °C	0,95	22,0 °C	0,00	
Centerbox	49,5 °C	25,7 °C	29,9 °C	0,95	22,0 °C	4,28	
Hot	54,7 °C	54,7 °C	54,7 °C	0,95	22,0 °C	0,00	
Cold	-1,7 °C	-1,7 °C	-1,7 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00188.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	17,50 °C to 53,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:39:01 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	52,5 °C	52,5 °C	52,5 °C	0,95	22,0 °C	0,00	
Centerbox	53,0 °C	20,0 °C	30,7 °C	0,95	22,0 °C	5,37	
Hot	53,0 °C	53,0 °C	53,0 °C	0,95	22,0 °C	0,00	
Cold	17,5 °C	17,5 °C	17,5 °C	0,95	22,0 °C	0,00	

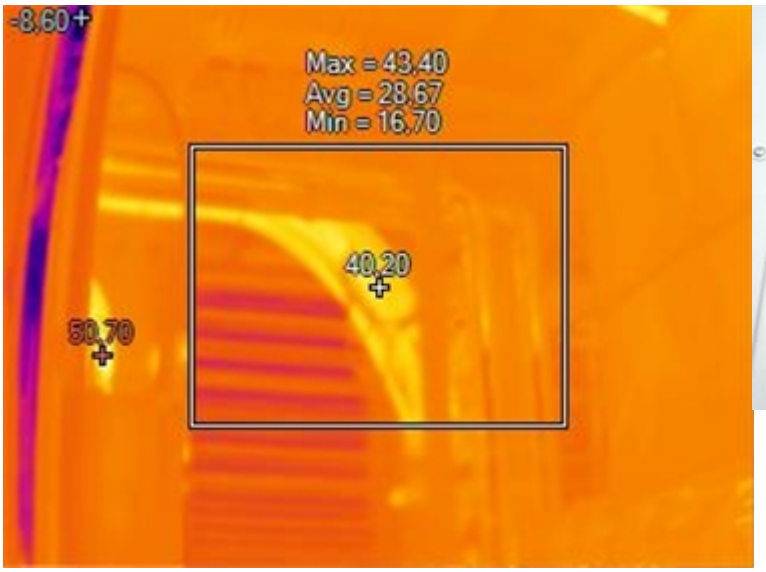




Image Info

Name	IR_00187.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	-8,60 °C to 50,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:38:43 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	40,2 °C	40,2 °C	40,2 °C	0,95	22,0 °C	0,00	
Centerbox	43,4 °C	16,7 °C	28,7 °C	0,95	22,0 °C	5,00	
Hot	50,7 °C	50,7 °C	50,7 °C	0,95	22,0 °C	0,00	
Cold	-8,6 °C	-8,6 °C	-8,6 °C	0,95	22,0 °C	0,00	

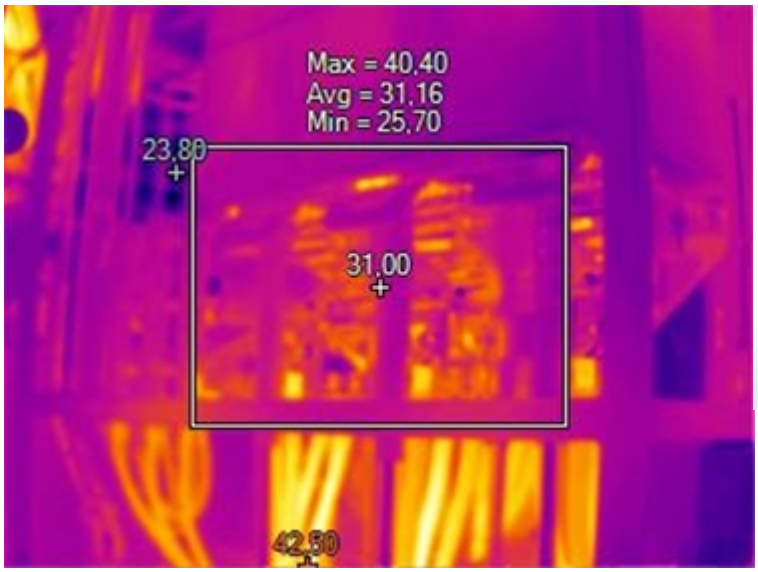




Image Info

Name	IR_00186.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	23,80 °C to 42,50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:38:30 PM

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31,0 °C	31,0 °C	31,0 °C	0,95	22,0 °C	0,00	
Centerbox	40,4 °C	25,7 °C	31,2 °C	0,95	22,0 °C	1,78	
Hot	42,5 °C	42,5 °C	42,5 °C	0,95	22,0 °C	0,00	
Cold	23,8 °C	23,8 °C	23,8 °C	0,95	22,0 °C	0,00	

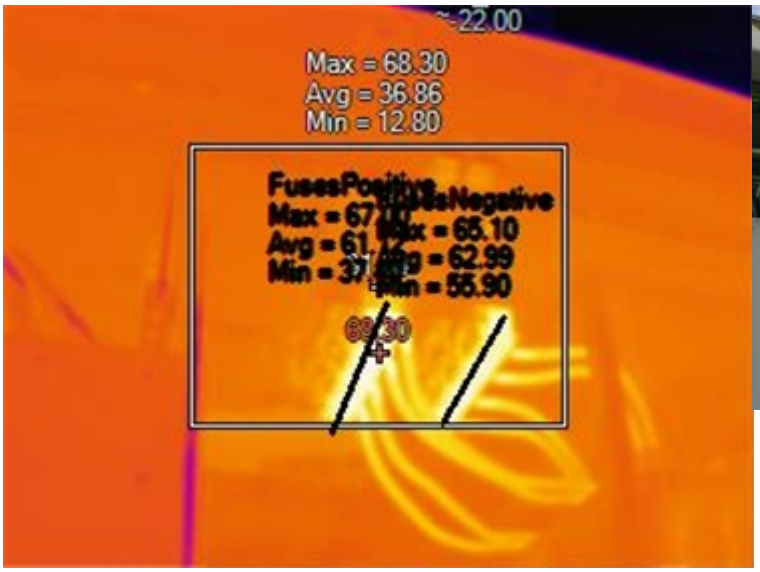




Image Info

Name	IR_00185.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	~-22.00 °C to 68.30 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:38:21 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.0 °C	31.0 °C	31.0 °C	0.95	22.0 °C	0.00	
Centerbox	68.3 °C	12.8 °C	36.9 °C	0.95	22.0 °C	9.49	
Hot	68.3 °C	68.3 °C	68.3 °C	0.95	22.0 °C	0.00	
Cold	-22.0 °C	-22.0 °C	-22.0 °C	0.95	22.0 °C	0.00	
FusesPositive	67.0 °C	37.4 °C	61.1 °C	0.95	22.0 °C	8.12	
FusesNegative	65.1 °C	55.9 °C	63.0 °C	0.95	22.0 °C	1.76	

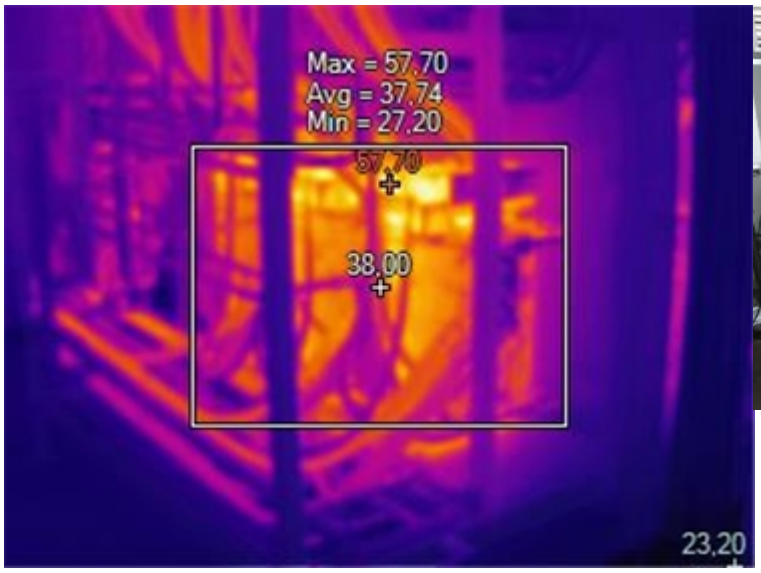




Image Info

Name	IR_00184.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	23,20 °C to 57,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:38:12 PM
Asset Name	PowerTrain
Asset Group	PowerTrain > DA03 10ft Container > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	38,0 °C	38,0 °C	38,0 °C	0,95	22,0 °C	0,00	
Centerbox	57,7 °C	27,2 °C	37,7 °C	0,95	22,0 °C	6,38	
Hot	57,7 °C	57,7 °C	57,7 °C	0,95	22,0 °C	0,00	
Cold	23,2 °C	23,2 °C	23,2 °C	0,95	22,0 °C	0,00	

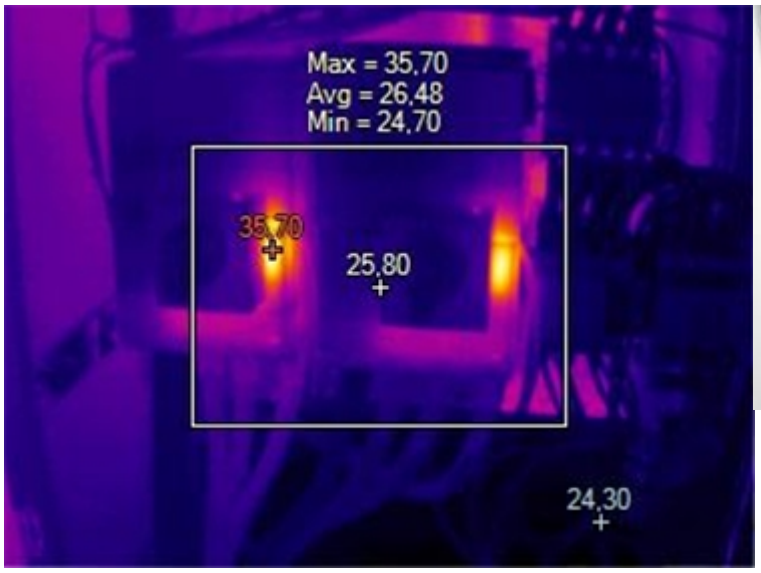




Image Info

Name	IR_00183.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	24,30 °C to 35,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:36:24 PM
Asset Name	UC50 Aux AC Cabinet
Asset Group	UC50 Aux AC Cabinet > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25,8 °C	25,8 °C	25,8 °C	0,95	22,0 °C	0,00	
Centerbox	35,7 °C	24,7 °C	26,5 °C	0,95	22,0 °C	1,52	
Hot	35,7 °C	35,7 °C	35,7 °C	0,95	22,0 °C	0,00	
Cold	24,3 °C	24,3 °C	24,3 °C	0,95	22,0 °C	0,00	

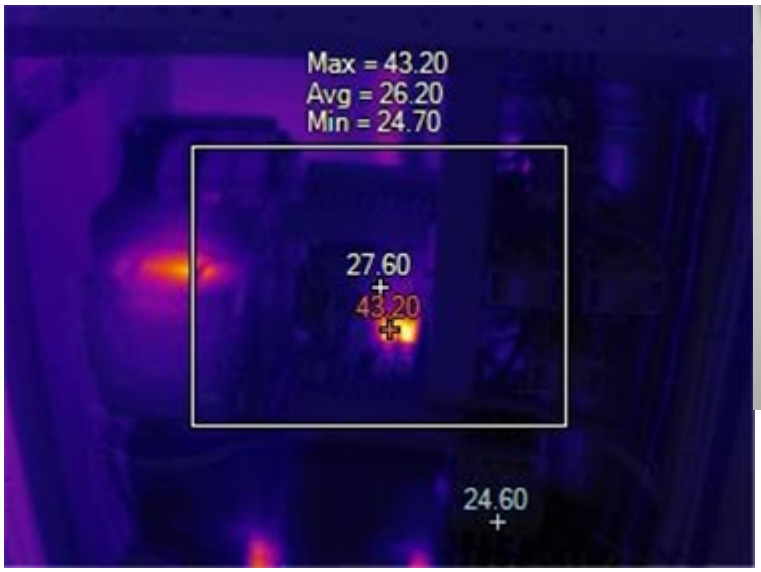




Image Info

Name	IR_00182.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	24.60 °C to 43.20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:36:15 PM
Asset Name	UC50 Aux AC Cabinet
Asset Group	UC50 Aux AC Cabinet > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27.6 °C	27.6 °C	27.6 °C	0.95	22.0 °C	0.00	
Centerbox	43.2 °C	24.7 °C	26.2 °C	0.95	22.0 °C	1.57	
Hot	43.2 °C	43.2 °C	43.2 °C	0.95	22.0 °C	0.00	
Cold	24.6 °C	24.6 °C	24.6 °C	0.95	22.0 °C	0.00	

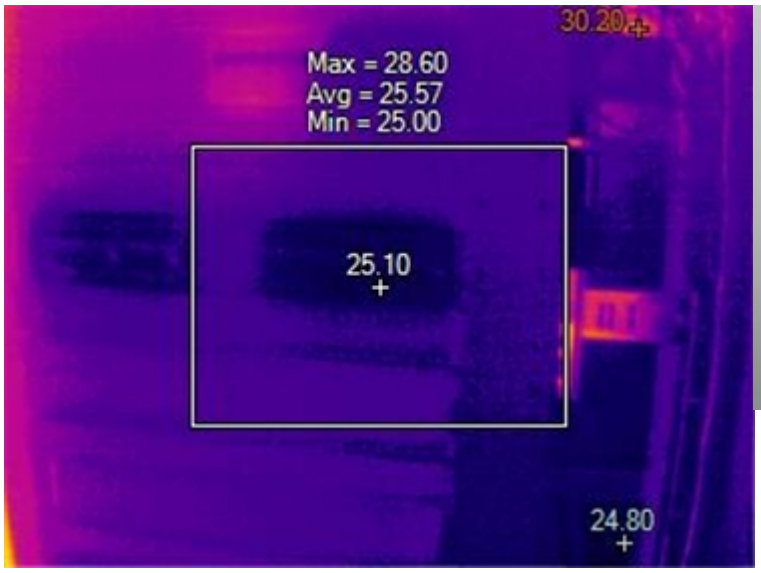




Image Info

Name	IR_00181.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	24.80 °C to 30.20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:36:10 PM
Asset Name	UC50 Aux AC Cabinet
Asset Group	UC50 Aux AC Cabinet > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25.1 °C	25.1 °C	25.1 °C	0.95	22.0 °C	0.00	
Centerbox	28.6 °C	25.0 °C	25.6 °C	0.95	22.0 °C	0.27	
Hot	30.2 °C	30.2 °C	30.2 °C	0.95	22.0 °C	0.00	
Cold	24.8 °C	24.8 °C	24.8 °C	0.95	22.0 °C	0.00	

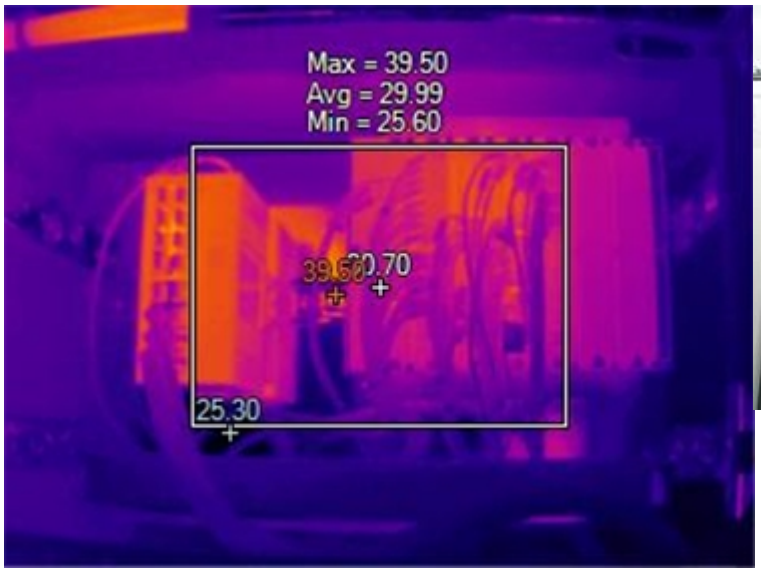




Image Info

Name	IR_00180.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.30 °C to 39.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:36:04 PM
Asset Name	UC50 Aux AC Cabinet
Asset Group	UC50 Aux AC Cabinet > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	30.7 °C	30.7 °C	30.7 °C	0.95	22.0 °C	0.00	
Centerbox	39.5 °C	25.6 °C	30.0 °C	0.95	22.0 °C	1.76	
Hot	39.5 °C	39.5 °C	39.5 °C	0.95	22.0 °C	0.00	
Cold	25.3 °C	25.3 °C	25.3 °C	0.95	22.0 °C	0.00	

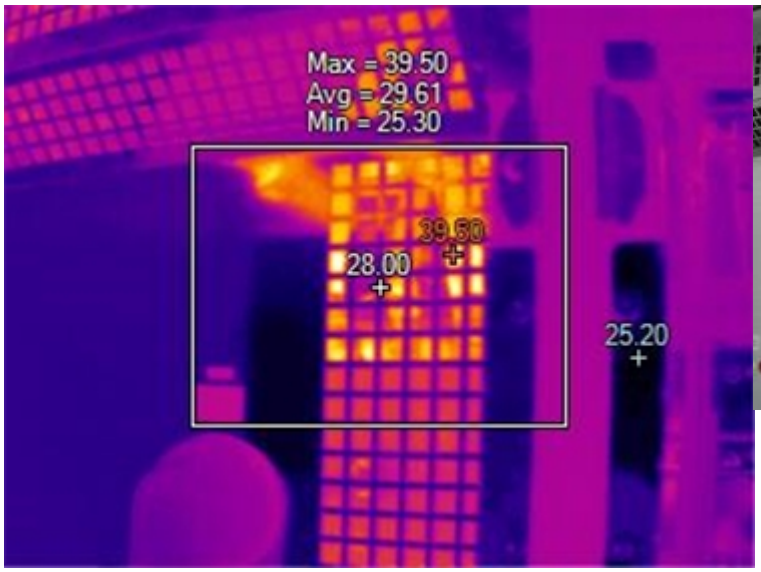


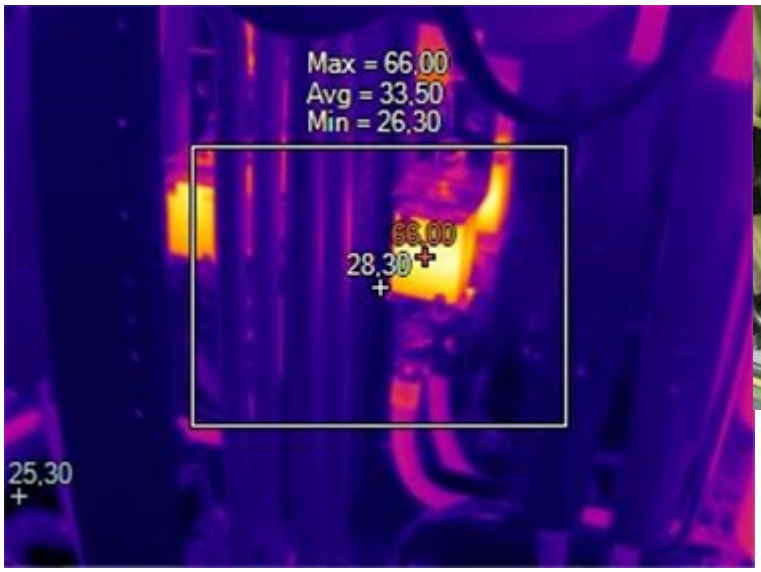


Image Info

Name	IR_00179.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.20 °C to 39.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:35:14 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.0 °C	28.0 °C	28.0 °C	0.95	22.0 °C	0.00	
Centerbox	39.5 °C	25.3 °C	29.6 °C	0.95	22.0 °C	2.95	
Hot	39.5 °C	39.5 °C	39.5 °C	0.95	22.0 °C	0.00	
Cold	25.2 °C	25.2 °C	25.2 °C	0.95	22.0 °C	0.00	



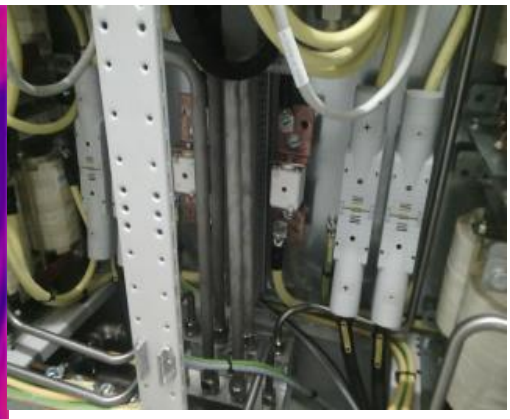
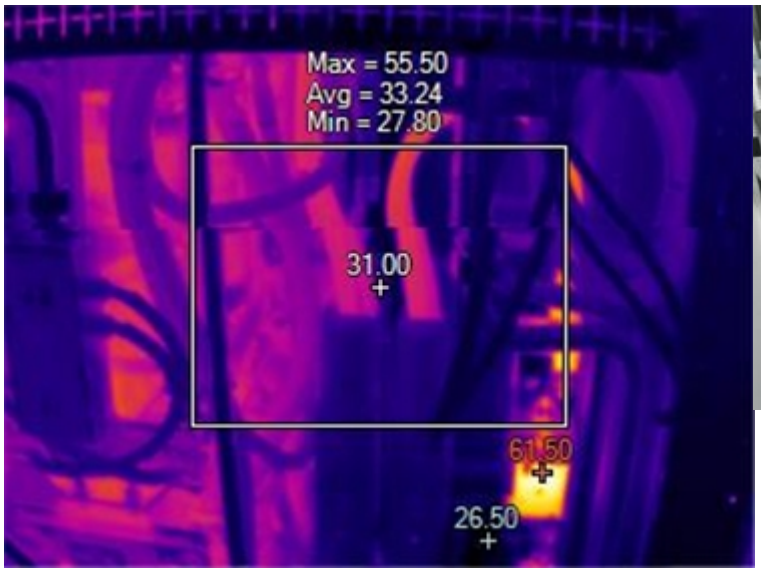


Image Info

Name	IR_00178.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,30 °C to 66,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:35:07 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28,3 °C	28,3 °C	28,3 °C	0,95	22,0 °C	0,00	
Centerbox	66,0 °C	26,3 °C	33,5 °C	0,95	22,0 °C	8,35	
Hot	66,0 °C	66,0 °C	66,0 °C	0,95	22,0 °C	0,00	
Cold	25,3 °C	25,3 °C	25,3 °C	0,95	22,0 °C	0,00	



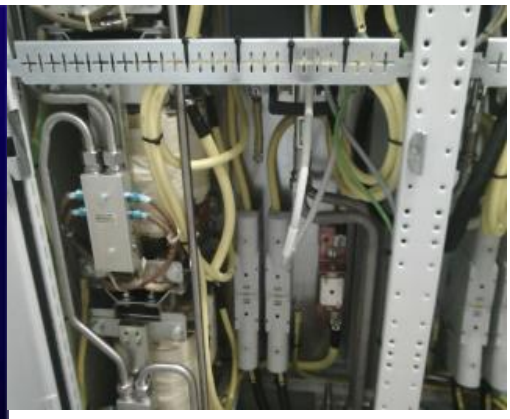


Image Info

Name	IR_00177.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.50 °C to 61.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:35:01 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.0 °C	31.0 °C	31.0 °C	0.95	22.0 °C	0.00	
Centerbox	55.5 °C	27.8 °C	33.2 °C	0.95	22.0 °C	4.10	
Hot	61.5 °C	61.5 °C	61.5 °C	0.95	22.0 °C	0.00	
Cold	26.5 °C	26.5 °C	26.5 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00176.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	26,20 °C to 44,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:34:54 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	34,5 °C	34,5 °C	34,5 °C	0,95	22,0 °C	0,00	
Centerbox	44,0 °C	27,1 °C	34,3 °C	0,95	22,0 °C	3,56	
Hot	44,0 °C	44,0 °C	44,0 °C	0,95	22,0 °C	0,00	
Cold	26,2 °C	26,2 °C	26,2 °C	0,95	22,0 °C	0,00	

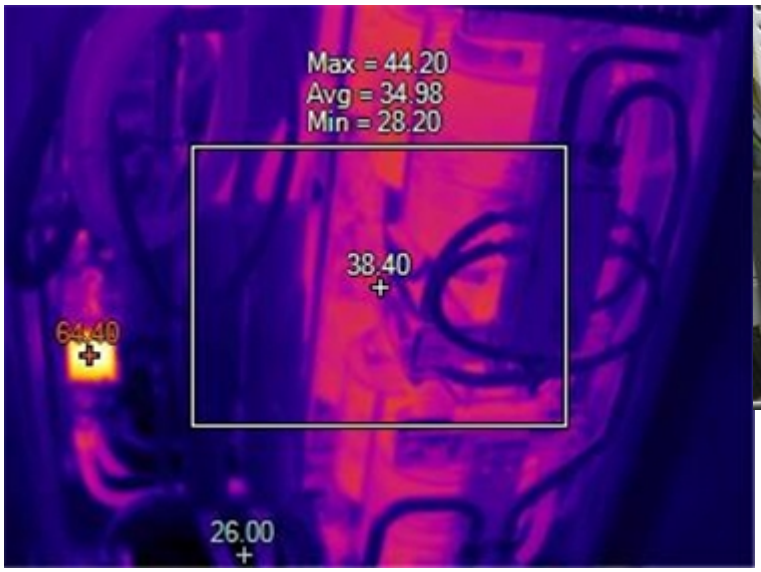




Image Info

Name	IR_00175.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.00 °C to 64.40 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:34:45 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	38.4 °C	38.4 °C	38.4 °C	0.95	22.0 °C	0.00	
Centerbox	44.2 °C	28.2 °C	35.0 °C	0.95	22.0 °C	4.79	
Hot	64.4 °C	64.4 °C	64.4 °C	0.95	22.0 °C	0.00	
Cold	26.0 °C	26.0 °C	26.0 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00174.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	27.50 °C to 43.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:34:39 PM
Asset Name	DCDC Converter 6
Asset Group	DCDC Converter 6 > UC06 DCDC Cabinet #6 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	32.0 °C	32.0 °C	32.0 °C	0.95	22.0 °C	0.00	
Centerbox	43.5 °C	27.7 °C	34.0 °C	0.95	22.0 °C	3.99	
Hot	43.5 °C	43.5 °C	43.5 °C	0.95	22.0 °C	0.00	
Cold	27.5 °C	27.5 °C	27.5 °C	0.95	22.0 °C	0.00	

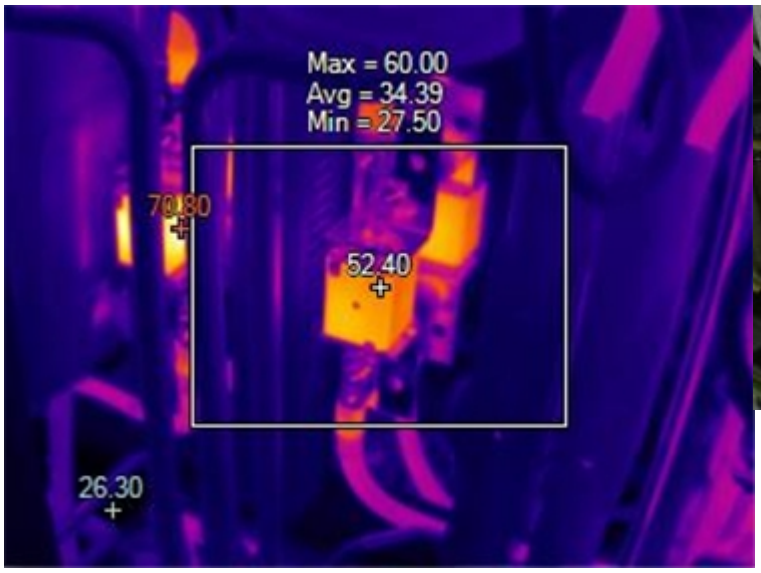


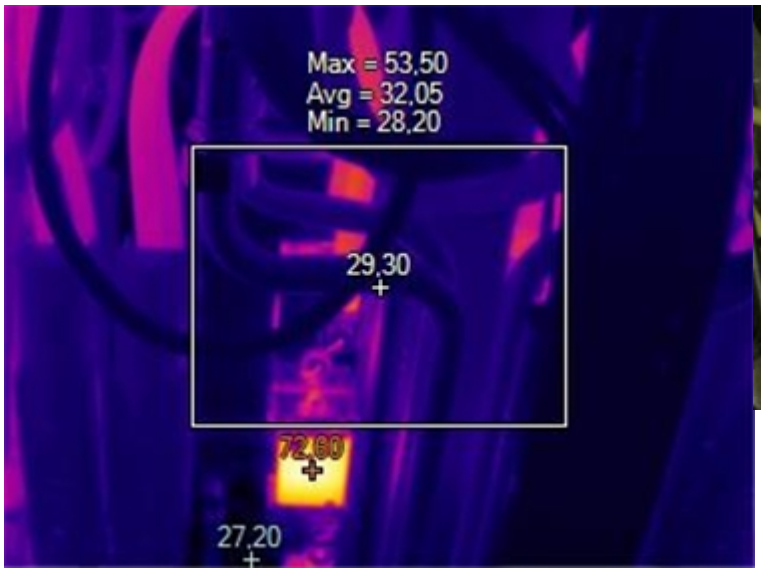


Image Info

Name	IR_00173.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.30 °C to 70.80 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:43 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	52.4 °C	52.4 °C	52.4 °C	0.95	22.0 °C	0.00	
Centerbox	60.0 °C	27.5 °C	34.4 °C	0.95	22.0 °C	7.82	
Hot	70.8 °C	70.8 °C	70.8 °C	0.95	22.0 °C	0.00	
Cold	26.3 °C	26.3 °C	26.3 °C	0.95	22.0 °C	0.00	



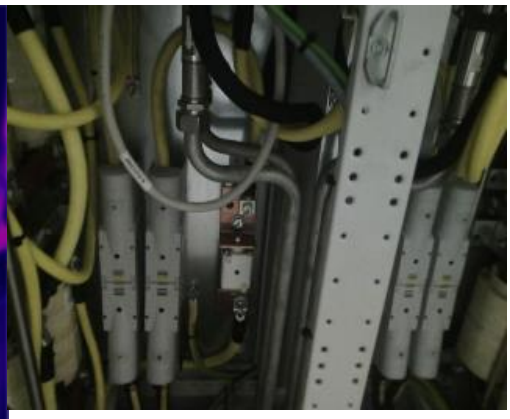


Image Info

Name	IR_00172.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	27,20 °C to 72,60 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:34 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,3 °C	29,3 °C	29,3 °C	0,95	22,0 °C	0,00	
Centerbox	53,5 °C	28,2 °C	32,0 °C	0,95	22,0 °C	3,91	
Hot	72,6 °C	72,6 °C	72,6 °C	0,95	22,0 °C	0,00	
Cold	27,2 °C	27,2 °C	27,2 °C	0,95	22,0 °C	0,00	



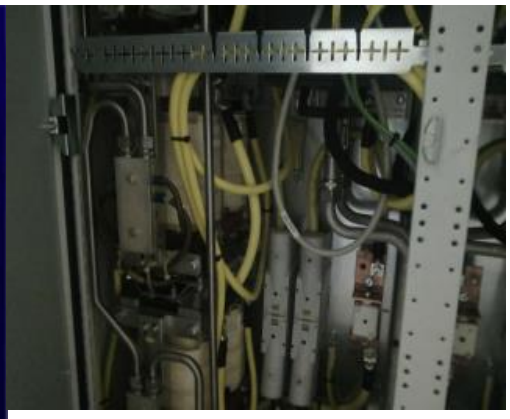


Image Info

Name	IR_00171.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.30 °C to 71.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:25 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	34.5 °C	34.5 °C	34.5 °C	0.95	22.0 °C	0.00	
Centerbox	44.2 °C	27.7 °C	34.6 °C	0.95	22.0 °C	3.91	
Hot	71.5 °C	71.5 °C	71.5 °C	0.95	22.0 °C	0.00	
Cold	26.3 °C	26.3 °C	26.3 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00170.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,80 °C to 44,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:18 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	32,0 °C	32,0 °C	32,0 °C	0,95	22,0 °C	0,00	
Centerbox	44,2 °C	28,3 °C	33,5 °C	0,95	22,0 °C	3,59	
Hot	44,7 °C	44,7 °C	44,7 °C	0,95	22,0 °C	0,00	
Cold	25,8 °C	25,8 °C	25,8 °C	0,95	22,0 °C	0,00	

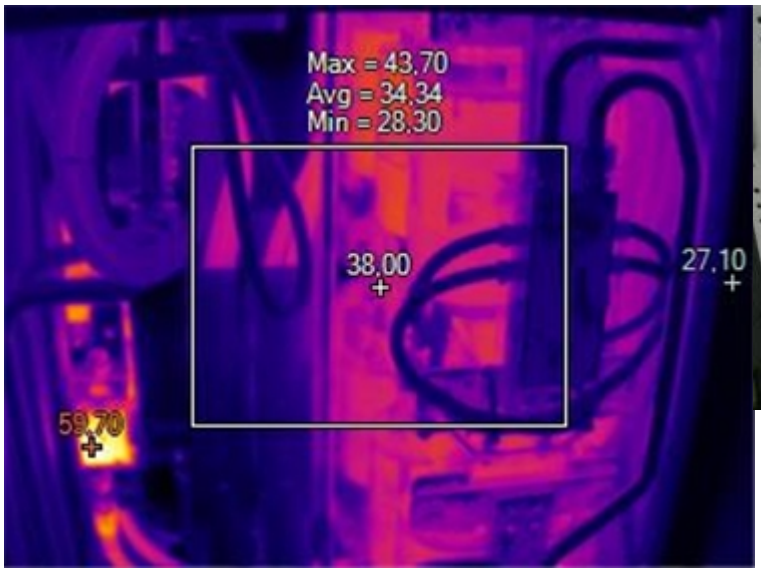




Image Info

Name	IR_00169.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	27,10 °C to 59,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:13 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	38,0 °C	38,0 °C	38,0 °C	0,95	22,0 °C	0,00	
Centerbox	43,7 °C	28,3 °C	34,3 °C	0,95	22,0 °C	4,34	
Hot	59,7 °C	59,7 °C	59,7 °C	0,95	22,0 °C	0,00	
Cold	27,1 °C	27,1 °C	27,1 °C	0,95	22,0 °C	0,00	

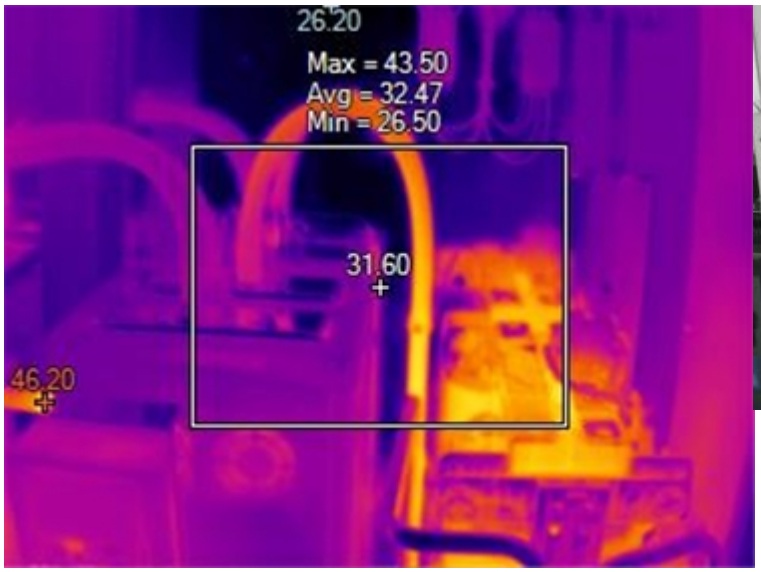




Image Info

Name	IR_00168.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.20 °C to 46.20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:33:07 PM
Asset Name	DCDC Converter 5
Asset Group	DCDC Converter 5 > UC05 DCDC Cabinet #5 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.6 °C	31.6 °C	31.6 °C	0.95	22.0 °C	0.00	
Centerbox	43.5 °C	26.5 °C	32.5 °C	0.95	22.0 °C	4.14	
Hot	46.2 °C	46.2 °C	46.2 °C	0.95	22.0 °C	0.00	
Cold	26.2 °C	26.2 °C	26.2 °C	0.95	22.0 °C	0.00	

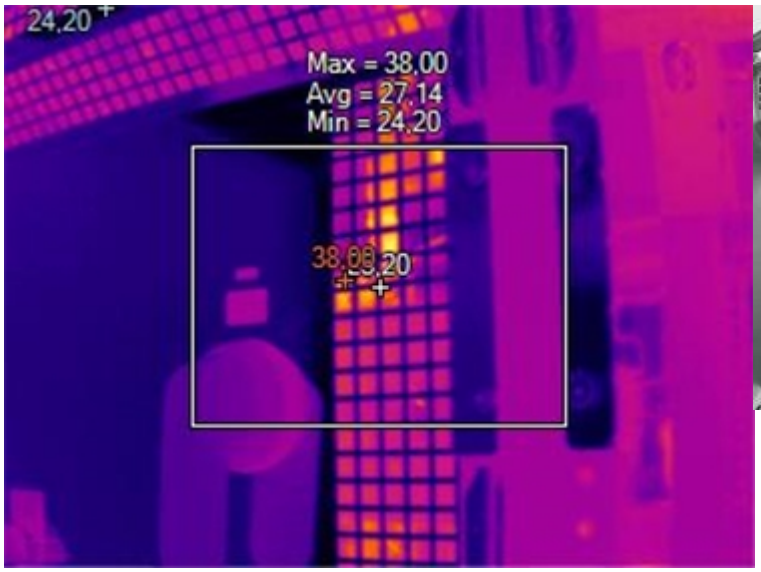




Image Info

Name	IR_00167.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	24,20 °C to 38,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:32:09 PM
Asset Name	DCDC Converter 4
Asset Group	DCDC Converter 4 > UC04 DCDC Cabinet #4 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	25,2 °C	25,2 °C	25,2 °C	0,95	22,0 °C	0,00	
Centerbox	38,0 °C	24,2 °C	27,1 °C	0,95	22,0 °C	1,86	
Hot	38,0 °C	38,0 °C	38,0 °C	0,95	22,0 °C	0,00	
Cold	24,2 °C	24,2 °C	24,2 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00166.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.70 °C to 42.90 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:32:01 PM
Asset Name	DCDC Converter 4
Asset Group	DCDC Converter 4 > UC04 DCDC Cabinet #4 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	32.7 °C	32.7 °C	32.7 °C	0.95	22.0 °C	0.00	
Centerbox	42.9 °C	25.7 °C	32.0 °C	0.95	22.0 °C	3.97	
Hot	42.9 °C	42.9 °C	42.9 °C	0.95	22.0 °C	0.00	
Cold	25.7 °C	25.7 °C	25.7 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00165.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	24.50 °C to 43.70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:31:56 PM
Asset Name	DCDC Converter 4
Asset Group	DCDC Converter 4 > UC04 DCDC Cabinet #4 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	30.7 °C	30.7 °C	30.7 °C	0.95	22.0 °C	0.00	
Centerbox	43.7 °C	27.2 °C	32.8 °C	0.95	22.0 °C	3.63	
Hot	43.7 °C	43.7 °C	43.7 °C	0.95	22.0 °C	0.00	
Cold	24.5 °C	24.5 °C	24.5 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00164.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	26,20 °C to 43,50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:31:49 PM
Asset Name	DCDC Converter 4
Asset Group	DCDC Converter 4 > UC04 DCDC Cabinet #4 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	30,3 °C	30,3 °C	30,3 °C	0,95	22,0 °C	0,00	
Centerbox	43,5 °C	26,7 °C	32,6 °C	0,95	22,0 °C	4,36	
Hot	43,5 °C	43,5 °C	43,5 °C	0,95	22,0 °C	0,00	
Cold	26,2 °C	26,2 °C	26,2 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00163.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,30 °C to 43,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:31:43 PM
Asset Name	DCDC Converter 4
Asset Group	DCDC Converter 4 > UC04 DCDC Cabinet #4 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	32,5 °C	32,5 °C	32,5 °C	0,95	22,0 °C	0,00	
Centerbox	43,0 °C	25,7 °C	32,2 °C	0,95	22,0 °C	3,73	
Hot	43,0 °C	43,0 °C	43,0 °C	0,95	22,0 °C	0,00	
Cold	25,3 °C	25,3 °C	25,3 °C	0,95	22,0 °C	0,00	

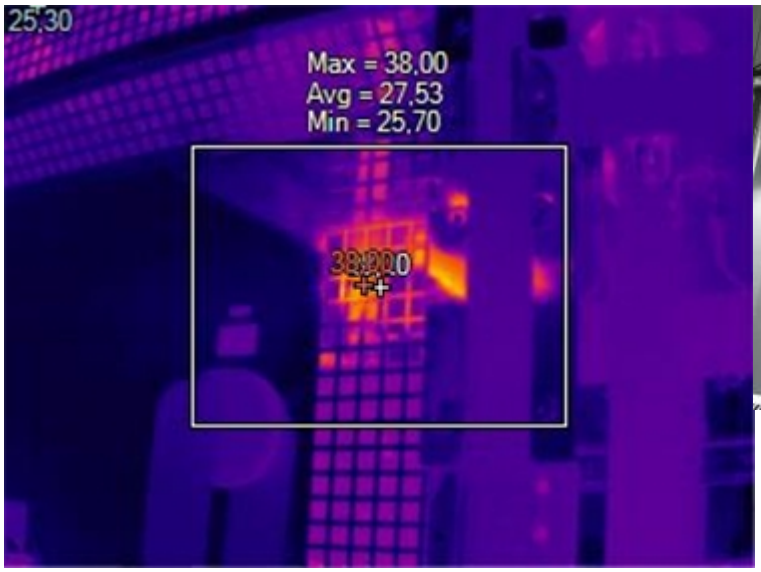




Image Info

Name	IR_00162.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,30 °C to 38,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:30:34 PM
Asset Name	DCDC Converter 3
Asset Group	DCDC Converter 3 > UC03 DCDC Cabinet #3 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28,2 °C	28,2 °C	28,2 °C	0,95	22,0 °C	0,00	
Centerbox	38,0 °C	25,7 °C	27,5 °C	0,95	22,0 °C	1,61	
Hot	38,0 °C	38,0 °C	38,0 °C	0,95	22,0 °C	0,00	
Cold	25,3 °C	25,3 °C	25,3 °C	0,95	22,0 °C	0,00	

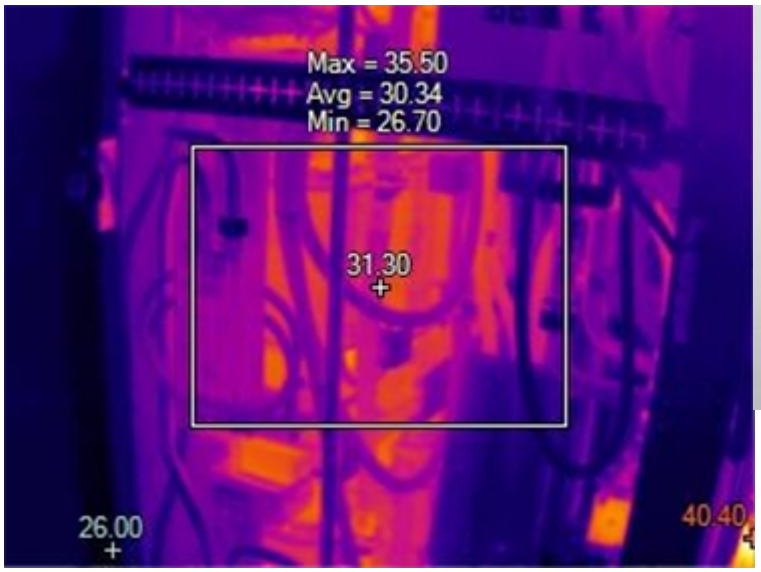




Image Info

Name	IR_00161.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	26.00 °C to 40.40 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:30:22 PM
Asset Name	DCDC Converter 3
Asset Group	DCDC Converter 3 > UC03 DCDC Cabinet #3 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.3 °C	31.3 °C	31.3 °C	0.95	22.0 °C	0.00	
Centerbox	35.5 °C	26.7 °C	30.3 °C	0.95	22.0 °C	1.65	
Hot	40.4 °C	40.4 °C	40.4 °C	0.95	22.0 °C	0.00	
Cold	26.0 °C	26.0 °C	26.0 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00160.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.60 °C to 36.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:30:16 PM
Asset Name	DCDC Converter 3
Asset Group	DCDC Converter 3 > UC03 DCDC Cabinet #3 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.5 °C	28.5 °C	28.5 °C	0.95	22.0 °C	0.00	
Centerbox	36.5 °C	26.7 °C	29.9 °C	0.95	22.0 °C	1.97	
Hot	36.5 °C	36.5 °C	36.5 °C	0.95	22.0 °C	0.00	
Cold	25.6 °C	25.6 °C	25.6 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00159.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.20 °C to 41.00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:30:07 PM
Asset Name	DCDC Converter 3
Asset Group	DCDC Converter 3 > UC03 DCDC Cabinet #3 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27.7 °C	27.7 °C	27.7 °C	0.95	22.0 °C	0.00	
Centerbox	41.0 °C	25.8 °C	29.5 °C	0.95	22.0 °C	2.41	
Hot	41.0 °C	41.0 °C	41.0 °C	0.95	22.0 °C	0.00	
Cold	25.2 °C	25.2 °C	25.2 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00158.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,10 °C to 34,40 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:30:02 PM
Asset Name	DCDC Converter 3
Asset Group	DCDC Converter 3 > UC03 DCDC Cabinet #3 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31,7 °C	31,7 °C	31,7 °C	0,95	22,0 °C	0,00	
Centerbox	34,4 °C	26,2 °C	30,1 °C	0,95	22,0 °C	1,63	
Hot	34,4 °C	34,4 °C	34,4 °C	0,95	22,0 °C	0,00	
Cold	25,1 °C	25,1 °C	25,1 °C	0,95	22,0 °C	0,00	

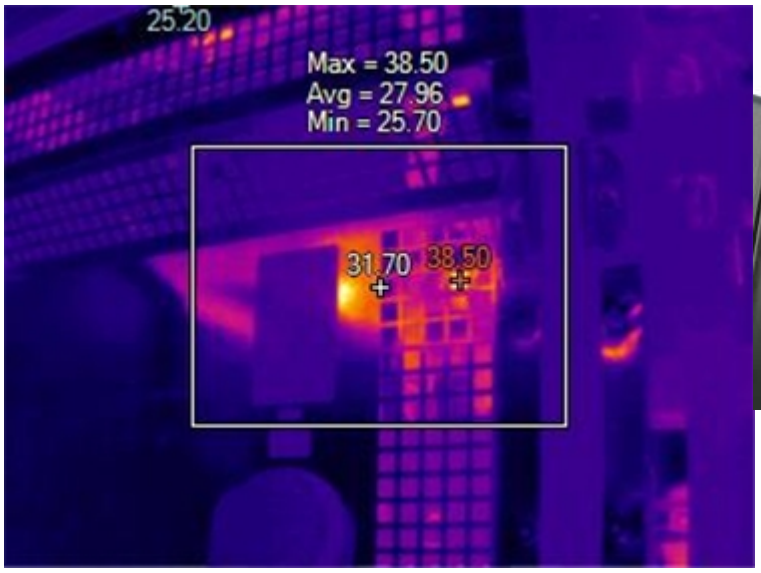




Image Info

Name	IR_00157.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.20 °C to 38.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:28:25 PM
Asset Name	DCDC Converter 2
Asset Group	DCDC Converter 2 > UC02 DCDC Cabinet #2 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.7 °C	31.7 °C	31.7 °C	0.95	22.0 °C	0.00	
Centerbox	38.5 °C	25.7 °C	28.0 °C	0.95	22.0 °C	1.71	
Hot	38.5 °C	38.5 °C	38.5 °C	0.95	22.0 °C	0.00	
Cold	25.2 °C	25.2 °C	25.2 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00156.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,80 °C to 35,70 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:28:13 PM
Asset Name	DCDC Converter 2
Asset Group	DCDC Converter 2 > UC02 DCDC Cabinet #2 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31,7 °C	31,7 °C	31,7 °C	0,95	22,0 °C	0,00	
Centerbox	34,0 °C	27,1 °C	29,9 °C	0,95	22,0 °C	1,34	
Hot	35,7 °C	35,7 °C	35,7 °C	0,95	22,0 °C	0,00	
Cold	25,8 °C	25,8 °C	25,8 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00155.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,30 °C to 35,50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:28:08 PM
Asset Name	DCDC Converter 2
Asset Group	DCDC Converter 2 > UC02 DCDC Cabinet #2 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,8 °C	29,8 °C	29,8 °C	0,95	22,0 °C	0,00	
Centerbox	35,5 °C	27,2 °C	29,7 °C	0,95	22,0 °C	1,43	
Hot	35,5 °C	35,5 °C	35,5 °C	0,95	22,0 °C	0,00	
Cold	25,3 °C	25,3 °C	25,3 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00154.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	24.70 °C to 34.40 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:28:00 PM
Asset Name	DCDC Converter 2
Asset Group	DCDC Converter 2 > UC02 DCDC Cabinet #2 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	31.0 °C	31.0 °C	31.0 °C	0.95	22.0 °C	0.00	
Centerbox	34.4 °C	25.8 °C	29.5 °C	0.95	22.0 °C	1.64	
Hot	34.4 °C	34.4 °C	34.4 °C	0.95	22.0 °C	0.00	
Cold	24.7 °C	24.7 °C	24.7 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00153.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.20 °C to 34.40 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:27:54 PM
Asset Name	DCDC Converter 2
Asset Group	DCDC Converter 2 > UC02 DCDC Cabinet #2 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	30.3 °C	30.3 °C	30.3 °C	0.95	22.0 °C	0.00	
Centerbox	33.5 °C	26.5 °C	29.6 °C	0.95	22.0 °C	1.38	
Hot	34.4 °C	34.4 °C	34.4 °C	0.95	22.0 °C	0.00	
Cold	25.2 °C	25.2 °C	25.2 °C	0.95	22.0 °C	0.00	

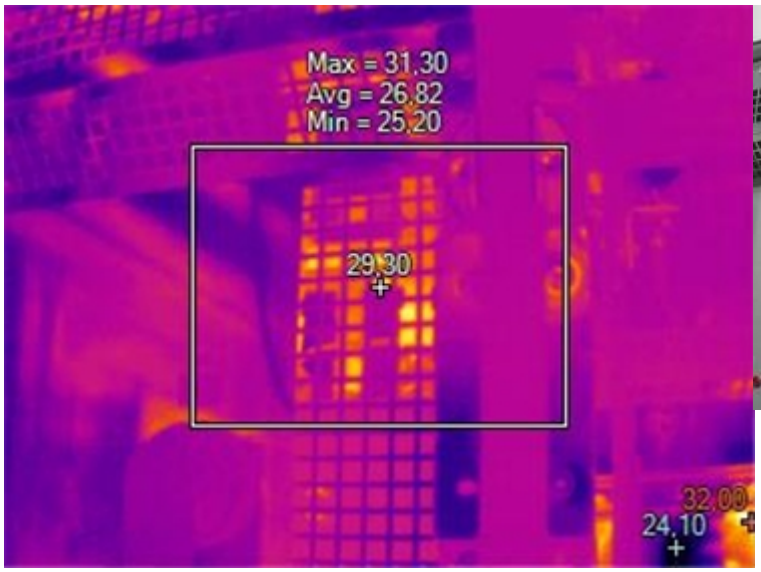




Image Info

Name	IR_00152.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	24,10 °C to 32,00 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:26:45 PM
Asset Name	DCDC Converter
Asset Group	DCDC Converter > UC01 DCDC Cabinet #1 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,3 °C	29,3 °C	29,3 °C	0,95	22,0 °C	0,00	
Centerbox	31,3 °C	25,2 °C	26,8 °C	0,95	22,0 °C	0,81	
Hot	32,0 °C	32,0 °C	32,0 °C	0,95	22,0 °C	0,00	
Cold	24,1 °C	24,1 °C	24,1 °C	0,95	22,0 °C	0,00	

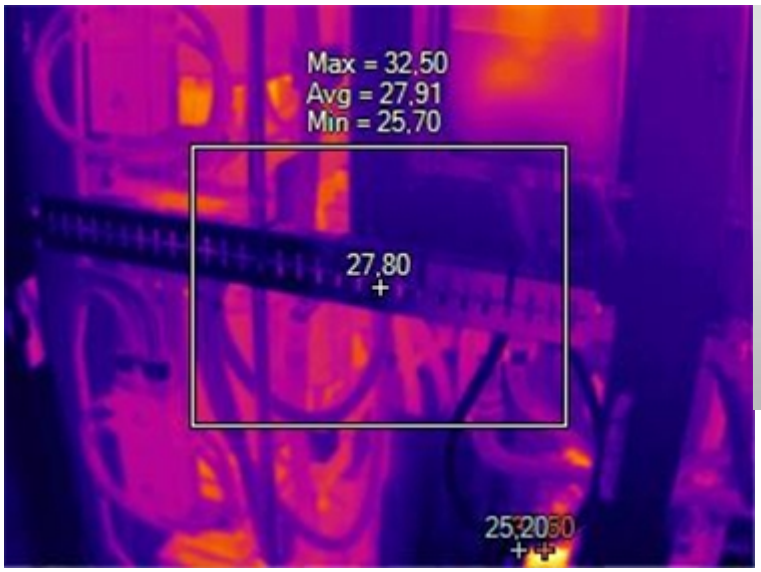




Image Info

Name	IR_00151.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,20 °C to 37,50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:26:31 PM
Asset Name	DCDC Converter
Asset Group	DCDC Converter > UC01 DCDC Cabinet #1 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27,8 °C	27,8 °C	27,8 °C	0,95	22,0 °C	0,00	
Centerbox	32,5 °C	25,7 °C	27,9 °C	0,95	22,0 °C	1,36	
Hot	37,5 °C	37,5 °C	37,5 °C	0,95	22,0 °C	0,00	
Cold	25,2 °C	25,2 °C	25,2 °C	0,95	22,0 °C	0,00	

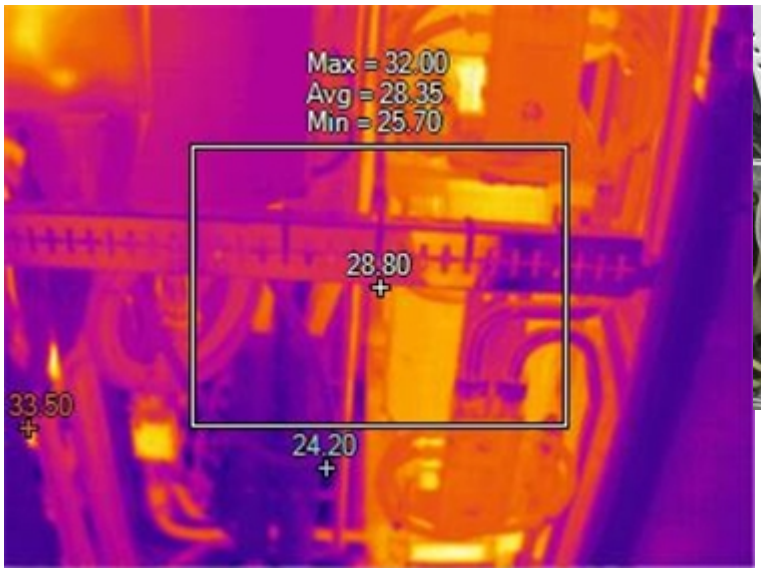




Image Info

Name	IR_00150.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	24.20 °C to 33.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:26:26 PM
Asset Name	DCDC Converter
Asset Group	DCDC Converter > UC01 DCDC Cabinet #1 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	28.8 °C	28.8 °C	28.8 °C	0.95	22.0 °C	0.00	
Centerbox	32.0 °C	25.7 °C	28.3 °C	0.95	22.0 °C	1.47	
Hot	33.5 °C	33.5 °C	33.5 °C	0.95	22.0 °C	0.00	
Cold	24.2 °C	24.2 °C	24.2 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00149.IS2
Emissivity	0,95
Background Temperature	22,00 °C
Image Range	25,30 °C to 34,20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:26:21 PM
Asset Name	DCDC Converter
Asset Group	DCDC Converter > UC01 DCDC Cabinet #1 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	29,1 °C	29,1 °C	29,1 °C	0,95	22,0 °C	0,00	
Centerbox	34,2 °C	26,3 °C	28,3 °C	0,95	22,0 °C	1,49	
Hot	34,2 °C	34,2 °C	34,2 °C	0,95	22,0 °C	0,00	
Cold	25,3 °C	25,3 °C	25,3 °C	0,95	22,0 °C	0,00	





Image Info

Name	IR_00148.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	25.00 °C to 33.50 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:26:16 PM
Asset Name	DCDC Converter
Asset Group	DCDC Converter > UC01 DCDC Cabinet #1 > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	27.1 °C	27.1 °C	27.1 °C	0.95	22.0 °C	0.00	
Centerbox	33.0 °C	26.0 °C	28.5 °C	0.95	22.0 °C	1.51	
Hot	33.5 °C	33.5 °C	33.5 °C	0.95	22.0 °C	0.00	
Cold	25.0 °C	25.0 °C	25.0 °C	0.95	22.0 °C	0.00	





Image Info

Name	IR_00147.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	20.60 °C to 448.20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:24:21 PM
Asset Name	Test Equipemnt
Asset Group	Test Equipemnt > Test Equipment > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
Centerpoint	52.2 °C	52.2 °C	52.2 °C	0.95	22.0 °C	0.00	
Centerbox	356.8 °C	24.7 °C	49.4 °C	0.95	22.0 °C	37.85	
Hot	448.2 °C	448.2 °C	448.2 °C	0.95	22.0 °C	0.00	
Cold	20.6 °C	20.6 °C	20.6 °C	0.95	22.0 °C	0.00	

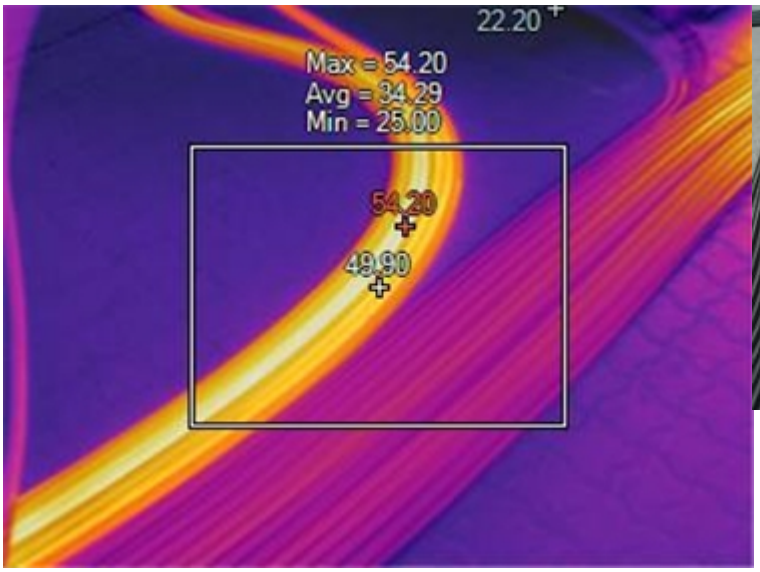




Image Info

Name	IR_00146.IS2
Emissivity	0.95
Background Temperature	22.00 °C
Image Range	22.20 °C to 54.20 °C
Camera Serial Number	TiS75+-23080231
Image Time	08/08/2024 16:24:03 PM
Asset Name	Test Equipemnt
Asset Group	Test Equipemnt > Test Equipment > Crosswind BLPH

Marker Info

Marker Name	Maximum	Minimum	Average	Emissivity	BG Temp	Std.Dev	Delta-T
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Centerbox	54.2 °C	25.0 °C	34.3 °C	0.95	22.0 °C	8.06	
Hot	54.2 °C	54.2 °C	54.2 °C	0.95	22.0 °C	0.00	
Cold	22.2 °C	22.2 °C	22.2 °C	0.95	22.0 °C	0.00	

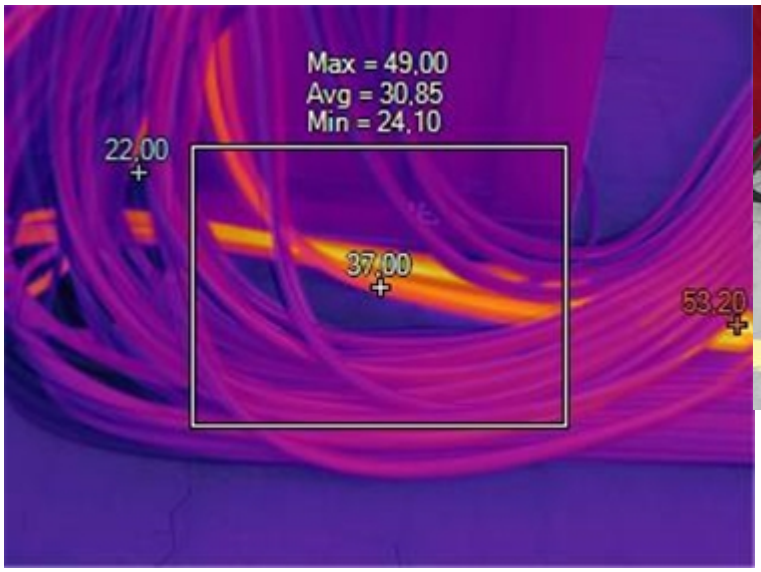




Image Info

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Image Range	22,00 °C to 53,20 °C
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Image Time	08/08/2024 16:23:52 PM

Marker Info

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Centerbox	49,0 °C	24,1 °C	30,9 °C	0,95	22,0 °C	4,13	
Hot	53,2 °C	53,2 °C	53,2 °C	0,95	22,0 °C	0,00	
Cold	22,0 °C	22,0 °C	22,0 °C	0,95	22,0 °C	0,00	

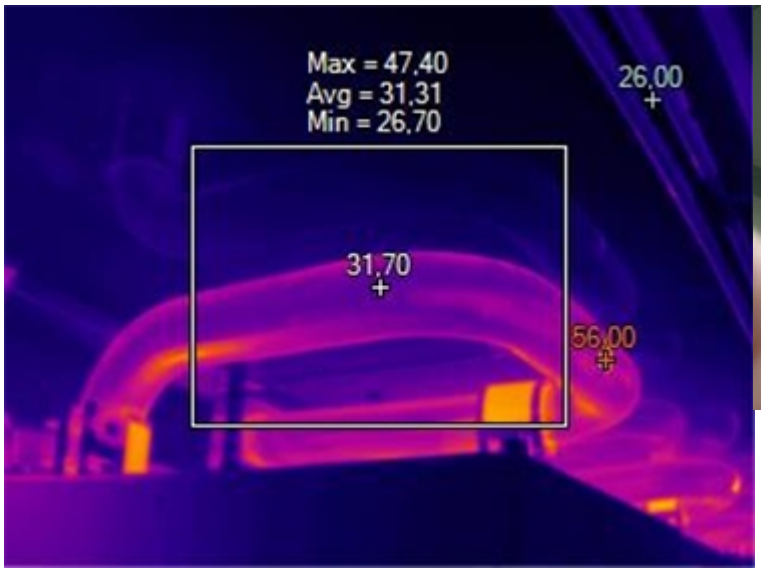




Image Info

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Marker Info

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Centerbox	47,4 °C	26,7 °C	31,3 °C	0,95	22,0 °C	3,73	
Hot	56,0 °C	56,0 °C	56,0 °C	0,95	22,0 °C	0,00	
Cold	26,0 °C	26,0 °C	26,0 °C	0,95	22,0 °C	0,00	

Summary:

Ballard Power Systems Europe A/S
Majsmarken 1
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Revision history		
Rev.	**Date.**	**Description**
001	28/06/2024	First Issue with General Updates from Initial Draft
002	18/10/2024	Updated following FAT completion
003	19/11/2024	Updates based on the review with Crosswind
004	21/03/2025	Updates based on the review with Crosswind

Document Title:	**BLPH Project - Site Acceptance Test (SAT) Procedure**
Document Number:	K559-2254-CWIWP4202202-J99-001
Revision:	Rev004
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-J99-001Rev004
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Short Title	Megablock Site Acceptance Test
Full Title	Megablock Site Acceptance Test
Abstract	*Site acceptance test for verification of full Megablock system*

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Revision Record

Rev #	Description	Revised By	Date (dd-mm-yyyy)
-	Initial Release	RKN	28-05-2024
1	General updates	RKN	28-06-2024
1.1	General updates	TAN	18-09-2024
2	Update prior to release to CW	PBL	16-10-2024
3	Updates based on review with CW	RKN	19-11-2024
4	Updates based on review with CW	RKN	09-01-2025

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1.0 Executive Summary

This document outlines the recommended commissioning activities and site acceptance tests. These tests aim to verify correct installation, and that the system performance onsite matches the performance level shown during FAT. There should be no CAT A items outstanding prior to power up.

2.0 References

- Confirmation of Satisfactory SAT - Signature Page
- PWR008 Ballard commissioning document
- EN 60204 Electrical safety test 10ft
- EN 60204 Electrical safety test 40ft
- EN 60204 Electrical safety test Cng Pltfrm
- F07 & F08, Electrical safety SAT
- F10 Safety checklist
- SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure
- SPC ID 0104 H2 Leak Test Procedure
- SPC ID 0106 Noise Level Measurement Test Procedure
- SPC ID 0204 System pressure decay test template

3.0 Definitions and Acronyms

FC	FCwave™
H2	Hydrogen
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
HT1	High temperature 1050kW cooling system 1
HT2	High temperature 1050kW cooling system 2
LT	Low temperature cooling system

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4.0 Objectives and Background

The tests in the document are based on the test matrix in document J99-02 (Aconex K559-2254-CWIWP4202202-J99-002-Rev002)

This document describes the witnessed Site Acceptance Tests. The tests do not include the internal testing that has been done to secure product maturity, mechanical and electrical connections have been done correctly.

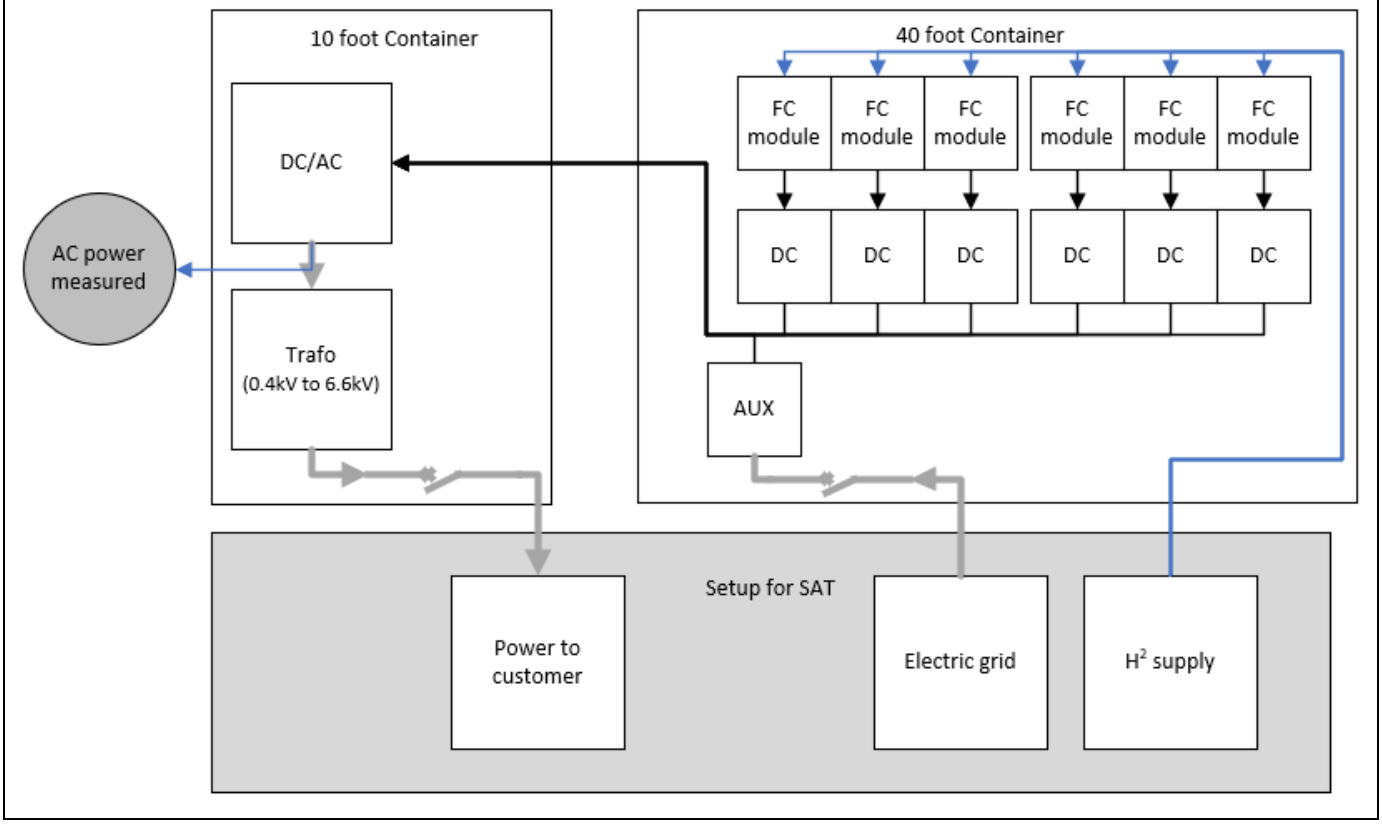
The SAT is not intended to replace an integration test. If third-party features are not yet ready for testing, those specific test cases will be temporarily excluded from the SAT and should be performed during integration testing. This will not affect the overall SAT signoff.

There should be no CAT A items outstanding prior to power up.

The scope of testing is:

- Visual Inspection of the delivered product (Tri-party walkaround)
- Verification of safety systems for the Megablock.
- Production of electrical power to the customer grid to verify performance.

Figure 1: Megablock System test overview



5.0 Note on Power Quality Measurements

The power quality measurements are indicative during SAT, as the measured power quality depends also on the customer load dissipating the produced power. Ballard is also not capable of measuring power quality on the 6.6kV bus, and any measurements are done on the 400V side of the output transformer. This results in lower measurements than on the medium voltage side of the output transformer, as the transformer inductance is an integral part of the harmonic dampening of the FC package.

Power quality measurements have been removed from pass/fail criteria.

6.0 Note on Electrical Load

The electrical load that is to dissipate the power generated by the FC package is not in Ballard scope. During step response tests and full load tests, it is required that it is present and able to absorb the power from the FC package.

7.0 Functional tests

7.1 F02 Visual inspection

7.1.1 Test

The test involves an examination of the paint job through visual inspection, assessing the overall build quality, and checking for any dents. The focus is also on evaluating the assembly quality to ensure compliance with weather resistance.

This test is superseded by the tri party walkaround.

7.1.2 Relevant Standard / document

- No reference

7.1.3 Brief Test Plan

- Visual inspection with customer of full system, meaning inside and outside container solution.
- Take comprehensive pictures of the full system and test setup, including close-ups of vital components, with timestamps for reference.

7.1.4 Pass/Fail criteria.

- Visual inspect with customer to review quality of full system.

7.1.5 Test Result

Table 1: Visual inspection – Test Result

Date tested	Item	Result	Pass/Fail	Notes

7.2 F07 Electrical safety test – 10-foot container

7.2.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.2.2 Relevant Standard / document

- EN 60204 Electrical safety test 10ft
- F07 & F08, Electrical safety SAT

7.2.3 Brief Test Plan

- According to EN 60204-1

7.2.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.2.5 Test Result

Table 2: Electrical safety test - Test results

Date tested	Item	Result	Pass/Fail	Notes

Table 3: Electrical safety test - calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for

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7.3 F08 Electrical safety test – 40-foot container

7.3.1 Test

Follow designated standard to conduct electrical safety test, grounding continuity and high potential.

7.3.2 Relevant Standard / document

- EN 60204 Electrical safety test 40ft
- EN 60204 Electrical safety test Cng Pltfrm
- F07 & F08, Electrical safety SAT

7.3.3 Brief Test Plan

- According to EN 60204-1

7.3.4 Pass/Fail criteria.

- All relevant checks in EN 60204-1 chapter 18 passed.

7.3.5 Test Result

Table 4: Electrical safety test - Test Result

Date tested	Item	Result	Pass/Fail	Notes

Table 5: Electrical safety test - Calibration equipment

Unit	Equipment number	Calibration due date	Equipment used for

7.4 F10 Safety

7.4.1 Test

Conduct tests of safety inputs and outputs, including emergency stop buttons, smoke detectors, gas detectors and external connections.

7.4.2 Relevant Standard / document

- F10 Safety checklist

7.4.3 Brief Test Plan

- Trigger each safety input according to checklist.
  - Emergency pushbuttons
  - Smoke detectors test
  - H2 sensor test
  - External safety switches
  - External feedback

7.4.4 Pass/Fail criteria.

- Verified according to checklist.
- Each item triggers the correct alarm

7.4.5 Test Result

Table 6: Safety - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Emergency pushbuttons			
	Smoke detectors			
	H2 sensors			
	External safety switches			
	External feedback			

Table 7: Safety – Calibration/Equipment

Unit	Equipment number	Calibration due date	Equipment used for

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7.5 F18 H_2 Leakage test

7.5.1 Test procedure

All pipework and H2 instrumentation subassemblies must be inspected, recorded, verified and pass in accordance with the procedure in section 5.4 in *SPC ID 0104 H2 Leak Test Procedure Rev 002* prior to full system SAT.

System H2 leakage test is done system pressure decay test, according to section 5.5 in *SPC ID 0104 H2 Leak Test Procedure Rev 002*.

7.5.2 Pass/Fail criteria.

Pressure decay test with a maximum leakage no greater than specified in test procedure.

Result details are documented in the template *SPC ID 0204 System pressure decay test template*

Parameter	Value	Description
L_A [Nm^3/h]	**2,72 – 3,58 x10^{-3}**	**Maximum allowed pressure decay to pass pressure decay test, where L_A = L_S + L_Mu**
L_S [Nm^3/h]	0	Summarized expected leak rates of all components in the system (per design leak rate).
L_Mu [Nm^3/h]	2,72 – 3,58 x10^{-3}	Calculated accuracy of the measuring system, used to perform the test.
L_C [Nm^3/h]	2,7x10^{-5}	Maximum allowed leak rate for a given pipe section, where integrity/operability of the system may be maintained safely

7.5.3 Test Result

Table 8: H2 leakage - Test Result

Date tested	Item	Leakage rate L_1 [Nm^3/h]	Pass/Fail	Notes
	H2 line 1			
	H2 line 2			
	H2 line 3			
	H2 line 4			
	H2 line 5			
	H2 line 6			

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8.0 Operational tests

Operations are done using operator HMI or remote HMI in normal operating mode.

8.1 O01 System Start/Stop - Normal low load operation.

8.1.1 Test

Fuel Cell system can start, deliver minimum power and perform controlled stop without faults. This test is based on DC power.

8.1.2 Relevant Standard / document

- No reference

8.1.3 Brief Test Plan

- All FC in standby
- Request 100kW DC
- Delay 120 seconds
- Request zero power
- Repeat with new preferred FC until all tested.

8.1.4 Pass/Fail criteria.

- Fuel Cell Package starts without faults.
- No persistent system alarms.
- Correct available power signal.
- DC Power output within +/-5% and stable in less than 60 seconds
- Fuel Cell Package stops without faults.
- Fuel Cell in stand-by in less than 120 seconds.

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8.1.5 Test Result

Table 9: System Start/Stop – Normal low load operation - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	FCwave 1			
	FCwave 2			
	FCwave 3			
	FCwave 4			
	FCwave 5			
	FCwave 6			

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8.2 O09 Load Test – step response 0 to 35%

8.2.1 Test

Test step response by adding 35% load in one step from no load while measuring AC power quality.

8.2.2 Relevant Standard / document

- N/A

8.2.3 Brief Test Plan

- All FC in stand-by.
- Apply set point by requesting 350kW AC

8.2.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.2.5 Test Result

Table 10: Load Test - step response 0 to 35% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Step response 0-35%			
	AC power quality		Indicative	

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8.3 O10 Load Test – step response 35% to 70%

8.3.1 Test

Test step response by adding 35% load in one step to reach 70% load while measuring AC power quality.

8.3.2 Relevant Standard / document

- N/A

8.3.3 Brief Test Plan

- 3 FC running delivering 350kW AC steady state.
- 3 FC in stand-by
- Apply set point by requesting 700kW AC power.

8.3.4 Pass/Fail criteria.

- No persistent system alarms.

8.3.5 Test Result

Table 11: Load Test - step response 35% to 70% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Step response 35%-70%			
	AC power quality		Indicative	

8.4 O11 Load Test – step response 65% to 100%

8.4.1 Test

Test step response by adding 35% load in one step to reach full load while measuring AC power quality.

8.4.2 Relevant Standard / document

- N/A

8.4.3 Brief Test Plan

- 6 FC running delivering 650kW AC steady state.
- Apply set point by requesting 1000kW AC power.

8.4.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.4.5 Test Result

Table 12: Load Test - step response 65% to 100% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Step response 65%-100%			
	AC power quality		Indicative	

8.5 O12 Load Test – 100% stability test - 3 hours.

8.5.1 Test

Test steady state at 100% load for 3 hours while measuring power quality.

This test is also dependent on the hydrogen supply for the system.

8.5.2 Relevant Standard / document

- N/A

8.5.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.

8.5.4 Pass/Fail criteria

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.5.5 Test Result

Table 13: Load Test – Steady state 100% load - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Full load test			
	AC power quality		Indicative	

8.6 O13 Load Test – step response 100% to 50%

8.6.1 Test

Test step response by removing 50% load in one step at full load while measuring power quality.

8.6.2 Relevant Standard / document

- N/A

8.6.3 Brief Test Plan

- 6 FC running delivering 1000kW steady state.
- Request 500kW AC.

8.6.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.6.5 Test Result

Table 14: Load Test - step response 100% to 50% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Step response 100%-50%			
	AC power quality		Indicative	

8.7 O14 Load Test – step response 50% to 0%

8.7.1 Test

Test step response by removing 50% load in one step to no load while measuring AC power quality.

8.7.2 Relevant Standard / document

- N/A

8.7.3 Brief Test Plan

- 3-6 FC running delivering 500kW AC.
- Request 0% and apply set point.

8.7.4 Pass/Fail criteria.

- AC output: +/- 10% actual to curve at any time.
- No persistent system alarms.

8.7.5 Test Result

Table 15: Load Test - step response 50% to 0% - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	Step response 50%-0%			
	AC power quality	n/a	n/a	Unit not producing power

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Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	
Test location	
Test performed by	

Grounding continuity
EN 60204-1:2018 - Section 18.2.2 - Test 1
Test performed with a test current of 10A

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	Busbar to busbar	0,024	Ohm	
	Module 1	0,018	Ohm	
	DC/DC cabinet 1	0,023	Ohm	
	Module 2	0,024	Ohm	
	DC/DC cabinet 2	0,019	Ohm	
	Module 3	0,026	Ohm	
	DC/DC cabinet 3	0,016	Ohm	
	Module 4	0,026	Ohm	
	DC/DC cabinet 4	0,016	Ohm	
	Module 5	0,024	Ohm	
	DC/DC cabinet 5	0,017	Ohm	
	Module 6	0,029	Ohm	
	DC/DC cabinet 6	0,015	Ohm	
	Control cabinet	0,021	Ohm	
	Control cabinet right door	0,032	Ohm	
	Lifting crane track, dolly	0,028	Ohm	
	LT piping	0,031	Ohm	
	Isolation transformer cover	0,039	Ohm	
	Cable tray	0,019	Ohm	

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	Busbar to busbar	0,019	Ohm	
	Main DC/Acpoint 1	0,032	Ohm	
	Main DC/Acpoint 2	0,024	Ohm	
	Main DC/Acpoint 3	0,027	Ohm	
	DC/AC conduncter point 1	0,037	Ohm	
	DC/AC conduncter point 2	0,022	Ohm	
	DC/AC conduncter point 3	0,023	Ohm	
	LT coolant pipe	0,024	Ohm	
	Cable tray	0,02	Ohm	
	Main transforer grounding bolt	0,023	Ohm	
	Main transformer chassis	0,02	Ohm	
	Cable tray	0,022	Ohm	

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	
Test location	
Test performed by	

Isolation resistance
EN 60204-1:2018 - Section 18.3
Test performed with a test voltage of 1000V

Main location	Location	Measurement FAT	Unit	Measurement SAT
40 ft container	L1-PE	> 999.9	MOhm	
	Cooling skid L1	10,01	Mohm	
	Colling skid L2	6,252	Mohm	
	Cooling skid L3	12,81	Mohm	
	AUX supply L1	251	Mohm	
	AUX supply L2	337	MOhm	
	AUX supply L3	237	Mohm	

Main location	Location	Measurement FAT	Unit	Measurement SAT
10ft container	L1+L2+L3-PE on AC circuit	592	Mohm	

Title	F07 & F08 Electrical safety test - 40 ft and 10 ft container
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	
Test location	
Test performed by	

Isolation resistance

EN 60204-1:2018 - Section 18.4

Test performed with a test voltage of 2500VAC

Main location	Location	Measurement FAT	Unit	Measurement SAT
40ft container	PE and L1	0	mA	
	PE and L2	0	mA	
	PE and L3	0	mA	

Main location	Location	Measurement FAT	Unit	Measurement SAT
10 FT container	PE and L1	7,1	mA	
	PE and L2	7,1	mA	
	PE and L3	7	mA	

Megablock		Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		9/11-2023
2.0	PBL	General updates		21/10-2024
3.0	RKN	General review		09/01-2025

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Megablock		Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

Table 6 – Summary Table 14

5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Megablock		Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

8. Test Equipment.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the coolant skid for the Megablock project. A rendering is shown below with selected items highlighted.

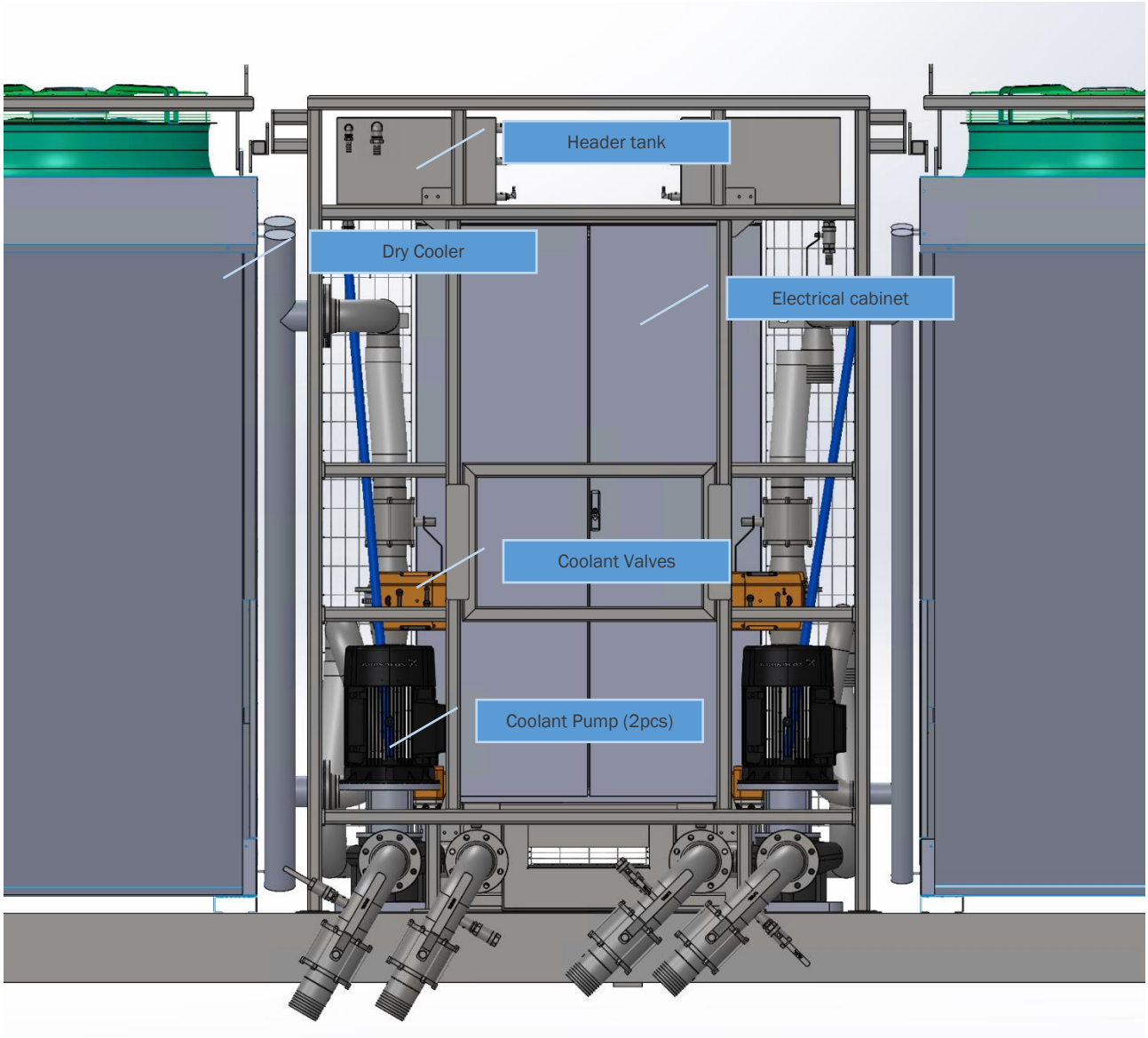


Figure 2 – Front view of coolant skid centre section with callouts.

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Test Specification	RKN	09-01-2025	3.0.0

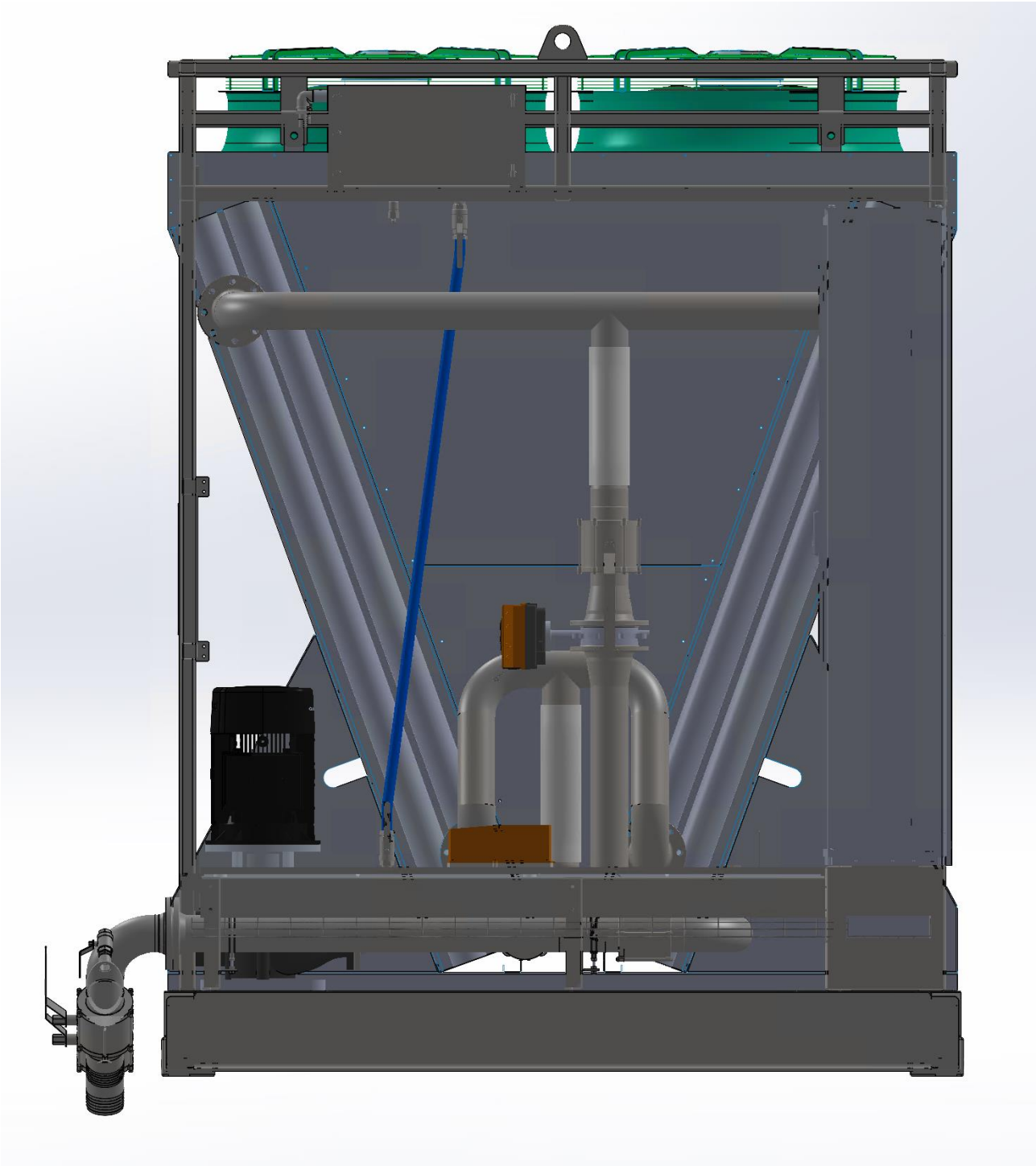


Figure 3 – Section view of the coolant skid, looking from centre towards left.

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Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 4 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	Coolant Skid
Result (pass/fail)	
Date and Initials	

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11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 5 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the coolant skid is the main ground terminal in the control enclosure.

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Control Cabinet Backplate	<100mΩ	
2	Grounding Bar, Below PLC		
3	HT1 Cooling Pipe, From HT1 Cooler		
4	HT1 Manual Valve, HT1 Cooler Outlet		
5	HT1 Coolant Pump, Grounding Connection		
6	HT1 Header Tank, Bolts		
7	HT1 Cooler Frame (Metal)		
8	HT2 Cooling Pipe, From HT1 Cooler		
9	HT2 Manual Valve, HT1 Cooler Outlet		
10	HT2 Coolant Pump, Grounding Connection		

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11	HT2 Header Tank, Bolts		
12	HT2 Cooler Frame (Metal)		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

Notes to test points:

- Point 1-2 is inside the electrical cabinet.
- Point 3-6 is indicated on Figure 6 – Test points for Grounding Test
- Point 7-12 are identical to points 3-6, except mirrored to HT2.

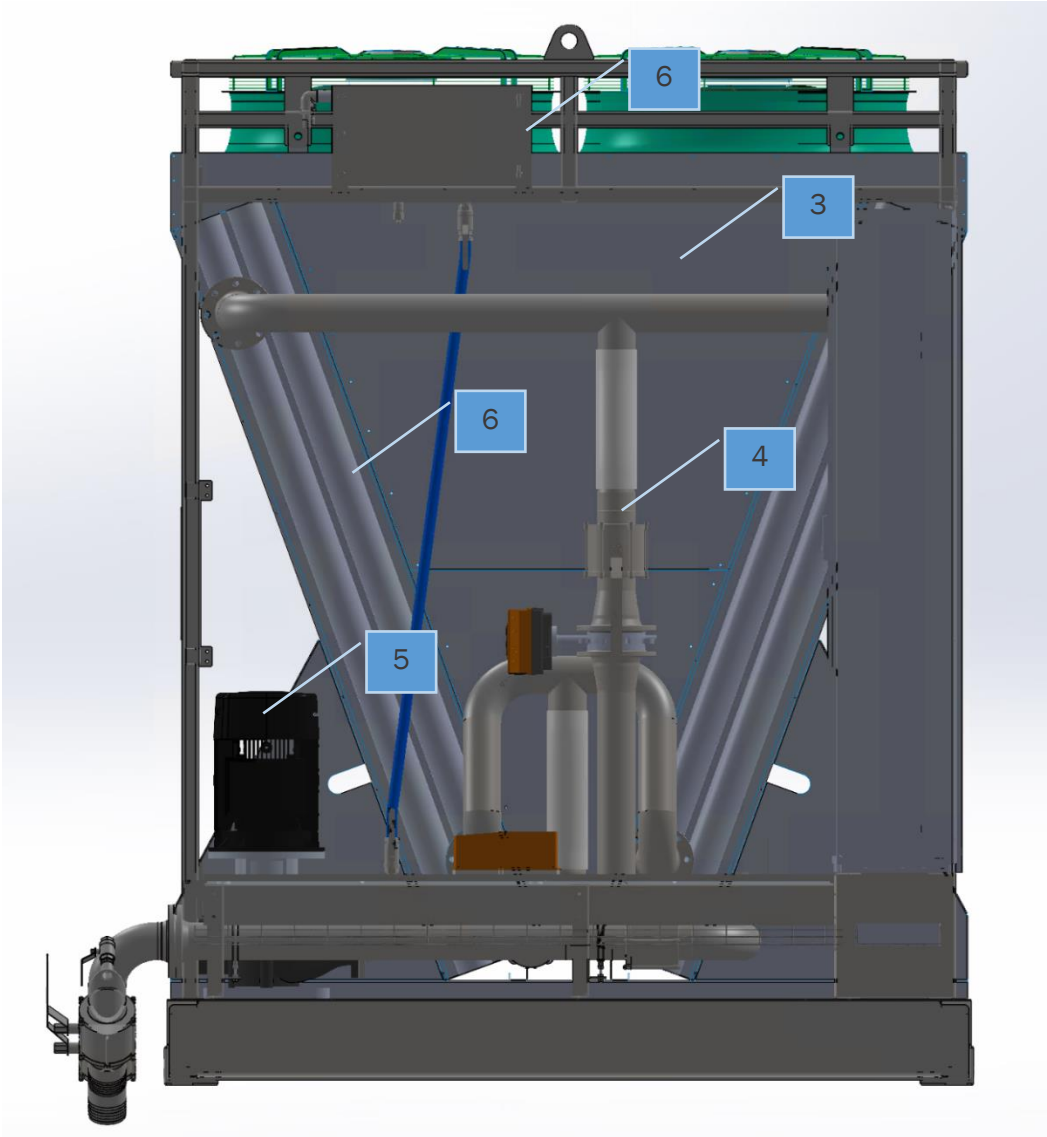


Figure 6 – Test points for Grounding Test

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12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 7 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11). Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications. Megablock Component module does not contain any RCD devices.

Megablock Component is not a TN-system, and Test #2 is not relevant.

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13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 8 – EN60204-1:2018, Chapter 18.3

Megablock Component requirements:

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
UC40-FC04	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Coolant Skid
Result – AC Node (value and pass/fail)	
Date and Initials	

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14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 9 – EN60204-1:2018, Chapter 18.4

Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Component	Coolant Skid
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

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15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 10 – EN60204-1:2018, Chapter 18.5

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 11 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a voltage drawdown process and manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 12 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is in the scope of the 10ft Container (DCAC system)
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		09/11-2023
2.0	PBL	Adapted from 40ft Coolant Skid document		04/07-2024
3.0	CJA	Adapted from 10ft power converter container document		15/10-2024
4.0	RKN	General review		09/01-2025

3. List of Figures

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4. List of Tables

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Table 2 – Requirement headlines, chapter, and ID mapping 3
Table 3 – Bonding Resistance Test point and expected resistance values. 7
Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements 9

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Table 5 – Voltage Test Requirements 10
Table 6 – Summary Table 13

5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

8. Test Equipment.

The test equipment is a CE MultiTester, manufactured by Metrel.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the 40ft Fuel Cell Container for the Megablock project.

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Document type	*Author*	*Revision date*	*Revision*
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10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 2 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	40ft Container
Result (pass/fail)	
Date and Initials	

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11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 3 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the 40ft Fuel Cell Container is the main ground bar located in +UC50.

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Busbar to busbar	<100mΩ	
2	Module 1		
3	DC/DC cabinet 1		
4	Module 2		
5	DC/DC cabinet 2		
6	Module 3		
7	DC/DC cabinet 3		
8	Module 4		
9	DC/DC cabinet 4		
10	Module 5		
11	DC/DC cabinet 5		

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12	Module 6		
13	DC/DC cabinet 6		
14	Control cabinet		
15	Control cabinet right door		
16	Lifting crane track, dolly		
17	LT piping		
18	Isolation transformer cover		
19	Cable tray		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 4 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11).

Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications.

Megablock RCD Testing:

All RCD (Residual Current Device) in the Megablock system is equipped with self-test functionality from the manufacturer. This takes the shape of a push button, which must cause the RCD device to trip when actuated.

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For the test, first enable all RCD circuits, and then actuate the self-test button on the devices. The devices must trip within 1 second. After the trip, use a multimeter to verify that the output of the device has no voltage (<10VAC)

Component	RCD Devices in UC20 (40ft Control Cabinet)
Result – 3ph RCD	
Result – 1ph RCD/MCCB	
Date and Initials	

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13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 5 – EN60204-1:2018, Chapter 18.3

Megablock Component requirements:

Before performing this test, isolate all fuel cell DCDC converters from the DC bus (Cabinets UC01 to UC05)

Use a set of test leads and alligator clips to create a single AC node (3 phases shorted together)

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
Internal side of the output breaker	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Fuel Cell Container
Result – AC Node (value and pass/fail)	
Date and Initials	

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 6 – EN60204-1:2018, Chapter 18.4

Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Connection point is internal side of main output breaker.

Component	Fuel Cell Container
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

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Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 7 – EN60204-1:2018, Chapter 18.5

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 8 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers or accessing electrical cabinets. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 9 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is installed with a proven component (Bender Isometer). Detection of ground fault causes system shutdown and service technician is dispatched.
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		09/11-2023
2.0	PBL	Adapted from 40ft Coolant Skid document		04/07-2024
3.0	RKN	General review		09/01-2025

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5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

8. Test Equipment.

The test equipment is a CE MultiTester, manufactured by Metrel.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the 10ft container for the Megablock project.

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10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 2 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	10ft Container
Result (pass/fail)	
Date and Initials	

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 3 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the Power Converter Container is the main ground bar located at the rear of the main output breaker (=BA30-FC30).

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Busbar to busbar	<100mΩ	
2	Main DC/Acpoint 1		
3	Main DC/Acpoint 2		
4	Main DC/Acpoint 3		
5	DC/AC conduncter point 1		
6	DC/AC conduncter point 2		
7	DC/AC conduncter point 3		
8	LT coolant pipe		
9	Cable tray		

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

10	Main transforer grounding bolt		
11	Main transformer chassis		
12	Cable tray		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 4 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11). Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications.

Megablock Component module does not contain any RCD devices.

13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 5 – EN60204-1:2018, Chapter 18.3

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

Megablock Component requirements:

Before performing this test, isolate all fuel cell DCDC converters from the DC bus (Cabinets UC01 to UC06)

Use a set of test leads and alligator clips to create a single AC node (3 phases shorted together)

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
=LA01+UC31-QB01	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Power Converter Container
Result – AC Node (value and pass/fail)	
Date and Initials	

14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 6 – EN60204-1:2018, Chapter 18.4

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Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Connection point is internal side of main output breaker.

Component	Power Converter Container
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 7 – EN60204-1:2018, Chapter 18.5

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 8 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers or accessing electrical cabinets. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 9 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is installed with a proven component (Bender Isometer). Detection of ground fault causes system shutdown and service technician is dispatched.
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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Short Title	Power Quality Measurement Test Procedure
Full Title	Power Quality Measurement Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for validating cooling circuits are leak free and can withstand normal operating pressure.

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
1	Initial Draft	RKN	01-06-2024
2	Update to match testing requirements	PBL/TAN	01-09-2024

Checked by: PBL	Date: August 2024
Approved by: PBL	Date: September 2024

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Abbreviation	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module

1.0 Objectives and Background

This test procedure aims to evaluate the power quality performance of Fuel Cell gensets and compare it to conventional diesel gensets G3.

2.0 References

Document	Titel
ISO 8528-5:2022	Reciprocating internal combustion engine driven alternating current generating sets

3.0 Equipment list

Equipment	Purpose
Fluke 1775	Power Quality Analyzer, measures Voltage, Current and Frequency Data

4.0 Test Procedure

4.1 Personal protective equipment

Before commencing the test procedure always analyze the work environment and make sure you take the right precautions.

Suggested PPE depending on solution and work environment:

- Safety shoes
- Goggles
- Hearing protection

4.2 Preparation

Fuel Cell Megablock system is to be connected to a variable power consumer such as a load bank or grid connection.

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4.3 Steady state testing

4.3.1 Apply rated power of the fuel cell Megablock system.

4.3.2 Monitor and record the following parameters for at least 10 minutes:

- Voltage
- Frequency
- THDi
- THDu

4.3.3 Analyse data to make sure recorded values are within the limits.

Fill in the following table:

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤±5% At 400V: +/-20V			
	Frequency	≤0.5% At 50Hz: +/-0.25Hz			
	THDu	<5%			
	THDi	<5%			

4.4 Dynamic testing

4.4.1 Apply the following load step changes of rated power of the system. In systems where these load steps are not possible perform alternative dynamic tests:

- 0% to 35%
- 35% to 70%
- 65% to 100%
- 100% to 50%
- 50% to 0%

If it is not possible to perform these load steps, due to either system design or test setup, alternative load steps shall be used, and these should be confirmed with SME and test engineer.

4.4.2 Monitor and record the following parameters for at least 1 minute after each load change:

- Voltage
- Frequency
- THDi
- THDu

Fill in the following tables:

4.4.3 0% to 35%

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤-15[c]% At 400V: (<60V_{ac} droop)			
	Frequency	≤-/7+δf_{st})[c] % At 50Hz: >45Hz			
	THDu	<5%			
	THDi	<5%			

4.4.4 35% to 70%

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤-15[c]% At 400V: (<60V_{ac} droop)			

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Frequency	≤-/7+δf_{st})^{c} % At 50 Hz: >45Hz			
	THDu	<5%			
	THDi	<5%			

4.4.5 65% to 100%

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤-15^{c}% At 400V: (<60V_{ac} droop)			
	Frequency	≤-/7+δf_{st})^{c} % At 50Hz: >45Hz			
	THDu	<5%			
	THDi	<5%			

4.4.6 100% to 50%

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤+20% At 400V: (<80V_{ac} overshoot)			
	Frequency	≤+10% At 50Hz <55Hz			

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Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	THDu	<5%			
	THDi	<5%			

4.4.7 50% to 0%

Date tested	Parameter	Criteria (ISO8528-5:2022, Table 4)	Result	Pass/Fail	Notes
	Voltage	≤+20% At 400V: (<80V_{ac} overshoot)			
	Frequency	≤+10% At 50Hz: <55Hz			
	THDu	<5%			
	THDi	<5%			

5.0 Appendix

(intentionally left blank)

Short Title	Noise Level Measurement Test Procedure
Full Title	Noise Level Measurement Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for measuring noise level inside and outside system. To validate work environment but also the noise emitted.

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
1	Initial Draft	RKN	23-04-2024
2	Updated description	TAN	30-07-2024

Checked by: TAN	Date: 30/7-2024
Approved by: TAN	Date: 30/7-2024

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Abrevassion	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module

1.0 Objectives and Background

The objective of this test procedure is to determine the noise level generated by a full system solution. The measurements will be conducted around solution as well as inside where service staff can enter while system stays operational.

- Ensure compliance with noise regulations and safety standards.
- Evaluating the impact of the system noise to the surrounding environment.

2.0 References

Document	Titel
ISO 8528	Reciprocating internal combustion engine driven alternating current generating sets – Part 5: Generating sets

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3.0 Equipment list

Equipment	Purpose
Decibel meter	Measure noise level
Anemometer	Measure wind speed
Measuring tape	To measure up to 7 meter

4.0 Test Procedure

4.1 Personal protective equipment

Before commencing the test procedure always analyze the work environment and make sure you take the right precautions.

Suggested PPE depending on solution and work environment:

- Safety shoes
- Goggles
- Hearing protection

4.2 Preparation

- Verify equipment is calibrated and within valid calibration period.
- Identify the main noise sources inside and outside solution.
- Identify at which the operating points the solution will emit the most noise.
- Identify normal operating point for solution.

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4.3 Measurement locations

- Inside solution
  - Multiple measurements to capture the overall sound level within the work environment.
- Outside solution
  - 1-meter grid around solution
  - 7-meter grid around solution

4.4 Conducting measurements

- If decibel meter does have recording function:
  - Inside container measurement:
    - Measure maximum noise level at identified operating point in 5.2 and at location identified in 5.3. Measure for around 30 seconds to ensure a stable reading.
    - Noise level sweep:
      - Container running normal operating condition.
      - Start record noise level and walk from one end of the container to the other end.
      - Sweep should last around 20 seconds.
  - Outside container 1 meter:
    - Mark up the 1-meter perimeter around the container for example with a cone in each corner. If site does not allow 360 degree walk around at 1 meter while running, multiple recordings can be taken and compared to find maximum noise level.
    - System off (with noisy surroundings take a reference log)
    - Start recording the noise level, and slowly walk around the perimeter marked up.
    - Container running at most noise emitting point.
    - Start recording the noise level, and slowly walk around the perimeter marked up.
    - Analyze and find maximum noise level.

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- Outside container 7 meter:
  - Mark up the 7-meter perimeter around the container for example with a cone in each corner. If site does not allow 360-degree walk around at 7 meter while runnin0g, multiple recordings can be taken and compared to find maximum noise level.
  - System off (with noisy surroundings take a reference log)
  - Start recording the noise level, and slowly walk around the perimeter marked up.
  - Container running at most noise emitting point.
  - Start recording the noise level, and slowly walk around the perimeter marked up.
  - Analyze and find maximum noise level.

- If decibel meter does not have recording function:
  - Inside container measurement:
    - Measure maximum noise level. Measure for around 30 seconds to ensure a stable reading.
    - Noise level at 3 points in the container:

      Container running normal operating condition.

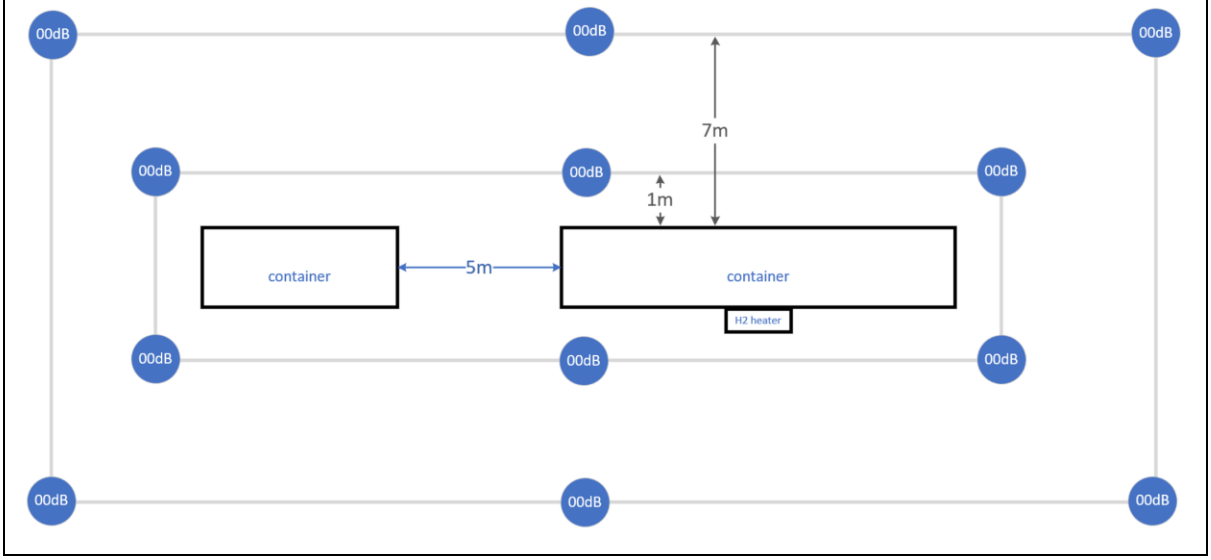
      - Measure noise level 1 meter from the one end of the container.
      - Measure noise in the mid point of the container.
      - Measure noise level 1 meter from the other end of the container.
  - Outside container 1 meter:
    - Mark up the 1-meter perimeter around the container for example with a cone in each corner. (If test setup does not allow full access complete as many points as possible)
    - System off (with noisy surroundings take a reference log)
    - Container running at most noise emitting point.
    - Start measuring the noise level, at each corner and in the mid point. Find reference map in appendix. And note down the noise level.
    - Analyze and find maximum noise level.

- Outside container 7 meter:
  - Mark up the 7-meter perimeter around the container for example with a cone in each corner. (If test setup does not allow access complete as many points as possible)
  - System off (with noisy surroundings take a reference log)
  - Container running at most noise emitting point.
  - Start measuring the noise level, at each corner and in the mid point. Find reference map in appendix. And note down the noise level.
  - Analyze and find maximum noise level.

5.0 Appendix

5.1 Reference map measurement grid

Figure 1: Reference map measurement grid



Short Title	Thermographic - Electrical Test Procedure
Full Title	Thermographic - Electrical Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for validating electrical cabinets and installation are performing correct.

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
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Figure 2 Test pressure set up with principle of attachments. ..... **Error! Bookmark not defined.**

List of Tables

No table of figures entries found.

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Abrevassion	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module

1.1 References

Document	Titel

2.0 Objectives and Background

The objectives of this test procedure are to demonstrate the performance of the electrical parts on full system solution. The thermographic inspection will be conducted around solution as well as inside where service staff can enter while system stays operational.

3.0 Test Procedure

3.1 Personal protective equipment

Before commencing the test procedure always analyze the work environment and make sure you take the right precautions.

Suggested PPE depending on solution and work environment:

- Safety shoes
- Goggles
- Hearing protection

3.2 Preparation

- Verify equipment is calibrated and withing valid calibration period.
- Identify how and where to measure the ventilation system.
- Identify how and where to measure the cooling system.
- Identify possible heat surfaces to be inspected.

3.3 Measurement locations

- Inside solution:
  - 40ft container
  - 10ft container
- Outside solution:
  - 40ft container
  - 10ft container
  - Cooling skid

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3.4 Conducting measurements

Set the Megablock to full power (1000 kW) and wait until temperatures have stabilised. Monitor the electrical cabinets and electrical installations described in section 3.3 through the thermographic imager and take pictures of all relevant areas with elevated temperatures. File in the pictures in a report.

4.0 Appendix

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Short Title	H2 Leak Test Procedure
Full Title	H2 Leak Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for validating H2 circuits are within allowed limits and can withstand normal operating pressure.

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
-	Initial Draft	RKN	13-05-2024
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1.0 Definitions

Abbreviation	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module
SME	Subject Matter Expert
PPE	Personal Protective Equipment
DUT	Device under test

2.0 Objectives and Background

The purpose of this test procedure is to generalise how Ballard Product Solutions secure that the fabricated hydrogen systems are not leaking more than the specified limits and the circuits will withstand maximum operation pressure. Furthermore, this procedure is intended to be used on full systems and/or sub assemblies. This test procedure is based on *IEC 62282-3-1 section 5.4 Leakage tests and 5.4.1 Gas leakage tests* with regards to system tests. For hydrogen pipework testing, the IEC 62282-3-1 references *ISO 15649:2001 "Petroleum and natural gas industries – Piping* which states that piping shall be tested according to *ASME B31.12 Hydrogen piping and pipelines.* Hence, the described procedure for component/pipework inspection and leakage test is based on this standard.

3.0 References

Document	Titel
IEC 62282-3-1:2019	Fuel cell technologies - Part 3-1: Stationary fuel cell power systems - Safety
ASME B31.12-2023	Hydrogen piping and pipelines
SPC ID 0202	Snooper mini H2 sniffing procedure
SPC ID 0203	Pipework inspection and leakage test check sheet template
SPC ID 0204	System pressure decay test template

4.0 Equipment list

Equipment	Type	Purpose
H2 sniffer	Sewerin Snooper Mini H2	Detection instrument to snif/locate source of potential leaks
Pressure sensor	Fluke 700RG07 500PSIG	Measuring device to accurately adjust and monitor gas pressure during leakage test
Test gas	Formier gas 5% hydrogen	Test gas for pressurizing pipework where the 5% hydrogen acts as tracer agent for sniffing.
Sniffer test station	Sewerin SPE-HG	Test instrument the emits a reference gas to check the correct function of the Snooper Mini H2 sniffer
Pressure regulator		Test gas pressure regulator for pressurizing the DUT
Pressure relief valve		Safety valve to ensure safe pipework pressurization during test.

5.0 Test Procedures

Any system is comprised of several subassemblies and/or components. Any of these subsystems must be individually inspected and leakage tested before assembly into the complete system. For systems fabricated or assembled by Ballard Product Solutions, testing per section 5.4 applies. Externally delivered systems/modules as well as Ballard standard products must be tested in accordance with *IEC 62282-3-1:2019* or similar industry relevant standards.

Attention: All test personnel, including external witness should be informed about risks associated with the test and instructed to use proper PPE prior to conducting the test.

WARNING: Pressure testing can potentially turn plugs or loose fittings into projectiles.

Minimum safety precautions:

- The test must be carried out by trained personnel.
- Prior to test start make sure that the work has been HSE risk assessed according to Ballard internal procedures.
- All connection and mechanical assemblies shall be checked before applying pressure.
- All personnel attending the test shall use appropriate PPE.

5.1 Installations and connections

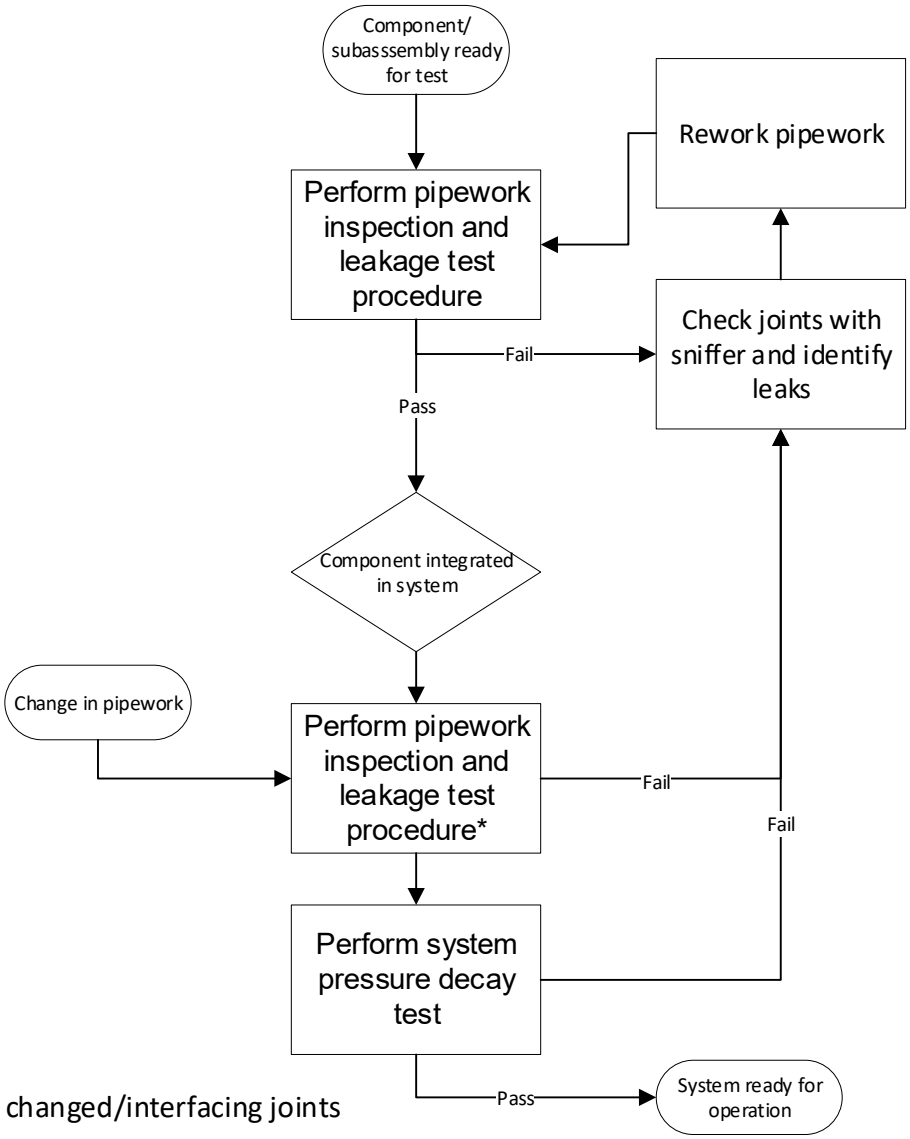
Make sure that all parts of the hydrogen system have been correctly assembled and according to assembly guides and build manuals.

5.2 Review test setup.

Before proceeding to testing, the test setup should be reviewed by a SME. The SME should also determine the pressure of which the system under test will be tested to. Once a setup has been reviewed and approved re-testing can proceed on same approval if the setup remains unchanged. If a diagram of the system under test does not exist create a diagram like the one in appendix. The results from the test should be added on the diagram and saved as part of the test report. During the review a risk assessment should be done and shared with all staff involved with testing and working in proximity to an ongoing test. Make sure that relevant measurement instruments, used during the test all have valid calibration certificates if applicable. Furthermore, ensure that manufacturers procedures are followed for maintaining the equipment accuracy and dependability.

5.3 System test sequence

On any system the following test sequence must be followed during first assembly or reassembly of a system.



* Only for changed/interfacing joints

5.4 Pipework inspection and leakage test

The pipework inspection and leakage test are performed to ensure proper assembly quality is achieved during fabrication and assembly of components/subassemblies. The test is designed to be performed upon work completion in the assembly plant/workshop before release to system assembly.

The test is performed in accordance with or exceeding requirements in *ASME B31.12 Hydrogen piping and pipelines*.

The associated template for documenting the test must be used: *SPC ID 0203 Pipework inspection and leakage test check sheet* template

5.4.1 Test setup

The assembled component or subassembly pipe ends are appropriately sealed off and the pressure regulator with formier gas supply is connected, together with a pressure gauge and appropriate pressure relief valve.

Use of the H2 sniffer instrument must be performed in accordance with *SPC ID 0202 Snooper mini H2 sniffing procedure.*

5.4.2 Test sequence

1. Check for proper functionality of the sniffing tool by using the sniffer test station
2. Inspect the pipework visually for any damage or loose parts
    a. For ferrule fittings, check every fitting with appropriate gap inspection gauge to ensure sufficient tightening is achieved
3. Pressurize pipework to between 1.0-1.2 barg with formier gas and listen for leaks
4. Increase pressure to 50% of test pressure by adjusting the pressure regulator
5. Maintain the pressure for 10 minutes.
6. Listen for leaks and use H2 sniffer to inspect all joints. If leaks are identified record all positions and values in the check sheet, abort test by proceeding to item 10 and file the pipework for rework.
7. If no leaks are detected, proceed to increase pressure to “test pressure” by adjusting the pressure regulator.
8. Maintain the pressure for minimum 10 minutes.
9. Listen for leaks and use the H2 sniffer to inspect all joints. Record all leak positions and values in the check sheet.
10. Blow down system, disconnect test gas supply and secure pipe ends.
11. Check for proper functionality of the sniffing tool by using the sniffer test station.
12. For identified leaks file the pipework for rework.
13. For joints that pass the procedure, a suitable marking must be applied to identify that the joint is verified.
14. If all joints are accepted, sign and file the check sheet.

If leaks are identified during the procedure, the test sequence must be performed again on reworked pipework.

5.4.1 Test evaluation

Each joint of the DUT is subject to the following test pass criteria:

Inspection element	Pass criteria
Visual inspection	No visible damage, incorrect assembly or misplacement of the joint. No dirt, lubricants or foreign materials left on the joint No indication of excessive use of force No indication of incorrect use of tools to assemble the joint.
Auditory inspection	No hearable leaks unless allowed by the particular joint.
Gauge inspection (where applicable)	According to gauge tool instruction.
Sniffing	According to acceptable leakage rate of a particular joint + measurement uncertainty of the sniffer (see SPC ID 0202) To be referenced from the ATEX documentation/design manual and recorded in the check sheet.

5.5 System pressure decay test

The system pressure decay test is performed to validate integrity of pipework and instrumentation of the complete H2 system. The test is performed in accordance with *IEC 62282-3-100:2020 section 6.2: Leakage test.*

5.5.1 Test setup

The system pressure decay test may only be performed if all subassemblies have been validated with the procedure described in section 5.4 or equivalent (for externally delivered subassemblies).

The test is performed using the regular fuel supply of the system at test pressure level.

If appropriate, the test may be isolated and divided into appropriate sections to allow for separate validation of individual pipe sections.

To ensure that the validation of the integrity of the pipework is sound, a measurement system analysis must be performed. The accuracy of the equipment, used to measure the necessary variables of the test must contribute to a measuring error of no more than 2% of the allowable leak rate in the system.

The associated template for documenting the test must be used: *SPC ID 0204 System pressure decay test template*

5.5.2 Test parameters

To properly validate the pipework system, the following variables are used. Variables are either universal constants, calculated values, system design values or measured values:

Variable	Name	Unit	Description
P_ops	Max operating pressure	barg	As defined by manufacturer spec
P_d	Design pressure	barg	Highest pressure that may occur under any and all operating modes, including steady state and transient.
P_t	Test pressure	barg	110% of design pressure
P_PRV	Relief pressure of relief valve	barg.	Test setup PRV
L_A	Max evaluated leak rate for pipework system acceptance	Nm^3/h	Maximum allowed pressure decay to pass pressure decay test
L_S	Expected leak rate for pipework system	Nm^3/h	Summarized expected leak rates of all components in the system (per design leak rate). The leak rates may be obtained from component category values or from actual measured leak rates during acceptance testing of the component.
L_C	Max allowed leak rate zone integrity (Critical leak level)	Nm^3/h	Maximum allowed leak rate for a given pipe section, where integrity/operability of the system may be maintained safely

Variable	Name	Unit	Description
L_Mu	Measuring system uncertainty	Nm^3/h	Calculated accuracy of the measuring system, used to perform the test. The MSA must consider the complete signal path of sensors and control system.
L1	Actual leak rate	Nm^3/h	Calculated gas leakage rate from the tested system by performing the pressure decay test
V	Internal space volume	m^3	Calculated Internal space volume within the pressurized section (m^3) (gas volume excepting the internal structure volume) Internal pipework space volume must be obtained from the system design team as a value for any of the relevant sections.
T0	Reference temperature	K	Theoretical reference temperature (288.15K)
T1	internal space temperature start	K	Measured internal space temperature at the beginning of measurement
T2	internal space temperature end	K	Measured internal space temperature at the end of measurement
P0	Absolute reference pressure	kPa	Theoretical reference pressure (1 atm) (101.325 kPa)
P1	Internal space pressure start	kPag	Measured internal space pressure at the beginning of measurement
P2	Internal space pressure end	kPag	Measured space pressure at the end of the measurement
Pa1	Absolute pressure start	kPag	Measured atmospheric pressure at the beginning of the measurement
Pa2	Absolute pressure end	kPag	Measured atmospheric pressure at the end of the measurement (kPa)
t	Test duration	min	Measured test duration (t_end – t_start)

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5.5.3 Sequence

If at any point the system pressure is dropping, investigate leak before continuing testing.

1. Introduce hydrogen to the system by increasing gradually the inlet pressure until test pressure level is reached in the system.
2. Close the relevant inlet valve, isolating pressure supply from the system under test.
3. Let the pressure in the system settle for 2 minutes.
4. Start the pressure decay monitoring by recording
   -start time t_start
   -start internal space pressure P1
   -start atmospheric pressure Pa1
   -start temperature T1
5. Wait for 10 minutes
6. Finish the pressure decay monitoring by recording
   -end time t_end
   -end internal space pressure P2
   -end atmospheric pressure Pa2
   -end temperature T2
7. Calculate the leak rate L1
8. Blow down system or continue operation if test is successful.

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5.5.4 Test evaluation

The actual leakage rate from the system is calculated in accordance with *IEC 62282-3-100:2019. Section 6.2* from the pressure difference in the system, measured over time using the following formula, and with variables as described in section 5.5.2:

$$L_1 = V \times T_0/p_0 \times \{(p_1 + p_{a1})/(T_1) - (p_2 + p_{a2})/(T_2)\} \times 60/t$$

The allowable leakage rate of the system is a function of the allowable leak rates of each component in the system and the uncertainty of the measurement system itself.

The expected leakage rate of components/subassemblies may vary from system to system and may be comprised of a mix of maximum allowed leak rates, obtained from the system's *ATEX zone classification and pipework plan* or expected leakage rates obtained from actual measured values in component acceptance tests.

The measurement system must be evaluated (MSA) to estimate the measurement uncertainty (L_Mu). The measuring system can only be considered sound if the calculated uncertainty amounts to less than 2% of the critical leak rate (L_C).

The test pass criteria threshold is calculated as the allowable/expected leak rate of the system + the measurement uncertainty:

$$L_A = L_S + L_Mu$$

System will pass the pressure decay test under the following criteria:

$$L_1 < L_A$$

6.0 Appendix

(Intentionally left blank)

Short Title	Cooling Circuit Pressure and Leak Test Procedure
Full Title	Cooling Circuit Pressure and Leak Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for validating cooling circuits are leak free and can withstand normal operating pressure.

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
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Abrevassion	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module

1.0 Objectives and background

The objective with this test procedure is to generalise how cooling circuits are leak free and pressure tested.

2.0 References

Document	Titel

3.0 Equipment list

Equipment	Purpose
Pressure gauge	Monitor pressure

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4.0 Test Procedure

The main purpose of this test procedure is to ensure that the cooling circuit is leak free and can handle maximum system pressure. Furthermore, it is structured in a way to minimize the chance of having big leaks or lose clamps or fittings.

WARNING: The stress test is with elevated pressure, potentially turning plugs or loose fittings into projectiles.

Minimum safety precautions:

- Hose clamps and fittings
- Wear safety goggles
- When dealing with glycol wear gloves
- Check service manual for maximum system pressure.

4.1 Pre-conditioning

- Check and make sure valves in the cooling circuit are in the correct position.
- For pressure testing with coolant in the cooling circuit, make sure the system is fully bleed. Air in the system can act as a spring and can obscure results.
- To achieve stable temperature let system soak for 12 hours. Alternative watch data from temperature sensors in the full system to ensure stable temperature conditions.

4.2 Leak test with air

- Maximum system pressure on Megablock is 1.5barg.
- No temperature pre-conditioning needed; this is not a sign off test.
- Find compressor and leak test kit.
- Adjust pressure reduction valve to minimum (no pressure after reduction valve)
- Attach leak test kit to cooling circuit (not applying pressure to circuit)
- Open valve from compressed air
- Slowly increase pressure from reduction valve to 20% of maximum system pressure (0.3barg)
- Close valve from compressed air
    - If pressure is not maintained
        - Open valve from compressed air again and look for leaks (where surface material is suitable soapy water spray can be used for leak detection)
        - Fix leak and repeat step.
    - If pressure is maintained
        - Continue to next step.
- Open valve from compressed air
- Slowly increase pressure from reduction valve to 80% of maximum system pressure (1.2barg)
- Close valve from compressed air
    - If pressure is not maintained
        - Open valve from compressed air again and look for leaks (where surface material is suitable soapy water spray can be used for leak detection)
        - Fix leak and repeat step.
    - If pressure is maintained
        - Continue to next step.
- Open valve from compressed air
- Slowly increase pressure from reduction valve to 100% of maximum system pressure (1.5barg)
- Close valve from compressed air
    - If pressure is not maintained
        - Open valve from compressed air again and look for leaks (where surface material is suitable soapy water spray can be used for leak detection)
        - Fix leak and repeat step.
    - If pressure is maintained – test completed and passed.

4.3 Leak test with air setup

Compressor and adaptor hose to be connected. Close valve to expansion tank so that pressure can build in cooling circuit. Find test setup image in appendix.

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4.4 Pressure decay test with coolant

- Maximum system pressure on Megablock is 1.5 barg.
- Make sure cooling circuit have been filled and bled before starting this test.
- Make sure pre-conditioning have been done.
- Find coolant pressure test kit.
- Attach test kit to cooling circuit (not applying pressure to circuit)
- Slowly increase pressure 50% of maximum system pressure (0.75barg)
- Close valve from test kit.
    - Quick inspection of cooling circuit for any coolant leaks.
    - If pressure is not maintained
        - Further inspection of test setup and cooling circuit
            - If there is still air in the system if can cause spring effect and drop in pressure
        - Found and fixed issue, repeat step.
    - If pressure is maintained
        - Continue to next step.
- Open valve from test kit
- Slowly increase pressure to 100% of maximum system pressure (1.5barg)
- Close valve from test kit
    - Quick inspection of cooling circuit for any coolant leaks.
    - If pressure is not maintained
        - Further inspection of test setup and cooling circuit
            - If there is still air in the system if can cause spring effect and drop in pressure
        - Found and fixed issue, repeat step.
    - If pressure is maintained
        - Continue to next step.
- Wait 30 minutes if pressure have dropped re-apply pressure to reach 100% system pressure again.
- Wait 2 hours and check pressure again.
    - If pressure have dropped more than 0.1bar
        - Repeat test
    - If pressure have dropped less than 0.1bar after 2 hours – test completed and passed.

4.5 Pressure decay test with coolant setup

Pressure pump and adaptor hose to be connected. Close valve to expansion tank so that pressure can build in cooling circuit. Find test setup image in appendix.

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5.0 Results and discussion

6.0 Appendix

6.1 Cooling leakage HT1 (Suggested section for FAT or SAT document)

6.1.1 Test

Follow designated test procedure for inspection and verification of a leak-free HT1 coolant circuit.

6.1.2 Relevant Standard / document

- SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure

6.1.3 Brief Test Plan

- Follow test procedure.

6.1.4 Pass/Fail criteria.

- Allow system to maintain pressure, after 2 hours pressure must not drop more than 0,1 bar.

6.1.5 Test Result

Table 1: Cooling leakage HT1 - Test Result

Date tested	Item	Result	Pass/Fail	Notes
	HT 1			

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6.2 Pressure decay test with coolant

Pressure pump and adaptor hose to connect and pressurise.



6.3 Leak test with air

Compressor and pressure test adaptor hose.



Short Title	Thermographic - Cooling and Ventilation Test Procedure
Full Title	Thermographic - Cooling and Ventilation Test Procedure
Abstract	This document describes the background, criteria and specifies the test procedure for validating cooling and ventilation are performing correct.

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Abrevassion	Meaning
FCwave	FCwave 200kW Marine Fuel Cell Module

1.0 Objectives and background

The objectives of this test procedure is to demonstrate the performance of ventilation and cooling on full system solution. The thermographic inspection will be conducted around solution as well as inside where service staff can enter while system stays operational.

- Ensure ventilation system performing as expected.
- Ensure cooling system is performing as expected.
- Validate accessible surface temperatures.

2.0 References

Document	Titel

3.0 Equipment list

Equipment	Purpose
Thermographic imager	Measure temperatures, capture images and create data folder with evidence.

4.0 Test Procedure

4.1 Personal protective equipment

Before commencing the test procedure always analyze the work environment and make sure you take the right precautions.

Suggested PPE depending on solution and work environment:

- Safety shoes
- Goggles
- Hearing protection

4.2 Preparation

- Verify equipment is calibrated and withing valid calibration period.
- Identify how and where to measure the ventilation system.
    - Access to areas that are normally accessible during operation to sweep for hot surfaces.
- Identify how and where to measure the cooling system.
    - It should be possible to view majority of cooling skid to check temperature distribution.
        - If this is not possible, review need for additional equipment during measurements
- Identify possible hot surfaces to be inspected.

4.3 Measurement locations

- Inside solution:
  - Ventilation of components
  - Container ventilation
  - Surface temperatures
  - Cooling circuit
- Outside solution:
  - Container ventilation
  - Surface temperatures
  - Coolers and cooling circuit

4.4 Conducting measurements

Set the Megablock to full power (1000 kW) and wait until temperatures have stabilised. Monitor the containers and ventilation described in section 4.3 through the thermographic imager and take pictures of all relevant areas with elevated temperatures. File in the pictures in a report.

5.0 Appendix

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Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project - Confirmation of Satisfactory SAT - Signature Page.pdf**
Document Number:	K559-2254-CWIWP4202202-J99-3-003
Revision:	Rev001
Sequence Number:	003
File Name:	K559-2254-CWIWP4202202-J99-3-003Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-3
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Ballard Power Systems Europe A/S
Majsmarken 1
DK-9500 Hobro
K559-2254-CWIWP4202202-J99-003

Confirmation of Satisfactory SAT

Part No.	601456B-7002362 Incl. sub-assemblies: 601456B-7002973 601456B-7003716
Product name	FC PowerGen 1000kW
Serial No.	601456B

Ballard Power Systems Europe A/S confirms that the above-listed equipment has satisfactorily with comments undergone and passed the Site Acceptance Test (SAT) according to

BLPH Project – Site Acceptance Test (SAT) Procedure [K559-2254-CWIWP4202202-J99-001]

BLPH Project - Test Matrix for FAT and SAT [K559-2254-CWIWP4202202-J99-002]

prior to the site integration test.

CrossWind C.V. acknowledges that the Site Acceptance Test (SAT) for the above-listed equipment was witnessed and confirms that the test was performed satisfactorily with comments, and all agreed-upon specifications have been met.

Signatures

Ballard Power Systems Europe A/S			
Signature:			
Name:			
Title:		Date:	
CrossWind C.V.			
Signature:			
Name:			
Title:	Crosswind Commissioning Manager	Date:	
Inspector			
Signature:			
Name:			
Title:	Inspector for Crosswind	Date:	

Note: This document serves as formal confirmation that the SAT has been successfully completed and witnessed, with both parties in agreement on the satisfactory results. It should be signed by authorized representatives of both parties.

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project - F10, Safety checklist**
Document Number:	K559-2254-CWIWP4202202-J99-4-004
Revision:	Rev001
Sequence Number:	004
File Name:	K559-2254-CWIWP4202202-J99-4-004Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-4
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Title	F10 Safety checklist
Project	601456B CrossWind BLPH
Test date [DD-MM-YYYY]	
Test location	
Test performed by	

Checklist for safety inputs

Main location	Location	Checked
40ft container	Emergency pushbuttons	
	40ft side door	
	UC50	
	UC30	
	Smoke detector	
	Left	
	Middle	
	Right	
	H2 sensor	
	Left	
	Middle	
	Right	
	External safety swithces	
	External feedback	

Ballard Power Systems Europe A/S
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9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project -EN 60204 Electrical safety test 10ft**
Document Number:	K559-2254-CWIWP4202202-J99-6-006
Revision:	Rev001
Sequence Number:	006
File Name:	K559-2254-CWIWP4202202-J99-6-006Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-6
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		09/11-2023
2.0	PBL	Adapted from 40ft Coolant Skid document		04/07-2024
3.0	RKN	General review		09/01-2025

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Figure 6 – EN60204-1:2018, Chapter 18.4 8
Figure 7 – EN60204-1:2018, Chapter 18.5 9
Figure 8 – EN60204-1:2018, Chapter 6.2.4 10
Figure 9 – EN60204-1:2018, Chapter 8.2.6 11

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5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

8. Test Equipment.

The test equipment is a CE MultiTester, manufactured by Metrel.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the 10ft container for the Megablock project.

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10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 2 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	10ft Container
Result (pass/fail)	
Date and Initials	

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 3 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the Power Converter Container is the main ground bar located at the rear of the main output breaker (=BA30-FC30).

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Busbar to busbar	<100mΩ	
2	Main DC/Acpoint 1		
3	Main DC/Acpoint 2		
4	Main DC/Acpoint 3		
5	DC/AC conduncter point 1		
6	DC/AC conduncter point 2		
7	DC/AC conduncter point 3		
8	LT coolant pipe		
9	Cable tray		

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

10	Main transforer grounding bolt		
11	Main transformer chassis		
12	Cable tray		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 4 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11). Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications.

Megablock Component module does not contain any RCD devices.

13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 5 – EN60204-1:2018, Chapter 18.3

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

Megablock Component requirements:

Before performing this test, isolate all fuel cell DCDC converters from the DC bus (Cabinets UC01 to UC06)

Use a set of test leads and alligator clips to create a single AC node (3 phases shorted together)

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
=LA01+UC31-QB01	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Power Converter Container
Result – AC Node (value and pass/fail)	
Date and Initials	

14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 6 – EN60204-1:2018, Chapter 18.4

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Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Connection point is internal side of main output breaker.

Component	Power Converter Container
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 7 – EN60204-1:2018, Chapter 18.5

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Megablock		10ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 8 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers or accessing electrical cabinets. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 9 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is installed with a proven component (Bender Isometer). Detection of ground fault causes system shutdown and service technician is dispatched.
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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Ballard Power Systems Europe A/S
Majsmarken 1
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Denmark

Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project -EN 60204 Electrical safety test 40ft**
Document Number:	K559-2254-CWIWP4202202-J99-7-007
Revision:	Rev001
Sequence Number:	007
File Name:	K559-2254-CWIWP4202202-J99-7-007Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-7
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		09/11-2023
2.0	PBL	Adapted from 40ft Coolant Skid document		04/07-2024
3.0	CJA	Adapted from 10ft power converter container document		15/10-2024
4.0	RKN	General review		09/01-2025

3. List of Figures

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1 3
Figure 2 – EN60204-1:2018, Chapter 18.1 5
Figure 3 – EN60204-1:2018, Chapter 18.2.2 6
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Figure 5 – EN60204-1:2018, Chapter 18.3 9
Figure 6 – EN60204-1:2018, Chapter 18.4 10
Figure 7 – EN60204-1:2018, Chapter 18.5 11
Figure 8 – EN60204-1:2018, Chapter 6.2.4 11
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4. List of Tables

Table 1 – References 2
Table 2 – Requirement headlines, chapter, and ID mapping 3
Table 3 – Bonding Resistance Test point and expected resistance values. 7
Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements 9

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Table 5 – Voltage Test Requirements 10
Table 6 – Summary Table 13

5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

8. Test Equipment.

The test equipment is a CE MultiTester, manufactured by Metrel.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the 40ft Fuel Cell Container for the Megablock project.

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 2 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	40ft Container
Result (pass/fail)	
Date and Initials	

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11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 3 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the 40ft Fuel Cell Container is the main ground bar located in +UC50.

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Busbar to busbar	<100mΩ	
2	Module 1		
3	DC/DC cabinet 1		
4	Module 2		
5	DC/DC cabinet 2		
6	Module 3		
7	DC/DC cabinet 3		
8	Module 4		
9	DC/DC cabinet 4		
10	Module 5		
11	DC/DC cabinet 5		

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12	Module 6		
13	DC/DC cabinet 6		
14	Control cabinet		
15	Control cabinet right door		
16	Lifting crane track, dolly		
17	LT piping		
18	Isolation transformer cover		
19	Cable tray		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 4 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11).

Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications.

Megablock RCD Testing:

All RCD (Residual Current Device) in the Megablock system is equipped with self-test functionality from the manufacturer. This takes the shape of a push button, which must cause the RCD device to trip when actuated.

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Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

For the test, first enable all RCD circuits, and then actuate the self-test button on the devices. The devices must trip within 1 second. After the trip, use a multimeter to verify that the output of the device has no voltage (<10VAC)

Component	RCD Devices in UC20 (40ft Control Cabinet)
Result – 3ph RCD	
Result – 1ph RCD/MCCB	
Date and Initials	

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13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 5 – EN60204-1:2018, Chapter 18.3

Megablock Component requirements:

Before performing this test, isolate all fuel cell DCDC converters from the DC bus (Cabinets UC01 to UC05)

Use a set of test leads and alligator clips to create a single AC node (3 phases shorted together)

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
Internal side of the output breaker	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Fuel Cell Container
Result – AC Node (value and pass/fail)	
Date and Initials	

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 6 – EN60204-1:2018, Chapter 18.4

Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Connection point is internal side of main output breaker.

Component	Fuel Cell Container
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

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Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 7 – EN60204-1:2018, Chapter 18.5

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 8 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers or accessing electrical cabinets. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 9 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is installed with a proven component (Bender Isometer). Detection of ground fault causes system shutdown and service technician is dispatched.
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project-EN 60204 Electrical safety test Cng Pltfrm**
Document Number:	K559-2254-CWIWP4202202-J99-8-008
Revision:	Rev001
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Purchaser Job:	K559-2254
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Megablock		Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		9/11-2023
2.0	PBL	General updates		21/10-2024
3.0	RKN	General review		09/01-2025

3. List of Figures

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Table 6 – Summary Table 14

5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

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7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

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Test Specification	RKN	09-01-2025	3.0.0

8. Test Equipment.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the coolant skid for the Megablock project. A rendering is shown below with selected items highlighted.

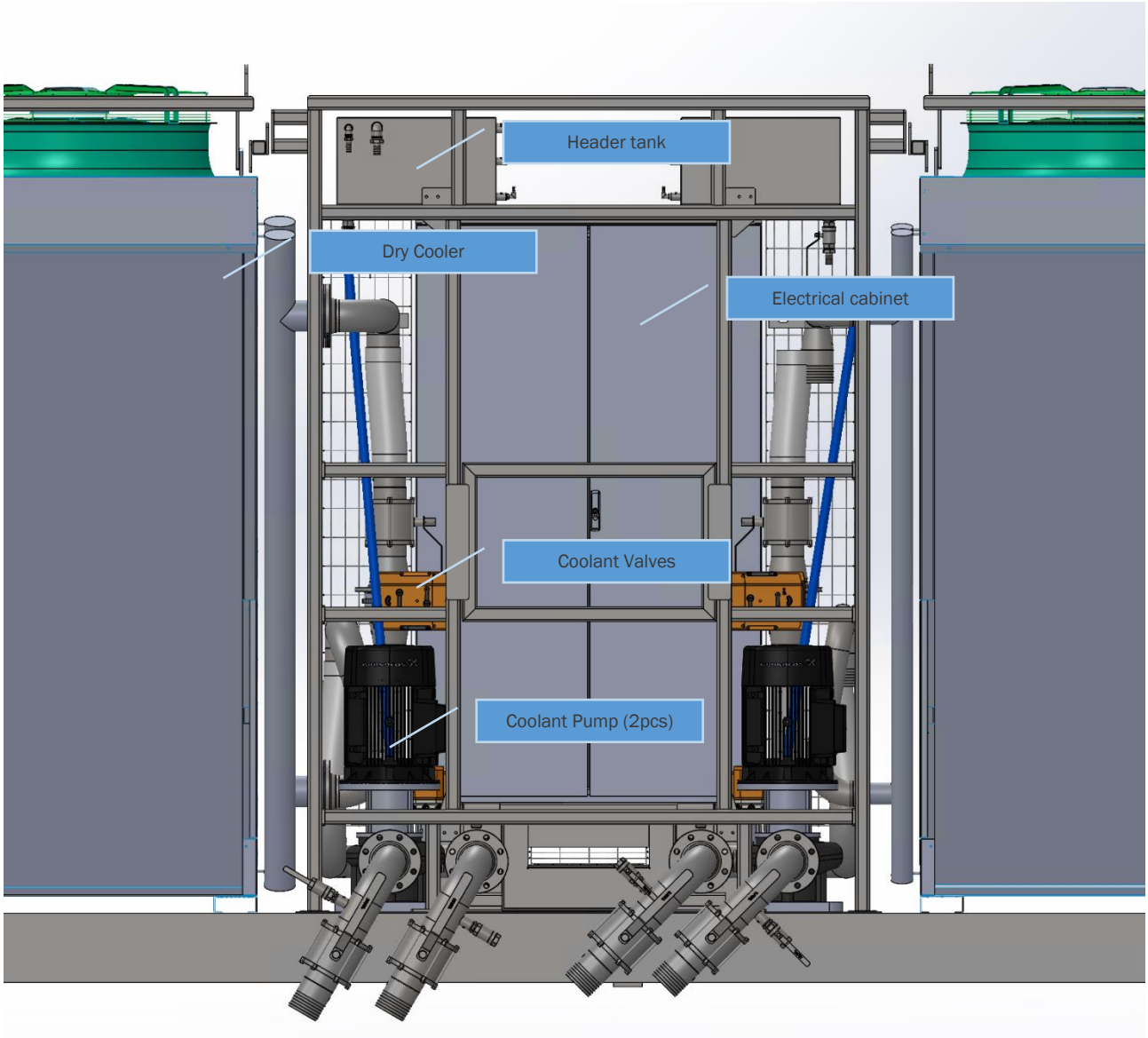


Figure 2 – Front view of coolant skid centre section with callouts.

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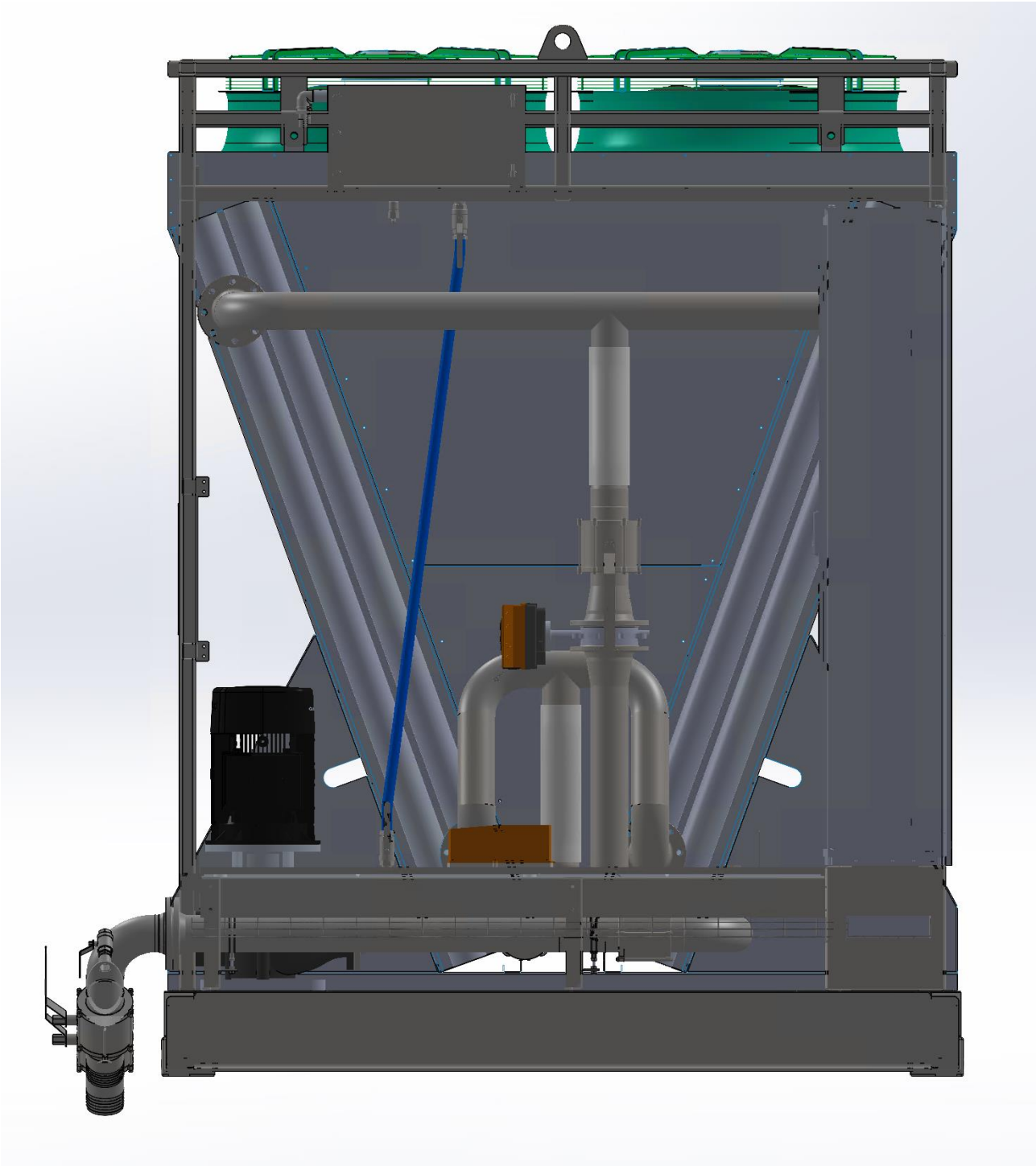


Figure 3 – Section view of the coolant skid, looking from centre towards left.

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Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	3.0.0

10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 4 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	Coolant Skid
Result (pass/fail)	
Date and Initials	

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11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 5 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the coolant skid is the main ground terminal in the control enclosure.

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Control Cabinet Backplate	<100mΩ	
2	Grounding Bar, Below PLC		
3	HT1 Cooling Pipe, From HT1 Cooler		
4	HT1 Manual Valve, HT1 Cooler Outlet		
5	HT1 Coolant Pump, Grounding Connection		
6	HT1 Header Tank, Bolts		
7	HT1 Cooler Frame (Metal)		
8	HT2 Cooling Pipe, From HT1 Cooler		
9	HT2 Manual Valve, HT1 Cooler Outlet		
10	HT2 Coolant Pump, Grounding Connection		

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11	HT2 Header Tank, Bolts		
12	HT2 Cooler Frame (Metal)		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

Notes to test points:

- Point 1-2 is inside the electrical cabinet.
- Point 3-6 is indicated on Figure 6 – Test points for Grounding Test
- Point 7-12 are identical to points 3-6, except mirrored to HT2.

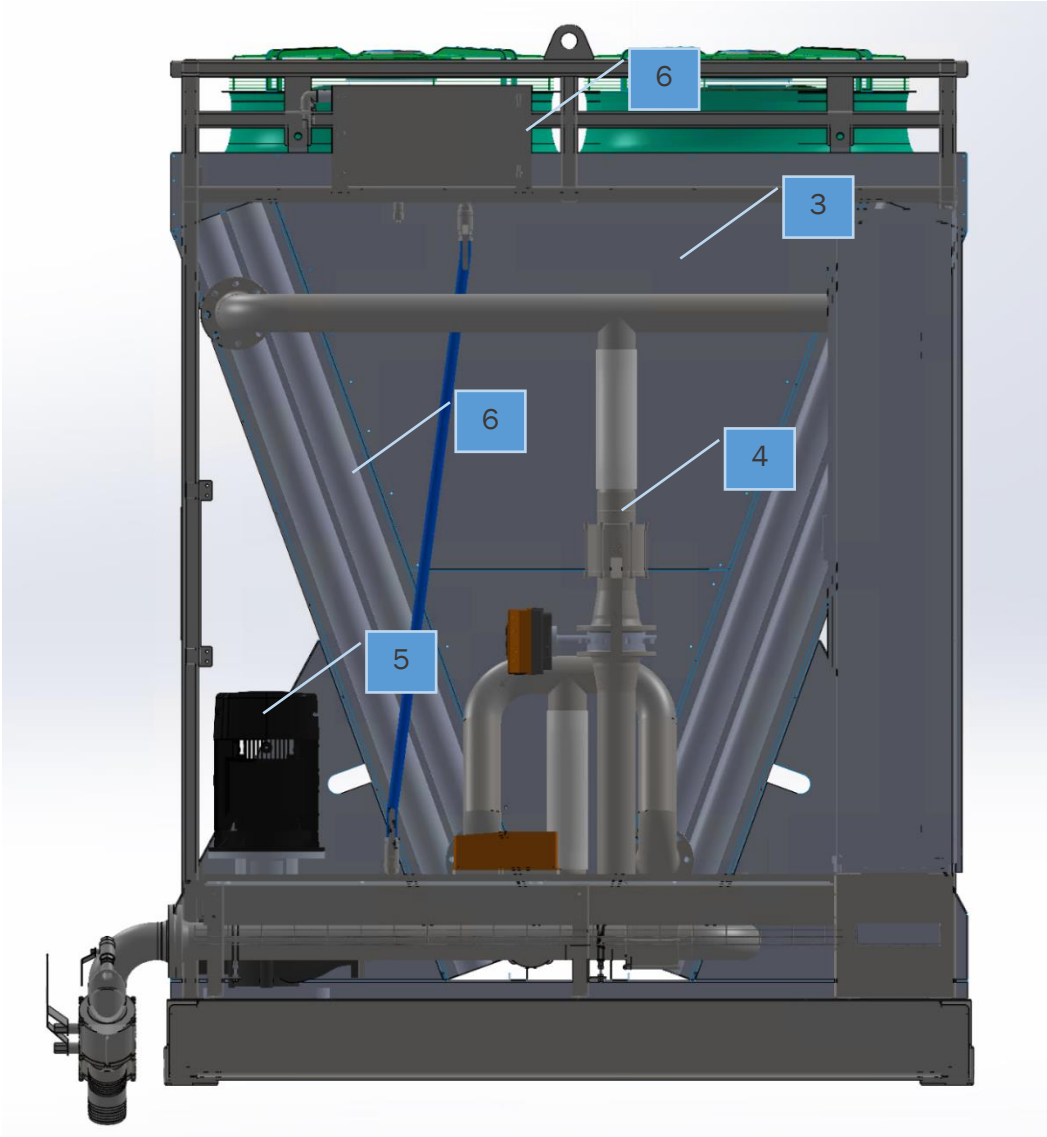


Figure 6 – Test points for Grounding Test

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12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 7 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11). Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications. Megablock Component module does not contain any RCD devices.

Megablock Component is not a TN-system, and Test #2 is not relevant.

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13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 8 – EN60204-1:2018, Chapter 18.3

Megablock Component requirements:

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
UC40-FC04	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Coolant Skid
Result – AC Node (value and pass/fail)	
Date and Initials	

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14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 9 – EN60204-1:2018, Chapter 18.4

Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Component	Coolant Skid
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

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15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 10 – EN60204-1:2018, Chapter 18.5

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 11 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a voltage drawdown process and manual verification before any work on exposed components is permitted.

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16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 12 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is in the scope of the 10ft Container (DCAC system)
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

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17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

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SPC ID 0204 System Pressure Decay Test Template

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
-	Initial Draft	TAN	21/08/2024
1	Released	TAN	30/08/2024
2	Updated	TAN	09/09/2024

Purpose	Pressure decay test template for recording tightness and evaluating system pipework integrity
Reference procedure	SPC ID 0104 rev 002 H2 Leak Test Procedure

Checked by	MHA	Date: 09/09-2024
Approved by	MHA	Date: 09/09-2024

Title	
Project	
Test date	
Identification of piping system (photo or P&ID) [✓ or -]	

Test volume	
Test fluid/gas	
Test location	
Test performed by	
Results approved by	
Filing date	

L_S - Expected leak rate for pipework system							
Ferrule fittings tightness tolerance	<		bar				
Bonded seal tightness tolerance	<		bar				
L_S total*	= 0		bar				
L_S total	=	0	NM3/h				
L_Mu - Measuring system uncertainty							
pressure gauge uncertainty							
transmitter FS (full scale)	=		barg				
Linearity	<		% of FS	=	<	0	mbar
Non-repeatability	<		% of FS	=	<	0	mbar
Analogue input	±		microA	=			mbar/10 minutes
Accuracy ±0.25% actual reading	±		microA		=		mbar
Temperature uncertainty (3 Kelvin)				=	±	82	mbar/10 minutes
L_Mu total					=	82,0	mbar
*=All joints and valves are considered to be classified "enhanced tightness". Hence zero allowable leak rate							

Calculation of L_Mu, measuring system uncertainty

	V	T0	T1	T2	P0	P1	P2	Pa1	Pa2	t	L_Mu
	M3	°C	°C	°C	kPa	barg	barg	kPa	kPa	minutes	NM3/h
String 1	3,46E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,68E-03
String 2	3,05E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,48E-03

String 3	2,67E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,29E-03
String 4	2,74E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,33E-03
String 5	3,12E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,52E-03
String 6	3,50E-03	15	15	15	101,325	7,150	7,068	101,325	101,325	10	1,70E-03

Calculation of L_A, max evaluated leak rate for pipework system acceptance

	L_S	L_Mu		L_A
	NM3/h	NM3/h		NM3/h
String 1	0	1,68E-03	=	1,68E-03
String 2	0	1,48E-03	=	1,48E-03
String 3	0	1,29E-03	=	1,29E-03
String 4	0	1,33E-03	=	1,33E-03
String 5	0	1,52E-03	=	1,52E-03
String 6	0	1,70E-03	=	1,70E-03

Procedure

Fill in design pressure = barg
The Test Pressure is 1.1 times design pressure or above = 0 barg
If the system previosly has been leakage tested with formier gas, this test can also use the used gas for operation
To perform the test follow "Sequence" paragraph 5.5.3 in SPC 0104 H2 Leak Test Procedure

Calculation of L1, actual leak rate

	V	T0	T1	T2	P0	P1	P2	Pa1	Pa2	t	L1 (gas leakage rate)
	M3	°C	°C	°C	kPa	barg	barg	kPa	kPa	minutes	NM3/h
String 1		15			101,325						#DIV/0!
String 2		15			101,325						#DIV/0!
String 3		15			101,325						#DIV/0!
String 4		15			101,325						#DIV/0!
String 5		15			101,325						#DIV/0!
String 6		15			101,325						#DIV/0!

Sensor	Sensor placement
Temperature sensor T1 & T2	BT01 Sensor in H2 heater
Pressure sensor P1 & P2	FCwave pressure inlet sensor
Atmospheric pressure Pa1 & Pa2	Data from https://www.dmi.dk/maalinger/show/DK/2620167/Hobro/

Result of test

	L1	<	L_A	Pass (Below acceptance criteria L_A)
	NM3/h		NM3/h	Pass/Fail
String 1	#DIV/0!	<	1,68E-03	
String 2	#DIV/0!	<	1,48E-03	
String 3	#DIV/0!	<	1,29E-03	
String 4	#DIV/0!	<	1,33E-03	
String 5	#DIV/0!	<	1,52E-03	
String 6	#DIV/0!	<	1,70E-03	

Title:
P&ID of Hydrogen Supply system

SPC ID:
Revision:

Printed on:

No.	Revision	Tag Number	Description	Location	Manufacturer	Model Type Catalogue Number	Serial Number	ATEX Certification Marking	Reference Document	ATEX Certificate Number	Installation Zone	Notes / Comments	P.O	Vendor	Skid /Package	Barrier Calculation ref.	Non-electrical Equipment	Special Conditions for Safe Use
1	04	BL01	Electronic level sensor; Operating voltage 18...30 DC V; ATEX; M12 Connector; Gold-plated contacts	=HA01+DA02 - H2 Supply System	IFM Electronic AS	LMT01A LMACE-A12E-QSKG-1/US/3D/3G	10000160523	II 3G Ex nA IIC T4 Gc	K559-2254-CWIWP4202202-C03-001	8003330	Zone 2		8517643	IFM Electronic AS	A-80000	No	No	No
2	04	BL01-WG01	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end, Black	=HA01+DA02 - H2 Supply System	IFM Electronic AS	EVC14A ADOGH040VAT0025H04/3G/2D	N/A	II 3G EX ec IIC Gc	K559-2254-CWIWP4202202-E03-003	BVS 08ATEX E 109U	Zone 2		8520141	IFM Electronic AS	A-80000	No	No	No
3	04	BP01	Pressure Transducer, 0-10 barg, 4-20mA, ATEX, -25 to 85°C Ta, M12 Connector, 10..30 VDC, 2-wire, G1/2 Process Connection, FPM Seal	=HA01+DA02 - H2 Supply System	HUBA Controls AG	Pressure Transducer 520 Series	N/A	Ex II 1/2G Ex ia IIC T4 Ga/Gb	K559-2254-CWIWP4202202-C03-001	SEV 10 ATEX 0145	Zone 2		8516809	HUBA Controls AG	A-80000	K559-2254-CWIWP4202202-G99-002	No	No
4	04	BP01-WG01	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end, Light blue	=LA01+UC42 - EX Barrier Box	IFM Electronic AS	ENC03A ADOGH040MSN0010H04/1G/1D	N/A	II 2G Ex ia IIC T6 Gb	K559-2254-CWIWP4202202-E03-008	BVS 11ATEX E 009X	Zone 2		8520269	IFM Electronic AS	A-80000	K559-2254-CWIWP4202202-G99-002	No	Yes
5	04	TF01	BP01 - Pressure Sensor – Ex Barrier (9106-B1B)	=LA01+UC42 - EX Barrier Box	PR Electronics AS	9106-B1B	N/A	II (1) G [Ex ia Ga] IIC/IIB/IIA	K559-2254-CWIWP4202202-E03-008	DEKRA 11ATEX0244 X	No Zone		146131-1	PR Electronics AS	A-80000	K559-2254-CWIWP4202202-G99-002	No	Yes
6	04	BT01	Temperature sensor: liquids and gases Connection: stainless steel (1.4404 / 316L) Ambient temperature: -25...80 °C	=HA01+DA02 - H2 Supply System	IFM Electronic AS	TT1050 TT-100KBBD10-...../US/	100000113592	N/A	K559-2254-CWIWP4202202-C03-001	N/A	Zone 2	Simple apparatus accordingly to IEC 60079-14 section 16.4	8516509	IFM Electronic AS	A-80000	K559-2254-CWIWP4202202-G99-002	No	No
7	04	BT02-WG01	Connecting cable with socket; 4x0.34mm2, AC/DC < 50 V; 10 m M12 to open end, Light blue	=LA01+UC42 - EX Barrier Box	IFM Electronic AS	ENC03A ADOGH040MSN0010H04/1G/1D	N/A	Ex ia IIC T6 Gb	K559-2254-CWIWP4202202-E03-008	BVS 11ATEX E 009X	Zone 2		8520269	IFM Electronic AS	A-80000	K559-2254-CWIWP4202202-G99-002	No	Yes
8	04	TF01	BT01 - Temperature Sensor – Ex Barrier (9113B-U9)	=LA01+UC42 - EX Barrier Box	PR Electronics AS	9113B-U9	N/A	II (1) G [Ex ia Ga] IIC/IIB/IIA	K559-2254-CWIWP4202202-E03-008	KEMA 07ATEX0148 X	No Zone		8520371	PR Electronics AS	A-80000	K559-2254-CWIWP4202202-G99-002	No	Yes
9	04	EA01	Immersion Heater, 3x400V, 9kW, ATEX, IP66, Screw plug 2", ASTM A182 F316, Element Length 600m	=HA01+DA02 - H2 Supply System	JEVI Heating Elements AS	D-8640	340386-1	Ex d IIC T4 Gb	K559-2254-CWIWP4202202-C03-001	ISSeP 08 ATEX 008X	Zone 2		8517682	JEVI Heating Elements AS	A-80000	No	No	Yes
10	04	EA01-WD01	Screened halogen free, highly flame retardant control cable, 4G 2.5mm2, 300/500V	=HA01+DA02 - H2 Supply System	Lapp Group	ÖLFLEX® CLASSIC 130H	N/A	N/A	K559-2254-CWIWP4202202-E03-003	N/A	Zone 2		N/A	Lapp Group	A-80000	No	No	No
11	04	EA01	Cable Gland	=HA01+DA02 - H2 Supply System	HAWKE	ICG 653 UNIV Os M20	N/A	EX db IIC Gb and EX eb IIC GB	K559-2254-CWIWP4202202-C03-001	IECEx CML18.0131X	Zone 2		8517682	HAWKE	A-80000	No	No	Yes
12	04	EA02	Immersion Heater, 3x400V, 9kW, ATEX, IP66, Screw plug 2", ASTM A182 F316, Element Length 600m	=HA01+DA02 - H2 Supply System	JEVI Heating Elements AS	D-8640	340386-2	Ex d IIC T4 Gb	K559-2254-CWIWP4202202-C03-001	ISSeP 08 ATEX 008X	Zone 2		8517682	JEVI Heating Elements AS	A-80000	No	No	Yes
13	04	EA02-WD01	Screened halogen free, highly flame retardant control cable, 4G 2.5mm2, 300/500V	=HA01+DA02 - H2 Supply System	Lapp Group	ÖLFLEX® CLASSIC 130H	N/A	N/A	K559-2254-CWIWP4202202-E03-003	N/A	Zone 2		N/A	Lapp Group	A-80000	No	No	No
14	04	EA02	Cable Gland	=HA01+DA02 - H2 Supply System	HAWKE	ICG 653 UNIV Os M20	N/A	EX db IIC Gb and EX eb IIC GB	K559-2254-CWIWP4202202-C03-001	IECEx CML18.0131X	Zone 2		8517682	HAWKE	A-80000	No	No	Yes
15	04	QM1.1	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP24068090	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8516694	Emerson ASCO	A-80000	No	No	Yes
16	04	QM1.1	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
17	04	QM1.1	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
18	04	QM2.1	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
19	04	QM2.1	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
20	04	QM2.1	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
21	04	QM1.2	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP24068090	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8516694	Emerson ASCO	A-80000	No	No	Yes
22	04	QM1.2	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
23	04	QM1.2	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
24	04	QM2.2	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
25	04	QM2.2	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
26	04	QM2.2	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
27	04	QM1.3	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP24068090	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8516694	Emerson ASCO	A-80000	No	No	Yes
28	04	QM1.3	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
29	04	QM1.3	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
30	04	QM2.3	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
31	04	QM2.3	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
32	04	QM2.3	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
33	04	QM1.4	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
34	04	QM1.4	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
35	04	QM1.4	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
36	04	QM2.4	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
37	04	QM2.4	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
38	04	QM2.4	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
39	04	QM1.5	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
40	04	QM1.5	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
41	04	QM1.5	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
42	04	QM2.5	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
43	04	QM2.5	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
44	04	QM2.5	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
45	04	QM1.6	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
46	04	QM1.6	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
47	04	QM1.6	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
48	04	QM2.6	Solenoid Valve, Normally Closed, 3/4" Bore, ATEX for Hydrogen, Material: Body and Bonnet SS316, Seal, Diaphragm NBR, Pressure 0 to 16 barg	=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2..T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes
49	04	QM2.6	1/2" NPT to M20 adaptor	=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semco maritime	A-80000	No	No	Yes
50	04	QM2.6	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
51	04	XT01	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
52	04	XT02	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
53	04	XT03	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
54	04	XT04	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
55	04	XT05	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
56	04	XT06	Roxtec RS 50 B Ex-kit AISI316/AISI316	=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes
57	04	XT07	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - Non EX Box	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
58	04	XT07	M32 to M20 Ex Reducer	=HA01+DA02 - Non EX Box	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
59	04	XT08	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - Exterior location, hydrog	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
60	04	XT08	M32 to M20 Ex Reducer	=HA01+DA02 - Exterior location, hydrog	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
61	04	XT09	Cable Gland, Ex, M20 501/421 O Brass	=HA01+DA02 - Exterior location, hydrog	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semco maritime	A-80000	No	No	Yes
62	04	XT09	M32 to M20 Ex Reducer	=HA01+DA02 - Exterior location, hydrog	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semco maritime	A-80001	No	No	Yes
63	04	XT10	Cable Gland, Ex, M20 501/421 A Brass	=HA01+DA02 - Exterior location, hydrog	HAWKE	501/421/A M20 421AM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C06-001	IECEx CML 19.0045X	Zone 2		CD3034021	Semco maritime	A-80002	No	No	Yes
64	04	XT10	M40 to M20 Ex Reducer	=HA01+DA02 - Exterior location, hydrog	Eaton Corporation	RDU100704	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C06-001	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semco maritime	A-80003	No	No	Yes
65	04	XT11	Cable Gland, Ex, M20 501/421 A Brass	=HA01+DA02 - Exterior location, hydrog	HAWKE	501/421/A M20 421AM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034021	Semco maritime	A-80004	No	No	Yes
66	04	XT11	M40 to M20 Ex Reducer	=HA01+DA02 - Exterior location, hydrog	Eaton Corporation	RDU100704	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semco maritime	A-80005	No	No	Yes

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Revision history		
Rev.	**Date.**	**Description**
001	30/08/2024	First Issue

Document Title:	**BLPH Project - ATEX Components Data Sheets**
Document Number:	K559-2254-CWIWP4202202-D99-001
Revision:	Rev001
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-D99-001Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	D99
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Pressure transmitter



Huba Control

Relative pressure transmitter

Type 520

The compact type 520 pressure transmitter is based upon the Huba Control developed thick film technology where the pressure measuring cell is fully welded.
This transmitter meets the high burst protection demands and is suitable for the use in all types of refrigerants including ammonia.

Pressure range

-1 ... 9 bar /
0 ... 2.5 – 1000 bar

+ Compact, rugged construction
+ Welded without sealing parts, no elastomer seals
+ Large selection of connections available.
+ Saving time by quick cable mounting by the customer with swift connector

Technical overview

Pressure range

Relative	-1 ... 9 bar / 0 ... 2.5 – 1000 bar

Operating conditions

Medium		Liquids, gases and refrigerants (incl. ammonia)	
Temperature	Medium	-40 ... +135 °C	(Ex) -30 ... +120 °C)
	Ambient	-30 ... +85 °C	(Ex) -25 ... +85 °C)
	Storage	-50 ... +100 °C	
Tolerable overload	≤ 6 bar	5 x fs	
	> 6 bar	3 x fs (max. 1500 bar)	
Rupture pressure	≤ 6 bar	10 x fs	
	> 6 bar	6 x fs (max. 2500 bar)	

Materials

Cover		Stainless steel 1.4404 / AISI 316L (inside thread Schrader 1.4305 / AISI 303 only)
Plug accommodation		Polyarylamide 50% GF UL 94 V-0
Materials in contact with medium	Pressure connection	Stainless steel 1.4404 / AISI 316L (inside thread Schrader 1.4305 / AISI 303 only)
	Sensor	Stainless steel

Electrical overview

		Output	Power supply	Load	Current consumption
2 wire		4 ... 20 mA	7 ... 33 VDC	$< \frac{\text{supply voltage - 7 V}}{0.02\ \text{A}}$ [Ohm]	< 23 mA
	Ex	4 ... 20 mA	10 ... 30 VDC	$< \frac{\text{supply voltage - 10 V}}{0.02\ \text{A}}$ [Ohm]	< 23 mA
3 wire		0 ... 5 V	7 ... 33 VDC	>10 kOhm / < 100 nF	< 7 mA
		1 ... 6 V	8 ... 33 VDC	>10 kOhm / < 100 nF	< 7 mA
		0 ... 10 V	12 ... 33 VDC	>10 kOhm / < 100 nF	< 7 mA
		0 ... 10 V	12 ... 33 VDC / 24 VAC ± 15%	>10 kOhm / < 100 nF	< 7 mA
		ratiom. 10 ... 90%	5 VDC ± 10%	>10 kOhm / < 100 nF	< 7 mA
	Ex	ratiom. 10 ... 90%	5 VDC ± 10%	>10 kOhm / < 100 nF	< 7 mA
Polarity reversal protection		Short circuit proof and protected against polarity reversal. Each connection is protected against crossover up to max. supply voltage.			
Insulation voltage				standard	500 VDC

Dynamic response

Response time	< 2 ms, 1 ms typ.
Load cycle	< 100 Hz

Electrical connection	**Protection standard**	**Protection class**
Swift connector with or without cable 1.5 / 2.0 / 3.0 / 5.0 m (PVC spec.)	IP 67	III
Connector DIN EN 175301-803-A or C (industrial standard 9.4 mm)	IP 65	III
Metri Pack Serie 150	IP 67	III
Connector M12x1	IP 67	III
Braids	IP 65	III
Connector RAST 2.5 (3 wire, only)	IP 00	III

Pressure connection

Inside thread	7/16 - 20 UNF	without or with Schrader
	½ -14 NPT	(≤ 60 bar)
	G ¼	with O-Ring seal FPM (-30 ... +135 °C)
Outside thread	7/16 - 20 UNF	sealing cone 45°
	¼ -18 NPT	
	7/16 - 20 UNF	sealed at back SAE 4 with O-Ring seal FPM (-20 ... +135 °C)
	G ¼	sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM (-30 ... +135 °C)
	G ¼	sealed at back and manometer (combi) with profile seal ring in FPM (-30 ... +135 °C) (≤ 60 bar)
	R ¼	EN 10226
	G ½	sealed at back and manometer (combi) with profile seal ring in FPM (-30 ... +135 °C)
	⅛ - 27 NPT	(≤ 60 bar)
	G ⅛	sealed at front (≤ 60 bar)
	G ⅛	sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM (-30 ... +135 °C) (> 60 bar - without ATEX certificate)
	M10x1	sealed at back DIN EN ISO 1179-2 with Profile seal ring in FPM (-30 ... +135 °C) (≤ 60 bar)
	M20x1.5	sealed at front and manometer (combi)
	G ½, G ¼	sealed at front

Installation arrangement

Unrestricted

Tests / Admissions

Electromagnetic compatibility	CE conformity acc. EN 61326-2-3
Enhanced EMC protection	EN 50121-3-2
Shock acc. IEC 68-2-27	100 g, 11 ms half sine wave, all 6 directions, free fall from 1 m on concrete (6x)
Constant shock acc. IEC 68-2-29	40 g for 6 ms, 1000x all 3 directions
Vibration acc. IEC 68-2-6	20 g, 15 ... 2000 Hz, 15 ... 25 Hz with amplitude ± 15 mm, 1 Octave/min. all 3 directions, 50 constant load
UL	ANSI/UL 61010-1 acc. E325110
Drinking water approval	NSF/ANSI 61/372 acc. MH60087
	WRAS
EAC	

Protection against explosion (Ex)	**ratiom. 10 ... 90%**	**4 ... 20 mA**
Intrinsic safety «i»	Ex II 1/2 G Ex ia IIC T4 Ga/Gb	Ex II 1/2 G Ex ia IIC T4 Ga/Gb
	Ex II 1/2 D Ex ia IIIC T125°C Da/Db	Ex II 1/2 D Ex ia IIIC T125°C Da/Db
EC type examination certificate	SEV 15 ATEX 0173	SEV 10 ATEX 0145
Connection to certified intrinsically safe resistive circuits with maximum values	Ui ≤ 15 VDC; Ii ≤ 200 mA; Pi ≤ 750 mW	Ui ≤ 30 VDC; Ii ≤ 100 mA; Pi ≤ 750 mW
Effective internal inductance and capacitance for versions with plugs complying with EN 175301-803-A or M12x1	Li = 0 nH; Ci ≤ 150 nF	Li = 0 nH; Ci = 0 nF
IECEx		SEV 16.0007

Weight

~ 90 g

Packaging (Please state on order)

Single packaging in cardboard	accessories integrated
Multiple packaging in cardboard (25 pcs)	

Accuracy

Parameter		Unit	
Characteristic line a [1]		% fs	± 0.3
Resolution		% fs	0.1
Thermal characteristic [2]	max.	% fs/10K	± 0.2
Long term stability acc. EN 60770-1	max.	% fs	± 0.25

Test conditions: 25 °C, 45% RH, power supply 24 VDC

Order code selection table in bar

			1	2	3	4	5	6	7	8	9	10	11
		520.	X	X	X	X	X	X	X	X	X	X	X
Pressure range [3]	-1 ... 9 bar		9	0	6								
	0 ... 2.5 bar		9	1	4								
	0 ... 4 bar		9	1	5								
	0 ... 6 bar		9	1	7								
	0 ... 10 bar		9	3	0								
	0 ... 16 bar		9	3	1								
	0 ... 25 bar		9	3	2								
	0 ... 40 bar		9	3	3								
	0 ... 60 bar		9	4	0								
	0 ... 100 bar		9	4	1								
	0 ... 160 bar		9	4	2								
	0 ... 250 bar		9	4	3								
	0 ... 400 bar		9	5	4								
	0 ... 600 bar		9	5	5								
	0 ... 1000 bar		9	5	7								
Application	standard					S	0						
	for oxygen applications					S	1				0		
	with drinking water approval NSF/ANSI 61/372, WRAS					S	4				0	1	
Output / power supply	0 ... 5 V	7 ... 33 VDC						1					
	1 ... 6 V	8 ... 33 VDC						6					
	0 ... 10 V	12 ... 33 VDC						2					
		12 ... 33 VDC Enhanced EMC protection						C	1,2,3				
		12 ... 33 VDC / 24 VAC ±15% *(not possible with M12x1, metri Pack, RAST, braids)*						8					
	ratiom. 10 ... 90%	5 VDC ±10%						7					
		5 VDC ±10% Ex protection					0,4	9	1,3			1	
	4 ... 20 mA	7 ... 33 VDC						3					
		7 ... 33 VDC Enhanced EMC protection *(not possible with Braids)*						A					
		10 ... 30 VDC Ex protection					0,4	4	1,3			1	
Electrical connection	Connector [4]	DIN EN 175301-803-A							1				
		DIN EN 175301-803-C (industrial standard 9.4 mm)							2				
		M12x1 *2w: IN=1 / OUT=3 3w: IN=1 / OUT=4 / GND=3*							3				
		M12x1 *2w: IN=1 / OUT=4 3w: IN=1 / OUT=3 / GND=4*							M				
		M12x1 *2w: IN=1 / OUT=2 3w: IN=1 / OUT=2 / GND=3*							P				
		RAST 2.5					0,4	7	4				
		Metri Pack Serie 150					0,4		5				
	Braids	80 ±10 mm					0,4		6				
		290 ±10 mm					0,4		7				
		480 ±10 mm					0,4		8				
		730 ±10 mm					0,4		9				
	Swift connector	without cable							0				
		with cable 1.5 m							L				
		with cable 2.0 m							N				
		with cable 3.0 m							Q				
		with cable 5.0 m							R				
Pressure connection [2]	Inside thread	$^{7}/_{16}$-20 UNF sealing cone with schrader					0,4			0	0	N	
		$^{7}/_{16}$-20 UNF sealing cone								K		1	
		½ -14 NPT [5]								D		1	
		G ¼ with O-Ring seal FPM								1		1	
	Outside thread	$^{7}/_{16}$ -20 UNF sealing cone								2		1	
		¼ -18 NPT								3		1	
		G ¼ sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM								4		1	
		G ¼ sealed at back and manometer with profile seal ring in FPM								5	0	1	
		R ¼ acc. to EN 10226								7		1	
		G ½ sealed at back and manometer with profile seal ring in FPM					0,1			8		1	
		$^{7}/_{16}$-20 UNF sealed at back SAE 4 with O-Ring seal FPM					0,1			G		1	
		⅛ - 27 NPT [5]								A		1	
		G ⅛ sealed at front [5]								M		1	
		G ⅛ sealed at back DIN EN ISO 1179-2 with Profile seal ring in FPM [6]					0,1			H		1	
		M10x1 sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM [5]					0,1			F		1	
		M20x1.5 sealed at front and manometer (combi)								E		1	
		G ¼ sealed at front								J		1	
		G ½ sealed at front								9		1	
Pressure orifice	without (inclusive pressure tip orifice from 100 bar on)										0		
	with										2		
Material pressure connection	Stainless steel 1.4305 / AISI 303											N	
	Stainless steel 1.4404 / AISI 316L											1	
Pressure range variation (optional)	Indicate W and state range on order (e.g.: W0... + 3bar/OUT0...5V)												W

[1] typ. ; max. 0.5% fs (incl. zero point, full scale, linearity, hysteresis and repeatability)
[2] -15 ... 85 °C
[3] Other pressure ranges or pressure connections on request
[4] Delivery without female connector
[5] Pressure range ≤ 60 bar
[6] Pressure range ≤ 250 bar (max. rupture pressure 1000 bar)

Order code selection table in psi

			1	2	3	4	5	6	7	8	9	10	11
		520.	X	X	X	X	X	X	X	X	X	X	X
Pressure range [1]	-15 ... 130 psi		9	A	6								
	0 ... 30 psi		9	B	4								
	0 ... 60 psi		9	B	5								
	0 ... 100 psi		9	B	7								
	0 ... 200 psi		9	C	1								
	0 ... 300 psi		9	C	2								
	0 ... 500 psi		9	C	3								
	0 ... 750 psi		9	D	0								
	0 ... 1000 psi		9	D	1								
	0 ... 2000 psi		9	D	2								
	0 ... 3000 psi		9	D	3								
	0 ... 5000 psi		9	E	4								
	0 ... 7500 psi		9	E	5								
	0 ... 14500 psi		9	E	7								
Application	standard					S	0						
	for oxygen applications					S	1				0		
	with drinking water approval NSF/ANSI 61/372, WRAS					S	4				0	1	
Output / power supply	0 ... 5 V	7 ... 33 VDC						1					
	1 ... 6 V	8 ... 33 VDC						6					
	0 ... 10 V	12 ... 33 VDC						2					
		12 ... 33 VDC Enhanced EMC protection						C	1,2,3				
		12 ... 33 VDC / 24 VAC ±15% *(not possible with M12x1, metri pack, RAST, braids)*						8					
	ratiom. 10 ... 90%	5 VDC ±10%						7					
		5 VDC ±10% Ex protection					0,4	9	1,3			1	
	4 ... 20 mA	7 ... 33 VDC						3					
		7 ... 33 VDC Enhanced EMC protection *(not possible with Braids)*						A					
		10 ... 30 VDC Ex protection					0,4	4	1,3			1	
Electrical connection	Connector [2]	DIN EN 175301-803-A							1				
		DIN EN 175301-803-C (industrial standard 9.4 mm)							2				
		M12x1 *2w: IN=1 / OUT=3 3w: IN=1 / OUT=4 / GND=3*							3				
		M12x1 *2w: IN=1 / OUT=4 3w: IN=1 / OUT=3 / GND=4*							M				
		M12x1 *2w: IN=1 / OUT=2 3w: IN=1 / OUT=2 / GND=3*							P				
		RAST 2.5					0,4	7	4				
		Metri Pack Serie 150					0,4		5				
	Braids	80 ±10 mm					0,4		6				
		290 ±10 mm					0,4		7				
		480 ±10 mm					0,4		8				
		730 ±10 mm					0,4		9				
	Swift connector	without cable							0				
		with cable 1.5 m							L				
		with cable 2.0 m							N				
		with cable 3.0 m							Q				
		with cable 5.0 m							R				
Pressure connection [1]	Inside thread	$^{7}/_{16}$-20 UNF sealing cone with schrader					0,4			0	0	N	
		$^{7}/_{16}$-20 UNF sealing cone								K		1	
		½ -14 NPT [3]								D		1	
		G ¼ with O-Ring seal FPM								1		1	
	Outside thread	$^{7}/_{16}$ -20 UNF sealing cone								2		1	
		¼ -18 NPT								3		1	
		G ¼ sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM								4		1	
		G ¼ sealed at back and manometer with profile seal ring in FPM								5	0	1	
		R ¼ acc. to EN 10226								7		1	
		G ½ sealed at back and manometer with profile seal ring in FPM					0,1			8		1	
		$^{7}/_{16}$-20 UNF sealed at back SAE 4 with O-Ring seal FPM					0,1			G		1	
		⅛ - 27 NPT [3]								A		1	
		G ⅛ sealed at front [3]								M		1	
		G ⅛ sealed at back DIN EN ISO 1179-2 with Profile seal ring in FPM [4]					0,1			H		1	
		M10x1 sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM [3]					0,1			F		1	
		M20x1.5 sealed at front and manometer (combi)								E		1	
		G ¼ sealed at front								J		1	
		G ½ sealed at front								9		1	
Pressure orifice	without (inclusive pressure tip orifice from 2000 psi on)										0		
	with										2		
Material pressure connection	Stainless steel 1.4305 / AISI 303											N	
	Stainless steel 1.4404 / AISI 316L											1	
Pressure range variation (optional)	Indicate W and state range on order (e.g.: W0... + 400psi/OUT0...5V)												W

[1] Other pressure ranges or pressure connections on request
[2] Delivery without female connector
[3] Pressure range ≤ 870 psi
[4] Pressure range ≤ 3000 psi (max. rupture pressure 14500 bar)

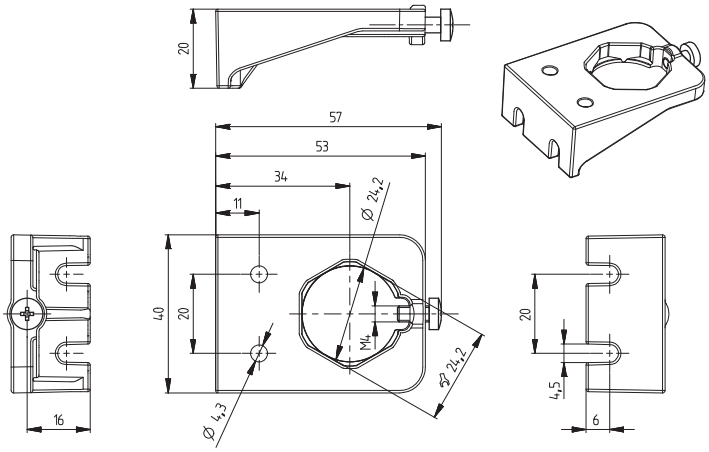
Order code selection table in MPa

			1	2	3	4	5	6	7	8	9	10	11
	520.		X	X	X	X	X	X	X	X	X	X	X
Pressure range [1]	-0.1 ... 0.9 MPa		9	F	6								
	0 ... 0.25 MPa		9	G	4								
	0 ... 0.4 MPa		9	G	5								
	0 ... 0.6 MPa		9	G	7								
	0 ... 1 MPa		9	H	0								
	0 ... 1.6 MPa		9	H	1								
	0 ... 2.5 MPa		9	H	2								
	0 ... 4 MPa		9	H	3								
	0 ... 6 MPa		9	K	0								
	0 ... 10 MPa		9	K	1								
	0 ... 16 MPa		9	K	2								
	0 ... 25 MPa		9	K	3								
	0 ... 40 MPa		9	L	4								
	0 ... 60 MPa		9	L	5								
	0 ... 100 MPa		9	L	7								
Application	standard					S	0						
	for oxygen applications					S	1				0		
	with drinking water approval NSF/ANSI 61/372, WRAS					S	4				0	1	
Output / power supply	0 ... 5 V	7 ... 33 VDC						1					
	1 ... 6 V	8 ... 33 VDC						6					
	0 ... 10 V	12 ... 33 VDC						2					
		12 ... 33 VDC Enhanced EMC protection						C	1,2,3				
		12 ... 33 VDC / 24 VAC ±15% *(not possible with M12x1, metri Pack, RAST, braids)*						8					
	ratiom. 10 ... 90%	5 VDC ±10%						7					
		5 VDC ±10% Ex protection					0,4	9	1,3				
	4 ... 20 mA	7 ... 33 VDC						3					
		7 ... 33 VDC Enhanced EMC protection *(not possible with Braids)*						A					
		10 ... 30 VDC Ex protection					0,4	4	1,3				
Electrical connection	Connector [2]	DIN EN 175301-803-A							1				
		DIN EN 175301-803-C (industrial standard 9.4 mm)							2				
		M12x1 *2w: IN=1 / OUT=3 3w: IN=1 / OUT=4 / GND=3*							3				
		M12x1 *2w: IN=1 / OUT=4 3w: IN=1 / OUT=3 / GND=4*							M				
		M12x1 *2w: IN=1 / OUT=2 3w: IN=1 / OUT=2 / GND=3*							P				
		RAST 2.5					0,4	7	4				
		Metri Pack Serie 150					0,4		5				
	Braids	80 ±10 mm					0,4		6				
		290 ±10 mm					0,4		7				
		480 ±10 mm					0,4		8				
		730 ±10 mm					0,4		9				
	Swift connector	without cable							0				
		with cable 1.5 m							L				
		with cable 2.0 m							N				
		with cable 3.0 m							Q				
		with cable 5.0 m							R				
Pressure connection [1]	Inside thread	$^{7}/_{16}$-20 UNF sealing cone with schrader					0,4			0	0	N	
		$^{7}/_{16}$-20 UNF sealing cone								K		1	
		½ -14 NPT [3]								D		1	
		G ¼ with O-Ring seal FPM								1		1	
	Outside thread	$^{7}/_{16}$ -20 UNF sealing cone								2		1	
		¼ -18 NPT								3		1	
		G ¼ sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM								4		1	
		G ¼ sealed at back and manometer with profile seal ring in FPM								5	0	1	
		R ¼ acc. to EN 10226								7		1	
		G ½ sealed at back and manometer with profile seal ring in FPM					0,1			8		1	
		$^{7}/_{16}$-20 UNF sealed at back SAE 4 with O-Ring seal FPM					0,1			G		1	
		⅛ - 27 NPT [3]								A		1	
		G ⅛ sealed at front [3]								M		1	
		G ⅛ sealed at back DIN EN ISO 1179-2 with Profile seal ring in FPM [4]					0,1			H		1	
		M10x1 sealed at back DIN EN ISO 1179-2 with profile seal ring in FPM [3]					0,1			F		1	
		M20x1.5 sealed at front and manometer (combi)								E		1	
		G ¼ sealed at front								J		1	
		G ½ sealed at front								9		1	
Pressure orifice	without (inclusive pressure tip orifice from 10 MPa on)										0		
	with										2		
Material pressure connection	Stainless steel 1.4305 / AISI 303											N	
	Stainless steel 1.4404 / AISI 316L											1	
Pressure range variation (optional)	Indicate W and state range on order (e.g.: W0... + 0.3MPa/OUT0...5V)												W

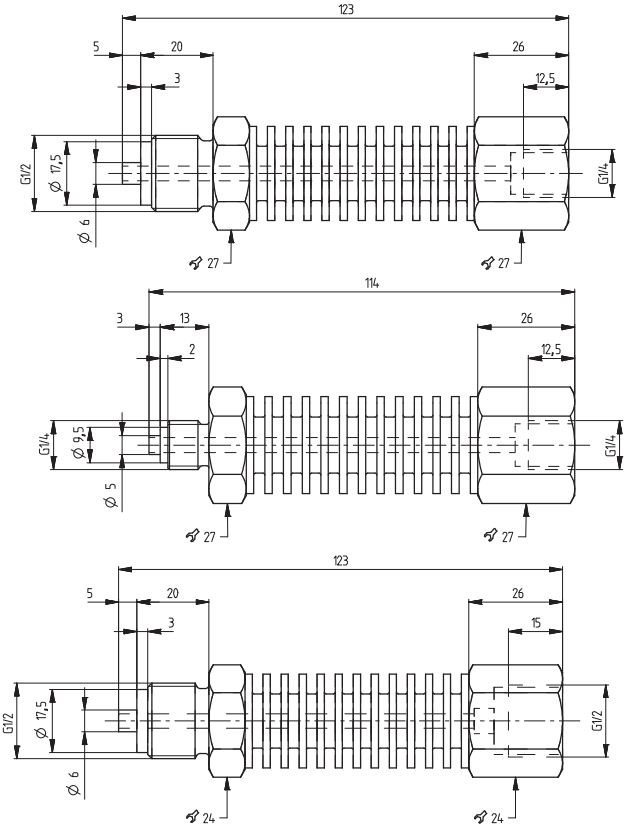
[1] Other pressure ranges or pressure connections on request
[2] Delivery without female connector
[3] Pressure range ≤ 6 MPa
[4] Pressure range ≤ 25 MPa (max. rupture pressure 100 MPa)

Accessories *(supplied loose)*	Order number
Swift connector	117312
Female connector DIN EN 175301-803-A with seal	103510
Female connector DIN EN 175301-803-C with seal	104244
Corner-wire box for connector M12x1	106975
Corner-wire box for connector M12x1 with cable 2.0 m	114604
Straight-wire box for connector M12x1	114570
Straight-wire box for connector M12x1 with cable 2.0 m	114605
Mounting bracket with screw	118716
Heat sink with outside thread G ½ sealed at front - inside thread G ½	105631
Heat sink with outside thread G ½ sealed at front - inside thread G ¼	105073
Heat sink with outside thread G ¼ sealed at front - inside thread G ¼	105074
Calibration certificate (≤ 600 bar)	104551

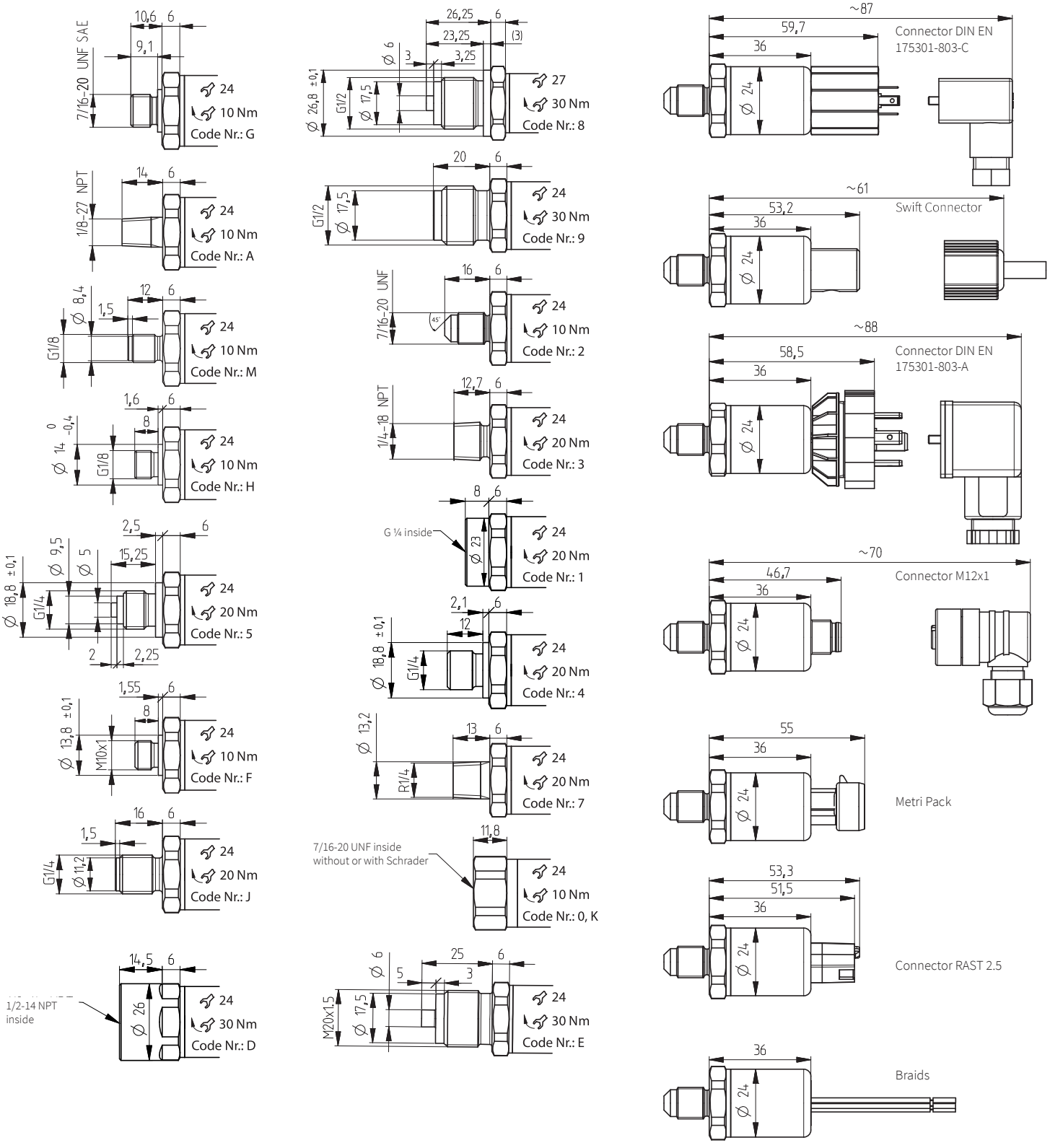
Mounting bracket



Heat sink



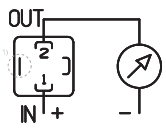
Dimensions in mm



Electrical connections

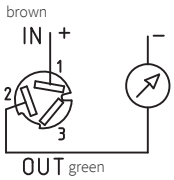
2 wire

Connector DIN EN 175301-803-A or C



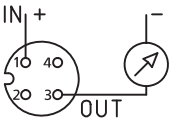
1 (IN) 2 (OUT)

Swift connector



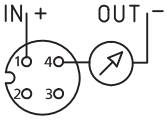
1 (IN) 2 (OUT)

Connector M12x1



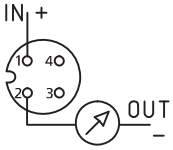
1 (IN) 3 (OUT)

Connector M12x1



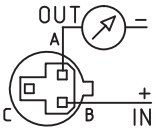
1 (IN) 4 (OUT)

Connector M12x1



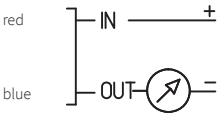
1 (IN) 2 (OUT)

Metri Pack Serie 150



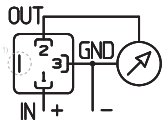
B (IN) A (OUT)

Braids



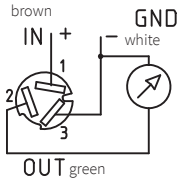
3 wire

Connector DIN EN 175301-803-A or C



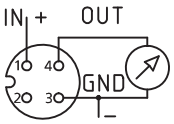
1 (IN) 2 (OUT) 3 (GND)

Swift connector



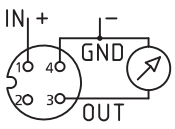
1 (IN) 2 (OUT) 3 (GND)

Connector M12x1



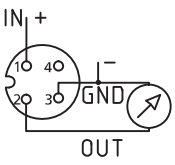
1 (IN) 4 (OUT) 3 (GND)

Connector M12x1



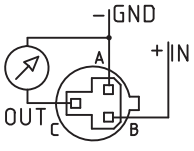
1 (IN) 3 (OUT) 4 (GND)

Connector M12x1



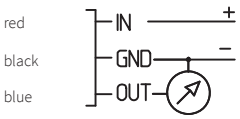
1 (IN) 2 (OUT) 3 (GND)

Metri Pack Serie 150

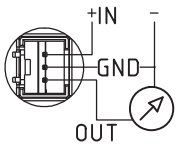


B (IN) C (OUT) A (GND)

Braids

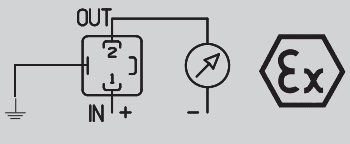


Connector RAST 2.5



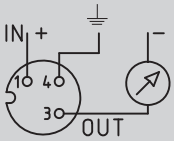
Device design with explosion protection: 4 ... 20 mA
The grounding connection is conductively connected to the transmitter housing.

Connector DIN EN 175301-803-A



1 (IN) 2 (OUT) ⏚

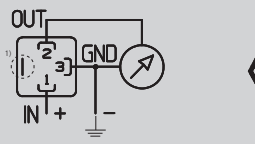
Connector M12x1



1 (IN) 3 (OUT) 4 (⏚)

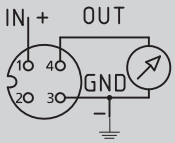
Device design with explosion protection: ratiom. 10 ... 90%
The electronic GND is connected with a 1MΩ resistor to the transmitter housing.

Connector DIN EN 175301-803-A



1 (IN) 2 (OUT) 3 (GND)

Connector M12x1



1 (IN) 3 (GND) 4 (OUT)

[1] Not connected with transmitter housing

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PERFORMANCE MADE SMARTER



Ex repeater / power supply

5104B

- 1- or 2-channel version
- 3- / 5-port 3.75 kVAC galvanic isolation
- Loop supply > 17.1 V in hazardous area
- 20 programmable measurement ranges
- Universal supply by AC or DC

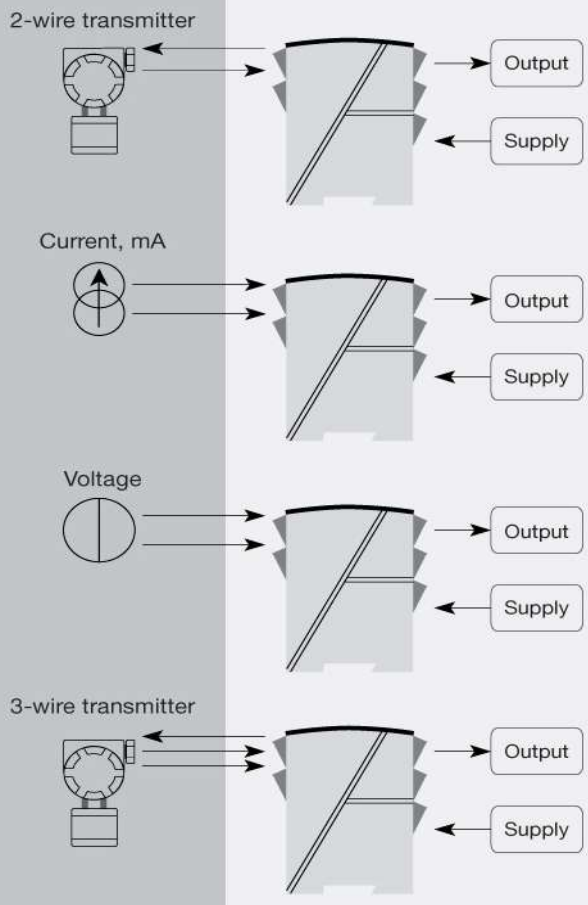
Application
- Supply voltage and safety barrier for 2-wire transmitters mounted in a hazardous area.
- Safety barrier for analog current / voltage signals from a hazardous area.
- 1 : 1 or signal conversion of analog current / voltage signals.

Technical characteristics
- The 20 factory-calibrated measurement ranges in the 5104B can be selected by the internal DIP-switches without the need for recalibration. Special measurement ranges can be delivered.
- PR5104B is based on microprocessor technology for gain and offset. The analog signal is transmitted at a response time of less than 25 ms.
- Inputs, outputs, and supply are floating and galvanically separated.
- The output can be connected either as an active current / voltage transmitter or as a 2-wire transmitter.

Mounting / installation
- Mounted vertically or horizontally on a DIN rail. By way of the 2-channel version up to 84 channels per meter can be mounted.

Note
- Not suitable for new installations requiring certification to the latest ATEX standards - see ATEX certificate DEMKO 99ATEX126013 and Declaration of conformity for details.

Applications



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Order :

Type	Input		Output		Channels	
5104B	0...20 mA	: A	Special	: 0	Single	: A
	4...20 mA	: B	0...20 mA	: 1	Double	: B
	0...10 V	: E	4...20 mA	: 2		
	2...10 V	: F	0...1 V	: 4		
	Special	: X	0.2...1 V	: 5		
			0...10 V	: 6		
			2...10 V	: 7		

Environmental Conditions

Operating temperature..... -20°C to +60°C
Calibration temperature..... 20...28°C
Relative humidity..... < 95% RH (non-cond.)
Protection degree..... IP20

Mechanical specifications

Dimensions (HxWxD)..... 109 x 23.5 x 130 mm
DIN rail type..... DIN 46277
Weight approx..... 225 g
Wire size..... 1 x 2.5 mm^2 stranded wire
Screw terminal torque..... 0.5 Nm
Vibration..... IEC 60068-2-6
2...13.2 Hz..... ±1 mm
13.2...100 Hz..... ±0.7 g

Common specifications

Supply

Supply voltage, universal..... 21.6...253 VAC, 50...60 Hz or 19.2...300 VDC
Fuse..... 400 mA SB / 250 VAC
Max. required power..... ≤ 3 W (2 channels)
Internal power dissipation..... ≤ 2 W (2 channels)

Isolation voltage

Isolation voltage, test / working..... 3.75 kVAC / 250 VAC
PELV/SELV..... IEC 61140

Auxiliary supplies

2-wire supply (pin 44...42 and 54...52)..... 28...17.1 VDC / 0...20 mA

Response time

Response time (0...90%, 100...10%)..... < 25 ms
Signal / noise ratio..... Min. 60 dB (0...100 kHz)
Accuracy..... Better than 0.1% of sel. range
EMC immunity influence..... < ±0.5% of span
Extended EMC immunity: NAMUR NE21, A criterion, burst..... < ±1% of span

Input specifications

Common input specifications

Max. offset..... 20% of max. value

Current input

Measurement range..... 0...20 mA
Min. measurement range (span)..... 16 mA
Input resistance..... Nom. 10 Ω + PTC 10 Ω

Voltage input

Measurement range..... 0...10 VDC
Min. measurement range (span)..... 8 VDC
Input resistance..... > 2 MΩ

Output specifications

Current output

Signal range..... 0...20 mA
Min. signal range..... 16 mA
Load (@ current output)..... ≤ 600 Ω
Load stability..... ≤ 0.01% of span / 100 Ω
Current limit..... ≤ 28 mA

Passive 2-wire mA output

Effect of external 2-wire supply voltage variation..... < 0.005% of span / V

Voltage output

Signal range..... 0...1 VDC / 0...10 VDC
Min. signal range..... 0.8 VDC / 8 VDC
Load (@ voltage output)..... ≥ 500 kΩ
External loop supply..... 29 VDC
of span..... = of the presently selected range

Observed authority requirements

EMC..... 2014/30/EU
LVD..... 2014/35/EU
EAC..... TR-CU 020/2011

Approvals

ATEX..... DEMKO 99ATEX126013, II (1) GD [EEx ia] IIC
c UL us, UL 913..... E233311
EAC Ex..... RU C-DK.GB08.V.00410
DNV Marine..... Stand. f. Certific. No. 2.4

PERFORMANCE MADE SMARTER



Temperature / mA converter

9113B

- Input for RTD, TC and mA
- Active / passive mA output via the same two terminals
- 1 or 2 channels
- Can be supplied separately or installed on power rail, PR type 9400
- SIL 2-certified via Full Assessment

Advanced features

- Configuration and monitoring by way of detachable display front (PR 4500); process calibration and signal simulation.
- Copying of the configuration from one device to others of the same type via the display front.
- TC inputs can use either the internal CJC or a terminal with a built-in Pt100 sensor (PR 5910Ex, channel 1 / PR 5913Ex, channel 2) for higher accuracy.
- Advanced monitoring of internal communication and stored data.
- SIL 2 functionality is optional and must be activated in a menu point.

Application

- 9113Bxx can be mounted in the safe area or in zone 2 / Class 1, Division 2 and receive signals from zone 0, 1, 2 and zone 20, 21, 22 including mining / Class I/II/III, Division 1, Gr. A-G.
- Conversion and scaling of temperature (Pt, Ni and TC) and active current signals.
- The 9113 has been designed, developed and certified for use in SIL 2 applications according to the requirements of IEC 61508.
- Suitable for the use in systems up to Performance Level “d” according to ISO-13849.

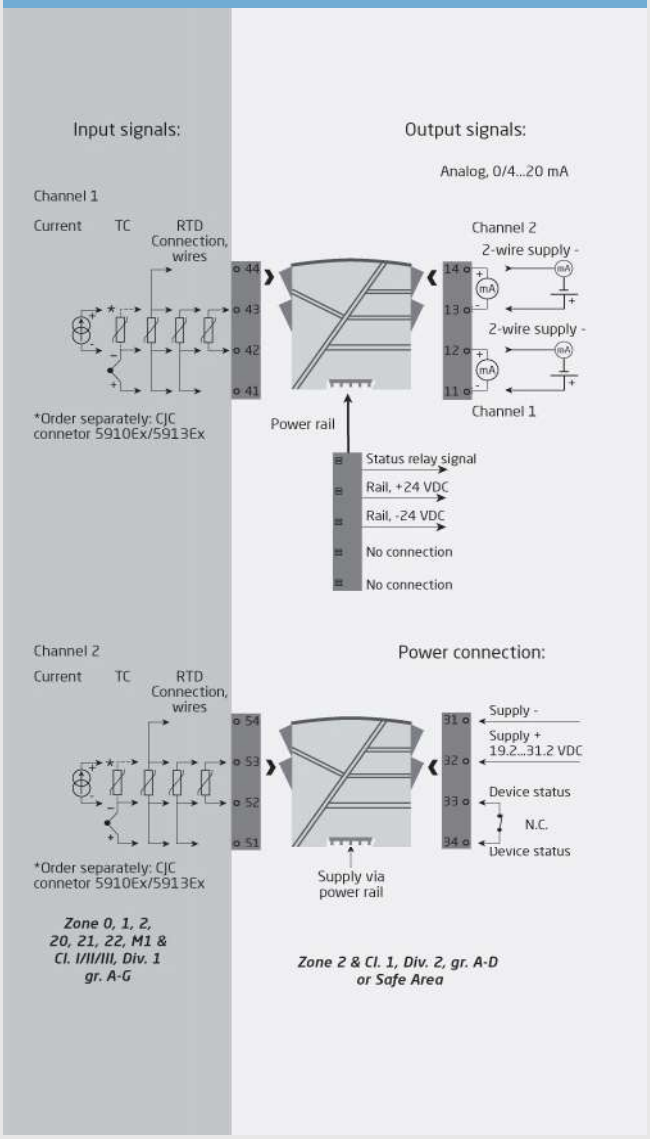
Technical characteristics

- 1 green and 2 red front LEDs indicate operation status and malfunction.
- 2.6 kVAC galvanic isolation between input, output and supply.

Mounting

- The devices can be mounted vertically or horizontally without distance between neighbouring units.

Applications



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Order

Type	Channels		I.S. / Ex approvals	
9113B	Single	: A	ATEX, IECEx, FM, INMETRO, EAC-Ex, UKEX	: -
	Double	: B	UL 913, ATEX, IECEx, FM, INMETRO, EAC-Ex, UKEX	: -U9
			KCs, ATEX, IECEx, FM, INMETRO, EAC-Ex, UKEX	: -KCs

Example: 9113BB

Environmental Conditions

Operating temperature	-20°C to +60°C
Storage temperature	-20°C to +85°C
Calibration temperature	20...28°C
Relative humidity	< 95% RH (non-cond.)
Protection degree	IP20
Installation in	Pollution degree 2 & meas. / overvoltage cat. II

Mechanical specifications

Dimensions (HxWxD)	109 x 23.5 x 104 mm
Dimensions (HxWxD) w/ PR 4500	109 x 23.5 x 131 mm
Weight approx.	250 g
DIN rail type	DIN EN 60715/35 mm
Wire size	0.13...2.08 mm^2 AWG 26...14 stranded wire
Screw terminal torque	0.5 Nm
Vibration	IEC 60068-2-6
2...13.2 Hz	±1 mm
13.2...100 Hz	±0.7 g

Common specifications

Supply

Supply voltage	19.2...31.2 VDC
Fuse	400 mA SB / 250 VAC
Max. required power	≤ 0.8 W/≤ 1.4 W (1 ch./2 ch.)
Max. power dissipation, 1 / 2 ch.	≤ 0.8 W / ≤ 1.4 W

Isolation voltage

Test /working: Input to any	2.6 kVAC / 300 VAC reinforced isolation
Analog output to supply	2.6 kVAC / 300 VAC reinforced isolation
Status relay to supply	1.5 kVAC / 150 VAC reinforced isolation

Response time

Temperature input, programmable (0...90%, 100...10%)	1...60 s
mA / V input (programmable)	0.4...60 s
Programming	PR 4500 communication interfaces
Signal / noise ratio	Min. 60 dB (0...100 kHz)
Signal dynamics, input	24 bit
Signal dynamics, output	16 bit
Accuracy	Better than 0.1% of sel. range
EMC immunity influence	< ±0.5% of span
Extended EMC immunity: NAMUR NE21, A criterion, burst	< ±1% of span

Input specifications

RTD input

RTD type	Pt10/20/50/100/200/250; Pt300/Pt400/500/1000; Ni50/100/120/1000
Cable resistance per wire	50 Ω (max.)
Sensor current	Nom. 0.2 mA
Effect of sensor cable resistance (3-/4-wire)	< 0.002 Ω / Ω
Sensor error detection	Programmable ON / OFF

TC input

Thermocouple type	B, E, J, K, L, N, R, S, T, U, W3, W5, LR
Cold junction compensation (CJC) via ext. sensor in 5910	20...28°C ≤ ±1°C, -20...20°C / 28...70°C ≤ 2°C
CJC via int. mounted sensor	±(2.0°C + 0.4°C * Δt)
Sensor error detection	Programmable ON or OFF (only wire breakage)
Sensor error current: When detecting / else	Nom. 2 µA / 0 µA

Current input

Measurement range	0...23 mA
Programmable measurement ranges	0...20 and 4...20 mA
Input resistance	Nom. 20 Ω + PTC 50 Ω
Sensor error detection	Programmable ON / OFF

Output specifications

Current output

Signal range	0...23 mA
Programmable signal ranges	0...20/4...20/20...0/20...4 mA
Load (@ current output)	≤ 600 Ω
Load stability	≤ 0.01% of span / 100 Ω
Sensor error indication	0 / 3.5 / 23 mA / none
NAMUR NE43 Upscale/Downscale	23 mA / 3.5 mA
Output limitation, on 4...20 and 20...4 mA signals	3.8...20.5 mA
Output limitation, on 0...20 and 20...0 mA signals	0...20.5 mA
Current limit	≤ 28 mA

Passive 2-wire mA output

Max. external 2-wire supply	26 VDC
Effect of external 2-wire supply voltage variation	< 0.005% of span / V

Status relay

Max. voltage	125 VAC / 110 VDC
Max. current	0.5 AAC / 0.3 ADC
Max. AC power	62.5 VA / 32 W

Observed authority requirements

EMC	2014/30/EU & UK SI 2016/1091
LVD	2014/35/EU & UK SI 2016/1101
ATEX	2014/34/EU & UK SI 2016/1107
RoHS	2011/65/EU & UK SI 2012/3032
EAC	TR-CU 020/2011
EAC Ex	TR-CU 012/2011
EAC LVD	TR-CU 004/2011

Approvals

ATEX	KEMA 07ATEX0148 X
IECEx	KEM 09.0052X
UKEX	DEKRA 21UKEX0175X
UKEX	DEKRA 23UKEX0109X
c FM us	FM19US0059X / FM19CA0032X
INMETRO	DEKRA 23.0005X
c UL us, UL 61010-1	E314307
c UL us, UL 913	E233311 (only 9113xx-U9)
KCs	21_AV4BO_0173X / 21_AV4BO_0174X (only 9113Bx-KCs)
EAC Ex	RU C-DK.HA65.B.00355/19
DNV Marine	TAA00000JD
ClassNK	TA24034M
SIL	SIL 2 certified & fully assessed acc. to IEC 61508

PERFORMANCE MADE SMARTER



Pulse isolator

9202B

- Interface for NAMUR sensors and switches
- Extended self-diagnostics and detection of cable fault
- 1 or 2 channels
- Can be supplied separately or installed on power rail, PR type 9400
- SIL 2-certified via Full Assessment

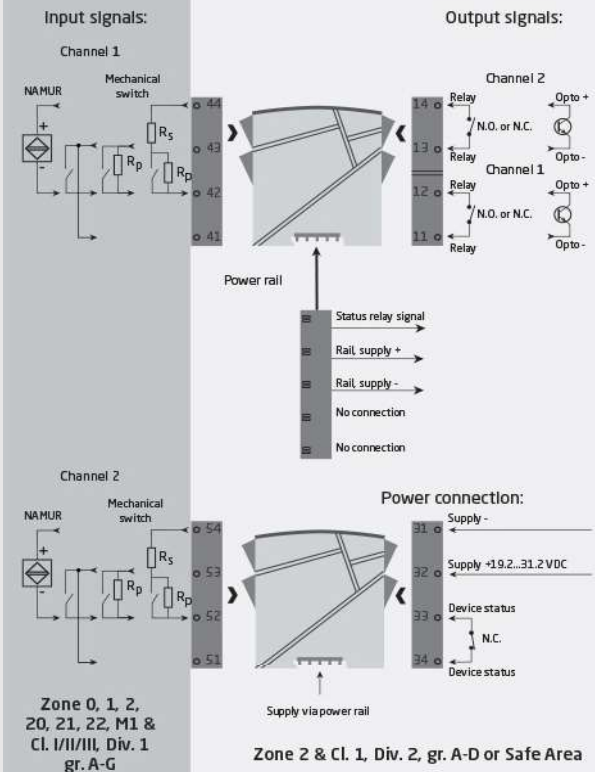
Advanced features
- Configuration and monitoring by way of detachable display front (PR 4500).
- Selection of direct or inverted function for each channel via PR 4500.
- Advanced monitoring of internal communication and stored data.
- Optional redundant supply via power rail and/ or separate supply.
- SIL 2 functionality is optional and must be activated in a menu point.

Application
- 9202B can be mounted in the safe area or in zone 2 / Cl. 1 div. 2 and receive signals from zone 0, 1, 2 and zone 20, 21, 22 including mining / Class I/II/III, Div. 1, Gr. A-G.
- Pulse isolator for transmission of signals to the safe area from NAMUR sensors and mechanical switches installed in the hazardous area.
- Monitoring of error events and cable breakage via the individual status relay and/or a collective electronic signal via the power rail.
- The 9202B has been designed, developed and certified for use in SIL 2 applications according to the requirements of IEC 61508.
- Suitable for the use in systems up to Performance Level “d” according to ISO-13849.

Technical characteristics
- 1 green and 2 yellow/red front LEDs indicate operation status and malfunction.
- 2.6 kVAC galvanic isolation between input, output and supply.

Mounting
- The devices can be mounted vertically or horizontally without distance between neighbouring units.

Applications



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Order

Type	Version	Unit channels	I.S. / Ex approvals
9202B	Opto : 1 Relay N.O. : 2 Relay N.C. : 3	Single : A Double : B	ATEX, IECEx, FM, INMETRO, CCC, EAC-Ex, UKEX : - UL 913, ATEX, IECEx, FM, INMETRO, CCC, EAC-Ex, UKEX : -U9 KCs, ATEX, IECEx, FM, INMETRO, CCC, EAC-Ex, UKEX : -KCs

Example: 9202B2B

Environmental Conditions

Operating temperature	-20°C to +60°C
Storage temperature	-20°C to +85°C
Calibration temperature	20...28°C
Relative humidity	< 95% RH (non-cond.)
Protection degree	IP20
Installation in	Pollution degree 2 & meas. / overvoltage cat. II

Mechanical specifications

Dimensions (HxWxD)	109 x 23.5 x 104 mm
Dimensions (HxWxD) w/ PR 4500	109 x 23.5 x 131 mm
Weight approx.	170 g
DIN rail type	DIN EN 60715/35 mm
Wire size	0.13...2.08 mm^2 AWG 26...14 stranded wire
Screw terminal torque	0.5 Nm
Vibration	IEC 60068-2-6
2...13.2 Hz	±1 mm
13.2...100 Hz	±0.7 g

Common specifications

Supply

Supply voltage	19.2...31.2 VDC
Fuse	400 mA SB / 250 VAC
Max. required power	≤ 1.1 W...≤ 1.3 W / ≤ 1.5 W...≤ 1.9 W (1 / 2 ch.)
Max. power dissipation, 1 / 2 ch.	≤ 1.2 W / ≤ 1.6...1.8 W

Isolation voltage

Test /working: Input to any	2.6 kVAC / 300 VAC reinforced isolation
Analog output to supply	2.6 kVAC / 300 VAC reinforced isolation
Output 1 to output 2	1.5 kVAC / 150 VAC reinforced isolation
Status relay to supply	1.5 kVAC / 150 VAC reinforced isolation

Auxiliary supplies

NAMUR supply	8 VDC / 8 mA
Programming	PR 4500 communication interfaces
Response time for cable fault	< 200 ms

Input specifications

Sensor types	NAMUR according to EN 60947-5-6 / mechanical contact
Frequency range	0...5 kHz
Min. pulse length	> 0.1 ms
Input resistance	Nom. 1 kΩ
Trig level, signal	< 1.2 mA, > 2.1 mA
Trig level, cable fault	< 0.1 mA, > 6.5 mA

Output specifications

Relay output

Max. switching frequency	20 Hz
Max. voltage	250 VAC / 30 VDC
Max. current	2 AAC / 2 ADC
Max. AC power	500 VA / 60 W

Status relay

Max. voltage	125 VAC / 110 VDC
Max. current	0.5 AAC / 0.3 ADC
Max. AC power	62.5 VA / 32 W

NPN output

Max. switching frequency	5 kHz
Min. pulse length	> 0.1 ms
Max. load, current / voltage	80 mA / 30 VDC
Max. voltage drop at 80 mA	2.5 VDC

Observed authority requirements

LVD	2014/35/EU & UK SI 2016/1101
EMC	2014/30/EU & UK SI 2016/1091
ATEX	2014/34/EU & UK SI 2016/1107
RoHS	2011/65/EU & UK SI 2012/3032
EAC	TR-CU 020/2011
EAC Ex	TR-CU 012/2011
EAC LVD	TR-CU 004/2011

Approvals

ATEX	KEMA 07ATEX0146 X
IECEx	KEM 06.0039X
UKEX	DEKRA 21UKEX0179X
UKEX	DEKRA 23UKEX0105X
c FM us	FM19US0055X / FM19CA0028X
INMETRO	DEKRA 23.0007X
c UL us, UL 61010-1	E314307
c UL us, UL 913	E233311 (only 9202xxx-U9)
CCC	2020322309003424
KCs	21_AV4BO_0179X / 21_AV4BO_0180X (only 9202Bxx-KCs)
EAC Ex	RU C-DK.HA65.B.00355/19
DNV Marine	TAA00000JD
ClassNK	TA24034M
SIL	SIL 2 certified & fully assessed acc. to IEC 61508

OPERATORS

for potentially explosive atmospheres
flameproof enclosure
II 2G/D Ex **d** IIC T6..T4 Gb / Ex **tb** IIIC Db IP66/IP67
aluminium or stainless steel enclosure

Series
NF
WSNF

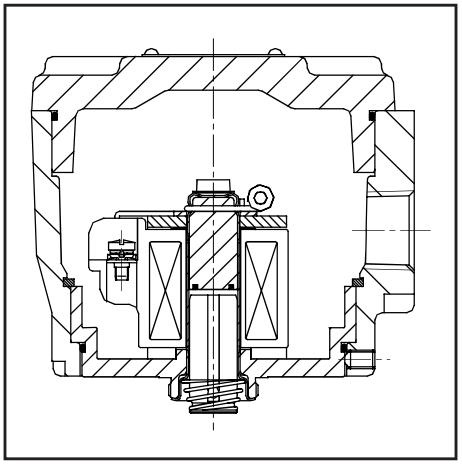
FEATURES

- *Explosionproof operator for use in potentially explosive atmospheres according to ATEX-Directive 2014/34/EU*
  EC type examination certificate no.: ***LCIE 00 ATEX 6008 X***
  IECEx Certificate of Conformity no.: ***IECEx LCI 07.0015X***
- *Compliance with the Essential Health and Safety Requirements has been assured by compliance with the International and European Standards EN-IEC 60079-0, EN-IEC 60079-1 and EN-IEC 60079-31*
- *Easy electrical installation by means of a screw terminal coil*
- *Enclosure provided with a 1/2 NPT threaded entry hole (M20 x 1,5 in option) for a broad range of cable entries*
- *Ingress protection degree IP66/67*
- *A wide range of valves can be supplied with the operator*



CONSTRUCTION

Solenoid enclosure	NF	Chromated aluminium, epoxy coated
	WSNF	Stainless steel (AISI 316L)
Bonnet	NF	Steel (zinc plated)
	WSNF	Stainless steel (nickel plated)
Core, core tube and plugnut	all	Stainless steel
Shading coil	all	Copper or silver
Nameplate	NF	Stainless steel
	WSNF	Stainless steel
Coil connection	all	Embedded screw terminals
Fasteners & screws	all	Stainless steel
Safety code		IECEx / Ex II 2G Ex d IIC T6..T4 Gb
		IECEx / Ex II 2D Ex tb IIIC 85°C..135°C Db IP66/67



ELECTRICAL CHARACTERISTICS

Standard voltages	DC (=) : 24V - 48V
(Other voltages and 60 Hz on request)	AC (~) : 24V - 48V - 115V - 230V(3) / 50 Hz

TEMPERATURE CLASSIFICATION TABLES

AC (~) solenoids

Pn (watt)	solenoid size				maximum ambient °C (1) surface temperature			
	MXX	M12			T6 85°C	T5 100°C	T4 135°C	T3 200°C
insulation class F/H (155°C/180°C) 100% E.D.								
1,85(2)(3)		●			75	80		
3,7 (2)		●			60	75	100	
5,8 (2)		●			60	75	100	
10,0 (2)	●				40	60	75	
10,0 (2)		●			40	60	100	
10,5	●				25	40	60	
13,4 (2)	●				40	60	75	
14,1 (2)		●			40	60	90	
15,4		●			25	40	60	
16,5		●			40	60	75	
16,7	●					25	40	
20,0		●				25	40	
20,5	●						25	
28,0		●					25	

DC (=) solenoids

Pn (watt)	solenoid size				maximum ambient °C (1) surface temperature			
	MXX	M12			T6 85°C	T5 100°C	T4 135°C	T3 200°C
insulation class F/H (155°C/180°C) 100% E.D.								
1,8		●			75	80		
3,6		●			60	75	100	
5,7		●			60	75	100	
10,0		●			40	60	100	
11,2	●				40	60	75	
14,0		●			40	60	90	
16,8		●			40	60	75	
19,7	●				25	40	60	
23,0		●			25	40	60	
26,6		●			25	40	60	
29,5		●				25	40	
36,2		●				25	40	

Check the wattage compatibility with the product selected.

(1) **The minimum allowable ambient temperature is -60°C for the operator.** Actual temperature range can be limited depending on valve operation limits.

(2) AC (~): rectified coil construction.

(3) 230 V AC does not exist (Pn 1,85 W).

ORDERING INFORMATION

A valve supplied with the explosionproof operator will be identified with prefix NF or WSNF before the catalogue number.

Example: **NF** E 210D095 230V/50 Hz

- **NF** — operator
- E — pipe thread ISO 7/1
- 210D095 — basic number
- 230V/50 Hz — voltage

A valve supplied with the explosionproof operator will be identified with electrical interface FN, FS, FT or FU in the 15-digit product code.

15-DIGIT PRODUCT CODE

E 262 K 232 **FN** V00 H1

- E — Thread connection
- 262 — Product series
- K — Revision letter
- 232 — Valves version
- **FN** — **Electrical interface**
  - **FN** = NF
  - **FS** = WSNF
  - **FT** = NFET
  - **FU** = WSNFET
- V00 — Options
- H1 — Voltage - class

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OPTIONS

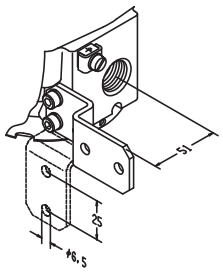
- Operators for mining, I M2 Ex d I, contact us

ORDERING EXAMPLES:

NF	B	327 B 001		230V / 50 Hz
NF	G	551 B 405		230V / 50 Hz
NFET	G	327 B 001	V	230V / 50 Hz
WSNF	E	272 A 047	MS	24V / DC
WSNF	B	320 A 184	E	24V / DC

prefix
pipe thread
basic number
suffix
voltage

MOUNTING BRACKET



Bracket kit no. **C139824**
contains: Stainless steel 304 SS screws and bracket

15-DIGIT PRODUCT CODE

E	262	K	232	**FN**	V00	H1
E	262	K	232	**FS**	V00	F8
E	262	K	232	**FT**	V00	FT
E	262	K	232	**FU**	V00	H9

Thread connection
Product series
Revision letter
Valves version
Electrical interface
Options
Voltage - class

CONNECTIONS

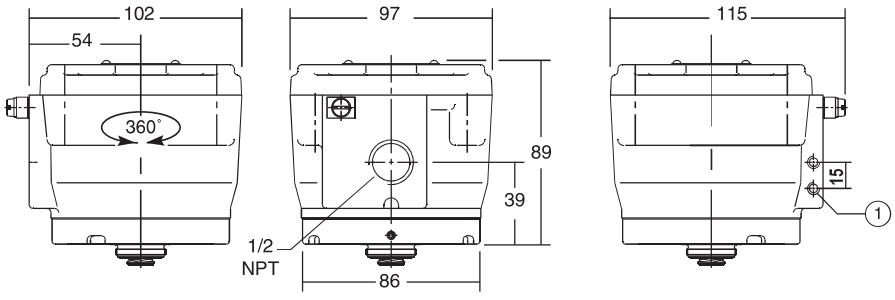
- Any ATEX approved cable entry device can be fitted in the 1/2 NPT threaded entry hole (M20 x 1.5 in option). Refer to the nameplate for identification of the maximum cable temperature
- Internal and external earthing connection
- The operator can be rotated through 360° to select the most favourable position for cable entry

DIMENSIONS (mm), WEIGHT (kg)



TYPE NF-WSNF

Prefix "NF" , "WSNF" Solenoid / Electrical interface FN/FS/FT/FU
Aluminium, stainless steel
(NF, epoxy coated)
EN-IEC 60079-1 and EN-IEC 60079-31
II 2G Ex d IIC Gb, II 2D Ex tb IIIC Db IP66/67



series	weight
NF	1,4
WSNF	2,7

(1) 2 mounting holes M5, depth 9 mm

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ASCO™ Solenoid Valves

Pilot Operated, Hung Diaphragm, 3/8" to 1 1/2"

Features and Benefits

- *Two way shut-off valves for the control air, inert gas, water, oil and other gases/liquids compatible with the sealing material used*
- *Valves do not require a minimum operating pressure*
- *All products are covered by Pressure Equipment Directive 2014/68/EU and are suitable for group 1 and 2 fluids*
- *The solenoid valves satisfy all relevant EU directives*



General

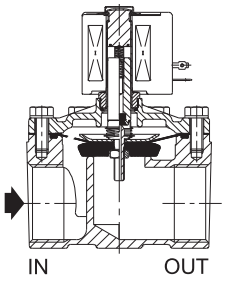
Differential pressure	See «SPECIFICATIONS» [1 bar =100 kPa]
Maximum viscosity	65 cSt (mm^2/s)
Response time	15 - 120 ms

Fluids (∗)	Temperature range (TS)	Seal materials (∗)
air, inert gas, water, oil	-20°C to +85°C	NBR (nitrile)

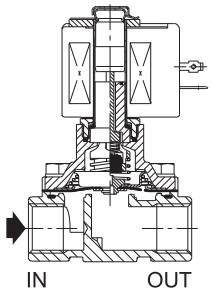
Materials of components in contact with fluid

(∗) Ensure that compatibility of materials in contact with fluids is verified.

	Brass body	Stainless steel body
Body	Brass	AISI 304 SS (AISI 316 SS on request)
Core tube	Stainless steel	Stainless steel
Core and plugnut	Stainless steel	Stainless steel
Springs	Stainless steel	Stainless steel
Seat	Brass	Stainless steel
Seals, diaphragm and disc	NBR	NBR
Disc holder (NO function)	PA	PA
Shading coil	Copper	Silver



NC function



NO function

Electrical characteristics

Coil insulation class	F or H
Connector	Spade plug (cable Ø 6-10 mm)
Connector specification	ISO 4400 / EN 175301-803, form A
Electrical safety	IEC 335
Electrical enclosure protection	Moulded IP65 (EN 60529)
Standard voltages	DC (=) : 24V - 48V
(Other voltages and 60 Hz on request)	AC (~) : 24V - 48V - 115V - 230V / 50 Hz

Prefix option	Power ratings				Operator ambient temperature range (TS) [1]	Replacement coil		Type [2]
	Inrush ~	Holding ~		Hot/cold =		~	=	
	(VA)	(VA)	(W)	(W)	(°C)	230 V/50 Hz	24 V DC	
SC	55	23	10.5	-	-20 to +75	400425-117	-	01
	78	35	16.7	-	-20 to +50	400425-217	-	01
	110	33.6	15.4	12/16.8	-20 to +75	400525-117	400625-142	02
	240	43	20	16.8/23	-20 to +50	400525-217	400625-242	02

[1] 3/8" up to 1" max. operator ambient temperature range (TS) 60°C.
[2] For dimensions, see drawing(s) for each construction type on the following page(s).

Specifications

Pipe size	Orifice size	Flow coefficient Kv		Operating pressure differential (bar) Min.	Max. (PS) Air (∗) ~	Air (∗) =	Water (∗) ~	Water (∗) =	Oil (∗) ~	Oil (∗) =	Power coil (W) ~	Power coil (W) =	Catalog number Brass	Catalog number Stainless steel	Options Maintained manual operator	Options FPM	Options EPDM	Options CR
	(mm)	(m^3/h)	(l/min)															
NC - Normally closed																		
Rp 3/8"	16	2.6	43	0	16	16	16	16	-	-	10.5	16.8	**SCE210C493**	-	MO	V	E	J
Rp 1/2"	16	3.4	57	0	16	16	16	16	-	-	10.5	16.8	**SCE210C494**	-	MO	V	E	J
					16	16	16	16	16	-	16.7	16.8	-	**SCE210C487**	MO	V	E	J
Rp 3/4"	19	4.3	72	0	16	16	16	16	-	-	10.5	16.8	**SCE210D495**	-	MO	V	E	J
	16	3.9	65	0	16	16	16	16	16	-	16.7	16.8	-	**SCE210C488**	MO	V	E	J
Rp 1"	25	9.6	160	0	16	16	16	16	16	10	15.4	23	**SCE210B454** [3]	-	MO	V	E	J
													-	**SCE210D489**	-	V	E	J
Rp 1 1/4"	28	12.8	213	0	9	6	9	6	9	4	15.4	23	**SCE210B155** [3]	-	MO	V	E	J
Rp 1 1/2"	32	19.3	322	0	9	5	9	5	9	3	15.4	23	**SCE210B156** [3]	-	MO	V	E	J

[3] Mounting position, DC only: piping horizontal, solenoid upright.

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Specifications

Pipe size	Orifice size	Flow coefficient Kv		Operating pressure differential (bar)							Power coil (W)		Catalog number		Options			
				Min.	Max. (PS)										Maintained manual operator	FPM	EPDM	CR
					Air (∗)		Water (∗)		Oil (∗)				Brass	Stainless steel				
	(mm)	(m^3/h)	(l/min)		~	=	~	=	~	=	~	=						
NO - Normally open																		
Rp 3/8”	16	2.6	43	0	16	16	16	16	16	10	10.5	23	**SCE210C433**	-	-	V	E	J
Rp 1/2”	16	3.4	57	0	16	16	16	16	16	10	10.5	23	**SCE210C434**	-	-	V	E	J
		2.6	43	0	16	16	16	16	10	10	10.5	23	-	**SCE210B430**	-	V	E	J
Rp 3/4”	19	4.7	79	0	16	16	16	16	16	10	10.5	23	**SCE210C435**	-	-	V	E	J
	16	2.6	43	0	16	16	16	16	10	10	10.5	23	-	**SCE210B438**	-	V	E	J
Rp 1”	25	11.2	185	0	16	-	16	-	16	-	20	-	**SCE210B457** (1)	-	-	V	E	J
Rp 1 1/4”	28	12.8	213	0	9	-	9	-	9	-	20	-	**SCE210B058** (1)	-	-	V	E	J
Rp 1 1/2”	32	19.3	322	0	9	-	9	-	9	-	20	-	**SCE210B059** (1)	-	-	V	E	J

(∗) Ensure that compatibility of materials in contact with fluids is verified.
(1) Mounting position: piping horizontal, solenoid upright.

Options

- Valves can also be supplied with FPM (fluoroelastomer), EPDM (ethylene-propylene) and CR (chloroprene) diaphragms, seals and discs. Use the appropriate optional suffix letter for identification
- Waterproof enclosure with embedded screw terminal coil according to protection class IP67, CEE-10
- Explosionproof enclosures for use in zones 1/21-2/22, categories 2-3 to ATEX Directive 2014/34/EU
- Electrical enclosures according to “NEMA” standards are available
- Compliance with “UL”, “CSA” and other local approvals available on request
- Mounting brackets for brass bodied valves, suffix MB (Except pipe size Rp 1, 1 1/4 and 1 1/2)
- For protection against corrosion caused by the environment or the fluid, contact us
- Other pipe connections are available on request
- Connector with visual indication and peak voltage suppression or with cable length of 2 m

Installation

- The solenoid valves can be mounted in any position without affecting operation, unless indicated otherwise in the specifications table.
- Stainless steel valves are standard supplied with mounting brackets
- Pipe connection is E = Rp (ISO 7/1)
- Installation/maintenance instructions are included with each valve

Spare parts kit and accessories

Catalog number	Spare parts kits no.		Mounting bracket
	~	=	
SCE210C493/C494	**C302272**	**C326540**	**038713-000**
SCE210D495	**C302276**	**C326541**	**038713-000**
SCE210B454	**C302283**	**C326542**	-
SCE210B155	**C302283**	**C133801**	-
SCE210B156	**C302286**	**C133802**	-
SCE210C433/C434	**C326551**	**C326543**	**038713-000**
SCE210C435	**C326552**	**C326544**	**038713-000**
SCE210B457	**C302337**	-	-
SCE210B058	**C302339**	-	-
SCE210B059	**C302340**	-	-
SCE210C487/C488	**C302328**	**C326548**	**standard**
SCE210B430/B438	**C326553**	**C326550**	**standard**
SCE210D489	**C302329**	**C326549**	-

- Not available

Ordering Examples Valves:

SC	E	210 **C** 493		230V / 50 Hz
SC	E	210 **C** 494	**MO**	115V / 50 Hz
SC	E	210 **C** 487	**V**	24V / DC
SC	E	210 **D** 489		230V / 50 Hz

prefix
pipe thread
basic number
voltage
suffix

Ordering Examples Kits:

C302272(2)	
C302276	**V**
C302280	**E**

basic number
suffix

(2) Standard prefixes/suffixes are also applicable to kits.

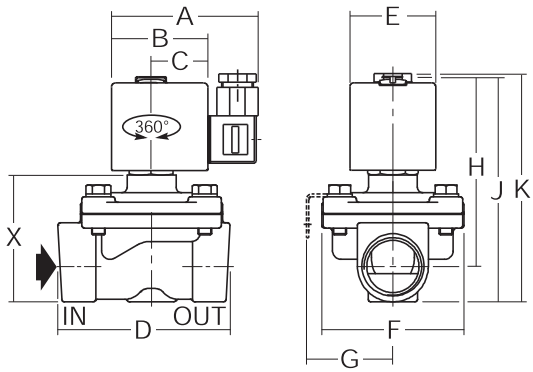
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Dimensions (mm), Weight (kg)

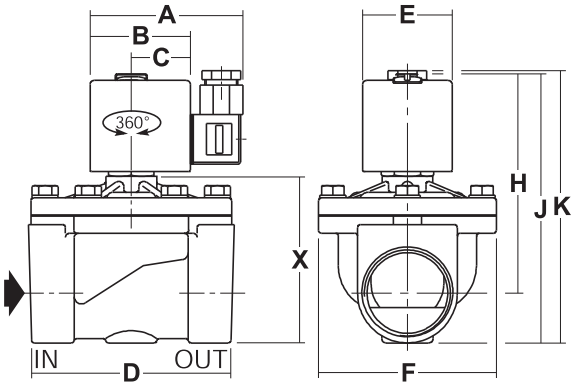


TYPE 01-02
Prefix "SC" Solenoid
Epoxy moulded
IEC 335 / ISO 4400
IP65

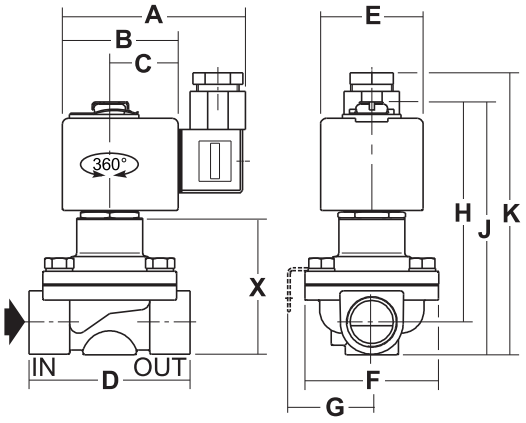
Type 01: SCE210C493/C494/D495 (AC)
SCE210C487/C488 (AC)
Type 02: SCE210C493/C494/D495/C487/C488 (DC)
SCE210D489/B454/B155 (AC/DC)

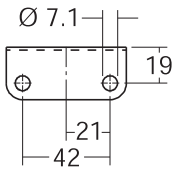


Type 02: SCE210B156 (AC/DC)



Type 01: SCE210C433/C434/C435 (AC)
SCE210B430/B438 (AC)
Type 02: SCE210B457/B058/B059 (AC/DC)





Mounting brackets for valves: (0.3 kg)
SCE210C493/C494/D495
SCE210C487/C488/D489
SCE210C433/C434/C435

Type	Prefix option	Catalog number	A	B	C	D	E	F	G	H	J	K	X	Weight [1]
01	SC	SCE210C493/C494	86	51	30	70	45	58	41	83	98	112	46	0.9
		SCE210D495	86	51	30	71	45	58	41	87	105	119	54	1.0
		SCE210C487/C488	86	51	30	71	45	58	41	87	105	119	55	1.0
		SCE210C433/C434	86	51	30	70	45	58	41	95	109	120	60	0.9
		SCE210C435	86	51	30	71	45	58	41	99	117	127	68	1.0
		SCE210B430/B438	86	51	30	71	45	58	41	98	116	127	67	1.0
02	SC	SCE210C493/C494	91	56	33	70	50	58	41	93	107	104	46	1.0
		SCE210D495	91	56	33	71	50	58	41	97	115	111	54	1.1
		SCE210C487/C488	91	56	33	71	50	58	41	97	116	112	55	1.1
		SCE210D489	91	56	33	95	50	98	41	112	134	134	75	2.2
		SCE210C433/C434	91	56	33	70	50	58	41	101	116	112	60	1.1
		SCE210C435	91	56	33	71	50	58	41	105	123	119	68	1.2
		SCE210B430/B438	91	56	33	71	50	58	41	105	123	119	67	1.1
		SCE210B454	91	56	33	95	50	83	-	114	134	131	75	2.0
		SCE210B457	91	56	33	95	50	83	-	155	176	160	98	2.1
		SCE210B155	86	56	33	95	50	83	-	112	143	148	86	2.0
		SCE210B156	86	56	33	111	50	99	-	125	153	158	96	2.8
		SCE210B058	86	56	33	95	50	83	-	161	187	187	130	2.0
		SCE210B059	86	56	33	111	50	99	-	167	194	194	137	2.5

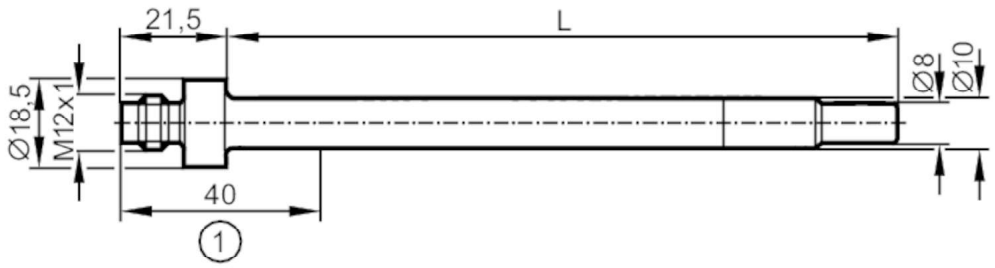
[1] Incl. coil(s) and connector(s)

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TT1050

Temperature probe sensor

TT-100KBBD10-...../US/



1 plug area
L = probe length corresponds to installation length EL

Product characteristics			
Measuring range		-40...150 °C	-40...302 °F
Process connection		Ø 10 mm	
Installation length EL	[mm]	160	
Application			
Special feature		Gold-plated contacts	
Measuring element		1 x Pt 1000; (to DIN EN 60751, class A)	
Media		liquids and gases	
Pressure rating	[bar]	160	
Minimum installation depth	[mm]	15	
Electrical data			
Protection class		III	
Measuring/setting range			
Probe length L	[mm]	160	
Measuring range		-40...150 °C	-40...302 °F
Accuracy / deviations			
Accuracy	[K]	± (0,15 K + 0,002 x|t|)	
Response times			
Dynamic response T05 / T09	[s]	1 / 3; (to DIN EN 60751)	
Operating conditions			
Ambient temperature	[°C]	-25...80	
Note on ambient temperature		plug area	
Storage temperature	[°C]	-40...100	
Protection		IP 68; IP 69K	
Tests / approvals			
Shock resistance		DIN EN 60068-2-27	50 g (11 ms)
Vibration resistance		DIN EN 60068-2-6	10 g (10...2000 Hz)
MTTF	[years]	22831	
Mechanical data			
Weight	[g]	54.3	
Dimensions	[mm]	Ø 10	
Materials		stainless steel (316L/1.4404)	

TT1050

Temperature probe sensor

TT-100KBBD10-...../US/

Materials (wetted parts)		stainless steel (316L/1.4404)
Process connection		Ø 10 mm
Probe diameter	[mm]	10
Installation length EL	[mm]	160

Remarks

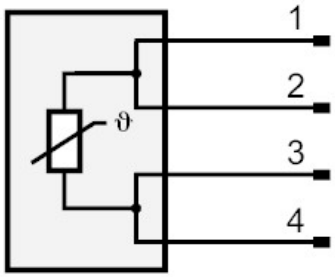
Remarks	The values for accuracy apply to flowing water.
Pack quantity	1 pcs.

Electrical connection

Connector: 1 x M12; coding: A; Contacts: gold-plated



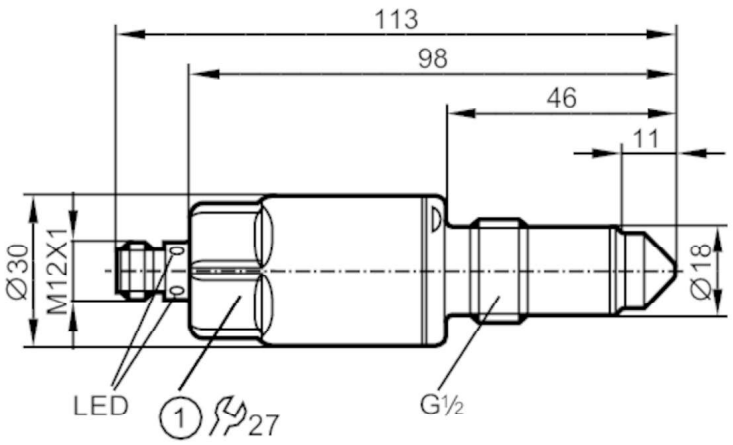
Connection



LMT01A

Sensor for point level detection in hazardous areas

LMACE-A12E-QSKG-1/US/3D/3G



1 Tightening torque 20...25 Nm

CE EC 1935/2004 EHEDG Certified Ex FDA IO-Link UKCA

Product characteristics		
Number of inputs and outputs		Number of digital outputs: 2
Factory setting		oils; oil-based media; powder
Process connection		threaded connection G 1/2 sealing cone
Application		
Special feature		Gold-plated contacts
Media		Liquids; viscous media; powder
Cannot be used for		See the operating instructions, chapter "Function and features".
Medium temperature	[°C]	-20...85
Probe length	[mm]	11
Tank pressure	[bar]	-1...40
Electrical data		
Operating voltage	[V]	18...30 DC
Current consumption	[mA]	< 50
Protection class		III
Reverse polarity protection		yes
Measuring principle		capacitive
Inputs / outputs		
Number of inputs and outputs		Number of digital outputs: 2
Outputs		
Total number of outputs		2
Output signal		switching signal; IO-Link
Electrical design		PNP/NPN
Number of digital outputs		2
Output function		normally open / normally closed; (parameterisable)
Max. voltage drop switching output DC	[V]	2.5
Permanent current rating of switching output DC	[mA]	100

LMT01A

Sensor for point level detection in hazardous areas

LMACE-A12E-QSKG-1/US/3D/3G

Short-circuit protection		yes	
Type of short-circuit protection		pulsed	
Overload protection		yes	
Measuring/setting range			
Factory setting		oils; oil-based media; powder	
Response times			
Response time	[s]	< 0.5	
Interfaces			
Communication interface		IO-Link	
Transmission type		COM2 (38,4 kBaud)	
IO-Link revision		1.1	
SDCI standard		IEC 61131-9	
Profiles		Smart Sensor: Process Data Variable; Device Identification	
SIO mode		yes	
Required master port type		A	
Process data analogue		1	
Process data binary		2	
Min. process cycle time	[ms]	2.3	
Supported DeviceIDs		**Type of operation**	**DeviceID**
		default	305
Operating conditions			
Ambient temperature	[°C]	-20...60	
Storage temperature	[°C]	-40...85	
Protection		IP 67; (when used outside the hazardous area: IP 68 / IP 69)	
Tests / approvals			
ATEX marking		II 3D Ex tc IIIC T90°C Dc X	
		II 3G Ex nA IIC T4 Gc X	
EMC		DIN EN 61000-6-2	
		DIN EN 61000-6-4	open tanks
		DIN EN 61000-6-3	closed tanks
Shock resistance		DIN EN 68000-2-27	50 g (11 ms)
Vibration resistance		DIN EN 68000-2-6	20 g (10...2000 Hz)
MTTF	[years]	223	
Mechanical data			
Weight	[g]	218	
Dimensions	[mm]	Ø 30 / L = 113	
Materials		stainless steel (316L/1.4404); PEEK; PEI; FKM	
Materials (wetted parts)		PEEK; surface characteristics: Ra < 0,8 / Rz 4	
Process connection		threaded connection G 1/2 sealing cone	
Displays / operating elements			
Display		switching status	LED, yellow
		operating status	LED, green

LMT01A

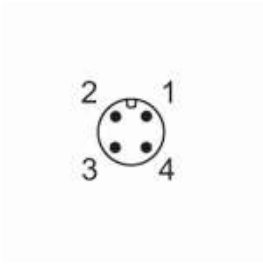
Sensor for point level detection in hazardous areas

LMACE-A12E-QSKG-1/US/3D/3G

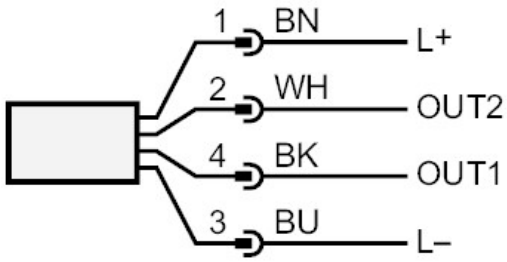
Remarks	
Pack quantity	1 pcs.

Electrical connection

Connector: 1 x M12; coding: A; Contacts: gold-plated



Connection



OUT1:	switching output IO-Link Teach
OUT2:	switching output
	colours to DIN EN 60947-5-2
	Core colours :
BK =	black
BN =	brown
BU =	blue
WH =	white

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Denmark

Revision history		
Rev.	Date.	Description
001	28/08/2024	First Issue
002	29/11/2024	Updated according to comments and implemented exhaust and drainage
003	19/03/2025	Corrected according to Code 2 comments
004	01/05/2025	Corrected rev 003 according to comments

Document Title:	BLPH Project - IEC60079-10 Analysis
Document Number:	K559-2254-CWIWP4202202-G99-001
Revision:	Rev003
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-G99-001Rev003
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	G99
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

IEC 60079-10 Analysis 601456B Crosswind

Full Title: EN IEC 60079-10-1 Analysis, Crosswind 1MW MEGAblock

Abstract: EN IEC 60079-10-1:2021 is intended to be applied where there may be a presence of flammable gas or vapor mixed with air. This is done by classifying areas where gas/air mixtures may be present into zones. Suitable design choices can be made based on the analysis, to eliminate the ignition hazard in the identified zones.

In this report, two areas are evaluated: the fuel connection to FCwave and External hydrogen handling unit.

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1.0 Executive Summary

Two areas were evaluated using the methodology described in EN IEC 60079-10-1:2021:

1. Fuel connection to FCwave: due to the presence of continuous ventilation, and the quality of the ventilation as well as the ventilation speed surrounding the connection the area is considered non-hazardous. Those are discussed in further detail in this report.
2. External hydrogen handling unit: this area contains several fittings, flanges and valves fittings, which are considered potential sources of a secondary grade of release. Using natural ventilation present in the external location and the methodology in the standard, it is determined that the fuel connection area should be classified as Zone 2 for hydrogen gas with 1 meter radius.

2.0 Reference documents

Table 2-1: Reference documents

Document no.:	Document name:
ATEX 114	Directive 2014/34/EU – equipment and protective systems intended for potentially explosive atmospheres
K559-2254-CWIWP4202202-E99-002	BLPH Project - Specials: Hazardous Area Layout
EN IEC 60079-10-1:2021	Classification of areas - Explosive gas atmospheres
IEC 62282-3-100:2020	Stationary fuel cell power systems - Safety
K559-2254-CWIWP4202202-C03-001	BLPH Project - P&IDs
MAN002	Integration manual FCWave
K559-2254-CWIWP4202202-B01-001	General arrangement
K559-2254-CWIWP4202202-C99-001	Megablock Hydrogen Safety Concept
EX calc 0B	ATEX zone definition calculations

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3.0 Definitions and Acronyms

Table 3-1: Definitions and Acronyms

Document no.:	Document name:
AC	Alternating Current
BOP	Balance Of Plant
DC	Direct Current
GA	General arrangement
LFL	Lower flammability limit
LEL	Lower Explosion Limit
LT	Low Temperature
HT	High Temperature
PLC	Programmable logic controller
P&ID	Process and Instrumentation Diagram
SIS	Safety instrumented system
HAC	Hazardous area classification
Secondary grade of release (Grade: S)	*Release, which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods*[1].
Primary Grade of Release	Release which can be expected to occur periodically or occasionally under normal operation[2]
Continuous grade of release	Release which is continuous or is expected to occur frequently or for long periods[2].

4.0 Hydrogen Properties

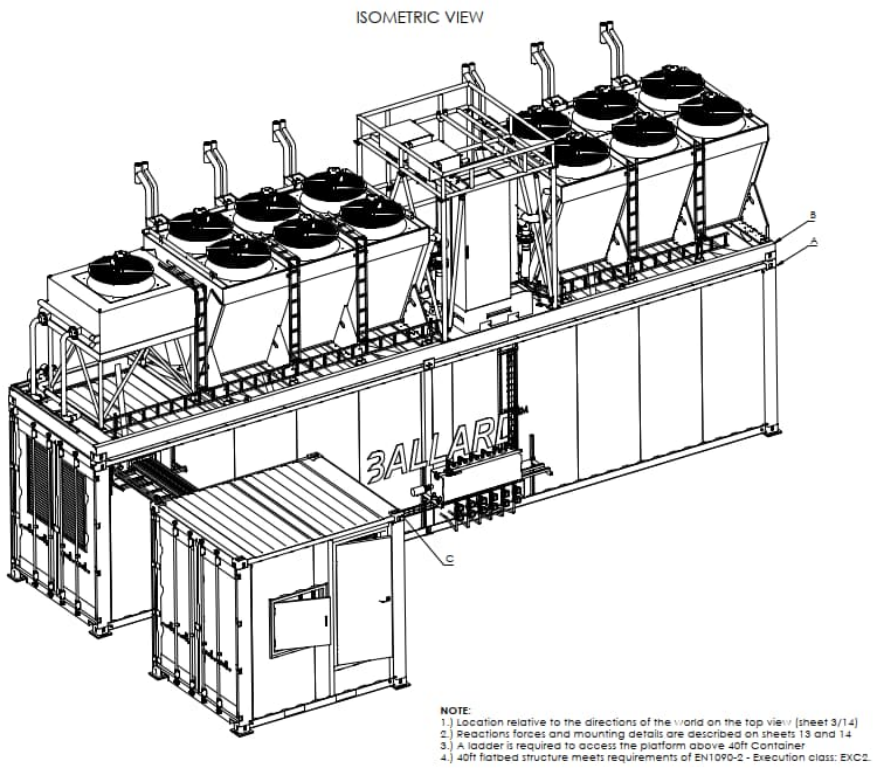
- Refer to Appendix A, Table 10-1
- Critical Pressure 192.1 kPa
- Hydrogen Density 0.08988 kg/m^3 @ 0 ℃

[1] From the definitions given in EN IEC 60079-10-1:2021.

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5.0 Background Information

Figure 1: System installation with auxiliary equipment



System overview of the complete assembled system

5.1 Crosswind 1MW MEGAblock

The FC PowerGen 1000kW® system is comprised of 3 main components:

1. Fuel cell container, 40ft: is an area for installation of the Ballard FCwave module and DCDC converters. Inside the container distribution of HT and LT cooling is done, as well as control system for all BOP components.
2. Power Converter container, 10ft: All the power electronic converting the DC from the FCwaves into AC to the customer, build up in a separate container. The Customer AC connections as well as switchgear and controls for equipment are included in this container.
3. Cooling Unit: An external skid frame containing dry coolers and pumps for cooling the FCwave and power electronic. The skid includes a control cabinet for controlling of valves and fans on the cooling.

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5.2 EN IEC 60079-10-1:2021

Specific terms used in this report are related to EN IEC 60079-10-1:2021, where a specific technical definition is given. Grade of release, zone type, and ventilation class are examples. Please refer to the standard for these definitions.

The standard provides a number of methods for classification of hazardous zones inside and outside of equipment containing flammable gases. The analysis performed and described through this report, follows the “classification by sources of release method” as described in Section 5.2 of the standard.

The general steps are:

- Is a flammable substance present (As described in Annex F, figure F.1.)
- Identify and specify grade of release sources (Continuously, Primary, Secondary).
- Determine the release rate for each source based on likely frequency and duration of release (as described in Annex F, figure F.4.).
- Assess ventilation or dilution conditions and effectiveness.
- Determine zone, based on grade of release and ventilation or dilution effectiveness.
- Determine extent of zone

For secondary grades of release, a process to determine the estimated leak rate and release characteristic is provided. The process relies on a number of calculations which are mentioned in this report but performed in a separate workbook. Results are shown in figures and tables included in this report.

5.3 Safety instrumented system

The safety instrumented system is comprised of a number of safety monitoring devices coupled with a safety controller which, in the event of a faulty condition being detected, stops the flow of hydrogen into the system. The monitoring devices include hydrogen detectors and smoke detectors, Further information on the Megablock Hydrogen Safety Concept referred to in document K559-2254-CWIWP4202202-C99-001.

5.4 P&ID

Several components are mentioned in this report that serve important functions with respect to hydrogen safety. These components and their relative location in the system can be found in the process and instrumentation diagram K559-2254-CWIWP4202202-C03-001 referenced in Section 2. For further details refer to the P&ID documentation.

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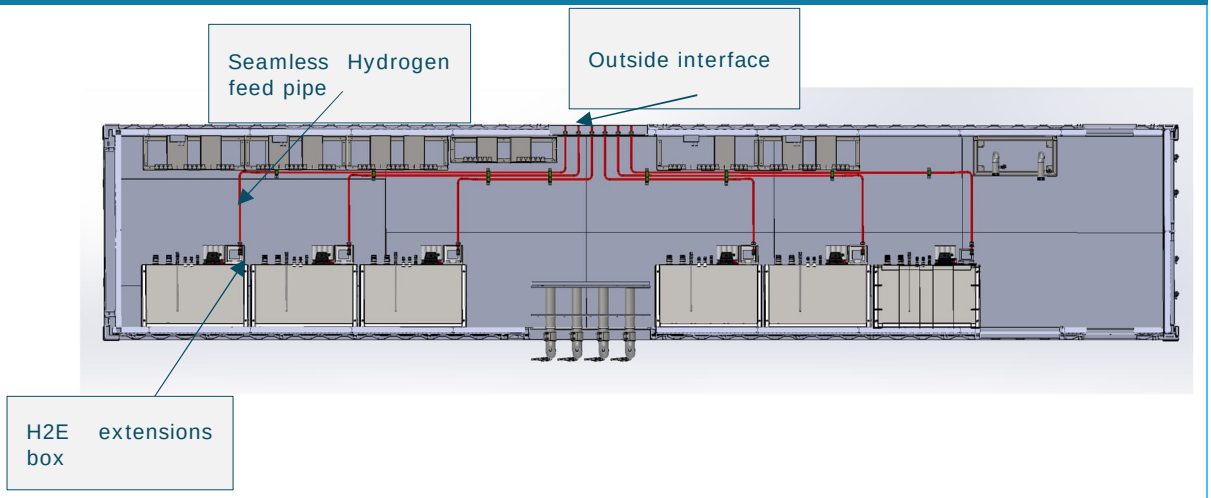
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6.0 Fuel connection to FCwave

Figure 2: Cross section of hydrogen extension box



Top view of the Fuel cell container. The red pipes are the unbroken seamless stainless-steel pipes, for hydrogen. The inlet connection is outside the container, and the outlet (inlet to FCwave) is enclosed in a ventilated space. See details in Figure 3.

6.1 Safety Approach

The hydrogen feed pipes are the connection pipes between the hydrogen interface pipe and the fuel cell module. All pipes are seamless stainless steel. The feed pipe is connected in both ends with a double-ferrule compression fitting. The pipe is a one-piece bended pipe with no welds or connections throughout the full length of the pipe, as illustrated on Figure 2 and Figure 3.

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Figure 3: Cross section of hydrogen extension box

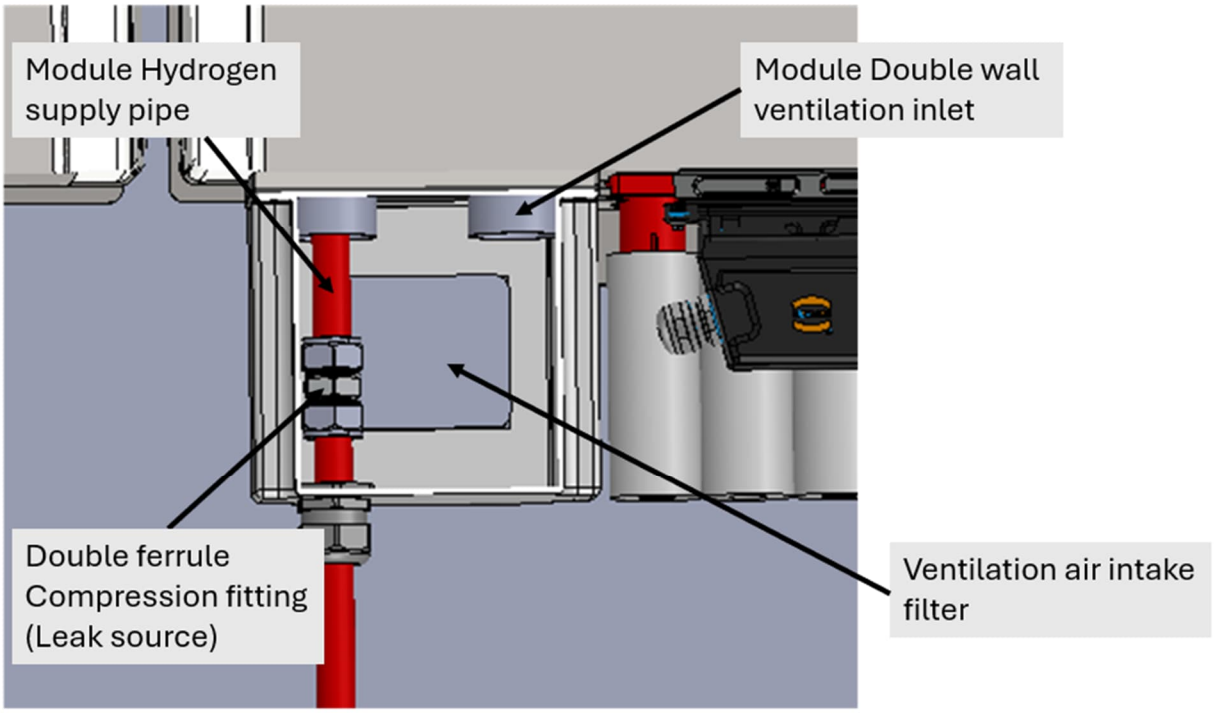


Figure shows a cross cut of the hydrogen enclosure extension. The prime component is the double ferrule compression fitting which is the potential leak

The connection to the fuel cell, from the hydrogen feed pipe, is made with a double-ferrule compression fitting, encapsulated in a ventilated space (box) as an extension of the fuel cell hydrogen ventilation system and the "double walled piping" approach, applied in the FCwave. Hereby transferring all the safety features from the module to this connection.

The FCwave module does not introduce any further risk of leakage due to the construction and certification on the product. For details on this refer to the safety Strategy for the FCwave in document MAN002.

Additionally, the container is equipped with 3 hydrogen sensors. 2 of these hydrogen sensors are located on the roof and near the point where the ventilated air from the container passes by to exhaust the container, so a leak anywhere in the container space will be detected here. The third is located next to the fresh air intake, making sure no hydrogen is introduced into the container from the outside.

The following chapter 6.2 to 6.6 are an assessment of the potential individual leak sources inside the container to determine if there is a local zone or area which requires further consideration.

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6.2 Sources of Release

There is one connection inside the container, hence this will be the only potential source of release. This potential leak will be defined as a secondary grade of release.

6.3 Degree of Dilution

The potential leak (1) in Table 6 1, on the connection to the FCwave module is inside the extension of the hydrogen enclosure, surrounded by forced ventilation. The air velocity in the enclosure surrounding the potential leak is defined: The area of the box is calculated to be: 0,0205m2, with the minimum ventilation flow from the FCwave integration manual (MAN002) being 0,0125m^3/s, resulting in a total air velocity of the ventilation surrounding the potential leak: 0,4062m/s.

Table B.1 from EN IEC 60079-10-1:2021 is used to determine the theoretical hole size (cross section) to estimate the release rate. Input data for the calculation and results are listed in Table 6-1.

Using the equations provided in the standard (ex. B.7.2.3.2 and B.7.2.3.3), release rates are determined for each group. Factoring in the lower flammability limit for hydrogen (4%), the release characteristics are calculated.

Based on the Ventilation velocity and the release characteristics, the degree of dilution is determined to be high, as shown in Figure 4, where the green square indicates the value from the leak source.

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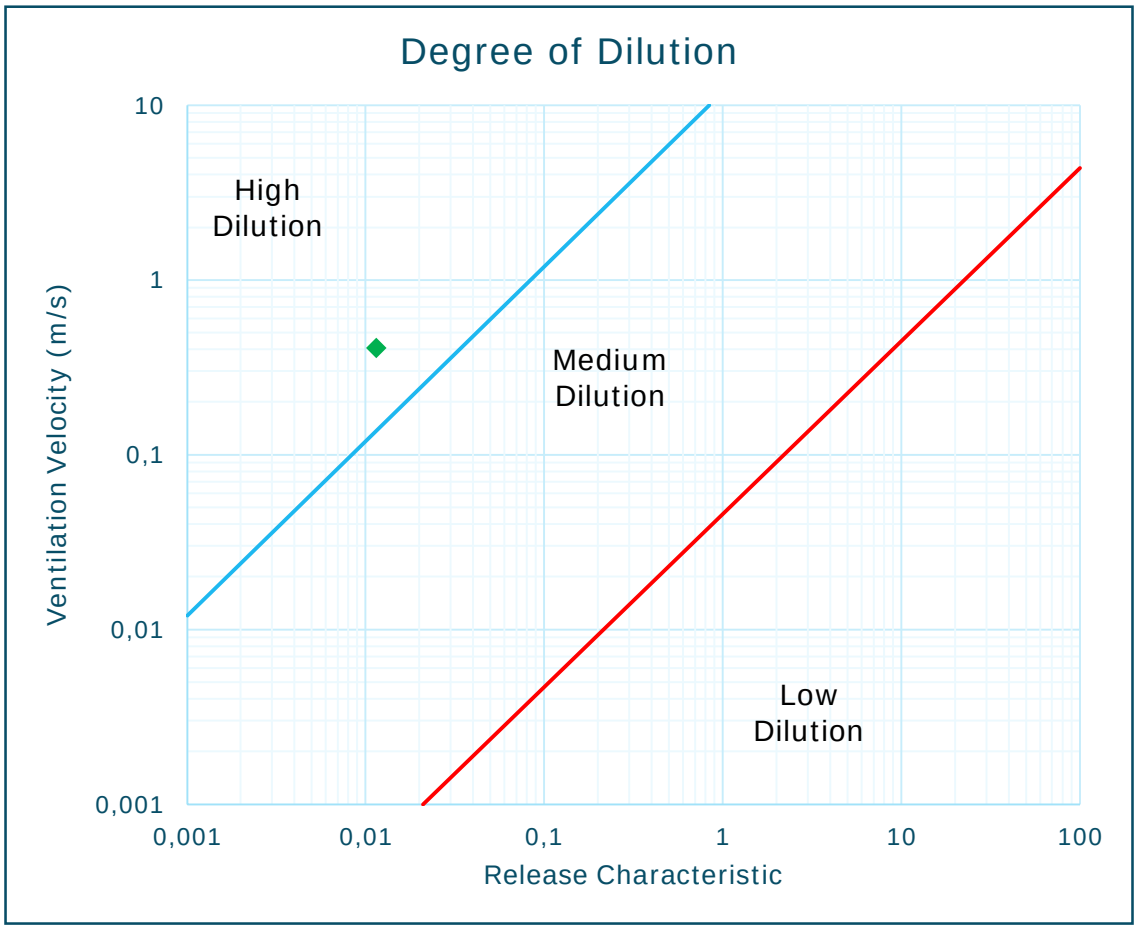
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Figure 4: Degree of Dilution Chart for release sources inside the container



The green point above corresponds to the data in Table 6-1. Points to the left of the blue line have a high degree of dilution, points between the blue and red lines have a medium degree of dilution.

6.4 Classification of Zone

Based on the schematic approach described in Figure F.4 of EN IEC 60079-10-1:2021, the zone classification of a *secondary grades of release* is assessed. The release characteristic and the degree of dilution, as described in Figure 4 and Table 6-1, “Leak 1”, results in a Non-Hazardous zone.

6.5 Extent of Zone

As the potential leak in “Leak 1” is classified to be a non-Hazardous zone, the extent is not calculated.

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6.6 Summary of Fuel connection to FCwave

The process fuel connection to the FCwave is considered non-hazardous due to the safety approach described in Table 6-1.

Table 6-1: *Release sources inside the container (not including FCwave).*

1	2	3	4	5	6	B.1	8	11	12	13	14
	Description	Location	Grade	Rate of Release (kg/s)	Release Characteristic (m^3/s)	Estimate Size of Hole (mm^2)	Operating Pressure (Barg)	Degree of Dilution	Availability	type	Extent (m)
1	M20-M25 Hy-lok double ferrule compression fitting reducer	Connection to FC wave module inside H2E extension box	S	3,62E-05	0,0115	0.1	10	High	Good	Non-Hazardous	none

The table is built up after the "Hazardous Area Classification data sheet" from Table A.2 – EN IEC 60079-10-1:2021. The data listed is equivalent to the "ATEX zone definition calculation document". Not all columns from Table A.2 are given in this table. Notes to columns:

1. The release source has reference "Leak 1" in the calculation document.

4. Grade: S. the Hy-lock connection is one of the tightest pipe connection methods on the market, hence only rare leakages are to be expected from this connection type.

5,6. Calculated based amongst others on the estimated hole size (after table B.1) and the maximum operation pressure in the pipes (8). (same as 6, but another unit)

B.1: from table B.1 in EN IEC 60079-10-1:2021 and based on sealing element type.

8. The maximum operating pressure is used in the calculations.

9. Releases are all "G" for gas type

10. Ventilation type is "Forced ventilation"

11. Based on the release characteristics and the available ventilation, figure C.1 from the standard, points to a "High" dilution.

12. The availability is specified as good, due to the safety/redundancy built into the ventilation pf the given space.

13. looking at table D.1 from the standard, the conditions: Secondary release, high dilution, good availability of ventilation points to "non-hazardous".

14. as the zone is classified to be "Non-hazardous", based on dilution and ventilation, the extend is Not applicable.

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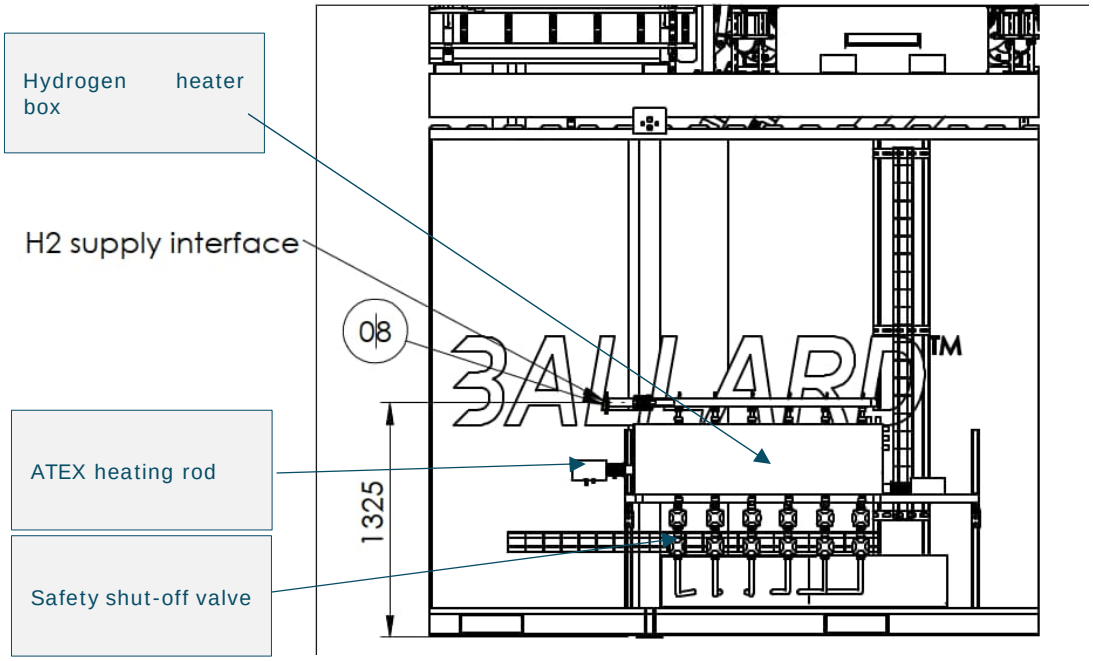
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7.0 External hydrogen handling unit

The fuel connection area is where the customer connects the hydrogen fuel supply to the fuel cell container. The external hydrogen handling unit also contains two in series safety shutoff valves as well as hydrogen heater for preheating the hydrogen in subzero conditions.

Figure 5: External hydrogen handling unit



The fuel connection area and safety shutoff valves are placed outside of the container, in free air.

The key elements of the "hydrogen handling unit" is pointed out in the figure.

7.1 Safety Approach

The fuel connection area outside the container contains a large number of fittings, flanges, and valves which may cause a secondary grade of release, at some point in the life of the product. As a hazardous zone is determined through the analysis, proper zone identification shall be made and the component and equipment in the area must be of the appropriate equipment category (EX approved). The extend and placement of the identified zone will be communicated to the integrator and end user in a general arrangement drawing K559-2254-CWIWP4202202-B01-001.

7.2 Sources of Release

There are three types of components which qualify as a potential source of release;

- fittings, flanges and valve stem packing.

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The Hydrogen handling unit consists of several individual fittings, flanges and connections, which are grouped in Table 7-1 below. Background hydrogen concentrations is not considered, as the system is not allowed to be installed in an already existing EX zone. All leaks are rated to be “secondary grade of release”, so according to EN IEC 60079-10-1:2021 Annex B section B4, one leak at a time is only considered.

7.3 Degree of Dilution

For outdoor locations where natural ventilation is available, a minimum ventilation velocity (for dilution) can be determined based on the location of the sources of release. Using Table C.1 from the standard, an estimated wind velocity or speed of buoyancy of worst case 0.5 m/s was determined based on:

- release of lighter than air gas.
- obstructed area less than 2 meters above ground.

Combined with the release characteristics from Table 7-1, the degree of dilution is determined to be “High” on “Leak 2,3”, and Medium at “Leak 4,5,6”, See Figure 6, where each leak source is plotted in to the diagram.

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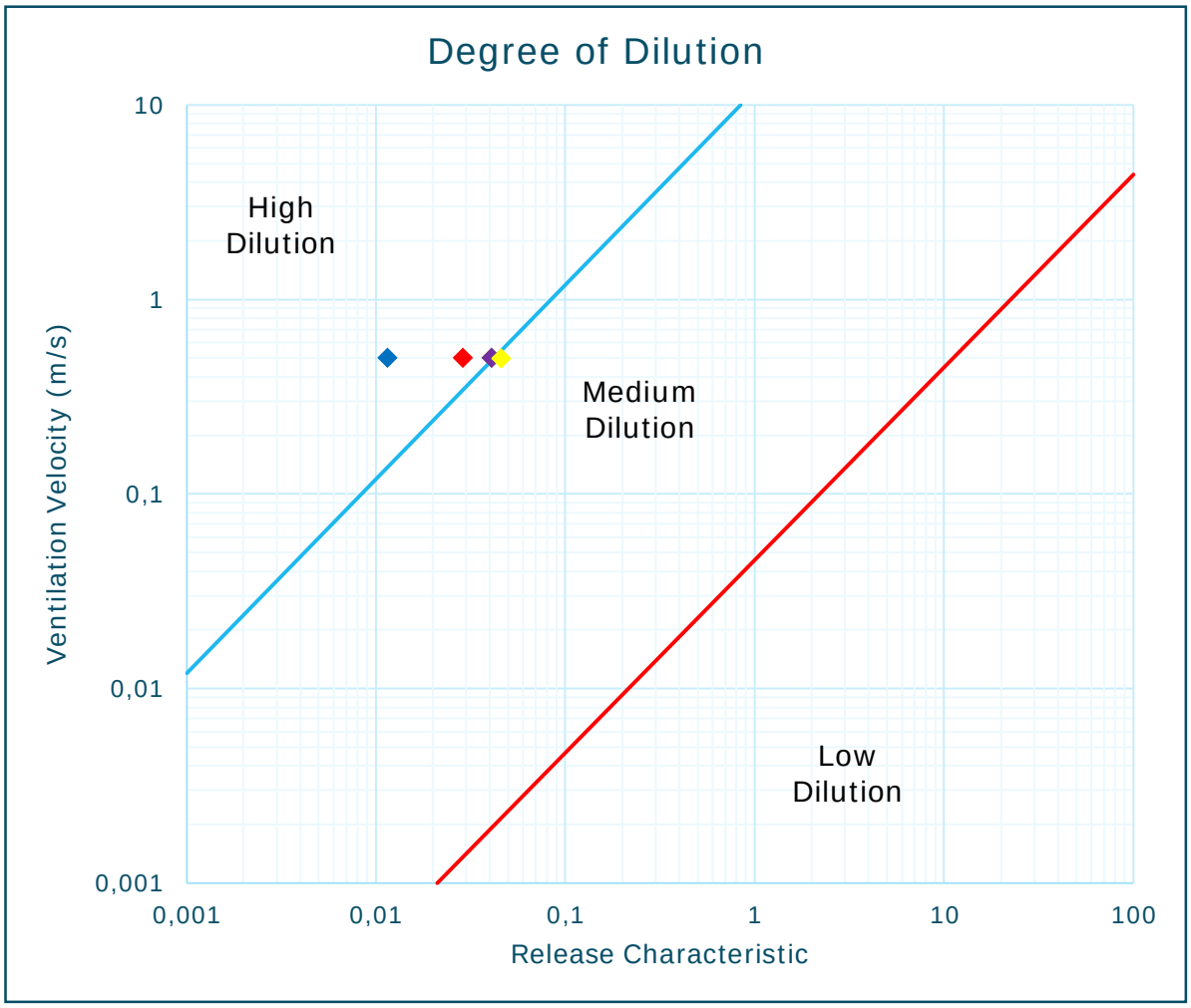
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Figure 6: Degree of dilution chart for connections on hydrogen handling unit.



The colored points in the chart correspond to the color groups in Table 7-1. Points to the left of the blue line have a high degree of dilution, points between the blue and red lines have a medium degree of dilution.

7.4 Classification of Zone

Based on the schematic approached described in Figure F.4 of EN IEC 60079-10-1:2021, the zone classification of a *secondary grades of release* is assessed. The release characteristic and the degree of dilution, as described in Figure 6 and Table 7-1, “Leak 2,3”, results in a Non-Hazardous zone and “Leak 4,5,6” result in a Zone 2, with max 1 m extend.

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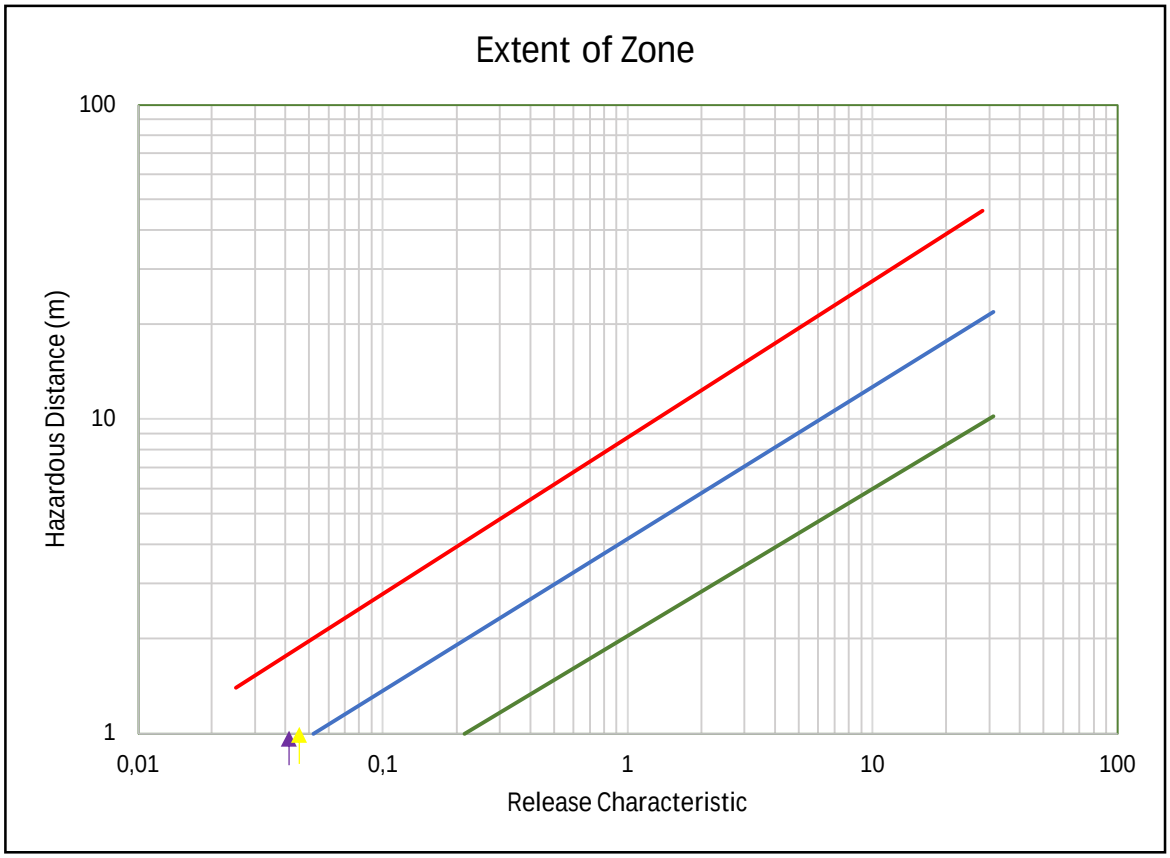
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7.5 Extent of Zone

Figure D.1 from EN IEC 60079-10-1:2021 is used as basics for the zone extend assessment. For the area around the "hydrogen handling unit", it is determined that all potential hydrogen releases will be jet type based, due to the high velocity of the modelled releases and the relative density of hydrogen to air. Based on the release characteristics specified in Table 7-1, it is found that the potential component releases from "Leak 5,6,7,8" would result in a zone that would be less than 1 meter in extent, see Figure 8. Since the minimum distance is 1 meter, the zone is defined to be 1m from the release source.

Figure 7: Extend of zone.



The colored points in the chart correspond to the color groups in Table 7-1. All points are below the line, determine the zone size.

7.6 Summary of External hydrogen handling unit

There are numerous fittings and valves (packing) that could leak at some point over the lifetime of the Fuel cell container. These leaks would generate jet plumes that would be relatively small and would dilute quickly. This analysis shows that adequate dilution would occur within 1 meter of the source. Therefore a 1 meter, Zone 2 setback should be

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established for the fuel connection area and components inside the zone should have the proper ATEX (Ex) rating.

Table 7-1: List of leak sources identified in the External hydrogen handling unit.

1	2	3	4	5	6	B.1	8	11	12	13	14
	Description	Location	Grade	Rate of Release (kg/s)	Release Characteristic (m^3/s)	Estimate Size of Hole (mm^2)	Operating Pressure (Barg)	Degree of Dilution	Availability	Zone type	Extent (m)
2	M25 Hy-lok double ferrule compression fitting	External connection to fuel cell container	S	3,62 E-05	0,0115	0,1	10	High	Fair	Non-Hazardous	<1
3	M25 to 3/4 BSPP + bonded seal Hy-lok double ferrule compression fitting	Connection to SOV	S	9,05 E-05	0,0288	0,25	10	High	Fair	Non-Hazardous	<1
4	Emerson Solenoid valve	Below H2 heater	S	0	0	0	10	NA	NA	Non-Hazardous	NA
5	Hy-lok Manual shut off valve	Above H2 heater	S	1,28 E-04	0,0409	0,25	10	Medium	Fair	Zone 2	<1
6	Flange connection	Customer interface	S	1,43 E-04	0,0457	0,25	10	Medium	Fair	Zone 2	<1
7	DVC main shutoff valve	Above H2 heater	S	1,28 E-04	0,0409	0,25	10	Medium	Fair	Zone 2	<1
8	DVC main shutoff flanges	Above H2 heater	S	1,43 E-04	0,0457	0,25	10	Medium	Fair	Zone 2	<1

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Table 7-1: List of leak sources identified in the External hydrogen handling unit.

The table is built up after the “Hazardous Area Classification data sheet” from Table A.2 – EN IEC 60079-10-1:2021. The data listed is equivalent to the “Atex zone definition calculation document”. Not all columns from Table A.2 are given in this table. Notes to columns:

1. The release source has reference “Leak 2-6” in the calculation document.

4. Grade: S. The Hy-lock connection, fittings and valves are selected due to their qualities in tightness, hence only rare leakages is connection with fault conditions are to be expected from this connection type.

5,6. Calculated based amongst others on the estimated hole size (after table B.1) and the maximum operation pressure in the pipes (8). (same as 6, but another unit)

7. No references used

B.1: from table B.1 in EN IEC 60079-10-1:2021 and based on sealing element type.

8: The maximum allowable operating pressure is applied in the calculations.

9. Releases are all “G” for gas type

10. Ventilation type is “Natural”

11. Based on the release characteristics and the available ventilation, figure C.1 from the standard, points to a “High” dilution from leak 2,3 and a medium dilution from leak 4,5,6.

12. The availability is specified as good, due to the ventilation being “natural”.

13. looking at table D.1 from the standard, the conditions: Secondary release, high dilution, good availability of ventilation points to “non-hazardous”. The conditions: Secondary release, medium dilution, good availability of ventilation points to “Zone 2”.

14. The extent of the zone is in all cases less than 1 m I radius from the leak point.

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8.0 Process exhaust and drain

8.1 Background for evaluation

As stated in the integration manual (MAN0002) for the FCwave module the maximum amount of hydrogen present at all scenarios in the process exhaust is 1%vol. This is equal to 25% LEL of hydrogen.

The composition of gas in the drain is the same as the process exhaust due to the fact that the process exhaust is by "fault" emptying the static air lock (previous referred to as water lock) within the module. This means the maximum content of hydrogen in the drain will be 1%vol equal to the process exhaust.

8.2 Definition of explosive gas atmosphere

Due to the concentration being so low (below LEL) the general foundation of the definition of an Explosive atmosphere is not met. According to the standard IEC 60079-10-1:2021 section 3.2 the definition is:

- *"Explosive gas atmosphere*

  Mixture of air, under atmospheric conditions, of flammable substances in the form of gas or vapor, which, after ignition, permits self-sustaining flame propagation"

As the composition of gas in the drain is below 25% of LEL the gas is not able to self-sustain a flame propagation, meaning it is by definition not an Explosive gas atmosphere. Additionally, the IEC 60079-10-1 section 4.4.2 has a clause for releases which is considered as negligible extend. Either due to the potential explosion being of a negligible consequence, or if the release rate or quantity is of a negligible extent in reference to the volume. Yet the clause still operates with the gas potentially being able to combust or explode, which is not the case for a mixture of 1% vol hydrogen.

Additionally, the mixture is also below 25% LEL making sure no clauses from IEC 60079-10-1 Annex I is applicable.

8.3 Risk mitigation considerations

As part of the IEC 60079-10-1 Zone classification procedure a risk assessment can determine to increase or decrease the zoning and EPL. For this installation, the mitigation for not increasing the zoning from e.g. a non-hazardous to a Zone 2 is mitigated by selection of components for the drain system. Which for this system is converted into gastight fittings, instrumentation and pipe with the weakest component being able to withstand a constant pressure of 69 Barg. In addition to this, the general design eliminates the risk of the hydrogen up-concentrating in unintended areas by making sure the exhaust is at the highest point and with a pressure less system securing hydrogen and steam from the process exhaust gas will be able to escape the system through normal buoyancy.

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9.0 Pressure testing according to IEC 62282-3-100

To make sure the Hazardous Area Classification is not exceeding the specified area of extent, release rate and frequency, the system within the Fuel cell container (from the hydrogen heating unit to the valve block (inside the FCwave)) has a build in function to automatically do a pressure decay test according to 62282-3-100:2020.

To maintain the specified HAC, the allowable maximum release of hydrogen is calculated in relation to the zone to make sure that the system is at all times within the boundaries provided in EN IEC 60079-10-1:2021.

The frequency at which this release can occur is still considered to be a “secondary grade of release” as *the release is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods*[4]. Safety precautions describe in the document: *K559-2254-CWIWP4202202-C99-001 Megablock Hydrogen Safety Concept*, supports this assessment of the grade of release.

All leak sources mentioned in Table 7-1, are considered as a uniform leak, throughout this chapter.

9.1 Maximum release flow in respect to zone extend

As calculated in chapter 7.5, the minimum required extent of the zone 2 is 1m in radius. The maximum allowable leak, from the secondary leak source, is determined by the Figure 8 to have a release characteristic on 0,22m^3/s.

[4] From the definitions given in EN IEC 60079-10-1:2021.

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Figure 8: Extent of Zone

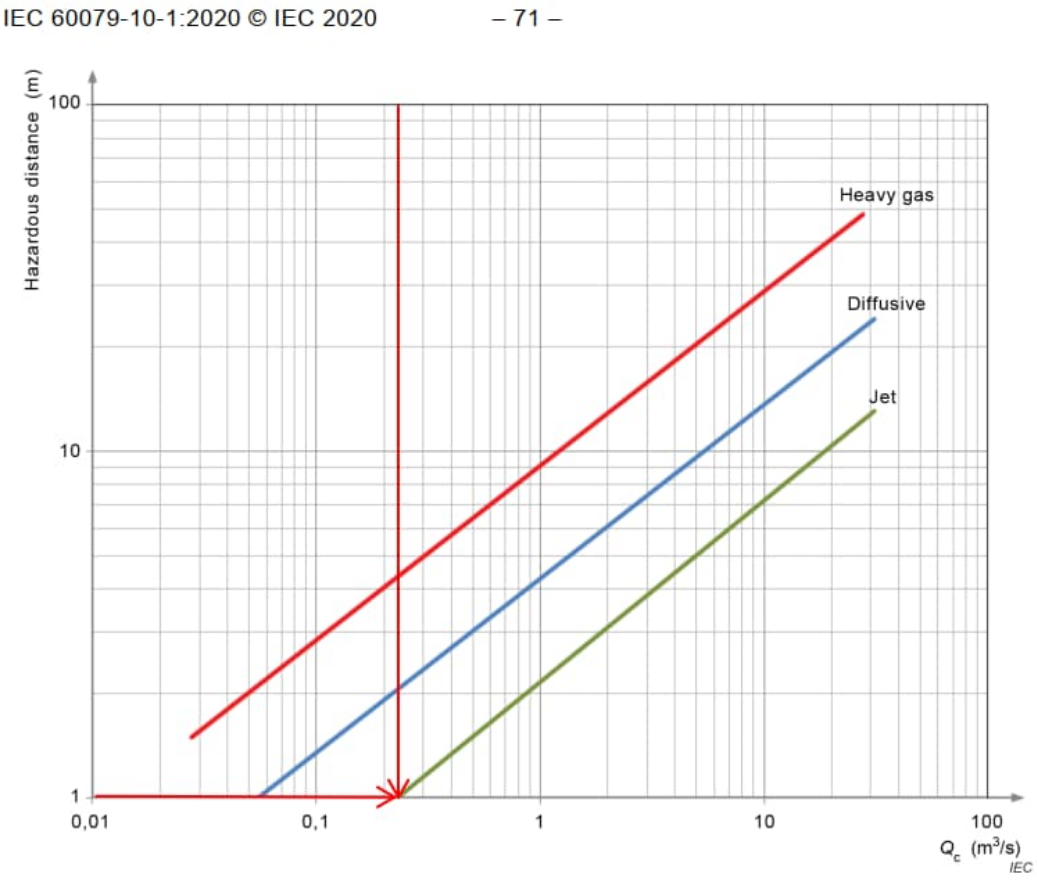


Figure D.1 – Chart for estimating hazardous area distances

Red lines show the assumptions for the minimum requirements to be measured

Converting this into the Release Flow (Wg) using the relative density and LFL, the maximum allowable Release Flow is 6,904x10-7 g/s to still maintain the applicable zone 2. However, considering the leak source a secondary grade of release, as under normal operation there is not expected to be a leak.

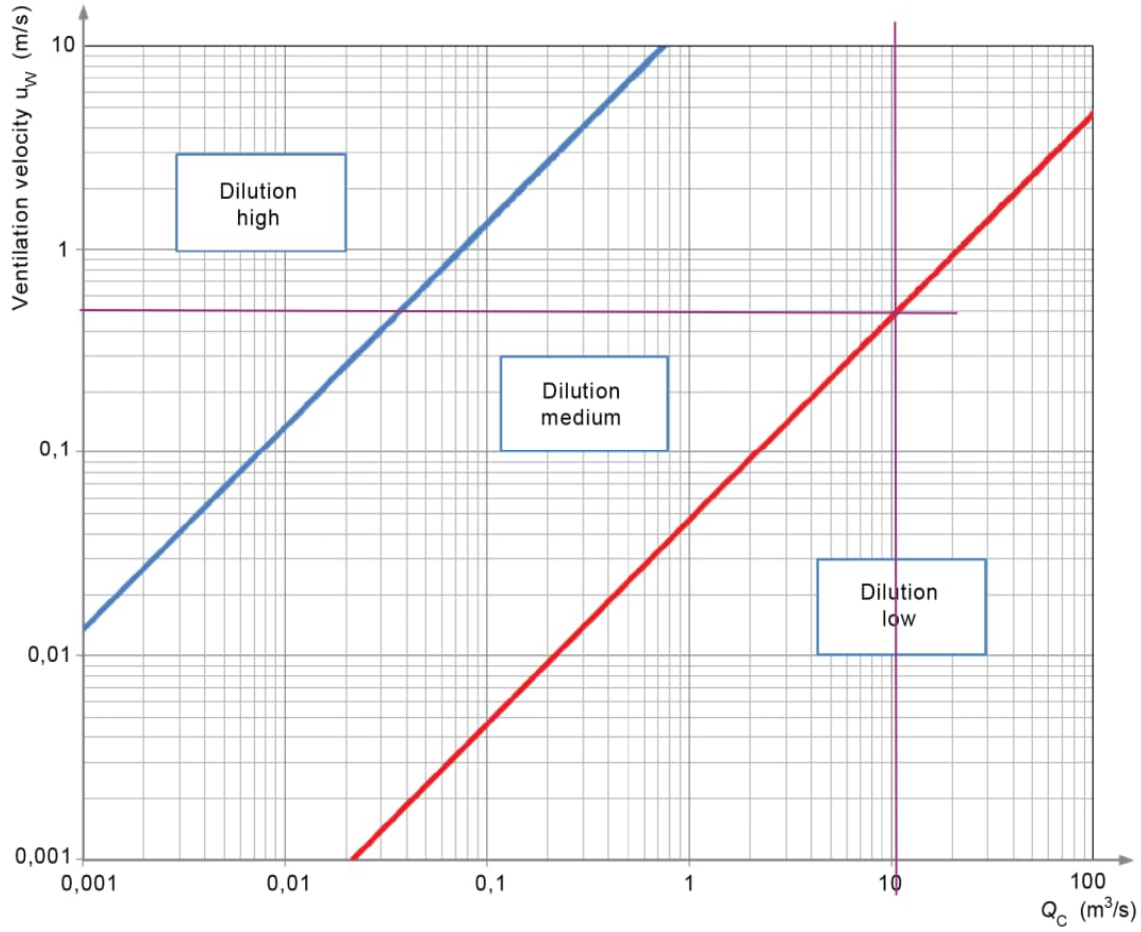
9.2 Maximum release flow in respect to effectiveness of ventilation

To maintain the same applicable zone 2 as calculated in chapter 7.4 the following criteria need to be met to maintain a Zone 2 according to Table D.1 and figure C.1 – EN IEC 60079-10-1:2021:

- Degree of dilution to be at least Medium Dilution
- Availability of ventilation to be at least Fair
- Ventilation speed is fixed by the physical installation to be 0,5m/s
- It is a prerequisite that the leak source is specified as secondary grade of release.

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Figure 9: Degree of dilution and maximum release flow accepted.



Based on C.1 from EN IEC 60079-10-1:2021. Chart for assessing the degree of dilution.

Converting this into the Release Flow (W_g) using the relative density and LFL we will get that the maximum allowable Release Flow is 3,169x10^{-5} g/s to still maintain the applicable zone 2

9.3 Summary of pressure testing value calculation

To make sure the Release Flow submitted to be the dimensioning value according to 60079-10. The value needs to be the one which will be equal or better than the worst Release Flow meaning but conditions for the calculation will be met. For the current installation this is equal to a maximum Release Flow of 6,904x10^{-7} g/s. To convert the value into a pressure, drop, which can be used to e.g. a pressure decay test, the volume, e.g. a pressure decay test, the volume and temperature need to be specified as part of the testing.

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10.0 Appendix

Table 10-1 *Hydrogen Properties*

1	2	3	4	5	6	8	9	11	13	14
	Name	Composition	Molar Mass (kg/kmol)	Relative density gas/air	Polytropic index of adiabatic expansion	Ignition temperature (℃)	Boiling Point (℃)	Vol (%)	Equipment Group	Temperature Class
1	Hydrogen gas (H2)	SAE J2719 ≥99.97%	2.01 (H2)	0.0696 (STP)	1.405	560	-252,8	4%	IIC	T1

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001	25/10/2024	First Issue
002	12/02/2025	Updated and corrected according to agreement during meetings
003	19/03/2025	Corrected according to code 2 comments

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Customer:	CrossWind C.V., Rotterdam, The Netherlands

1.0 Purpose

The purpose of this document is to highlight the safe design of the simple apparatus circuit on the FC PowerGen 1000kW®. The document will be formed on background of IEC 60079-25.

2.0 Analysis

The following system contains only a pressure transmitter and a temperature transmitter. Since they are connected to different complete independent barriers, two analyses will be made following the Annex A in IEC 60079-25.

Table 2-1: Simple system analysis pressure transmitter.

Step	Item	I.S. interface PR electronic 9106B1B	Pressure sensor HUBA control 520 Series	System
A	Equipment group	IIC	IIC	IIC
B	Level of protection	ic	ia	ic
C	Temperature classification	NA	T4	T4
D	Ambient temperature	-20 to 60°C	-25 to 85°C	-20 to 60°C
E	Parameter comparison			
	Voltage	U_0=27,5V	U_i≤30V	OK
	Current	I_0=92,6mA	I_i≤100mA	OK
	Power	P_0=0,64W	P_i≤0,75W	OK
F	Cable parameters			
	Capacitance	C_0=0,084µF	C_{cabel}=1nF Max	C_0=0,083µF
	Inductance	L_0=4,15mH	L_{cabel}=20µH Max	L_0=4,13mH
	L/R ratio	- µH/Ω	NA	NA
G	Earthing	Isolated	Isolated	Isolated

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Table 2-2: Simple system analysis pressure transmitter.

Step	Item	I.S. interface PR electronic 9113B	IFM 1050 Temperatur transmitter	System
A	Equipment group	IIC	NA[1]	
B	Level of protection	ic	NA[2]	
C	Temperature classification	NA	T4[3]	
D	Ambient temperature	-20 to 60°C	-25 to 80°C	-20 to 60°C
E	Parameter comparison			
	Voltage	U_0=8,7V	NA[4]	Ok
	Current	I_0=18,4mA	NA[4]	Ok
	Power	P_0=40mW	NA[4]	Ok
F	Cable parameters			
	Capacitance	C_0=5nF	C_{cabel}=1nF Max	C_0=4nF
	Inductance	L_0=100mH	L_{cabel}=20µH Max	L_0=98mH
	L/R ratio	892 µH/Ω	NA	892 µH/Ω
G	Earthing	Isolated	Isolated	Isolated

[1]Not applicable for simple apparatus.

[2]Not applicable for simple apparatus.

[3]Acordingly to IEC 60079-25 annex F the temperature rating will be T4 if the power does not exceed 1,2W at the ambient temperature of 60°C, which is applicable for this application. Further explanation is described in IEC 60079-0 section 5.3.3 Table 3 and 4.

[4]As it is a RTD type temperature sensor those values are not applicable.

2.1 Simple apparatus requirements

There are some requirements to apply for a component to be classified as a simple apparatus. The IEC 60079-11 section 5.7 describes the following requirements:

a) *Passive components, for example switches, junction boxes, resistors and simple semiconductor devices;*

b) *Sources of stored energy consisting of single components in simple circuits with well defined parameters, for example capacitors or inductors, whose values shall be considered when determining the overall safety of the system;*

c) *sources of generated energy, for example thermocouples and photocells, which do not generate more than 1.5 V, 100 mA and 25 mW.*

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Sins this temperature sensor is based on the RTD technology the sensor will not be able to induce any current nor voltage to make this a potential ignition source. Hence relying on the associated apparatus being the EX Barriere.

The barrier is built and approved for connection to RTD type of temperature sensors. The following data from the barrier is included in the Table 2-2.

3.0 Conclusion

According to this analysis of both the Pressure transmitter HUBA520 and the corresponding EX barrier PR electronic 9106B1B the conditions for intrinsically safe circuit are being met accordingly to the IEC 60079-25.

Furthermore, the analysis of Temperature transmitter IFM TT1050 and the corresponding EX barrier PR electronic 9113B does also comply with the requirements form intrinsically safe according to the IEC 60079-25. Since this is a simple apparatus the conditions for this are met accordingly to IEC 60079-11.

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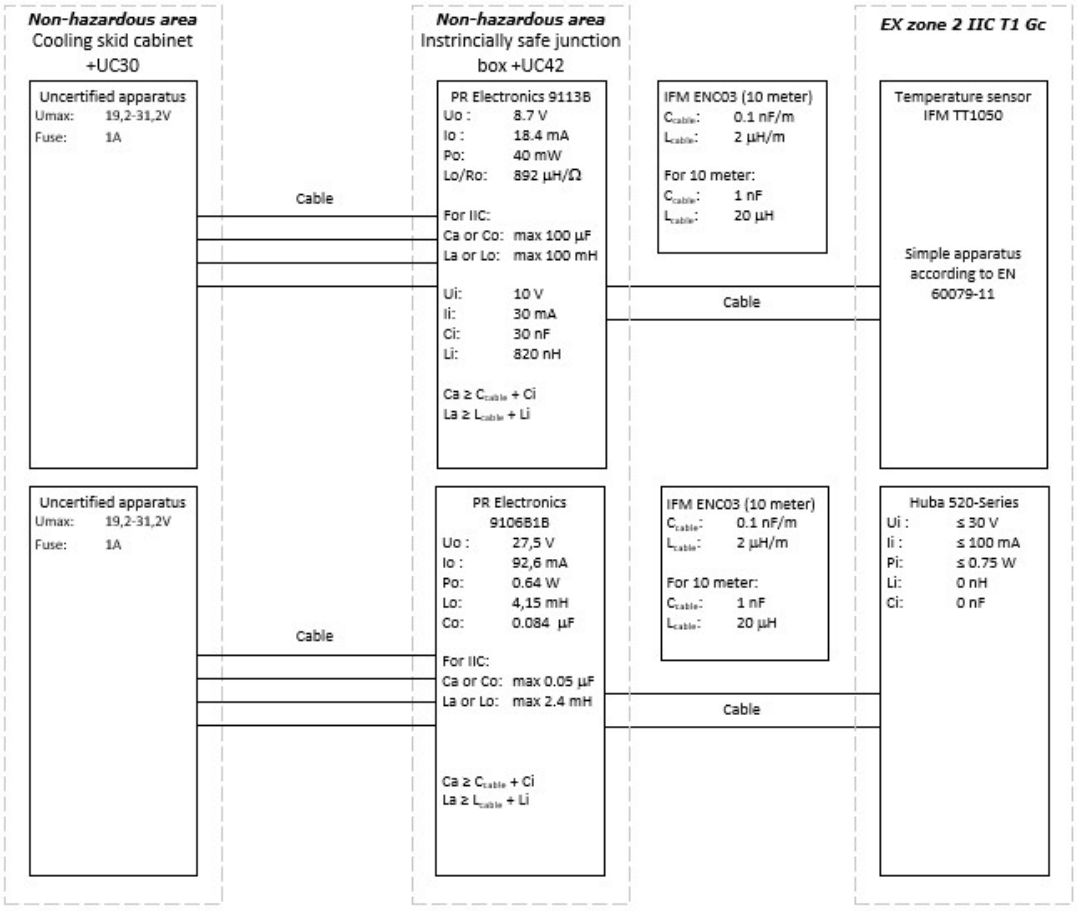
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Figure 1: Intrinsically safe calculations



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001	23/05/2023	First Issue
002	18/09/2023	Updated according to comments
003	30/08/2024	Updated according to comments
004	15/11/2024	Updated following ATEX Register (K02-002)
005	19/03/2025	Updatad in accordance with Code 2 corrections

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Customer:	CrossWind C.V., Rotterdam, The Netherlands

Short Title	K02-001 - Equipment Hazardous Area Certificates and Schedule
Full Title	Certificates and documentation of equipment for hazardous area of 1MW hydrogen fuel cell container for Crosswind
Abstract	

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Revision Record

Rev #	Description	Revised By	Date [dd/mm/yyyy]
1.0	Initial Release	RBS	23/05/2023
2.0	Updated to address review comments	EZE	18/09/2023
3.0	Expanded to include components from H2 Pre-heating System	EZE	30/08/2024
4.0	Updated following ATEX Register (K02-002)	RBS	15/11/2024
5.0	Updated following ATEX Register	KHE	18/03/2025

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1.0 Purpose

The purpose of this document is to provide the ATEX certificates of the equipment for hazardous area of the 1MW fuel cell container (MEGABLOCK) provided by Ballard Power Systems Europe to CrossWind.

2.0 References

Table 1 – List of references.

Document ID	Document Title	Source
K559-2254-DM-PRO-001	Supplier Documentation Requirements Listing (SDRL) Definitions	KBR
K559-2254-CWIWP4202202-K02-002	ATEX Register	Ballard

3.0 List of ATEX Equipment

The ATEX Register lists the following ATEX equipment as shown in the table below. For more details, please refer to the ATEX Register.

Table 2 – List of ATEX equipment (extract from document K559-2254-CWIWP4202202-K02-002).

Location	Manufacturer	Model Type Catalogue Number	Serial Number	ATEX Certification Marking	Reference Document	ATEX Certificate Number	Installation Zone	Notes / Comments	P.O	Vendor	Skid /Package	Barrier Calculation ref.	Non-electrical Equipment	Special Conditions for Safe Use	
=HA01+DA02 - H2 Supply System	IFM Electronic AS	LM701A LMACE-E12E-Q9KG-1/US/3D/3G	10000160523	II 3G Ex nA IIC T4 Gc	K559-2254-CWIWP4202202-C03-001	8003330	Zone 2		8517643	IFM Electronic AS	A-80000	No	No	No	
=HA01+DA02 - H2 Supply System	IFM Electronic AS	EVC14A ADOGH040VAT0025H04/3G/2D	N/A	II 3G Ex ec IIC Gc	K559-2254-CWIWP4202202-E03-003	BVS 08ATEX E 109U	Zone 2		8520141	IFM Electronic AS	A-80000	No	No		
=HA01+DA02 - H2 Supply System	HUBA Controls AG	Pressure Transducer 520 Series	N/A	Ex II 1/2G Ex ia IIC T4 Ga/Gb	K559-2254-CWIWP4202202-C03-001	SEV 10 ATEX 0145	Zone 2		8516809	HUBA Controls AG	A-80000	K559-2254-CWIWP420220	No	No	
=LA01+UC42 - EX Barrier Box	IFM Electronic AS	EN C03A ADOGH040MSN0010H04/1G/1D	N/A	II 2(1) Ex ia IIC T6 Gb	K559-2254-CWIWP4202202-E03-008	BVS 11ATEX E 009X	Zone 2		8520269	IFM Electronic AS	A-80000	K559-2254-CWIWP420220	No	Yes	
=LA01+UC42 - EX Barrier Box	PR Electronics AS	9106-B1B	N/A	II (1) G [Ex ia Ga] IIC/IIB/IIA	K559-2254-CWIWP4202202-E03-008	DEKRA 11ATEX0244 X	No Zone		146113-1	PR Electronics AS	A-80000	K559-2254-CWIWP420220	No	Yes	
=HA01+DA02 - H2 Supply System	IFM Electronic AS	TT1050 TT-100KBBD10……/US/	100000113592	N/A	K559-2254-CWIWP4202202-C03-001	N/A	Zone 2	Simple apparatus acc	8516509	IFM Electronic AS	A-80000	K559-2254-CWIWP420220	No	No	
=LA01+UC42 - EX Barrier Box	IFM Electronic AS	EN C03A ADOGH040MSN0010H04/1G/1D	N/A	Ex ia IIC T6 Gb	K559-2254-CWIWP4202202-E03-008	BVS 11ATEX E 009X	Zone 2		8520269	IFM Electronic AS	A-80000	K559-2254-CWIWP420220	No	Yes	
=LA01+UC42 - EX Barrier Box	PR Electronics AS	9113B-U9	N/A	II (1) G [Ex ia Ga] IIC/IIB/IIA	K559-2254-CWIWP4202202-E03-008	IECEx 07ATEX0148 X	No Zone		8520371	PR Electronics AS	A-80000	K559-2254-CWIWP420220	No	Yes	
=HA01+DA02 - H2 Supply System	JEVI Heating Elements AS	D-8640	340386-1	Ex d IIC T4 Gb	K559-2254-CWIWP4202202-C03-001	ISSeP 08 ATEX 008X	Zone 2		8517682	JEVI Heating Elements AS	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Lapp Group	OLFLEX® CLASSIC 130H	N/A	N/A	K559-2254-CWIWP4202202-E03-003	N/A	Zone 2		N/A	Lapp Group	A-80000	No	No	No	
=HA01+DA02 - H2 Supply System	HAWKE	ICG 653 UNIV Os M20	N/A	EX db IIC Gb and EX eb IIC GB	K559-2254-CWIWP4202202-C03-001	IECEx_CML18.0131X	Zone 2		8517682	HAWKE	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	JEVI Heating Elements AS	D-8640	340386-2	Ex d IIC T4 Gb	K559-2254-CWIWP4202202-C03-001	ISSeP 08 ATEX 008X	Zone 2		8517682	JEVI Heating Elements AS	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Lapp Group	OLFLEX® CLASSIC 130H	N/A	N/A	K559-2254-CWIWP4202202-E03-003	N/A	Zone 2		N/A	Lapp Group	A-80000	No	No	No	
=HA01+DA02 - H2 Supply System	HAWKE	ICG 653 UNIV Os M20	N/A	EX db IIC Gb and EX eb IIC GB	K559-2254-CWIWP4202202-C03-001	IECEx_CML18.0131X	Zone 2		8517682	HAWKE	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP24068090	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8516694	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP24068090	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8516694	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Emerson ASCO	NF X E210D488E 24/DC	ZP23091327	II 2 G D Ex db IIC T2...T6 Gb	K559-2254-CWIWP4202202-C03-001	LCIE 00 ATEX 6008 X	Zone 2		8514701	Emerson ASCO	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Eaton Corporation	ADU102904	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	ITS16ATEX101339X R.1	Zone 2		CD3034021	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes	
=HA01+DA02 - H2 Supply System	Roxtec International AB	EXRSB0500002121	202439	II 2G EX e IIC Gb	K559-2254-CWIWP4202202-C03-001	IECEx NEM 12.0014X	Zone 2		8520214	Roxtec International AB	A-80000	No	No	Yes	
=HA01+DA02 - Non EX Box	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - Non EX Box	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	HAWKE	501/421/O M20 421OM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034005	Semcomaritime	A-80000	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	Eaton Corporation	RDU100604	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semcomaritime	A-80001	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	HAWKE	501/421/A M20 421AM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-C06-001	IECEx CML 19.0045X	Zone 2		CD3034021	Semcomaritime	A-80002	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	Eaton Corporation	RDU100704	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-C06-001	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semcomaritime	A-80003	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	HAWKE	501/421/A M20 421AM20	N/A	Ex db IIC Gb Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	IECEx CML 19.0045X	Zone 2		CD3034021	Semcomaritime	A-80004	No	No	Yes	
=HA01+DA02 - Exterior location, hydroj	Eaton Corporation	RDU100704	N/A	II 2G Ex db IIC Gb II 2G Ex eb IIC Gb	K559-2254-CWIWP4202202-E03-002	ITS16ATEX101339X R.1	Zone 2		CD3034005	Semcomaritime	A-80005	No	No	Yes	

4.0 ATEX Certificates

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4.1 BL01 – Electronic Level Sensor, LMT01A

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ifm electronic

EU – Konformitätserklärung

EU declaration of conformity

Déclaration de conformité UE

ifm electronic gmbh
Friedrichstraße 1
45128 Essen
Germany

Telefon: +49 (0)201 / 24 22 - 0
Telefax: +49 (0)201 / 24 22 - 1200
Internet: www.ifm.com

Die EU-Konformitätserklärung gilt für folgende Geräte:	The EU declaration of conformity applies to the following units:	La déclaration de conformité UE s'applique aux appareils suivants:

Elektronische Füllstandssensoren der Produktfamilie
Electronic level sensors of the product family
Capteurs des niveau électroniques de la famille de produits

LMTxxA

Die alleinige Verantwortung für die Ausstellung dieser Konformitäts-erklärung trägt der Hersteller.	This declaration of conformity is issued under the sole responsibility of the manufacturer.	La présente déclaration de conformité est établie sous la seule responsabilité du fabricant.
Wir bestätigen die Übereinstimmung mit den wesentlichen Anforderungen der europäischen Richtlinie(n):	We confirm the conformity to the essential requirements of the European directive(s):	Nous confirmons la conformité aux exigences essentielles de la (des) directive(s) européenne(s):
2011/65/EU **2014/30/EU** **2014/34/EU**	**2011/65/EU** **2014/30/EU** **2014/34/EU**	**2011/65/UE** **2014/30/UE** **2014/34/UE**
Folgende Norm(en) wurde(n) angewandt:	The following standard(s) was (were) applied:	La (Les) norme(s) suivante(s) a (ont) été appliquée(s):

EN IEC 63000: 2018
EN 61000-6-3: 2007 +A: 2011 + AC: 2012
EN 61000-6-4: 2007 +A1: 2011
EN IEC 61000-6-2: 2019
EN 60079-15: 2010
EN 60079-31: 2014
EN IEC 60079-0: 2018

Kennzeichnung	Marking	Marquage
	Ex II 3D Ex tc IIIC T90°C Dc **Ex II 3G Ex nA IIC T4 Gc**	

Artikel - Nr.: 80304277

Tettnang, 20.07.2021
(Ort und Datum der Ausstellung)
(Place and date of issue)
(Lieu et date de l'établissement)

(Unterschrift) i.V. Alfred Wagner /
(Signature) Head of development
(Signature)

Dokument-Nr.: 8003330

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ifm electronic

Declaración UE de conformidad

Dichiarazione di conformità UE

EU – försäkran om överensstämmelse

ifm electronic gmbh
Friedrichstraße 1
45128 Essen
Germany

Telefon: +49 (0)201 / 24 22 - 0
Telefax: +49 (0)201 / 24 22 - 1200
Internet: www.ifm.com

La declaración UE de conformidad se aplica a los siguientes productos:	La dichiarazione di conformità UE si applica ai seguenti dispositivi:	EU-försäkran om överensstämmelse gäller för följande enheter:

Sensores electrónicos de nivel de la gama de productos
Sensori elettronici di livello della serie
Elektroniska nivågivare i produktfamiljen

LMTxxA

La presente declaración de conformidad se expide bajo la exclusiva responsabilidad del fabricante.	La presente dichiarazione di conformità è rilasciata sotto la responsabilità esclusiva del fabbricante.	Tillverkaren har ensam ansvar för utfärdandet av denna försäkran om överensstämmelse.
Certificamos la conformidad con los requisitos esenciales de la(s) directiva(s) europea(s):	Confermiamo la conformità con i requisiti essenziali della(e) direttiva(e) europea(e):	Vi intygar att alla väsentliga krav i den (de) europeiska direktivet (direktiven) är uppfyllda:
2011/65/UE **2014/30/UE** **2014/34/UE**	**2011/65/UE** **2014/30/UE** **2014/34/UE**	**2011/65/EU** **2014/30/EU** **2014/34/EU**
Se ha(n) aplicado la(s) siguiente(s) norma(s):	La(e) seguente(i) norma(e) è(sono) stata(e) applicata(e):	Följande standard(er) tillämpas:

EN IEC 63000: 2018
EN 61000-6-3: 2007 +A: 2011 + AC: 2012
EN 61000-6-4: 2007 +A1: 2011
EN IEC 61000-6-2: 2019
EN 60079-15: 2010
EN 60079-31: 2014
EN IEC 60079-0: 2018

Marcado	Contrassegno	Märkning
	Ⓔx II 3D Ex tc IIIC T90°C Dc Ⓔx II 3G Ex nA IIC T4 Gc	

N° de artículo: 80304277

Tettnang, 20.07.2021
(Lugar y fecha de expedición)
(Luogo e data del rilascio)
(Ort och datum för utfärdande)

(Firma) i.V. Alfred Wagner /
(Firma) Head of development
(Underskrift)

Nº de documento: 8003330

4.2 BL01-WG01 – Connecting Cable with Socket for Level Sensor, EVC14A

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DEKRA

1 # EU-Baumusterprüfbescheinigung

2 **Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014**

3 Nr. der EU-Baumusterprüfbescheinigung: **BVS 08 ATEX E 109 U** Ausgabe: **01**

4 Komponente: **Kabeldosen und -stecker Typ EVC** A**

5 Hersteller: **ifm electronic gmbh**

6 Anschrift: **Friedrichstraße 1, 45128 Essen, Deutschland**

7 Die Bauart dieses Produktes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

8 Die Zertifizierungsstelle der DEKRA Testing and Certification GmbH, benannte Stelle Nr. 0158 gemäß Artikel 17 der Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014, bescheinigt, dass das Produkt die wesentlichen Gesundheits- und Sicherheitsanforderungen für die Konzeption und den Bau von Produkten zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt.
Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfprotokoll BVS PP 08.2137 EU niedergelegt.
Diese Ausgabe der EU-Baumusterprüfbescheinigung ersetzt die bisherige Ausgabe der EG-Baumusterprüfbescheinigung BVS 08 ATEX E 109 U inklusive der Nachträge 1 bis 2.

9 Die Einhaltung der Grundlegenden Sicherheits- und Gesundheitsanforderungen wurde überprüft durch Berücksichtigung von:

EN IEC 60079-0:2018	**Allgemeine Anforderungen**
EN IEC 60079-7:2015 + A1:2018	**Erhöhte Sicherheit „e“**
EN 60079-31:2014	**Schutz durch Gehäuse „t“**

10 Das Zeichen „U“ hinter der Zertifikatsnummer weist darauf hin, dass dieses Zertifikat nicht mit Zertifikaten für Geräte oder Schutzsysteme verwechselt werden darf. Diese Teilzertifizierung kann als Grundlage für die Zertifizierung eines Geräts oder Schutzsystems verwendet werden. Die „Einschränkungen für die Verwendung“ ist unter Punkt 17 dieser Bescheinigung aufgeführt.

11 Diese EU-Baumusterprüfbescheinigung bezieht sich nur auf den technischen Entwurf des angegebenen Produkts gemäß der Richtlinie 2014/34/EU.
Weitere Anforderungen der Richtlinie gelten für den Herstellungsprozess und die Bereitstellung dieses Produkts. Diese sind nicht Gegenstand der Zertifizierung.

12 Die Kennzeichnung des Produktes muss die folgenden Angaben enthalten:

Ex **II 2D Ex tb IIIC Db**
II 3G Ex ec IIC Gc

DEKRA Testing and Certification GmbH
Bochum, 17.02.2023

Geschäftsführer

DEKRA Testing and Certification GmbH, Handwerkstraße 15, 70565 Stuttgart
Zertifizierungsstelle: Dinnendahlstraße 9, 44809 Bochum
Telefon +49.234.3696-400, Fax +49.234.3696-401, DTC-Certification-body@dekra.com

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13 **Anlage zur**

14 **EU-Baumusterprüfbescheinigung**

BVS 08 ATEX E 109 U Ausgabe 01

15 **Beschreibung des Produktes**

15.1 **Gegenstand und Typ**

Kabeldosen und -stecker Typ EVC**A

** - Kabellänge (0,1 ...100 m)

15.2 **Beschreibung**

Die 90° abgewinkelten M12 Kabeldosen Typ EVC0*A haben 4 Kontakte und ein angespritztes 4-adriges Kabel. Sie sind mit einer Edelstahl-Überwurfmutter versehen, die zur mechanischen Befestigung des Kabels an den Betriebsmitteln verwendet wird. Die Fixierung wird über eine spezielle Befestigungstechnik sichergestellt, die über eine Rasterung ein ungewolltes Lösen der Mutter verhindert. Die Kabeldosen und -stecker Typ EVC**A sind in der Zündschutzart Erhöhte Sicherheit „ec" und Schutz durch Gehäuse „tb" ausgeführt.

Grund für diese Ausgabe

- Umstellung auf die Richtlinie 2014/34/EU
- Aktualisierung der Normen EN IEC 60079-0:2018 und EN 60079-31:2014, sowie Umstellung von EN 60079-15:2010 auf EN IEC 60079-7:2015+A1:2018.

15.3 **Kenngrößen**

Bemessungsspannung		AC/DC 60 V
Stromtragfähigkeit		2 A
Umgebungstemperaturbereich	-	20 °C ≤ T_a ≤ 60 °C
Anzugsdrehmoment der Überwurfmutter		1,2… 1,5 Nm

16 **Prüfprotokoll**

BVS PP 08.2137 EU, Stand 17.02.2023

17 **Einschränkungen für die Verwendung**

Die Kabeldosen und -stecker müssen an ein metallisches Gegenstück angeschlossen werden, das die IP-Anforderungen gemäß EN IEC 60079-7 und EN 60079-31 erfüllt und eine M12-Größe hat.

Die Kabeldosen und -stecker müssen gegen eine Schlagenergie > 4 J geschützt sein.

Die Kabeldosen und -stecker müssen gegen UV-Licht geschützt sein.

Die Kontermutter muss mit einem Anzugsmoment von 1,2...1,5 Nm angezogen werden.

Die Kabel sind fest zu verlegen und gegen mechanische Beschädigungen zu schützen.

DEKRA Testing and Certification GmbH, Handwerkstraße 15, 70565 Stuttgart
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18 **Wesentliche Gesundheits- und Sicherheitsanforderungen**

Erfüllt durch Einhaltung der unter Punkt 9 genannten Anforderungen.

19 **Zeichnungen und Unterlagen**

Die Zeichnungen und Unterlagen sind in dem vertraulichen Prüfprotokoll gelistet.

DEKRA Testing and Certification GmbH, Handwerkstraße 15, 70565 Stuttgart
Zertifizierungsstelle: Dinnendahlstraße 9, 44809 Bochum
Telefon +49.234.3696-400, Fax +49.234.3696-401, DTC-Certification-body@dekra.com

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Translation

1 # EU-Type Examination Certificate

2 **Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014**

3 EU-Type Examination Certificate Number: **BVS 08 ATEX E 109 U** Issue: **01**

4 Component: **Sockets and plugs type EVC**A**

5 Manufacturer: **ifm electronic gmbh**

6 Address: **Friedrichstraße 1, 45128 Essen, Germany**

7 This product and any acceptable variations thereto are specified in the appendix to this certificate and the documents referred to therein.

8 DEKRA Testing and Certification GmbH, Notified Body number 0158, in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.
The examination and test results are recorded in the confidential Report No. BVS PP 08.2137 EU.
This issue of the EU-Type Examination Certificate replaces the previous issue of the EC-Type Examination Certificate BVS 08 ATEX E 109 U including supplements 1 to 2.

9 Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN IEC 60079-0:2018	**General requirements**
EN IEC 60079-7:2015 + A1:2018	**Increased Safety "e"**
EN 60079-31:2014	**Protection by Enclosure "t"**

10 The sign "U" placed behind the certificate number indicates that this certificate should not be confounded with certificates issued for equipment or protective systems. This partial certification may be used as a basis for certification of an equipment or protective systems. "Schedule of limitations" is listed under item 17 of this certificate.

11 This EU-Type Examination Certificate relates only to the technical design of the specified product in accordance to the Directive 2014/34/EU. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

12 The marking of the product shall include the following:

II 2D Ex tb IIIC Db
II 3G Ex ec IIIC Gc

DEKRA Testing and Certification GmbH
Bochum, 2023-02-17

Signed: Dr. Rolf Krökel

Managing Director

This certificate may only be reproduced in its entirety and without any change.

DEKRA Testing and Certification GmbH, Handwerkstr. 15, 70565 Stuttgart, Germany
Certification body: Dinnendahlstr. 9, 44809 Bochum, Germany
Phone +49.234.3696-400, Fax +49.234.3696-401, e-mail DTC-Certification-body@dekra.com

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13 **Appendix**

14 **EU-Type Examination Certificate**

BVS 08 ATEX E 109 U issue 01

15 **Product description**

15.1 **Subject and type**

Sockets and plugs type EVC**A

**-length of cable (0.1 ...100 m)

15.2 **Description**

The 90° angled M12 sockets type EVC0*A have 4 pins and a potted 4-wire cable. They are equipped with a stainless steel lock nut to fasten the socket at the equipment. A special fastening technique protects against unintended loosening. The plugs and sockets type EVC**A are built in type of protection Increased Safety “ec” and Protection by Enclosure “tb”.

Reason for this issue

- Change to Directive 2014/34/EU
- The reason of the supplement is the updating to the standards EN IEC 60079-0:2018 and EN 60079-31:2014, as well as change from EN 60079-15:2010 to EN IEC 60079-7:2015+A1:2018.

15.3 **Parameters**

Rated voltage AC/DC	60 V
Current carrying capacity	2 A
Ambient temperature range	-20 °C ≤ T_a ≤ 60 °C
Tightening torque of lock nut	1.2… 1.5 Nm

16 **Report Number**

BVS PP 08.2137 EU, as of 2023-02-17

17 **Schedule of limitations**

The sockets have to be connected to a metallic counterpart which meets the IP requirements according to EN IEC 60079-7 and EN 60079-31 which has a M12 size.

The sockets have to be protected against an impact energy > 4 J.

The sockets have to be protected against UV emitting light.

The lock nut has to be fastened with a tightening torque of 1.2…1.5 Nm.

The cables have to be installed in a fixed manner and have to be protected against mechanical damage.

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18 **Essential Health and Safety Requirements**

Met by compliance with the requirements mentioned in item 9.

19 **Remarks and additional information**

Drawings and documents are listed in the confidential report.

We confirm the correctness of the translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

DEKRA Testing and Certification GmbH
Bochum, 2023-02-17
BVS-Pz/Mu A 20220792 / 342813900

Managing Director

DEKRA Testing and Certification GmbH, Handwerkstr. 15, 70565 Stuttgart, Germany
Certification body: Dinnendahlstr. 9, 44809 Bochum, Germany
Phone +49.234.3696-400, Fax +49.234.3696-401, e-mail DTC-Certification-body@dekra.com

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4.3 BP01 – Pressure Sensor, 520 Series

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EU-Type Examination Certificate

(1)

(2) Equipment or protective system intended for use in potentially explosive atmospheres **- Directive 2014/34/EU**

(3) Certificate number: **SEV 10 ATEX 0145**

(4) Product: Pressure transmitter, Types: 520.*, 522.*, 527.*, 528.*

(5) Manufacturer: Huba Control AG

(6) Address: Industriestrasse 17, 5436 Würenlos, Switzerland

(7) The equipment and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) Eurofins, notified body No. 1258, in accordance with article 17 of Directive 2014/34/EU of the European parliament and of the council, dated 26 February 2014, certifies that this product has been found to comply with the essential health and safety requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.
The examination and test results are recorded in confidential report no 21CH-00562.X04

(9) Compliance with the essential health and safety requirements has been assured by compliance with:

EN IEC 60079-0:2018
EN 60079-11:2012
EN 60079-26:2015

Except in respect of those requirements listed at item 18 of the schedule.

(10) If the sign «X» is placed after the certificate number, it indicates that the product is subjected to special conditions for safe use specified in the schedule to this certificate. The sign "U" is placed after the certificate number. It indicates that this certificate must not be mistaken for a certificate intended for an equipment or protective system. This partial certification may be used as a basis for certification of an equipment or protective system.

(11) This EU type examination certificate relates only to design and construction of the specified product. Further requirements of this directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

(12) The marking of the product shall include the following:

II 1/2G Ex ia IIC T4 Ga/Gb
II 1/2D Ex ia IIIC T125 °C Da/Db

Eurofins Electric & Electronic Product Testing AG
Notified Body ATEX

Martin Plüss
Product Certification

www.eurofins.ch Fehraltorf, 2021-12-16 Issue: 4 Page 1 of 2

T8a_V01

eurofins | E&E

(13) # Appendix

(14) **EU-Type Examination Certificate no. SEV 10 ATEX 0145**

(15) **Description of product**

The pressure transmitter is used to measure relative and absolute pressure of gases, liquids and refrigerants (incl. ammonia). The pressure transmitter differ in the pressure measuring cell and the pressure range. For the measuring of the pressure the signal of a pressure measuring cell made of stainless steel (type 520.* / 522.*) or made of ceramic (type 527.* / 528.*) with a membrane is converted into a 4…20 mA output signal by the electronic.
The pressure transmitter can be installed in the partition which separates the area, which requires apparatus of category 1 from the area, which requires apparatus of category 2. The pressure measuring cell may be used only for flammable substances for which the membranes of cells are sufficiently chemically and corrosion resistant.
Effective internal inductance and capacitance for versions with plugs complying with EN 175301-80 A (IP65) or M12x1 (IP67)

Classification of installation and use:	stationary
Ingress protection:	IP65 with connector EN 175301-803A IP67 with connector M12x1
Rated ambient temperature range (°C):	-25 °C ≤ Tamb ≤ +85 °C
Rated medium temperature range (°C):	-30 °C … +120 °C
Rated ambient temperature range (°C) for Ex Components:	N/A

Ratings:
Connection to certified intrinsically safe resistive circuits with maximum values:

Ui ≤ 30 V
Ii ≤ 100 mA
Pi ≤ 750 mW
Ci = 0 nF
Li = 0 µH

Output:
4 … 20 mA

(16) **Report number** 21CH-00562.X04

(17) **"Special conditions for safe use" / "Schedule of limitations"**
None

(18) **Essential health and safety requirements**
In addition to the essential health and safety requirements (EHSRs) covered by the standards listed at item 9, the following are considered relevant to this product, and conformity is demonstrated in the report:

Clause **Subject**
None

(19) **Drawings and Documents**
See test report "Manufacturer's Documents"

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IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	**IECEx SEV 16.0007**	Page 1 of 5	Certificate history:
Status:	**Current**	Issue No: 2	Issue 1 (2018-03-12) Issue 0 (2016-05-19)
Date of Issue:	2021-12-16		
Applicant:	**Huba Control AG** Industriestrasse 17 5436 Würenlos **Switzerland**		
Equipment:	**Pressure transmitter Type 520.*, 522.*, 527.*, 528.***		
Optional accessory:			
Type of Protection:	**ia**		
Marking:	Ex ia IIC T4 Ga/Gb Ex ia IIIC T125 °C Da/Db		

SWISS ACCREDITATION sas.admin.ch SCESp 0127

Approved for issue on behalf of the IECEx Certification Body: **Martin Plüss**

Position: **Manager Product Certification**

Signature: (for printed version)

Date: 2021-12-16

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting www.iecex.com or use of this QR Code.

Certificate issued by:

Eurofins Electric & Electronic Product Testing AG
Luppmenstrasse 3
8320 FEHRALTORF .
Switzerland

eurofins | E&E

IECEx Certificate of Conformity

Certificate No.: **IECEx SEV 16.0007** Page 2 of 5

Date of issue: 2021-12-16 Issue No: 2

Manufacturer: **Huba Control AG**
Industriestrasse 17
5436 Würenlos
Switzerland

Additional manufacturing locations:

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements.This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended

STANDARDS :
The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

IEC 60079-0:2017 Edition:7.0	Explosive atmospheres - Part 0: Equipment - General requirements
IEC 60079-11:2011 Edition:6.0	Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"
IEC 60079-26:2014-10 Edition:3.0	Explosive atmospheres – Part 26: Equipment with Equipment Protection Level (EPL) Ga

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Report:

CH/SEV/ExTR16.0008/02

Quality Assessment Report:

CH/SEV/QAR12.0006/06

IECEx Certificate of Conformity

Certificate No.: **IECEx SEV 16.0007** Page 3 of 5

Date of issue: 2021-12-16 Issue No: 2

EQUIPMENT:
Equipment and systems covered by this Certificate are as follows:

Pressure transmitter Type 520.*, 522.*, 527.*, 528.*

The pressure transmitter is used to measure relative and absolute pressure of gases, liquids and refrigerants (incl. ammonia). The pressure transmitter differ in the pressure measuring cell and the pressure range. For the measuring of the pressure the signal of a pressure measuring cell made of stainless steel (type 520.* / 522.*) or made of ceramic (type 527.* / 528.*) with a membrane is converted into a 4...20 mA output signal by the electronic.

The pressure transmitter can be installed in the partition which separates the area, which requires apparatus of category 1 from the area, which requires apparatus of category 2. The pressure measuring cell may be used only for flammable substances for which the membranes of cells are sufficiently chemically and corrosion resistant.

Effective internal inductance and capacitance for versions with plugs complying with EN 175301-80 A (IP65) or M12x1 (IP67)

SPECIFIC CONDITIONS OF USE: NO

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IECEx Certificate of Conformity

Certificate No.: **IECEx SEV 16.0007** Page 4 of 5

Date of issue: 2021-12-16 Issue No: 2

Equipment (continued):

Classification of installation and use ..... : stationary
Ingress protection ..... : IP65 with connector EN 175301-803A
IP67 with connector M12x1
Rated ambient temperature range (°C)..... : -25 °C ≤ Tamb ≤ +85 °C
Rated medium temperature range (°C) ..... : -30 °C ... +120 °C
Rated ambient temperature range (°C) for Ex Components ....: N/A

Rating:
Power Supply:

Connection to certified intrinsically safe resistive circuits with maximum values:

U_i ≤ 30 VDC
I_i ≤ 100 mA
P_i ≤ 0.75 W
L_i = 0 µH
C_i = 0 nF

Output:
4 ... 20 mA

SWISS ACCREDITATION sas.admin.ch SCESp 0008

IECEx Certificate of Conformity

Certificate No.: **IECEx SEV 16.0007** Page 5 of 5

Date of issue: 2021-12-16 Issue No: 2

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above)
All previous addendums have been combined in a new file with current test reports and drawings.

SWISS ACCREDITATION
sas.admin.ch
SCESp 0236

4.4 BP01-WG01 – Connecting Cable with Socket for Pressure Sensor, ENC03A

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DEKRA

EU-Baumusterprüfbescheinigung

Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014

3 Nr. der EU-Baumusterprüfbescheinigung: **BVS 11 ATEX E 009 X** Ausgabe: **01**

4 Gerät: **Steckverbinder Typ ENC**A**

5 Hersteller: **ifm electronic gmbh**

6 Anschrift: **Friedrichstraße 1, 45128 Essen, Deutschland**

7 Die Bauart dieses Produktes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

8 Die Zertifizierungsstelle der DEKRA Testing and Certification GmbH, benannte Stelle Nr. 0158 gemäß Artikel 17 der Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014, bescheinigt, dass das Produkt die wesentlichen Gesundheits- und Sicherheitsanforderungen für die Konzeption und den Bau von Produkten zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt.
Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfprotokoll BVS PP 11.2018 EU niedergelegt.
Diese Ausgabe der EU-Baumusterprüfbescheinigung ersetzt die bisherige Ausgabe der EG-Baumusterprüfbescheinigung BVS 11 ATEX E 009 X inklusive des Nachtrags 1.

9 Die Einhaltung der Grundlegenden Sicherheits- und Gesundheitsanforderungen wurde überprüft durch Berücksichtigung von:

EN IEC 60079-0:2018	**Allgemeine Anforderungen**
EN 60079-11:2012	**Eigensicherheit „i"**

10 Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, bedeutet dies, dass das Produkt den unter Punkt 17 dieser Bescheinigung aufgeführten „Besondere Bedingungen für die Installation und den Betrieb" unterliegt.

11 Diese EU-Baumusterprüfbescheinigung bezieht sich nur auf den technischen Entwurf des angegebenen Produkts gemäß der Richtlinie 2014/34/EU.
Weitere Anforderungen der Richtlinie gelten für den Herstellungsprozess und die Bereitstellung dieses Produkts. Diese sind nicht Gegenstand der Zertifizierung.

12 Die Kennzeichnung des Produktes muss die folgenden Angaben:

II 1G Ex ia IIB T6 Ga	**II 1G Ex ia IIB T5 Ga**	**II 1D Ex ia IIIC T_{200}70°C Da**
II 2G Ex ia IIC T6 Gb	**II 2G Ex ia IIC T5 Gb**	**for -20 °C ≤ T_a ≤ +60 °C**
II 1D Ex ia IIIB T_{200}85°C Da	**II 1D Ex ia IIIB T_{200}95°C Da**	
for -25 °C ≤ T_a ≤ +75 °C	**for -25 °C ≤ T_a ≤ +85 °C**	

DEKRA Testing and Certification GmbH
Bochum, 06.09.2023

Geschäftsführer

DEKRA Testing and Certification GmbH, Handwerkstraße 15, 70565 Stuttgart
Zertifizierungsstelle: Dinnendahlstraße 9, 44809 Bochum
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13 **Anlage zur**

14 **EU-Baumusterprüfbescheinigung**

BVS 11 ATEX E 009 X Ausgabe 01

15 **Beschreibung des Produktes**

15.1 **Gegenstand und Typ**

Steckverbinder Typ ENC**A

In der vollständigen Bezeichnung werden anstelle der ** Ziffern eingefügt, die Änderungen kennzeichnen wie: Art des Kabels, Länge des Kabels, Konstruktion gerade oder gebogen.

15.2 **Beschreibung**

Der Steckverbinder wird bei eigensicheren Geräten für den Anschluss der eigensicheren Stromkreise verwendet.
Die Steckdose ist ein einfaches elektrisches Betriebsmittel.
Der Steckverbinder hat ein fest angeschlossenes Kabel und ist konstruktionsbedingt in der Lage, zwei verschiedene eigensichere Stromkreise bis zu einer Summe von Spannungen von 30 V zu führen; in diesem Fall muss das Kabel wirksam gegen Beschädigung geschützt werden.

Grund für diese Ausgabe:

- Umstellung auf die Richtlinie 2014/34/EU
- Aktualisierung der Norm EN IEC 60079-0:2018
- Modifikation des Umgebungstemperaturbereichs
- Erweiterung der "Besondere Bedingungen für die Verwendung"

15.3 **Kenngrößen**

Spannung	U_i	DC	30	V
Strom	I_i		1	A
Leistung	P_i			
Für den Einsatz in Gruppe II			1	W
Für den Einsatz in Gruppe III			1	W
Umgebungstemperaturbereich (mit Ausnahme von IIIC)	T_a	-25 °C bis +75 °C / +85 °C		
Für Gruppe IIIC	T_a	-20 °C bis +60 °C		

Für Umgebungstemperaturen bis 75 °C sind die Sensoren als T6 bzw. T_{200} 85 °C klassifiziert (ausgenommen Gruppe IIIC).
Für Umgebungstemperaturen bis 85 °C sind die Sensoren als T5 bzw. T200 95 °C klassifiziert (ausgenommen Gruppe IIIC).

Der Steckverbinder darf zwei verschiedene eigensichere Stromkreise bis zu einer Summe der Spannungen von 30 V führen.

Die Werte der internen Kapazität und Induktivität hängen von der Länge des fest angeschlossenen Kabels ab und werden wie folgt berechnet:

Interne Kapazität	C_i	0,1 nF/m
Interne Induktivität	L_i	2 µH/m

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Zertifizierungsstelle: Dinnendahlstraße 9, 44809 Bochum
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16 **Prüfprotokoll**

BVS PP 11.2018 EU, Stand 06.09.2023

17 **Besondere Bedingungen für die Installation und den Betrieb**

17.1 Die Steckverbinder und das angeschlossene Kabel müssen so installiert werden, dass intensive elektrostatische Aufladung ausgeschlossen ist.

17.2 Aus Platzgründen kann die Kennzeichnung nicht vollständig auf dem Gerät angebracht werden. Die vollständige Kennzeichnung ist der Betriebsanleitung zu entnehmen.

17.3 Das Kabel und der Steckverbinder müssen fest verlegt und wirksam gegen mechanische Beschädigungen geschützt werden.

17.4 Für Gruppe IIIC:

- Der Betrieb des Steckverbinders ohne ein geeignetes M12-Gegenstück ist nicht zulässig. Das M12-Gegenstück muss die IP-Anforderungen nach IEC 60079-11 erfüllen.
- Beim Öffnen des Steckverbinders muss das Eindringen von Staub vermieden werden.
- Der Steckverbinder muss vor UV-Strahlung geschützt werden.
- Die Überwurfmutter muss mit einem Anzugsdrehmoment von 1,2...1,5 Nm angezogen werden.

18 **Wesentliche Gesundheits- und Sicherheitsanforderungen**

Erfüllt durch Einhaltung der unter Punkt 9 genannten Anforderungen.

19 **Zeichnungen und Unterlagen**

Die Zeichnungen und Unterlagen sind in dem vertraulichen Prüfprotokoll gelistet.

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Translation

1 # EU-Type Examination Certificate

2 **Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014**

3 EU-Type Examination Certificate Number: **BVS 11 ATEX E 009 X** Issue: **01**

4 Equipment: **Socket type ENC**A**

5 Manufacturer: **ifm electronic gmbh**

6 Address: **Friedrichstraße 1, 45128 Essen, Germany**

7 This product and any acceptable variations thereto are specified in the appendix to this certificate and the documents referred to therein.

8 DEKRA Testing and Certification GmbH, Notified Body number 0158, in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.
The examination and test results are recorded in the confidential Report No. BVS PP 11.2018 EU.
This issue of the EU-Type Examination Certificate replaces the previous issue of the EC-Type Examination Certificate BVS 11 ATEX E 009 X including supplement 1.

9 Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN IEC 60079-0:2018	**General requirements**
EN 60079-11:2012	**Intrinsic Safety "i"**

10 If the sign "X" is placed after the certificate number, it indicates that the product is subject to the "Specific Conditions of Use" listed under item 17 of this certificate.

11 This EU-Type Examination Certificate relates only to the technical design of the specified product in accordance with the Directive 2014/34/EU. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

12 The marking of the product shall include the following:

II 1G Ex ia IIB T6 Ga **II 2G Ex ia IIC T6 Gb** **II 1D Ex ia IIIB T_{200}85°C Da** **for -25 °C ≤ T_a ≤ +75 °C**	**II 1G Ex ia IIB T5 Ga** **II 2G Ex ia IIC T5 Gb** **II 1D Ex ia IIIB T_{200}95°C Da** **for -25 °C ≤ T_a ≤ +85 °C**	**II 1D Ex ia IIIC T_{200}70°C Da** **for -20 °C ≤ T_a ≤ +60 °C**

DEKRA Testing and Certification GmbH
Bochum, 2023-09-06

Signed: Oliver Brumm

Managing Director

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DEKRA Testing and Certification GmbH, Handwerkstr. 15, 70565 Stuttgart, Germany
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13 **Appendix**

14 **EU-Type Examination Certificate**

BVS 11 ATEX E 009 X issue 01

15 **Product description**

15.1 **Subject and type**

Steckverbinder type ENC**A

In the complete denomination instead of the ** numerals will be inserted which characterize modifications as: kind of cable, length of cable, construction straight or bent.

15.2 **Description**

The socket is used as intrinsically safe apparatus for the connection of the intrinsically safe circuits.
The socket is a simple apparatus.
The socket has a permanently connected cable and is due to construction able to carry two different intrinsically safe circuits up to a sum of voltages of 30 V; in this case the cable must be effectively protected against damage.

Reason for this issue:

- Change to Directive 2014/34/EU
- Standards update EN IEC 60079-0:2018
- Modification of the ambient temperature range
- Extension of the "Special conditions for use"

15.3 **Parameters**

Voltage	U_i	DC	30	V
Current	I_i		1	A
Power	P_i			
For use in Group II			1	W
For use in Group III			1	W
Ambient temperature range (except IIIC)	T_a	-25 °C up to +75 °C / +85 °C		
For Group IIIC	T_a	-20 °C up to 60 °C		

For ambient temperatures up to 75 °C, the sensors are classified as T6 resp. T_{200} 85 °C (except Group IIIC).
For ambient temperatures up to 85 °C, the sensors are classified as T5 resp. T_{200} 95 °C (except Group IIIC).

The socket may carry two different intrinsically safe circuits up to a sum of voltages of 30 V.

The values of internal capacitance and inductance depend on the length of the permanently connected cable and be calculated as:

Internal capacitance	C_i	0.1	nF/m
Internal inductance	L_i	2	µH/m

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Certification body: Dinnendahlstr. 9, 44809 Bochum, Germany
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DAkkS Deutsche Akkreditierungsstelle D-ZE-17438-02-00

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16 **Report Number**

BVS PP 11.2018 EU, as of 2023-09-06

17 **Specific Conditions of Use**

17.1 The connectors and the connected cable must be installed in a way that an intensive electrostatic charge is excluded.

17.2 Due to space restriction the markings may not be applied completely to the unit. See operating instructions for the compete marking.

17.3 The cable and socket must be installed fixed and effectively protected against mechanical damage.

17.4 For Group IIIC:

- The operation of the sockets without a suitable M12 counterpart is not permissible.
  The M12 counterpart has to meet the IP requirements according to IEC 60079-11.
- When the socket is opened, the ingress of dust must be avoided.
- The sockets have to be protected against UV emitting light.
- The lock nut has to be fastened with a tightening torque of 1.2…1.5 Nm.

18 **Essential Health and Safety Requirements**

Met by compliance with the requirements mentioned in item 9.

19 **Remarks and additional information**

Drawings and documents are listed in the confidential report.

We confirm the correctness of the translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

DEKRA Testing and Certification GmbH
Bochum, 2023-09-06
BVS-Fro/Mu A 20220779 / 342812500

Managing Director

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4.5 TF01 – Pressure Sensor Ex Barrier, 9106B

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CERTIFICATE

EU-Type Examination

(1)

(2) **Equipment or protective systems intended for use in potentially explosive atmospheres - Directive 2014/34/EU**

(3) EU-Type Examination Certificate Number: **DEKRA 11ATEX0244 X** Issue Number: **4**

(4) Product: **HART-Transparent Repeater, Types 9106B1A, 9106B1B, 9106B2A , 9106B2B and Types 9106A1A, 9106A1B, 9106A2A , 9106A2B**

(5) Manufacturer: **PR electronics A/S**

(6) Address: **Lerbakken 10, 8410 Rønde, Denmark**

(7) This product and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) DEKRA Certification B.V., Notified Body number 0344 in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.

The examination and test results are recorded in confidential test report number NL/DEK/ExTR11.0097/04.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN IEC 60079-0 : 2018 **EN 60079-11 : 2012**

EN 60079-15 : 2019 **EN 60079-7 : 2015 + A1 : 2018**

except in respect of those requirements listed at item 18 of the Schedule.

(10) If the sign "X" is placed after the certificate number, it indicates that the product is subject to the Specific Conditions of Use specified in the schedule to this certificate.

(11) This EU-Type Examination Certificate relates only to the design and construction of the specified product. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

(12) The marking of the product shall include the following:

II (1) G [Ex ia Ga] IIC/IIB/IIA
II (1) D [Ex ia Da] IIIC
I (M1) [Ex ia Ma] I

Date of certification: 23 June 2020

DEKRA Certification B.V.

R. Schuller
Certification Manager

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DEKRA Certification B.V. Meander 1051, 6825 MJ Arnhem P.O. Box 5185, 6802 ED Arnhem The Netherlands
T +31 88 96 83000 F +31 88 96 83100 www.dekra-product-safety.com Registered Arnhem 09085396

DEKRA

(13) **SCHEDULE**

(14) **to EU-Type Examination Certificate DEKRA 11ATEX0244 X** Issue No. **4**

(15) **Description**

HART-Transparent Repeater, Types 9106B1A, 9106B1B, 9106B2A, 9106B2B and Types 9106A1A, 9106A1B, 9106A2A, 9106A2B for rail mounting, are 24 V powered isolating barriers that serve as a repeater.
The repeater transfers the intrinsically safe 4 - 20 mA current signal (with HART communication) of either a loop powered transmitter or an active current source to a non-intrinsically safe 4 - 20 mA output signal (with HART communication).
The Repeater is supplied via terminals at the front of the module, or via Power Rail Type 9400.
Removable display module 4501 can be used for programming of the Repeater.

The HART-Transparent Repeater, Types 9106B*A, 9106A*A are one channel version and Types 9106B*B, 9106A*B are two channel version.

Ambient temperature range -20 °C to +60 °C.

Marking

The equipment marking may additionally include the code II 3 G Ex ec nC IIC T4 Gc.

Electrical data

All Repeater Types

Supply (terminals 31, 32 and rear contacts): U = 19,2 ... 31,2 Vdc.

Status-Relay output (terminals 33, 34):
U ≤ 32 Vac or 32 Vdc, I ≤ 0,5 Aac or I ≤ 1 Adc respectively.
If the Repeater is installed outside the hazardous area, the following data for the relay contacts apply: U ≤ 110 Vdc or 125 Vac, I ≤ 0,3 Adc or I ≤ 0,5 Aac respectively.

Outputs (terminals 11, 12 resp. 13, 14): I = 4 ... 20 mA.

For all circuits above: U_m = 253 Vac (max. frequency 400 Hz).

Repeater Types 9106B1A, 9106B1B, 9106B2A, 9106B2B

Loop current input (terminals 43, 44 resp. terminals 53, 54):
in type of protection intrinsic safety Ex ia IIC/IIB/IIA/IIIC/I, with following maximum values:
for Type 9106B1A and Type 9106B1B:
U_o = 27,5 V; I_o = 92,6 mA; P_o = 0,64 W;
C_o = 0,084 µF (IIC) or 0,67 µF (IIB) or 2,23 µF (IIA) or 3,94 µF (I) ;
L_o = 4,15 mH (IIC) or 16,59 mH (IIB) or 33,17 mH (IIA) or 54,42 mH (I);
L_o/R_o = 223 µH/Ω (IIB) or 447 µH/Ω (IIA) or 733 µH/Ω (I)

for Type 9106B2A and Type 9106B2B:
U_o = 25,3 V; I_o = 96 mA; P_o = 0,61 W;
C_o = 0,104 µF (IIC) or 0,818 µF (IIB) or 2,85 µF (IIA) or 4,74 µF (I);
L_o = 3,86 mH (IIC) or 15,43 mH (IIB) or 30,86 mH (IIA) or 50,64 mH (I).
L_o/R_o = 234 µH/Ω (IIB) or 468 µH/Ω (IIA) or 769 µH/Ω (I)
For group IIIC, the parameters of group IIB apply.

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DEKRA

(13) **SCHEDULE**

(14) **to EU-Type Examination Certificate DEKRA 11ATEX0244 X** Issue No. **4**

Current input (terminals 41, 42 resp. terminals 51, 52):
in type of protection intrinsic safety Ex ia IIC/IIB/IIA/IIIC/I, for connection to a certified intrinsically safe circuit, with following maximum values:
U_i = 30 V; I_i = 120 mA; P_i = 0,85 W; $_{Ci}$ = 2 nF; L_i = 0 µH;
U_o = 0 V; I_o = 0 mA; P_o = 0 mW.

Current input and Loop current input of one channel are not applied simultaneously.

Both channels (terminals 41...44 and terminals 51...54) are infallibly galvanically isolated from each other and from the non-intrinsically safe supply and output circuits

Combination of Loop current input of channel 1 (terminals 43, 44) and Current input of channel 2 (terminals 51, 52) in series, where terminal 43 is connected to terminal 51:
Loop current circuit (terminals 44 and 52) is in type of protection intrinsic safety Ex ia IIC/IIB/IIA/IIIC/I, with following maximum values:
for Type 9106B1A and Type 9106B1B:
U_o = 27,5 V; I_o = 92,6 mA; P_o = 0,64 W;
C_o = 0,084 µF (IIC) or 0,67 µF (IIB) or 2,23 µF (IIA) or 3,94 µF (I) ;
L_o = 4,15 mH (IIC) or 16,59 mH (IIB) or 33,17 mH (IIA) or 54,42 mH (I);
L_o/R_o = 223 µH/Ω (IIB) or 447 µH/Ω (IIA) or 733 µH/Ω (I)

for Type 9106B2A and Type 9106B2B:
U_o = 25,3 V; I_o = 96 mA; P_o = 0,61 W;
C_o = 0,104 µF (IIC) or 0,818 µF (IIB) or 2,85 µF (IIA) or 4,74 µF (I);
L_o = 3,86 mH (IIC) or 15,43 mH (IIB) or 30,86 mH (IIA) or 50,64 mH (I).
L_o/R_o = 234 µH/Ω (IIB) or 468 µH/Ω (IIA) or 769 µH/Ω (I)
For group IIIC, the parameters of group IIB apply.

Combination of both Current inputs (terminals 41, 42 resp. 51, 52) in series, where terminal 41 is connected to terminal 52:
Current input (terminals 42 and 51) is in type of protection intrinsic safety Ex ia IIC/IIB/IIA/IIIC/I, for connection to a certified intrinsically safe circuit, with following maximum values:
U_i = 30 V; Ii = 120 mA; Pi = 0,85 W; C_i = 4 nF; L_i = 0 µH;
U_o = 0 V; I_o = 0 mA; P_o = 0 mW.

Installation instructions

The instructions provided with the product shall be followed in detail to assure safe operation.

(16) **Report Number**

No. NL/DEK/ExTR11.0097/04.

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DEKRA

(13) **SCHEDULE**

(14) **to EU-Type Examination Certificate DEKRA 11ATEX0244 X** Issue No. **4**

(17) **Specific conditions of use**

The HART Transparent Repeater shall be installed in a controlled environment with suitably reduced pollution, limited to pollution degree 2 or better.

The non intrinsically safe circuits shall be limited to overvoltage category I/II as defined in EN 60664-1.

If the HART-Transparent Repeater is installed in an explosive atmosphere where the use of apparatus of equipment category 3 G is required, the following specific conditions of use apply:

The HART Transparent Repeater shall be installed in an enclosure in type of protection Ex n or Ex e, providing a degree of protection of at least IP54. Cable entry devices and blanking elements shall fulfil the same requirements.

Removable Display Module 4501, when connected to the Repeater, may not be damaged and shall be free of dust and moisture.

(18) **Essential Health and Safety Requirements**

Covered by the standards listed at item (9)

(19) **Test documentation**

As listed in Report No. NL/DEK/ExTR11.0097/04.

(20) **Certificate history**

Issue 1 -	214940700	initial certificate
Issue 2 -	215635200	changes to the construction and standards update
Issue 3 -	219950900	changes to the electrical data
Issue 4 -	224396500	assesed per latest edition of the standards addition of 9106Axx models

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Form 227A
Version 1 (2016-04)

4.6 BT01 – Temperature Sensor, TT1050

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ifm electronic

EU – Konformitätserklärung

EU declaration of conformity

Déclaration de conformité UE

ifm electronic gmbh
Friedrichstraße 1
45128 Essen
Germany

Telefon: +49 (0)201 / 24 22 - 0
Telefax: +49 (0)201 / 24 22 - 1200
Internet: www.ifm.com

Die EU-Konformitätserklärung gilt für folgende Geräte:	The EU declaration of conformity applies to the following units:	La déclaration de conformité UE s'applique aux appareils suivants:

Temperatursensoren der Produktfamilie
Temperature sensors of the product family
Capteurs de température de la famille de produits

TTxxxx/ TMxxxx/ TSxxxx/ TXxx81/ TX4511/ TX9920/ TY9159

Wir bestätigen die Übereinstimmung mit den grundlegenden Anforderungen der europäischen Richtlinie(n):	We confirm the conformity to the essential requirements of the European directive(s):	Nous confirmons la conformité aux exigences essentielles de la (des) directive(s) européenne(s):
2011/65/EU	**2011/65/EU**	**2011/65/UE**

Folgende Norm(en) wurde(n) angewandt:	The following standard(s) was (were) applied:	La (Les) norme(s) suivante(s) a (ont) été appliquée(s):

EN IEC 63000: 2018

Malvern, July 22nd , 2021
(Ort und Datum der Ausstellung)
(Place and date of issue)
(Lieu et date de l'établissement)

(Unterschrift) i.V. Peter Breh
(Signature) Director of Technology
(Signature)

Dokument-Nr.: 8003349

4.7 BT02-WG01 – Connecting Cable with Socket for Temperature Sensor, ENC03A

[Please refer to certificate from Section 4.4.]

4.8 TF01 – Temperature Sensor Ex Barrier, 9113B-U9

[Please refer to certificate from Section 4.5.]

4.9 EA01..02 – Immersion Heater, D-8640

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ISSeP
Institut scientifique de service public
Métrologie environnementale
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Essais - Expertises

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Fax : +32(0)65.61.08.08

e-mail :
direction@issep.be
site web :
http://www.issep.be

(1) EC TYPE EXAMINATION CERTIFICATE

(2) **Equipment or protective system intended for use in potentially explosive atmospheres**
Directive 94/9/EC

(3) EC type examination certificate number: **ISSeP08ATEX008X**

(4) Equipment or protective system: housing for electrical heating apparatus
Type: D-8640

(5) Applicant – Manufacturer :
Sinus Jevi Electric Heating B.V.

(6) Address: Nijverheidsweg 2
1671 GC Medemblik

(7) This equipment or protective system and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) ISSeP, notified body n^{r} 492 in accordance with article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment or protective system has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in annex II to the Directive.

The examination and test results are recorded in confidential report no 06090

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:
EN 60079-0: 2006 (IEC 60079-0: 2004) EN 60079-1: 2007 (IEC 60079-1: 2007)
EN 60079-7: 2007 (IEC 60079-7:2006)
EN 61241-0: 2006 (IEC 61241-0: 2004) EN 61241-1: 2004 (IEC 61241-1: 2004)

(10) If the symbol "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for safe use specified in the schedule to this certificate

(11) This EC TYPE EXAMINATION CERTIFICATE relates only to the design, examination and tests of the specified equipment or protective system in accordance to the Directive 94/9/EC. Further requirements of this Directive may apply to the manufacturing process and supply of this equipment or protective system. These are not covered by this certificate.

(12) The marking of the equipment or protective system shall include the following indications:
Ex II 2 G D Ex de IIC T6 to T1 Ex tD A21 IP66 T110°C

Colfontaine, the 07.03.2008

INSTITUT SCIENTIFIQUE DE SERVICE PUBLIC
Zoning A. Schweitzer - B7340 Colfontaine (Wasmes)
Tél: ++ 32 65 610811 – Fax: ++ 32 65 610808

Marcel Lambert,
Manager.

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RÉGION WALLONNE

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(13) SCHEDULE

(14) **EC TYPE EXAMINATION CERTIFICATE No ISSeP08ATEX008X**

(15) Description of the equipment :
Electrical heating apparatus allotted to the heating of inert liquids and gases. This apparatus bears the type designation D-8640 and consists of:

- a certified flameproof connection box
- certified electrical heating elements
- a manually rearmed protective device

The length "H" (to see drawing 953.D8640-01) required to not exceed the temperature limit of 80°C inside the connection box in accordance with the different temperature classes is listed in the here-below table

Temperature class	Length "H" (mm)
T6	50
T5	75
T4	100
T3	150
T2	200
T1	250

Remark :
When the heating elements are fitted on the bottom plate of the housing, the temperature is limited by a safety thermostat and an additional marking is foreseen for the cables (to see drawing 953.D8521-04)

Temperature classes

TEMPERATURE CLASS	TEMPERATURE SETTING OF THE THERMOSTAT (°C)					
	Inert liquids	Gases				
	Power dissipated by the heating element (W/cm^2)	Power dissipated by the heating element (W/cm^2)				
	7,5	2	1,5	1	0,5	0,2
T6	90	-----	-----	-----	-----	-----
T5	110	-----	-----	-----	-----	65
T4	145	-----	-----	-----	70	85
T3	210	-----	-----	90	110	130
T2	310	130	135	150	190	250
T1	-------	230	250	300	-----	-----

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SCHEDULE

EC TYPE EXAMINATION CERTIFICATE No ISSeP08ATEX008X

Electrical parameters
Voltage supply: 110 up to 690 V
Eventual prescriptions
The ambient temperature range: -30 °C to + 50°C
Routine tests
The manufacturer shall make the routine verifications and tests to ensure that the electrical apparatus produced complies with the specification submitted to the testing station together with the prototype.
Each empty enclosure shall be submitted to a routine test under the pressure of 10.5 bar maintained during at least 10 seconds (maximum 60 seconds)

(16) Report n° 06090 of 5.03.2008 composed of 29 pages
The descriptive and technical note from the manufacturer dated of 25.05.2007 related to heating apparatus – size 6" (6 and 3 pages)
The additional descriptive note dated 1.08.2007 (2 pages)
The notices of instruction (8 pages)
A data sheet related to the sealing gasket dated 1.09.2006
The drawings
953.D6150-10 of 19.11.2002 Rev.1 of 28.01.2008
953.D8521-04 of 14.08.2006
953.D8615-20 of 18.02.2008
953.D8640-01 of 29.08.2002
953.D8640-03 of 9.12.2002
953.D8640-05 of 10.01.2005
953.D8640-11 of 11.05.2000
953.D8640-12 of 24.10.2000 – Rev.1 of 21.01.2008
953.D8640-13 of 20.05.2005
953.D8640-20 of 8.12.2003
953.D8640-22 of 7.05.2007 – Rev.1 of 18.02.2008
953.D8640-23 of 7.05.2007 – Rev.1 of 18.02.2008

(17) Special conditions for safe use: symbol X
- The layer of dust accumulated on the housing shall not exceed 5 mm.
- The ignition temperature of the dust shall be higher than 185°C
- The setting of the protective device to the limit temperature ensuring the temperature class shall be realised for each apparatus under the responsibility of the manufacturer. Furthermore this device shall be sealed and its setting shall not be modified later.
- The temperature sensor of the protective device shall be placed as nearest as possible to the tube containing the heating elements.
- When the apparatus is energised the tube containing the heating elements shall be completely immersed in the liquid – the depth of immersion above the tube is at least 50 mm.
- The values of the power dissipated by the heating elements mentioned in the table (page 2) cannot be exceeded

(18) Essential Health and Safety Requirements: covered by the standards listed at 9 and by the descriptive documents of the manufacturer

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VARIATION

EC TYPE EXAMINATION CERTIFICATE N° ISSeP08ATEX008X/1

(14) Equipment: housing for electrical heating apparatus type D-8640

(15) Subject to the variation:
To allow the manufacturing of this equipment under the name of the mother company JEVI A/S located at Godthaabsvej 7 – 7100 Vejle – Denmark

Marking : Unchanged except the addition of the name and address of the mother company

Eventual Prescriptions :
Ambient temperature range: -30°C ≤ Tamb ≤ +50°C

(16) Report n°09103 of 5.10.2009 (5 pages) completed by the descriptive documents below:
The drawings
953.D8615-11 of 10.09.2009
953.D8640-22 of 7.05.2007 – Rev.2 of 2.10.2009
953.D8640-23 of 7.05.2007 – Rev.2 of 2.10.2009

(17) Special conditions for safe use: unchanged

(18) Essential Health and Safety Requirements: covered by the standards listed at point 9 of the initial certificate and by the descriptive documents of the manufacturer.

Colfontaine, 07.10.2009

Marcel Lambert,
Manager.

INSTITUT SCIENTIFIQUE DE SERVICE PUBLIC
Zoning A. Schweitzer - B 7340 Colfontaine (Wasmes)
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VARIATION

EC TYPE EXAMINATION CERTIFICATE N° ISSeP08ATEX008X/2

(14) Apparatus: Housing for electrical heating apparatus type D-8640.

(15) Subject of the variation

- To permit the extension of the ambient temperature range. This one becomes: -50 °C ≤ Ta ≤ +50 °C.
- To permit the updating of the certificate according to the latest edition of the standards in force. (IEC 60079-0: 2011 – EN 60079-1: 2007 – EN 60079-7: 2007 – EN 60079-31: 2009)

Marking: Unchanged, except the code « Ex de IIC T6 to T1 / Ex tD A21 IP66 T110°C » which is now « Ex d IIC T6…T1 Gb / Ex tb IIIC T110°C Db ».

Eventual prescriptions: Unchanged.

(16) Report N° 12032 completed by 10 documents.

(17) Special conditions for safe use: Unchanged.

(18) Essential Health and Safety Requirements

- Covered by the standards listed at point 9 of the initial certificate.

Colfontaine, 27.08.2012.

INSTITUT SCIENTIFIQUE DE SERVICE PUBLIC
Zoning A. Schweitzer, rue de la Platinerie
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Tél: ++ 32 65 610811 – Fax: ++ 32 65 610808
colfontaine@issep.be

Marcel LAMBERT,
Director.

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4.10 EA01-WD01 and EA02-WD01 – Control Cable for Immersion Heater, CLASSIC 135 CH

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LAPP

LEISTUNGSERKLÄRUNG
Gemäß Anhang III der Verordnung (EU) Nr. 305/2011

Declaration of Performance
According to Annex III of Regulation (EU) no. 305/2011

Dokument-Nr.
Document-no.

UILCPRDoP17_1123460-1_C

1. Eindeutiger Kenncode des Produkttyps
Unique identification code of the product type

OELFLEX_CLASSIC_135_CH_BK-1

2. Verwendungszweck
Usage
Kabel und Leitungen für allgemeine Anwendungen in Bauwerken in Bezug auf die Anforderungen an das Brandverhalten
Cables for general applications in construction works subject to reaction to fire requirements

3. Hersteller
Manufacturer

U.I. Lapp GmbH
Schulze-Delitzsch-Straße 25
D-70565 Stuttgart

4. System zur Bewertung und Überprüfung der Leistungsbeständigkeit
System of assessment and verification of constancy of performance

System 3

5. Harmonisierte Norm
Harmonised standard

EN 50575:2014 + A1:2016

6. Produktzertifizierungsstelle
Product certification body

No. 0366

7. Erklärte Leistung
Declared Performance

Wesentliche Merkmale *Essential characteristics*	Leistung *Performance*	Harmonisierte technische Spezifikation *Harmonized technical standard*
Brandverhalten *Reaction to fire*	**Dca-s3-d2-a3**	**EN 50575:2014 + A1:2016**
Gefährliche Stoffe *Hazardous substances*	**NPD**	

8. Die Leistung des in Nummer 1 genannten Produkts ist in Übereinstimmung mit der erklärten Leistung in Punkt 7.
The performance of the referred product in paragraphs 1 is in conformity with the declared performance in Section 7.

Diese Leistungserklärung ist ausgestellt unter der allgemeinen Verantwortung des unter Punkt 3 genannten Herstellers.
This declaration of performance is issued under the general responsibilities listed in section 3. Manufacturer.

Unterzeichnet für und im Namen des Herstellers von:
Signed for and in name of the manufacturer by:

Stuttgart, 12.05.2021
U.I.Lapp GmbH
Leiter Kabelentwicklung
Head of Cable Development

i.V. Alexander Terpe

U.I. Lapp GmbH
Schulze-Delitzsch-Straße 25
70565 Stuttgart
Tel.: +49 (0)7 11/78 38-01
Fax: +49 (0)7 11/78 38-26 40
E-Mail: info@lappkabel.de
www.lappkabel.de

Registergericht
Stuttgart HRB 12720

Geschäftsführer
Matthias Lapp, Dr. Matthias Kirchherr,
Boris Katic, Lutz Grotebrune

Vorsitzende des Aufsichtsrats
Andreas Lapp

Niederlassung
Hannover

Ein Unternehmen der Lapp Gruppe

Lapp Insulator ist kein
Unternehmen der Lapp Gruppe

FM PD 0802/02_04.21

Seite 1 von 1

4.11 EA01..02 – Cable Gland for Immersion Heater, ICG 653 UNIV Os M20

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IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	**IECEx CML 18.0131X**	Page 1 of 4	Certificate history:
Status:	**Current**	Issue No: 4	Issue 3 (2021-09-29) Issue 2 (2020-04-20) Issue 1 (2020-02-11) Issue 0 (2019-05-10)
Date of Issue:	2024-03-26		

Applicant: **Hawke International (A Division of Hubbell Limited) (A Member of the Hubbell group of companies)**
Oxford Street West
Ashton under Lyne
OL7 0NA
United Kingdom

Equipment: **Ranges of Barrier and Diaphragm Seal Hybrid Cable Glands**

Optional accessory:

Type of Protection: **Flameproof "db", Increased Safety "eb", Restricted Breathing "nR", Dust Ignition "tb"**

Marking: Ex db IIC Gb
Ex eb IIC Gb
Ex tb IIIC Db

-60°C to +80°C

Approved for issue on behalf of the IECEx Certification Body: **H M Amos**

Position: **Technical Specialist**

Signature: (for printed version)

Date: (for printed version) March, 26, 2024

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting www.iecex.com or use of this QR Code.

Certificate issued by:

Eurofins E&E CML Limited
Unit 1, Newport Business Park
New Port Road
Ellesmere Port, CH65 4LZ
United Kingdom

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 18.0131X** Page 2 of 4

Date of issue: 2024-03-26 Issue No: 4

Manufacturer: **Hawke International (A Division of Hubbell Limited) (A Member of the Hubbell group of companies)**
Oxford Street West
Ashton under Lyne
OL7 0NA
United Kingdom

Manufacturing locations:

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements.This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended

STANDARDS :
The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

IEC 60079-0:2017 Edition:7.0	Explosive atmospheres - Part 0: Equipment - General requirements
IEC 60079-1:2014 Edition:7.0	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
IEC 60079-31:2013 Edition:2	Explosive atmospheres - Part 31: Equipment dust ignition protection by enclosure "t"
IEC 60079-7:2017 Edition:5.1	Explosive atmospheres - Part 7: Equipment protection by increased safety "e"

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Reports:

GB/CML/ExTR18.0186/00
GB/CML/ExTR19.0255/00
GB/CML/ExTR20.0050/00
GB/CML/ExTR21.0018/00
GB/CML/ExTR23.0028/00

Quality Assessment Report:

GB/BAS/QAR06.0061/10

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 18.0131X** Page 3 of 4

Date of issue: 2024-03-26 Issue No: 4

EQUIPMENT:
Equipment and systems covered by this Certificate are as follows:

Refer to Annex for full description and conditions of manufacture.

SPECIFIC CONDITIONS OF USE: YES as shown below:
Refer to Annex for specific conditions of use.

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 18.0131X** Page 4 of 4

Date of issue: 2024-03-26 Issue No: 4

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above)
Refer to certificate annex for details of changes.

Annex:

Certificate Annex IECEx CML 18.0131X Issue 4.pdf

eurofins cml

Annexe to:	IECEx CML 18.0131X Issue 4
Applicant:	Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of companies)
Apparatus:	Ranges of Barrier and Diaphragm Seal Hybrid Cable Glands

Description

The ranges of cable glands are designed in two versions: barrier and diaphragm seal. Hybrid configurations of these glands are also described.

All cable glands within the ranges are manufactured in brass, nickel plated brass, stainless steel, or aluminium.

Both barrier and diaphragm seal type glands internal parts marked with an asterisk (*) in the description below are interchangeable with respect to the type of application. When parts are interchanged, these assemblies may be dual marked with both product types on the stamp band. The "Deluge Boot" colour indicates the internal component that is used, the ICG/653/UNIV being indicated by a red deluge boot. This does not apply to the ICG 653 UNIV J-Size.

Cable glands may be fitted with an optional external clamp or a Hawke Gland Mounted Clamp (GMC) accessory. When fitted, no additional clamping is required on the barrier or diaphragm sealed glands.

Items in *italic* are optional and may be omitted from the cable gland dependent on the application.

Hybrid cable glands are available for the gland types ICG/653/UNIV and 501/453/UNIV. These types are fitted with the middle nut and back nut components of any smaller trade size compared to the entry. Glands may combine entries and seals with small armour clamping rings and back nut seals. Hybrid gland marking to include second size reference with no spaces e.g. for example C2 to C hybrid size reference would be C2C.

The use of Hawke IP sealing washers may be considered a suitable sealing method to maintain IP rating to the enclosure (see conditions of use) and will maintain the service temperature.

Where marked IIC or IIIC, the equipment can also be marked for gas groups IIA or IIB and for dust groups IIIA or IIIB.

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Type 501/453/UNIV Cable Gland

501/453/UNIV cable gland is a diaphragm seal cable gland the glands are fitted with a diaphragm silicone rubber seal and are designed for effectively filled type cable when used for flameproof applications. This gland type is rated for ingress protection IP66, 67, 69 and IPX8 size Os to C only at 10m for 24 hours. This cable gland is available in sizes Os (M16) up to and including F(M75). The entry thread form can either be metric or NPT equivalent. They are used with cables that are circular and armoured, un-armoured or braided cables. The cable gland comprises the following components:

a) Entry
b) Deluge boot *
c) Diaphragm seal *
d) Spigot *
e) Armour clamping ring
f) Middle nut
g) Back nut
h) Back nut clamp
i) Back nut seal

Type ICG/653/UNIV Cable Gland

The ICG/653/UNIV Cable Gland is a barrier seal type gland designed for sealing around individual cores and are for use with circular cables of armoured, un-armoured or corrugated cables. This cable gland is available in sizes Os (M16) up to and including J (M100). The entry thread form is either metric or NPT equivalent. This gland type is rated for ingress protection IP66, 67, 69 and IPX8 size Os to C only at 10m for 24 hours. Trade size J is IP66 only.
The cable gland comprises the following components:

a) Entry
b) Deluge boot*
c) Compound chamber*
*d) Resin dam **
e) Spigot*
*f) VBL Clip **
g) Armour/braid clamping ring
h) Middle nut
i) Back nut
j) Back nut clamp
k) Back nut seal

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Type 710 Cable Gland

The 710 Cable gland is a barrier cable gland designed for sealing around individual cores and are for use with circular cables of armoured, un-armoured or corrugated cables. This gland type is rated for ingress protection IP66, 67, 69 and IPX8 size Os to C only at 10m for 24 hours. This cable gland is available in sizes Os (M16) up to and including F (M75). The entry thread form is either metric or NPT equivalent. The cable gland comprises the following components:

a) Entry
b) Deluge boot
c) Compound chamber
d) Resin dam
e) Spigot
f) Middle nut
g) Back nut
h) Back nut clamp
i) Back nut seal

Type 711 Cable Gland

711 Cable gland is a barrier cable gland designed for sealing around individual cores and are for use with circular cables of armoured, un-armoured or corrugated cables. This gland type is rated for ingress protection IP66, 67, 69 and IPX8 size Os to C only at 10m for 24 hours. This cable gland is available in sizes A (M20) up to and including F (M75). The entry thread form is either metric or NPT equivalent. The cable gland comprises the following components:

a) Entry
b) Deluge boot
c) Compound chamber
d) Resin dam
e) Front diablo support
f) Diablo cage
g) Rear diablo support
h) Middle nut
i) Back nut
j) Back nut clamp
k) Back nut seal

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Type 753 Cable Gland

753 cable gland Cable gland is a barrier cable gland designed for sealing around individual cores and are for use with circular cables of armoured, un-armoured or braided cables. This gland type is rated for ingress protection IP66, 67, 69 and IPX8 size Os to C only at 10m for 24 hours. This cable gland is available in sizes Os (M16) up to and including F(M75). The entry thread form is either metric or NPT equivalent. The cable gland comprises the following components:

a) Entry
b) Deluge boot
c) Compound chamber
d) Resin dam
e) Spigot
f) Middle nut
g) Back nut
h) Back nut clamp
i) Back nut seal

Cable glands types ICG/653/UNIV, 710, 711 and 753, in trade sizes Os to F, have been subjected to overpressure test up to 62bar/900 Psi.

Variation 1

1. To update the certification drawing with minor dimensional corrections.
2. To include the type of protection “Ex nR” Restricted Breathing.
3. To include an additional specific condition of use for braided cables.

Variation 2

1. Introduction of undersize compound pot for gland size Os, O, D, E and F.
2. Introduction of thread size M16 for size Os and O, except from gland type 711.
3. Adding NPT thread size: 1½”, 2”, 2½” for gland size D, E and F respectively.

Variation 3

1. To amend the specific conditions of safe use.
2. Update GA drawings.
3. Add accessory optional item GMC 'Gland Mounted Clamp'.
4. Clarify the Ingress Protections IP ratings.
5. To review and update the cable glands against the latest standard.
6. Hybrid Gland Combinations to permit flexibility.
7. Update the marking.
8. To revise the equipment title.
9. To revise the product description.

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Variation 4

1. To introduce and update the certification product description to include type ICG 653 oversize cable gland J-Size.
2. Removal of Ex nR from IECEx CML 18.0131X.
3. To review and assess the ICG 653 Oversize cable glands J-Size against the latest technical knowledge IEC 60079-0:2017 Ed.7.
4. To review the ICG 653 Oversize cable gland J-Size against the latest Increase Safety requirements "Ex eb".
5. To amend the specific condition of safe use.
6. To remove the condition of manufacture.
7. Introduction of new set of certification drawings.

Conditions of Manufacture

None

Specific Conditions of Use

The following conditions relate to safe installation and/or use of the equipment.

i. 501/453/UNIV when used with unarmoured or braided cables are only suitable for fixed installations, the cable for which shall be effectively clamped to prevent pulling and twisting (does not apply when fitted with rear clamping device or Hawke Gland Mounted Clamp (GMC)).

ii. Barrier glands of sizes C2, D, E and F and containing (Express) XO99-41-2 resin when used with unarmoured or braided cables are only suitable for fixed installations, the cable for which must be effectively clamped to prevent pulling and twisting. No clamping is required on barrier cable glands sizes Os-C2, or if containing 2122 Hawkeseal or 2132 QSP compound.

iii. The entry thread shall be suitably sealed (in accordance with IEC 60079-14) to maintain the ingress protection rating of the associated enclosure. This condition does not apply if the Hawke International nylon sealing washer is installed as part of the gland assembly.

Components covered by Ex Certificates issued to older editions of Standards

None

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4.12 QM1.1..1.6 and QM2.1..2.6 – Solenoid Valve, NF X E210D488E 24/DC

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ATTESTATION D'EXAMEN UE DE TYPE
EU TYPE EXAMINATION CERTIFICATE

1 **Version : 15** — **LCIE 00 ATEX 6008 X** — **Issue : 15**

	Directive 2014/34/UE	**Directive 2014/34/EU**
2	Appareil ou Système de Protection destiné à être utilisé en Atmosphères Explosibles	Equipment or Protective System Intended for use in Potentially Explosive Atmospheres
3	Produit : Tête magnétique	Product : Magnetic head
	Type: *NF-*	
4	Fabricant :	Manufacturer :
	ASCO SAS	
5	Adresse :	Address :
	53 rue de Beauce 28110 Lucé FRANCE	
6	Ce produit et ses variantes éventuelles acceptées sont décrits dans l'annexe de la présente attestation et dans les documents descriptifs cités en référence.	This product and any acceptable variations thereto are specified in the schedule to this certificate and the documents therein referred to.
7	Le LCIE, Organisme Notifié sous la référence 0081 conformément à l'article 17 de la directive 2014/34/UE du Parlement européen et du Conseil du 26 février 2014, certifie que ce produit est conforme aux Exigences Essentielles de Sécurité et de Santé pour la conception et la construction de produits destinés à être utilisés en atmosphères explosibles, données dans l'annexe II de la Directive.	LCIE, Notified Body number 0081 in accordance with article 17 of the Directive 2014/34/EU of the European Parliament and the Council of 26 February 2014 certifies that product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres, given in Annex II to the Directive.
	Les résultats des vérifications et essais figurent dans le(s) rapport(s) confidentiel(s) N° :	The examination and test results are recorded in confidential report(s) N°:
	19 547 010 ; 36439010 ; 43226010 ; 60014591-507770 ; 60054967-555404/01 ; 84176-574816 ; 90110-581349 ; 96896-592747 ; 99828-598318 ; 106456-611161 ; 117816-635598-01 ; 120216-640042 ; 140308-682225 ; 143136-689151 – CR22/05/17 ; 158525-730110	
8	Le respect des Exigences Essentielles de Sécurité et de Santé est assuré par la conformité à :	Compliance with the Essential Health and Safety Requirements has been assured by compliance with :
	EN 60079-0:2012 + A11:2013 ; EN 60079-1:2014 ; EN 60079-31:2014	
9	Le signe « X » lorsqu'il est placé à la suite du numéro de l'attestation, indique que cet appareil est soumis aux conditions particulières d'utilisation, mentionnées dans l'annexe de cette attestation.	If the sign "X" is placed after the certificate number, it indicates that the product is subject to the Specific Conditions of Use specified in the schedule to this certificate.
10	Cette Attestation d'Examen UE de Type concerne uniquement la conception et la construction du produit spécifié. Des exigences supplémentaires de la directive sont applicables pour la fabrication et la fourniture du produit. Ces dernières ne sont pas couvertes par la présente attestation.	This EU Type Examination Certificate relates only to the design and construction of the specified product. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.
11	Le marquage du produit est mentionné dans l'annexe de cette attestation.	The marking of the product is specified in the schedule to this certificate.

Fontenay-aux-Roses, le 31 janvier 2019

Responsable de Certification
Certification Officer
Julien Gauthier

LABORATOIRE CENTRAL DES INDUSTRIES ELECTRIQUES
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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** — **LCIE 00 ATEX 6008 X** — **Issue : 15**

12 **DESCRIPTION DU PRODUIT**

Le produit est constitué d'une enveloppe en aluminium ou en acier inoxydable contenant une bobine et deux bornes de connexions.

Il fonctionne sur différentes puissances (AC-DC). Il est conçu pour être utilisé avec des vannes avec 2, 3, 4 ou 5 voies.

Les types de protection sont « d » (enveloppe antidéflagrante) et « t » (protection contre l'inflammation des poussières).

Il y a également 2 versions spéciales où les caractéristiques électriques sont différentes, à la demande de clients.

DESCRIPTION OF PRODUCT

The product is made of an aluminium or stainless steel enclosure including a coil and two connections terminals.

It operates on different wattage (AC-DC). It is designed to be used in conjunction with valves with 2, 3, 4 or 5 channels.

The types of protection are "d" (flameproof enclosure) and "t" (dust ignition protection).

There is also 2 specific version where the electrical ratings are different, at customer's request.

DETAIL DE LA GAMME

* | NF | - | *

Modèle de la bobine
MXX
M12-I
M12-II

Matière de l'enveloppe
WS = Acier inoxydable
Vide = Aluminium

Note : les bobines se distinguent par leurs dimensions.

Pour la version spéciale NF 14462403.24/DC :

* | NF | - | M12-II

Modèle de la bobine
M12-II

Matière de l'enveloppe
WS = Acier inoxydable
Vide = Aluminium

Pour la version spéciale X263429069235F1:

* | NF | - | MXX

Modèle de la bobine
MXX

Matière de l'enveloppe
WS = Acier inoxydable
Vide = Aluminium

RANGE DETAILS

* | NF | - | *

Model of coil
MXX
M12-I
M12-II

Material enclosure
WS = Stainless steel
Blank = Aluminium

Note: the coils are distinguished by their dimension.

For the specific version NF 14462403.24/DC :

* | NF | - | M12-II

Model of coil
M12-II

Material enclosure
WS = Stainless steel
Blank = Aluminium

For the specific version X263429069235F1:

* | NF | - | MXX

Model of coil
MXX

Material enclosure
WS = Stainless steel
Blank = Aluminium

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
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1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

CARACTERISTIQUES

Tension d'alimentation :
6 à 250 V DC / rectifié ou 6 à 380 V AC.

Pour la version spéciale NF 14462403.24/DC :

Tension d'alimentation : 24 V DC
Puissance maximale : 36.2 W
Fonctionnement électrique intermittent :
- Temps de fonctionnement = 2 minutes
- Temps à l'arrêt = 5 minutes
Température maximale du fluide : 55°C.

Pour la version spéciale X263429069235F1 :

Tension d'alimentation : 24 V DC
Puissance maximale : 11.2 W
Fonctionnement électrique intermittent :
- Temps de fonctionnement = 2 minutes
- Temps à l'arrêt = 15 minutes
Température maximale du fluide : 70°C.

RATINGS

Supply voltage :
6 to 250 V DC / rectified or 6 to 380 V AC.

For the specific version NF 14462403.24/DC :

Supply voltage : 24 V DC
Maximum power : 36.2W
Electric operation intermittent :
- Time on = 2 minutes
- Time off = 5 minutes.
Maximum fluid temperature: 55°C.

For the specific version X263429069235F1 :

Supply voltage : 24 V DC
Maximum power : 11.2W
Electric operation intermittent :
- Time on = 2 minutes
- Time off = 15 minutes.
Maximum fluid temperature: 70°C.

MARQUAGE

Le marquage du produit doit comprendre :

ASCO SAS ou ASCO™
Adresse : …
Type : *NF-* (1)
N° de fabrication : …
Année de fabrication : …
Ⓔx II 2 G D
Ex db IIC T6…220°C (T2) Gb (2)
Ex tb IIIC T85°C…T220°C Db (2)
LCIE 00 ATEX 6008 X
-60°C ≤ Tamb ≤ +…°C (2)
AVERTISSEMENTS –
NE PAS OUVRIR SOUS TENSION.
APRES MISE HORS TENSION, ATTENDRE 35 MINUTES AVANT L'OUVERTURE.
Sur la plaque de marquage :
T câble : …°C (2)
U = ….V ; I = …. A ; P = …. W (3)

(1) : complété par la désignation du type.
(2) : voir les tableaux des températures.
(3) : complété par les paramètres électriques.

MARKING

The marking of the product shall include the following :

ASCO SAS or ASCO™
Address: …
Type : *NF-* (1)
Serial number: …
Year of construction: …
Ⓔx II 2 G D
Ex db IIC T6…220°C (T2) Gb (2)
Ex tb IIIC T85°C…T220°C Db (2)
LCIE 00 ATEX 6008 X
-60°C ≤ Tamb ≤ +…°C (2)
WARNINGS –
DO NOT OPEN WHEN ENERGIZED.
AFTER DE-ENERGIZING, DELAY 35 MINUTES BEFORE OPENING.
On the marking plate :
T cable : …°C (2)
U = ….V; I = …. A; P = …. W (3)

(1): completed with type designation.
(2): see temperatures tables.
(3): completed by electrical parameters.

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
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1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

MARQUAGE (suite)

Tables des températures :

- Pour une température de fluide plus basse que la température ambiante :

Classe de température *Temperature class* (Gaz / *Gas*)	Température de surface *Surface temperature* (Poussière / *Dust*)	Température ambiante max. *Max. Amb. Temp.* (°C)	Puissance maximale / *Maximum power* (W)	
			Courant alternatif *Alternating current (AC) supply*	Courant continu ou rectifié *Direct current (DC) supply or rectified*
T6	T85°C	25	17	31,5
		40	11,5	20
		60	5,5	8,5
		75	1	2,5
T5	T100°C	25	21	40,5
		40	15	32,5
		60	10,5	18
		75	6	10
T4	T135°C	25	28,5	40,5
		40	22,5	37,5
		60	19,5	32,5
		75	16,5	31
		80	15,4	25
		100	10,5	20

- Pour une température de fluide plus haute que la température ambiante :

Température ambiante max. *Max. Amb. Temp.* (°C)	Puissance maximale / *Maximum power* (W)		Température maximale du fluide *Maximum fluid temperature* (°C)			
	Courant alternatif *Alternating current (AC) supply*	Courant continu ou rectifié *Direct current (DC) supply or rectified*				
25	17	31,5	40	75	140	-
40	11,5	20	55	90	155	-
60	5,5	8,5	75	110	175	-
75	1	2,5	90	125	180	-
25	21	40,5	-	60	125	-
40	15	32,5	-	75	140	-
60	10,5	18	-	95	160	-
75	6	10	-	110	175	-
25	28,5	40,5	-	-	90	-
40	22,5	37,5	-	-	105	-
60	19,5	32,5	-	-	125	-
75	16,5	31	-	-	140	-
80	15,4	25	-	-	145	160
100	10,5	20	-	-	165	-
Classe de température / *Temperature class* (G)			T5	T4	T3	220°C
Température de surface / *Surface temperature* (D)			T100°C	T125°C	T200°C	T220°C

MARKING (continued)

Temperatures tables :

- For a fluid temperature lower than ambient temperature :

- For a fluid temperature higher than ambient temperature :

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

MARQUAGE (suite)

- Table de température pour le choix des câbles :

Température ambiante max. *Max. Amb. Temp.* (°C)	Température du câble *Cable temperature* (°C)	Puissance maximale / *Maximum power* (W)	
		Courant alternatif *Alternating current (AC)* supply	Courant continu ou rectifié *Direct current (DC) supply or rectified*
25	70	26	40,5
	80	30	-
40	70	16	23
	80	22,5	37,5
60	70	4	6
	80	10	14
	90	17	27
	100	25	40,5
75	80	1,5	4
	90	7,5	13
	100	14	24
	105	18	32
80	120	15,4	25
100	105	3	5
	110	6,5	10
	120	13,5	23,5

Pour la version spéciale NF 14462403.24/DC :

ASCO SAS ou ASCO™
Adresse : …
Type : *NF-M12-II (1)
N° de fabrication : …
Année de fabrication : …
Ⓔx II 2 G D
Ex db IIC T6 Gb
Ex tb IIIC T85°C Db
LCIE 00 ATEX 6008 X

-60°C ≤ Tamb ≤ +55°C

AVERTISSEMENTS –
NE PAS OUVRIR SOUS TENSION.
APRES MISE HORS TENSION, ATTENDRE 35 MINUTES AVANT L'OUVERTURE.

U = ….V ; I = …. A ; P = …. W (2)

(1) : complété par la désignation du type.
(2) : complété par les paramètres électriques.

MARKING (continued)

- Temperature table for choosing cable :

For the specific version NF 14462403.24/DC :

ASCO SAS or ASCO™
Address: …
Type : *NF-M12-II (1)
Serial number: …
Year of construction: …
Ⓔx II 2 G D
Ex db IIC T6 Gb
Ex tb IIIC T85°C Db
LCIE 00 ATEX 6008 X

-60°C ≤ Tamb ≤ +55°C

WARNINGS –
DO NOT OPEN WHEN ENERGIZED.
AFTER DE-ENERGIZING, DELAY 35 MINUTES BEFORE OPENING.

U = ….V; I = …. A; P = …. W (2)

(1): completed with type designation.
(2): completed by electrical parameters.

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** — **LCIE 00 ATEX 6008 X** — **Issue : 15**

MARQUAGE (suite)

Pour la version spéciale X263429069235F1 :

ASCO SAS ou ASCO™
Adresse : …
Type : *NF-MXX (1)
N° de fabrication : …
Année de fabrication : …
Ⓔx II 2 G D
Ex db IIC T6 Gb
Ex tb IIIC T85°C Db
LCIE 00 ATEX 6008 X
-60°C ≤ Tamb ≤ +70°C

AVERTISSEMENTS –
NE PAS OUVRIR SOUS TENSION.
APRES MISE HORS TENSION, ATTENDRE 35 MINUTES AVANT L'OUVERTURE.
U = ….V ; I = …. A ; P = …. W (2)

(1) : complété par la désignation du type.
(2) : complété par les paramètres électriques.

L'appareil doit également comporter le marquage normalement prévu par les normes de construction qui le concernent sous la responsabilité du fabricant.

MARKING (continued)

For the specific version X263429069235F1 :

ASCO SAS or ASCO™
Address: …
Type : *NF-MXX (1)
Serial number: …
Year of construction: …
Ⓔx II 2 G D
Ex db IIC T6 Gb
Ex tb IIIC T85°C Db
LCIE 00 ATEX 6008 X
-60°C ≤ Tamb ≤ +70°C

WARNINGS –
DO NOT OPEN WHEN ENERGIZED.
AFTER DE-ENERGIZING, DELAY 35 MINUTES BEFORE OPENING.
U = ….V; I = …. A; P = …. W (2)

(1): completed with type designation.
(2): completed by electrical parameters.

The equipment shall also bear the usual marking required by the product standards applying to such equipment under the manufacturer responsibility.

13 **CONDITIONS PARTICULIERES D'UTILISATION**

a. Les joints antidéflagrants ne sont pas destinés à être réparés.

b. Les fermetures spéciales du couvercle sont des vis hexagonales à six pans creux conformes à l'ISO 4762. La classe de propriété minimale des vis doit être A4-70. Le cas échéant, les vis du couvercle doivent être remplacées par des vis identiques.

c. Le classement en température dépend de la température ambiante. Voir tableaux des températures.

SPECIFIC CONDITIONS OF USE

The flameproof joints are not intended to be repaired.

The special fasteners of the cover are hexagon socket head cap screws conforming to ISO 4762. The minimum grade of screws must be A4-70. If any, the screws shall only be replaced with identical ones.

The temperature class depend on ambient temperature. See temperature tables.

14 **EXIGENCES ESSENTIELLES DE SANTE ET DE SECURITE**

Couvertes par les normes listées au point 8.

ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

Covered by standards listed at 8.

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** — **LCIE 00 ATEX 6008 X** — **Issue : 15**

15 **DOCUMENTS DESCRIPTIFS** / **DESCRIPTIVE DOCUMENTS**

N°	Description	Reference	Rev.	Date	Page(s)
1.	Dossier technique, tête magnétique type (WS)NF. *Technical file, magnetic solenoid (WS)NF type.*	293584	M	2018/11/22	37
2.	Notice d'instruction ((WS)NF – MXX) *Installation and maintenance instruction, Flameproof solenoid operator ((WS)NF – MXX)*	AJN 123620-794	--	--	--
3.	Notice d'instruction ((WS)NF – M12 – II) *Installation and maintenance instruction, Flameproof solenoid operator ((WS)NF – M12 – II)*	AJN 123620-793	--	--	--
4.	Notice d'instruction ((WS)NF – M12 – I) *Installation and maintenance instruction, Flameproof solenoid operator ((WS)NF – M12 – I)*	AJN 123620-795	--	--	--
5.	Notice d'instruction NF/WSNF – MXX (Version X263429069235F1) *Installation and maintenance instruction, Flameproof solenoid operator NF/WSNF – MXX (Version X263429069235F1)*	536657-001	--	--	--

16 **INFORMATIONS COMPLEMENTAIRES** / **ADDITIONAL INFORMATIONS**

Essais individuels

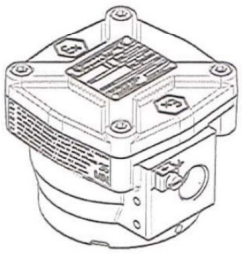
N/A

Routine tests

N/A

Vue générale

Apparatus overview



Sites de fabrication additionnels

ASCO SAS
53 rue de Beauce
28110 LUCE, FRANCE

ASCO JOUCOMATIC Ltd
2 Pit Hey Place
West Pimbo
SKELMERSDALE Lancashire WN8 9PG,
ROYAUME-UNI

ASCO CONTROLS B.V.
Neonstraat 3
6718 WX Ede, PAYS-BAS

Additional manufacturing locations

ASCO SAS
53 rue de Beauce
28110 LUCE, France

ASCO JOUCOMATIC Ltd
2 Pit Hey Place
West Pimbo
SKELMERSDALE Lancashire WN8 9PG,
UNITED KINGDOM

ASCO CONTROLS B.V.
Neonstraat 3
6718 WX Ede, The NETHERLANDS

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CERT-ATEX-FORM 04 Rev. 05

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

INFORMATIONS COMPLEMENTAIRES (suite)

Sites de fabrication additionnels (suite)

ASCO NUMATICS SP .Z.O.O
Kurczaki 132
93331 Lodz, POLOGNE

ASCO L.P.
160 Park Avenue, Florham Park
New Jersey 07932, USA

ASCO L.P.
1561 Colombia Highway
Aiken, South Carolina 29801, USA

ASCOTECH, SA de C.V
Circuito del progresso, #27
Parque Industrial Progresso, Mexicali
Baja California 21190 MEXIQUE

ASCO NUMATICS (India) Pvt.Ltd,
57, Kundrathur Main Road,
Gerugambakkam,Porur
Chennai. 600128, Tamilnadu, INDE

ASCO VALVE (Shanghai) Co. Limited
No. 480, Xin Miao N°.3 Road, Xia Qiao Town,
Song Jiang District
Shanghai 201612, P.R. CHINE

ASCO Japan Co, Ltd
1-20 Takahata-cho, Nishinomiya, Hyogo
663-8202, JAPON

ASCO ASIA
Block 4008, Ang Mo Kio Avenue 10
#04- 08/10/17/22, Techplace 1
569625, SINGAPOUR

Conditions de certification

Les détenteurs d'attestations d'examen UE de type doivent également satisfaire les exigences de contrôle de production telles que définies à l'article 13 de la Directive 2014/34/UE.

En accord avec l'Article 41 de la Directive 2014/34/UE, les attestations d'examen CE de type mentionnant la Directive 94/9/CE émises avant la date d'application de la Directive 2014/34/UE (20 avril 2016) peuvent être considérées comme émises en accord avec la Directive 2014/34/UE. Les nouvelles versions de ces attestations peuvent conserver le numéro de l'attestation d'origine émise avant le 20 avril 2016.

ADDITIONAL INFORMATIONS (continued)

Additional manufacturing locations (continued)

ASCO NUMATICS SP .Z.O.O
Kurczaki 132
93331 Lodz, POLAND

ASCO L.P.
160 Park Avenue, Florham Park
New Jersey 07932, USA

ASCO L.P.
1561 Colombia Highway
Aiken, South Carolina 29801, USA

ASCOTECH, SA de C.V
Circuito del progresso, #27
Parque Industrial Progresso, Mexicali
Baja California 21190 MEXICO

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57, Kundrathur Main Road,
Gerugambakkam,Porur
Chennai. 600128, Tamilnadu, INDIA

ASCO VALVE (Shanghai) Co. Limited
No. 480, Xin Miao N°.3 Road, Xia Qiao Town,
Song Jiang District
Shanghai 201612, P.R. CHINA

ASCO Japan Co, Ltd
1-20 Takahata-cho, Nishinomiya, Hyogo
663-8202, JAPAN

ASCO ASIA
Block 4008, Ang Mo Kio Avenue 10
#04- 08/10/17/22, Techplace 1
569625, SINGAPORE

Conditions of certification

Holders of EU type examination certificates are also required to comply with the production control requirements defined in article 13 of Directive 2014/34/EU.

In accordance with Article 41 of Directive 2014/34/EU, EC-Type Examination Certificates referring to Directive 94/9/EC that were in existence prior to the date of application of Directive 2014/34/EU (20 April 2016) may be referenced as if they were issued in accordance with Directive 2014/34/EU. New issues of such certificates may continue to bear the original certificate number issued prior to 20 April 2016.

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

17 **DETAILS DES MODIFICATIONS DE L'ATTESTATION**

Version 00 : 02/03/2001	Version initiale selon les normes suivantes : - EN 50014:1997, - EN 50018:1994.
Version 01 : 18/01/2002	Possibilité d'utiliser l'équipement en atmosphère poussières.
Version 02 : 10/09/2002	Modification du dossier technique.
Version 03 : 28/11/2003	Diminution de la température ambiante minimale à -60°C.
Version 04 : 10/09/2007	Mise à jour normative suivant les normes suivantes : - EN 60079-0:2006, - EN 60079-1:2004, - EN 61241-0:2006, - EN 61241-1:2004. Mise à jour des classements en température.
Version 05 : 23/10/2008	Ajout de sites de production.
Version 06 : 05/03/2009	Ajout d'un site de production.
Version 07 : 25/02/2010	Ajout d'un site de production. Modification du dossier technique.
Version 08 : 12/10/2010	Mise à jour normative suivant les normes suivantes : - EN 60079-0:2009, - EN 60079-1:2007, - EN 61241-1:2004. Mise à jour des classements en température.
Version 09 : 27/12/2011	Mise à jour normative suivant la norme EN 60079-31:2009.
Version 10 : 08/03/2013	Mise à jour de la liste des sites de production.
Version 11 : 25/04/2013	Ajout d'un nouveau site de production.
Version 12 : 25/02/2016	Changement du nom de la société. Mise à jour normative suivant les normes suivantes : - EN 60079-0:2012 + A11:2013, - EN 60079-31:2014. Ajout d'un nouveau site de production.
Version 13 : 25/10/2016	Ajout d'une version spéciale codifiée NF 14462403.24/DC, pour le type *NF-M12-II. Mise à jour suivant la norme EN 60079-1:2014.

DETAILS OF CERTIFICATE CHANGES

Issue 00 : 2003/03/02	Initial issue according to following standards: - EN 50014:1997, - EN 50018:1994.
Issue 01 : 2002/01/18	Possibility to use the equipment in dust atmosphere.
Issue 02 : 2002/09/10	Technical file modification.
Issue 03 : 2003/11/28	Decrease of minimal ambient operating temperature to -60°C.
Issue 04 : 2007/09/10	Normative update according to following standards : - EN 60079-0:2006, - EN 60079-1:2004, - EN 61241-0:2006, - EN 61241-1:2004. Update of temperature classes.
Issue 05 : 2008/10/23	Addition of manufacturing locations.
Issue 06 : 2009/03/05	Addition of a manufacturing location.
Issue 07 : 2010/02/25	Addition of a new manufacturing location. Technical file modification.
Issue 08 : 2010/10/12	Normative update according to following standards : - EN 60079-0:2009, - EN 60079-1:2007, - EN 61241-1:2004. Update of temperature tables.
Issue 09 : 2011/12/27	Normative update according to standard EN 60079-31:2009.
Issue 10 : 2013/03/08	Update of manufacturing locations list.
Issue 10 : 2013/04/25	Addition of a new manufacturing location.
Issue 12 : 2016/02/25	Change of company name. Normative update according to following standards : - EN 60079-0:2012 + A11:2013, - EN 60079-31:2014. Addition of a new manufacturing location.
Issue 13 : 2016/10/25	Addition of a specific version, codified NF 14462403.24/DC for type *NF-M12-II. Normative update according to standard EN 60079-1:2014.

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ATTESTATION D'EXAMEN UE DE TYPE - ANNEXE
EU TYPE EXAMINATION CERTIFICATE - SCHEDULE

1 **Version : 15** **LCIE 00 ATEX 6008 X** **Issue : 15**

DETAILS DES MODIFICATIONS DE L'ATTESTATION (suite)

Version 14 : 26/07/2017	Correction de la version 13 (mise à jour du marquage et de la description du produit). Nouvelle détermination de la pression d'explosion. Mise à jour des conditions particulières d'utilisation. Mise à jour de la liste des sites de production.
Version 15 :	Ajout d'une version spéciale codifiée X263429069235F1, pour le type *NF-MXX. Mise à jour de la liste des sites de production. Clarification sur la définition du type.

DETAILS OF CERTIFICATE CHANGES (continued)

Issue 14 : 2017/07/26	Correction of the issue 13 (update marking and description of product). New determination of explosion pressure. Update of specific conditions of use. Update of manufacturing locations list.
Issue 15 :	Addition of a specific version, codified X263429069235F1, for type *NF-MXX. Update list of manufacturing locations. Clarification of type definition.

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4.13 QM1.1..1.6 and QM2.1..2.6 – 1/2" NPT to M20 Adaptor, ADU102904

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Total Quality. Assured.

EU TYPE-EXAMINATION CERTIFICATE

1. **EU type-examination Certificate (Module B)**
2. **Equipment or Protective System intended for use in potentially explosive atmospheres (Directive 2014/34/EU)**
3. **EU type examination certificate Nr** **ITS16ATEX101339X R.1**
4. **Product:** AD-U, AM-D/AM-U, AF-U, AD-E4 Thread Adapters, RD-U, RD-E4 Reducers and AE-E Earthlead Adapters, Reducers, UN-D / UN-U, UF-D / UF-U, FB and FL Unions
5. **Manufacturer:** EATON ELECTRICAL SYSTEMS Ltd Trading as Eaton, Raxton, Redapt or Capri
   Applicant: EATON ELECTRICAL SYSTEMS Ltd Trading as Eaton, Raxton, Redapt or Capri
6. **Address:** Kingsway South Westgate, Aldridge West Midlands WS9 8FS
   Address: Kingsway South Westgate, Aldridge West Midlands WS9 8FS
7. This product and any acceptable variation thereto are specified in the schedule to this certificate and therein referred to.
8. INTERTEK ITALIA S.p.A., Notified Body n° 2575 in accordance with article 17 of the Directive 2014/34/EU of the European Parliament and Council of the 26 February 2014, certifies that the equipment or protective system has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective system intended for use in potentially explosive atmosphere, given in Annex II of the Directive.

   The examination and tests results are recorded in confidential technical evaluation Intertek Report Nr. 105332195LHD-001 dated 31st August 2023.
9. Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN IEC 60079-0:2018, EN 60079-1:2014, EN IEC 60079-7:2015+A1:2018 and EN 60079-31:2014 except in respect of those requirements referred to at item 16 of the Schedule.
10. If the sign X is placed after the certificate number, it indicates that the product is subject to Specific Conditions of Use specified in the schedule to this certificate.
11. This EU-Type Examination Certificate relates only to the design and construction of the specified product. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.
12. The marking of the product shall include the following:

Types AD-U, AM-D/AM-U, AF-U Thread Adapters, RD-U Reducers and UN-D / UN-U, UF-D / UF-U, FB and FL Unions (Mining not applicable to Aluminium version)

I M2 Ex db I Mb
II 2 G Ex db IIC Gb
I M2 Ex eb I Mb
II 2 G Ex eb IIC Gb
II 2D Ex tb IIIC Db

Type AE-E earth lead Adapters, Reducers (Mining not applicable to Aluminium version)

I M2 Ex eb I Mb,
II 2G Ex eb IIC Gb,
II 2D Ex tb IIIC Db

Type AD-E 4 Thread Adapters or RD-E4 Reducers

II 2G Ex eb IIC Gb,
II 2D Ex tb IIIC Db

Certificate issue date

1st September 2023

Mark Newman
Certification Officer
Intertek Italia S.p.A. (NB 2575)

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

PDR N° 277B

Membro degli Accordi di Mutuo Riconoscimento EA, IAF e ILAC

Signatory of EA, IAF and ILAC Mutual Recognition Agreements

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Only the Client is authorized to permit copying or distribution of this Certificate and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.

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SCHEDULE

EU TYPE EXAMINATION CERTIFICATE NUMBER: ITS16ATEX101339X R.1

13. **DESCRIPTION OF THE EQUIPMENT OR PROTECTIVE SYSTEM**

Adaptors and Reducers
The ranges of thread adaptors and reducers each comprise a hollow body with an external male thread and an internal female thread. The devices are used to convert an existing cable entry aperture thread to a different thread form and / or size. The adaptors and reducers may optionally be machined with a groove to fit an 'o' ring seal. An increase of up to two step thread sizes is permitted on the AD-U series.

AD-U and RD-U Series – Metallic hexagonal or round bodied adaptors (AD-U) or reducers (RD-U)
Coded: Ex db I/IIC Mb/Gb, Ex eb I/IIC Mb/ Gb Ex tb IIIC Db
M12 TO M120 (or equivalent thread forms)

The **AM-D / AM-U** range of Male to Male thread adaptors each comprises a hexagon body with a male thread form at each end. The devices are used to convert an existing cable entry aperture thread to a different thread form and/or size. Coded: Ex db I/IIC Mb/Gb, Ex eb I/IIC Mb/ Gb Ex tb IIIC Db
M16 TO M90 (or equivalent thread forms)

The **AF-U** range of Female to Female thread adaptors each comprises a hexagon body with a female thread form at each end. The devices are used to convert an existing cable entry aperture thread to a different thread form and/or size. Coded: Ex db I/IIC Mb/Gb, Ex eb I/IIC Mb/ Gb Ex tb IIIC Db
M16 TO M120 (or equivalent thread forms)

Types **AD-E4** Adaptors and Types **RD-E4** Reducers are glass fibre nylon versions, 30% Glass filled Nylon is the standard material type and 40% Glass filed Nylon is a specific type. They are designed to convert an existing cable entry aperture in the associated apparatus to a different thread form and/or size. Each device comprises a hollow body with a male thread at one end and a female thread at the other. The AD-E4 is a hexagon type adaptor. The RD-E4 is a hexagon type reducer.
Coded: Ex eb IIC Gb, Ex tb IIIC Db

The **AE-E** Series range of earth lead adaptors and reducers each comprise a hexagon body with a male thread at one end and a female thread machined into the other. The devices are designed to provide a connection from a cable gland or termination to earth via a 300mm long earth lead cable riveted and soldered to the body and additionally may be used to convert an existing cable entry aperture thread to a different thread form and/or size. Coded Ex eb I/IIC Mb/Gb Ex tb IIIC Db IP6X
M16 TO M75 (or equivalent thread forms)

Type **UN-D / UN-U and FB** Male to Female Unions and **UF-D / UF-U and FL** Female to Female Unions each comprise a hexagon body, an internally threaded cone and an external nut. The devices are designed for connection when a conventional adaptor is impractical. Additionally, they may be used to convert an existing cable entry to a different thread form and/or size.
Coded: Ex db I/IIC Mb/Gb, Ex eb I/IIC Mb/Gb Ex tb IIIC Db IP6X
M16 TO M75 for FB-FL (or equivalent thread forms)
UN-D / UN-U and **UF-D / UF-U** are between M20 and M75 (or equivalent thread forms)

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SCHEDULE

EU TYPE EXAMINATION CERTIFICATE NUMBER: ITS16ATEX101339X R.1

Thread forms Options:

ISO Metric (to BS3463), PG to DIN40430, NPT (ANSI/ASME B1.20.1), NPS (ANSI/ASME B1.20.1), ISO Pipe Thread (BS21) BSPP/BSPT, Imperial conduit ET BS31 BSP to BS21 or thread forms complying with standard EN 60079-1.

As an option for AD-E4 & ADU adaptors (Ex eb or tb application only), male threads can be drilled with holes to drain the water (when assembled with a breather drain for instance).

Material options:

Brass to BS 2874:1985
Brass to BS 2872:1989
Lead-free brass: CW724R Stainless
steel to BS 970: part4 Mild steel to
BS 970: Part 1: 1983 Aluminium
(Not for Group I) 30 % Glass filled
Nylon
40% Glass filled Nylon

CE Marking shall be accompanied by the identification number of the Notified Body responsible for surveillance of production.

14. **DRAWINGS AND DOCUMENTS**

TITLE	DOCUMENT Nr	LEVEL	DATE
*Ex d I&IIC AND Exe I&II ADAPTORS	AD-U	2	24-05-2021
*Ex accessories Safety Instructions	CAP184267	2022-03b	-
*Technical Specification	SPEC-ADAPT-RD-Rev-I-0.docx	0	2023/03/09
*Ex Accessories – Adaptors & Reducers – ATEX & IECEx (2 Pages)	MARK-ADAPT-RD-Rev-I-0.docx	0	2023/03/09
Ex e II CERTIFIED G.F.N ADAPTORS & REDUCERS	AD / RD-E4	2	09-07-2019
Ex e II CERTIFIED EARTH LEAD ADAPTORS	AE-E Adaptor	1	09-03-2016
Ex e II CERTIFIED EARTH LEAD REDUCER	AE-E Reducer	1	09-03-2016
Ex d I&IIC & Ex e I&II F x F ADAPTOR/ REDUCER	AF-U	1	08-03-2016
MALE x MALE ADAPTOR / REDUCER	AM-U	1	08-03-2016
Ex d I&IIC & Exe I &II REDUCERS	RD-U	1	08-03-2016
Exd/ Exe IIC UNIONS	UN-U/ UF-U	1	08-03-2016
FB-FL SERIES UNIONS	FB-FL	1	05-04-2016
Marking Drawing	IECExITS16.0013X ITS16ATEX101339X	1	15-11-2016

Documents marked with a '*' have been modified or added as part of the revision. Copies of the above listed documents are kept at Intertek Italia S.p.A. archive.

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SCHEDULE

EU TYPE EXAMINATION CERTIFICATE NUMBER: ITS16ATEX101339X R.1

15. **SPECIFIC CONDITIONS OF USE**

1. When used in flameproof applications. only one adaptor or reducer is to be used with any single cable entry on the associated equipment.
2. The interfaces between these devices and the associated enclosure cannot be defined; therefore, it is the user's responsibility to ensure that the appropriate ingress protection level is maintained at these interfaces.
3. Aluminum variants are not permitted for Group I applications
4. At their point of mounting, these devices are suitable for use at the following temperatures dependent on the type of 'o'-ring:

O-ring Service temp

Material	Service Temperature
None fitted	-60°C to 200°C*
EPDM	-50°C to +100°C
Nitrile	-30°C to +80°C
Neoprene	-40°C to +80°C
Viton	-20°C to +180°C*
Silicone	-60°C to +180°C *
Fluorosilicone	-60°C to +130°C
30% Glass Filled Nylon	-30°C to +90°C
40% Glass Filled Nylon	-20°C to +45°C

Note:. The limiting temperatures specified above are de-rated by 20K according to Clause 7.2.2 'Material Selection' of EN 60079-0

Note: The maximum temperature is limited to 150°C in Group I application (Coal dust, Mining) O-ring materials affect marked with '*' above.

Note: Unless fitted with an interface sealing O-ring with lower properties, temperatures shall then be limited as per the manufacturer's instructions.

Conditions specific to type:

AD-U Adaptors and RD-U Reducers

1. When installed in Group I applications, the ADU M12 (M) to M20 (F) adaptor manufactured in brass shall be installed where the risk of impact is low

AE-E Earth Lead Adaptors and Reducer

2. At their point of mounting, these devices are suitable for use at -20°C to +40°C.

AD-E4, RD-E4

3. The adaptors/reducers, made from non-metallic material, are only suitable for installation in areas considered to be a low risk from mechanical impact.
4. The adaptors/reducers, made from non-metallic material 40% Glass Filled Nylon, shall be adequately protected from direct exposure to sunlight.

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TEMPLATE FRM5100236 0H **Ballard Confidential** Printed on: Wednesday, March 19, 2025

SCHEDULE

EU TYPE EXAMINATION CERTIFICATE NUMBER: ITS16ATEX101339X R.1

16. **ESSENTIAL HEALTH AND SAFETY REQUIREMENTS**

The relevant essential Health and Safety Requirements have been identified and assessed in Intertek Report Nr. 105332195LHD-001 dated 31st August 2023.

17. **ROUTINE (FACTORY) TESTS**

None.

18. **DETAIL OF CERTIFICATE CHANGES**

R.1 (?? August 2023):

- Add holes into threads for the Adaptors & Reducers AD-U / AD-E4 in order to drain moisture when associated with a breather.
- Update of some drawings.
- Update to EN IEC 60079-0:2018.

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4.14 QM1.1..QM1.6 and QM2.1..QM2.6 – Cable Gland for Solenoid Valve, 501/421 O M20 Brass

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cml B.V. certification management

EU Type Examination Certificate CML 19ATEX1167X Issue 3

1 Equipment intended for use in Potentially Explosive Atmospheres Directive 2014/34/EU

2 Equipment **A Range of Cable Glands with Compression Seals**

501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474

3 Manufacturer **Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of Companies)**

4 Address **Oxford Street West, Ashton-under-Lyne, Lancashire, OL7 0NA United Kingdom**

5 The equipment is specified in the description of this certificate and the documents to which it refers.

6 CML B.V., Chamber of Commerce No 67386717, Koopvaardijweg 32, 4906CV Oosterhout, The Netherlands, Notified Body Number 2776, in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment intended for use in potentially explosive atmospheres given in Annex II to the Directive.

The examination and test results are recorded in the confidential reports listed in Section 12.

7 If an 'X' suffix appears after the certificate number, it indicates that the equipment is subject to conditions of safe use (affecting correct installation or safe use). These are specified in Section 14.

8 This EU Type Examination certificate relates only to the design and construction of the specified equipment or component. Further requirements of Directive 2014/34/EU Article 13 apply to the manufacture of the equipment or component and are separately certified.

9 Compliance with the Essential Health and Safety Requirements, with the exception of those listed in the confidential report, has been demonstrated through compliance with the following documents:

EN IEC 60079-0:2018 EN 60079-1:2014 EN 60079-31:2014

EN IEC 60079-7:2015+A1:2018

10 The equipment shall be marked with the following:

Ex II 2 G D

Ex db IIC Gb

Ex eb IIC Gb

Ex tb IIIC Db
IP 66/67/X8 – 10m/24h
See conditions of use for service temperature range

RvA C 640 PRODUCTS

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L A Brisk
Assistant Certification Manager

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CML 19ATEX1167X
Issue 3

11 Description

Each of the following gland types may be manufactured in brass, nickel plated brass, stainless steel or aluminium and may be supplied with agreed alternative entry thread forms.

The Type 501/421 Cable Gland is intended for use with an effectively filled and circular unarmoured cables and comprises the following components: -

a) An entry component in the size range Os to J
b) A compressible sealing ring
c) A compression spigot
d) A back nut
e) An optional earth continuity device for use with metallic sheathed cables

The Type 501/421 'Size 2K' Gland comprises the following components only: -

a) A dedicated entry component
b) A compressible sealing ring
c) A nylon skid washer
d) A threaded compression spigot

The Type 501/423 Cable Gland is intended for use with effectively filled and circular unarmoured cables and comprises the following components: -

a) An entry component, in the size range Os to J
b) Two compressible sealing rings
c) Two compression spigots
d) A middle nut
e) A back nut
f) An optional earth continuity device for use with metallic sheathed cables

The Type 501/453 RAC Cable Gland is intended for use with armoured, unarmoured, or braided cable and comprises the following components:

a. An entry component, in the size range Os to J
b. A compressible sealing ring.
c. A combined compression spigot and armour clamping cone.
d. A reversible armour clamping ring.
e. A middle nut
f. An outer seal assembly (sleeve seal and support cage)
g. A back nut
h. An optional earth continuity device for use with metallic inner sheathed cables

The Type PSG 553 RAC Cable Gland is intended for use with armoured, unarmoured, or braided cables of unspecified construction and comprises the following components: -

a) An entry component in the size range Os to C
b) A compressible seal designed to accept a number of individual conductors
c) A combined compression spigot and armour clamping cone
d) A reversible armour clamping ring.
e) A middle nut
f) An outer seal assembly (sleeve seal and support cage)
g) A back nut

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CML 19ATEX1167X
Issue 3

The Type 501/414 Conduit Stopping Gland is intended for use with an effectively filled and circular unarmoured cable enclosed within a conduit and comprises the following components: -

a) An entry component in the size range Os to F
b) A compressible sealing ring
c) A compression assembly comprising a compression spigot with a female thread at the rear and integral back nut

The Type SB474 Conduit Stopping Gland is intended for use with a number of circular conductors enclosed within a conduit and comprises the following components: -

a) An entry component in the size range O to C
b) A compressible seal designed to accept a number of individual conductors
c) A compression assembly comprising a compression spigot with a female thread at the rear and integral back nut.

Design option

1. The use of a 3M cold Shrink tubing to be fitted to the outer sheath of specific non-circular cables as specified in the drawing 320000, and fitted into 'Os', 'O' and 'A' sizes of the 501/453 cable glands. To ensure that the IP sealing arrangement utilizing the cable shrink tube assembly does not affect the assigned IP rating of the glands. The selection of the relevant cable gland to meet the protection concept for the cable and the enclosure it is fitted on to as detailed in EN 60079-14 remain un-affected.
2. The gland assemblies as described above are rated for ingress protection IP66 and 67.
3. Cable glands may be fitted with an optional external clamp or a second accessory option type Hawke Gland Mounted Clamp (GMC).
4. Where marked IIC or IIIC, the equipment can also be marked for gas groups IIA or IIB and for dust groups IIIA or IIIB.

Variation 1

This variation introduces the following modifications:

i. Update GA drawings.
ii. Add accessory optional item GMC 'Gland Mounted Clamp'.
iii. Clarify the ingress protection, IP ratings.
iv. To review and update the cable glands against the latest standard.
v. To include the 501/453 RAC type cable Gland.
vi. To permit the update to gland sizes.
vii. Update the marking.
viii. To revise the equipment title.
ix. To revise the product description.
x. To revise the specific conditions of use.

Variation 2

This variation introduces the following modifications, and it is is applicable to Type PSG 553 RAC Cable Gland and Type SB474 Conduit Stopping Gland.

i. To introduce a new seal design for PSG/553/RAC, sizes Os to C and SB 474, sizes O to C; as a result the product description was amended.

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CML 19ATEX1167X
Issue 3

ii. To introduce a new compressible seal which has an increased service temperature of -60°C to +100°C; to reflect this modification the product description and Specific Conditions of Use were updated.
iii. To permit minor editorial updates to the Product Description.
iv. To permit changes to the Specific Conditions of Use.
v. To remove cable gland types 501/452 RAC and PSG 421; as a result, the product description was amended.

Variation 3
This variation introduces the following modifications:

i. To modify the core diameter range on sizes O/A/B/C and B-ALT of the PSG 553 RAC and SB474 gland types and modify certification documentation.

12 Certificate history and evaluation reports

Issue	Date	Associated report	Notes
0	04 June 2019	R11908A/00	The issue of the prime certification.
1	28 Sept 2021	R13593A/00	The introduction of variation 1. (UKEX)
2	31 Mar 2022	R14930A/00	The introduction of variation 2
3	23 Aug 2023	R16380A/00	The introduction of variation 3

Note: Drawings that describe the equipment or component are listed in the Annex.

13 Conditions of Manufacture

None

14 Specific Conditions of Use (Special Conditions)

The following conditions relate to safe installation and/or use of the equipment.

i. The PSG/553/RAC and SB 474 cables glands are limited to an operating temperature range of -60°C to +80°C, unless marked “P PSG/553/RAC” and “P SB 474” respectively. In these cases, they are suitable for use with an operating temperature range of -60°C to +100°C. All other cable gland types are suitable for use with an operating temperature range of -60°C to +100°C.

ii. When the glands are used for increased safety or dust protection the entry thread shall be suitably sealed (in accordance with IEC 60079-14) to maintain the ingress protection rating of the associated enclosure. Not applicable when Hawke IP 66/67 seal is used.

iii. Glands for use with conduit, unarmoured or braided cables are only suitable for fixed installations, the cable for which must be effectively clamped to prevent pulling and twisting (does not apply when fitted with rear clamping device or Hawke Gland Mounted Clamp (GMC)).

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Certificate Annex

Certificate Number	**CML 19ATEX1167X**
Equipment	**A Range of Cable Glands with Compression Seals** **501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474**
Manufacturer	**Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of Companies)**

The following documents describe the equipment or component defined in this certificate:

Issue 0

Drawing No	Sheets	Rev	Approved date	Title
501 421	1 to 2	L	04 June 2019	General Arrangement for Unarmoured 501 421 Gland
501 421 Oversized	1 of 1	H	04 June 2019	General Arrangement for Unarmoured 501 421 Oversized Gland
501 423	1 of 1	L	04 June 2019	General Arrangement for 501/423 Gland
501 423 Oversized	1 of 1	H	04 June 2019	General Arrangement for 501/423 Oversized Gland
501 414	1 of 1	L	04 June 2019	General Arrangement for 501/414 Conduit Stopper Box (using Compression Seal)
501 452 RAC X	1 of 1	A	04 June 2019	General Arrangement of Gland Type 501/452/RAC-X
501 453 RAC X	1 of 1	A	04 June 2019	General Arrangement of Gland Type 501/453/RAC-X
PSG 553 RAC X	1 of 1	A	04 June 2019	General Arrangement for PSG 553 Gland
PSG 421	1 of 1	B	04 June 2019	General Arrangement for Unarmoured PSG 421 Glan
SB 474	1 of 1	L	04 June 2019	General Arrangement for SB 474 Gland

Issue 1

Drawing No.	Sheets	Rev	Approved date	Title
320016*	1 of 1	A	28 Sept 2021	501/453/RAC
320021*	1 of 1	A	28 Sept 2021	501/421 schedule drawing
320026*	1 of 1	A	28 Sept 2021	501/423 schedule drawing
320028*	1 of 1	A	28 Sept 2021	501/452/RAC schedule drawing
320035*	1 of 1	A	28 Sept 2021	PSG/421 schedule drawing
320037*	1 of 1	A	28 Sept 2021	PSG/553/RAC schedule drawing
320038*	1 of 1	A	28 Sept 2021	501/414 schedule drawing
320040*	1 of 1	A	28 Sept 2021	SB 474 schedule drawing

The following component drawings are common to each of the cable gland as indicated.

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Certificate Annex

Certificate Number CML 19ATEX1167X

Equipment A Range of Cable Glands with Compression Seals

501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474

Manufacturer Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of Companies)

	Drawing No.	Sheets	Rev	Approved /issued date	Title	501/421	501/423	501/452/RAC	PSG/421	PSG/553/RAC	501/414	SB 474	CSB 656N	501/453/RAC
a	320002	1 of 1	A	28-09-2021	Armour clamping ring			x		x				x
b	320009	1 of 1	A	28-09-2021	Middle nut			x		x				x
c	320003	1 of 1	A	28-09-2021	Back nut seal					x				x
d	320010	1 of 1	A	28-09-2021	Back nut					x				x
e	320011	1 of 1	A	28-09-2021	Thread forms		x	x	x	x	x	x	x	x
f	320012	1 of 1	A	28-09-2021	External clamp	x				x				x
g	320082	1 of 1	A	28-09-2021	GMC	x	x			x				x
h	320031	1 of 1	A	28-09-2021	ALT Compound Chamber Entry								x	
i	320032	1 of 1	A	28-09-2021	ALT Compound Chamber								x	
j	320017	1 of 1	A	28-09-2021	Compression seal entry	x	x	x	x	x	x	x		x
k	320018	1 of 1	A	28-09-2021	Compression seal	x	x	x			x			x
l	320022	1 of 1	A	28-09-2021	Compression spigot	x	x		x					
m	320023	1 of 1	A	28-09-2021	Tail nut	x	x		x		x	x	x	
n	3027 2k	1 of 1	A	28-09-2021	Nylon skid washer	x								
o	3077 Os-2K	1 of 1	A	28-09-2021	Spigot 411/321/421 2K Gland	x								
p	320027	1 of 1	A	28-09-2021	Body nut		x							
q	320036	1 of 1	A	28-09-2021	PSG Seal				x	x		x		
r	320039	1 of 1	A	28-09-2021	Conduit gland body						x	x	x	

Issue 2

	Drawing No.	Sheets	Rev	Approved date	Title
01	320036	1 of 1	B	31 Mar 2022	PSG Seal Schedule Drawing
02	320037	1 of 1	B	31 Mar 2022	PSG/553/RAC Schedule Drawing
03	320040	1 of 1	B	31 Mar 2022	SBS474 Schedule Drawing
04	320091	1 of 1	A	31 Mar 2022	PPSG Seal Schedule Drawing

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Certificate Annex

Certificate Number	**CML 19ATEX1167X**
Equipment	**A Range of Cable Glands with Compression Seals** **501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474**
Manufacturer	**Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of Companies)**

Issue 3

Drawing No	Sheets	Rev	Approved date	Title
320091	1 of 1	B	23 Aug 2023	PPSG Seal Schedule Drawing

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IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	**IECEx CML 19.0045X**	Page 1 of 4	Certificate history:
Status:	**Current**	Issue No: 3	Issue 2 (2022-03-31) Issue 1 (2021-09-28) Issue 0 (2019-06-04)
Date of Issue:	2023-08-23		

Applicant: **Hawke International**
A Division of Hubbell Limited
A Member of the Hubbell Group of Companies
Oxford Street West
Ashton-under-Lyne
Lancashire OL7 0NA
United Kingdom

Equipment: **A Range of Cable Glands with Compression Seals 501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474**

Optional accessory:

Type of Protection: **Flameproof Ex "db", Increased Safety Ex "eb" and Dust Protection by Enclosure Ex "tb"**

Marking: Ex db IIC Gb

Ex eb IIC Gb

Ex tb IIIC Db

IP 66/67/X8-10m/24h

See conditions of use for service temperature range

Approved for issue on behalf of the IECEx Certification Body: **L A Brisk**

Position: **Assistant Certification Manager**

Signature: (for printed version)

Date: (for printed version) 23 Aug 2023

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Eurofins E&E CML Limited
Unit 1, Newport Business Park
New Port Road
Ellesmere Port, CH65 4LZ
United Kingdom

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 19.0045X** Page 2 of 4

Date of issue: 2023-08-23 Issue No: 3

Manufacturer: **Hawke International**
A Division of Hubbell Limited
A Member of the Hubbell Group of Companies
Oxford Street West
Ashton-under-Lyne, Lancashire, OL7 0NA
United Kingdom

Manufacturing locations: **Hawke International**
A Division of Hubbell Limited
A Member of the Hubbell Group of Companies
Oxford Street West
Ashton-under-Lyne, Lancashire, OL7 0NA
United Kingdom

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements.This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended

STANDARDS :
The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

IEC 60079-0:2017 Edition:7.0	Explosive atmospheres - Part 0: Equipment - General requirements
IEC 60079-1:2014 Edition:7.0	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
IEC 60079-31:2022 Edition:3.0	Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"
IEC 60079-7:2017 Edition:5.1	Explosive atmospheres - Part 7: Equipment protection by increased safety "e"

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Reports:

GB/CML/ExTR19.0096/00 GB/CML/ExTR21.0018/00 GB/CML/ExTR21.0314/00
GB/CML/ExTR23.0191/00

Quality Assessment Report:

GB/BAS/QAR06.0061/10

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 19.0045X** Page 3 of 4

Date of issue: 2023-08-23 Issue No: 3

EQUIPMENT:
Equipment and systems covered by this Certificate are as follows:

Each of the gland types may be manufactured in brass, stainless steel or aluminium and may be supplied with agreed alternative entry thread forms.

Refer to Certificate Annex for full product description.

SPECIFIC CONDITIONS OF USE: YES as shown below:
Refer to Certificate Annex for list of specific conditions of use.

IECEx Certificate of Conformity

Certificate No.: **IECEx CML 19.0045X** Page 4 of 4

Date of issue: 2023-08-23 Issue No: 3

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above)
Issue 1
This issue introduces the following changes:

1. Update GA drawings.
2. Add accessory optional item GMC 'Gland Mounted Clamp'.
3. Clarify the ingress protection, IP
4. To review and update the cable glands against the latest standard.
5. To include the 501/453 RAC type cable Gland.
6. To permit the update to gland sizes.
7. Update the marking.
8. To revise the equipment title.
9. To revise the product description.
10. To revise the specific conditions of use.

Issue 2
This issue introduces the following changes and it is applicable to Type PSG 553 RAC Cable Gland and Type SB474 Conduit Stopping Gland.

1. To introduce a new seal design for PSG/553/RAC, sizes Os to C and SB 474, sizes O to C; as a result the product description was amended.
2. To introduce a new compressible seal which has an increased service temperature of -60°C to +100°C; to reflect this modification the product description and Specific Conditions of Use were updated.
3. To permit minor editorial updates to the Product Description.
4. To permit changes to the Specific Conditions of Use.
5. To remove cable gland types 501/452 RAC and PSG 421; as a result, the product description was amended.

Issue 3
This issue introduces the following changes:

1. To modify the core diameter range on sizes O/A/B/C and B-ALT of the PSG 553 RAC and SB474 gland types and modify certification documentation.
2. To review and update the equipment against the latest requirement of IEC 60079-31:2022 Ed.3.

Annex:

Certificate Annex IECEx CML 19.0045X Iss 3.pdf

Annexe to:	IECEx CML 19.0045X, Issue 3
Apparatus:	A Range of Cable Glands with Compression Seals 501/421; 501/421 "Size 2K"; 501/423; 501/453 RAC; PSG 553 RAC; 501/414; SB474
Applicant:	Hawke International (A Division of Hubbell Limited) (A member of the Hubbell group of Companies)

Description

Each of the following gland types may be manufactured in brass, nickel plated brass, stainless steel or aluminium and may be supplied with agreed alternative entry thread forms.

The Type 501/421 Cable Gland is intended for use with an effectively filled and circular unarmoured cables and comprises the following components: -

a) An entry component in the size range Os to J
b) A compressible sealing ring
c) A compression spigot
d) A back nut
e) An optional earth continuity device for use with metallic sheathed cables

The Type 501/421 'Size 2K' Gland comprises the following components only: -

a) A dedicated entry component
b) A compressible sealing ring
c) A nylon skid washer
d) A threaded compression spigot

The Type 501/423 Cable Gland is intended for use with effectively filled and circular unarmoured cables and comprises the following components: -

a) An entry component, in the size range Os to J
b) Two compressible sealing rings
c) Two compression spigots
d) A middle nut
e) A back nut
f) An optional earth continuity device for use with metallic sheathed cables

The Type 501/453 RAC Cable Gland is intended for use with armoured, unarmoured, or braided cable and comprises the following components:

a. An entry component, in the size range Os to J
b. A compressible sealing ring.
c. A combined compression spigot and armour clamping cone.
d. A reversible armour clamping ring.
e. A middle nut
f. An outer seal assembly (sleeve seal and support cage)
g. A back nut
h. An optional earth continuity device for use with metallic inner sheathed cables

Eurofins E&E CML Limited
Newport Business Park, New Port Road
Ellesmere Port, CH65 4LZ, UK

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Printed on: Wednesday, March 19, 2025

The Type PSG 553 RAC Cable Gland is intended for use with armoured, unarmoured, or braided cables of unspecified construction and comprises the following components: -

a) An entry component in the size range Os to C
b) A compressible seal designed to accept a number of individual conductors
c) A combined compression spigot and armour clamping cone
d) A reversible armour clamping ring.
e) A middle nut
f) An outer seal assembly (sleeve seal and support cage)
g) A back nut

The Type 501/414 Conduit Stopping Gland is intended for use with an effectively filled and circular unarmoured cable enclosed within a conduit and comprises the following components: -

a) An entry component in the size range Os to F
b) A compressible sealing ring
c) A compression assembly comprising a compression spigot with a female thread at the rear and integral back nut

The Type SB474 Conduit Stopping Gland is intended for use with a number of circular conductors enclosed within a conduit and comprises the following components: -

a) An entry component in the size range O to C
b) A compressible seal designed to accept a number of individual conductors
c) A compression assembly comprising a compression spigot with a female thread at the rear and integral back nut.

Design option

1. The use of a 3M cold Shrink tubing to be fitted to the outer sheath of specific non-circular cables as specified in the drawing 320000, and fitted into 'Os', 'O' and 'A' sizes of the 501/453 cable glands. To ensure that the IP sealing arrangement utilizing the cable shrink tube assembly does not affect the assigned IP rating of the glands. The selection of the relevant cable gland to meet the protection concept for the cable and the enclosure it is fitted on to as detailed in EN 60079-14 remain un-affected.
2. The gland assemblies as described above are rated for ingress protection IP66 and 67.
3. Cable glands may be fitted with an optional external clamp or a second accessory option type Hawke Gland Mounted Clamp (GMC).
4. Where marked IIC or IIIC, the equipment can also be marked for gas groups IIA or IIB and for dust groups IIIA or IIIB

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Conditions of Manufacture

None

Specific Conditions of Use

The following conditions relate to safe installation and/or use of the equipment.

i. The PSG/553/RAC and SB 474 cables glands are limited to an operating temperature range of -60°C to +80°C, unless marked "P PSG/553/RAC" and "P SB 474" respectively. In these cases, they are suitable for use with an operating temperature range of -60°C to +100°C. All other cable gland types are suitable for use with an operating temperature range of -60°C to +100°C.

ii. When the glands are used for increased safety or dust protection the entry thread shall be suitably sealed (in accordance with IEC 60079-14) to maintain the ingress protection rating of the associated enclosure. Not applicable when Hawke IP 66/67 seal is used.

iii. Glands for use with conduit, unarmoured or braided cables are only suitable for fixed installations, the cable for which must be effectively clamped to prevent pulling and twisting (does not apply when fitted with rear clamping device or Hawke Gland Mounted Clamp (GMC)).

Components used which are covered by Ex Certificates issued to older editions of Standards

None

Eurofins E&E CML Limited
Newport Business Park, New Port Road
Ellesmere Port, CH65 4LZ, UK

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4.15 XT01..06 – Compression Seal for Wall Penetration, Roxtec RS 50 B Ex-kit

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Attestation of Conformity for Components

We, Roxtec International AB, declare under sole responsibility that the products to which this declaration relates is in accordance with the provisions of the Directive 2014/34/EU
The products complies following harmonized stancards:

EN IEC 60079-0:2018, EN IEC 60079-7:2015/A1:2018 and EN 60079-31:2014

The standards listed in the EC-Type Examination Certificate are no longer harmonized, the revised (now harmonized) standards have been compared to the standards used for certification purposes and no changes in the "state of the art" apply to the equipment.

Cable Transit Device:
G...W Ex, S Ex, S...S0...Ex, SRC Ex, SK Ex, S BTB Ex, S...WM Ex,
SF...W Ex, R...W Ex, RO...W Ex, RS...W Ex and B...C Ex

Certificate:
No.12ATEX1279U issued by Nemko (id.no. 0470), based on EC-type Examination performed by them.
No. SP03ATEX7102 issued by RISE - Research Institutes of Sweden
(id.no 0402), based on assessment of the quality system performed by them.

Characteristics and how the components shall be incorporated into equipment:
Stated in EC-type Examination certificate and the instructions which accompany the components.

Marking:
CE 0402 Ex II 2G Ex e IIC Gb
CE 0402 Ex II 2D Ex tb IIIC Db

Karlskrona 2021-02-11

Roxtec International AB
Box 540
S-371 23 Karlskrona
SWEDEN

Jörgen Åkesson
Explosion Protection Manager

EU Declaration of Conformity

We, Roxtec International AB, declare under sole responsibility that the products to which this declaration relates is in accordance with the provisions of the Directive 2014/34/EU.
The products complies with following harmonized standards:

EN IEC 60079-0:2018, EN IEC 60079-7:2015/A1:2018 and EN 60079-31:2014
The standards listed in the EC-Type Examination Certificate are no longer harmonized, the revised (now harmonized) standards have been compared to the standards used for certification purposes and no changes in the "state of the art" apply to the equipment.

Cable Transit Device:
CF 16 Ex, CF 8/32 Ex, G Ex, G BG Ex, SF Ex, SF BG Ex, SFX...B Ex, R...B Ex, RO...B Ex, RS...B Ex, B...B Ex and C RS T- Ex

Certificate:
No.12ATEX1278X issued by Nemko (id.no. 0470), based on EC-Type Examination performed by them.
No. SP03ATEX7102 issued by RISE - Research Institutes of Sweden
(id.no 0402), based on assessment of the quality system performed by them.

Marking:
CE 0402 Ex II 2G Ex e IIC Gb
CE 0402 Ex II 2D Ex tb IIIC Db

Karlskrona 2021-02-11
Roxtec International AB
Box 540
SE-371 23 Karlskrona
SWEDEN

Jörgen Åkesson
Explosion Protection Manager

EU Declaration of Conformity

Document number: DOC-000575 revision F

We, Roxtec International AB, declare under sole responsibility that the products to which this declaration relates is in accordance with the provisions of the Directive 2014/34/EU.
The products complies with following harmonized standards:

EN IEC 60079-0:2018, EN IEC 60079-7:2015/A1:2018 and EN 60079-31:2014

The standard EN 60079-7:2015 listed in the EC-Type Examination Certificate are no longer harmonized. The revised (now harmonized) EN IEC 60079-7:2015/A1:2018 have been compared to the standard used for certification purposes and no changes in the "state of the art" apply to the equipment.

Cable Transit Device:
HD 16 Ex, HD 24 Ex, HD 32 Ex, HDLC Ex

Certificate:
No.15 ATEX6419X issued by Presafe (id. No 2460), based on EC-Type Examination performed by them.
No. SP03ATEX7102 issued by RISE - Research Institutes of Sweden (id.no 0402), based on assessment of the quality system performed by them.

Marking:
CE 0402 Ex II 2G Ex eb IIC Gb
CE 0402 Ex II 2D Ex tb IIIC Db

Karlskrona 2021-02-11
Roxtec International AB
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IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	IECEx NEM 12.0014X	Issue No: 4	Certificate history:
Status:	**Current**	Page 1 of 5	Issue No. 4 (2015-11-04) Issue No. 3 (2015-07-08) Issue No. 2 (2015-05-07) Issue No. 1 (2015-01-27) Issue No. 0 (2013-03-15)
Date of Issue:	**2015-11-04**		

Applicant: **Roxtec International AB**
Rombvägen 2
Box 540
SE-371 23 Karlskrona
Sweden

Equipment: **Cable Transit Device**
Optional accessory:

Type of Protection: **Ex e IIC Ex tb IIIC**

Marking:

Ex e IIC Gb, Ta -40°C To +80°C for CF 8 and CF 32.
Ex e IIC Gb, Ta -60°C To +80°C for all other variants.
Ex tb IIIC Db, Ta -40°C To +80°C for CF 8 and CF 32.
Ex tb IIIC Db, Ta -60°C To +80°C for all other variants.

Approved for issue on behalf of the IECEx Certification Body: Bjørn Spongsveen

Position: Certification Manager, Ex-products

Signature:
(for printed version)

Date:

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:

NEMKO
Gaustadelleen 30
Oslo N-0314
Norway

IECEx Certificate of Conformity

Certificate No:	IECEx NEM 12.0014X	Issue No: 4
Date of Issue:	**2015-11-04**	Page 2 of 5
Manufacturer:	**Roxtec International AB** Rombvägen 2 Box 540 SE-371 23 Karlskrona **Sweden**	
Additional Manufacturing location(s):		

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended.

STANDARDS:

The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

IEC 60079-0 : 2011 Edition:6.0	Explosive atmospheres - Part 0: General requirements
IEC 60079-31 : 2008 Edition:1	Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure 't'
IEC 60079-7 : 2006-07 Edition:4	Explosive atmospheres - Part 7: Equipment protection by increased safety "e"

*This Certificate **does not** indicate compliance with electrical safety and performance requirements other than those expressly included in the Standards listed above.*

TEST & ASSESSMENT REPORTS:

A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in

Test Report:

NO/NEM/ExTR12.0016/00 NO/NEM/ExTR12.0016/01 NO/NEM/ExTR12.0016/02
NO/NEM/ExTR12.0016/03 NO/NEM/ExTR12.0016/04

Quality Assessment Report:

SE/SP/QAR09.0001/04 SE/SP/QAR09.0001/03

IECEx Certificate of Conformity

Certificate No: IECEx NEM 12.0014X Issue No: 4

Date of Issue: **2015-11-04** Page 3 of 5

Schedule

EQUIPMENT:

Equipment and systems covered by this certificate are as follows:

The Cable Transit Devices 'CTDs'(see Type Designation below), for use with circular cables both armoured and non-armoured or corrugated cables (see Corrugated cables below) of non-interrupted and non-metallic outer jacket type or conduits. The CTDs consists of multi diameter sealing modules (type RM Ex and CM Ex as standard or with EMC properties) that depending on each individual size, accepts a limited number of cable diameters in applicable types of frames or sleeves and shall be marked with the Ex symbol.

The modules are made of mirrored rubber profiles and each part has a number of thin rubber layers that are ending up with a solid rubber core. The layers are made with two different colours to make the adaption to a cable exactly same on both halves and are allowed to differ one layer at most. To achieve appropriate sealing and mechanical properties to prevent the cables from slippage there shall always be a visible separation between the sealing module halves.

The modules made of EPDM are available with layers and core, but some greater sizes are also available without the core. In addition there are also single diameter- and solid modules.

The correct sizes and procedure of assembling the cables to the modules are described in detail in the enclosed installation instructions. Ex Compression devices are used to achieve appropriate compression of the modules and solids some CTDs uses compression units that expands inside the CTDs and some others have incorporated solid rubber profiles that achieve the expansion.

There are also two types of CTDs that incorporates both the compression device and multi diameter modules as a single unit, but still with two halves. The method to assemble the compression devices etc. and to achieve sealing of the CTDs is described in detail in the enclosed installation instructions.

Most CTDs that has a rectangular opening with or without rounded corners with modules of type RM Ex are all available for different combinations with several openings in width and/or in high. CTDs for use with rectangular openings with CM Ex modules (one type with dual opening) and round sleeves are only available with single openings.

The CTDs installation instructions listed in this report will define each variant in detail and all applicable parts that are approved for use within that variant.

CONDITIONS OF CERTIFICATION: YES as shown below:

Conditions for safe use

1. For maintaining the explosion protection, the installation instructions that accompany the products shall be considered.
2. Only cable for fixed installation is permitted for the cable transit device.
3. For optimum reliability wait 24 hours or longer after installation before exposing the cables/pipes to strain or pressure.

IECEx Certificate of Conformity

Certificate No: IECEx NEM 12.0014X Issue No: 4

Date of Issue: **2015-11-04** Page 4 of 5

EQUIPMENT (continued):

Type Designations:
CF 8 Ex, CF 32 Ex, CF 16 Ex, C RS T… Ex, RS…B Ex, G… Ex, SF… Ex, SFX...B Ex, B…B Ex, R…B Ex and RO…B Ex
Temperature Range:
CF 8 Ex and CF 32 Ex , -40°C to +80°C
CF 16, C RS T…, RS…B, G…, SF…, SFX...B, B…B, R…B and RO…B, -60°C to +80°C
Corrugated cables for use with: CF 8, CF 32, SF… and G…
ACIC (Armoured Control and Instrumentation Cable) according to C22.1-06 CEC,
ACWU (Armoured Cable for Wet locations) according to UL4,
TECK90 according to C22.2 No. 131-07
MC (Metal Clad) according to UL1569

IECEx Certificate of Conformity

Certificate No:	IECEx NEM 12.0014X	Issue No: 4
Date of Issue:	2015-11-04	Page 5 of 5

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above):

New revisions added and corrections to mistyping in previous descriptive document list, issue No. 4.0.

4.16 XT07..09 – Cable Gland for Wall Penetration, 501/421 O M20 Brass

[Please refer to certificate from Section 4.14.]

4.17 XT07..09 – M32 to M20 Reducer, RDU100604

[Please refer to certificate from Section 4.13.]

4.18 XT10..11 – Cable Gland for Wall Penetration, 501/421 A M20 Brass

[Please refer to certificate from Section 4.14.]

4.19 XT10..11 – M40 to M20 Reducer, RDU100704

[Please refer to certificate from Section 4.13.]

Ballard Power Systems Europe A/S
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Revision history		
Rev.	**Date.**	**Description**
001	25/10/2024	First Issue
002	27/11/2024	Updated to as-built and according to comments
003	28/01/2025	updated additional parts added
004	12/02/2025	2.1.2 - 1st paragraph corrected from eb or e to db or d
005	19/03/2025	Updated according to code 2 comments

Document Title:	**BLPH Project - ATEX Design Journal**
Document Number:	K559-2254-CWIWP4202202-K02-003
Revision:	Rev005
Sequence Number:	003
File Name:	K559-2254-CWIWP4202202-K02-003Rev005
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	K02
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

ATEX design journal

Full Title: *FC PowerGen 1000kW® - ATEX design journal*

Abstract: The following document will contain an internal walk through of the ATEX related components and philosophies for the installation on the *FC PowerGen 1000kW®*

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Specifications and descriptions in this document were in effect at the time of publication. Ballard Power Systems, Inc. reserves the right to change specifications, product appearance or to discontinue products at any time.

1.0 Objectives and Background

The following document contains the design journal and considerations for the EX related system. This document is an internal document stating the decisions and background for a safe system.

This is an addendum to the ATEX dossier containing the following documents.

- ATEX general arrangement
- ATEX register
- ATEX inspection checklist
- ATEX personal competences
- Intrinsically safe calculations
- Datasheet dossier
- Certification dossier

2.0 *FC PowerGen 1000kW®*

2.1 H2 solenoid valve

2.1.1 Selection of component

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is ***Emerson ASCO*** valve ***NF X E210D488E 24/DC*** with the following EX approvals: ***II 2 G D Ex db IIC T2..T6 Gb*** hereby confirming that the points above is covered by the certificate.

2.1.2 Cable glands

The cable glands for the installation shall maintain the certificate and appropriate Type of protection as the valve accordingly to section 10.2 in IEC 60079-14, hence the cable gland shall be a type of protection: db or d.

The following component is ***HAWKE* 501/421/O M20 421OM20** *with an adaptor to fit the thread of the valve from* ***Eaton Corporation*** *type* ***ADU102904*** with the following EX approvals: **Ex db IIC Gb Ex eb IIC Gb** for the cable gland, and **II 2G Ex db IIC Gb II 2G Ex eb IIC Gb** hereby confirming that the points above is covered by the certificate.

2.1.3 Cable and installation

The valve is installed with a LAPP 3G1 and resistant to UV light making them suitable for outside use.

The grounding is installed inside the valve to eliminate any risk of corrosion. The cable is in all its length (from valve to terminal box) un-cut

The cable is installed together with the other valves, with at smooth bend before cable glands. The cable will be mechanical fixed to a cable tray making sure no mechanical ware will happen.

The diameter of the cable is according to manufacture 8,4mm which is within the specifications (6,5-11,9mm) provided by the manufacture of the cable glands.

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2.2 H2 pressure transmitter

2.2.1 Selection of component

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is ***HUBA controls AG*** type ***520930S04M801*** with the following EX approvals: ***Ex II 1/2G EX ia IIC T4 Ga/Gb*** hereby confirming that the points above are covered by the certificate.

2.2.2 Ex barrier

The component will be installed with an Ex barrier eliminating the potential current going out the component and zone. The following Ex barrier is chosen: ***PR electronic 9106-B1B*** with the following EX approvals: ***II (1) G [Ex ia Ga] IIC/IIB/IIA*** hereby confirming that the points above are covered by the certificate. Installation of the barrier will be covered in section 2.8

2.2.3 Cables

For the connection of the temperature transmitter to the Ex barrier the following cable is used: ***IFM ENC03A*** with the following EX approvals: ***Ex ia IIC T6 Gb*** hereby confirming that the points above are covered by the certificate.

2.3 H2 heater heating element

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is ***JEVI Heating Elements A/S*** heating element ***D-8640*** with the following EX approvals: ***Ex d IIC T4 Gb*** hereby confirming that the points above is covered by the certificate.

The heating element has a build in over temperature cut off. The heating element is factory tested to make sure to not be able to overheat as part of the EX installation.

The flameproof type of protection is a threaded joint type and is installed according to IEC 60079-1. This means that there are no distances required to obstructions.

2.3.1 Cable glands

The cable glands for the installation shall maintain the certificate and appropriate Type of protection as the valve accordingly to point 16.3 in IEC 60079-0, hence the cable gland shall be a type of protection: d.

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For this component the cable gland was delivered as part of the delivery from the manufacture of the heating element. Following cable glands for the valve is delivered: ***HAWKE*** type ***ICG 653 UNIV Os M20*** with the EX approvals: ***EX db IIC Gb and EX eb IIC GB***

2.3.2 Cable and installation

The Heater unit is installed with a LAPP 4G2.5 and resistant to UV light making them suitable for outside use.

The grounding is installed inside the heating unit to eliminate any risk of corrosion. The cable is in all its length (from heating unit to terminal box) un-cut

The cable is installed together with the other non intrinsically safe components, with at smooth bend before cable glands. The cable will be mechanical fixed to a cable tray making sure no mechanical ware will happen.

The diameter of the cable is according to manufacture 9 mm which is within the specifications (5,5-12mm) provided by the manufacture of the cable glands.

2.4 H2 heater Level sensor

2.4.1 Selection of component

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is ***IFM LMT01A*** with the following EX approvals: ***II 3G Ex nA IIC T4 Gc X*** hereby confirming that the points above is covered by the certificate.

2.4.2 Ex barrier

The level sensor does not require a barrier due to the type of protection not being intrinsically safe.

2.4.3 Cables

For the connection of the temperature transmitter to the controller the following cable is used: ***IFM EVC14A*** with the following EX approvals: ***II 3G EX ec IIC Gc*** hereby confirming that the points above is covered by the certificate.

Installation of the cabling will be separated from intrinsically safe sensors, as the cable on this devise is not protected by an ex barrier.

2.5 H2 heater Temperature transmitter

2.5.1 Selection of component

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

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Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The temperature transmitter is defined as a simple apparatus accordingly to IEC 60079-14 section 16.4 as the type of transmitter is resister type PT1000 hence no possibility for generating any voltage by its own. Hereby eliminating the option of calculating the surface temperature. Since there are no requirement for an Ex certificate for an simple apparatus, there are no code for concluding the match.

2.5.2 Ex barrier

The component will be installed with an Ex barrier eliminating the potential current going out the component and zone. The following Ex barrier is chosen: ***PR electronic 9113B-U9*** with the following EX approvals: ***II (1) G [Ex ia Ga] IIC/IIB/IIA*** hereby confirming that the points above is covered by the certificate. Installation of the barrier will be covered in section 2.8

2.5.3 Cables

For the connection of the temperature transmitter to the Ex barriere the following cable is used: ***IFM ENC03A*** with the following EX approvals: ***Ex ia IIC T6 Gb*** hereby confirming that the points above is covered by the certificate.

2.6 H2 feed pipe container penetration

2.6.1 Selection of component

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is chosen to safe penetrate the container: **Roxtec** cable and pipe penetration type: **RS 50 B Ex-kit AISI316/AISI316** with the following EX approvals**: II 2G EX e IIC Gb** hereby confirming that the points above is covered by the certificate.

2.7 Electrical container penetration within EX zone

The component is to be placed with the following zone: ***EX zone 2 IIC T1***

Following allowable EPL is ok to use in the installation: Ga, Gb and Gc

Type of protection is limited to table 1 in IEC 60079-14

Ignition temperature is T1 for the medium (Hydrogen) in the zone. Hereby accepting the following ratings on the components T1-T6.

The following component is ***HAWKE*** cable gland type **501/421/O M20 and 501/421/A M20** with the following adaptor to compensate for the hole size: **Eaton Corporation** type **RDU100604 and RDU100704** with the following EX approvals: **Ex db IIC Gb Ex eb IIC Gb** for the cable glands and **II 2G Ex db IIC Gb II 2G Ex eb IIC Gb** for the reducers hereby confirming that the points above is covered by the certificate.

2.7.1 Cable and installation

The following type of cables are used in the above-mentioned cable glands:

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- ÖLFLEX CLASSIC 110 CH 4X1 from Mastercontorller in 40' container to cooling skid cabinet. Diameter 8,9mm with an allowable diameter for the cable gland of 6,5mm to 11,9mm
- ETHERLINE® TORSION Cat.6A from mastercontorller in 40' container to cooling skid cabinet. Diameter 8,9mm with an allowable diameter for the cable gland of 6,5mm to 11,9mm
- ETHERLINE® TORSION Cat.6A from mastercontorller in 40' container to cooling skid cabinet. Diameter 8,9mm with an allowable diameter for the cable gland of 6,5mm to 11,9mm
- ÖLFLEX CLASSIC 135 CH 18G0,75 from mastercontroller cabinet in 40' to hydrogen valve box. Diameter 13mm with an allowable diameter for the cable gland of 10,0mm to 14,3mm
- ÖLFLEX CLASSIC 135 CH 18G0,75 from mastercontorller in 40' container to cooling skid cabinet. Diameter 13mm with an allowable diameter for the cable gland of 10,0mm to 14,3mm

2.8 General electrical installation

There are no junction boxes within the zone except the one which is a part of the components. All junction boxes are moved outside the zone.

Cables are all installed below the temperature of the zone and goes uncut through the zone as 60079-14pt. 9.6.1

The intrinsically safe barriers are positioned in a separate junction box outside the Ex Zone. The junction box will contain the components which are described in section 2.2.2 and 2.5.2. The intrinsically safe circuits are separated from the non-safe circuit. Where the one side of the box will contain the non-safe part and the opposite side containing the intrinsically safe circuit hereby following the guidelines/philosophy from the manufacture of the Ex barriers. The circuits are to be installed **50mm** apart from each other according to section 16.5.3 in IEC 60079-14

The junction box will be the following: ***Schneider Electric Thalassa PLS, fiber glass armed polyester cabinet, IP65, 180 x 270 x 180mm, gray*** With the IP rating of IP65. The box will be marked with: *"Warning - Non Intrinsically safe circuits protected by internal IP20 cover"*

The cables will be separated from the non-safe circuits in the cable tray.

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9500 Hobro
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Revision history		
Rev.	**Date.**	**Description**
001	01/05/2025	First Issue

Document Title:	**BLPH Project - ATEX Inspections during Manufacturing**
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Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

SPC ID 0203 Pipework inspection and leakage test check sheet

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Revision Record

Rev #	Description	Revised By	Date dd-mm-yyyy
-	Initial Draft	TAN	21-08-2024
1	Released	TAN	30-8-2024

Checked by: MHA	Date: 29/08-2024
Approved by: MHA	Date: 30/08-2024

Project	601456B Crosswind BLPH
Date	30-08-2024
Identification of piping system (photo or P&ID) [✓ or -]	✓
Inspected by	MKD
Document Approved by	MFO
Filing date	02-09-2024

Follow the procedure in section 5.4 of *SPC ID 0104 Leakage Test Procedure*

*=Pass criteria according to inspection tool user instruction

**=Calculated value based on expected leakage rate plus sniffing tool uncertainty

*** Not applicable due to refitting/preswaging of joint/Not a ferrule fitting

		Visual inspection	Gauge Inspection*	Auditorial inspection	Sniffing inspection		Overall result
Item type	**Item ID**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass criteria** [PPM]**	**[Pass/fail]**
H2 Heater+Container, String 1	1-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 1	1-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 2	2-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 2	2-C-CUR-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater+Container, String 3	3-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 3	3-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 4	4-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 4	4-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 5	5-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 5	5-C-CUR-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 6	6-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 Heater+Container, String 6	6-C-CUR-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater+Container string 1,2,3,4,5,6



M: Manifold
H: Heater
C: Container
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.

H2 Container pipe to FCwave



M: Manifold
H: Heater
C: Container
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
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SPC ID 0203 Pipework inspection and leakage test check sheet

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Approved by: MHA	Date: 30/08-2024

Project	601456B Crosswind BLPH
Date	30-08-2024
Identification of piping system (photo or P&ID) [✓ or -]	✓
Inspected by	MKD
Document Approved by	MFO
Filing date	02-09-2024

Follow the procedure in section 5.4 of *SPC ID 0104 Leakage Test Procedure*

*=Pass criteria according to inspection tool user instruction

**=Calculated value based on allowable leakage rate plus sniffing tool uncertainty

*** Not applicable due to refitting/preswaging of joint/Not a ferrule fitting

		Visual inspection	Gauge Inspection*	Auditorial inspection	Sniffing inspection		Overall result
Item type	**Item ID**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass/fail**	**Pass criteria** [PPM]**	**[Pass/fail]**
H2 heater, String 1	1-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 1	1-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 1	1-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 2	2-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 3	3-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 3	3-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 4	4-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓

H2 heater, String 5	5-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 5	5-H-CUA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-BV-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CLA-1	✓	NA***	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-1	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-2	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-3	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CMC-G-4	✓	✓	✓	✓	35ppm	✓
H2 heater, String 6	6-H-CUA-1	✓	NA***	✓	✓	35ppm	✓

H2 Heater string 1,2,3 Inlet

M: Manifold
H: Heater
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.





H2 Heater string 4,5,6 Inlet



H2 Heater string 1,2,3,4,5,6 Shut-off Valve & Pipes

M: Manifold
H: Heater
BV: Ball Valve
MANO: Manometer
PRV: Pressure Relief Valve
CUR: Reducing Union
CTR: Reducing Tee
CMC: Male Connector
CLA: Union Elbow
CTA: Union Tee
CSWC: Tube Socket Weld Connector
CPA: Plug
Red Arrow indicates inspected item.





Short Title	**ATEX Inspection Checklist**
Full Title	**ATEX Inspection Checklist, 601456B Crosswind Hydrogen Manifold**
Abstract	-

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Revision Record

Rev #	Description	Revised By	Date
1	Initial Release	RBS	2. September 2024

Checked by: RBS	Date: Sept 2024
Approved by: PBL	Date: Sept 2024

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• Purpose and Scope

The purpose of this document is to provide a checklist for the Crosswind ATEX area containing the hydrogen manifold.

• References

Document	Name	Author
IEC 60079-17	Explosive atmospheres - Part 17: Electrical installations inspection and maintenance	IEC
JEVI 1953 861 100	Datasheet "Ex D-8640 Immersion Heater, 9kW 3x400VAC"	Sinus JEVI
	Datasheet "ASCO Solenoid Valves 210 series"	Emerson
	Datasheet "ASCO Solenoid NF series"	Emerson
	Datasheet "IFM LMT01A"	IFM
	Datasheet "HUBA 520 pressure sensor"	HUBA
	Datasheet "IFM TT1050-01"	IFM
	Datasheet "PR electronic 9202	PR electronic
	Datasheet "PR electronic 9113"	PR electronic
	Datasheet "PR electronic 9106"	PR electronic

- **Checklist:**

1.1 Hydrogen heater element

1.1.1 Test

The test is done accordingly to the test schematics in IEC 60079-17 Tabel C.1 following descriptions of the test will be below if applicable.

1.1.2 Relevant Standard / document

- IEC 60079-17
- JEVI datasheet 1953 861 100

1.1.3 Brief Test Plan

- Inspection will be done in respect to the datasheet, standards and Visual inspection prior to startup.

1.1.4 Pass/Fail criteria.

- The pass/fail criteria is specified for each inspection element is shown in Table 1.

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Table 1: Heater Inspection – Test Result

Item	Criteria	Result	Pass/Fail	Notes
Equipment is appropriate to the EPL/Zone requirement of the location	Gc or better	GB	✓	
Equipment group is correct	IIC	IIC	✓	
Equipment temperature class is correct	T1	T4	✓	
Degree of protection (IP grade) of the equipment is appropriate for the level of protection/group/conductivity	>IP55	IP66	✓	
Equipment circuit identification is correct	Present	✓	✓	
Equipment circuit identification is available	Yes	✓	✓	
Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	NA	—	—	—
There is no damage or unauthorized modifications	None	none	✓	
There is no evidence of unauthorized modification	None	none	✓	
Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight	Yes		✓	
Threaded covers on enclosures are of the correct type, are tight and secured	Yes		✓	
Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	Yes		✓	
Condition of enclosure gaskets is satisfactory	Yes		✓	
There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	No		✓	

Dimensions of flanged joint gaps are: – within the limits in accordance with the manufacturer's documentation or – within maximum values permitted by the relevant construction standard at time of installation or – within maximum values permitted by site documentation	—	—	—	—
Electrical connections are tight	Yes		✓	
Unused terminals are tightened	Yes		✓	
Type of cable is appropriate	Voltage and Environmental		✓	
There is no obvious damage to cables	No		✓	
Sealing of trunking, ducts, pipes and/or conduits is satisfactory	Not relevant	Not relevant	Not relevant	Not relevant
Stopping boxes and cable boxes are correctly filled	Yes		N/A	N/A
Integrity of conduit system and interface with mixed system maintained	No leaks			
Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)	Inspection		✓	Gnd connected inside housing
Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	<100mOhm	32mΩ	✓	
Automatic electrical protective devices are set correctly (auto-reset not possible)	Not present	Not present	Not present	Not present
Automatic electrical protective devices operate within permitted limits	Not present	Not present	Not present	Not present
Specific conditions of use (if applicable) are complied with	None	none	N/A	

Cables not in use are correctly terminated	Yes		✓	
Obstructions adjacent to flameproof flanged joints are in accordance with IEC 60079-14	Not present		N/A	
Variable voltage/frequency installation complies with documentation	Not present	Not present	Not present	Not present
Temperature sensors function according to manufacturer's documents	Not present	Not present	Not present	Not present
Safety cut off devices function according to manufacturer's documents	Inspected		✓	
The setting of the safety cut off is sealed	Yes		✓	
Reset of a heating system safety cut off possible with tool only	Yes		✓	
Auto-reset is not possible	Yes		✓	
Reset of a safety cut off under fault conditions is prevented	Yes		✓	
Safety cut off independent from control system	Yes		✓	
Level switch is installed and correctly set, if required	Yes (External to heater)		✓	
Flow switch is installed and correctly set, if required	NA		N/A	
Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	Yes = X in product number	IP66 SS ect	✓	
No undue accumulation of dust and dirt	No		✓	

1.2 H2 Shut Off Valve

1.2.1 Test

The test is done accordingly to the test schematics in IEC 60079-17 Tabel C.1 following descriptions of the test will be below if applicable.

1.2.2 Relevant Standard / document

- IEC 60079-17
- Datasheet "ASCO solenoid valves 210 series"
- Datasheet "ASCO Solenoid NF series"

1.2.3 Brief Test Plan

- Inspection will be done in respect to the datasheet, standards and Visual inspection prior to startup.

1.2.4 Pass/Fail criteria.

- The pass/fail criteria are specified for each inspection element is shown in Table 2.

Table 2: Hydrogen Valve Inspection – Test Result

Item	Criteria	Result	Pass/Fail	Notes
Equipment is appropriate to the EPL/Zone requirement of the location	Gc or better	Gb	✓	
Equipment group is correct	IIC	IIc	✓	
Equipment temperature class is correct	T1	T4	✓	
Degree of protection (IP grade) of the equipment is appropriate for the level of protection/group/conductivity	>IP55	IP67	✓	
Equipment circuit identification is correct	Present		✓	
Equipment circuit identification is available	Present		✓	
Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	Not applicable	Not applicable	Not applicable	Not applicable
There is no damage or unauthorized modifications	None		✓	
There is no evidence of unauthorized modification	None		✓	
Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight	Yes		✓	
Threaded covers on enclosures are of the correct type, are tight and secured	No threaded cover	No threaded cover	No threaded cover	No threaded cover
Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	Yes		✓	
Condition of enclosure gaskets is satisfactory	Yes		✓	
There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	No		✓	

Dimensions of flanged joint gaps are: – within the limits in accordance with the manufacturer's documentation or – within maximum values permitted by the relevant construction standard at time of installation or – within maximum values permitted by site documentation	Tightened to 85 Nm on bonded seal connection	85 Nm	✓	
Electrical connections are tight	Yes		✓	
Unused terminals are tightened	Yes		NA	
Type of cable is appropriate	Voltage and Environmental		✓	
There is no obvious damage to cables	None		✓	
Sealing of trunking, ducts, pipes and/or conduits is satisfactory	Tightness – refer to leakage test		Leakage Passed ✓	
Stopping boxes and cable boxes are correctly filled	Not applicable	Not applicable	Not applicable	Not applicable
Integrity of conduit system and interface with mixed system maintained	Not applicable	Not applicable	Not applicable	Not applicable
Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)	Inspection		✓	Gnd connected inside
Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	<100mOhm	<40mΩ	✓	
Automatic electrical protective devices are set correctly (auto-reset not possible)	Not present	Not present	Not present	Not present
Automatic electrical protective devices operate within permitted limits	Not present	Not present	Not present	Not present
Specific conditions of use (if applicable) are complied with	X= stainless steel	Ok	✓	

Cables not in use are correctly terminated	Pass		✓	no loose cables
Obstructions adjacent to flameproof flanged joints are in accordance with IEC 60079-14	Not present	Not present	Not present	Not present
Variable voltage/frequency installation complies with documentation	Not present	Not present	Not present	Not present
Temperature sensors function according to manufacturer's documents	Not present	Not present	Not present	Not present
Safety cut off devices function according to manufacturer's documents	Not present	Not present	Not present	Not present
The setting of the safety cut off is sealed	Not relevant	Not relevant	Not relevant	Not relevant
Reset of a heating system safety cut off possible with tool only	Not relevant	Not relevant	Not relevant	Not relevant
Auto-reset is not possible	Not relevant	Not relevant	Not relevant	Not relevant
Reset of a safety cut off under fault conditions is prevented	Not relevant	Not relevant	Not relevant	Not relevant
Safety cut off independent from control system	Not relevant	Not relevant	Not relevant	Not relevant
Level switch is installed and correctly set, if required	Not relevant	Not relevant	Not relevant	Not relevant
Flow switch is installed and correctly set, if required	Not relevant	Not relevant	Not relevant	Not relevant
Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	Yes = X in product number	Yes	✓	
No undue accumulation of dust and dirt	No		✓	

1.3 Sensing elements

1.3.1 Test

The test is done accordingly to the test schematics in IEC 60079-17 Tabel C.2 following descriptions of the test will be below if applicable.

1.3.2 Relevant Standard / document

- IEC 60079-17
- Datasheet "IFM LMT01A"
- Datasheet "HUBA 520 pressure sensor"
- Datasheet "IFM TT1050-01"
- Datasheet "PR electronic 9202"
- Datasheet "PR electronic 9113"
- Datasheet "PR electronic 9106"

1.3.3 Brief Test Plan

- Inspection will be done in respect to the datasheet, standards and Visual inspection prior to startup.

1.3.4 Pass/Fail criteria.

- The pass/fail criteria are specified for each inspection element is shown in Table 3.

Table 3: Sensing Elements – Test Result

Item	Criteria	Result	Pass/Fail	Notes
Circuit and/or equipment documentation is appropriate to the EPL/zone	Gc or better	Ga + Gb	✓	
Equipment installed is that specified in the documentation	Yes		✓	
Circuit and/or equipment category and group correct	Yes		✓	
IP rating of equipment is appropriate to the Group III material present	>IP55	IP67 IP66	✓	
Equipment temperature class is correct	T1	T4, T4	✓	
Ambient temperature range of the apparatus is correct for the installation	-10°C to +25°C		✓	
Service temperature range of the apparatus is correct for the installation	0°C to 40°C		✓	
Installation is clearly labelled	Yes			needs label on PT+LT
Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	Not applicable	Not applicable	Not applicable	Not applicable
Cable glands and blanking elements are the correct type, complete and tight	Yes		✓	
There are no unauthorized modifications	None		✓	
There is no evidence of unauthorized modifications	None		✓	
Diode safety barriers, galvanic isolators, relays and other energy limiting devices are of the approved type, installed in accordance with the certification requirements and securely earthed where required	Yes		✓	

Condition of enclosure gaskets is satisfactory	Yes; if applicable	N/A	✓	
Electrical connections are tight	Yes		✓	
Printed circuit boards are clean and undamaged	Yes	N/A	N/A	N/A
The maximum voltage Um of the associated apparatus is not exceeded	Yes		✓	
Cables are installed in accordance with the documentation	Yes		✓	
Cable screens are earthed in accordance with the documentation	Yes		✓	
There is no obvious damage to cables	None		✓	
Sealing of trunking, ducts, pipes and/or conduits is satisfactory	Yes		N/A	
Point-to-point connections are all correct	Yes		✓	
Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section) for non-galvanically isolated circuits	<100mOhm	<35mΩ	✓	
Earth connections maintain the integrity of the type of protection	Yes		✓	
Intrinsically safe circuit earthing is satisfactory	Yes		✓	
Insulation resistance is satisfactory	Yes		✓	
Separation is maintained between intrinsically safe and non-intrinsically safe circuits in common distribution boxes or relay cubicles	Yes			Partly
Short-circuit protection of the power supply is in accordance with the documentation	Yes		✓	

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Specific conditions of use (if applicable) are complied with			N/A	
Cables not in use are correctly terminated	Yes		✓	
Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	Yes		✓	
No undue external accumulation of dust and dirt	Yes		✓	

Inspection performed by: RBS

Ballard Power Systems Product Solution

Date:

03/09-2024

Executed

30/08-2024

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	Date.	Description
001	19/09/2024	First Issue
002	07/02/2025	Latest revision of Declaration replace rev 001
004	28/02/2025	Comments to CrossWind - No corrections

Document Title:	BLPH Project - Declaration of Conformity (FCwave)
Document Number:	K559-2254-CWIWP4202202-K01-001
Revision:	Rev004
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Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	K01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Declaration of Conformity

As manufacturer, Ballard Power Systems Europe A/S, Majsmarken 1, 9500 Hobro, Denmark, hereby declares that the product(s) mentioned below:

Product no. and name:

Product no.: **7001000** Product name: **FCwave**
Product Designation: **Fuel Cell Power System**

Complies with the requirements of the following Union harmonized legislation, standards and specifications:

Legislation:

- Machinery Directive (2006/42/EC)
- Electromagnetic Compatibility Directive (2014/30/EU)
- RoHS (2011/65/EU)

References:

Directive	Standard	Description
MD	EN 62282-3-100:2020	Fuel cell technologies - Part 3-100: Stationary fuel cell power systems - Safety
EMC	EN 61000-6-2:2019	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
EMC	EN 61000-6-4:2019	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
RoHS	EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Additional:

This declaration is only valid as long as the service and maintenance instructions for the product is followed, and the product is not modified.

The pressurized equipment in the product is out of scope for the PED directive 2014/68/EU, as it is covered by article 4, section 3. Hence the PED directive is not listed.

Hobro, 05.09.2024
Place and date

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Ballard Power Systems Europe A/S

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Revision history		
Rev.	**Date.**	**Description**
001		First Issue
002	14/02/2025	New release of DoC for CrossWind container

Document Title:	**BLPH Project - Declaration of Conformity (Container Solution)**
Document Number:	K559-2254-CWIWP4202202-K01-002
Revision:	Rev002
Sequence Number:	002
File Name:	K559-2254-CWIWP4202202-K01-002Rev002
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	K01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Declaration of Conformity

Ballard Power Systems Europe A/S, Majsmarken 1, 9500 Hobro, Denmark hereby declares that the product(s) mentioned below:

Product no. and name:

Product no.: **601456B-7002362** Product name: **FC PowerGen 1000kW**
Product designation: **Stationary Fuel Cell Power System**

Complies with the requirements of the following directives and standards:

Accessories/sub-assemblies:
The following accessories/sub-assemblies are also cowered by this DoC (If any):

Product no.:	**601456B-7002362**	Product name:	**40ft Fuel Cell Container**
Product no.:	**601456B-7002973**	Product name:	**Cooling unit**
Product no.:	**601456B-7003716**	Product name:	**10ft Converter container**

Directives:

- Machinery Directive (2006/42/EC)
- Pressure equipment (2014/68EU)
- ATEX Directive (2014/34/EU)
- Low voltage Directive (2014/35/EU)
- Electromagnetic Compatibility (EMC) (2014/30/EU)

Additional:

This declaration is only valid as long as the service and maintenance instructions for the product is followed, and the product is not modified.
Hydrogen Manifold compliance to PED is covered by K599-2254-CWIWP4202202-K01-003.

Hobro, 13022025

Henrik Rise Christensen
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Director, Operations & Business
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Ballard Power Systems Europe A/S

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Revision history		
Rev.	**Date.**	**Description**
001		First Issue
002		Drawing added
003		Revision corrected

Document Title:	**BLPH Project - PED Compliance H2 Manifold Addendum**
Document Number:	K559-2254-CWIWP4202202-K01-3
Revision:	Rev003
Sequence Number:	3
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Purchase Order:	CWIWP4202202
Code:	K01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

PED compliance H2 manifold

Full Title: *Addendum – PED compliance H2 manifold for DoC*

Abstract: The following document will contain an internal walk through of the compliance of the Pressure equipment directive and the technical dossier for Declaration of conformity

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1.0 Executive Summary

The document will contain a walkthrough of the analysis of Pressure equipment directive compliance accordingly to 2008/68/EU. The analysis concluded that the maximum pipe diameter is a DN32 and a pressure of 6,5 Barg. Due to this the conformity category is "category 1" which leads to "Module A" conformity assessment procedure. Documentation according to this is described, and/or combined in a PED dossier to verify compliance with PED module A.

2.0 Reference documents

Table 2-1: Reference documents

Document no.:	Document name:
2014/68/EU	Pressure equipment directive
550002	DoC FC PowerGen 1000kW®
	Certificate dossier
SPC ID 0104	H2 Leak Test Procedure

3.0 Definitions and Acronyms

Table 3-1: Definitions and Acronyms

Document no.:	Document name:
PED	Pressure Equipment directive
DoC	Declaration of Conformity

4.0 Purpose

The following document will contain the PED analysis of the H2 manifold as an add on part to the FC PowerGen 1000kW®. The document is created based on the process described in the PED 2014/68/EU

The following part which is not a part of the document 550002 and will be covered by this PED statement: **DN32 H2 collector manifold**

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5.0 Analysis of technical demands in relation to 2010/68/EU

5.1 Background for analysis

Table 5-1: Background for *conformity assessment*

Item	**Document name:**
Dimensioning pipe size	DN32
Maximum operating pressure	6,5 Barg
Fluida groupe[1]	Hydrogen Groupe 1

[1] According to article 13 a)

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5.2 Analysis of conformity category.

According to article 4 section C, the category for Fluida groupe 1 is defined in following table 6 in the PED shown in Figure 1.

Figure 1: Conformity category PED 2008/68/EU Tabel 6

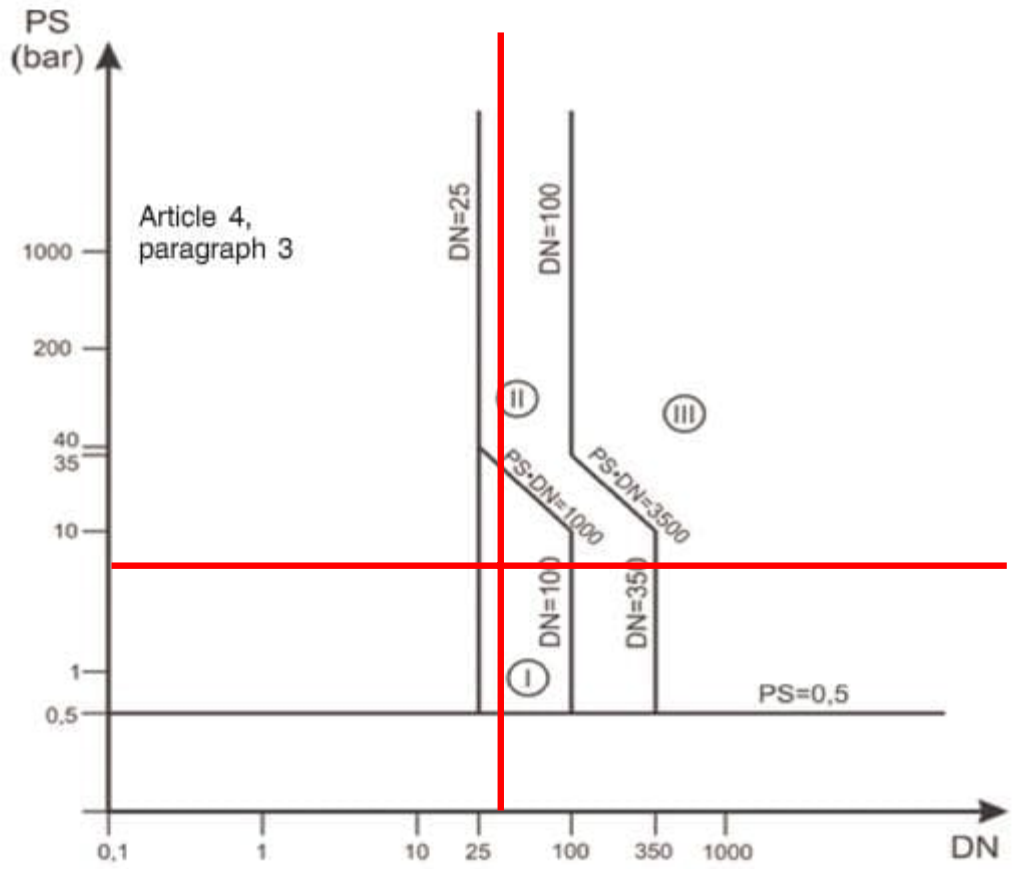


Table 6

Piping referred to in Article 4(1)(c)(i), first indent

The Red lines is an approximate line of the Size and pressure of the part. The intersection will define the point defining the category.

As visualized in the Figure 1, the category applicable for the part will be **Category 1.** As shown in the diagram from PED Annex II section 1. The "Conformity group I" will refer to a "module A" Conformity assessment procedure according to PED Annex III. The following procedure will be described in the following sections of this document.

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6.0 Technical documentation

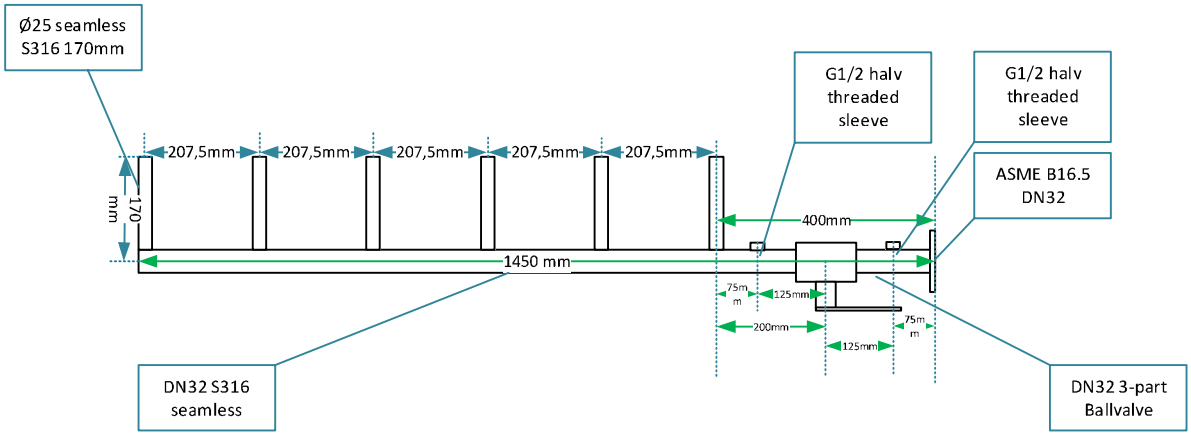
6.1 General description of the product

The product is a hydrogen manifold capable of distributing hydrogen from a single input into 6 independent outputs. The product contains an ASME B16.5 flange for connecting the input. A DN32 pipe with 25mm branches all in stainless steel. There is installed a 3-part welded ball valve type DVC 131150032 suitable for hydrogen 6,5 Barg. The valve is for manually blocking the hydrogen supply during e.g. service.

The product may not be installed in applications where a non-sufficient pressure relief valve set to 10 Barg is not installed.

6.2 Drawings of the Construction

Figure 2: Technical drawing of H2 Manifold



6.3 Results of construction calculations and examination

As the part is not relying on any structural strength since the pipe is not holding any weight, the only relevant construction is the pipe pressure rating. The following pipes are used:

- DN32 42.40x2.00mm EN-10216-5 1.4401/1.4404 TC2 pressure tested to 1500 PSI
- 25.00x2.00mm EN-10216-5 TC2 A269 213 pressure tested to 199 Barg

Further Certificates on welds and parts for the manifold will be in a separate file. And is done according to the "module A" requirements

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6.4 Inspection and test

6.4.1 Hydrogen pressure test

The hydrogen manifold has gone through several tests to verify the tightness of the system, even though the material used for manufacturing the hydrogen manifold is higher than the intended maximum pressure of the Hydrogen manifold.

To sum up the test:

- Individual test of component (document not released. Procedure according to 62282-3-100:2020 section 6.2 Leakage test)
- Complete assembly test Formier gas 5% H2 (document not released. Procedure according to 62282-3-100:2020 section 6.2 Leakage test and SPC ID 0104)
- Complete test pure H2 (document not released. Procedure according to 62282-3-100:2020 section 6.2 Leakage test and SPC ID 0104)

6.4.2 Welding testing

The following welds on the hydrogen manifold has been tested according to the certificates included in the Certificate dossier.

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Revision history		
Rev.	**Date.**	**Description**
001	15/08/2024	First Issue

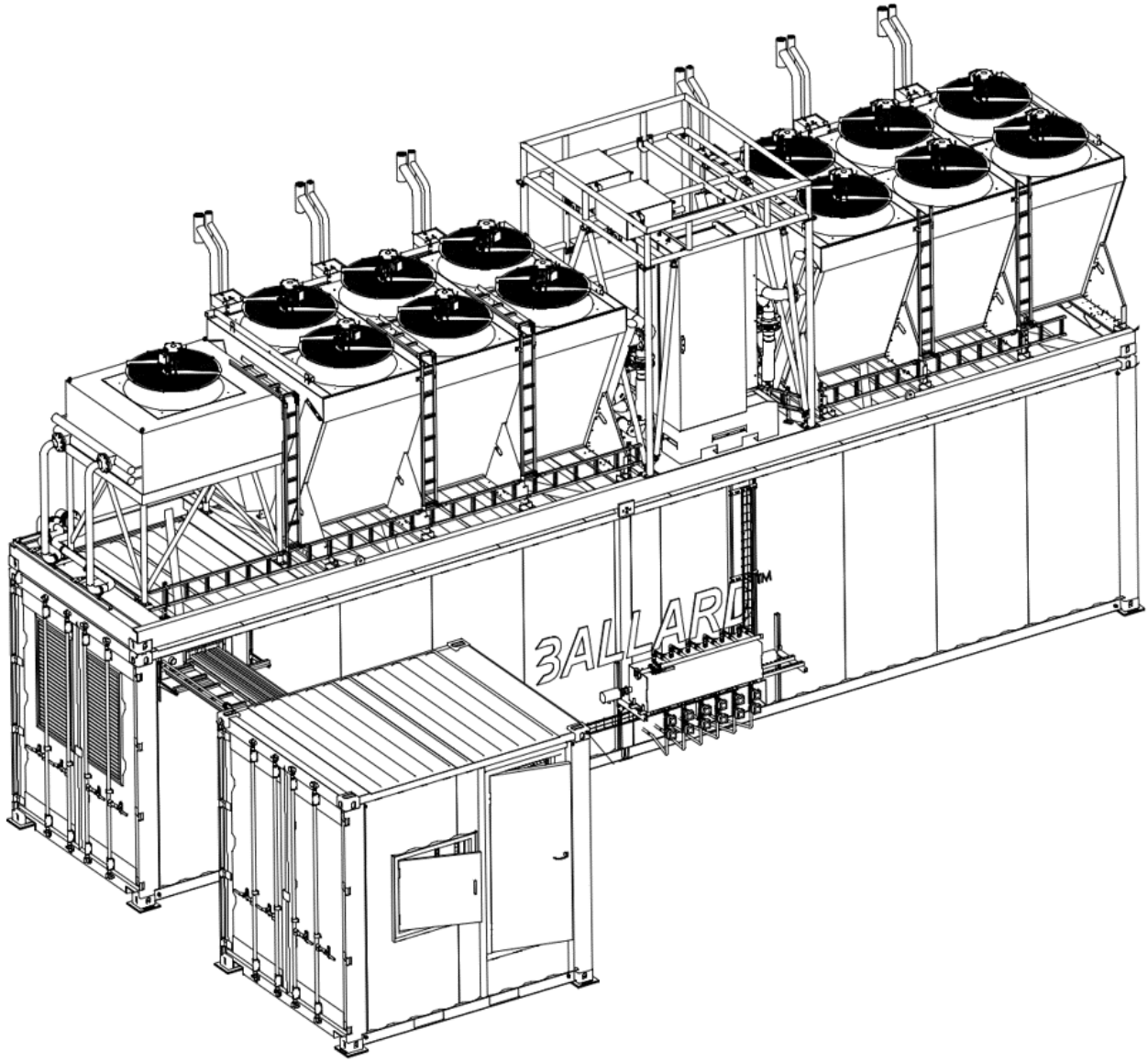
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Document Number:	K559-2254-CWIWP4202202-N01-001
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Purchase Order:	CWIWP4202202
Code:	N01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

FC Megablock 1000kW

Part no.: 5550003

Configuration: 40ft Fuel Cell Container w. 6 FCwave™
10ft Grid Interface Container, 6,6 kVAC

Integration Manual



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1.0 Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURES DESCRIBED IN THIS MANUAL

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property. It is therefore necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device. Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, compressed gases, and H2.

This manual includes certain safety guidelines and recommendations; however, this manual is not intended to cover all situations. The customer is responsible for determining the suitability of the customer's particular design or application, and for ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated. Ballard Power Systems Europe A/S ("BPSE") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the operating recommendations in the manual. The customer is responsible for being aware of, and complying with, all applicable laws and regulations. BPSE has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual. Failure to follow any instruction or recommendation could result in death or bodily injury or loss or damage to property.

BPSE intends for the device to be installed, operated, and serviced only by approved technically qualified and experienced people who understand the principles of fuel cell technology, are aware of the safe operating limits of fuel cells, and are familiar with the risks posed by operating a fuel cell module. BPSE relies on customers to use their own knowledge and experience when installing, operating, and servicing the device. BPSE also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual.

Information in this manual is subject to change without notice. BPSE makes no commitment to update or keep current the information in this manual and reserves the right to make updates or other changes to this manual and/or to the products described in this manual, at any time without notice. Updates and other changes to the manual may be posted on the BPSE website and may be accessed through the customer portal; it is the customer’s responsibility to check for any such updates or changes.

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2.0 General Information

2.1 System introduction

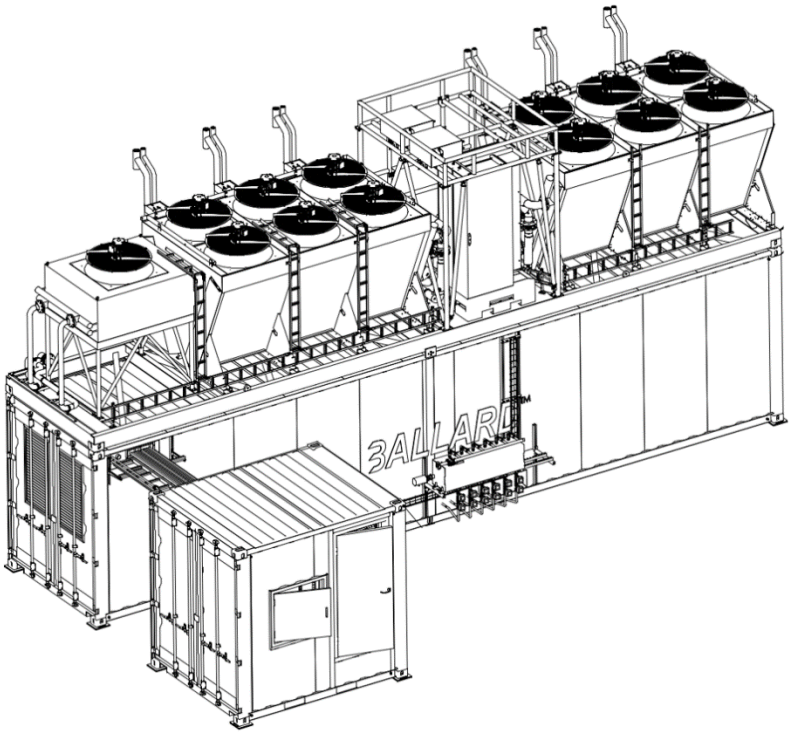
The Ballard FC Megablock is a modularized power generator, comparable to a diesel-generator. It is a stationary, megawatt-scale hydrogen PEM fuel cell solution, utilizing the FCwave™ from Ballard.

The solution contains all needed elements to produce 1MW AC, when supplied with an auxiliary power supply, a local hydrogen supply, and an electrical grid that is controlled by a Power Management System (PMS), communicating with the use of Modbus.

Integration between the FC Megablock and the local PMS enables the integrator to create a coherent and automatic system that reacts on the power-demand on the grid, within the given dynamic and capability limits of the solution.

The FCwave and the internals of the containers are designed in such a way that no explosive hazard zones are created inside the solution.

Figure 1: System overview



Indicative illustration layout of system.

2.2 Manual purpose and scope

This Integration Manual offers instructions, procedures, technical information, and best practice to assist integrators in designing a compatible designated site and subsystems that integrate seamlessly with it, in preparation for installation of the system.

It covers topics such as:

- Integration safety
- System descriptions
- Mechanical/electrical interfaces and control details.
- Required In- and Outputs

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Before commencing integration and installation of the system, personnel must read and understand the Operator Manual and this Integration Manual.

2.3 Intended audience

The intended user of this manual is qualified Integrators partaking in designing the designated site and subsystems for the FC Megablock, within the intended use and limits of the system.

Aspects of this manual require the integrator to have read and understood the Transport and Handling Manual, Operator Manual and Service and Maintenance Manual. Furthermore, a general knowledge of the fuel cell processes, and how to set up control and communications using Modbus TCP/IP are required.

2.4 Manual series

The Manual Series provides manuals covering different life-phases of the system, as defined in Table 2-1:

Table 2-1: Manual series contents

Document no.	Title	Brief purpose description	Intended user(s)
7003672	Transportation and Handling Manual	Enables safe, land-based, transport and handling from manufacturer to designated site.	Personnel qualified in preparation of, handling, and transport of freight.
7003718	Integration Manual	As described in section 2.2	As described in section 2.3
7003717	Operator Manual	Provides information to personnel for safe operation of the solution, instructions for operator-based maintenance, safety rules and recommendations	Operators, Integrators, Installers, Service and Maintenance personnel, personnel working in or near the system, and persons instructing visitors.
7003719	Service and Maintenance Manual	Provide information regarding Service and Maintenance schedules and related safety.	Service and Maintenance personnel.

Ballard Power Systems Europe may update the provided manuals on an ongoing basis.

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2.5 Hazard Symbols

Hazard symbols throughout the manual indicate objectives or potentially dangerous situations.

Table 2-2: Hazard symbols

	**MANDATORY ACTIONS**: are marked with blue action-points. This indicates actions that must be performed. Ignoring may result in an accident, which could cause damage to equipment or other property, and could cause bodily injury if not promptly detected and remedied.
	**PROHIBITIONS**: are marked with red prohibition-signs. This indicates a forbidden action. Ignoring may result in immediate bodily injury or loss of life or could cause damage to equipment or other property
	**WARNINGS**: are marked with yellow triangles and/or square warning. Indicates hazards that may result in an accident, which could cause immediate bodily injury or loss of life or could cause damage to equipment or other property.
	**CAUTION:** indicates actions that may result in an accident, which could cause damage to equipment or other property, and which could cause bodily injury if not promptly detected and remedied.
	**ELECRICAL HAZARD** Obey ALL warnings, cautions, and safety instruction related to electricity. Failure to do so may result in electrical shock leading to personal injury or death.

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2.6 References

Throughout the manual are referrals to separate documents. These references documents are available on the BPSE after sales Service Portal.

Should a document not be available, contact BPSE.

Table 2-3: Reference documents

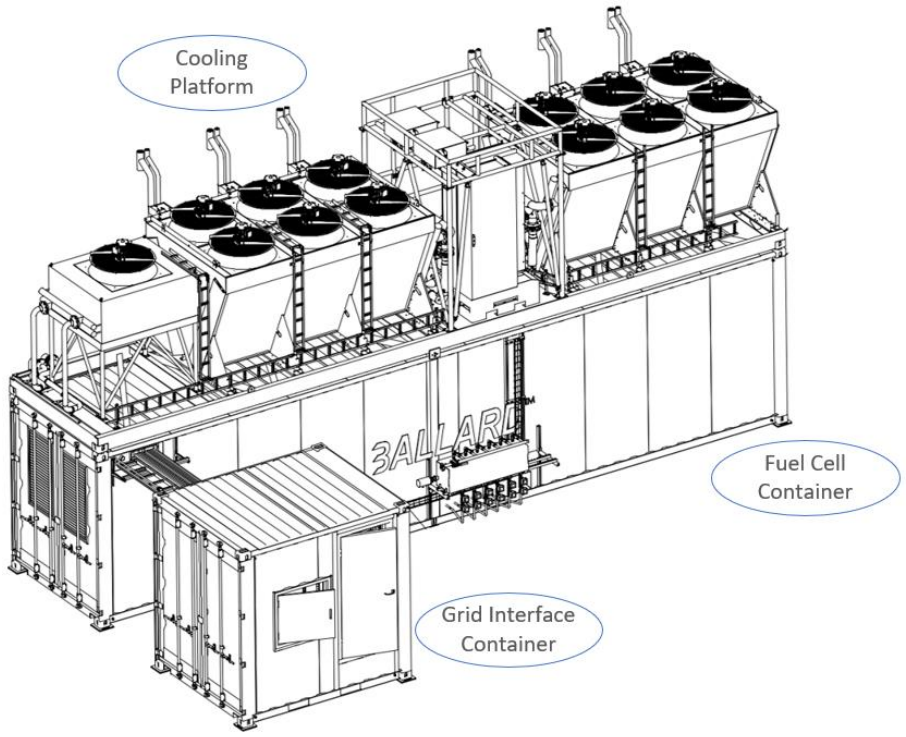
Document no.:	Document name:
K559-2254-CWIWP4202202-D03-001Rev002	Technical Datasheet
K559-2254-CWIWP4202202-C08-001	Control philosophy and Logic block diagrams
K559-2254-CWIWP4202202-D05-001	Material Safety Data Sheets
K559-2254-CWIWP4202202-C99-001Rev002	Hydrogen Safety Concept
K559-2254-CWIWP4202202-K02-001Rev002	Equipment hazardous area certificate and schedule
K559-2254-CWIWP4202202-B01-001Rev007	General Arrangement
K559-2254-CWIWP4202202-E99-004Rev002	Grounding Layout
K559-2254-CWIWP4202202-E01-001Rev001	Interconnection Diagram
K559-2254-CWIWP4202202-E99-003Rev001	Cable Transit Schedule
E03-007	Electrical Interface Documentation
K559-2254-CWIWP4202202-E99-005Rev001	Secure Remote Access
K559-2254-CWIWP4202202-C03-001Rev004	P&IDs
K559-2254-CWIWP4202202-J08-001	Factory Acceptance Test
C08 - 002	FC package Modbus Map
N/A	Alarm list

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3.0 System Description

The system is a modularized power generator based on a number of FCwave™ Fuel cell units.
The FC Megablock consists of the following main components:

Figure 2: Major components overview



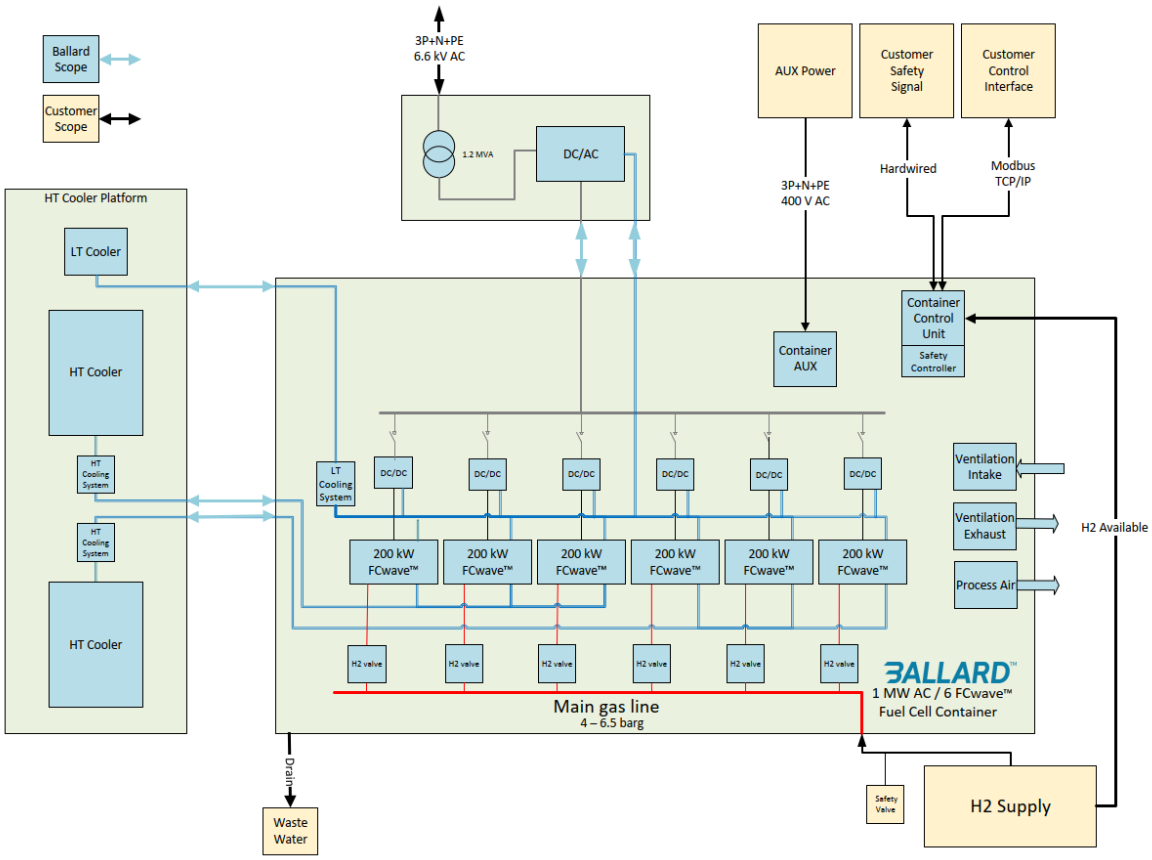
Short descriptions of major components can be found in Table 3-1

Table 3-1: Major components of the machine (See Figure 2)

Component	Short Description
Fuel Cell Container	Based on a 40ft HC container, modified to a machine housing with access, ventilation, light safety etc. The container holds 6 FCwave modules with installation, internal 400VAC power supply for complete Balance of Plant components, main controller, LT pump system and DC/DC converters.
Cooling Platform	40ft Cooling Platform with service platform. 2 individual HT radiators dimensioned to the specific solution 2 individual HT pump-systems 1 LT radiator
Grid Interface Container	Based on a 10ft HC container, modified to a machine housing with access, ventilation, light, safety etc. Holds DC to AC grid-forming power electronics, Isolation transformer, and Grid Main Breaker.

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Figure 3: Scope block diagram



Block Diagram showing the scope of main components and connections of the system.

3.1 Intended use

The system acts as a grid following power generator, providing up to 1MW at 6.6kVAC 50Hz. This system is designed and is intended to be used for offshore stationery application (fixed installed system). Hydrogen supply to the system is in the customer scope and the details about the hydrogen standards, quality etc. are mentioned in the integration and other manuals that will be provided to the customers. The customer local Power Management System (PMS) requests the amount of power to be generated within the given dynamic and capacity limits of the system, which are communicated in real-time on the Modbus TCP/IP. The Modbus data is transported between the system and the PMS.

The system has multiple operating data available on the same Modbus, including alarms.

The system is placed in operation by request from PMS via Modbus, and similarly can be stopped, if necessary, which will stop power supplying the to the grid. The system can be stopped remotely on request. During normal operation, a power request of 0 is accepted by the system.

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3.2 General Operating states

Table 3-2: General Operating mode descriptions	
Operating Mode	**Brief description**
Off	Container fully depowered.
Sleep	Container minimum operational level. Control and safety system are operating, but no high-power systems (>20kW) are operating. Hydrogen supply and fuel cells are inactive.
Standby	Waiting state for "Run" command from high level control system. Hydrogen supply and MV link disabled.
Running	Operational state for the container, where the fuel cell modules are consuming hydrogen to produce electrical energy. Cooling and ventilation systems are operating to support fuel cell modules.
Shutdown	The cooling and ventilation systems shuts down. Container returns to standby.
Fault	Internal fault state. Hydrogen supply and fuel cells are inactive.

For more details, refer to section 7.1

3.3 General System description

3.3.1 Fuel Cell Container

The Fuel Cell Container houses 4-6 FCwave™ units. Each FCwave™ is a separate unit with full hydrogen safety and a double wall barrier to ventilate any possible hydrogen leakages, internal to the FCwave™, directly to the outside.

The fuel cell container is equipped with a ventilation system, which will ensure that the filtered process air for the FCwave™ is available. The ventilation system will also create an air flow through the container, for cooling and ventilation the room.

Process piping installation is generally below the raised floor. Access to this area below the floor is for service only and requires tools. For moving heavy service components inside the container, it is equipped with a crane rail for a manual trolley.

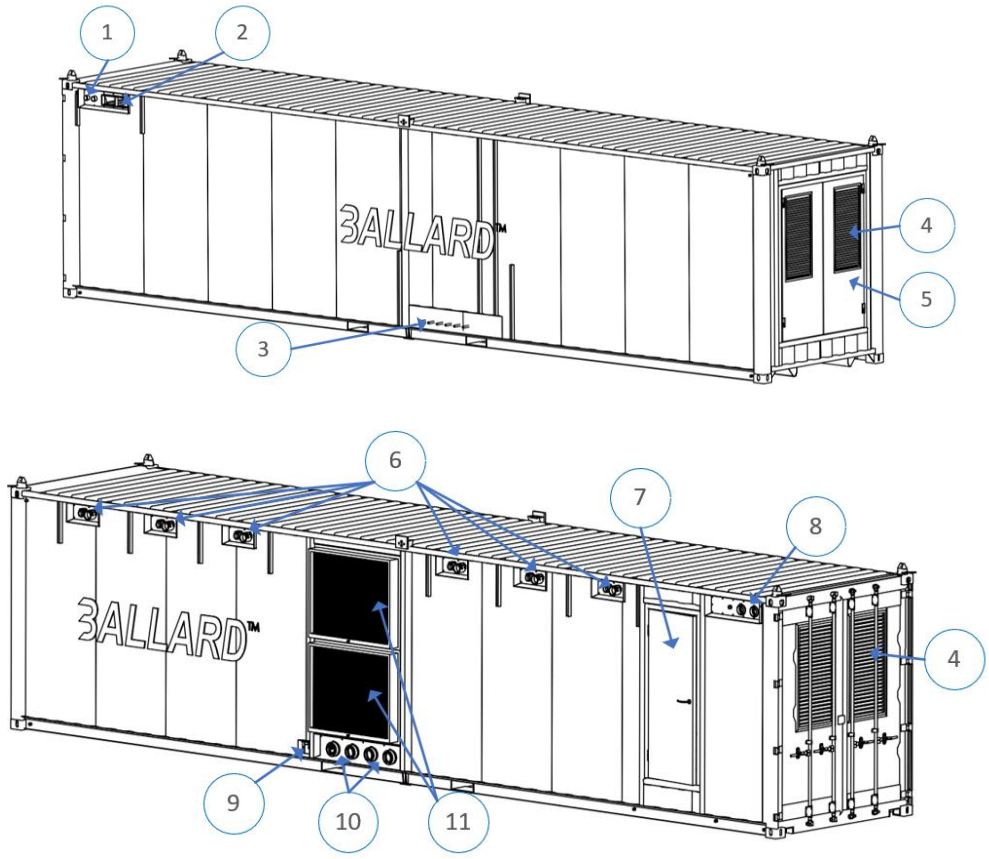
The DCDC panels for fuel cell power output connects each FCwave™ to a common DC link busbar, which feeds the outgoing connection of the Fuel Cell Container. Each DCDC panel for fuel cell output can be isolated electrically, to allow for maintenance on the specific cabinet or related FC wave.

The system controller is a centralized unit that monitors and operates the entire system and includes a separate safety controller to prevent any critical failure or emergency situations to escalate.

The power for auxiliary units such as water pumps, container ventilation and basic power is fed from a 400V AUX power panel which again is supplied from the DC link or from an external power supply, in case of shutdown of the solution.

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Figure 4: Fuel Cell Container overview



Indicative overview of Fuel Cell Container with numbered ballons (see Table 3-3)

Table 3-3: Fuel cell Container overview descriptions (See Figure 4)

1	LT Cooling interface (Grid Interface Container)
2	Wall passthrough for Control Signals, auxiliary power, and DC power cables to Grid Interface Container
3	Gaseous hydrogen piping wall passthrough
4	Ventilation exhaust
5	Service doors
6	Process air and hydrogen enclosure ventilation exhausts
7	Main access door
8	LT Cooling interface (Heat dissipation and Header tank)
9	Process water drain
10	HT Cooling system interface
11	Ambient air intake: Container ventilations and process air

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3.3.2 Cooling Platform

The Cooling platform is a steel structure with the footprint of a 40ft container. The purpose of the cooling platform is to dissipate the heat generated by the High Temperature (HT) cooling system that cools the Fuel Cell Modules, and by the Low Temperature (LT) cooling system that cools the power electronics of the solution. The standard installation method of the platform is to mount it on top of the fuel cell container, using standard container locks.

The sizing of the coolant fans and radiators are dependent on the ambient temperatures of the designated site and operating conditions of the system.

If utilization of the generated heat produced by the fuel cells during operating for heating of building etc., a heat exchanger can be fitted to allow heat recovery.

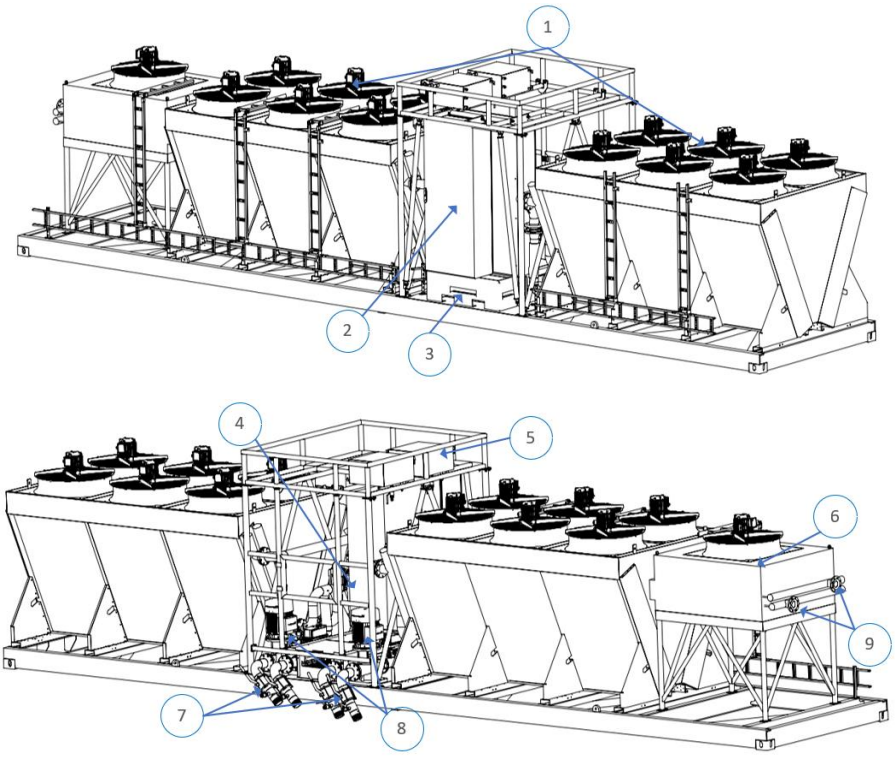
The cooling systems are open unpressurized circuits, cooling with the media Ethylene glycol. Each system has an open header tank for volume changes due to temperature.

The highest temperature of the HT and LT cooling systems are approximately 60 and 48 °C.

The pumps and pump control for the HT Cooling system is placed between the two big radiators (HT Coolers) on the cooling platform. Access is to this area is for service only and requires a ladder.

The pump and pump control for the LT Cooling system is located inside the Fuel Cell Container.

Figure 5: HT cooling platform overview



Indicative overview of HT Cooling Platform with numbered ballons (see Table 3-4)

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Table 3-4: HT Cooling platform overview descriptions (See Figure 5)	
1	HT Cooler with fans
2	Controller panel (backside)
3	Control signals in- and out
4	Service platform
5	Header tank
6	LT Cooler with fan
7	HT Coolant in- and outlet
8	HT Coolant pump
9	LT Coolant in- and outlet

3.3.3 Grid Interface Container

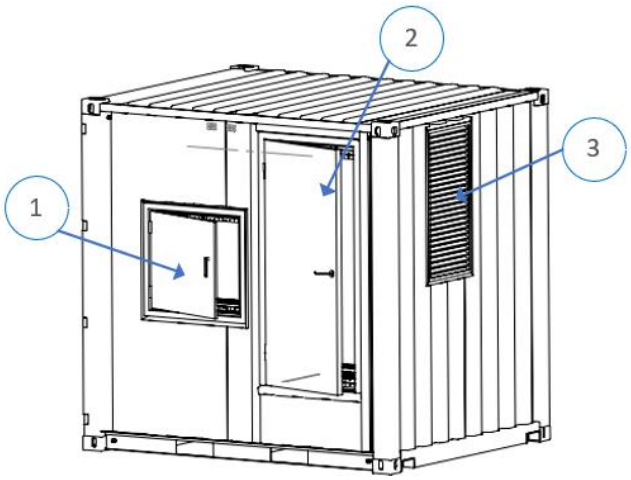
The Grid Interface Container is structurally a 10ft high-cube double-door container, modified to the specific need. It is designed as an electrical cabinet, housing DC/AC converters and a transformer that converts the energy to the desired voltage (6,6kV). Access to the inside is through the normal container doors which are, because of electrical safety, mechanically prevented from opening during operation. These are also equipped with safety sensors, which will immediately bring the entire solution to "Failure state" if opened.

Access is restricted to instructed and trained personnel, and only after a safety procedure is followed, which will deenergize the container to a safe mode.

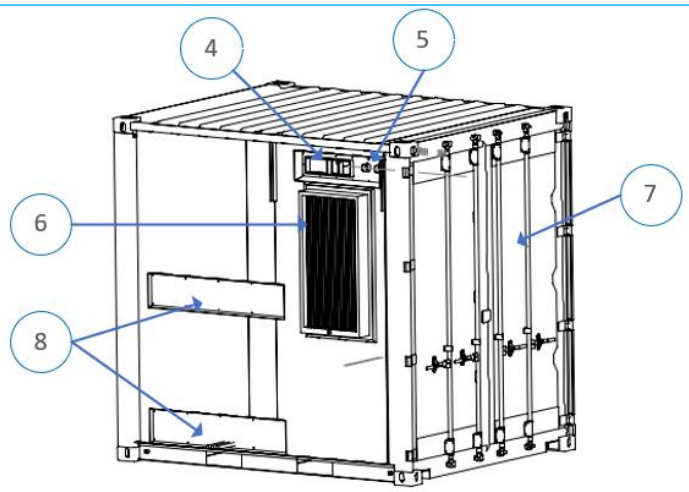
The control panel and grid breaker front of the Grid Interface Container is accessible from the outside, behind an additional locked door which will not shut down the solution if opened.

Customers connection of the grid is through the container side.

Figure 6: Grid Interface Container overview



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Indicative overview of Grid Interface Container with numbered ballons (see Table 3-5)

Table 3-5: Grid Interface Container overview descriptions (See Figure 6)	
1	Control panel access door
2	Main output breaker access door
3	Ventilation exhaust
4	Wall passthrough for Control Signals and DC power cables from Fuel Cell Container
5	LT Cooling interface
6	Ventilation air intake
7	Service doors
8	Grid interface (1MW AC output)

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4.0 Safety

The system is to be installed in cooperation with Ballard personnel. While working on the system there should always be more than one person present.



The reader of this manual must read the operator manual mentioned in section 2.4 as a complement to this integration manual regarding general function and safety.

4.1 Designated site Access and Security

It is recommended that the designated site is fenced off to prevent unauthorized access, and access within the fenced area should be limited.

The site responsible shall ensure that access to the site is limited to qualified personnel who are familiar with the site safety requirements. Appropriate Personal Protection Equipment (PPE) must be worn per site guidelines and warning signage must be adhered to.

4.2 Machine Access

At no time is unauthorized personnel permitted inside the containers or on the Cooling Platform of the solution.

To access the containers and the Cooling Platform through the designated doors, it may be required by local legislation that permanent stairs and use of temporary scaffolding or lifts are installed/available. Stairs could be as indicated in Figure 7.

Ballard can assist in creating such additional component to the system if agreed upon.

Figure 7: Example access stairs



Indicative example of solution to access the Main Access Door on the Fuel Cell Container

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The exterior container doors must always remain locked except during active installation, integration, service, or maintenance. The locks should be inspected regularly by site personnel to ensure that only authorized personnel have access to the insides.

It is recommended to keep a communications device on your person when being inside.

During operation, it is not recommended to be inside the Fuel Cell Container and access the Cooling Platforms.

The Grid Interface Container is designed with safety-interlock on the access door, preventing access during operation. Opening the container doors of the Grid Interface Container triggers a safety-switch which acts as an emergency stop, immediately shutting down the system.

4.3 Site safety for Personnel

As soon as practical the site responsible shall provide Ballard with a written set of site safety requirements and safety protocols that will conform with local regulations and industry norms.

The site responsible may amend the site safety requirements to conform to local regulations and such industry norms, by providing written notice of changes to Ballard reasonably in advance of their effective date.

The site responsible must require that all contractors and visitors comply with these site safety requirements. Ballard will comply with site safety requirements provided and be allowed access to the site to perform necessary tasks throughout the life of the system.

Site safety requirements given by Ballard are minimum requirements, as they may be a result of a mitigation measure from the risk assessment.

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4.4 Hazardous materials

The complete list of coolants and lubricants used in the 1MW Fuel Cell Container is shown below.

Table 4-1: Hazardous materials

Type	Name	Description / Use	Sub-assembly
Coolant	Glysantin® FC G20®	Used in the internal cooling loop of the fuel cell modules, where a low electrical conductivity is required. Pre-mixed 50/50 ethylene glycol-based coolant specifically developed to support the requirements in fuel cell technologies. It maintains a low and stable electrical conductivity, while at the same time providing protection against corrosion, frost and overheating.	Fuel Cell Modules
Coolant	Proviflow® Neo	Used in both HT and LT cooling loops. Pre-mixed 50/50 ethylene glycol-based coolant with OAT (Organic Acid Technology) inhibitors and designed to offer freeze point suppression as well as protection against corrosion, hard water scaling and bacterial growth.	Container Solution
Lubricant	Ceramic Grease PV.20.01	High-grade assembly paste and high temperature lubricant grease without metal particles used for lubrication of bolts.	Container Solution
Lubricant	Krytox™ GPL 205	Chemically inert, PTFE thickened grease based on perfluoropolyether (PFPE) oils that is safe for use around hazardous chemicals, these lubricants are non-flammable and safe for use in oxygen service. They can be used in extreme conditions, such as continuous high temperatures of up to 204 °C (400 °F) and will survive short-term peak temperatures of up to 220 °C (429 °F).	Fuel Cell Modules
Lubricant	Krytox™ GPL 206	Chemically inert, PTFE thickened grease based on perfluoropolyether (PFPE) oils that is safe for use around hazardous chemicals, these lubricants are non-flammable and safe for use in oxygen service. They can be used in extreme conditions, such as continuous high temperatures of up to 260 °C (500 °F) and will survive short-term peak temperatures of up to 270 °C (518 °F).	

More details can be found in the document Material Safety Data Sheets.

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4.5 Energy Lock-out-tag-out (LOTO)

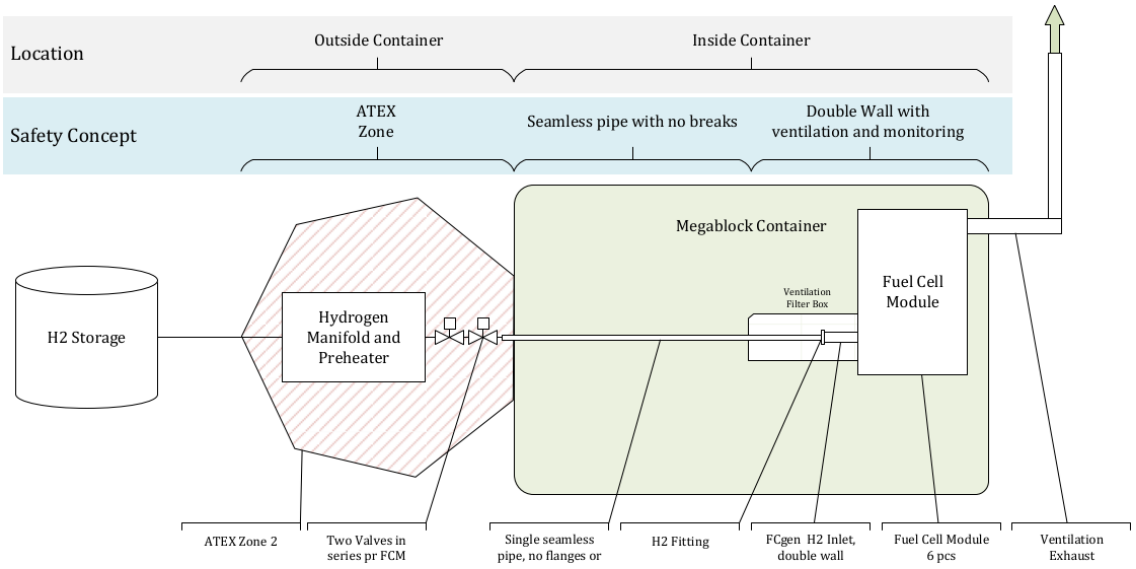
Energy sources provided to the system, as well as the Grid connection, must be provided with means for lockout (de-energization), and a written procedure detailing the equipment, and steps required.

Use proper work-etiquette regarding LOTO when working on energy-suppling components.

4.6 Explosion safety

The hydrogen safety philosophy has several safety concepts, as indicated in Figure 8.

Figure 8: Hydrogen flow overview



Illustrative overview of hydrogen flow. See Hydrogen Safety Concept for more details.

Hydrogen is delivered to the hydrogen interface from a local hydrogen storage (refer to section 6.3 for specifications).

The area in which the interface, the hydrogen-manifold and -preheater, and hydrogen safety valves resides, is classified as an ATEX Zone 2. A hazardous mixture will not likely be present in normal operating conditions, and if so, only for a short period at a time. Electrical equipment in this zone is and shall conform to regulations and have the "EX" marking or similar. Detailed drawing of the hazard zone can be found in the General Arrangement. For more information regarding equipment installed in the zone, refer to the Equipment hazardous area certificate and schedule

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Respect the zone indicated, do not introduce any source of ignition.

There is no risk of hydrogen leakages inside the general space of the Megablock Fuel Cell Container that can create an explosive atmosphere, due to the design of the feed pipes being seamless, one-piece-bends from outside of the container, routed through the container space, and connected the applicable Fuel Cell module.

The connection to a Fuel Cell Module (The H2 Fitting) is encapsulated within an extension of the Fuel Cell Modules Hydrogen Enclosure called the "Ventilation filter box", thus utilizing dilution and removal of any potential hydrogen with mechanical ventilation. Should leakages from this connection occur, the hydrogen detectors within the Fuel Cell Module will detect it and trigger a safe shutdown of that module and hydrogen supply.

The Ventilation system of the Fuel Cell Container creates a slight over-pressure to counteract ingress from particles and gas. As an additional precaution in case of hydrogen entering, the general space inside is equipped with hydrogen sensors. The position of these will detect any hydrogen entering or exiting the container through the ventilation system.

All safety-related triggers of the solution will shut off the hydrogen supply of either the affected system or the entire system.

The process exhaust contains all biproducts from the fuel-cell stacks within the Fuel Cell Modules. The exhaust is a mixture of high-humidity, low-oxygen process air with trace amounts of hydrogen. The concentration of hydrogen will always be below 25% of Lower Explosive Level (LEL), leading to a non-hazardous zone.

4.7 Fire safety

The Fuel Cell Modules have internal fire detection in the form om smoke detectors and linear heat detectors. If a Fuel Cell module detects to high temperature, it will automatically perform a safe shutdown of itself and indicate an alarm.

If Smoke is detected inside the general space of the Fuel Cell Container, the entire system will perform a safe shutdown and indicate an alarm.

Should a fire occur, exit through the provided emergency exits.

The system is not delivered with fire-extinguishers.

4.8 Craneage and lifts

During installation onto the designated site, and installation of general hardware i.e. exhausts and interconnections between the major components of the solution, tools such as cranes and lifts are to be used. These tasks can only be done by instructed personnel.

Scaffolding, lifts, and cranes must be made available, unless otherwise agreed upon with Ballard.

A lifting study for craneage is recommended to be conducted by the site responsible, referring to the respective transport and handling manual of the solution's major components and description of positioning and assembly in section 5.1.

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4.9 Electrical safety

Installation of electrical connections between the major components of the solution is the responsibility of Ballard if not agreed upon otherwise. Electrical connections to the Interfaces described in section 6.0 is the responsibility of the interface-connecting party.



The electrical system of the solution is designed in accordance with electrical and fuel cell codes to minimize electrical hazards. Electrical hazards will occur when the design is significantly compromised, typically through alteration, improper maintenance, or wear.

Dimensioning of cables and safety-equipment on the supplying and receiving end of electrical connections outside the solution must be done according to local legislation.

Select cabling and safety-equipment to the system that appropriately suits the application. Ensure to meet specifications of voltage, current, environmental temperature limits, chemical and mechanical resistance, and flexure requirements of the application. Avoid hazardous and unsafe situations that could result from condition such as, but not limited to:

- Improper grounding
- Handling electrical leads or devices with wet hands or on wet ground
- Frayed electrical leads
- Incorrect or improper connection of the terminal leads
- Short circuits
- Back-feed from energized normal and emergency power sources

Shutting down the solution during active installation and integration may be necessary. Voltages may remain in the solution for a length of time. No activities are to be performed during this time as it presents a shock hazard.

Certain circumstances can lead to voltage persisting on the electrical systems. Always check for residual voltage before any activities. In some cases, it may require removal of hydrogen in the FCwave.

4.9.1 High DC Voltage Isolation Failures

Under normal circumstances, all high DC voltages are isolated from ground and the resistance is monitored. If isolation is lost on one high-voltage pole, a person working on the electrical system can sustain a fatal current-flow by touching the other voltage-pole and ground.

If two simultaneous faults occur and isolation is lost on both voltage-poles, a high voltage short circuit can occur resulting in extremely high currents/flash arcs. High currents can generate a large amount of heat which can subsequently damage electrical equipment and cause bodily harm.

Components inside the solution affects the resistance to ground, resulting in lower resistance over time.

Above-mentioned hazards are mitigated by the safety system of the solution. It actively monitors the resistance, warning if anything is to be reacted on, or shutting down the entire system in case of sustained resistance-drop or fault.

⚠ ELECTRICAL HAZARD	
	**If an isolation failure is detected and located in the MODULE, do not operate the fuel cell module until the root cause is determined and remedied.**

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4.9.2 Batteries



Inside the solution reside several Lead-acid batteries for UPS systems. Prior to transportation of the solution, the State of Charge (SoC) have been lowered to >30% and connections have been disconnected.

Ballard personnel will re-connect these according to respective manuals and the SoC is raised to normal operation conditions during commissioning.

4.9.3 Grid Interface Container access



The internals of the Grid Interface Container is designed as an electrical cabinet (IP00), meaning that current-carrying conductors and terminals are exposed.

⚠ ELECTRICAL HAZARD	
	**HIGH VOLTAGE – 6.6 kV** **Danger of electrocution** **Authorized personnel only** **Keep clear and follow safety protocols** **Proper PPE required** **Failure to comply may result in serious injury or death**

Access is prohibited during operation. Opening the doors, except the control panel door on the side, activates the safety system, triggering emergency stop of the entire system. Residual voltages remain in certain components.

Entering this container requires prober de-energization and lockout tagout. Wait at least 10 minutes after de-energization before entering, and measure for residual voltages (<20VDC is safe)

4.9.4 Earthing

Provided Earthing-connection by the site is crucial for electrical safety. Refer to Grounding Layout for details.

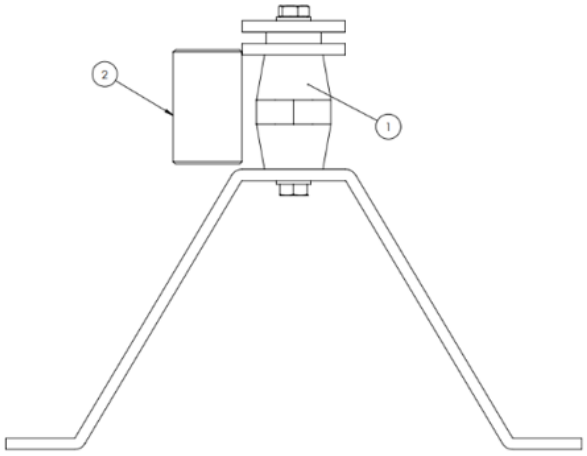
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4.9.5 Transportation Spacer

Prior to Transportation of the solution, an electrical isolator has been swapped with a transportation tube made of steel, ensuring stability of the MV transformer, located in the Grid Interface Container.

This must be swapped back to the isolator prior to any commissioning activities.

Figure 9: Transportation Spacer



Indicative illustration of the Isolator (1) that are swapped with the transportation tube (2)

4.10 Personal Protective Equipment (PPE)

Personnel must bring and use appropriate PPE.

In general:

- Safety shoes are mandatory.
- Hearing protection must be available and used when the system is operational.
- Fire inhibited clothes must be used when working on the electrical system.
- Helmets must be used when working with internal crane.
- Helmets and Fall arrest equipment must be used when working in heights.
- Suitable gloves and eye protection must be used for working with coolant.
- Suitable gloves must be used for where risk of cuts is present.
- Suitable tools for working on live voltages

During installation is it further recommended that personnel around the activities wear fluorescent jackets for visibility.

Working atop the containers (outside of the service platform) creates a risk of falling from almost 3m - Harnesses are required.

Do not work in these areas during extreme raining, windy, or snowy conditions.

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4.11 Freezing conditions



Process exhaust contains water. During freezing conditions, snow and icicles may form.

Wear safety helmets under these conditions.

4.12 Installation planning



It is recommended to create a realistic timeline for an installation-plan, mitigating the risk of stressful situations, potentially leading to injuries.

4.13 Control safety

The solution provides several control signals and information through the Modbus TCP/IP Connection. Follow the instructions in section 7.0 to ensure safe operation.

4.14 Testing safety

The solution is tested at the manufactures site according to the Factory Acceptance Test (FAT).

During commissioning of the solution, a similar Site Acceptance Test (SAT) will be conducted.

Only authorized personnel are allowed in the vicinity of the solution during testing.

During full-load testing (all FCwave™ running), no personnel are allowed on the Cooling platform.

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5.0 Positioning and Assembly

Activities during positioning and assembly of the solution at the designated site is according to agreements with Ballard. Customer must provide the specified requirements in section 5.2 as well as a cranage plan on site, prior to Ballard engagement in these activities.

NOTE: Some interface connections described in section 6.0 could be beneficial to have ready prior to Positioning and Assembly.

5.1 General Positioning and Assembly process

The following procedure describes the general process of positioning and assembly onto the designated site, not necessarily in chronological order. Refer to General Arrangement for details on site-specific details.

The major units of the system are to be handled as described in the respective Transport and Handling Manual (See section 2.4).

- The Fuel Cell Container is positioned onto the designated site for permanent installation, anchored to the ground.
- Twist-locks are placed in the upper ISO corners of the Fuel Cell Container, as well as middle-support for Cooling Platform.
- The Cooling platform is lifted and placed on top of the twist-locks and the middle-support, ensuring that it is properly supported.
- Twist-locks are locked, permanently fixating the Cooling platform to Fuel Cell Container.
- The Grid Interface Container is positioned onto the designated site for permanent installation, anchored to the ground.
- Electrical and mechanical assembly between the units are carried out by Ballard personnel.
- Electrical and mechanical connection to the system is carried out by suppliers.
- Applicable tests after assembly are performed.

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5.2 Designated site Requirements

The following sections describe requirements for Positioning and Assembly of the system.

5.2.1 Environmental Operation Conditions

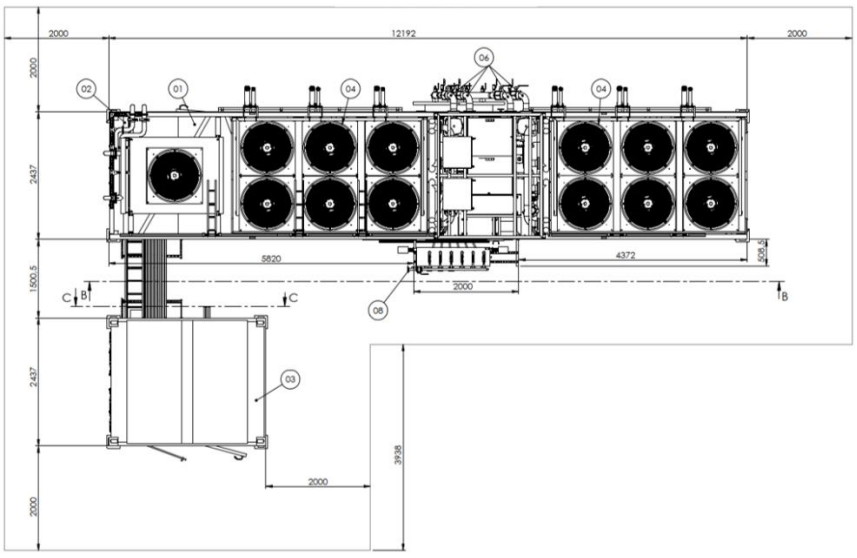
The system is intended to be installed outside, exposed to weather conditions.

Table 5-1: Operating conditions	
Altitude	< 100 m
Minimum ambient temperature, operating	-8,4 °C
Maximum ambient temperature, operating	+25 °C
Humidity	5-95% RH
Wind velocity	31 m/s
Extreme wind velocity for 1-Year recurrence	33,1 m/s
Extreme wind velocity	41 m/s
Weather	Designed for all year operation in temperate offshore areas, including wind driven rain and snow
Salt mist and Sea salt protection	Yes
Flooding	Approx 10cm above ground level
Earthquake	Not earthquake safe but designed to withstand customer-defined accelerations.

5.2.2 Space claim

The system has a space claim that enables access to the system required for future service and maintenance. To ensure proper function of the coolers, any buildings taller than 6.6 meters should be located at least 5 meters away.

Figure 10: Indicative illustration of space claim



Actual space claim can be found in General Arrangement

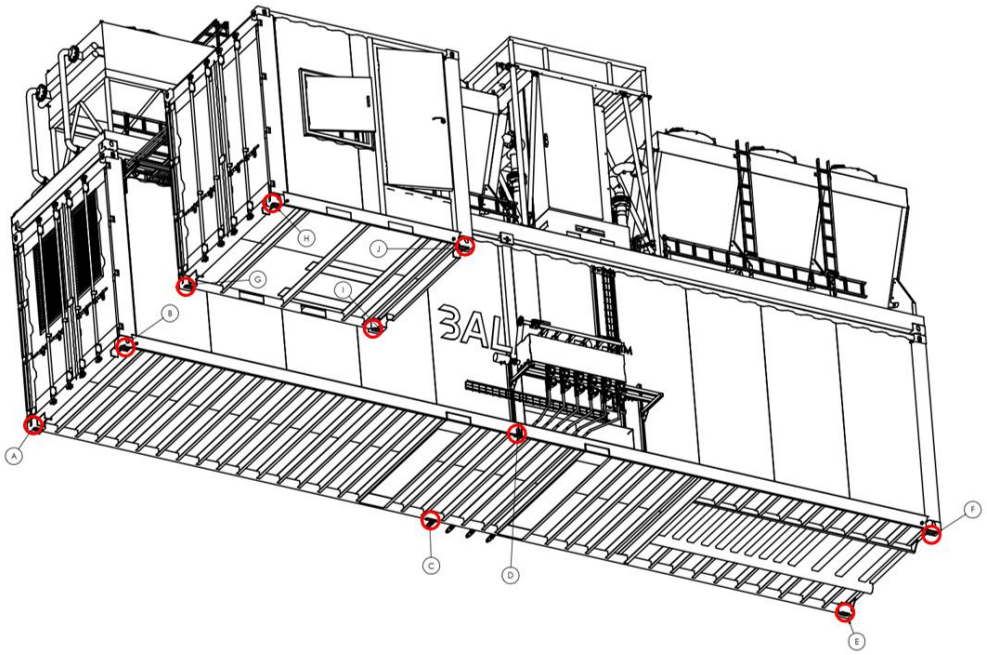
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5.2.3 Floor/foundation characteristics

Requirements of the foundation is a level surface, and it need to be able to carry the final weight of the assembled system on the designated load-points.

Refer to General Arrangement for details.

Figure 11: Indicative illustration of load-points



Specific Loads can be found in General Arrangement

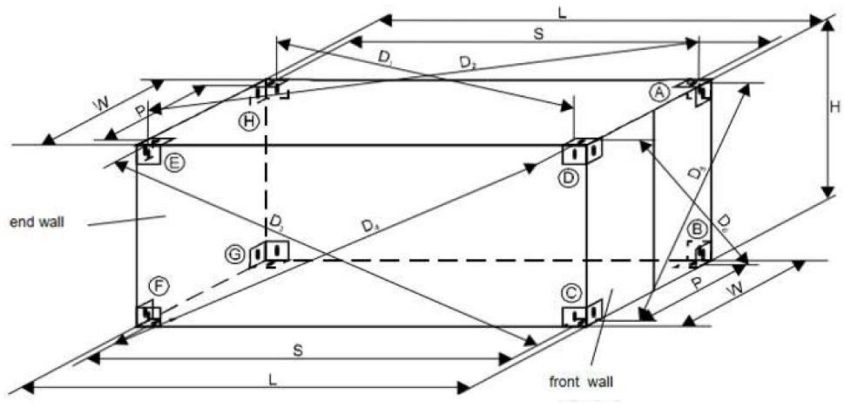
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5.2.4 Anchoring

The containers must be anchored to the ground using container tie-downs or ground-plate twist-locks. Ensure physical support of designated load-points as described in section 5.2.3.

If anchoring is done using the bottom-side of the ISO corners (B, C, F, G in Figure 12), e.g. ground-plate twist-locks, verify the corner-distances of the containers prior to design of site.

Figure 12: ISO Container corners distances (see Table 5-2)



Source: Polski Rejestr Statków – Rules for the construction of containers – July 2014

Table 5-2: Distance between container corners for anchoring (See Figure 12)

Item	P	S
Fuel Cell Container	2260 (+3) (-5) mm.	11989 (+3) (-10) mm.
Grid Interface Container		2787 (+3) (-10) mm.

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5.3 Temporary requirements

For commissioning of the system, the following temporary requirements are applicable, depending on the agreements with Ballard.

5.3.1 Trucking and crane workspace

The designated site for the system shall provide space for the trucks delivering the major system components, as well as for crane lifting and handling as defined in the respective Transportation and Handling Manual (see section 2.4).

5.3.2 Load bank

If the designated grid for the system is not ready to provide the needed load for testing procedures defined in the SAT, an electrical load bank may be necessary during commissioning. The load bank can be provided by Ballard if agreed upon.

A load bank needs to be installed temporarily, and the site must provide space and power for this unit.

Space claim and power requirements for the Load bank provided by Ballard may vary.

Ballard-provided load bank will be removed after functional testing of the system.

5.3.3 Hydrogen Battery

For testing purposes during commissioning, a Hydrogen Battery may be needed if the local supply is not ready. The Hydrogen battery can be provided by Ballard if agreed upon.

The hydrogen battery needs to be installed temporarily, and the site must provide space and power for the unit, keeping in mind safety precautions.

Space claim for the Hydrogen Battery may vary. Contact your Ballard representative for more information.

Ballard-provided Hydrogen battery will be removed after functional testing of the system.

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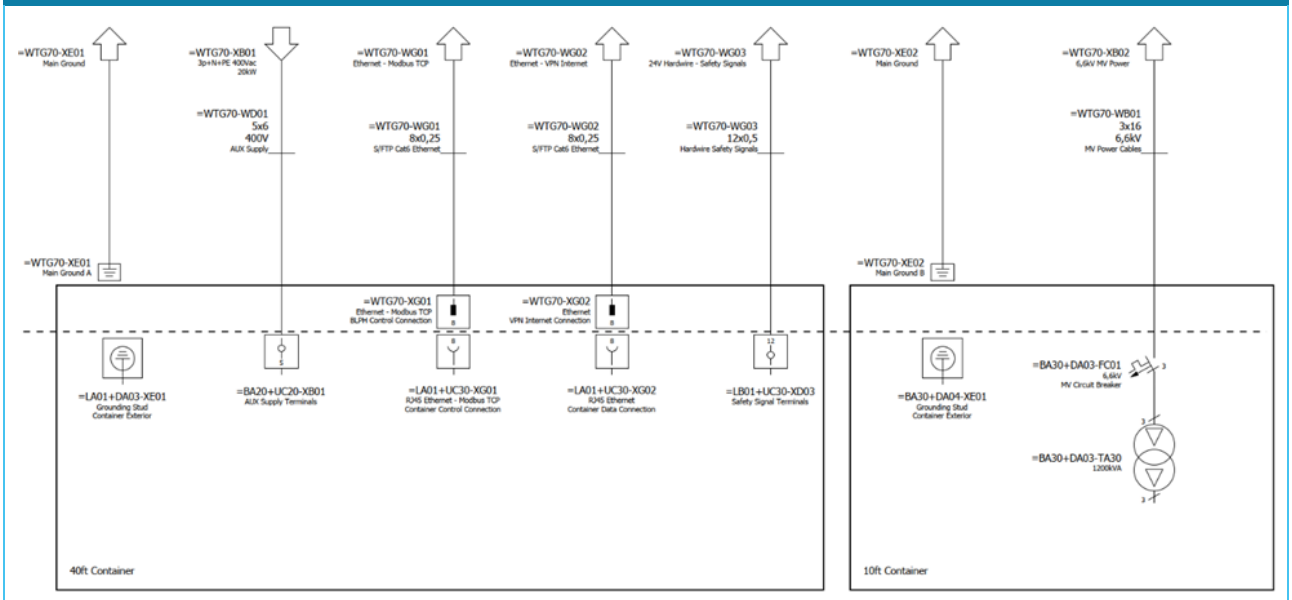
6.0 Interface descriptions and requirements

All delivered energy sources to the interfaces must have an applicable LOTO-procedure for Ballard personnel to use when installing.

6.1 Cable connections

Drawing of cable connections can be found in the Interconnection Diagram shown below in Figure 13.

Figure 13: Cable Interconnection Diagram



See Interconnection Diagram for detailed version.

Table 6-1: Electrical, network and safety-signals connections

Connection	Description	Physical connection
MV Interface	Main power delivery interface – 3 phase 6,6kV AC 50Hz 100A connection	3 pcs single Conductor Cables
Auxiliary supply	Container auxiliary supply – 3p+N+PE 400V 50Hz 32A supply	5G6 Cable (optionally 5G10)
Network Connection	Network cable carrying Modbus TCP control signals and SCADA data to local Power Management System.	Fiber optic cable
Service Connection	Network cable carrying service and troubleshooting information to Ballard. Encrypted. See section 0 for details.	Fiber optic cable OR Copper ethernet ($4x2x0,5mm^2$)
Safety Signals	Multiconductor signal cable carrying safety signals between FC package and local Power Management System.	Multiconductor cable ($6x2x0,75mm^2$)

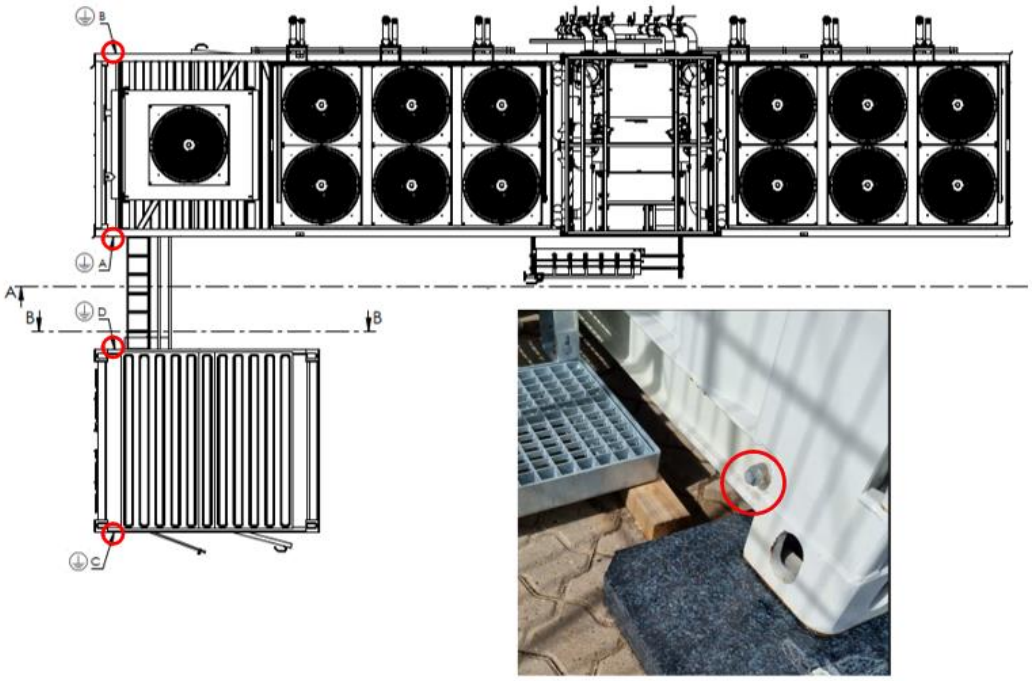
Details of connections in Table 6-1 can be found in the Cable Transit Schedule and the Electrical Interface Documentation.

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6.1.1 Earthing

The solution provides 2 earthing studs on each container. Each stud needs an earthing connection with low enough resistance to ground as defined by local legislation.

Figure 14: Location of interfaces for Earthing



The earthing points are located at each corner of each container – refer to Grounding Layout

Table 6-2: Earthing point specifications

Point	Bolt size
A	M12x1.5
B	M12x1.5
C	M12x1.5
D	M12x1.5

6.2 Service connection

The service connection enables Ballard service technicians to use a secure and encrypted VPN connection to gain remote access to the control system for monitoring and service. During installation, it is Ballard preference to deliver with a Secure Remote Access gateway installed including a 4G wireless antenna, which allows the service connection, data collection and remote access.

This wireless function will be removed if the final architecture enables a wired secure access tunnel through the local infrastructure to the internet. This access tunnel should be completely separated from the local PMS in order to maintain the best possible separation between the Operational Technology and data going to the internet.

Refer to Secure Remote Access for more details.

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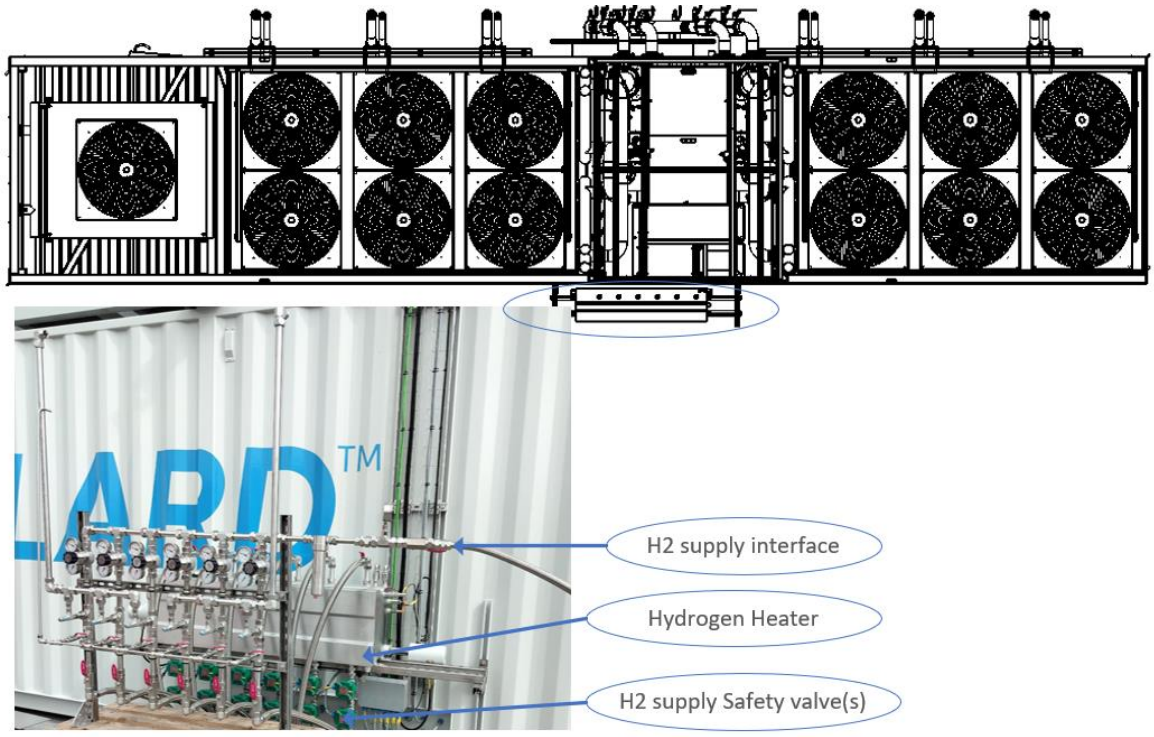
6.3 Upstream Hydrogen supply

For each FCwave™ installed in the Fuel Cell Container, a hydrogen supply pipe is routed inside the Fuel Cell Container to the outside. Each pipe it is connected to an outlet on the Hydrogen heater, that increases the temperature of the supplied hydrogen if needed.

The upstream hydrogen supply is to be connected to the interfaces on the hydrogen heater, located as indicated in Figure 15.

The upstream hydrogen supply provided may be compressed gas storage, vaporization of liquid hydrogen or reforming of other fuels, if requirements listed in Table 6-3 are met.

Figure 15: Location of Upstream hydrogen supply interface



Indicative figure of Upstream hydrogen supply interface. Refer to General Arrangement for specific location.

Table 6-3: Upstream hydrogen supply requirements

Item	Requirements
Fuel type	Gaseous hydrogen
Hydrogen grade	As per SAE spec. J2719 OR ISO 14687:2019 Type I, Type II – Grade D
Hydrogen supply Pressure	4 – 6.5 bar(g)
Hydrogen temperature	-8,4 - 80 °C
Hydrogen Consumption Rate, BOL	0,9-29,4 g/s

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Table 6-3: Upstream hydrogen supply requirements	
Physical interface	1xØ32mm (DN32 ASME B16.5) stainless steel pipes with double-ferrule compression fittings. OR Welding of pipes - special procedures are applicable. Contact Ballard for support.
Upstream particulate filter	40µm
Upstream isolation valve	Manual and lockable isolation valve as close interface as possible (Access for service personnel)

Refer to P&IDs for more details.



The pipe connection must be protected against accidental damage.



Purging the internal H2 system through the hydrogen supply is prohibited. Special procedures apply for purging of the FCwave, and training is required.

6.3.1 Pressure relief valve

With the required pressure of the system stated in Table 6-3, the integrator must install a pressure relief valve for the hydrogen supply set for 10 bar(g). The solution closes the hydrogen supply safety valve(s) applicable if pressure exceeds the maximum.

Handling of released hydrogen must be done in a safe manner, not creating a potential explosion zone near the equipment.

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6.4 Process Water drainage

The fuel cell process produces DI water, which are routed from each FCwave™ to a common drainpipe using gravity.

The process water drain piping downstream must be constructed of materials resistant to corrosion since DI water is present. Contact Ballard with questions regarding material selection.

The solution provides a heat-trace cable that is pushed into the drainpipe downstream from the interface so that it does not freeze and/or block the flow of liquid. If the process water is unable to flow, the system will indicate with an error.

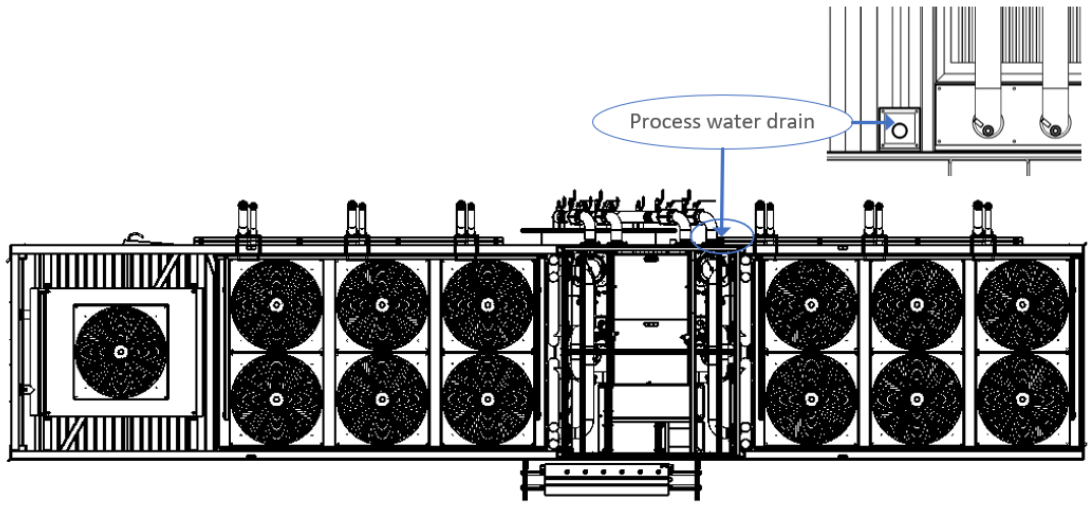
In the unlikely event of overfilling or overheating the HT or LT cooling circuits, overflow from the header tanks is routed to the process water drainage.

Disposal of the media should be done according to local legislation.

Table 6-4: Process Water Drainage connection requirements

Item	Value
Media	De-Ionized Water, possible overflow from coolant header tanks
Temperature	10-50 °C
Volume	0 – 13,2 L/min
Drinking water	no

Figure 16: Location of upstream process water interface



The water is not drinkable and must be disposed of according to local legislation.

6.5 Lightning protection

The site responsible must follow EN62305 or other applicable local legislation regarding lightning protection.

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7.0 Control of the system

The FC Megablock is controlled using Modbus TCP/IP.

The solution is made as simple as possible for the Integrator, with few control signals and a high system information availability.

7.1 Operating States

The solution is designed for the Integrators local PMS to control the system through a wired Ethernet Modbus TCP/IP Connection.

The solution operates in the modes described in Table 7-1.

Table 7-1: Operating mode descriptions

Operating Mode	Brief description	Preconditions
Off	Container fully depowered.	No power supplied to container; UPS batteries depleted
Initialization	Functions to establish baseline container status, with connections to external power and communications.	After bootup. 400Vac Auxiliary power supplied to Container.
Sleep	Container minimum operational level. Control and safety system are operating, but no high-power systems (>20kW) are operating. Hydrogen supply and fuel cells are inactive.	400Vac Supplied to Container. Communications heartbeat from PMS
Wakeup	Container enables 24V supply to fuel cell modules and starts container ventilation system.	400Vac Supplied to Container. Signal from PMS (Standby).
Standby	Waiting state for "Run" command from high level control system. Hydrogen supply and MV link disabled.	400Vac Supplied to Container Signal from PMS (Standby)
Startup	Transitional phase when PMS signals container to initiate operation. The significant part of this phase is that the container will draw a significant amount of power during startup, to energize fuel cell modules and cooling fans/pumps. After startup is complete on the fuel cells, the container transitions to "Running". All systems operational. Hydrogen system active.	400Vac from internal microgrid. Signal from PMS (Run). MV link active (10-150kW power draw, depending on # of FCwave starts concurrent). Hydrogen-supply active.
Running	Operational state for the container, where the fuel cell modules are consuming hydrogen to produce electrical energy. Cooling and ventilation systems are operating to support fuel cell modules.	Signal from PMS (Run). Signal from PMS (Power request). MV link active (up to 1050kW power produced) Hydrogen-supply active.

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Table 7-1: Operating mode descriptions		
Rampdown	When signaled from PMS that operation is done, the container stops power production and performs fuel cell module shutdown procedures. Fuel cell modules shutting down. Hydrogen system transitions from active to inactive. After shutdown is complete, container proceeds to aftercooling.	Signal from PMS (Standby) MV link active (~10kW power draw) Hydrogen-supply active.
Aftercooling	After fuel cell system has shut down, container performs aftercooling from the cooling system and ventilation from the container ventilation	400Vac Supplied to Container MV link active (~5kW power draw)
Shutdown	The cooling and ventilation systems shuts down. Container returns to standby.	400Vac Supplied to Container. MV link transitions from active to Inactive.
Fault	Internal fault state. Hydrogen supply and fuel cells are inactive.	400Vac Supplied to Container. Fault indication to PMS.

For more details, refer to Control philosophy and Logic block diagrams.

The primary state machine is shown below in Figure 17.
For states with a fixed duration, the current best estimate is shown.
For states with no duration listed, the transition depends on external signals.
In all states, the solution can transition to a fault state, where measures must be remedied prior to re-engagement/reset.

Figure 17: Location of upstream process water interface

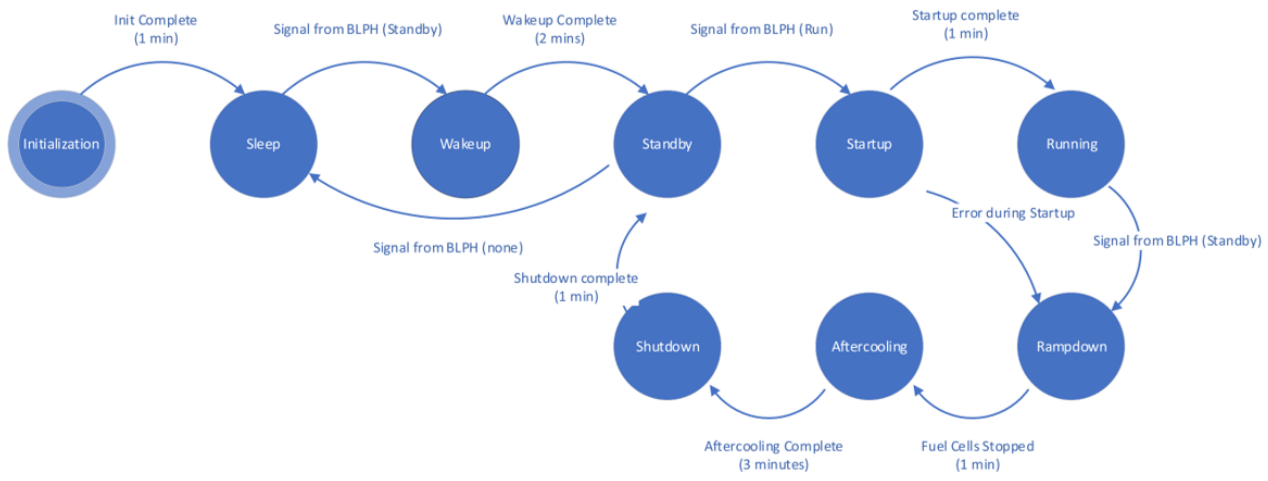


Diagram for the main state machine for the fuel cell container.

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7.2 Control

Control of the system is through the use of ethernet Modbus TCP/IP. Provided Modbus table can be found in the FC package Modbus Map.

The Modbus Map presents the available read and write signals, using the function codes in Table 7-2.

The following descriptions presents the main signals that are available for the Integrator.

Table 7-2: Allowable Function Codes	
Discrete coils	
Function code 01	Read single coil
Function code 05	Write single coil
Function code 15	Write multiple coils
Discrete inputs	
Function code 02	Read single discrete input
Holding register	
Function code 03	Read single Holding register
Function code 06	Write single Holding register
Function code 16	Write multiple Holding register
Input register	
Function code 04	Read single Input register

7.2.1 Discrete coils

Read and write access.

A limited amount, if any at all, of discrete coils may be available.

7.2.2 Discrete Inputs

Read only access.

Here the status of components such as the Main Low Voltage Breaker, Local/remote control status, and statuses of internal subsystem are available.

7.2.3 Holding register

Read and write access.

7.2.3.1 Export Power Setpoint

The purpose of this signal is for the integrators PMS to signal the amount of delivered power desired at any given time.

Function: Export Power Setpoint

Tag: POWER_SP

Address 1000

Datatype: INT16

Scaling: 0.1 [kW]

Range: 55.0 to 1000.0 kW *(.0 is necessary)*

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If 0<POWER_SP<55.0, the delivered power is 55.0 kW.

The nature of Fuel Cell technology limits the speed of which it can rise and lower the delivered power. With this, the integrator can expect a defined maximum ramp-up and Ramp-down. The system will automatically follow these ramps, regardless of the export power setpoint.

7.2.3.2 Control word

The control word is the signal that enables the external signal to initiate the state changes described in section 7.1.

Function: Control word

Address 1001

Datatype: BOOL

Bit 0: wakeup/go to standby

Bit 1: go to sleep

Bit 2: Start/run

(In running mode, exported power is controlled as defined in section 7.2.1)

Bit 3: Stop

Bit 4: Not used/spare

Bit 5: Reset

7.3 Input Register

Read only access.

An extensive list of live information, such as status and error codes.

7.4 Alarm list

Refer to Alarm list for details.

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8.0 Testing

During installation and integration of the system, subsystems and interface connections, test procedures are conducted. These procedures verify the functionality and safety of specific parts of the system and integrated subsystems.

The tests are performed by/in collaboration with Ballard personnel and sub-suppliers.

The Site Acceptance Test (SAT) is similar to the Factory Acceptance Test document.

Tests could include, but are not limited to:

- Functionality tests
  - Visual inspection
  - Coolant circuit leakage tests
  - Electrical interconnection test
  - Electrical safety test
  - Initial Power up
  - Safety system
  - Auxiliary power and Balance of Plant (BOP) validation
  - UPS
  - Internal Load test
  - Hydrogen leakage test
- Pre-operations tests
  - Fuel Cell Commissioning
  - Emergency stop, no load, low load, full load
  - Hydrogen storage interface
  - Cooling circuits
  - Ventilation
  - Noise level
  - Thermographic
- Operations test
  - System start/stop – normal low load
  - Error simulation
  - Change FCwave to "service state"
  - Steady state operation
  - Power quality tests
  - Load test
    - ramp up, ramp down
    - step response
    - Load test – full load
    - Load test – no load
  - Full operation test cycle

8.1 Testing of hydrogen supply

For initial testing of the system itself, a temporary hydrogen supply in the form of a Hydrogen Battery (See requirements of this in section 5.3.3) may be used. This is to verify the functionality of the delivered system, prior to integration of the hydrogen supply delivery system of the designated site.

Integration and testing of the hydrogen supply on the designated site is a collaborative test.

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8.2 Load testing

Initial load-testing of the solution may be performed with the use of a temporary load bank that is mounted to the grid interface.

Testing with the designated grid and signals to/from the integrators PMS is done in collaboration with the responsible.

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Revision history		
Rev.	**Date.**	**Description**
001	16/08/2024	First Issue
002	06/06/2025	Corrected according to comments sheet
003	13/03/2025	Corrected according to comments sheet

Document Title:	**BLPH Project - Operator Manual**
Document Number:	K559-2254-CWIWP4202202-N01-002
Revision:	Rev003
Sequence Number:	002
File Name:	K559-2254-CWIWP4202202-N01-002Rev003
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	N01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

FC PowerGen 1000kW

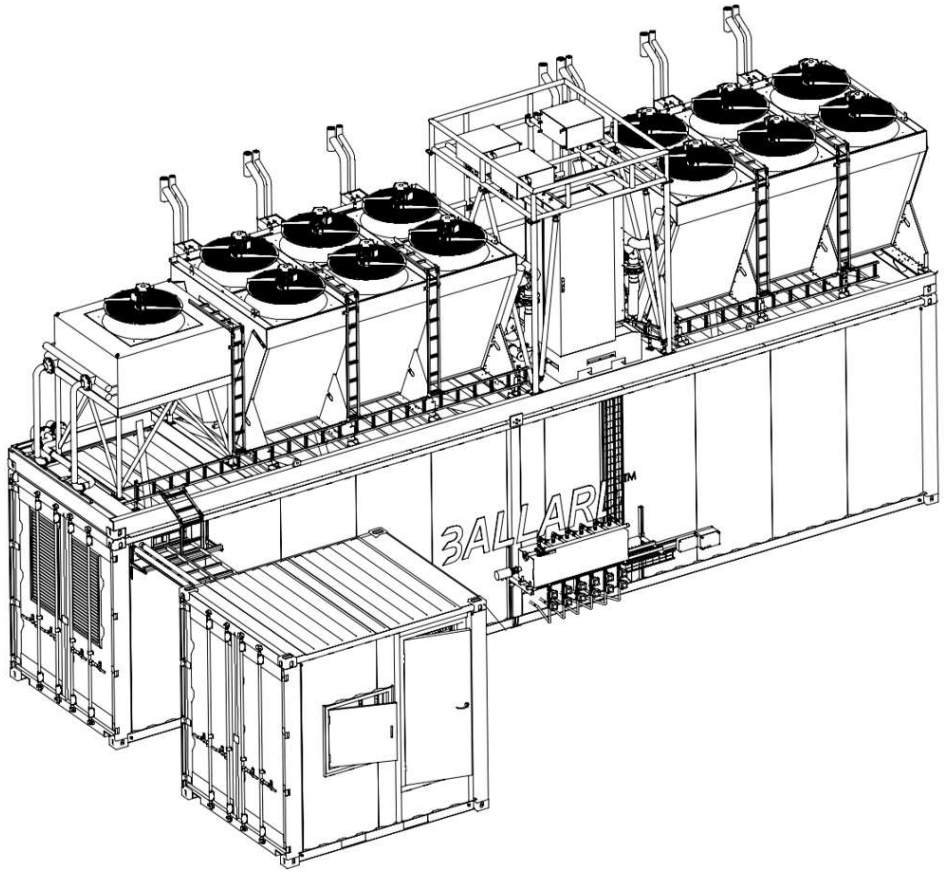
Part no.: 601456B-7002362

Configuration: 40ft Fuel Cell Container w. 6 FCwave™
10ft Converter Container, 6.6 kVAC

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1.0 Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURES DESCRIBED IN THIS MANUAL

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property. It is therefore necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device. Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, compressed gases, and H2.

This manual includes certain safety guidelines and recommendations; however, this manual is not intended to cover all situations. The customer is responsible for determining the suitability of the customer's particular design or application, and for ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated. Ballard Power Systems Europe A/S ("BPSE") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the operating recommendations in the manual. The customer is responsible for being aware of, and complying with, all applicable laws and regulations. BPSE has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual. Failure to follow any instruction or recommendation could result in death or bodily injury or loss or damage to property.

BPSE intends for the device to be installed, operated, and serviced only by approved technically qualified and experienced people who understand the principles of fuel cell technology, are aware of the safe operating limits of fuel cells, and are familiar with the risks posed by operating a fuel cell module. BPSE relies on customers to use their own knowledge and experience when installing, operating, and servicing the device. BPSE also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual.

Information in this manual is subject to change without notice. BPSE makes no commitment to update or keep current the information in this manual and reserves the right to make updates or other changes to this manual and/or to the products described in this manual, at any time without notice. Updates and other changes to the manual may be posted on the BPSE website and may be accessed through the customer portal; it is the customer's responsibility to check for any such updates or changes.

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2.0 General Information

This manual is mandatory reading for personnel working in or near the system, and persons instructing visitors prior to access to the system.

2.1 System introduction

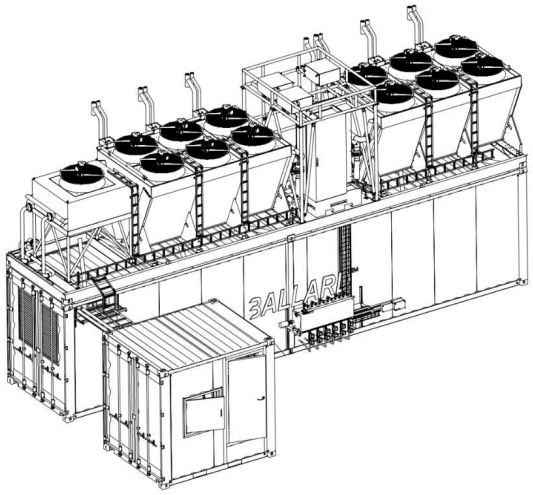
The Ballard FC PowerGen is a modularized power generator, comparable to a diesel-generator. It is a stationary, megawatt-scale hydrogen PEM fuel cell solution, utilizing the Ballard FCwave™.

The solution contains all needed elements to produce 1MW AC, when supplied with an auxiliary power supply, a local hydrogen supply, and an electrical grid that is controlled by a Power Management System (PMS), communicating with the use of Modbus.

Integration between the FC PowerGen and the local PMS enables the integrator to create a coherent and automatic system that reacts on the power-demand on the grid, within the given dynamic and capability limits of the solution.

The FCwave and the internals of the containers are designed in such a way that no explosive hazard zones are created in or around the system.

Figure 1: System overview



Indicative illustration of entire system

2.2 Manual purpose and scope

This operator Manual offers instructions for operating the system, instructions for operator-based maintenance, safety rules and recommendations.

It does not cover the operating instructions through the Modbus connection, refer to the Integration manual.

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2.3 Intended audience

The intended user of this Operator Manual is Operators, integrators, Installers, Service and Maintenance personnel, customer personnel working in or near the system, and persons instructing visitors prior to access to the system.



Before interacting directly or indirectly with the system, personnel must read and apply this manual.

2.4 Manual series

The Manual Series provides manuals covering different life-phases of the plant, as defined in Table 2-1:

Table 2-1: Manual series contents

Document no.	Title	Brief purpose description	Intended user(s)
Ballard: 7003672 CW: K559-2254-CWIWP4202202-R01-002	Transportation and Handling Manual	Enables safe, land-based, transport and handling from manufacturer to designated site.	Personnel qualified in preparation of, handling, and transport of freight.
Ballard: 7003718 CW: K559-2254-CWIWP4202202-N01-001	Integration Manual	Enables integrators to design designated site and subsystems required within the intended use and limits of the system.	Integrators partaking in designing the designated site and subsystems, and commissioning.
Ballard: 7003717 CW: K559-2254-CWIWP4202202-N01-002	Operator Manual	As described in section 2.2	As described in section 2.3
Ballard: 7003719 CW: K559-2254-CWIWP4202202-N01-003	Service and Maintenance Manual	Provide information regarding Service and Maintenance schedules and related safety.	Service and Maintenance personnel.

Ballard Power Systems Europe (BPSE) may update the provided manuals on an ongoing basis.

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2.5 Hazards Symbols

Hazard symbols throughout the manual indicate objectives or potentially dangerous situations.

Table 2-2: Hazard symbols	
	**MANDATORY ACTIONS**: are marked with blue action-points. This indicates actions that must be performed. Ignoring may result in an accident, which could cause damage to equipment or other property, and could cause bodily injury if not promptly detected and remedied.
	**PROHIBITIONS**: are marked with red prohibition-signs. This indicates a forbidden action. Ignoring may result in immediate bodily injury or loss of life or could cause damage to equipment or other property
	**WARNINGS**: are marked with yellow triangles and/or square warning. Indicates hazards that may result in an accident, which could cause immediate bodily injury or loss of life or could cause damage to equipment or other property.
	**CAUTION** in this manual indicates actions that may result in an accident, which could cause damage to equipment or other property, and which could cause bodily injury if not promptly detected and remedied.
	**ELECRICAL HAZARD** Obey ALL warnings, cautions, and safety instruction related to electricity. Failure to do so may result in electrical shock leading to personal injury or death.

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2.6 References

Throughout the manual are referrals to separate documents. These references documents are available on the BSPE after sales Service Portal.

Should a document not be available, contact BSPE.

Table 2-3: Reference documents

Document no.:	Document name:
K559-2254-CWIWP4202202-B01-001Rev009	General Arrangement
K559-2254-CWIWP4202202-D05-001Rev001	Material Safety Data Sheets
K559-2254-CWIWP4202202-C08-001Rev004	Control philosophy and Logic block diagrams
K559-2254-CWIWP4202202-C99-001Rev002	Hydrogen Safety Concept

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Commented [CJ6R5]: Rev009 now

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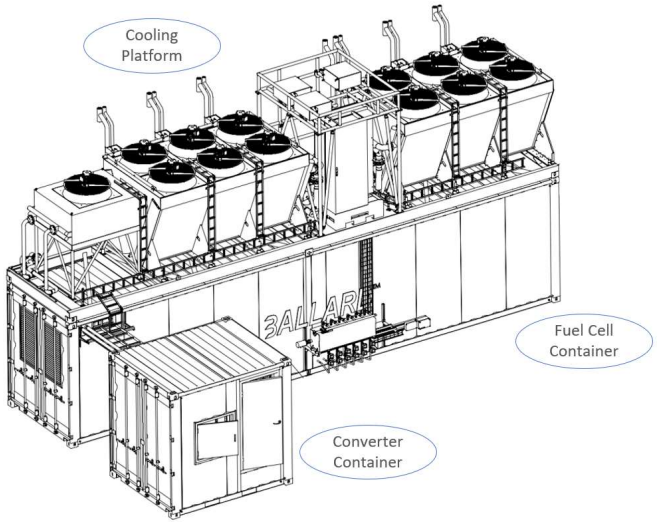
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3.0 FC PowerGen Description

3.1 Major components

The system is a modularized power generator based on a number of FCwave™ Fuel cell units.
The FC PowerGen consists of the following main components:

Figure 2: Major components overview



Short descriptions of major components can be found in Table 3-1

Table 3-1: Major components of the machine (See Figure 2)

Component	Short Description
Fuel Cell Container	Based on a 40ft HC container, modified to a machine housing with access, ventilation, light safety etc. The container holds 6 FCwave modules with installation, internal 400VAC power supply for complete Balance of Plant components, main controller, LT pump system and DC/DC converters.
Cooling Platform	40ft Cooling Platform with service platform. 2 individual HT radiators dimensioned to the specific solution 2 individual HT pump-systems 1 LT radiator
Converter Container	Based on a 10ft HC container, modified to a machine housing with access, ventilation, light, safety etc. Holds DC to AC grid-forming power electronics, Isolation transformer, and Grid Main Breaker.

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3.2 General Functional Description

The FC PowerGen is designed for fully autonomous and remote operation with no operator interface, except for service purposes. It is activated and operated remotely by the PMS of the integrators designated microgrid, for the solution to deliver power to.

While there is no fault internally on the fuel cell system or externally signaled, the solution will start and stop fuel cells as needed, to maintain delivery of requested power and keep operational health.

The solution accepts a power-request of zero. In this case it will be running in a stand-by mode, powered by either the auxiliary power supply, the power produced by itself, or a combination.

If any single input to the safety controller is outside acceptable parameters, e.g. hydrogen detection, E-stop activation, or external trip, the safety-system will trip and activate emergency shutdown. Depending on the severity of a potential fault, it will either:

- Initiate controlled shutdown on affected system(s) or the entire solution, or
- Instantaneously shutdown and isolate energy on affected system(s) or the entire solution.

Loss of hydrogen supply will stop operation and be handled as a failure.

3.3 Local HMI

Inside the Fuel Cell Container is located an HMI in the form of a touchscreen. This is available for service purposes of the machine. An overview of the system can be seen, and parameter changes can be made when unlocked with the use of a password (for authorized personnel only).

Instructions of use and/or creation of an HMI/SCADA for the PMS of local grid is not within the scope of the FC PowerGen, but a responsibility of the local integrator with the use of the Integration Manual.

3.4 Alarms

The following alarms are externally to the FC PowerGen triggered and should be handled by the site operator. For other alarms than mentioned, contact Ballard.

3.4.1 No hydrogen

The solution provides a signal to show that hydrogen is not available at the proper requirements. In case of "no hydrogen" alarm, please investigate hydrogen-supply upstream.

3.4.2 Remote Emergency Hydrogen Supply

The system has received a remote stop signal from upstream hydrogen supply, please investigate upstream.

3.4.3 Remote Emergency Site

The system has received a remote stop signal from PMS, please investigate downstream.

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3.5 General Operating States

The solution is designed for the Integrators local PMS to control the system through a wired Ethernet Modbus TCP/IP Connection.

The solution operates in the modes described in Table 3-2.

Table 3-2: General Operating mode descriptions

Operating Mode	Brief description	Preconditions
Off	Container fully depowered.	No power supplied to container; UPS batteries depleted
Initialization	Functions to establish baseline container status, with connections to external power and communications.	After bootup. 400Vac Supplied to Container.
Sleep	Container minimum operational level. Control and safety system are operating, but no high-power systems (>20kW) are operating. Hydrogen supply and fuel cells are inactive.	400Vac Supplied to Container. Communications heartbeat from PMS
Wakeup	Container enables 24V supply to fuel cell modules and starts container ventilation system.	400Vac Supplied to Container. Signal from PMS (Standby).
Standby	Waiting state for "Run" command from high level control system. Hydrogen supply and MV link disabled.	400Vac Supplied to Container Signal from PMS (Standby)
Startup	Transitional phase when PMS signals container to initiate operation. The significant part of this phase is that the container will draw a significant amount of power during startup, to energize fuel cell modules and cooling fans/pumps. After startup is complete on the fuel cells, the container transitions to "Running". All systems operational. Hydrogen system active.	400Vac from internal microgrid. Signal from PMS (Run). MV link active (10-150kW power draw, depending on # of FCwave starts concurrent). Hydrogen-supply active.
Running	Operational state for the container, where the fuel cell modules are consuming hydrogen to produce electrical energy. Cooling and ventilation systems are operating to support fuel cell modules.	Signal from PMS (Run). Signal from PMS (Power request). MV link active (up to 1050kW power produced) Hydrogen-supply active.
Rampdown	When signaled from PMS that operation is done, the container stops power production and performs fuel cell module shutdown procedures. Fuel cell modules shutting down. Hydrogen system transitions from active to inactive. After shutdown is complete, container proceeds to aftercooling.	Signal from PMS (Standby) MV link active (~10kW power draw) Hydrogen-supply active.

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Table 3-2: General Operating mode descriptions		
Aftercooling	After fuel cell system has shut down, container performs aftercooling from the cooling system and ventilation from the container ventilation	400Vac Supplied to Container MV link active (~5kW power draw)
Shutdown	The cooling and ventilation systems shuts down. Container returns to standby.	400Vac Supplied to Container. MV link transitions from active to Inactive.
Fault	Internal fault state. Hydrogen supply and fuel cells are inactive.	400Vac Supplied to Container. Fault indication to PMS.

For more details, refer to Control philosophy and Logic block diagrams.

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4.0 General Safety

⚠ CAUTION	
	**The FC PowerGen is intended to be remotely controlled. Automated start up may occur at any time if not prevented with applicable procedures.**

4.1 Machine access

At no time is access permitted inside the machine containers for unauthorized personnel, especially the Converter Container.

The exterior container doors must always remain locked except during active installation, integration, service, or maintenance.

⚠ WARNING	
	**Access to the internals of Converter Container is strictly prohibited except when applicable procedures are done by trained personnel, approved by the manufacturer.**

4.2 Hazardous materials

4.2.1 Coolant



The solution utilizes two types of coolant. The LT and HT cooling circuit uses the Glycol-based coolant Proviflow®, and the internal closed coolant loop of the FCwave™ uses GLYSANTIN® FC G20.

For more details, refer to the document "Material Safety Data Sheets".

During normal operation there should be no leakage of coolant. If a leakage is noted, Manufacturer must be informed.

General rules are:

- Avoid contact with eyes and skin.
- Use protective gloves and tightly sealed googles.
- Avoid ingestion and inhalation of vapors.
- Spillage – do not allow to enter sewers/surface or ground water, absorb with a liquid–binding material, dilute with water.
- Disposal must be made according to official regulations.

4.2.2 Lubricant

General for container solution: Ceramic Grease PV.20.01, used as assembly paste and high temperature lubricant grease without metal particles for lubrication of bolts.

Fuel Cell Modules: Krytox™ GPL 205 & 206: Grease safe for use around hazardous chemicals, non-flammable. For extreme temperatures.

General rules are:

- Avoid contact with eyes and skin
- Avoid ingestion and inhalation of vapors.
- Use protective gloves, safety glasses, and suitable protective clothing.
- Spillage – do not allow to enter sewers/surface or ground water, absorb with a liquid-binding material, dilute with water.
- Disposal must be made according to official regulations.

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4.2.3 Process water

The fuel cell process produces De-Ionized Water, which is routed from each FCwave™ to a H2 separator. The trace amount of H2 is led to the process-drain exhaust, and the process water is led to a drainpipe, connected to the outside drain system.

De-Ionized Water is not suitable for drinking water.

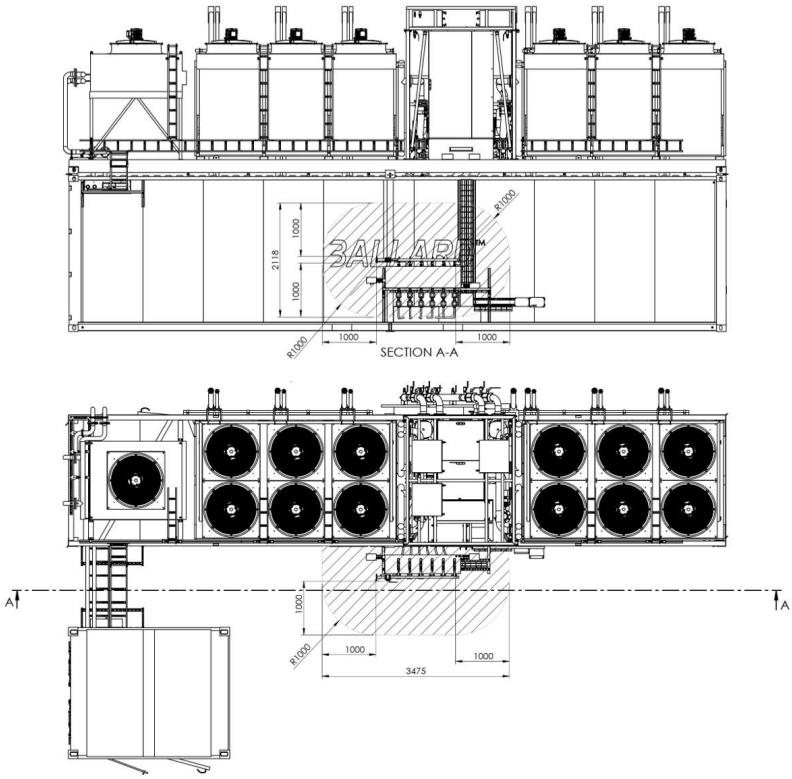
4.2.4 Hydrogen

Risks of hydrogen leakages is highly unlikely.

Areas within the solution are classified as non-hazardous since areas with the slightest risk of leakage are monitored by the safety system and excessively ventilated to dilute and remove the hydrogen, thereby removing any explosion hazard inside the system.

The area around the External hydrogen handling unit is classified as an EX-Zone 2 with a max 1 meter extend. Here, an explosive gas atmosphere is not likely to occur in normal operation, but, if it does occur, will exist for a short period only.

Figure 3: EX Zone – External hydrogen handling unit



EX-zone marked around the External hydrogen handling unit.

Refer to Hydrogen Safety Concept for more details about the EX-zone.

Commented [CJ8]: Add details regarding the ATEX zone and the dangers hereof

Commented [CJ9]: This can't be true when we have defined an ATEX zone outside - Having that zone means we haven't removed all explosion hazards

Commented [CJ10R9]: Maybe rephrase: "Thereby removing any explosion hazard inside the system" and show the applicable zone, warning that no source of ignition are allowed etc.

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Minimize all activities in the EX-zone
Activities must be done by trained personnel
Do not introduce any ignition source into the EX-zone



4.3 Site safety for Personnel

4.3.1 Personal Protection Equipment (PPE)

Appropriate PPE should always be worn while interacting with the system directly and/or indirectly. Wear a safety helmet, protective glasses, gloves, and other protective equipment, as required by the designated site.

4.3.2 Noise

During normal operation the noise-level emitted varies depending on the operating conditions. The noise-level in the surrounding area may reach up to 80dB, the highest being in front of the air-intakes.



Hearing protection should be available and used when in the surrounding area.

4.3.3 Emergency doors

The fuel cell container is equipped with two emergency exit doors, see Figure 4.

Do not store material or in other way block the emergency doors.

4.3.4 Freezing conditions

The process exhaust contains water. This water will freeze and turn into snow and ice. Care must be taken when outside temperatures are at or below 0 °C.

- It is possible that icicles are formed on the exterior of the containers, creating a risk of falling objects.
- It is possible that surrounding surfaces have icing, creating a risk of slipping.
- Avoid or restrict access to the area if needed

Commented [CJ11]: Safexpert risk assessment Fuel cell container -> Mechanical hazard -> Slipping, tripping and falling

4.3.5 Medical devices

During some operating modes, the system will create a magnetic field which may influence medical devices. Such devices shall not enter the system.

4.3.6 Fire

The Fuel Cell Modules have internal fire detection in the form of smoke detectors and linear heat detectors. If a Fuel Cell module detects fire, it will automatically perform a safe shutdown of itself and indicate an alarm.

If Smoke is detected inside the general space of the Fuel Cell Container, the entire system will perform a safe shutdown and indicate an alarm.

Commented [CJ12]: See integration manual and write something similar here

Commented [CJ13]: CRS Comment 3

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Should a fire occur, exit through the provided emergency exits.

4.3.7 Explosion Safety

The solution introduces an area with explosion hazard around the hydrogen interface. This zone is classified as a Zone 2, meaning that a hazardous mixture of hydrogen in the area will not likely be present under normal operating conditions, and if so, only for a short period at a time. Detailed drawing of the hazard zone can be found in the General Arrangement.

Commented [CJ14]: Short version of the description in integration manual

Commented [CJ15R14]: Show area

	**Respect the zone indicated, do not introduce any source of ignition.**

4.3.8 Hot surfaces

	**During operation, hot surfaces are present. Respect the nature of the machine and avoid touching surfaces marked.**

4.3.9 Service and maintenance

	**When service and maintenance are conducted, personnel in the area must follow the instructions from the responsible service technician.**

4.4 Cleaning

The area around the system should be kept clean and with unrestricted access, e.g. during winter snow.

Cleaning of the major components of the system must be done according to the service instruction. Do not wash down exterior without consulting the service manual.

4.5 Settings

No settings for the FC PowerGen are available for the general operator. Settings are restricted to Integrators and Service and Maintenance Personnel through the use of Modbus communication and the HMI inside the Fuel Cell Container.

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4.6 Safety labels on the machine

Table 4-1: Safety labels on the machine

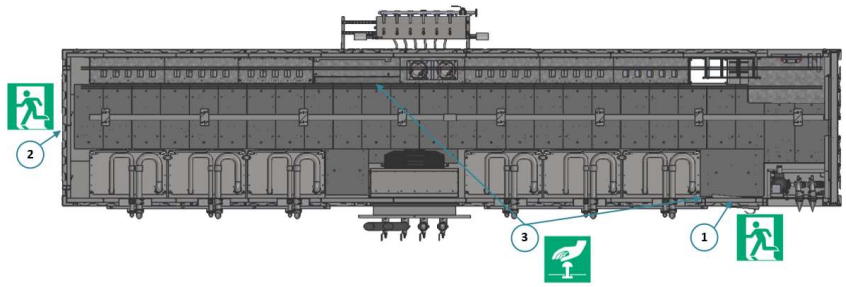
	Emergency exit		Use hearing protection
	Authorized personnel only		Wear safety footwear
	No smoking		Read manual
	No open flame		Risk of electric shock
	No access for active implanted cardiac devices or others alike		Hot surface
	Not lifting point		Automatic startup
	Lifting point		Crush of hands

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5.0 Safety inside Fuel Cell Container

When the entirety of this manual has been consulted, it is safe to enter the Fuel Cell Container during operation. The Fuel Cell Container is designed to meet minimum IP20 for all equipment installed.

Figure 4: Safety equipment in Fuel Cell container



Emergency doors, emergency buttons

Commented [CJ16]: New picture

5.1 General rules

The interior of the Fuel Cell Container is to be kept as clean as possible:

- Remove any litter or debris.
- Keep the doors closed to allow for ventilation air to be filtered.
- The Fuel Cell Container is a machine, respect the rules and signs. Do NOT open equipment without proper instruction and safety measures as described in relevant service work instruction.
- It is recommended to keep a communications device on your person when being inside.

The interior light can be switched on and off next to the main entrance door.

If any abnormal condition is noted on entry, avoid entering and contact Ballard service.

5.2 Emergency exit

The main entry door (Figure 4, 1) is on the side of the container. The door is equipped with an emergency Push bar on the inside.

There is an additional service access door (Figure 4, 2) at the end of the container. This door is intended for use only during specific service activities and emergency exit.

5.3 Emergency Stop button

The Emergency Stop buttons (Figure 4, 3) are placed next to the main access door, and on the MCU panel. Activating one will immediately shut down the entire system and disengage the main output connection to the grid.

The emergency stop button may not be used as a general stop button of the machine.

It is important to note that not all energy sources are disconnected from the machine when the emergency button is activated. Systems such as UPS batteries for the control-systems and the Auxiliary power supply etc., supplies energy to the system during emergency stop.

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5.4 Emergency lighting

Part of the internal lighting of the container is supplied with power from the UPS during an emergency.

5.5 Fire safety

The Fuel Cell Container is equipped with a fire detection system using multiple detectors. The activating of a detector may lead to partial shutdown of the affected unit or a complete shutdown of the system.

- Smoke detectors are mounted in the ceiling of the container, monitoring the inlet and outlet of the ventilation air.
- Each FCwave module contains an internal smoke detector and linear heat detector.

5.6 Hydrogen safety

The Fuel Cell Container is designed to prevent leakages of hydrogen inside the container, and there are no hydrogen-flammable or -explosive conditions inside the system.

As an additional precaution, in case of hydrogen entering the container, the container is equipped with three hydrogen sensors in the general space of the container. One at the ventilation intake and one at each of the ventilation exhausts, which will detect incoming and exiting hydrogen.

If one of these hydrogen detector is triggered, the safety system shuts off all the hydrogen supply valves and trigger emergency shutdown of the fuel cell modules and power converters.

Refer to Hydrogen Safety Concept for more details.

5.7 Electrical safety

The electrical cabinets are only to be opened by instructed electricians and require a tool.

⚠ ELECTRICAL HAZARD	
	**Special attention is required to the DC cabinets.** **The voltage on the DC busbars is 750V, and special procedures must be followed to disconnect and discharge the system prior to opening.** **Refer to Service and Maintenance Manual.**

5.8 Auxiliary power supply

The system requires a permanently mounted auxiliary power supply. Auxiliary power supply is used during operating modes where power from the fuel cells is not available.

The auxiliary power is present at all times, also when the main grid breaker is open, unless disconnected remotely.

5.9 Noise

During operation the sound level may reach up to 94dB inside the container. Hearing protection must be used when inside the container.

If the fuel cell system is shut down for service and starting are prevented by applicable lock-out, hearing protection is not mandatory.

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	**Hearing protection must be worn during operation.**

5.10 Hot surfaces

The components and piping of the LT cooling rack may reach a temperature of 45°C.

The components and piping of the HT cooling that are placed below the raised technical floor may reach a temperature of 65°C. The floor should only be opened in consultation with the instructions in the service manual.

The Process exhaust piping above the fuel cells may reach a temperature of 70°C during fuel cell operation. Avoid touching.

	**The HT Coolant pipes reach temperatures up to 65°C during normal operation.**
	The process exhausts reach temperatures above 70°C during operation.

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6.0 Cooling Platform

Commented [CJ17]: CRS Comment 5

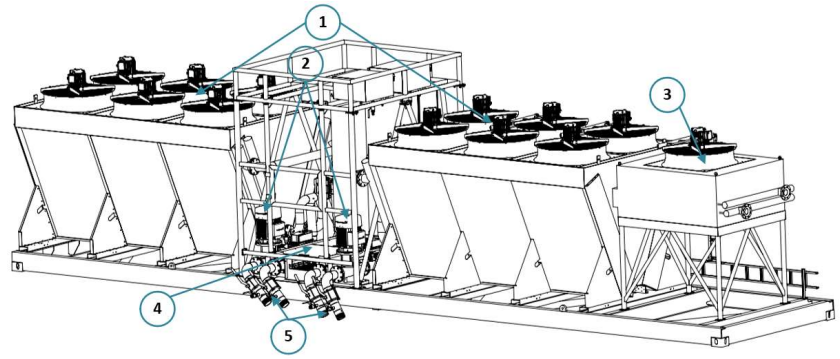
The Cooling platform is a steel structure with the footprint of a 40ft container. The purpose of the cooling platform is to dissipate the excess heat generated. The cooling systems are open unpressurized systems with open header tanks to accommodate for volume changes due to temperature. The cooling media is Ethylene glycol, and the highest temperature is approximately 65 °C.

The exhausts from each FCwave™ is fastened to the HT cooling platform.

- Process air, oxygen reduced air from the electrochemical process saturated with water.
- Hydrogen ventilation air

Figure 5: Cooling platform [illegible]

Commented [CJ18]: New picture



Indicative overview of HT Cooling Platform with numbered ballons (see Table 6-1)

Table 6-1: HT Cooling platform overview descriptions (See Figure 5)	
1	HT Coolers with fans
2	HT Coolant pumps
3	LT Cooler with fan
4	Platform Service area
5	HT Coolant in- and outlet

6.1 Platform Service area

The Service Area of the Cooling Platform is located between the HT coolers. The Cooling Platform is placed on top of the Fuel Cell Container, approximately 3 meters above ground level. This makes the Service Area inaccessible for unauthorized personnel.

Access for authorized personnel is with a designated ladder which is hooked on to the service area extension, or from a scaffold or similar, if service work requires.

The Service Area has a surrounding fencing. This prevents service engineers from falling from height. Special care must be taken in extreme weather conditions, consider using PPE equipment (harness).

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Prior to accessing the Service Area of the Cooling Platform, the Service and Maintenance Manual must be consulted.

6.2 Hydrogen safety

There is no Hydrogen present at the service area.

6.3 Electrical safety

The electrical cabinets are only to be opened by instructed electricians and require a tool.

6.4 Noise

During operation the sound level may reach up to 80dB in the Service Area, main source being the cooling fans on top of the coolers.

Use hearing protection when in operation.

6.5 Hot surfaces

The components and piping of the HT cooling may reach a temperature of 65°C during operation.

Mounted to the HT Cooling Platform are the Process exhaust from the Fuel Cell Modules that resides inside the Fuel Cell Container. These may reach temperatures up to 70°C.

Avoid touching.

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7.0 Converter Container

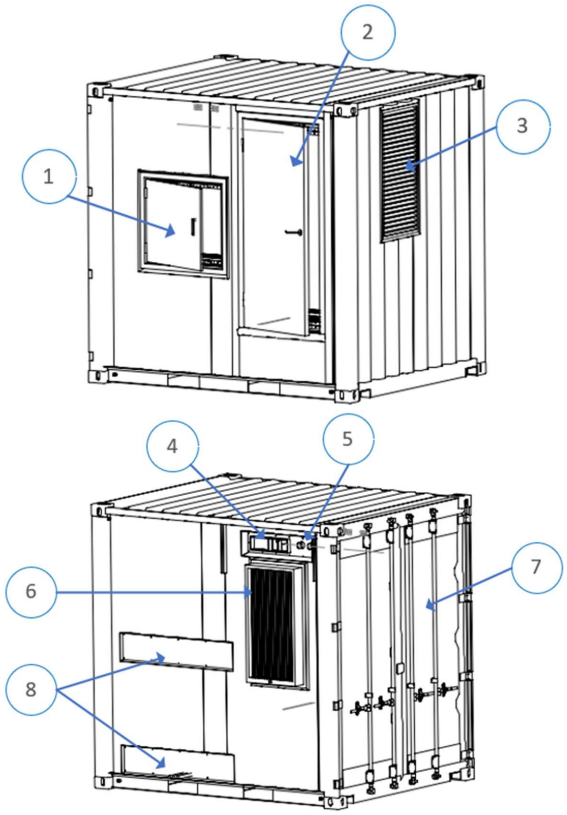
The Converter Container is structurally a 10ft high-cube double-door container, modified to the specific need. It is designed as an electrical cabinet, housing DC/AC converters and a transformer that converts the energy to the desired voltage (6.6 kV).

Access to the inside is through the normal container doors which are, because of electrical safety, mechanically prevented from opening during operation. These are also equipped with safety sensors, which will immediately bring the entire solution to "Failure state" if opened.

Access is restricted to instructed and trained personnel, and only after a safety procedure is followed, which will deenergize the container to a safe mode.

The control panel and grid breaker front of the Converter Container is accessible from the outside, behind an additional locked door which will not shut down the solution if opened.

Figure 6: Converter Container overview



Indicative overview of 10ft Converter Container with numbered ballons (see Table 7-1)

Commented [CJ19]: Need to mention the 6,6 kV!

Commented [CJ20]: Get the updated version from Integration Manual

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Table 7-1: Converter Container overview descriptions (See Figure 6)	
1	Control panel access door
2	Main output breaker access door
3	Ventilation exhaust
4	Wall passthrough for Control Signals and DC power cables from Fuel Cell Container
5	LT Cooling interface
6	Ventilation air intake
7	Service doors
8	Converter (1MW AC output)

7.1 Electrical safety

⚠ ELECTRICAL HAZARD	
	**HIGH VOLTAGE – 6.6 kV** **Danger of electrocution** **Authorized personnel only** **Keep clear and follow safety protocols** **Proper PPE required** **Failure to comply may result in serious injury or death**

7.2 Access

There is no access to the insides of the Converter Container for unauthorized personnel, as some aspects inside are IP00.

Access is only granted with proper de-energization procedures found in the Service and Maintenance Manual.

Commented [CJ21]: CRS Comment 6

Opening any of the access doors triggers a safeguard, immediately de-energizing the entire FC PowerGen and requires a resetting procedure.

It is recommended to keep a communications device on your person when being inside.

⚠ WARNING	
	**Access to the internals of Converter Container is strictly prohibited except when applicable procedures are done by trained personnel, approved by the manufacturer.**

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Revision Record			
Rev	**CO**	**Description**	Date
0B	CJA	Updated part number and naming to match nameplate (Megablock → PowerGen, Grid Interface Container → Converter Container). Reacting to CRS. Incorporated content from N01-004. Added section 6.1 regarding top-swap tool Added section 10 troubleshooting, with Cause and Effects chart as source.	2024-12-17
0C	KHE	Corrected in accordance with comments from CrossWind	2025-02-27

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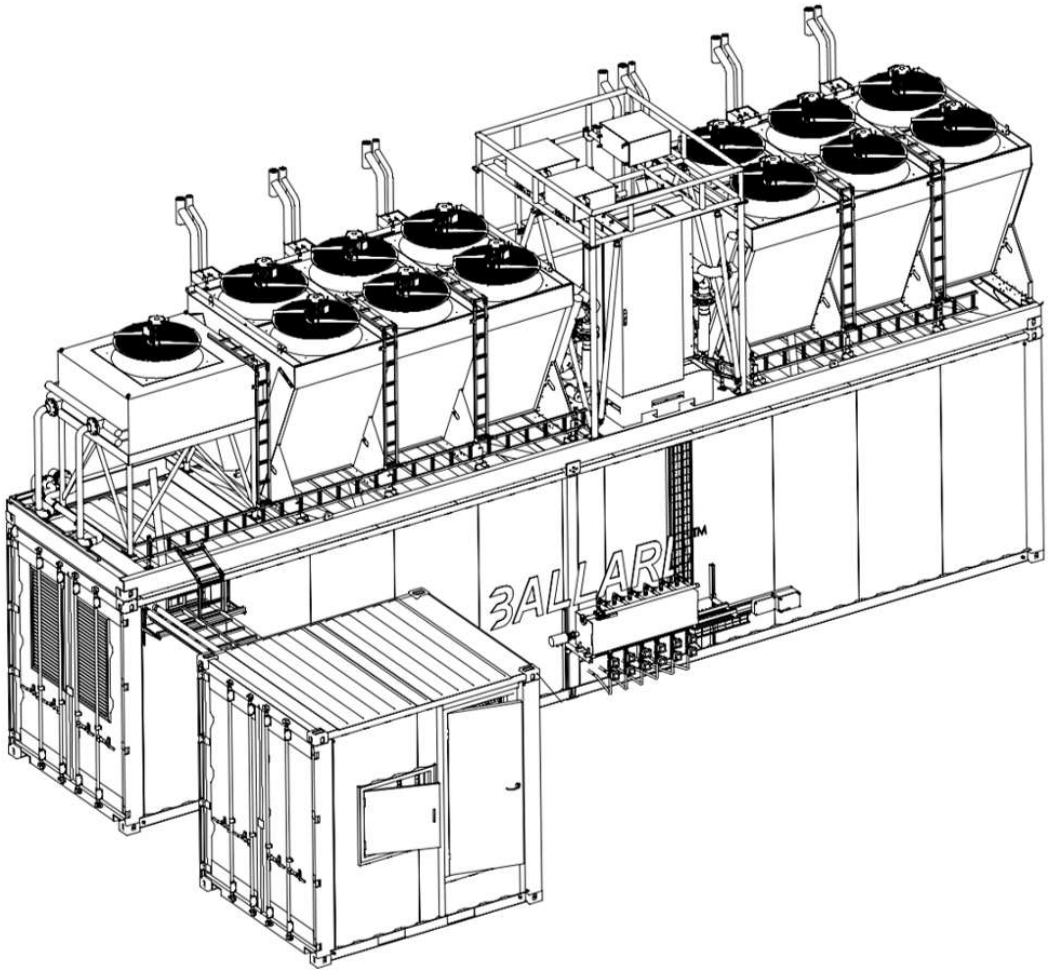
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FC PowerGen 1000kW

Part no.: 601456B-7002362

Configuration: 40ft Fuel Cell Container w. 6 FCwave's
10ft Converter Container, 6,6 kVAC

Service and Maintenance Manual



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1.0 Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURES DESCRIBED IN THIS MANUAL

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property. It is therefore necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device. Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, compressed gases, and H2.

This manual includes certain safety guidelines and recommendations; however, this manual is not intended to cover all situations. The customer is responsible for determining the suitability of the customer's particular design or application, and for ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated. Ballard Power Systems Europe A/S ("BPSE") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the operating recommendations in the manual. The customer is responsible for being aware of, and complying with, all applicable laws and regulations. BPSE has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual. Failure to follow any instruction or recommendation could result in death or bodily injury or loss or damage to property.

BPSE intends for the device to be installed, operated, and serviced only by approved technically qualified and experienced people who understand the principles of fuel cell technology, are aware of the safe operating limits of fuel cells, and are familiar with the risks posed by operating a fuel cell module. BPSE relies on customers to use their own knowledge and experience when installing, operating, and servicing the device. BPSE also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual.

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2.0 General Information



Service and Maintenance personnel must read and understand the Operator Manual mentioned in section 2.4 prior to activities covered by this manual.

2.1 Manual Purpose and scope

This Service and Maintenance Manual for the FC PowerGen provides guidance and instructions for routine inspections, testing, and maintenance tasks necessary for the safe and reliable operation of the system throughout its operational lifetime.

It covers topics such as:

- Safety protocols
- System Description
- Preventative Maintenance

Excluded from this manual are specific Service-, Maintenance-, and Repair- instructions. These are separate documents, reserved for trained and authorized personnel.

2.2 Intended audience

The intended audience for this manual is persons involved in service and maintenance of the FC PowerGen system.

Technicians and maintenance personnel who are responsible for servicing and maintaining the system must be authorized and trained by Ballard to perform service and maintenance according to this Manual, referred documentation, and instructions.



Technicians and Maintenance personnel must read and adhere to this manual when performing service and maintenance on the system.

Audience Key characteristics:

- **Technical proficiency**: The intended audience possesses a strong technical background and expertise in Fuel cells and electrical systems.
- **Authorized personnel**: Technicians and maintenance personnel are authorized by the manufacturer to access and use the Service and Maintenance Manual.
- **Training requirement**: The service responsible must use technicians who have undergone specific training programs provided by the manufacturer to ensure proficiency in servicing and maintaining the system safely.
- **Responsibility**: The service responsible must ensure the execution of routine inspections, testing, components change, and other maintenance tasks necessary for the safe functionality of the system.

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2.3 Training Level Certification

2.3.1 System service

Service on the system, excluding the FCwave, may only be performed by Ballard authorized personnel listed in the service authorization list and only according to the service tasks for which they are approved.

2.3.2 Fuel cell service

Personnel performing service on FCwave must be trained according to Ballard training levels:

Tier 1 – Service technicians and fuelers

Tier 2 – Service technicians and mechanics

Tier 3 – Senior Service technicians and Engineers

Details of roles and responsibilities are reinforced by Ballard's standard Service Level Agreement. Contact Ballard for details regarding training.

2.4 Manual series

The Manual Series provides manuals covering different life-phases of the system, as defined in Table 2-1:

Table 2-1: Manual series contents

Document no.	Title	Brief purpose description	Intended user(s)
Ballard: 7003672 CW: K559-2254-CWIWP4202202-R01-002	Transportation and Handling Manual	Enables safe, land-based, transport and handling from manufacturer to designated site.	Personnel qualified in preparation of, handling, and transport of freight.
Ballard: 7003718 CW: K559-2254-CWIWP4202202-N01-001	Integration Manual	Enables integrators to design a designated site and subsystems required within the intended use and limits of the system.	Integrators partaking in designing the designated site and subsystems, and commissioning.
Ballard: 7003717 CW: K559-2254-CWIWP4202202-N01-002	Operator Manual	Provides information to personnel for safe operation of the solution, instructions for operator-based maintenance, safety rules and recommendations	Operators, Integrators, Installers, Service and Maintenance personnel, personnel working in or near the system, and persons instructing visitors.
Ballard: 7003719 CW: K559-2254-CWIWP4202202-N01-003	Service and Maintenance Manual	As described in section 2.1	As described in section 2.2

Ballard Power Systems Europe (BPSE) may update the provided manuals on an ongoing basis.

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2.5 Ballard Aftersales Service

Contact information on Ballard Aftersales Service can be found at:
https://www.ballard.com/support/

2.6 Hazard Symbols

Hazard symbols throughout the manual indicate objectives or potentially dangerous situations.

Table 2-2: Hazard symbols

	**MANDATORY ACTIONS**: are marked with blue action-points. This indicates actions that must be performed. Ignoring may result in an accident, which could cause damage to equipment or other property, and could cause bodily injury if not promptly detected and remedied.
	**PROHIBITIONS**: are marked with red prohibition-signs. This indicates a forbidden action. Ignoring may result in immediate bodily injury or loss of life or could cause damage to equipment or other property
	**WARNINGS**: are marked with yellow triangles and/or square warning. Indicates hazards that may result in an accident, which could cause immediate bodily injury or loss of life or could cause damage to equipment or other property.
	**CAUTION** in this manual indicates actions that may result in an accident, which could cause damage to equipment or other property, and which could cause bodily injury if not promptly detected and remedied.
	**ELECRICAL HAZARD** Obey ALL warnings, cautions, and safety instruction related to electricity. Failure to do so may result in electrical shock leading to personal injury or death.

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2.7 References

Throughout the manual are referrals to separate documents. These references documents are available on the BPSE after sales Service Portal.

Should a document not be available, contact BPSE.

Table 2-3: Reference documents

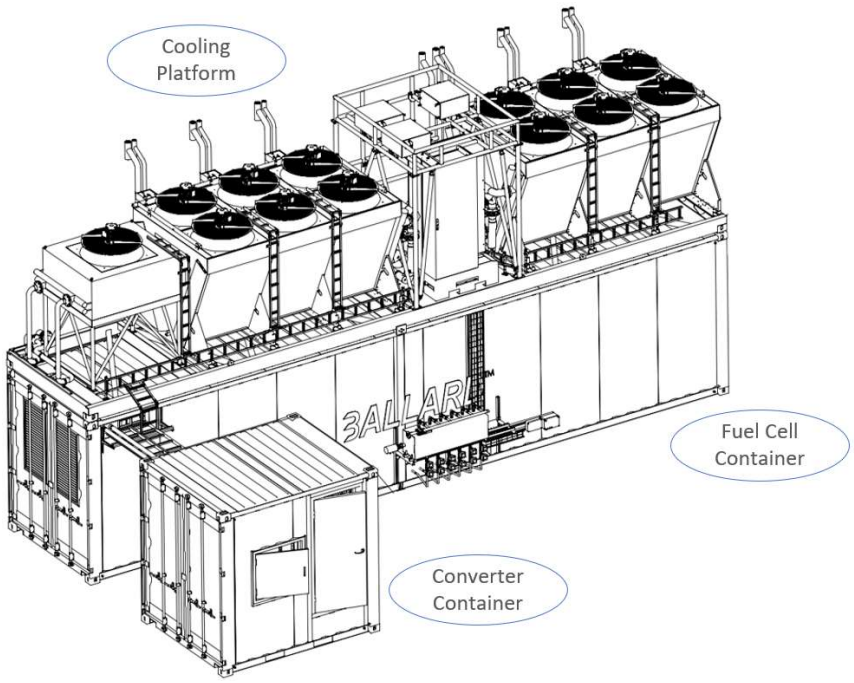
Document no.:	Document name:
7003724 (attached)	Maintenance Plan
K559-2254-CWIWP4202202-D05-001Rev001	Material Safety Data Sheets
K559-2254-CWIWP4202202-C99-001Rev002	Hydrogen Safety Concept
K559-2254-CWIWP4202202-K02-001Rev002	Equipment hazardous area certificate and schedule
K559-2254-CWIWP4202202-B99-003Rev001	Structural calculations - false floor
K559-2254-CWIWP4202202-B01-001Rev009	General Arrangement
K559-2254-CWIWP4202202-C03-001Rev006	P&IDs
K559-2254-CWIWP4202202-C06-001Rev007	Electrical Single Line Diagram
K559-2254-CWIWP4202202-E03	Electrical Cabinet Documentation
K559-2254-CWIWP4202202-N01-005Rev001	Lockout Tagout
N99 - MAN001Rev1.1.1	FCwave – Service and Maintenance Manual
K559-2254-CWIWP4202202-C07-001Rev002	Cause and Effects Chart

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3.0 General System Description

The system is a modularized power generator based on a number of FCwave™ Fuel cell units.
The FC PowerGen consists of the following main components:

Figure 1: Major components overview



Short descriptions of major components can be found in Table 3-1

Table 3-1: Major components of the machine (See Figure 1)

Component	Short Description
Fuel Cell Container	Based on a 40ft HC container, modified to a machine housing with access, ventilation, light safety etc. The container holds 6 FCwave modules with installation, internal 400VAC power supply for complete Balance of Plant components, main controller, LT pump system and DC/DC converters.
Cooling Platform	40ft Cooling Platform with service platform. 2 individual HT radiators dimensioned to the specific solution 2 individual HT pump-systems 1 LT radiator
Converter Container	Based on a 10ft HC container, modified to a machine housing with access, ventilation, light, safety etc. Holds DC to AC grid-supplying power electronics, Isolation transformer, and Grid Main Breaker.

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4.0 Safety

4.1 General safety



The reader of this manual shall read the operator manual mentioned in section 2.4 for additional information on general function and safety, as a supplement to the manual.

The applicable service procedure must always be consulted before any service activity is performed.

Any safety related information herein must be followed.



All service technicians must understand and comply with good workmanship and safety procedures generally associated with machinery service, even if these procedures are not specifically stated in this document.

While working on the system, there should always be more than one person present on-site.

4.2 Personal Protective Equipment

The service technician must bring and use appropriate PPE.

In general:

- Safety shoes are mandatory.
- Hearing protection must be available and used when the system is operational.
- Fire inhibited clothes must be used when working on the electrical system.
- Helmets must be used when hoisting equipment inside the Fuel Cell Container.
- Helmets and Fall arrest equipment must be used when working at heights.
- Suitable gloves and eye protection must be used for working with coolant.
- Suitable gloves must be used for where risk of cuts is present, i.e. under the raised floor because of sharp edges.
- Suitable tools for working on live voltages – as per EN 60900.

Procedures may specify additional PPE.

4.3 Corrective maintenance

In situations where errors arise because of defective or worn-out parts, contact Ballard for support. Corrective maintenance must be done by authorized personnel.

4.4 Retrofitting and modifications

Retrofitting and modifications of the system shall be in collaboration with Ballard. Contant Ballard for support. Ballard will not take responsibility for any non-approved items applied; it is the responsibility of the applying entity. Unapproved modification may affect the warranty on the entire system.

4.5 Spare and wear parts and consumables

Using spare parts and consumables from third party manufacturers can cause risk. Only use original parts or parts approved by the manufacturer.

The manufacturer takes no responsibility for damage as a result of using parts not released by, or approved by, the manufacturer.

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4.6 Coolant



The solution utilizes two types of coolant. The LT and HT cooling circuit uses the Glycol-based coolant Proviflow®, and the internal closed coolant loop of the FCwave™ uses GLYSANTIN® FC G20.

For more details, refer to the document "Material Safety Data Sheets".

During normal operation there should be no leakage of coolant. If a leakage is noted, Manufacturer must be informed.

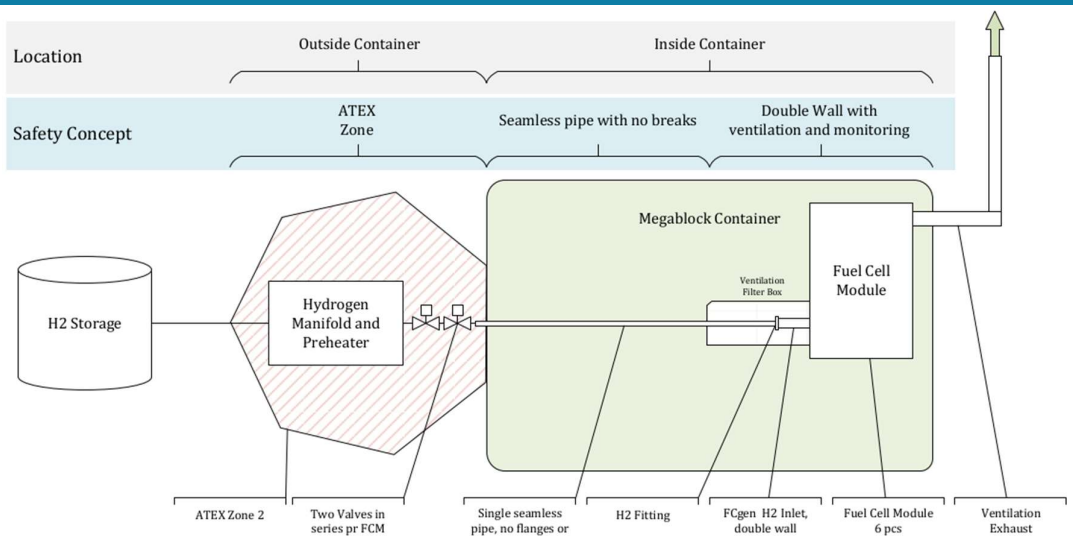
General rules are:

- Avoid contact with eyes and skin.
- Use protective gloves and tightly sealed googles.
- Avoid ingestion and inhalation of vapors.
- Spillage – do not allow to enter sewers/surface or ground water, absorb with a liquid–binding material, dilute with water.
- Disposal must be made according to official regulations.

4.7 Explosion safety

The hydrogen safety philosophy has several safety concepts, as indicated in Figure 2.

Figure 2: Hydrogen flow overview



Illustrative overview of hydrogen flow. See Hydrogen Safety Concept for more details.

Hydrogen is delivered to the hydrogen interface from a local hydrogen storage.

The area in which the interface, the hydrogen-manifold and -preheater, and hydrogen safety valves resides, is classified as an ATEX Zone 2. A hazardous mixture will not likely be present in normal operating conditions, and if so, only for a short period at a time. Electrical equipment in this zone is and shall conform to regulations and have the "EX" marking or similar. Detailed drawing of the hazard zone can be found in the General Arrangement. For more information regarding equipment installed in the zone, refer to the Equipment hazardous area certificate and schedule

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Respect the zone indicated, do not introduce any source of ignition.

There is no risk of hydrogen leakages inside the general space of the FC PowerGen Fuel Cell Container that can create an explosive atmosphere, due to the design of the feed pipes being seamless, one-piece-bends from outside of the container, routed through the container space, and connected the applicable Fuel Cell module.

The connection to a Fuel Cell Module (The H2 Fitting) is encapsulated within an extension of the Fuel Cell Modules Hydrogen Enclosure called the "Ventilation filter box", thus utilizing dilution and removal of any potential hydrogen with mechanical ventilation. Should leakages from this connection occur, the hydrogen detectors within the Fuel Cell Module will detect it and trigger a safe shutdown of that module and hydrogen supply.

The Ventilation system of the Fuel Cell Container creates a slight over-pressure to counteract ingress from particles and gas. As an additional precaution in case of hydrogen entering, the general space inside is equipped with hydrogen sensors. The position of these will detect any hydrogen entering or exiting the container through the ventilation system.

All safety-related triggers of the solution will shut off the hydrogen supply of either the affected system or the entire system.

4.7.1 Trace amount of H2

The process exhaust contains all biproducts from the fuel-cell stacks within the Fuel Cell Modules. The exhaust is a mixture of high-humidity, low-oxygen process air with trace amounts of hydrogen. The concentration of hydrogen will always be below 1%v, i.e. 25% of Lower Explosive Level (LEL), leading to a non-hazardous zone.

The source of the media in the Process Water Drain stems from the process exhaust. Thereby are also here found trace amount hydrogen which also are under 25% of LEL, leading to a non-hazardous zone. A hydrogen separator is fitted upstream to the process water drain and the trace amount of hydrogen are led through an exhaust to above the containers.

4.7.2 Working in the EX Zone

Personnel working in the EX-zone needs knowledge and skills as required by IEC 60079-14 and be approved as Operatives or Technicians on the EX-installation.



The defined EX zone is classified as Zone 2.

Only approved personnel are allowed to work in the ATEX Zone.



When working on systems containing hydrogen, refer to the correct procedures for Lock-out-tag-out. See Lockout Tagout document.

4.8 Fire safety

The Fuel Cell Modules have internal fire detection in the form of smoke detectors and linear heat detectors. If a Fuel Cell module detects fire, it will automatically perform a safe shutdown of itself and indicate an alarm.

If Smoke is detected inside the general space of the Fuel Cell Container or Converter Container, the entire system will perform a safe shutdown and indicate an alarm.

Should a fire occur, exit through the provided emergency exits.

There is no fire fighting equipment provided with the system.

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4.9 Electrical safety



The electrical system of the solution is designed in accordance with electrical and fuel cell codes to minimize electrical hazards. Electrical hazards may occur when the design is significantly compromised, typically through alteration, improper maintenance, or wear.

Dimensioning of cables and safety-equipment on the supplying and receiving end of electrical connections outside the solution must be done according to local legislation.

Select cabling and safety-equipment to the system that appropriately suits the application. Ensure to meet specifications of voltage, current, environmental temperature limits, chemical and mechanical resistance, and flexure requirements of the application. Avoid hazardous and unsafe situations that could result from condition such as, but not limited to:

- Improper grounding
- Handling electrical leads or devices with wet hands or on wet ground
- Frayed electrical leads
- Incorrect or improper connection of the terminal leads
- Short circuits
- Back-feed from energized normal and emergency power sources

Shutting down the solution during active Service and Maintenance may be necessary. Voltages may remain in the solution for a length of time. No activities are to be performed during this time as it presents a shock hazard.

Certain circumstances can lead to voltage persisting on the electrical systems. Always check for residual voltage before any activities. In some cases, it may require removal of hydrogen in the FCwave.

4.9.1 High DC Voltage Isolation Failures

Under normal circumstances, all high DC voltages are isolated from ground and the resistance is monitored. If isolation is lost on one high-voltage pole, a person working on the electrical system can sustain a fatal current-flow by touching the other voltage-pole and ground.

If two simultaneous faults occur and isolation is lost on both voltage-poles, a high voltage short circuit can occur resulting in extremely high currents/flash arcs. High currents can generate a large amount of heat which can subsequently damage electrical equipment and cause bodily harm.

Components inside the solution affects the resistance to ground, resulting in lower resistance over time.

Above-mentioned hazards are mitigated by the safety system of the solution. It actively monitors the resistance, warning if anything is to be reacted on, or shutting down the entire system in case of sustained resistance-drop or fault. Maintenance on the resistance-lowering-over-time-, and the monitoring-device(s) are crucial for the electrical safety of the system.

⚠ ELECTRICAL HAZARD	
	**If an isolation failure is detected and located in the MODULE, do not operate the fuel cell module until the root cause is determined and remedied.**

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4.9.2 Batteries

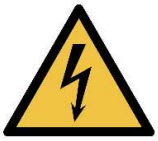


Batteries resides inside the system. Use applicable LOTO when working on system to avoid electrical hazards.

4.9.3 Converter Container access



The internals of the Converter Container are designed as an electrical cabinet (IP00), meaning that current-carrying conductors and terminals are exposed.

⚠ ELECTRICAL HAZARD	
	**HIGH VOLTAGE – 6.6 kV** **Danger of electrocution** **Authorized personnel only** **Keep clear and follow safety protocols** **Proper PPE required** **Failure to comply may result in serious injury or death**

Access is prohibited during operation. Opening the container doors activates the safety system, triggering emergency stop of the entire system. Residual voltages remain in certain components.

Entering this container requires prober de-energization and lockout tagout. Wait at least 10 minutes after de-energization before entering, and measure for residual voltages (<20VDC is safe).

4.10 Lock-out-tag-out (LOTO)

Ensure to use proper work-etiquette regarding LOTO on energy-containing systems, such as electrical supply, hydrogen, and batteries, when working on the system.

See Lockout Tagout document for procedures.

4.11 Heavy equipment

Some service and maintenance procedures require lifting of heavy equipment, such as an air-intake fan, top-module of an FCwave™, or an HT coolant pump motor.

Use of the monorail inside the fuel cell container, chain hoists, or forklifts are required, and safety precautions regarding these apply.

The Working Load Limit (WLL) of the monorail inside the Fuel Cell Container is 750kg.

4.12 Environmental conditions

Activities during rainy/snowy conditions should be avoided. If activities are performed during these conditions, the technician is responsible for ensuring that rain etc. does not enter the containers and electrical cabinets.

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Process exhaust contains water. During freezing conditions, snow and icicles may form.

Wear safety helmets under these conditions.

5.0 HMI - Service Interface

The system has a password-protected Service Interface, only accessible for authorized technicians.

The Service Interface can be accessed in three different ways:

1. Locally through the HMI touch screen located inside the Fuel Cell Container,
2. Locally with the use of a PC and a wired ethernet connection, to the secure internal network of the system, or
3. Remote access through the Secure Remote Access gateway.



Only trained and authorized personnel may access and use the Service Interface



Unauthorized accessing and usage of the Service Interface without proper training may result in serious injury

A default display showing main operating status is displayed when not in use as service interface.

6.0 Preparation for Maintenance

Technicians must examine the need for de-energization through means which is not within the scope of the system. Processes for de-energization of these shall be provided by whomever responsible.
Examples:

- Grid-connection switch-disconnector at customer end.
- Safety and/or isolation valve for Hydrogen supply.

Each service and maintenance tasks within the system may require varying de-energization of different sub-systems. User proper LOTO procedures as defined in the Lockout Tagout document.

An FCwave™ is placed in a "service state" prior to any de-energization of the hydrogen supply.

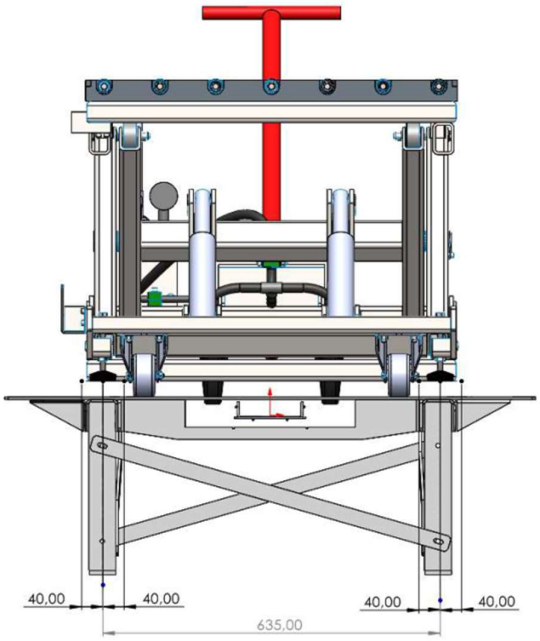
Service technicians must refer to the documents P&IDs, Electrical Single Line Diagram, and Electrical Cabinet Documentation for technical details of the system.

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6.1 FCwave™ Top-swap service tool

In order to perform a top-swap on an FCwave™, the service technician must use the applicable Service Cart Tool and follow the limits-of-use described below.

Figure 3: Placement of FCwave™ Service Cart Tool



Applicable service tool part number: 7000512

The flooring is designed only to temporarily carry the weight of the cart and top-module in a static state, transferring the weight to the legs of the floor through the leveling foots.

Ensure that the placement is correct (±40mm) – failing to do so will deform the flooring and may create a potential hazard for personnel.

The Service Cart Tool it is NOT intended to be moved on the wheels while carrying the top part of an FCwave™

To move a top-module of an FCwave™ inside the container, use an applicable hoist, mounted in the monorail.

For more details on the flooring, refer to the document Structural calculations - false floor.

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7.0 Preventative Maintenance - Fuel Cell Container

Figure 4: Fuel Cell Container – External overview



1: Main access door	4: HT drain valves
2: Service door	5: Hydrogen Heater
3: Air intakes	6: Hydrogen Interface

7.1 General External

7.1.1 Cleaning

The outside of the container may be cleaned using water and a nonabrasive cleaning agent.

Do not use high pressure cleaning.

During cleaning of Air intakes, the corresponding damper must manually be placed in closed position and disconnected. Reset to automatic after cleaning. The dampers can be actuated from the service interface.

7.1.2 Air dampers

The ventilation dampers must be able to operate unobstructed. Any material block or damage to damper blades must be corrected without unnecessary delay.

7.1.3 HT coolant drains

The HT coolant-drain valves at the bottom of the HT main pipes connecting the HT loop of the container to the HT cooling platform must be closed.

In case of leakage, immediately correct and check level of coolant.

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7.1.4 Access areas

The areas in front of the main door, the service door, and the cooling platform service area should be kept clean and free from obstacles.

7.1.5 Process water drain

The process water drain is directed to a designated drainage system of the local site.

It should be checked at every maintenance period that the drain is unobstructed.

The process drain is equipped with an exhaust and a heat trace that protects the drain against freezing. Inspection is performed according to the Maintenance Plan.

Process water is DI water and is not suitable as drinking water.

7.1.6 Process-, ventilation, and drain exhausts.

Each FCwave unit has a set of exhausts: process air and ventilation.

The drain has an exhaust.

It should be checked at every maintenance period that the exhausts are unobstructed.

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7.2 EX-zone

De-energization of electrical components for maintenance must be done, ensuring that no ignition source ever exists in the EX-zone.

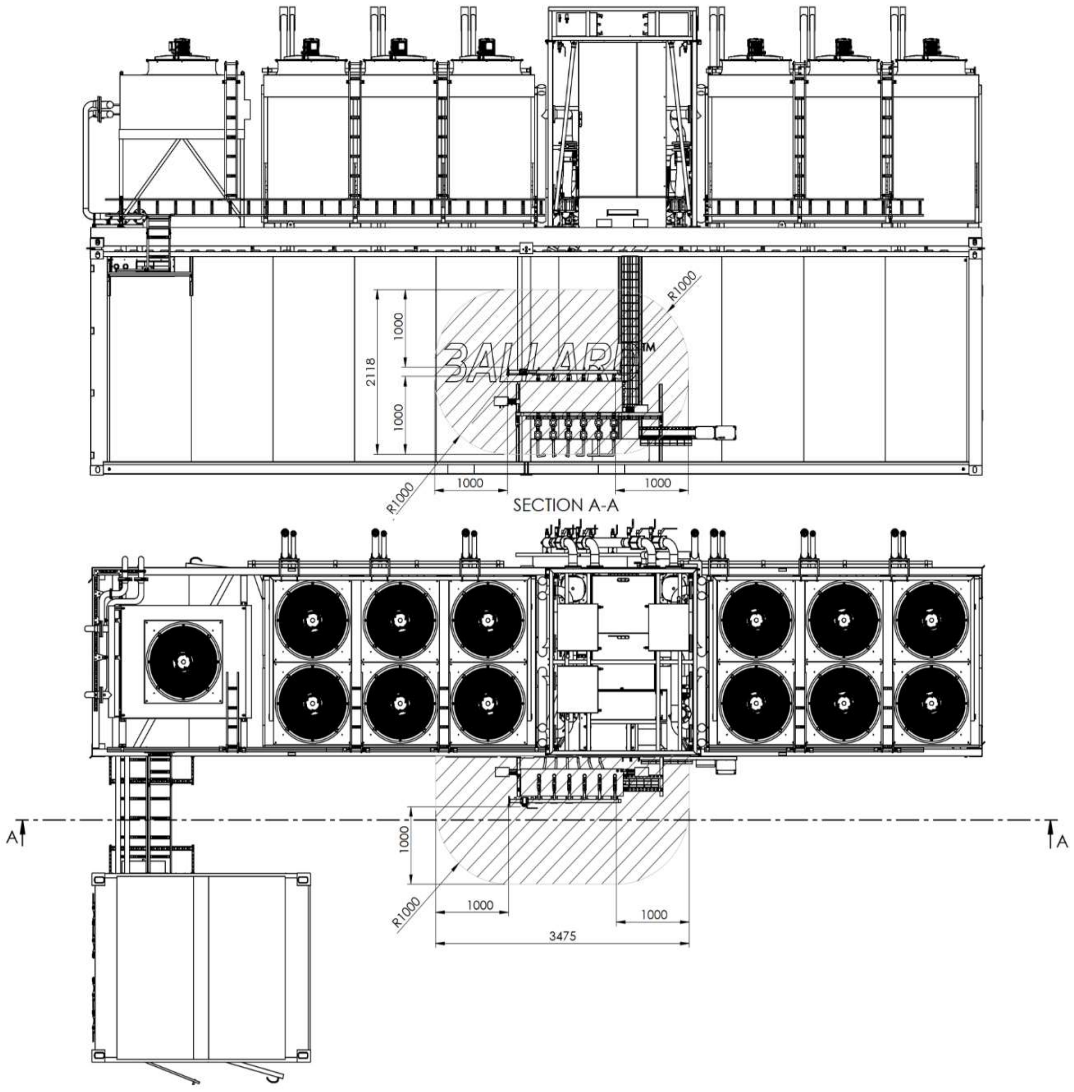


The defined EX zone is classified as Zone 2.

Only approved personnel are allowed to work in the ATEX Zone.



Figure 5: EZ-zone illustration



For detailed version, refer to the General Arrangement

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7.2.1 Hydrogen heater

During low ambient temperature, the hydrogen is heated to the hydrogen heater. The heater is filled with coolant and are heated using electrical heating elements.

The surface of the heater may reach up to 45°C.



If the Hydrogen Heater has run recently, wait for it to cool down before touching it and components mounted.

The following components of the Hydrogen Heater have no defined service/maintenance tasks defined by their documentation.

- Pressure sensor
- Temperature sensor
- Cables to sensors
- Cables to heating elements
- Cable glands on JEVI D-8640 heating elements
- Cable glands on Solenoid Shut-off valve (H2)
- Sensor EX barrier
- General Hy-lok fittings

  It is recommended that visual inspection on above-mentioned components is done.

7.2.1.1 Hydrogen Heater cooling media

The coolant level is monitored. In case of low level, it must be topped up.

The Hydrogen heater must have the coolant freeze-protection checked with the use of a refractometer regularly and changed as needed.

Coolant is 50/50% mixture of demineralized water and Proviflow Neo, which is an Ethylene-glycol based. Can be purchased as pre-mixed.

Criteria: minimum freezing point of -30°C

7.2.1.2 Level sensor – IFM LMT01A

Refer to Manufacturers (IFM) Operating Instructions – section 9.

- De-energize supply
- Check sensor tip for deposits and damage. Clean if badly soiled. In case of damage, replace the unit – the unit cannot be repaired.
- When reinstalling, carefully clean the probe neck and the installation slot, especially the sealing surface, with appropriate methods to ensure that the unit is resistant to ingress and without dead space.
- Re-energize supply.

7.2.1.3 Heating element - JEVI D-8640

Refer to Manufacturer's (JEVI) Installation, Operation and maintenance instructions, section 4.0

Maintenance free, however after 1 year of operation:

- De-energize supply (=LA01+UC30-FC41…42)
- Check the thermostat for damage

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- Check connections inside junction box
- verify correct connections and re-assemble
- Re-energize supply

If no heating is done when needed, check and press the manual reset button.

7.2.2 H2 Solenoid Shut-off valve – Emerson ACSO

Check for excessive wear – leakage tests

- Externally

  Potential leakage areas: Pipe connections (Hy-lok) and valve stem.

  Hy-lok connections have low probability of leakage. If leakage occur, refer to components manual for replacement.

  If leakage from valve stem, rebuild with manufacturer kit or replace component.
- Inline

  If inline leakage occurs, rebuild with manufacturer kit or replace component.

Leakage test:

- Close valve(s) on designated H2 line
- Lower pressure downstream
- Monitor pressure downstream for a set period
- Search for external leakages with applicable outdoor-use leakage detector.

7.2.3 Manual isolation valve – Hy-lok 110 Ball Valve

Refer to Manufacturers (Hy-lok) Instruction manual for maintenance.

Leakage test – Stem:

In case of stem leakage, tighten the Flange Nut. If the leakage remains after tightening, check damage to the stem, outer package and inner package. Replace parts or component(s) as needed,

Leakage test – Inline:

If the leakage happens inside the valve, ensure whether the valve is in fully closed condition. If the reason of leakage is seat damage, replace the seat or the component.

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7.3 Access



Access is restricted to authorized personnel only

7.3.1 Main access door

The door on the container side is the main entrance to the interior of the Fuel Cell Container. The door is locked and should only be unlocked by authorized personnel during service.

It is possible to unlock the door and enter the container while it is in full or partial operation.

In this case the door may not be kept open for a longer period, as this will affect the internal ventilation system. **Note**: The ventilation creates a slight overpressure inside the container.

Generally, the door should be closed to keep a clean environment inside the container.

7.3.2 Service door

The service door at the end of the container is intended for special service cases and should otherwise be kept closed.

The door can in any case be opened from inside and functions as an emergency exit.



Service personnel must unlock this service door when any activities are performed inside the container, to enable any first responders to gain access if needed.

7.3.3 Container doors

The standard container doors are not intended for use and should always be locked.

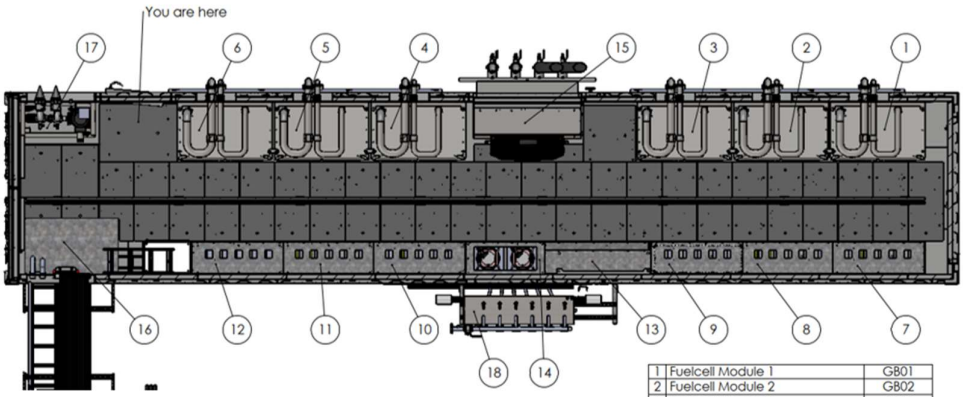


Before leaving the site check that all doors are safely locked.

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7.4 Internal

Figure 6: Fuel Cell Container - Internal overview



1	Fuelcell Module 1	GB01
2	Fuelcell Module 2	GB02
3	Fuelcell Module 3	GB03
4	Fuelcell Module 4	GB04
5	Fuelcell Module 5	GB05
6	Fuelcell Module 6	GB06
7	Fuelcell DC/DC Cabinet 1	UC01
8	Fuelcell DC/DC Cabinet 2	UC02
9	Fuelcell DC/DC Cabinet 3	UC03
10	Fuelcell DC/DC Cabinet 4	UC04
11	Fuelcell DC/DC Cabinet 5	UC05
12	Fuelcell DC/DC Cabinet 6	UC06
13	Controle Cabinet	UC20
14	Internal Container Ventilation	UC07
15	Container Ventilation	
16	AUX Transformer	TA03
17	LT Pump Rack	GP11
18	H2 Heater	EB01

Indicative illustration of the internals of the Fuel Cell Container

7.4.1 General

The interior should be kept clean and walking space unobstructed.

The floor plates are secured by screws and should always be secured unless service is in progress.

When working in the area below the floor, it is recommended to use gloves.



When the system is in operation use hearing protection.

If the system is locked to prevent starting, having hearing protection available is only recommended.



When working in the container, make sure that there is free access to an emergency exit door, and unlock the doors to allow for rescue personnel to enter the container through the emergency doors.



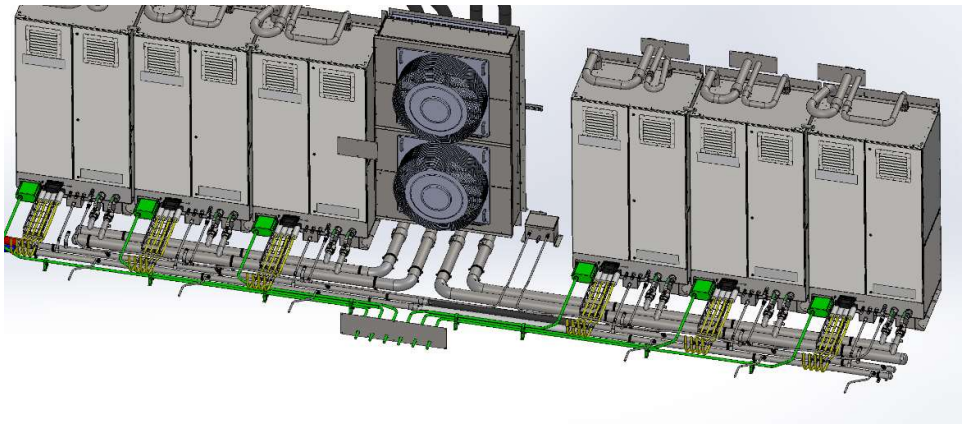
The container interior is equipped with overhead light sources. Use additional light where appropriate to avoid errors.

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7.4.2 Hydrogen piping

The hydrogen-piping runs as seamless feed pipes from the outside of the container and into Ventilation Filter Box where it is connected to the Fuel cell module.

Figure 7: Hydrogen piping



The interior hydrogen supply system is located below the floor.

Refer to P&IDs document for more details.

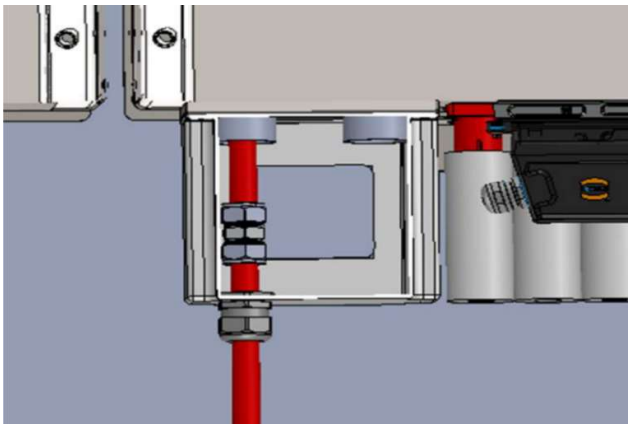
Special procedure must be followed to purge hydrogen in the piping downstream from isolation valve

7.4.3 Fuel cell hydrogen connection (ventilation filter box)

The ventilation filter box ensures that the supply-connection is well ventilated during normal operation, ensuring dilution and removal of any, highly unlikely, hydrogen leakage.

These connections must be checked with a hydrogen sniffer, and the filter of the ventilation filter box changed as defined by the Maintenance Plan.

Figure 8: Ventilation filter box



Top-view cut-off illustration of ventilation filter box. The filter is fitted to the bottom opening.

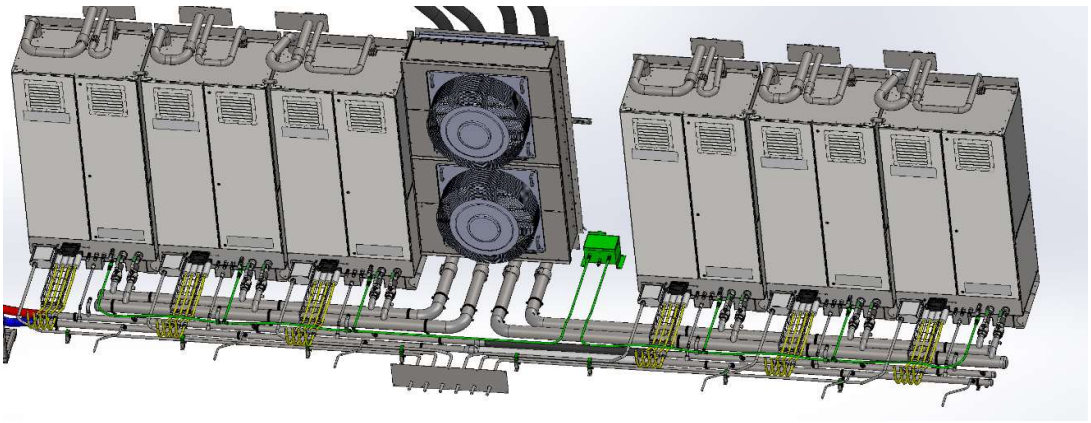
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7.4.4 Fuel cell process water drain

The fuel cell process water drain system collects process water from the Fuel Cell Modules (DI-water from the chemical reaction). This is led to a separator tank where gaseous matter is separated from the media. The gaseous matter is led to an exhaust, and the liquid matter are led to the exterior drain described in section 7.1.5.

Refer to P&IDs document for more details.

Figure 9: Process water drain system



Indicative illustration of piping and tank – layout/design my vary.

The separator tank is placed below the floor next to the main air-intake.

A heater wire is mounted to the exhaust and drain interface, ensuring that the water does not freeze. Inspect this system as defined by the Maintenance Plan.

7.4.5 Fuel cells

The service scheme for the FCwave is not covered in this document. Prior to service activity on the FCwave, the person must complete Ballard training relevant for the service planned. Service and safety instructions will be made available as part of the training.

Access to the interior of the FCwave units is only permitted for authorized personnel - see 2.3.2

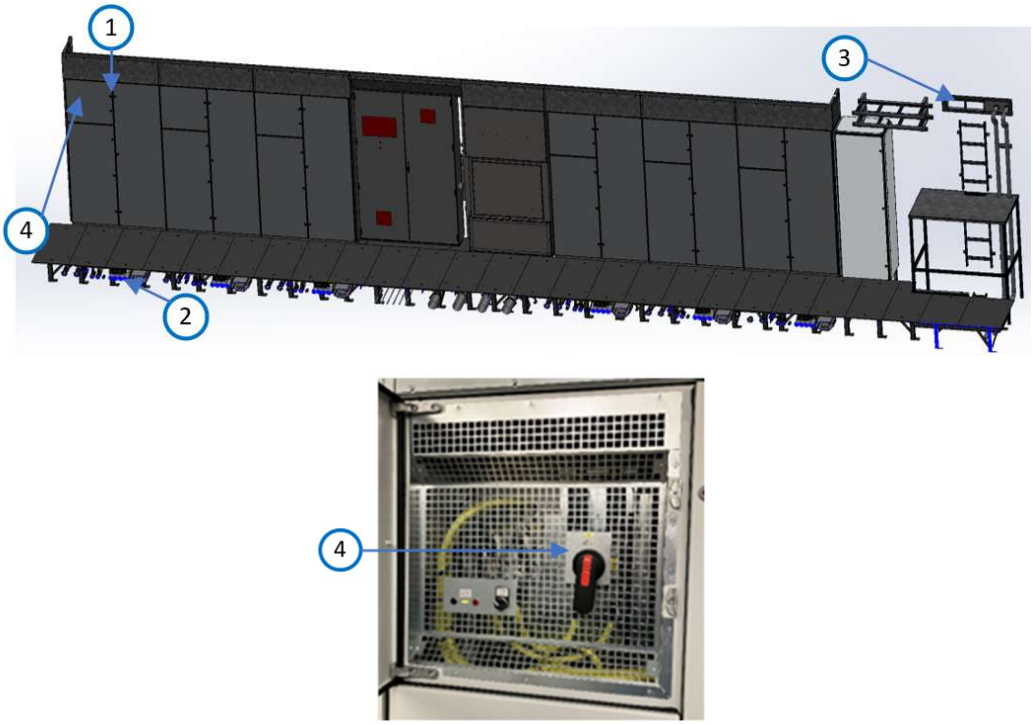
For details on service and maintenance tasks, refer to FCwave – Service and Maintenance Manual and the attached Maintenance plan for the FCwave.

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7.4.6 Electrical DC system

The power system is based on 750 VDC.
Special safety procedures must be followed when working on the system.
Do not open DC cabinets without following proper procedure

Figure 10: DC system



1: DC cabinet (1 of 6)
2: DC fuel cell cable
3: DC out to Converter Container
4: DC cabinet breaker

Each DC cabinet is equipped with a breaker behind the top left door. The breaker is used to isolate the cabinet and corresponding Fuel Cell Module from the DC link.

Proper procedure must be followed when dis- and re-connecting a DC cabinet, failure to do so may result in damage or injury.

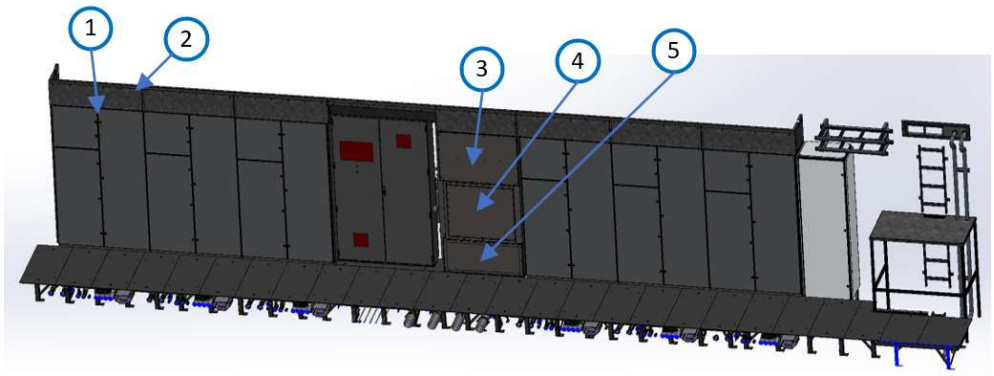
A yearly inspection of each DC cabinet must be done, including checking for leakages of coolant and a thermographic inspection of electrical components and connections.

Any time access to DC areas is made, ensure cleanliness.

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7.4.7 Internal ventilation

Figure 11: Internal ventilation



1: DC/DC cabinet 2: Ventilation/DC-cable duct	3: Ventilation fan box 4: Heating element box 5: Ventilation outlet

The internal ventilation system is removing heat from the power electronics and adding room heating in case of low temperature.

The circulation fan is placed in the central unit (3) together with a heater (4). It pulls air from below the floor, through the DC cabinets (1). Heated air exits at the outlet by the floor (5).

Each of the cabinets that the air is pulled through has a manual air-restrictor in the top, which is mounted in a fixed position, equalizing the flow through all ventilated cabinets. The settings of these are not to be changed.

There are no filters in the system.

Refer to P&IDs document for more details.



Do not open the ventilation duct unless the entire system is shut down and deenergized.

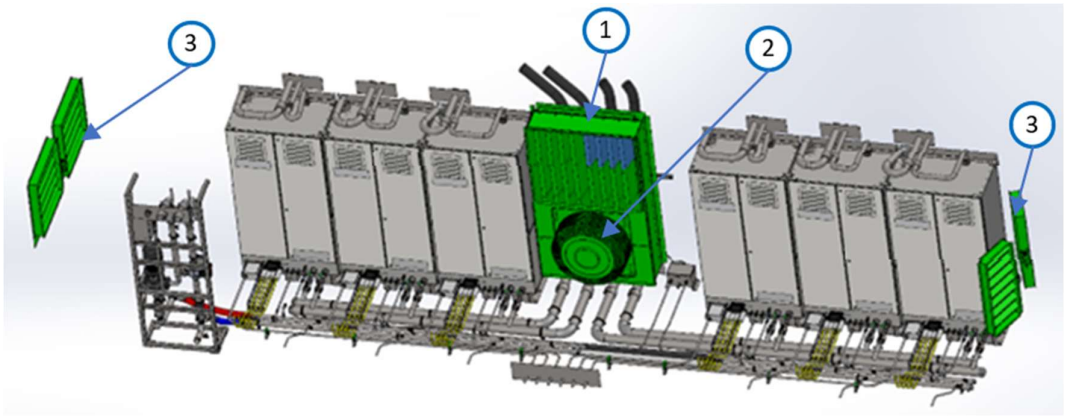
The DC cables are inside the conduit and there is access to the DC cabinets from the duct.

The heating element box must be cleaned and undergo a thermographic inspection of electrical power connections.

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7.4.8 External ventilation

Figure 12: Indicative illustration of external ventilation



1: Inlet filters
2: Main intake fans
3: Ventilation outlet with damper
Layout may vary

The external ventilation system is dual functioning, using external air to remove heat from the inside and providing air for the fuel cell process. Air flow is based on multiple parameters and controlled by fan speed and damper position.

The external ventilation is made to ensure a clean environment inside the container by filtering all incoming air and maintaining a slight overpressure inside the container.

Refer to P&IDs for more details.

Opening the doors of the container disturbs the air balance in the container. When doors are open, the fans will run in a locked base, unregulated setting – do not leave doors open unnecessarily.

The pressure-drop across the main filters is monitored to ensure proper function. The main filters replacement schedule is defined by the Maintenance Plan.

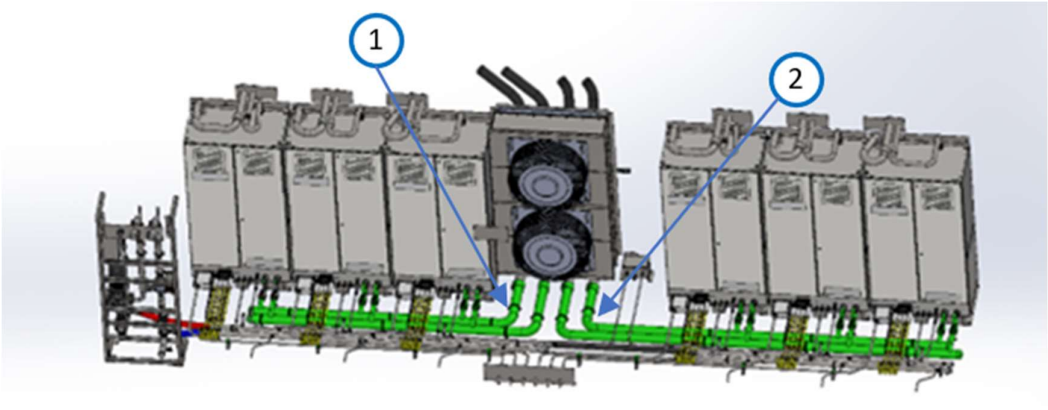
The service schedule for the fans of the intake is defined by the Maintenance Plan.

The dampers should be able to operate unobstructed. Any material block or damage to damper blades must be corrected without delay.

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7.4.9 HT Cooling systems

Figure 13: Indicative illustration of HT cooling system



1: HT cooling manifold FC 4, 5 & 6
2: HT cooling manifold FC 1, 2 & 3
Layout may vary

The 2 HT cooling systems are cooling the fuel cell stacks for FC1,2,3 and FC4,5,6 respectively, at approximately 60°C.

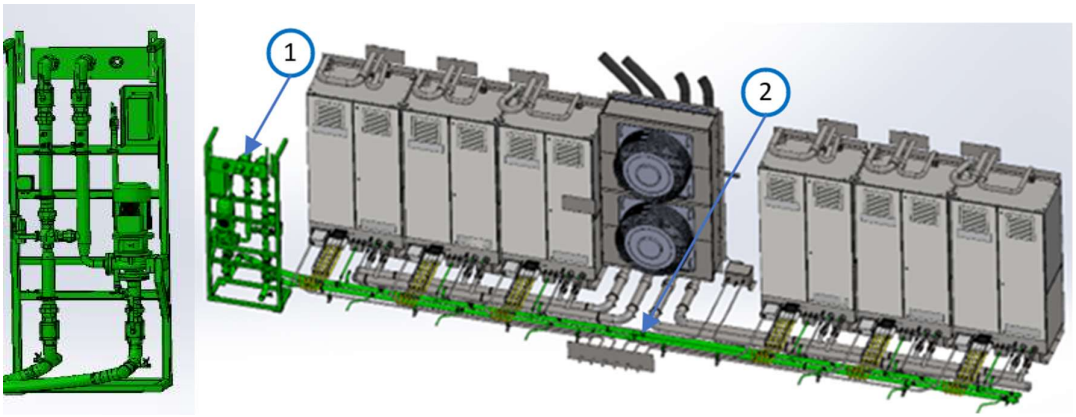
Details of the cooling media can be found in the document Material Safety Data Sheets.

There are no serviceable parts of the HT cooling system inside the container, but a visual inspection for leakages must be conducted.

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7.4.10 LT Cooling systems

Figure 14: Indicative illustration of LT cooling system



1: LT cooling pump rack
2: LT cooling manifold
Layout may vary

The LT cooling systems provides cooling for power electronics at approximately 45°C.
Refer to P&IDs and document for more details.
Details of the cooling media can be found in the document Material Safety Data Sheets.
The LT pump must be serviced as defined by the Maintenance Plan.
The LT Coolant strainer must be inspected and cleaned as defined by the Maintenance Plan.
Testing of the quality of the freeze-protection in the coolant.

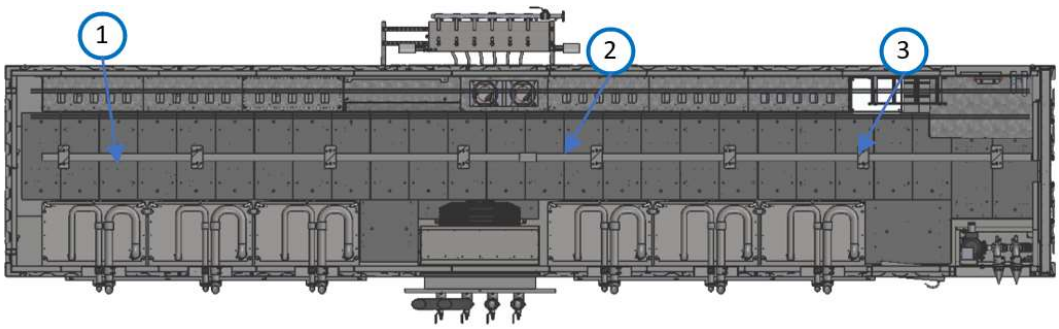
7.4.11 UPS

The container houses several 24VDC UPS modules. These are located under the floor.
The functionality of these, and the battery health must be checked.

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7.4.12 Container safety system

Figure 15: Safety sensors location



1, 2 and 3: H2 sensor & smoke detector

The container interior is equipped with 3 sets of safety sensors, each consisting of an H2 sensor and a smoke detector.

The sensors are integrated in the container safety system together with the FCwave safety signals, emergency stop, and electrical safety.

Figure 16: Safety sensors



H2 detection and smoke detection

The function of the sensors is tested as defined by the Maintenance Plan.

The H2 sensor must be calibrated as defined and change of sensor must be done because of degradation.

Functionality test on the emergency stops internally and externally to the system must be conducted.

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8.0 Preventative Maintenance – Converter Container

Figure 17: Converter Container – external overview



1: Access door	4: Air exhaust
2: Main breaker access door	5: Grid Interface
3: Control cabinet access door	6: Air Intake

The Converter Container has the main output power electronics and transformer inside. The interior is not a workplace, and it should only be accessed as needed for specific services.

8.1 External

8.1.1 Cleaning

The outside of the container may be cleaned using water and a nonabrasive cleaning agent.

Do not use high pressure cleaning.

During cleaning of Air intakes, the corresponding damper must manually be places in closed position and disconnected. Reset to automatic after cleaning. The dampers can be actuated from the service interface.

8.1.2 Air dampers

The ventilation dampers must be able to operate unobstructed. Any material block or damage to damper blades must be corrected without unnecessary delay.

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8.2 Access

The service door at the end of the container is intended for special service cases and should otherwise be kept closed.



Access to the internals is for authorized personnel only.
Never force entry.



Proper procedures for lock-out-tag-out must be performed, prior to entering.
See Lockout Tagout document.



Before leaving the site check that all doors are safely locked.

8.3 Internal

8.3.1 General

The interior should be kept clean and walking space unobstructed.



The UPS actively supply power to the control cabinet when the AC supply is disconnected.



Never work inside the container without a colleague.

Only firefighters should open the doors in case of fire.

8.4 Ventilation

The ventilation is made to ensure proper temperature and a clean environment inside the container by filtering all incoming air and maintaining a slight overpressure inside the container.

The pressure-drop across the main filters is monitored to ensure proper function. The main filters replacement schedule is defined by the Maintenance Plan.

The service schedule for the fans of the intake is defined by the Maintenance Plan.

The dampers should be able to operate unobstructed. Any material block or damage to damper blades must be corrected without delay.

The heating elements of the container heater must be inspected and cleaned.

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8.5 Power components

The internal DC bus is supplied by the incoming DC from the Fuel Cell Container.

The power from the Fuel Cell Container is converted to 400 V AC and connects to the Main breaker (grid connection). Components include DCAC converter with filter, transformer 400VAC to 6,6 kVAC, main breaker and connecting busbars.

Thermographic inspection of power electronics, connections, and applicable cabinets must be performed.

8.6 LT Cooling

The LT cooling system provides cooling of power electronics at approximately 45°C.

Refer to P&IDs and Material Safety Data Sheets document for more details.

The connections of the LT cooling system must be inspected for leakages.

8.7 UPS

The container houses several 24VDC UPS modules. The functionality of these, and the battery health must be checked.

8.8 Container safety sensors

Figure 18: Sensors



Smoke detector & temperature sensor

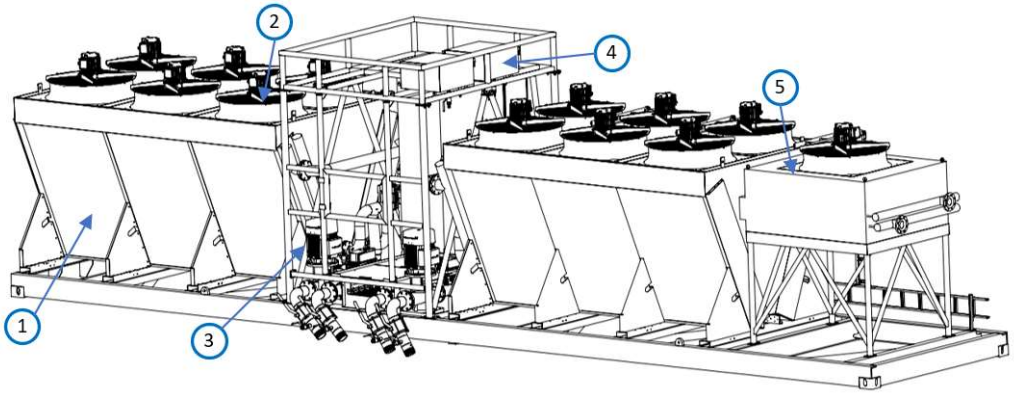
The container interior is monitored for smoke, has a safe-lock and door safety switches, one on each container door pair.

The sensors are integrated in the container safety system.

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9.0 Preventative Maintenance - Cooling Platform

Figure 19: Cooling platform - Overview



1: HT Cooler 2: Cooler fan 3: HT pump	4: Header Tank 5: LT Cooler

The Cooler platform has 2 individual HT cooling systems and the cooler for the LT Cooling system.

The HT Cooling systems are identical, each with a dry cooler, header tank, pump, valves, and sensors.

Each of the three cooling system is designed to allow for operation up to external temperature of 45°C. The systems are without active cooling, and it is therefore important that the coolers are kept in good operating condition.

There must be regular inspection of coolers at each service visit. The coolers must be kept clean and free from material blocking the airflow.

There is minimum a yearly cleaning and inspection of the coolers.

Cleaning of coolers, access to fans etc. may require using a ladder, lift, scaffolding or similar - Availability is customer responsibility, or as agreed upon.

Rules for working in height and fall arrest equipment applies.

Pumps, sensors, and valves can generally be serviced from the work platform. The platform is designed to be reachable by ladder and has a safety cave. Working inside the cave with the gate closed can be done without fall arrest equipment.

The HT pumps must be visually checked for leakages and serviced as defined by the Maintenance Plan.

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The cooling system contains Glycol.
See Material Safety Data Sheets for details.
Avoid spillage, use gloves and eye protection.

The coolant levels are monitored by level switches in the header tanks. In case of low coolant level, it must be topped up. The function of the level switches must be verified, defined by the Maintenance Plan.

The coolant must be checked yearly to secure proper freezing protection.

If for service or other reasons one of the cooling systems must be emptied and refilled, procedure must be followed, ensuring that the system is de-aeriated.

The Control Cabinet of the Cooling platform contains a UPS that must be tested as defined by the Maintenance Plan.

Fans on the coolers must be visually inspected and cleaned.

HT Fan Drive Cabinet Chiller shall have checked/cleaned/replaced the air-intake filter, cleaned the condensate drain trap and recharged refrigerant as needed.

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10.0 Troubleshooting

The system allows for remote monitoring where warnings and alarms are available. The following troubleshooting processes should be done by trained personnel. Refer to Cause and Effects Chart.

10.1 Safety system

Safety trip on an FCwave, Hydrogen safety valve override, Power converter Safe Torque Off (STO) or motor drive STO:

- Check internal and integrator-provided emergency stop buttons
- Check for hydrogen detection
- Check for fire detection

10.2 Hydrogen

If the hydrogen valves by the hydrogen heater are unexpectedly closed:

- Check internal emergency stop buttons
- Check for hydrogen detection
- Check for fire detection
- Check for DCAC Converter trip
- Check for LT Cooling system loss
- Check for ventilation failure
- Check the process water drain for blockage
- Check for communication failure to integrator
- Check for hydrogen supply and signal

10.3 FCwave

Single module has stopped:

- Check for FCwave internal alarm
- Check for applicable DCDC's trip

Multiple modules have stopped:

- Check for HT Cooling system loss

All modules have stopped:

- Check for DCAC converter trip
- Check for LT Cooling system loss
- Check for ventilation failure
- Check the process water drain for blockage
- Check for communication failure to integrator
- Check for hydrogen supply and signal

Single module Derate:

- Check for FCwave internal warnings

Multiple modules Derate:

- Check for HT cooling system loss

All modules Derate:

- Check for LT Cooling system loss
- Check for Ventilation Derate

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10.4 Power converters

Power converter derates:

- Check LT Cooling system Derate
- Check ventilation derate (Some power converters are air-cooled)

Power converter stop:

- Check DCDC converter trip
- Check DCAC converter trip
- Check for LT Cooling system loss
- Check ventilation derate (Some power converters are air-cooled)
- Check for communication failure to integrator

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Revision history		
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001	29/10/2024	First Issue
002	25/11/2024	Updated based on changes in ATEX Register Rev004

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ATEX Zone components maintenance



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1.0 Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURES DESCRIBED IN THIS MANUAL

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property. It is therefore necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device. Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, compressed gases, and H2.

This manual includes certain safety guidelines and recommendations; however, this manual is not intended to cover all situations. The customer is responsible for determining the suitability of the customer's particular design or application, and for ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated. Ballard Power Systems Europe A/S ("BPSE") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the operating recommendations in the manual. The customer is responsible for being aware of, and complying with, all applicable laws and regulations. BPSE has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual. Failure to follow any instruction or recommendation could result in death or bodily injury or loss or damage to property.

BPSE intends for the device to be installed, operated, and serviced only by approved technically qualified and experienced people who understand the principles of fuel cell technology, are aware of the safe operating limits of fuel cells, and are familiar with the risks posed by operating a fuel cell module. BPSE relies on customers to use their own knowledge and experience when installing, operating, and servicing the device. BPSE also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual.

Information in this manual is subject to change without notice. BPSE makes no commitment to update or keep current the information in this manual and reserves the right to make updates or other changes to this manual and/or to the products described in this manual, at any time without notice. Updates and other changes to the manual may be posted on the BPSE website and may be accessed through the customer portal; it is the customer’s responsibility to check for any such updates or changes.

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Table 2-1: List of components in ATEX zone 5

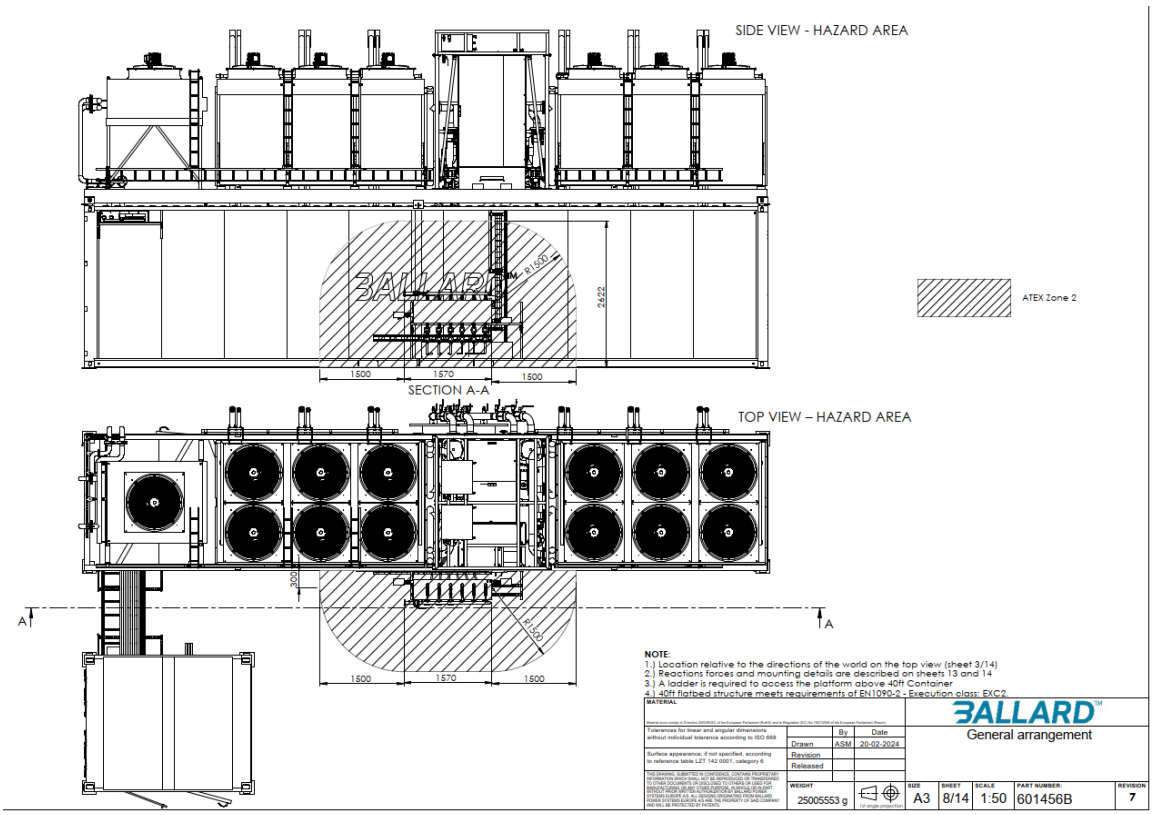
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2.0 General information

2.1 Introduction

This document serves to supply information regarding the needed maintenance on components that exists inside the ATEX zone.

Figure 1: ATEX zone



Source document: General arrangement - K559-2254-CWIWP4202202-B01-001Rev008

2.2 ATEX Zone maintenance safety



The defined EX zone is classified as Zone 2.

Only approved personnel are allowed to work in the ATEX Zone.



2.3 Coolant media

Coolant is Proviflow Neo. Refer to Material Safety Data Sheets - K559-2254-CWIWP4202202-D05-001.

2.4 De-energization

De-energization of electrical components for maintenance must be done, ensuring that no ignition source ever exists in the EX-zone.

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2.5 Components relevant to the ATEX zone

Table 2-1: List of components relevant to ATEX zone

Component	Device full tag	Manufacturer	Device/model/type	Service/ maintenance section
Hydrogen Heater	=HA01+DA02-CM01	Ballard	7003635	3.1
Level sensor – Hydrogen heater	=HA01+DA02-BL01	IFM	LMT01A - LMACE-A12E-QSKG-1/US/3D/3G	3.1.2
Connection wire – Level sensor	=HA01+DA02-BL01-WG01	IFM	ADOGH040MSS0010K04	N/A
Pressure Sensor – Hydrogen heater	=HA01+DA02-BP01	HUBA Control AG	Pressure Transducer 520 Series	N/A
Connection wire – Pressure sensor	=HA01+DA02-BP01-WG01	IFM	ADOGH040MSS0010K04	N/A
Temperature sensor – Hydrogen heater	=HA01+DA02-BT01	IFM	TT1050	N/A
Connection wire – Temperature sensor	=HA01+DA02-BT01-WG01	IFM	ADOGH040MSS0010K04	N/A
Heater element 1&2 - Hydrogen heater	=HA01+DA02-CM01-EA01...EA02	JEVI A/S	D-8640	3.1.3
Connection wires – Heater element 1&2	=HA01+DA02-EA01-WD01	Miltronic AB /Lapp Group	ÖLFLEX® CLASSIC 135 CH	N/A
	=HA01+DA02-EA02-WD01			
Cable glands – Heater element 1&2	=HA01+DA02-EA01	HAWKE	ICG 653 UNIV Os M20	N/A
	=HA01+DA02-EA02			
Solenoid Shut-off Valve, NC	=HA01+DA02-QM1.1...1.6	Emerson ASCO	NF X E210C488E 24/DC	3.2
	=HA01+DA02-QM2.1...2.6			
Solenoid Shut-off Valve cable gland	=HA01+DA02-QM1.1....16	HAWKE	501/421/O M20 421OM20	N/A
	=HA01+DA02-QM2.1...2.6			
H2 pipe wall passthrough	=HA01+DA02-XT01…06	Roxtec	EXRSB050000212	N/A
Sensor Ex Barrier*	=LA01+UC42-TF01	PR Electronics AS	9113B-U9	N/A
Container wall pass-through cable gland	=HA01+DA02-XT07…11	HAWKE	501/421/O M20 421OM20	N/A

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Table 2-1: List of components relevant to ATEX zone				
Fuel Cell string Manual isolation valve	=HA01+DA02-QM01…06	Hy-lok	Hy-lok 110 Ball Valve	3.3
Main H2 manual isolation valve	=HA01+DA02-QM00	Armatec	DVC Type 1311, 131150032	N/A
H2 pipe wall passthrough	=HA01+DA02-XT01…06	Roxtec	EXRSB0500002121	N/A

*Not installed inside ATEX zone

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3.0 Maintenance tasks on components in ATEX zone

3.1 Hydrogen Heater



If the Hydrogen Heater has run recently, wait for it to cool down before touching it and components mounted.

The following components of the Hydrogen Heater have no defined service/maintenance tasks defined by their documentation.

- Pressure sensor
- Temperature sensor
- Cables to sensors
- Cables to heating elements
- Cable glands on JEVI D-8640 heating elements
- Cable glands on Solenoid Shut-off valve (H2)
- Sensor EX barrier
- General Hy-lok fittings

It is recommended that visual inspection on above-mentioned components is done.

3.1.1 Hydrogen Heater cooling media

The Hydrogen heater must have the coolant freeze-protection checked with the use of a refractometer regularly and changed as needed.

Coolant is 50/50% mixture of demineralized water and Proviflow Neo, which is an Ethylene-glycol based.

Criteria: minimum freezing point of -30°C

3.1.2 Level sensor – IFM LMT01A

Refer to Manufacturers (IFM) Operating Instructions – section 9.

- De-energize supply
- Check sensor tip for deposits and damage. Clean if badly soiled. In case of damage, replace the unit – the unit cannot be repaired.
- When reinstalling, carefully clean the probe neck and the installation slot, especially the sealing surface, with appropriate methods to ensure that the unit is resistant to ingress and without dead space.
- Re-energize supply.

3.1.3 Heating element - JEVI D-8640

Refer to Manufacturer's (JEVI) Installation, Operation and maintenance instructions, section 4.0

Maintenance free, however after 1 year of operation:

- De-energize supply (=LA01+UC30-FC41…42)
- Check the thermostat for damage

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- Check connections inside junction box
- Re-assemble and verify correct connections
- Re-energize supply

If no heating is done when needed, check and press the manual reset button.

3.2 H2 Solenoid Shut-off valve – Emerson ACSO

Check for excessive wear – leakage tests

- Externally

  Potential leakage areas: Pipe connections (Hy-lok) and valve stem.

  Hy-lok connections have low probability of leakage. If leakage occur, refer to components manual for replacement.

  If leakage from valve stem, rebuild with manufacturer kit or replace component.
- Inline

  If inline leakage occurs, rebuild with manufacturer kit or replace component.

Leakage test:

- Close valve(s) on designated H2 line
- Lower pressure downstream
- Monitor pressure downstream for a set period
- Search for external leakages with applicable outdoor-use leakage detector.

3.3 Manual isolation valve – Hy-lok 110 Ball Valve

Refer to Manufacturers (Hy-lok) Instruction manual for maintenance.

Leakage test – Stem:

In case of stem leakage, tighten the Flange Nut. If the leakage remains after tightening, check damage to the stem, outer package and inner package. Replace parts or component(s) as needed,

Leakage test – Inline:

If the leakage happens inside the valve, ensure whether the valve is in fully closed condition. If the reason of leakage is seat damage, replace the seat or the component.

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Rev.	**Date.**	**Description**
001	09/01/2025	First Issue

Document Title:	**BLPH Project - ATEX Zone Components Maintenance**
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Sequence Number:	005
File Name:	K559-2254-CWIWP4202202-N01-005
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	N01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

FC PowerGen 1000kW

Part no.: 601456B-7002362

Configuration: 40ft Fuel Cell Container w. 6 FCwave™
10ft Converter Container, 6,6 kVAC

Lockout Tagout (LOTO)



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1.0 General information

1.1 Lock-out-tag-out

Always open/disconnect applicable connections and perform lock-out-tag-out, using relevant locking-methods and tagging-signage to reduce the risk of accidents.

Figure 1: ABB SA1



Example log-out-tag-out kit for MCB's and others



Always measure for voltages



Emergency buttons are NOT for Lock-out-tag-out.

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2.0 Fuel Cell Container

2.1 Interface connections (Externals)

2.1.1 Auxiliary power supply (=HKN70-XB01)

The auxiliary power supply is outside Ballard scope. Responsible entity must either provide a procedure for their end (Upstream) or perform the procedure when needed.

If work on the supply-side of the switch disconnector is to be done, follow that procedure.

When disconnecting the Auxiliary Power supply, the UPS inside may engage.

2.1.2 Hydrogen supply (=HKN70)

The Hydrogen Supply is outside Ballard scope. Responsible entity must provide a procedure for their end (Upstream) or perform the procedure when needed.

If work on the supply side of the interface is to be done, follow that procedure.

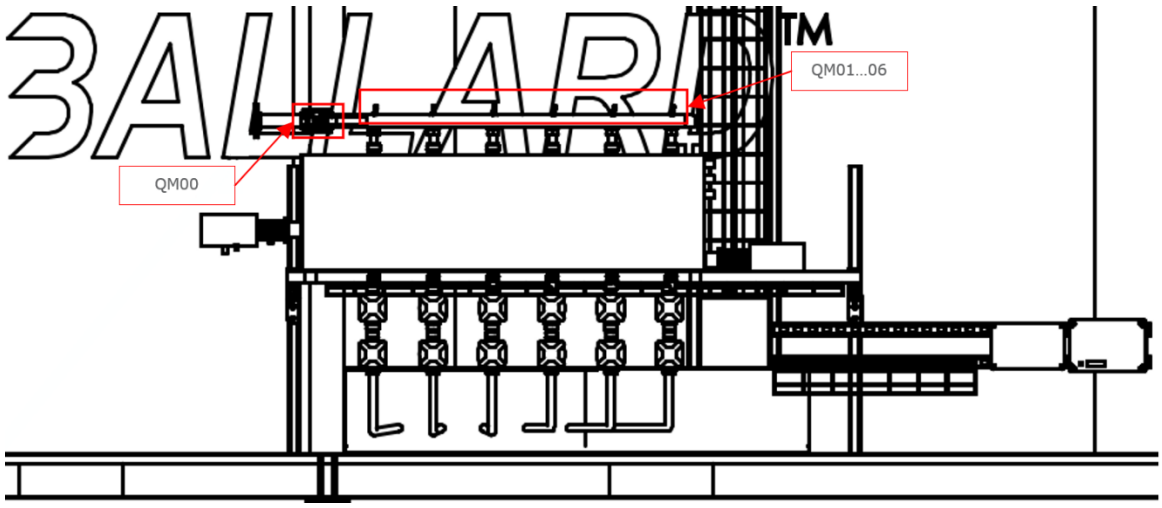
LOTO from the interface and downstream on is normally in correlation with service tasks on an FCwave™ (see section electrical LOTO in section 2.2.3)

Typical hydrogen supply LOTO:

- Locate applicable manual isolation valve by the hydrogen heater (=HA01+DA02-QM01…06)
  alternatively, supply to all FCwave's can be done with the main shutoff valve (HA01+DA02-QM00)
- Turn off
- Lock-out-tag-out with padlock and sign

Hydrogen remains in the piping from the manual isolation valve, downstream to the hydrogen supply interface of the FCwave. Refer to section 2.2.3 for bleeding.

Figure 2: Manual H2 isolation valves



All valves are lockable, enabling LOTO

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2.2 Internals

2.2.1 Auxiliary power supply (-SG01)

LOTO of auxiliary power supply to the internal of the container

Auxiliary power supply may be live

1. Locate +UC50
2. Open +UC50 (The bigger cabinet door on the left)
3. Open switch disconnector (-SG01)
4. Lock-out-tag-out with padlock and sign
5. Verify absence of voltage with applicable voltmeter

When disconnecting the Auxiliary Power supply, the UPS may engage.

Re-connect

1. Ensure that work is finished, and that cabinet is clean
2. Ensure that fuses downstream of auxiliary supply switch disconnector is off
3. Re-engage switch disconnector
4. Re-engage fuses downstream one at a time
5. Remove tag-out

2.2.2 DCDC cabinet (+UC01…06)

LOTO and De-energization

1. Shut down the FCwave applicable to the DCDC cabinet through the HMI/ModBus.
   e.g.: Fuel Cell Module 1 (+GB01) if working on DCDC Cabinet #1 (+UC01)
2. Open the top-left door of the applicable DCDC cabinet with Double-bit key no. 5 cabinet key.

Do not open any other doors of the DCDC cabinet yet.

Figure 3: Top-left door on DCDC cabinet (left)



Cabinet door marked with "Switch disconnector inside"

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3. Open the switch disconnector
4. Lock-out-tag-out switch disconnector with padlock and sign

 RESIDUAL POWER – In DCDC's - Wait at least 5 minutes

5. Open cabinet doors

 DC-link is most likely LIVE

6. Remove pre-charge fuses (4pcs - right top)
   This ensures that accidental activation of pre-charge turn-knop next to the switch disconnector handle does not introduce electrical hazard.
7. Optional: Unplug the 4 DC-connections in the bottom of the FCwave (beneath the floor).
8. Verify absence of voltage with applicable voltmeter (between top of DCDC's B+ and B-)

Re-connect

1. Ensure that work is finished, and that cabinet is clean
2. Re-apply pre-charge fuses
3. Close the two cabinet doors without the switch disconnector and turn-knop for pre-charge behind
4. Pre-charge the components of the cabinet using the turn-knop
5. Verify voltage by measuring with voltmeter in the two available plugs (530-750VDC)
6. Re-engage switch disconnector and close cabinet door.
7. Remove tag-out

2.2.3 FCwave™ (+GB01…06)

LOTO and De-energization (External to the FCwave™)

Electrical power

1. Set FCwave state to "Prepare for service" in HMI/ModBus and wait for it to transition.
2. Electrical supply LOTO:
   a. Open the top-left door of the applicable DCDC cabinet.

    *Do not open any other doors of the DCDC cabinet yet.*

   b. Open switch disconnector
   c. Lock-out-tag-out switch disconnector with padlock and sign

    RESIDUAL POWER – In DCDC's - Wait at least 5 minutes

   d. Open cabinet doors

    DC-link is most likely LIVE

   e. Remove pre-charge fuses (4pcs - right top)
   This ensures that accidental activation of pre-charge turn-knop next to the switch disconnector handle does not introduce electrical hazard.

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f. Verify absence of voltage with applicable voltmeter (between top of DCDC's B+ and B-)
g. Optional: Unplug the 4 DC-connections in the bottom of the FCwave (beneath the floor).

Re-connect

1. Ensure that work is finished, and that areas are clean
2. Close the doors on the FCwave™
3. Re-apply pre-charge fuses in DCDC cabinet
4. Close the two cabinet doors in the DCDC cabinet without the switch disconnector and turn-knop for pre-charge behind
5. Pre-charge the components of the cabinet using the turn-knop
6. Verify voltage by measuring with voltmeter in the two available plugs (530-750VDC)
7. Re-engage switch disconnector and close cabinet door.
8. Remove tag-out
9. Take FCwave™ out of service state through HMI/ModBus

Gas

1. Typically, as described in section 2.1.1

 Hydrogen remains in the piping from the manual isolation valve, downstream to the hydrogen supply interface of the FCwave

2. Continue de-energization of FCwave internals as described it's in manual

Re-connect

Typically reverse

24VDC Supply and control

1. Disconnect plug from the bottom of the FCwave (beneath the floor)
2. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that areas are clean
2. Reconnect

2.2.4 MCU cabinet (+UC20)

 MCU cabinet contains foreign control voltages – e.g. safety signals from customer

 UPS batteries supply energy to the MCU cabinet. These are located under floor by door (24VDC) and disconnected as described in section 2.2.5

The MCU cabinet is powered from +UC50

1. Ensure low-to-no power consumption in the MCU cabinet by opening fuses inside
2. Locate +UC50
3. Open +UC50 Right-lower door with Double-bit key no. 5 cabinet key
4. Open -FC04
5. Lock-out-tag-out -FC04 with ABB SA1, padlock and sign
6. Verify absence of voltage with applicable voltmeter

Alternative:

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1. Ensure low-to-no power consumption in the MCU cabinet by opening fuses inside
2. Locate switch disconnector on the right side of the cabinet (-QB01)
3. Open -QB01

 The power supply (upstream from switch disconnector) remains live

4. Lock-out-tag out -QB01with padlock and sign
5. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that cabinets are clean
2. Re-engage chosen switch disconnector
3. Re-engage fuses inside MCU cabinet
4. Remove LOTO

2.2.5 UPS

Access the UPS(s) by removing the floor-panel marked “Batteries”.

Power source:

1. Locate and turn off applicable fuse in +UC20
2. Lock-out-tag-out applicable fuse with ABB SA1, padlock and sign
3. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain

Outgoing power:

1. Ensure no power is drawn from UPS
2. Remove the 2x spade-fuses on applicable UPS unit(s)
3. Tag-out
4. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that area is clean
2. Ensure no energy-draw from the UPS when reconnecting the spade-fuses by opening the applicable fuses
3. Reconnect spade connectors
4. Close the earlier opened fuses

2.2.6 LT pump drive

1. Locate and turn off the fuse in the MCU cabinet (+UC20)
2. Lock-out-tag-out of fuse with ABB SA1, padlock and sign

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

3. Verify absence of voltage with applicable voltmeter

 The 24VDC control and supply remains active

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect in reverse order

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2.2.7 Intake fans

1. Locate and turn off the fuse in the MCU cabinet (+UC20)
2. Lock-out-tag-out fuse(s) with ABB SA1, padlock and sign
3. Turn lock-function of plug on the fan and remove by pulling

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect plug on fan
3. Close fuse(s)

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3.0 Converter Container

	**The internals of the Converter Container are not accessible when the system is running.**
	**Internals are IP00 area**
	**Never force entry, never de-activate safeguards.**

Entering the 10ft Converter Container

1. Remove the on the padlock on the container door with applicable key
2. Open the container door
3. Mount the padlock to the locking handle (like in Figure 4), ensuring that the container doors cannot be closed and locked by anyone with no knowledge of the work being done.

Figure 4: Mounted padlock on open container door



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3.1 Interface connections

3.1.1 Grid connection (=HKN70-XB02)

 – The Grid connection is outside Ballard scope. The responsible entity must provide a procedure for their end of the cable(s). If work downstream of the 1250KVA Transformer (-TA30) is to be done, follow that procedure.

3.1.2 DC bus (DC1)

 The DC bus in the Converter Container may be supplied both from the DC interconnection from the Fuel Cell Container and the grid connection.

If work is to be done inside the Converter Container, the DC bus must be fully de-energized.

3.1.3 AC Power Supply (BP2)

AC is supplied from the Fuel Cell Container to the Control Cabinet (+UC31) in the Converter Container. It can be shut-off locally or externally (locally – refer to section 3.2.1)

 UPS batteries supply energy to the Control cabinet. – refer to section 3.2.5.

Externally to Power Converter Container:

1. Locate +UC50 in the Fuel Cell Container
2. Open door with Double-bit key no. 5 cabinet key
3. Open switch disconnector -FC05
4. Lock-out-tag-out with padlock and sign

 RESIDUAL POWER – In converters - Wait at least 5 minutes

5. Verify absence of voltage with applicable Voltmeter

3.2 Internals

3.2.1 AC Power Supply (-QB01)

AC is supplied from the Fuel Cell Container to the Control Cabinet in the Power Converter Container. It can be shut-off locally or externally (Externally - refer to section 3.1.3).

Locally:

1. Access the Control Cabinet (+UC31) on the Converter Container by opening the door on the backside of the container (Key needed).
2. Open the control cabinet (+UC31) with a Double-bit key no. 5 cabinet key.
3. Turn off the fused switch disconnector (-QB01) in the cabinet (+UC31)

 The power-supply remains active upstream from -QB01. If work is to be done upstream, follow the procedure in section 3.1.3.

 RESIDUAL POWER – In converters - Wait at least 5 minutes before proceeding

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4. Verify absence of voltage with applicable voltmeter

 When disconnecting the Auxiliary Power supply, the UPS may engage.

3.2.2 Grid connection (-FC30)

Actuating/ Lock-out-tag-out is performed as defined by the manual for ABB SACE Emax 2.

 – Live parts may be present

Description of Disconnection of the Customer-end of the connected cable(s) is provided by customer

3.2.3 Transformer

Voltage to the Transformer is removed by the safety-system, when opening a door.

Make sure that the grid connection, described in section 3.2.2, is disconnected.

3.2.4 Capacitors

Voltage to the capacitors is removed by the safety system, when opening a door.

Make sure that the grid connection, described in section 3.2.2, is disconnected.

 RESIDUAL POWER – In capacitors - Wait at least 5 minutes

3.2.5 UPS

The UPS(s) is located in +UC31 which is accessed by opening the container doors that face away the Fuel Cell Container.

Power source:

1. Locate and turn off applicable fuse in +UC31
2. Lock-out-tag-out applicable fuse with ABB SA1, padlock and sign
3. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain present

Outgoing power of UPS:

4. Stop machine through HMI/ModBus
5. Locate the container doors that face away from the Fuel Cell Container.
6. Open the door with applicable key
7. Access the UPS that is located inside +UC41
8. Ensure no power is drawn from UPS
9. Remove the 2x spade-fuses on applicable UPS unit(s)
10. Tag-out
11. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that area is clean

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2. Ensure no energy-draw from the UPS when reconnecting the spade-fuses by opening the applicable fuses
3. Reconnect spade connectors
4. Close the earlier opened fuses

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4.0 HT Cooling Platform

4.1.1 Control cabinet (+UC30)

The power supply of the HT Cooling Platform can be shut off locally on the Control Cabinet, or in +UC50 inside the Fuel Cell Container.



A 24VDC UPS is in the cabinet.

Converters: DCDC for the UPS and Frequency converters for the pumps.

Foreign control signals.

Locally:

1. Turn off switch disconnector on the cabinet (-QB01)

 RESIDUAL POWER – In converters - Wait at least 5 minutes

2. Verify absence of voltage with applicable voltmeter

 The power-supply remains active upstream from -QB01. If work is to be done upstream, follow the procedure below.

Externally to HT Cooling Platform:

1. Locate +UC50 in the Fuel Cell Container
2. Open +UC50 with a Double-bit key no. 5 cabinet key.
3. Open switch disconnector -FC04
4. Lock-out-tag-out with padlock and sign

 RESIDUAL POWER – In converters - Wait at least 5 minutes

5. Access the Control Cabinet (+UC30) on the HT Cooling Platform with a Double-bit key no. 5 cabinet key.
6. Verify absence of voltage with applicable voltmeter

4.1.2 UPS

The UPS is in the Control Cabinet.

Using MCCB:

1. Locate applicable fuse (MCCB) in +UC30
2. Open the fuse
3. Lock-out-tag-out fuse with ABB SA1, padlock and sign
4. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain present

Using fuses on UPS:

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1. Ensure no power is drawn from UPS by opening applicable fuses
2. Remove the 2x spade-fuses on UPS unit

 Energy in UPS batteries remain present

3. Tag-out with sign
4. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that the cabinet is clean
2. Open the applicable fuses to ensure no energy-draw from the UPS when reconnecting the spade connectors
3. Reconnect spade connectors or turn on fuse
4. Close the earlier opened fuses

4.1.3 HT Coolant pump

1. Locate and turn off the applicable fuse in the Control cabinet (+UC30)
2. Lock-out-tag-out fuse with ABB SA1, padlock and sign

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

3. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that area is clean
2. Close fuse

4.1.4 Cooling fan / VFD

This section applies to the cooling fans -GQ11…16, -GQ21…16, and -QG31, as well as their applicable Variable Frequency Drive (VFD)

 Foreign control signals

1. Locate and turn off the applicable fuse in the Control cabinet (+UC30)

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

2. Lock-out-tag-out fuse with ABB SA1, padlock and sign
3. Turn lock-function of plug on the fan and remove by pulling

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect any disconnected plugs on fan
3. Close fuse

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4.1.5 VFD Cabinet chiller

1. Locate and turn off -FC40 in the Control cabinet (+UC30)
2. Lock-out-tag-out fuse with ABB SA1, padlock and sign

Re-connect

1. Ensure that work is finished, and that area is clean
2. Close fuse

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Purchase Order:	CWIWP4202202
Code:	N01
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

200kW Marine Fuel Cell Integration Manual



1. Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURE DESCRIBED IN THIS MANUAL

This manual includes certain safety guidelines and recommendations. However, this manual is not intended to cover all situations.

This manual attempt to specify the requirements for most applications, but for applications which may require operation outside of the stated specifications, please contact Ballard Power Systems Europe.

The integrator is responsible for being aware of, and complying with, all applicable laws and regulations.

The integrator is responsible for determining the suitability of the FCwave™ for the particular application and ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated.

Ballard Power Systems Europe, Inc. ("Ballard") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the intended use according to this manual.

Ballard has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual.

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property.

- It is necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device.
- Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, hot and/or pressurized fluids, and hydrogen.

Ballard relies on customers to use their own knowledge and experience when installing, operating, and servicing the device.

Ballard also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual. See abbreviation list.

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Updates and other changes to the manual may be posted on the Ballard website and may be accessed through the customer portal.

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4. Abbreviations

Acronym	Definition
BOL	Beginning of Life
BOP	Balance of Plant
BPSE	Ballard Power Systems Europe
CAN	Controller Area Network
DI	Deionized
EOL	End Of Life
FC	Fuel Cell
FCM	Fuel Cell Module
FCwave	Product name 200kW Marine Fuel Cell module
H2	Hydrogen (Gaseous)
H2E	Hydrogen Enclosure
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
IP	Ingress Protection Rating
LEL	Lower Explosive Limit (18% vol mix with atmospheric air)
LFL	Lower Flammability Limit (4% vol mix with atmospheric air)
LVC	Low Voltage Connector
MCU	Module Control Unit
PEM	Proton Exchange Membrane (Fuel Cell Technology)
RDU	Remote Data Unit
SVN	Subversion, internal source code repository
UPS	Uninterruptable Power Supply
VCS	Vessel Control System

Table 1 – List of Abbreviations

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5. Reference Documents

Document	Title
7001000-01	FCwave™ 200kW Arrangement Plan
CMS010	Schematic description of Input and Output Circuits
CMS013	Customer CAN Matrix
CMS014	Control System Alarm List
CMS006	Electrical Datasheet

Table 2 – List of Reference Documents

6. General Information

6.1. Scope of Manual

This Integration Manual provides the necessary system requirements for integrating and operating the FCwave™ 200 kW Marine Fuel Cell Module (hereafter referred to as the "module").

It covers topics such as

Expected product performance,
Required system inputs/outputs,
Mechanical/electrical interfaces and control details.

7. FCwave™ Fuel Cell Module Datasheet

Too see the latest revision of the electrical datasheet (CMS006), go to Customer Portal, or contact Ballard Power Systems Europe.

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7.1. Fuel cell module

The major components and features of the module sub-systems are listed below:

- Liquid cooled PEM (Proton Exchange Membrane) fuel cell stacks.
- Built-in control system, control power supplies and control power distribution.
- Independent Safety Controller with separate power supply and safety instrumentation.
- Sensors for voltage, current, pressure and temperature measurements.
- Safety devices, including ventilation system (fans and ventilation exhaust line), fuel pressure relief device, fire detection and hydrogen sensors.
- High voltage contactors for electrically isolating the fuel cell stack from the high voltage output terminals.
- High voltage system pre-charging and reverse current protection during start-up.

Hydrogen (Anode) Sub-system

- Complete hydrogen subsystem, which delivers and conditions the fuel supply to the fuel cell stacks.
- Valve block with integrated hydrogen shutoff, pressure regulation and safety pressure relief device.
- Hydrogen recirculation with purge.

Air (Cathode) Sub-system

- Air compressors and inverter assemblies for supplying process air to the fuel cell module.
- Air mass flow sensor for air flow rate measurement and control.
- Intercooler and humidifier for conditioning the incoming air stream.

Coolant Sub-system

- Internal high-temperature coolant loop, with coolant pump and controller assembly for supplying coolant to the fuel cell stacks.
- Liquid to liquid stainless-steel heat exchanger between internal high-temperature coolant loop and customer coolant loop, able to handle a wide range of coolant media (fresh water, water-glycol mix).
- Electronically actuated control valves used for stack coolant inlet temperature control.
- Separate low-temperature coolant loop to cool motors and motor controllers.

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8. Safety

8.1. Hazard Symbols



WARNING *in this manual indicates actions that may result in an accident, which could cause immediate bodily injury or loss of life or could cause damage to equipment or other property.*



CAUTION *in this manual indicates actions that may result in an accident, which could cause damage to equipment or other property, and which could cause bodily injury if not promptly detected and remedied.*



ELECTRICAL HAZARD*- Obey ALL warnings, cautions, and safety instruction related to electricity. Failure to do so may result in electrical shock leading to personal injury or death.*

8.2. General Safety



The modules are to be installed in a dedicated fuel cell installation room.

The system integrator is responsible for providing means to lockout energy sources on the system prior to any service activity being performed, and a written procedure to Ballard service personnel detailing the equipment and steps required to sufficiently lock out all necessary energy sources.

- Keep module doors and electrical enclosures closed when the system is operating.
- The module and its auxiliary systems are intended to be serviced only by personnel technically qualified and experienced in handling electrical equipment and compressed/flammable gases
- Remove jewelry, watches, rings, and metal objects on clothing that can potentially cause short circuits when working on the fuel cell module.

8.3. High Temperature Safety



Integrator shall ensure that process exhaust piping is leak tight and touch proof.

- Surfaces on coolant interfaces and the process exhaust can reach up to 80 °C during normal operation.
- Components within the fuel cell module can reach temperatures up to 120 °C during normal operation.

8.4. High-Pressure Safety



The module uses pressurized gases which can be hazardous.

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- Use caution and ensure circuits are de-pressurized before opening any lines or fittings.
- Some sub-systems may remain pressurized even when the fuel cell module is powered off.

8.5. High Voltage Safety



Ballard recommends that the electrical integration of the fuel cell module must be designed under the supervision of a qualified professional electrical engineer.

It is the integrator's responsibility to design the integration of the fuel cell module such that the integration complies with all applicable legislation and requirements.

After shutdown, high voltages may remain on the fuel cell stacks for a duration of time. No maintenance activities are to be performed during this time as the stacks present a shock hazard. Also, residual reactants (oxygen and hydrogen) within the fuel cell module can cause the fuel cell output voltage to rise unexpectedly.

Allow the fuel cell voltage to drop to below 30 VDC prior to servicing the fuel cell module. Certain circumstances can lead to voltage persisting on the fuel cell stack indefinitely.

Always check for residual voltage before any service activity.

Operate the fuel cell module high voltage as a "floating electrical system". Ensure that neither the fuel cell high voltage positive terminal nor the fuel cell high voltage negative terminal is connected to the application ground, earth or chassis.

Before working on the fuel cell module and its auxiliary systems in a floating DC system, it's important to make sure the system is de-energized. This involves checking for near-zero volts in three key areas: between the fuel cell's high voltage positive and negative terminals, between the high voltage positive terminal and the chassis, and between the high voltage negative terminal and the chassis.

Measurements are to be made on both AC volts and DC volts scales.

The monitoring of the isolation resistance of the overall high voltage system shall be done with a device capable of detecting both single and double pole isolation failures.

The system integrator is responsible for ensuring that a suitable ground fault monitoring system is installed and functioning during operation of the fuel cell power system. If the level of electrical isolation is ever deemed unsafe according to regulatory standards, the integrator must provide means for the fuel cell power system to be shut down in case of a ground fault.

Select fuel cell module power output cables that appropriately suit the application.

Ensure that cable specifications meet voltage, current, environmental temperature limits, chemical and mechanical resistance and flexure requirements of the application.

Avoid hazardous and unsafe situations that could result from conditions such as, but not limited to, the following:

Improper grounding
Handling electrical leads or devices with wet hands or on wet ground
Frayed electrical leads

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Incorrect or improper connection of the terminal leads
Short circuits
Back-feed from energized normal and emergency power sources

8.6. High Voltage Isolation Failures



Under normal circumstances both high voltage output terminals (positive and negative) are isolated from the fuel cell module enclosure and low voltage system.

If isolation is lost on one high voltage pole, a person working on the module could sustain a fatal current flow by touching the other high voltage pole and ground.

If two simultaneous faults occur and isolation is lost on both high voltage poles, a high voltage short circuit can occur resulting in extremely high currents. High currents can generate a large amount of heat which will subsequently damage electrical and fuel cell systems and cause bodily harm.

It is the responsibility of the system integrator to ensure that the electrical isolation between the high voltage and low voltage systems (Ground) is accurately and continuously measured and that appropriate action is taken before a hazardous condition develops.

Normal System

Under normal operation, the fuel cell system will operate as shown in Figure 1 where both high voltage poles are isolated from ground.

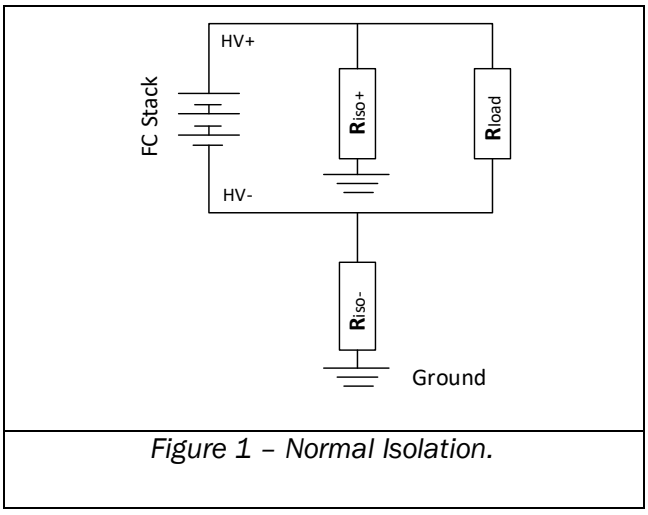


Figure 1 – Normal Isolation.

Single Pole Isolation Failure

In a single pole isolation failure, one point on the high voltage circuit is no longer isolated from ground as shown in Figure 2. An isolation resistance measurement or ground fault detection system can typically detect this failure if utilized. A single pole isolation failure will not cause a short-circuit, nor will

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it prevent fuel cell operation, however, it significantly increases the risk of electrical shock for personnel working on or around the fuel cell system.

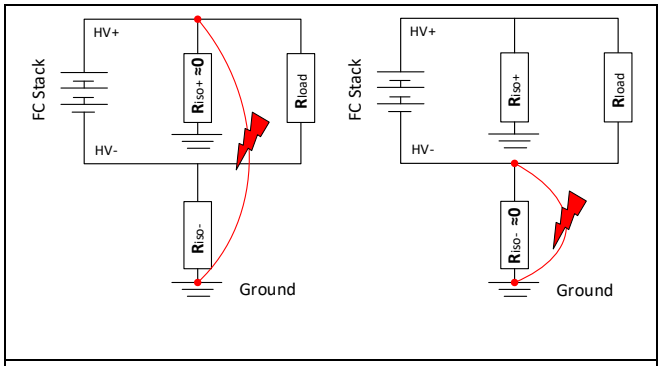


Figure 2 – Single Pole Isolation Failure.

Double Pole Isolation Failure

A double pole isolation failure, where the high voltage system is no longer isolated from ground in two different locations, may result in a high voltage short-circuit as shown in Figure 3. An isolation resistance measurement or ground fault detection system can typically detect this failure if utilized.

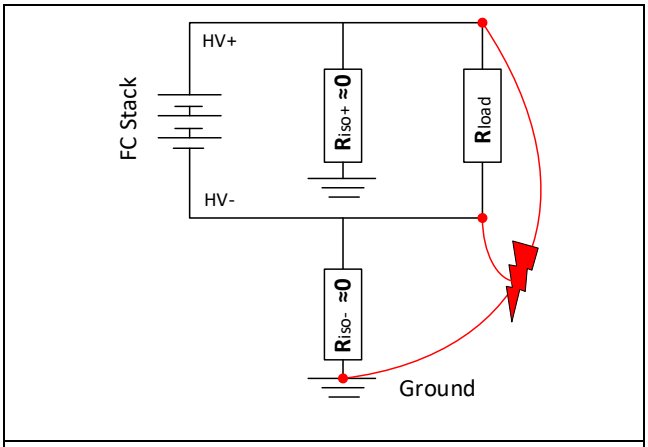


Figure 3 – Double Pole Isolation Failure.

ELECTRICAL HAZARD

If an isolation failure is detected and found to be located in the module, do not operate the fuel cell module until the root cause is determined and remedied.

Distributed Capacitance and Effects on HV Safety

The Distributed capacitance is the total amount of capacitance that exists between each pole of an isolated high voltage system and the chassis (fuel cell enclosure). This capacitance is a concern as it can hold charge which can be discharged into a person that simultaneously touches the high voltage system and chassis.

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In normal operation, this is not an issue as all high voltage conductors are covered and insulated but could be a concern if a system is being serviced.

HV safety due to residual reactants

Within the module, the fuel cell stack will also maintain voltage if hydrogen and air are present within the system. Voltage could also be generated when a fuel or air source is introduced, and reactants are moved to an active point in the fuel cell stack. This voltage will normally bleed down to safe levels within minutes, but this should always be verified using the RDU interface first, and then testing with digital multi-meter prior to accessing the module.

Confirm that the voltage is zero

Between pole to pole (positive to negative)
Between each pole to chassis before service.

Built in service procedures involve running the air compressors and hydrogen recirculation blower to inert the fuel cell prior to servicing the system Is necessary.

Refer to section “31.2 State: Prepare for Service” for pre-maintenance procedures. Untrained service personnel should not perform maintenance procedures on fuel cell modules.

One other effect of the distributed capacitance will be a delay in the ground fault detection system measurement.

8.7. Hydrogen Safety

WARNING

Install and handle the hydrogen in accordance with applicable regulations and the gas supplier’s recommendations.

- Hydrogen is a colorless, odorless, and highly flammable gas so there will be no warning signals before unconsciousness results.
- Hydrogen is lighter than air and will escape upwards. This also allows it to diffuse through many materials considered airtight.
- Hydrogen is non-toxic, but it can cause asphyxiation by displacing the oxygen in the air, so do not operate the module in enclosed or non-ventilated areas.

Furthermore, hydrogen’s small molecular size results in high buoyancy and diffusivity, so any leaked hydrogen will be diluted readily by the surrounding air.

Present potential leakage or permeation sites

- Fuel lines,
- Non-welded connections,
- Non-metal seals such as gaskets, O-rings,
- Pipe thread compounds and packings

Hydrogen leaks which develop within the fuel cell module will be detected by a hydrogen sensor located inside the fuel cell module hydrogen enclosure ventilation duct. Detection of a high hydrogen concentration will trigger an alarm causing the closing of the fuel cell module hydrogen supply valve

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(integrator's scope) before an unsafe condition can exist. For more information see section "14.5 Module H2 Supply Valve and H2_ENABLE"

It is possible for a hydrogen sensor to degrade to the point where it will no longer trigger an alarm if the hydrogen content exceeds safety limits. For this reason, the H2 sensor is part of the maintenance plan.

Exposure to Volatile Organic Compounds (VOC's) is known to cause hydrogen sensor degradation, care should be taken to avoid exposure whenever possible. High levels of VOCs are often encountered during vessel painting and solvent degreasing; therefore, it is recommended that the module or hydrogen sensors to be removed during these processes. Efforts have been made to isolate the sensor from contamination; however, degradation can still occur.

Some failure modes can result in hydrogen gas being present in the cooling system header tank. The risk can be mitigated by following the design considerations, maintenance procedures and filling instructions specified in Section 18.8.

The hydrogen supply to the module will remain pressurized when the module is shut down. Verify that there is no pressure in this line prior to disconnecting the hydrogen supply.

The hydrogen lines inside the module may contain hydrogen, even after the module has been removed from the system. Safely vent the remaining hydrogen pressure prior to removing the fuel cell module.

The responsibility for leak detection external of the fuel cell module rests with the system integrator.

It is strongly recommended that the integrator implement hydrogen detection in any enclosure where the fuel cell module is installed, including the fuel cell room, or similar enclosed space. Interlock the hydrogen detection system with a hydrogen supply valve installed directly upstream of the fuel cell module.

If an excessive hydrogen leak is detected, cease operation of the FCM and do not restart the FCM until safe operation conditions are reestablished.

⚠WARNING **The module hydrogen sensor may degrade if exposed to various contaminants and become less sensitive when degraded. Scheduled checks, as per the module service schedule, ensure that the sensors have sufficient sensitivity for safe operation. Failure to perform scheduled hydrogen sensor checks can result in unsafe operation of the module, as the module may not shut down in the presence of ventilation outlet emissions if the hydrogen sensor is severely degraded.**

8.8. Chemical Hazards

The fuel cell HT coolant loop contains ethylene glycol.

Ethylene glycol is toxic if ingested or if its vapors are inhaled.

All personnel handling ethylene glycol or working on the fuel cell stack HT coolant loop are required to adhere to the precautionary measures identified in the Safety Data Sheet of the specific coolant being used.

Such precautionary measures include Personal Protective Equipment (PPE), for instance wearing safety glasses and chemically protective gloves.

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Dispose ethylene glycol in accordance with applicable local regulations.

8.9. Acoustical Noise

The acoustical noise of the FCwave™ during standby has an A-weighted equivalent Sound Pressure Level (SPL) of 69 dB(A) $L_{Aeq,2min}$ 1 meter from module front. During normal operation (steady at 200kW) the A-weighted equivalent SPL is 88 dB(A) $L_{Aeq,2min}$ at the same location. During ramping up, the maximum noise level reaches 92 dB(A) $L_{Aeq,1sec}$ (1m from module front).

To reduce the likelihood of hearing impairment, all personnel are advised to wear hearing protection devices entering the fuel cell engine room while FCwave(s) are operational.

8.10. FCwave™ hazard mitigation approach

The potential hazards related to the FCwave, posing the highest risks are:

- Unacceptable hydrogen concentrations (in the ventilation or process air exhaust) leading to fuel-fed combustion.
- Electrical short-circuits and possible shock hazards caused by reduced electrical isolation of the high voltage system.

The control system is coupled with sensors (Such as Pressure, temperature, H2 concentration et.al.) intended to identify conditions (which can lead to a hazardous situation) and shut down the operation of the FCwave™ and related functions, before an unsafe condition develops. The safety control functions are managed in a dedicated controller unit.

9. FCwave™ Performance

The performance and lifetime of the FCwave™ module is, among others, depending on good quality reactants (fuel = hydrogen, oxidant = air). Make sure the quality of the reactants meets or exceeds requirements outlined in this document.

The FCwave™ can be configured in either Single or Dual Output modes. The preferred configuration has to be planned before commissioning.

Table 3 shows the module output to the DC/DC or DC/AC converter (in general connected to a DC/DC).

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Power	Configuration	Voltage	Current
50 – 200kW	Dual Output	350 – 720 VDC	(2x) 50 - 300A
50 – 195kW	Single Output	350 – 720 VDC	(1x) 100 - 550A

Table 3 – Module power, voltage, and current limits

Figure 4, Figure 5, Figure 6 and Figure 7 show the expected performance envelope of the FCwave™ module. The net power output represents the output to the module DC/DC converter and accounts for the power generated by the fuel cell stacks and the power draw of the BOP components. The net power output is the total power available to the vessel.

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9.1. System Output Voltage and Current

The voltage from the module is dependent on the load drawn from the system, the correlation between power and voltage is shown in Figure 4. Output current in relation to system output power is shown in Figure 5.

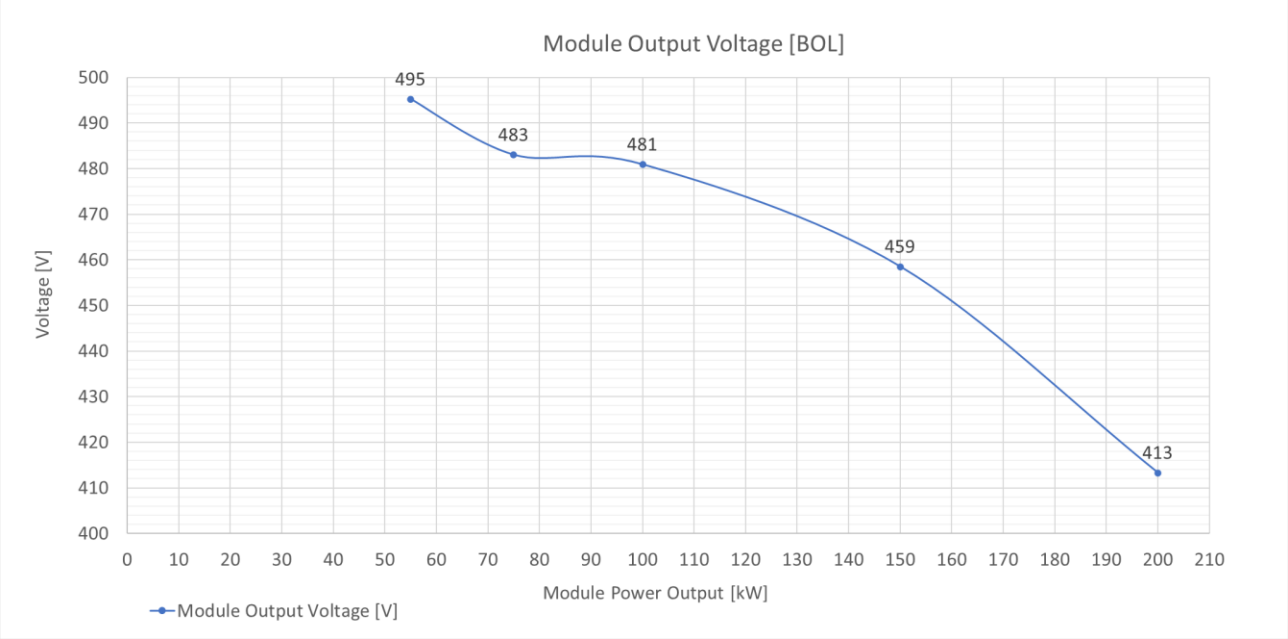


Figure 4 – Module output Voltage at Beginning of Life.

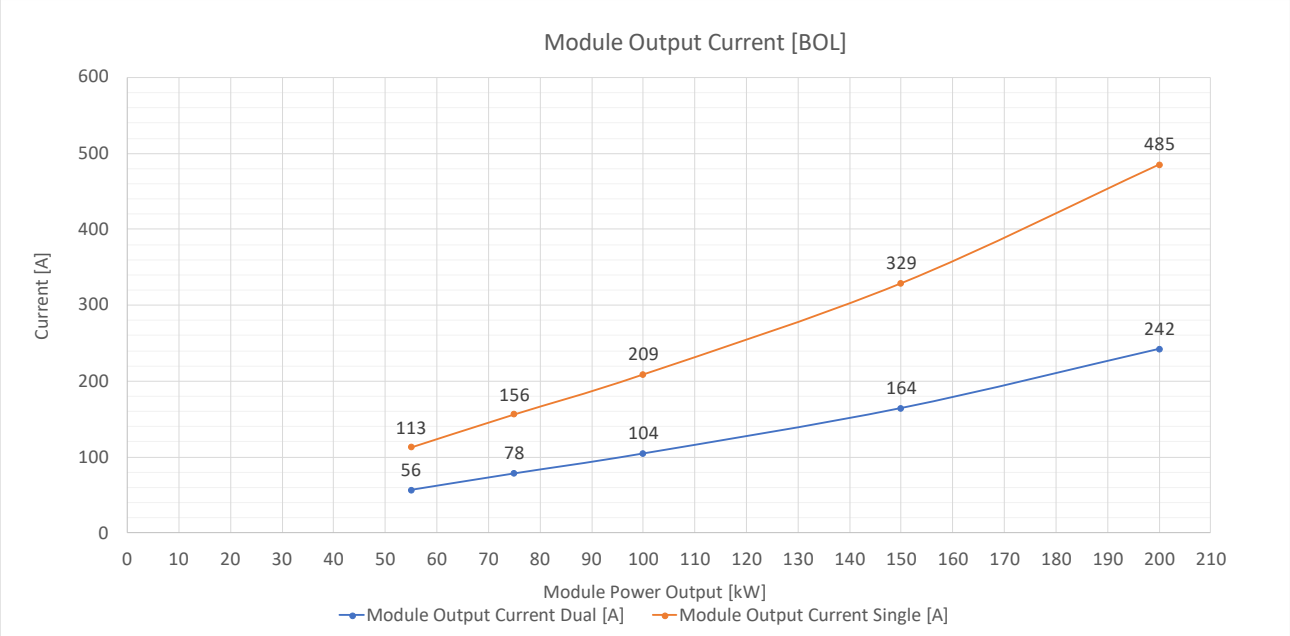


Figure 5 – Module Output Current at BOL.

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9.2. System Efficiency

The module electrical net efficiency in Figure 6 is defined as the fraction of electrical energy produced.

The lower heating value of hydrogen used for the calculation is 119,91 MJ/kg (ISO 6976:1995).

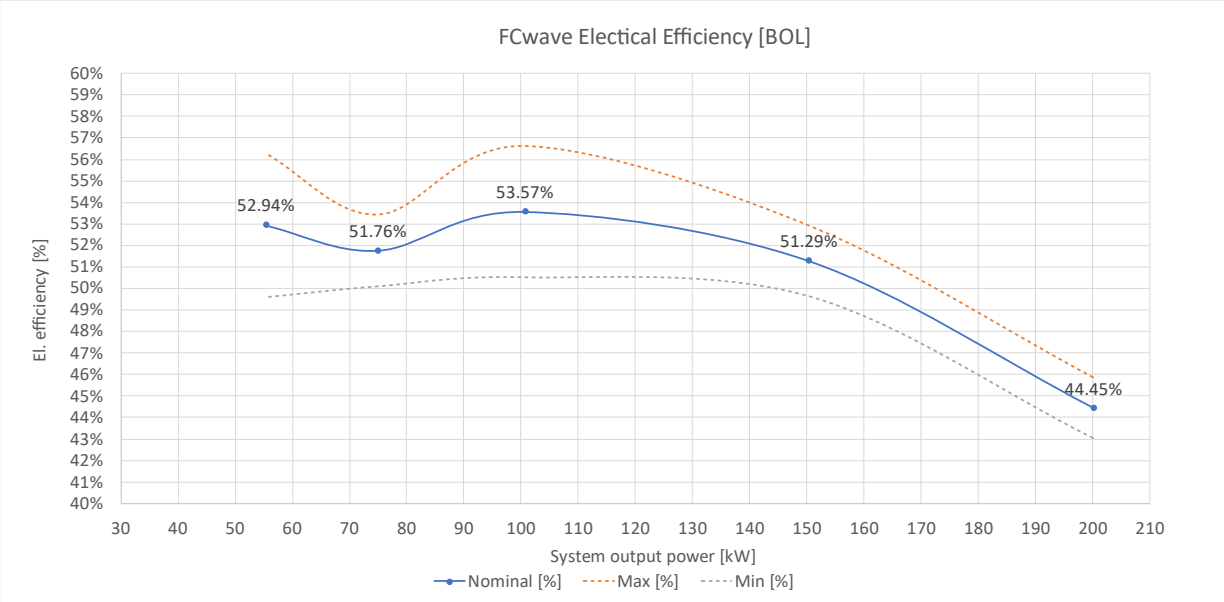


Figure 6 – Module Net Efficiency BOL.
(Test done according to IEC62282-3-200:2016 using 95 confidence interval)

9.3. System Hydrogen mass flow

The hydrogen consumed by the module at different load points are shown in Figure 7 – Hydrogen mass flow.

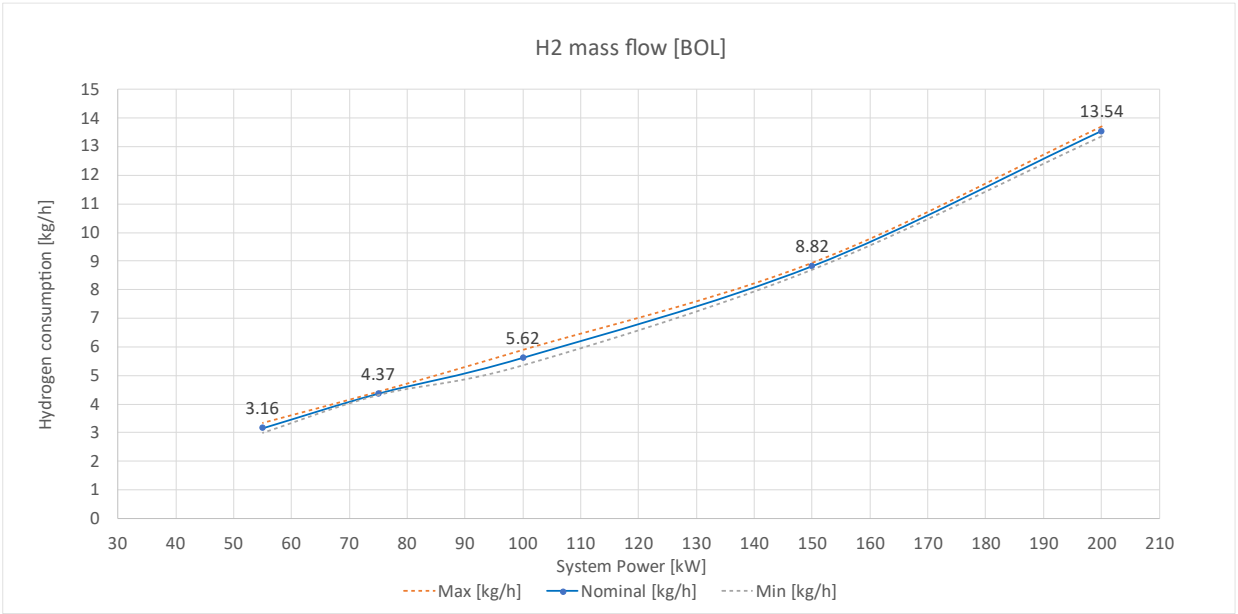


Figure 7 – Hydrogen mass flow BOL.
(Test done according to IEC62282-3-200:2016 using 95 confidence interval)

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10. Mechanical Integration

Measurements and figures in this section are for reference only and should not be used for design purposes. Ballard can supply 3D models and integration drawings upon request.

10.1. Reference Drawings

For a list of the mechanical reference drawings contained in the **7001000-01**, refer to Table 4 – Mechanical Reference Drawings.

Mechanical Reference Drawings	
Drawing Number	Drawing Title
7001000-01, Sheet 1	General Arrangement Plan
7001000-01, Sheet 2	Interface Panel Connection Locations
7001000-01, Sheet 3	Process Exhaust and H2E Ventilation Locations

Table 4 – Mechanical Reference Drawings contained in 7001000-01.

10.2. Module Installation

This section describes the major physical properties of the FCwave™ fuel cell module.

Modules require front access, refer to section 10.4 “Space Claim for Service Access”. Modules do not require side or rear access and can be placed side by side, back-to-back or a combination thereof.

Refer to the isometric view of the module in Figure 8, below.

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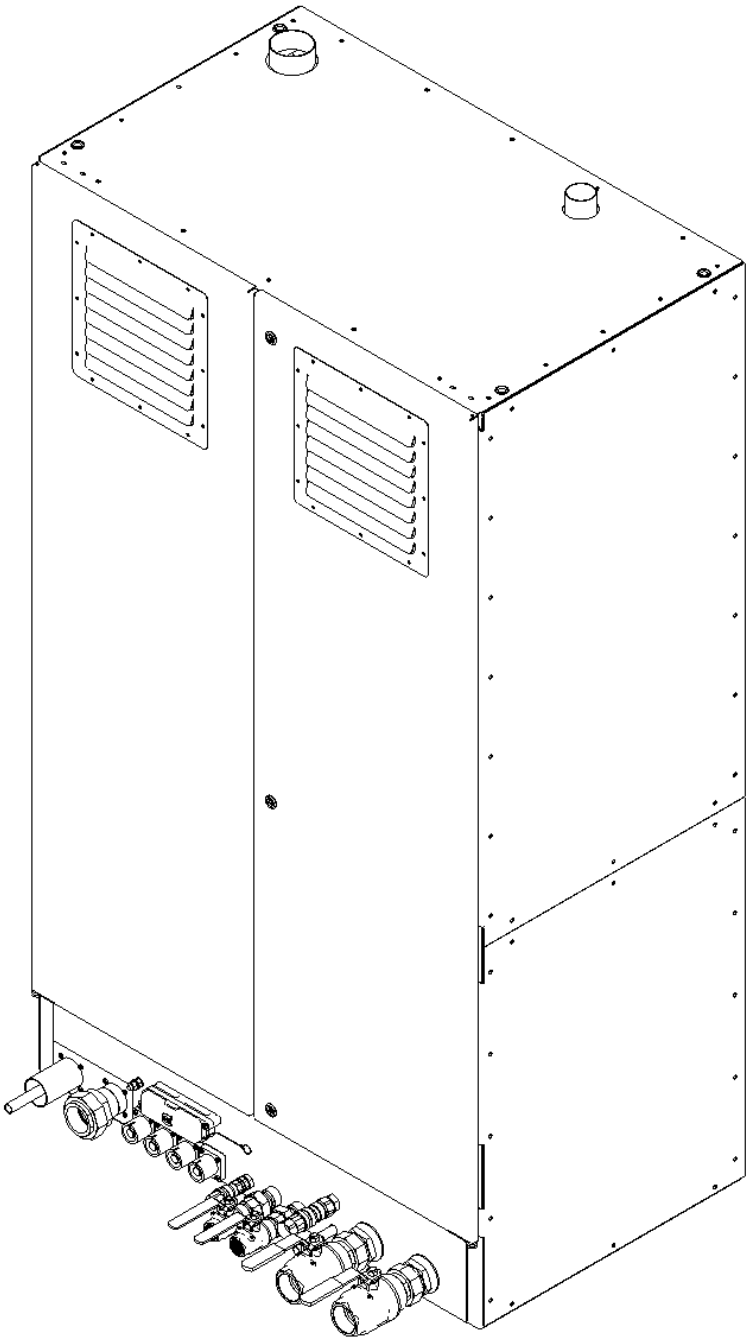


Figure 8 – Isometric view of FCwave™ module.

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10.3. False Floor

The module is designed to be installed in a Fuel Cell Installation Room, with a false floor.

As shown in Figure 9 and Figure 10, the module is designed to mount on a solid floor, with the false floor installed 200mm above (the false floor is not included, it is responsibility of the integrator). The

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200mm space is used to connect process and electrical connections to the module. The false floor will serve as protection for these connections.

The false floor panels should be removable for service access.

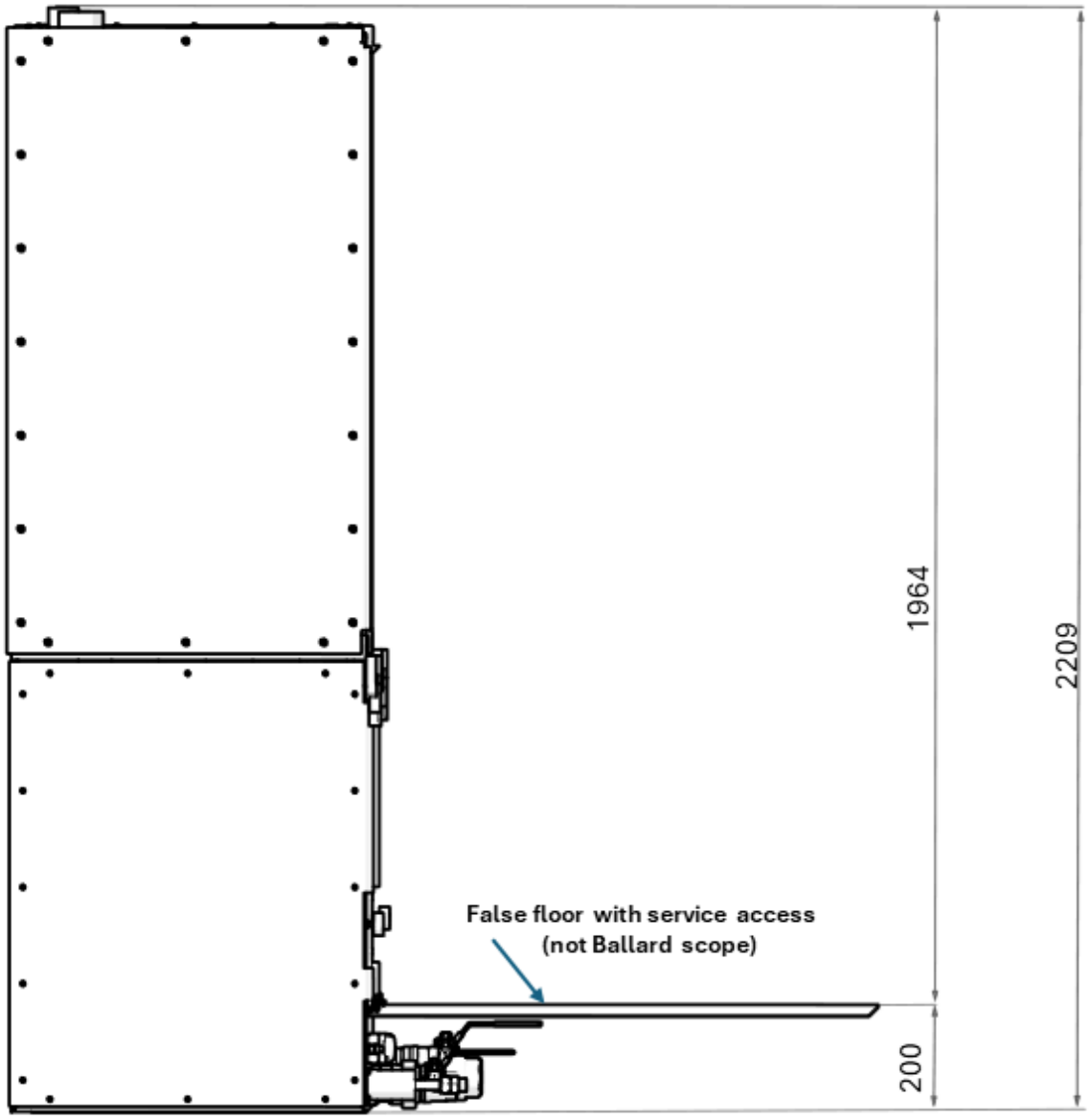


Figure 9 – Module Side View, showing details of False Floor with service access.

[Dimensions in mm]

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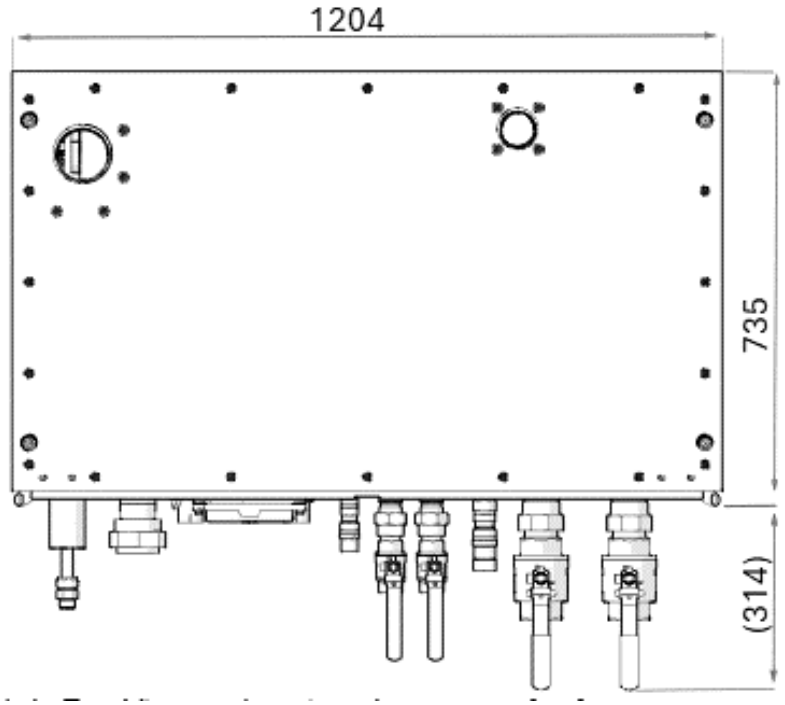


Figure 10 – Module Top View, showing clearances for front process and electrical connectors. [Dimensions in mm].

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10.4. Space Claim for Service Access

The space in front of the module shall be available for service activities. See Table 5 and Figure 11.

Cabinet doors can be wide-opened to 120°. If necessary, demount the cabinet doors for additional service access during maintenance procedures.

The false floor must be designed to carry the weight during service and component replacements, see Table 5.

Specification	
Width	1500 mm
Depth	1100 mm
Height	2300 mm
False floor load capacity	>845 kg

Table 5 – Space Claim for Service Access

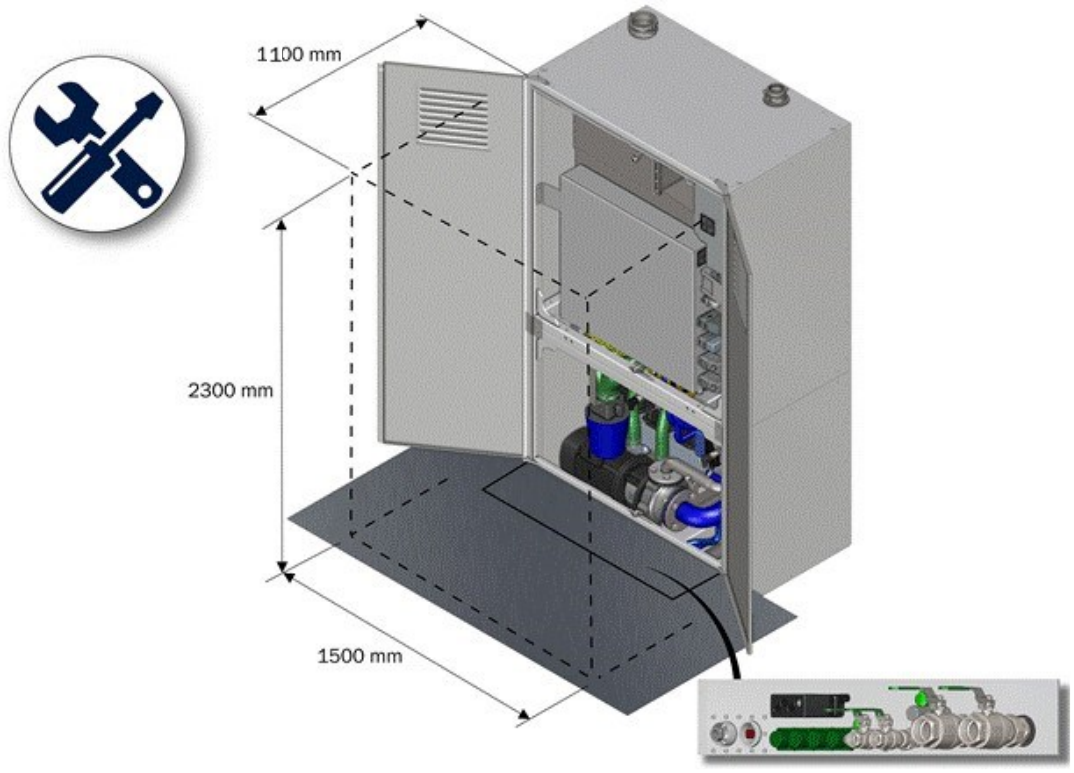


Figure 11 – Space Claim for service access to module.

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10.5. Mounting points and Center of Gravity

Please refer to Ballard document 7001000-01. This document specifies mounting points and center of gravity for a complete FCwave™ module.

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10.6. Module Lifting

When lifting the FCwave™ module during shipping and installation, only use a suitable lifting beam, or equipment design to connect to all four lifting points on the top. Lifting beam and eyebolts are not provided by Ballard.

WARNING **Local regulation for lifting and handling the equipment have to be followed, failure to follow guidelines can cause lifting accident, which leads to personnel injury and damage to equipment.**



Figure 12 – FCwave™ cabinet with lifting beam and eyebolts.

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10.7. Module Split Cabinet

The FCwave™ module can be split in two halves (top and bottom). This separation in halves eases the installation of the module in the Fuel Cell Room (if necessary) and also makes a “top swap” of the Fuel Cell section possible, see Figure 13. This procedure is only to be undertaken by Ballard personnel or people trained by Ballard.

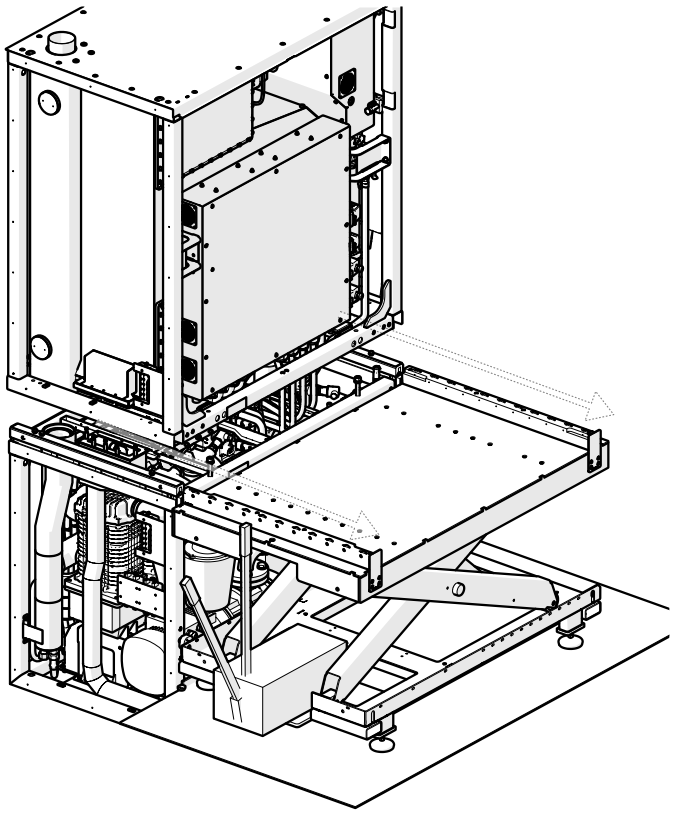


Figure 13 – The module cabinet split into upper and lower sections with lifting cart.

10.8. Lifting on sight

On sight, it is recommended to have a crane in front of the module that can lift the top part of the module and the cart, in case of top module swap. The crane has to be able to go from the module to the exit of the installation room. An example of this crane can be seen in Figure 14.

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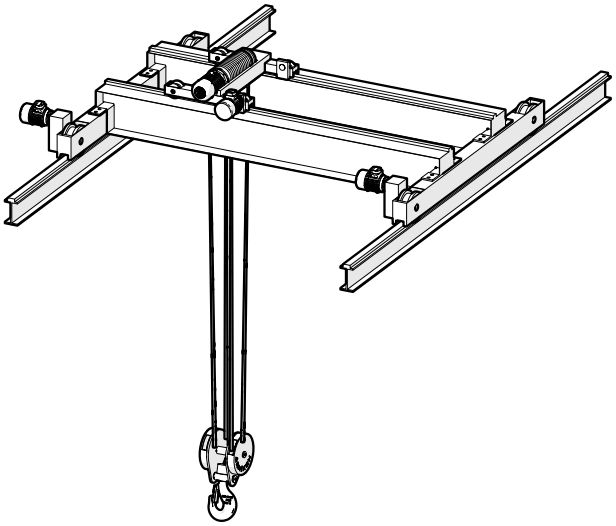


Figure 14 Crane used to move the Top module and the cart.

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11. Fuel Cell Installation Room Requirements

For type approved FCwave™ modules it is required that the fuel cell is installed within a Fuel Cell Installation Room, which must fulfill all requirements from the classification society and IMO.

The compartment in which the fuel cell modules are to be installed are termed the “Fuel Cell Installation Room”, and requirements are presented below in the following sections.

11.1. Structural Requirements for the Installation

This section describes the structural requirements for the Fuel Cell Installation Room, where one or more fuel cell modules are installed. The FCwave™ module shall always be installed in a shelter to protect against weather conditions such as but not limited to, heavy rain, direct sun, extreme heat & cold, dust etc.

1. The FCwave™ must be securely fastened at bottom, back and top.
2. The FCwave™ is designed to be accommodated in a Fuel Cell Installation Room with a false floor, with the hydrogen and electrical supply placed below the floor.
3. Requirements for service access in front of the FCwave™ must be followed, see Figure 11.
4. The Fuel Cell Installation Room free volume should not be less than 10m^3.

11.2. Hydrogen connection

The hydrogen supply connection to the module must fulfill the following requirements:

1. A hydrogen supply shutoff valve with a reaction time less than 2 seconds is required to be installed for each module.
2. The hydrogen flow must be restricted by suitable means such that hydrogen mass flowrate shall not exceed 4.9 g/s.
3. The amount of hydrogen in the fuel cell module must be minimized when not in operation. The physical volume of the pipe between hydrogen shutoff valve and module interface plate is not to exceed 5 liters.
4. For maritime installations, it is a requirement that the pipe between the hydrogen shutoff valve and module interface plate is double-walled, with detection measures for the annular space.

11.3. Process exhaust connection

This section describes the options for process exhaust connections from a FCwave™ module in a Fuel Cell Installation Room:

In all cases, the following apply:

1. Process exhaust must be let to the outside.
2. FCwave™ process exhaust can be fully water saturated and with negligible hydrogen (below <2% of the LFL) content.

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3. The process exhaust must have provision for a drain at the lowest point of the connection, as there will be condensation inside the process piping.[1]

11.4. Module Ventilation exhaust connection

Module ventilation exhaust should be led to a safe exterior location free of any spark or ignition source. The integrator must prevent ingress of water droplets or other debris running backwards into the system through the ventilation exhaust.

The material of the exhaust systems shall withstand the environment, and not be of risk of corrosion clogging due to sediments in the exhaust system. Recommended material is EN 1.4301 / AISI 304 or EN 1.4401 / AISI 316 stainless steel. It is important that no debris or lose sediments enter the FCwave™ .

The exhaust and the ventilation is two separate systems, and should not be joined.

The integrator's side of the ventilation exhaust connection should be done of 1.4404/AISI 316L or 1.401/AISI 304 stainless steel, to minimize the amount of corrosion and other particles accumulating in their walls and the possibility of them falling into the FCwave™.

11.5. Installation Room ventilation

The air handling system in the fuel cell installation room must be sufficient to supply the FCwave™ process air (as specified in section 11.1). Addition ventilation of the fuel cell installation room to be determined by Classification Society or Vessel Integrator.

Ballard recommends performing a calculation according to IEC 60079-10 to establish the required ventilation rate for the fuel cell installation room. In normal operation, all probable leakage scenarios internal to the FCwave™ are managed inside the module.

11.6. Drain connections

It is required that integrator implements backflow prevention from module to module and/or from external source to module(s).

11.7. Safety system

The vessel control and safety system must include visual and audible signaling to crew in appropriate locations.

Recommendation is to clearly indicate which FC module is in operation inside the fuel cell room.

The FCwave™ does not provide an emergency stop button, only an input for one. It is the responsibility of the integrator to install adequate and accessible safety stop buttons or similar, as well as ensure the integration of FCwave™ in the emergency stop circuit (Figure 36).

An uninterruptible power supply must provide a 24VDC output with a maximum voltage deviation of ±10% (applicable to both normal and safety supply) for a duration exceeding 10 minutes, as indicated in Table 25.

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[1] Draining the process exhaust though the FCwave™ module process water drain is not permissible.

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11.8. Fuel Cell Installation Room Access

Access to the fuel cell installation room during operation shall be limited to trained service technicians and personnel that have received Ballard fuel cell training.

Unrestricted access to the fuel cell installation room can be permitted by the vessel authorities when all fuel cell modules are powered off and otherwise deemed permissible.

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12. Process Connections

Process connections for the module are located on the lower part of the front panel, as shown in Figure 15. Annotation references are shown in Table 6.

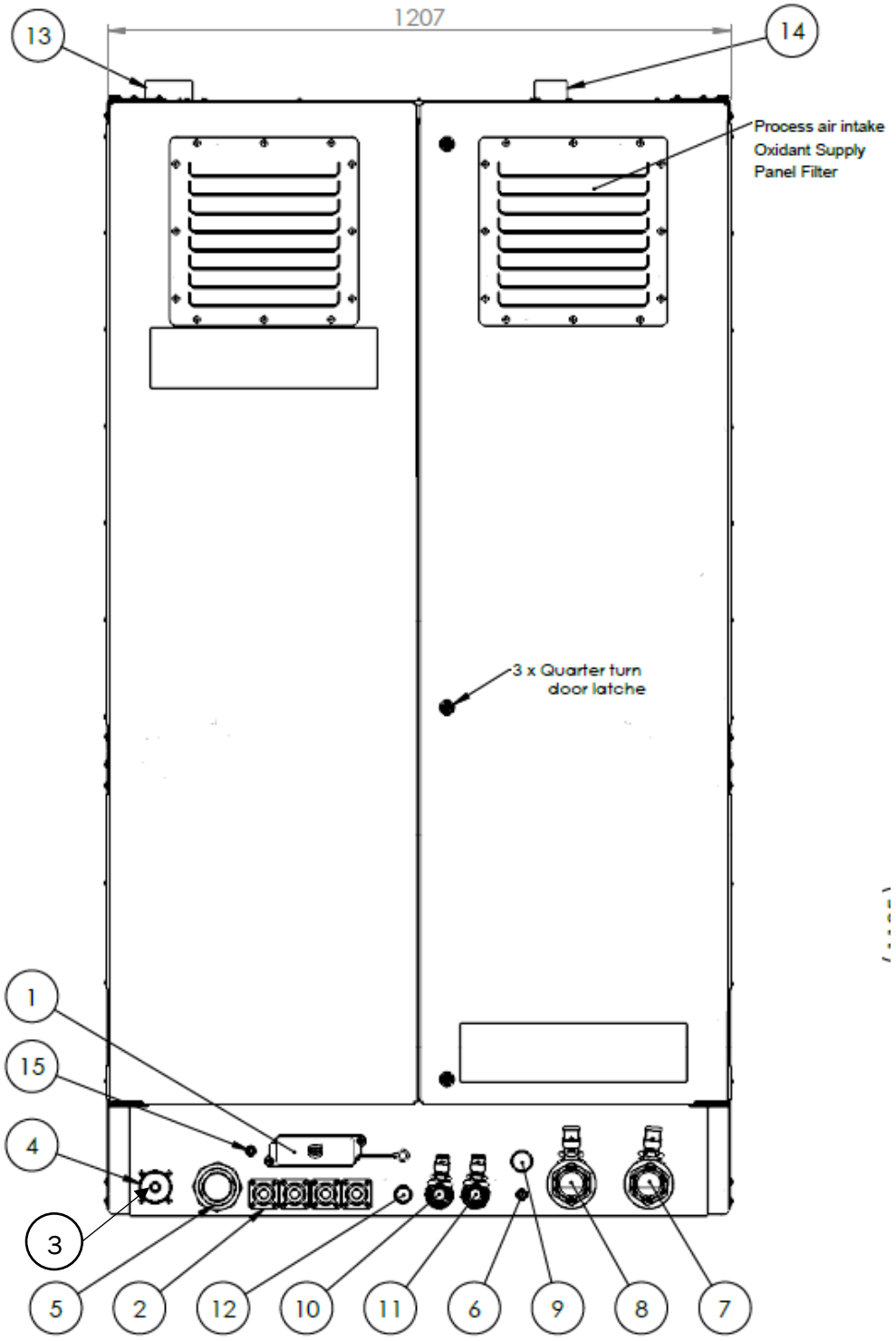


Figure 15 – Detail View of module process connections.

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Process Connections					
Position	Description	Connection	Media	Temperature	Pressure
1	Control and Communication Connector	Harting Male 24HPR	24V DC, Hardwired, CAN bus, Ethernet	n/a	n/a
2	High Voltage Connectors	Amphe-Phase, SLS Panel Source	330-720 VDC, 2*300A or 1*550A	n/a	n/a
3	H2 Supply – Primary Barrier	Ø20 x 1,8mm	Gaseous H2, <4,9 g/s	0 – 80 °C	3,5 – 6,5 barg
4	H2 Supply – Secondary Barrier	Ø60,3 x 2mm	n/a	n/a	n/a
5	H2 Enclosure Ventilation Inlet	DN50 – ISO7/1 R2”	Air, Salt-filtered	<45 °C	Ambient
6	Process Water Drain	Ø18 mm	DI Water	10-70 °C	n/a
7	High Temperature Coolant Out	DN50 – ISO7/1 Rp 2”	Coolant, see section 18.5	dT = 25 °C max 65°C	dP < 0,3 bar
8	High Temperature Coolant In	DN50 – ISO7/1 Rp 2”	Coolant, see section 18.5	5 – 45 °C	<30 barg
9	High Temperature Coolant Fill/Drain	Non-drip coupling G3/4” DN14	Internal Coolant fluid, see section 18.3	10 – 70 °C	<100 mbarg
10	Low Temperature Coolant In/Out	DN25 – ISO7/1 – Rp1”	LT Coolant, see section 19	5 – 50 °C	< 1,5 barg
11	Low Temperature Coolant In/Out	DN25 – ISO7/1 – Rp1”	LT Coolant, see section 19	5 – 50 °C	< 1,5 barg
12	Low Temperature Coolant Fill/Drain	Non-drip coupling G1/2” DN9	LT Coolant, see section 19	5 – 50 °C	< 1,5 barg
13	Process Exhaust	Ø88,9 x 2,0mm	Oxygen-depleted air, DI water droplets. See section 16.5	50 – 80 °C	Backpressure <15mbar @ 12700 lpm
14	H2 Enclosure Ventilation Exhaust	Ø60,3 x 2,0 mm	Air, trace H2 amounts	< 55 °C	Backpressure < 200 Pa @ 750 lpm
15	Grounding stud	M10 Zinc coated copper stud	Grounding point	n/A	n/a

Table 6 – Process Connections, refer to Figure 15.

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12.1. Process Air

The installation section describes the intake and exhaust for process air.

Process air intake is through the air filters on the module door panels, as shown on Figure 8. Integrator shall supply conditioned air to the Fuel Cell Installation Room as described in section 16.2 - Process Air Intake Quality.

The module air exhaust should be connected to an outlet with a drain downstream of the process air outlet to capture liquid that will condensate in the pipe.

Note that the pressure-drop presented by the exhaust piping and any installed equipment must be considered. See section 16.4 and 16.5 for more details.

12.2. Ventilation Air

The module is equipped with active ventilation of the hydrogen carrying sections of the module (Hydrogen Enclosure / “H2E”). The air intake for the ventilation is in the cabinet base of the module, incorporating the hydrogen pipe.

The ventilation fans inside the module are only designed to ventilate the module itself. The fans are not designed to ventilate any double-wall piping arrangement outside the module. The annular space around the primary fuel pipe is welded closed at the interface panel

The integration shall ensure the exhaust from FC modules (ventilation air) is led to a safe location free of any spark or ignition source.

The ventilation inlet and outlet must be equipped with automated fire dampers. The dampers must be closed in case of fire, and before releasing a fire extinguishing system.

12.3. Hydrogen Fuel

The gaseous hydrogen fuel process interface connections are a double wall design, detailed in Figure 16:

Primary Barrier:
Ø20 x 1,8 mm
Welded connection
Secondary Barrier:
Ø60,3mm
Welded connection surrounding the primary barrier.

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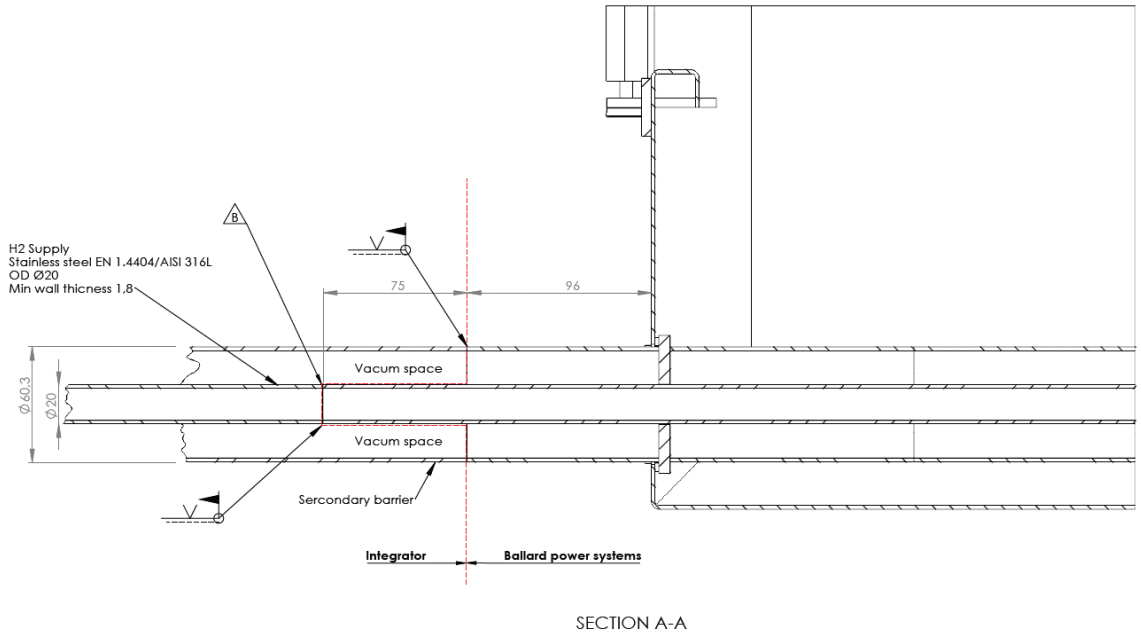


Figure 16 – H2 Supply Connection Detail View.

The space between primary and secondary barrier inside the FC module carries the H2E ventilation air. The space between inner and outer tubes must be ventilated by the integrator in a marine application. For stationary applications no ventilation is needed.

12.4. Welding of Hydrogen pipe

In marine applications, the welding of the double walled pipe has to be performed in accordance with requirements from Classification Societies and Vessel Integrator.

After welding the Hydrogen pipe in on the interface of the FCwave™ system, the welding shall go through a cleaning and pressure test.

Contact Ballard support for details

Cleaning recommendations

When welding of the double walled pipe is completed and approved, cleaning of the hydrogen pipe is required, due to removal of any impurities in the pipe. Cleaning can be performed by blowing with air or Nitrogen.

⚠ CAUTION Contact Ballard service for details regarding this procedure or check the service documentation

Pressure testing recommendations

After cleaning of H2 supply pipe, a pressure test must be carried out.

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CAUTION *Contact Ballard service for details regarding this procedure or check the service documentation*

12.5. Coolant

The integrator is to supply module coolant to both the High Temperature and Low Temperature coolant loop inside the module.

High Temperature Coolant Loop:
Transfers the excess heat produced by the reaction inside the fuel cells to the integrator. See section 18 - High temperature Coolant Subsystem.

Low Temperature Coolant Loop:
Transfers the excess heat produced by the liquid cooled balance of plant components inside the module to the integrator. See 19 - Low Temperature Cooling .

12.6. Process Drain

The integrator is to connect a drain to the Process water drain. This drain separates and leads away the liquid water produced in the reaction and not carried away in the process exhaust.

12.7. Electrical connections

Locate the fuel cell module such that there is enough clearance to access:

The Low Voltage Connector, which provides 24V power to the Control and Safety systems alongside hardwired and bus data connections.
High Voltage DC output connectors, which provide the electrical power produced by the system.

13. Environmental Protection

The module is constructed with the ingress protection rating IP44 for the module (excluding connectors) and IP67 for front panel electrical connectors only.

~~Do not use a direct high pressure water spray on the FC module.~~

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14. Anode Subsystem

This section contains information about the anode (hydrogen) system inside the FCwave™ (Ballard scope) and the upstream hydrogen delivery system (customer scope).

The purpose of the internal hydrogen system is providing hydrogen for the fuel cell stacks. A simplified hydrogen system is shown in Figure 17 – Simplified Hydrogen System.

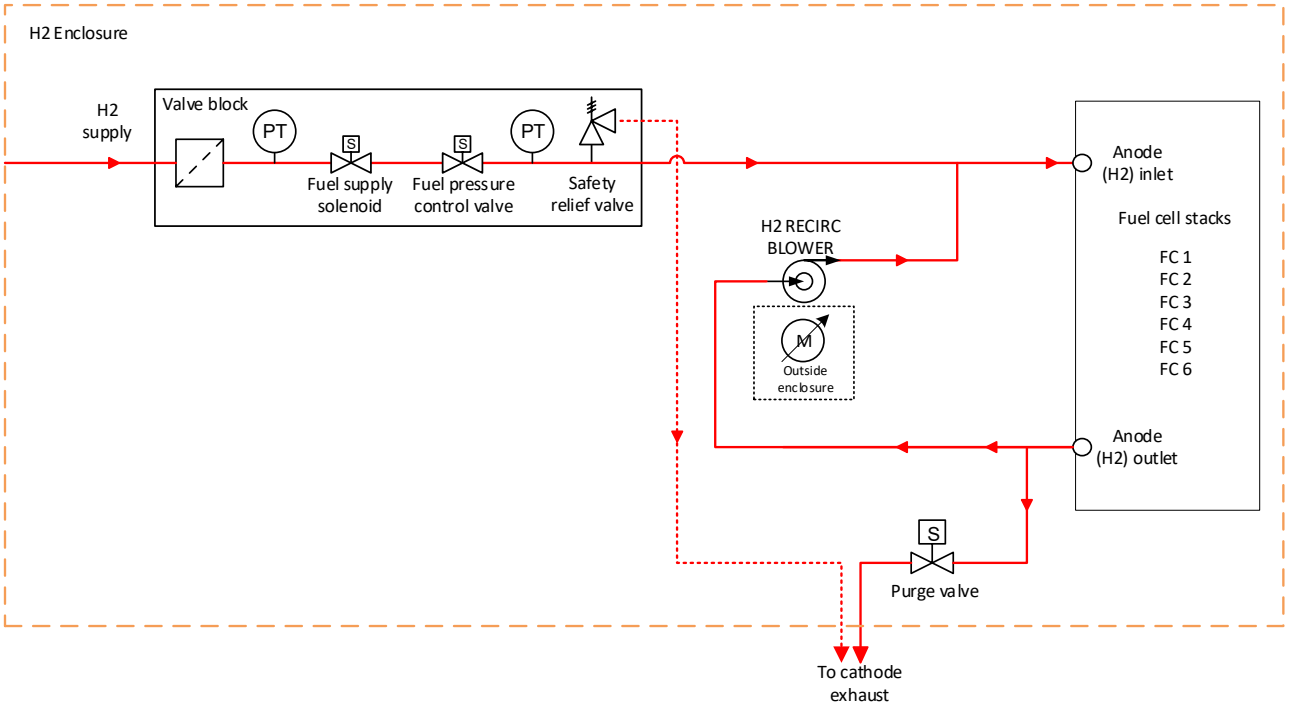


Figure 17 – Simplified Hydrogen System.

14.1. Requirements for upstream H2 delivery system

This section describes the requirements that the integrator must fulfill in the H2 supply system before the module boundary.

Integrator must provide sufficient hydrogen of a quality, pressure and temperature as specified in:

Table 7 – Hydrogen Supply Quality Specification.
Table 8 – Hydrogen Supply Temperature and Pressure Specification.
Table 9 – Hydrogen Supply Flow Rate Specification.

The source of hydrogen may be compressed gas storage, vaporization of liquid hydrogen or reforming of other fuels, if quality, pressure and temperature requirements are met.

Integrator must in accordance with classification society fulfill the requirement of H2 supply pipe leading to module.

Integrator must provide a block and bleed capability upstream of the module. A schematic of this can be seen in Figure 18.

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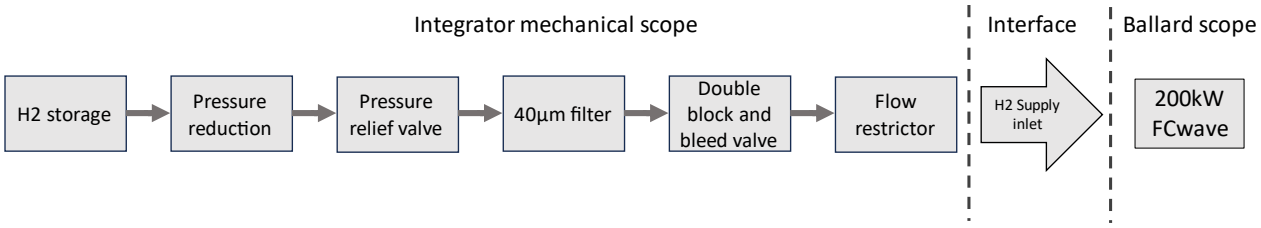


Figure 18-- Installation diagram of the H2 system with integrator and Ballard's parts differentiated.

14.2. Anode System Overview

The fuel cell module anode system is primarily comprised of an internal fuel supply shutoff valve and devices for regulating and conditioning the fuel pressure and water content. A Hydrogen Recirculation Blower (HRB) circulates the hydrogen inside the fuel loop.

A small amount of gas in the hydrogen circuit is purged to maintain acceptable hydrogen concentrations at the stack and remove N2 and water. This purged gas is directed to the process exhaust where it is diluted to a safe concentration by mixing with the process exhaust.

In the unlikely event that the hydrogen loop is over-pressurized, a mechanical pressure relief valve installed on the fuel valve block is in place to safely relieve the pressure (see section 14.3).

Perform a leak check after any service work is done to hydrogen supply fittings and associated piping

Follow the hydrogen supply quality requirements specified in Table 7 – Hydrogen Supply Quality Specification. Both hydrogen quality specifications are acceptable.

Specification	
Hydrogen Quality	SAE J2719:MAR2020
OR	
Hydrogen Quality	ISO 14687:2019 Type I, Type II – Grade D

Table 7 – Hydrogen Supply Quality Specification.

Hydrogen can be sourced from compressed gaseous storage or vaporization of liquid hydrogen if quality and temperature requirements are met.

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Before commissioning and after service on the hydrogen supply system (external to module), a sequence of fill and drain cycles will be needed to ensure the correct hydrogen purity.

For the vessel tank system several fill and drain cycles (especially with new hydrogen storage tanks) will be required as they often come pre-filled with nitrogen or air. Contact the tank manufacturer for the recommended purge procedure.

If the resultant hydrogen purity is questionable, then it is recommended that a sample of the gas be analyzed by a laboratory for its composition. If these purity levels are not achieved, then there can be adverse effects to the performance of the fuel cell stack.

A 40µm filter should be installed directly upstream of the fuel cell module fuel supply inlet to ensure the particulate size requirement is met.

Note: Incomplete purging of the vessels hydrogen tank is often a source of impurity. Ensuring that hydrogen tanks are purged as per the manufacturer's specification is crucial to remove residual inert gases. After purging, it is recommended to have a gas sample analyzed ensure all inert gases are removed from the hydrogen storage system

⚠CAUTION **Improper purging can often result in conditions leading to irreversible fuel cell damage and may have warranty implications.**

14.3. Hydrogen Supply Temperature and Pressure

When selecting a pressure regulator to install upstream of the fuel cell module, regulator droop[2] and hysteresis should be considered to ensure that the supply pressure is always within the range specified in Table 8.

Specification	
Nominal Inlet Pressure	4,5 barg
Minimum Inlet Pressure	3,5 barg
Maximum Inlet Pressure	6,5 barg
Maximum Inlet Temperature	80 °C
Minimum Inlet Temperature	0 °C

Table 8 – Hydrogen Supply Temperature and Pressure Specification.

Locating a pressure transducer and/or pressure gauge immediately upstream of the fuel cell module can be a valuable tool for troubleshooting hydrogen supply issues.

NOTE: A low pressure relief valve (internal to the module) is vented into the cathode exhaust. Implement overpressure protection in case of a fuel delivery system regulator malfunction. It is recommended that the integrator provide two levels of protection:

Electronic: If a regulating device from a storage is installed upstream ensure following:

Allow for electrical disabling of the fuel delivery system (e.g., remove power from the normally closed solenoid valves using a pressure switch) if the regulator outlet pressure exceeds 10 barg. Set up the system such that the hydrogen

[2] Sometimes referred to as the 'Proportional Band' or 'Offset', droop is an inherent characteristic in all self-operated and pilot-operated regulators. Droop is a decrease in outlet pressure from the set value due to an increase in media flow rate.

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supply will not be switched on automatically when the downstream pressure drops.

Mechanical: Install a pressure relief valve, sized to maintain the pressure less than **10 barg** at maximum flow.

WARNING **Fuel supply overpressure can result in an unsafe situation since it can cause the fuel cell module hydrogen components to fail. It is very important that these components are adequately protected in the event of a hydrogen supply pressure regulator malfunction or failure which results in an overpressure.**

14.4. Hydrogen Supply Flow Rate

Always provide enough hydrogen flow to the fuel cell module. The maximum expected hydrogen flow rates are specified in Table 9.

At this maximum flow rate, the hydrogen supply pressure should remain within the range specified in Table 8.

Integrator **shall** install an orifice restriction such that hydrogen mass flowrate shall not exceed 4,9 g/s.

Specification	
Max H2 Flow (Design)	4,9 g/s
Minimum Flow Operational Flow Full Load [BOL]	3,76 g/s

Table 9 – Hydrogen Supply Flow Rate Specification.

14.5. Module H2 Supply Valve and H2_ENABLE

The integrator is required to install a fuel shutoff solenoid valve directly upstream of the fuel cell module. This valve should be situated as close as possible to the fuel cell module fuel supply inlet to minimize the volume of hydrogen which will remain in the supply line during a shutdown.
The fuel cell module has a hydrogen supply shutoff valve inside the fuel cell module. This valve is meant to stop the flow of fuel into the fuel cell when the fuel cell module transitions from Running to Standby state. It is not designed to be a fuel system isolation/shutoff valve and does not replace the integrator's main fuel shutoff valve.

WARNING **The integrator is to ensure the H2 Supply valve is not used a shutoff method or that this valve is not closed during operation or though the shutdown sequence (see section "25 Control System – State Machine"). Failure to abide by this may result in stack fuel starvation or an alarm condition that will allow the high voltage contactors to open under load.**

WARNING **When shutdown, pressurized hydrogen is trapped in the supply line connected to the fuel cell module. The integrator must provide a means to isolate the supply line and vent any hydrogen remaining in the supply line prior to disconnecting the fuel cell module from the system for service**

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The module provides an output to the integrator (H2_ENABLE), which signals to the vessel that the module requests opening of the H2 Supply Valve. H2_ENABLE is switched to the negative of the 24V supply when active, see Figure 19.
Please note that the H2 Supply Valve is separate from the internal shut-off valve inside the module.

This low-side output switching arrangement allows both module and integrator to control the open/close status of the H2 supply valve for the module.

The integrators H2 supply valve must be of the Normally Closed type.

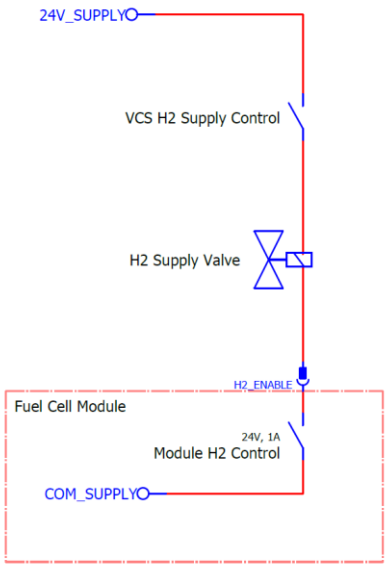


Figure 19 – H_2 Supply Valve Control.

15. Hydrogen Enclosure Ventilation

The module is equipped with active ventilation of the hydrogen carrying sections of the module (Hydrogen Enclosure / “H2E”).

> Integrator is responsible for salt and water droplet filtration from H2E Ventilation air.
> This includes prevention of water droplets running backwards into the system through the ventilation exhaust.

The air intake for the ventilation is in the cabinet base of the module. The ventilation air is in customer scope. Module ventilation shown in Figure 20 – Simplified P&ID for the Module Ventilation system.

The maximum allowable fuel cell module and auxiliary systems ambient temperature is specified in Table 10.

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Specification	
Maximum Fuel Cell Module Ambient Temperature	45°C
Minimum Fuel Cell Module Ambient Temperature	>0°C

Table 10 – Ambient Temperature Specification.

Specification	
Module Ventilation Air Salt Content maximum allowable content	< 20µg/m³

Table 11 – Ventilation Air Salt Content Specification.

The ventilation duct acts as the secondary barrier in the double barrier protection principle.

Two ventilation fans are installed in the ventilation exhaust. The ventilation fans draw air from the inlet through the H2 Enclosure to the ventilation exhaust outlet.

The ventilation air is exhausted out of the upper-most part of the module, and shall be routed to a zone, with no ignition sources within a safe distance.
There is an option for rear facing ventilation exhaust, see section **Error! Reference source not found.**.

Note that the pressure-drop presented by the ventilation exhaust piping and any installed equipment must be considered. See Table 12.

Specification	
Ventilation Exhaust Backpressure (Maximum allowable pressure-drop between at Ventilation air outlet port and atmosphere)	≤2 mBar at 750 lpm
Ventilation inlet pressure drop (Maximum allowable pressure-drop between atmosphere and Ventilation air inlet port)	≤2 mBar at 750 lpm

Table 12 – Air Ventilation Exhaust Backpressure Specification.

The ventilation system is a key safety component, and is under close surveillance, with multiple monitored functions:

Redundancy of fans,
Fan rotation monitoring
Flow monitoring in inlet duct.
Pressure monitoring in hydrogen enclosure
Redundancy on Hydrogen sensors, which will detect any unacceptable levels of hydrogen in the outlet.

NOTE: The hydrogen sensors will need to be accessed periodically as part of preventive maintenance activities.

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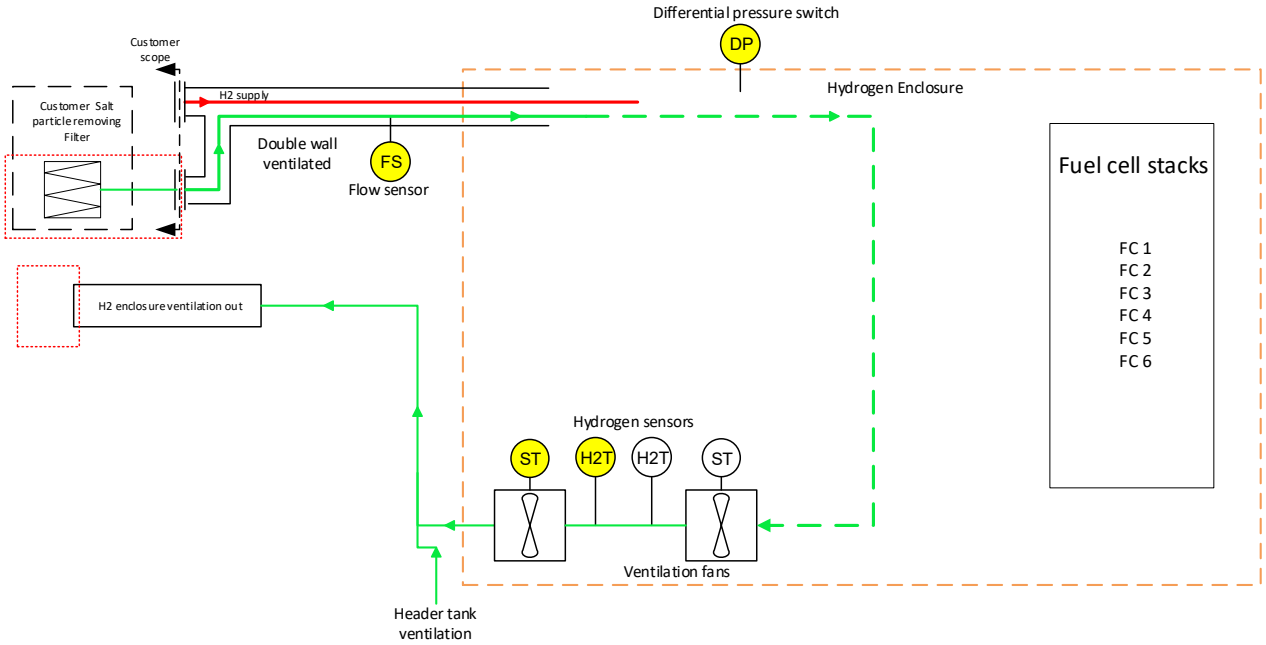


Figure 20 – Simplified P&ID for the Module Ventilation system.

16. Cathode Subsystem

The purpose of the cathode subsystem is to provide oxygen from atmospheric air to the fuel cell stacks. Process air is taken from the fuel cell installation room. It is the integrators responsibility to ensure sufficient air supply to the fuel cell modules as well as the required air quality.

Table 13 Ambient air characteristics necessary for the cathode subsystem.

Specification.	
Air inlet minimum temperature	0°C
Air inlet maximum temperature	+45°C
Maximum allowable salt concentration	< 20µg/m³
Process air pr FCwave™ module[3]	12.700 l/min

16.1. Process Air Subsystem Overview

The process air delivery system will automatically supply the necessary air to the fuel cell module. The amount of process air will depend on the current being drawn from the fuel cell.

[3] Minimum amount of air available at all times while the FC module is running

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The process air delivery subsystem is primarily composed of an intake filter, twin compressors, and air conditioning elements (humidifiers) before air enters the stacks. After the stacks, air exits from the module through the process air exhaust. A simplified process air system is shown in Figure 21.

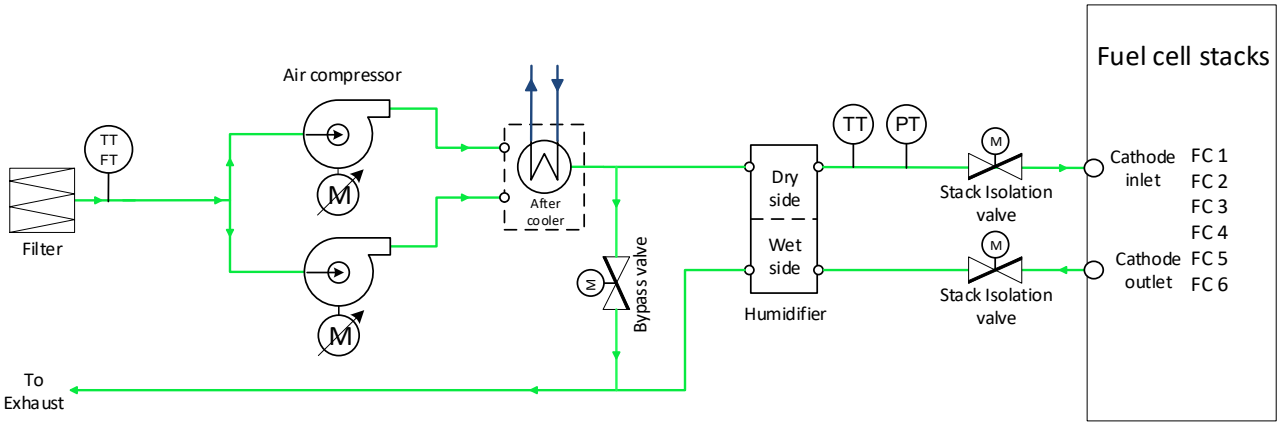


Figure 21 – Simplified Process Air System.

16.2. Process Air Intake Quality

The air filter in the cabinet doors of the module will ensure the purity of the air delivered to the fuel cell stack meets acceptable levels. To increase filter life and improve their performance, the fuel cell room shall be treated to minimize quantity of salts, SOx, NOx and ammonia, as they are quite harmful to the FCwave™ module. The air filter is a service item and part of the preventative maintenance schedule.

Consult Ballard during the integration design for feedback on this topic.

16.3. Process Air Intake

The process air intake is in the top of the two cabinet doors in the module. The air intake must have enough clearance and not be restricted . See Figure 8 – Isometric view of FCwave™ module. The air in the fuel cell room shall be of good quality (as explained above) and come from a non-hazardous zone. There shall be enough free space around the module to ensure sufficient air intake (as explained in section 11.1).

16.4. Process Air Exhaust Backpressure

The process air flow rate capacity of the air delivery system is sensitive to the backpressure exerted at the process air exhaust of the fuel cell module. In vessel integration, the integrator should work to minimize the pressure drop through the exhaust piping and any additional components such as a water separator in the exhaust. The backpressure at this exhaust should not exceed the value in Table 14

Specification	
Item	Value
Process air Exhaust Backpressure (Maximum allowable pressure-drop between the process air outlet port and atmosphere)	≤15 mbar
Average exhaust flow	12.700 lpm

Table 14 – Air Exhaust Backpressure Specification.

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Consult Ballard during the integration design for feedback on this topic.

16.5. Process Air Exhaust Composition

Specification	
Item	Value
Temperature	50-80 °C
Mass flow	100 – 260 g/s (dry basis)
Nitrogen	78 – 92% (dry vol)
Oxygen	7 – 21% (dry vol)
Relative Humidity	~100% RH
Liquid Water	Stack current and coolant temperature specific
Hydrogen	Startup: <1 % (dry vol) Operation: <1 % (dry vol)

Table 15 – Air Exhaust Composition Specification.

The expected composition of the process air exhaust stream is detailed in Table 15.

The process air exhaust will contain oxygen-depleted air, water in liquid and vapor form, and a small amount of hydrogen. The hydrogen component in the process air exhaust is the result of purged gas from the hydrogen circuit.

WARNING Special note should be taken of the reduced oxygen content in the exhaust stream. Personnel is not permitted inside exhaust ducting or other spaces containing fuel cell exhaust with fuel cell operating. All such spaces shall be thoroughly ventilated before personnel is permitted to enter.

16.6. Process Air Exhaust Integrator Requirements

This section describes the requirements to the integrator when designing the process air exhaust from the fuel cell module.

The exhaust piping must be suitable for the temperatures and composition as outlined in Table 15. Note that the air stream contains significant amounts of de-ionized water droplets and vapor. The surface temperatures of the exhaust can be up to 80 °C hot.

The liquid water from the exhaust must be handled by the integrator. As the condensed water will collect in the lowest sections of the exhaust piping, experience has shown that this settlement of liquid could lead to corrosion, freezing during periods of non-operation and intermittent spraying of liquid water out the exhaust pipe. It is recommended that the integrator incorporate a water drain on low sections of the piping.

Note: The drain in the FCwave™ is not intended for draining customer part of the exhaust system.

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17. Process Water Drain

The fuel cell reaction produces DI water, which must be drained from the module from the Process Water Drain.

Refer to section 12 “Process Connections”, in Figure 15, the Process Water Drain is number “6”.

The process water drain piping must be constructed of materials resistant to DI water. Contact Ballard if there are questions regarding material selection.

The Integrator shall ensure the drain does not freeze and block the flow of liquid.

The produced water at 200 kW is ≤ 3 L/min. This is mostly water vapor mixed with the process exhaust.

Only a small percentage of this water will come out the process water drain as liquid.

Specification	
Item	**Value**
Media	De-Ionized Water
Temperature	20 – 70°C
Volume	0 – 3 L/min
Potable Water	No

Table 16 – Process Water Properties and Composition.

18. High temperature Coolant Subsystem

As part of the fuel cell stack operation, heat is developed. The liquid cooled stacks reject heat proportional to the power output. The amount of rejected heat is increased in proportion to stack aging/degradation and load. A simplified coolant circuit is shown in Figure 22 – Simplified HT Coolant Circuit.

18.1. HT Coolant System Overview

The FCwave™ module coolant delivery subsystem contains a coolant pump and motor set with a liquid cooled controller which delivers the required coolant flow to the fuel cell module. The coolant inside the module passes through an internal heat exchanger, where heat is transferred to the external coolant loop, provided by the integrator.

Coolant loop and composition:

Internal Coolant
Allowed cooling medium: High-purity De-ionized water / ethylene glycol 50/50 mix (further options see Table 17 and Table 59)

External Coolant (High Temperature loop) – **Integrator supply**
De-ionized water, fresh water, or glycol mixture. Integrator is responsible for cooling medium and pump.

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A pair of electronically controlled valves are regulating the stack coolant inlet temperature. The valves either throttles the flow of coolant to the heat exchanger or bypass the heat exchanger.

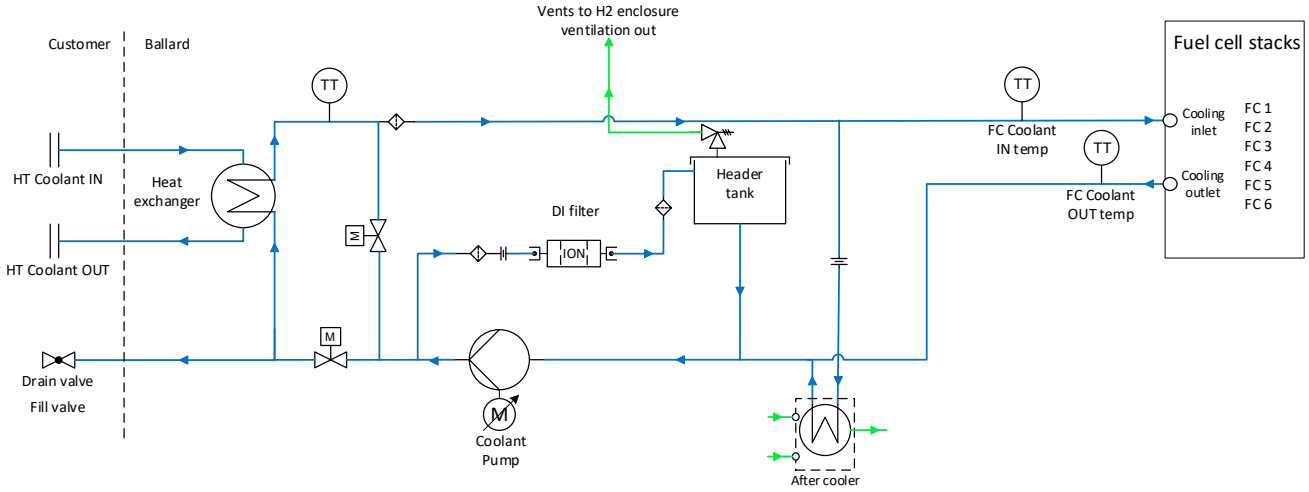


Figure 22 – Simplified HT Coolant Circuit.

During start-up, the coolant valves is positioned to bypass the heat exchanger, allowing coolant to recirculate though the stack, reducing the warm-up time. The internal cooling system also contains a particulate filter to remove any particulate matter present.

18.2. Coolant Chemical Hazard

⚠ CAUTION

The fuel cell coolant loop will contain ethylene glycol. For safety see chapter 8.8

18.3. Internal Coolant Specification

Follow the requirements specified in Table 17 – Module Coolant Specification, ensure that:

- The cooling system can maintain the conductivity below the maximum specified value.
- Adequate clean maintenance practices are in place.
- Any material used in the cooling system is compatible with the coolant type.

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Specification	
Item	Value
Conductivity	≤ 5µS/cm @ 25 °C
Ethylene Glycol Concentration	≤ 50% volume Balance DI Water or 60% volume Balance DI Water[4]
Particulate Size	<100 µm
Chloride Concentration	≤2 ppm
Iron Concentration	≤2 ppm

Table 17 – Module Coolant Specification.

NOTE: High coolant conductivity will result in loss of electrical isolation between the fuel cell high voltage and the system chassis since the coolant circuit can provide a conductive path. The coolant conductivity specified in Table 17 should be suitable for most applications; however, the conductivity required for a specific application may need to be lower to achieve an overall system isolation which satisfies regulatory standards. The integrator should ensure that the conductivity limit chosen is suitable for their application.

To maintain the stack coolant conductivity below the maximum level, a DI filter is installed in the coolant circuit. Part of the overall coolant flow is diverted to the DI filter to continuously remove ions in the water.

Table 18 lists the recommended suppliers for fuel cell grade ethylene glycol mixture. Pure ethylene glycol mixed with deionized water is acceptable (providing the conductivity is <5µs) and deionized water (under **non-freezing** operation). Do not use other coolant types. Pure deionized water (<5µS conductivity) is permissible if the module is used for laboratory operation and is kept above freezing temperatures.

Specification		
Supplier	**Part Number**	**Notes**
BASF	Glysantin J21725	50/50 Ethylene Glycol / DI Water Pre-mixed
BASF / Valvoline	Glysantin FC G 20-00/50	50/50 Ethylene Glycol / DI Water Pre-mixed
Merck	100949	Ethylene Glycol Extra Pure
Univar	610583	50/50 Ethylene Glycol / DI Water Pre-mixed
Univar	1126085	Pure Ethylene Glycol
Univar UK	4338	Pure Monoethylene Glycol
Dynalene	LC-EG	Ethylene Glycol / DI Water Pre-mixed

Table 18 – Coolant Suppliers. Some of these coolants come pre-mixed others need to be diluted. The maximum 50% Ethylene Glycol concentration as mentioned in the specification must be followed.

[4] If the storage temperature after operation is expected to be <-37°C then use 60/40 glycol/DI water mix. The module is pre-flushed with 60/40 glycol/DI before shipping.

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NOTE: It is not recommended to store modules filled with deionized water for more than 7 days, due to its reactivity. Stagnant deionized water has shown an ability to create a corrosion reaction in some components of the module. For extended storage it is recommended to flush the coolant circuit with a water/ethylene glycol mix. Use only coolants shown in Table 18 or consult Ballard Power Systems.

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18.4. Internal Coolant Volume

The coolant volume of the fuel cell module and coolant delivery system is specified in Table 19.

Specification	
Item	Value
Internal coolant system volume	45 L

Table 19 – Module Coolant Volume Specification.

For filling and draining the internal coolant system, see section "18.8 Filling and Draining the Internal Coolant Loop"

The coolant header tank contains no more than 10 liters of volume.

CAUTION **Overpressure of the coolant circuit during filling can cause permanent damage to the fuel cell.**

18.5. External Coolant Specification

The list of permitted coolant compositions for the external primary coolant loop is listed in Table 20.

Specification	
Item	Value
Coolant Medium	DI Water, Water/Glycol mixture
Maximum particulate size	1,2 mm
Maximum pressure	30 barg
Maximum inlet temperature	45 °C

Table 20 – Module External Coolant Specification.

18.6. Coolant Inlet Temperature and Heat Rejection

Maintain the temperature specified in Table 21 for a nominal fuel cell module coolant inlet temperature.

Some comments and considerations for coolant heat rejection and inlet temperature control:

The expected module coolant heat rejection and flow rates at End Of Life (EOL) are specified in Table 21 – HT coolant loop specifications. These values can be used as a guideline for sizing the coolant radiator.

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Specification		
Parameter	**Value**	**Unit**
Coolant inlet temperature nominal	40	°C
Coolant inlet temperature minimum	5	°C
Coolant outlet temperature maximum	65	°C
Coolant loop ΔT	25	°C
Maximum heat dissipation full load EOL	350	kW
Expected mass flowrate cold side [@40°C inlet]	14.015	kg/h
Connections	DN50, 2" ISO7/1	
Pressure drop, Heat exchanger customer side [@ 11.000 kg/h]	< 100	mbar

Table 21 – HT coolant loop specifications.

The expected module coolant heat rejection and flow rates at End Of Life.

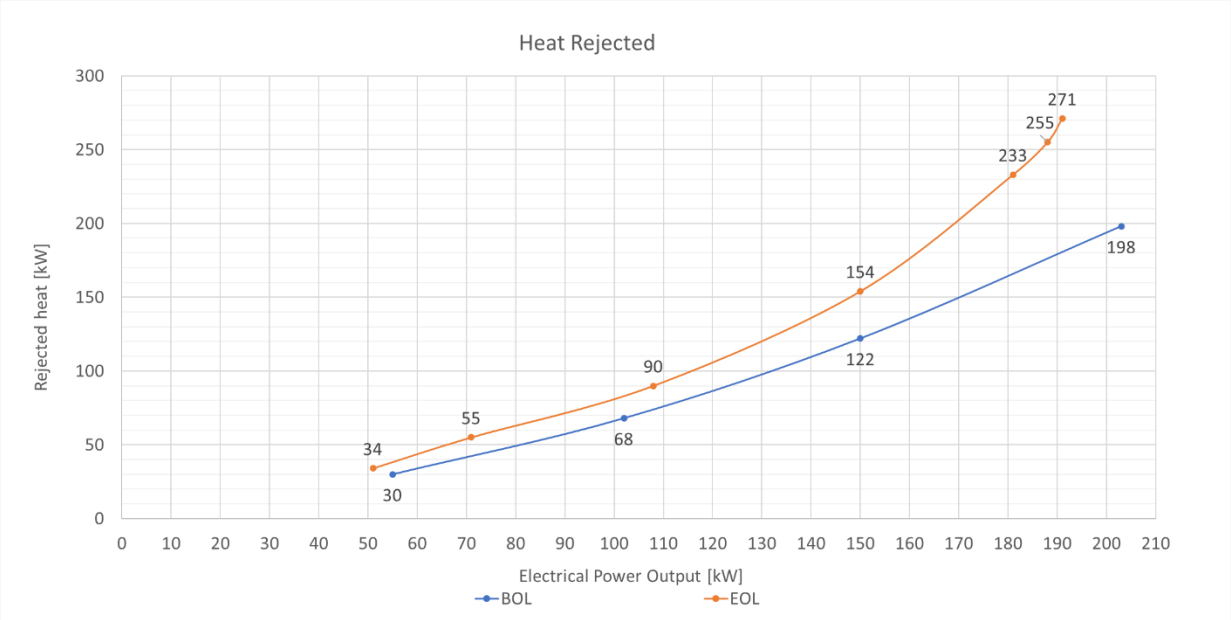


Figure 23 - System Heat Rejection through the heat exchanger vs. Power.

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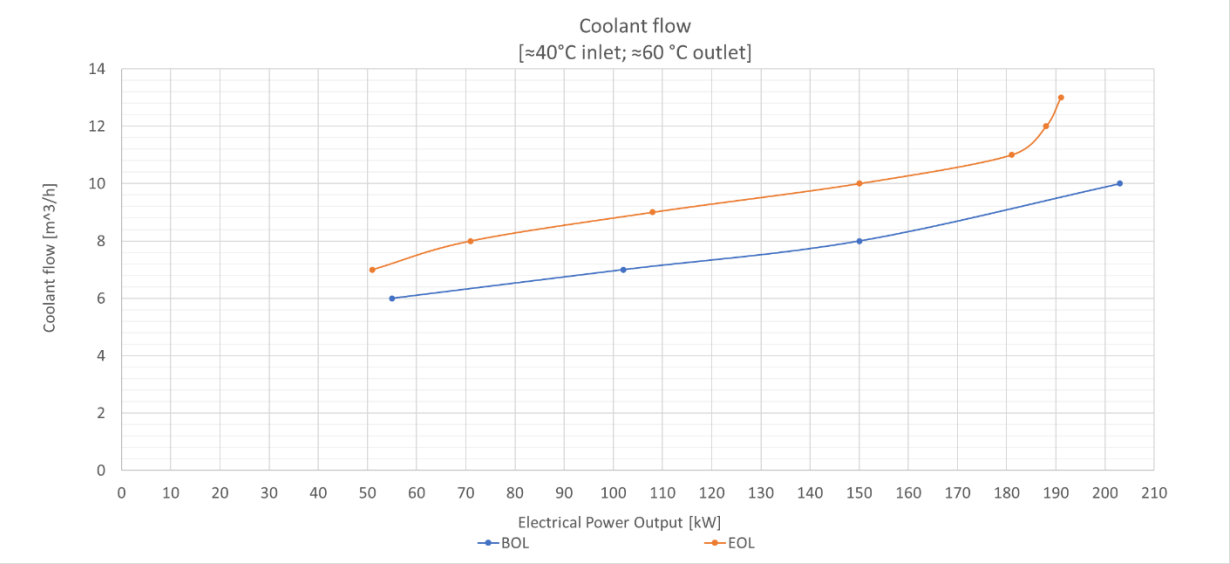


Figure 24 - System Coolant Flow vs. Power (HT customer coolant flow)

18.7. Header Tank of the Coolant System, Air Bleed and Pump Make Up

The module contains an internal header tank for the HT coolant loop, which provides a reservoir of coolant and accommodates thermal expansion of the coolant. There is a low level switch in the header tank to provide warning for low coolant levels.

When filling or draining the module's HT coolant loop, use the makeup connector outlined in Table 6 position 9. Connect an external pump to the connector and use the pump to fill the module with coolant.

When handling coolant, wear personal protective equipment in accordance with the Safety Data Sheet and local regulations. Hydrogen gas may accumulate in the coolant tank. Purge the header tank of said hydrogen prior to servicing. Always wear safety eyewear and eliminate sources of ignition (flames, sparks, electrical tools, etc.) when servicing the header tank.

18.8. Filling and Draining the Internal Coolant Loop

The Internal Coolant loop can be filled and drained by a fill/drain connection on the interface plate of the module. An external pump is connected to this port and used to fill or drain the module.

During filling operations, **do not** overfill the coolant header tank, but continually observe the reading in the sight glass on the header tank. Flowrates and pressure during filling are specified in Table 22.

To perform a filling and draining of the system Service Tier 1 training completion is required.

Specification	
Make-up pressure	Between 200 mbarg and 1 Barg

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Make-up flowrate	< 10 lpm

Table 22 – Module Coolant make up pressure and flowrate.

When changing the coolant inside the module, use the provided fill/drain port (see Figure 15).

It is strongly recommended that the coolant is pumped into the lowest part of the circuit with the use of a small off-board coolant fill pump. When filling the internal coolant circuit, keep an eye on the sight glass on the header tank, where the coolant level is visible.

Care should be taken as to not overpressure the coolant circuit during filling. This can occur if the flow of the coolant being pumped in exceeds the capacity of the header tank vent to relieve the displaced air. It is recommended to install a mechanical pressure relief device at the outlet of the coolant fill pump cart that is set to 1.0 Barg.

19. Low Temperature Cooling System

The fuel cell module also contains a low temperature cooling system. The low temperature cooling system is an independent system used for cooling of:

- Inverter for Cooling Pump motor
- Inverter for Hydrogen Recirculation Blower electrical motor
- Air compressors (2 pcs)
- Inverters for air compressors

The low temperature cooling system is considered as an auxiliary coolant circuit internal to the fuel cell module. Unlike the main cooling system, there is no coolant pump in the auxiliary circuit. The coolant and flow for this system is supplied by the integrator and should comply to the data given in Table 23. Integrator connection to the low temperature cooling system is in the base of the cabinet.

Diagram over the low temperature coolant circuit is shown in Figure 25. Interface connectors are shown in Figure 15.

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Specification		
Parameter	**Value**	**Unit**
Maximum inlet temperature	50	°C
Minimum inlet temperature	5	°C
Maximum inlet pressure	1,5	barg
Maximum heat dissipation	5	kW
Pressure drop	1	barg
Typical flow *[@Δt 10°C; inlet 40°C & outlet 50°C]*	8	L/min
Coolant mix	50/50 Water Glycol mix.[5]	
Connections	DN25 – ISO7/1 – Rp1”	

Table 23 – LT coolant loop specifications.

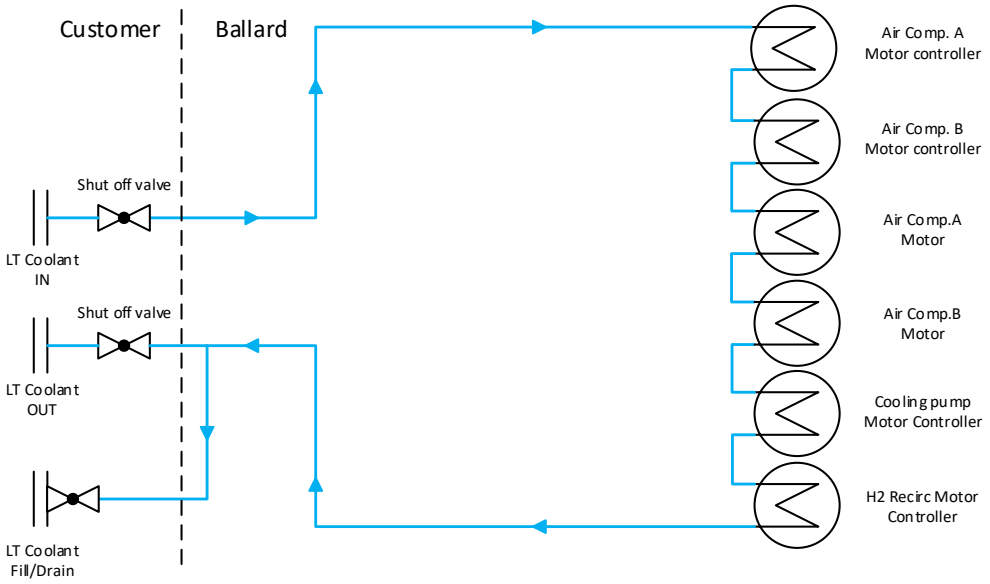


Figure 25 – Low Temperature cooling loop (LT Cooling).

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[5] DI water is not permitted as coolant medium

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20. Gas Freeing and Inerting Procedures

Before performing service on the FCwave™ module, the following must be verified:

- Hydrogen supply line has been depleted
- No dangerous voltages are present in the system

The FCwave™ system includes an automated procedure that must be executed before beginning maintenance procedures, which depletes hydrogen from the supply line and system.

WARNING **Before accessing High Voltage Panel or components inside the Hydrogen Enclosure, all procedures must be followed**

20.1. Inerting procedure – Prepare for Service

This automatic procedure is carried out by request of the Vessel Control System, which activates an automatic subroutine in the FCwave™ fuel cell module which performs the inerting procedure. The function “Prepare for Service” uses the module blowers and compressors to ensure the module is ready for maintenance.

There is no requirement for the integrator to supply inert gas such as Nitrogen.

After completion of the automated procedure, manual verification of voltage must be performed before any maintenance actions.

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21. Control and Electrical Introduction

The purpose of this section is to provide the integrator a high-level overview of the control and electrical systems that comprises the FCwave™ module.

The fuel cell module contains four main control and electrical systems:

- Low voltage electrical (24 VDC)
  - Responsible for supplying all process instrumentation and controllers with power. Contains internal EMC filters and fuses
- High voltage electrical (350-720 VDC)
  - Responsible for supplying power from the fuel cell stacks to the integrator and balance of plant components. Power to start the system is provided by the integrator during the start-up sequence.
- Control System
  - Responsible for monitoring and controlling the processes inside the fuel cell module, communicating with the integrator, datalogging and service functionality
- Safety System
  - Responsible for monitoring the safety and integrity of the fuel cell module. This includes hydrogen concentration measurements, ventilation air flow verification and fire detection.

The following overview includes references to the different aspects of the operation of the FCwave™ module and the sections where they are described. Use Ctrl+Click to jump to the references.

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- Functionality
25 Control System – State Machine
30 Start-up sequence for the FCwave™ module
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37.4 CAN Customization Key
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- Physical connections
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35 Low Voltage Connector Construction
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Safety System
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CAUTION **Before operating the FCwave™ module, carefully read through all above points and refer any questions to your Ballard representative. Improper use and handling of the fuel cell may lead to dangerous situations and permanent or temporary damage and performance degradation of the fuel cell module.**

22. Low Voltage Electrical Overview

The control system of the FCwave™ is powered by two 24V DC supply voltages, as specified in CMS006.

The normal 24V supply powers the module controller, module sensors and control voltage for the motor controllers.

The safety 24V supply powers the safety system, safety controller and safety sensors.

The 24V supply voltages are passed through EMI filters before being separated out to the different sub-systems in the module.

The module controllers are powered from the 24V supply and runs continuously while 24V is supplied to the module. Ventilation fans, internal to the module, are also running while 24V is supplied.

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The 24V system is internally fused with resettable electronic circuit breakers.

22.1. Low Voltage Supply

The system is supplied by 24V DC. Please note the voltage tolerance on the 24V supply is narrower than normal 24V marine supply. The Low voltage supply shall be equipped with a UPS system with at least 10 minutes of backup duration. When the UPS system is active, Ballard strongly recommends that the module is brought to a controlled **shutdown** without delay.

Specification	
Control and Safety system supply voltage	24 V DC
Maximum Allowable voltage deviation	±10%

*Table 24 – **Control and Safety system** supply specification.*

Specification	
Control and Safety system supply backup	Uninterruptible Power Supply required
Backup duration	10 minutes

Table 25 – Control and Safety system UPS specification.

22.2. Design Standard and Exceptions

The module control system is designed to comply with EN-60204-1:2018.

The system does not have a bonding between 0 Vdc and chassis/ground.

23. High Voltage Electrical Overview

The FCwave™ module PEM fuel cell stacks are a DC current source, with an output voltage which varies depending on the current drawn from the system. This relationship is shown in Figure 4 – Module output Voltage and Figure 5 – Module Output Current.

The HV DC system must be operated as a floating electrical system, see section 40.1.

During operation, the stacks supply power to the BOP components, internal to the module, making it self-sufficient. As described in section 27.2, external high voltage DC power must be provided during startup. During operation, the fuel cell stacks convert chemical energy from hydrogen to electrical and thermal energy, the rate of which is dependent on the load imposed on the fuel cell module by the external DCDC converters. The fuel cell operates as a load follower, such that the managing of the load is the responsibility of the integrator. To assist in this, the module communicates its operational limits to the integrator over the CAN bus.

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23.1. Pre-charge of the Electrical HV system

The input stages of the motor inverters in the module contain capacitors, which may lead to surges in current draw if directly connected to a high voltage supply without current limiting measures in place.

The FCwave™ module contain equipment and control sequences for gradually charging the internal capacitances such that current surges are avoided.

The pre-charge sequence is detailed in section “30.3 Pre-charge”

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24. Control and Safety System Overview

The control and safety system of the Module is comprised of the following, illustrated in Figure 26:

- **Module Control Unit**
  - Responsible for control of the fuel cell and balance of plant components.
  - Monitors and controls the state of reactants and power flowing to and from the module.
  - Monitors and reacts to system conditions, including hydrogen concentration measurements.
  - Transfers data logs to Ballard when able to establish communication with the Internet (via encrypted connection)
- **Safety Control Unit**
  - Responsible for monitoring safety of the module via independent sensors and inputs. Provides hardwire signals to and from the vessel.
  - Independent from Module Control Unit, triggers emergency shutdown of module when it detects an emergency.

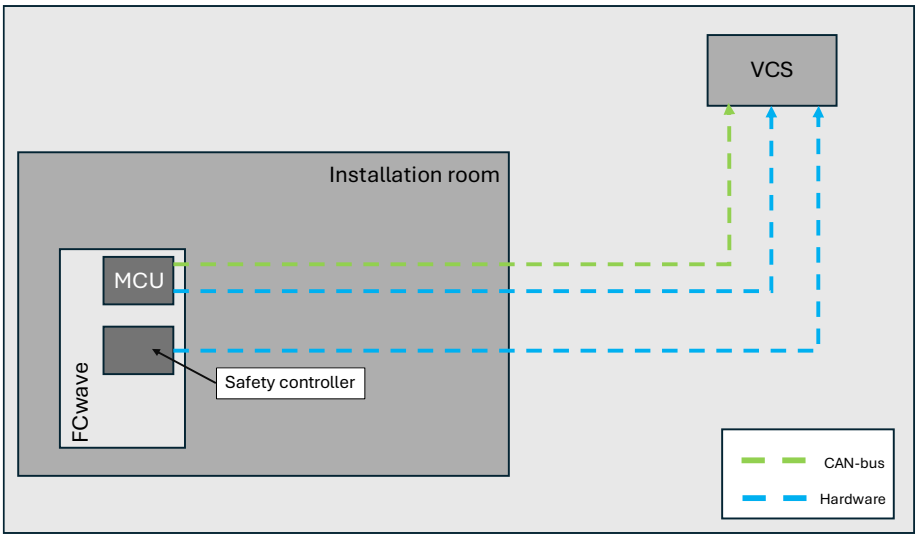


Figure 26 – Control System Architecture.

25. Control System – State Machine

The module control is based on a state machine, in which states correspond to the operating mode of the fuel cell. These states are communicated to the integrator over the CAN bus.

25.1. Introduction

In normal operation, inputs from the integrator causes the state machine to transition from the initial “Locked” state towards the “Running” state, in which the fuel cell is in operation.

The states are enumerated in Table 26. Please note that some states contain internal sub-states.

The normal high-level sequence of states for the fuel cell module, as well as the customer signals, required to initiate the various state changes, is shown in Figure 27 – High Level State Sequence.

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Estimates of power flow, to and from the fuel cell, during the state sequence and the approximate timing of **Startup** and **Shutdown** sequences, are also shown.

The integrator should follow the diagram for the control signal sequence to ensure safe operation of the module.

State	Description
Locked	The module controller is active, after receiving the **SAFE_IN** signal (see Table 41) but will remain in **Locked** state until the correct CAN customization key is received.
Unlocked	Correct CAN customization key received from the drive system (see Section 37.4). High Voltage circuits are depowered.
Pre-charge	The module pre-charge internal HV circuit. When pre-charge is complete, module enters **Standby.**
Standby	The module is waiting for the **MODULE_RUN** CAN signal to start the fuel cell. Module HV bus is connected to Vessel. Stack contactors are open.
Prepare for maintenance	This state provides a function for depleting the module of hydrogen to prepare for maintenance.
Startup	A sequence of steps that power up the fuel cell stacks and prepare the module to provide power. Air and hydrogen start flowing to the fuel cell module. Fuel cell stack voltage will rise. High voltage output contactors are closed. Note: This state contains sub-states internally.
Running	The module will set I_ALLOW > 0 Amps and current can be drawn from the fuel cell (see Section 32.1).
Shutdown	Water is purged from the reactant gas circuits and a controlled bleed down of voltage from the stack is performed. Module state will return to Unlocked. Note: This state contains sub-states internally.

Table 26 – System Operating States and Descriptions.

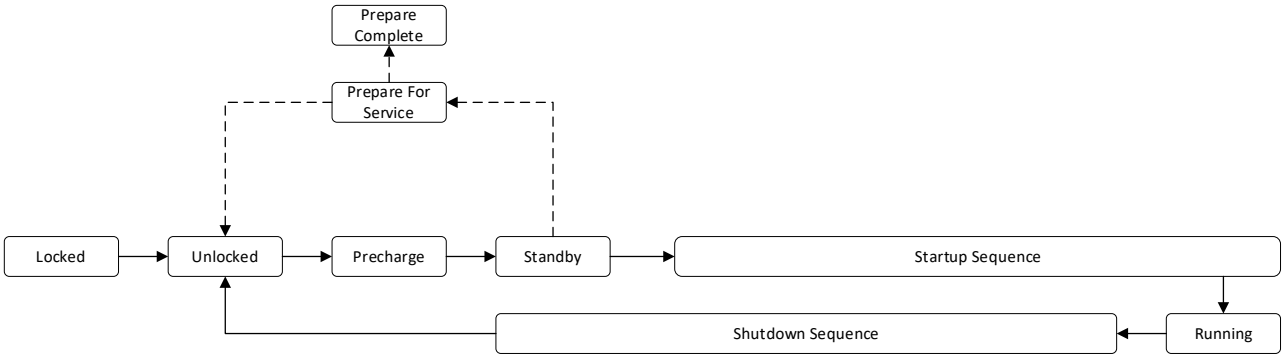


Figure 27 – High Level State Sequence for FCwave.

A more detailed overview of the module state machine is available in section 28 " DCDC Control Indicators", Figure 29 – FCwave™ State machine with DCDC Indicators.

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26. Ballard Master Control Unit

The module can be operated from a Vessel Control System directly, or if several FCwave™ modules are present, they can be controlled from a Ballard Master Control Unit.

For questions regarding the master control unit, contact Ballard.

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27. Integration with external DCDC Converters

The fuel cell module is a DC power source and operates as a load follower, with the external DCDC operating as load controller. This makes it extremely important to have the right understanding of the fuel cell module operation when designing the DCDC control.

27.1. Requirements for external DCDC converters

This section describes the functional requirements for the DCDC converters connected to the high voltage DC outputs.

These requirements are valid for bi-directional DCDC converters, which can provide power to the module during startup. For other configurations, please contact Ballard Europe.

For control specification for the DCDC converter(s), see section 30.6 “Startup procedure of DCDCs” and section 30.7 “Shutdown procedure of the DCDCs”.

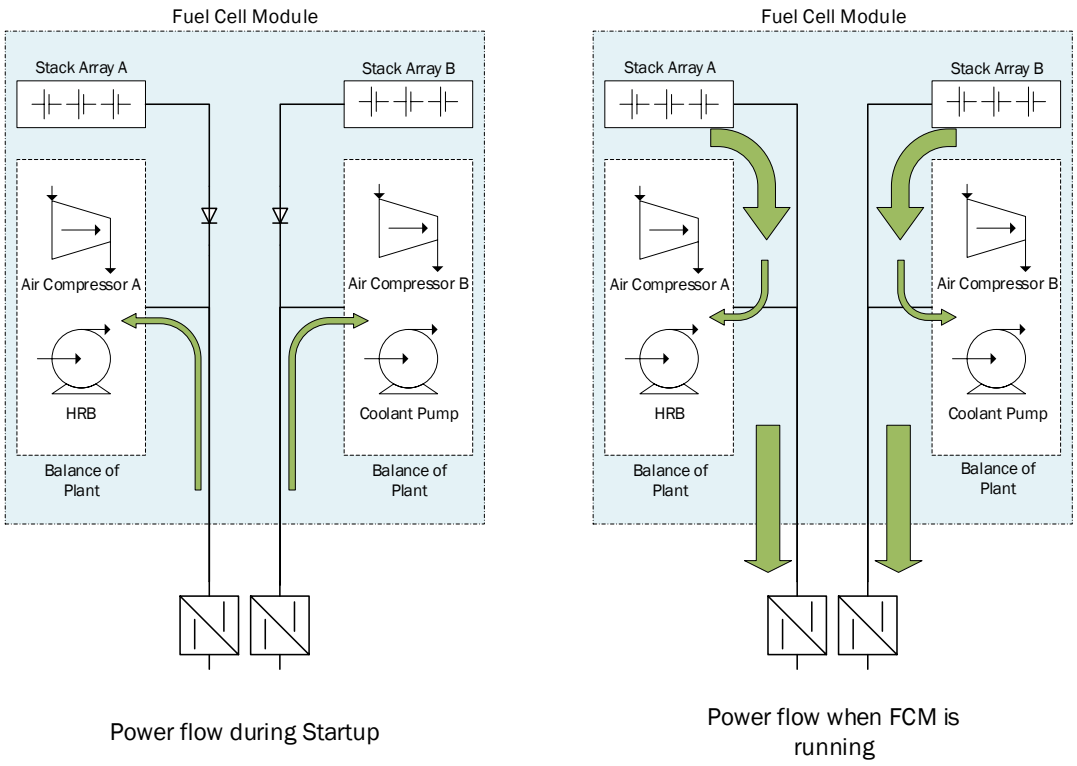


Figure 28 – Power flow to and from FCM during startup and run mode.

Dual Output configuration shown.

27.2. Role of the DCDC converters

The role of the DCDC converters is twofold:

During module startup, DCDC(s) must source power to the Balance of Plant (BOP) components of the module. After startup, the BOP components are powered by the stacks, directly.

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During normal operation, regulate the current drawn from the module, within the specified limits of I_Allow and the vessel operator.

Proper integration between the DCDC and the module is essential, as the module is a load-follower with dynamic and static limitations that the module cannot enforce by itself.

These limitations are communicated to the integrator via CAN bus (see section 37.2), and the integrator is responsible for respecting them when supplying power to the vessel.

27.3. Functional Requirements

Two converters are to be connected to the module for the dual output configuration.
Single converter is to be connected to the module for the single output configuration.
Converters must be able to handle voltages and currents as specified in CMS006 “FCwave™ Fuel Cell Module Datasheet”.
When the converter is drawing power from module to the vessel DC bus (power supplied from module to vessel):
The converter must be able to operate in constant-current (CC) mode, or a functionally identical mode. The setpoint must be on the input side.
The converter must have input side high and low voltage limits.
Stack voltage measurement is provided by the module controller and provided to integrator over CAN bus.
Output voltage and current limits are solely the responsibility of the integrator.
When the converter is drawing power form the vessel DC bus and supplying to the module (sourcing from vessel to module):
The converter must be able to operate in constant-voltage (CV) mode. The setpoint must be set on the input side.
The setpoint for the CV operation is received over CAN bus from the module and will in the range from 300 to 500 VDC.
During CV operation, the voltage must be within ±5% of setpoint. Below 2% deviation is preferred.
The CV operational mode shall implement a current-limiting function on the input side, which ensures the safety of the system.
The current draw from the module will start high and fall to 0 as BOP load transitions from external DCDCs to the internal stacks. The DCDC must allow the voltage to increase above the setpoint without exporting power from the module. Power needs during startup is detailed in section 32.2 “Startup Energy Consumption”.
Voltage ripple during operation shall not exceed 5% nominal voltage during the full range of operation. Voltage ripple of less than 2% is preferred.

27.4. DCDC Converters during start up

When the customer wishes to operate the fuel cell module, external power must be supplied.
As the stacks require both oxygen and hydrogen, the air compressor and hydrogen recirculation system must operate before the stacks can supply power.

To operate the module successfully, the DCDC must adhere to the procedures, described below and illustrated in Figure 28:

During module startup, DCDC(s) must source power to the Balance of Plant (BOP) components of the module. After startup, the BOP components are powered by the stacks, directly.

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During normal operation, regulate the current drawn from the module, within the specified limits of I_Allow and the vessel operator.
See the section 28 “DCDC Control Indicators” which describe when the DCDC converters are to operate in which direction and mode.

The voltage and current requirements are detailed in section 30.6 “Startup procedure of DCDCs”.

27.5. DCDC Converters during operation

During the “Running” state of the module, the DCDC converters are required to operate in constant current mode, with the setpoint set at the input side (towards module).

27.6. Definitions

- All voltages and currents are Direct Current.
- Power flow **from** Fuel Cell Module **to** rest of vessel is defined as positive direction.
  - Current flowing from module is denoted I > 0.
  - Current flowing from vessel to module (e.g., during startup) is I < 0.
- Input of the DCDC converter is defined to be towards the fuel cell module.
- Output of the DCDC converter is defined to be towards the vessel drivetrain.
- In dual output configuration, the DCDC converter connected to stack string A is referred to as “Converter A” or “CNV A” in abbreviated terms. “Converter B” or “CNV B” is similarly connected to stack string B.
- $I_{OutputA}$ is the current flowing from module to Converter A
- $I_{OutputB}$ is the current flowing from module to Converter B

27.7. DCDC Technical Requirements

This section describes the validated specifications for the external DCDC converters.

Product validation and EMC testing has been performed with DCDC converter switching frequency of 4kHz and 5kHz. If the integrator wishes to use switching frequencies outside the validated range, contact Ballard. If there are questions about using bigger DCDC converters, ask Ballard.

Specification		
External DCDC Converter switching frequency	Minimum	4 kHz
	Maximum	5 kHz
Voltage Ripple	Maximum	5% peak-peak
	Preferred	2% peak-peak
Maximum DCDC size	< 400kW	

Table 27 – DCDC Converter requirements.

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28. DCDC Control Indicators

This section describes the function of several indicator bits, transmitted over the CAN bus to the integrator. These bits indicate the desired operating mode of the connect DCDC converters.

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The bits are transmitted in the CAN Message "FCM_REQUEST_1" and are defined as follows:

- **DCDC_STOP**
  - This bit, if active, signals that the Fuel Cell does not require the DCDC converter to be active and it should not be actively modulating.
- **DCDC_IMPORT**
  - This bit, if active, signals that the Fuel Cell requests that the DCDC converter is active and operates in constant voltage mode towards the fuel cell module. Desired voltage setpoints and current limits are transmitted in the "FCM_REQUEST_2" CAN message.
- **DCDC_EXPORT**
  - This bit, if active, signals that the Fuel Cell is ready to provide power to the vessel and the DCDC converter should be active and operating in constant current mode towards the vessel. Current limitations are described in the following sections:
    - Section 29 - Important limits during operation.
    - Section 29.5 - Ramp rates

The DCDC Control Indicators are illustrated in Figure 29 – FCwave™ State machine with DCDC Indicators.

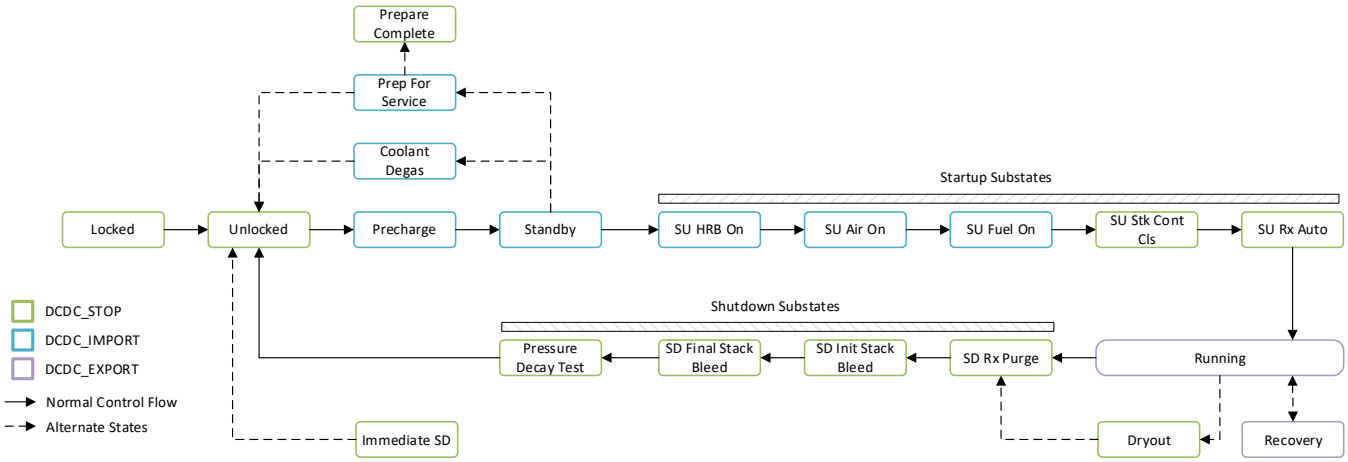


Figure 29 – FCwave™ State machine with DCDC Indicators.

28.1. DCDC_STOP Control Indicator

In case the DCDC_STOP control indicator is active, the module requests no action from the connected DCDC converters. They can be in standby mode, but no active modulation.

The DCDC_STOP control indicator is active during the following states:

- When the module is in Locked and Unlocked states
- When the module is in the shutdown sequence after operating
- When the module is in the later part of the **Startup** sequence
- When the module is in the **Dry-out** or **Prepare for Service Complete** state (see section 31 "Special Operating States")

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28.2. DCDC_IMPORT Control Indicator

In case the DCDC_IMPORT control indicator is active, the module requests that the connected DCDC converter is active, operating in Constant Voltage mode with constant voltage towards the fuel cell module.

The DCDC_IMPORT Control Indicator is active during the following states:

When the module is in **Pre-charge** and **Standby** states.
When the module is in the early part of the **Startup** sequence
Please note that the module becomes self-powering after the SU Fuel On state, as both hydrogen and oxygen is present in the stacks, therefore the DCDC is stopped until the module reaches Running state
When the module is in the **Coolant Degas** or **Prepare for Service** state (see section 31 “Special Operating States”)

28.3. DCDC_EXPORT Control Indicator

In case the DCDC_EXPORT control indicator is active, the module requests that the connected DCDC converter is active, operating in Constant Current mode, exporting power from the fuel cell module to the DC-bus.

Current limitations are described in the following sections:

- Section 29 - Important limits during operation
- Section 29.5 - Ramp rates

The DCDC_EXPORT Control Indicator is active during the following states:

When the module is in the Running state
When the module is in the Recovery state (see section 31 “Special Operating States”)

29. Important limits during operation

29.1. Minimum and Startup Current Draw

The fuel cell module has a minimum current draw of 50A for each stack string at BOL (Equivalent to approx. 55 kW) from the module. Operating at a power level below this, for an extended period, will reduce stack lifetime. If the customer current draw is below the minimum level, for more than 10-20 seconds, the module will shut down in a controlled fashion and report an error code to the operator. For a single output module, the value is doubled (100A minimum current draw)

During startup, it is recommended that the initial current is 10A (20A for single output configuration), (see Table 28 – Initial Current Draw Specification) and then ramped to minimum current draw with the ramp rate specified in section 29.5 “Ramp rates”

Specification	
Single Output Configuration – Initial Current Draw	20 A
Dual Output Configuration – Initial Current Draw	10 A

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Table 28 – Initial Current Draw Specification.

29.2. I_Allow and I_Offset

The fuel cell controller will report a maximum allowable instantaneous current draw for the stacks (*I_Allow*) as part of the CAN message transmitted by the Fuel Cell – the message is transmitted with a 100 ms interval.

The Module Control Unit will also report a desired offset between the stack strings, which serves to balance load between components and extend lifetime of the stacks. This parameter is not used in single output systems

- Single Output Configuration:
  - The I_Allow parameter is the maximum allowable current draw from the system. Current draw is never to exceed this value
  - The I_Offset parameter is disregarded.

- Dual Output Configuration:
  - The I_Allow parameter is the maximum allowable current that can be drawn from each string. Current draw for each string is never to exceed this value.
  - The module transmits the I_Offset parameter, which should be added to the current draw from string A and subtracted to the current draw from string B
  - The I_Offset parameter is signed, and a positive value indicates that a higher current should be drawn from string A than string B
  - I_Offset is capped at ±7,5A.

$$I_{OutputA} < I_{Allow}$$

$$I_{OutputB} < I_{Allow}$$

$$I_{OutputA} = I_{Output} + I_{Offset}$$

$$I_{OutputB} = I_{Output} - I_{Offset}$$

Where:

I_{Output} is the current as desired by the customer
$I_{OutputA}$ is the current setpoint for the DCDC converter attached to Output A
$I_{OutputB}$ is the current setpoint for the DCDC converter attached to Output B
I_{Allow} is the maximum instantaneous current draw, transmitted from the Module Control Unit via CAN bus
I_{Offset} is the desired offset between $I_{OutputA}$ and $I_{OutputB}$.

Example:

- Dual Output Configuration

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- I_{Output} is 200A
- I_{Allow} is 250A
- I_{Offset} is +2A
- In this example, the current draw from the DCDC converters ($I_{OutputA}$ and $I_{OutputB}$) must be below 250A and $I_{OutputA}$ should be 202A and $I_{OutputB}$ should be 198A.

29.3. Origin of the I_Allow parameter

The default current limit is set based on maintaining a minimum air stoichiometric ratio, with a maximum allowable current. Computations are then made to determine whether any other factors should be limiting the stack current below its default value. If any of these computations lead to a lower maximum allowable current than the default, module output is de-rated.

Exceeding I_Allow for more than 3 sec will result in an immediate shutdown procedure, to protect the module.

In order to obtain best long-term performance from the module, it is recommended to follow the current-ramp, described in section 29.5.

29.4. Reverse current protection during start-up operation

During startup, the following precautions are taken to prevent reverse polarization of the stacks:

HV system is isolated from stacks via diodes.
HV system is pre-charged gradually, to prevent sudden voltage and current spikes.
The permissible voltage range is transmitted to the integrator over CAN bus.
Voltage is measured inside the module and compared to the acceptable range.
Current limitations are transmitted to integrator over CAN bus. Integrator is responsible for ensuring that the DCDC(s) operate within this range.

If any parameters deviate from allowed ranges, start-up is aborted, and module returns to the ‘unlocked’ state. Module may open HV contactors to isolate itself if parameters are outside acceptable range. This is done in all alarm severity 3 and safety severity 4 situations.

⚠WARNING Reverse polarization of the stacks must be prevented. This occurs when a voltage, higher than the stack voltage, is applied to the system. A direct consequence of this is rapid heating, hydrogen development and irreversible damage to the stacks.

In worst-case, rapid heating and hydrogen development can lead to detonation or deflagration of present or developed hydrogen, inside the module.

29.5. Ramp rates

As described in section 29 “Important limits”, the ability of the fuel cell module to respond to dynamic changes in current draw is bounded.

For longevity of the stacks and balance of plant components, it is recommended to avoid rapid cycling of the current draw, as this will lead to excessive wear on stacks and BOP components.

Ballard recommends that current draw, during normal operation, follows the current vs. time graph shown in Figure 30 – Current/Time ramp for operation of external DCDCs.

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Specification	
Single Output Configuration - Maximum increase/decrease in current draw	40 A/s
Dual Output Configuration - Maximum increase/decrease in current draw (each output)	20 A/s

Table 29 – Current Draw Delta Specification.

Please note that in some shutdown conditions, the I_Allow parameter will decrease more rapidly than specified in Table 29.

Current draw must never exceed I_Allow, which may decrease (or become 0) more rapidly than specified ramp rates. In this case, converter current draw must be immediately reduced to I_Allow or less.

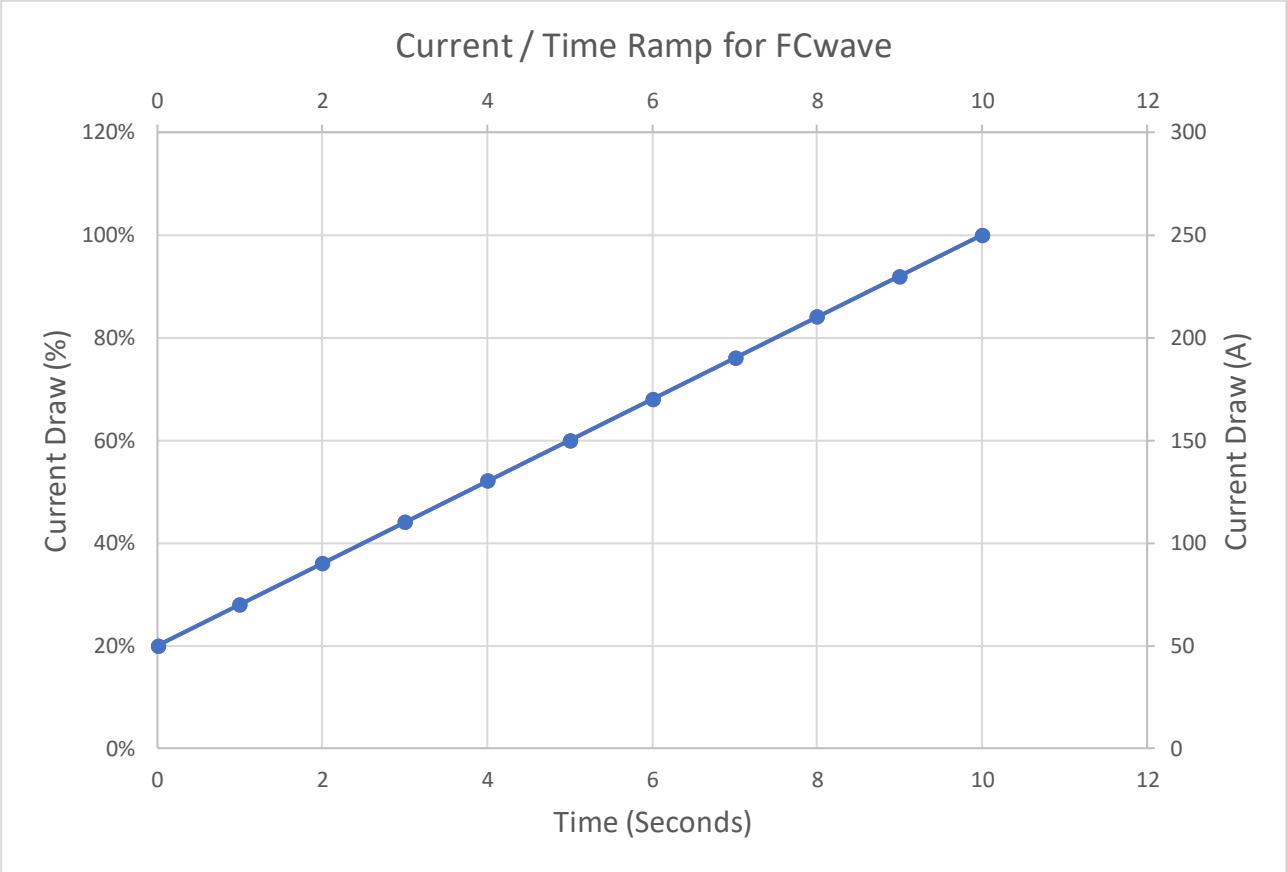


Figure 30 – Current/Time ramp for operation of external DCDCs. Dual Output Configuration shown.

The integrator must always ensure that the current draw remains below the I_Allow parameter, as transmitted over the CAN bus.

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30. Start-up sequence for the FCwave™ module

This section describes the sequence to start operation of the FCwave™ module.

30.1. Standby to Running Cycles

Lifetime of the system is based on the maximum number of **Standby** to **Running** cycles specified in Table 30. This is to preserve the performance of the fuel cell stack and BOP for the entire life cycle of the module. Ballard recommends this is not exceeded in daily use.

Recommendation	
Average Standby to Running Cycles	4 cycles per day (based on 18-hour days)

Table 30 – Maximum Standby-Running Cycles Recommended.

30.2. Vessel Requirements

When integrator desires to operate the Fuel Cell Module (FCM), the integrator must first ensure the following systems are ready to perform as outlined in the datasheet:

- H_2 supply system is ready to provide hydrogen.
- Coolant system is ready to transport heat away from module.
- DCDC converters are ready to operate.
- FCM is in the **Unlocked** state.

The integrator sets the “MD_Enable” hardwire connection to the FCM. This causes the module to enter the **Precharge** state.

30.3. Pre-charge

The module can enter the **Precharge** state from the Unlocked state. In the pre-charge state, the module connects the internal HVDC bus to the external HVDC supply and gradually charges the internal capacitors.

In Pre-charge state, the module awaits HVDC from Integrator. The module will send a severity 1 warning if HV is not measured after 5 seconds. It will stay in Pre-charge indefinitely until either HV is present and pre-charge process is complete or MD_Enable is not active.

- The module low side DC bus is directly coupled to the external DC bus.
- The module high side DC bus is coupled to the external DC bus over a pair of 500Ω resistors.
- This limits the current to 1A or less.
- Internally the voltage is measured:

When the voltage has exceeded a minimum level **AND**
Rate of change on the internal voltage is below a threshold.

- The module high side DC bus is coupled directly to the external DC bus.
- The resistors are decoupled.
- **Precharge** is complete.

When pre-charge is complete, module transitions to the **Standby** state.

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30.4. Standby state

From the **Standby** state, the module provides power to the motor controllers and prepares for operation. H_2 supply valves are closed.

When the integrator transmits the "MD_Run" signal over the CAN bus, the module will transition to the **Startup** state.

The DCDCs must provide a constant voltage to the HV system.

The module can be kept in **Standby** state indefinitely. High voltage DC power is present, but consumption is very low in **Standby** state, unless maintenance is being performed.

30.5. Startup sequence

In the **Startup** state, which comprises several sub-states, the module readies all systems for operation, requests H_2 valves open from the Integrator, and performs the stack power-up sequence.

In this mode, the constant voltage provided by the DCDCs must be kept operating, in order to provide power for the **Startup** sequence, see section 28.

> The air compressors are brought to minimum power levels and start providing oxidizer to the stacks.
> When the HRB is running, the module will flush the H_2 loop, to quickly fill the fuel cells with hydrogen.
> As oxygen and hydrogen are circulated in the stacks, the voltage increases, and rises above the voltage provided by the DCDCs. BOP supply is transitioned from external supply to the stacks.

Integrator shall stop providing a constant voltage when module state (as reported in the FCM_STATUS_1 CAN telegram, see **CMS013 CAN Matrix**) is "**Startup Stk Cont Cls**" or **Startup RX Auto**

The MCU signals the DCDCs to stop and air compressors are spooled up and the module will be able to provide power as the MCU transitions to Running state

During startup, the power supplied from the DCDCs to the module is below 4kW.

30.6. Startup procedure of DCDCs

When controlling the DCDC converters, attention must be paid to the CAN messages from the module, which describe when to provide or draw power.

The DCDC(s) must react according to the following CAN-messages, see **CMS013 - CAN Matrix**:

From message "FCM_STATUS_1"

- DCDC_STOP
- DCDC_IMPORT
- DCDC_EXPORT

From message "FCM_REQUEST_2"

- String A Maximum Import Current (I_BOP_A)
- String B Maximum Import Current (I_BOP_B)
- String A Minimum Voltage (UFC_MIN_A)

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- String B Minimum Voltage (UFC_MIN_B)

The module must not receive nor draw any current through the DCDCs in states *Locked* and *Unlocked*. (DCDC disabled or in stopped state). In these states the contactors are open and the module is disconnected from the DCDC.

In the states **Precharge** until[6] **Startup *Stk Cont Close***, the DCDCs must keep a voltage above the minimum voltages, by supplying adequate current. Preferred voltages are 350 to 450 V, and maximum voltages are 550 V. This is signaled by the flag "DCDC_IMPORT" being true.

There must never be supplied more current than the Maximum Import Current, even if the voltage would drop to less than the minimum voltage.

Going from the beginning of the **Startup** sequence to **Startup Stk Cont Close** takes 30 seconds typically.

In the state **Startup Stk Cont Close**, the DCDC shall stop providing constant voltage (Flag DCDC_STOP is true).

In the state **Running** the DCDC converter shall be in voltage-following constant current mode. In this state I_ALLOW will be ramped up to above the minimum current, described in section 29, within 1 second. The DCDC then has 10 seconds to increase the current draw to above the minimum current.

If the DCDC fails to draw more than the minimum current, the module will first provide a warning over the CAN bus, and if the current draw still does not exceed minimum levels, will signal a fault and perform a controlled shutdown.

30.7. Shutdown procedure of the DCDCs

Before a shutdown, it is required to reduce the current draw to the minimum current, described in section 32.4 "Shutdown sequence".

When a shutdown is initiated, the module will enter the state *Shutdown Rx Purge.* The maximum current the DCDCs must draw is now 0 A. I_ALLOW will within 1 second fall to below 10 A. This state will last between 10 and 60 seconds.

After reducing DCDC power to 0A and module has transitioned to *Shutdown Rx Purge*, the DCDC converters are not needed until next restart of the module and can be switched to standby.

The module will then deplete internal reactant remains and perform a pressure decay test to verify the tightness of the hydrogen system (see section 32.5). After this test is complete the module transitions to unlocked state. If MD_Enable is still present, the module will again enter the **Precharge** state.

[6] Following the normal startup procedure. The states are *Standby, Startup HRB on, Startup Air On, and Startup Fuel On*

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31. Special Operating States

This section describes the special operating states that the system can operate in when requested.

These states are not a part of normal operating sequence but are necessary for maintenance activities and pre-storage preparations.

31.1. State: Coolant Degas

The purpose of this state is to remove air bubbles from the Internal HT coolant loop. This state is typically used after coolant fill/drain cycles, or maintenance involving the HT coolant loop

Parameter:	Value:	Comment:
Preceding state	Standby	
HV Supply	Yes, <3kW	Power to operate coolant pump
Customer HT Coolant	No	
Customer LT Coolant	Yes	Coolant for inverter, expected <500W
H2 Supply	No	
Exit condition	Manual	Returns to Unlocked state

Table 31 – Coolant Degas State.

To use this state, bring module to **Standby** and activate the DEGAS_REQ bit. When completed, disable the bit. This state takes typically 5-10 minutes to degas the coolant loop after a complete drain/fill cycle.

In this state, the coolant pump circulates the coolant while the internal valves actuate in order to flush all air bubbles in the internal coolant loop.

The state is active as long as requested by customer/maintenance personnel.

This state does not affect the external HT coolant supply.

31.2. State: Prepare for Service

The purpose of this state is to remove all residual hydrogen from the fuel circuit, such that maintenance activities can be performed in a safe manner. The hydrogen is reacted with oxygen from the air and either used by the motor inverters or dissipated in the bleed resistors.

This is achieved by circulating the contents in the fuel system by operating the HRB and supplying oxygen by operating the compressors at low speed.

Parameter:	Value:	Comment:
Preceding state	Standby	
HV Supply	Yes, <4kW	Power to operate HRB, Air compressors
Customer HT Coolant	No	
Customer LT Coolant	Yes	Coolant for inverters, expected <500W
H2 Supply	No	
Exit condition	When finished	Next state: “Prepare Complete”

Table 32 – Prepare for Service State.

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When **Prepare for Service** is complete, all hydrogen in the fuel system is exhausted and the stack voltage is reduced to below 10V. The system transitions to **Prepare Complete**.

31.3. State: Prepare Complete

The purpose of this state is to indicate for maintenance personnel that the system has completed the procedures to exhaust available hydrogen and stack voltage is below dangerous levels.

This state has no exit condition, and a power cycle is required to exit it.

Parameter:	Value:	Comment:
Preceding state	Prepare for Service	
HV Supply	No	
Customer HT Coolant	No	
LT Coolant	No	
H2 Supply	No	
Exit condition	None	Requires power cycle to exit state.

Table 33 – Prepare Complete State.

Please note that the prepare for maintenance procedure it not intended for daily use, as excessive use of this functionality may degrade stack performance.

31.4. State: Dry-out

The purpose of this state is to remove liquid water from the module, such that stacks are in a “dry” condition after completing this procedure. This is intended to be the final part of the last operation cycle before long term storage or transportation of the module, where temperatures may reach freezing conditions.

Parameter:	Value:	Comment:
Preceding state	Running	I_Allow ramps to 0A, then disconnects HV system.
HV Supply	Disconnected	
Customer HT Coolant	Yes	Reduced cooling requirements
LT Coolant	Yes	
H2 Supply	Yes	
Exit condition	Timed, Conditional	Exits to module shutdown. Duration 6 min or less

Table 34 – Dry-out State.

Initiating Dry-out

The prerequisites for the dry-out sequence are as follows:

- The module must be in the “Running” state.
- No alarms

To start the dry-out sequence, enable the “DRYOUT REQUEST” bit from over the CAN bus.

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Dry-out Sequence

When requested to begin a dry-out, the module ramps I_Allow to 0A. When the customer current is reduced to <5A, the module begins the dry-out process.

The integrator will observe that the fuel cell module opens its HV connectors and disconnects from the vessel HV system. When disconnected, the module ramps up temperature and airflow to accomplish the dry-out process. During this state, the air compressors are operating at high power levels.

Dry-out Completion

When the module has completed the dry-out process or 6 minutes has elapsed, the module will perform a controlled shutdown process, identical to a normal operational shutdown. After the shutdown, the module is prepared for long term storage.

Restarting module after Dry-out and Storage

When the module is to be operated again after the dry-out procedure, integrator must operate the module in a low power regime (50-75kW) for at least 20 minutes before increasing power. This allows the stack to return to proper humidification conditions.

Expect that performance is impacted until stacks are re-humidified. This is temporary and can be helped by performing a conditioning cycle, contact Ballard for details.

31.5. State: Recovery

The Recovery state is intended to recover temporary performance degradations.

Please consult with Ballard before utilizing the recovery functionality.

Parameter:	Value:	Comment:
Preceding state	Running	Certain conditions apply.
HV Supply	Operating	
HT Coolant	Yes	
LT Coolant	Yes	
H2 Supply	Yes	
Exit condition	Manual	Returns to Running.

Table 35 – Recovery State.

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32. Normal Operation Example

During normal operation, the stack converts hydrogen to power, dependent on the current drawn and at a voltage primarily dependent on the stack operating point. The voltage vs. current relationship is described by the system polarization curve.

Operation Example					
Sequence	**Description**	**Module State or Transition**	**DCDC Indicators**		**Typical duration**
1	Integrator enables 24V supplies to module and SAFE_IN safety input. Integrator sends Module key over CAN bus	Module transitions from Off to Locked to Unlocked	STOP	False	1-2 minute
			IMPORT	False	
			EXPORT	False	
	Module is in Unlocked state	Module state is Unlocked	STOP	True	Can stay in Unlocked indefinitely.
			IMPORT	False	
			EXPORT	False	
2	Integrator enables MD_Enable input	Module transitions from Unlocked to Precharge	STOP	True	<1 second
			IMPORT	False	
			EXPORT	False	
	Module pre-charges HV Circuit	Module transitions from Precharge to Standby	STOP	False	2 seconds
			IMPORT	True	
			EXPORT	False	
	Module is in Standby	Module State is Standby	STOP	False	Can stay in Standby indefinitely
			IMPORT	True	
			EXPORT	False	
3	Integrator wishes to operate FCwave™ module and sends MD_Run over CAN bus	Module transitions from Standby to Startup sequence	STOP	False	<1 second
			IMPORT	True	
			EXPORT	False	
4	Module has begun drawing power on HV bus to spin compressors, module requests H2 valves open. Hydrogen flows to stacks	Startup sequence	STOP	False	30 seconds
			IMPORT	True	
			EXPORT	False	
5	Module is self-powered from stacks, start-up sequence continues	Startup sequence	STOP	True	<15 seconds
			IMPORT	False	
			EXPORT	False	

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6	Module completes the startup sequence and enters Running. Module transmits I_Allow > 0 on CAN bus and begins producing power	Running	STOP	False	<5 seconds
			IMPORT	False	
			EXPORT	True	
7	Module is in Running state and produces power to vessel. Integrator follows current ramp and does not exceed I_Allow	Running	STOP	False	Module can operate indefinitely
			IMPORT	False	
			EXPORT	True	
8	Integrator wishes to stop operating the module. Ramp current draw to <10A as described in section 32.4 and stop sending MD_Run	Running	STOP	False	<10 seconds
			IMPORT	False	
			EXPORT	True	
9	Module begins shutdown sequence	Module transitions from Running to Shutdown	STOP	True	<1 second
			IMPORT	False	
			EXPORT	False	
10	Module executes shutdown sequence. After complete shutdown sequence module transitions to Unlocked	Shutdown to Pressure Decay	STOP	True	30 seconds
			IMPORT	False	
			EXPORT	False	
11	Module performs pressure decay self-test of hydrogen system.	Pressure Decay to Unlocked	STOP	True	30 seconds
			IMPORT	False	
			EXPORT	False	
12	After 15 minutes inactivity, it is permissible to power off module	Unlocked to Off			15 mins

Table 36 – Operation Example Events. See Figure 31.

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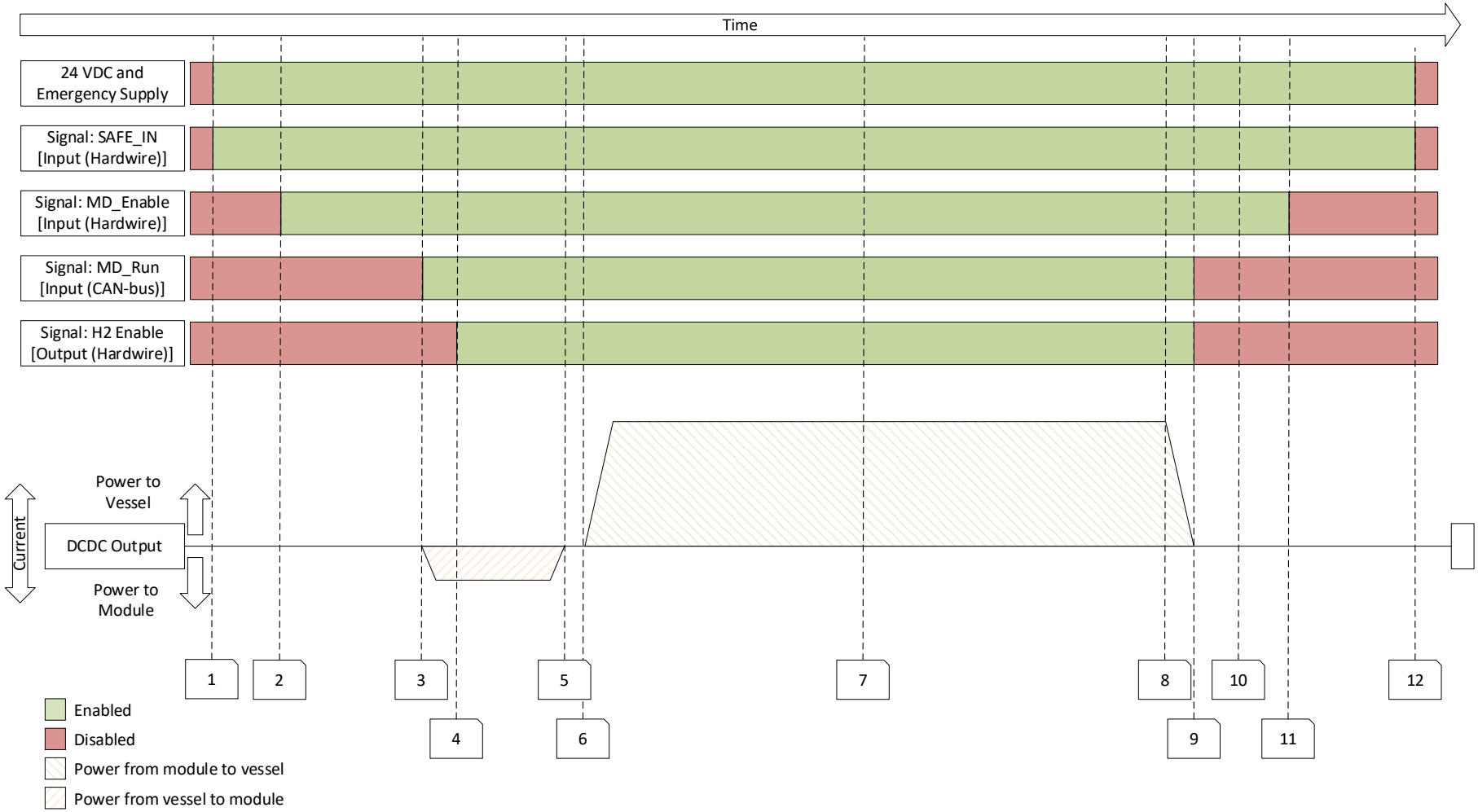


Figure 31 – Control Sequence during startup and operation of FCwave. See Table 36.

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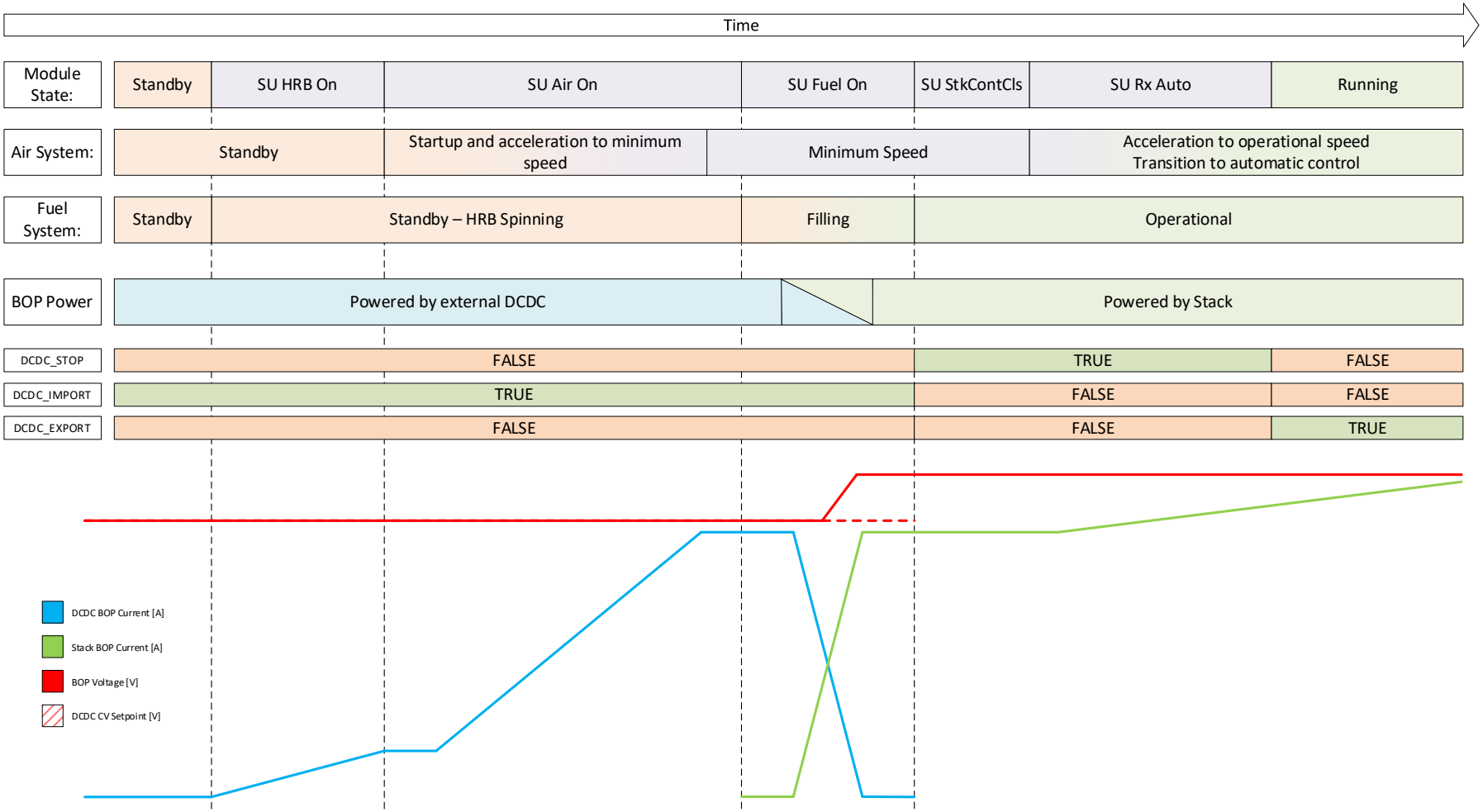


Figure 32 – FCwave™ Startup Sequence and DCDC Integration.

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32.1. Startup Sequence

The detailed **Startup** sequence for the FCwave™ module is outlined in Table 37 and shown in Figure 32.

FCwave™ Module Startup - Detailed			
Module State	**Description**	**Module State or Transition**	**Typical duration**
Standby	Module has completed pre-charge. DCDC is providing constant voltage to BOP components. Current draw is ~0	Standby	Indefinite
Standby	Integrator transmits MD_RUN over CAN bus	Transition to SU HRB On	n/a
SU HRB On	HRB Motor spins up. DCDC maintains voltage, current draw increases.	SU HRB On	~5 sec
	HRB is at speed	Transition to SU Air On	n/a
SU Air On	Air compressors initialize and spin to startup speed. DCDC load increases as compressors draw power.	SU Air On	~10 sec
SU Air On	Air compressors stable at startup speed. DCDC load stable.	Transition to SU Fuel On	n/a
SU Fuel On	Fuel subsystem opens valves and flood stacks with hydrogen. Stack voltage increase to ~600V. Load on DCDCs fall to nearly 0, as BOP is powered by stacks through diodes.	SU HRB On	~15 sec
SU Fuel On	Fuel pressure is stable at nominal levels	Transition to SU StkContCls	n/a
SU StkContCls	Main stack contactors close, bypassing startup diodes.	Transition to SU Rx Auto	<1 sec
SU Rx Auto	BOP Components switch from minimum setpoints to operational control	SU Rx Auto	~5 sec
SU Rx Auto	BOP Components are stable at operational control	Transition to Running	n/a
Running	Module is ready to provide power	Running	n/a

Table 37 – Detailed Startup sequence, See Figure 32.

32.2. Startup Energy Consumption

The energy consumption during **Startup** is detailed in Table 38.

Type	Duration	Amount	Total Energy
24VDC auxiliary power input	Continuously	352W	10 kJ
HV DC	0-27s	4000W	52
Hydrogen	4-6s	0,11 g/s	66 kJ
Combined	-	-	128 kJ

Table 38 – Startup energy consumption.

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32.3. Running state

Transition from start-up to running state

When module transitions from **Startup** to **Running** state, "I_ALLOW" will rise above 0 Amps and the integrator can begin drawing current from the module.

The interval between the transition to **Running** mode and for the integrator to begin drawing current should not exceed 5 seconds, under normal operating conditions.

If the integrator does not draw more than the minimum current, the module will first signal a severity 1 warning. If the current draw remains below minimum level for more than 20 seconds, the module will perform a controlled shutdown and signal a severity 2 alarm.

Running state limitations

In the running state, the system is providing electrical power, and acting as a load follower for the DCDCs. The system has limited dynamic capabilities and will signal its ability to provide current as described in section 29.

Note: During operation, the integrator must respect the limits imposed by "I_ALLOW".

Note: During operation, the integrator shall not reduce current draw below minimum levels (50A), except during shutdown. Brief (<5 seconds) reductions below 50A can be permitted but should be avoided.

Note: The recommended current ramp is specified in section 29.5

32.4. Shutdown sequence

When the integrator wishes to stop operating the FCM, the proper procedure is as follows:

1. Reduce current draw from DCDCs to 10A.
2. Reduce to 0 A, within 5 seconds disable the MD_Run CAN signal.
3. The module preforms the shutdown sequence. Expected duration is 45 seconds.
4. During the shutdown, the module performs a pressure decay self-test, see section 32.5.
5. After shutdown is complete, module returns to Unlocked state.
6. Integrator decides if module is expected to operate soon:
    a. If module is not expected to operate in < 1h, disable MD_Enable and module transitions to **Unlocked** state.
    b. If module is expected to operate in < 1h, maintain MD_Enable and module will return to **Standby** state
    In order to return to Standby, external HVDC supply must be active as described in section "30.3 Pre-charge"
7. When the module switches to **Standby** state, integrator can re-enable MD_Run to restart module or disable MD_Enable if an imminent restart is not expected.
8. If integrator disables MD_Enable, module switches to **Unlocked** state

Module may be powered off 15 minutes after entering **Unlocked** state[7]. The module will during this time consume the remaining hydrogen in the supply system, as it may not be turned off with excess

[7] Duration to be revised after system testing, in order to verify the duration it takes to dissipate H2 inside the module

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hydrogen in the supply line. It is recommended to turn off the 24V supply if the module is not used for the next several hours.

During this time, the module will also upload log files to Ballard if internet is available.

32.5. Pressure Decay self-test

This section describes the pressure decay self-test performed by the module as a part of the shutdown sequence.

Conditions for performing the self-test is as follows:

- Shutdown is caused by customer disabling MD_Run CAN signal
- No alarms active

During the test, the module uses hydrogen to partially pressurize the internal hydrogen loop and then close supply valve. Then the pressure decay over time is monitored and evaluated. The pressure decay self-test typically lasts 30 seconds.

Failed Pressure Decay self-test

If the module fails the pressure decay self-test, it will signal a severity 2 alarm and require a specific acknowledgement of the alarm before allowing restart. The causes of a failed self-test can be:

- Unable to pressurize internal hydrogen loop.
  - Internal pressure does not reach setpoint within time limit. Ensure module has available hydrogen to perform self-test
- Pressure decays too rapidly
  - This indicates a leakage inside the hydrogen loop. Contact Ballard service
- Pressure test aborted
  - The test is aborted if MD_Enable becomes high or any alarms are active.

If a pressure decay test failure occurs, it is required to perform an investigation into the cause of the failure. This investigation should include all relevant data, including ventilation exhaust hydrogen content and inlet pressure. When the cause has been identified and the system is deemed safe, the pressure decay failure can be reset by setting the “Pressure Decay Failure Reset” bit in the VCS_REQUEST CAN message. For further instruction on pressure decay testing follow the maintenance instructions.

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33. Overnight storage of FCwave

This section describes the options for an installed FCwave™ module during overnight (unattended) options on the vessel.

33.1. Environmental Concerns

If the module is left overnight or for longer periods, for example weekend and holidays, the environment surrounding the module must stay within the environmental specifications as listed in Table 10 – Ambient Temperature Specification.

NOTE: Do not permit the hydrogen enclosure ventilation intake to circulate air <0°C into the module

33.2. Power off

When finished with the daily operation of the module, allow the module to remain 15 minutes in non-operating state (Unlocked or Standby), such that H2E ventilation may continue to operate and allow the module to cool down.

After the 15 minutes has elapsed, shut off 24V power to the FCwave™ module.

In the unpowered state, no part of the control or safety system is operational and there is no activity inside the module.

It is not possible to turn off the control system only, as one of the ventilation fans operate off the control system supply.

33.3. Unlocked

If it is desired to maintain the hydrogen enclosure ventilation and monitoring system of the module, allow the module to remain in the “Unlocked” state, where the alarm system is operational, and the hydrogen enclosure is continually ventilated by the fans.

In this state, the module draws 350W continuously, which must be provided by the vessel.

NOTE: Do not permit the hydrogen enclosure ventilation intake to circulate air <0°C into the module

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34. Low Voltage Electrical Connections

This section describes in detail the connections between the FCwave™ module and the vessel. For the recommended wiring diagram, refer to document CMS010 “Schematic description of Input and Output Circuits”, with focus on appendix CMS101-A.

34.1. Switching types

Figure 33, Figure 34 and Figure 35 illustrate the different types of inputs and outputs from the module.

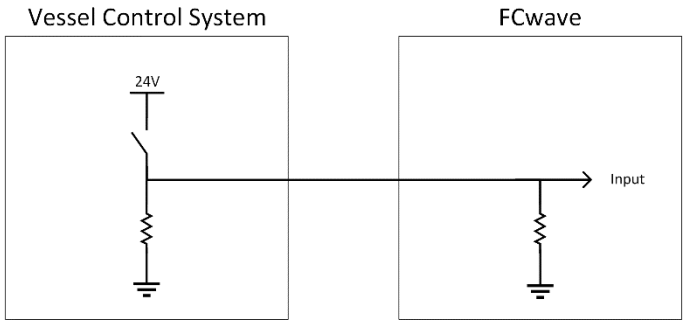


Figure 33 – High-Side Switching Input.

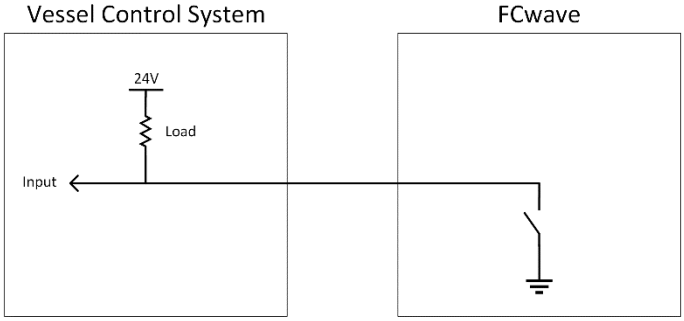


Figure 34 – Low-Side Switching Output.

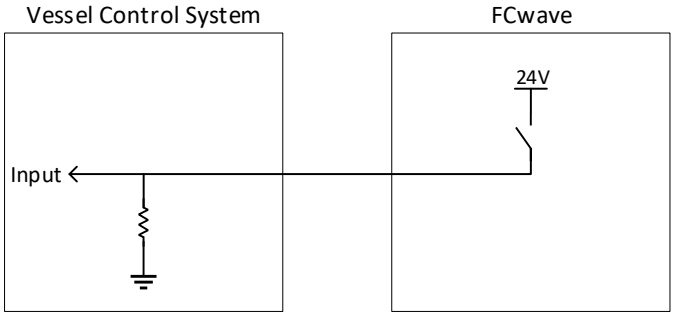


Figure 35 – High-Side Switching Output.

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34.2. Digital Supply and Signal Definitions

Hardwired inputs and outputs between the drive system and module are defined in Table 39, Table 40, and Table 41. These include the type of signal and a description of their purpose.

Module Supply Definitions

Interface Specification				
Interface name long	**Interface name**	**Interface type**	**Input / Output**	**Description**
24V DC supply	24V_SUPPLY	Supply	Input	Max 750W power draw
DC common	COM_SUPPLY	Supply	Input	DC Common. Not connected to GND.
Module grounding stud	GND_01	Grounding stud	Grounding	Grounding of module frame

Table 39 – Connection Definitions for Module Control Supply.

Fuel Cell Controller Signal Definitions

Signals in this category are referenced to 24V_SUPPPLY. CAN bus communications are specified in **CMS013 CAN Matrix**.

Interface Specification						
Interface name long	**Interface name**	**Interface type**	**Input / output**	**Switching type**	**Description**	**Active High/Low**
Module enable	MD_Enable	24V Hardline	Input	High side input	Signal to transition module from **Unlocked** to **Standby** state – Used prior to module activation	Active High
H2 enable	H2_ENABLE	24V Hardline	Output	Low side output	Signal to hydrogen supply system to open upstream H2 valves and provide hydrogen for module activation. Switched to COM_SUPPLY when active. See section 14.5.	Switched to COM_SUPPLY when active.
FUEL CELL MODULE STATUS OK	FCM_OK	24V Hardline	Output	High side output	Signal to customer if module is operational (I.e., has no fault of severity 2 or 3). (*Please note that this is separate from a Safety system emergency).*	Active low. High = FCM OK Low = FCM Error
Customer CAN bus	CAN_02	CAN bus	Bidirectional	n/a	Customer interface to fuel cell module.	n/a
Ethernet	ETH_01	Ethernet	Bidirectional	n/a	Service and Datalogging interface.	n/a

Table 40 – Signal Definitions for Module Controller and Display Panel.

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Safety System Supply and Signal Definitions

Signals in this category are referenced to 24V_SAFE.

Interface Specification						
Interface name long	**Interface name**	**Interface type**	**Input / output**	**Switching type**	**Description**	**Active High/Low**
24V DC supply safety	24V_SAFE	Supply	Input	n/a	Max 250W power draw, Ship Emergency Supply	n/a
DC common safety	COM_SAFE	Supply	Input	n/a	DC Emergency Supply Common. Not connected to GND.	n/a
Main safety in	SAFE_IN	24V Hardline	Input	High side input	Safety input from Vessel control system. Disable this signal to trip emergency system externally.	Active High
Main safety out	SAFE_MAIN	24V Hardline	Output	High side output	Main output from safety control system. This output will, together with the following sub-system specific output signal give the condition of the emergency system.	Active High
Safety – fire detection	SAFE_FIRE	24V Hardline	Output	High side output	Output indicating the status of the fire detection system.	Active High
Safety – hydrogen concentration	SAFE_H2CONC	24V Hardline	Output	High side output	Output indicating the status of the hydrogen concentration in the H2 enclosure being too high.	Active High
Safety – ventilation status	SAFE_VENT	24V Hardline	Output	High side output	Output indicating the status of the ventilation system.	Active High
Safety - watchdog	SAFE_WD	24V Hardline	Output	High side output	Output indicating the status of the safety system internal monitoring.	Active High
Estop – wire 1	ESTOP_W1	24V Hardline	Input	High side Input	Input to safety system from external 2-wire ESTOP button, Integrator responsibility.	Active High
Estop – wire 2	ESTOP_W2	24V Hardline	Input	High side Input	Input to safety system from external 2-wire ESTOP button, Integrator responsibility.	Active High
Estop – out 1	ESTOP_OUT1	24V Hardline	Output	n/a	ESTOP output for external 2-wire ESTOP button. Connected internally to “24V-SAFE”.	n/a
Estop – out 2	ESTOP_OUT2	24V Hardline	Output	n/a	ESTOP output for external 2-wire ESTOP button. Connected internally to “24V-SAFE”.	n/a
Safety – External ESTOP	SAFE_EXTERN	24V Hardline	Output	High side output	Output indicating the status of the external safety inputs	Active High

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Safety – Fire Detection System Malfunction	SAFE_FIREMALF	24V Hardline	Output	High side output	Output indicating the status of the fire detection apparatus. When inactive, indicates a malfunction in the fire detection system	Active High

Table 41 – Signal Definitions for Safety System.

34.3. ESTOP Connections and wiring

The ESTOP connections on the FCwave™ module, as detailed in Table 41 should be wired according to applicable standards and rules for the application.

Ballard recommends the ESTOP connection and button connected to the FCwave™ should fulfill the following requirements:

Construction compliant to EN/ISO 13850
Contacts should be of the type "Positive forced opening normally closed contact", two contact sets
Wiring performed in accordance with diagram CMS010-A and section 35 2133586288.429.

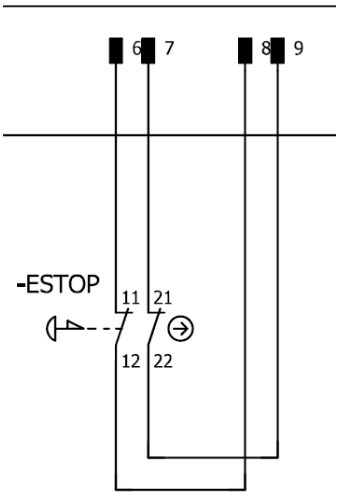


Figure 36 – ESTOP Wiring diagram, reproduced from CMS010-A.

35. Low Voltage Connector Construction

The Low Voltage Connector ("LVC") is constructed with a housing and a frame containing six modular elements, each with a distinct function and connection pattern.

35.1. Signal Wiring

Ballard strongly suggests shielded wiring for low voltage power, bus and signals. Shielding is absolutely required for CAN bus communications (Slot D).

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35.2. Connector Elements

The Ballard scope of the Low Voltage Connector (LVC) is constructed by the following elements:

Component	Tag	Manufacturer	MFG Part name	MFG Part #
Housing	X_E01	Harting	Han 24HPR Base Panel Screw locking	09 40 024 0311
Frame	X_E01	Harting	Han hinged frame plus, for 6 modules a-f	09 14 024 0371
Slot A	X_E01-A	Harting	Han 40A axial module, female 2,5-8 mm²	09 14 002 2701
Slot B	X_E01-B	Harting	Han DD Quick-Lock module, female	09 14 012 2732
Slot C	X_E01-C	Harting	Han Gigabit Module, Female	09 14 008 3111
Slot D	X_E01-D	Harting	Han D-Sub module, crimp female	09 14 009 3101
Slot E	X_E01-E	Harting	Han 40A axial module, female 2,5-8 mm²	09 14 002 2701
Slot F	X_E01-F	Harting	Han DD Quick-Lock module, female	09 14 012 2732

Table 42 – Low Voltage Connector Construction.

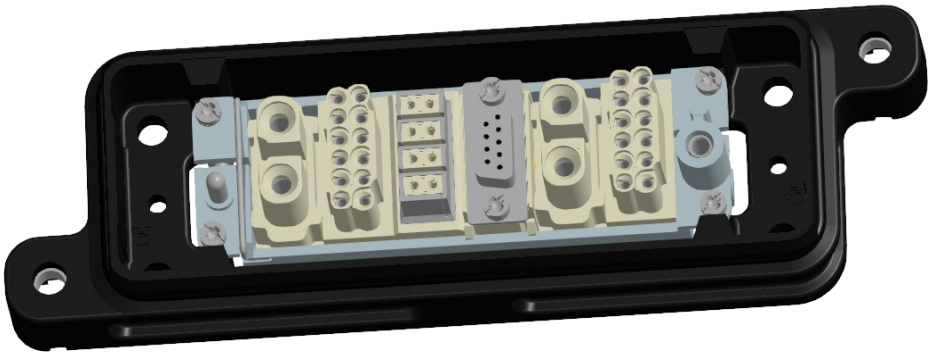


Figure 37 – Rendering of Low Voltage Connector. Slots A to F are shown from left to right.

As shown in Figure 37, the LVC is comprised of the frame with the 6 modules slotted into the frame. The Modules are designated A to F, viewing the image from left to right.

35.3. Protection of the Low Voltage Connector

When the Control and Communication Connector is not mated to a suitable plug, it should be protected against ingress of dust, grime and fluids by an appropriate protective cover.

Ballard will provide a screw locking cover for the connector during shipping and handling. If this cover is lost, replacement can be purchased from Ballard or Harting, quoting Harting Stock # 9400245411.

When mated to a suitable connector or protective cover, the Ingress Protection rating of the connector is IP65 and IP68 in both cases.

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35.4. Low Voltage Connector kit

Ballard can supply a kit containing a suitable set of parts to construct a connector. Contact Ballard Europe and request “7500168 Integrator LVDC Connector Kit”.

35.5. Low Voltage Connector Pin Assignment

This section describes the pin assignment for the low voltage connector.

Slot A

This slot in the connector is the connection point for the module 24VDC supply. Voltages and tolerances are described in CMS006.

Pin	Tag	Function	Interface name
1	=X_E01-A:1	+24VDC	24V_SUPPLY
2	=X_E01-A:2	0VDC	COM_SUPPLY

Table 43 – Slot A Signal Definitions and Assignments.

Slot B

This slot in the connector is the connection point for the fuel cell controller signals. These signals are referenced to the potentials in Slot A

Pin	Tag	Function	Interface name
1	=X_E01-B:1	Digital Out	FCM_OK
2	=X_E01-B:2	Digital Out	H2_ENABLE
3	=X_E01-B:3	Digital In	MD_Enable
4-12	Various	Not Connected	Not Applicable

Table 44 – Slot B Signal Definitions and Assignments.

Slot C

This slot in the connector is the connection point for the Module Control Unit Ethernet Interface.

The module is wired according to TIA **T568B**.

Pin	Color	Function	Interface name
1	Orange / White	Ethernet	MCU Network
2	Orange	Ethernet	
3	Green / White	Ethernet	
4	Blue	Ethernet	
5	Blue / White	Ethernet	
6	Green	Ethernet	
7	Brown / White	Ethernet	
8	Brown	Ethernet	

Table 45 – Slot C Signal Definitions and Assignments.

See section 37.6 “Module Default IP and CAN Address” for details on the ethernet connection.

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Slot D

This slot in the connector is the connection point for the Module Control Unit CAN bus module control interface. The connector accepts a standard D-SUB 9 pin plug, male.

For functional details, please refer to **CMS013 CAN Matrix.**

Pin	Tag	Function	Interface name
2	=X_E01-D:2	CAN LOW	CAN02, Low
7	=X_E01-D:7	CAN HIGH	CAN02, High
3	=X_E01-D:3	CAN GND	CAN02, Ground
SH	=X_E01-D:SH	CAN Shield	CAN02, Shield
<others>	Various	Not Connected	Not Applicable

Table 46 – Slot D Signal Definitions and Assignments.

Slot E

This slot in the connector is the connection point for the module 24VDC supply for the Safety System. Voltages, Power Draw and tolerances are described in CMS006.

This should be connected to the Vessel Emergency Supply.

Pin	Tag	Function	Interface name
1	=X_E01-E:1	+24VDC	24V_SAFE
2	=X_E01-E:2	0VDC	COM_SAFE

Table 47 – Slot E Signal Definitions and Assignments.

Slot F

This slot in the connector is the connection point for the safety system signals. These signals are referenced to the potentials in Slot E.

Please refer to Table 41 – Signal Definitions for Safety System for functional description.

Pin	Tag	Function	Interface name
1	=X_E01-F:1	Digital Out	SAFE_MAIN
2	=X_E01-F:2	Digital Out	SAFE_FIRE
3	=X_E01-F:3	Digital Out	SAFE_H2CONC
4	=X_E01-F:4	Digital Out	SAFE_VENT
5	=X_E01-F:5	Digital Out	SAFE_WD
6	=X_E01-F:6	+24VDC, Max 0,25A	ESTOP_OUT1
7	=X_E01-F:7	+24VDC, Max 0,25A	ESTOP_OUT2
8	=X_E01-F:8	Digital In	ESTOP_IN1
9	=X_E01-F:9	Digital In	ESTOP_IN2
10	=X_E01-F:10	Digital In	SAFE_IN
11	=X_E01-F:11	Digital Out	SAFE_FIREMALF
12	=X_E01-F:12	Digital Out	SAFE_EXTERN

Table 48 – Slot F Signal Definitions and Assignments.

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36. High Voltage Connections

The purpose of this section is to describe the HVDC connectors on the front plate of the module.

The module has 4 connection points from the stack strings, two from each.

36.1. Connector - HVDC

The HVDC connectors are produced by Amphenol Industrial, within the product line Amphe-Power.



Figure 38 – Amphe-Power panel mount connector – Module connectors are red or black.

The four front panel mount connectors are color coded and keyed to prevent connection errors.

TAG	Electrical Connection	MFG	MFG#	Ballard Part #	Color	Keying
X_HV01	String A Positive	Amphenol Industrial	APSPS-1-R-T5	7000819	Red	1
X_HV02	String B Positive	Amphenol Industrial	APSPS-2-R-T5	7000820	Red	2
X_HV03	String A Negative	Amphenol Industrial	APSPS-1-BK-T5	7000821	Black	1
X_HV04	String B Negative	Amphenol Industrial	APSPS-2-BK-T5	7000822	Black	2

Table 49 – HVDC Connector Tags.

Amphe-Power Range – Key Specification	
No of Contacts	1
Maximum Continuous Current Rating	Up to 800A
Surge Current	75kA
Short Circuit Rating	Up to 35.5kA
Cables Cross Sectional Area C.S.A	24mm2 to 300mm2
Contact Termination	Screw or Crimp
Mating Method	Bayonet Lock
Operating Voltage	1000VAC
Max Rated Voltage to Earth	2kV AC/ 3kV DC

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Minimum Flashover	9.5kV DC or AC Peak
Insulation Resistance	>5M ohms @ 500V DC
Ingress Protection	IP67
Protection against Electrical Shock	IP2X
Flammability	UL94-V0
Mating Cycles	>500
Shell Material	High Temperature Thermoplastic
Contact Plating	Silver

Table 50 Amphe-Power key specifications

36.2. Mating Part - HVDC

This section describes the recommended mating Parts to be used with the power connectors.

TAG	Electrical Connection	MFG	MFG#	Ballard Part #	Color	Keying
Customer Scope	String A Positive	Amphenol Industrial	APSLD-1-R-S120-M40S	7000823	Red	1
Customer Scope	String B Positive	Amphenol Industrial	APSLD-2-R-S120-M40S	7000825	Red	2
Customer Scope	String A Negative	Amphenol Industrial	APSLD-1-BK-S120-M40S	7000824	Black	1
Customer Scope	String B Negative	Amphenol Industrial	APSLD-2-BK-S120-M40S	7000826	Black	2

Table 51 – HVDC Connector Mating parts.

Ballard Europe can supply a set of matching connectors suitable for 120mm2 cables. Contact Ballard Europe and request “7500169 Integrator HVDC Connector Kit”.

36.3. Protection of the High Voltage Connector

When the High Voltage Connectors are not mated to a suitable plug, they should be protected against ingress of dust, grime and fluids by an appropriate protective cover.

When mated to a suitable connector or protective cover, the Ingress Protection rating of the connectors is IP67.

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37. Control System – Fault Severities and Reporting

This section details the reporting of severities and fault handling by the module. A sample alarm is listed, but the full list of possible alarms is too long to present here. Integrators are referred to **CMS014 Control System Alarm List**.

The module has 1 level of informational message and 3 levels of warnings and alarms of increasing severity, internal to the control system.
A further level is handled separately by the safety control system and is included for completeness.

37.1. Fault Severities

Table 52 – Module Fault Severities and Descriptions lists the five types of module fault severities.

> Severity 0 through 3 is handled by the control system and does not involve the independent safety system.
> Severity 4 is handled by the safety system and overrides the module control system.

There are several ways the module can notify the Vessel Control System of a fault condition. The module provides a hardwired output (**FCM_OK**) to indicate when it has entered an alarm state. The module also broadcasts its Operating State via CAN, along with the fault codes detailed in the CAN Matrix Customer Specification (**CMS013 CAN Matrix**) document. The list of fault codes, their description and details are available in document **CMS014 Control System Alarm List**.

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Alarm Severities	
Severity	**Description**
0: information	No fault reporting to drive system. May derate **I_ALLOW**, otherwise for information only. Severity 0 events are logged by the modules on-board data acquisition system.
1: Warning	A system parameter has deviated from normal range. The fault category is reported to the drive system over CAN, along with its severity. The hardwired **FCM_OK** output remains unchanged. The module should be inspected and/or process data reviewed. Does not result in a shutdown.
2: Alarm	A system parameter has exceeded acceptable operating range, and the fuel cell module will undergo a **controlled shutdown**. The fault is reported to the drive system over CAN and the hardwired signal **FCM_OK** output will go to **0V.** **I_ALLOW** will be set to 0A. Do not exceed **I_ALLOW**. After a severity 2 fault, **do not** attempt a restart until action has been taken to identify and resolve the cause of the fault. To clear this fault, cycle the hardwired **MD_EN** signal.
3: Severe Alarm	• A system parameter has exceeded a safe operating range, and the fuel cell module will undergo an **immediate shut down**. • The fault is reported to the drive system over CAN and the hardwired signal **FCM_OK** output will go **0V**. • **I_ALLOW** will be set to 0A **immediately**. Cease current draw from the fuel cell module immediately. This severity will cause the high voltage contactors to open under load. • After a severity 3 fault, the fuel cell module must not be restarted until the cause of the fault has been determined and resolved. In addition, the module should be inspected for safe operation and Ballard must be consulted before a restart is performed.
4: Safety System Activation	• The module safety system has tripped and disabled all outputs from the module controller. This causes contactors to open under load and closes all hydrogen valves. The module performs an **immediate uncontrolled shutdown.** • The type of emergency is reported over the safety hardline connections (see section Safety System Supply and Signal Definitions2133586288.429). The hardwired signal **FCM_OK** output will go **0V**. • **I_ALLOW** will be set to 0A **immediately**. Cease current draw from the fuel cell module immediately. This severity will cause the high voltage contactors to open under load. • After a severity 4 fault, the fuel cell module must not be restarted until the cause of the fault has been determined and resolved. In addition, the module should be inspected for safe operation and Ballard must be consulted before any further actions are taken.

Table 52 – Module Fault Severities and Descriptions.

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37.2. Resetting a fault

To reset an alarm from the module, after remedying the fault and verifying that the underlying cause cannot reoccur, the integrator can toggle the **MD_Enable** signal.

The module controller clears alarms on the rising edge of **MD_Enable**, refer to section 2133586288.429 “Fuel Cell Controller Signal Definitions”.

Alternatively, the integrator can attempt to reset faults over the CAN bus. This can be done in the “Unlocked” state by sending the “Alarm Acknowledge” bit in the **VCS_REQUEST** can message.

37.3. CAN Communication

The individual CAN messages to and from the fuel cell module are detailed in the CAN Matrix Customer Specification **CMS013**. Contact Ballard Power Systems for the latest version of the customer-specific CAN matrix. The CAN network operates at a fixed baud rate of 250 kbps and a watchdog is in place to verify CAN activity.

As CAN networks are susceptible to noise, it is strongly recommended to follow best practice and use shielded cables for all CAN wiring. Special care should be taken for the placement of the two terminating resistors on the CAN bus.

Include a 120Ω terminating resistor on the module CAN interface. It is the responsibility of the integrator to add the terminating resistors on the customer interface harness. The module contains one 120 Ω resistor at the MCU CAN bus connection point. After complete assembly, the measured resistance between CAN high and Low should be 60±5 Ω.

Note: The module will shut down (Severity 2) if CAN communication is lost during operation. It is strongly recommended to have a proper wiring, shield each CAN cable and to be EMI proof.

37.4. CAN Customization Key

Ballard will supply each integrator with a unique customization key, which can be found on the CAN Matrix Customer Specification (**CMS013**) document. Send this specific CAN message to allow the module to exit **Locked** state (refer to Figure 27 – High Level State Sequence). It is also used to ensure the correct software is in place for the integrator.

37.5. Controller Heartbeat

The module controller sends a heartbeat over CAN, for the integrator to use as an input for their watchdog. This heartbeat should be synchronized with the drive side watchdog as a method to ensure the module controller is powered up and active. The CAN message **FCM_REQUEST_1** transmits as soon as low voltage power is provided, and the controller is booted-up. As per the CAN matrix (**CMS013**), it is an 8-bit counter that increments every 100 milliseconds and will wrap around after 25.5 seconds (255 heartbeats).

37.6. Module Default IP and CAN Address

Modules are delivered, unless explicitly requested otherwise by customer/Integrator, according to a default IP and CAN address schedule provided in Table 54 – Single Module IP and CAN address. For multiple modules in a deployment, the range of IP, CAN source addresses and CAN destination addresses (called “PDU Specific”) are given in Table 55 – Multiple Module IP and CAN .

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37.7. Single Module and Vessel CAN Address

For deployments of a single module, default IP and CAN addresses are as follows:

Vessel Name	IP Address	CAN bus Source Address
<no fixed name>	<no fixed address>	0x27

Table 53 – Vessel Control System CAN address.

Module Name	IP Address	CAN bus Source Address
“Vesselname 1”	10.10.10.10	0x12

Table 54 – Single Module IP and CAN address.

37.8. Multiple modules

There is a practical limit to how many modules can co-exist on a single CAN bus. This limit is currently unconfirmed but is expected to be around 8 modules without exceeding CAN bus traffic recommendations. This pre supposes no other traffic on the CAN bus.

For deployments of multiple modules, the default IP and CAN addresses are as Table 55. The vessel control system CAN source address is unchanged.

Module Name	MCU IP Address	MCU CAN bus Source Address	VCS CAN bus PDU Specific Offset
“Vesselname 1”	10.10.10.10	0x12	0x00
“Vesselname 2”	10.10.10.11	0x13	0x01
“Vesselname 3”	10.10.10.12	0x14	0x02
“Vesselname 4”	10.10.10.13	0x15	0x03
“Vesselname 5”	10.10.10.14	0x16	0x04
“Vesselname 6”	10.10.10.15	0x17	0x05
“Vesselname 7”	10.10.10.16	0x18	0x06
“Vesselname 8”	10.10.10.17	0x19	0x07
<etc>	<etc>	<etc>	<etc>

Table 55 – Multiple Module IP and CAN addresses.

The FCwave™ CAN matrix is designed with inspiration from SAE standard J1939, thus the FCwave™ CAN Matrix specifies a PDU Specific for all CAN messages from Vessel to Module controller. The CAN bus PDU Specific Offset must be added to the value specified in that document, in effect modifying the message ID of the relevant CAN messages.

Example

Table 56 below shows how the IP and CAN addresses should be set up for a vessel named “Ballard” with four FCwave™ modules installed.

Module Name	MCU IP Address	VCS_REQUEST Msg ID	VCS_STATUS Msg ID	VCS_REQUEST_FAST Msg ID	MCU CAN Source Address
“Ballard 1”	10.10.10.10	0x10FF0027	0x18FF0027	0x00FFA027	0x12
“Ballard 2”	10.10.10.11	0x10FF0127	0x18FF0127	0x00FFA127	0x13
“Ballard 3”	10.10.10.12	0x10FF0227	0x18FF0227	0x00FFA227	0x14

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"Ballard 4"	10.10.10.13	0x10FF0327	0x18FF0327	0x00FFA327	0x15

Table 56 - IP and CAN address example for deployment of four FCwave™ modules.

37.9. EMC / EMI

The system integrator is responsible for ensuring EMC/EMI conformity to regulatory standards for the integration with DCDC equipment and vessel communication system.

Steps can be taken when routing the high voltage output cables in order to minimize emissions from a switching load during operation. The positive and negative conductor going to each individual load should be bundled closely and routed together. If possible, the conductors should be shielded as well.

37.10. Hydrogen Alarm Lockout

The module is equipped with two hydrogen sensors to monitor the hydrogen concentration in the hydrogen enclosure outlet ventilation.
The sensor associated with the control alarms are discussed below.

Alarm: A2_ AZT_J50_H

In an event where the ventilation air hydrogen sensor trips, a severity 2 alarm ***A2_AZT_J50_H*** will shut the module down and **FCM_OK** signal will be set to 0V. This alarm will trigger an additional alarm called ***A2_ AZT_J50_HLOCK*** (high lock) which will lock the module and prevent further attempts of restarting until the Hydrogen level is below the acceptable limit. Once the H2 is no longer in alarm, ***A2_ AZT_J50_H*** may be cleared by cycling ***MD_Enable*** but ***A2_ AZT_J50_HLOCK*** will remain latched.

A2_ AZT_J50_HLOCK

To *clear* ***AZT_J50_HLOCK, AZT_J50_HLOCK_RESET*** must be enabled from the Service Interface or over customer CAN link. Only trained personnel should perform the reset function after it is deemed safe to do so.

Note: if an attempt is made to set the *RESET* flag without a hydrogen lockout present, another severity 2 alarm ***A2_ AZT_J50_RESETERR*** will be set to ensure the system is not forced to run in an unsafe condition. To reset the reset error the reset flag needs to be cleared followed by cycling ***MD_Enable***. For details, please refer to the CAN Matrix Customer Specification (CMS013) document.

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38. Safety System – Functional description

The Safety Controllers purpose in the module is to ensure that all foreseable dangerous situations are detected, signaled to the vessel, and that the module is brought to a safe state.

The safety controller takes input from the following safety subsystems:

- Hydrogen detection
- Ventilation monitoring
- Fire detection
- External emergency notification
- Controller Watchdog

38.1. Warning and Alarm notification

It is the responsibility of the integrator to display an audible and a visual alarm if the emergency system notifies the vessel control system. The module does not include audible or visual indicators for the alarms.

38.2. Hydrogen detection

The safety controller takes input from a hydrogen volumetric concentration sensor, which gives an alarm at 40% LFL. Activation of this alarm leads to immediate shutdown of the module and signals to the vessel that an H_2 alarm has been tripped, this signaling is done over the SAFE_H2 hardwire connection, see 2133586288.429 “Safety System Supply and Signal Definitions”.

Failure of the sensor is treated as a high-level detection.

Detection of H_2 above 40% LFL or failure of the sensor causes a Severity 4 Safety System Activation.

38.3. Ventilation monitoring

The safety controller takes input from the devices and sensors ensuring the flow of ventilation air though the H_2 enclosure. If any of these fails, the safety system triggers an immediate shutdown and signals the vessel that a ventilation failure has occurred.

The ventilation subsystem monitors the following parameters:

- Ventilation intake airflow speed.
- H2 enclosure differential pressure monitoring.
- Fan and secondary fan rotational speed (Tacho).

Failure of any sensor is treated as a failure of the ventilation monitoring and causes a Severity 4 Safety System Activation.

Restriction of the ventilation airflow

If the air flow through the module ventilation is restricted, due to accident or buildup of debris, the airflow flow switch will trip. Ensure that the ventilation intake and outlet are routed correctly, and no debris may collect in the ventilation intake.

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38.4. Fire detection

The safety system has fire detection via a linear heat detection cable. This cable passes over the electric motors, motor controllers, high voltage panel and fuel cell stacks, where heat from a fire would be detected if present.

In case of a fire, the heat will melt the insulation on the internal conductors in the fire wire cable and cause a change in ohmic resistance of the fire wire. The monitoring system detects this change and triggers a Severity 4 Alarm (Safety System Activation). The signal will be sent to vessel firefighting system.

The system also contains a smoke detector, which will trigger the Safety System activation if it detects smoke inside the module.

The monitoring system can discriminate between a fire detection and the cable failing open circuit. The open circuit triggers a shutdown and lockout of the controller, until certified personnel can perform trouble shooting and maintenance. No signal will be sent to vessel firefighting system.

38.5. External emergency

The safety controller has two external inputs to the module.

- Vessel Safety Status
- Emergency Pushbutton (two-wire)

The vessel safety status is an input from the vessel control system to the module, where the vessel signals to the module that the vessel is in a safe state. If an emergency, external to the module, occurs (from the Vessel control system, such as flooding, fire in other compartments, hydrogen detection, etc.), this input allows the vessel control system to trigger an emergency shutdown of the module.

The emergency pushbutton input is connected to a two-wire emergency “mushroom-style” pushbutton, placed in the fuel cell room **Note: Integrator scope**. This allows personnel in the fuel cell room to trigger an emergency shutdown.

38.6. Reset of the Safety Controller

A reset of the Safety Controller requires a full power cycle of the 24V power supply to the module.

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39. Datalogging function

The MCU stores operational date from the module. This information is then transmitted to Ballard over a secure connection via the vessel internet connection when the connection is enabled by bridge control.

This data allows Ballard personnel to troubleshoot and diagnose issues with the module and is essential to rapid response and resolving issues.

Before requesting assistance from Ballard, allow remote data unit to upload data to Ballard.

39.1. Remote connection details

Network Communication Specification	
Parameter	**Value**
Network Access	Ethernet/IP 100/1000 Mbit/s
WAN	Dynamic, private, internet routable IP address.
Availability	When possible, required at least once each 24-hr. period.
Internet Connection Throughput	>256 Kbps upload.
Data Logging Rate	10 MB/Hr/Module
Internet connection details	Provided during commissioning of module. Dedicated IP address and gateway needs to be aligned with integrator

Table 23 - Datalogging Connection Requirements.

39.2. Location of Stored Data

Data is stored on the module control unit (MCU) locally before being transmitted securely to Ballard.

39.3. Maintenance access

During commissioning and service, Ballard service personnel will require a wired ethernet connection which is routable to the module ethernet interface.

Service access is also possible via a service interface on the low voltage panel.

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40. High Voltage Electrical

This section describes the High Voltage interface between the FCwave™ and the DC/DC converters on the integrator's side. It also covers electrical safety both for the service personnel and the module.

40.1. High Voltage Interface

Operate the fuel cell module as a "floating electrical system" by ensuring that neither the fuel cell high voltage positive terminal nor the fuel cell high voltage negative terminal is connected to the application ground, earth or chassis.

The peak total current output at the fuel cell module high voltage connections is not to exceed 300 amps, but higher currents are possible if the limit is exceeded by the vessel system. Note that the module is **unfused**. Load cables must be sized properly for the maximum load that the vessel is expected to draw.

WARNING **To ensure a floating DC system is de-energized prior to servicing the fuel cell module, it is critical to measure zero volts between the fuel cell high voltage positive and high voltage negative terminals, between the fuel cell high voltage positive terminal and chassis, and between the fuel cell high voltage negative terminal and chassis. Measurements need to be made on both AC volts and DC volts scales.**

The system integrator is responsible for providing a means to lockout all necessary energy sources on the system prior to any service activity being performed. Furthermore, the integrator must provide a written procedure to Ballard personnel, detailing the equipment and steps required to sufficiently lock out all energy sources, such as a high voltage or high-power electrical sources.

40.2. Voltage Measurement

The fuel cell module has on-board measurements of the fuel cell stack DC voltages. While these measurements are sent by the module over CAN, it is strongly recommended that integrators do not only rely on the internal module voltage measurement.

40.3. High Voltage Disconnection

The module is disconnected from the Vessel by decoupling the HV DC connectors on the interface panel. See item #2 on Figure 15 – Detail View of module process connections.

40.4. Bonding

A stud is provided on the module for bonding. The bonding point is located left of the Control and Communication Connector (item #1 in Figure 15). The integrator must ensure that the bonding points are bonded to the vessel chassis or earth ground by a cable rated for the full current output of the fuel cell module, see (CMS006). The required maximum resistance between the fuel cell module bonding stud and chassis or earth ground is shown in Table 57.

Specification	
Maximum Resistance to Chassis	0.005Ω

Table 57 – Bonding Resistance Specification

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40.5. Ground Fault Monitor

The system integrator must ensure that a suitable ground fault monitoring system is installed and is functional. For a DC dual-output floating electrical system, the ground fault monitoring system must monitor all High-voltage DC outputs. Refer to section 8.6 for safety related issues to ground faults.

40.6. Electrical Isolation

Following the directives in DS/EN 60204-1-2018, two isolating devices are required.

1. For each **incoming** supply to a machine
2. For each **onboard** power supply

The isolation of the **incoming** supply is the customer's responsibility.

For the **onboard** power supply, the precautions taken are:

- The Ampherol plugs have retaining means to prevent accidental disconnection.
- There is a clear warning notice stating "Do not disconnect under load".

Use the isolation resistance in Table 58 as a reference. The isolation resistance of the FCwave will depend on the filter used. The filter each module have will depend on whether the module was produced before or after the 2nd of August of 2024.

Typical Resistance (HV) to Chassis:	
Modules from before 02/07/2024	240kΩ
Modules from after 02/07/2024	400kΩ

Table 58 – Module Electrical Isolation.

40.7. High Voltage Power During Maintenance

During service by Ballard certified personnel, the module may request HV power to perform diagnostic tasks.

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41. Multiple Module Installation

The purpose of this section is to describe the requirements and additional action points needed for an installation of multiple FCwave™ modules in a single installation onboard a vessel or installation room.

The compartment in which the fuel cell modules are to be installed is termed the “Fuel Cell Installation Room”, and requirements are presented below in the following sections.

41.1. Structural Requirements for the Installation

Follow instructions from section 11 Fuel Cell Installation Room Requirements.

41.2. Hydrogen connection

The hydrogen supply connection to the module must fulfill the following requirements:

5. A hydrogen supply shutoff valve with a reaction time less than 2 seconds is required to be installed for each module.
6. The hydrogen flow must be restricted by suitable means such that hydrogen mass flowrate shall not exceed 4.9 g/s.
7. The amount of hydrogen in the fuel cell module must be minimized when not in operation. The physical volume of the pipe between hydrogen shutoff valve and module interface plate is not to exceed 5 liters.
8. It is a requirement that the pipe between the hydrogen shutoff valve and module interface plate is double-walled, with detection measures for the annular space.

41.3. Process exhaust connection

This section describes the options for process exhaust connections from multiple FCwave™ modules in a Fuel Cell Installation Room:

Permitted options are:

1. Individual process exhausts from each module led to the outside without combining them
   1.1. The process exhaust should not exceed the backpressure specifications in Table 14
2. Combined process exhaust from multiple modules led to the outside
   2.1. This requires a separate isolation damper for each module, which will close when modules are not operating to prevent backflow from running modules to non-running modules.
   2.2. The combined process exhaust should not exceed the backpressure specifications in Table 14 in any operational scenario
   2.3. The design of the combined process exhaust should in all operational cases prevent backflow from modules running at differing output levels (e.g. full power and partial power)

Option 1 and 2 are illustrated in Figure 39.

In all cases, the following apply:

- Process exhaust must be let to the outside.
- FCwave™ process exhaust is fully water saturated and with negligible hydrogen content.

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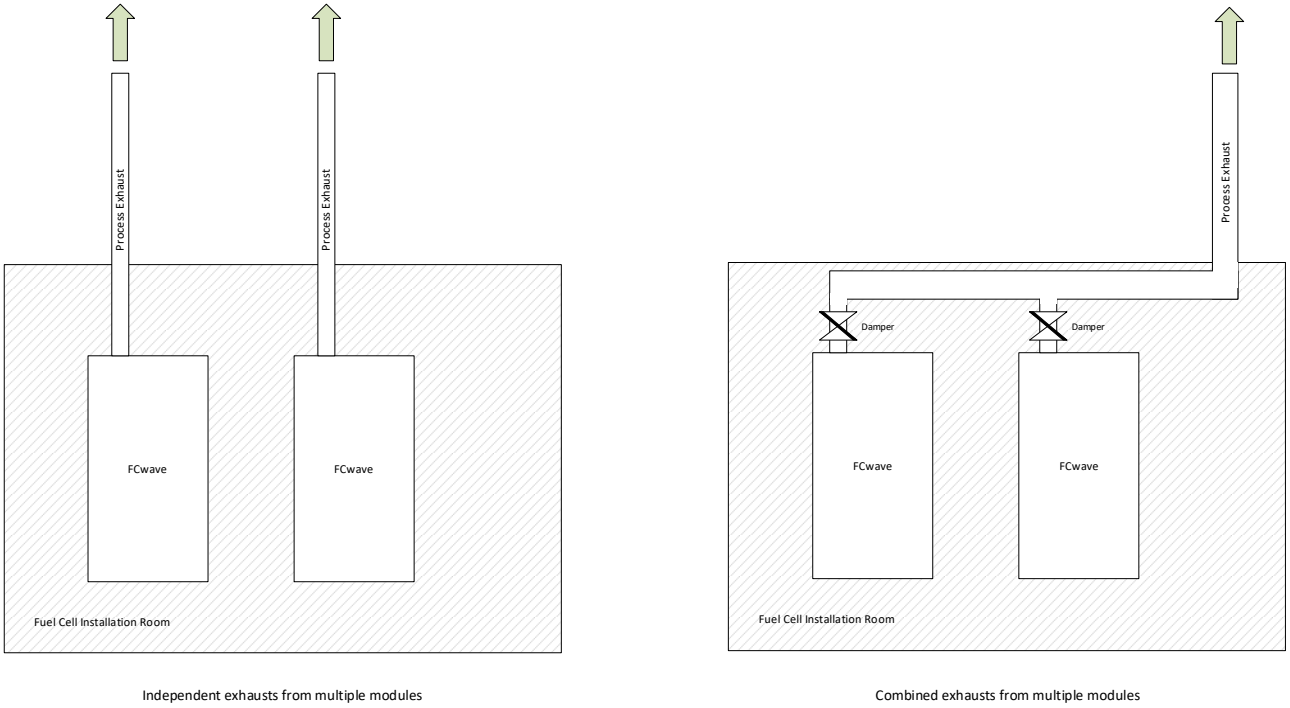


Figure 39 – Options for process exhaust of multiple FCwave™ modules.

41.4. Module Ventilation exhaust connection

If ventilation exhausts are combined from multiple systems, they must be equipped with separate isolation dampers, which must close if the module are not operating.

H2 Enclosure ventilation must be let to the outside.

The integration to the vessel shall ensure the exhaust from FC modules (ventilation air) is led to a safe location free of any spark or ignition source.

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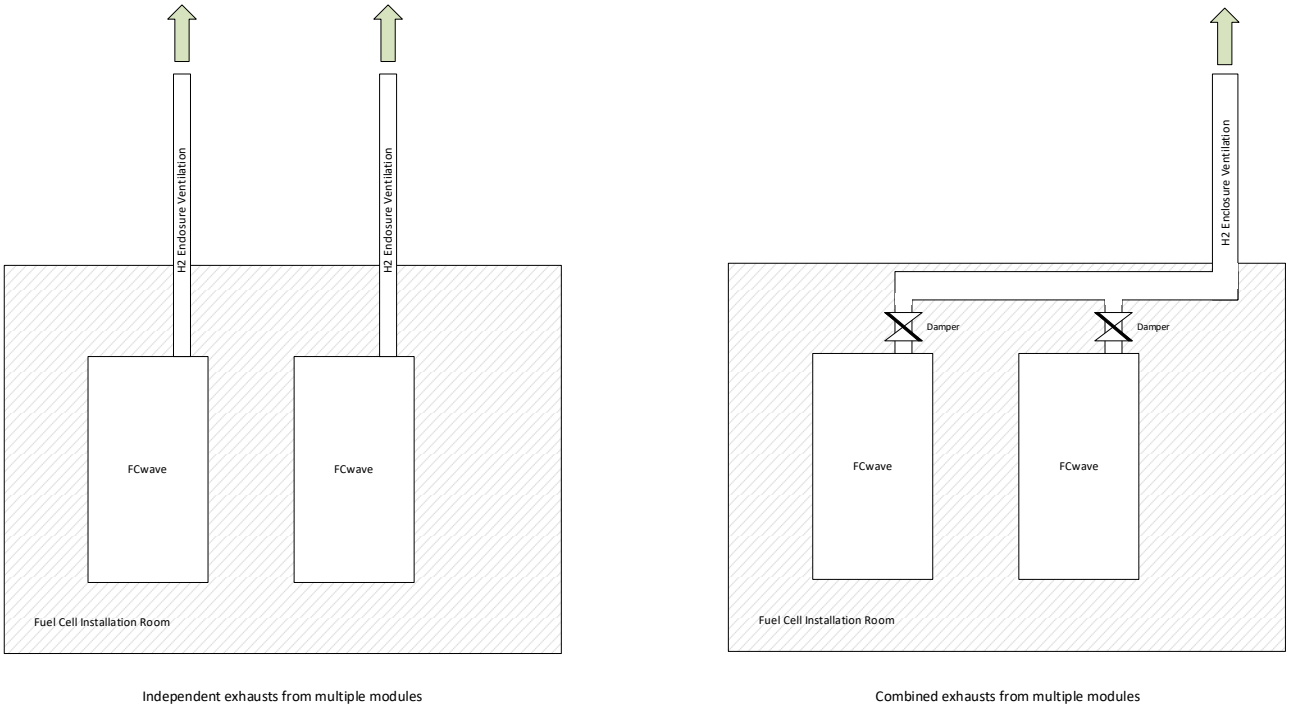


Figure 40 – Options for ventilation exhaust of multiple FCwave™ modules.

41.5. Installation Room ventilation

The air handling system in the fuel cell installation room must be sufficient to supply the FCwave™ process air. Addition ventilation of the fuel cell installation room to be determined by Classification Society or Vessel Integrator.

Ballard recommends performing a calculation according to IEC 60079-10 to establish the required ventilation rate for the fuel cell installation room. In normal operation, all probable leakage scenarios internal to the FCwave™ are managed inside the module.

41.6. Drain connections

The process water drain connection from multiple modules may be combined. It is required that integrator implements backflow prevention from module to module or from external source to module(s). The maximum allowed pressure is 25mbar.

41.7. Coolant connections

The coolant circuits from multiple modules may be combined. The integrator should consider the following:

- Each module must be provided sufficient coolant during operation.
- If individual models are in different states of operation (running / not-running), consider shutting off the cooling flow to the not-running modules.

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41.8. Safety system

The vessel control and safety system must include visual and audible signaling to crew in appropriate locations.

Recommendation is to clearly indicate which FC module is in operation inside the fuel cell room.

The FCwave™ does not provide an emergency stop button. It is the responsibility of the integrator to install adequate and accessible safety stop buttons or similar, as well as ensure the integration of FCwave™ in the emergency stop circuit.

41.9. Fuel Cell Installation Room Access

Access to the fuel cell installation room during operation shall be limited to trained service technicians and crew that have received Ballard fuel cell training

Unrestricted access to the fuel cell installation room can be permitted by the vessel authorities when all fuel cell modules are powered off and otherwise deemed permissible.

42. Maintenance

The fuel cell module requires periodic maintenance for safe operation throughout the service lifetime of the module. Contact Ballard Customer Care for training.

It is the responsibility of the customer to carry out the maintenance tasks according to the maintenance schedule. Additionally, the customer must keep maintenance records listing each task, along with dates, fuel cell module serial number, operating hours, replaced parts, and any measurement values. The records must be provided to Ballard upon request.

43. Module Shipping and Storage

The FCwave™ module is designed to be installed in a dedicated fuel cell room fulfilling the relevant fire protection and ventilation requirements as per SOLAS and Classification Society. Generally, all the electrical components are stored in a dry room. Always place the equipment indoors for safety reasons.

Minimum requirements of warehouse/dry room storage:

Temperature between -40 °C to +60 °C
0-95% relative humidity
No condensing
Corrosion-proof atmosphere
No dripping water

For sub-zero storage after integration, consult Ballard and ensure proper precautions have been taken. Refer to Table 59 for a specified and exhaustive list.

Modules operated with deionized water are required to be flushed, according to Table 59.

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CAUTION **Ensure the low temperature coolant loop (detailed in section 19) is supplied with the appropriate coolant temperature range for the intended storage temperature.**

System	Coolant	Indoor storage conditions	Need to do this preparation
HT Loop	50/50 DI water-Ethylene Glycol	-40° to 60°C	Drain and flush with 50/50 Ethylene Glycol /DI water
LT Loop	50/50 Water-Glycol	-40° to 60°C	Drain and flush with 50/50 Glycol/water

Table 59 – Module Storage Preparations.

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44. Appendix

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Process Exhaust Hydrogen Content

Full Title: Process Exhaust Hydrogen Concentration

Abstract: The process exhaust hydrogen concentration is analyzed. The result is that in all situations the ventilation/airflow, release rate, and release type lead to a non-hazardous zone according to IEC 60079-10-1.

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1.0 Background

This document is intended to provide information on the potential hydrogen concentrations that can be present in the FCwave process exhaust and the resulting zone at the exhaust point. It is not covering the Hydrogen Enclosure Ventilation.

2.0 FCwave Operation

The FCwave is designed based on a dilution principle where air is used to dilute any hydrogen present down to a safe level. The gas present in the process exhaust is a mix of oxygen depleted air (product from the electrochemical reaction), air (from stack bypassing), and hydrogen (from purging).

The target is to dilute the hydrogen content to below 25% of LFL (1%v of H2). The safety systems in the FCwave, collectively provide assurance, that if an error occurs, safety features are in place to shut down hydrogen supply and maintain a high dilution.

2.1 Steady State Operation

During steady state operation of the FCwave the source of hydrogen is from purging. This purging happens following an internal algorithm adjusting the purge cycle based on current drawn from the fuel cell stack. At minimum load the air flow required for the electrochemical reaction is not enough to ensure high dilution. Therefore, an air bypass valve is incorporated to allow for increased air flow in these situations, resulting in high dilutions.

With this dilution principle the measured hydrogen concentration of the exhaust is as listed in Table 2-1.

Table 2-1: *Hydrogen Concentration in Exhaust*	
55 kW	<1%v H2 (dry volume)
200 kW	<1%v H2 (dry volume)
Startup	<1%v H2 (dry volume)

The ventilation/airflow, release rate, and release type lead to a non-hazardous zone according to IEC 60079-10-1[1].

During ramping the concentration is not different from steady state operation.

2.2 Startup

During startup it is ensured that air flow is initiated, and sufficient ventilation is present before any hydrogen is entering the system. This ensures that ventilation is always available, and the needed dilution is achieved.

The purge cycle in startup is adjusted to remove water and nitrogen from the anode side of the stack.

With this dilution principle the calculated hydrogen concentration of the exhaust is as listed in Table 2-1.

The ventilation/airflow, release rate, and release type lead to a non-hazardous zone according to IEC 60079-10-1.

[1] Based on IEC 60079-10-1, Table D.1, Figure F.3, and Figure F.4.

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2.3 Shutdown

During shutdown purging is stopped before air flow. Any residual hydrogen will be consumed by the electrochemical reaction. Thus, there are no sources of release and hence a non-hazardous zone.

2.4 Abnormal operation

During abnormal operation any release will be stopped immediately and there will be no persistent hydrogen present. The air flow is maintained to secure high dilution.

The ventilation/airflow, release rate, and release type lead to a non-hazardous zone according to IEC 60079-10-1.

3.0 Definitions and Acronyms

Table 3-1: Definitions and Acronyms	
LFL	Lower Flammability Level

4.0 Reference documents

Table 4-1: Reference documents	
IEC 60079-10-1	Explosive Atmospheres – Part 10-1: Classification of Areas – Explosive Gas Atmospheres
MAN002	FCwave Integration Manual

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Fuel Cell Module Service Manual, FCwave™ 200kW



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1.0 Disclaimer

NOTE: READ THIS BEFORE ATTEMPTING ANY PROCEDURES DESCRIBED IN THIS MANUAL

There are inherent risks in the operation of a fuel cell module that can result in death or bodily injury or loss or damage to property. It is therefore necessary for the customer to take all prudent safety precautions in the installation, use, and maintenance of this device. Persons who install, operate, and service the device are required to be technically qualified and experienced in working with electrical equipment, compressed gases, and H_2.

This manual includes certain safety guidelines and recommendations; however, this manual is not intended to cover all situations. The customer is responsible for determining the suitability of the customer's particular design or application, and for ensuring the safe operation, maintenance, and storage of the device and any systems into which it is integrated. Ballard Power Systems Europe A/S ("BPSE") cannot be responsible for the use of the device in ways, or as part of systems, that deviate from the operating recommendations in the manual. The customer is responsible for being aware of, and complying with, all applicable laws and regulations. BPSE has limited its liability for damages incurred by the customer or its personnel in the contract documents pursuant to which the device is provided to the customer. Please refer to those documents for additional information.

Procedures described in any part of the manual can only be attempted once the customer has read this entire manual. Failure to follow any instruction or recommendation could result in death or bodily injury or loss or damage to property.

BPSE intends for the device to be installed, operated, and serviced only by approved technically qualified and experienced people who understand the principles of fuel cell technology, are aware of the safe operating limits of fuel cells, and are familiar with the risks posed by operating a fuel cell module. BPSE relies on customers to use their own knowledge and experience when installing, operating, and servicing the device. BPSE also relies on the people using this manual to be familiar with common terms and abbreviations used in the manual.

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2.0 Abbreviations

Table 2-1: List of abbreviations

Acronym	Definition	Acronym	Definition
AC	Alternating Current	**HV**	High Voltage
BOL	Beginning of Life	**HVAC**	Heating, Ventilation and Air Conditioning
BOP	Balance of Plant	**HVP**	High Voltage Panel
BPSE	Ballard Power Systems Europe	**I/O**	Input / Output
CAN	Controller Area Network	**IMO**	International Maritime Organization
CNV	Converter	**IP**	Internet Protocol
CUS	Customer	**LED**	Light Emitting Diode
CE	Conformité Européene (European Conformity)	**LEL**	Lower Explosive Limit (18% vol mix with atmospheric air)
DC	Direct Current	**LFL**	Lower Flammability Limit (4% vol mix with atmospheric air)
DI	Deionized	**LT**	Low Temperature
EOL	End of Life	**LV**	Low Voltage
ESD	Electrostatic Discharge	**LVP**	Low Voltage Panel
FC	Fuel Cell	**MCU**	Module Control Unit
FCM	Fuel Cell Module	**PEM**	Proton Exchange Membrane (Fuel Cell Technology)
FCwave®	Product name Fuel Cell module	**RDU**	Remote Data Unit
FRU	Field Replacement Unit	**TBC/TBD**	To Be Controlled/Determined
-XD	Hydrogen Power Management	**UPS**	Uninterruptable Power Supply
H2	Hydrogen (Gaseous)	**VAC**	Volts Alternating Current
H2E	Hydrogen Enclosure	**VCS**	Vessel Control System
HT	High Temperature	**WEG**	Water Ethylene Glycol

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3.0 Symbols

Table 3-1: List of Symbols

Term	Description		Term	Description
°	degree		**kg**	kilograms
µS	microsiemens		**kW**	kilowatt
Ω	ohm		**kΩ**	kiloohm
%	percent		**lbs**	pound
A	ampere		**MHz**	megahertz
bard	bar differential		**mm**	millimeter
Bar(g)	bar gauge pressure		**mVpp**	milli volts peak to peak
bin	binary (true or false)		**PCV**	pressure control valve
°C	Celsius		**PN**	part number
cm	centimeter		**rpm**	revolutions per minute
dBA	decibel		**s**	second
°F	Fahrenheit		**SEV**	severity (of a fault)
g	gram		**TETRA**	TErrestrial Trunked RAdio
H2	Hydrogen (Gaseous)		**v**	Volt
IP Rating	Ingress Protection Rating		**Vdc**	volts direct current

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4.0 General information

4.1 Introduction

The FCwave™ 200kW Marine Fuel Cell Module documentation package provides a general system description, operation, installation, maintenance requirements, and safety information with the specific needs of user in mind.

This Service Manual describes the requirements and information necessary for the operation and maintenance of the FCwave™ 200kW Marine Fuel Cell Module. Proper installation and integration is described in the Integration Manual.

This manual is applicable to systems with the following name plates:

FCwave™ 200kW Marine Fuel Cell Module.

For any other additional technical information, which is not specified in this manual, please contact BPSE.

Please refer to http://ballard.com/support/global-support for updated support contact information, call +45 88435500 or contact technicalcare@ballardeurope.com.

Download Service Documentation

Customers can log on to BPSE After Sales Service Portal to download the latest product-related documents:

Go to http://www.ballard.com/, click on "Support/Global Product Support" option at the top of webpage, then go to BPSE After Sales Portal by clicking on "customer portal here."

OR

Use the direct link: https://www.ballard.com/support/customer-portal-(beta)

At the Login screen, use your Username and Password[1] to enter the portal, where you can download the latest product documentation.

Remember to read and acknowledge the terms of use in the Customer Care Portal by ensuring the box is ticked off beside the declaration:

"I have read and accept the terms and conditions as outlined by Ballard Power Systems."

[1] If you do not have a Username and Password, click on the "register here" link to get an account.

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4.2 Product information

The FCwave™ 200kW Marine Fuel Cell Module operating on hydrogen fuel is an efficient, environment-friendly, zero-emission, direct-current (DC) Power source used for mobility applications in the marine industries. The only emissions from a fuel cell are water vapor and heat. The principle is well-described, proven performance and thoroughly tested with type approvals. The system is modular in design and scalable to meet variable power requirements.

Benefits of fuel cell technology (FCwave™ module) in the marine industries are:

Longer range	–	H2 has a much higher energy density than batteries.
Fast, flexible refueling	–	onboard storage tanks which allow convenient refueling at dock.
Modular design	–	deployed in parallel and dispatchable with vessel space constraints.
Reliable power	–	proven performance, less maintenance and costs, longer service life.

Multiple 200kW modules, electrically configured in parallel to provide efficient power, for any other ranges and design requirements contact Ballard.

4.3 FCwave Marine Fuel cell Module Overview

Power	:	55 – 200 kW
Operating voltage	:	350 – 720 VDC
Input voltage	:	24 VDC
Current	:	(2x) 50 – 300 A, for dual output configuration (1x) 100 - 550 A, for single output configuration
Cooling Output Temperature	:	65°C
Humidity	:	5 – 95 %RH

The major components and features of the module systems are listed below:

- Liquid cooled PEM (Proton Exchange Membrane) fuel cell stacks.
- Built-in control system, control power supplies and control power distribution.
- Independent Safety Controller with separate power supply and safety instrumentation.
- Sensors for voltage, current, pressure and temperature measurements.
- Safety devices, including ventilation fans, fuel pressure relief device, fire detection and hydrogen sensors.
- High voltage contactors for electrically isolating the fuel cell stack from the high voltage output terminals.
- High voltage system pre-charging and reverse current protection during start-up.

4.3.1 Hydrogen Fuel sub-system (Anode)

- Complete hydrogen subsystem, which delivers and conditions the fuel supply to fuel cell stacks.
- Integrated valve block with hydrogen shutoff, pressure regulation and safety pressure relief device.
- Hydrogen recirculation with purge.

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4.3.2 Process Air sub-system (Cathode)

- Built in air compressors, motors, and inverter assemblies for supplying process air to the fuel cell module.
- Air mass flow sensor for air flow rate measurement and control.
- Intercooler and humidifier for conditioning the incoming air stream.

4.3.3 Coolant sub-system

- Internal high-temperature coolant loop, with coolant pump, motor, and controller assembly for supplying coolant to the fuel cell stacks.
- Liquid to liquid stainless-steel heat exchanger between internal high-temperature coolant loop and customer coolant loop, able to handle a wide range of coolant media (fresh water, water-glycol mix).
- Electronically actuated control valves used for stack coolant inlet temperature control.
- Separate low-temperature coolant loop to cool motors and motor controllers.

4.4 Reference Documents

The documents below are available in the online customer portal. In case you would like to request one of the documents below, please feel free to contact the Customer Care department of Ballard Power Systems Europe.

Document	Title
MAN002 2.2.0	200kW Marine Fuel Cell Integration Manual
FRM5104414	Leak Test Report Form, FCwave™ 200kW
SER5104300	FRU List
MAN5100654	Portable leak test box instruction (25-5000 sccm)
CMS006	FCwave Fuel Cell Module Datasheet

Table 4-1: List of Reference Documents

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5.0 Technical datasheet

Too see the latest revision of the electrical datasheet, go to the Customer Portal, or contact Ballard Power System Europe (see section 4.1).

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6.0 Safety, hazards, warnings, and provisos

It is the responsibility of the operator to read and understand this service manual and other information provided, and to use the correct operating procedures.

The product should only be operated by qualified (trained) personnel. Failure to do so can result in personal injury or equipment damage.

Read the entire manual before the initial start-up of the product. It is important to know the correct operating procedures for the product and all safety precautions to prevent the possibility of property damage and/or personal injury.

This section contains general safety-related information. It describes the potential hazards and associated warnings for the system and the precautions that must be taken to minimize these hazards.



Figure 6-1: General safety precautions

6.1 Hazard symbols



WARNING in this manual indicates actions that may result in an accident, which could cause immediate bodily injury or loss of life or could cause damage to equipment or other property.



CAUTION in this manual indicates actions that may result in an accident, which could cause damage to equipment or other property, and which could cause bodily injury if not promptly detected and remedied.



ELECTRICAL HAZARD Obey ALL warnings, cautions, and safety instruction related to electricity. Failure to do so may result in electrical shock leading to personal injury or death.

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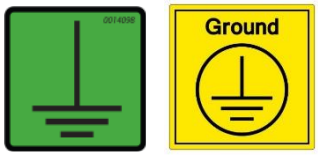
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6.2 Safety labels

The following standard ISO labels are used in the FCwave™ System:



The Hazardous Voltage symbol indicates that hazardous voltages exist inside the equipment.



The Earth Ground symbol (green is an older version which might occur) indicates the grounding point on the system where an Earth ground connection is required for proper system grounding.



The Auto Start symbol indicates that there are components that may start on without warning. Proper Shutdown and then disconnection of the system will prevent equipment from starting while work is being performed.

6.3 General safety

WARNING

The module is to be installed in a dedicated fuel cell installation room.

The system integrator is responsible for providing means to lockout energy sources on the system prior to any service activity being performed, and a written procedure to Ballard personnel detailing the equipment and steps required to sufficiently lockout all necessary energy sources.

- Keep cabinet doors and electrical enclosures closed when the system is operating.
- Only personnel who are technically qualified and experienced in handling electrical equipment and compressed/flammable gases are permitted to service the fuel cell module and its auxiliary system.
- Remove jewelry, watches, rings, and metal objects on clothing that can potentially cause short circuits when working on the fuel cell system.

6.4 High temperature and high-pressure safety

WARNING

Integrator shall ensure that cathode exhaust piping is leak tight and touch proof.

- Coolant interfaces and the process exhaust can reach up to 80°C during normal operation.
- Components within the fuel cell module can reach temperatures up to 120°C during normal operation.

The module uses pressurized gases which can be hazardous.

- Use caution and ensure circuits are de-pressurized before opening any lines or fittings.
- Some sub-systems may remain pressurized even when the fuel cell module is powered off.

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6.5 High voltage safety



Ballard recommends that the electrical integration of the fuel cell module must be designed under strict supervision of a qualified professional electrical engineer.

It is the integrator's responsibility to design the fuel cell system such that it complies with all applicable codes and standards.

After shutdown, high voltages may remain on the fuel cell stacks for a period of time. No maintenance activities are to be performed during this time as the stacks present a shock hazard. Also, residual reactants (oxygen and hydrogen) within the fuel cell module can cause the fuel cell output voltage to rise unexpectedly.

Allow the fuel cell voltage to drop to below 30 VDC prior to servicing the fuel cell module. Certain circumstances can lead to voltage persisting on the fuel cell stack indefinitely.

- Always check for residual voltage before any service activity.

Operate the fuel cell module high voltage as a "floating electrical system". Ensure that neither the fuel cell high voltage positive terminal nor the fuel cell high voltage negative terminal is connected to the application ground, earth, or chassis.

To ensure a floating DC system is de-energized prior to servicing the fuel cell module and its auxiliary systems, it is critical to measure near zero volts between

- the fuel cell high voltage positive and high voltage negative terminals
- between the fuel cell high voltage positive terminal and chassis
- between the fuel cell high voltage negative terminal and chassis

Measurements are to be made on both AC volts and DC volts scales.

Monitor the isolation resistance of the overall high voltage system with a device capable of detecting both single and double pole isolation failures.

The system integrator is responsible for ensuring that a suitable ground fault monitoring system is installed and functioning during operation. If the level of electrical isolation is ever deemed unsafe according to regulatory standards, the system integrator is required to completely shut down the fuel cell module.

Select fuel cell module power output cables that appropriately suit the application.

Ensure that cable specifications meet voltage, current, environmental temperature limits, chemical and mechanical resistance, and flexure requirements of the application.

Avoid hazardous and unsafe situations that could result from conditions such as, but not limited to, the following:

- Improper grounding
- Handling electrical leads or devices with wet hands or on wet ground
- Frayed electrical leads
- Incorrect or improper connection of the terminal leads
- Short circuits
- Back-feed from energized normal and emergency power sources

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6.5.1 High Voltage safety check before module maintenance

Before servicing the module, Ballard strongly recommends that a high voltage safety check is performed by a trained technician.

Tools needed for procedure	10mm socket screwdriver, door key, 4mm hex key, multimeter

Table 6-1: Tools needed for High Voltage safety check

1. The first step is to request system into 'Prepare for service'. Ensure module reaches 'Prepare complete' (refer to section 7.2.7 for more details) as shown below.

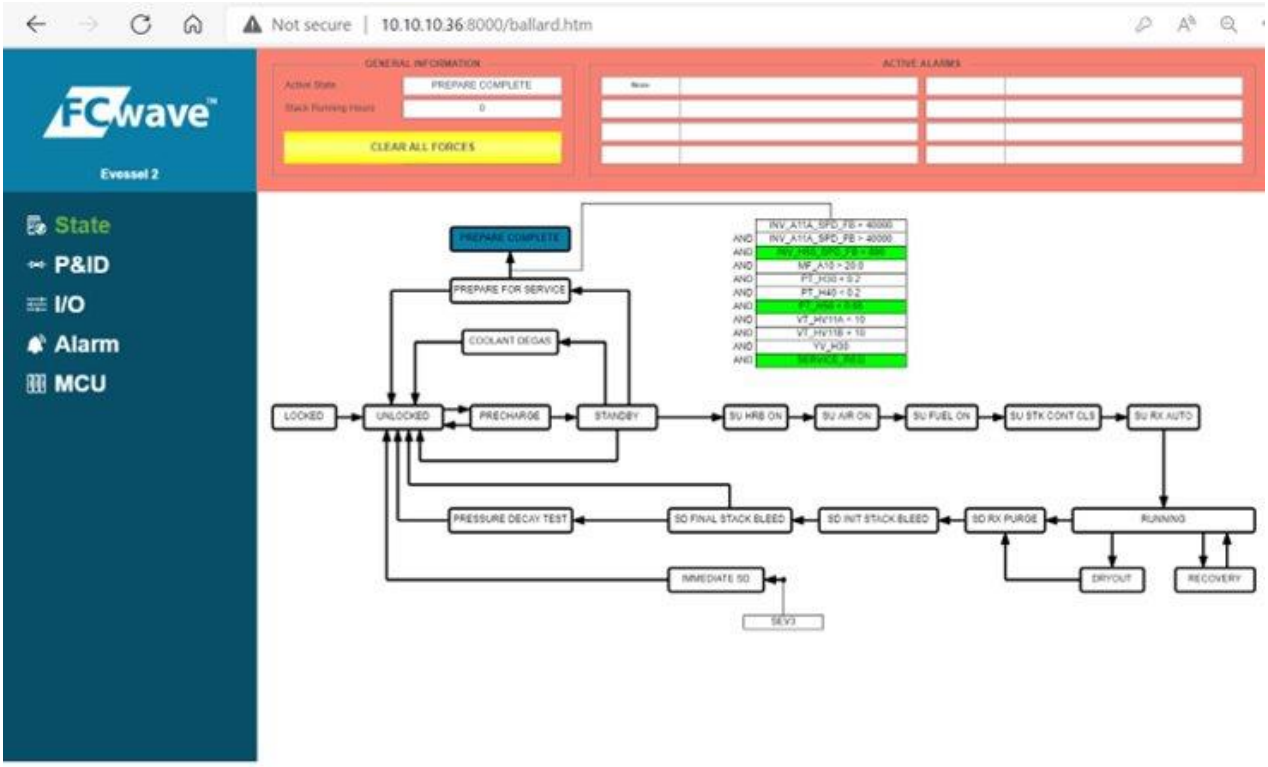


Figure 6-2: Request system to Prepare for Service

2. Confirm the module is ready for power down and maintenance by checking the integrator side. Remember to follow local lockout and tagout procedures.
3. Open system doors.

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4. Loosen 2 pcs. M6 bolts to disconnect the low voltage electrical connection (X_E01) with attached cables from the module.

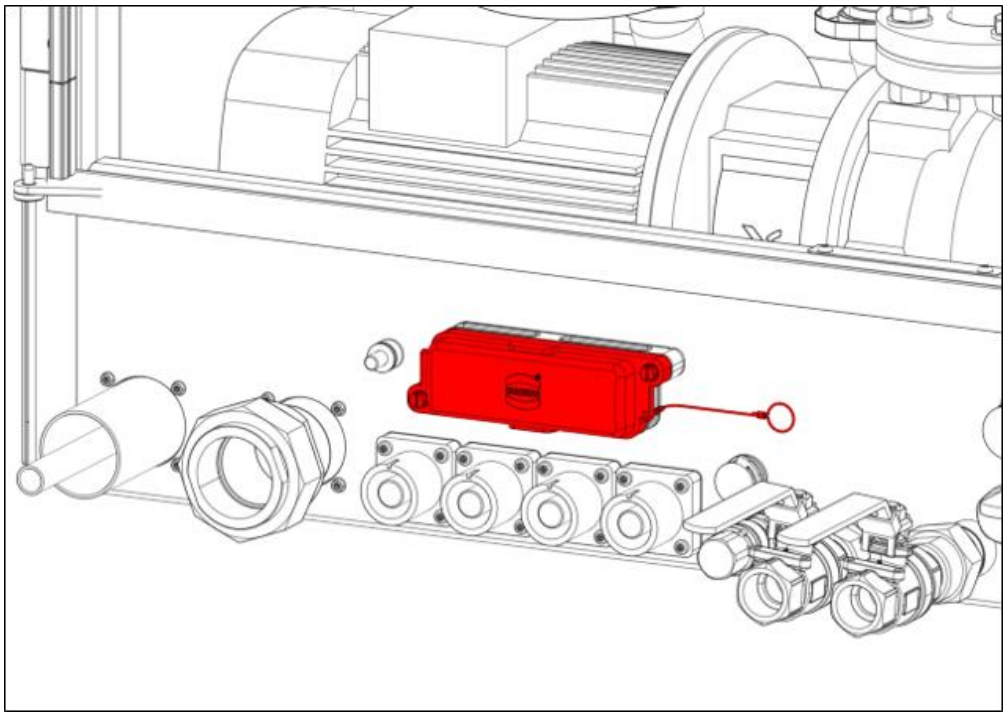


Figure 6-3: Removed low voltage electrical connection from module (shown in disconnected condition)

5. Press lock pin and turn counterclockwise to disconnect the high voltage electrical plugs from the front of the module.

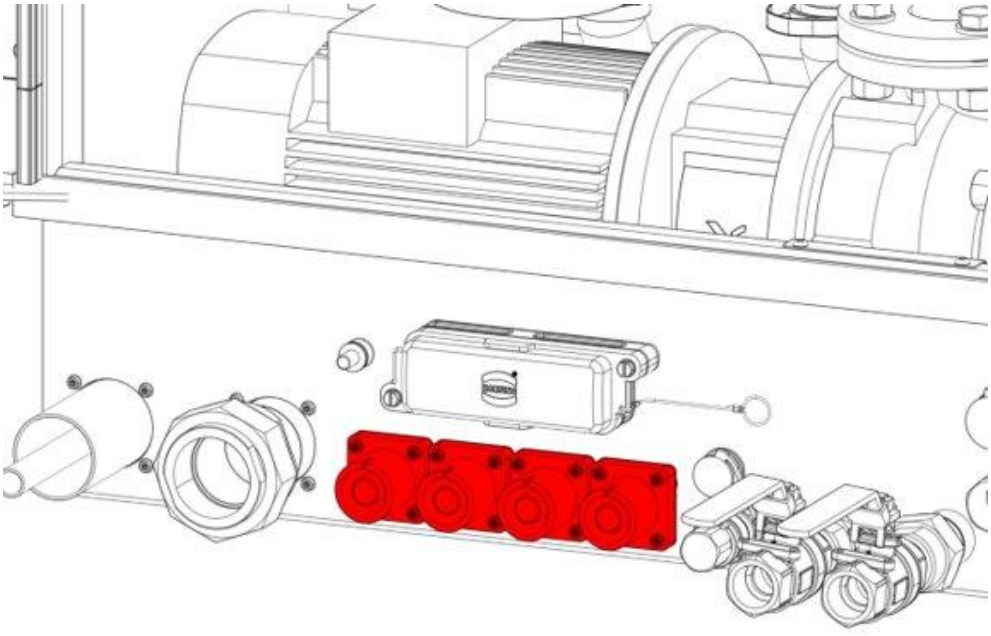


Figure 6-4: Removed high voltage electrical connection from module (shown in disconnected condition)

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6. Uninstall 12 pcs. M5x10 hex head bolts and remove the high voltage panel cover.

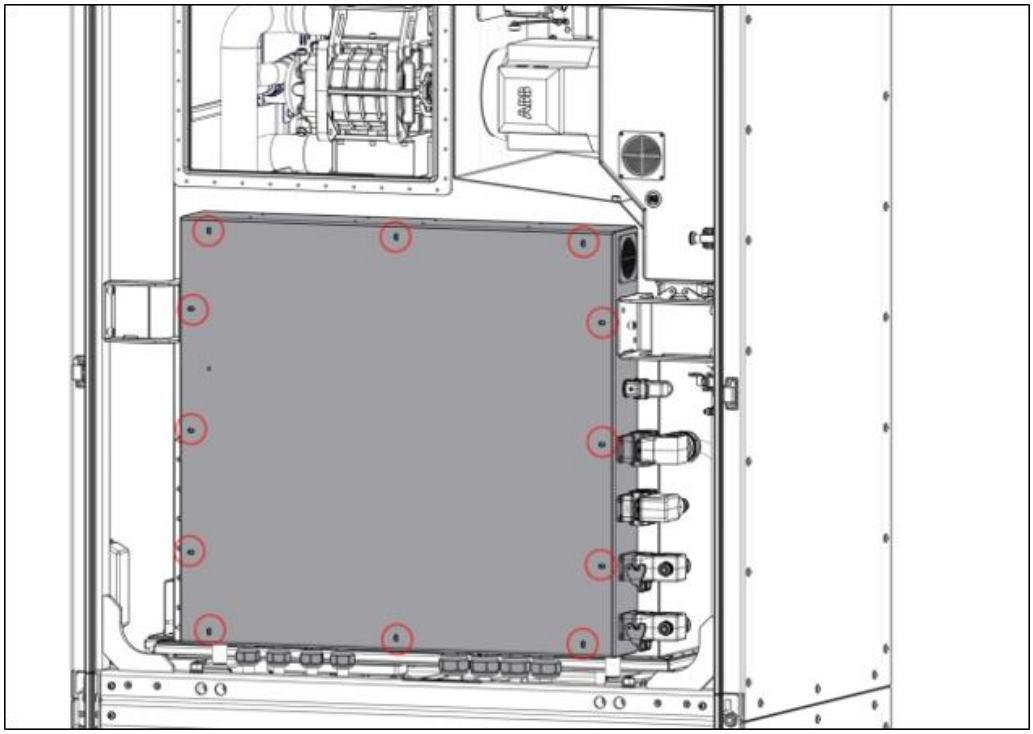


Figure 6-5: Remove high voltage panel cover

7. Measure the terminals to verify that no DC voltage is present in the HV panel.

   Use a multimeter to measure following terminals (shown in Figure 6-6) to verify that the voltage is lower than 10 VDC.:

   - negative (_XDA-2)
   - positive (_XDA+1, F_VTHV11A, F_VTHV12A, F_VTHV13A, and F_VTHV40A)

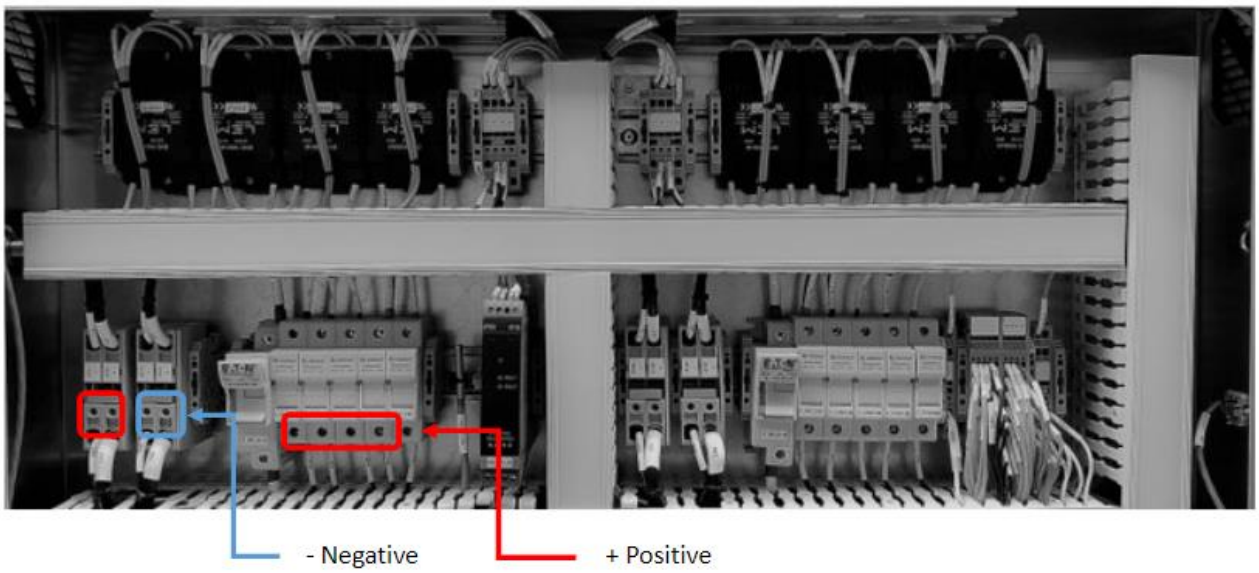


Figure 6-6: Left-hand side terminals

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8. After measurement of left-hand terminals, proceed to do the same for the following right-hand terminals (shown in Figure 6-7):
   - negative (_XDB-2)
   - positive (_XDB+1, F_VTHV11B, F_VTHV12B. F_VTHV13B. F_VTHV40B)

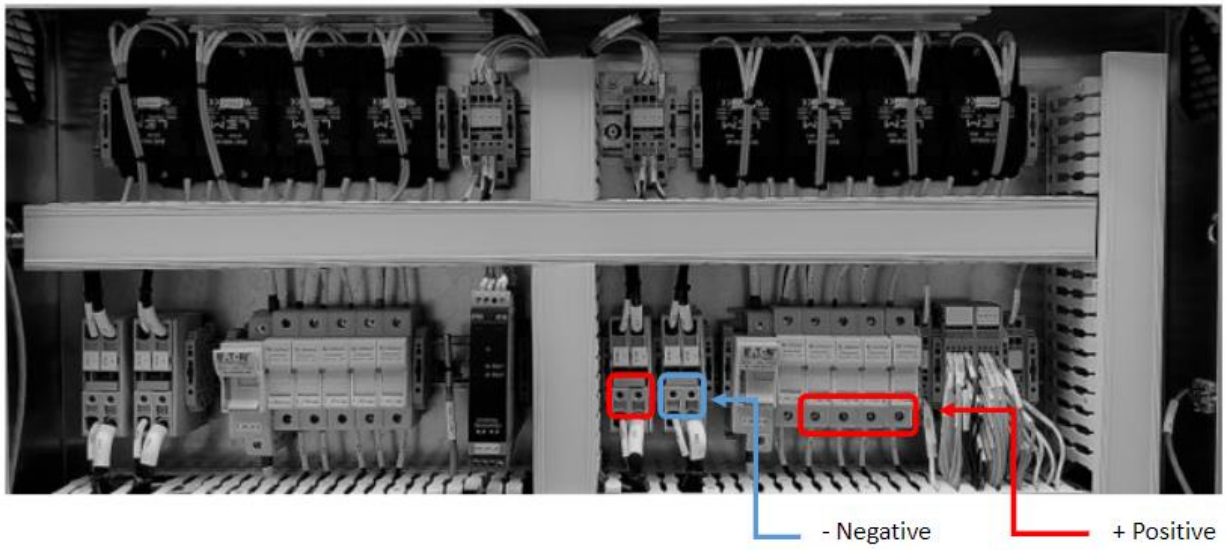


Figure 6-7: Right-hand side terminals

9. The module is now safe for maintenance and/or service.

6.6 High Voltage Isolation Failures



Under normal circumstances both high voltage output terminals (positive and negative) are isolated from the fuel cell module enclosure and low voltage system.

If isolation is lost on one high voltage pole, a person working on the module could sustain a fatal current flow by touching the other high voltage pole and ground.

If two simultaneous faults occur and isolation is lost on both high voltage poles, a high voltage short circuit can occur resulting in extremely high currents. High currents can generate a large amount of heat which will subsequently damage electrical and fuel cell systems and cause bodily harm.

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6.6.1 Normal system

In normal operation, the FCwave module will operate as shown below where both high voltage poles are isolated from ground.

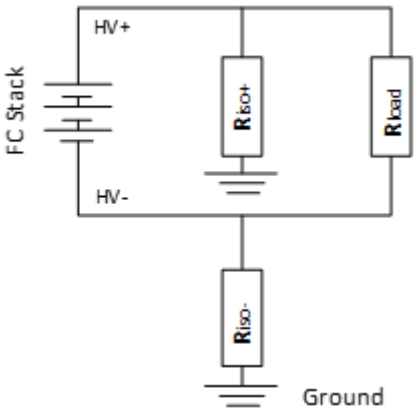


Figure 6-8: Normal isolation

6.6.2 Single Pole Isolation Failure

In a single pole isolation failure, one point on the high voltage circuit is no longer isolated from ground as shown in below figure.

An isolation resistance measurement or ground fault detection system can typically detect this failure on utilization.

A single pole isolation failure cannot cause a short-circuit nor prevent fuel cell operation, but it importantly increases the risk of electrical shock and causes injury to personnel while working on the FCwave module.

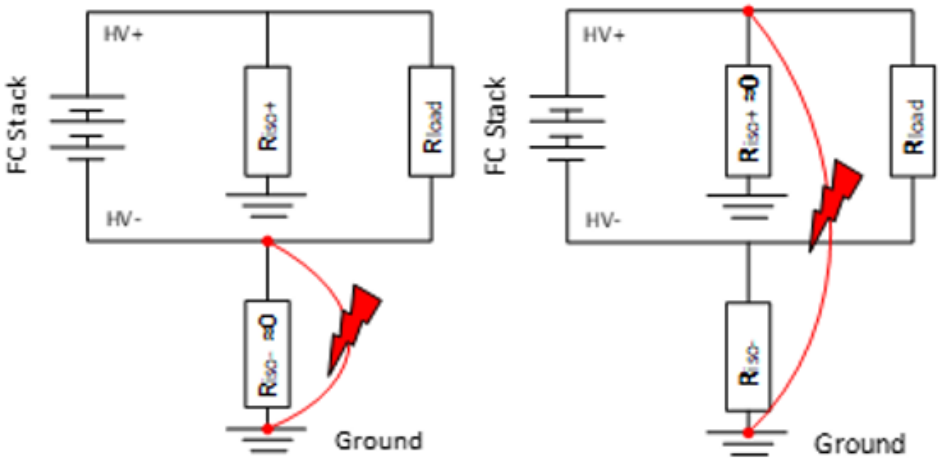


Figure 6-9: Single Pole Isolation Failure

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6.6.3 Double Pole Isolation Failure

A double pole isolation failure, where the high voltage system is no longer isolated from ground in two different locations, can result in a high voltage short-circuit as shown in figure below.

An isolation resistance measurement or ground fault detection system can typically detect this failure on utilization.

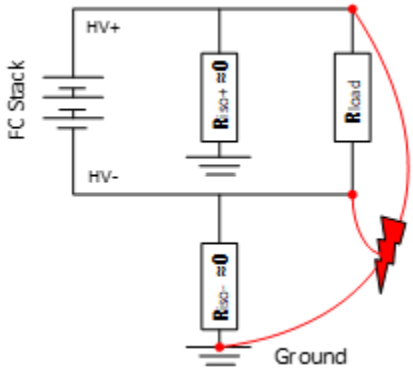


Figure 6-10: Double Pole Isolation Failure



If an isolation failure is detected and indicated in the FCwave module, do not operate the fuel cell module until the malfunction is determined and corrected.

6.6.4 Distributed Capacitance and Effects on HV Safety



The Distributed capacitance is the total amount of capacitance that exists between each pole of an isolated high voltage system and the chassis. This capacitance is a concern as it can hold charge which can be discharged into a person that simultaneously touches the high voltage system and chassis.

In normal operation, this is not an issue as all high voltage conductors are covered and insulated but it could be a concern if a system is being serviced. The fuel cell module has sources of capacitance that should be considered before servicing the high voltage system.

Within the module, the fuel cell stack will also maintain voltage if hydrogen and air are present within the system. Voltage could also be generated when a fuel or air source is introduced, and reactants are moved to an active point in the fuel cell stack. This voltage will normally bleed down to safe levels within minutes, but this should always be verified using the RDU interface first, and then testing with digital multi-meter prior to accessing the module.

Confirm that the voltage is zero

- Between pole to pole (positive to negative)
- Between each pole to chassis before service

Built in "Prepare for service" procedure involves running the air compressors and hydrogen recirculation blower to ensure the fuel cell reaches "STATE- PREPARE COMPLETE" prior to servicing the system.

One other effect of the distributed capacitance will be a delay in the ground fault detection system measurement. Some versions of the ground fault detectors are only suitable for distributed capacitance values of 1uF, and others are suitable for values up to 20uF.

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6.7 Hydrogen safety



Hydrogen is a colorless, odorless, and highly flammable gas. Hydrogen is non-poisonous, but it can cause breathing problems when mixed with oxygen in the air.

1. There are no warning symptoms before unconsciousness occurs.
2. Do not operate the module in a closed space or in non-ventilated areas.
3. Install and handle the hydrogen in accordance with applicable regulations and the gas supplier's recommendations.
4. Hydrogen is lighter than air and will deflate upwards.
5. Leaked hydrogen can readily mix with the adjacent air, as its small molecular size has higher buoyancy and diffusivity.

Handle with care as hydrogen can diffuse through materials even though considered gastight. Fuel lines and non-metal seals such as gaskets, O-rings, pipe thread compounds and packings can cause potential leakages.



The FCwave module hydrogen sensors can degrade if they are exposed to various contaminants and thus become less sensitive.

The FCwave module hydrogen enclosure is equipped with primary and secondary sensors to detect leakages in the system:

- A high hydrogen concentration indication report as
  - Severity 1 Warning at 0.8% vol H_2 (20% LFL)
  - Severity 2 Alarm at 1.2% vol H_2 (30% LFL)
  - Severity 4 Safety system activation at 1.6% vol H_2 (40% LFL)
- These hydrogen sensors send signal to ship control system, which triggers alarm to the integrator (refer to Table 6-3).
- Interconnect hydrogen detection system with a hydrogen supply shutoff valve installed directly upstream of the FCwave module.
- If an excessive hydrogen concentration leak is detected, STOP the FCwave module operation.
- Perform leak tests.

As part of preventive maintenance, check the hydrogen sensor in the module regularly. Refer to the sensor's service maintenance plan (section 8.1.4).

Exposure to Volatile Organic Compounds (VOC's) causes hydrogen sensor degradation and thus precautions must be taken to avoid exposure whenever possible. The system is installed with high grade technology sensors with longer service life and increased tolerance to VOC's. High levels of VOC's are frequently experienced during vessel painting and solvent degreasing. Therefore, it is recommended that the module or hydrogen sensors are removed during these processes.

The degraded hydrogen sensor effects are:

- Makes sensor less sensitive.
- Output will have a lower indication for a given hydrogen concentration.
- A degraded sensor in operation will no longer send any alarm, even when the concentration of hydrogen exceeds the threshold limits.

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A failure mode can occur if there is hydrogen present in the cooling system header tank. Follow the precautions that follow the design considerations and maintenance procedures.

- The hydrogen supply to the module can stay pressurized even after the module is shut down.
- Make sure there is no pressure in the line before disconnecting the hydrogen supply pipes
- The hydrogen lines inside the module can contain hydrogen, even after the module is removed from the system
- Safely vent the hydrogen pressure before removal of the fuel cell module

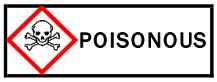
6.7.1 H_2 Sensor Alarm and Warning Limits

Control system warnings and alarms are communicated via CAN-bus. Alarm time is sensor response time plus debounce time, estimated to be 5 seconds.

H2 Alarm Limits				
Hydrogen level (vol%)	Lower Flammability Level for %vol H2	Module Action	Severity	Sensor
0.8	20%	Warning – Operation continues	1	Primary
1.2	30%	Alarm – Controlled Shutdown	2	Primary
1.6	40%	Alarm – Emergency Shutdown	4	Primary and Secondary

Table 6-2: H_2 Alarm Limits

6.8 Chemical hazards



Ethylene-glycol is poisonous, when swallowed get medical aid immediately.

The fuel cell coolant loop contains ethylene glycol.

- Ethylene glycol is toxic if ingested or if its vapors are inhaled.
- All personnel handling ethylene glycol or working on the fuel cell stack coolant loop are required to adhere to the precautionary measures identified in the safety data sheet of the specific coolant being used.
- Such precautionary measures include wearing safety glasses and chemically protective gloves.
- Dispose ethylene glycol in accordance with applicable local regulations.

6.9 FCwave module Hazard mitigation approach

The highest risk potential hazards posed by the module are unacceptable hydrogen concentrations (in the ventilation or process air exhaust) leading to fuel-fed combustion, electrical short-circuits, and possible shock hazards caused by reduced electrical isolation of the high voltage system.

The control system is coupled with various measurement devices that are designed to identify conditions (which can lead to hazards) and will terminate module operation before unsafe conditions develop.

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6.9.1 Module Alarm and Shutdown Types

This section describes the types of alarm activation and subsequent control system shutdowns. The system has two controllers:

- Fuel cell module controller unit (MCU)
- Separate safety controller which handles safety related sensors

Alarm type	Description	Action	Consequence
Severity 0 – Information	No fault reporting to drive system. May derate 'I_ALLOW', otherwise for information only. Severity 0 events are logged by the module's on-board data acquisition system.	Messages of this level are only for information to the vessel, and no time constraint is placed on reaction from the vessel or integrator.	No timer
Severity 1 – Warning	A system parameter has deviated from normal range. The fault category is reported to the drive system over CAN, along with its severity. The hardwired 'FCM_OK' output remains unchanged. This level of severity is used for a functional or internal parameter, which is at the limits of normal operation. The current value of the parameter does not harm personnel or material.	Bring the warning limit back within optimal range.	If the deviation from normal operating range continues to increase, a severity 2 alarm is activated.
Severity 2 - Alarm	A system parameter has exceeded acceptable operating range, and the fuel cell module will undergo a controlled shutdown. The fault is reported to the drive system over CAN and the hardwired signal 'FCM_OK' output will go to 0V. 'I_ALLOW' will be set to 0A.	Do not exceed 'I_ALLOW' when the severity 2 fault is active. After a severity 2 fault, do not attempt a restart until action has been taken to identify and resolve the cause of the fault. To clear this fault, cycle the hardwired 'MD_EN' signal.	System performs a shutdown. ≤ 30 sec for the controlled shutdown.
Severity 3 – Severe alarm /immediate shutdown	A system parameter has exceeded a safe operating range, and the fuel cell module will undergo an immediate shut down. The fault is reported to the drive system over CAN and the hardwired signal 'FCM_OK' output will go to 0V. 'I_ALLOW' will be set to 0A immediately. Cease current draw from the fuel cell module immediately, since this severity will cause the high voltage contactors to open under load.	After a severity 3 fault, the fuel cell module must not be restarted until the cause of the fault has been determined and resolved. In addition, inspect the module for safe operation and consult Ballard before a restart is performed.	≤ 1 sec hard shut down.
Severity 4 – Safety System Activation (SIS)	The module safety system has tripped and disabled all outputs from the module controller. This causes contactors to open under load and close all hydrogen valves. The module performs an immediate shutdown. This type of emergency is reported over the safety hardline connections. The hardwired signal 'FCM_OK' output will go to 0V. 'I_ALLOW' will be set to 0A immediately. Severity 4 is handled by the safety and overrides the module control system	Cease current draw from the fuel cell module immediately, since this severity will cause the high voltage contactors to open under load. After a severity 4 fault, the fuel cell module must not be restarted until the cause of the fault has been determined and resolved. In addition, inspect the module for safe operation and consult Ballard before any further actions are taken.	≤ 1 sec emergency shut down.

Table 6-3: Module Alarm and Shutdown Types

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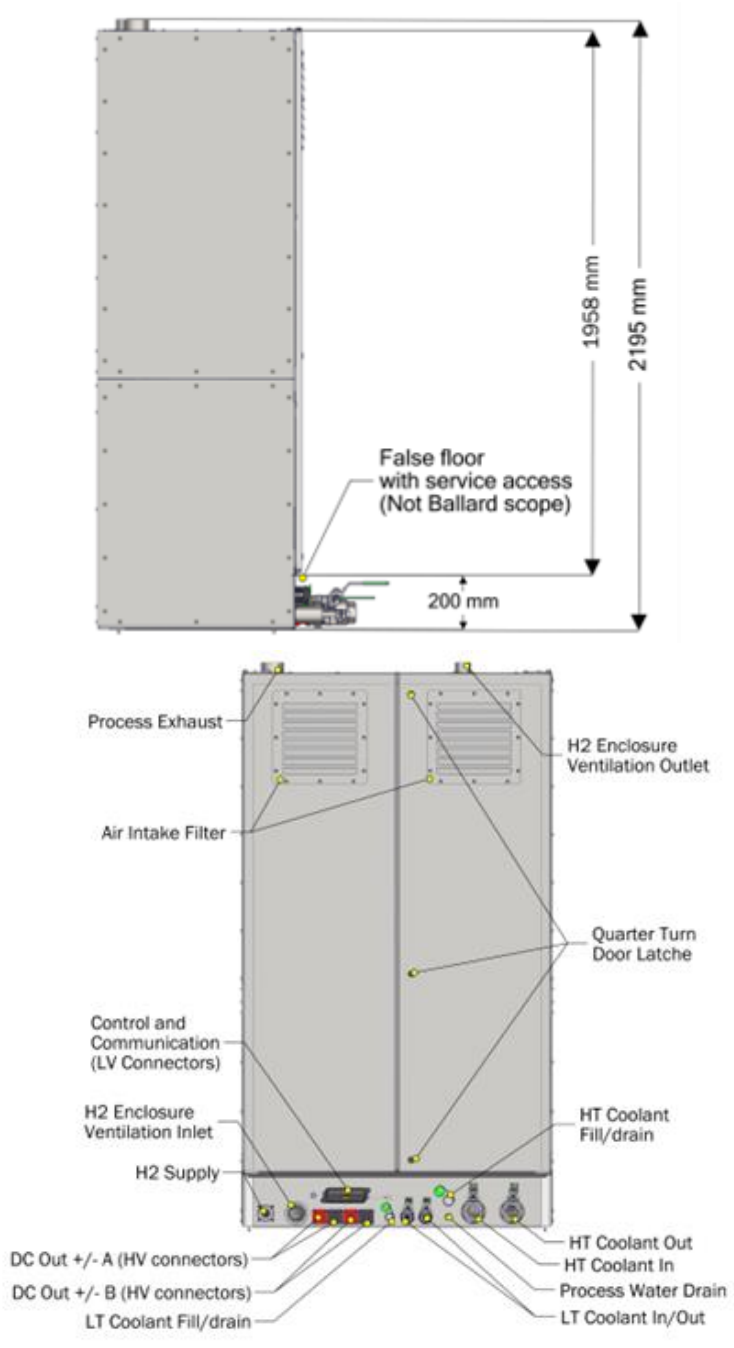
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7.0 General Preparation for Maintenance on the FCwave module

7.1 Interface Connections

The external hydrogen supply, coolant supply, electrical, control and communication connections in the cabinet are installed on the base of the FCwave module. The interface connections are shown in Figure 7-1 (3 figures).



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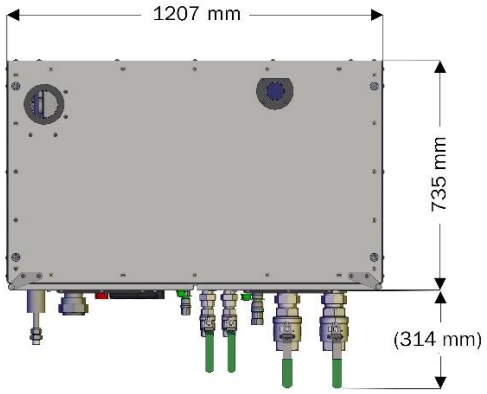


Figure 7-1: FCwave 200 kW module interface connections

7.1.1 Service Access

It is recommended to ensure necessary service space in front of the FCwave module cabinet for lifting of BOP components, removal, and to carry out maintenance operations (

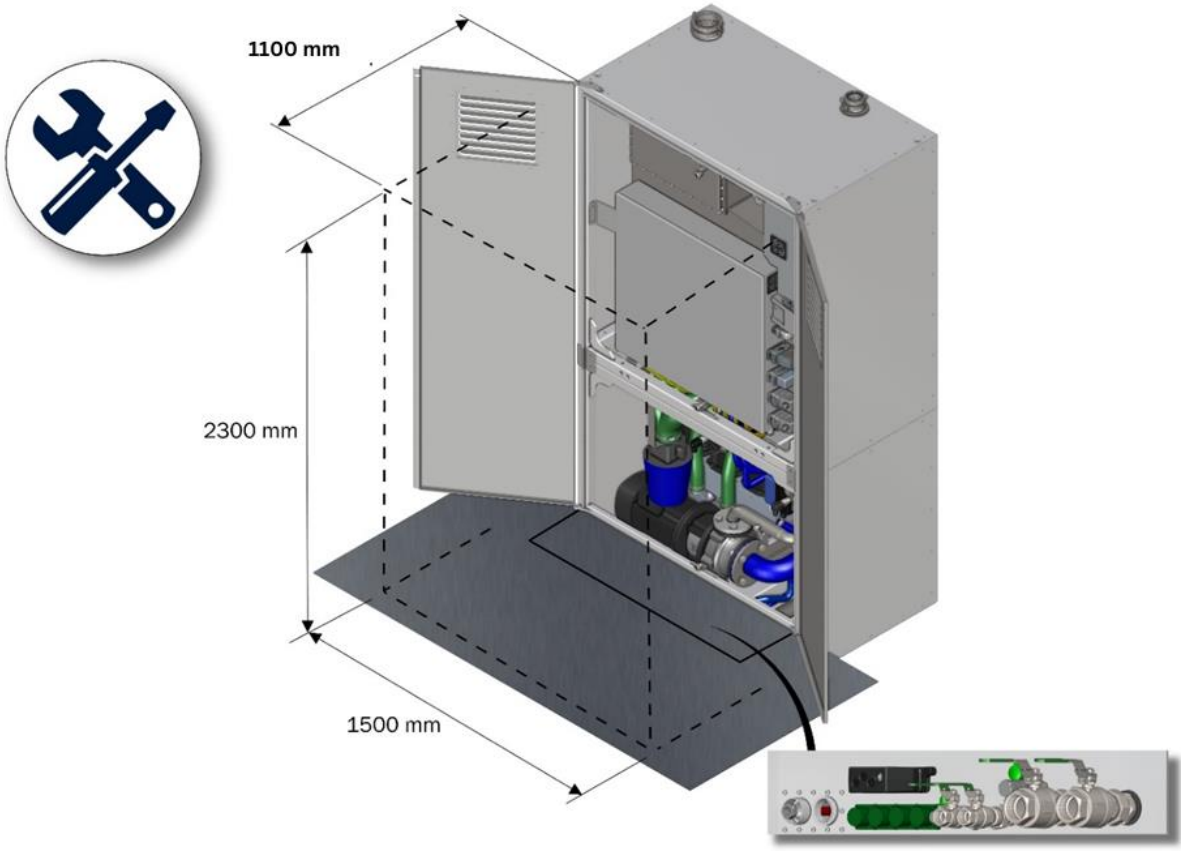


Figure 7-2).

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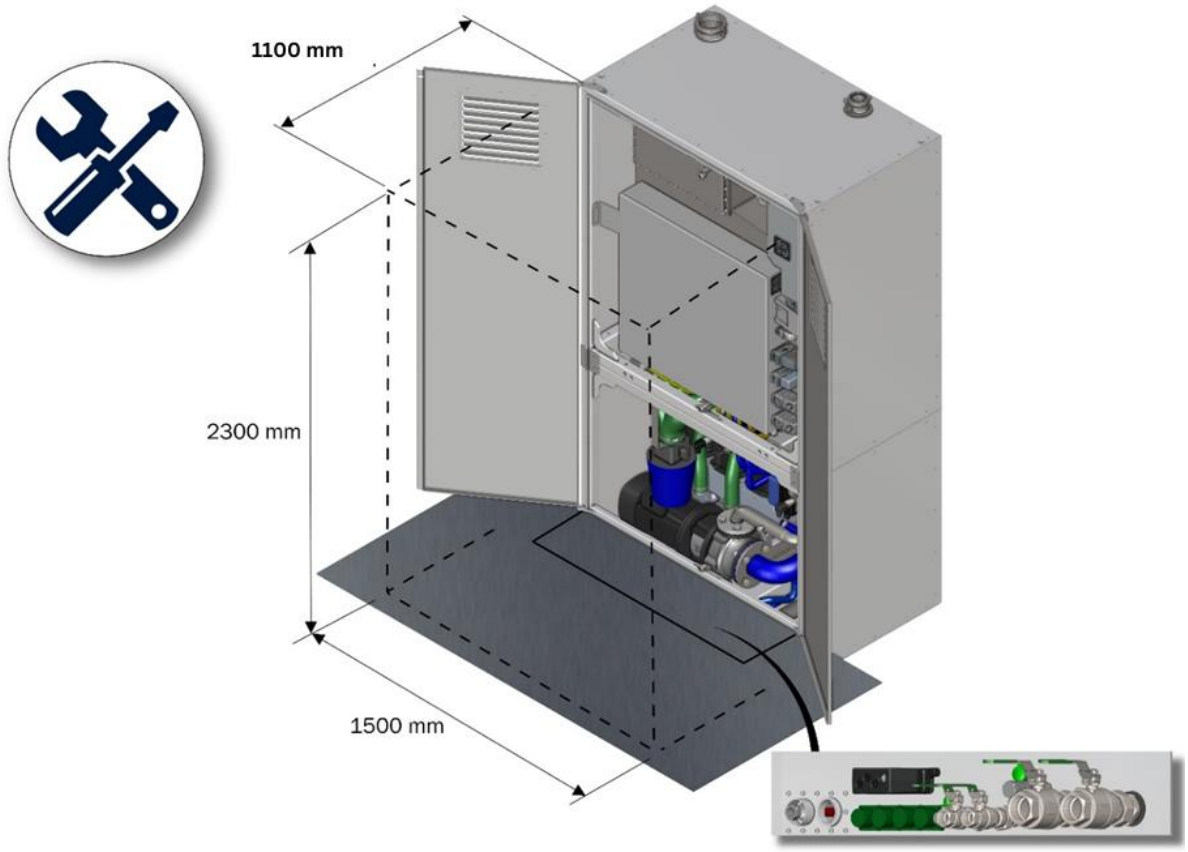


Figure 7-2: Recommended Service access for FCwave module

NOTE: Cabinet doors can be opened to 120°. If necessary, dismantle the cabinet doors to have additional service access during maintenance procedures.

7.2 Module Controller Unit (MCU) usage

The MCU is a marine-approved multi-line 300 controller, specifically for the Power and Paralleling Unit (PPU) 300 variant. The controller communicates with the Vessel Control System (VCS) via hardwires, ethernet, and a dedicated CAN bus. The VCS is in the integrator scope.

The module controller unit (MCU) consists of a main controller and an extension rack, which:

- Is responsible for overall control of the fuel cell and balance of plant (BOP) components power supply.
- Monitors and controls the state of reactants and power flowing to and from the module.
- Monitors and reacts to system conditions with various sensors, including H_2 concentration measurements.
- Has an in-built CPU with SD card for processing, communication, and bus systems.
- Has ethernet connections for rack interconnect and external communication.

An industrial grade SD card in the MCU is utilized for local data logging storage. The ethernet connection to the VCS must provide internet connectivity for the MCU to transmit data to a Ballard server through TCP port 22 (for further information contact BPSE – section 4.1). Furthermore, the ethernet connection must provide internet connectivity through TCP port 123 for time synchronization for the MCU.

NOTE: The MCU interface is primarily used to view operational data for maintenance and troubleshooting tasks. The data is available from the MCU information pages after logging into the engineering interface.

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7.2.1 Software requirements

Any computer that is used with an MCU engineering interface must be configured with the applicable software and settings. Perform this procedure the first time logging into the engineering interface, to initialize the computer for use with the MCU interface.

Setting up the computer IP address:

- Go to computer settings,
- Select 'network and settings'
- Select 'ethernet' in the left side menu
- Select 'change adaptor options' in the right side menu
- Right click on 'Ethernet 2' and select 'Properties'.
- Select 'Internet Protocol Version 4 (TCO/Pv4) and select on 'properties'.
- Insert the IP address from the module, which can be seen as a label on the Low Voltage Panel, and introduce the rest of the setting as showed in the figure below (Figure 7-3).
- Finish off by clicking 'ok'.



Figure 7-3: Settings for setting up IP address

After the computer is correctly configured to communicate with the MCU engineering interface, it is highly recommended to install the Google Chrome web browser. Although the MCU can be used with other web browsers, it was developed for Google Chrome.

For instructions on how to login to the MCU interface the first time, see section 7.2.3.

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7.2.2 Hardware requirements

Connection to the MCU can usually be performed in two separate ways, depending on the integration.

1. The integrator must provide an ethernet connection port onboard or a service access panel onboard the vessel.
2. A technician can connect their computer to this port using an ethernet cable to access the MCU interface, when the MCU is powered by the module or by the onboard system battery.

It is necessary for a technician to be able to connect to 24 V power to the MCU, to keep it running when it is not powered by the module or by the onboard system battery. A service technician can connect their computer to the I/O tester by an ethernet cable to access the MCU engineering interface.

Follow the maintenance procedures that are necessary for the I/O tester, so the MCU can be powered when the module is not in operation.

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7.2.3 Log in to the MCU Engineering Interface

The technician can log in to the MCU interface to perform the preventive maintenance and diagnostic procedures for the FCwave module.

The general procedure for log in to the engineering interface is:

- Connect an ethernet cable from the computer to the connector of the MCU ports located in the LV panel.
- Open Google Chrome (or another web browser). Type the IP address "http://10.10.10.10:8000/ballard.htm" into the address bar at the top of the screen.
- (This IP address does not represent the IP address for any specific module, but is the standard IP address the module is "born" with. The address which will be changed by a BPSE employee during commissioning, where the IP address will be adapted to customer's local network.)
- Make sure the login screen is displayed as shown below.
- Users of different training levels will have different privileges for viewing and forcing tags.
- Operators are given the read-only log in credentials (see Table 7-1) and only have permission to view diagnostics.
- Log in credentials for technicians and integrators, which provide further access privileges, will be given by completion of appropriate level of training.

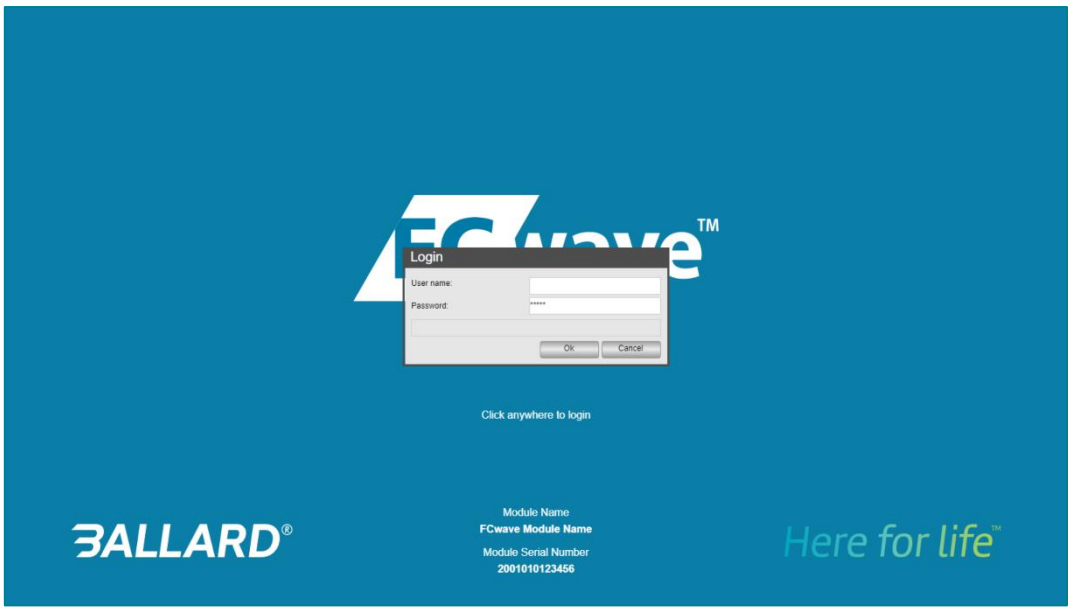


Figure 7-4: MCU Engineering Interface Login screen

User Group	Username	Password
Internal technicians (both Ballard and its partners)	OEM	[Contact BPSE (section 4.1) to get password]
Customer technicians	Customer	
Customer operators	Read-only	Ballard

Table 7-1: MCU interface login credentials

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7.2.4 MCU Engineering Interface usage

1. Use MCU engineering interface to view run-time data and alarm codes, at the time of troubleshooting.
2. After login you will be directed to the State page of the MCU engineering interface (see Figure 7-5: MCU engineering interface State screen).
3. The State screen displays all the run-time data tags which are included in the user's selection of favorites.

- Use the navigation bar on the left of the engineering interface screen to switch between different MCU interface pages.
- Use the I/O page to access the fuel cell control unit's input and output functions.

The status bar in the top band across the screen provides information about the FCwave module's current operating state and active alarms. These are always displayed on all pages of the engineering interface.

The status bar currently displays the MCU State diagram of module page.

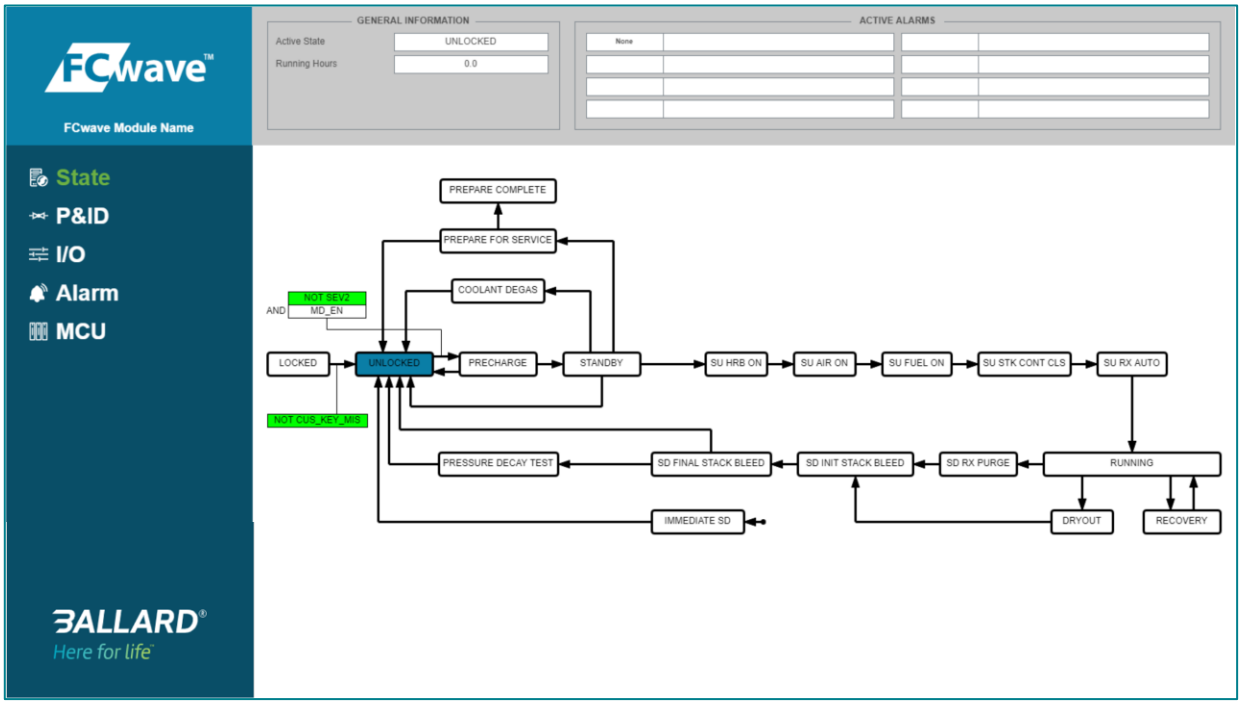


Figure 7-5: MCU engineering interface State screen

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7.2.5 MCU Interface usage

The MCU button in the navigation bar opens the MCU Information Screen.

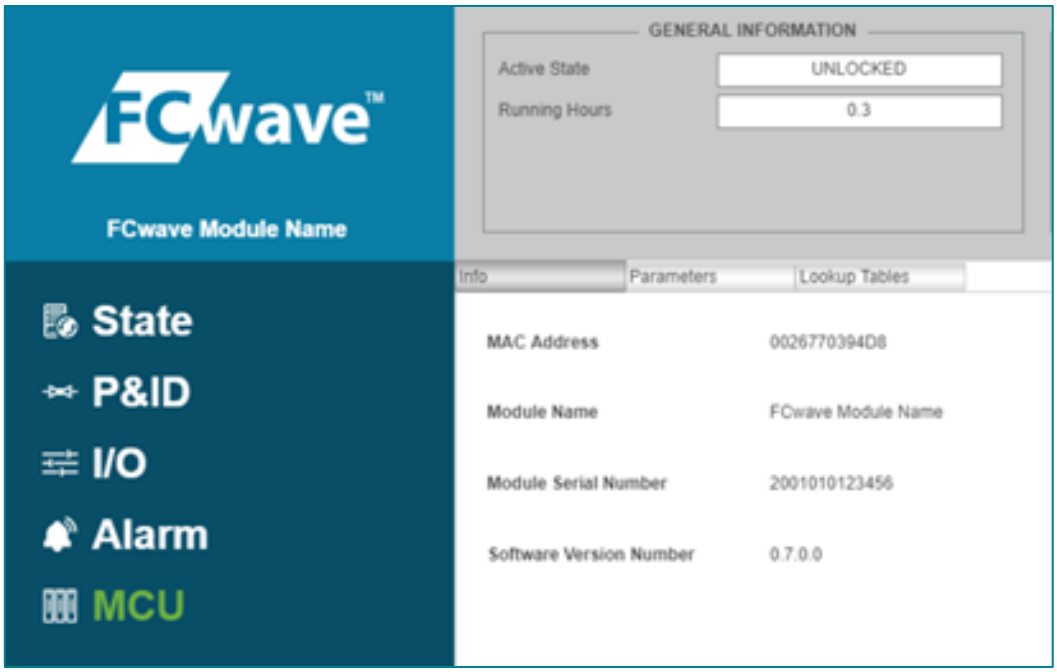


Figure 7-6: MCU Info screen

Check the module serial number.

This can be checked in two ways:

- The module serial number is shown on the login screen (Figure 7-4)
- Select MCU page in the navigation bar and then navigate the info screen to see module serial number as shown in Figure 7-6.

Check the MAC address and Software version number.

- Select MCU page in the navigation bar and then navigate the info screen to see the unique media access control (MAC) address.
- Select MCU button in the navigation bar and then navigate the info screen to see the software version number as shown in Figure 7-6.

Check running hours.

- The running hours record the FCwave module's operational hours. It is displayed on all pages of the engineering interface at the top band in status bar as shown in Figure 7-6.

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7.2.6 I/O Interface usage

It is possible to manually set the value of the various controls and sensors before/while performing any repairs.

1. Log in to the MCU engineering interface as an internal technician or customer technician user and navigate to the I/O page (Figure 7-7).
2. The MCU interface currently displays the I/O page in the navigation tab as shown in Figure 7-7.
3. Depending on the service requirement, maneuver to each I/O page - Fuel, Air, Compressors, Coolant, Electrical, Stack, Cabinet, All Input, All Output and All Calc service tabs as shown in Figure 7-7.



Figure 7-7: I/O Interface page

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7.2.7 PrepForService feature usage

Tools used for procedure	Laptop, 3m ethernet cable

Table 7-2: Tools needed for PrepForService

1. Enable 'PrepforService' by activating the module state "Standby" as shown in Figure 7-8.
2. This function is developed to reduce the time for the fuel cell stacks to de-energize and to ensure safe work environment.
3. After activation, the MCU automatically operates through a protocol that commands the air compressor, the hydrogen recirculation blower, and the coolant pump to start operating with the fuel supply closed.
4. This consumes any residual reactants that can raise the stack voltage during maintenance activities.
5. Though it is intended to bleed-down the voltage to a safe level, technicians must always check the stack voltage with a multimeter before performing any service or maintenance on the module (see section 6.5.1)

'PrepForService' can be requested/forced by any MCU user group account level. It can be found under the I/O tab – 'All inputs'.

CAUTION **The coolant pump operates at a minimum speed while 'PrepForService' is active. DO NOT activate this feature, if the coolant system is already drained.**

Activate 'Standby' state, to start 'PrepForService' function. The protocol continues for 3 minutes but it can be turned off manually if the stack voltage indicates below **10V**.

CAUTION **Always check stack voltage manually with a multimeter after 'PrepForService' operation. Do not fully depend on interface stack bleed-down voltage.**

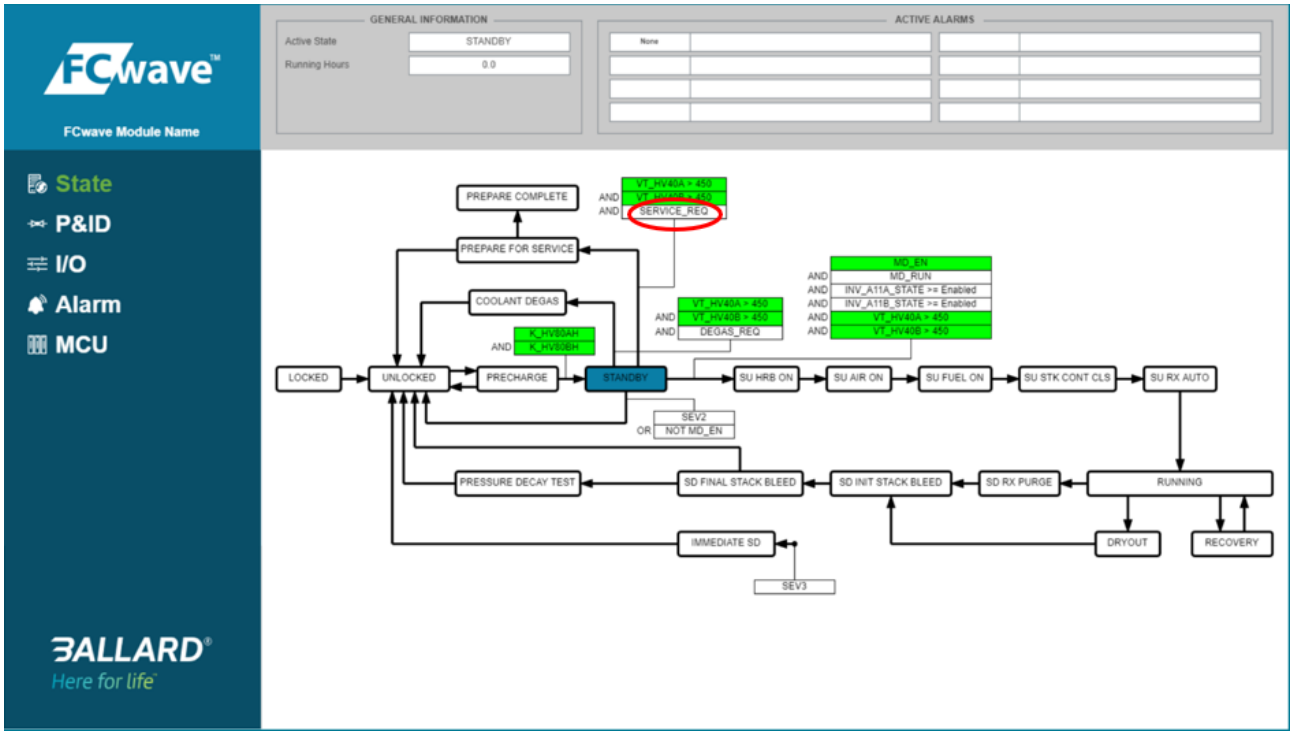


Figure 7-8: 'PrepForService'

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7.2.8 Reset the shutdown alarms

High severity faults on the FCwave module requires specific inspections, to make sure the cause of the fault is corrected for safe operation. The MCU has four levels of alarms called 'Severities'.

1. **Severity 0** – Informational Message. By CAN-Bus to vessel control system
2. **Severity 1** – Warning. By CAN-Bus to vessel control system
3. **Severity 2** – Alarm, leading to shutdown. By CAN-Bus to vessel control system in ≤ 30 sec.
4. **Severity 3** – Immediate shutdown. By CAN-Bus to vessel control system in ≤ 1 sec.
5. **Severity 4** – Emergency shutdown alarm.

The **Severity 4** Emergency shutdown alarm is handled by the safety controller - Safety System Activation (SIS) by using hardwire connection and CAN bus to vessel control system. For this type of alarm activation and actions refer to section 6.9.1.

When any of the high severity fault alarms occur, it activates the hard shutdown alarm to prevent the operator from further module operation.

- When a high severity fault activates the shutdown alarm, contact BPSE for troubleshooting support.
- The shutdown alarm must only be reset after the fault is resolved and verified by a Ballard technician.
- DO NOT use the CLEAR ALARMS button, when the shutdown alarm activates like any other alarms (Also, a shutdown cannot be cleared on its own).
- To reset any shutdown alarm - disable and enable MD_EN function on the MCU I/O page.
- The safety controller will only allow to reset emergency shutdown alarm, when the fault is cleared, no failure on components is found and after power cycling of the module.

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7.3 System de-energization, shut down and stack voltage check.

Perform steps in section 7.2.7 (PrepforService feature usage) and steps in section 6.5.1 (High Voltage safety check before module maintenance) to make sure all components are cooled off to a safe temperature before proceeding.

De-energizing relevant systems before dismounting the BOP components from the cabinet or while performing any maintenance activities.

This procedure can only be performed on a functional module which does not have any known failures. A custom shut down procedure is necessary if there is any failure in the module. Contact BPSE before start of any work (see section 4.1 for information).

The following sections identify safe shut down of each source of energy to be performed in sequential order:

7.3.1 Hydrogen supply shut-off

A hydrogen supply shut-off is necessary before dismantling the FCwave module from any integration, or to perform any work on the hydrogen supply pipelines.

1. It is recommended to use local lock out and tag out, then shut off and bleed the line on the integrated hydrogen supply system to upstream of H_2 inlet fuel cell module (Figure 7-9: Hydrogen supply shut-off). Double block and bleed valve functionality are in the customer scope.
2. Use the Purge valve and Air compressors to release the remaining H_2 pressure from the anode subsystem.
3. H_2 concentration in the process exhaust will be safely diluted by the air flow supplied by the air compressors into the exhaust system.

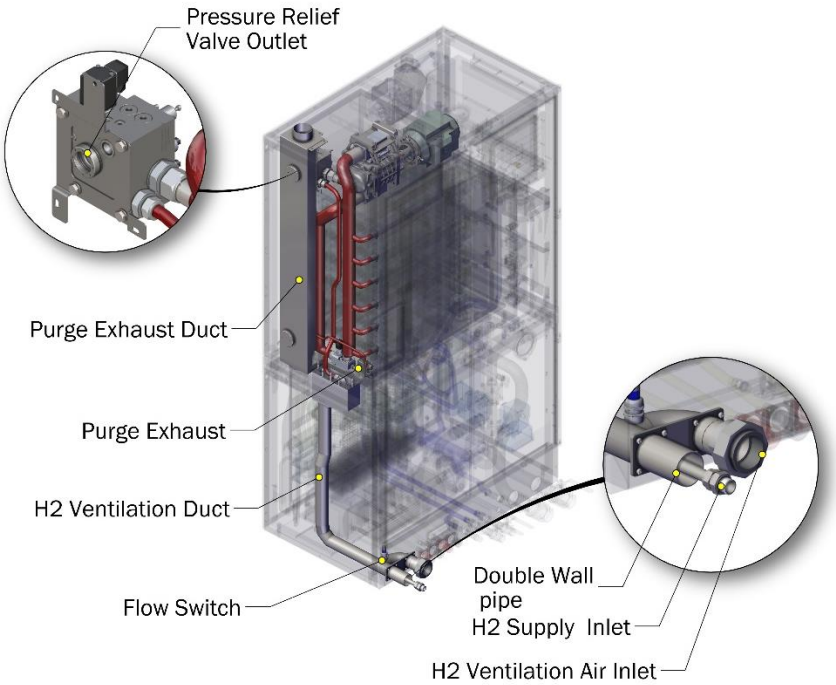


Figure 7-9: Hydrogen supply shut-off

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7.3.2 Check coolant temperature

Perform steps in section 7.2.7 to cool down internal coolant systems to be able to check coolant temperature.

WARNING **The water can be up to 50°C.**

7.3.3 'PrepForService' Operation

1. After shutdown, the module requires at least 20 minutes to de-energize. Run 'PrepForService' via MCU engineering interface to perform any service activity (see section 7.2.7).
2. Make sure that stack voltage transducers indicate less than 10 VDC. If 'PrepForService' fails and the stack voltages CT_HV30A and CT_HV30B do not drop below 10 VDC after 3 minutes, contact Ballard for assistance (see section 4.1).

7.3.4 Electrical system shut down

An electrical system shut down is necessary before removing the FCwave module from the integration or disassembling any of the BOP components from the cabinet.

1. Turn off and disconnect the customer load terminals and outputs that follows the shut-off procedure described by the system integrator.
2. Make sure the power supply(s) is turned off and bled down before performing the next steps.
3. Disconnect the customer low voltage connection from 'HRNS-X_E01' and 24 VDC power connection.
4. Shut down and disconnect all the four terminals that are connected to the module's high voltage output from the customer interface connections (Figure 7-12):
   - HV DC A+ (HRNS-X_HV01)
   - HV DC A- (HRNS-X_HV02)
   - HV DC B- (HRNS-X_HV03)
   - HV DC B+ (HRNS-X_HV04)
5. Listen for any fan or motor operation. All rotating parts should have come to a complete stop.

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7.3.5 Stack voltage check

During servicing to ensure the stack voltage is operating in safe range, follow below maintenance procedures:

1. Make sure the power output connections are disconnected to prevent personnel from starting the module.
2. Make sure the hydrogen supply is shut off upstream of the module and open the HV panel cover.

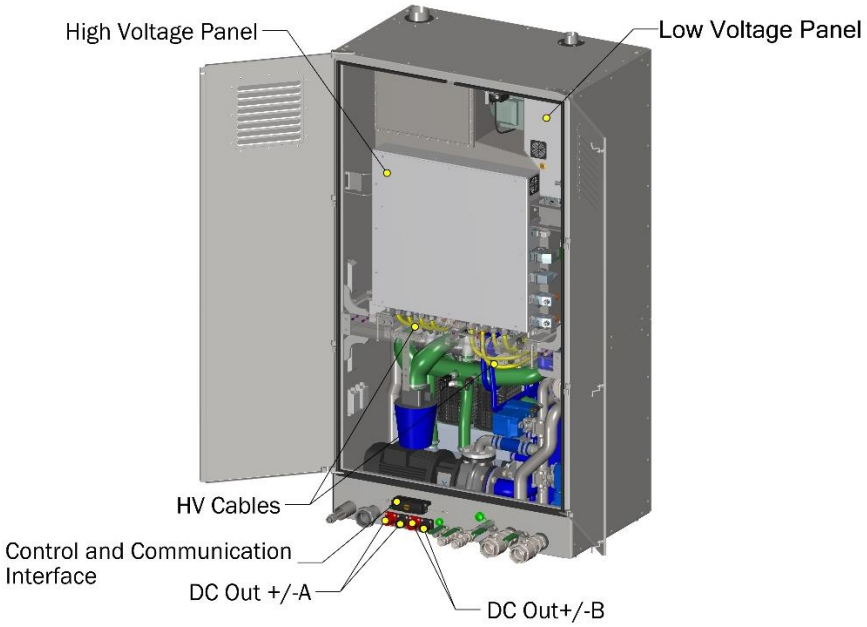


Figure 7-10: Stack voltage connections

3. Examine the components inside the HV panel using an approved multimeter.

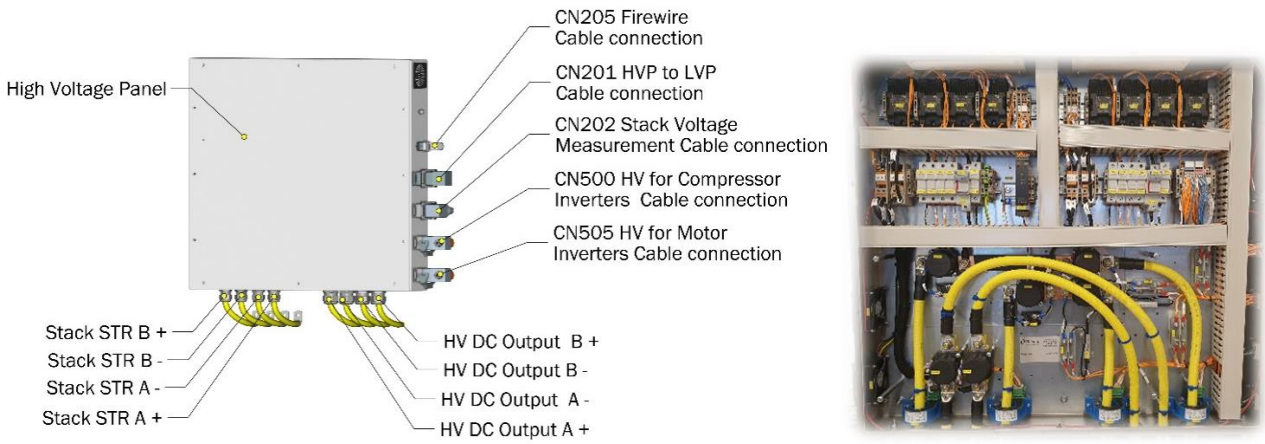


Figure 7-11: Inside the HV Panel

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4. For safety reasons, the absence of dangerous voltage must be measured with a voltage tester (for further information, see section 6.5.1). In case of failure, try to find the root cause using the troubleshooting guide. Alternatively, discharge the electric charge using a resistor in an external circuit. Make sure the measurement criteria from Table 7-3 are met.

Measurement	Pass Criteria
HV DC A+ to STACK OUT B-	≤10 VDC
HV DC B+ to STACK OUT B+	≤10 VDC
HV DC A- to STACK OUT A-	≤10 VDC
HV DC B- to STACK OUT A+	≤10 VDC
LV -X_E01 to -CN100	≤10 VDC
LV -X_E01 to -CN101	≤10 VDC

Table 7-3: Voltage measurement criteria

5. Run PrepForService (section 7.2.7). If voltage is higher than ± 5 V AC or DC between one of the test points, wait at least 15 minutes and perform this step again.

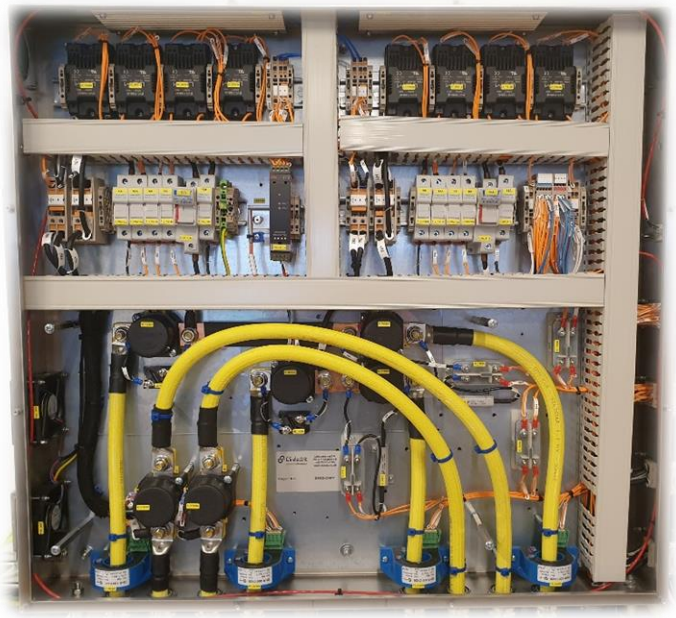


Figure 7-12: HV Panel voltage measurement points

6. Complete all further disconnections necessary by the system integrator before performing work.

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7.3.6 Coolant system shut-off

A coolant system shut-off is necessary before dismantling the FCwave module from the integration, or to perform any work on the cooling systems.

1. Close and shut off all valves on the integrated coolant system to isolate the circuit of the HT external circuit and LT auxiliary coolant loop.
2. Place a clean container below the coolant drain points.
3. There are two drain valves at the lowest point on the integrated cooling system for HT and LT coolant (Figure 7-13: HT and LT Coolant drain ports
4.).
5. Drain the stack HT coolant via drain port located at the interface of lower cabinet (see section 7.1 for Interface connections).
6. Drain the low temperature coolant loop via drain port located at the interface of lower cabinet (see section 7.1).
7. Discard the used coolant according to local environmental regulations.

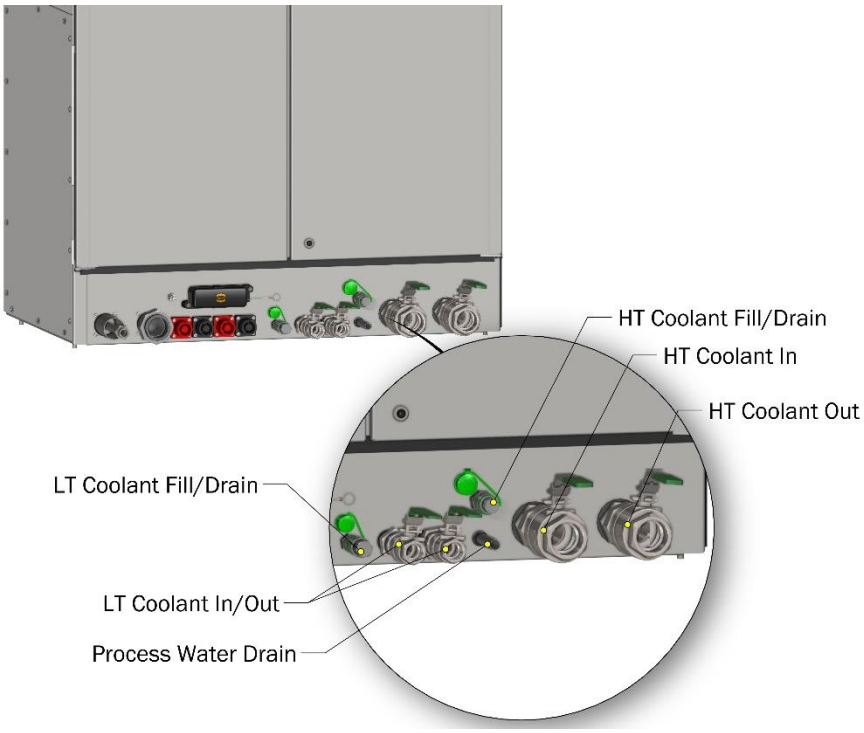


Figure 7-13: HT and LT Coolant drain ports

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7.4 Lifting and Handling of the FCwave™

Lift and handle the FCwave module equipment carefully with slow motions, to avoid sudden movements and shocks. Before installation on the floor, check the alignment of all four bottom and four rear installation points on the vessel.

WARNING **Only approved personnel are allowed to lift and handle the equipment, failure to follow guidelines can cause lifting accident, which leads to personnel injury and damage to equipment.**



Figure 7-14: Lifting and handling of FCwave module

NOTE: Lifting eye bolts, slings and lifting beam are NOT in the Ballard scope of supply.

Follow the guidelines for safe use of lifting the FCwave module:

- Make sure all 4 lifting points provided on the top of cabinet are used, which carry the total weight of the complete FCwave module.
- Make sure all lifting devices are rated for the required load (see technical datasheet for exact dry weight).
- Use shackles, lifting straps, spreader/lifting beam and lifting brackets to equally distribute the load.
- Make sure the lifting points are only loaded vertically. Do not pull the lifting mounts at an angle.
- The use of an overhead electric hoist with a lifting beam is highly recommended.
- For dismounting the upper cabinet from the lower cabinet refer to section 8.5.10.

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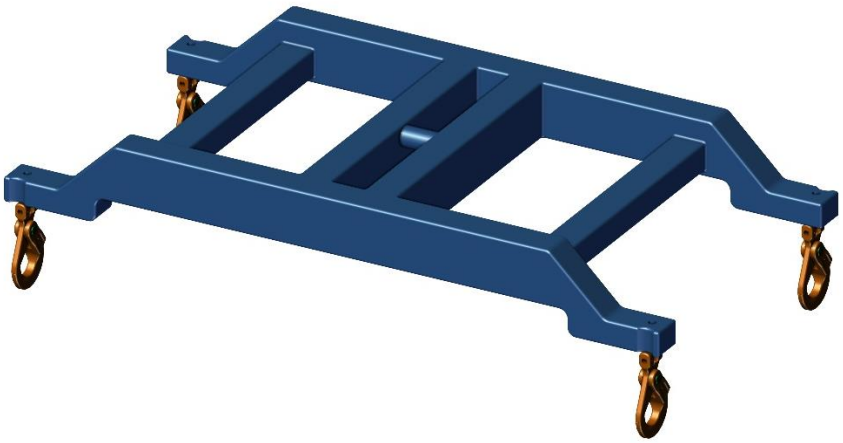


Figure 7-15: Lifting beam

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7.5 Insulation resistance Test

This procedure is currently under development and will be a part of the next revision.

Purpose

Insulation resistance (megohmmeter) tests the electrical resistance of the insulating components in a circuit. The insulation resistance is measured when the voltage is applied to the circuit, to determine if there is enough insulation to isolate the electrical current.

After performing any work on the fuel cell stacks, bus bars, high voltage connectors, contactors, or circuit boards, it is necessary to perform an Insulation resistance test.

Responsibilities

Only trained service technicians must perform this activity. For details refer to section 8.1.3.

Parts and Equipment

A list of parts and special equipment is identified to perform the procedure during the life and operation of the FCwave module.

- Crocodile clips (quantity to be decided)
- Multimeter

Safety

Wear all the required PPE (Nitrile gloves, etc.). Refer to section 8.1.2 to follow the instructions.

To perform an insulation resistance test, proceed as follows:

1. Keep a minimum of 1m safety barrier around the FCwave module with red tape. Remove all other equipment from the work area to allow the personnel to leave the area.
2. Remove all unwanted material or tripping hazards. Furthermore, no hydrogen, coolant or airline must be connected to the module.
3. System needs to be in state “Prepare for complete service”.
4. System doors can be opened safely.
5. Check stack voltage to make sure the module is safe to work.
6. Disconnect all the electrical connections to the module.
7. Locate the HV panel assembly installed in the upper cabinet and remove its front cover bolts (Figure 7-16).

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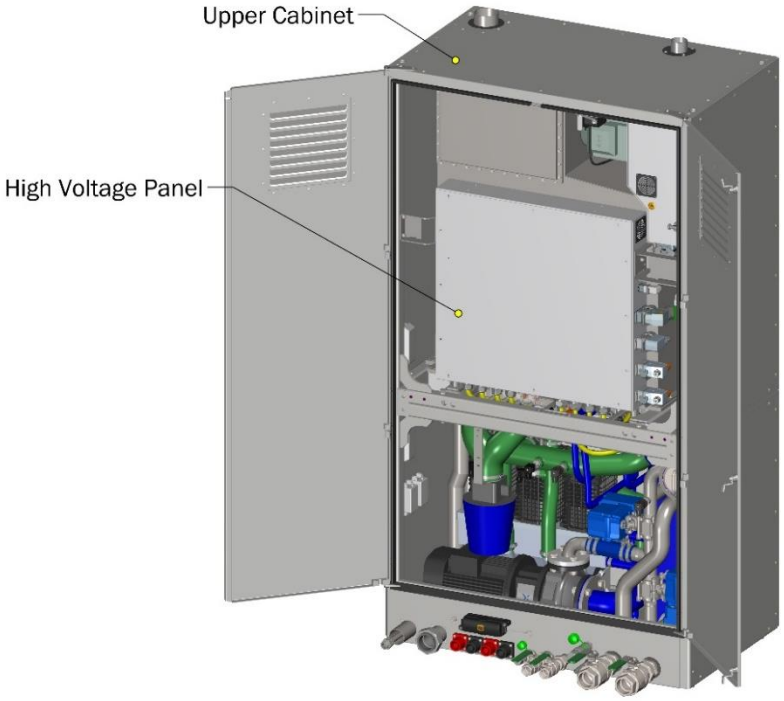


Figure 7-16: High Voltage probe positions for HV insulation test

This procedure is currently under development and will be a part of the next revision.

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7.6 Best Practices

7.6.1 Torque and Fastener Specifications

It is necessary to use the recommended tightening torques for fasteners, hose clamps and sensors for safe operation of the FCwave module.

- Tighten all fasteners to prevent parts from loosening due to vibration.
- Torque tightening must be applied with a calibrated torque wrench.
- Torque requirements depend on the type of materials, the type of part being connected, and if any washers or thread-locking chemicals are utilized.
- Do not apply excessive torque, that can cause damage to the fastener or other components.
- Do checks on torque wrenches and guns regularly, to make sure for correct calibration.
- Record the data in the logbook.

Warning and recommendations when using stainless steel bolts:

- When stainless steel surfaces with the same or similar materials come into contact and undergo friction, the risk of galling increases.
- High contact pressure between the bolt thread and nut can exacerbate galling. As the threads tighten, they can create significant friction, leading to galling if there's insufficient lubrication.
- Proper lubrication between the threads is essential to reduce friction and prevent galling.
- Under high stress and elevated temperatures, the risk of galling increases.
- Apply krytox for bolts used in the H_2 full system and for the process air system.
- To prevent galling with stainless steel bolts and nuts:
  - Apply an appropriate anti-seize lubricant or thread lubricant to the threads before assembly
  - Avoid excessive tightening torque, which can increase the risk of galling
  - Coating the threads with a material like zinc or cadmium can reduce the risk of galling

Usually, fasteners must be tightened with hand before applying the specified torque. If the assembly procedure is in the reverse order of disassembly, torque specifications will be included in its replacement maintenance section. Assembly steps will be given only when the fasteners or parts are critical. Follow manufacturer guidelines where they are applicable.

Refer to Table 7-4 for the FCwave module standard torque values. All fasteners of a given size require the torque of stainless-steel grade 8.8. Few exceptions can be found for parts that are made from a softer material, such as aluminum, plastic, etc. Multiple torque tools can be required for satisfactory torque range and safety of the BOP components.

Fastener	Tool		Torque Specification for FCwave module (Nm)	Exceptions
	Allen key	Wrench		
M3	2.5 mm hex		1.3 ± 0.2	
M4	3 mm hex	7 mm	3.5 ± 0.5	
M5	4 mm hex	8 mm	6.5 ± 0.5	
M6	5 mm hex	10 mm	10 ± 0.5	For Manifold connections M6 bolt must be tightened to 6 Nm only.

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Fastener	Tool		Torque Specification for FCwave module (Nm)	Exceptions
	Allen key	Wrench		
M8	6 mm hex	13 mm	25 ± 0.5	M8 on Compressor, Inverter, Exhaust fit bolts, Humidifier connection brackets– use 15 Nm only. M8 on Heat exchanger bracket – use 9.5 Nm only.
M10	8 mm hex	17 mm	50 ± 5	For H_2 Valve block bracket – use 25 Nm only.
M12	10 mm key	19 mm	85 ± 5	
M14	12 mm key	22 mm	140 ± 5	
M16	14 mm key	24 mm	150 ± 5	
Thread connection 1/4”		19mm Wrench	15 ± 0.5	
Thread connection 1/8”		18mm Wrench	18 ± 0.5	
Thread connection 1/2” Sensors		12, 24x27, 30, 32 mm Wrench	25 ± 0.5	For DI strainer connection – use 30 Nm + PTFE tape, For Valve block vent connection – use 35 Nm.
		IMPORTANT to have a Wrench for counterturn		
Thread connection 3/4”		32 and 41 mm Wrench	50 ± 0.5	
Thread connection 1 ¼”		46x50 mm Wrench	120 ± 0.5	
Fuel supply line		20 mm Wrench	Hand tight + 1.25 turn	For new fittings
Fuel supply line		20 mm Wrench	Hand tight + 0.25 turn	For existing fittings
Contactors to bus bar		15 mm socket	17 ± 1	
HV connector to bus bar		6 mm hex and 13 mm socket	25 ± 1	
HRB controller terminals		7 mm socket	7.0 ± 0.5	
Hose clamps		7 mm socket	5.0 ± 0.5 Nm	

Table 7-4: Fastener torque specifications

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7.6.2 Handling Controllers (MCU)

The MCU controllers are complex and easily damaged components that must be carefully handled. They are vulnerable to electrostatic discharge (ESD).



Figure 7-17: MCU Controller

ESD (also called 'static electricity') can be generated by the movement of a personnel's clothes against the skin or shoes against the floor, so it is easy for a service technician to build up a static charge. The skin is conductive, which allows the static charge to flow around the body and build up. To dissipate this charge, the skin needs to be continually grounded.

An ESD wrist strap has a conductive strap that makes 360-degree contact with the technician's wrist. The cord makes sure the technician is grounded when the clip is attached to a non-painted metal surface or other grounded point.

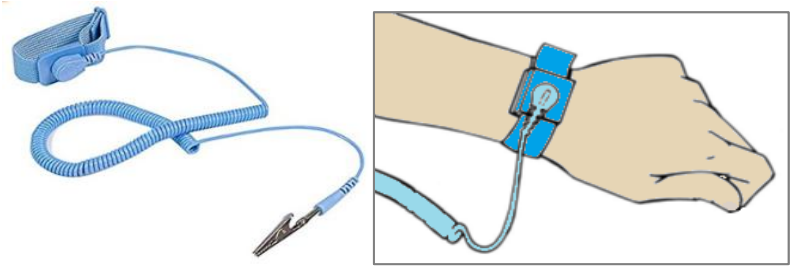


Figure 7-18: ESD wrist strap and cord

Here are a few things to keep in mind when working with controllers:

- ESD can easily damage electrical components in the MCU, even at levels that a technician cannot feel.
- Failure of controllers can happen any time after the electrostatic discharge occurs.
- Always use an ESD anti-static wrist strap and cord.
- Always transport and store controllers in sealed static protection bags (Figure 7-19: Controller cards in shielded bag) or similar containers.

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Figure 7-19: Controller cards in shielded bag

7.6.3 Environmental Protection

The FCwave module is constructed to be in accordance with the ingress protection ratings IP44. The module is designed for installation in a dedicated fuel cell room (Machinery space of category A) fulfilling the relevant fire protection and ventilation requirements as per SOLAS and Classification Society. Although the module is IP44 rated, prevent direct high-pressure water sprays.

7.6.4 Standby to Operation Cycles

Maximum standby to operation cycles: **6 cycles per hour (average)**

To prevent wear of mechanical and electrical components and to preserve the performance of the fuel cell stack, it is necessary that the number of 'Standby to Operation' cycles is limited to 6 cycles/hr. More frequent cycles can result in premature performance loss.

7.6.5 Disposition

All parts removed during maintenance must be disposed of according to section 10.0. The specified disposition is included in the preventive maintenance instructions (refer to section 8.0).

There are 3 disposition specifications:

- **Return to Ballard** — Return faulty part to Ballard for failure analysis, repair, or refurbishment.
- **Scrap** — Discard the faulty part appropriately, according to any local government regulations.
- **Hold** — Hold faulty part until Ballard has been contacted, part may need to be returned.

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8.0 Preventive Maintenance (PM) and Corrective Maintenance (CM)

The FCwave module requires periodic preventive maintenance for safe and reliable operation throughout the service life of the system.

Corrective maintenance of the FCwave module can be required in the case of a component not functioning and needs to be replaced.

8.1 Service Schedule

Adequate maintenance records verifying compliance with these tasks are required to validate warranty coverage. Failure to provide these records to Ballard can result in dismissal of warranty claims.

The end user must comply with these maintenance records:

- Date of each task performed
- Operating hours on the module at the time of each service task
- Calibrations of all service parts
- Date of all service part replacements and serial number of the part (where available)

The FCwave module Preventive Maintenance Checklist can be used as a detailed maintenance record form. Refer to the Customer Portal or contact BPSE (see section 4.1) for the latest revision.

The preventive maintenance activities that are necessary for FCwave module are listed in the preventive maintenance plan, find the newest version in the Customer Portal, which includes reference to relevant section for detailed instructions.

The Service Schedule specifies the necessary service interval for each procedure

- in hours (module operation time)
- months (elapsed time)

Service intervals are based on a duty cycle with an average output power of 67% rated power. Operating at a higher average power, which means exceeding 67% of rated power, will increase maintenance frequency of the module.

8.1.1 Responsibilities

Ballard provides necessary training to customer(s) for the FCwave module installation, operation, and maintenance procedures. This work must only be performed by approved personnel who understand the principle and are aware of the safe operation limits of the fuel cell. Thus, it is the customer's responsibility to get adequate training to operate, install, servicing and proper handling of the FCwave module.

Preventive maintenance of the fuel cell module is necessary for safe operation and is the responsibility of the end user, as described in the preventive maintenance plan.



DO NOT PERFORM MAINTENANCE SERVICE WITHOUT TRAINING OR SUPERVISION FROM BALLARD, AS DOING SO CAN RESULT IN LOSS OF WARRANTY

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8.1.2 Safety Instructions and Precautions

ALL PERSONNEL MUST READ AND FOLLOW THE INSTRUCTIONS BEFORE START OF ANY WORK.



Isolate the hydrogen supply to the upstream of fuel cell system before start of any service procedures.

Always wear adequate PPE. Follow all shipboard vessel safety protocols and general safety guidelines refer to section 6.0.



Components of the fuel cell system can reach a surface temperature of 80°C or higher. Do not perform maintenance procedures immediately after operation or before the module is cooled down.



Fuel cell voltage can exceed 390V during operation. Stack voltage stays even when the system is not in operation. Allow residual voltage decay to below 5V before performing any work. Always check stack voltage before service accessing inside the module.

8.1.3 Training level Certification

At Ballard, training is classified into 3 tiers:

- **Tier 1 – Service technicians and fuelers**
  - 1st point of contact for product support
  - Activities: Cleaning and Fueling

- **Tier 2 – Service technicians and mechanics**
  - 2nd point of contact for product support
  - Activities: Preventive Maintenance, basic troubleshooting, and spare part support

- **Tier 3 – Senior service technicians and engineers**
  - 3rd point of contact for product support
  - Activities: Report design issues, provide Tier 1 and Tier 2 training, advanced support and advanced trouble shooting

Details of roles and responsibilities are reinforced by Ballard's standard Service Level Agreement.

8.1.4 Maintenance Plan

It is required to follow the maintenance plan to ensure trouble-free operation during the lifetime of the FCwave module.

The maintenance tasks for the FCwave module are listed in the preventive maintenance plan. Go to the Customer Portal or contact BPSE, to see the latest revision (see section 4.1).

8.1.5 Maintenance Checklist

To perform periodic service maintenance, refer to the preventive maintenance checklist. Go to the Customer Portal or contact BPSE, to see the latest revision (see section 4.1).

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8.2 H_2 Fuel Anode Sub-system

For detailed P&ID requirements, refer to "Piping and Instrumentation Diagram" (PWR005), which can be found the Customer Portal or by contacting BPSE (see section 4.1 for further information).

8.2.1 Replace Purge Valve

Purpose:

The procedure describes the work instruction to replace a purge valve for the fuel cell system. The solenoid valve controls the purge of excess hydrogen and water from the fuel cell stack outlet, into the process exhaust. This keeps adequate concentration of H_2 in the sub-system and H_2 concentration in the process exhaust is kept below 2% volume.

Responsibilities:

Preventive maintenance of the purge valve is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance (see section 8.1.1)

Parts and equipment:

A list of parts and special equipment is identified to replace the purge valve during the life and operation of the FCwave module.

- FRU, Purge Valve (part no. 7500017)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Purge Valve

Based on the normal conditions, the estimated time for replacement is:

Purge Valve		
Duration	8 hours	
Personnel	1	
Tightening Torque	M4 bolt	3.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	M10 bolt	50 ± 5 Nm
	1/8" Thread connection	18 ± 0.5 Nm
	Tool: 3mm, 5mm, 6mm, 8 mm Hex key, 18mm spanner	

Table 8-1: Time to replace the purge valve

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Disconnect all connectors (CN201, CN202, CN500, CN505) in the high voltage panel as shown:

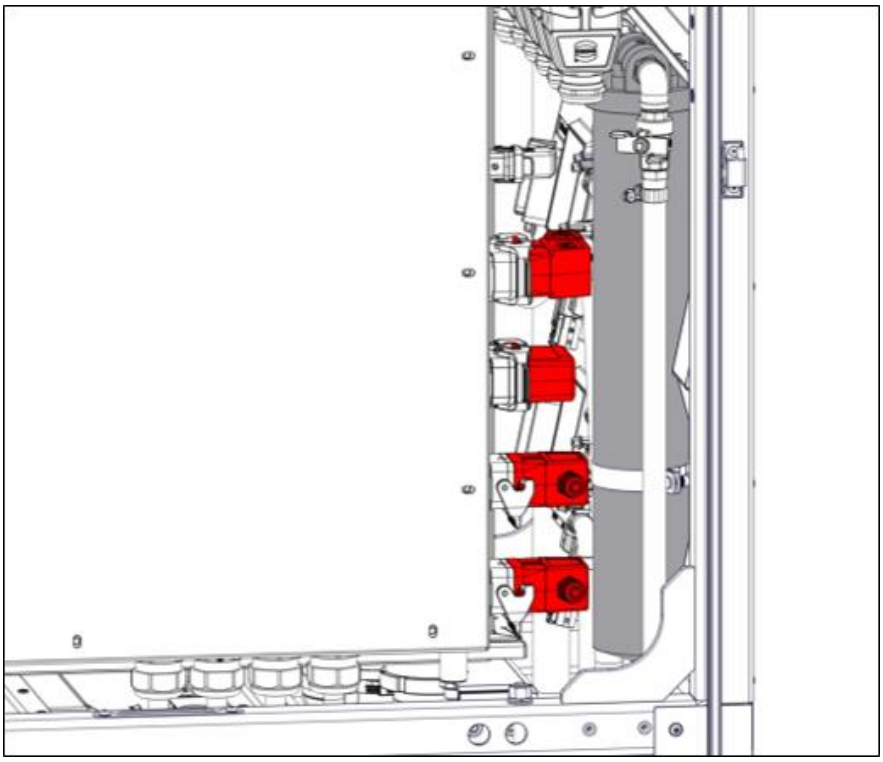


Figure 8-1: Overview of connectors in HV panel

3. Disconnect connection CN205 for fire detection from the side of the high voltage panel.

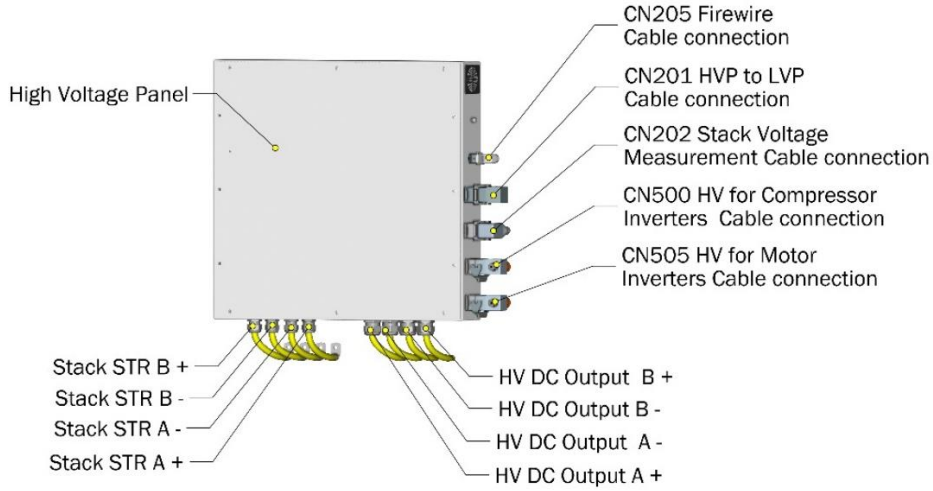


Figure 8-2: Cable connections in HV panel

4. Loosen M32 cable glands to disconnect the HV stack cable connections to positive terminals (A+, B+) and negative terminals (A-, B-).

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5. Loosen M32 cable glands to disconnect the HV DC output cable connections to positive terminals (A+, B+) and negative terminals (A-, B-).
6. Uninstall 2 pcs. M10 bolts and washers used to tighten the HV panel assembly to the bottom of upper cabinet.
7. Uninstall 2pcs. M8 bolts and washers used to tighten the HV panel assembly to the sides of upper cabinet.

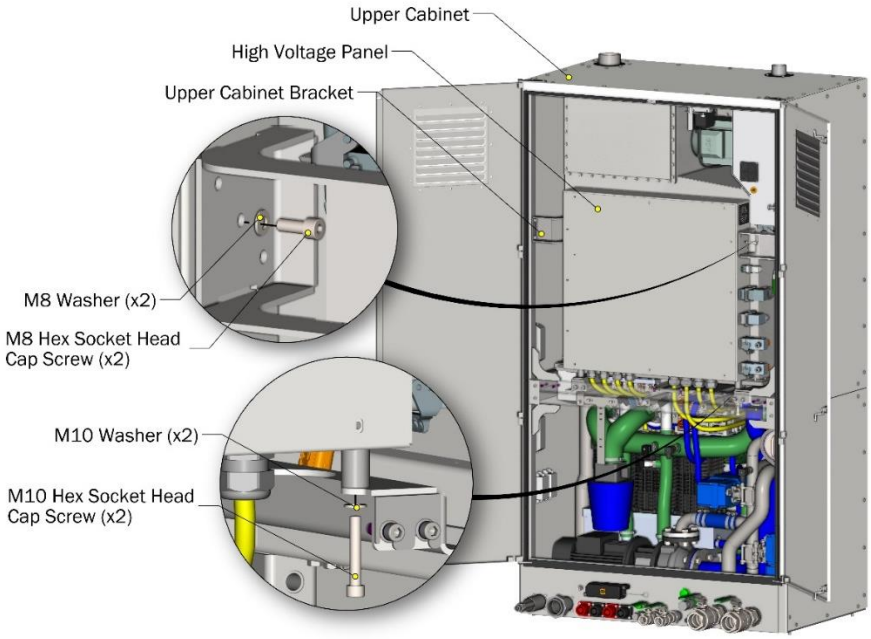


Figure 8-3: Dismount HV panel

8. If applicable, remove the ground fault monitor board.
9. Install eyebolt on each side of the HV panel and carefully lift the panel assembly, with all its hardware inside, out of the cabinet and move to flat work surface.

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10. Uninstall 22 pcs. M6 bolts and washers to remove the purge hatch cover from the H_2 enclosure.

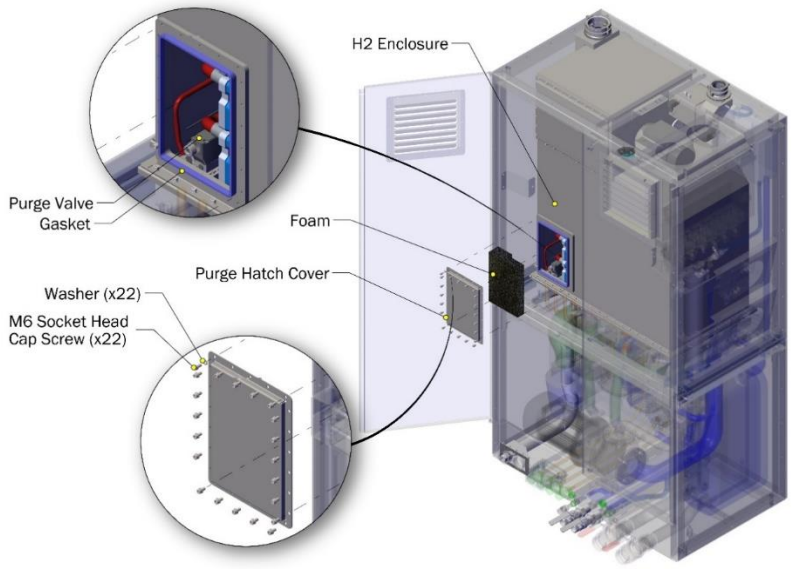


Figure 8-4: Removal of purge hatch cover

11. Remove foam in the enclosure to locate the fuel-out pressure sensor (PT_H50) behind the purge valve.
12. Remove connector (HRNS-300-YV_H50) which is routed all the way through the HRB unit.
13. Locate the H_2 enclosure top hatch and uninstall 34 pcs. M6x12 bolts to access the enclosure.

    Use a protective special plate below the HRB unit to prevent any loose part falling into the stack while servicing.

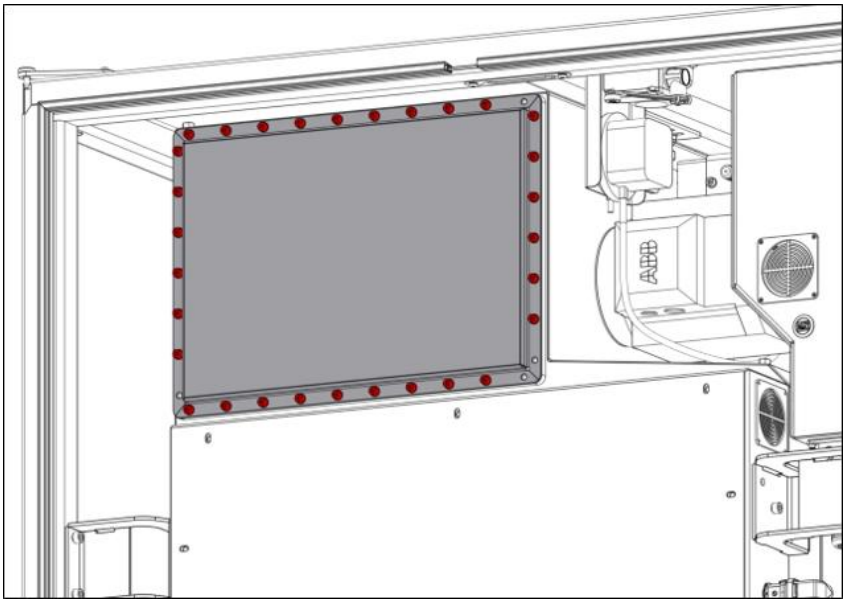


Figure 8-5: Location of H_2 enclosure top hatch

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14. Uninstall 2 pcs. M4 bolts and washers used to tighten the purge valve to the bracket in the purge hatch.

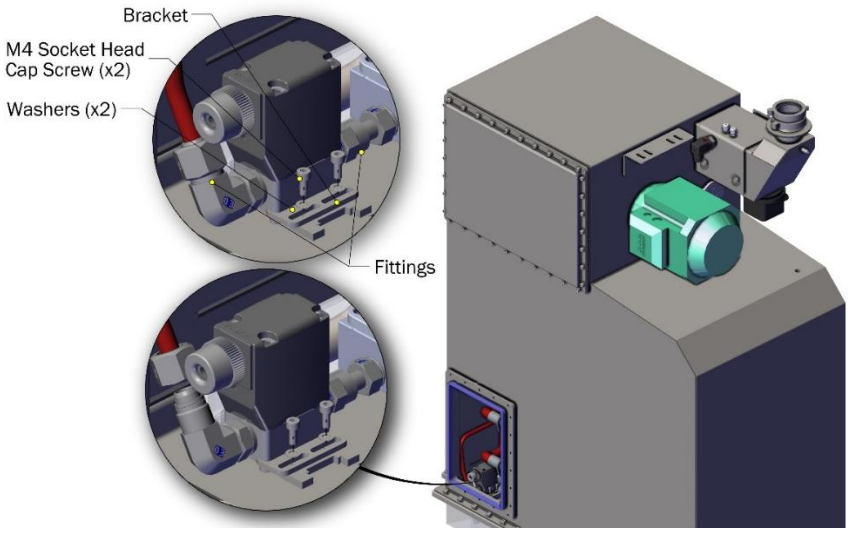


Figure 8-6: Removal of purge valve

15. Dismount the purge valve connection fittings and move to a clean work surface.
16. Uninstall 4 pcs. M4 bolts and washers used to tighten the purge valve to the bracket and remove the used gasket.

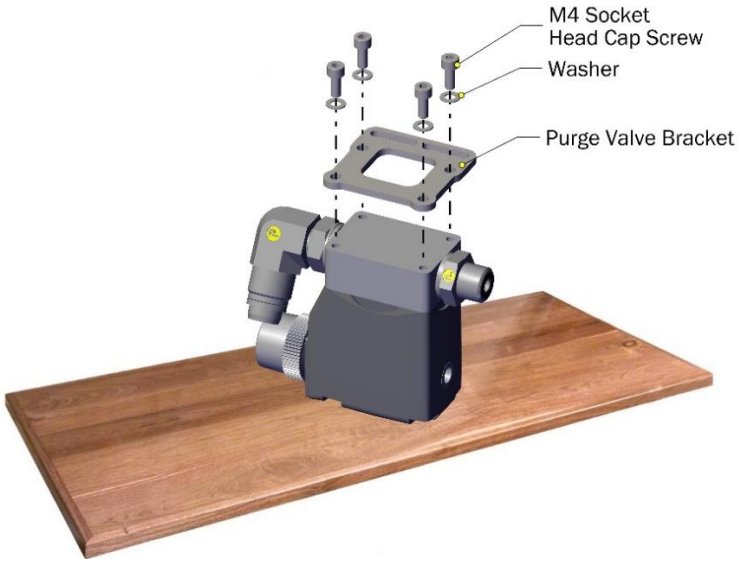


Figure 8-7: Removal of purge valve bracket and gasket

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Assembling procedure:

1. Insert new gasket in the purge valve and use 4 pcs. M4 bolts and washers to install purge valve to the bracket.
2. Place purge valve assembly into position in the purge hatch and connect the purge valve connection fittings.
3. Use 2 pcs. M4 bolts and washers to tighten the purge valve to the bracket in the purge hatch.
4. It is highly recommended to perform a leak test with H_2 sensor after any service maintenance on the purge valve (refer to section 8.2.4).
5. Use 34 pcs. M6x12 bolts and washers to install H_2 enclosure top hatch.
6. Install connector (HRNS-300-YV_H50) and place foam to cover the purge valve.
7. Use 22 pcs. M6 bolts and washers to install the purge hatch cover to the H_2 enclosure.
8. Reverse steps 2 through 9 of the disassembling procedure to install the HV panel assembly.
9. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
10. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
11. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
12. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.2.2 Hydrogen Recirculation Blower (HRB) Assembly

8.2.2.1 Check Hydrogen Recirculation Blower (HRB) Assembly

Purpose:

The procedure describes how to check the HRB assembly (Unit and Motor).

Responsibilities:

Checking the HRB assembly is necessary for safe operation according to the preventive maintenance plan (see Customer Portal). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the HRB Assembly

Based on the normal conditions, the estimated time for check is:

HRB Assembly	
Duration	20 min
Personnel	1
Tools	5mm hex key

Table 8-2: Time to check HRB Assembly

Procedure:

1. Before proceeding with the check, perform all steps in section 7.2.7 and 6.5.1.
2. Locate the hydrogen enclosure top hatch and use 5mm hex key to remove 34 pcs. M6x12 bolts.

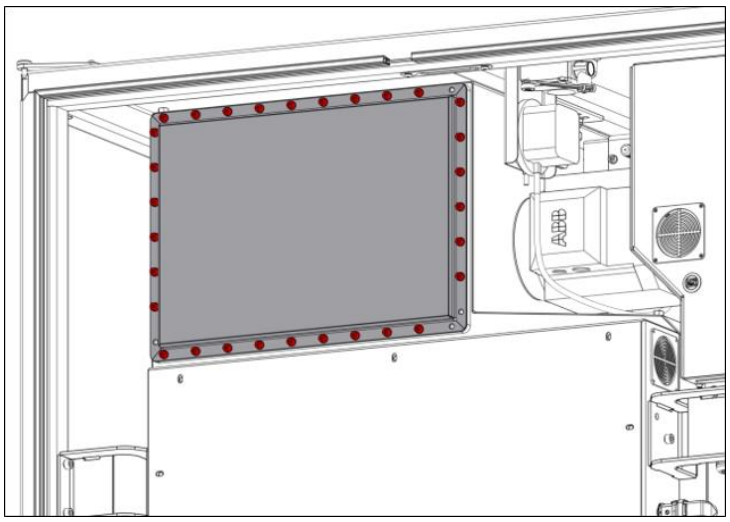


Figure 8-8: Location of H_2 enclosure top hatch

3. Remove the foam and check each piece for oil contamination from the HRB.
4. Check the HRB for oil leakage.

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5. Check the surface below the HRB for oil contamination.
6. Check the coupling material between the motor and HRB for wear.
7. Reinstall the foam and use 34 pcs. M6x12 bolts to reinstall the HRB hatch cover.
   The module is ready to be restored to normal operating state.
8. Confirm the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.2.2.2 Replace Hydrogen Recirculation Blower (HRB) Assembly

The following section describes how to replace the two parts of a hydrogen recirculation blower (HRB) assembly for the fuel cell system. The HRB assembly comprises the HRB unit and HRB motor. Both the HRB unit and HRB motor can be disassembled by disengaging the coupling connection.

8.2.2.2.1 Replace a Hydrogen Recirculation Blower (HRB) Motor

Purpose:

The procedure describes how to replace a hydrogen recirculation blower (HRB) motor assembly for the fuel cell system.

Responsibilities:

Preventive maintenance of HRB motor is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace a HRB motor during the life and operation of the FCwave module:

- FRU, HRB Motor (part no. 7500011)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the HRB motor

Based on the normal conditions, the estimated time for replacement is:

HRB motor		
Duration	2 – 2½ hours	
Personnel	1 – 2	
Tightening Torque	M6 bolts	10 ± 0.5 Nm
	M8 bolts	25 ± 0.5 Nm
	Tool: 5mm, 6mm hex key, air bags, ¼" ratchet, ¼" extension 100mm, 22mm key, 7mm, 8mm hex socket, torque wrench	
Weight	HRB motor	25 kg

Table 8-3: Time to replace the HRB motor

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the H_2 enclosure top hatch and uninstall 34 pcs. M6x12 bolts to access the enclosure.

   Use a protective special plate below the HRB unit to prevent any loose part falling into the stack while servicing.

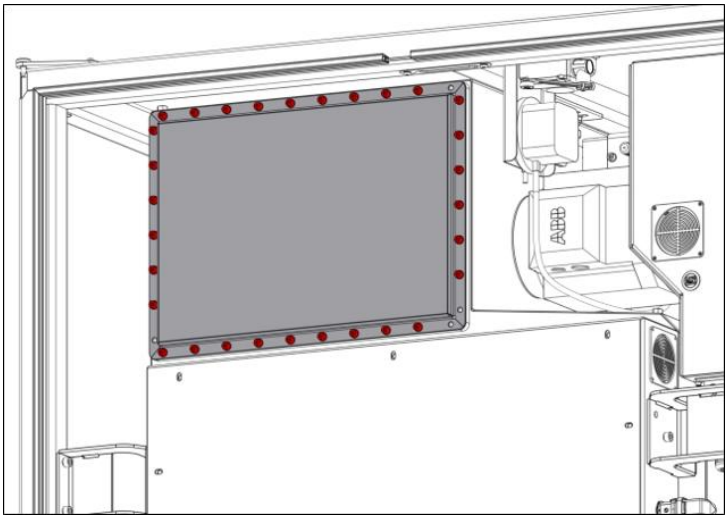


Figure 8-9: Location of H_2 enclosure top hatch

3. Gently remove foams in the enclosure and locate the HRB assembly.
4. Disconnect the CN500 plug from the right side of the HV panel to disable the HV power supply for the HRB motor controller.
5. Uninstall 2 pcs. bolts to open the HRB motor cover.
6. On the HRB motor, disconnect the inverter controller for the HRB motor connection HRN-400-CN_INV_H50 and the ground cable.
7. Uninstall 3 pcs. M8x30 bolts from the top right support bracket of the high voltage panel and remove the bracket.

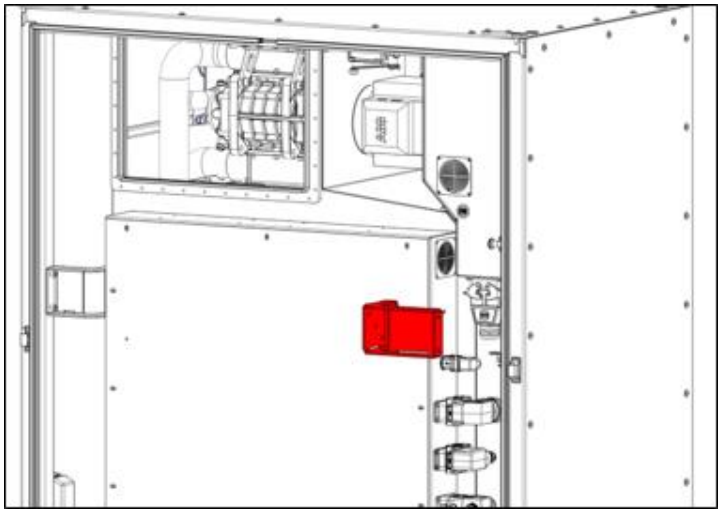


Figure 8-10: Support bracket on HV panel

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8. Slide the LV panel out a bit to make room for removing the HRB motor from the enclosure.
9. Insert 2 pcs. air bags below the HRB motor and inflate to support the motor.
10. Remove 4 pcs. M8x30 bolts.

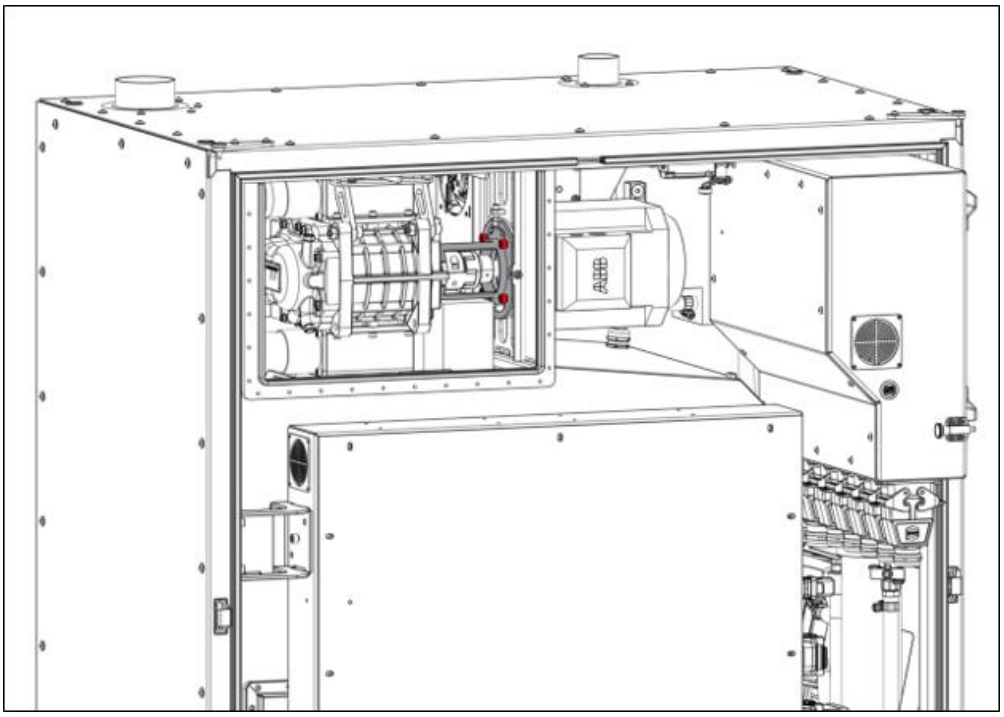


Figure 8-11: Removal of bolts to loosen HRB motor

11. Slide HRB motor to the right, turn and remove from the enclosure. Also remove air bags. Place the motor on a flat surface for service purposes.

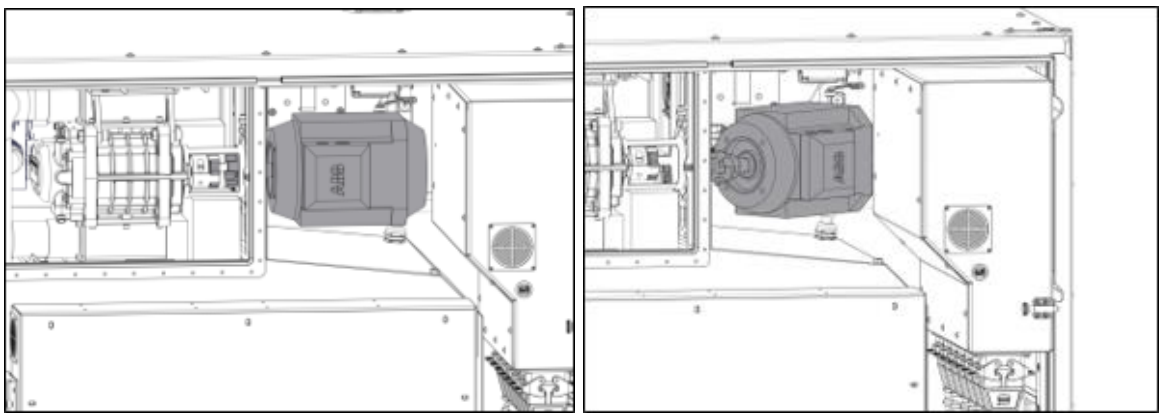


Figure 8-12: Turning and removing HRB motor

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Assembling procedure:

1. Place air bags beside the H_2 enclosure to support the HRB motor.
2. Carefully lift the HRB motor and place it on the air bags. Then carefully slide the motor clamping hub into the enclosure.

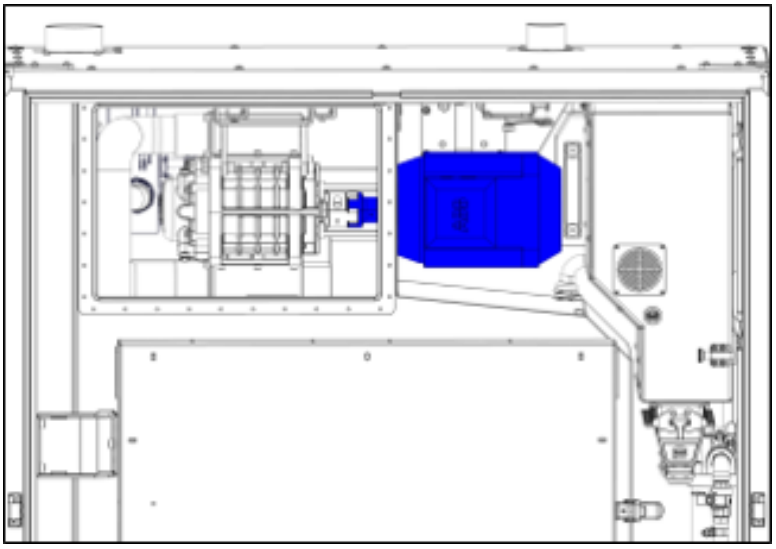


Figure 8-13: Install HRB motor to enclosure

3. Use the M6 alignment bolts to align the motor shaft.
4. Use 4 pcs. lubricated new M8 bolts to install the HRB motor to the enclosure. Tighten to 25 Nm.

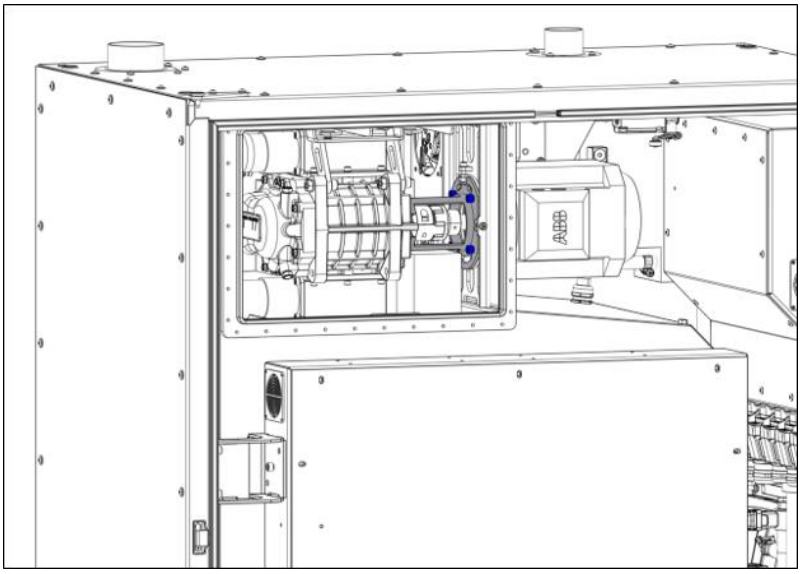


Figure 8-14: Securing motor to enclosure

5. Remove air bags from underneath the motor.
6. Connect both the inverter controller for the HRB motor connection HRNS-400-CN_INV_H50 and the ground cable.
7. Use 2 pcs. M8 bolts to install the HRB motor cover.

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8. Slide in the LV panel.
9. Use 3 pcs. M8x30 bolts and washers to install the right-side bracket of the HV panel. Tighten to 10 Nm.
10. Insert the foam on the front-side of the H_2 enclosure as shown:

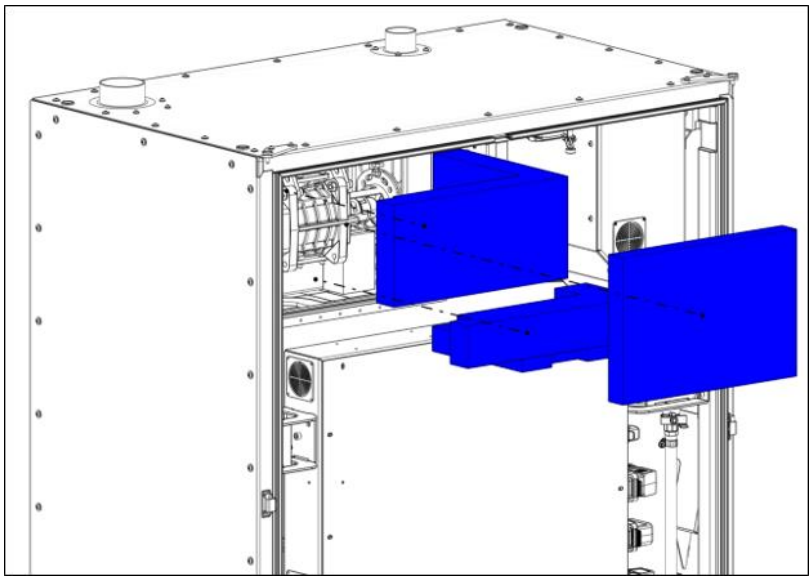


Figure 8-15: Install foam after installing HRB unit

11. Use 34 pcs. M6 bolts to install the H_2 enclosure top hatch cover. Tighten to 6 Nm.
12. Power up the module. Follow the HRB Test procedure to test the HRB alignment by manually activating the HRB motor through the engineering interface. Listen for loud noise and vibrations in the HRB assembly area before proceeding.
13. Contact BPSE customer care to register and reset the hour counter in the engineering interface for the HRB assembly.
14. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
15. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
16. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.2.2.2.2 Replace a Hydrogen Recirculation Blower (HRB) Unit

Purpose:

The procedure describes how to replace a hydrogen recirculation blower (HRB) unit assembly for the fuel cell system.

Responsibilities:

Preventive maintenance of HRB unit is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace a HRB unit during the life and operation of the FCwave module:

- FRU, HRB (part no. 7500007)
- FRU, Coupling (part no. 7500008)
- FRU, Coupling Element (part no. 7500013)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the HRB unit

Based on the normal conditions, the estimated time for replacement is:

HRB unit		
Duration	4 – 4½ hours	
Personnel	1 – 2	
Tightening Torque	M6 bolts	10 ± 0.5 Nm
	M10 bolts	50 ± 5 Nm
	Tool: 5mm + 8mm hex key, 12mm socket, 46mm crow's foot wrench, 17mm spanner, plastic bag/tape, ½" ratchet, ½" extension 400mm, torque wrench	
Weight	HRB unit	18 kg

Table 8-4: Time to replace the HRB unit

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Perform all steps in section 8.2.2.2.1 disassembling (Replace a Hydrogen Recirculation Blower (HRB) Motor) before proceeding.
3. Uninstall 3 pcs. M6 bolts from the fuel inlet manifold fitting. Afterwards cover the opening to prevent any unwanted material from entering the inlet. Slide off the hose as much as possible.

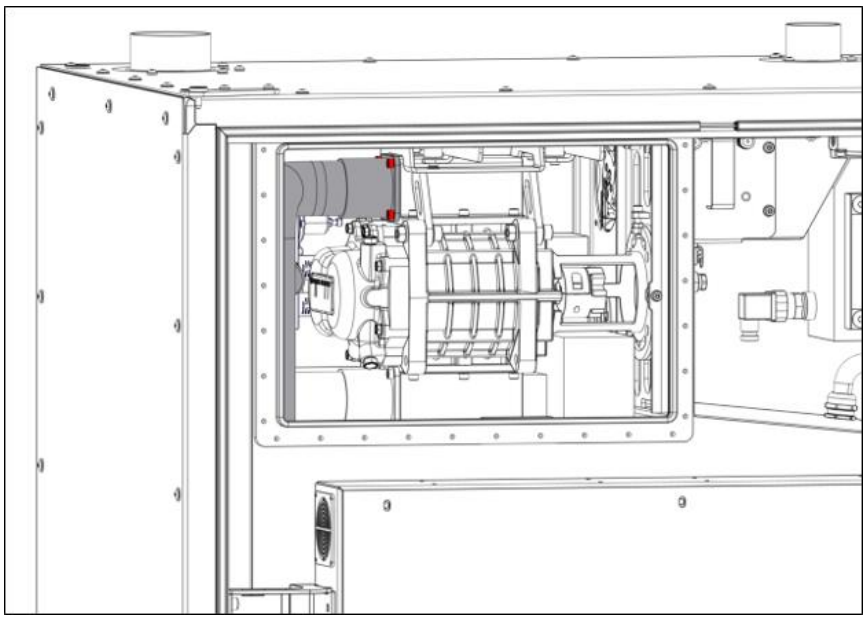


Figure 8-16: Removal of bolts for fuel inlet manifold

4. Uninstall 3 pcs. M6 bolts from the fuel outlet manifold fitting. Afterwards cover the opening to prevent any unwanted material from entering the inlet. Slide off the hose as much as possible.

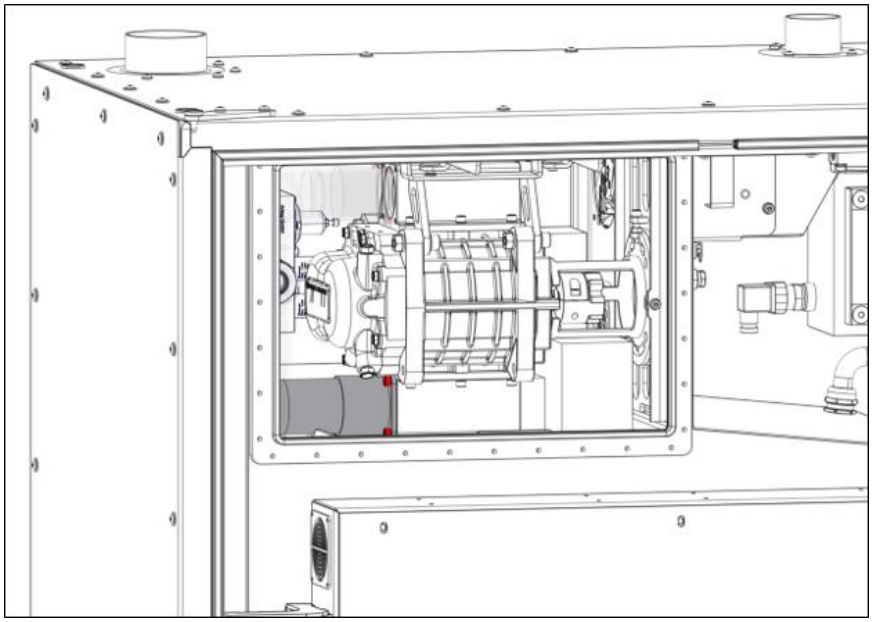


Figure 8-17: Removal of bolts for fuel outlet manifold

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5. Use crow's foot wrench to remove the fuel outlet hose fitting from the valve block.

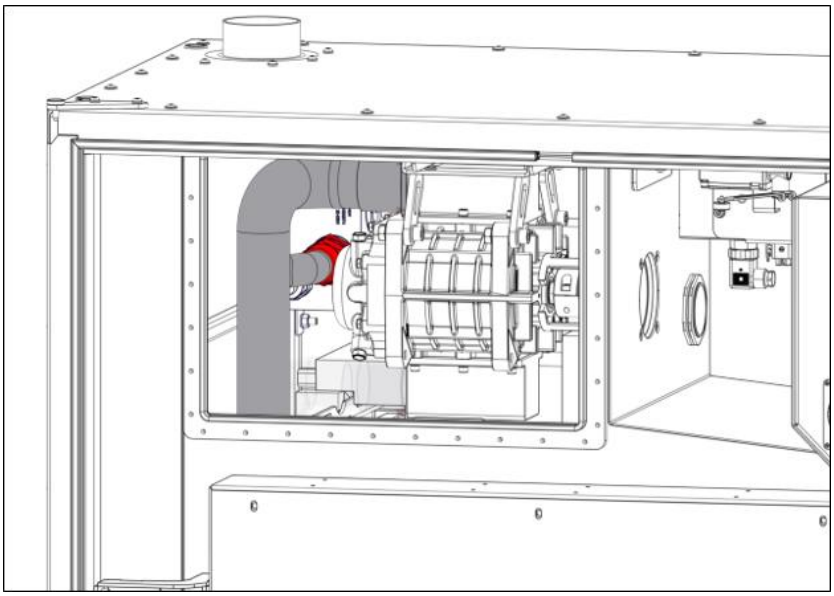


Figure 8-18: Removal of fuel outlet hose fitting

6. Uninstall 3 pcs. M6 bolts from the damper shoe brackets.
7. Carefully slide the HRB unit to the left over the mounting rails to dismount it from the H_2 enclosure. Rotate it 90 degrees horizontally, so the damper shoe bracket faces the enclosure top hatch and remove the HRB unit from the enclosure. Place it on a flat surface for service maintenance.

⚠ CAUTION Wear long sleeves and gloves to prevent cutting yourself on sharp edges when removing the HRB unit.

8. Remove old O-rings from disconnected hoses and open ports and then cover with a clean cap, plastic bag, or tape.
9. Disassemble the HRB compressor as shown:



Figure 8-19: Disassemble HRB compressor

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Assembling procedure:

1. Use 12 pcs. new M6x20 bolts and washers to reassemble the HRB manifolds with new O-rings. Tighten to 10 Nm. Remember to lubricate the bolts and to note down the serial number.
2. If not already there, carefully install the foam behind the HRB assembly.
3. Apply krytox and mount new O-rings in the fuel outlet and fuel inlet manifold fittings.
4. To insert the HRB unit, rotate it 90 degrees horizontally, so the bottom of the HRB faces the H_2 enclosure. Carefully insert the HRB unit inside the enclosure and rotate back to the correct position to mount it on the H_2 enclosure frame.
5. Fasten 3 pcs. M6 bolts to secure the HRB assembly to the H_2 enclosure. Tighten to 6 Nm.

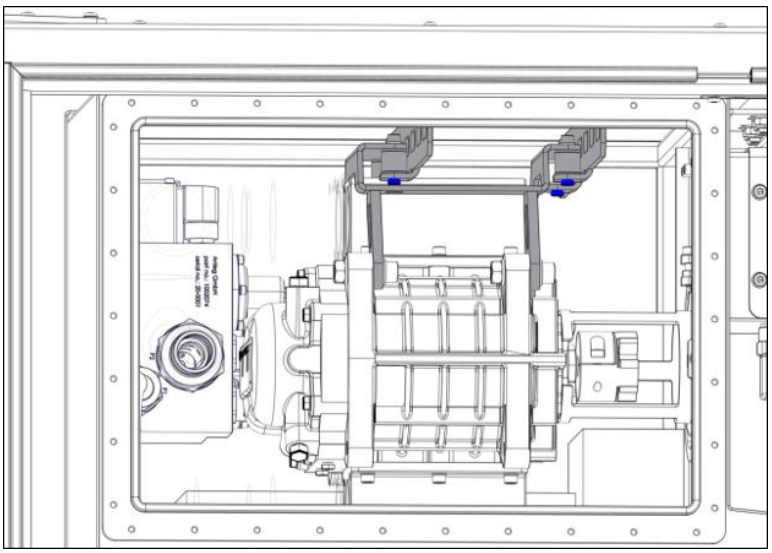


Figure 8-20: Install HRB assembly to bracket

6. Slide the lower hose onto the HRB fitting and make sure not to cut the O-ring. Use 3 pcs. M6 bolts to install it. Tighten to 6 Nm.

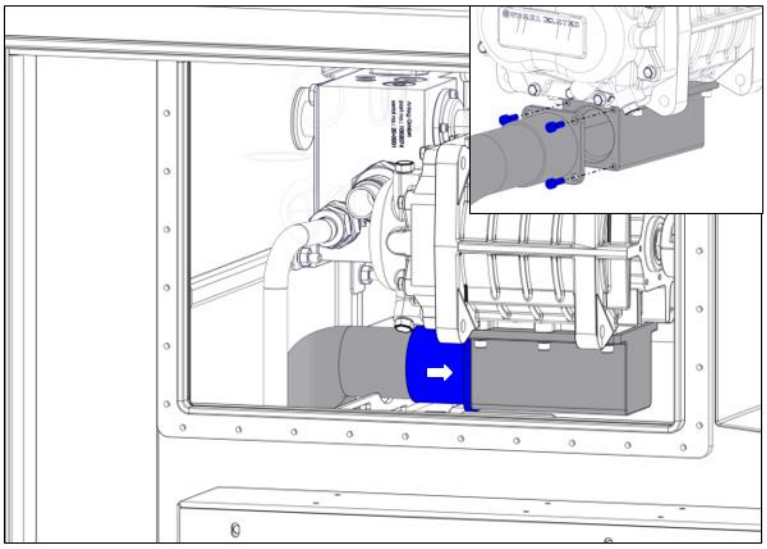


Figure 8-21: Install lower hose to HRB fitting

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7. Apply a bit of krytox to the fitting thread and connect the fuel outlet hose fitting to the valve block. Tighten to 120 Nm.
8. Slide the upper hose onto the HRB fitting and make sure not to cut the O-ring. Use 3 pcs. M6 bolts to install it. Tighten to 6 Nm.
9. Replace the motor gasket.

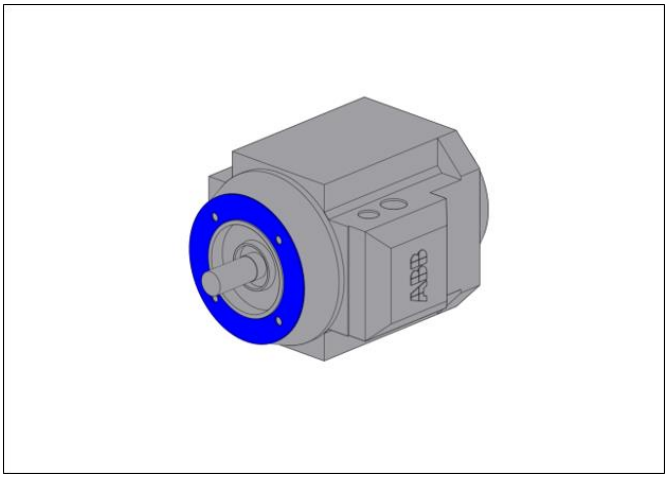


Figure 8-22: Replace motor gasket

10. Mount the new element 24/32 onto the clamping hub of the motor.

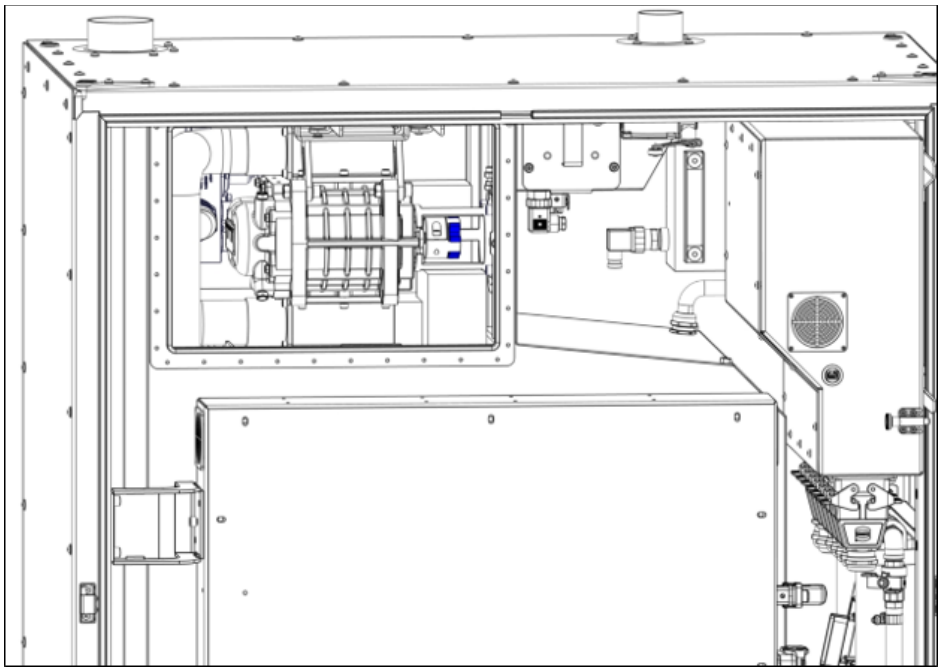


Figure 8-23: Mount new element onto clamping hub

11. Proceed the assembling procedure with all steps in section 8.2.2.2.1 assembling procedure.

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8.2.3 Replace Hydrogen Valve Block

Purpose:

The procedure describes how to replace a hydrogen valve block in the fuel sub-system. The function of the valve block is to start and stop the flow of H_2 fuel supply, and it is comprised of:

- Fuel filter – removes fuel intake impurities to protect the upstream equipment
- Fuel supply solenoid valve – controls the flow of H_2 to the fuel cell
- Fuel pressure control valve – from supply pressure to specified output pressure
- Safety relief valve – shuts off the inlet valve in case of an emergency

The valve block also provides feedback on inlet/outlet pressure and regulation of pressure.

Responsibilities:

Preventive maintenance of the hydrogen valve block is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the valve block during the life and operation of the FCwave module.

- FRU, Hydrogen Valve Block (part no. 7500025)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace H_2 Valve Block

Based on the normal conditions, the estimated time for replacement is:

H_2 Valve Block		
Duration	5 hours (need to remove HRB unit)	
Personnel	1	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M10 bolt	
	1/2" Thread connection	25 ± 1 Nm
	3/4" Thread connection	50 ± 1 Nm
	1 1/4" Thread connection	120 ± 2 Nm
	Tool: 5mm + 8mm hex key, 14mm + 17mm spanner, cross-head screwdriver, 13mm hex socket, 20mm extension, 32mm crow's foot wrench, ½" ratchet, ½" extension 400mm, plastic bag/tape, torque wrench	

Table 8-5: Time to replace the H_2 valve block

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Perform all steps in section 8.2.2.2.2 (Replace a Hydrogen Recirculation Blower (HRB) Unit) to remove the HRB unit from the HRB assembly. Next, locate the hydrogen valve block at the top left corner in the H_2 enclosure.
3. Use a wrench to disconnect the H_2 valve block supply fitting.

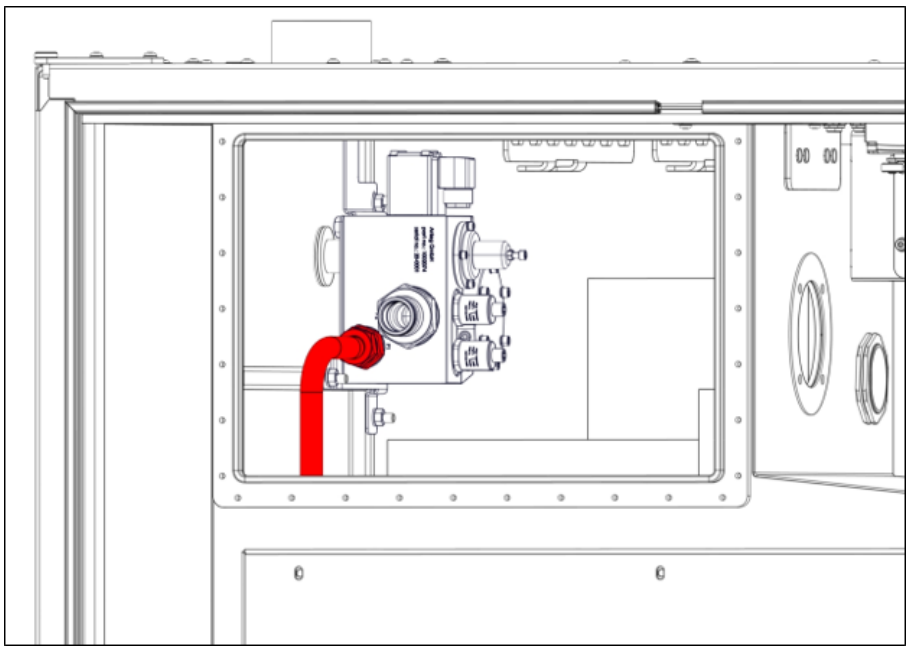


Figure 8-24: Valve block supply fitting

4. Remove the following connectors from the valve block:
   - HRNS-300-CN-YV_H30
   - HRNS-300-CN-PCV_H40
   - HRNS-300-CN-PT_H30
   - HRNS-300-CN-PT_H40

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5. Remove 4 pcs. nuts and washers used to tighten the valve block bracket to the H_2 enclosure.

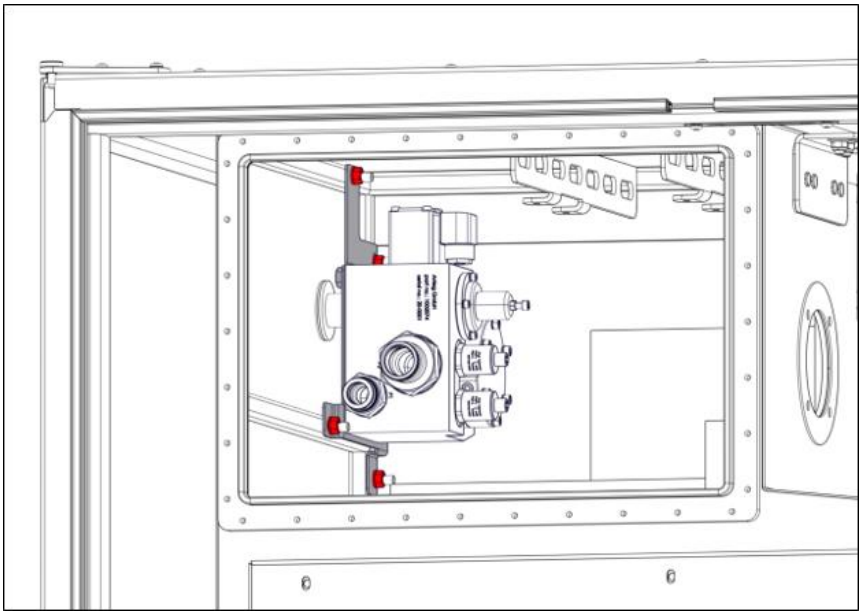


Figure 8-25: Removal of nut/washers of valve block bracket

6. Remove the valve block assembly and place it on a flat surface for service purpose.
7. Cover all disconnected hoses and open ports with clean cap or tape to prevent any unwanted material entering the hoses and open ports.

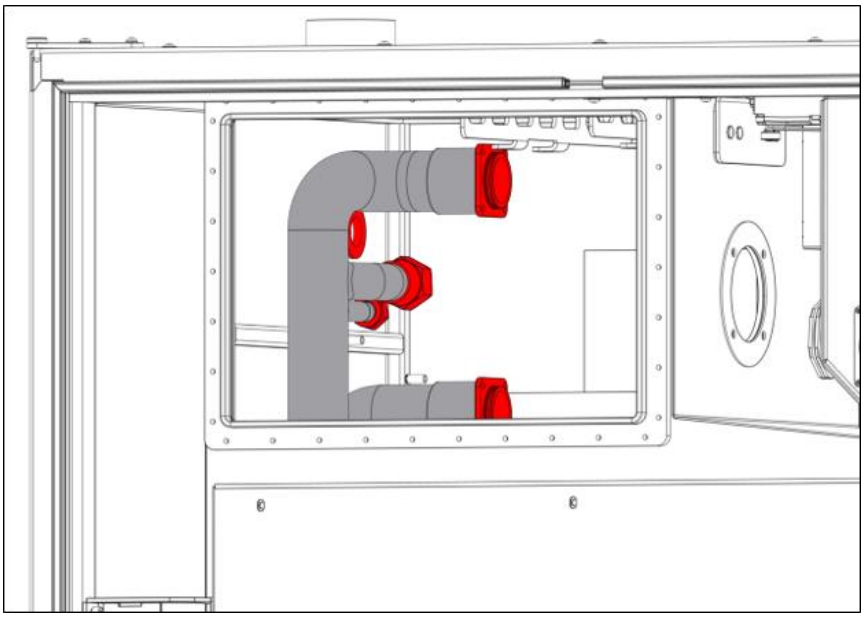


Figure 8-26: Cover up hoses and open ports

8. Remove 4 pcs. M10 bolts and washers and remove the valve block bracket from the valve block.
9. Send the used hydrogen valve block to Ballard for failure analysis (see section 4.1 for contact information).

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Assembling procedure:

1. Install a new bonded seal in the connection tube and install the connection tube on the valve block. Apply krytox to the thread and seal to prevent any damage.
2. Use 4 pcs. M10 bolts and washers to install the valve block to the valve block bracket. Keep the bolts loose while sliding the valve block onto the bracket. Apply ceramic grease to the bolts.
3. Place the valve block assembly on the mounting points. Adjust the valve block to fit the connection tube into the exhaust. Tighten the M10 bolts to 15 Nm to secure the valve block.

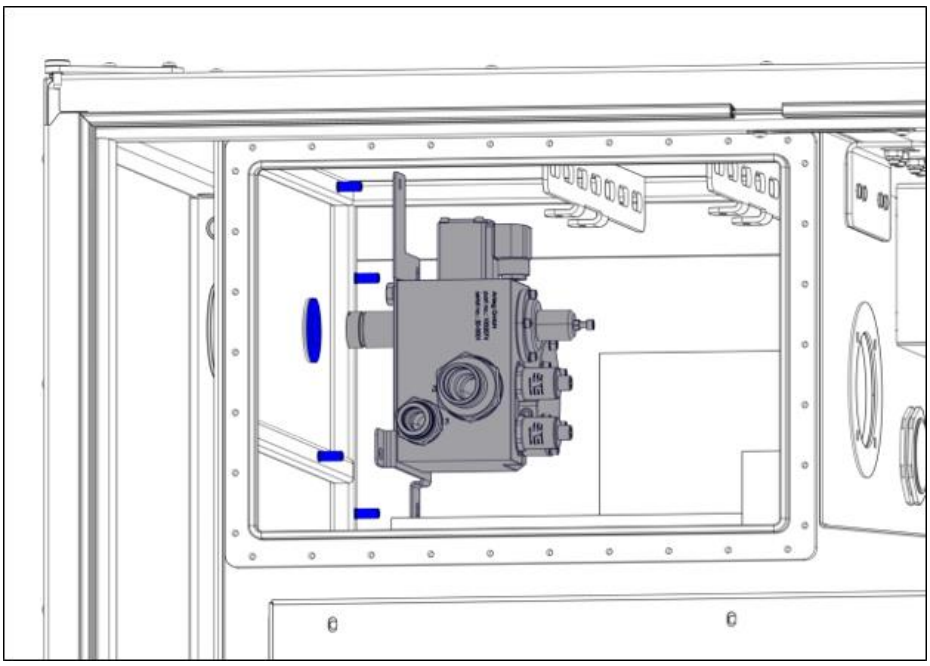


Figure 8-27: Mounting the valve block in the enclosure

4. Apply krytox and install the new O-ring onto the connection tube.

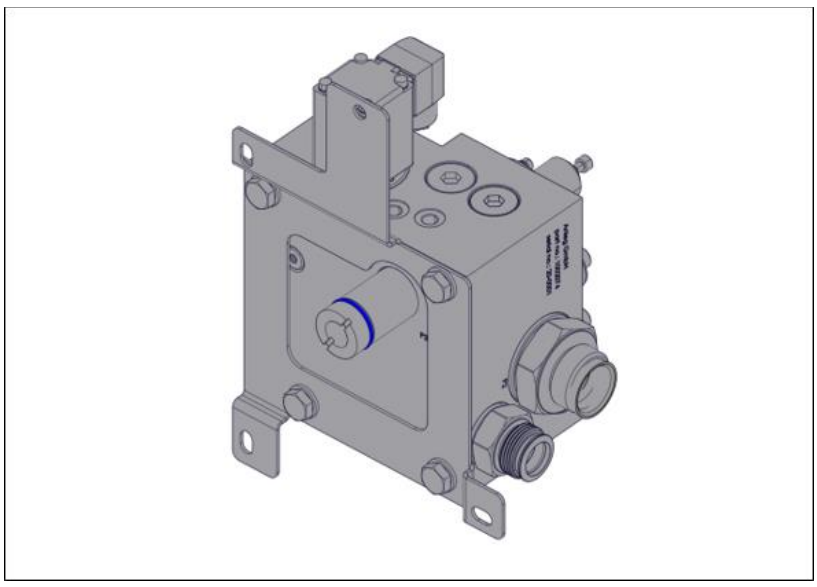


Figure 8-28: O-ring on connection tube

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5. Install the valve block assembly on the mounting points of the H_2 enclosure frame.
6. Use 4 pcs. M8 locknuts and washers to secure valve block bracket to the enclosure. Tighten to 15 Nm.
7. Use a spanner to connect the fuel supply fitting.
8. Install the following connectors to the valve block:
    - HRNS-300-CN-YV_H30
    - HRNS-300-CN-PCV_H40
    - HRNS-300-CN-PT_H30
    - HRNS-300-CN-PT_H40
9. Perform steps 3 through 23 of assembling procedure in section 8.2.2 to reassemble HRB assembly.
10. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
11. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
12. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.2.4 Assurance Procedure – Anode Sub-system leak test

Succes criteria for leak testing:

There is a leak if:

- Values recorded during the test are out of acceptable range provided by the "Leak Test Report Form", which can be found on the Customer Portal (see section 4.1 for further information)
- Unable to create correct pressure in the system
- Escaping air can be heard within the module
- Hydrogen gas and a hydrogen sniffer can be used to identify leaks

There is no leak if:

- All the values recorded during the test are within the accepted range provided by the "Leak Test Report Form" which can be found on the Customer Portal (see section 4.1 for further information)
- No sound coming from the module can be heard

Estimated time to perform the anode sub-system leak test

Based on the normal conditions, the estimated time for testing is:

Anode sub-system Leak Test		
Duration	3 hours	
Personnel	1	
Tightening Torque	M5 bolt	6.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	Tool: 4mm + 5mm hex key, 8mm hex socket, leak tester, leak test hose, 32mm crow's foot wrench, laptop, WLAN cable	

Table 8-6: Time to perform anode sub-system leak test

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Procedure:

1. Secure the area before pressurizing the system components.
   Use warning signs around the working area to ensure safety.
2. Locate the adaptor box, located in the top left corner of the lower cabinet, covering the C-piece.



Figure 8-29: Location of box covering c-piece

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3. From the top of the box, uninstall 5 pcs. M5 bolts and washers.

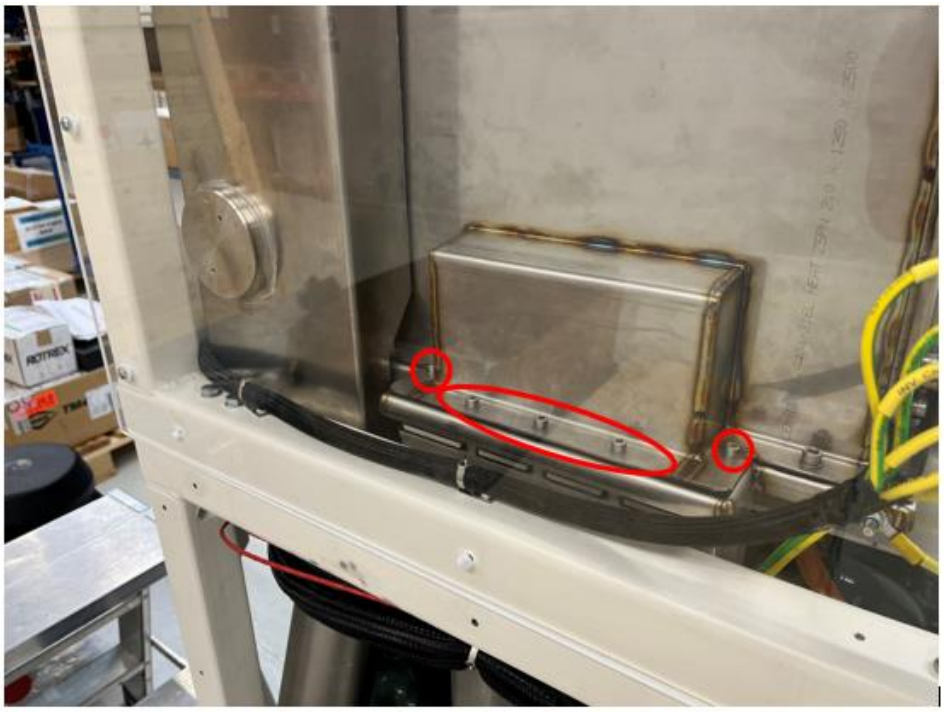


Figure 8-30: Removal bolts top side of adaptor box

4. From the bottom of the box, uninstall 3 pcs. M5 nuts and washers and 4 pcs. M6 bolts and washers.



Figure 8-31: Removal bolts bottom side of adaptor box

5. Slide down the box to access the process exhaust swivel located behind the adaptor box.

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6. Use the special tool (exhaust swivel) to loosen the exhaust swivel and install exhaust blinding plate between the top and bottom part of the process exhaust as indicated.



Figure 8-32: Placement of blinding plate in swivel

7. Re-establish the process exhaust. Tighten to 20 Nm.
8. Remove the C-piece.

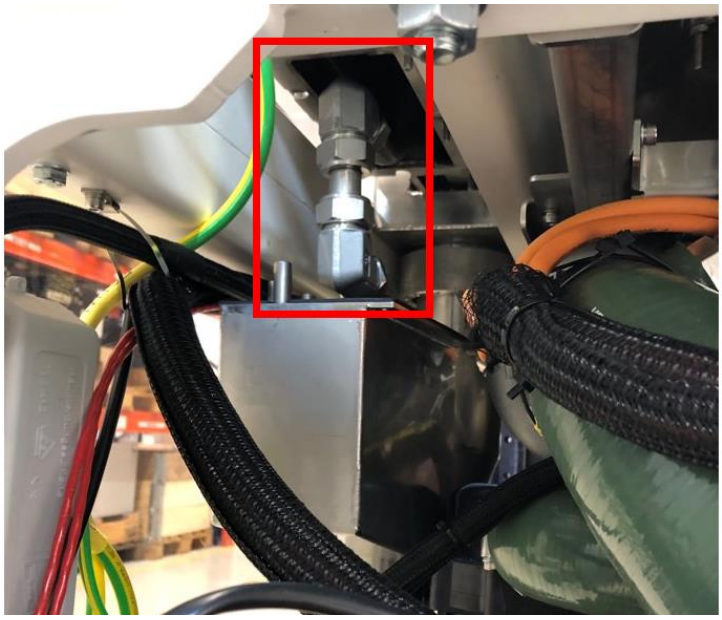


Figure 8-33: Uninstall C-piece

9. Install the pressure inlet plug where the top of the C-piece was installed.

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10. Use laptop to connect to module engineering interface.
11. Navigate to the I/O page and stay on the Fuel tab. Force 'YV_H30' to open and set valve for PCV_CTRL_SP to 1.1 - equivalent to 1.1 bar(g) – not to 1.0 as shown in the picture.



Figure 8-34: Forcing YV_H30 to open

12. Navigate to the P&ID page and check that 'YV_H30' is open and the box above PCV_H40 (PCV_CTRL_SP) is set to 1.1 - equivalent to 1.1 bar(g) – not to 1.0 as shown in the picture.

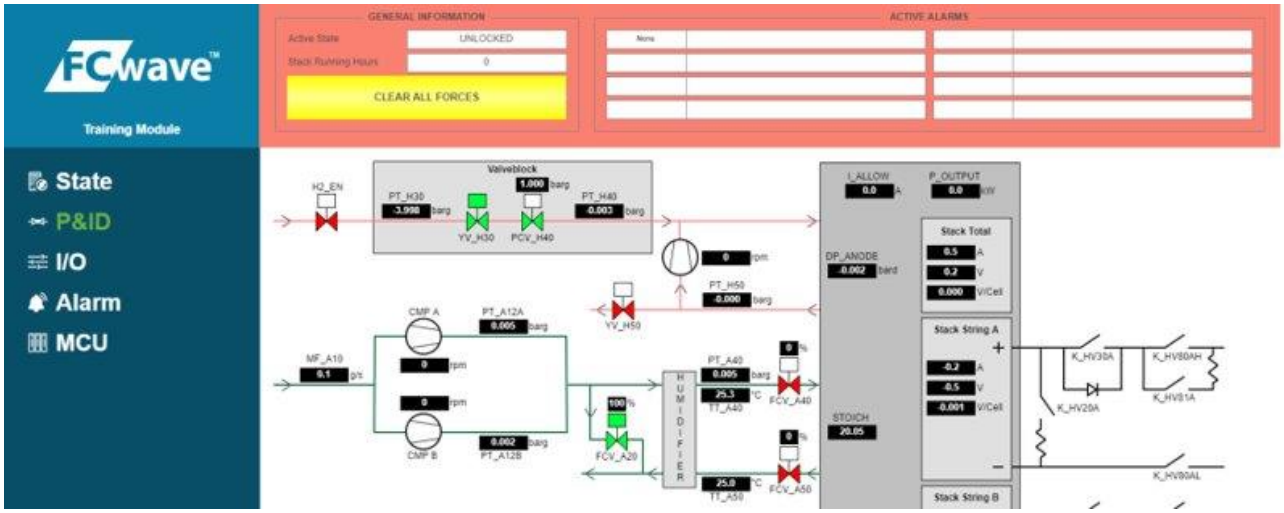


Figure 8-35: Checking YV_H30 is open

13. Prepare the leak tester according to document MAN5100654, which can be found in the customer portal (see section 4.1 for further information).

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14. Connect the leak tester hose to the plugs as shown:

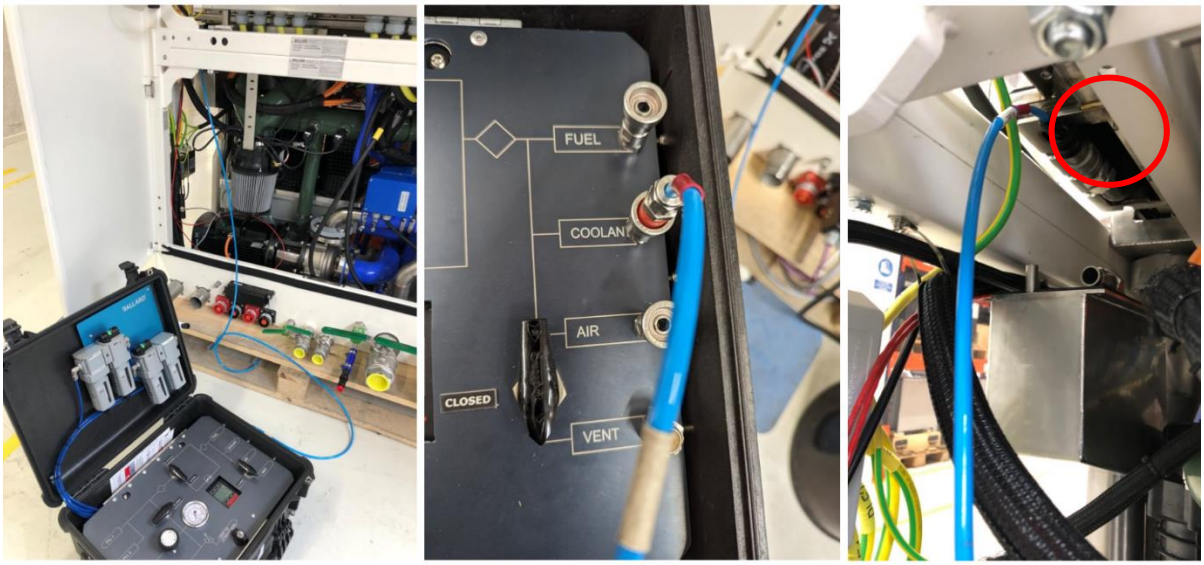


Figure 8-36: Install leak tester hose to pressure inlet plug

15. Slowly turn the pressure regulator clockwise to test pressure of 7 Psi. Let the system stabilize for 5 min.

    Use the digital ALICAT MFM for a more precise reading than the analogue pressure gauge.

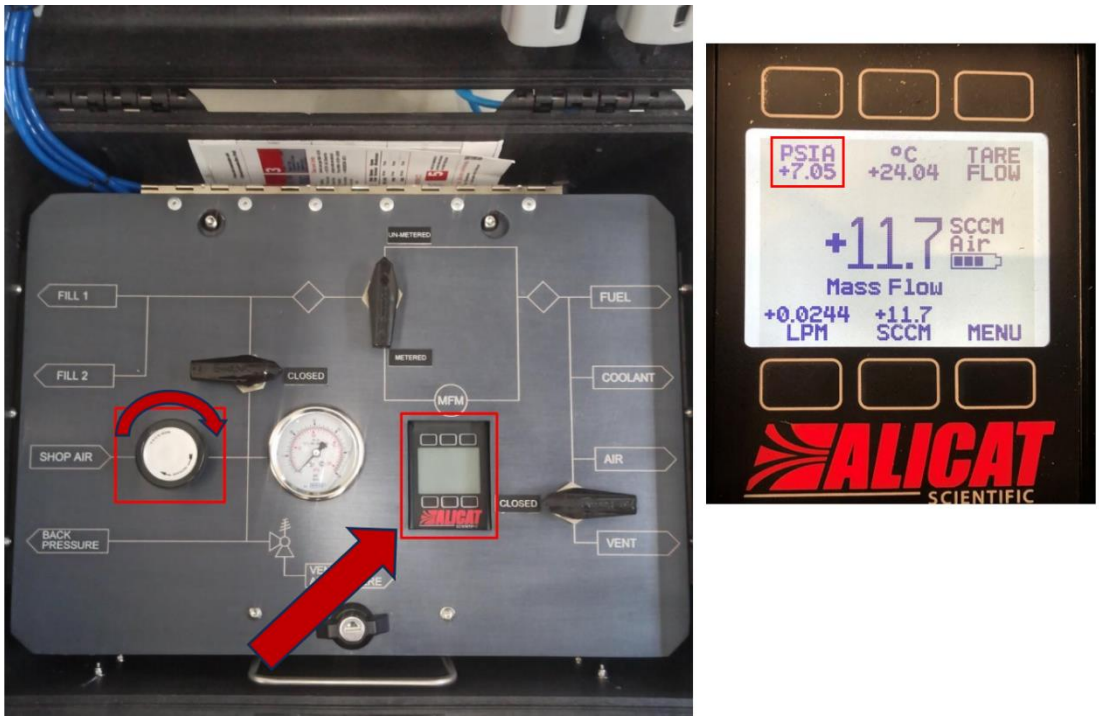


Figure 8-37: Use digital ALICAT MFM for pressure reading

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16. Force valve A to the "un-metered" position. Open valve B. Ensure valve C is in the "closed" position.

    Manometer pressure measurement should be 7 Psi/0.5 bar(g). Verify the pressure on both the manometer and the ALICAT MFM.

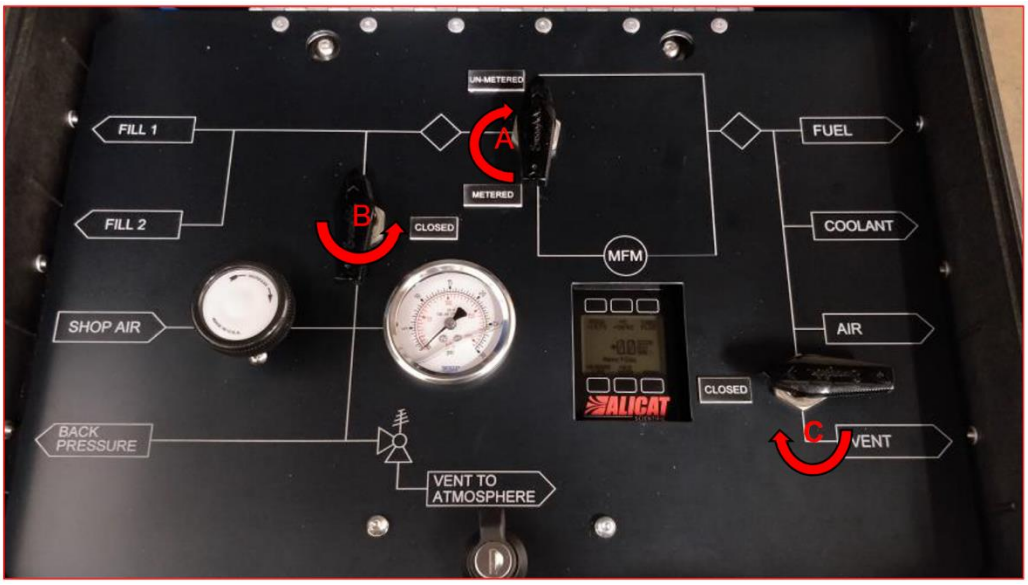


Figure 8-38: Leak tester valves1

17. Gradually force valve A to the "metered" position. Wait for the MFM to stabilize. Read and record the MFM reading in the leak test report form.



Figure 8-39: Leak tester valves2

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18. After completion of the leak test, force valve A to the "un-metered" position. Force valve B to the "closed" position to close off the air supply.

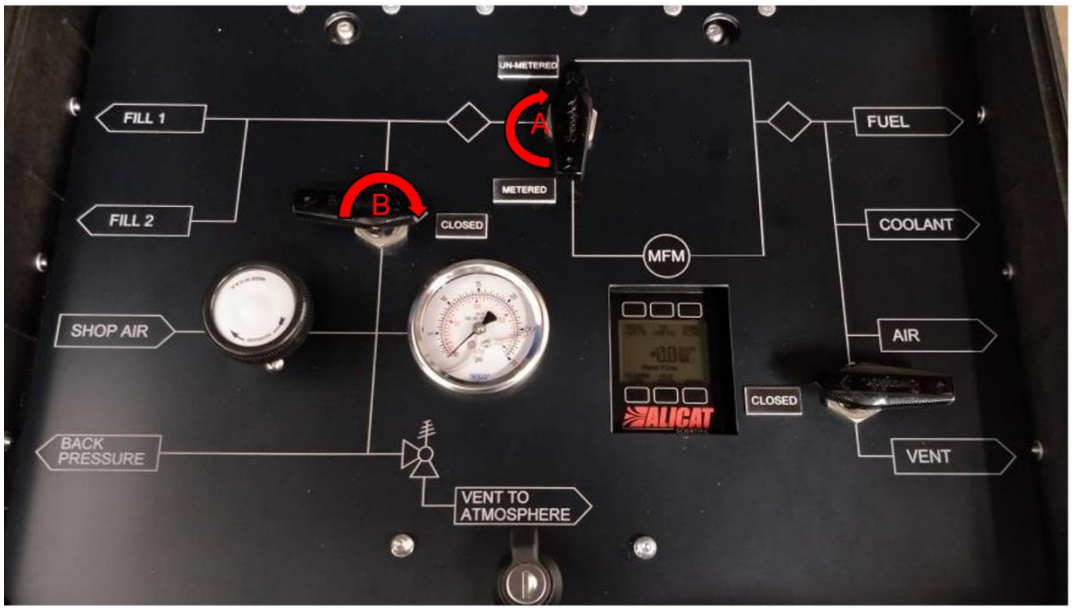


Figure 8-40: Leak tester valves3

19. Slowly force vent valve C to the "open" position to release the buildup pressure. Force the pressure regulator counter-clockwise to dial down the pressure.

    Ensure all hoses are vented before disconnecting from the module.

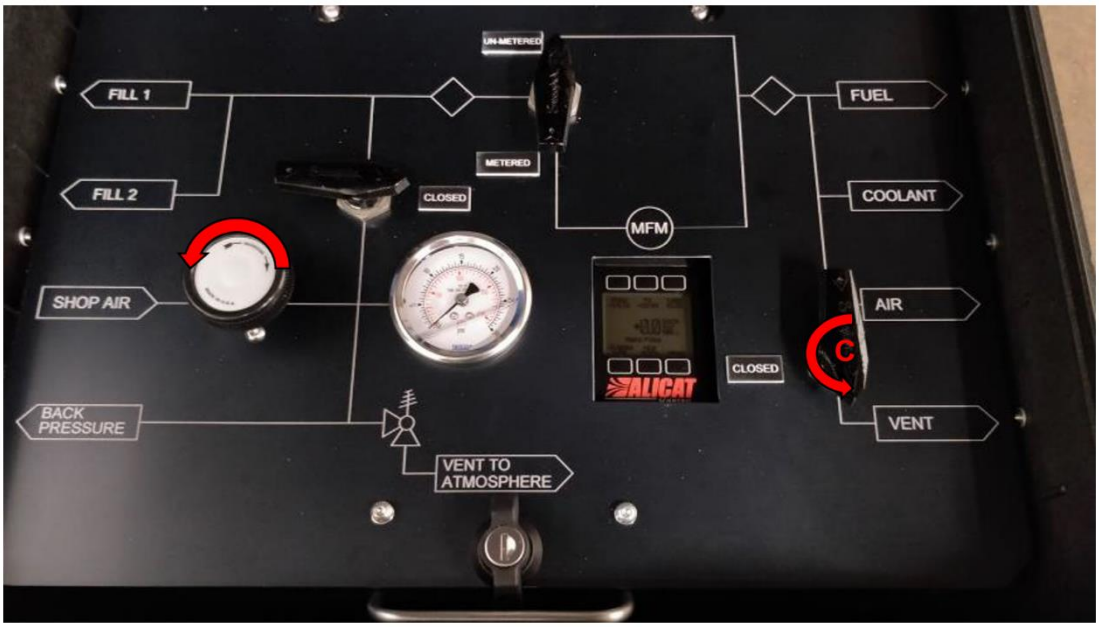


Figure 8-41: Leak tester valves4

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20. Navigate to the I/O page in the engineering interface and press “clear all forces”.
21. Navigate to the P&ID page and check that YV_H30 is closed and the box above PCV_H40 (PCV_CTRL_SP) is set to ‘0’.

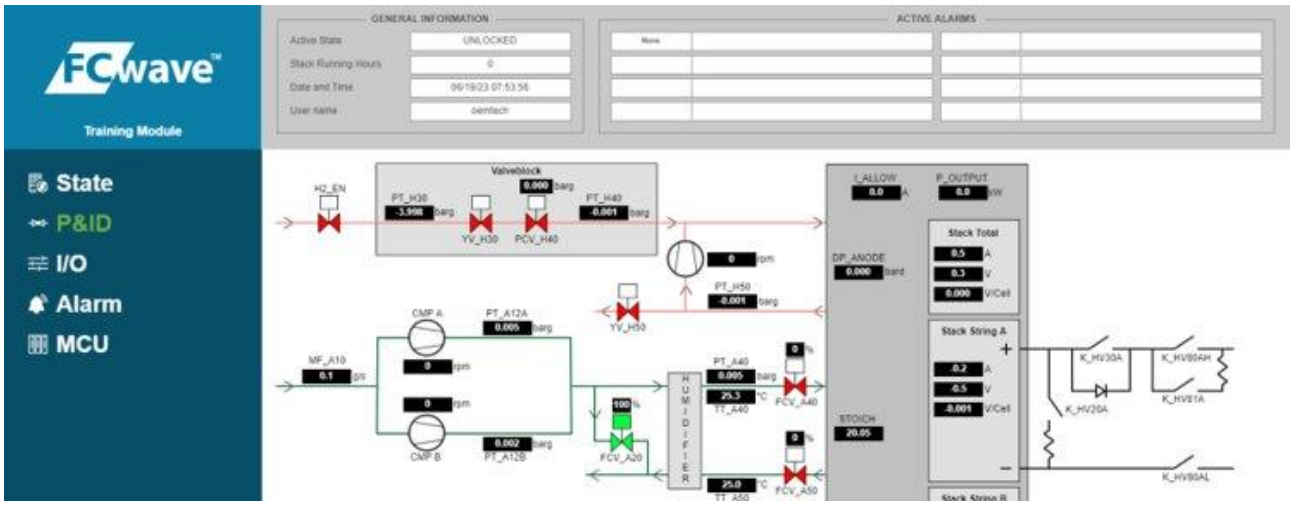


Figure 8-42: Checking YV_H30 is closed

22. Dismount the leak tester hose and reconnect hoses as before leak testing procedure.
23. Loosen process exhaust and remove the blinding plate. Replace O-ring and re-establish process exhaust. Tighten to 20 Nm.
24. Dismount the pressure inlet plug from where the C-piece was mounted and re-install the C-piece. Tighten to 50 Nm.
25. Use 5 pcs. M5 bolts and washers, 4 pcs. M6 bolts and washers, and 3 M5 nuts and washers to re-install the adaptor box. Tighten all to 5 Nm.

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8.3 Process Air Cathode Syb-system

For detailed P&ID requirements, refer to "Piping and Instrumentation Diagram" (PWR005), which can be found the Customer Portal or by contacting BPSE (see section 4.1 for further information).

8.3.1 Replace Process Air Filter/Mass Flow Meter

Purpose:

The procedure describes how to replace a process air filter integrated with mass flow meter for the air compressors in the cathode system. The filter conditions the clean air intake, and the mass flow meter monitors the airflow that enters the air compressors.

Responsibilities:

Preventive maintenance of the air filter/mass flow meter is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace a process air filter during the life and operation of the FCwave module.

- FRU, MAF Sensor & Inlet Filter (part no. 7500059)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Air Filter/Mass Flow Meter

Based on the normal conditions, the estimated time for replacement is:

Air Filter/Mass Flow Meter		
Duration	15 min	
Personnel	1	
Tightening Torque	Hose clamps	5 ± 0.5 Nm
	Tool: 7mm socket, torque wrench	

Table 8-7: Time to replace the air filter/mass flow meter

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the air filter/mass flow meter installed in front of the twin compressors.
3. Disconnect the mass flow meter sensor (FT_A10).

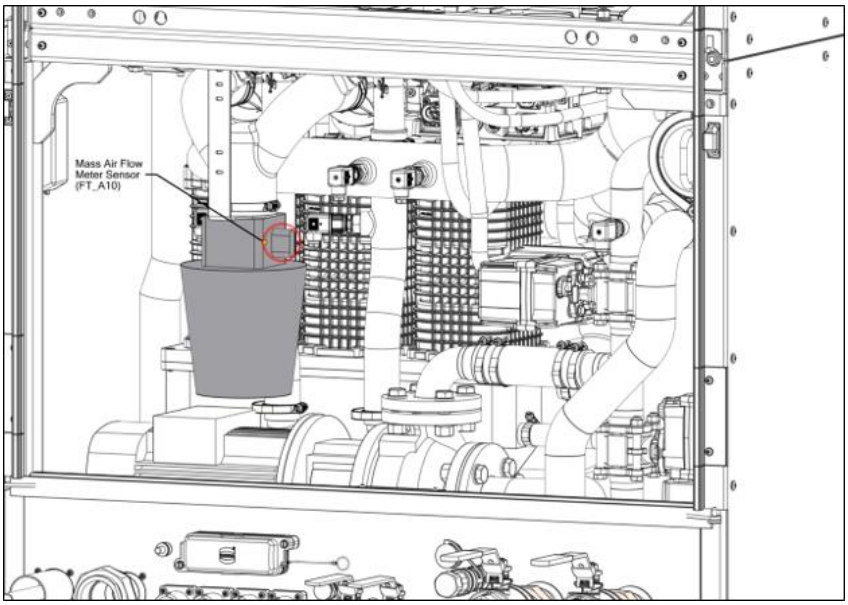


Figure 8-43: Location of mass flow sensor

4. Release the 7mm socket hose clamp to uninstall the filter/mass air flow meter.
5. Slide down the filter unit and take it out.

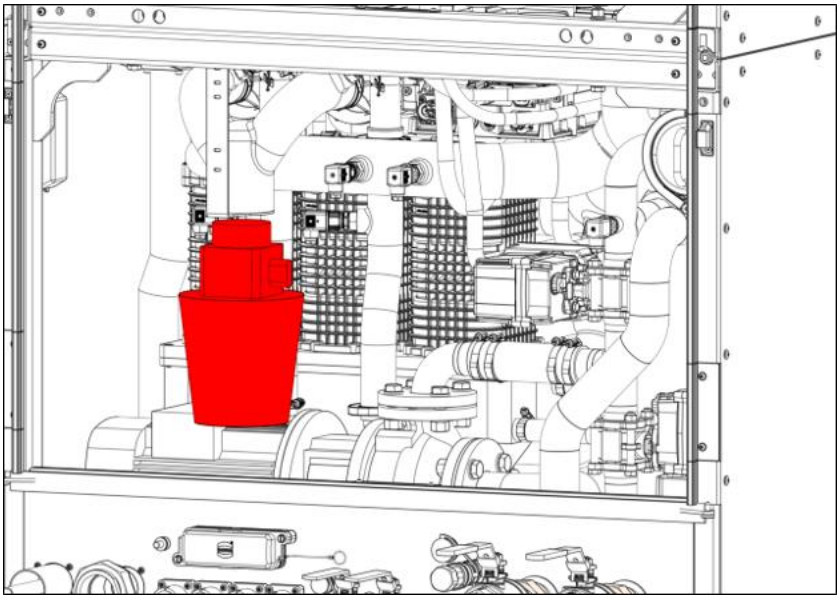


Figure 8-44: Removal of filter unit

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Assembling procedure:

1. Slide on the new unit and secure it with the 7mm socket hose clamp. Tighten to 3.5 Nm.
2. Connect the mass flow meter sensor (FT_A10).

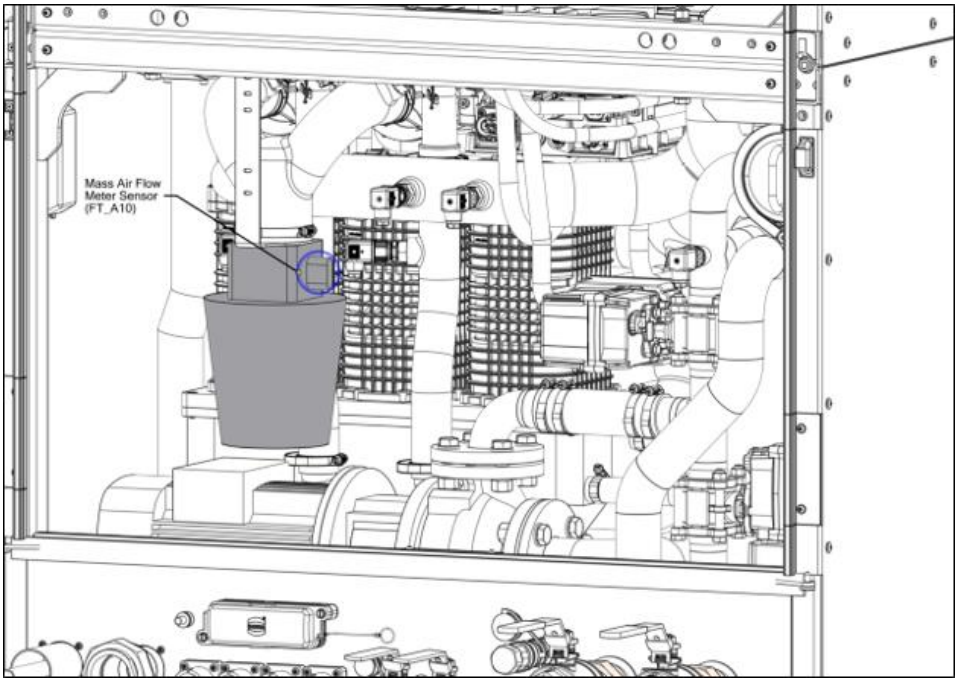


Figure 8-45: Install new mass air flow sensor

3. Use 12 pcs. M5 bolts to install the high voltage panel cover.
4. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.3.2 Replace Process Air (cathode) Valves

Purpose:

The procedure describes how to replace air valves in the process air cathode system. There are three air valves, which are used to direct the air flow in the module, to bypass the stacks, and to recirculate the exhaust.

Responsibilities:

Preventive maintenance of the air valves is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the air valves during the life and operation of the FCwave module.

- FRU, Shutoff Valve, 3" (part no. 7500061) x2.
- FRU, Shutoff Valve, 1.75" (part no. 7500068)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Cathode Valves

Based on the normal conditions, the estimated time for replacement is:

Cathode Butterfly Valves		
Duration	30 min	
Personnel	1	
Tightening torque	Hose clamps	5 ± 0.5 Nm
	Tool: 7mm flexible socket, torque wrench	

Table 8-8: Time to replace the cathode valves

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Disconnect the connector from the air process inlet valve (FCV_A40).

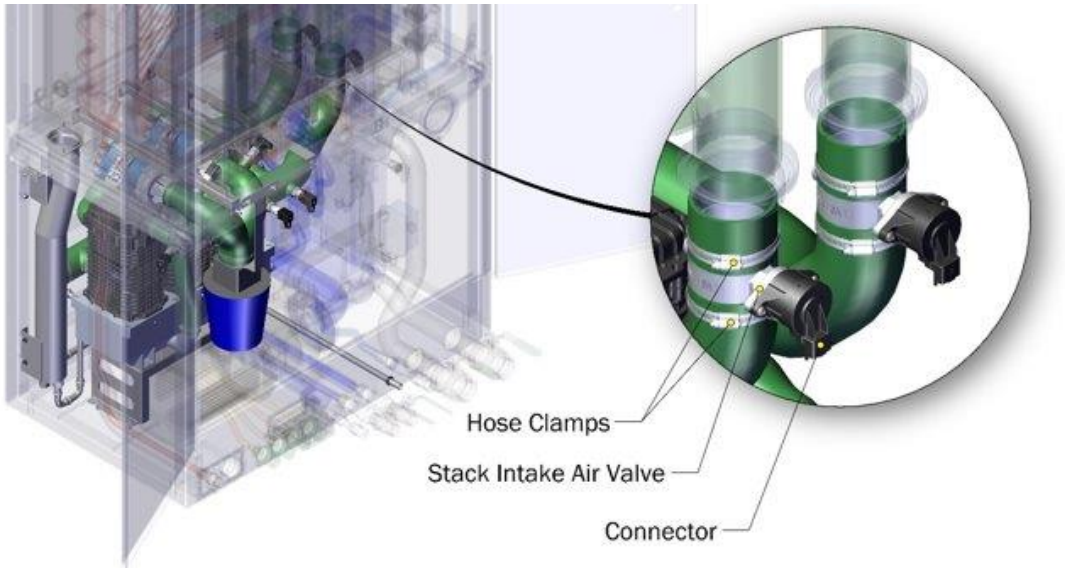


Figure 8-46: Location of air process inlet valve

3. Release 2 pcs. hose clamps securing the valve from above and below.
4. Remove the air process inlet valve (FCV_A40). Remember to cover all disconnected hoses and open ports with a clean cap or tape.
5. Disconnect the connector from the air process outlet valve (FCV_A50).

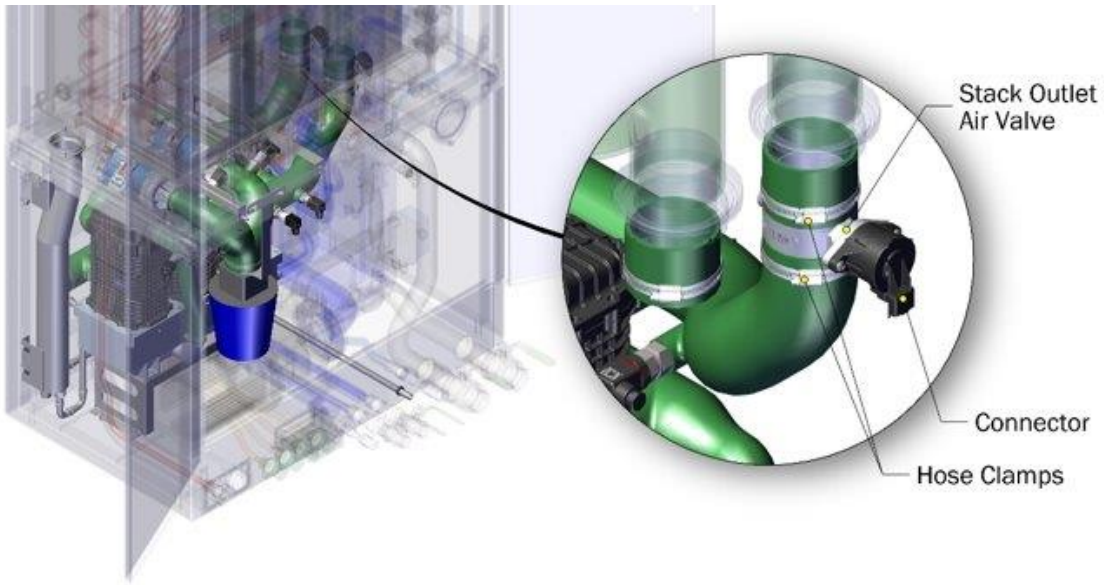


Figure 8-47: Location of air process outlet valve

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6. Release 2 pcs. hose clamps from the oxidant outlet side to remove the valve from the hoses.
7. Press both sides of the bypass air valve and pull to remove connector HRNS-600-CN_FCV_A20.

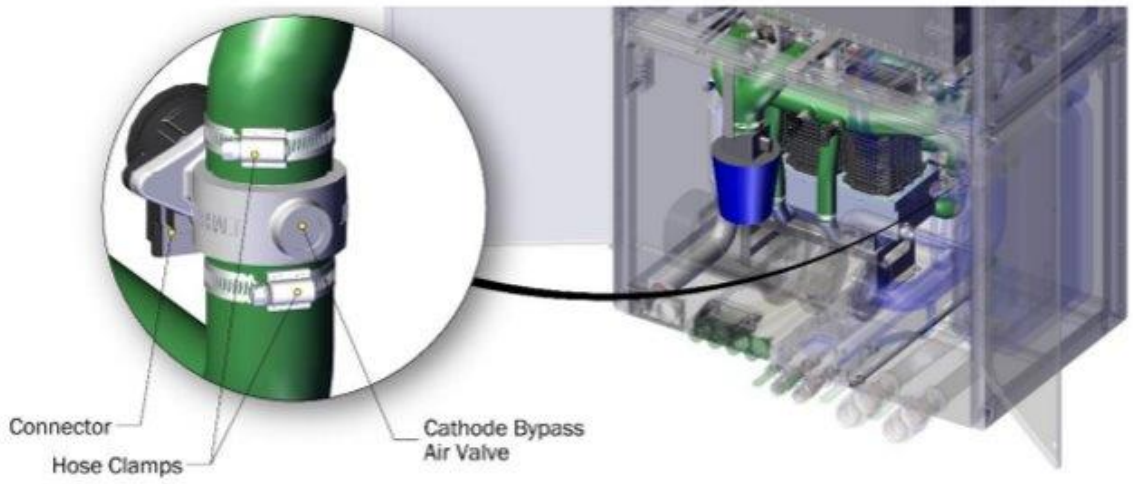


Figure 8-48: Removal of bypass air valve

8. Release 2 pcs. hose clamps on the outer connections of the cathode bypass valve outlet hose to remove the valve from the hoses.

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Assembling procedure:

1. Install the new bypass valve (FCV_A20) and secure it with the hose clamp. Tighten clamp to 3.5 – 4.5 Nm.

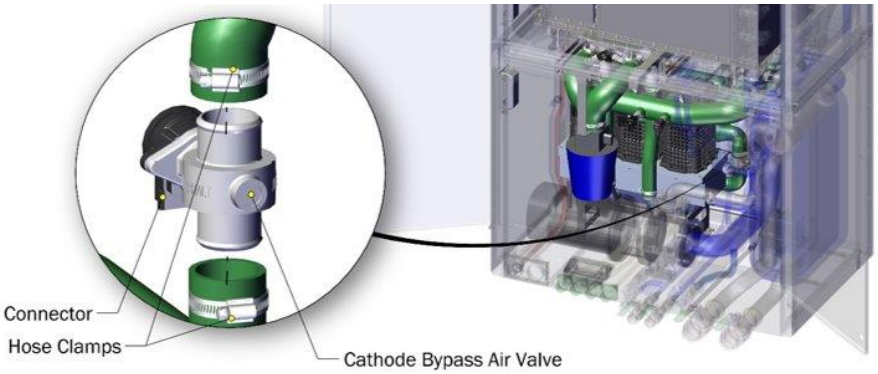


Figure 8-49: Removal of bypass air valve

2. Connect the cathode bypass valve connector.
3. Install the new outlet valve (FCV_A50) and secure it with the hose clamp. Tighten clamp to 3.5 – 4.5 Nm.

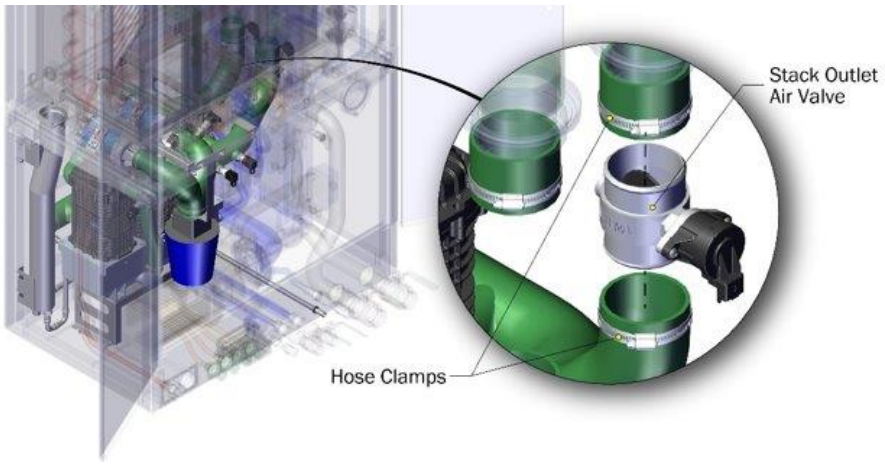


Figure 8-50: Removal of bypass air valve

4. Connect the FCV_A50 connector.

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5. Install the new air inlet valve (FCV_A40) and secure it with the hose clamp. Tighten clamp to 3.5 – 4.5 Nm.

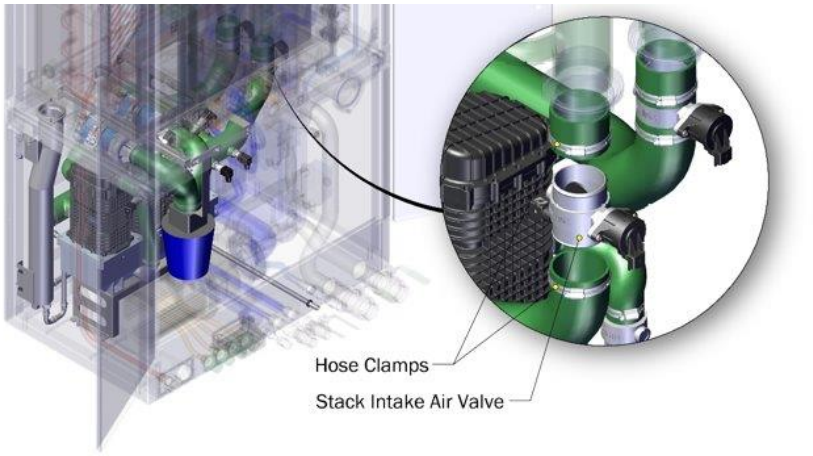


Figure 8-51: Install new air inlet valve

6. Connect the FCV_A40 connector.
7. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
8. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
9. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
10. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.3.3 Replace Humidifier Assembly

Purpose:

The procedure describes how to replace a humidifier assembly for the process air system. The unit exchanges humidity between dry air entering the fuel cell inlet and outlet. This is necessary to maintain minimum fuel cell inlet relative to humidity requirements.

Responsibilities:

Preventive maintenance of the humidifier assembly is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace a humidifier assembly during the life and operation of the FCwave module.

- FRU, Humidifier Assembly v2 (part no. 7500359)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace Humidifier

Based on the normal conditions, the estimated time for replacement is:

Humidifier		
Duration	2 – 2½ hours	
Personnel	1	
Tightening Torque	M5 bolt	6.5 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	Hose clamps	5 ± 0.5 Nm
	Tool: 3mm + 4mm + 6mm hex key, 7mm flexible socket, cross-head screwdriver, cable tie cutter, plastic bag/tape, 6mm hex bit, ¼" ratchet, 500mm extension, 13mm wrench, torque wrench	
Weight	10 kg	

Table 8-9: Time to replace the humidifier assembly

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Perform disassembling procedure of Air Compressor (section 8.3.5) to remove the compressors to gain access to the humidifier.
3. Disconnect sensor TT_A50.

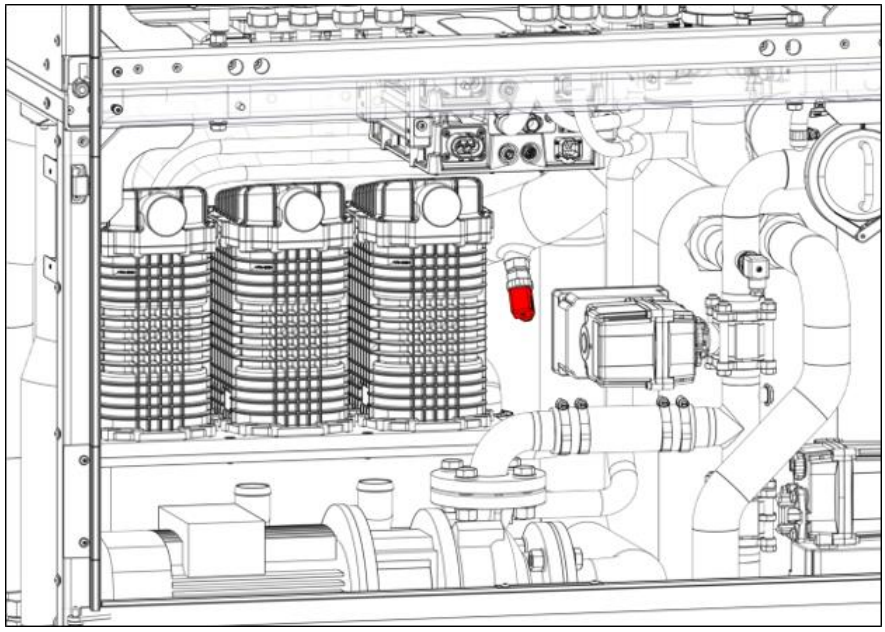


Figure 8-52: Removal of sensor TT_A50

4. Release the hose clamp and slide off the hose connected to the motorized shut-off valve. Remember to cover hoses and open ports.

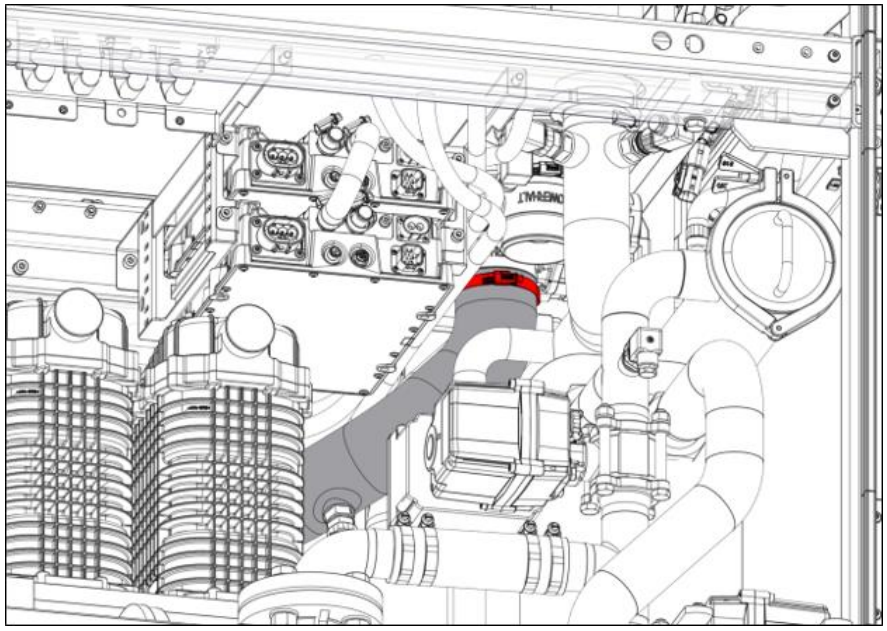


Figure 8-53: Removal of hose to motorized shut-off valve

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5. Cut the cable tie used to tighten the LT coolant hoses to the rear-side humidifier hose.
6. Release the hose clamp used to tighten the bypass valve. Slide hoses off to remove the valve. Disconnect the electrical connection of the bypass valve.

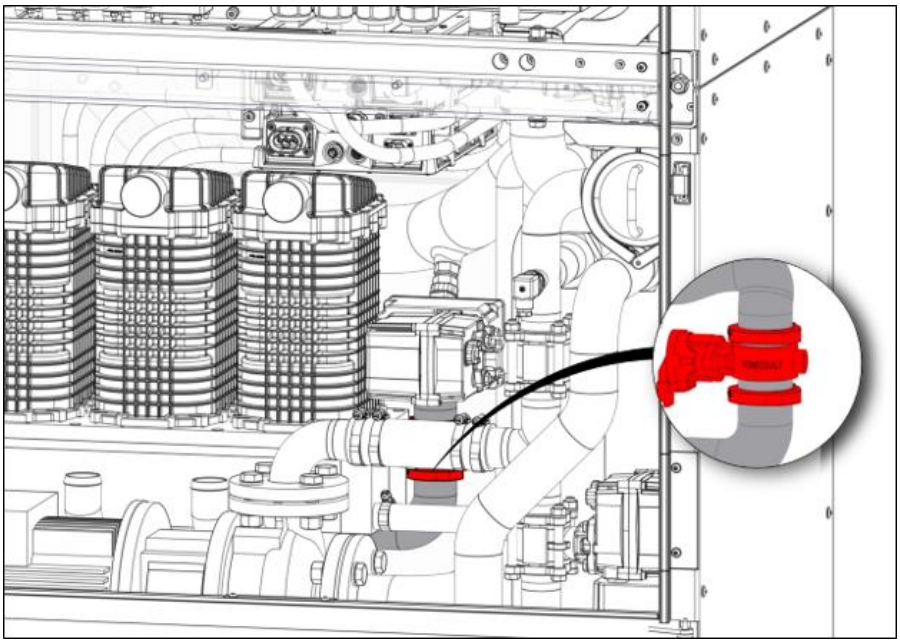


Figure 8-54: Removal of bypass valve for humidifier

7. Release the hose clamp used to tighten the humidifier outlet hose to the exhaust.

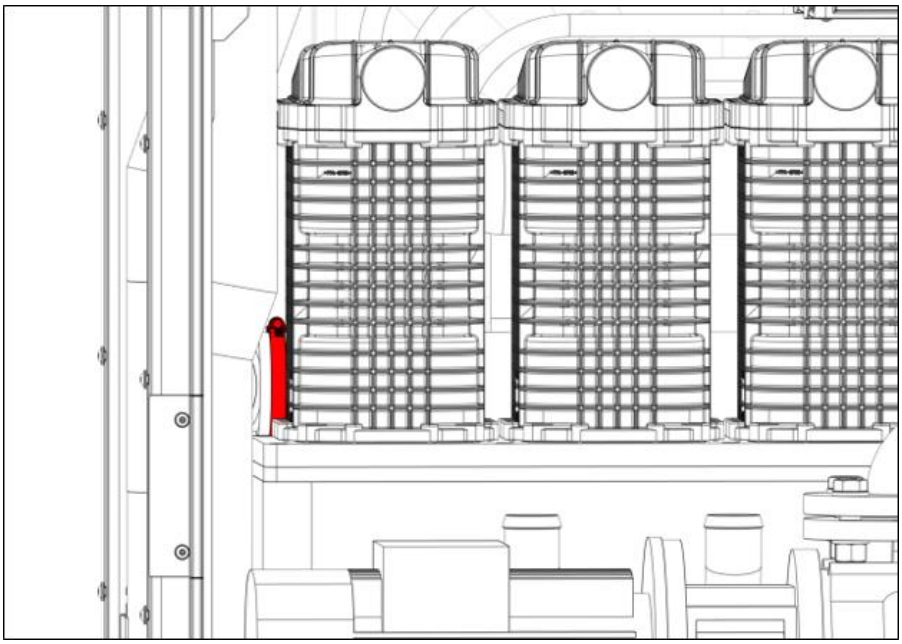


Figure 8-55: Removal of outlet hose to the exhaust

8. Uninstall 8 pcs. M8 bolts used to tighten the humidifier assembly to the aftercooler. Use a magnet to remove the bolts.

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9. Loosen, but not remove, 2 pcs. bolts, washers, and lock washers used to tighten the aftercooler to the mounting bracket.

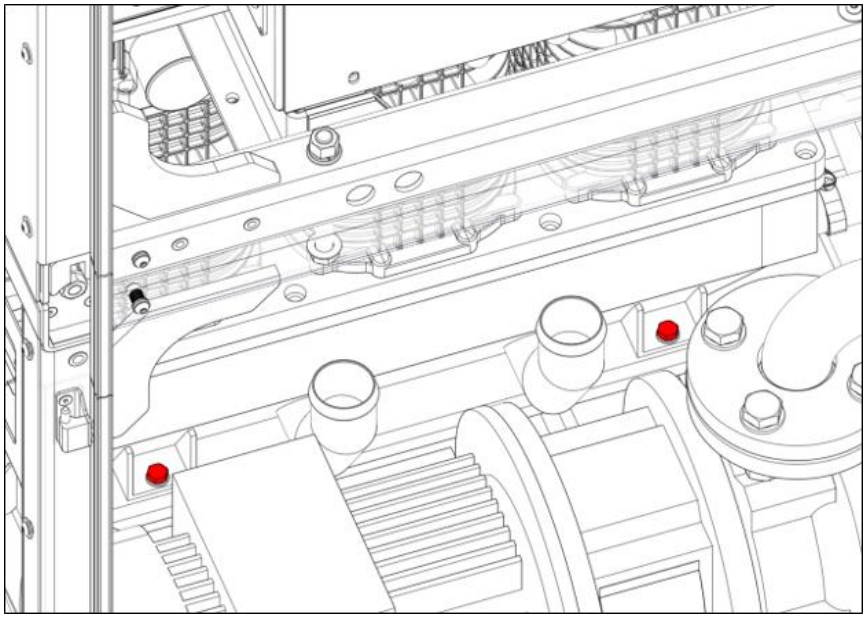


Figure 8-56: Removal of bolts in aftercooler/mounting bracket

10. Insert the lifting table legs in the lower cabinet under 2 pcs. M8 bolts previously loosened and on the module front frame as shown:

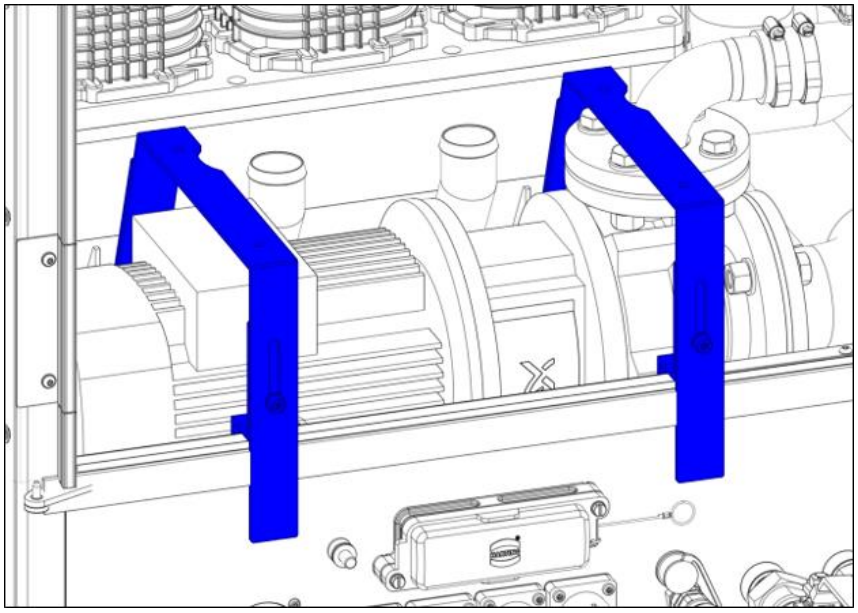


Figure 8-57: Insert lifting table legs

11. Re-tighten 2 pcs. M8 bolts mentioned in step 15 to secure the lifting table legs.
12. Use 4 pcs. M5x20 bolts to install the lifting table on the legs. Align the surface to the plastic slides by adjusting the height of the legs.
13. Carefully lift one side of the humidifier and insert plastic slides all the way as shown. Align the thread of the slides with the M8 bolts on the inlet flange.

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Remember to use the short slide on the right side of the humidifier.

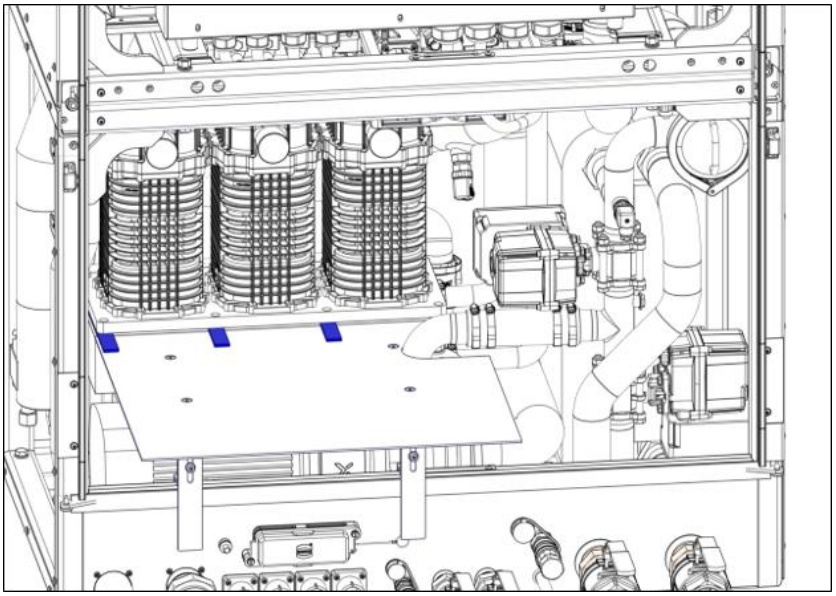


Figure 8-58: Insert slides under humidifier

14. Use 8 pcs. M8 bolts to tighten the humidifier inlet flange to the plastic slides.

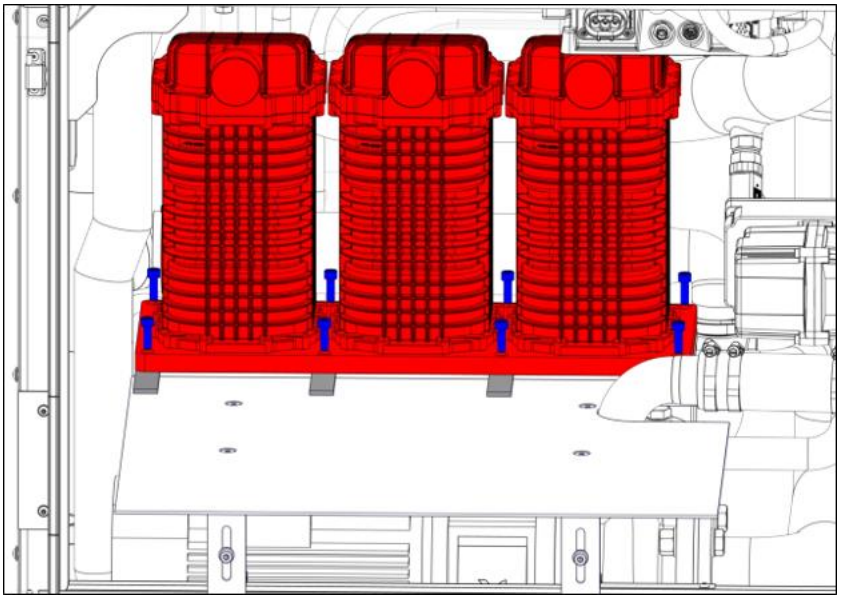


Figure 8-59: Securing humidifier flange to slides

15. Slide the humidifiers a bit to the right to make room for sliding off the air connected to the process exhaust. Cover up open ports and disconnected hoses.
16. Turn the humidifier assembly 90 degrees and move to the left side of the lifting table as shown. Next, carefully move the assembly to a clean, flat surface for service purposes.

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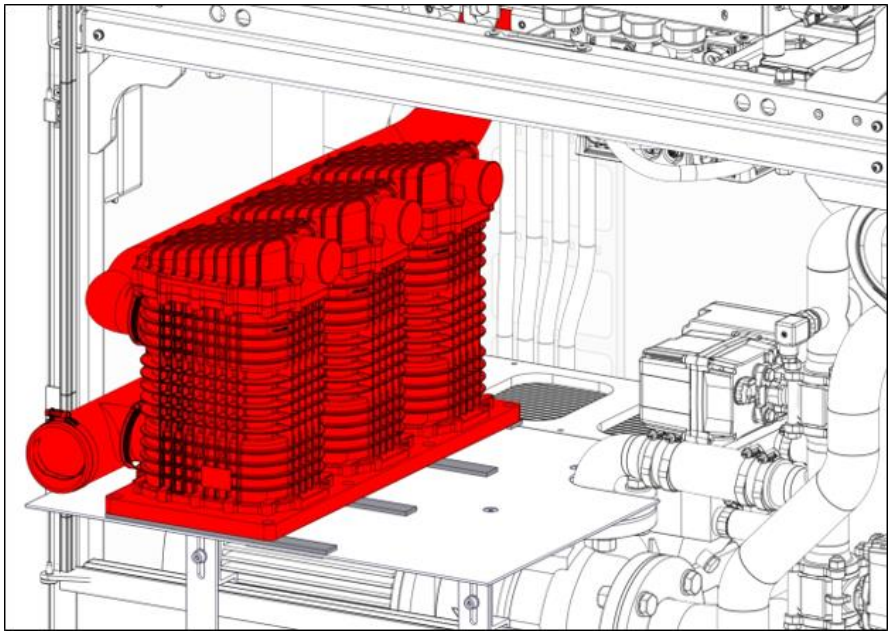


Figure 8-60: Removal of humidifiers

17. Uninstall the wet side inlet hose and wet side outlet hose installed on the back side of the humidifier.

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Assembling procedure:

1. Use 6 pcs. hose clamps to install the wet side inlet hose (upper) and wet side outlet hose (lower) to the back side of the new humidifier. Tighten clamps to 3.5 Nm. Remember to replace the hose clamp if damaged.
2. Flip the humidifier. Apply krytox and install O-rings in all 3 flanges as shown:

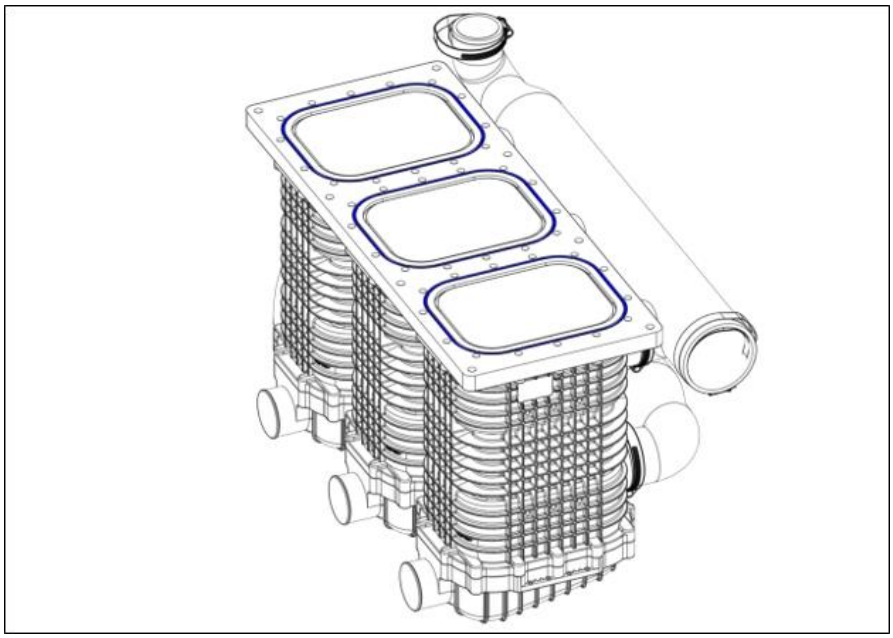


Figure 8-61: O-rings in flanges

3. Use 8 pcs. M8 bolts to install plastic slide to humidifier as shown:

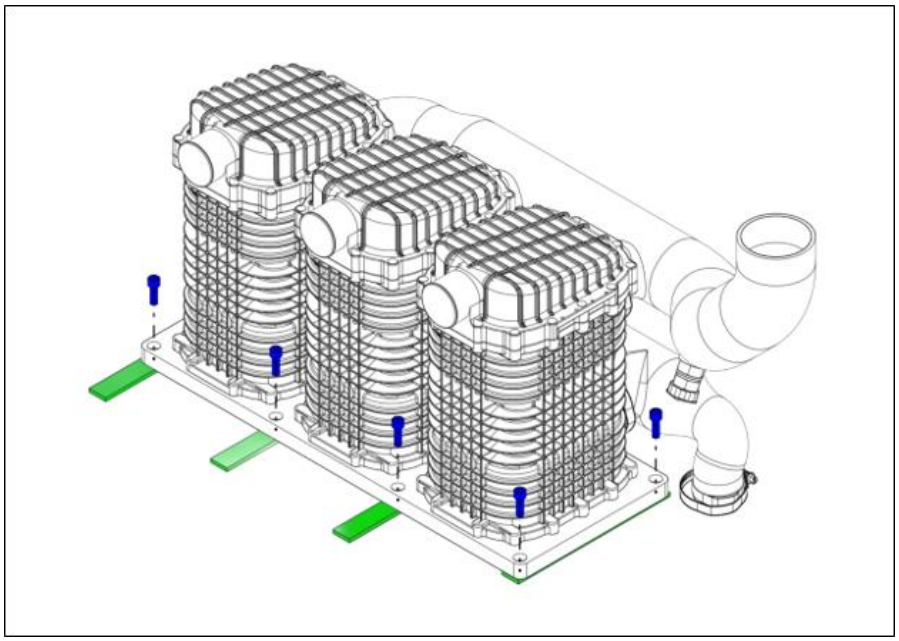


Figure 8-62: slides on new humidifier

4. Lift the humidifier assembly to the lifting table and place it as in the disassembling procedure step 23.

   Remember to clean the surface of the aftercooler to prevent scratches.

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5. Install the hose clamp on the process exhaust connection hose and then slide the humidifier in position on top of the aftercooler.
6. While sliding the humidifier into position to the left, mount the process exhaust connection hose. Tighten the hose clamp to 3.5 Nm.

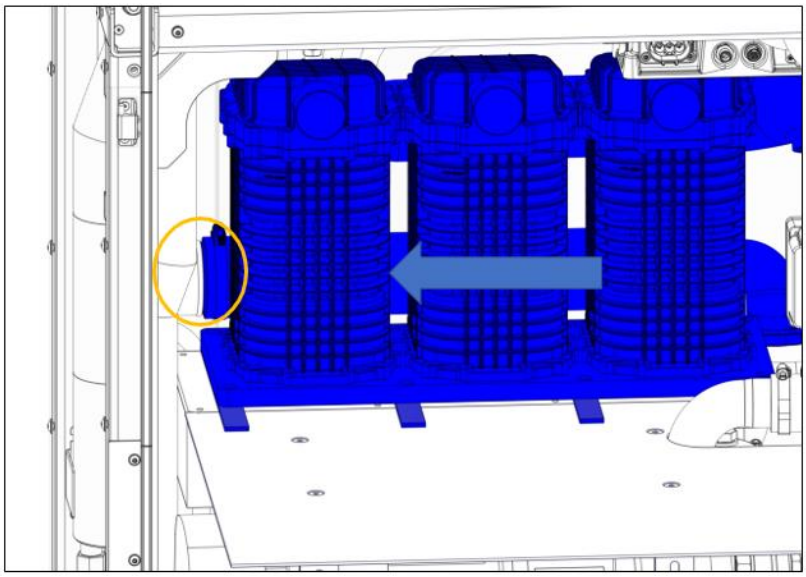


Figure 8-63: Sliding assembly and install process exhaust

7. Uninstall 8 pcs. M8 bolts from the plastic slides and remove the slides. Carefully lower the assembly onto the aftercooler.
8. Uninstall 4 pcs. M5x20 bolts to remove the lifting table.
9. Loosen 2 pcs. M8 bolts to remove the lifting table legs and re-tighten the bolts to 15 Nm.

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10. Use 8 pcs. M8 bolts to install the humidifier assembly to the aftercooler. Follow pattern as shown and tighten to 25 Nm.

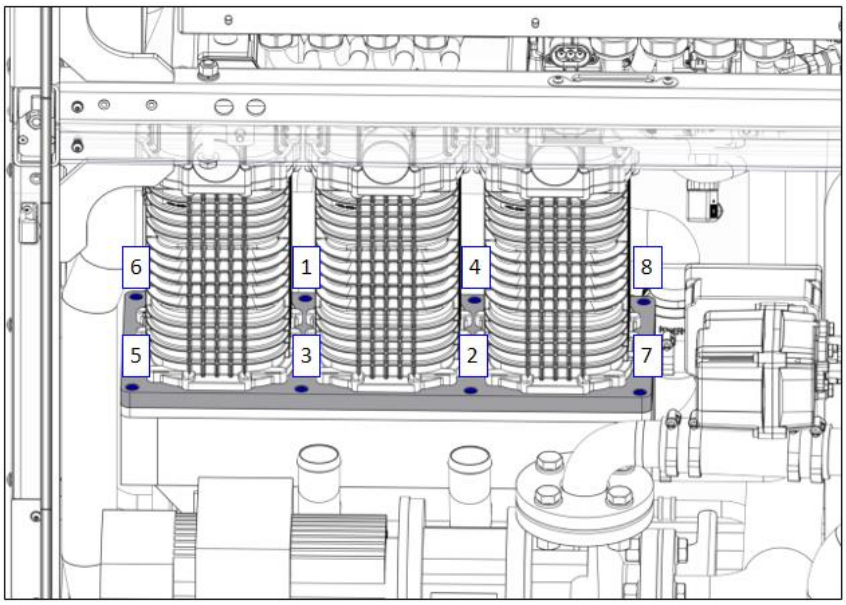


Figure 8-64: Fastening pattern for humidifier assembly to aftercooler

11. Leak test the humidifier and aftercooler assembly according to the humidifier leak test after corrective maintenance procedure.
12. Mount the FCV_A20 valve and tighten the hose clamp to 3.5 Nm.

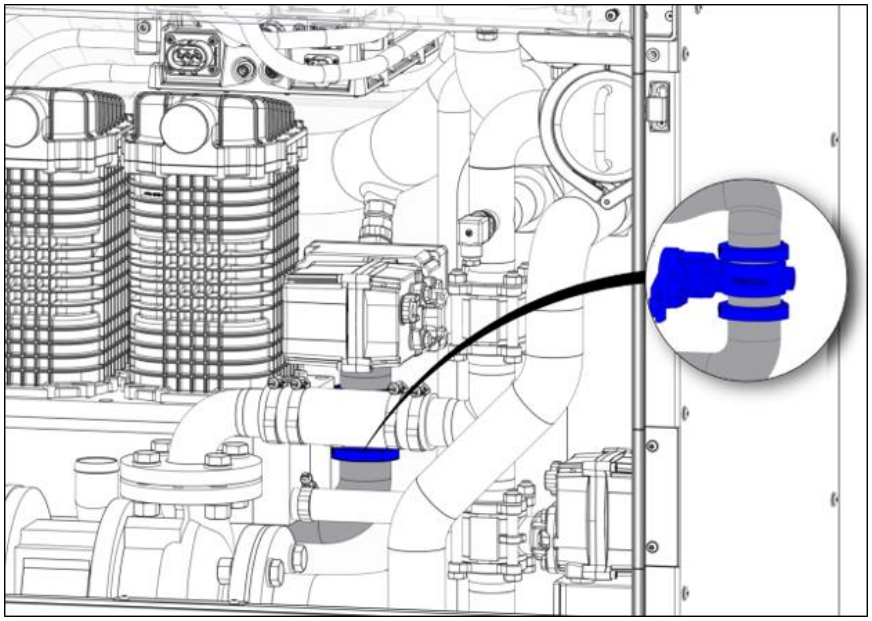


Figure 8-65: Installing the FCV_A20 valve

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13. Use a cable tie to secure the LT coolant hoses to the bypass hose.
14. Connect the upper rear hose from the humidifier to the stack inlet motorized shut-off valve (FCV_A50). Tighten the hose clamp to 3.5 Nm.

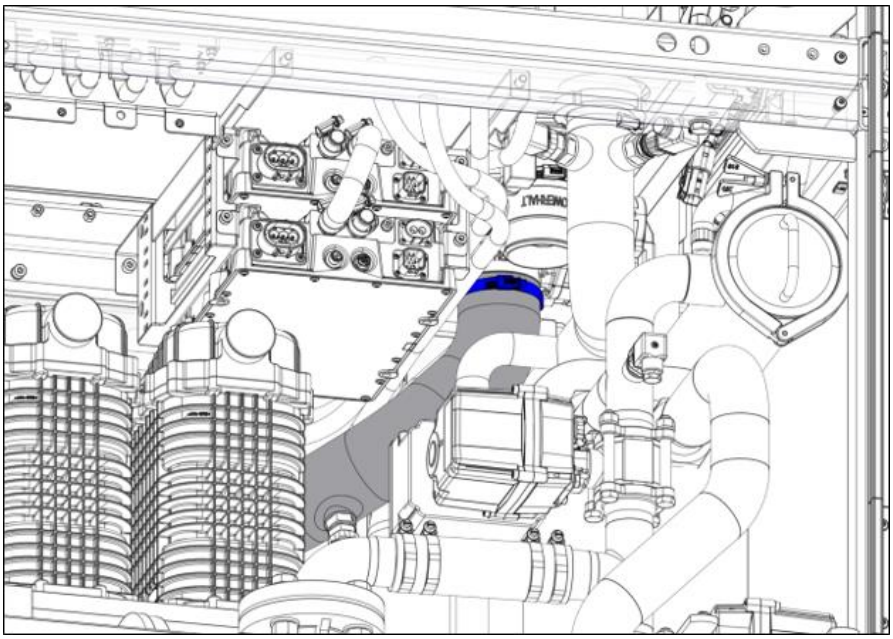


Figure 8-66: Mounting the FCV_A50 valve

15. Connect the temperature sensor (TT_A50) plug.

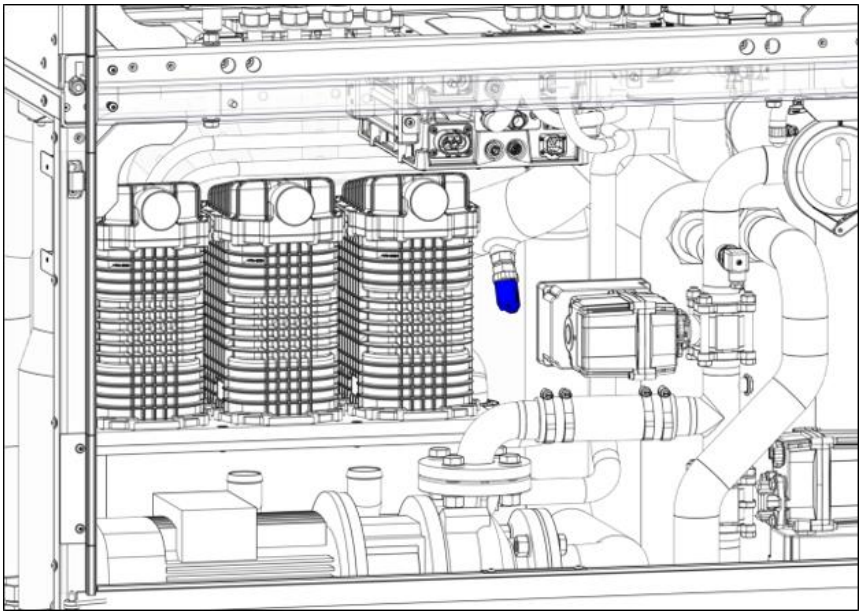


Figure 8-67: Mounting TT_A50 plug

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16. Perform steps in section 8.3.5 to reassemble the twin air compressors.
17. Log into the engineering interface to reset the hour counter for the humidifier assembly.
18. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
19. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
20. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
21. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.3.4 Replace Aftercooler

Purpose:

The procedure describes how to replace an aftercooler assembly for the process air system. The aftercooler cools down the temperature of the process air before it enters the humidifiers.

Responsibilities:

Preventive maintenance of the aftercooler assembly is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace an aftercooler assembly during the life and operation of the FCwave module.

- FRU, Aftercooler (part no. 7500070)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Aftercooler

Based on the normal conditions, the estimated time for replacements is:

Aftercooler		
Duration	3 – 3½ hours	
Personnel	1	
Tightening Torque	M8 bolt	
	Tool: 6mm hex key, 13mm wrench, 7mm socket, plastic bag/tape, torque wrench, hose clamps (if needed to be replaced)	

Table 8-10: Time to replace the aftercooler

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Perform disassembling procedure of Air Compressor (section 8.3.5) and Humidifiers Assembly (section 8.3.3) to remove both parts to access the aftercooler.
3. Remove the lifting table and lifting table legs from the lower cabinet. Remember to tighten M8 bolts and washers. Tighten to 15 Nm.
4. Release 2 pcs. hose clamps on the coolant hoses connected to the aftercooler assembly and slide off hoses. Prepare an empty container to drain leftover coolant to prevent leak inside the module.

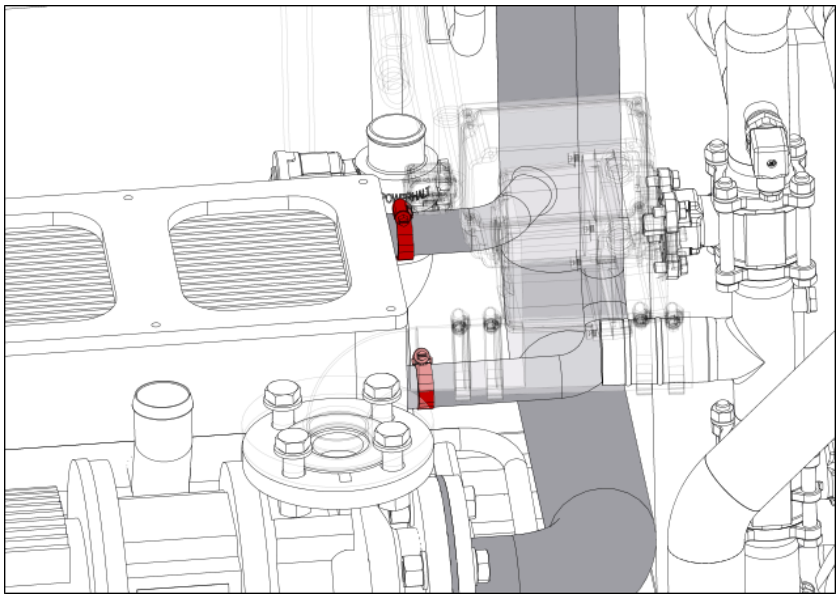


Figure 8-68: Removal of hoses to aftercooler

5. Cover disconnected ports and hoses to prevent leakage while moving the parts.
6. Release hose clamp on the back side of aftercooler and slide off hose.

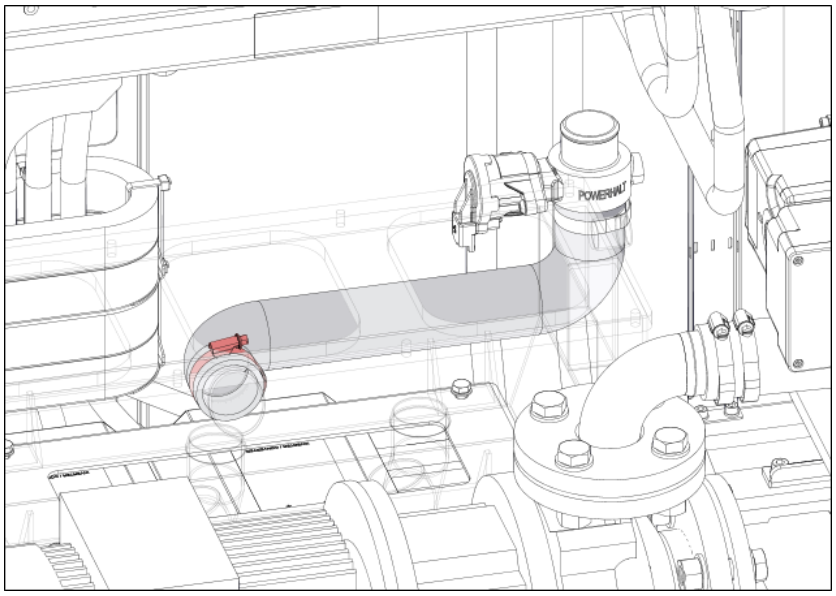


Figure 8-69: Removal of back side hose of aftercooler

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7. Uninstall 4 pcs. M8 bolts, washers and lock washers used to tighten the aftercooler mounting bracket to the base of the cabinet.

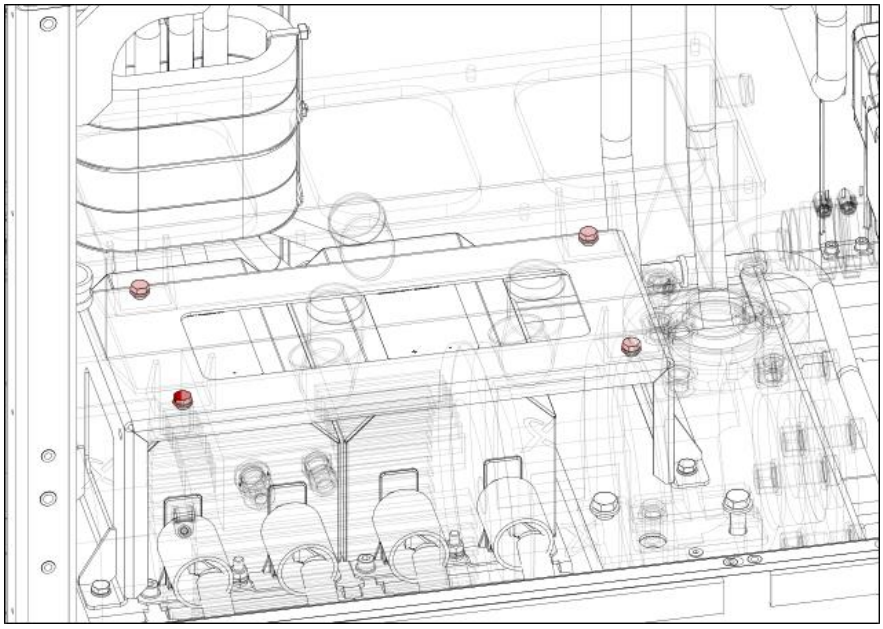


Figure 8-70: Removal of bolts in mounting bracket

8. Cover all disconnected hoses and open ports to prevent any unwanted material from entering, and carefully lift the aftercooler and bracket out of the cabinet. Place on a flat surface.
9. Uninstall 4 pcs. M8 bolts and washers used to tighten the aftercooler to the bracket.



Figure 8-71: Removal of bolts for bracket

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Assembling procedure:

1. Use 4 pcs. M8 bolts and washers to install the new aftercooler to the bracket. Tighten to 15 Nm.
2. Carefully lift the assembly to the lower cabinet. Use 4 pcs. M8 bolts to secure the assembly to the base of the cabinet. Tighten to 20 Nm.
3. Connect the cathode bypass hose to the back side of the aftercooler. Tighten hose clamp to 3.5 Nm. Remember to replace the hose clamp if damaged.
4. Perform assembling procedure of Humidifier Assembly (section 8.3.3) to install the humidifiers and air compressors.

   Make sure new O-rings are mounted and the surface is clean before tightening humidifier assembly to aftercooler assembly.
5. Connect the coolant hoses to the aftercooler. Tighten hose clamps to 3.5 Nm. Remember to replace the hose clamp if damaged.
6. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
7. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
8. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
9. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.3.5 Replace Air Compressors

Purpose:

The procedure describes how to replace an air compressor for the process air cathode system. The air compressors supply pressurized air to the fuel cell stacks. The compressor is sized to deliver the air at a mass flow regulated by the module system controller. The delivery pressure will be a function of air system flow resistance and required inlet pressure to the fuel cell stacks.

Responsibilities:

Preventive maintenance of the air compressors is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace an air compressor during the life and operation of the FCwave module.

- FRU, Gen3 Air Compressor (part no. 7500053)
- FRU, Gen3 Air Compressor to Inverter Sensor Cable (part no. 7500054)
- FRU, Inverter 2.0B Adaptor Cable[2] (part no. 7500361)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Air Compressors

Based on the normal conditions, the estimated time for replacement is:

Air Compressors		
Duration	2 hours	
Personnel	1	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	Hose clamps	5 ± 0.5 Nm
	Tool: 5mm + 6mm hex key, 7mm + 10mm + 13mm socket, side cutting pliers, hose clamp plier set, cross-head screwdriver, plastic bag/tape, cable ties, torque wrench	

Table 8-11: Time to replace the air compressors

[2] Applies ONLY for modules with Inverter 2.0B

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain and purge the LT cooling system.
3. Locate the air filter/mass flow meter installed in front of the twin compressors. Disconnect the mass flow meter sensor (FT_A10).

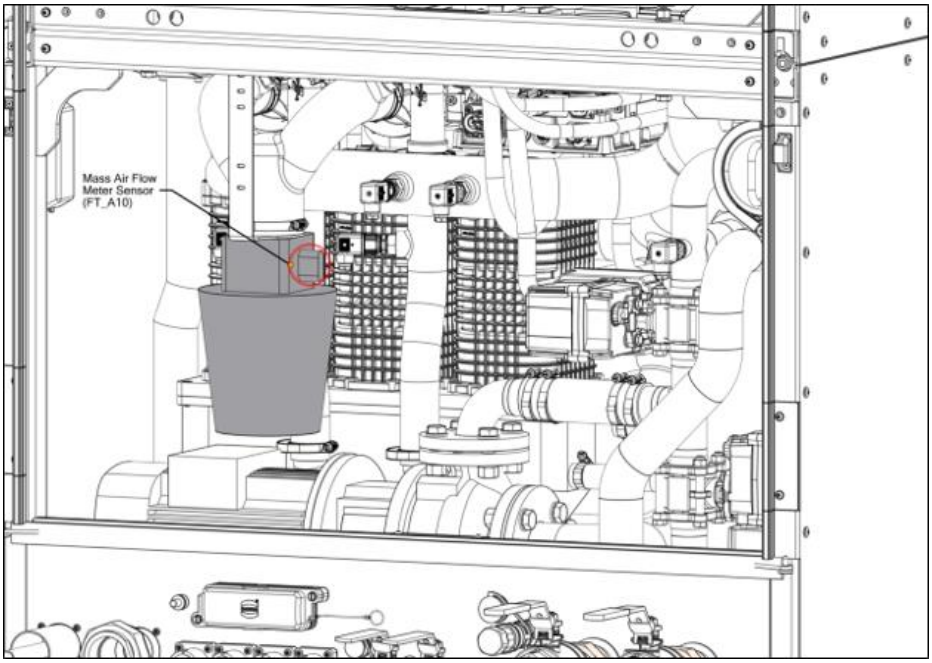


Figure 8-72: Location of mass flow sensor

4. Release the 7mm socket hose clamp to uninstall the filter/mass air flow meter.
5. Slide down the filter unit and take it out.

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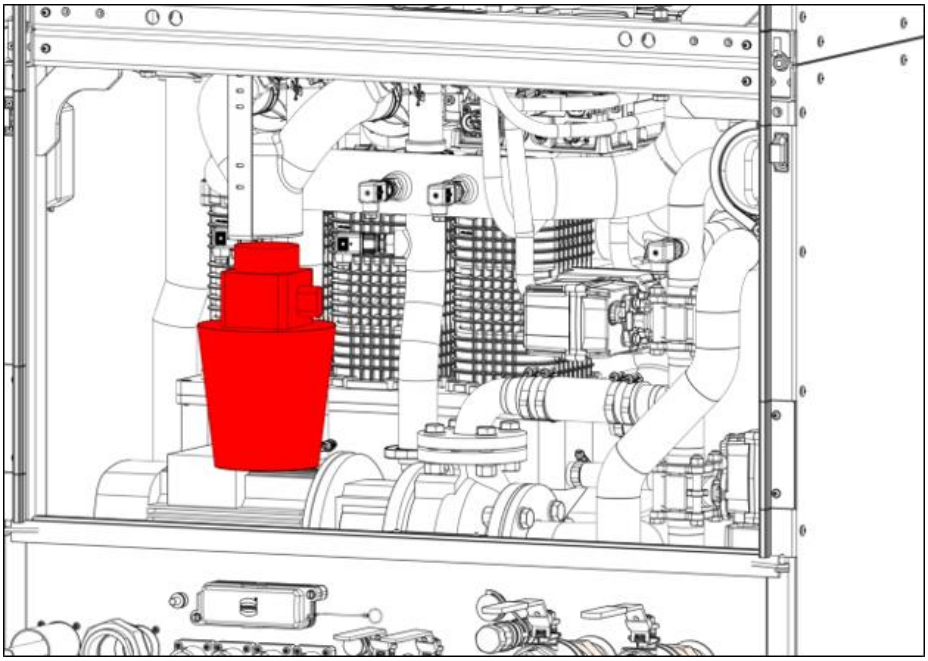


Figure 8-73: Removal of filter unit

6. Cut the cable tie used to secure the harness CN600 to the MAF/filter bracket.
7. Uninstall 2 pcs. M8 bolts and washers used to install the bracket to the cabinet and remove the bracket.

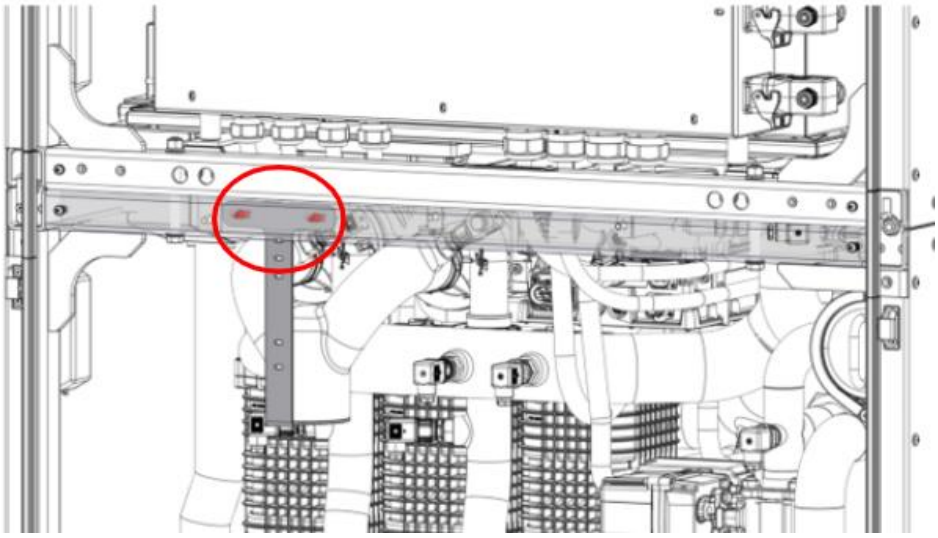


Figure 8-74: Removal of MAF/filter bracket

8. Disconnect all the following sensor connections on the harness CN600: PT_A11A, PT_A11B, PT_A12A, PT_A12B, PT_A40, TT_A40

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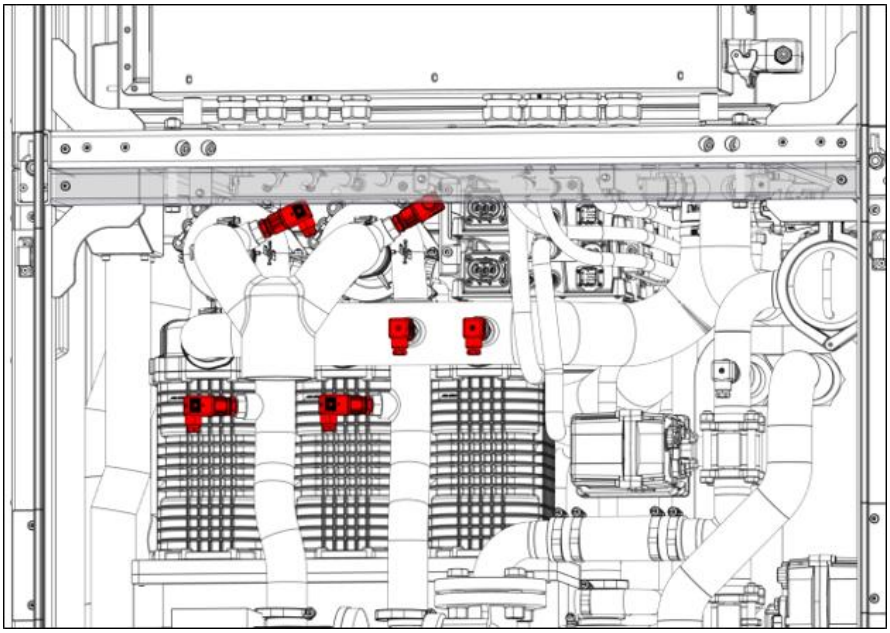


Figure 8-75: Sensor connections on harness CN600

9. Release 2 pcs. hose clamps used to secure the compressor inlet hose to the compressors and remove the hoses.

   Remember to cover all disconnected hoses and open ports.

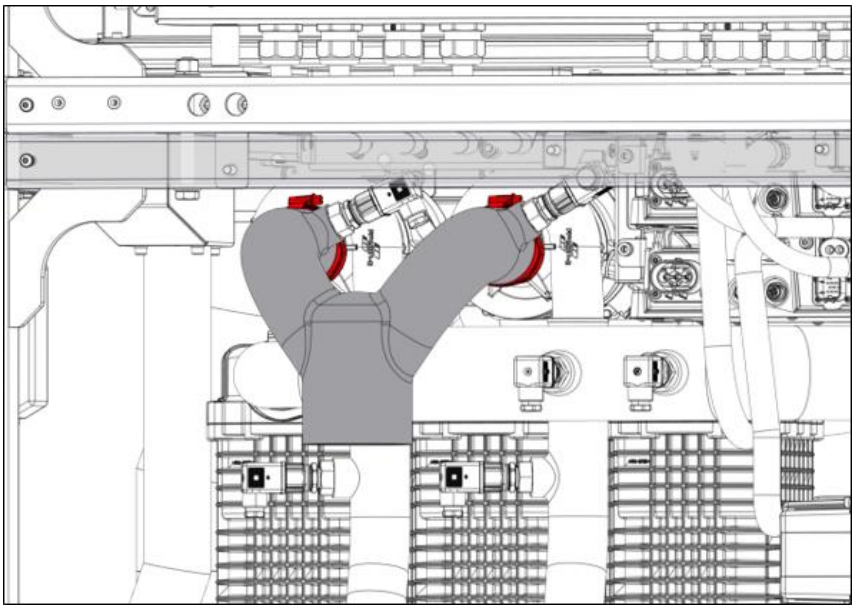


Figure 8-76: Hose clamps for inlet hose to compressors

10. Release 4 pcs. hose clamps used to secure the hose from humidifiers to the motorized shut-off valve and remove the hoses.

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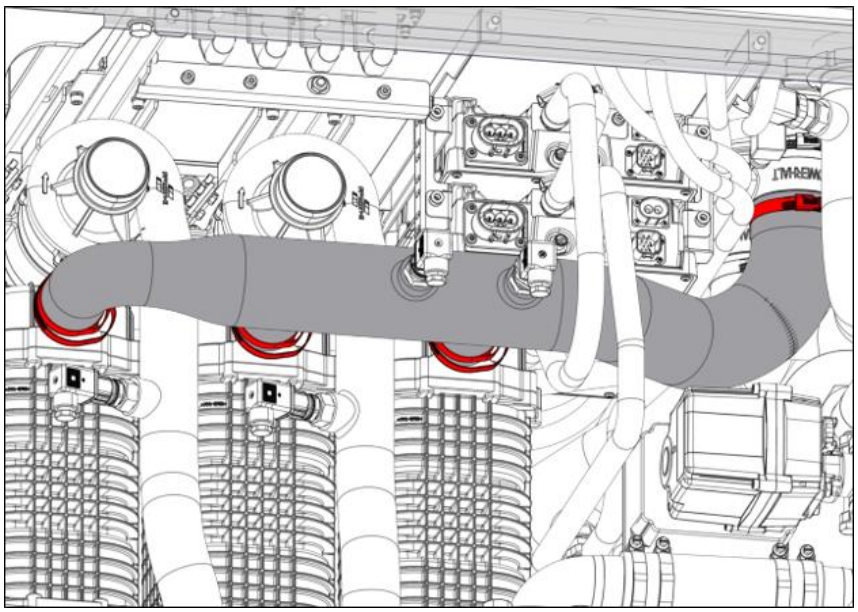


Figure 8-77: Hose clamps on humidifier to motorized shut-off valve hose

11. Release 4 pcs. hose clamps used to secure the hose from aftercooler to the air compressors and remove the hoses.

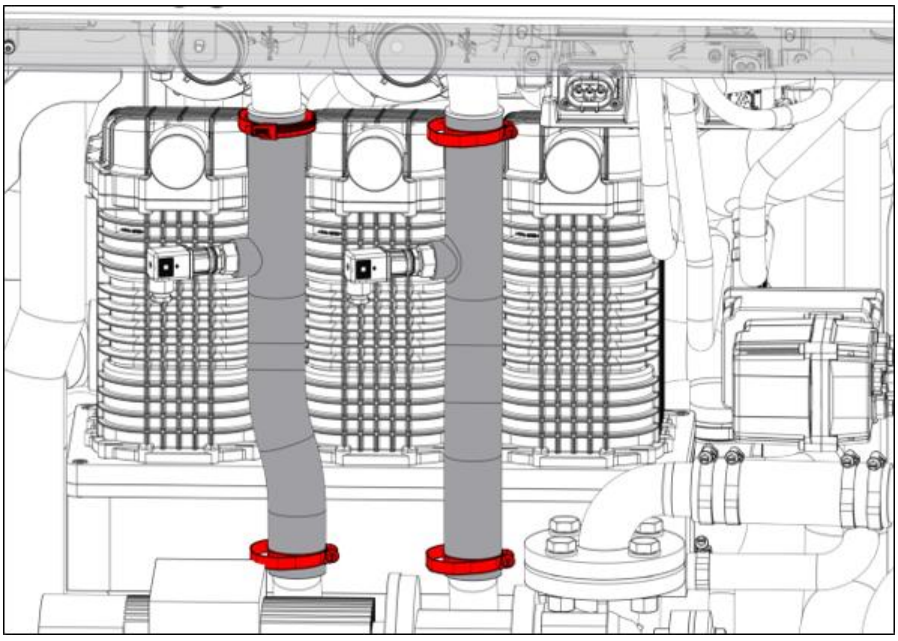


Figure 8-78: Hose clamps on aftercooler to air compressors hose

12. Unplug the HV compressor cables from inverters A and B and remove the protective mesh from the power cables.

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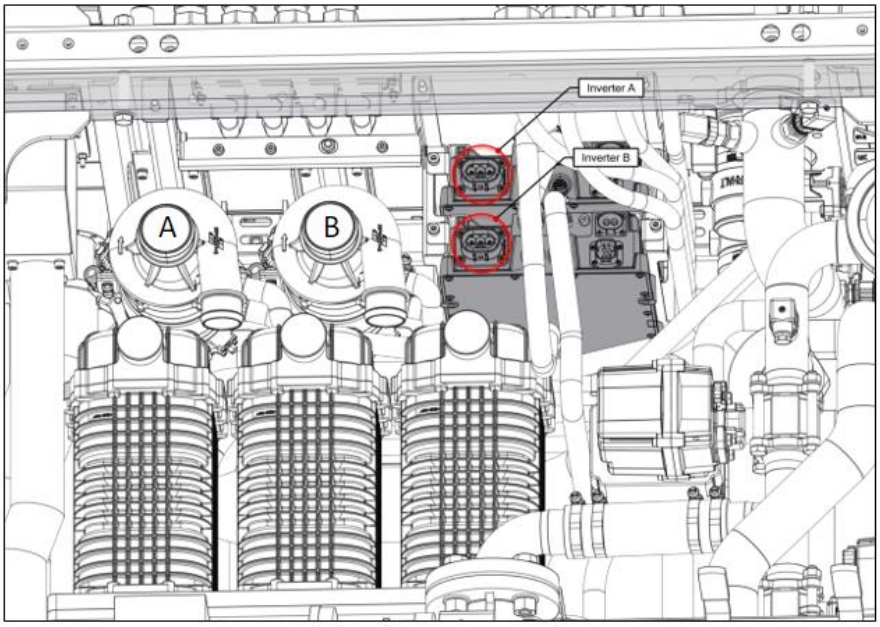


Figure 8-79: Inverters and compressor HV cables

13. Uninstall 4 pcs. M6 bolts from the cross beam bracket above the air compressors and remove the bracket.

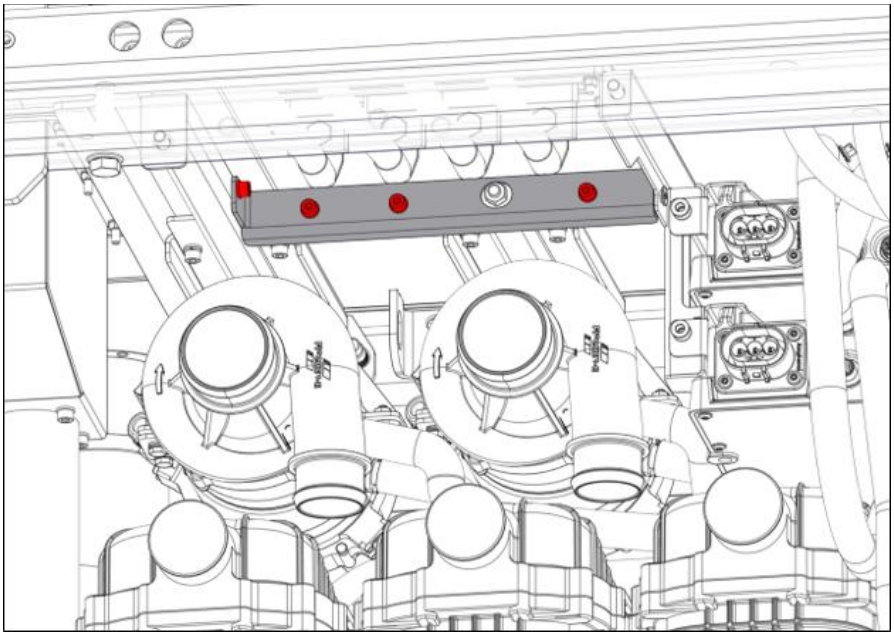


Figure 8-80: Removal of cross beam bracket

14. (This step only applies to early FCwave modules) Cut the cable tie and slide back the linear heat detection cable to give more slack at the compressor back end. Then, cut the cable tie supporting the HV cables. Lastly, remove the linear heat detection cable wrapped around compressors A and B.
15. Uninstall 8 pcs. M6 bolts and spring washers used to tighten the air compressor mounting brackets to the left and right compressor mountings.

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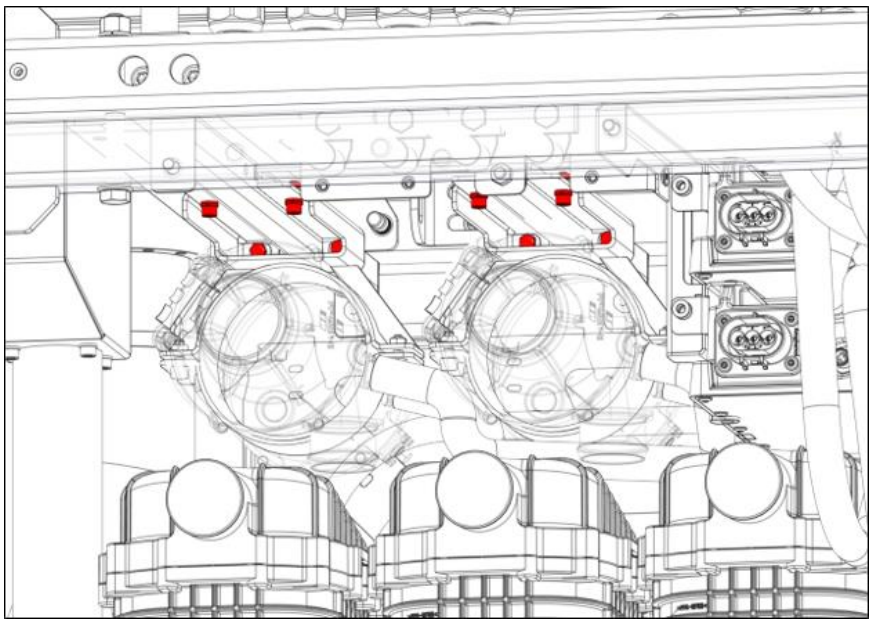


Figure 8-81: Bolts in air compressor mounting brackets

16. Block 2 pcs. LT coolant hoses for compressor A with hose clamp pliers and place paper towels below the compressor to prevent coolant leaking to other components.
17. Slide compressor A about 10cm and release the hose clamp for the air compressor coolant inlet hose and dismount the coolant hose from the compressor. Cover the compressor and the hose with clean caps.
18. Further slide compressor A until it is possible to release the hose clamp for the air compressor coolant outlet hose and dismount the coolant hose from the compressor. Cover the compressor and the hose with clean caps.
19. Unplug the sensor cable from compressor A.

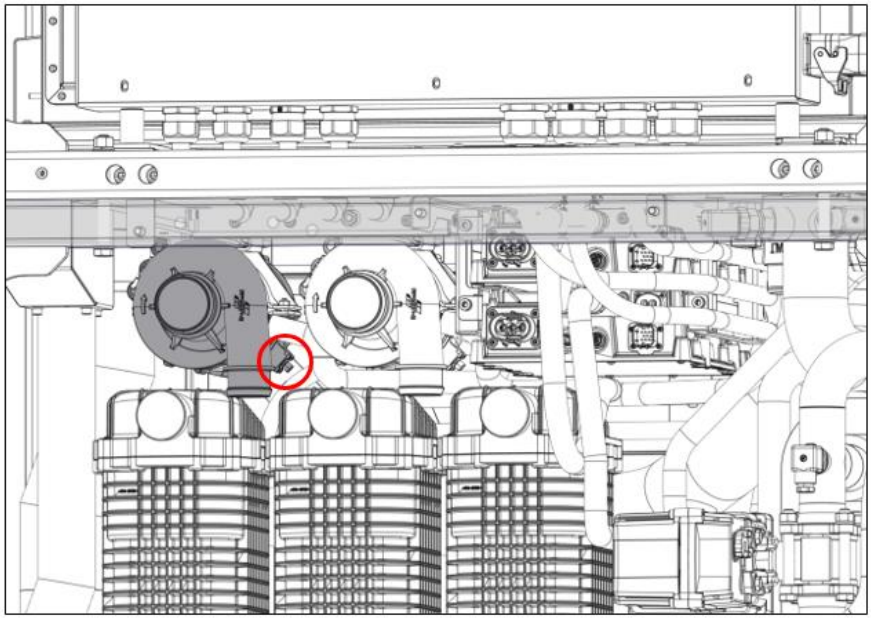


Figure 8-82: Sensor cable on compressor A

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20. Remove the grounding cable from compressor A.
21. Remove compressor A from the module and place it on a clean, flat surface.
22. Remove the grounding cable from compressor B.
23. Block 2 pcs. LT coolant hoses for compressor B with hose clamp pliers and place paper towels below the compressor to prevent coolant leaking to other components.

24. Uninstall the front M8 bolt from the compressor mounting bracket and loosen the rear M8 bolt.

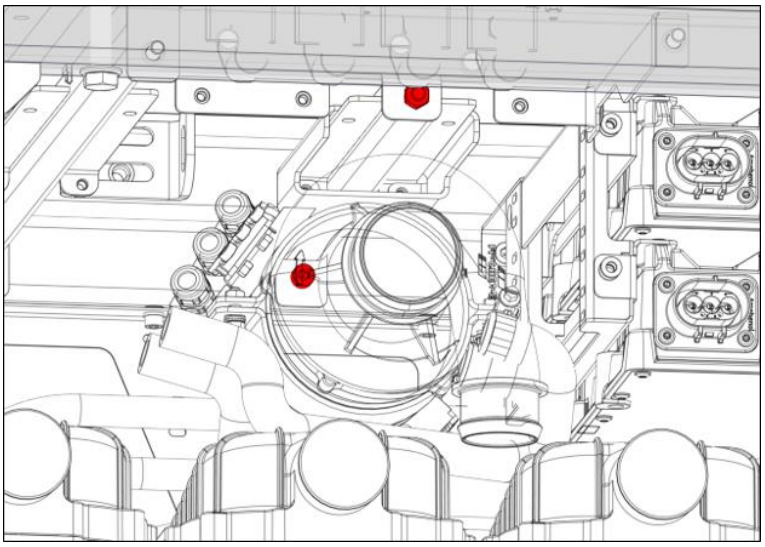


Figure 8-83: Front and rear bolt in compressor mounting bracket

25. Lower the front of the bracket 30mm to make room for the compressor to be removed.
26. Slide compressor B about 10cm and release the hose clamp for the air compressor coolant inlet hose and dismount the coolant hose from the compressor. Cover the compressor and the hose with clean caps.
27. Unplug the sensor cable from compressor B.
28. Remove compressor B from the module and place it on a clean, flat surface. Remove the coolant hose from the compressor. Cover the compressor and the hose with clean caps.
29. Place both verticals in a vertical position. Cut the cable ties used to secure the HV cables to the compressor brackets. Then, uninstall 4 pcs. M6 bolts used to secure the bracket and remove the bracket.

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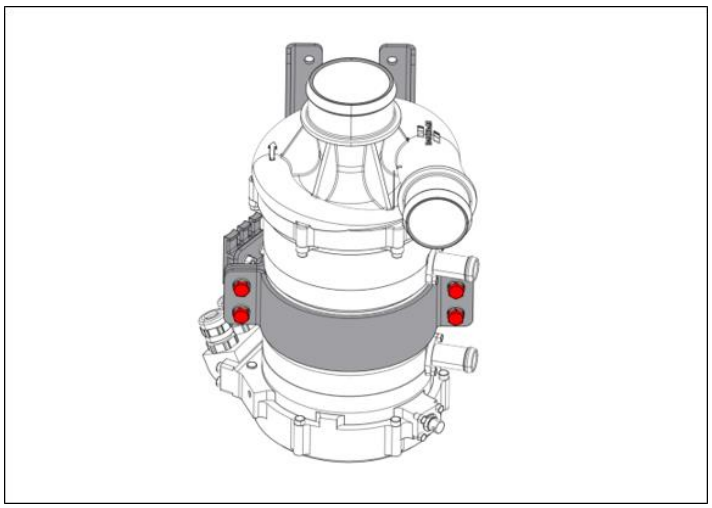


Figure 8-84: Removal of compressor bracket

30. Remove the compressor rubber damper from the compressors.

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Assembling procedure:

1. place the new compressors in a vertical position and mount the rubber damper.

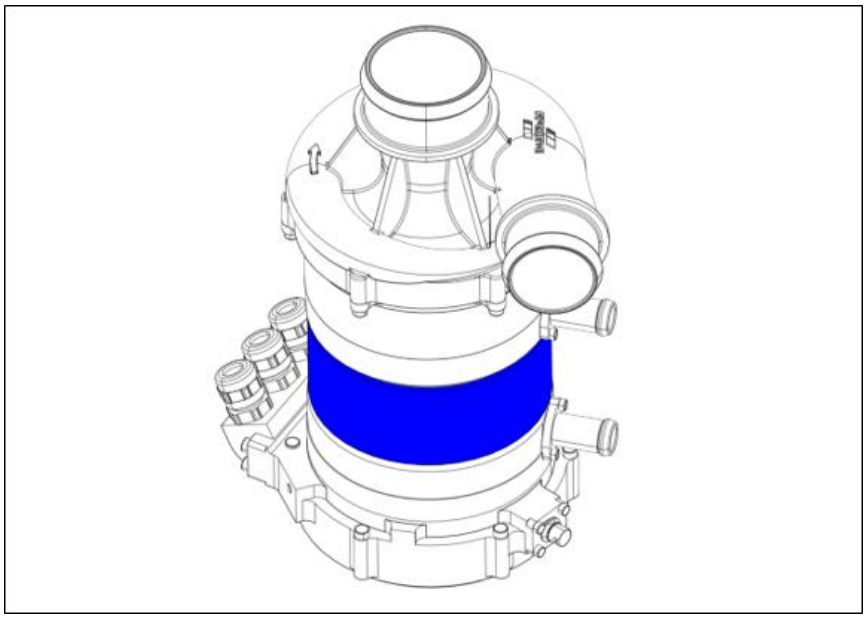


Figure 8-85: Install rubber damper on compressor

2. Use 4 pcs. M6 bolts to install the compressor bracket as shown and install the cable ties used to secure the HV cables to the bracket. Tighten the bolts to 6 Nm. Repeat for both compressors.
3. Secure the HV supply cable with cable ties as shown. Repeat for both compressors.

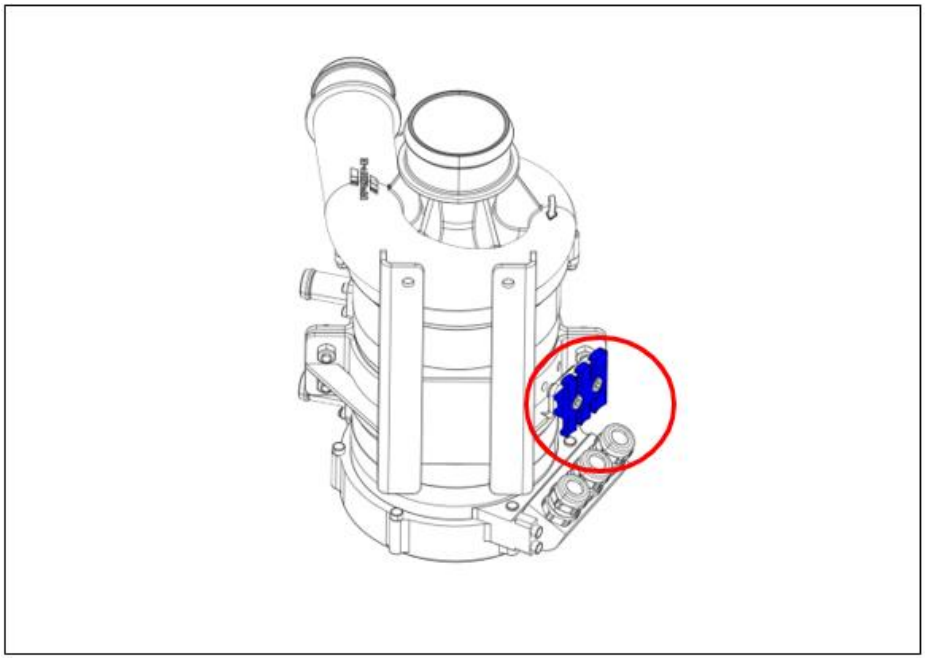


Figure 8-86: Securing HV supply cable

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4. Install the coolant hose to the compressor B coolant outlet and tighten the hose clamp. Tighten to 3.5 Nm.
5. Mount compressor B in the cabinet, slide inwards 10cm and connect the sensor cable.

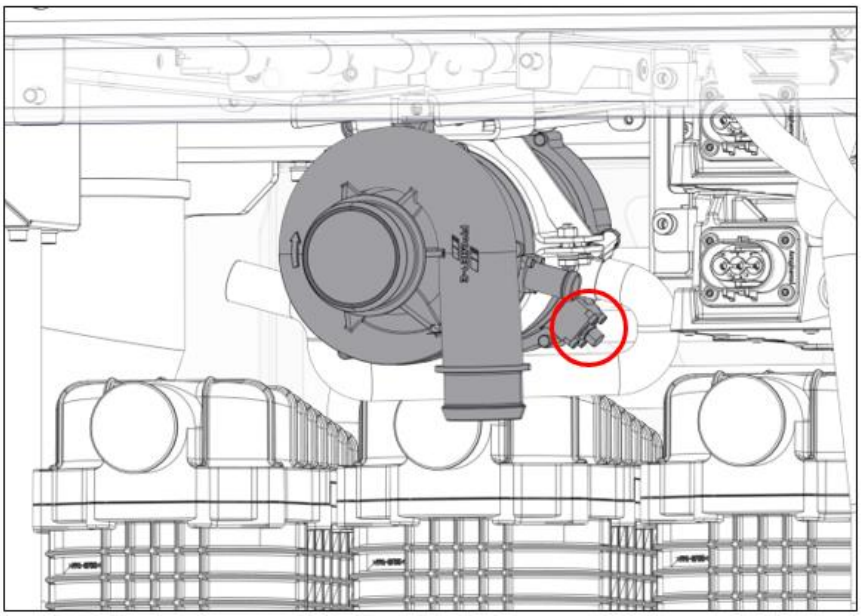


Figure 8-87: Install sensor cable to compressor B

6. Slide compressor B further in until it is possible to mount the coolant inlet hose and mount it. Tighten hose clamp to 3.5 Nm.
7. Slide compressor B into complete mounting position and raise the bracket front into position.
8. Install the front M8 bolt in the mounting bracket and tighten both front and rear M8 bolt to 15 Nm.

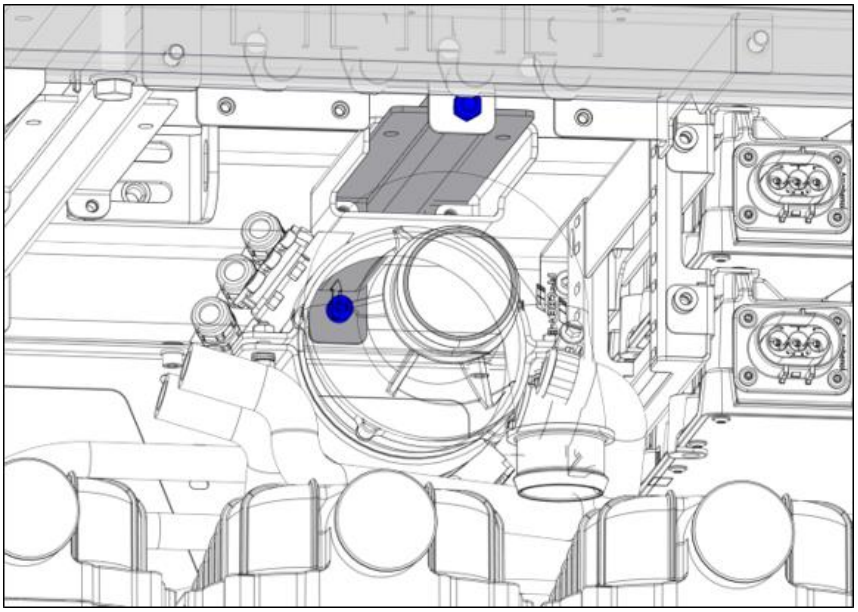


Figure 8-88: Install bolts for mounting bracket

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9. Mount compressor A and slide in 10cm. Connect the sensor cable and mount the coolant hose on the coolant outlet. Tighten hose clamp to 3.5 Nm.

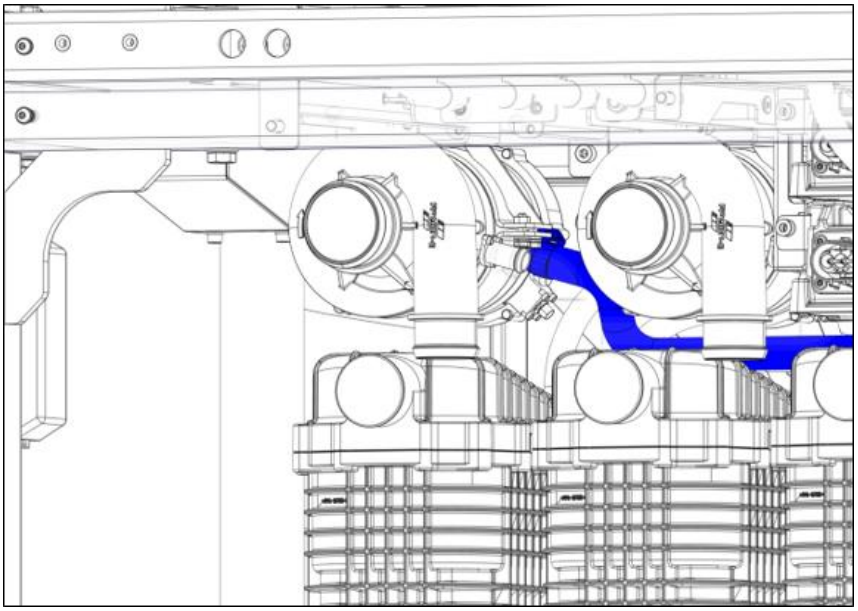


Figure 8-89: Mounting of compressor A

10. Slide compressor A further in until it is possible to mount the coolant inlet hose and mount it. Tighten hose clamp to 3.5 Nm.
11. Slide in compressor A to final mounting position.
12. Use 8 pcs. M6 bolts and washers to secure the bracket as shown. Tighten to 6 Nm.

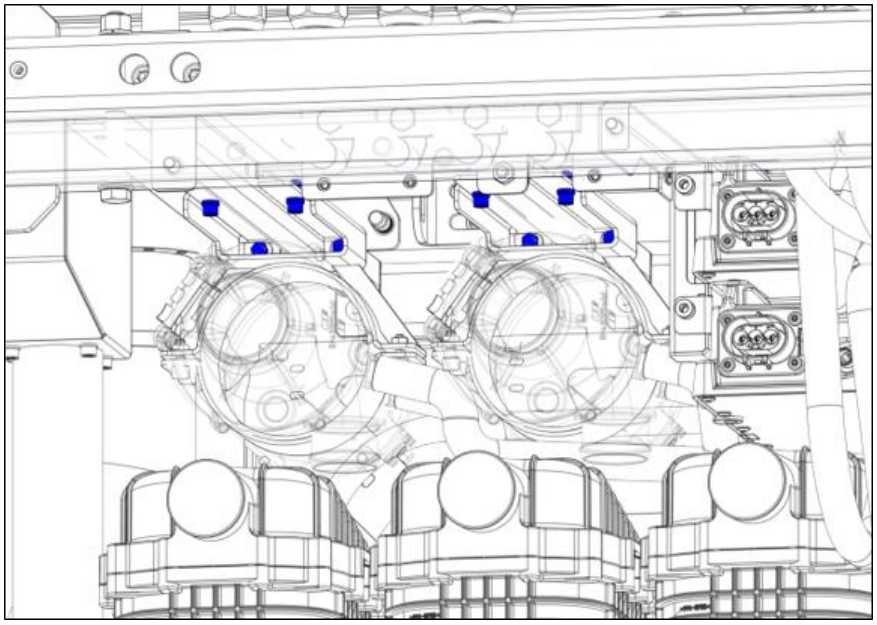


Figure 8-90: Securing mounting brackets

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13. Use 4 pcs. M6 bolts to install the cross beam bracket. Tighten to 6 Nm.
14. Wrap protective mesh around the power cables and secure with 3 pcs. cable ties.
15. Connect the HV cables from the compressors to inverters A and B.
    If you have Inverter 2.0B installed, use 'Inverter 2.0B Adaptor Cable' (part no. 7500631).

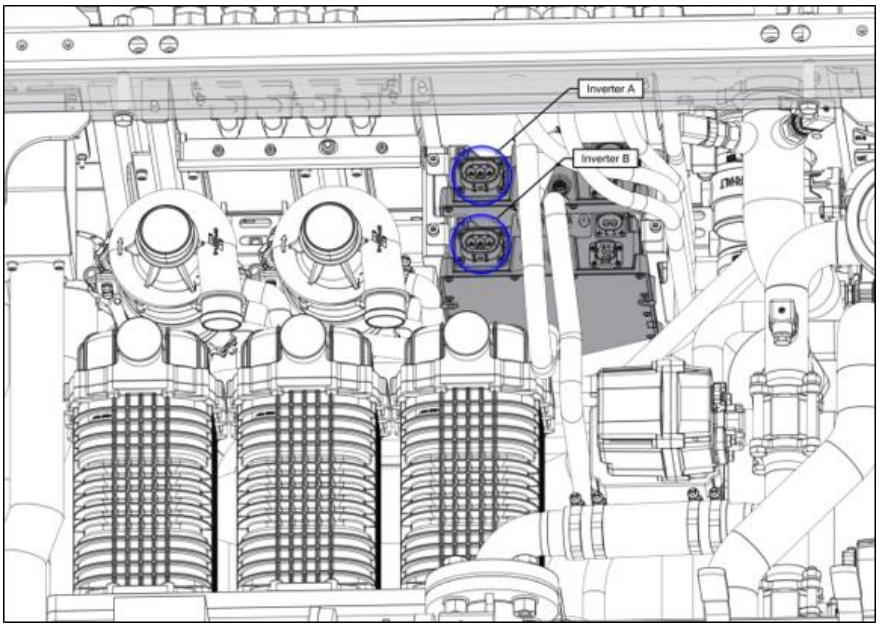


Figure 8-91: HV cables to inverters

16. Use 4 pcs. hose clamps to mount hoses from aftercooler to air compressors as shown. Tighten hose clamps to 3.5 Nm.

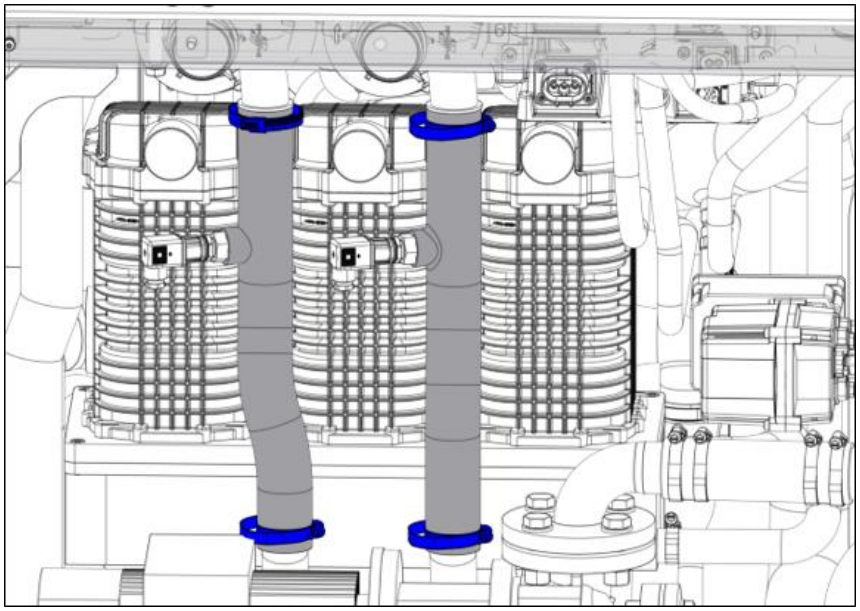


Figure 8-92: Installing hoses from aftercooler to compressors

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17. Use 4 pcs. hose clamps to mount hoses from humidifiers to motorized shut-off valve as shown. Tighten hose clamps to 3.5 Nm.

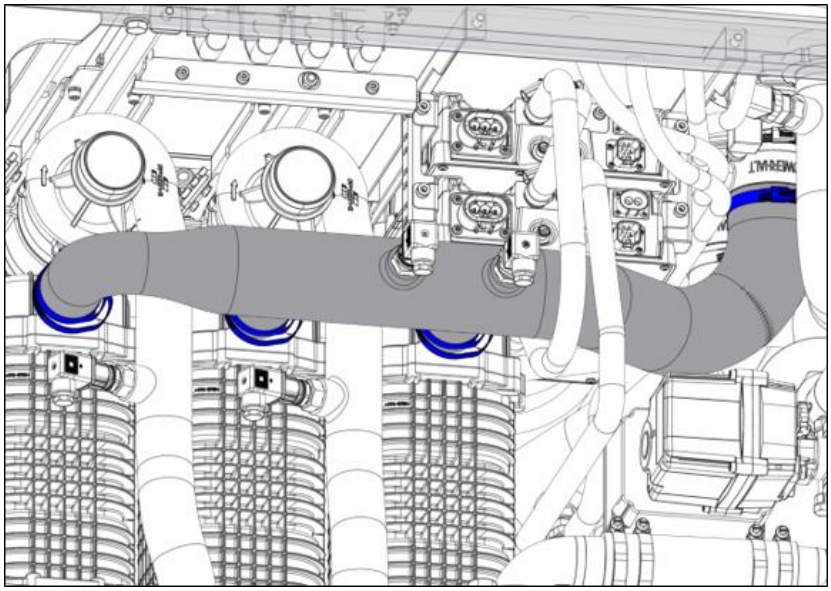


Figure 8-93: Installing hose from humidifiers to shut-off valve

18. Use 2 pcs. hose clamps to install compressor inlet hose to the compressors. Tighten hose clamps to 3.5 Nm.
19. Connect all following sensor connections of harness CN600 as shown: PT_A11A, PT_A11B, PT_A12A, PT_A12B, PT_A40, TT_A40.

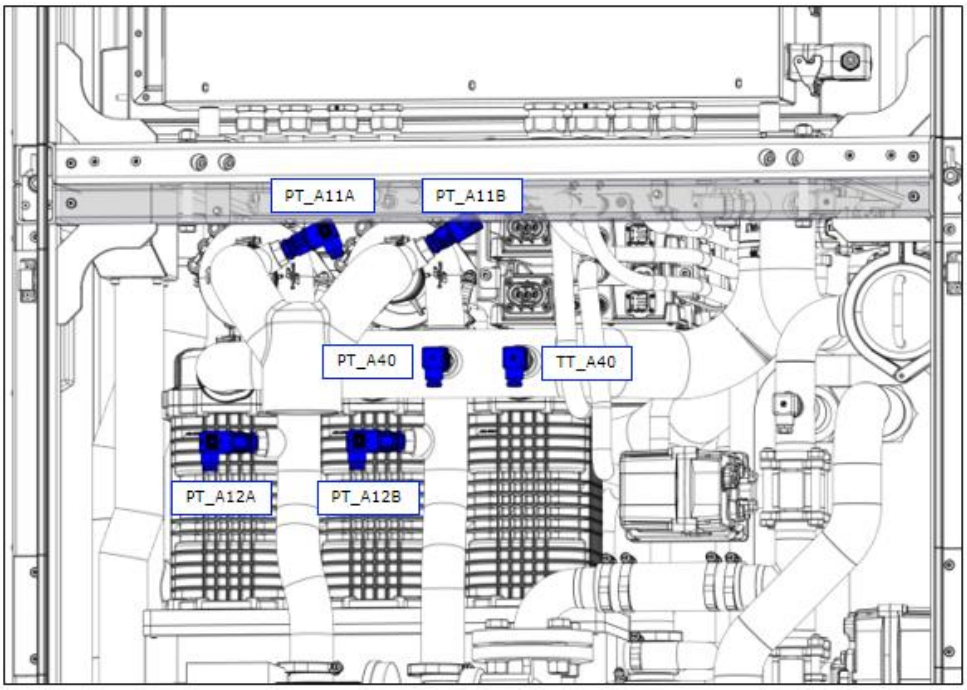


Figure 8-94: installing sensor connections

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20. Use 2 pcs. M8 bolts and washers to install mounting bracket to the cabinet as shown. Tighten to 15 Nm.

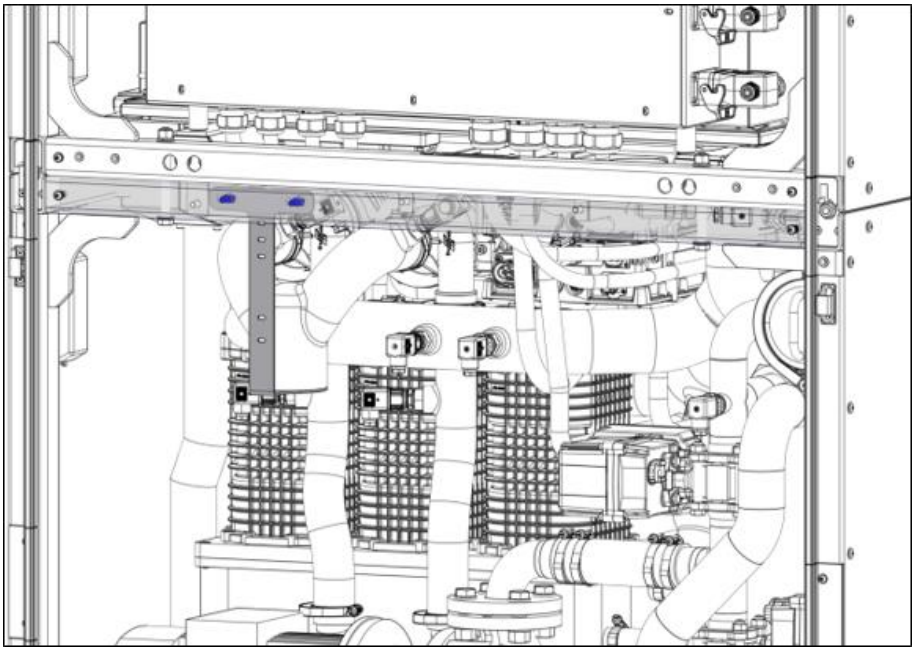


Figure 8-95: Installing mounting bracket to cabinet

21. Mount intake filter on intake hose. Tighten hose clamp to 3.5 Nm.
22. Connect the mass air flow meter sensor (FT_A10).
23. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
24. Run “auxiliary coolant system” from integrator side to fill and de-air the auxiliary coolant system.
25. Test the operation of the air compressors.
26. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
27. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
28. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.3.6 Assurance Procedure – Air Cathode Sub-system leak test

Succes criteria for leak testing:

There is a leak if:

- Values recorded during the test are out of acceptable range provided by the "Leak Test Report Form", which can be found on the Customer Portal (see section 4.1 for further information)
- Unable to create correct pressure in the system
- Escaping air can be heard within the module
- Hydrogen gas and a hydrogen sniffer can be used to identify leaks

There is no leak if:

- All the values recorded during the test are within the accepted range provided by the "Leak Test Report Form" which can be found on the Customer Portal (see section 4.1 for further information)
- No sound coming from the module can be heard

Estimated time to perform the cathode sub-system leak test

Based on the normal conditions, the estimated time for testing is:

Cathode sub-system Leak Test		
Duration	3 hours	
Personnel	1	
Tightening Torque	M5 bolt	6.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	Tool: 4mm + 5mm hex key, leak tester, leak test hose, 3/8" wrench, 8mm hex socket, 7mm socket flex screwdriver, laptop, WLAN cable, 45mm fitting plug, 95mm exhaust blinding plate, 45mm blinding plug	

Table 8-12: Time to perform cathode sub-system leak test

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Procedure:

1. Secure the area before pressurizing the system components.
   Use warning signs around the working area to ensure safety.
2. Locate and loosen 2 pcs. hose clamp on air-out hoses of the air compressor. Disconnect the hoses after clamps is loosened.



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Figure 8-96: Location of hose clamp on air-out hoses

3. Use plugs to cover the disconnected hoses. Use plug with connection for left hose and plug for right hose and use the hose clamps to secure the plugs. Tighten to 5 Nm.

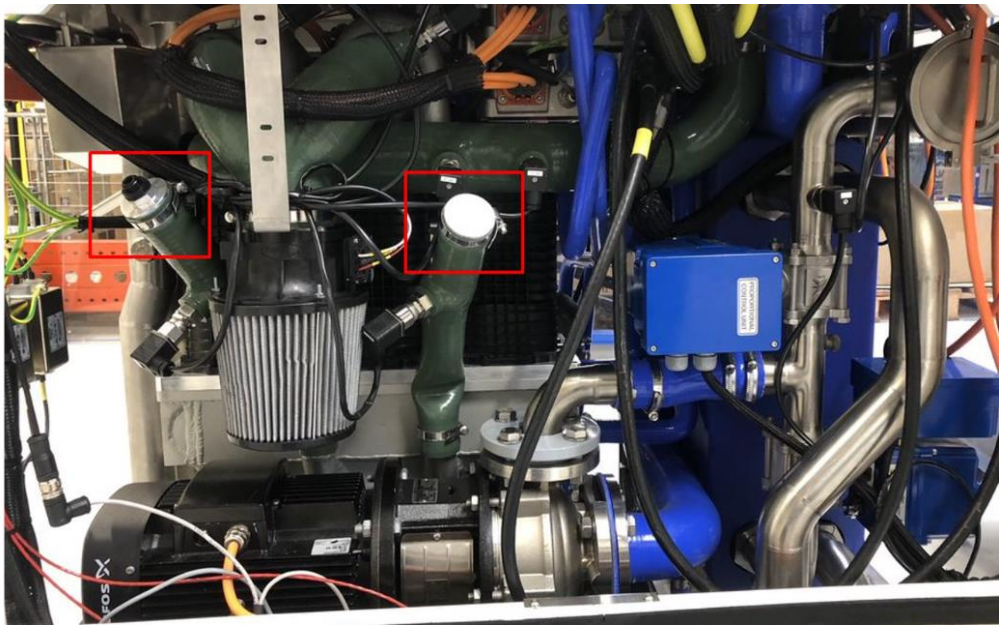


Figure 8-97: Using plugs to cover disconnected air-out hoses

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4. Locate the adaptor box, located in the top left corner of the lower cabinet, covering the C-piece.



Figure 8-98: Location of box covering c-piece

5. From the top of the box, uninstall 5 pcs. M5 bolts and washers.

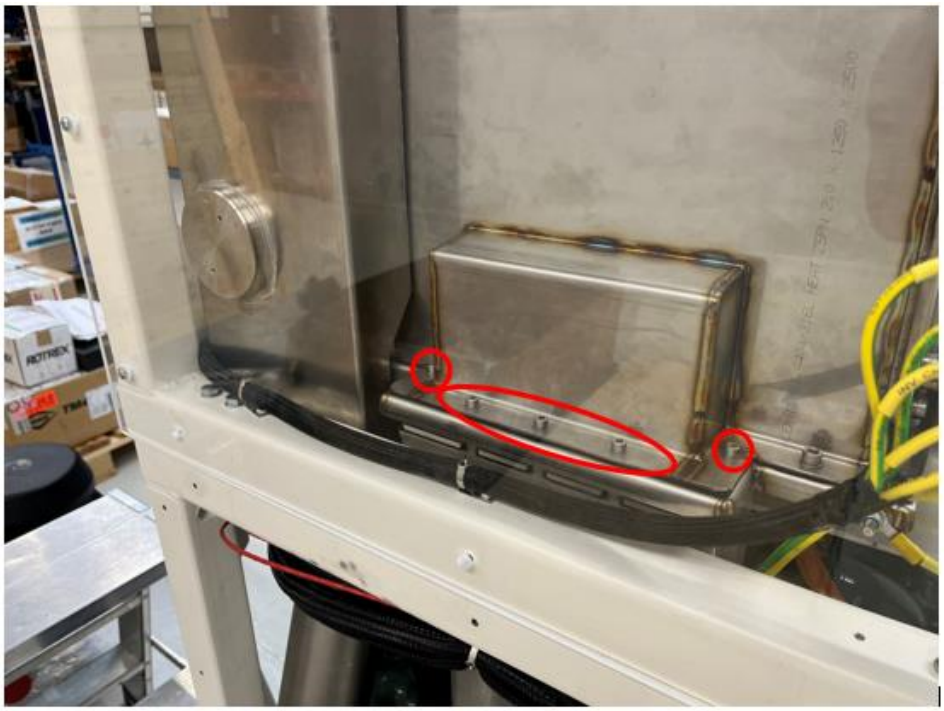


Figure 8-99: Removal bolts top side of adaptor box

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6. From the bottom of the box, uninstall 3 pcs. M5 nuts and washers and 4 pcs. M6 bolts and washers.

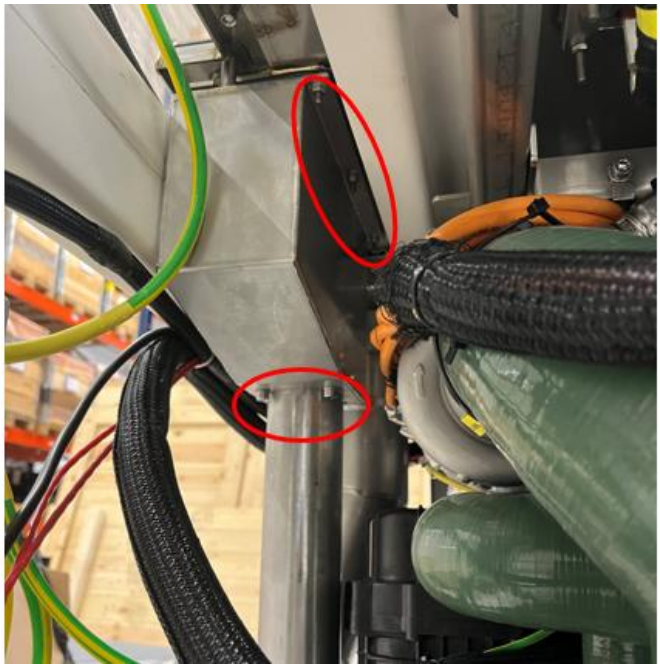


Figure 8-100: Removal bolts bottom side of adaptor box

7. Slide down the box to access the process exhaust swivel located behind the adaptor box.
8. Use the special tool (exhaust swivel) to loosen the exhaust swivel and install exhaust blinding plate between the top and bottom part of the process exhaust as indicated.



Figure 8-101: Placement of blinding plate in swivel

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9. Re-establish the process exhaust. Tighten to 20 Nm.
10. Use laptop to connect to module engineering interface.
11. Navigate to the I/O page and go to the Air tab in the menu.

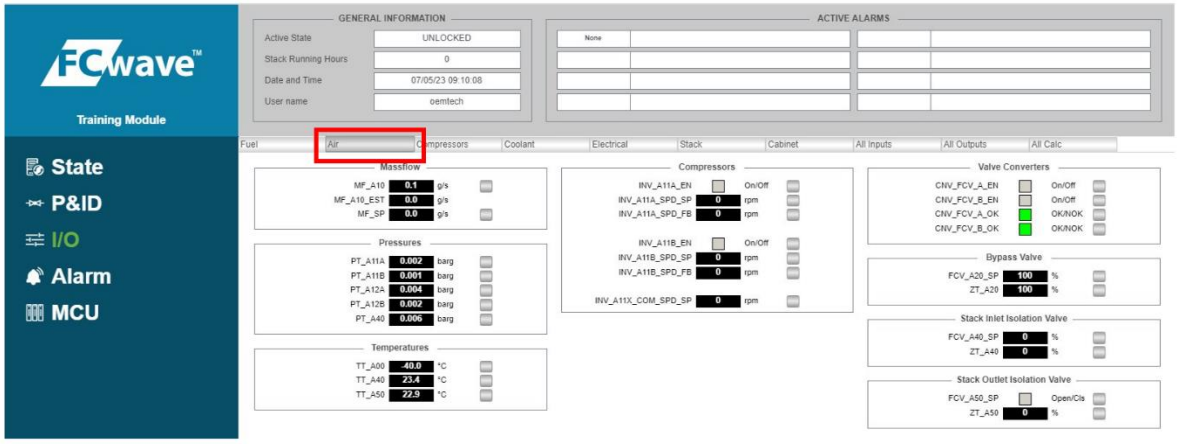


Figure 8-102: Navigate to air tab in the menu

12. Force CNV_FCV_A_EN & CNV_FCV_B_EN to 'on' as shown (1). Force FCV_A20_SP to 50% as shown (2). Force FCV_A40_SP to 50% as shown (3). Force FCV_A50_SP to 'open' as shown (4).

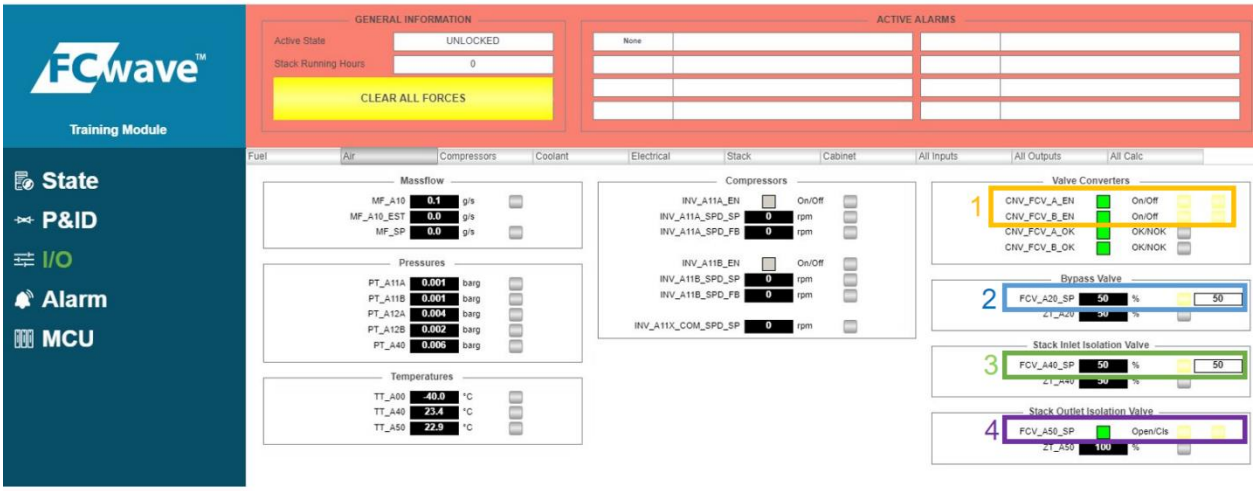


Figure 8-103: Forcing values in air tab

13. Prepare the leak tester according to document MAN5100654, which can be found in the customer portal (see section 4.1 for further information).

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14. Connect the leak tester to the disconnected air compressor hose with the connection plug, marked as (2) in the picture.

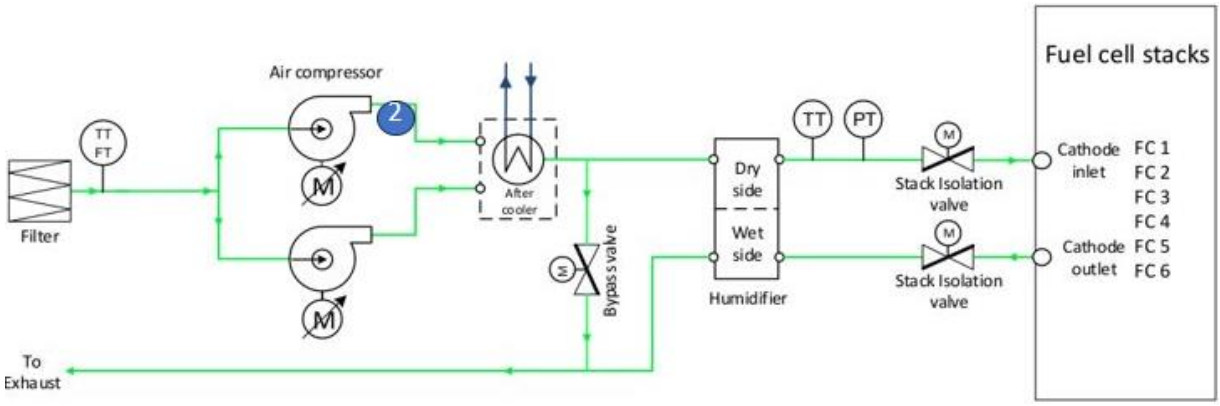


Figure 8-104: Connecting leak tester for cathode sub-system

15. Slowly turn the pressure regulator clockwise to test pressure of 7 Psi. Let the system stabilize for 5 min.

    Use the digital ALICAT MFM for a more precise reading than the analogue pressure gauge.

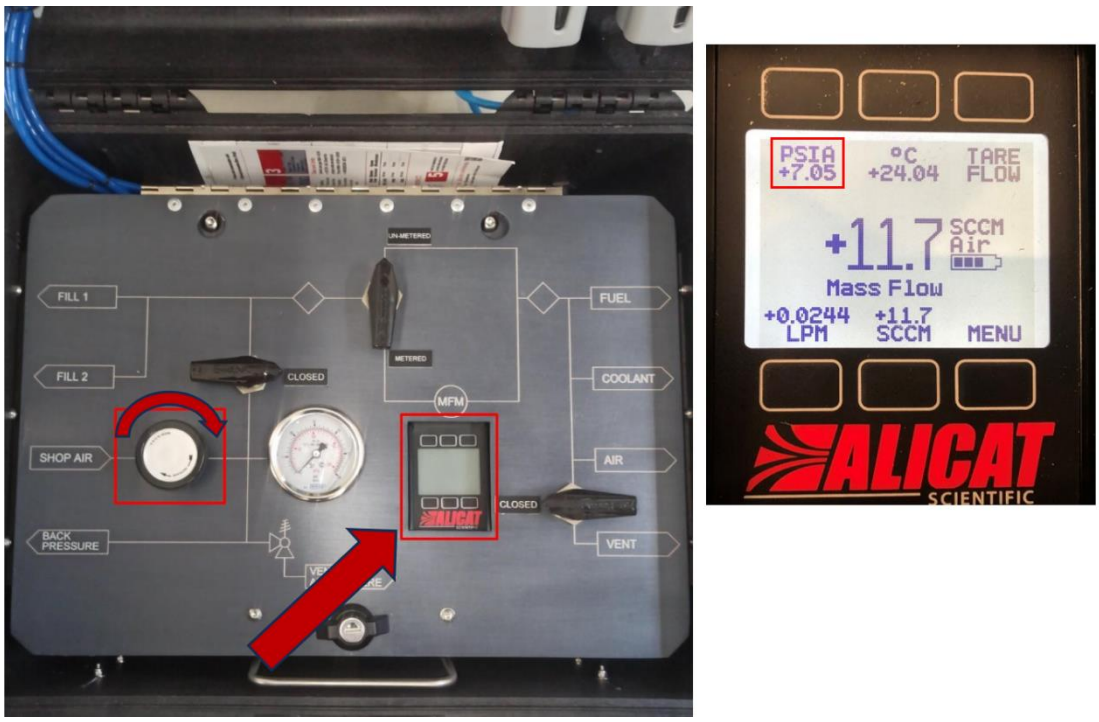


Figure 8-105: Use digital ALICAT MFM for pressure reading

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16. Force valve A to the "un-metered" position. Open valve B. Ensure valve C is in the "closed" position.

    Manometer pressure measurement should be 7 Psi/0.5 bar(g). Verify the pressure on both the manometer and the ALICAT MFM.

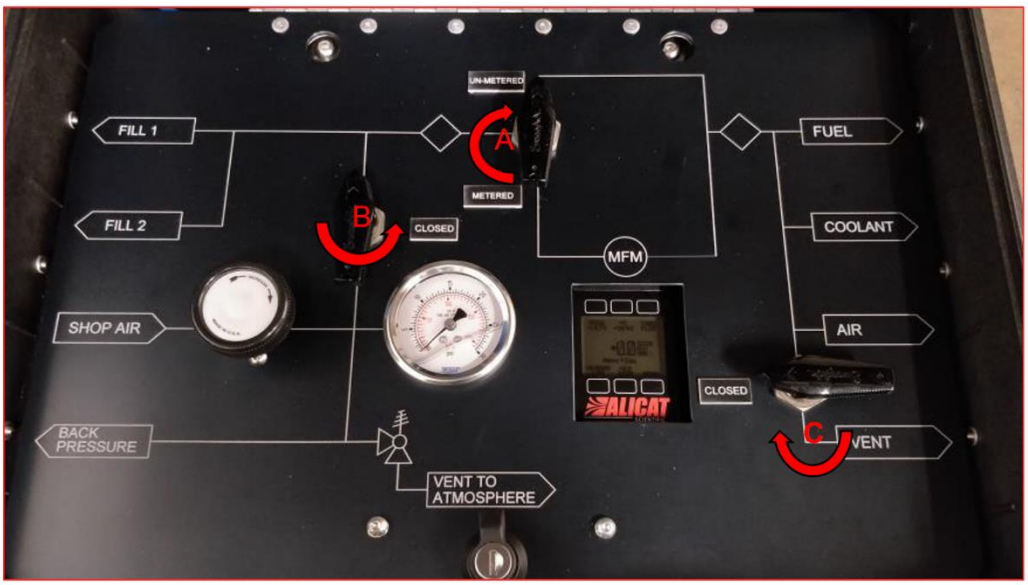


Figure 8-106: Leak tester valves1

17. Gradually force valve A to the "metered" position. Wait for the MFM to stabilize. Read and record the MFM reading in the leak test report form.



Figure 8-107: Leak tester valves2

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18. After completion of the leak test, force valve A to the "un-metered" position. Force valve B to the "closed" position to close off the air supply.

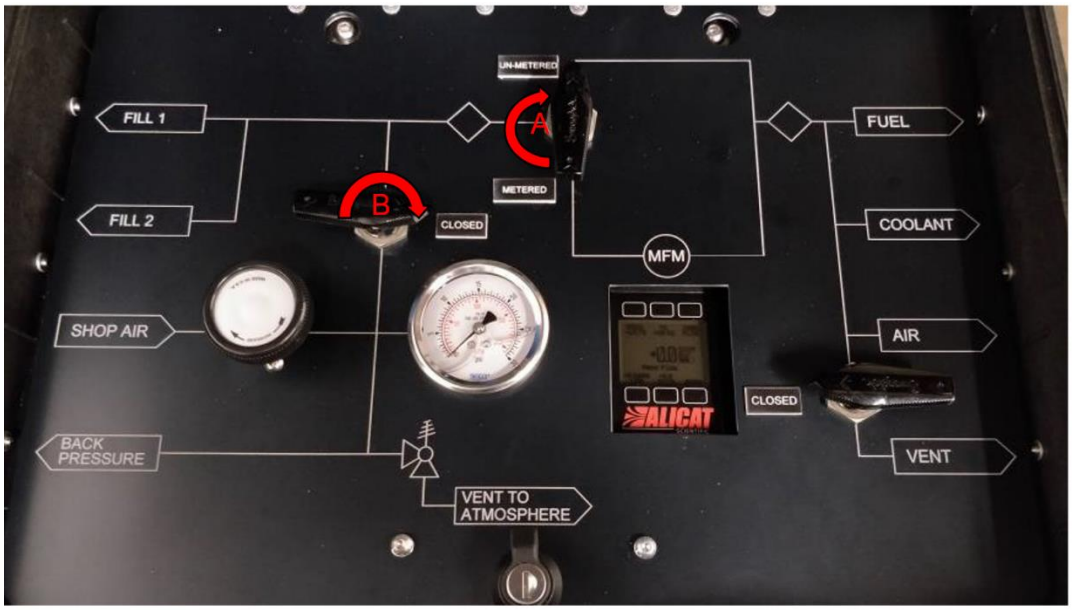


Figure 8-108: Leak tester valves3

19. Slowly force vent valve C to the "open" position to release the buildup pressure. Force the pressure regulator counter-clockwise to dial down the pressure.

    Ensure all hoses are vented before disconnecting from the module.

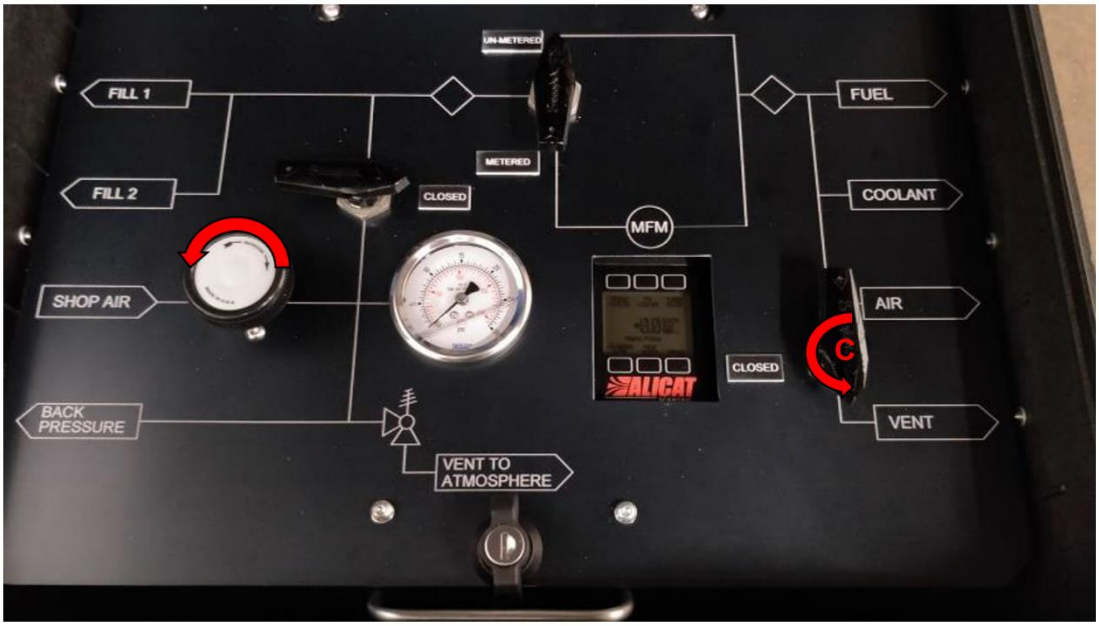


Figure 8-109: Leak tester valves4

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20. Navigate to the I/O page in the engineering interface and press “clear all forces”.
21. Navigate to the P&ID page and check that YV_H30 is closed and the box above PCV_H40 (PCV_CTRL_SP) is set to ‘0’.

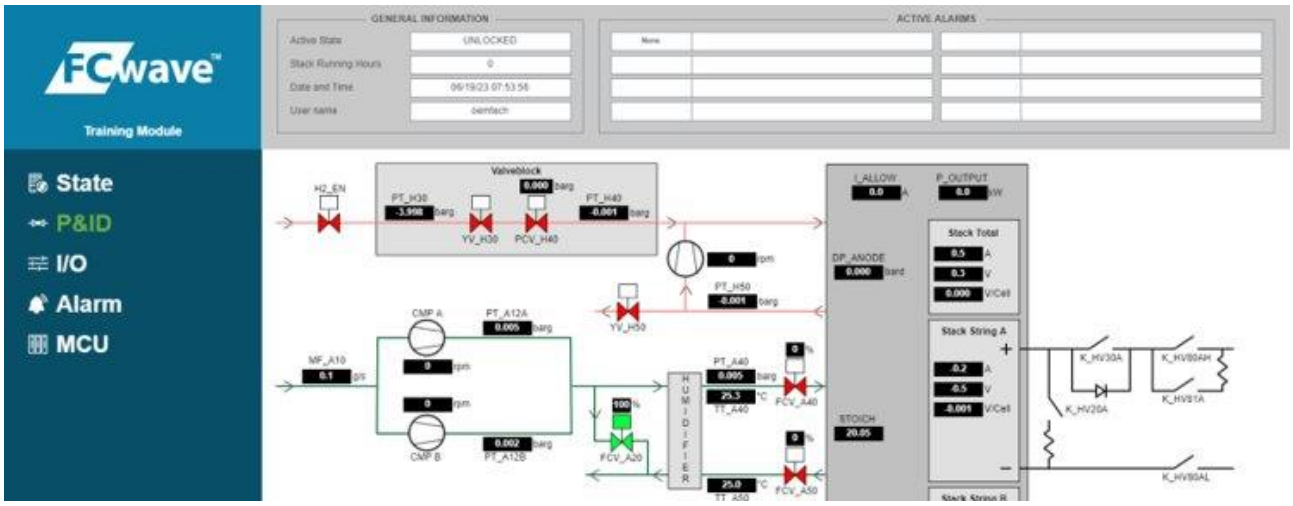


Figure 8-110: Checking YV_H30 is closed

22. Dismount the leak tester hose and reconnect hoses as before leak testing procedure.
23. Loosen process exhaust and remove the blinding plate. Replace the O-ring and re-establish process exhaust. Tighten to 20 Nm.
24. Use 5 pcs. M5 bolts and washers, 4 pcs. M6 bolts and washers, and 3 M5 nuts and washers to re-install the adaptor box. Tighten all to 5 Nm.

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8.4 Cooling Sub-system

For detailed P&ID requirements, refer to "Piping and Instrumentation Diagram" (PWR005), which can be found the Customer Portal or by contacting BPSE (see section 4.1 for further information).

8.4.1 Check for Coolant Leaks

Purpose:

The procedure describes how to visually inspect the cooling system and how to check for leaks or other issues. Components that show signs of damage or problems must be reported to BPSE to determine if any corrective action is necessary.

Responsibilities:

It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1).

Safety:

Refer to section 8.1.2 to follow the instructions.

Procedure:

1. Perform step 1-3 in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the disassembling procedure.
2. Visually examine HT coolant and air hoses installed in the upper cabinet and lower cabinet of module.
3. If accessible, examine the hoses connected to the air compressor and motor controllers of the LT coolant loop.
4. Record the observations and findings during inspection. If any leaks or damage are reported, do not operate the module until the issue is corrected. Contact BPSE (see section 4.1) for further support.
5. For coolant hose inspections:
    - Check DI filter housing for cracks or signs of leaks.
    - Check all coolant hoses. Make sure there are no loose clamps, bends, pinching, cuts, or cracks.
    - Check that all bolt fastenings and connections in the coolant circuit are tight and correctly aligned.
    - Check for signs of overheating, wear, or damage — damages of an excessive nature can be sign of more dangerous issues and must be investigated further.
    - Check that there are no visible leak spots, pooled liquid, corrosion, or excessive moisture around the H2 enclosure and in the lower cabinet base.
    - Check the fluid level in the header tank for evidence of any coolant loss.

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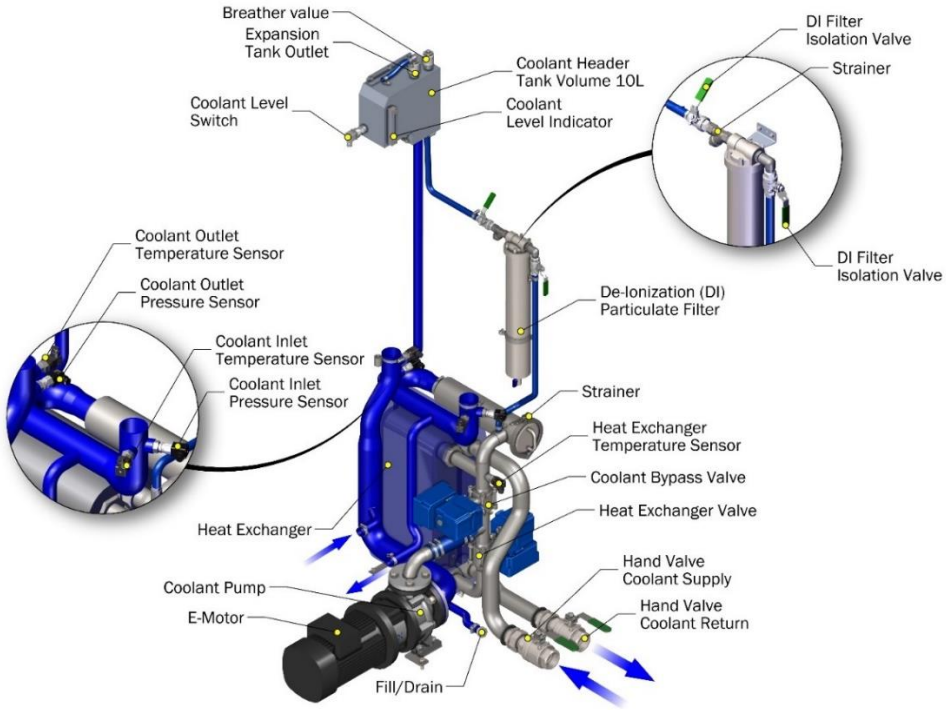


Figure 8-111: Overview of coolant hose inspections

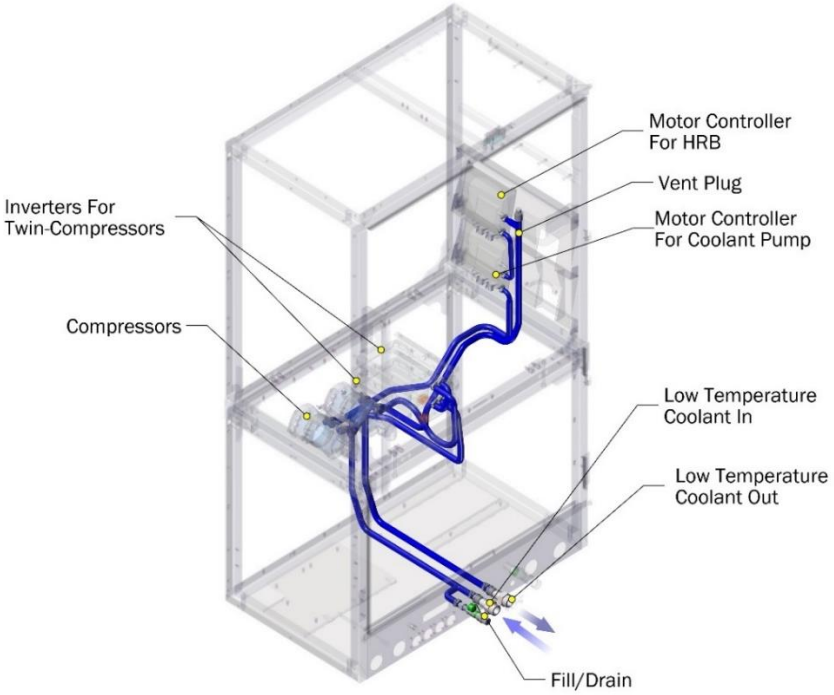


Figure 8-112: Second overview of coolant hose inspections

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8.4.2 Check Stack Coolant Conductivity

Purpose:

The procedure describes how to check the electrical conductivity of a fluid sample collected from the HT coolant circuit, through the DI filter drain valve with a conductivity meter. Higher than expected electrical conductance (5 µS) is an indication to replace the DI particulate filter. This DI filter maintains the cleanliness of the coolant circuit which prevents a conductive path through the circuit.

Responsibilities:

It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1).

Parts and equipment:

A list of parts and special equipment is identified for examination of the cooling system during the life and operation of the FCwave module.

- Cooling sample KIT (part no. 7001351)
- Conductivity meter[3] 0.0 to 99.9 µS/cm or equivalent (part no. 6500424)

Safety:

Refer to section 8.1.2 to follow the instructions.

Procedure:

1. Check that the system has been in operation during the 24 hours before performing the test, to make sure the collected sample is filtered and deionized, so the data collected is representative of electrical conductance that can be expected during operation (coolant conductivity will increase over time when the system is not in operation).
2. If the module has not been in operation during the last 24 hours, operate the FCwave module for 10 minutes to circulate coolant through the DI particulate filter.
3. Perform step 1-3 in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the disassembling procedure.
4. Follow the manufacturer instructions to prepare the conductivity meter before taking the sample.
5. Make sure the coolant sample cool to below 40°C, before immersing the conductivity probe in the collected sample.
6. Collect the necessary quantity of fluid from the HT coolant circuit into a clean container through the DI filter drain valve, so the sensing element of the conductivity meter can be immersed to about half of its length. Follow the instructions on the conductivity meter.
7. Stir the probe in the coolant sample and monitor the value until the indication is stable and record the value.
8. Make sure the indication is less than 5 µS. If conductivity indication is initially higher than 5 µS:
   - Replace the coolant DI particulate filter in the system coolant circuit (see section 8.4.8).
   - Locate the ports normally used for filling/draining the HT circuit, use a portable pump secured with mechanical relief valve to fill the HT circuit.
   - Operate the system until it reaches 40°C to deionize the coolant.
   - Collect a new test sample.
   - Measure the conductivity again, until it is below 5 µS.

   Pay attention to disconnect the vent valve connected to H_2 ventilation outlet duct to prevent any coolant spillage in the fuel cell stack during filling procedure.
9. Clean and follow the manufacturer instructions to store the conductivity meter.

[3] Conductivity meter is part of the 'Special Tools Kit FCwave' (part no. 6100062)

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8.4.3 Check the Coolant Particulate Filter

Purpose:

The procedure describes how to check a coolant particulate filter (wedge wire screen) of the HT coolant system and how to replace if necessary. The cooling system contains a wedge wire screen to remove any particulate matter present in the coolant loop.

Responsibilities:

Preventive maintenance of the coolant wedge wire screen is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the H_2 sensors during the life and operation of the FCwave module.

- FRU, Coolant Particulate Filter (part no. 7500087) – if replaced

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the Coolant Particulate Filter

Based on the normal conditions, the estimated time for check is:

Coolant Particulate Filter	
Duration	10 min
Personnel	1

Table 8-13: Time to check coolant particulate filter

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Procedure:

1. Before proceeding with the check, perform all steps in section 7.2.7 and 6.5.1.
2. Drain the high temperature (HT) stack coolant circuit.
   Coolant spillage may occur while opening the wedge wire screen.
3. Loosen by hand the clamp securing the filter and then remove. There might be leftover coolant in the filter housing so prepare area for possible coolant spill.

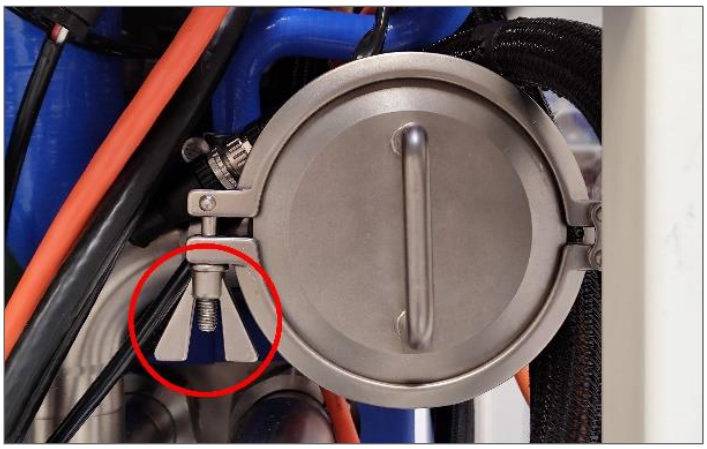


Figure 8-113: Clamp securing particulate filter

4. Grab handle on filter and gently pull out to avoid unnecessary contact with inner side of filter housing.
5. Check the filter for damage and particles. If there are any, rinse off with deionized water (DI).
6. Before reinstalling the filter, make sure the O-ring and gasket on the filter are seated properly.

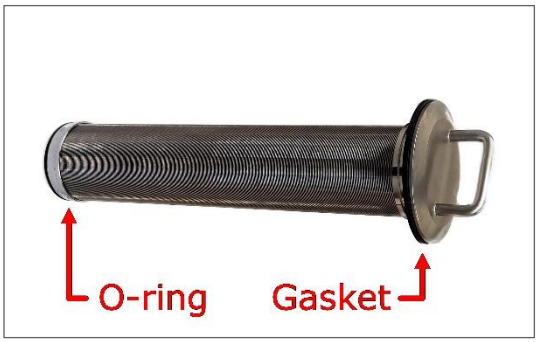


Figure 8-114: Particulate filter gasket and O-ring

7. Gently insert the filter into the housing, making sure the O-ring does not get unseated.
8. Make sure the gasket is properly seated.
   Wiggling the filter by the handle may help the gasket get seated more easily.
9. Reinstall the clamp, securing the filter to the housing, and tighten by hand.
   The module is ready to be restored to normal operating system.
10. Connect a portable pump secured with a mechanical relief valve to the connector, to fill the module with HT coolant as necessary.
11. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.4.4 Check the Coolant Level Indicator

Purpose:

The procedure describes how to visually inspect the coolant level in the header tank. The module contains an internal coolant header tank of no more than 10 litres. It provides a reservoir of coolant, allows for thermal expansion of the coolant, and has a level indicator in the header tank to provide warning for low coolant levels.

Responsibilities:

Preventive maintenance of the coolant level indicator is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Procedure:

1. Perform step 1-3 in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the disassembling procedure.
2. Locate the level indicator behind the HRB motor in the upper cabinet, which is installed on the coolant header tank.

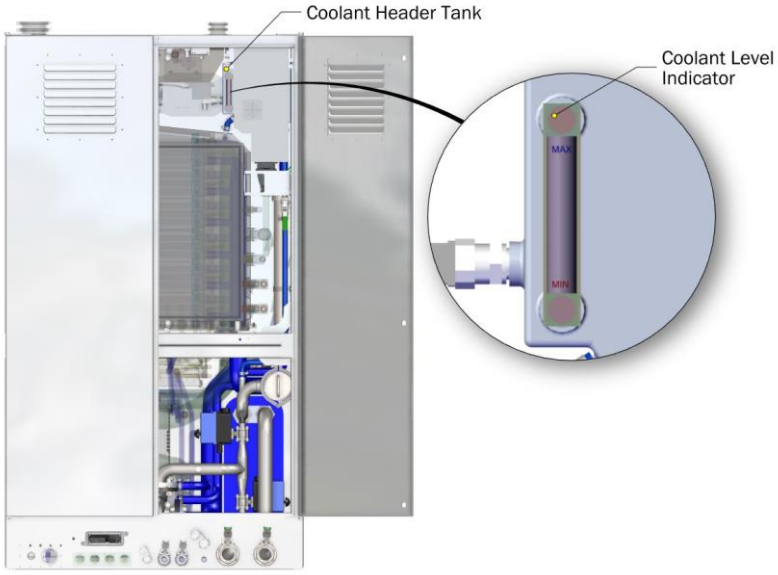


Figure 8-115: Overview of coolant header tank/level indicator

3. Visually examine the sight glass on the header tank, to make sure the coolant level is between maximum and minimum.
4. Do not exceed the maximum level of coolant to avoid any coolant spillage into the system. (During operation coolant level increases due to thermal expansion)
5. Refill the header tank when the coolant is below the minimum level.
6. Connect a portable pump secured with a mechanical relief valve to the connector, to fill the module with HT coolant as necessary.
7. Ensure the air pockets are vented through the vent valve located on the top of header tank.

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Pay attention to disconnect the vent valve connected to the H_2 ventilation outlet duct, to prevent any coolant spillage into the fuel cell stack during the filling procedure.

8. If accessible, examine the hoses connected to the header tank.

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8.4.5 Coolant Tank Level Switch

8.4.5.1 Check Coolant Tank Level Switch

Purpose:

This procedure describes how to check the coolant tank level switch in the FCwave™ module. The switch monitors the High Temperature (HT) coolant level. If the level is too low, it will trigger an alarm.

Responsibilities:

Preventive maintenance of the level switch is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the Coolant Tank Level Switch

Based on the normal conditions, the estimated time for check is:

Coolant Tank Level Switch	
Duration	15 min
Personnel	1

Table 8-14: Time to check Coolant Tank Level Switch

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Procedure:

1. Before proceeding with the check, perform all steps in section 7.2.7 and 6.5.1.
2. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the bolts.

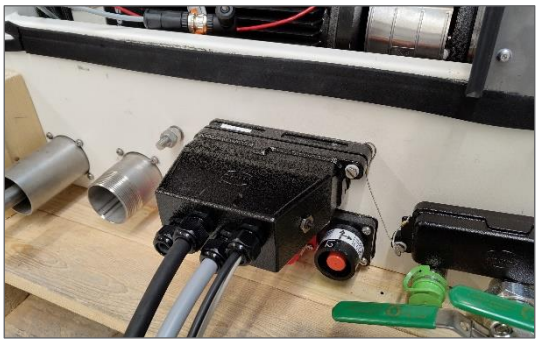


Figure 8-116: Low voltage electrical connection (X_E01)

3. Monitor the MCU engineering interface with the module in "Unlocked" state. Make sure there are no active alarms.
4. Drain the HT coolant via the fill/drain valve.



Figure 8-117: Drain the HT coolant

5. Confirm the following alarm can be seen in the engineering interface:
   - A2_LSL_D25_S_10721
6. Refill with new HT coolant to normal level. The recommended level is 66%, between MIN and MAX on the coolant level indicator.

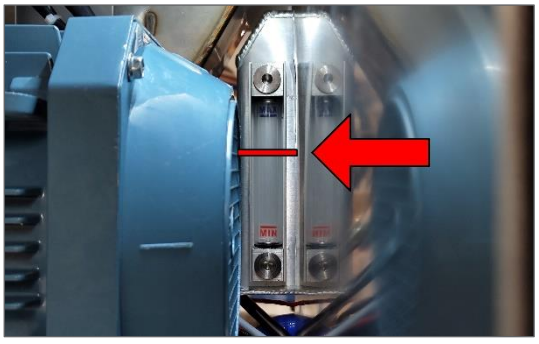


Figure 8-118: Recommended coolant level

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7. Clear the alarm in the engineering interface and confirm it does not reappear.
   Remember to clear all forces.
8. The module is ready to be powered down by disconnecting the X_E01 electrical connection, and the module is ready to be restored to normal operating state.
9. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.4.5.2 Replace Coolant Tank Level Switch

Purpose:

The procedure describes how to replace a coolant tank level switch for the HT coolant system. The level switch monitors the filling level of cooling water in the header tank. The level switch detects when a filling level exceeds or subceeds a set limit.

Responsibilities:

Preventive maintenance of the level switch is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the level switch H_2 sensors during the life and operation of the FCwave module.

- FRU, Coolant Tank Level Switch (part no. 7500078)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Level Switch

Based on the normal conditions, the estimated time for replacement is:

Coolant Tank Level Switch		
Duration	1 – 1½ hours	
Personnel	1	
Tightening Torque	1/2" sensor fittings	25 ± 0.5 Nm
	Tool	27 mm spanner, torque wrench, 10mm hex socket,

Table 8-15: Time to replace the level switch

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain the HT cooling system.
3. To get more space, remove the HRB motor. Follow steps 8 through 17 of the disassembling procedure in section 8.2.2.
4. Locate the level switch behind the HRB motor, installed on the coolant header tank in the upper cabinet.

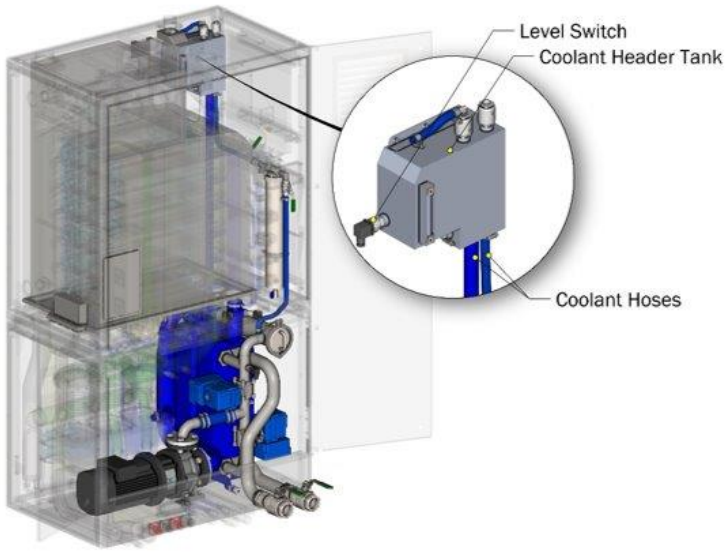


Figure 8-119: Location of the coolant header tank and level switch

5. Disconnect the level switch connection (LSL_D25) by removing the bolt in the middle of the plug.
6. Loosen the level switch and remove it by hand.

Assembling procedure:

1. Install a new level switch. Tighten to 25 Nm.
2. Use the bolt to install the sensor connector.
3. Re-install the HRB motor. Follow steps 11 through 22 of the assembling procedure in section 8.2.2.
4. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
5. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
6. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
7. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.4.6 Replace Coolant Flow Control Valves

Purpose:

The procedure describes how to replace flow control valves for the HT cooling system. A pair of electronically controlled valves regulates the stack coolant inlet temperature. One valve throttles the flow of coolant to the heat exchanger and the other bypasses the heat exchanger, depending on coolant temperature. During start-up, the coolant valves are positioned to bypass the heat exchanger, which allows coolant to recirculate through the stack and reduces warm-up time.

Responsibilities:

Preventive maintenance of the flow control coolant valve is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the coolant flow control valve during the life and operation of the FCwave module.

- FRU, Coolant Valve Actuator (part no. 7500088)
- FRU, Coolant Valve (part no. 7500089)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Coolant Valves

Based on the normal conditions, the estimated time for replacement is:

Coolant Valves		
Duration	1 – 1½ hours	
Personnel	1	
Tightening Torque	M8 bolt	25 ± 0.5 Nm
	M10 bolt	50 ± 5 Nm
	Tool	6mm + 8mm hex key, 13mm + 17mm socket key, 17 mm spanner, torque wrench

Table 8-16: Time to replace the coolant valves

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain and purge the HT cooling system.
3. Locate the coolant bypass valve in the lower cabinet (FCV_D30A).

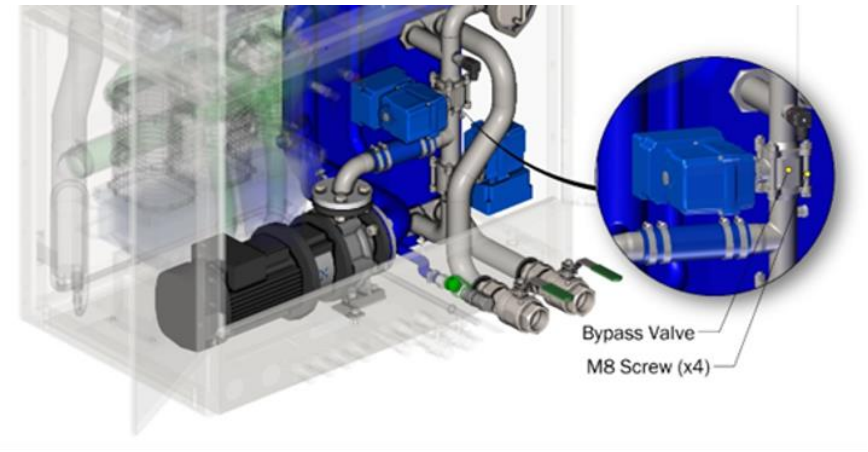


Figure 8-120: Location of coolant bypass valve

4. Uninstall 4 pcs. M8 bolts used to connect the ball valve to the motor and remove the electric actuator.

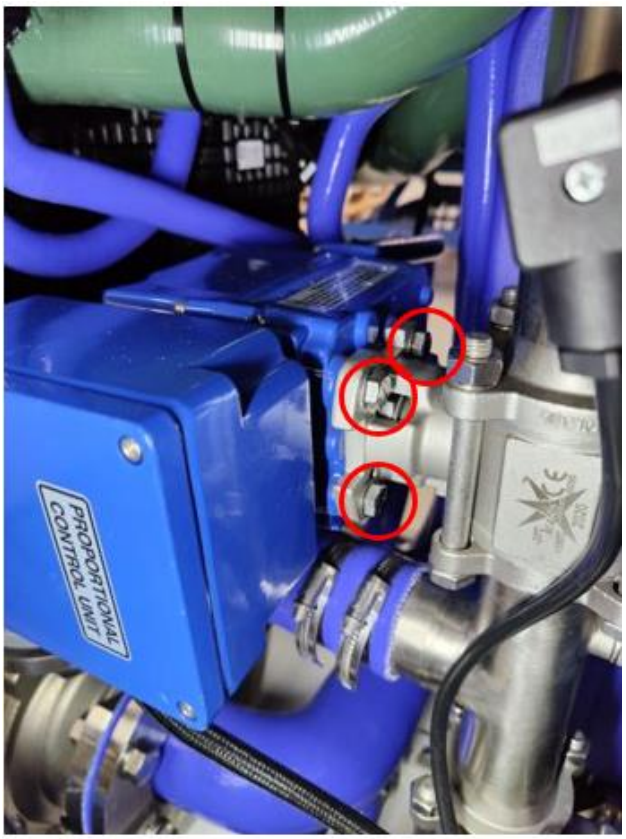


Figure 8-121: Removal of bolts for electric actuator

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5. Uninstall 4 pcs. M10 bolts used to secure the ball valve and slide it out.

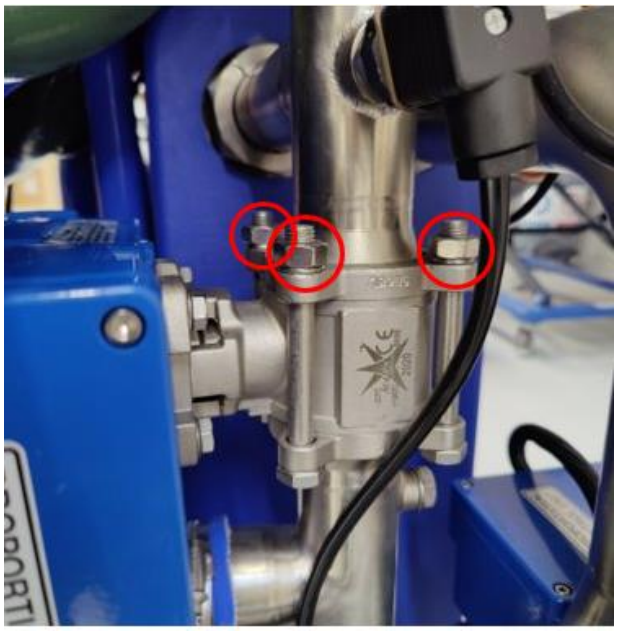


Figure 8-122: Removal of bolts for ball valve

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Assembling procedure:

1. Use 4 pcs. M8 bolts to install the valve motor to the flow control valve. Tighten to 20 Nm.
2. Slide in the new ball valve and secure with 4 pcs. M10 bolts. Tighten to 25 Nm.
3. Disconnect the tank ventilation hose from the ventilation duct. The LV panel can be moved forward if more room is needed.



Figure 8-123: Disconnecting the tank ventilation hose

4. Use the filling valve to refill the HT cooling system. Pay attention to the HT coolant tank level indicator to not overflow the system.
5. Run the degas procedure (refer to 8.4.9).
6. Re-connect the tank ventilation hose from step 3.
7. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
8. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
9. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
10. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.4.7 Replace Coolant Pump

Purpose:

The procedure describes how to replace a coolant pump for the High Temperature (HT) cooling in the FCwave system. The pump re-circulates a mixture of de-ionized water and ethylene glycol through the fuel cell stacks, heat exchanger, valves, hoses, and fittings to transfer the heat generated in the fuel cells to the heat exchanger. The pump speed is controlled to maintain a steady outlet temperature from the fuel cell stack.

Responsibilities:

Preventive maintenance of the coolant pump is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the coolant pump during the life and operation of the FCwave module.

- FRU, Coolant Pump (part no. 7500355)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Coolant Pump

Based on the normal conditions, the estimated time for replacement is:

Coolant Pump		
Duration	4 hours	
Personnel	1	
Tightening Torque	M8 bolt	25 ± 0.5 Nm
	M12 bolt	85 ± 5 Nm
	M16 bolt	150 ± 5 Nm
	Tool: 6mm + 10mm + 14mm hex key, 7mm socket, 18mm + 24mm socket, 19mm + 24mm key, torx screwdriver, plugs/plastic bag, torque wrench,	

Table 8-17: Time to replace coolant pump

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain and purge the LT cooling system.
3. Locate the air filter/mass flow meter installed in front of the twin compressors.
4. Disconnect the mass flow meter sensor (FT_A10).

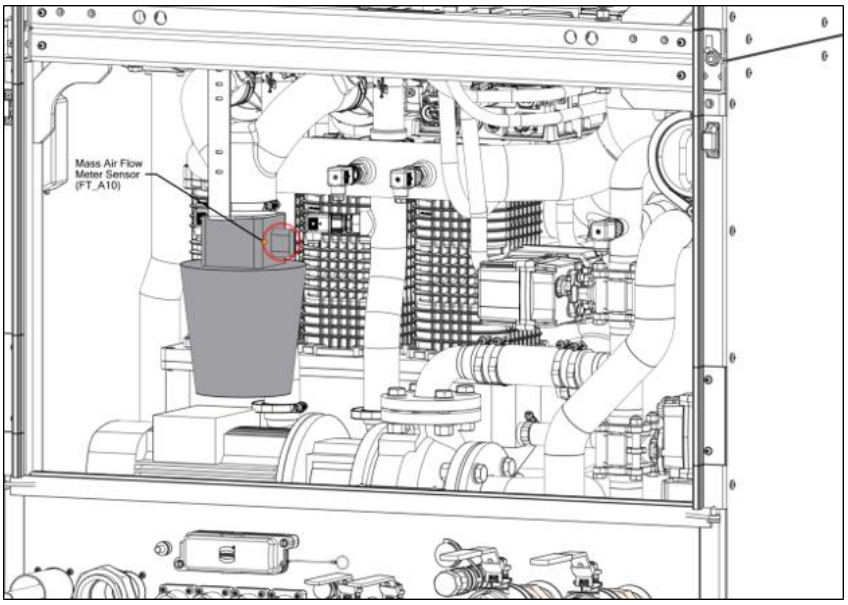


Figure 8-124: Location of mass flow sensor

5. Release the 7mm socket hose clamp to uninstall the filter/mass air flow meter.
6. Slide down the filter unit and take it out.

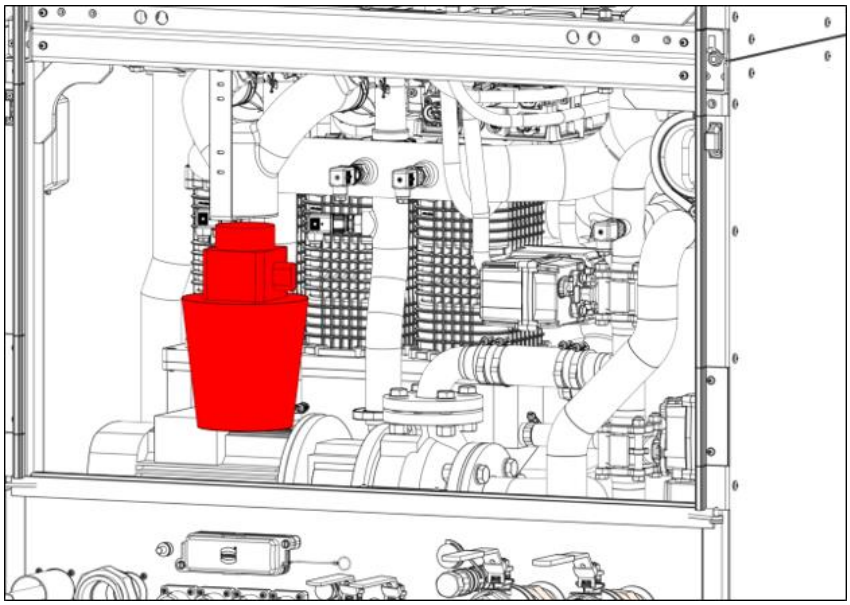


Figure 8-125: Removal of filter unit

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7. Uninstall 2 pcs. M8 bolts and washers used to install the bracket to the cabinet and remove the bracket.

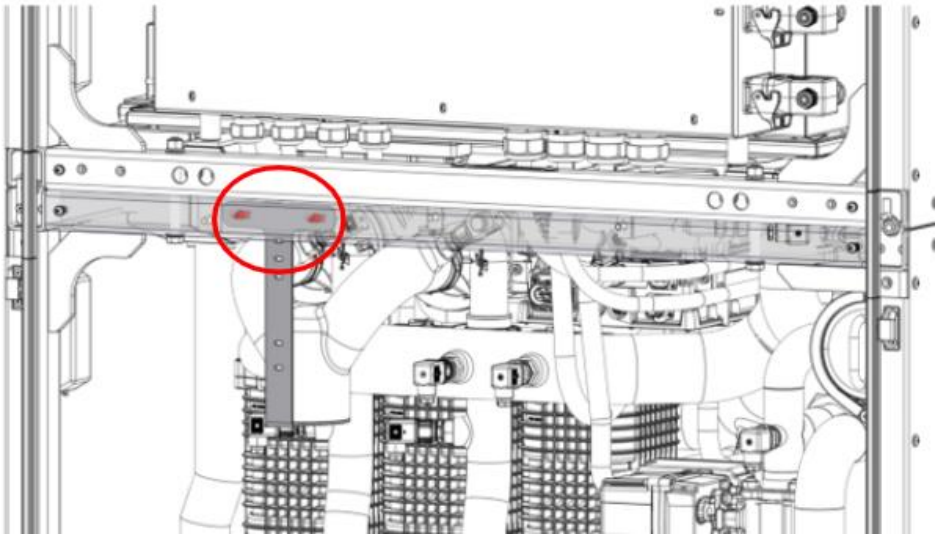


Figure 8-126: Removal of MAF/filter bracket

8. Disconnect all the following sensor connections on the harness CN600: PT_A11A, PT_A11B, PT_A12A, PT_A12B, PT_A40, TT_A40

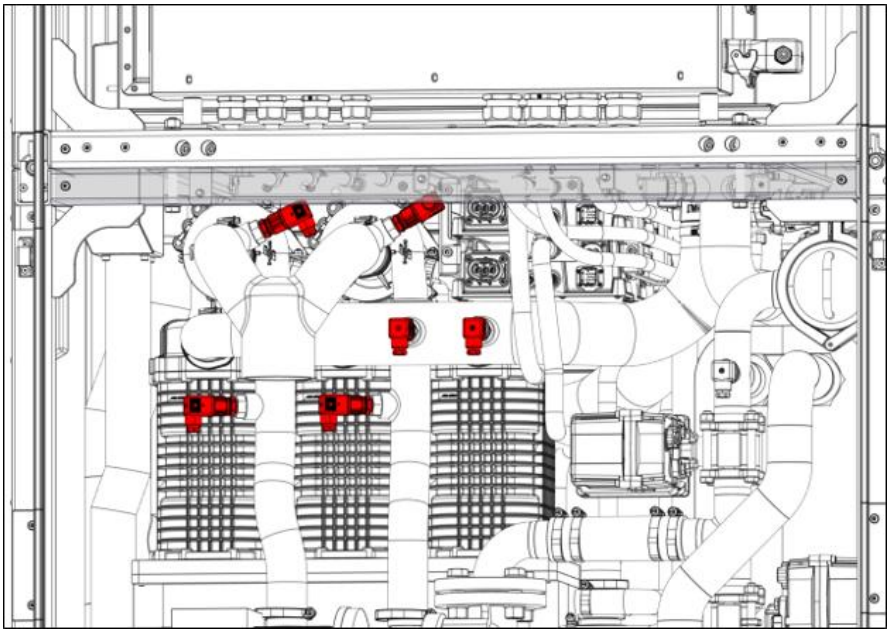


Figure 8-127: Sensor connections on harness CN600

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9. Release 2 pcs. hose clamps used to secure the compressor inlet hose to the compressors and remove the hoses.

   Remember to cover all disconnected hoses and open ports.

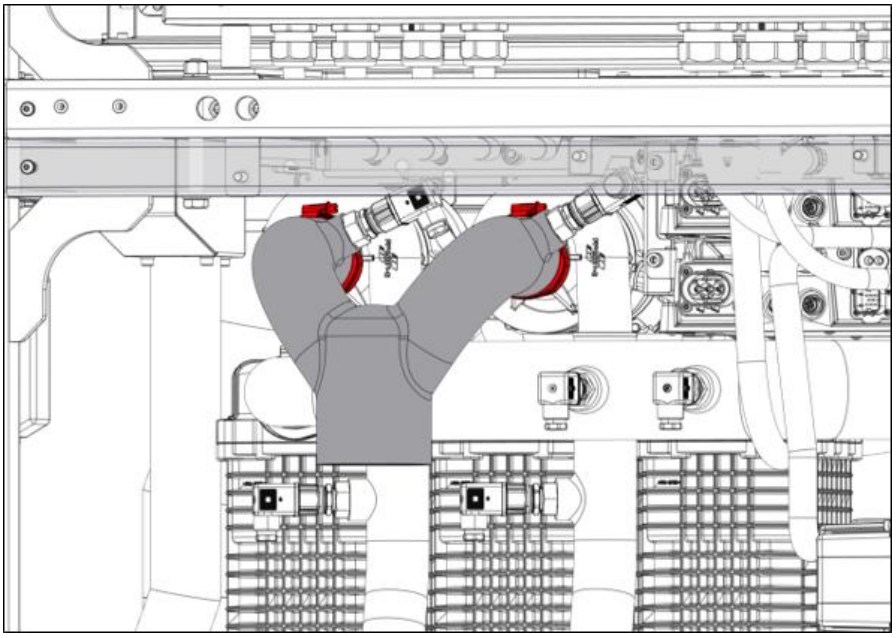


Figure 8-128: Hose clamps for inlet hose to compressors

10. Release 4 pcs. hose clamps used to secure the hose from humidifiers to the motorized shut-off valve and remove the hoses.

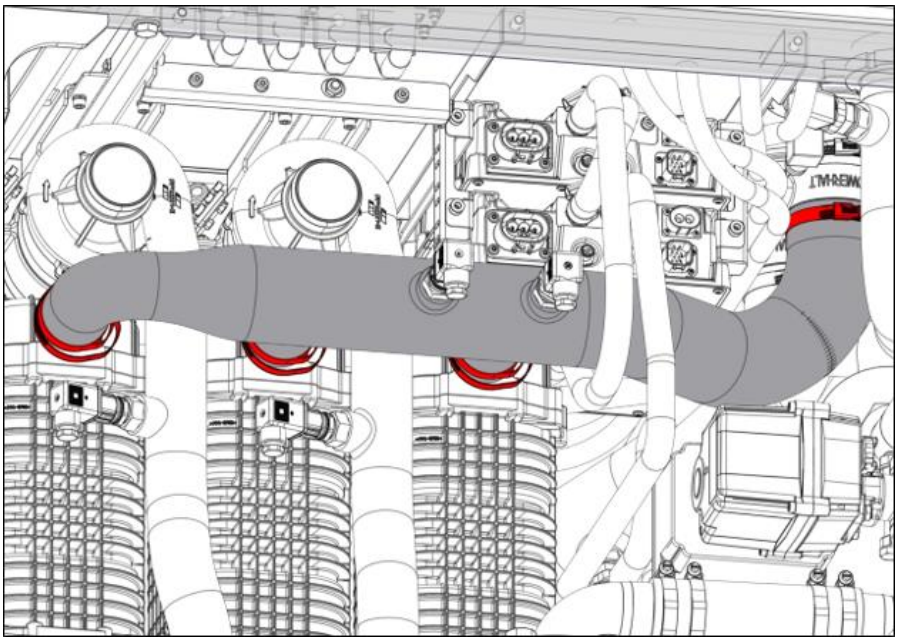


Figure 8-129: Hose clamps on humidifier to motorized shut-off valve hose

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11. (OPTIONAL) Release 4 pcs. hose clamps used to secure the hose from aftercooler to the air compressors and remove the hoses.

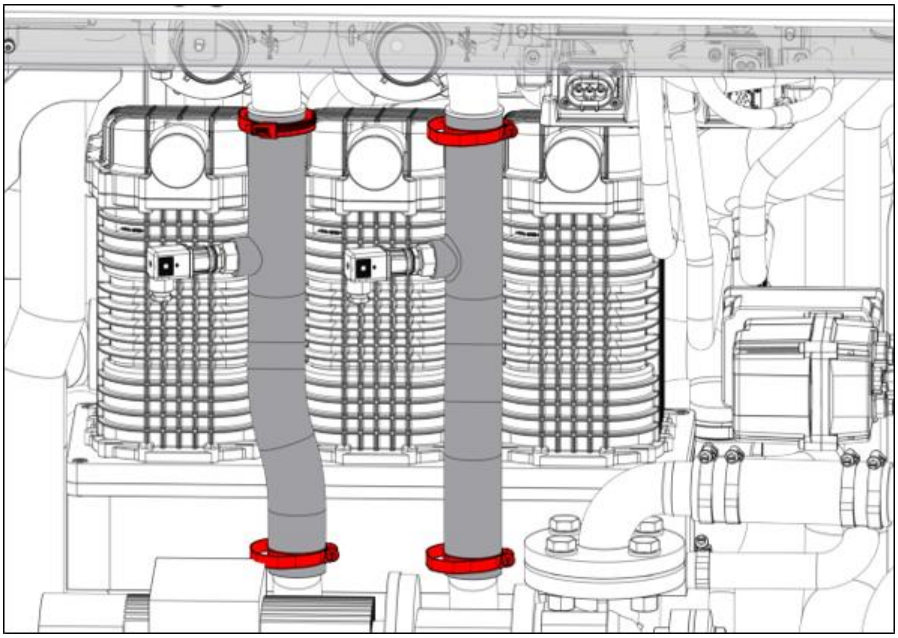


Figure 8-130: hose clamps on aftercooler to air compressors hose

12. Disconnect the coolant pump electrical connection (highlighted in left picture), ground cable, cable gland (highlighted in right picture) and disconnect wires from the three electrical terminals (highlighted in right picture. Pull out cable with cable gland after disconnecting.

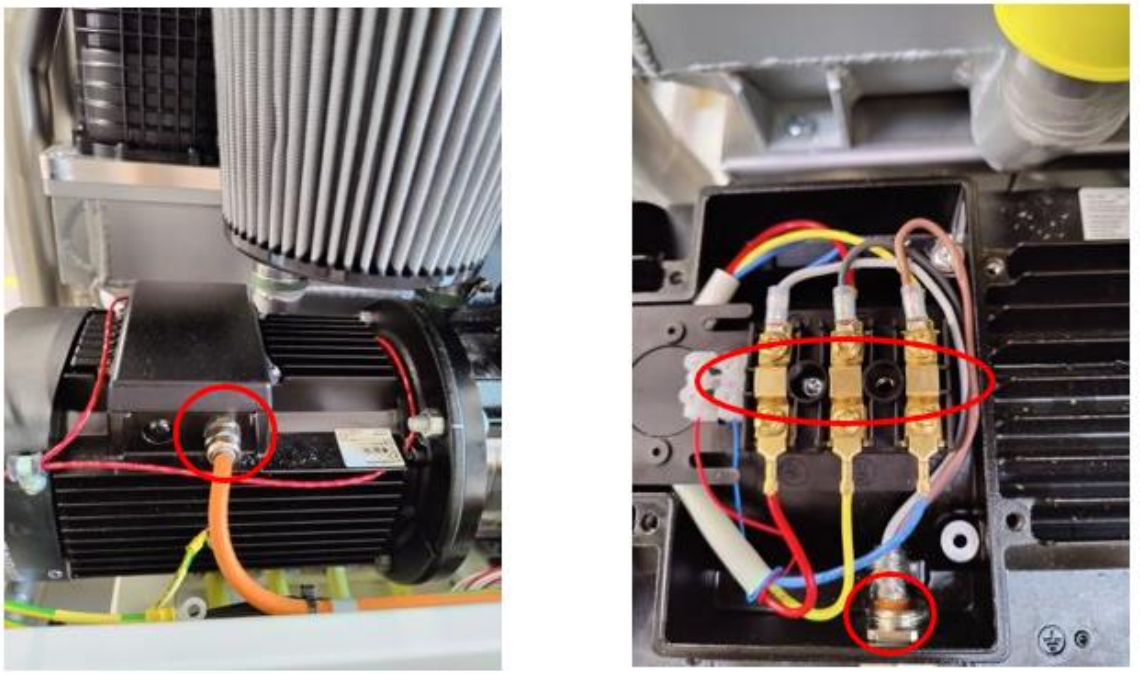


Figure 8-131: Removal of coolant pump electrical connection and control connectors

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13. Release 2 pcs. hose clamps on the coolant hose connected to the coolant pump discharge flange and slide off hose as much as possible.

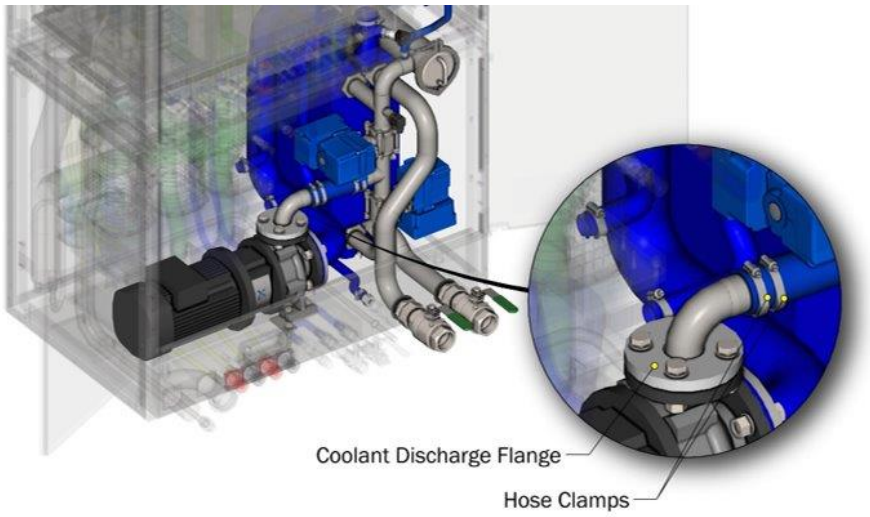


Figure 8-132: Removal of clamps on coolant pump flange

14. Remove 4 pcs. M16 bolts, washers, nuts, and gasket from the coolant pump discharge flange connection.
15. Remove 4 pcs. M16 bolts, washers, and nuts from the coolant pump suction flange connection and slide off hose as much as possible.
16. Attach a lifting device to the frame of the module and to the compressors supporting bracket.
17. Attach lifting chain around the pump and raise it just enough to create tension on the chain.
18. Uninstall 4 pcs. M12 bolts and washers used to tighten the pump mounting bracket to the base of the cabinet.

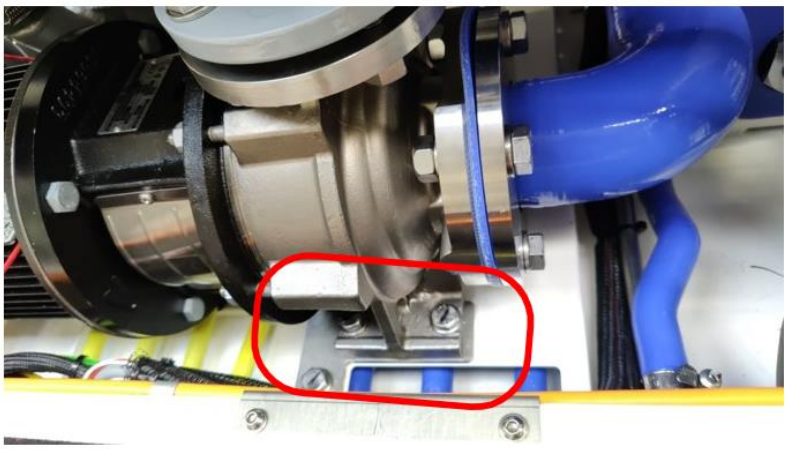


Figure 8-133: Disconnecting pump from base of cabinet

19. Lift the pump and slide it out. Remember to cover all exposed hoses and pump holes with rubber plugs or zip-tied plastic bags to avoid contamination and leaks.

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Assembling procedure:

1. Wipe up any spilled coolant from the module and remove all plugs and plastic bags from the exposed hoses.
2. Use the crane and lift the pump into the module. When in the module, lower the pump just enough so it is possible to attach the mounting bracket to the module frame, by use of 4 pcs. M12 bolts. Tighten to 85 Nm.
3. Release the tension on the crane and dismount it from the module frame.
4. Use 4 pcs. M16 bolts, washers, and nuts to install coolant pump suction flange connection to the pump. Tighten to 40 Nm.
5. Connect the coolant hose to the coolant pump discharge flange, but do not tighten the hose clamps yet.
6. Insert plastic gasket between the hose and the pump discharge flange and secure it with 4 pcs. M16 bolts, nuts, and 8 pcs. washers. Tighten to 150 Nm and tighten hose clamps from step 5 to 3.5 Nm.

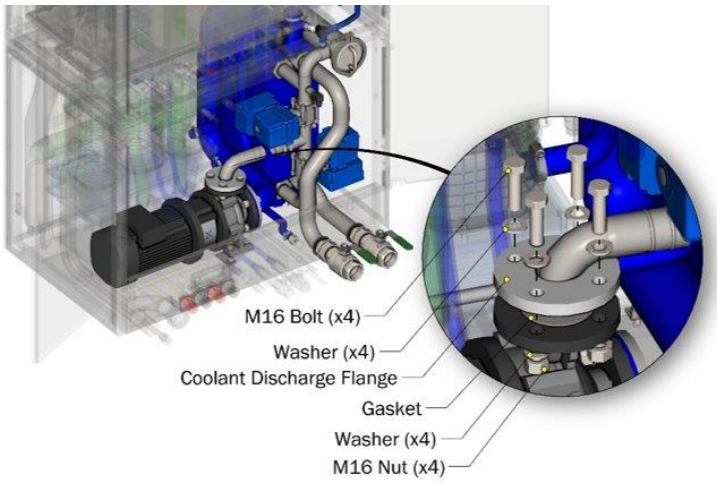


Figure 8-134: Installing plastic gasket

7. Install the orange power cable (the electrical connection) and ground wire to the black control box on top of the coolant pump as shown and secure it to the case.



Figure 8-135: Installing electrical connection to pump

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8. Arrange the fire wire (the grey, black and brown cables) and the cable gland on the electrical connection as show in the control box.

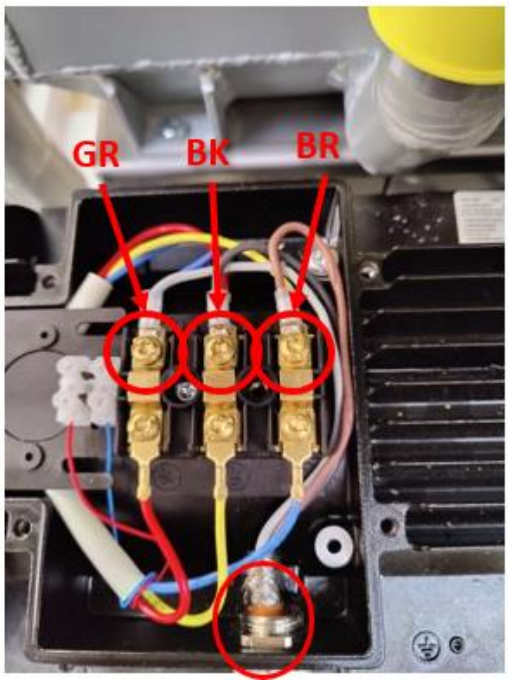


Figure 8-136: Install wire fire in control box

9. (ONLY TO BE DONE, IF YOU REMOVED THESE IN THE DISASSEBMLING PROCEDURE) Use 4 pcs. hose clamps to mount hoses from aftercooler to air compressors as shown. Tighten hose clamps to 3.5 Nm.

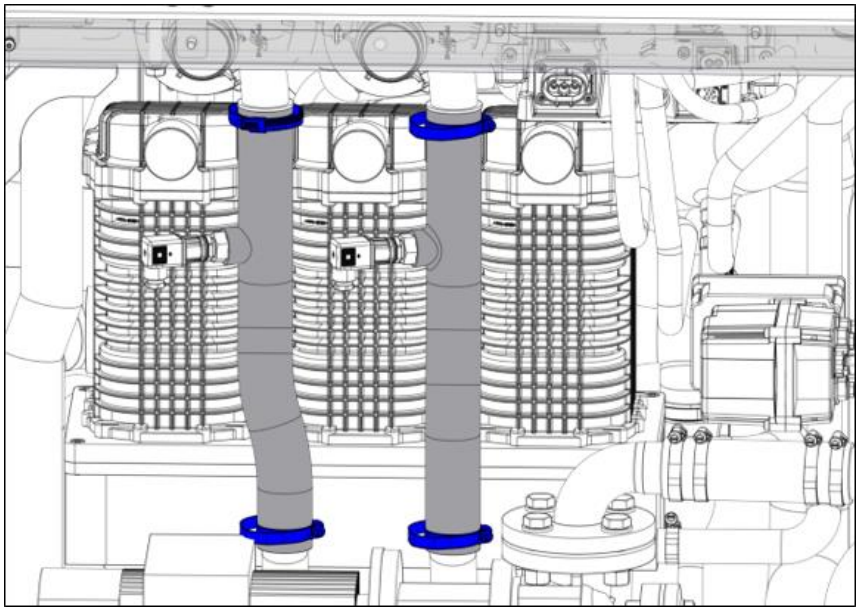


Figure 8-137: Installing hoses from aftercooler to compressors

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10. Use 4 pcs. hose clamps to mount hoses from humidifiers to motorized shut-off valve as shown. Tighten hose clamps to 3.5 Nm.

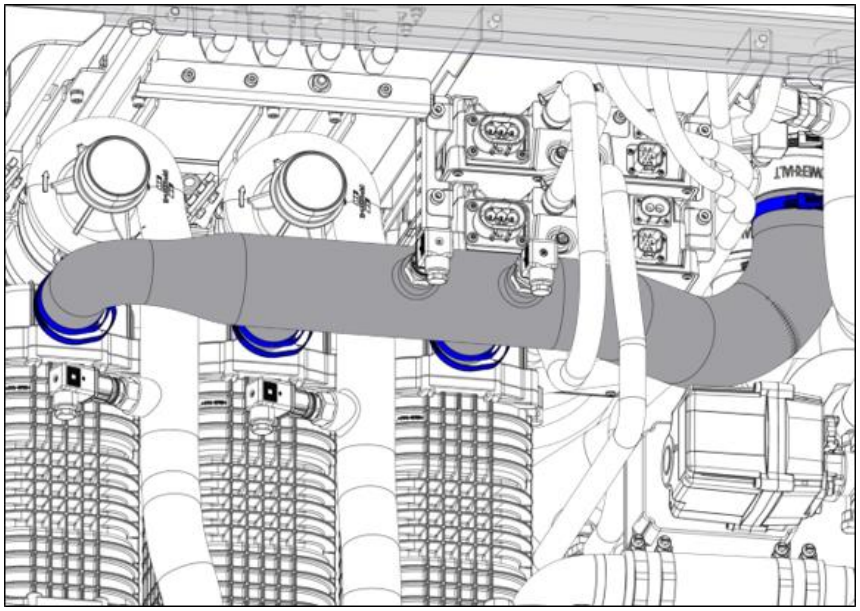


Figure 8-138: Installing hose from humidifiers to shut-off valve

11. Use 2 pcs. hose clamps to install compressor inlet hose to the compressors. Tighten hose clamps to 3.5 Nm.
12. Connect all following sensor connections of harness CN600 as shown: PT_A11A, PT_A11B, PT_A12A, PT_A12B, PT_A40, TT_A40.

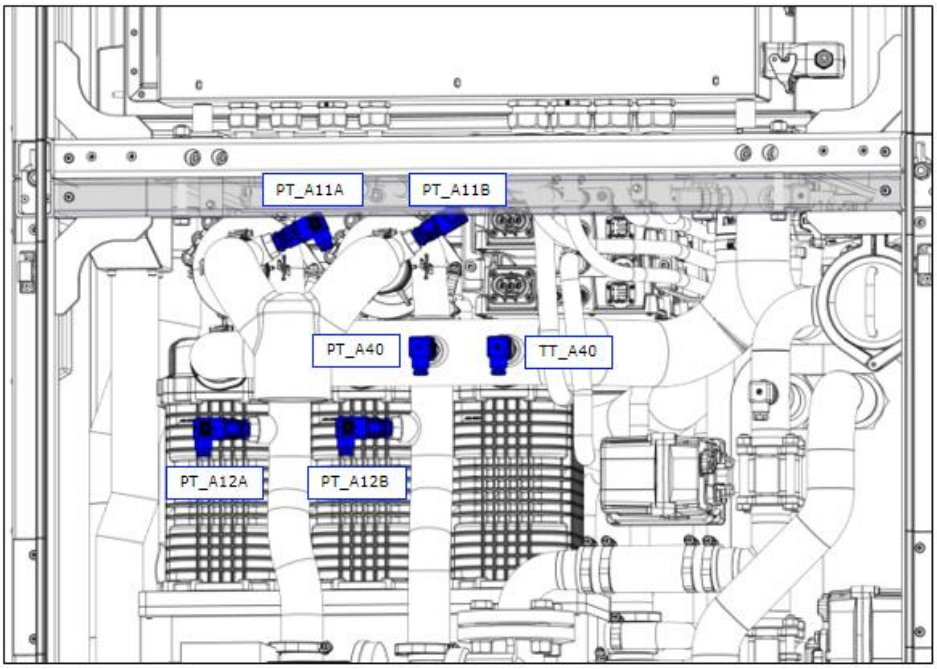


Figure 8-139: Installing sensor connections

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13. Use 2 pcs. M8 bolts and washers to install mounting bracket to the cabinet as shown. Tighten to 15 Nm.

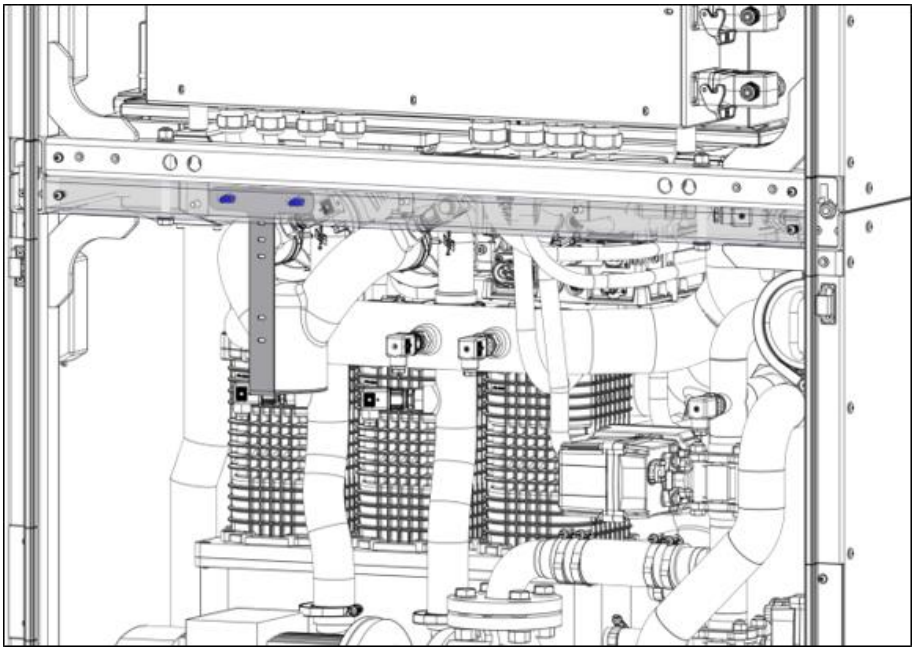


Figure 8-140: Installing mounting bracket to cabinet

14. Mount intake filter on intake hose. Tighten hose clamp to 3.5 Nm.
15. Connect the mass air flow meter sensor (FT_A10).
16. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
17. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
18. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
19. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.4.8 Replace DI Filter Cartridge

Purpose:

The procedure describes how to replace a de-ionization (DI) filter for the HT cooling system. To maintain the stack coolant conductivity below the maximum level, part of the overall coolant flow is diverted to the DI filter to continuously remove ions in the liquid coolant, which minimizes the risk of electrical ground fault.

Responsibilities:

Preventive maintenance of the DI filter is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the DI filter during the life and operation of the FCwave module.

- FRU, DI Filter Cartridge (part no. 7500095)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the DI Filter

Based on the normal conditions, the estimated time for replacement is:

DI Filter		
Duration	15 min	
Personnel	1	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	Tool	5mm + 6mm hex key, clean container, 8.15mm tube, valve, 3/8" BSP to 8mm plastic pipe adaptor

Table 8-18: Time to replace the DI filter

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall 3 pcs. M8x30 bolts from the top right support bracket of the high voltage panel and remove the bracket.

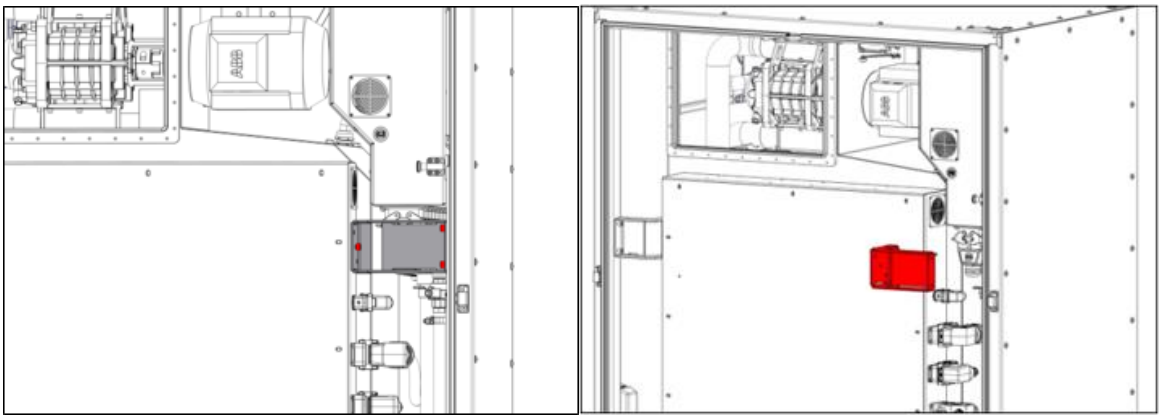


Figure 8-141: Bolts and support bracket in HV panel

3. Disconnect all connectors (CN201, CN202, CN500, CN505) in the high voltage panel as shown.



Figure 8-142: Overview of connectors in HV panel

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4. Disconnect all connectors (CN400, CN303, CN300, CN101, CN100) in the low voltage panel as shown.



Figure 8-143: Overview of all connectors in LV panel

5. Shut off the DI filter isolation valves.
6. Install special tool kit (7500095) on the DI filter housing. Start by installing the pipe adaptor and then the plastic pipe into the adaptor.

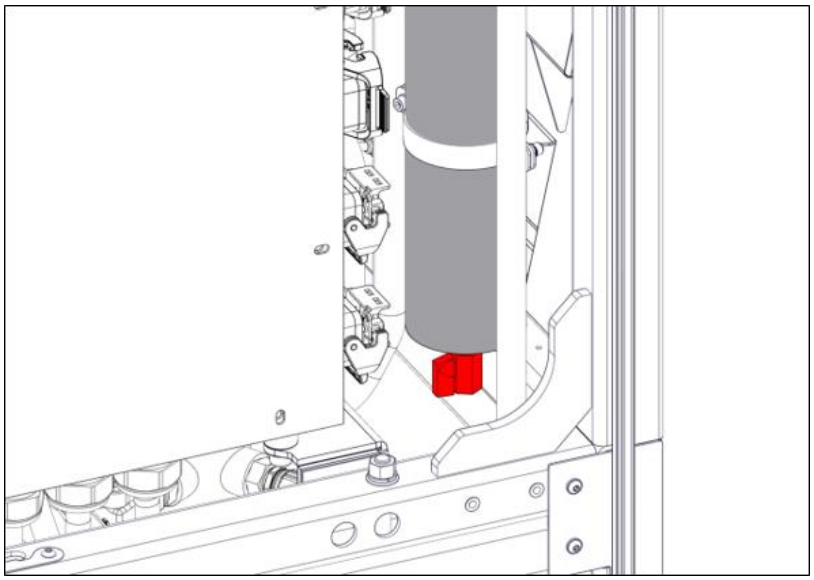


Figure 8-144: Adaptor on the DI filter housing

7. Place the plastic pipe in a clean container. Open the plastic pipe valve and open the drain valve at the bottom of the HT cooling DI filter.
8. Uninstall 2 pcs. M6 bolt and clamp used for securing the DI filter housing.

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9. Remove the DI filter housing nut to release the vacuum in the DI filter housing and drain the DI filter cartridge completely.

   Remember to place paper towels below the filter housing to prevent any spillage.
10. Close the DI filter drain valve and remove the plastic pipe from the adaptor.
11. Remove the DI filter housing from the cabinet and remove the DI filter cartridge from the DI filter housing.

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Assembling procedure:

1. Insert new DI filter cartridge in the DI filter housing with the blue rubber gasket facing up.



Figure 8-145: Install DI filter cartridge

2. Install the DI filter housing. Use the special key to tighten the housing ring.
3. Use 2 pcs. M6 bolts to install the clamp securing the DI filter housing.
   Ensure the drain valve handle is accessible.
4. Open the DI filter isolation valves.
5. Connect the following connectors to the LV panel; CN100, CN101, CN300, CN303, CN400.
6. Connect the following connectors to the HV panel; CN201, CN202, CN500, CN505.
7. Mount the right-side bracket on the high voltage panel.
8. Use 3 pcs. M8x30 bolts and washers to secure the bracket to the frame.

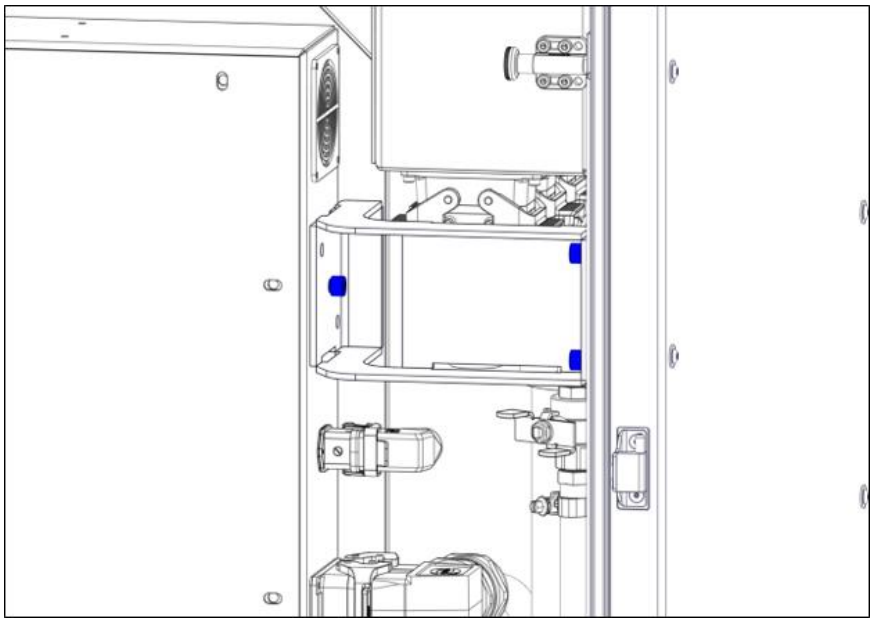


Figure 8-146: Securing bracket to frame

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9. Use 12 pcs. M5x10 bolts and washers to install the high voltage panel cover.
10. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
11. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
12. Check and refill (using new coolant) the coolant level. Run the HT cooling system degas procedure. (refer to 8.4.9).
13. Log into the engineering interface with supplied username and password and reset the hour counter for the DI filter cartridge.
14. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.4.9 Assurance procedure – Cooling Sub-system Degas

Estimated time to perform degas procedure

Based on the normal conditions, the estimated time for procedure is:

Degas procedure	
Duration	1 hour
Personnel	1
Tools needed	Laptop, ethernet cable

Table 8-19: Time to perform degas procedure

Procedure:

1. Secure the area before pressurizing the system components.
   Use warning signs around the working area to ensure safety.
2. Power up the module by enabling the 24 VDC power supply.
3. Log into the engineering interface.
4. In the "unlocked" state, the module is ready to be supplied with the MD_EN signal.
   The "unlocked" state can be reached by providing the customer key from the integrator system via CAN bus.

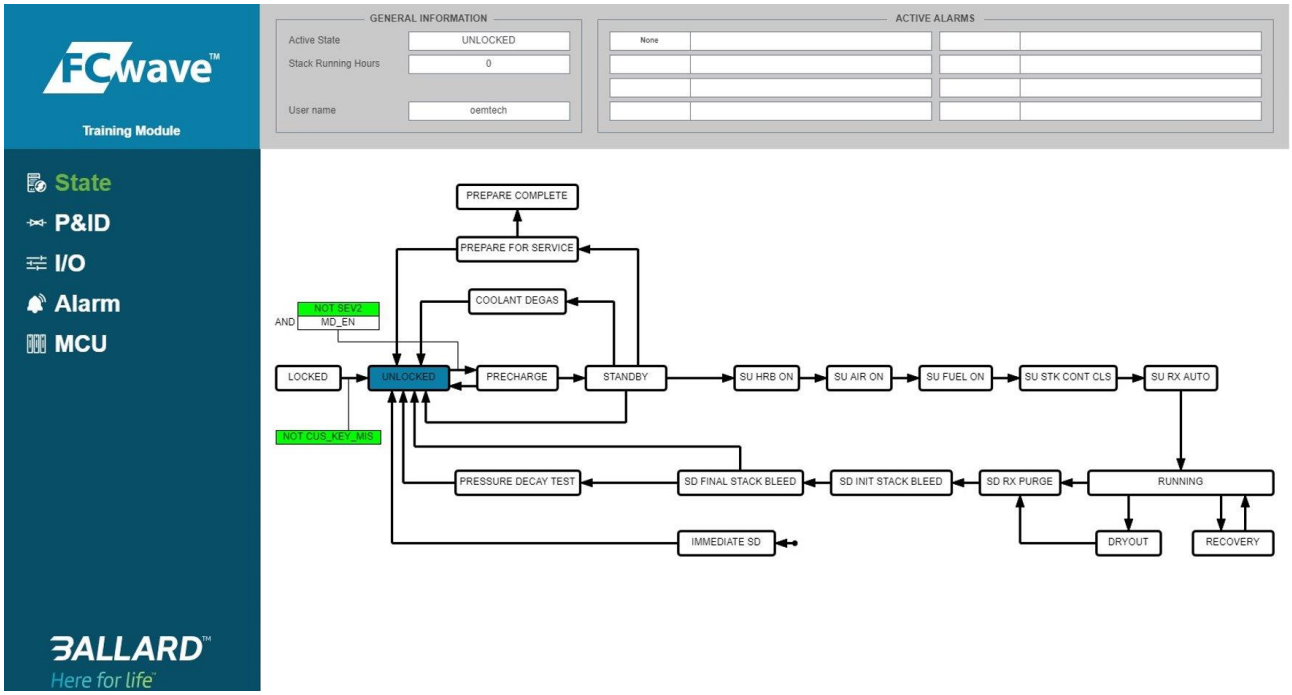


Figure 8-147: overview of unlocked state

5. Supply the module HV with "Min – 350 VDC". In the "unlocked" state, send the MD_EN signal from the integrator system.

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6. After the MD_EN signal is sent, the module will go into "standby" state.

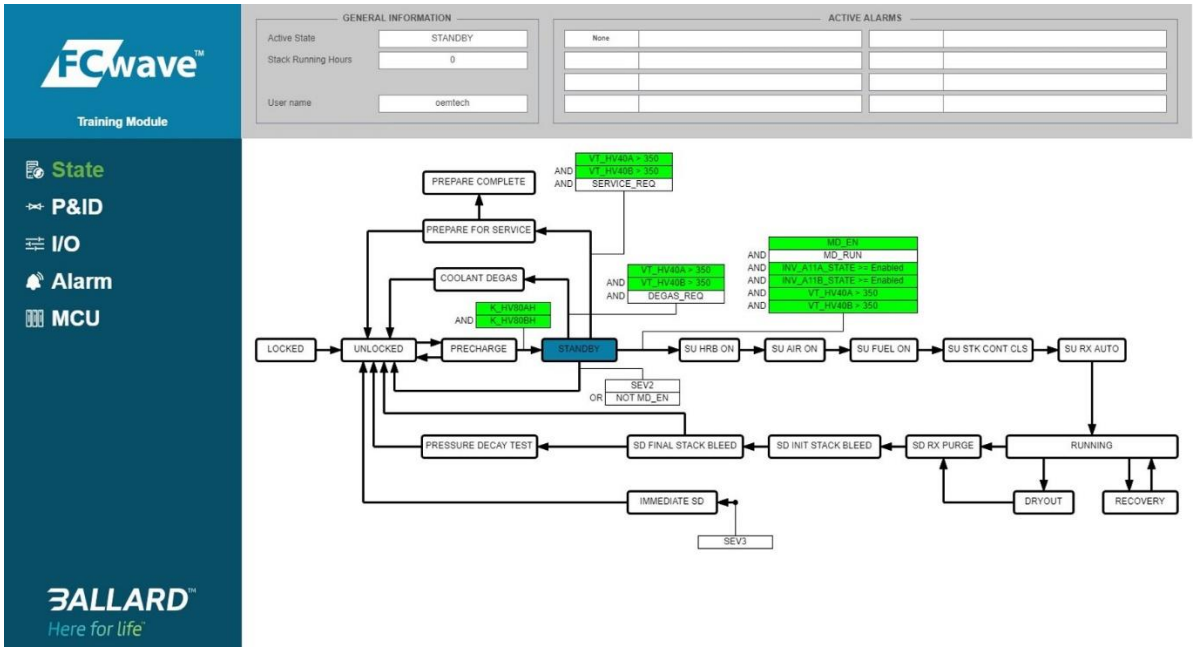


Figure 8-148: Overview of standby state

7. Access the I/O page (1) and select the 'all inputs' tab (2).
   - Enable "degas_req" (3).
   - Let the degas procedure run for at least 30 min.



Figure 8-149: Force values for degas procedure

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8. The degas procedure can be observed from the P&ID page as shown.

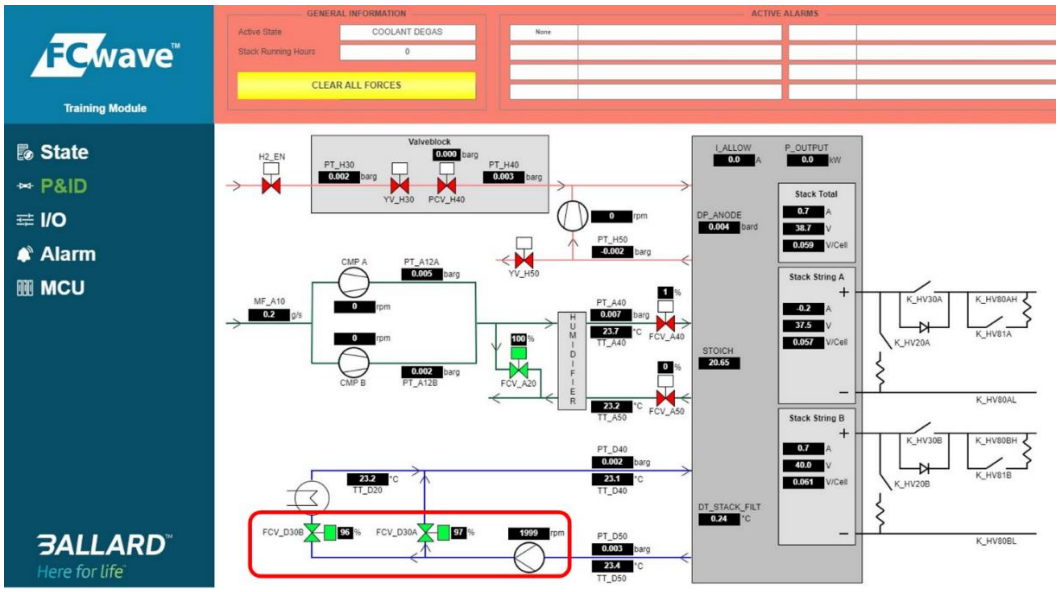


Figure 8-150: Observing the degas procedure

9. Use "clear all forces" after a minimum of 30 min, disable the MD_EN signal from the integrator side and disable the 350 VDC power feed from the integrator to the module.



Figure 8-151: Clear all forces for degas procedure

10. Module will enter the "unlocked" state, log out of engineering interface, and module 24 VDC can be disabled.
11. Remove the warning signs after the test and confirm the module is ready for power up from the integrator side after maintenance. Remove local lockout and tagout when done.

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8.5 H_2 Enclosure Ventilation and Stack Assembly

For detailed P&ID requirements, refer to "Piping and Instrumentation Diagram" (PWR005), which can be found the Customer Portal or by contacting BPSE (see section 4.1 for further information).

8.5.1 Check Linear Heat Detector (LHD) Functionality

Purpose:

The procedure describes how to check the functionality of the LHD (also called the Fire Wire) relay in the module. The LHD will trip a relay, causing a fire alarm based on the resistance in the circuit, if a fire were to occur in the module. The LHD will also trip another relay for a Fire Wire malfunction if the circuit is broken (open circuit).

Responsibilities:

Preventive maintenance of the LHD is necessary for safe operation. It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1). The LHD is considered a Field Instrument as per Classification society rules.

Parts and equipment:

A list of parts and special equipment is identified to check the LHD during the life and operation of the FCwave module.

- HRNS-LHD KIT (part no. 7500131)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the LHD:

Based on the normal conditions, the estimated time for check is:

Linear Heat Detector	
Duration	15 min
Personnel	1

Table 8-20: Time to check the LHD

Note:

During the procedure you will trigger the fire detection system. Personnel must coordinate with the vessel representative to ensure that a fire detection signal from the module will not cause activation of the firefighting system or in other ways cause hazard to the personnel or equipment.

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Procedure:

1. Before proceeding with the check, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Disconnect the LHD connector from CN205 in the HV panel and connect the LHD test plug to CN205.

   The switch for 'Malfunction' should be ON, simulating that the Fire Wire circuit is closed and functional.

   The switch for 'Fire' should be OFF, simulating that the Fire Wire's resistance is normal. Meaning that fire has not been detected.
3. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the two bolts.
4. Monitor the MCU engineering interface with the module in "Unlocked" state.

   Make sure there are no active alarms.
5. To test the LHD relay for "Fire", confirm the following state of LEDs on the relay 'CNV_AZT_J30':
   - Relay 1: ON
   - Relay 2: ON
6. Toggle the switch for 'Fire' to ON to simulate a change in the LHD's resistance.
7. Confirm the following state of LEDs on the relay 'CNV_AZT_J30':
   - Relay 1: OFF
   - Relay 2: ON



Figure 8-152: LED status relay CNV_AZT_J30

8. Toggle the switch for 'Fire' to OFF
9. Confirm the following alarms can be seen in the engineering interface (as shown in the figure below):
   - A3_SAFETYSTOP_I_10120
   - A2_CNV_FCV_A_OK_I_10020
   - A2_CNV_FCV_A_OK_I_10030

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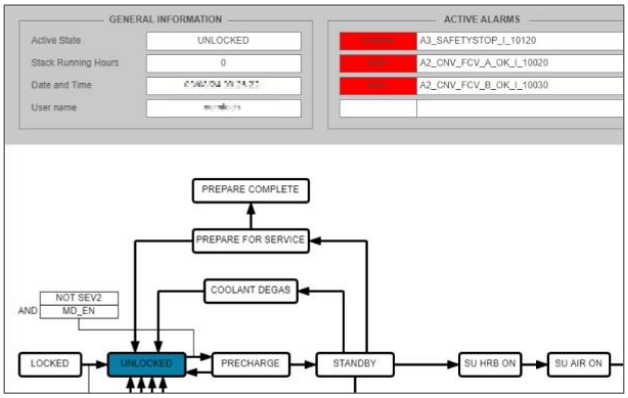


Figure 8-153: Overview of alarms

Disconnect and reconnect the X_E01 to power cycle the module to reset and confirm there are no alarms.

10. To test the LHD relay for "Malfunction", confirm the following state of LEDs on the relay 'CNV_AZT_J30'
    - Relay 1: ON
    - Relay 2: ON
11. Toggle the switch for 'Malfunction' to OFF to simulate the LHD's connection is broken.
12. Confirm the following state of LEDs on the relay 'CNV_AZT_J30':
    - Relay 1: OFF
    - Relay 2: OFF



Figure 8-154: LED status relay CNV_AZT_J30

13. Toggle the switch for 'Malfunction' to ON
14. Confirm the following alarms can be seen in the engineering interface:
    - A3_SAFETYSTOP_I_10120
    - A2_CNV_FCV_A_OK_I_10020
    - A2_CNV_FCV_A_OK_I_10030
15. Power down the module, disconnect the LHD test plug from CN205 and reconnect the LHD connector to CN205.
16. Power up the module and confirm there are no alarms.

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17. Confirm the confirm the following state of LEDs on the relay 'CNV_AZT_J30':
    - Relay 1: ON
    - Relay 2: ON



Figure 8-155: LED status relay CNV_AZT_J30

18. The module can now be powered down by disconnecting the X_E01 and the module is ready to be restored to normal operating state.
19. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.5.2 Check the H_2 Sensor

Purpose:

The procedure describes how to check calibration of the ventilation H_2 sensor. The correct operation of these hydrogen sensors is important to ensure that H_2 concentration gases exiting the FCwave module are in acceptable safe levels. The hydrogen sensors are attached to the ventilation hatch cover.

Responsibilities:

Preventive maintenance of the ventilations H_2 sensors is necessary for safe operation. It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1).

Parts and equipment:

A list of parts and special equipment is identified to service the hydrogen sensors during the life and operation of the FCwave module.

- 2% hydrogen (balance air) calibration test gas mixture — calibration gas must have balance air component for correct operation of hydrogen sensors. Calibration gas with balance nitrogen or other gases is not applicable.
- Pressure regulator with flow rate control — must be used to decrease the pressure from the test gas bottle. A regulator that is sized to minimum flow, equivalent of 0.5 SLPM air, must be sufficient.
- Test nozzle — it is recommended that a simple test nozzle with a built-in needle valve is required to supply the test gas to the H_2 sensor.
- Repeat process with 1.6% hydrogen (balance air) calibration test gas mixture.

Safety:

Refer to section 8.1.2 to follow the instructions.

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Procedure:

1. System needs to be in "prepare for complete service" state.
2. Open system doors.
3. Supply 24V power from the shipboard or connect an I/O tester to power the module MCU engineering interface.
4. Connect a computer to the MCU and log in to the engineering interface (see section 7.2).
5. Connect a pressure regulator to a test gas canister and test the nozzle. Do not flow gas at this point.
6. Locate the ventilation hatch cover in the top right corner of the H2 enclosure behind the HRB motor.

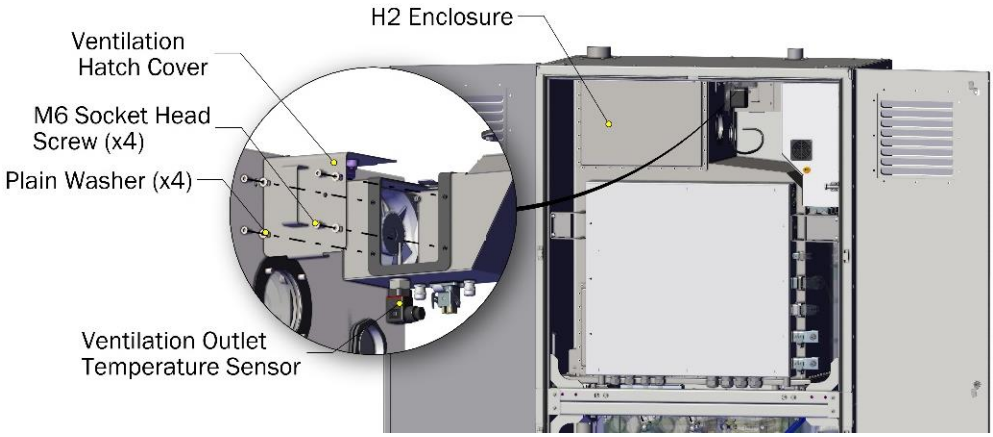


Figure 8-156: Location of ventilation hatch cover

7. Use 5mm hex key to uninstall 4 pcs. M6 bolts and washers to remove the ventilation hatch cover.
8. Disconnect the ventilation H2 sensors connections (HRNS-303-CN_AZT_J50 and CN_AZT_J50B).

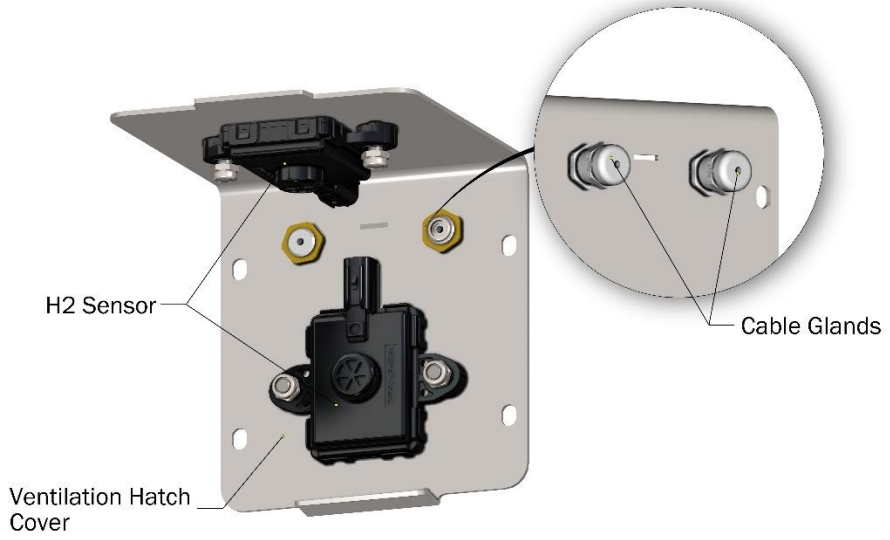


Figure 8-157: H_2 sensors

9. Remove both sensors along with the hatch cover.
10. Position the test nozzle directly over the hydrogen sensor. Make sure the nozzle fully covers the sensor element.

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11. In the MCU engineering interface, go to the I/O page and select the 'Cabinet' tab.
12. Scroll to tag 'AZT_J50A' and record the indication. The indication must be in the range 0 ± 0.2%. If the hydrogen sensor indication is outside the range:
    - Make sure the module is not in 'sleep' condition, as then the H_2 sensors will not be powered. Refer to the MCU user manual for more information. If the module is in 'sleep' condition, force 'on' to start the module that will energize the sensors.
    - Contact BPSE (see section 4.1) for further troubleshooting support.
13. Open the supply valve on the calibration gas. Expose the sensor for 10 – 30 sec until the AZT_J50A reading stabilizes.
14. Hold the sensor head above the nozzle during the test. To store the calibration gas efficiently, close the supply valve immediately after a stable indication is achieved.
15. Make sure the sensor indication is more than 1.4% and less than 2.2% H_2 concentration and record the indications.
16. If the sensor indication is still out of permitted range after performing these steps, replace the hydrogen sensor (see section 8.5.3) and repeat the steps to verify sensor functionality. Contact BPSE (see section 4.1) for further support.
17. Reset the hydrogen connection with the "Reset Lockout" button on the MCU home screen (see section 7.2).
18. Disconnect the gas nozzle from the hydrogen sensor.
19. Log out of the MCU and disconnect the computer.
20. If applicable, power off the IO tester and disconnect it from the module.

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8.5.3 Replace the H_2 Sensors

Purpose:

The procedure describes how to replace a ventilation outlet H_2 sensor and safety H_2 sensor for the FCwave module. To ensure a safe atmosphere inside the H_2 Enclosure two H_2 detectors are installed, to measure the H_2 concentration in ventilation exhaust and to detect leaks in stack seals or HRB circulation piping in the H_2 enclosure.

Responsibilities:

Preventive maintenance of the H_2 sensors is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the H_2 sensors during the life and operation of the FCwave module.

- FRU, Sensor H_2, 0-4% (part no. 7500036) x2

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the H_2 Sensors

Based on the normal conditions, the estimated time for replacement is:

H_2 Sensors		
Duration	15-30 min	
Personnel	1	
Tightening Torque	M6 bolt	
	Tool	5mm hex key, 10mm wrench, torque wrench

Table 8-21: Time to replace the H_2 sensors

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the ventilation hatch cover, behind the HRB motor, on the top right corner of the H_2 enclosure.
3. Remove 4 pcs. M6 bolts and washers and remove the ventilation hatch cover.

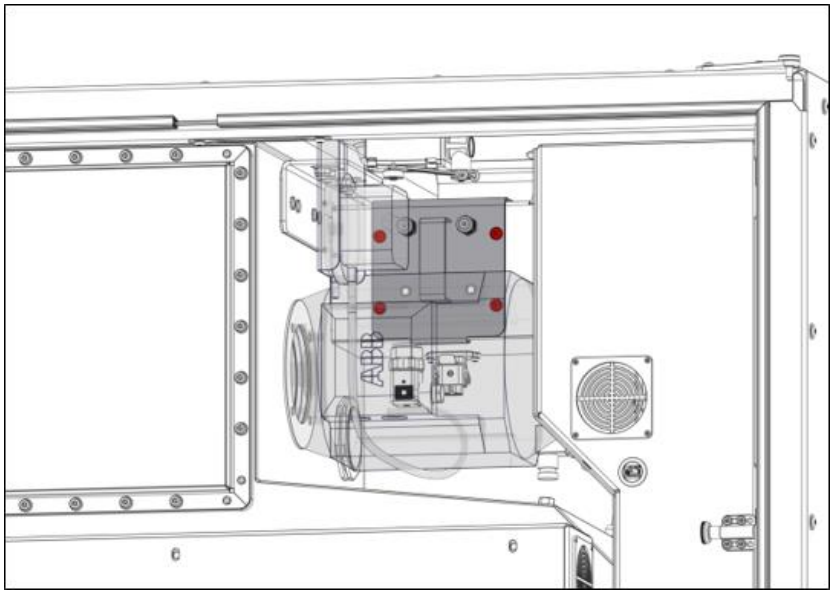


Figure 8-158: Bolts in the ventilation hatch cover

4. Remove the old gasket from the H_2 enclosure.
5. Remove 4 pcs. M6 lock nuts and washers used to tighten the H_2 detection module to the ventilation duct hatch. Then disconnect the ventilation detector connections (CN_AZT_J50A & CN-AZT_J50B) and remove the H_2 sensor from the hatch cover.

Make sure to note down the position of the sensors before removing.

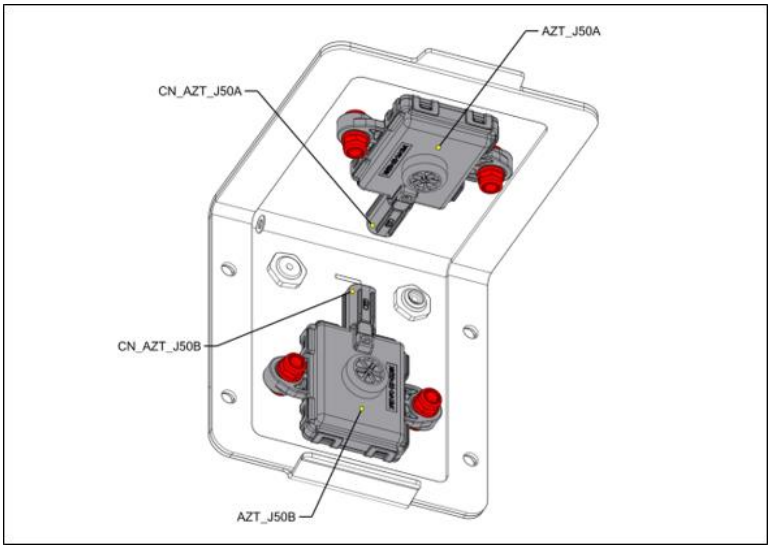


Figure 8-159: Ventilation detector connections

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Assembling procedure:

1. Insert the H_2 detectors in the ventilation hatch cover. Use M6 lock nuts and washers to fasten the H_2 detection module to the ventilation duct hatch. Tighten to 6 Nm. Then connect the ventilation detector connections (CN_AZT_J50A & CN_AZT_J50B).

   Remember to lubricate the bolts with ceramic grease.

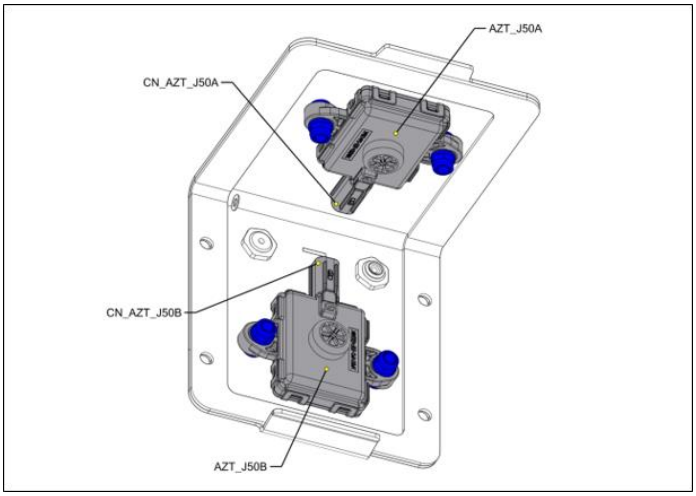


Figure 8-160: Install H_2 detectors to hatch cover

2. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm. Prepare to power up the 24 VDC system.
3. Power up the 24 VDC system. Calibrate and verify the sensor readings before assembling the cover. Refer to 8.5.2
4. Install the new rubber gasket on the H_2 enclosure.
5. Install the ventilation hatch cover to the H_2 enclosure. Use 4 pcs. M6 bolts and washers to tighten the ventilation duct hatch assembly to the ventilation duct. Tighten to 6 Nm. Remember to lubricate the bolts with ceramic grease.

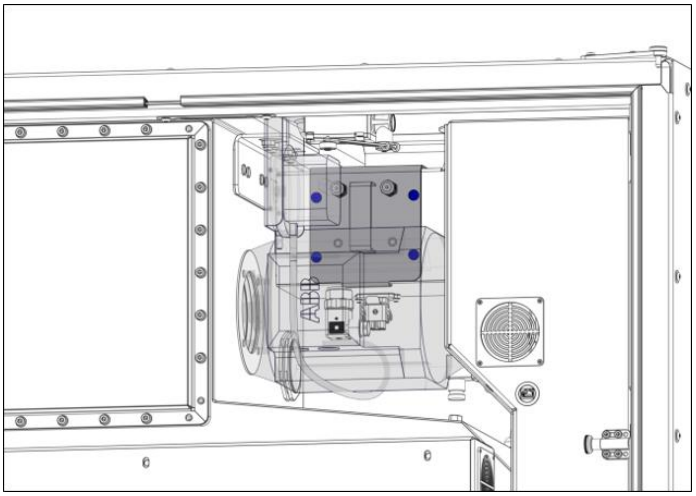


Figure 8-161: Install hatch assembly to ventilation duct

6. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.5.4 Ventilation Inlet Flow Switch

8.5.4.1 Check Ventilation Inlet Flow Switch

Purpose:

The procedure describes how to check a ventilation inlet flow switch in the FCwave™ module. The switch monitors for presence of airflow in the ventilation of the fuel supply and Hydrogen Enclosure (H_2E) and will trigger an alarm if there is no airflow through the system.

Responsibilities:

Checking the ventilation inlet flow switch functionality is necessary for safe operation according to the maintenance plan (refer to the Customer Portal) or after a replacement. It is the end user's responsibility to do preventive maintenance, as stated in section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the Ventilation Inlet Flow Switch

Based on the normal conditions, the estimated time for check is:

Ventilation Inlet Flow Switch	
Duration	10 min
Personnel	1
Tool	32mm spanner

Table 8-22: Time to check ventilation inlet flow switch

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Procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Installed in the ventilation pipe in front of the coolant pump, locate the flow switch at the bottom left side of the cabinet.

   If possible, and if more convenient, the flow switch can be tested from integrator side by closing the ventilation inlet during the test to stop the airflow. If tested from integrator side, skip step 3.
3. If needed, take a photo of approximate position of flow switch before proceeding.

   Use 32mm spanner or crow foot to loosen the nut used to secure the flow switch. Loosen just enough to turn it by hand, and do not remove the switch nor let it drop down in the cabinet.

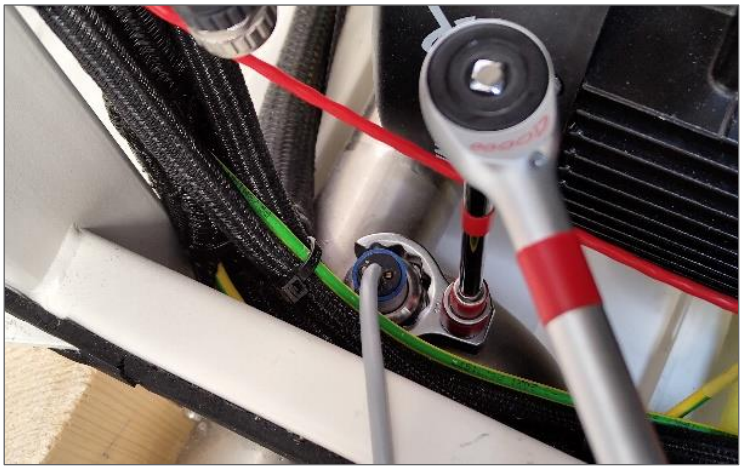


Figure 8-162: Removing inlet flow switch nut

4. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the bolts.
5. Monitor the MCU engineering interface with the module in “Unlocked” state.

   Make sure there are no active alarms.
6. To test the flow switch, confirm the LED on the switch is green, indicating there is airflow.
7. Confirm the switch’s LED turn red once removed from the source of airflow. By hand loosen the nut securing the switch to remove it.

   If tested from the integrator side, close the ventilation inlet instead.



Figure 8-163: Inlet flow switch LED testing

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8. Loosely reinstall the switch by hand and check the alarm codes.
9. Confirm the following alarms can be seen in the engineering interface:
    - A3_SAFETYSTOP_I_10120
    - A2_CNV_FCV_A_OK_I_10020
    - A2_CNV_FCV_A_OK_I_10030

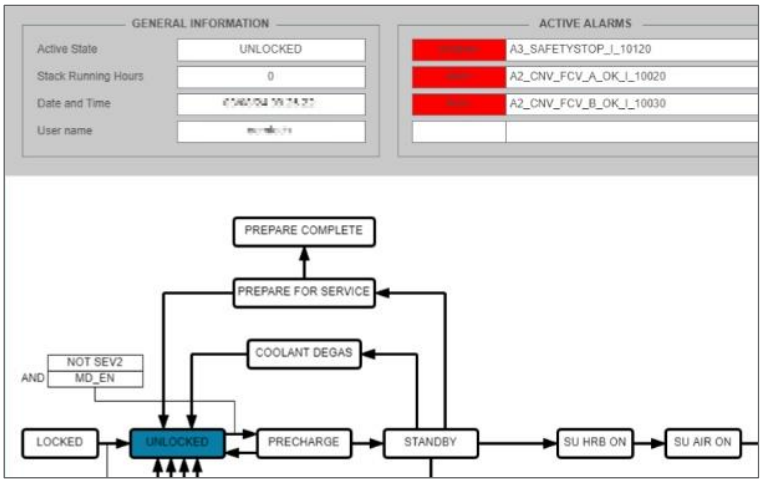


Figure 8-164: Overview of alarms

10. Remove the X_E01 to power off the module.
11. Make sure the switch is installed in the original position and use 32mm spanner or crow foot to secure it by lightly tightening. If tested from integrator side, open the ventilation side.

    Be aware to not overtighten the nut, as it can damage the switch's housing.
12. Power up the module to confirm there are no alarms, and that the switch's LED is green.



Figure 8-165: Inlet flow switch LED testing

13. The module is ready to be powered down by disconnecting the X_E01 electrical connection, and the module is ready to be restored to normal operating state.
14. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.5.4.2 Replace Ventilation Inlet Flow Switch

Purpose:

The procedure describes how to replace a ventilation inlet flow switch for the H2 ventilation intake. The flow switch monitors the airflow through the enclosure ventilation, to ensure the dilution of H2 concentration and verifies that the airflow into H2 enclosure is above the set limit.

Responsibilities:

Preventive maintenance of the flow switch is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the flow switch during the life and operation of the FCwave module.

- FRU, Ventilation Inlet Flow Switch (part no. 7500018)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Ventilation Inlet Flow Switch

Based on the normal conditions, the estimated time for replacement is:

Ventilation Inlet Flow Switch		
Duration	30 - 45 min	
Personnel	1	
Tightening Torque	1/2" sensor fitting	6 ± 0.5 Nm
	Tool	32 mm spanner, torque wrench

Table 8-23: Time to replace the Ventilation Inlet Flow Switch

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the ventilation inlet flow switch on the bottom left corner of the lower cabinet, installed on the ventilation inlet duct assembly. Disconnect the switch connection (FSZ_J50 - part of the CN300 harness).

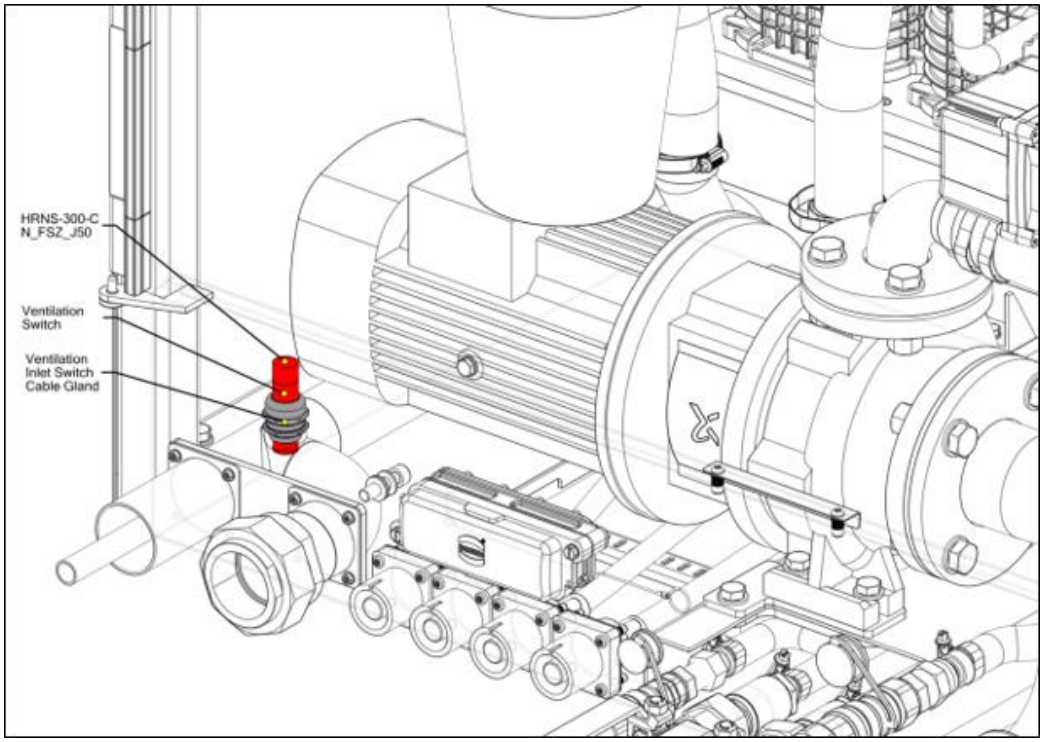


Figure 8-166: Location of ventilation flow switch.

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Assembling procedure:

1. Install the replacement flow switch halfway deep or with the label sticking out. Tighten to 6 ± 0.5 Nm.
2. Connect the ventilation inlet flow switch connection (FSZ_J50).

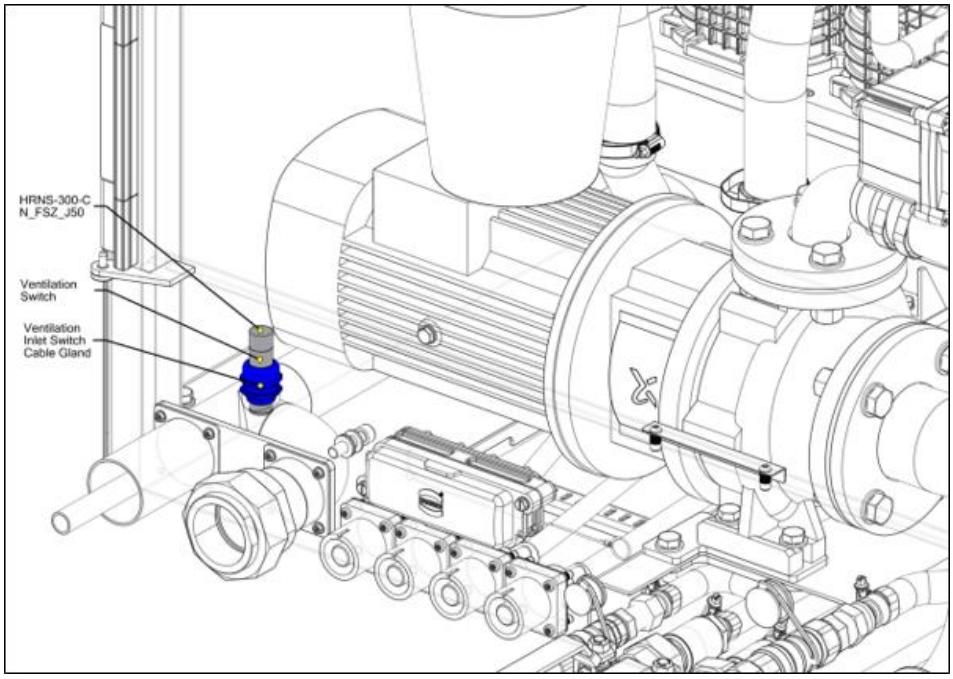


Figure 8-167: Ventilation inlet flow switch connection FSZ_J50.

3. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
4. Power up the 24V system and check if the LED sensor lights up green. Create an air flow restriction to check if the sensor trips and the module has a SafeCon alarm.
5. Close system doors and use the integrator side to confirm the module is ready for power up. Remember to follow local lockout/tagout procedures.

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8.5.5 H_2 Enclosure Water Ingress Sensor

8.5.5.1 Check H_2 Enclosure Water Ingress Sensor

Purpose:

The procedure describes how to check a water ingress sensor in the H_2 enclosure for the FCwave module.

Responsibilities:

Preventive maintenance of the water ingress sensor in the H_2 enclosure is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the H_2 Enclosure Water Ingress Sensor

Based on the normal conditions, the estimated time for replacement is:

H_2 Enclosure Water Ingress Sensor	
Duration	10 – 90 min
Personnel	1
Tool	27mm spanner

Table 8-24: Time to replace water ingress sensor

Note:
The sensor has different locations depending on the module.
Location A is towards the back of the module.
Location B is towards the front of the module.

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Procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. (For location A sensor) Perform steps 6-12 in section 8.5.5.2 to remove the sensor.
3. (For location B sensor) Loosen the bolt in the housing to remove the connector housing from the sensor and use a 27mm spanner to remove the sensor.

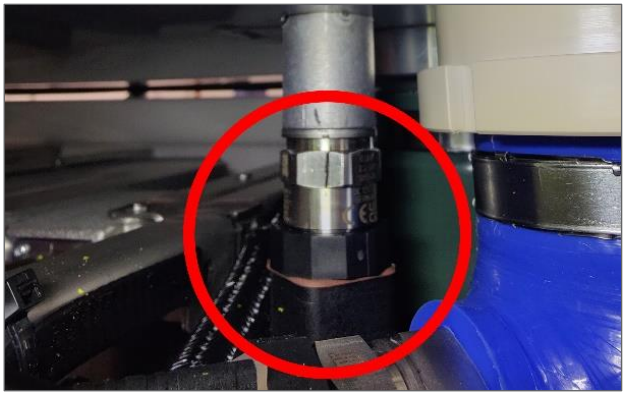


Figure 8-168: H_2 ingress sensor housing

4. Reconnect the connector housing to the sensor. Tighten the bolt if necessary.
5. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the bolts.
6. Monitor the MCU engineering interface with the module in "Unlocked" state.
   Make sure there are no active alarms.
7. Test the sensor by one of following three methods:
   a. Cover the sensor's electrode as much as possible by hand.
      This method relies on skin contact and result can vary depending on coverage area and skin moisture.
      Wait up to 30 seconds. If there is an alarm, skip to alarm codes, otherwise try the next method.

   b. Dampen a paper or cloth towel with water and press it against the sensor's electrode, covering as much of it as possible.
      Wait up to 30 seconds. If there is an alarm, skip to alarm codes, otherwise try the next method.

   c. Submerge the sensor's electrode in a container filled with water.
      Wait up to 30 seconds for the alarm to appear.

8. No matter the method, the alarm should disappear as soon as the sensor's electrode is not in contact with the test medium. Confirm the following warning alarm can be seen in the engineering interface:
   - A1_LSH_Z40_S_10700

   Alarm events are logged and can be found in the "Alarm" tab on the menu to the left side of the engineering interface.

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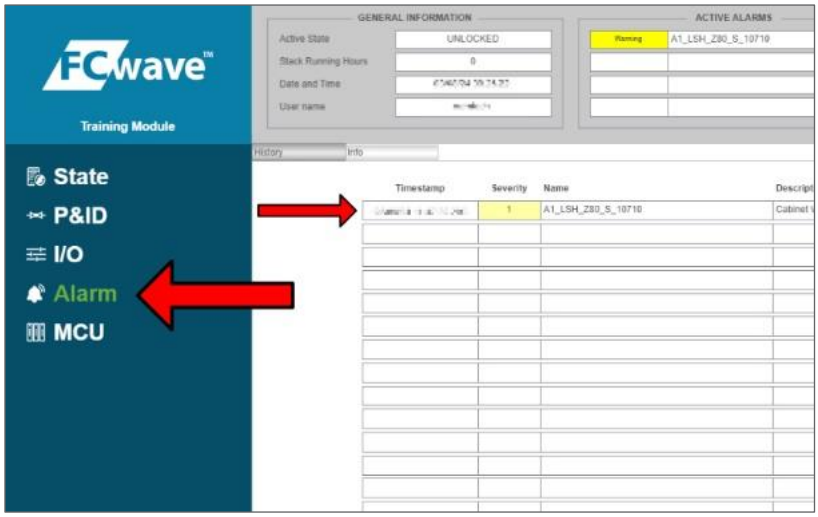


Figure 8-169: A1_LSH_Z40_S_10700 alarm

9. Confirm there are no active alarms and power down the module by disconnecting X_E01.
10. Clean and dry the sensor's electrode and disconnect the connector.
11. Perform step 2 or 3 in reverse order, depending on the location of the sensor, to reassemble the module.
12. If the cathode air hoses were disconnected, perform an air cathode leak test (see section 8.3.6).
13. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.5.5.2 Replace H_2 Enclosure Water Ingress Sensor

Purpose:

The procedure describes how to replace a water ingress sensor in the H_2 enclosure for the FCwave module. The sensor monitors moisture content in the H_2 Enclosure. The level sensor detects when the moisture level exceeds a set limit.

Responsibilities:

Preventive maintenance of the water ingress sensor in the H_2 enclosure is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the differential pressure safety switch during the life and operation of the FCwave module.

- FRU, Sensor, H_2 Enclosure Water Ingress (part no. 7500035)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the H_2 Enclosure Water Ingress Sensor

Based on the normal conditions, the estimated time for replacement is:

H_2 Enclosure Water Ingress Sensor		
Duration	1 – 1½ hours	
Personnel	1	
Tightening Torque	1/2" sensor fitting	25 ± 0.5 Nm
	Tool	27 mm spanner, torque wrench, flathead + cross-head screwdriver, 10mm socket screwdriver, 7mm socket

Table 8-25: Time to replace water ingress sensor

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Disassembling procedure:

The FCwave module was built in two different ways regarding this sensor. Either located in the back of the H_2 enclosure (location A) or located in front of the H_2 enclosure (location B).

Location A	Location B
Perform all steps in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the disassembling procedure.	Perform all steps in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the disassembling procedure.
1. Drain the HT cooling system	1. Locate the water ingress sensor on the H2 Enclosure in the upper cabinet, which is installed behind the coolant stack outlet connections.
2. Disconnect the 2 sensors on the HT cooling inlet hose (TT_D50 & PT_D50). (Figure 8-170)	2. Disconnect the water ingress sensor connection (LSH_Z40), use spanner to loosen the sensor and remove it.
3. Uninstall bolt keeping the HT cooling inlet hose in place, dismount the hose and tuck it out of the way.	
4. Disconnect the cable from the air inlet control valve (FCV_A40). (Figure 8-171)	
5. Relive the lower hose clamp from the FCV_A40 (no. 1) and take out the air inlet hose.Then relive the hose clamp directly under the H_2 Enclosure (no.2) and take out the FCV_A40 valve. (Figure 8-172)	
6. Disconnect the cable from the air outlet control valve (FCV_A50).	
7. Relive the lower hose clamp from the FCV_A50 and take out the air inlet hose. Then relive the hose clamp directly under the H_2 Enclosure and take out the FCV_A50 valve.	
8. Locate the H_2 enclosure ingress sensor in the back of the module. (Figure 8-173)	
9. Release the bolt in the middle of the plug and remove it. (Figure 8-174)	
10. Use a spanner to disconnect the sensor (LSH_Z40) and remove it.	

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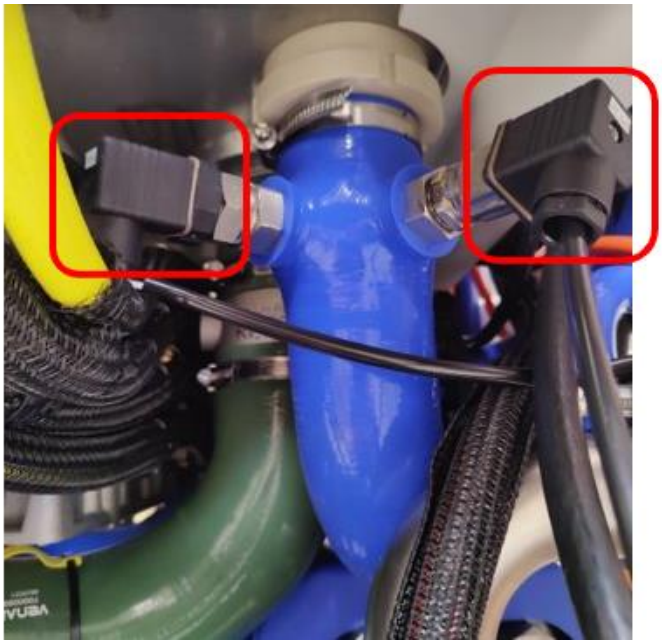


Figure 8-170: 2 sensors on HT cooling inlet hose

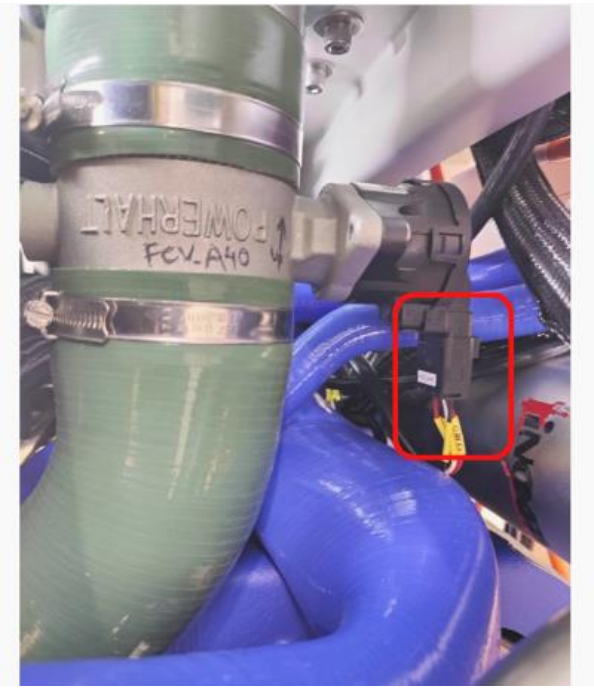


Figure 8-171: Cable on air inlet control valve

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Figure 8-172: Hose clamps on FCV_A40



Figure 8-173: Locate ingress sensor in back of module

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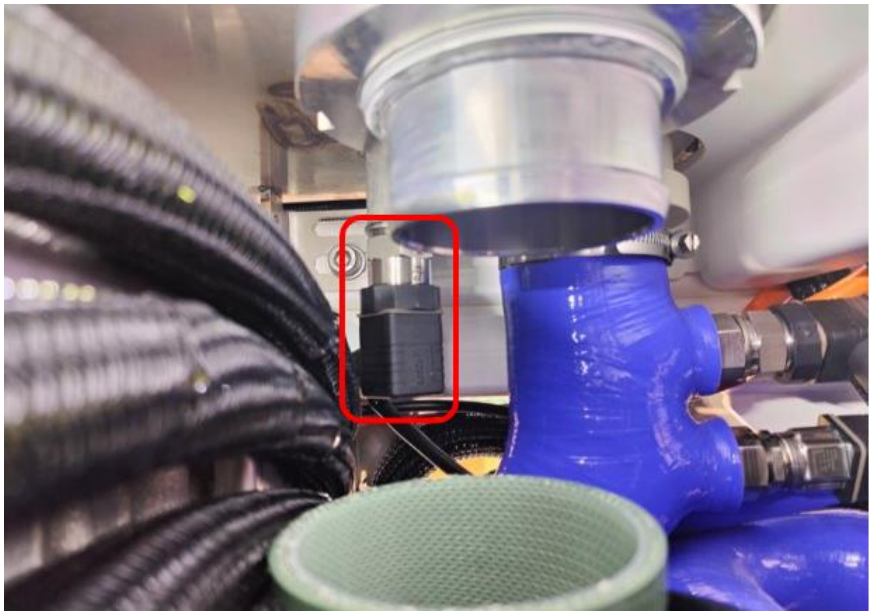


Figure 8-174: Release bolt in middle of plug on ingress sensor

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Assembling procedure:

The FCwave module was built in two different ways regarding this sensor. Either located in the back of the H_2 enclosure (location A) or located in front of the H_2 enclosure (location B).

Location A	Location B
1. Install the new sensor. Tighten to 25 Nm.	1. Install new sensor with a new bonded seal. Tighten to 25 Nm
2. Use the bolt to install the sensor connector.	2. Connect the new sensor to the module.
3. Reinstall the FCV_A50 valve and secure it with the hose clamps. Tighten to 3.5 Nm.	3. Install the high voltage panel cover. Use 12 pcs. M5x10 bolts
4. Reinstall the plug in the FCV_A50 valve connector.	4. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
5. Reinstall the FCV_A40 valve and secure it with the hose clamps. Tighten to 3.5 Nm.	5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Reinstall the plug in the FCV_A40 valve connector.	6. Close the system doors and confirm that the module is ready for power up from the integrator side after the maintenance. Remove local lockout and tagout procedures when work is done.
7. Remount the HT cooling inlet hose and tighten the hose clamp	
8. Install the pressure and temperature sensors (PT_D50 & TT_D50) on the HT cooling outlet. (Figure 8-175)	
9. Install the high voltage panel cover. Use 12 pcs. M5x10 bolts	
10. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.	
11. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.	
12. Close the system doors and confirm that the module is ready for power up from the integrator side after the maintenance. Remove local lockout and tagout procedures when work is done.	

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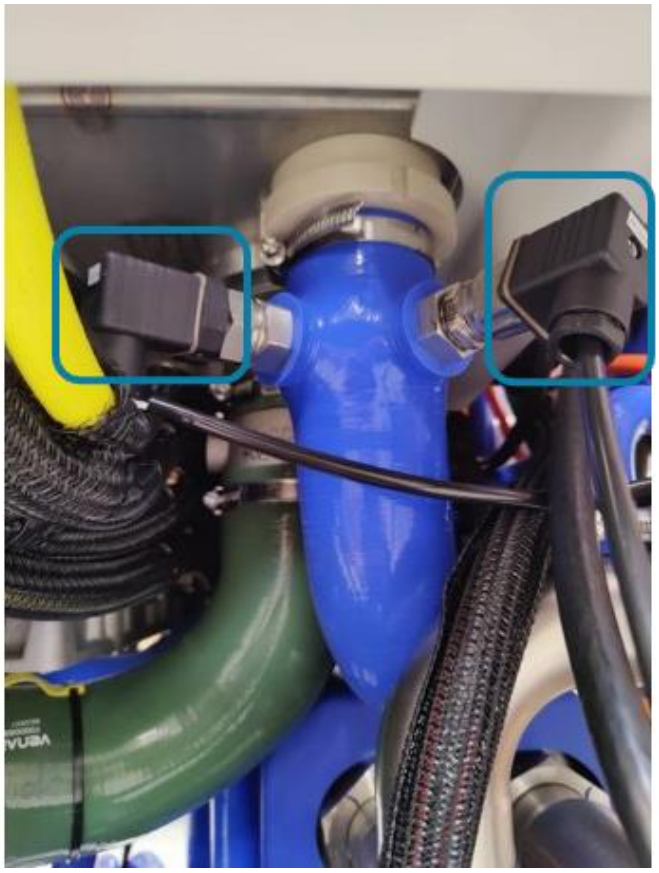


Figure 8-175: Install sensors on the HT cooling outlet

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8.5.6 Differential Pressure Safety Switch

8.5.6.1 Check Differential Pressure Safety Switch

Purpose:

The procedure describes how to check a differential pressure safety switch in the FCwave™ module. The safety switch monitors the air pressure difference between the inside of the Hydrogen Enclosure (H2E) and that of the outside. The switch will trigger an alarm if the air pressure inside the H2E is not lower than the outside pressure.

Responsibilities:

Checking the differential pressure safety switch is necessary for safe operation according to the maintenance plan (refer to the customer portal) or after a replacement. It is the end user's responsibility to do preventive maintenance, as stated in section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the Differential Pressure Safety Switch

Based on the normal conditions, the estimated time for check is:

Differential Pressure Safety Switch	
Duration	10 min
Personnel	1

Table 8-26: Time to check differential pressure switch

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Procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the bolts.
3. Monitor the MCU engineering interface with the module in "Unlocked" state.
   Make sure there are no active alarms.
4. Between the H_2E and the low voltage panel, locate the differential pressure safety switch below the smoke detector. Gently disconnect the tube attached to the switch.

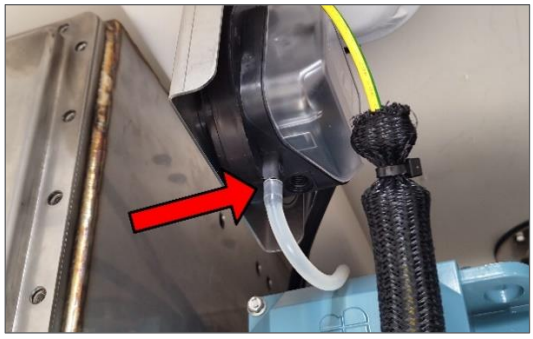


Figure 8-176: Disconnect differential pressure switch tube

5. Confirm the following alarms can be seen in the engineering:
   - A3_SAFETYSTOP_I_10120
   - A2_CNV_FCV_A_OK_I_10020
   - A2_CNV_FCV_A_OK_I_10030

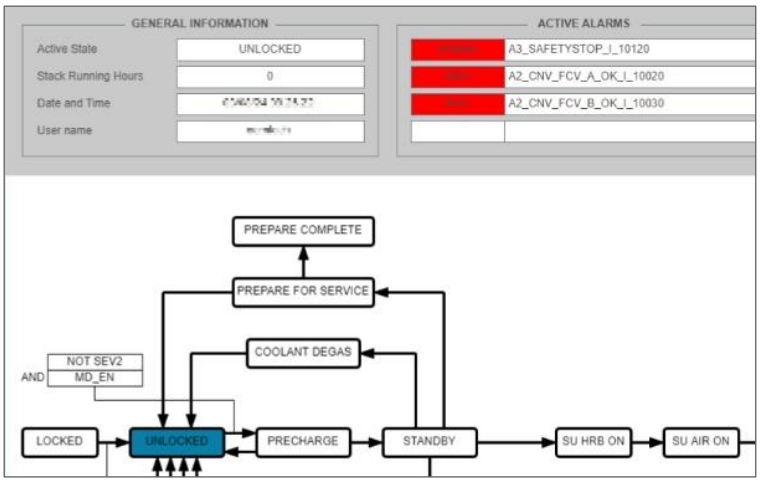


Figure 8-177: Overview of alarms

6. Reconnect the tube to the switch.
7. Power cycle the module to reset and confirm that there are no alarms.
   This can be done by disconnecting and reconnecting the X_E01 electrical connection.
8. The module is ready to be powered down by disconnecting the X_E01 electrical connection, and the module is ready to be restored to normal operating state.
9. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.5.6.2 Replace Differential Pressure Safety Switch

Purpose:

The procedure describes how to replace a differential pressure safety switch for the FCwave module. To safeguard the system, the pressure switch verifies that the pressure within the H2 enclosure is below the pressure outside the H2 enclosure.

It is important that there is a small negative pressure inside the H2 enclosure when it is in operation.

Responsibilities:

Preventive maintenance of the differential pressure switch is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace differential pressure safety switch during the life and operation of the FCwave module.

- FRU, Differential Pressure Safety Switch (Part No. 7500034)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Differential Pressure Safety Switch

Based on the normal conditions, the estimated time for replacement is:

Differential Pressure Safety Switch	
Duration	45 min
Personnel	1
Tool	3mm hex key, flathead + cross-head screwdriver, cross-head bit, hex bit rachet

Table 8-27: Time to replace differential pressure switch

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the Differential Pressure Safety Switch in the top right corner of the upper cabinet installed on the bracket. Use flathead screwdriver to open the transparent plastic cover of the pressure switch.

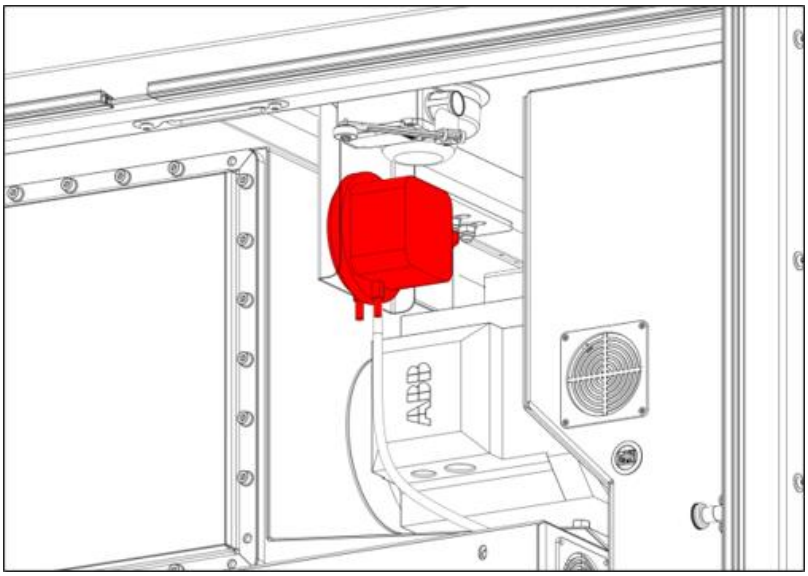


Figure 8-178: Location of differential pressure switch

3. Disconnect the differential pressure switch connection (HRNS-303-CN_PDSZ_J40). Remember to note down the wiring connection order before removing wires from the pressure switch.
4. Remove pressure differential switch silicone tube from pressure differential switch.

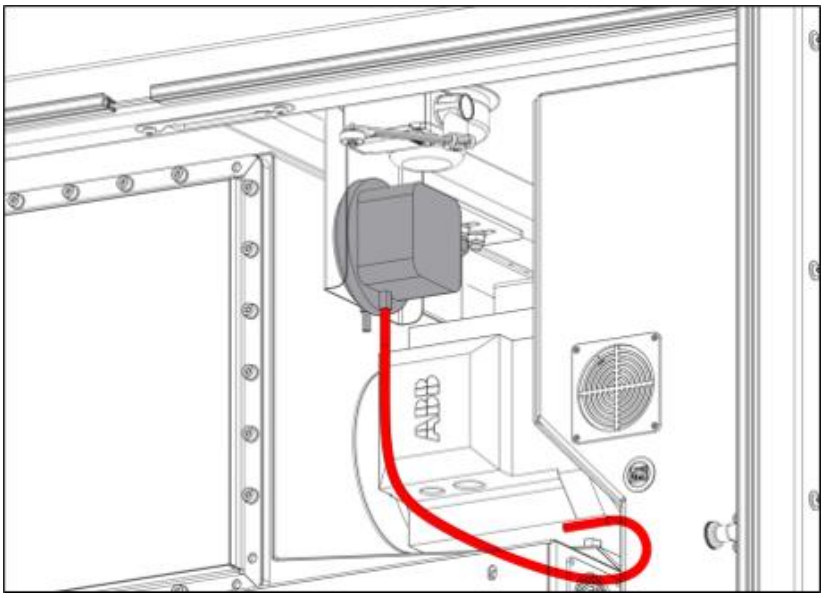


Figure 8-179: Silicone tube on pressure differential switch

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5. Remove 4 sets of panhead bolts/washers used to install the differential pressure switch to the bracket.

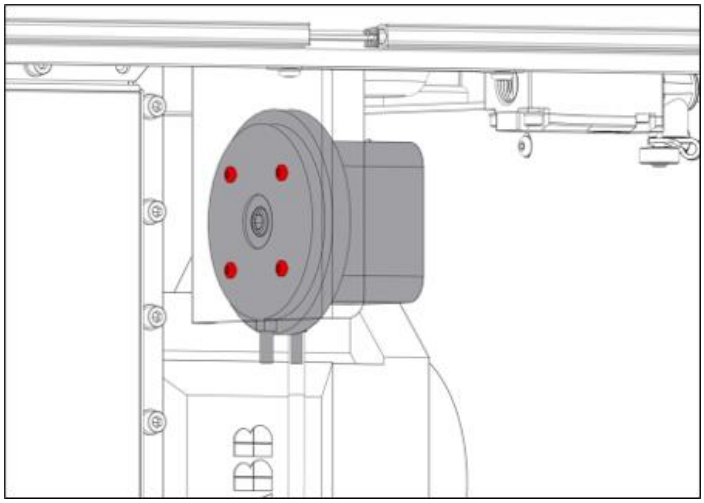


Figure 8-180: Panhead bolts on differential pressure switch bracket

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Assembling procedure:

1. Fasten 4 pcs. panhead bolts used to tighten the H2E differential pressure switch to the bracket. Remember to replace the bolts.
2. Install the end of silicon tube to the differential pressure safety switch.
3. Connect the differential pressure switch connection, HRNS-303-CN_PDSZ_J40.

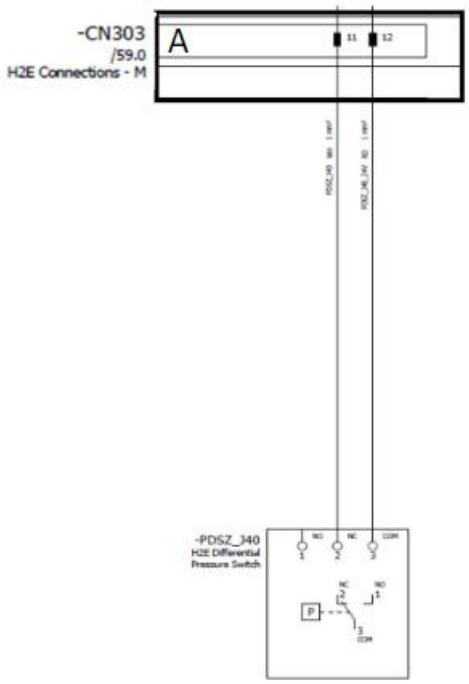


Figure 8-181: Connection HRNS-303-CN_PDSZ_J40

4. Close the transparent plastic cover of the pressure differential switch and tighten the bolt.
5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Power up the 24V system. Check if the sensor reacts if the HRB hatch is open.
7. Close the doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.5.7 Check Smoke Detector Functionality

Purpose:

The procedure describes how to check correct functionality of the smoke detector for the FCwave module.

Responsibilities:

Preventive maintenance of the smoke detector is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the smoke detector during the life and operation of the FCwave module.

- Smoke Detector Tester[4] (part no. 5129595, 6500524) or equivalent

Safety:

Refer to section 8.1.2 to follow the instructions.

Procedure:

During the procedure you will activate the fire detection system, so make sure to disconnect the automatic firefighting system before starting the procedure.

1. Before proceeding with the check procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Supply 24V power from the shipboard of connect an I/O tester to power up the module MCU.
3. Connect a computer to the MCU and log in to the engineering interface (see section 8.2).
4. Locate the smoke detector installed in the upper cabinet next to the H_2 enclosure.

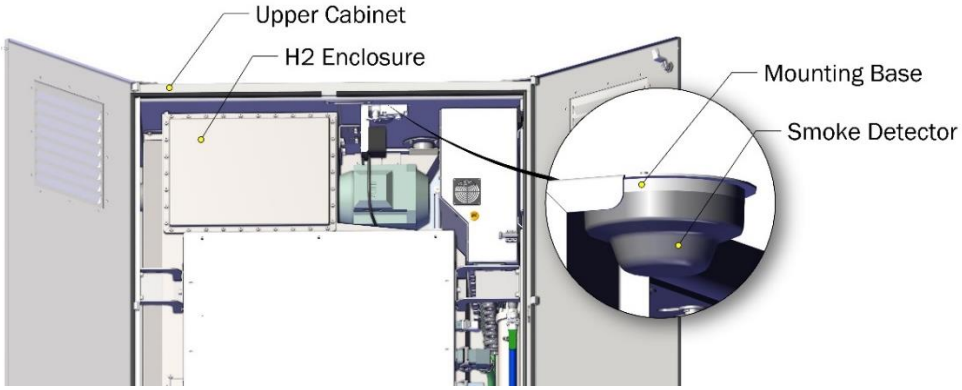


Figure 8-182: Location of smoke detector in upper cabinet

5. Read written instructions on smoke detector and follow as explained to check the smoke detector is not expired.
6. With the module in the "unlocked" state, spray a small quantity of test smoke (press for 2-3 sec) close to the smoke detector. Repeat process a few times.
7. In the engineering interface, navigate to the I/O page and select the All Inputs tab.
8. The tag "SAFETYSTOP" will be activated (ON) (1) and 3 alarms

[4] Smoke Detector Tester is part of the 'Special Tools Kit FCwave' (part no. 6100062)

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- A3_SAFETYSOP_I_10120
- A2_CNV_FCV_A_OK_I_100200
- A2_CNV_FCV_B_OK_I_10030

will appear in the "Active Alarms" list (2).



Figure 8-183: Overview of fire alarms

9. To reset the alarms, cycle both 24V power supply's OFF and ON.
10. Log out of the MCU engineering interface and disconnect the computer.
11. If applicable, shut down the IO tester and disconnect from the module.

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8.5.8 Replace Smoke Detector

Purpose:

The procedure describes how to replace a smoke detector for the FCwave module. The smoke detector senses any smoke in the module's cabinet.

Responsibilities:

Preventive maintenance of the smoke detector is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the smoke detector during the life and operation of the FCwave module.

- FRU, Smoke Detector (part no. 7500149)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace a Smoke Detector

Based on the normal conditions, the estimated time for replacement is:

Smoke Detector	
Duration	5 min
Personnel	1

Table 8-28: Time to replace smoke detector

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the smoke detector in the upper cabinet behind the door switch.
3. Hold the smoke detector and turn it counterclockwise to remove it.

Assembling procedure:

1. Replace the smoke detector by aligning it to the electrical contacts on the relay base and turn it clockwise to lock it in place.

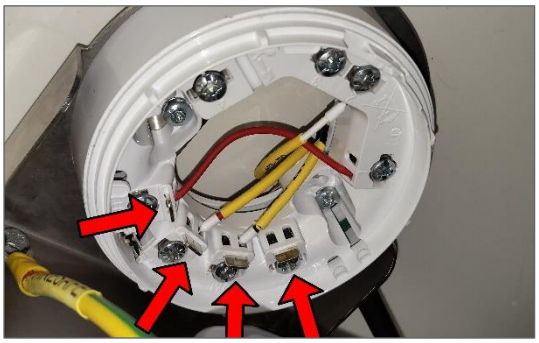


Figure 8-184: Aligning smoke detector

2. Verify the replacement smoke detector by confirming that the module will not cause a fire alarm on the integrator side during the test.
3. Confirm that the module is ready for power up to perform the smoke detector test.
4. Check smoke detector functionality (section 8.5.7).
5. Confirm the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.5.9 Replace Ventilation Fan

Purpose:

The procedure describes how to replace a ventilation fan for the FCwave module. A pair of fans draws ventilation air through the air inlet duct along the length of H_2 enclosure and exhaust through the ventilation outlet duct.

Responsibilities:

Preventive maintenance of the ventilation fan is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the smoke detector during the life and operation of the FCwave module.

- FRU, H_2E Ventilation Fans (part no. 7500038)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Ventilation Fan

Based on the normal conditions, the estimated time for replacement is:

Ventilation Fan		
Duration	15 – 30 min + 2 – 2½ hours for HRB Motor	
Personnel	1	
Tightening Torque	M4 nut	3.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	Tool: 3mm + 5 mm hex key,	

Table 8-29: Time to replace ventilation fan

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the ventilation hatch cover on the top right corner of the H_2 enclosure, which is behind the HRB Motor. It is high likely necessary to remove the HRB motor, to create proper access. Refer to section 8.2.2.2.1.

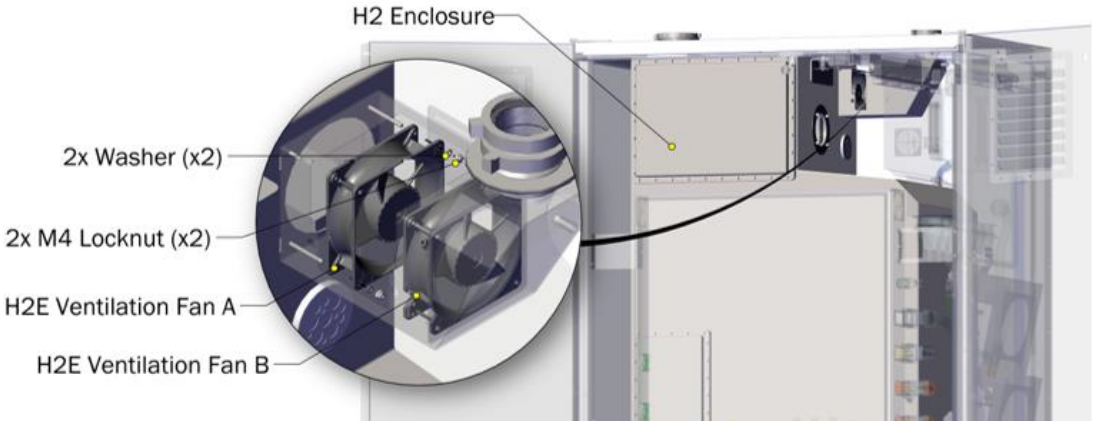


Figure 8-185: Location of ventilation hatch cover

3. Remove 4 pcs. M6 bolts and washers to disassemble the ventilation hatch cover.

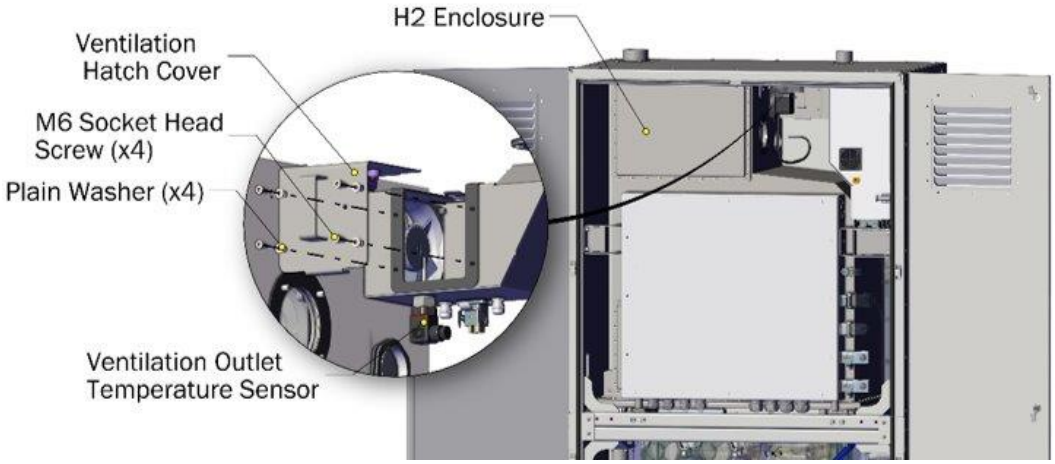


Figure 8-186: Disassemble the ventilation hatch cover

4. Disconnect the ventilation blower connection, HRNS-303-CN-FAN_J10A and CN-FAN_J10B.
5. Remove 2 pcs. M4 lock nuts and washers used to tighten the ventilation fan A to the ventilation outlet duct and remove fan. Do similarly to ventilation fan B if needed.

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Assembling procedure:

1. Use 2 pcs. M4 lock nuts and washers to tighten the ventilation fan A to the ventilation outlet duct. Do similarly to ventilation fan B if needed.
2. Reconnect the ventilation blower connection – HRNS-303-CN-FAN_J10A and CN-FAN-J10B.
3. Use 4 pcs. M6 bolts and washers to install the ventilation hatch cover.
4. If HRB Motor was removed to create access, reinstall the motor. Refer to section 8.2.2.2.1.
5. Install 12 pcs. M5x10 hex head bolts to install the high voltage panel cover.
6. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
7. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
8. Close the doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.5.10 Replace Fuel Cell Stack Assembly/Module Top Cabinet Swap

Purpose:

The procedure describes how to replace a fuel cell stack assembly for the FCwave module. The fuel cell stack delivers the required power, current, and voltage to the system. The fuel cell stack assembly is installed at the center of the H_2 enclosure. Only qualified service personnel shall install, inspect, and service the fuel cell stack assembly.

Responsibilities:

Preventive maintenance of the fuel cell stack assembly is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment:

A list of parts and special equipment is identified to replace the fuel cell stack during the life and operation of the FCwave module.

- FRU, FCwave Top Module Swap Unit (part no. 7500164)

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Fuel Cell Stack Assembly

Based on the normal conditions, the estimated time for replacement is:

Fuel Cell Stack Assembly		
Duration	10 hours	
Personnel	1 - 2	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	M10 nut	50 ± 5 Nm
	M12 bolt	85 ± 5 Nm
	Fuel supply fitting (20mm)	Hand tight + 1.25 turn
	Tool	5mm + 6mm + 8mm + 10mm hex key, 10mm + 12mm + 20mm spanner

Table 8-30: Time to replace fuel cell stack

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain the internal HT and LT coolant loop.
3. Disconnect the LV panel connections (see section 8.6.15).
4. Disconnect the HT panel connections (see section 8.6.14).
5. Disconnect the external connections to process exhaust and H_2 enclosure ventilation output of the upper cabinet of the module.

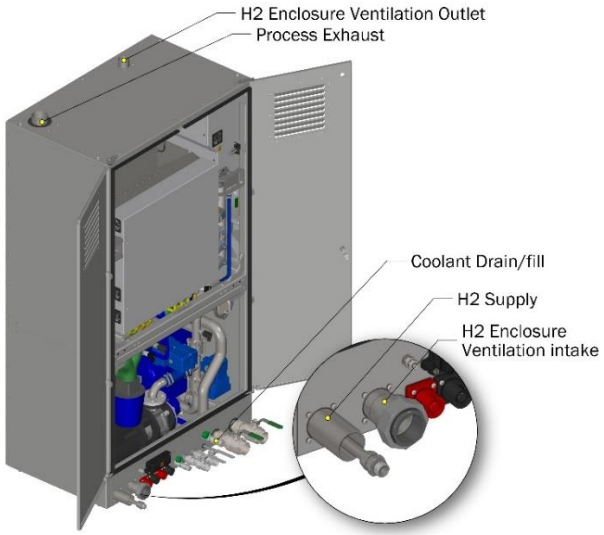


Figure 8-187: Dismounting exhaust and ventilation outlet external connections

6. Disconnect the LT cooling connections to the HRB and coolant pump motor controllers (see section 8.6.4).
7. Release the hose clamp on the bulkhead fittings of the coolant inlet hose manifold. Slide off the hoses attached with a pressure sensor and temperature sensor to have service access.

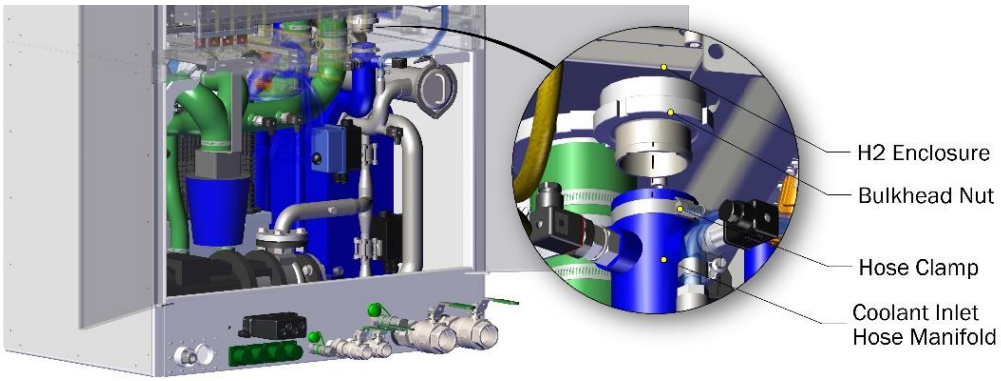


Figure 8-188: Removal of hose clamp for coolant inlet

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8. Release the hose clamp on the bulkhead fittings of the oxidant inlet hose manifold. Slide off the hoses to have service access.

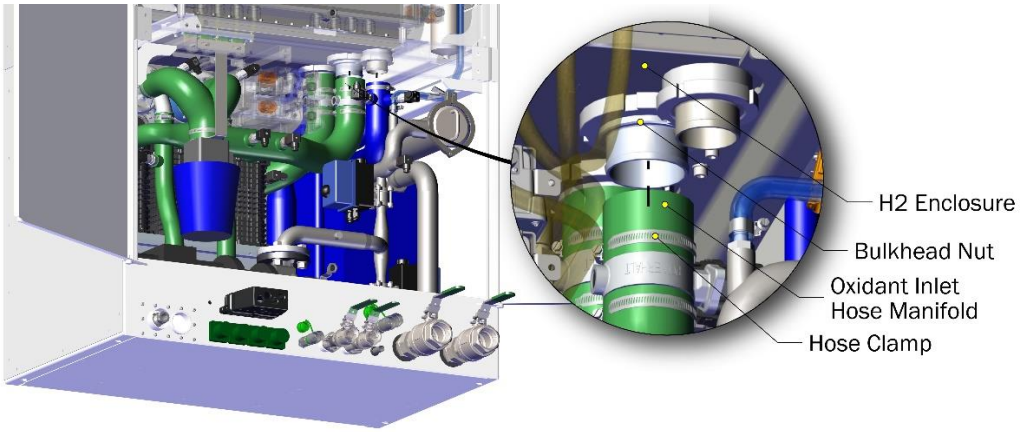


Figure 8-189: Removal of hose clamp for oxidant inlet

9. Release the hose clamp on the bulkhead fittings of the oxidant outlet hose manifold. Slide off the hoses to have service access.

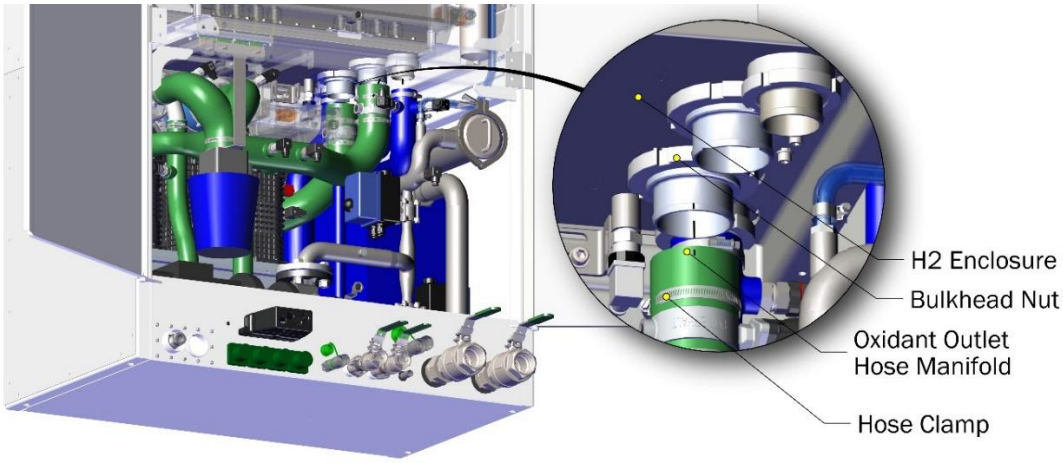


Figure 8-190: Removal of hose clamp for oxidant outlet

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10. Release the hose clamp on the bulkhead fittings of the coolant outlet hose manifold. Slide off the hoses attached a with pressure sensor and temperature sensor to have service access.

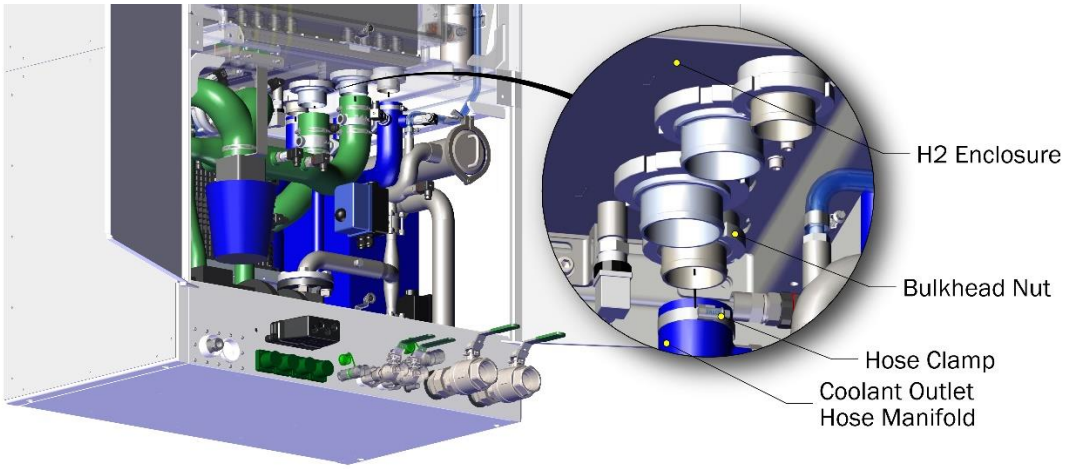


Figure 8-191: Removal of hose clamp for coolant outlet

11. Release the coolant hoses connected to the header tank and from the DI filter outlet.

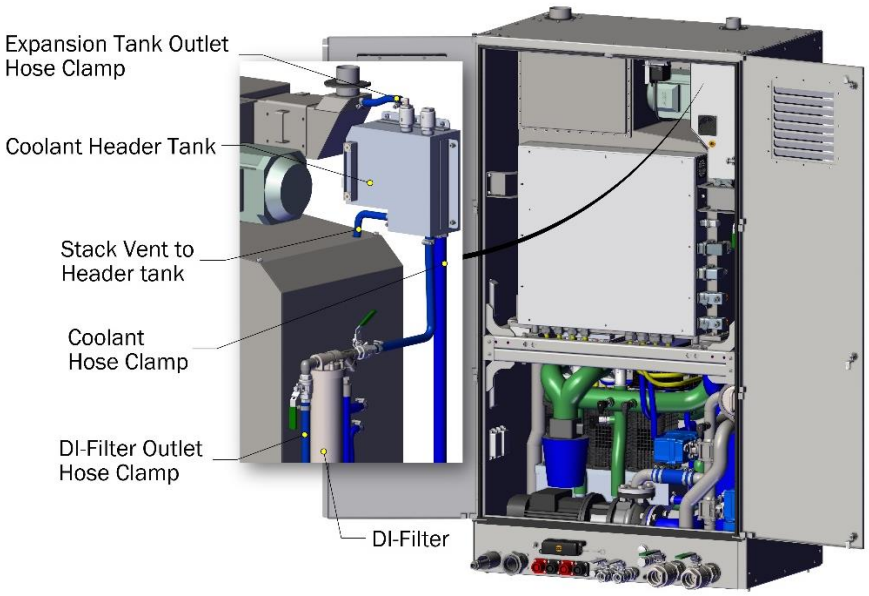


Figure 8-192: Dismounting coolant hoses connected to header tank and Di filter

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12. Remove 4pcs. M6 bolts on the bottom side of H_2 pipe top adapter box, gasket and lower the box.

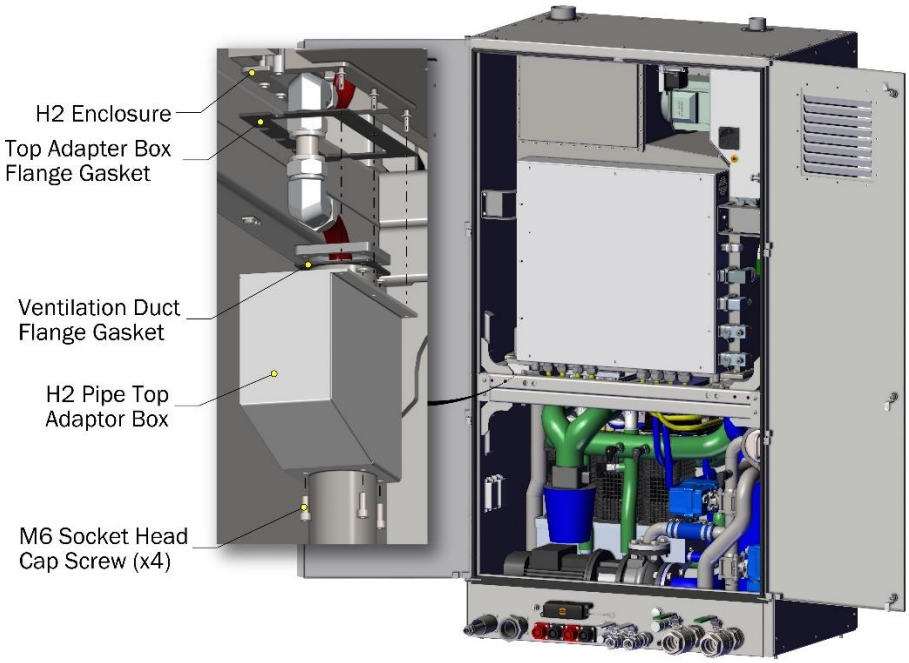


Figure 8-193: Removal of bolts of H_2 pipe top adapter box

13. Disconnect the internal H_2 fuel pipe supply union nut fitting to disconnect the lower ventilation duct.

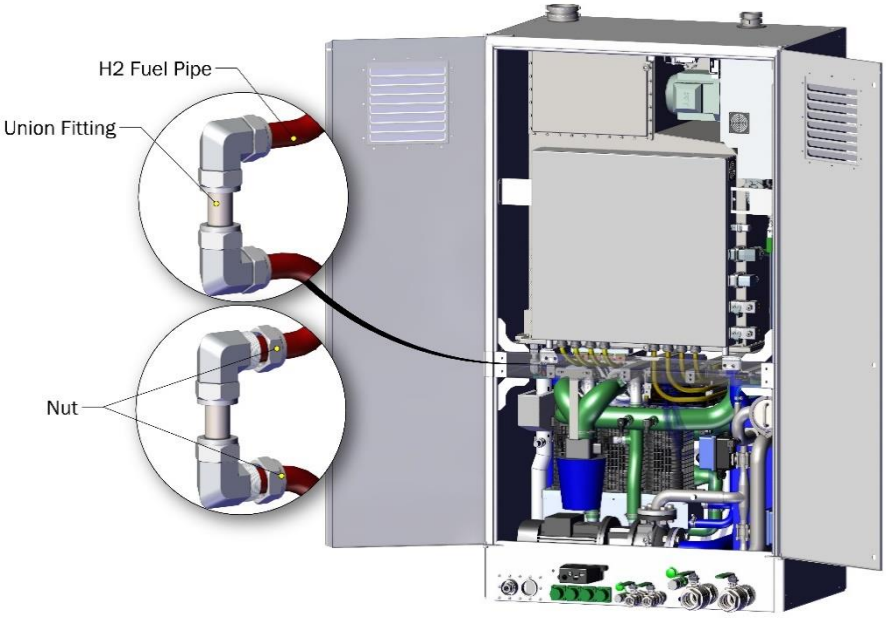


Figure 8-194: Disconnect internal H_2 supply

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14. Uninstall 2 pcs. M6 bolts and washers of the process exhaust flange and rotate counter-clockwise to dismount the connection to the exhaust duct.

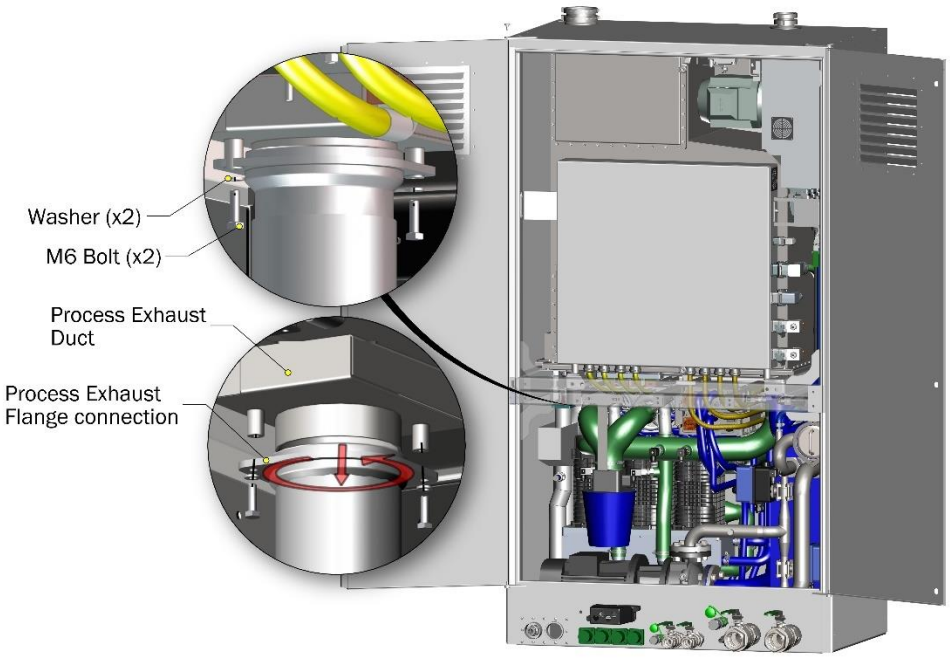


Figure 8-195: Dismounting process exhaust flange connection

15. Dismount the right and left doors of the integrated upper and lower cabinet by uninstalling the detachable M12 anchoring bolts.

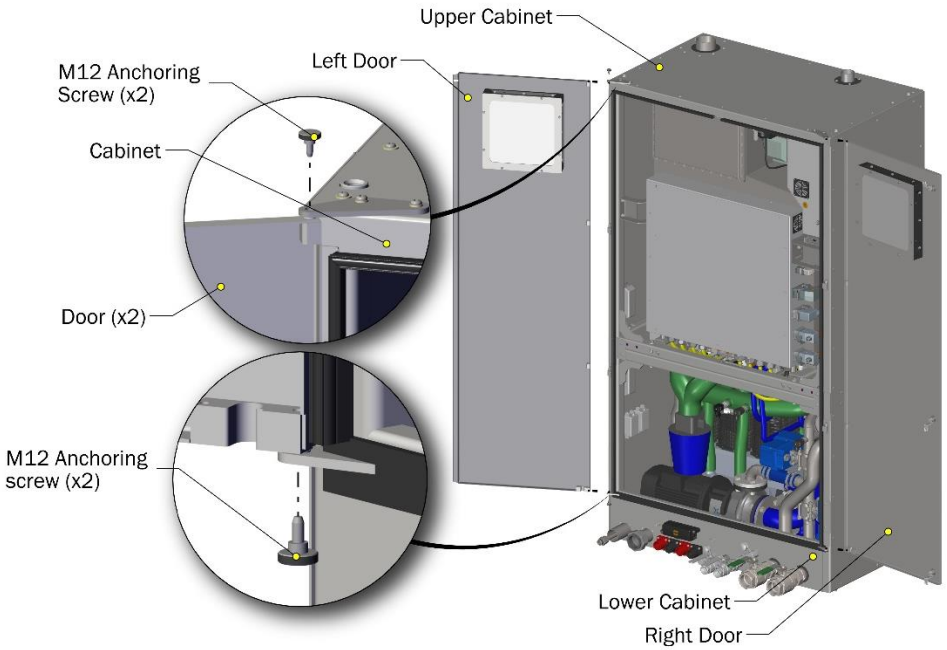


Figure 8-196: Dismounting anchoring bolts for the doors

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16. Uninstall 2 pcs. M6 bolts to access the sliding lock mechanism to dismount the upper cabinet.

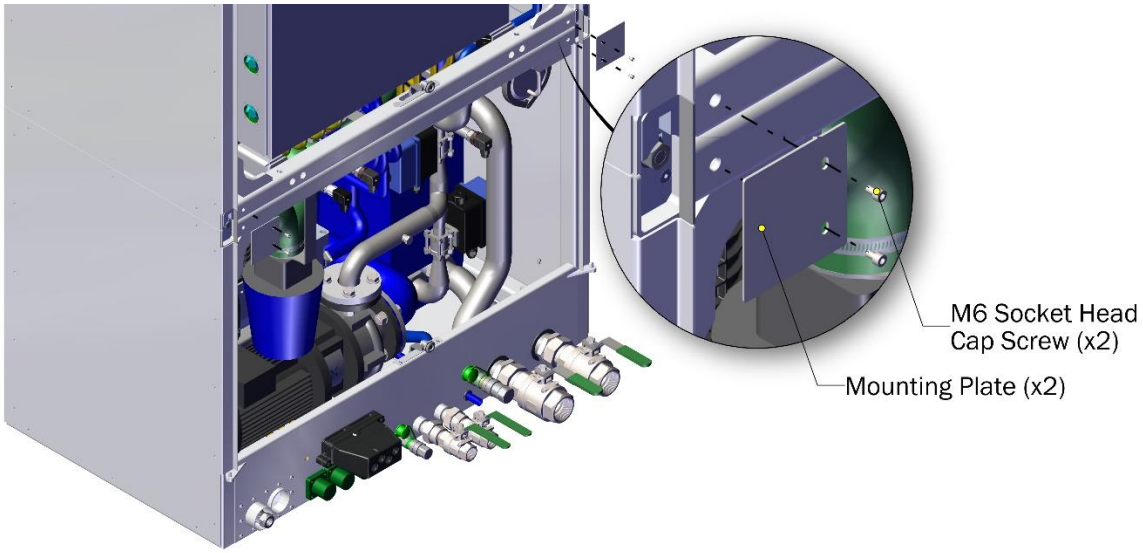


Figure 8-197: Dismounting mounting plate

17. Loosen the M10 nut on the movable lock shaft, which unlocks the locking bracket mounted on the locking pin and remove the movable lock shaft unit.

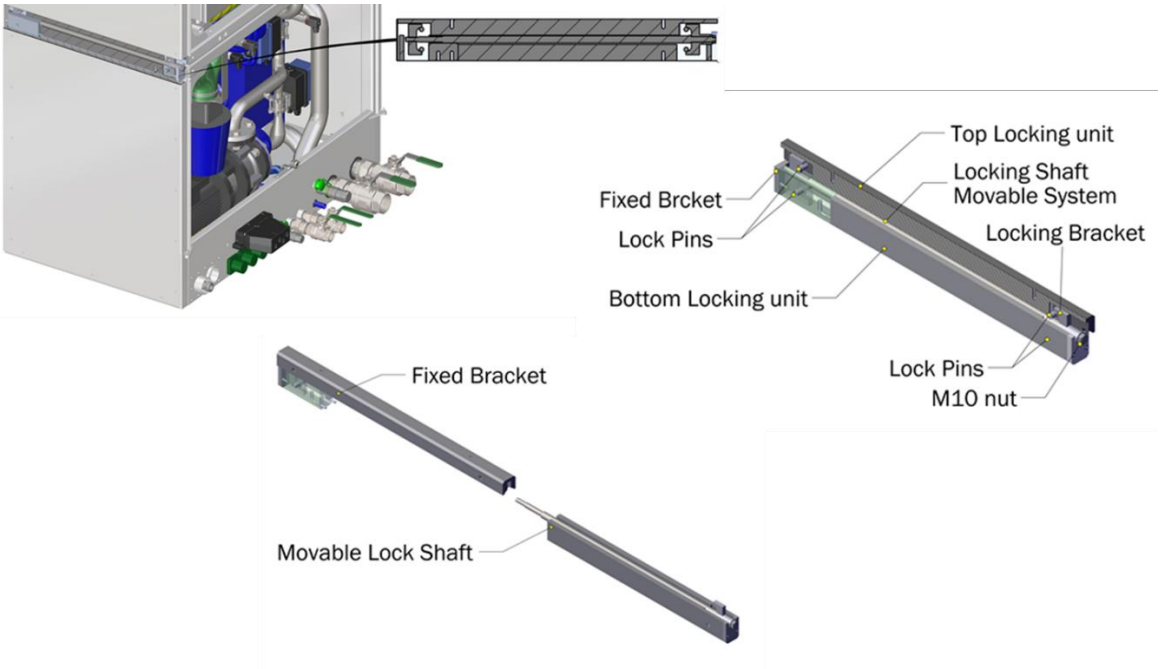


Figure 8-198: Removal of movable lock shaft unit

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18. Dismount the movable lock shaft system from the cabinet assembly with the top unit connected to the upper cabinet assembly.

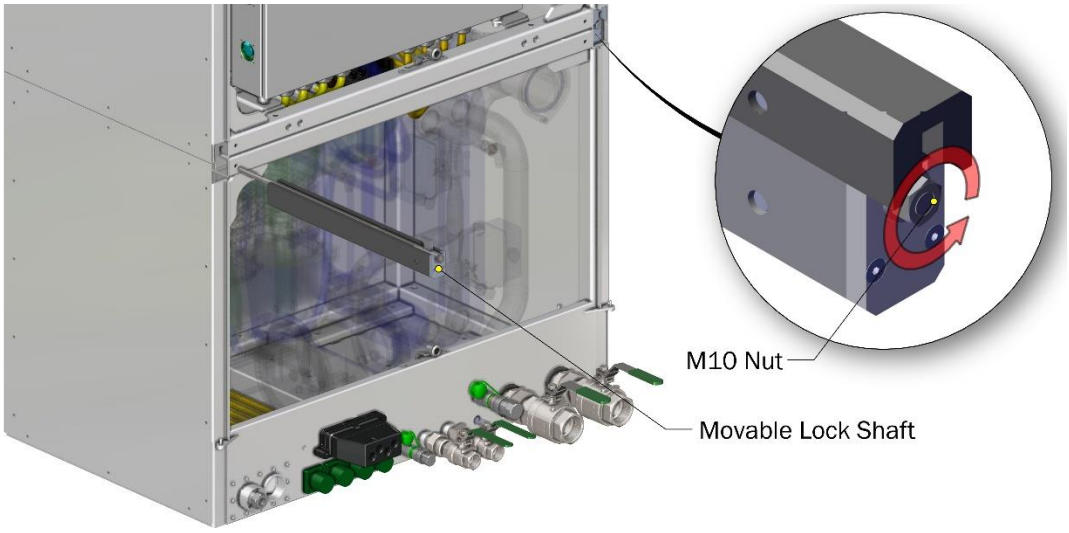


Figure 8-199: Removal movable lock shaft

19. Place the special lifting tool in the cabinet assembly below the top locking unit to lift and slide out the upper cabinet on to the lifting table.

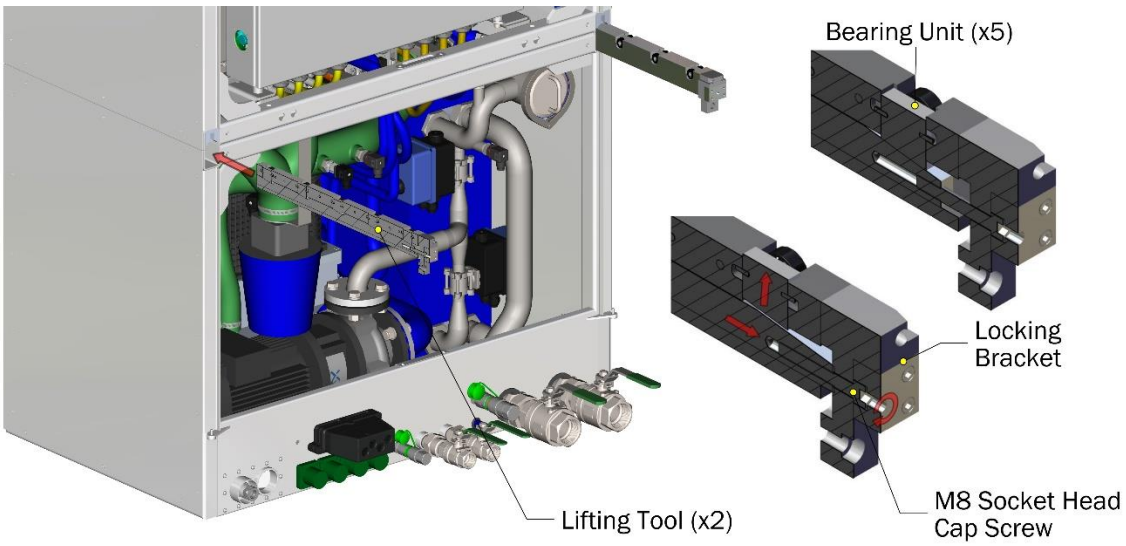


Figure 8-200: Removal upper cabinet

20. Tighten M8 bolts connected to the beam to lift the upper cabinet to engage 5 pcs. bearing units of lifting tool.

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21. Sliding out the upper cabinet includes the H_2 enclosure unit, HV panel, LV panel, coolant header tank, DI filter, and motor controllers. Slide onto a specially designed adjustable lifting equipment to pull out the upper cabinet.

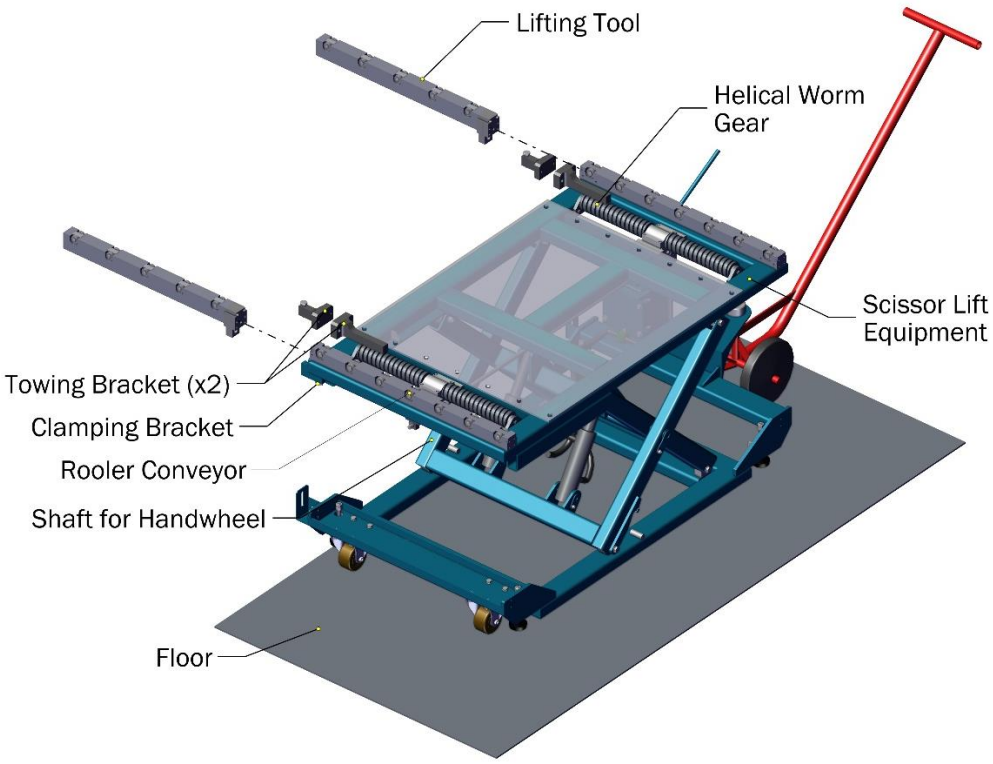


Figure 8-201: Special scissor lift equipment

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22. The lifting table is placed in front of the cabinet and the fixing plate is connected to the lifting mechanism tool with 2 pcs. M10 bolts on both sides.

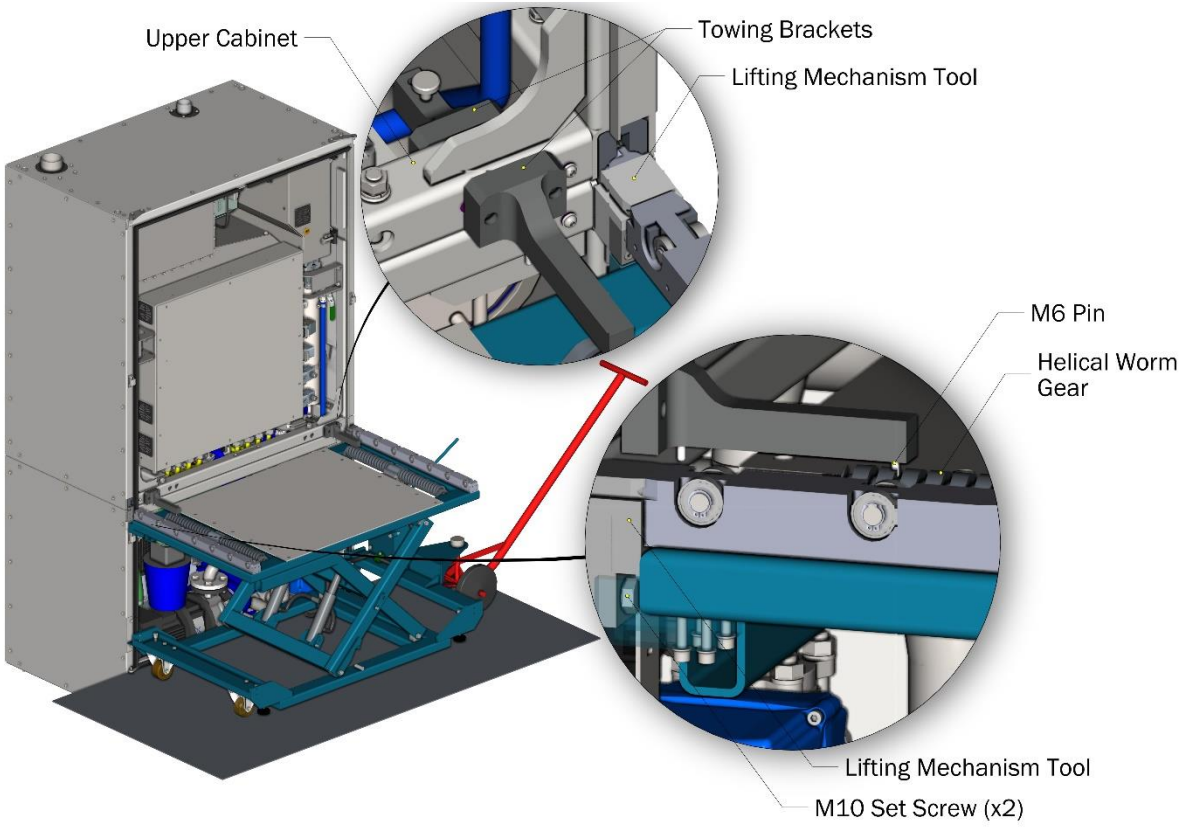


Figure 8-202: Fixing lifting table to upper cabinet

23. Install towing brackets on the front beams of the upper cabinet and the extended end of the towing bracket guide pin should be engaged on the helical bolt of the worm gear.
24. Remove all cable ties from the wire harness connections in the upper cabinet.
25. When the worm gear shaft is rotated by handwheel, the gear pulls out the upper cabinet from the cabinet assembly. Lifting and handling the upper cabinet must be performed slowly to avoid sudden jerks and movements.
26. For safety reasons, connect the four lifting points with eye bolts on top of the cabinet to the overhead electric hoist with a lifting beam while disassembly.

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27. Mount the upper cabinet onto the scissor lift equipment.

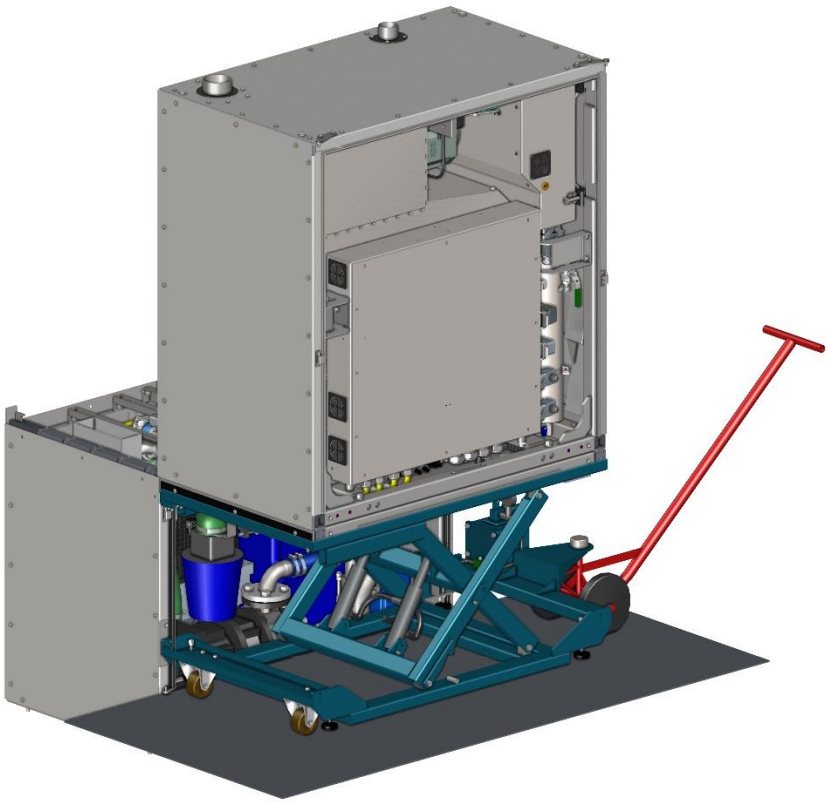


Figure 8-203: Placing upper cabinet of scissor lift

28. Make sure to cover all disconnected ports and hoses with a clean cap or tape.
29. Cover the coolant inlet and outlet ports of the stack assembly to prevent any unwanted material from falling into it.
30. Cover the oxidant inlet and outlet ports of the stack assembly to prevent any unwanted material from falling into it.
31. Cover the fuel inlet and outlet ports of the stack assembly to prevent any unwanted material from falling into it.
32. Assemble in reverse order with replacement fuel cell stack assembly.
    It is highly recommended to perform a leak test with smoke detector and H_2 sensor after any service maintenance (refer to section 8.2.4).
33. Pack and send the used fuel cell stack assembly with complete upper cabinet to Ballard, as service maintenance and stack assembly replacement requires Level-III certified service personnel from Ballard (see section 4.1 for contact information).

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8.6 Electrical Sub-system

For detailed in-depth electrical document, contact BPSE (see section 4.1) to get sent document 'CMS010' (Schematic Description of IO Circuits).

8.6.1 Check Fuel Cell Module BOP Components

Purpose:

The procedure describes how to visually inspect the BOP components of the FCwave module. Any damage or deformation of the parts in BOP must be reported to BPSE to find out if corrective action is necessary, as it can lead to potentially dangerous issues.

Responsibilities:

It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1).

Safety:

Refer to section 8.1.2 to follow the instructions.

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Procedure:

1. Perform step 1-3 in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the check procedure.
2. Visually check the cabinet BOP components for signs of damage, corrosion, missing or loose fasteners, or unusual wear patterns that could identify more dangerous issues. If possible, check by removing the HRB hatch and purge valve hatch covers on the H_2 enclosure.



Figure 8-204: Overview of cabinet BOP

3. Record the observations and findings during inspection. If any leaks or damages are reported, do not operate the module until the issue is corrected. Contact BPSE (see section 4.1) for further support.

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8.6.2 Check External Harnesses and Electrical Components

Purpose:

The procedure describes how to visually inspect the external harnesses and electrical components of the FCwave module. Harnesses or hoses that show signs of damage or problems must be reported to BPSE to find out if corrective action is necessary, as it can lead to potentially dangerous issues.

Responsibilities:

It is the end user's responsibility to do preventive maintenance (refer to section 8.1.1).

Safety:

Refer to section 8.1.2 to follow the instructions.

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Procedure:

1. Perform steps in section 6.5.1 (High Voltage safety check before module maintenance) before proceeding with the check procedure.
2. Make sure the connectors are securely plugged in.
3. Uninstall the bolts to remove the LV panel cover.

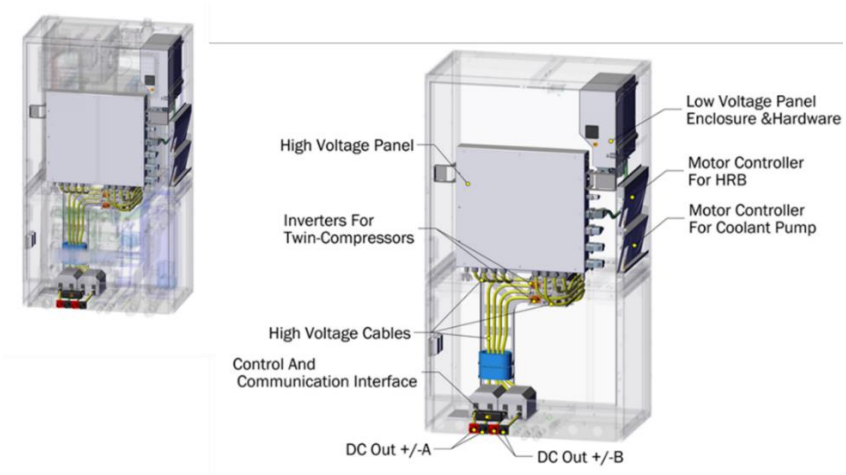


Figure 8-205: Overview of HV and LV panel covers

4. Visually examine the external harnesses and electrical components in the HV panel, LV panel, and in the BOP of the FCwave module.
5. If accessible, examine the harnesses connected to air compressor controllers and on the HRB and coolant pump controllers.
6. For inspection of harnesses and electrical components:
   - Check all the harnesses and hoses. Make sure there are no loose clamps, bends, pinching, cuts, or cracks.
   - Check that all bolt fastenings and connections are tight and correctly aligned.
   - Check that terminal boots and other covers are correctly installed.
   - Check that cable ties provides cable strain relief at vulnerable points.
   - Check that the module bonding stud and bonding harnesses are correctly installed on both upper and lower cabinet and free of corrosion.
   - Check for signs of overheating, wear, or damage — Damages of an excessive nature can be sign of more dangerous issues and must be investigated.
   - Check that there are no visible leak spots, pooled liquid, corrosion, or excessive moisture in the enclosures.
7. Record the observations and findings during inspection. If any damages are reported, do not operate the module until the issue is corrected. Contact BPSE (see Section 4.1) for further support.

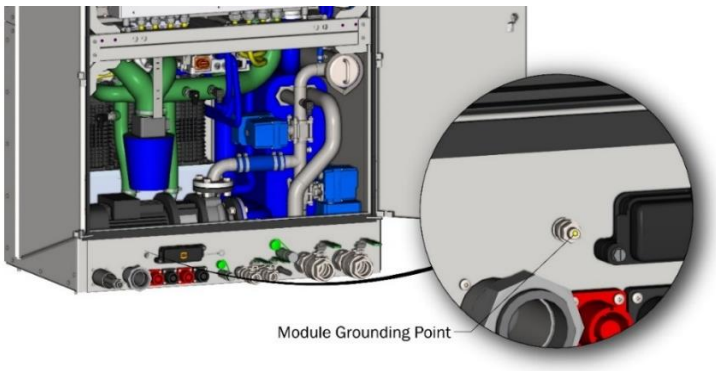


Figure 8-206: Overview of module grounding port

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8.6.3 Check Ground Fault Monitor Functionality

This is part of customer scope of supply, refer to the instructions and written procedures for periodic test of ground fault monitor.

8.6.4 Replace HRB Motor and Coolant Pump Controllers

Purpose

The procedure describes how to replace an HRB motor and coolant pump controllers for the FCwave module. Both the motor controllers are installed on the right side of the upper cabinet below the low voltage panel.

Responsibilities

Preventive maintenance of the motor controllers is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the motor controllers during the life and operation of the FCwave module.

- FRU, HRB Motor Controller (part no. 7500112)
- FRU, Coolant Pump Motor Controller (part no. 7500113)

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Motor Controllers

Based on the normal conditions, the estimated time for replacement is:

Motor Controllers		
Duration	1 hours	
Personnel	1	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	Fitting 1/4"	15 ± 0.5 Nm
	Tools	5mm + 6mm hex key, special tool (7500211), clean container, valve, 8mm plastic pipe, 8mm plastic pipe adaptor, 7mm + 10mm + 19mm socket, torque wrench

Table 8-31: Time to replace motor controllers

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall 3 pcs. M8x30 bolts from the top right support bracket of the high voltage panel. Remove the bracket on the right side of the high voltage panel.

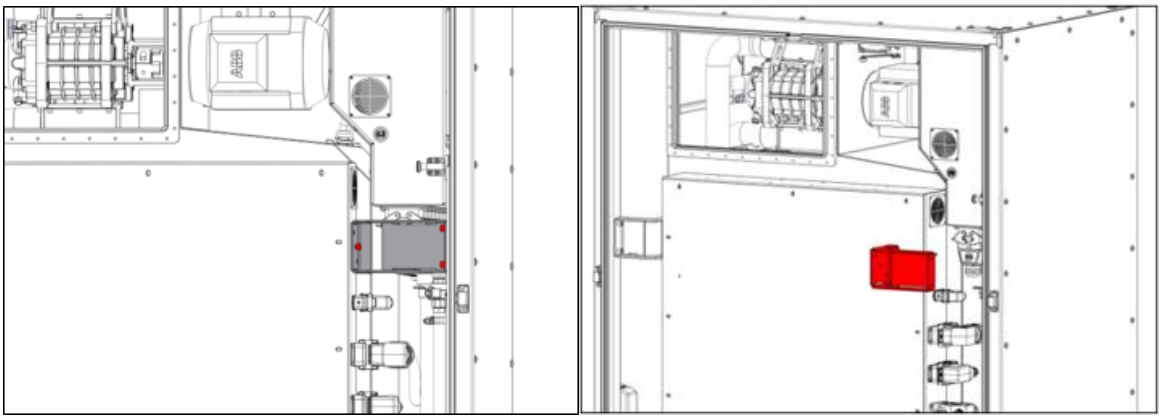


Figure 8-207: Bolts and support bracket in HV panel

3. To get service access, disconnect all connectors in the high voltage panel.

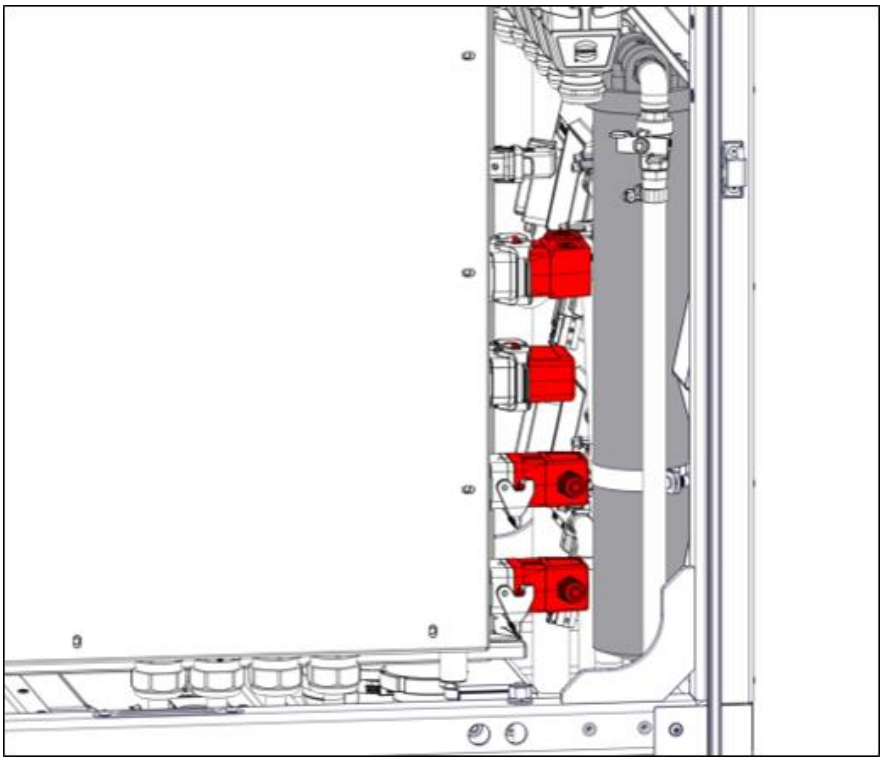


Figure 8-208: overview of connectors in HV panel

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4. To get service access, disconnect all connectors in the low voltage panel.



Figure 8-209: Overview of all connectors in LV panel

5. Shut off the DI filter isolation valves.
6. Install special tool kit (7500211) on the DI filter housing. Start by installing the pipe adaptor and then the plastic pipe into the adaptor.

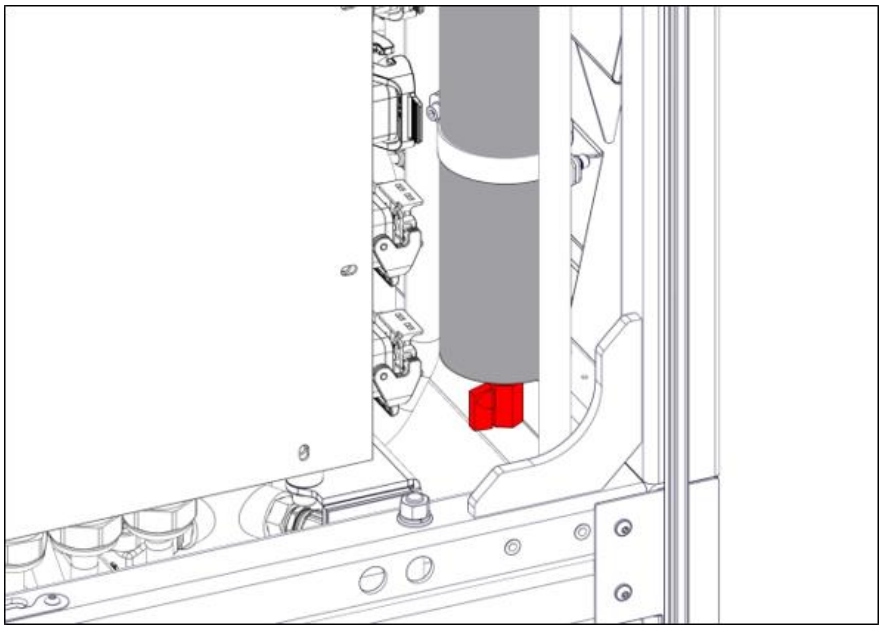


Figure 8-210: Adaptor on the DI filter housing

7. Uninstall 2 pcs. M6 bolts and clamp used for securing the DI filter housing.
8. Remove the DI filter housing nut to release the vacuum in the DI filter housing and drain the DI filter cartridge completely. Then remove the housing.

   Remember to place paper towels below the housing to prevent any spillage.

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9. Shut off the external coolant connection valves to the module.

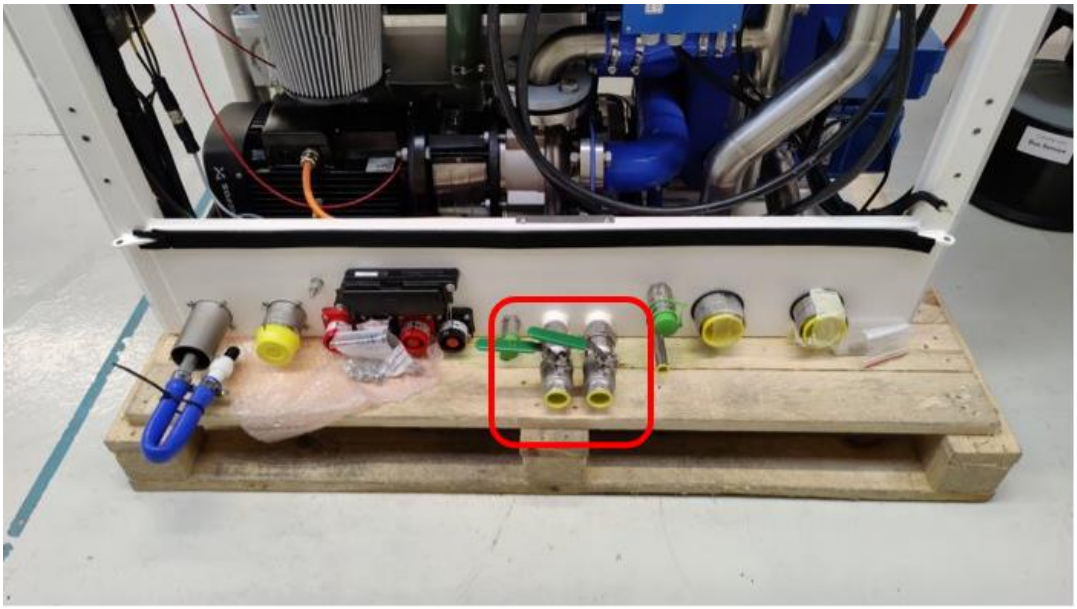


Figure 8-211: External coolant connection valves

10. Open the vent plug deaerator of the coolant loop which is located near the motor controllers.

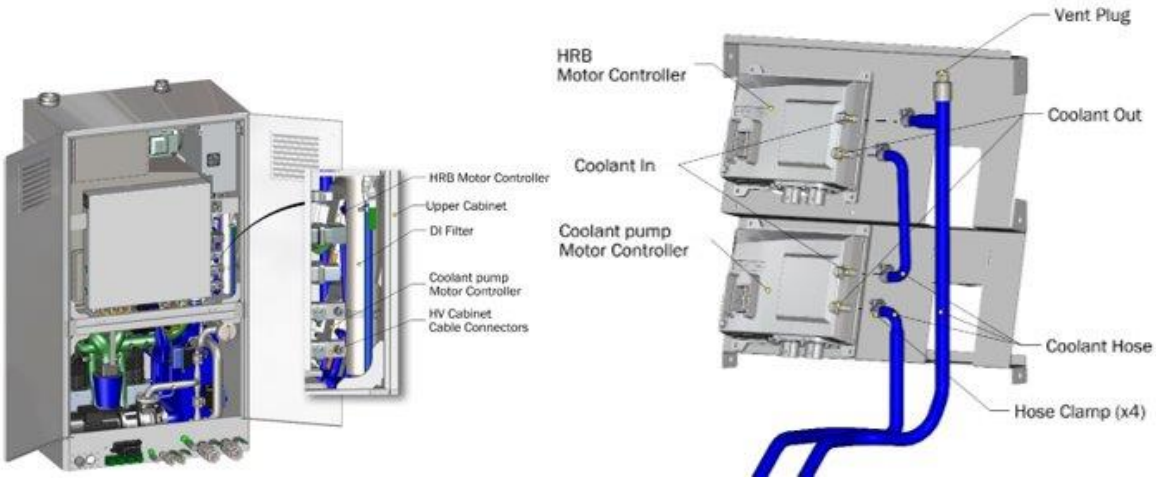


Figure 8-212: Overview of vent plug deaerator

11. Use the drain/fill dry plug, located just left of the external coolant connection valves, and drain the LT coolant system.
12. Release 4 pcs. hose clamps on the LT coolant hoses connected to the motor controllers and remove the hoses.
13. Remove all electronic connections from the HRB motor and the coolant pump controller.

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14. Press the clip to remove both communication port connections (INV_H50 & INV_D10) from the motor controllers.

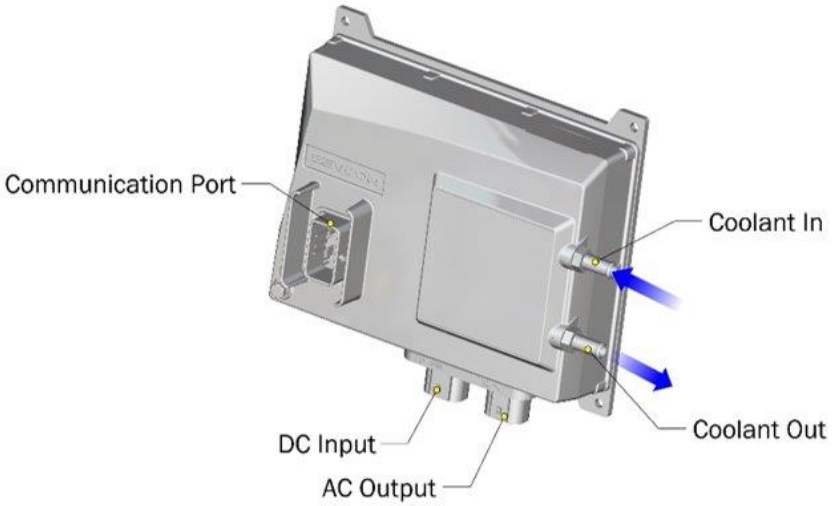


Figure 8-213: Comm port, DC input & AC output on motor controller

15. Press the tab and slide the lock bottom to remove the DC input connector plugs.
16. Press the tab and slide the lock bottom to remove the AC output connector plugs.
17. Remove 4 pcs. M6 studs, washers and nuts used to tighten the controllers to the bracket in the upper cabinet.

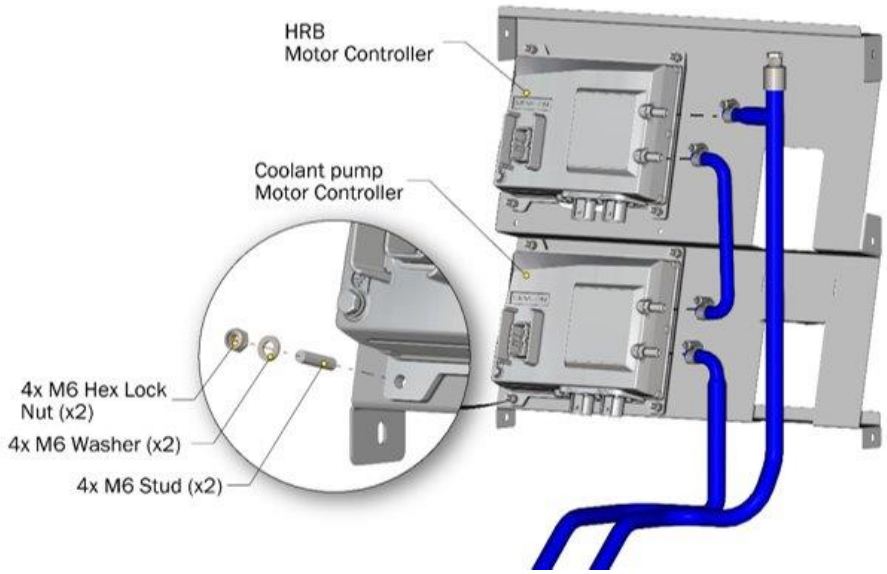


Figure 8-214: Controller studs on bracket

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Assembling procedure:

1. Use new M6 nuts and washers to install the new controllers.
2. Connect the LT cooling hoses and secure with hose clamps. Tighten to 3.5 Nm. Remember to tighten the vent plug.
3. Connect the communication port, the DC and AC cables to the controller.
4. Install the DI filter cartridge. Use the special key to tighten the housing ring.
5. Use 2 pcs. M6 bolts to install the clamp securing the DI filter housing.
   Ensure the drain valve handle is accessible.
6. Open the DI filter isolation valves.
7. Connect the following connectors to the low voltage panel; CN100, CN101, CN300, CN303, CN400.
8. Connect the following connectors to the high voltage panel; CN201, CN202, CN500, CN505.
9. Mount the right-side bracket on the high voltage panel.
10. Use 3 pcs. M8x30 bolts and washers to secure the bracket to the frame.

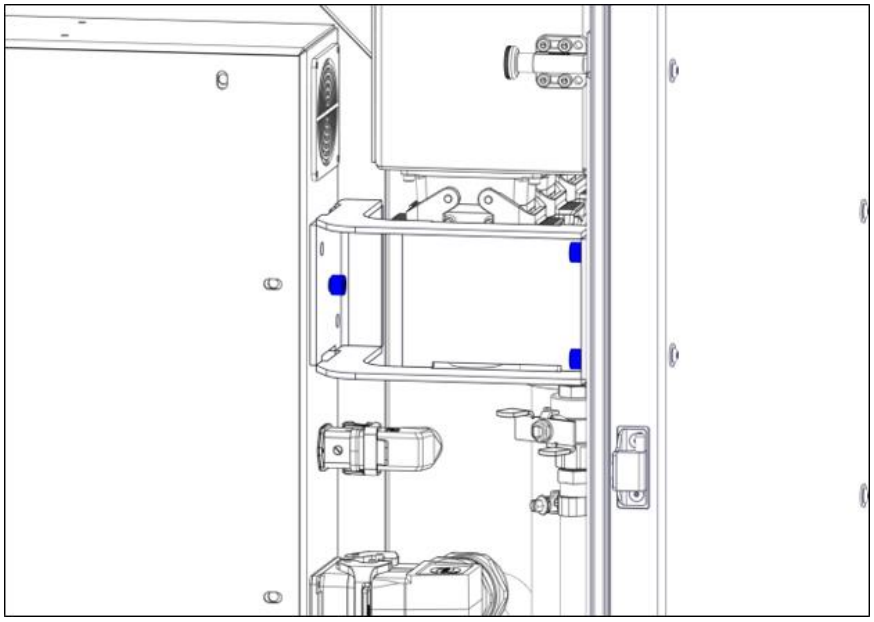


Figure 8-215: Securing bracket to frame

11. Use 12 pcs. M5x10 bolts and washers to install the high voltage panel cover.
12. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
13. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
14. Check and refill (using new coolant) the coolant level. Run the HT cooling system degas procedure. (refer to 8.4.9).
15. Log into the engineering interface with supplied username and password and reset the hour counter for the DI filter cartridge.
16. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.6.5 Replace Air Compressor Controllers

Purpose

The procedure describes how to replace the air compressor controllers for the FCwave module. These controllers have a built-in inverter, cooling channels, and interface connections to energize the air compressor unit.

Responsibilities

Preventive maintenance of the air compressor controllers is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the motor controllers during the life and operation of the FCwave module.

- FRU, Gen3 Air Compressor Inverter 2.0B (part no. 7500360)
- FRU, Inverter 2.0B, Adaptor Cable (part no. 7500361)

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Air Compressor Controllers

Based on the normal conditions, the estimated time for replacement is:

Air Compressor Controllers		
Duration	10 hours	
Personnel	1	
Tightening Torque	M6 bolt	10 ± 0.5 Nm
	M10 nut	50 ± 5 Nm
	Fitting 1/4"	15 ± 0.5 Nm
	Tools	Flathead screwdriver, 5mm hex bit, bent nose pliers, hose clamp pliers, 7mm hex socket flexible screwdriver, wire cutter, 15mm hex socket, clip removal tool, 5mm torx bit

Table 8-32: Time to replace air compressor controllers

Note

Based on the module, the installed inverter will be either 'Inverter 2' or the updated 'Inverter 2.0B'. The disassembling procedure will show/tell the procedure for both, while the assembling procedure will only instruct how to install a new inverter (Inverter 2.0B).

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Disassembling procedure for 'Inverter 2':

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Shut off the external coolant connections valves to the module.
3. Locate the air compressor controllers in the lower cabinet next to the air compressors.

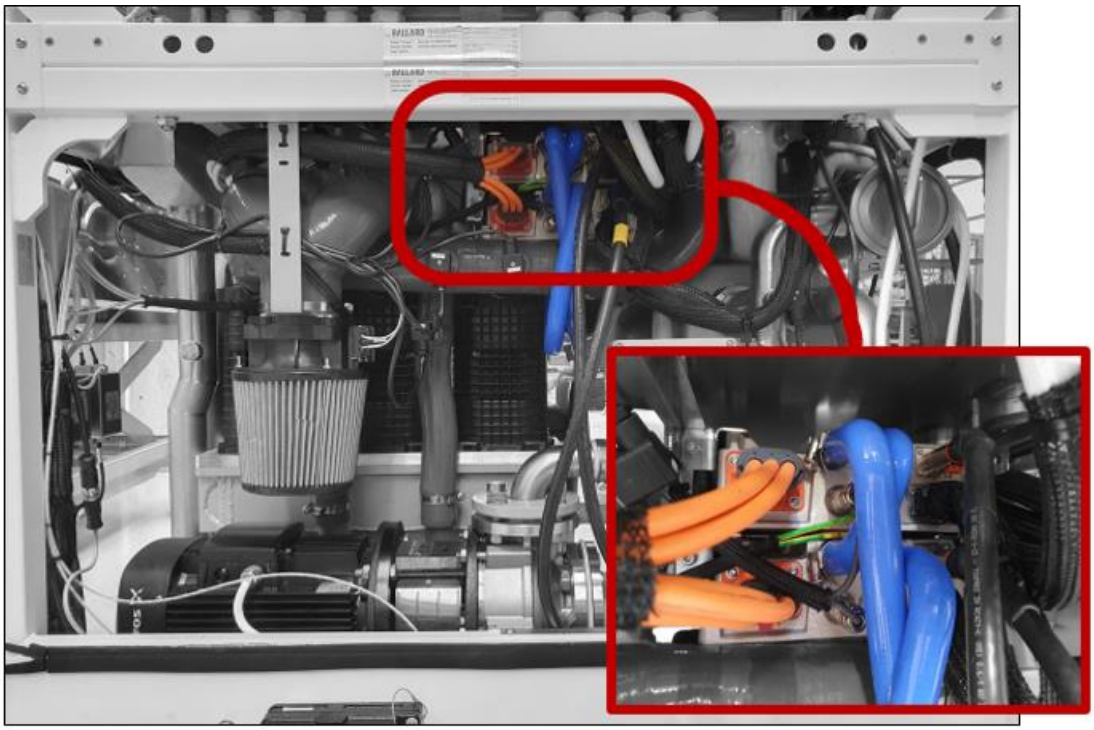


Figure 8-216: Location of air compressor controllers

4. Disconnect the HRNS-400-AC output connector plugs by pulling back and pressing the red clip.

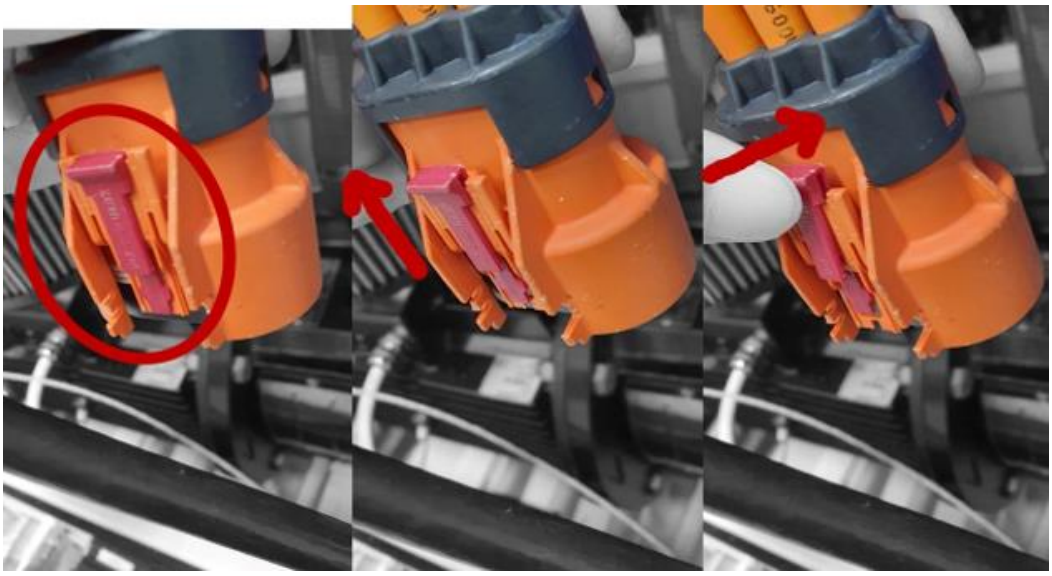


Figure 8-217: Disconnecting the HRNS-400-AC output connector

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5. Use a flathead screwdriver to press the clip away from the connector to disconnect the HRNS-400-CN-INV_A11A and the HRNS-400-CN-INV_A11B plug.
6. Disconnect the HRNS-400-DC Input connector plugs by pushing in and pressing down the orange piece on the clip to uninstall.



Figure 8-218: Disconnecting the HRNS-400-DC input connector

7. Remove the grounding wire terminals.
8. To carefully loosen and remove the air compressor sensor connector plugs, turn the knurled nut with a bent nose pliers.

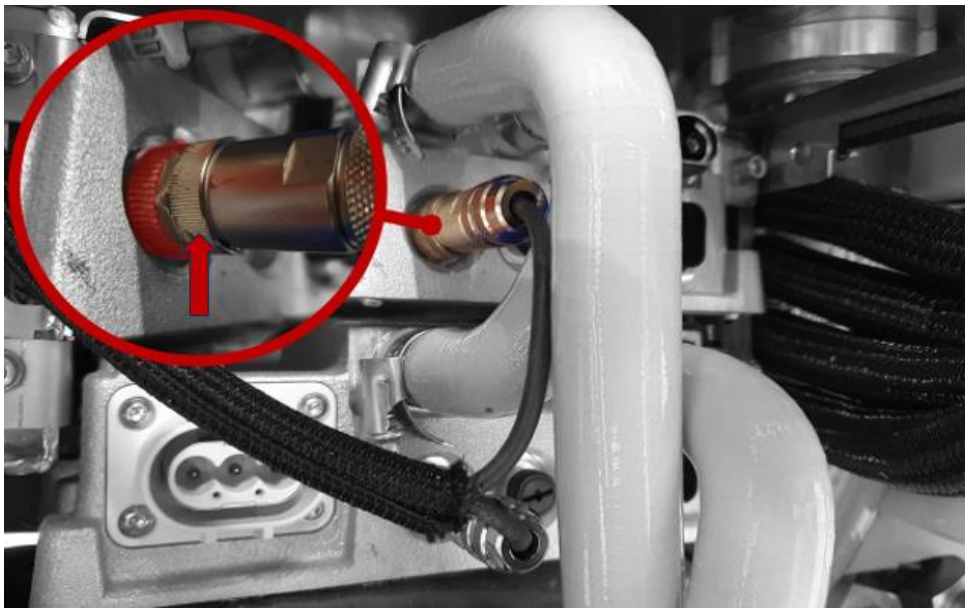


Figure 8-219: Remove air compressor sensor connector plugs

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9. Clamp the LT coolant inlet hose and the LT outlet hose for the two controllers with hose clamp pliers. DO NOT clamp the hose that connects them serially.
10. Release 4 pcs. hose clamps on the LT coolant hoses connected to the compressor controllers and remove the hoses.

    Place an open container below the hoses to collect the coolant and prepare towers to wipe off possible coolant spillage.

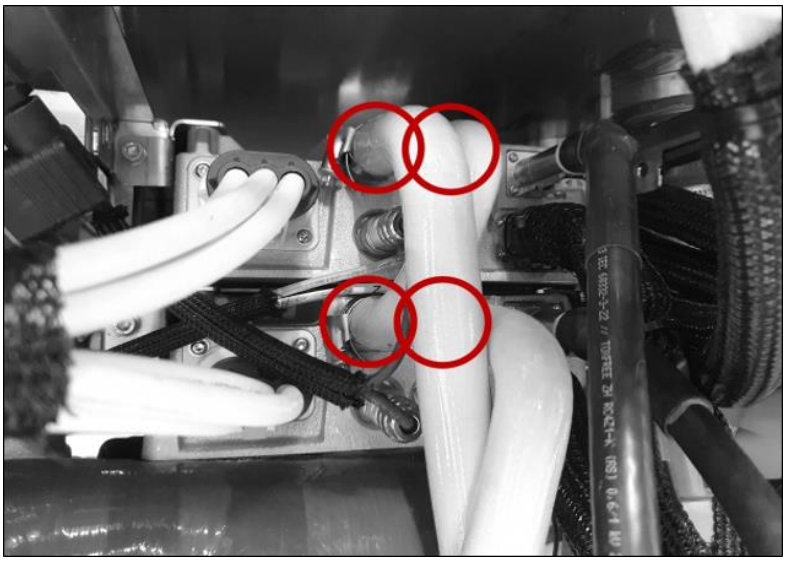


Figure 8-220: Hose clamps on LT coolant hoses

11. In the HV panel, cut the 4 pcs. zip ties for harness B+ and B- connected to the HV contractors on the A2/+ side.

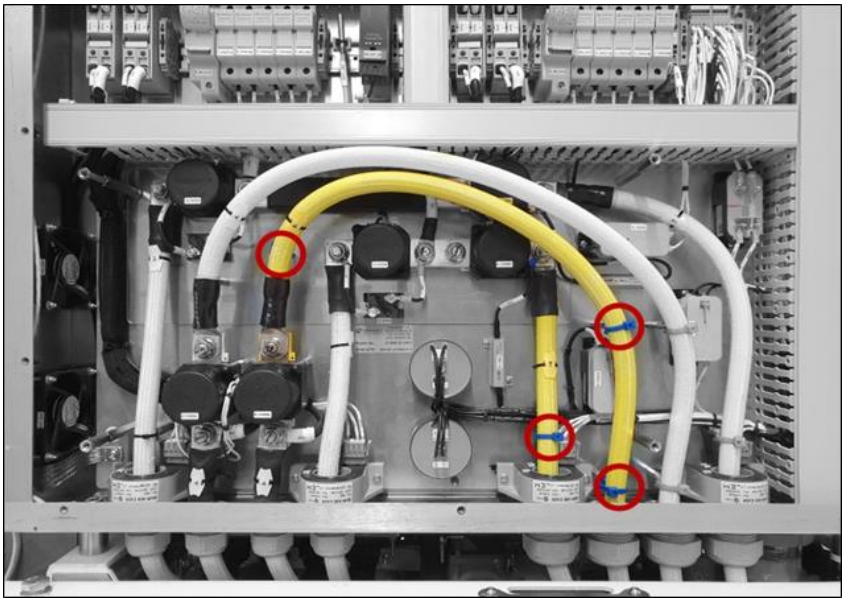


Figure 8-221: Zip ties in the HV panel

12. Uninstall 2 pcs. M10 nuts and remove harness B+ and B- from the HV contactor studs A2/+.

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13. Carefully pull out a bit of the harnesses out of the HV panel, enough to make room for sliding out the air compressor controllers.
14. Support controller B (the bottom one) from below to make sure it does not drop and remove the lower 2 pcs. M6 bolts used to tighten the controller to the bracket in the lower cabinet.

    There might be leftover coolant in the controller.
15. Slide out controller B from the lower cabinet and remove it.
16. Remove the upper 2 pcs. M6 bolts used to tighten the controller to the bracket in the lower cabinet.
17. Remove controller A by pulling it out a little where the bolt head will obstruct the controller. Gently use the clip removal tool to force the bracket around the bolt head.

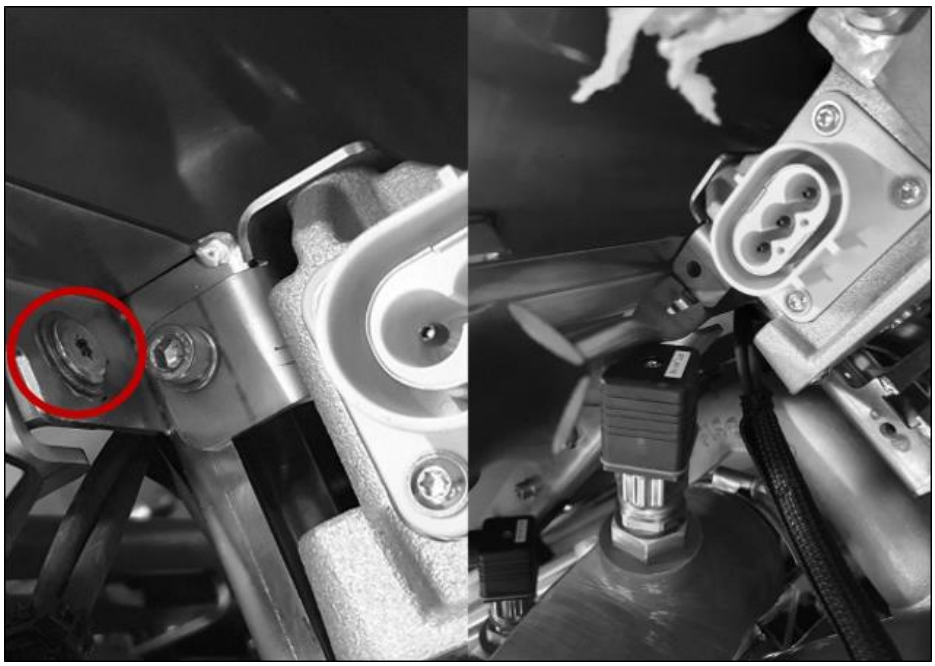


Figure 8-222: Bolt head in the way, removal of A controller

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18. Carefully push up the back of controller A, so the two pins at the rear sits on top of the rails and then slide out the controller.



Figure 8-223: Removal of controller A

19. Remove 12 pcs. M6 bolts used to tighten the left and right mounting bracket to the controller.

Disassembling procedure for 'Inverter 2.0B':

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Shut off the external coolant connections valves to the module.
3. Locate the air compressor controllers in the lower cabinet next to the air compressors.
4. Disconnect the HRNS-400-AC output connector plugs by pulling back and pressing the red clip.

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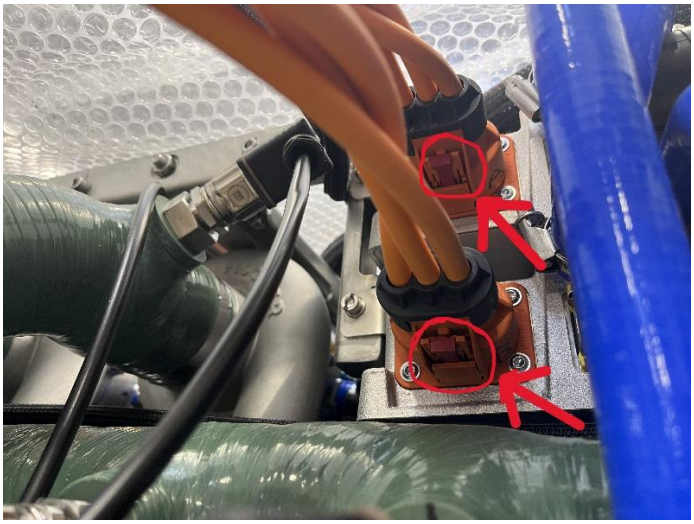


Figure 8-224: Red clip on HRNS-400-AC output connector

5. Disconnect the HRNS-400-DC Input connector plugs from both controller by pushing in and pressing down the orange piece on the clip to uninstall.

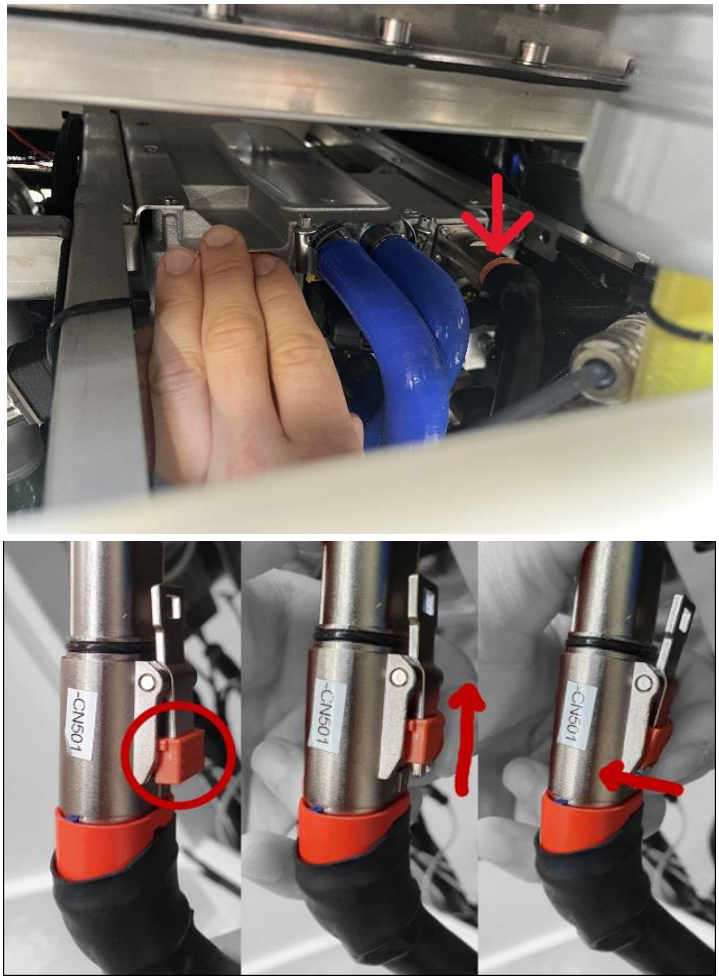


Figure 8-225: Disconnecting the HRNS-400-DC input connector

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6. Use a flathead screwdriver for the connector clip to disconnect the LV and sensor connector (HRNS-400-CN-INV_A11A & HRNS-400-CN-INV_A11B) from the controller.

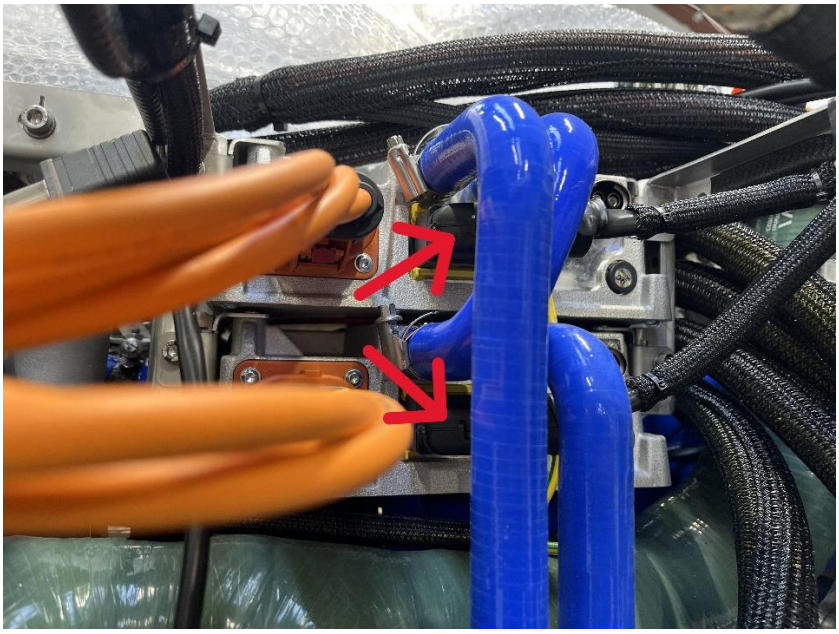


Figure 8-226: Disconnecting the LV and sensor connector plugs

7. Remove the grounding wire terminals.
8. Clamp the LT coolant inlet hose and the LT outlet hose for the two controllers with hose clamp pliers. DO NOT clamp the hose that connects them serially.
9. Release 4 pcs. hose clamps on the LT coolant hoses connected to the compressor controllers and remove the hoses.

   Place an open container below the hoses to collect the coolant and prepare towers to wipe off possible coolant spillage.

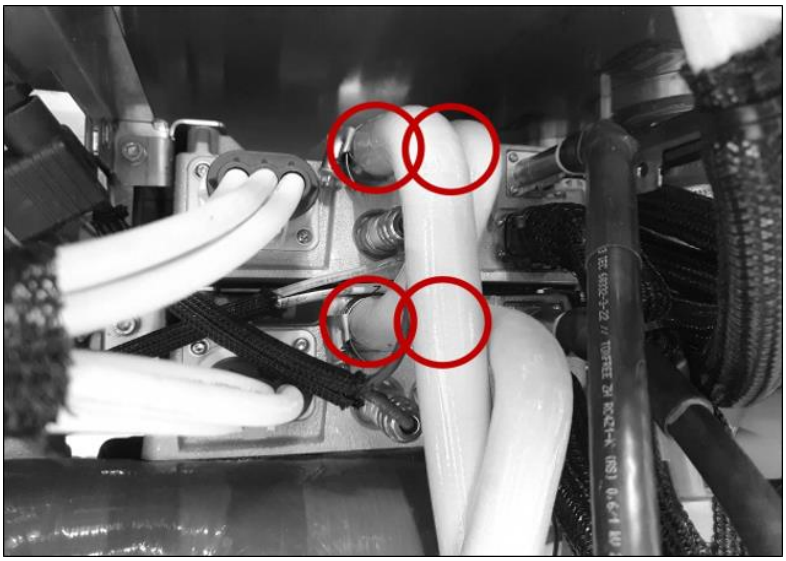


Figure 8-227: Hose clamps on LT coolant hoses

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10. In the HV panel, cut the 4 pcs. zip ties for harness B+ and B- connected to the HV contractors on the A2/+ side.

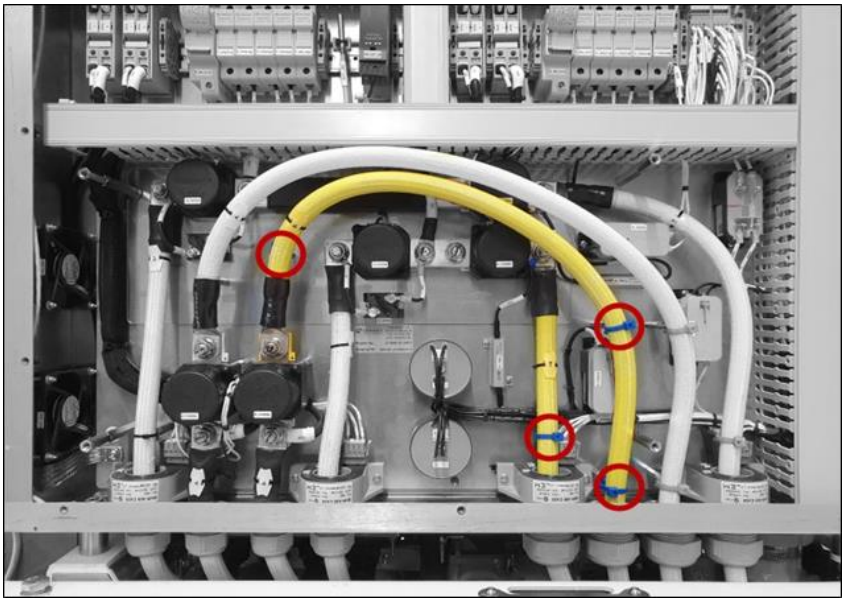


Figure 8-228: Zip ties in the HV panel

11. Uninstall 2 pcs. M10 nuts and remove harness B+ and B- from the HV contactor studs A2/+.
12. Carefully pull out a bit of the harnesses out of the HV panel, enough to make room for sliding out the air compressor controllers.
13. Support controller B (the bottom one) from below to make sure it does not drop and remove the lower 2 pcs. M6 bolts used to tighten the controller to the bracket in the lower cabinet.

    There might be leftover coolant in the controller.
14. Slide out controller B from the lower cabinet and remove it.
15. Remove the upper 2 pcs. M6 bolts used to tighten the controller to the bracket in the lower cabinet.
16. Remove controller A by pulling it out a little where the bolt head will obstruct the controller. Gently use the clip removal tool to force the bracket around the bolt head.

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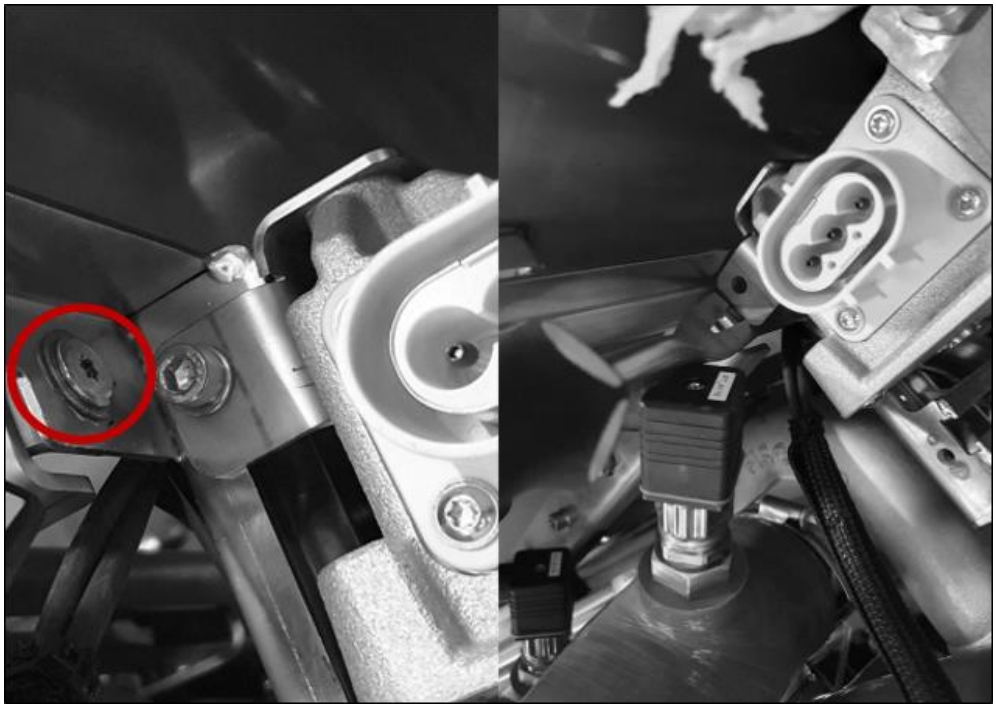


Figure 8-229: Bolt head in the way, removal of A controller

17. Carefully push up the back of controller A, so the two pins at the rear sits on top of the rails and then slide out the controller.



Figure 8-230: Removal of controller A

18. Remove 12 pcs. M6 bolts used to tighten the left and right mounting bracket to the controller.

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Assembling procedure:

1. With the pins facing away from the connector side, use 12 pcs. M6 bolts to install the mounting brackets for the two air compressor controllers.
2. Install controller A, with connectors facing down/out, in the upper slot by inserting it at an angle from below, so the pins sit on top of the rails.
3. Slide in controller A and gently force the bracket around the obstructing bolt head with a clip removal tool. Also ensure that the pins at the rear will fall into place.
4. Install 2 pcs. M6 bolts to tighten the controller to the bracket in the lower cabinet.

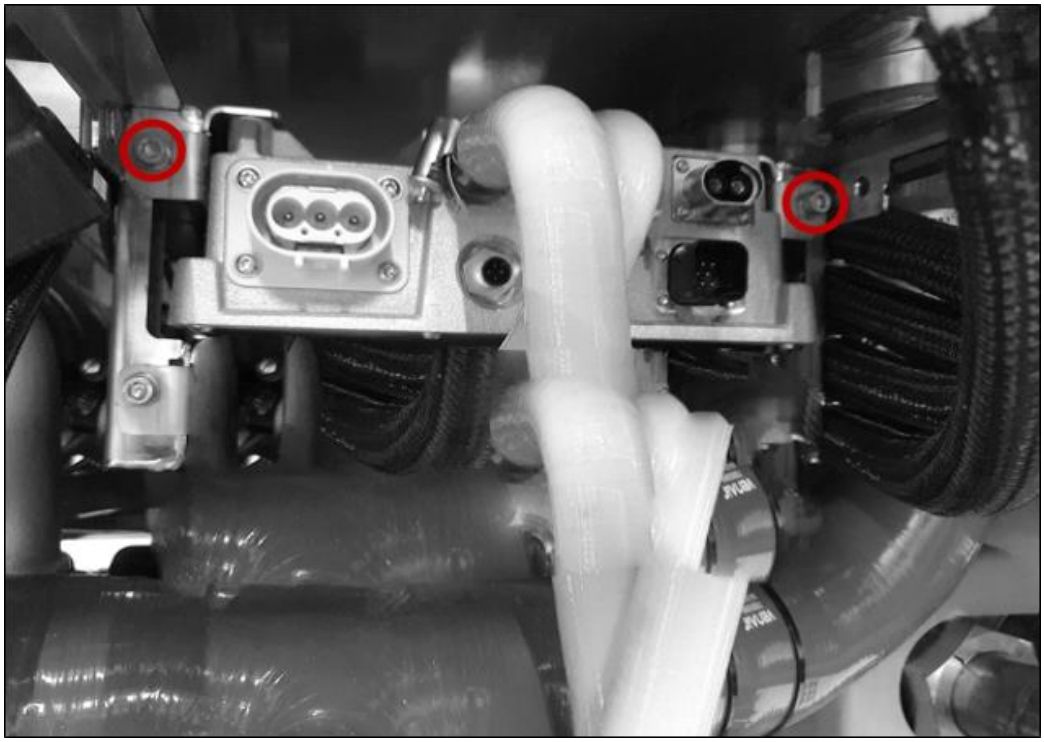


Figure 8-231: Install controller A

5. Slide in controller B in the slot below controller A. Then install 2 pcs. M6 bolts to tighten the controller to the bracket in the lower cabinet.

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6. Install the coolant hoses to the controllers and tighten 4 pcs. hose clamps.

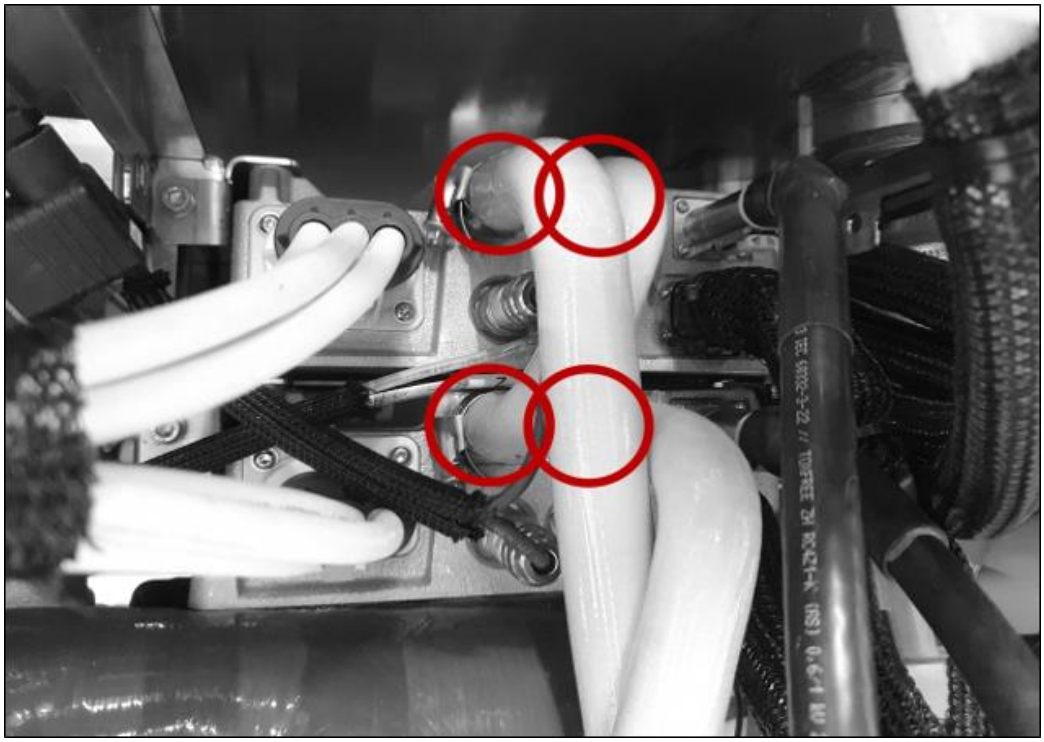


Figure 8-232: Install coolant hoses on controller

7. Install the grounding wire with M6 bolts.
8. Connect the LV and sensor connector plug (HRNS-400-CN-INV_A11A & HRNS-400-CN-INV_A11B) to the controllers.

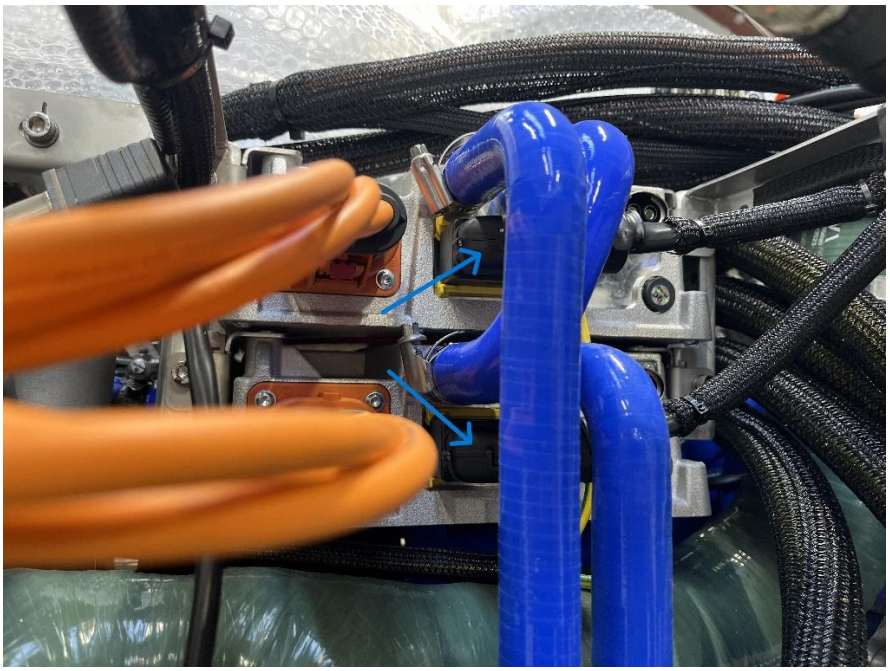


Figure 8-233: Install the LV and sensor connector plugs

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9. In the top right corner of the controllers, install the HRNS-400-DC input connector plugs by pushing in and then press down the orange piece to connect it.

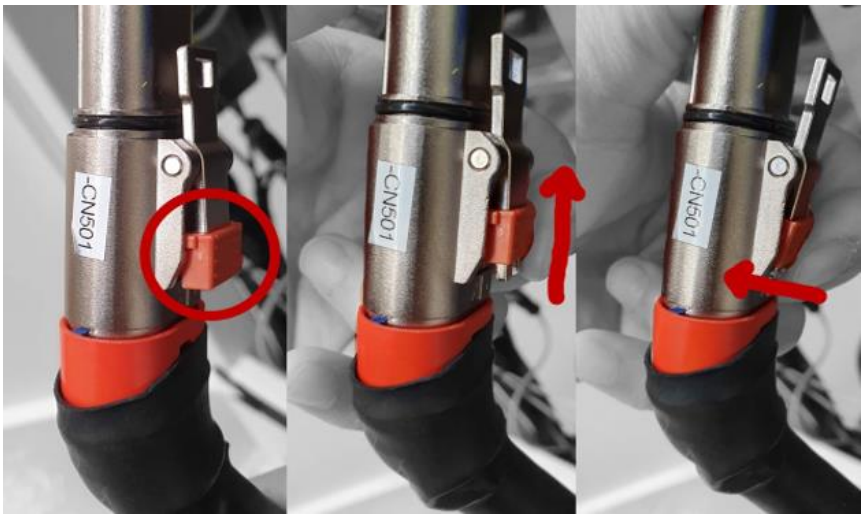


Figure 8-234: Install the HRNS-400-DC plugs

10. Install the HRNS-400-AC output connector plugs by pushing in and press in the red clip to lock the connector.

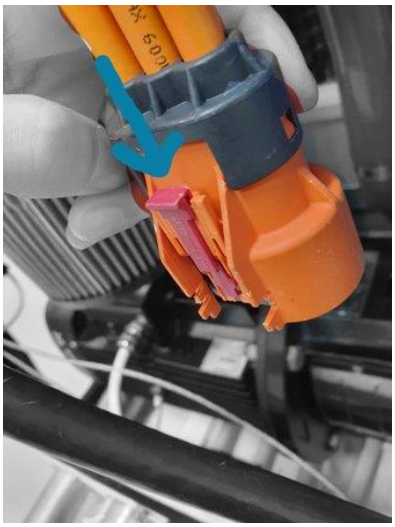


Figure 8-235: Install the HRNS-400-AC plugs

11. In the HV panel, use M10 nuts to install the B+ harness, B- harness and the pre-charge resistor's ring terminal.
12. Tighten the harnesses with 4 pcs. cable ties and cut off excess length.

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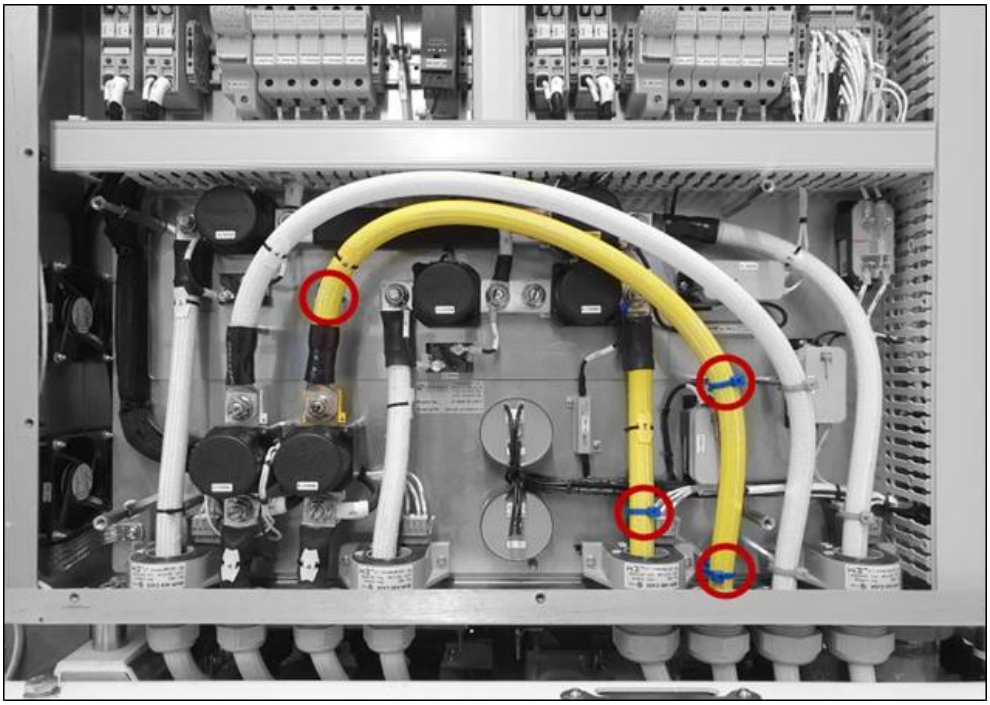


Figure 8-236: Install cable ties on harnesses

13. Use 12 pcs. M5 bolts to install the high voltage panel cover.
14. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
15. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
16. Connect a portable pump secured with mechanical relief valve to the connector, to fill the module with LT coolant as necessary.
17. Open the vent plug deaerator in the coolant loop located near the motor controllers.

    Pay attention to release the 1/4" vent plug slowly to prevent any coolant spillage in the cabinet, while filling procedure and then tighten to specified torque value.
18. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.6.6 Replace Current Transducer

Purpose

The procedure describes how to replace a current transducer for the FCwave module. There are four current transducers installed in the High voltage (HV) panel assembly.

Responsibilities

Preventive maintenance of the current transducer is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the motor controllers during the life and operation of the FCwave module.

- FRU, DHR 400 C420 Current Measurement KIT (part no. 7500115)

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Current Transducer

Based on the normal conditions, the estimated time for replacement is:

Current Transducer		
Duration	1 – 1½ hours	
Personnel	1	
Tightening Torque	M4 bolt	3.5 ± 0.5 Nm
	M10 nut	50 ± 5 Nm
	Tool: 3mm hex key, cross-head screwdriver, cutting pliers, 10mm socket + 15mm socket, torque wrench	

Table 8-33: Time to replace current transducer

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate all 4 current transducers in the high voltage panel.

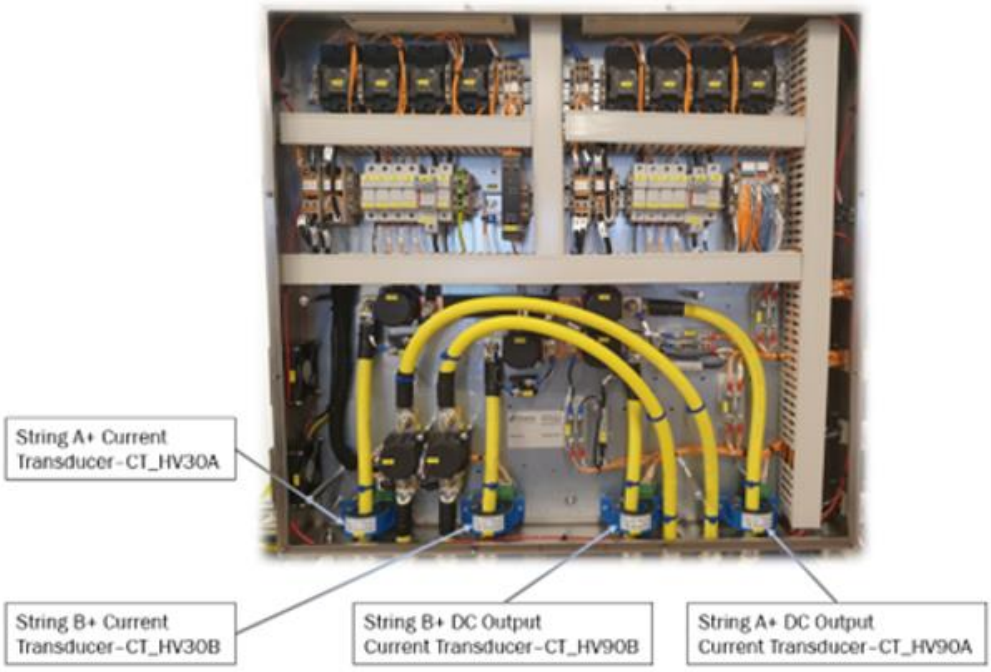


Figure 8-237: Overview of current transducers

As the process is the same for all current transducers, only 1 will be showcased in the following process, replacing 'CT_HV30A' on 'A+ String'.

3. Uninstall the M10 nut of the HV stack contactor K_HV30A connected to the bus bar.
4. Remove the cable ties install on the mounting bracket of the current transducer and loosen 2 pcs. M4 bolts on the mountings.



Figure 8-238: Cable ties on a current transducer

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5. Disconnect the current transducer's connector (CN-CT_HV30A) and remove the current transducer from the high voltage bus bar by sliding it up and out.



Figure 8-239: Current transducer's connector

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Assembling procedure:

1. Slide on the new current transducer and connect to harness HRNS-882.
2. Secure the transducer with 2 pcs M4 bolts. Tighten to 3.5 Nm. Then secure the A+ stack output cable with the M10 nut. Tighten to 25 Nm.
3. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
4. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.6.7 Replace a Voltage Contractor

Due to late changes, this section will be included in the next revision.

8.6.8 Replace a Voltage Transducer

Due to late changes, this section will be included in the next revision.

8.6.9 Replace a Fuse

Due to late changes, this section will be included in the next revision.

8.6.10 Replace a Bleed Down and Precharge Resistor

Due to late changes, this section will be included in the next revision.

8.6.11 Replace a Diode

Due to late changes, this section will be included in the next revision.

8.6.12 Replace an Electrical Panel Ventilation Fan

Due to late changes, this section will be included in the next revision.

8.6.13 Reset a LV Electronic Circuit Breaker

Due to late changes, this section will be included in the next revision.

8.6.14 Replace a HV Panel Assembly

Due to late changes, this section will be included in the next revision.

Parts and equipment

A list of parts and special equipment is identified to replace the motor controllers during the life and operation of the FCwave module.

- FRU, HV Panel (part no. 7500128)

8.6.15 Replace a LV Panel Assembly

Due to late changes, this section will be included in the next revision.

Parts and equipment

A list of parts and special equipment is identified to replace the motor controllers during the life and operation of the FCwave module.

- FRU, LV Panel (part no. 7500130)

8.6.16 Replace a Module Controller Unit (MCU)

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8.7 Cabinet and Customer Interface Sub-system

8.7.1 Replace Intake Air Filter

Purpose

The procedure describes how to check and replace the air filter for the FCwave module. The filters installed on the front panel of the cabinet clean the intake air from NOx, Sox, salts, and other chemicals entering the module.

Responsibilities

Preventive maintenance of the air filters is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the air filters during the life and operation of the FCwave module.

- FRU, Intake Air Filters (part no. 7500162)

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Intake Air Filter

Based on the normal conditions, the estimate time for replacement is:

Intake Air Filter		
Duration	10 – 15 min	
Personnel	1	
Tightening Torque	M6 nut	10 ± 0.5 Nm
	Tool: 5mm hex key, 10mm flex head ratcheting combination wrench	

Table 8-34: Time to replace intake air filter

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-3 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the 2 air intake filter frames on the front panel of the cabinet.
3. Uninstall 8 pcs. M6 nuts used to tighten the filter back frame to the inside of the cabinet doors and remove the filter.

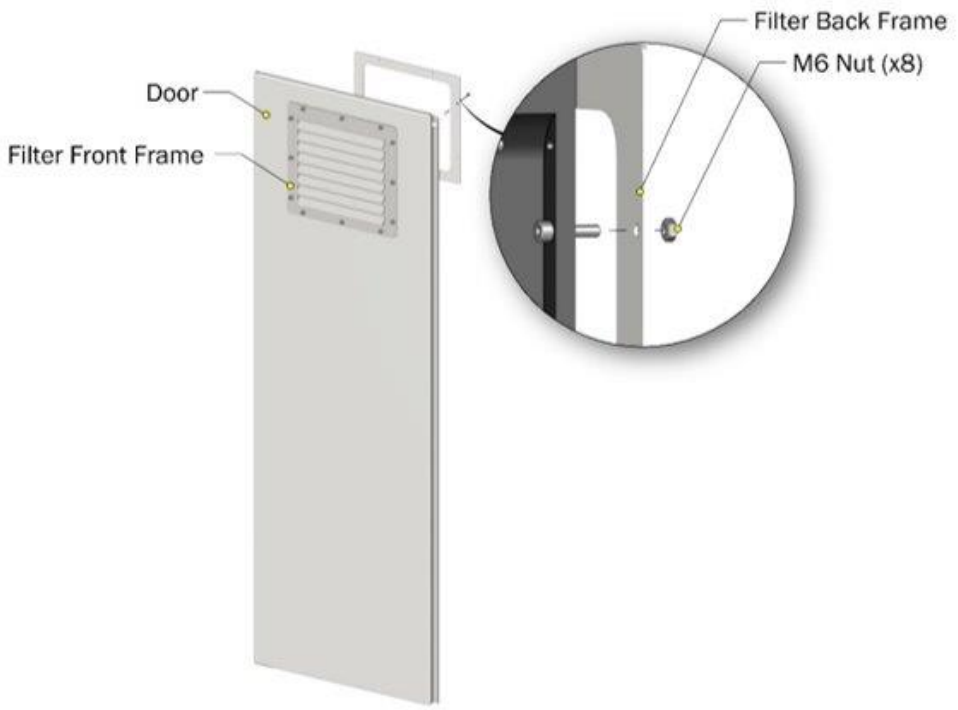


Figure 8-240: Overview air intake filter

4. Examine the air intake filter for cleanliness and check for blockages or unwanted material around it.

Assembling procedure:

1. Use 8 pcs. M6 nuts to tighten the filter back frame to the inside of the cabinet door.
2. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.7.2 Cabinet Water Ingress Sensor

8.7.2.1 Check Cabinet Water Ingress Sensor

Purpose:

The procedure describes how to check a cabinet water ingress sensor in the FCwave™ module. The sensor monitors for water ingress in the cabinet and will trigger a warning alarm when it encounters liquid.

Responsibilities:

Checking the water ingress sensor functionality is necessary for safe operation according to the maintenance plan (refer to the customer portal) or after a replacement. It is the end user's responsibility to do preventive maintenance, as stated in section 8.1.1.

Safety:

Refer to section 8.1.2 to follow the instructions.

Estimated time to check the Cabinet Water Ingress Sensor

Based on the normal conditions, the estimated time for check is:

Cabinet Water Ingress Sensor	
Duration	10 min
Personnel	1
Tools	4mm hex key

Table 8-35: Time to check differential pressure switch

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Procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Connect the low voltage electrical connection (X_E01) and secure it by finger-tightening the bolts.
3. Monitor the MCU engineering interface with the module in "Unlocked" state.

   Make sure there are no active alarms.
4. Mounted in the bottom of the of the cabinet frame, locate the water ingress sensor in front of the heat exchanger.

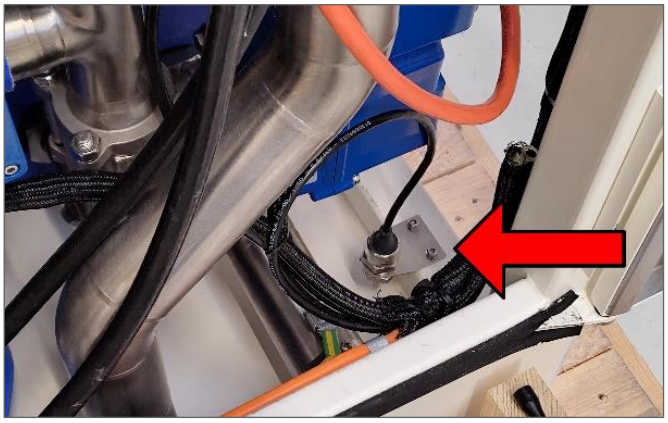


Figure 8-241: Location of water ingress sensor

5. There are 3 different methods to check the sensor. Method A and B avoids disassembly, while method C allows the sensor's electrode to be submerged in a container of liquid. Choose the most suitable.

   Be aware that the high temperature coolant pipes could be hot after a recent system shutdown.

   a) Cover the sensor's electrode as much as possible by hand. The method relies on skin contact and the result can vary depending on coverage area and skin moisture. Wait up to 30 seconds, if there is an alarm, skip to step 6, otherwise try the next method.

   b) Dampen a paper or cloth towel with water and press it against the sensor's electrode, covering as much of it as possible. Wait up to 30 seconds. If there is an alarm, skip to step 6, otherwise try the next method.

   c) Use a 4mm hex to remove 2 pcs. bolts and demount the bracket with the sensor. Cover the sensor's electrode either by hand, a damped towel, or submerge in a container filled with water. Wait up to 30 seconds for the alarm to appear.
6. No matter the method, the alarm should disappear as soon as the sensor's electrode is not in contact with the test medium. Confirm the following warning alarm can be seen in the engineering interface:
   - A1_LSH_Z80_S_10710

   Alarm events are logged and can be found in the "Alarm" tab on the menu to the left side of the engineering interface.

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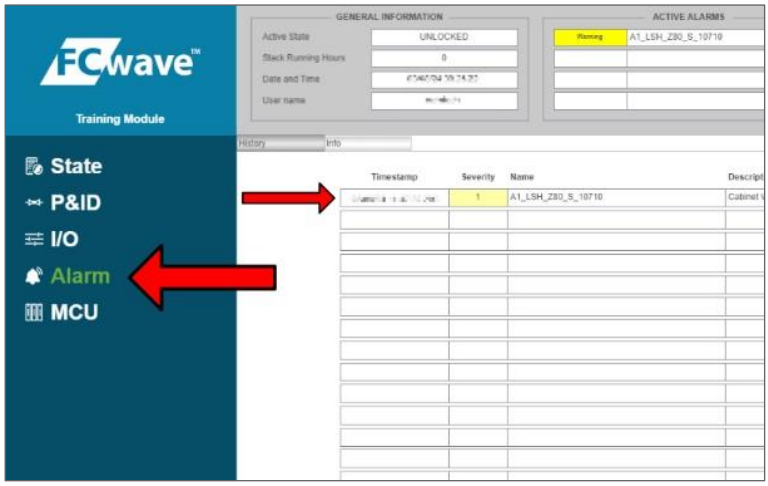


Figure 8-242: Overview alarm water ingress sensor

7. Clean and dry the sensor's electrode. Remount if it was removed.
8. Confirm there are no alarms.
9. The module can be powered down by disconnecting the X_E01 electrical connection and then the module is ready to be restored to normal operating state.
10. Confirm that the module is ready for normal operation and remove local lockout and tagout when work is done.

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8.7.2.2 Replace Cabinet Water Ingress Sensor

Purpose

The procedure describes how to replace the water ingress sensor in the lower cabinet for the FCwave module. The sensor monitors the leakage of water-based liquids like coolants or condensation. The level sensor detects when the water level exceeds the switch point.

Responsibilities

Preventive maintenance of the water ingress sensor is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the water ingress sensor during the life and operation of the FCwave module.

- FRU, Sensor, Cabinet Water Ingress (part no. 7500151)

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Water Ingress Sensor

Based on the normal conditions, the estimated time for replacement is:

Water Ingress Sensor		
Duration	15 – 30 min	
Personnel	1	
Tightening Torque	1/2" sensor fitting	25 ± 0.5 Nm
	Tool: spanner	

Table 8-36: Time to replace water ingress sensor

How to test a level sensor

Inspect the wires, check voltage of the level switch wire with a multimeter set to 20V DC. The level switch must read 24V in presence of water and 0V when there is no water. A poor connection with the signal wire can cause inaccurate readings. Check all wires for any signs of damage and follow the manufacturer instructions.

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Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Mounted on the cabinet frame bracket, disconnect the water ingress sensor connection (HRNS-601-CN_LSH_Z80).

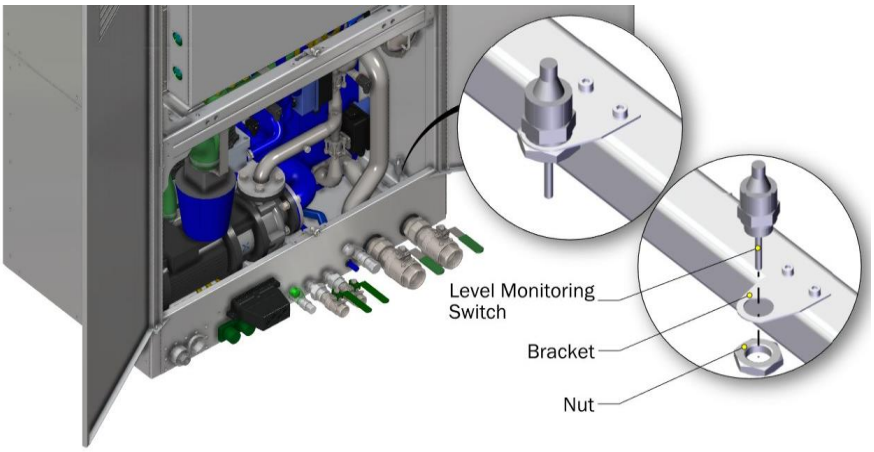


Figure 8-243: Removal of water ingress sensor

3. Use a spanner to remove the sensor.

Assembling procedure:

1. Use a spanner to install the new sensor.
2. Connect the sensor connection and make sure the correct harness is connected by checking the label.
3. Test the new sensor according to the short section just above.
4. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
5. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8 Replace Temperature Sensor

Purpose

The procedures in section 8.8 describe how to replace the temperature sensors for the FCwave module. The module has eight temperature sensors, which measure the temperature of the process air, stack coolant, ventilation outlet, HV panel, and LV panel.

Responsibilities

Preventive maintenance of the temperature sensors is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the temperature sensors during the life and operation of the FCwave module.

- FRU, Sensor, Temperature PT-100, L 50mm, ø 3.5mm (part no. 7500037) x3. For section 8.8.1 + 8.8.2 + 8.8.6
- FRU, Sensor, Temperature PT-100, L 150mm, ø 8mm (part no. 7500090). For section 8.8.3
- FRU, Sensor, Temperature PT-100, L 50mm, ø 8mm (part no. 7500085) x2. For section 8.8.4 + 8.8.5

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Temperature Sensors

Based on the normal conditions, the estimated time for replacement is:

Temperature Sensors		
Duration	5 – 10 min	
	Except for coolant sensors, which requires 1 hour additional time for draining the coolant circuit	
Personnel	1	
Tightening Torque	M5 bolt	6.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	1/2" sensor fittings	25 ± 0.5 Nm
	Tool: 4mm + 5mm + 6mm hex key, 27 mm spanner (x2), crow foot's wrench, cross-head + flathead screwdriver, Phillips bit (PH2), torque wrench, tie cutter, cable ties	

Table 8-37: Time to replace temperature sensors

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8.8.1 Replace the Humidifier Outlet Air Temperature Sensor (TT_A40)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall bolt on the connector TT_A40 to uninstall the temperature sensor.

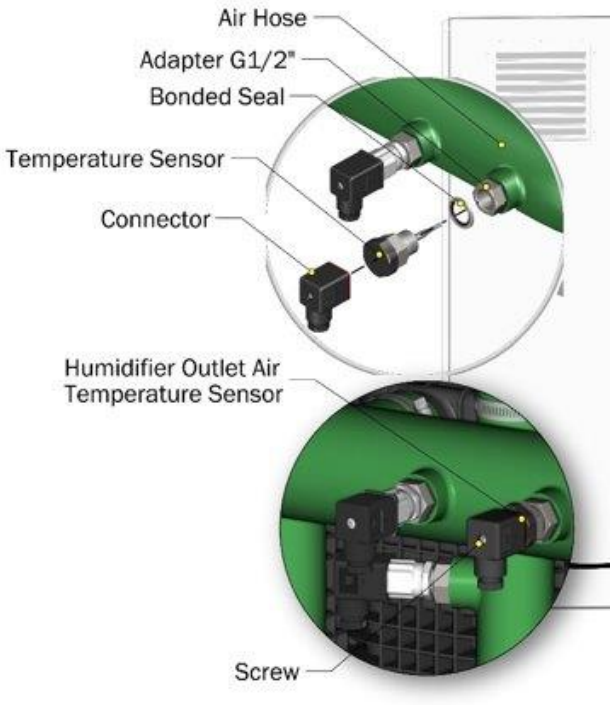


Figure 8-244: Overview of air temperature sensor

3. Uninstall the temperature sensor and the bonded seal washer.

   Remember to use a second spanner for counter turn on the silicon hose fitting to prevent any damage to the threaded insert.

Assembling procedure:

1. Install the new bonded seal washer, insert adaptor G1/2”, and then install the temperature sensor using the bolt. Tighten to 25 Nm.
2. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
3. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.2 Replace the Stack Outlet Air Temperature Sensor (TT_A50)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall bolt on the connector TT_A50 to uninstall the temperature sensor.

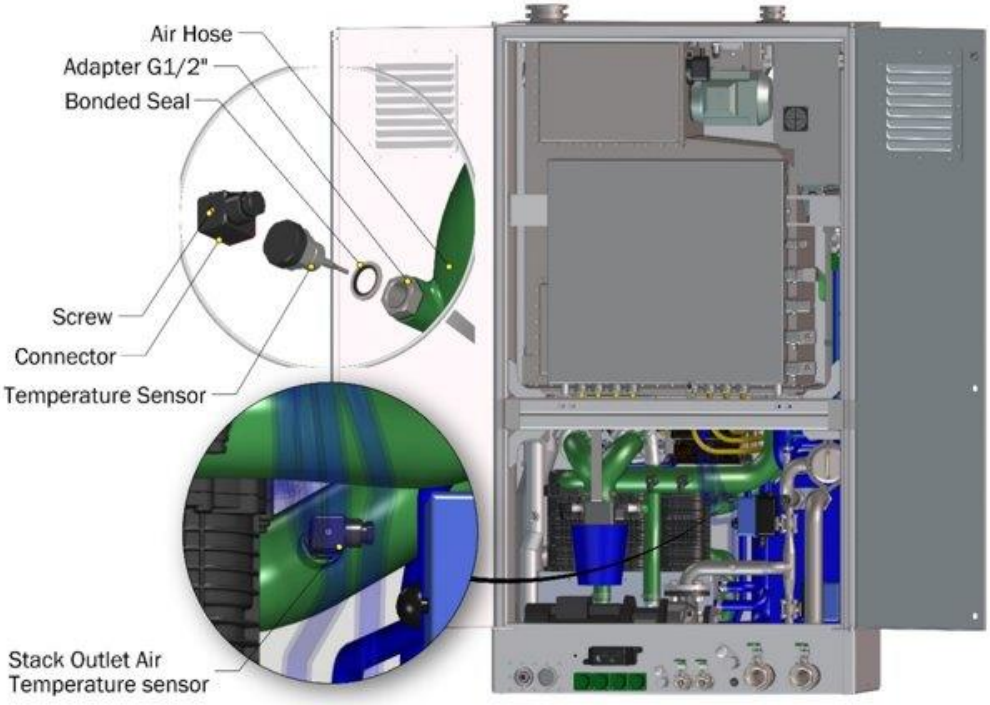


Figure 8-245: Overview of stack outlet temperature sensor

3. Uninstall the temperature sensor and the bonded seal washer.

   Remember to use a second spanner for counter turn on the silicon hose fitting to prevent any damage to the threaded insert.

Assembling procedure:

1. Install the new bonded seal washer and insert the temperature sensor. Tighten to 25 Nm.
2. Install the connector and secure it with the bolt.
3. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
4. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.3 Replace the Heat Exchange Temperature Sensor (TT_D20)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and steps 1-4 of section 6.5.1 (High Voltage safety check before module maintenance).
2. Drain and purge the LT cooling system.
3. Locate TT_D20 temperature sensor on the control valve assembly in the cooling system.

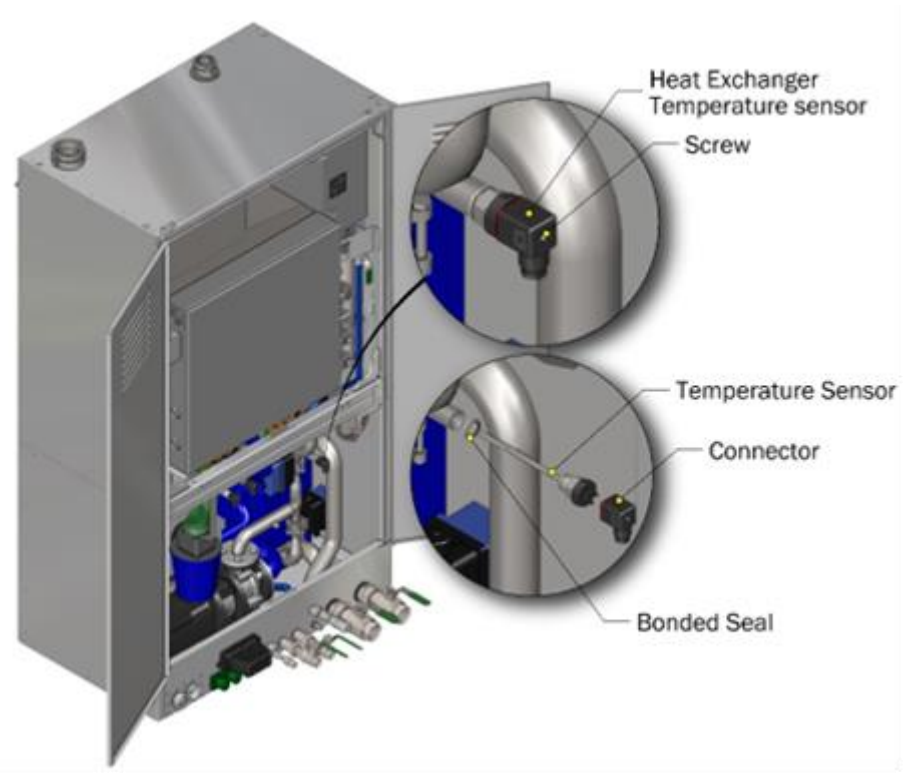


Figure 8-246: Overview of heat exchange temperature sensor

4. Disconnect the HT coolant connections of the module and drain the stack coolant system.
5. Uninstall bolt on the connector TT_D20 to uninstall the temperature sensor.
6. Uninstall the temperature sensor and the bonded seal washer.

   Remember to use a second spanner for counter turn on the silicon hose fitting to prevent any damage to the threaded insert.

Assembling procedure:

1. Install the new bonded seal washer, insert adaptor G1/2”, and then install the temperature sensor using the bolt. Tighten to 25 Nm.
2. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
3. Use the coolant pump to refill the HT coolant system and run the degas procedure (refer to section 8.4.9)
4. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.4 Replace the Coolant-In Temperature Sensor (TT_D40)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain and purge the high temperature cooling system.
3. Locate the coolant-in temperature sensor on the stack coolant inlet hose.

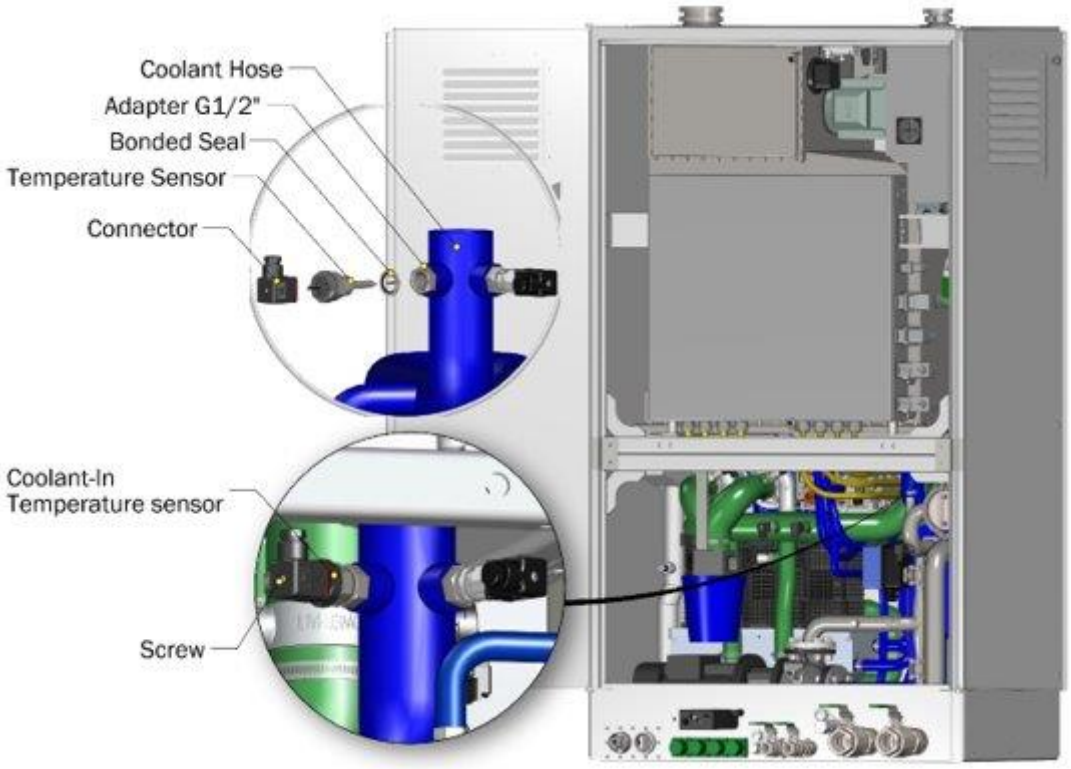


Figure 8-247: Overview of coolant-in temperature sensor

4. Uninstall bolt on the connector TT_D40 to uninstall the temperature sensor.
5. Uninstall the temperature sensor and the bonded seal washer.

   Remember to use a second spanner for counter turn on the silicon hose fitting to prevent any damage to the threaded insert.

Assembling procedure:

1. Install the new bonded seal washer, insert adaptor G1/2”, and then install the temperature sensor using the bolt. Tighten to 25 Nm.
2. Use the coolant pump to refill the HT coolant system.

   Remember to pay attention to the HT coolant tank’s level indicator while refilling.
3. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
4. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
5. Run the degas procedure (refer to section 8.4.9).
6. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.5 Replace the Coolant-Out Temperature Sensor (TT_D50)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain the coolant to a level where the sensor can be removed without coolant spillage.
3. To gain access to the temperature sensor, loosen the hose clamp securing the coolant hose to the inlet fitting and pull down to create space. Keep the hose clamp on the coolant hose for assembling procedure.

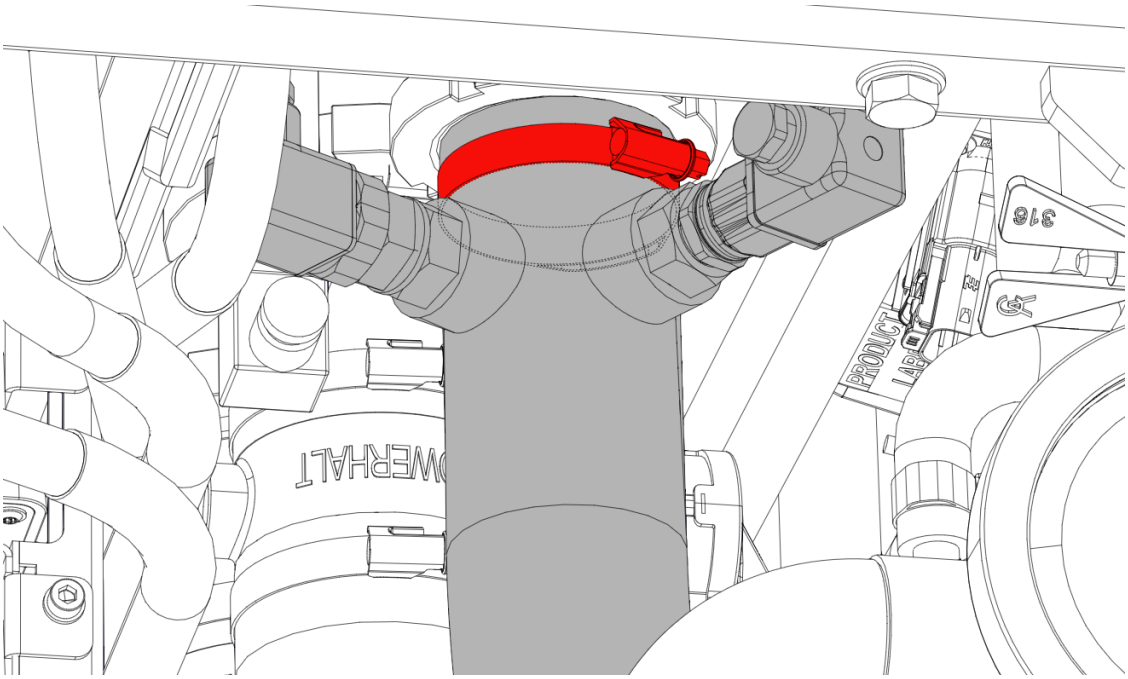


Figure 8-248: Hose clamp on coolant hose to make room

4. Loosen the lower hose clamp securing the air inlet hose to the process inlet valve and pull the hose away to create space. Keep the hose clamp on the hose for assembling procedure.

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5. Disconnect the connector from the air process inlet valve.

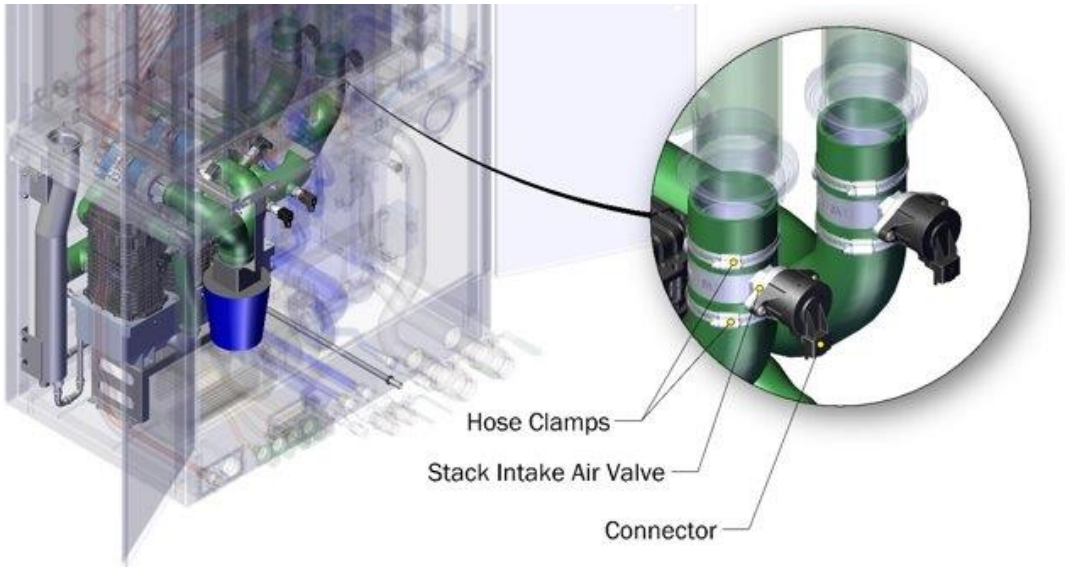


Figure 8-249: Location of air process inlet valve

6. Loosen the upper hose clamp used to secure the process inlet valve to the inlet fitting and pull out the air process inlet valve. Remember to cover all disconnected hoses and open ports with a clean cap or tape and keep the hose clamp on the hose for assembling procedure.

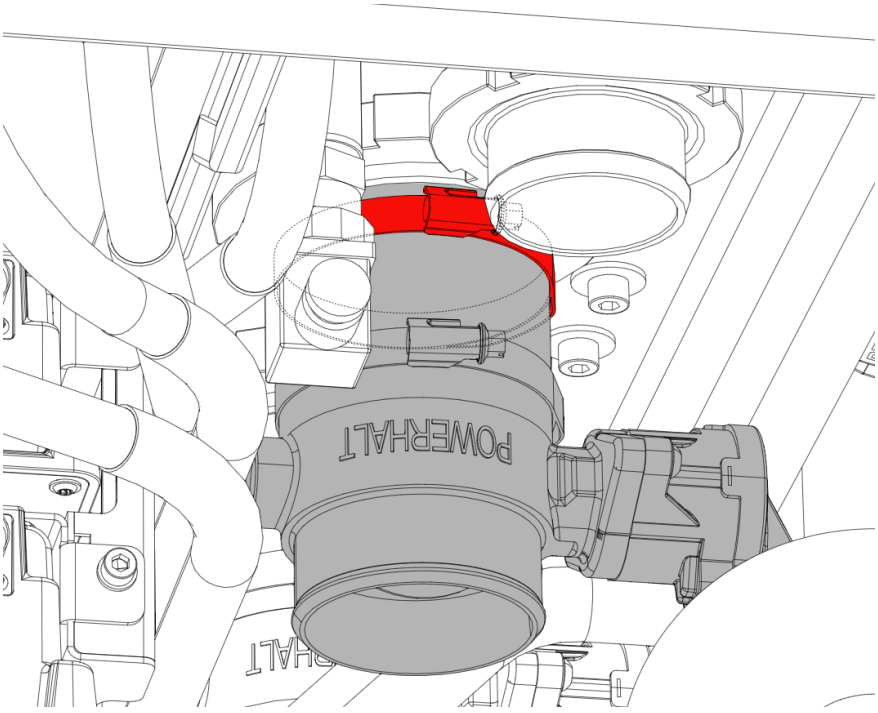


Figure 8-250: Hose clamp on air inlet hose to make room

7. Loosen the lower hose clamp securing the air outlet hose to the process outlet valve and pull the hose away to create space. Keep the hose clamp on the hose for assembling procedure.

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8. Disconnect the connector from the air process outlet valve.

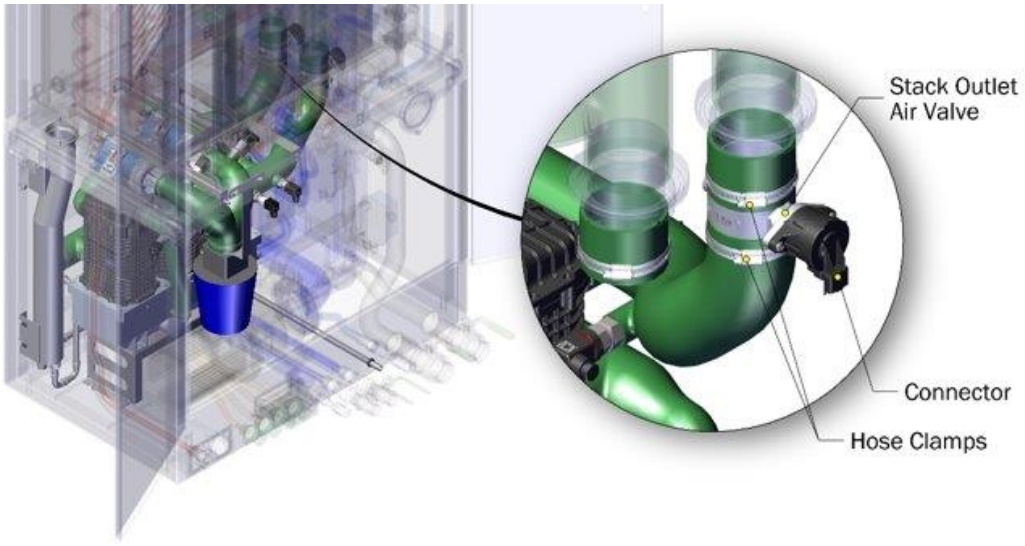


Figure 8-251: Location of air process outlet valve

9. Loosen the upper hose clamp used to secure the process outlet valve to the outlet fitting and pull out the air process outlet valve. Remember to cover all disconnected hoses and open ports with a clean cap or tape and keep the hose clamp on the hose for assembling procedure.

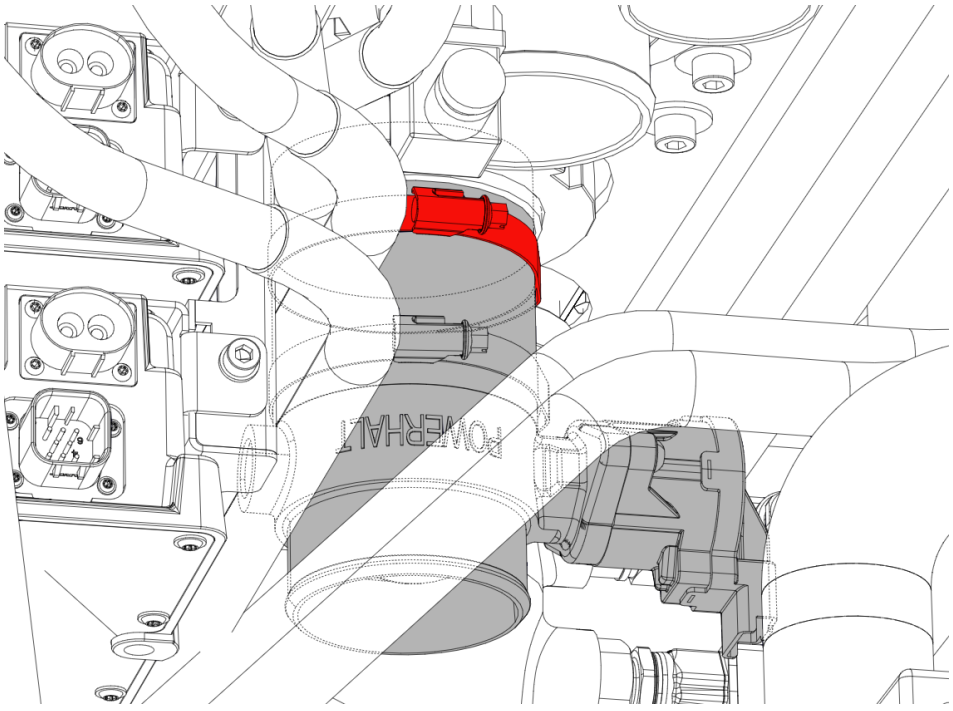


Figure 8-252: Hose clamp on air outlet hose to make room

10. Disconnect the temperature sensor connector (TT_D50).

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11. Remove the temperature sensor. Use a spanner as a contra to not damage the thread connection on the hose.

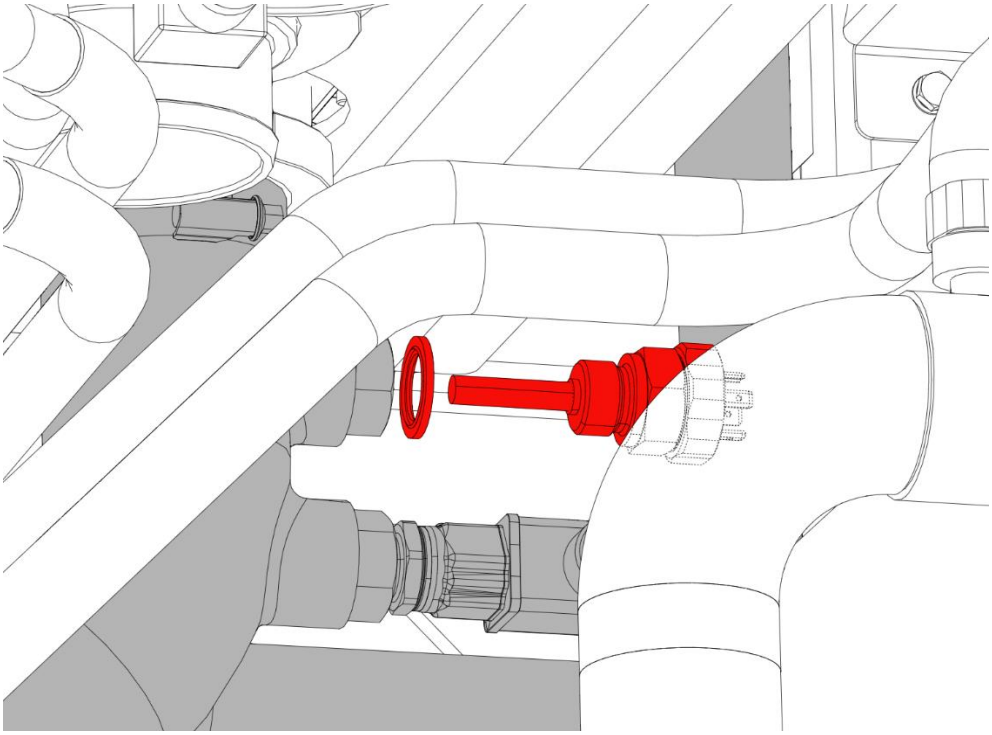


Figure 8-253: Removal of temperature sensor TT_D50

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Assembling procedure:

1. Install new bonded seal washer and lubricate the thread with krytox before installing the new temperature sensor (TT_D50). Tighten to 25 Nm.
2. Connect the TT_D50 connector.
3. Use the hose clamp to secure the air outlet process valve to its fitting. Tighten clamp to 3.5 – 4.5 Nm.
4. Reconnect the FCV_A50 connector to the air process outlet valve.
5. Use the hose clamp to secure the air outlet hose to the process outlet valve. Tighten clamp to 3.5 – 4.5 Nm.
6. Use the hose clamp to secure the air inlet process valve to its fitting. Tighten clamp to 3.5 – 4.5 Nm.
7. Reconnect the FCV_A40 connector to the air process inlet valve.
8. Use the hose clamp to secure the air inlet hose to the process inlet valve. Tighten clamp to 3.5 – 4.5 Nm.
9. Use the hose clamp to secure the coolant hose to its fitting. Tighten clamp to 3.5 – 4.5 Nm.
10. Refill the coolant.
11. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
12. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
13. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
14. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.6 Replace the Ventilation Outlet Temperature Sensor (TT_J30)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall 3 pcs. M8x30 bolts from the top right support bracket of the high voltage panel. Remove the bracket on the right side of the high voltage panel.

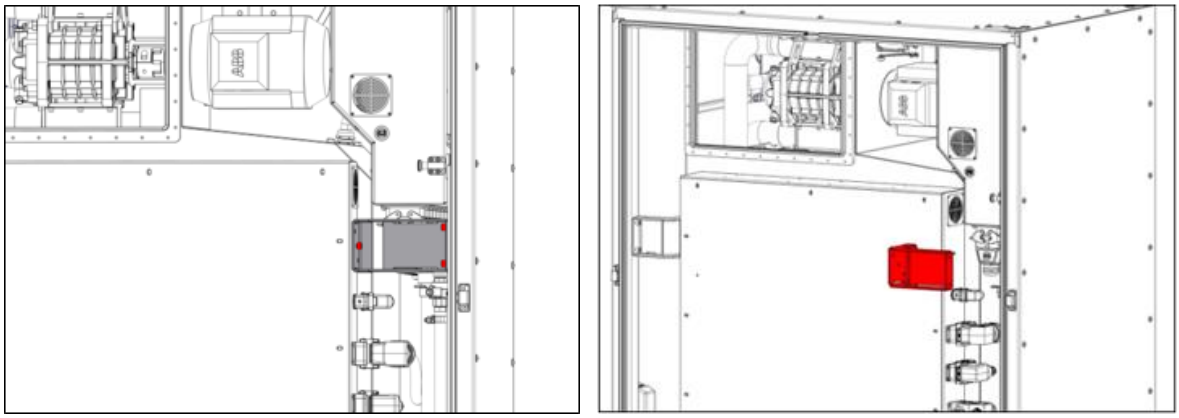


Figure 8-254: Bolts and support bracket in HV panel for TT_J30

3. Loosen the spring-loaded lock pin that locks the low voltage panel assembly to the slide on the mounting bracket.
4. Disconnect all following connectors from the bottom of the low voltage panel: CN400, CN303, CN300, CN101, CN100, CN601, CN600
5. Disconnect the CN201 connector from the side of the high voltage panel.
6. Disconnect the grounding wire from the back of the low voltage panel.
7. Remove the low voltage panel by using the rails to slide out the panel. The spring-loaded locking pin in the back will need to be loosened during the dismantling.

   Make the right precautions is taken as the panel is heavy.
8. Uninstall 4 pcs. bolts and carefully remove the ventilation hatch cover.



Figure 8-255: Ventilation hatch cover dismounting

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9. Disconnect the temperature sensor connector and use a crowfoot for the contra nut and a spanner for the sensor to remove the temperature sensor.



Figure 8-256: Removal of ventilation temperature sensor

Assembling procedure:

1. Install new bonded seal washer and lubricate the thread with krytox before installing the new temperature sensor using the crowfoot on the contra nut and the spanner on the sensor. Install the sensor by hand and re-tighten to 25 Nm.
2. Mount the ventilation hatch. Make sure the hatch slides in between the hooks on top and bottom. Install the sensor by hand and re-tighten to 10 Nm.
3. Connect the temperature sensor connector.
4. Slide in the low voltage panel a little so it is placed steady and stable. Connect the grounding wire.
5. Connect all the following connectors in the low voltage panel: CN400, CN303, CN300, CN101, CN100, CN601, CN600
6. Connect the CN201 connector to the side of the high voltage panel.
7. Use 3 pcs. M8x30 bolts to install the top right support bracket to the high voltage panel.
8. Use 12 pcs M5x10 bolts to install the high voltage panel cover.
9. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
10. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
11. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.7 Replace the High Voltage Panel Temperature Sensor (TT_J50)

To test a new or existing temperature sensor in the high voltage panel temperature sensor (TT_J50), connect the black and the red lead of the meter to the leads from the PT1000 sensor. A typical reading for a temperature sensor on the service interface shows approx. 1078 ohms at 20° C.

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Remove the marked cable rail covers.

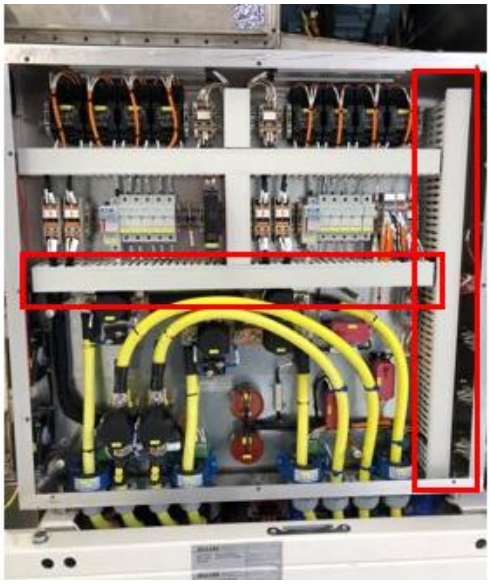


Figure 8-257: Overview of cable rail covers

3. Disconnect the CC-TT_J50 (CN201) connector.
4. Cut the cable tie securing temperature sensor TT_J50.

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5. Use a flathead screwdriver to disconnect the cable from the connector terminal.



Figure 8-258: Cable in connector terminal for TT_J5

6. Remove marked cable from the cable rail.



Figure 8-259: Remove sensor cable from cable rail

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Assembling procedure:

1. Install new temperature sensor TT_J50 with a new cable tie.



Figure 8-260: New sensor cable installed

2. Use a flathead screwdriver to connect TT_J50 cable to the correct terminals.
3. Fit cable back into cable rail and reinstall cable rail covers.
4. Connect CN-TT_J50 (CN201) connector.
5. Use 12 pcs. M5x10 bolts to install high voltage panel cover.
6. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
7. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
8. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.8.8 Replace the Low Voltage Panel Temperature Sensor (TT_J40)

To test a new or existing temperature sensor in the low voltage panel temperature sensor (TT_J40), connect the black and the red lead of the meter to the leads from the PT1000 sensor. A typical reading for a temperature sensor on the service interface shows approx. 1078 ohms at 20° C.

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Uninstall 3 pcs. M8x30 bolts from the top right support bracket of the high voltage panel. Remove the bracket on the right side of the high voltage panel.

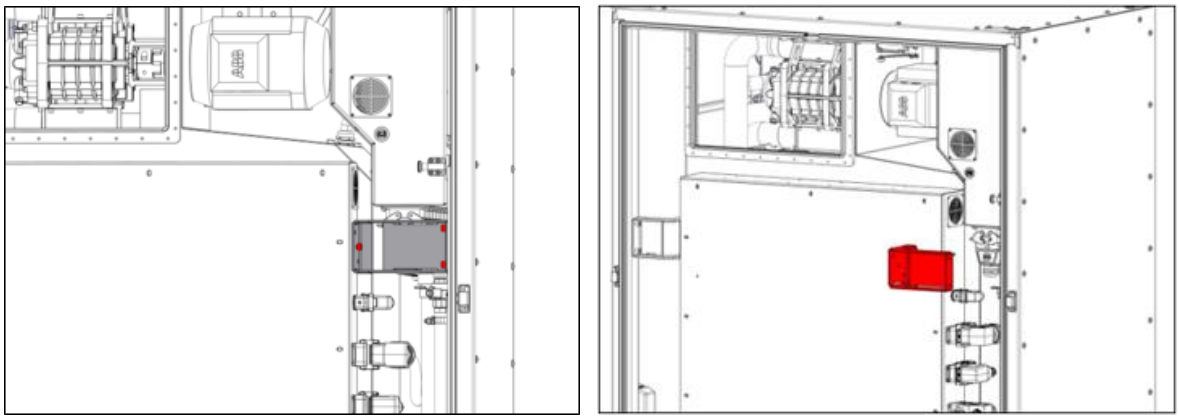


Figure 8-261: Bolts and support bracket in HV panel for TT_J30

3. Loosen the spring-loaded lock pin that locks the low voltage panel assembly to the slide on the mounting bracket.
4. Uninstall 14 pcs. M5 bolts to remove the low voltage panel cover.
5. Cut the cable tie holding the TT_J40.



Figure 8-262: Cable tie holding TT_J40

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6. Disconnect the terminal for the TT_J40 cable.
7. Use a flathead screwdriver to disconnect the cables from the terminal.
8. Remove the temperature sensor and cut the cable ties where needed to remove the cable.

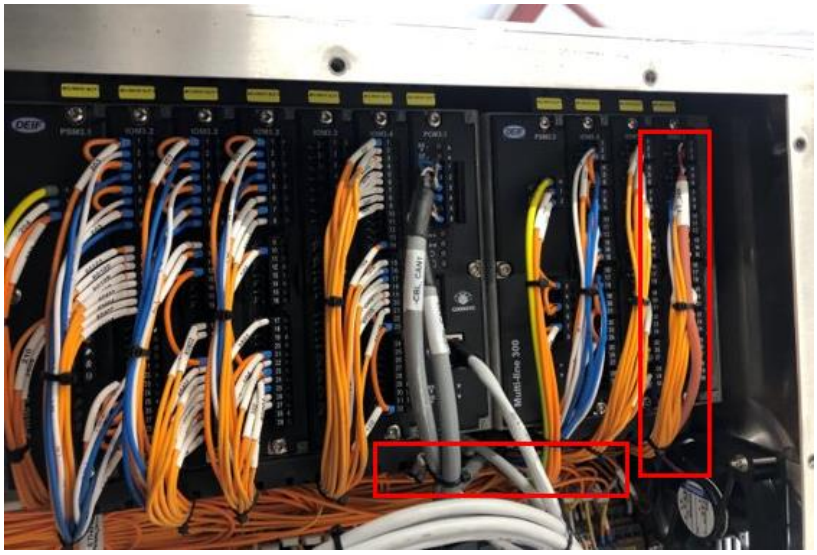


Figure 8-263: Overview of cable ties to be cut

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Assembling procedure:

1. Install the new temperature sensor (TT_J40) with a new cable tie.
2. Use a flathead screwdriver to install the new temperature sensor cables in the terminal.
3. Route the new temperature sensor cable and replace the cable ties that were removed.
4. Install the connector to the unit.



Figure 8-264: Mount connector to unit

5. Use 14 pcs. M5 bolts to install the top plate on the low voltage panel.
6. Carefully slide the low voltage panel halfway into place.
7. Connect all plugs to the low voltage panel from back to front but starting with the grounding cable.

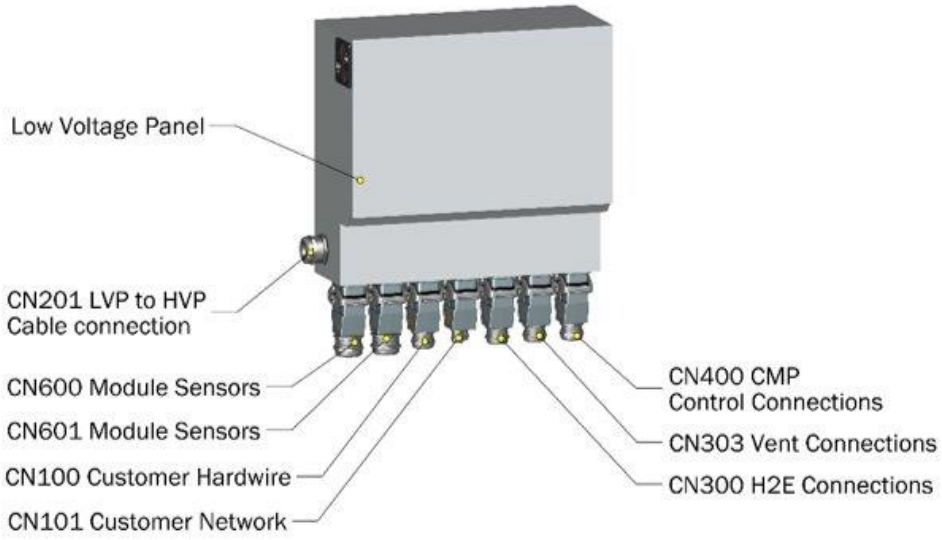


Figure 8-265: Overview of cables installed on LVP

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8. Use 3 pcs. M8 bolts to install the bracket used to secure the right side of the high voltage panel to the module frame.
9. Use 12 pcs. M5x10 bolts to install the high voltage panel cover.
10. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
11. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
12. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9 Replace Pressure Sensors

Purpose

The procedures in section 8.9 describe how to replace the pressure sensors for the FCwave module. The module has eight pressure sensors that are a part of H_2 Fuel anode, oxidant cathode and stack coolant sub-systems.

Responsibilities

Preventive maintenance of the pressure sensors is necessary for safe operation, according to the preventive maintenance plan (see Customer Portal for newest revision of the plan). It is the end user's responsibility to do preventive maintenance, refer to section 8.1.1.

Parts and equipment

A list of parts and special equipment is identified to replace the pressure sensors during the life and operation of the FCwave module.

- FRU, Sensor, Pressure 0-4 bar(g) (part no. 7500016) x6. For section 8.9.2 + 8.9.4 + 8.9.5 + 8.9.6 + 8.9.7.
- FRU, Sensor, Air Compressor Pressure 0-1 bar(g) (part no. 7500058) x2. For section 8.9.3

Safety

Refer to section 8.1.2 to follow the instructions.

Estimated time to replace the Pressure Sensors

Based on the normal conditions, the estimated time for replacement is:

Pressure Sensors		
Duration	5 – 10 min	
	Except for coolant sensors, which requires 1 hour additional time for draining the coolant circuit	
Personnel	1	
Tightening Torque	M5 bolt	6.5 ± 0.5 Nm
	M6 bolt	10 ± 0.5 Nm
	M8 bolt	25 ± 0.5 Nm
	M10 bolt	50 ± 5 Nm
	1/2" sensor fittings	25 ± 0.5 Nm
	Tool: 4mm + 5mm + 6mm + 8mm hex key, 27 mm spanner (x2), cross-head screwdriver, Phillips bit (PH2), torque wrench, krytox	

Table 8-38: Time to replace pressure sensors

Test a Pressure Sensor

It is important to test a new or existing pressure sensor before replacement.

2-Wire Current Pressure Sensor:

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- Connect the +ve terminal of the sensor to the +ve terminal of the power supply
- Connect the -ve terminal of the sensor to the +ve lead on the multimeter
- Connect the –ve lead of the multimeter to the –ve terminal on the power supply

Under no-load conditions, the sensor must produce a current ranging from 4 to 20mA. Refer to the datasheet and verify if the sensor is working within specifications.

8.9.1 Pressure Sensors on the Hydrogen Valve Block

See section 8.2.3 for instructions on how to replace the entire hydrogen valve block which contains the fuel-out pressure sensor. Do not replace only the sensors in the valve block.

8.9.2 Replace the Fuel-Out Pressure Sensor (PT_H50)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Disconnect all connectors (CN201, CN202, CN500, CN505) in the high voltage panel as shown.



Figure 8-266: Overview of connectors in HV panel

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3. Disconnect connection CN205 for fire detection from the side of the high voltage panel.

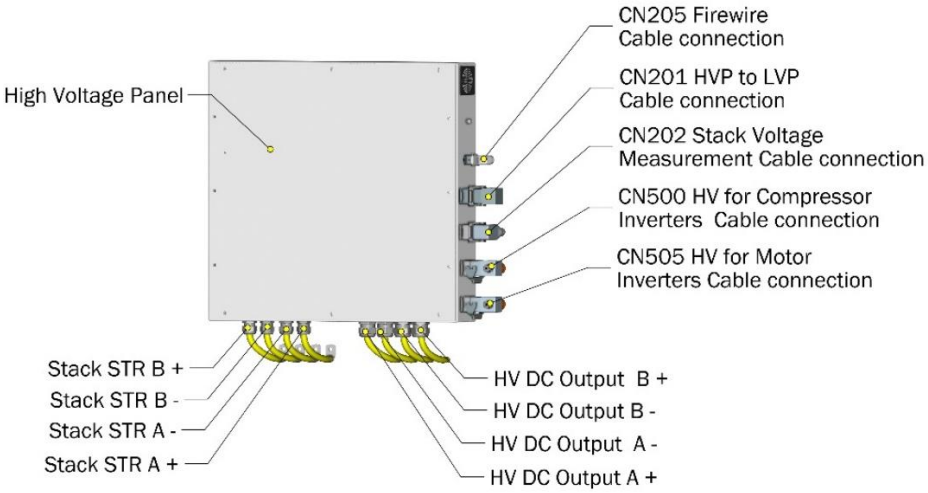


Figure 8-267: Cable connections in HV panel

4. Loosen M32 cable glands to disconnect the HV stack cable connections to positive terminals (A+, B+) and negative terminals (A-, B-).
5. Loosen M32 cable glands to disconnect the HV DC output cable connections to positive terminals (A+, B+) and negative terminals (A-, B-).
6. Uninstall 2 pcs. M10 bolts and washers used to tighten the HV panel assembly to the bottom of upper cabinet.
7. Uninstall 2pcs. M8 bolts and washers used to tighten the HV panel assembly to the sides of upper cabinet.

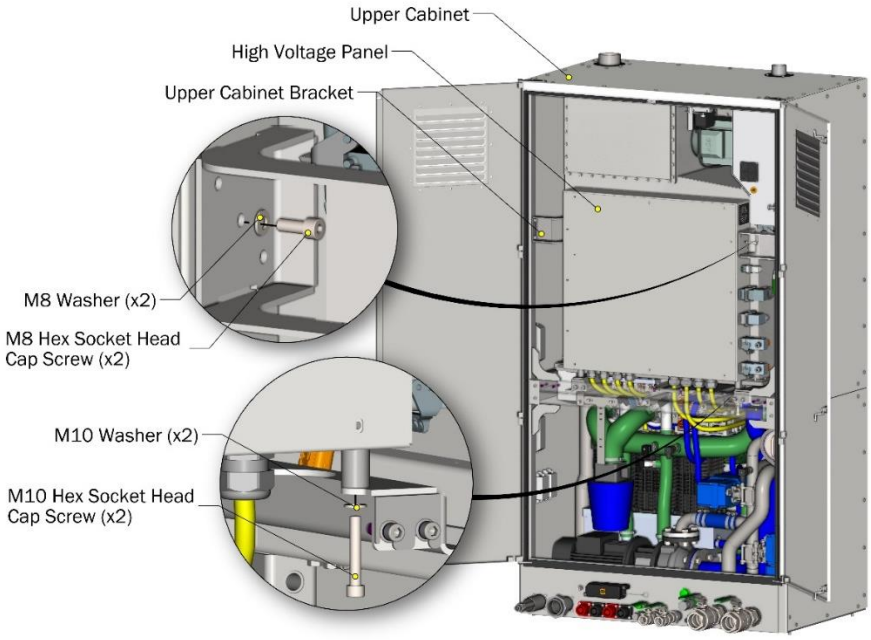


Figure 8-268: Dismount HV panel

8. If applicable, remove the ground fault monitor board.

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9. Install eyebolt on each side of the HV panel and carefully lift the panel assembly, with all its hardware inside, out of the cabinet and move to flat work surface.
10. Uninstall 22 pcs. M6 bolts and washers to remove the purge hatch cover from the H_2 enclosure.

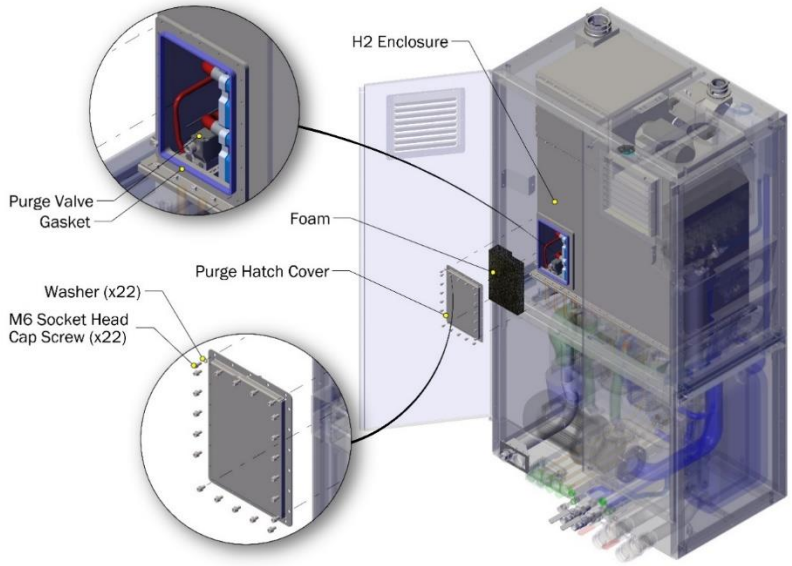


Figure 8-269: Removal of purge hatch cover

11. Remove foam in the enclosure to locate the fuel-out pressure sensor (PT_H50) behind the purge valve.
12. Uninstall the bolt in the connector (HRNS-300-CN_PT_H50) and dismount the pressure sensor.

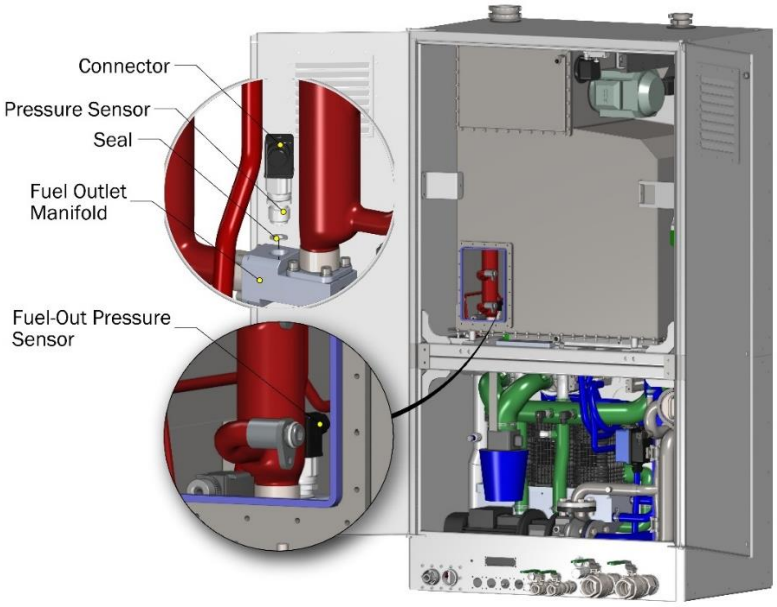


Figure 8-270: Removal of fuel-out pressure sensor

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Assembling procedure:

1. Install new PFTE gasket in the sensor adaptor and install new pressure sensor by hand. Re-tighten to 25 Nm.
2. Use a new bolt to install the connector.
3. Install new foam and use 22 pcs. M6 bolts and washers to install the purge hatch cover to the H_2 enclosure.
4. Reverse steps 8 through 15 of the disassembling procedure to install the HV panel assembly.
5. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
6. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
7. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
8. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9.3 Replace the Dual Inlet Air Pressure Sensors (PT_A11A & PT_A11B)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the pressure sensors (PT_A11A & PTA11B) on the inlet compressor hose and uninstall the bolt in both sensor connectors to dismount the connectors and rubber seals.

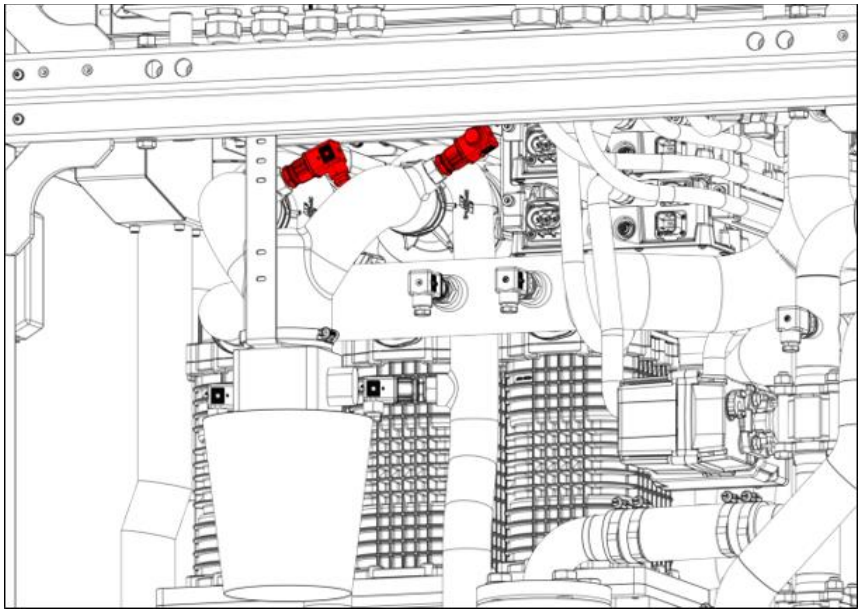


Figure 8-271: Removal of pressure sensors on dual inlet compressor hose

3. Use 2 spanners (1 as counter on the silicon hose fitting to avoid damaging the threaded insert) to uninstall both sensors and PTFE gaskets.

Assembling procedure:

1. Install new PFTE gaskets in both sensor adaptors and install new pressure sensor by hand. Re-tighten to 25 Nm.
2. Connect the sensors to harness CN_600 and mount the rubber seal and the connectors for the sensors.
3. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
4. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9.4 Replace the Dual Outlet Air Pressure Sensors (PT_A12A & PT_A12B)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the connectors for both sensors (PT_A12A & PT_A12B) and disconnect them.

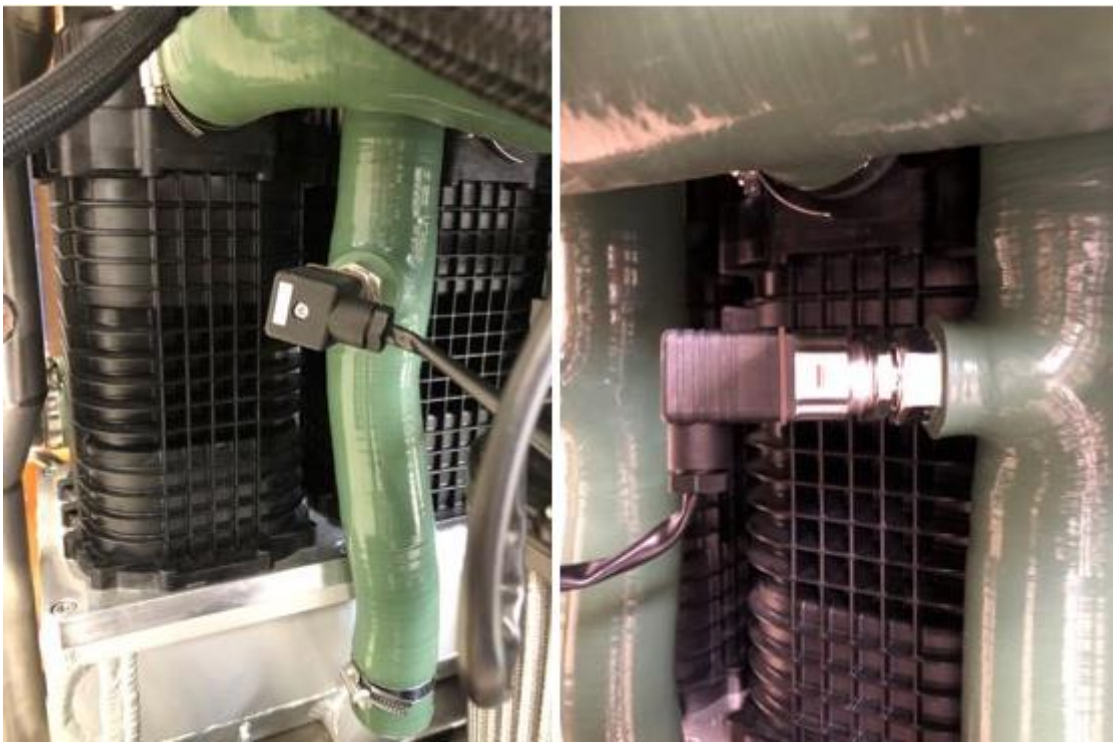


Figure 8-272: Overview of connector sensor for output air

3. Use 2 spanners (1 as counter on the nut to avoid damaging the connection) to uninstall both sensors and remove the PTFE gasket from both sensors.

Assembling procedure:

1. Install new PFTE gaskets in both sensors.
2. Lubricate thread with krytox and install new sensors. Tighten to 25 Nm.
3. Install connectors on sensors.
4. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
5. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
6. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
7. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9.5 Replace the Stack Inlet Air Pressure Sensor (PT_A40)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Locate the PT_A40 pressure transducer and remove the bolt in the connector to uninstall the pressure sensor.

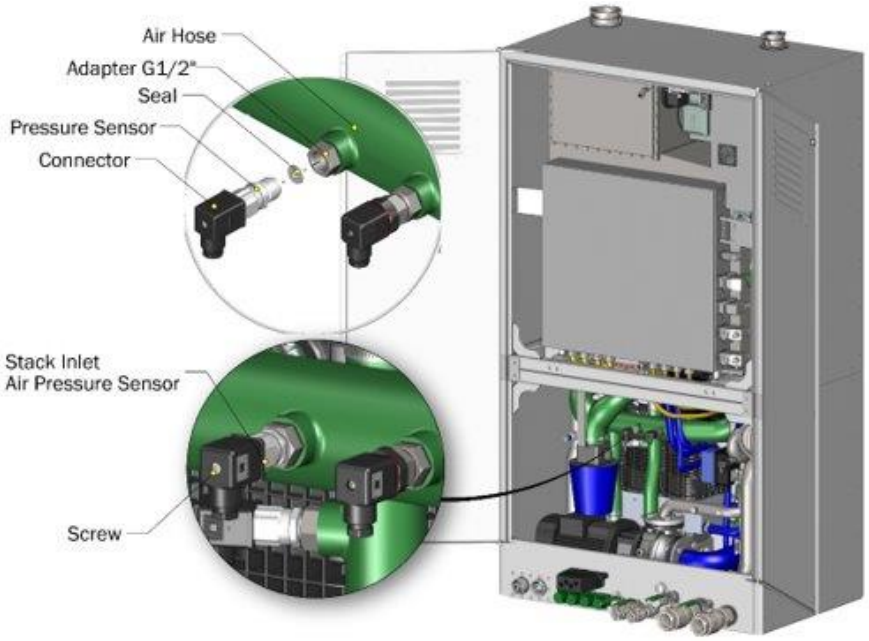


Figure 8-273: Overview of pressure transducer

3. Use a spanner to remove the pressure sensor fitting and use another as counter turn on the silicon hose fitting to avoid any damage to the threaded insert.

Assembling procedure:

1. Apply krytox to the new sensor and install sensor and seal. Tighten to 25 Nm.
2. Use the bolt to install the connector to the sensor.
3. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
4. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
5. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
6. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9.6 Replace the Coolant-In Pressure Sensor (PT_D40)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain the HT cooling system.
3. Locate the PT_D40 pressure sensor on the coolant inlet hose and remove the bolt holding socket to disconnect the socket.

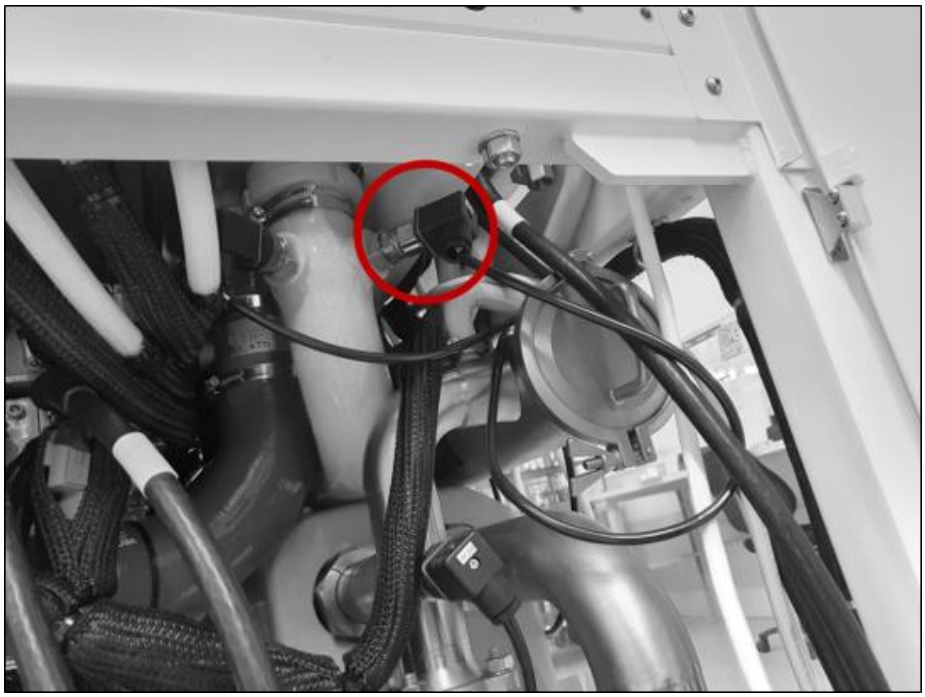


Figure 8-274: Location of PT_D40 pressure sensor

4. Use a spanner to loosen the pressure sensor fitting and use another as counter turn on the silicon hose fitting to avoid any damage to the threaded insert.
5. Remove the pressure sensor, seal washer, and wipe off any leftover grease in the hose fitting.

Assembling procedure:

1. Grease the pressure sensor thread and the new seal washer.
2. Install the new PT_D40 sensor by hand. Use spanner to re-tighten it to 25 Nm.
3. Connect socket to PT_D40 and use the bolt to install it. Check the label to make sure the right harness is connected.
4. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
5. Connect a portable pump, secured with mechanical relief valve, to the connector to fill the module with HT coolant.
6. Ensure the air pockets are vented through the vent valve located on top of the header tank.
7. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
8. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
9. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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8.9.7 Replace the Coolant-Out Pressure Sensor (PT_D50)

Disassembling procedure:

1. Before proceeding with the disassembling procedure, perform all steps in section 7.2.7 (PrepForService feature usage) and 6.5.1 (High Voltage safety check before module maintenance).
2. Drain the HT cooling system.
3. Locate the PT_D50 pressure sensor on the coolant outlet hose and remove the bolt in the connector to dismount the pressure sensor.

   If necessary, release the hose clamp to remove the oxidant outlet fittings to get better access to the sensor.

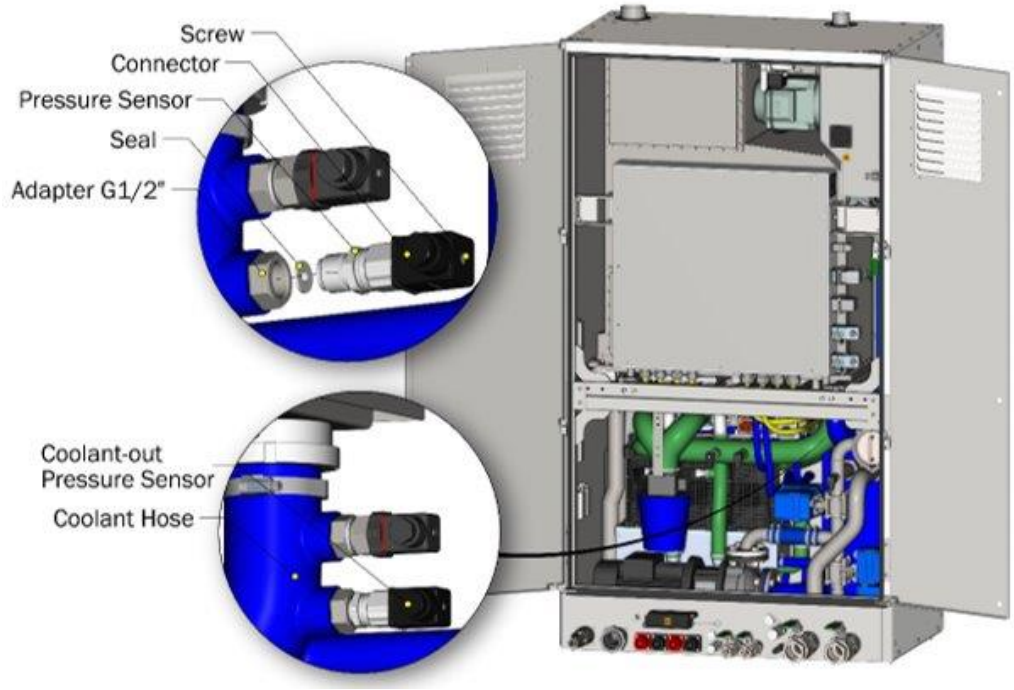


Figure 8-275: Location of PT_D50 pressure sensor

4. Use a spanner to loosen the pressure sensor fitting and use another as counter turn on the silicon hose fitting to avoid any damage to the threaded insert.
5. Remove the pressure sensor, seal washer, and wipe off any leftover grease in the hose fitting.

Assembling procedure:

1. Insert the new pressure sensor and seal in the adaptor. Tighten to 25 Nm.
2. Insert the bolt in the connector and mount the pressure sensor.
3. Use the coolant pump to refill the HT cooling system.
4. Use 12 pcs. M5x10 bolts and install the high voltage panel cover.
5. Insert the high voltage electrical plugs and turn clockwise to install in the front of the module.
6. Use 2 pcs. M6 bolt to install the low voltage electrical connection (X_E01) with attached cables to the module. Tighten to 5 Nm.
7. Run degas procedure for 30-60 min. Refer to 8.4.9.
8. Close the system doors and confirm that the module is ready for power up from the integrator side after maintenance. Remember to remove local lockout and tagout when work is done.

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9.0 Appendices

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10.0 Handling of defective or worn-out components and disposal

Table 10-1: Handling of defective or worn-out components and disposal





The Fuel Cell system is designed to last for many years. When the time comes for the unit to be re-cycled, the unit should be recycled according to national rules and procedures to protect the environment.

- Return faulty part to BPSE for failure analysis, repair, or refurbishment in original packing.

  Every year thousands of fuel cell stacks are recycled. We seek to keep every fuel cell in use for as long as possible.
- Any parts removed during installation or maintenance should be disposed according to any local government regulations.

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Base Load Power Hub (BLPH)

TITLE: Ballard (Fuel Cell) Method Statement

Document Number: K559-2254-CWIWP4202202-J99-009

Rev.	Date	Description	Prepared	Reviewed	Approved
06	06/05/2025	Issue for Review (IFR)	JTA	PBL	KH
05	01/05/2025	Issue for Review (IFR)	RKN	JTA	KH
04	11/04/2025	Issue for Review (IFR)	RKN	JTA	KH
03	16/01/2025	Issue for Review (IFR)	PBL	RKN	KH
02	09/01/2025	Issue for Review (IFR)	PBL	RKN	KH
01	14/12/2024	Issue for Review (IFR)	PBL/RKN	MHA	MHA
00	06/11/2024	Issue for Review (IFR)	PBL/RKN	MHA	MHA

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Revision / Change Log

Rev.	Description
00	Issue for Review (internal only)
01	Updated for Mechanical Completion Dossier (internal only)
02	Added Software Update method statement (Activity 18) & aligned to new schedule (internal only)
03	Updated text on Cooler VFD test (Campaign 3, Activity 3)
04	Updated campaign 4 activities (hot commissioning)
05	Updates campaign 4 (hot commissioning)

HOLDS LIST

No.	Description
1	
2	
3	
4	

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

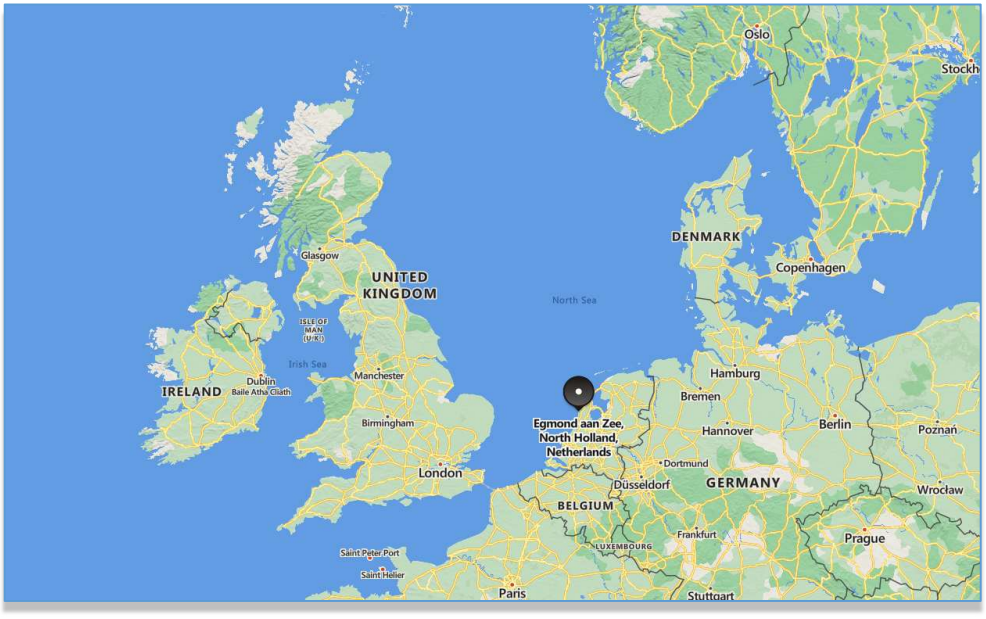


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

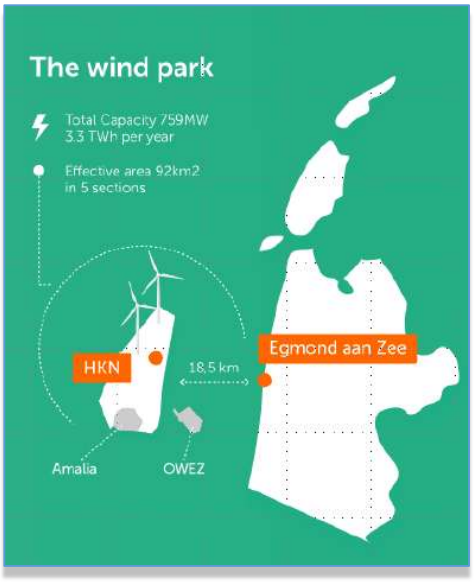


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile is located on coordinates E 590719.1, N 5841602.3 and is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

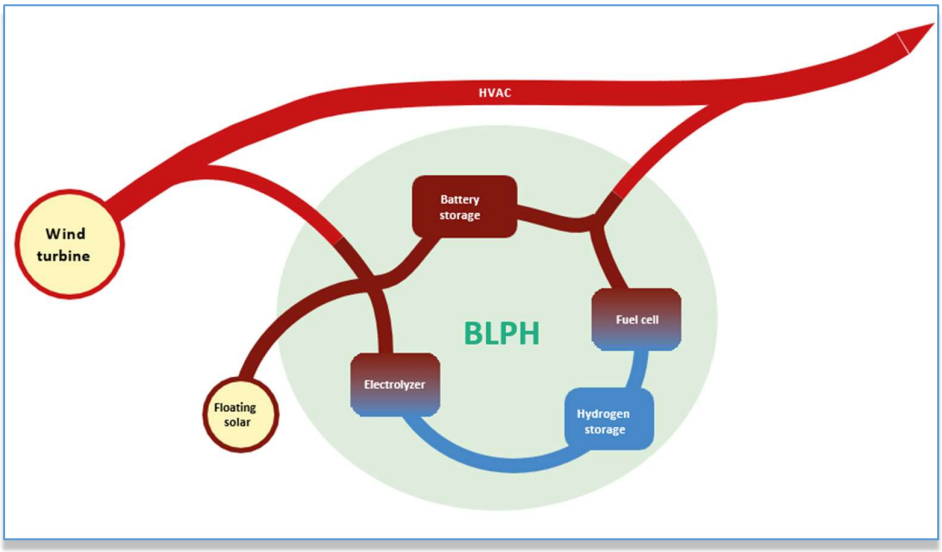


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH is to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

The purpose of this Procedure/Plan is to establish a detailed methodology for carrying out:

All activities at the integration yard.

2.1 REFERENCES

Doc. No.	Description
BLPH-Ballard-Fuel-Cell_Schedule-Update_Oct-2024_Rev007	Latest Ballard Schedule
K559-2254-CWIWP4202202-J99-001-Rev004	Site Acceptance Test (SAT) Procedure

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY)	CrossWind C.V.
CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
PROJECT	HOLLANDSE KUST NOORD WIND PARK Project
VENDOR	Ballard

Table 2 - Definitions and Abbreviations

2.3 LIST OF DRAWINGS

Drawing No.	Description
K559-2254-CWIWP4202202-B01-001Rev009	General Arrangement

2.4 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

Description	Company Doc. Number

2.5 CRITICALITY, KEY RISK AND CONTROLS

The work described in the procedure has been classified as Critical.

All the work must be carried in the vicinity of the Fuel Cell already installed on the platform. The key risk is electrical shock once energisation occurs, and risks associated with the introduction of hydrogen.

Adequate lighting shall be provided.

2.6 ROLES & RESPONSIBILITIES

2.6.1 Company Representative

Responsibilities:

- Management of all resources, equipment / materials and subcontractors mobilized for the execution of the onshore activities;
- Promotes safety & quality to all personnel within his organization;
- Assess project risks and ensure proper mitigation;

2.6.2 Vendor Representative

Responsibilities:

- Implements and issues a comprehensive and supported Progress Reporting System to the Project Manager all the necessary info to be used as a basis for decisions (i.e. Target, Actual & Forecast), to maintain analyses in a proactive manner the possible impacts to contractual key dates on a continuous basis.
- Preparation of project specific templates for Periodical Project Progress Report to Client (Daily)
- Safely execute the work in compliance with all HSE & Quality requirements.

2.6.3 Vendor workers

- Peter Blok Hansen (lead)
- Peter Van Black (lead – CE&I)
- Rasmus Knudsen (lead – Mechanical)
- John Holebæk
- Mikkel Kannegaard

2.7 LIST OF MACHINERIES, TOOLS AND EQUIPMENT

S.No.	DESCRIPTION	QTY
1	General PPE	3
2	Various tools for electrical wiring	1
3	Various tools for mechanical installation	1

4	H2 Sniffer - Sewerin Snooper Mini H2	1
5	Pressure sensor - Fluke 700RG07 500PSIG	1
6	Test gas - Formier gas 5% hydrogen	1
7	Sniffer test station - Sewerin SPE-HG	1
8	Pressure regulator	1
9	Pressure relief valve	1
10	Snoke generator for fire detector test	1
11	H2 test gas for detector test	1
12	Coolant pumping/filling equipment	1
13	CE multitester	1
14	Multimeter	1

- H2 Sniffer - Sewerin Snooper Mini H2, Detection instrument to sniff/locate source of potential leaks.
- Pressure sensor - Fluke 700RG07 500PSIG, measuring device to accurately adjust and monitor gas pressure during leakage test.
- Test gas - Formier gas 5% hydrogen. Test gas for pressurizing pipework where the 5% hydrogen acts as tracer agent for sniffing
- Sniffer test station - Sewerin SPE-HG. Test instrument the emits a reference gas to check the correct function of the Snooper Mini H2 sniffer.
- Pressure regulator, Test gas pressure regulator for pressurizing the DUT.
- Pressure relief valve, Safety valve to ensure safe pipework pressurization during test.

2.8 SEQUENCE OF ACTIVITIES

This method statement has been developed to provide the necessary information and guidelines toensure satisfactory and safe execution at Site.

2.8.1 General Requirements and Site Preparation

- All CONTRACTOR approved AFC drawings, schedule and construction documents (Method Statement andJSA) shall be available and understood by site construction team.
- During the operation in the ups room only qualified personnel shall be allowed.
- Adequate ventilation and lighting shall be provided.
- Identify the working area and barricade with proper signage by company. (Such as Warning,Work in Progress).
- Ensure that all the necessary equipment and tools are approved by CONTRACTOR focal safety/maintenance personnel and are in good condition and safe to use with

current colorcodes and CONTRACTOR stickers.

- All competent direct and indirect manpower shall be available at site.
- Personnel shall be qualified and approved by Company for such job.
- All the doors at nearest roof elevation shall be kept open during the work and shall be properly barricaded for personal entry.
- Keep the work permit in the PTW Bag and display at work booth.
- Entry and Exit register shall be kept ready and ensure to maintain properly.
- Tool box talks with LMRA will be done prior work start.

2.8.2 Mandatory Requirements

ATEX corrections

- No interfaces live (no AUX power, no HV power, no H2 pressurized).

Pre-commissioning

- No interfaces live (no AUX power, no HV power, no H2 pressurized).

Commissioning (Powered)

- Mechanically Complete.
    - ITRs complete.
    - Rosetti drain connection complete.
- Aux Power available.

Commissioning Campaign 2

- Air compressor on platform – coolant system testing.
- Coolant IBCs on platform – coolant system testing.
- Spill pads available. – coolant system testing.
- Formier gas procured – H2 installation leak test.

Commissioning Campaign 3

- Platform communication ready.
- Rosetti test genset setup ready for energisation – 6.6kV.

Commissioning Campaign 4

- Commissioning test setup ready for hydrogen – H2 supply, LB & 6.6kV.
- Rosetti H2 interface connection complete.
- Confirmation from Crosswind ready for SAT.

2.8.3 Sequence of Activities

2.8.3.1 ATEX CORRECTIONS

ACTIVITY 1 – PREPARE CONTAINER FOR ATEX CORRECTIONS

- Remove existing internal drain hoses (40' container).
- Remove collector tank.
- Remove bulkhead plate with drain flange.
- Modify 6x H2 fuel pipe bulkhead entries (enlarge holes for new pipe glands).

ACTIVITY 2 – NEW DRAIN INSTALLATION

Note once this activity is complete CONTRACTOR are to complete the drainpipe interface connection.

- Install new collector box assembly.
- Install and route 6x SS pipes from FC wave to collector box.
- Install external exhaust.
- CONTRACTOR to connect drain interface.

ACTIVITY 3 – ATEX INSPECTION

Note this is not currently detailed in the schedule.

- Perform ATEX ITR inspection

ACTIVITY 4 – MECHANICAL COMPLETION PRE-CHECK INSPECTIONS

Note this is not currently detailed in the schedule.

- CONTRACTOR to complete mechanical and electrical prechecks utilizing the provided ITRs by COMPANY.
- ITRs to be reviewed by COMPANY & VENDOR prior to triparty walkdown.

2.8.3.2 TRIPARTY WALKDOWN

To be completed with the COMPANY, CONTRACTOR & VENDOR in attendance upon completion of all the above activities.

Walkdown procedure is to be provided by CONTRACTOR

2.8.3.3 COMMISSIONING (POWERED)

ACTIVITY 1 – AUX FIRST POWER ON

- Check 400V AUX connection integrity
- Power up the container controller

Enable essential systems in container (lighting, heating, ventilation, detection systems)

ACTIVITY 2 – SUBSYTEMS POWER ON CHECK

- Power up remaining BOP functions

2.8.3.4 COMMISSIONING CAMPAIGN 2

ACTIVITY 1 – PREPARE COOLANT FILL (SETUP PUMPS, HOSES, TANKS)

- CONTRACTOR to lifr air compressor on to platform.
- CONTRACTOR to lift 2x IBC coolant tanks to platform
- CONTRACTOR to ensure scaffolding to access cooling skid service area
- CONTRACTOR to provide spill kit and overflow routing for coolant
- Connect pump station to IBC tanks and cooling skid, including header tank return flow pipework

ACTIVITY 2 – COOLANT SYSTEM LEAK TEST (DRY)

Vendor to complete cooling system dry leakage test as per Vendor Document: SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure

- HT coolant system dry leakage test (with compressed air)
- LT coolant system dry leakage test (with compressed air)
- Connect pump station to IBC tanks and cooling skid, including header tank return flow pipework

ACTIVITY 3 – COOLANT FILL

- Perform HT coolant filling procedure
- Perform LT coolant filling procedure

ACTIVITY 4 – COOLANT SYSTEM DEGAS

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- Perform HT system degas procedure (pump agitation and coolant top up)
- Perform LT system degas procedure (pump agitation and coolant top up)

ACTIVITY 5 – COOLING SYSTEM LEAK CHECK (WET)

Vendor to complete Cooling Circuit Pressure and Leak Test procedure per Vendor Document: SPC ID 0103 Cooling Circuit Pressure and Leak Test Procedure

- Perform leak test procedure on HT system
- Perform leak test procedure on LT system

ACTIVITY 6 – H2 INSTALLATION ASSEMBLY LEAK TESTING

Vendor to complete *Pipework inspection and leakage test* per Vendor Document: SPC ID 0104 H2 Leak Test Procedure

- Install test pressurization equipment to H2 manifold
- Perform sniffing test to ensure pipework tightness
    - Pressurize pipework with formier gas and perform sniffing procedure

2.8.3.5 COMMISSIONING CAMPAIGN 3

ACTIVITY 1 – IO TEST (PACKAGE INTERNAL)

- Test all sensors and actuators on BOP systems

ACTIVITY 2 ELECTRICAL SAFETY CHECK (PART OF SAT PROCEDURE)

- According to SAT procedure.
    - F07 Electrical Safety Test – 10 foot container
    - F08 Electrical Safety Test – 40 foot container
    - F10 Safety

ACTIVITY 3 FUNCTION CHECK OF VFD COOLER/HVAC

- Manually operate HT Cooling system pumps and fans, checking functionality of fans, pumps and valves.

ACTIVITY 4 - SOFTWARE UPDATE ON CONTROL SYSTEMS

- Connect Ballard laptop to control system of container and fuel cells
- From Ballard servers, upload updated versions of programming on the container and fuel control systems.
- This activity will cause disruptions on communication between BLPH and Fuel Cell package, as the control system is stopped as a part of the upgrade process.
- This activity allows activity #3 in campaign 4 to be completed, which includes testing of the software functions which have been impacted by the changes.

ACTIVITY 5 - PLATFORM COMMUINCATION CHECK

Note the platform is to be "communication ready" by CONTRACTOR before this activity can start and be completed.

- CONTRACTOR to bring communication interface live
- Check network communication between package controller and platform
- Check E-stop (hardwired) between package controller and platform

ACTIVITY 6 – HV LINK CHECK (6.6 kV TRAFO ENERGIZATION)

Note the platform is genset is to be confirmed ready by CONTRACTOR before this activity can start and be completed.

- Perform LOTO procedure with CONTRACTOR (Lock 10ft container with breaker room key)
- CONTRACTOR to energize 6,6kV supply to package

ACTIVITY 7 – TEST BACKFLOW 6.6KV TRAFO

Note the platform is genset is to be confirmed ready by CONTRACTOR before this activity can start and be completed.

- Energize DC link through 6,6kV supply (backflow)
- Bring BOP functions to operation to test load capability

ACTIVITY 8 – BRING FUEL CELLS TO STANDBY (NO H2)

Note the platform is genset is to be confirmed ready by CONTRACTOR before this activity can start and be completed.

- Energize DC link (backflow)
- Bring Fuel Cell 1 – 6 to standby state (power from DC link) – no H2 introduced.
- Operate BOP components within each Fuel Cell

2.8.3.6 COMMISSIONING CAMPAIGN 4 (HOT COMMISSIONING)

ACTIVITY 1 – H2 AVAILABILITY AND QUALITY CHECK (BEFORE INTRODUCING H2 to FC MODULES)

Note CONTRACTOR to confirm following ACTIVITY 1 tasks completed before VENDOR can continue HOT COMMISSIONING. If H2 quality check is not completed, COMPANY takes full responsibility for potential damages or repairs caused by poor fuel quality.

- CONTRACTOR providing documentation on H2 fuel quality from sampling point
- CONTRACTOR providing Load Bank

ACTIVITY 2 – FILL H2 HEATER WITH COOLANT

- CONTRACTOR to lift 1x IBC coolant tanks to platform
- CONTRACTOR to provide spill kit and overflow routing for coolant
- VENDOR connecting pump to H2 heater and fill to level

ACTIVITY 3 – COMMISSIONING SINGLE FC FROM ONE OF TWO VESSELS WITH REDUCED PRESSURE (UNTIL SINGLE FC COMMISSIONED) (WITH H2, 0 to 200 KW, 6.6KV LIVE)

Main purpose: Start 1 FC verifying H2 fuel quality and regulator capable of start-up and commissioning

Note if FC module shutdown due to low H2 quality, VENDOR will stop activities and wait for CONTRACTOR to perform new H2 quality checks. If FC modules shutdown due to H2 pressure issues CONTRACTOR must perform pressure regulator adjustments. If H2 quality check is not completed, COMPANY takes full responsibility for potential damages or repairs caused by poor fuel quality.

- First start of one FC module (first start from long time out of service)
    - If FC module does not start after completing VENDOR start up procedure VENDOR will stop further start up attempts. If VENDOR deems the cause to be poor fuel quality, COMPANY/CONTRACTOR will have the responsibility to improve fuel quality before continuing.
- Continue conditioning by running one FC module at varies load point between 50kW and 200kW

ACTIVITY 4 (ROSETTI) – REGULATOR/CONTROL VALVE TUNING WITH FC (UNTIL BASELINE FUNCTIONALITY IS PROVEN WITH FC (REDUCED LOAD, INLET RANGE) (WITH H2, 0 to 200 KW, 6.6KV LIVE)

Main purpose: Give CONTRACTOR the opportunity to adjust and setup regulator control for a single (one) FC Module

Note if FC modules shutdown due to low H2 quality, VENDOR will stop activities and wait for CONTRACTOR to perform new H2 quality checks. If FC modules shutdown due to H2 pressure issues CONTRACTOR must perform pressure regulator adjustments before VENDOR continue testing.

- CONTRACTOR to adjust H2 regulators
- Start FC Module No.1 from idle to max load (50 to 200kW)
- Run module – ramping up and down
- Start stop test of module with storage tank high and low pressure

ACTIVITY 5 – COMMISSIONING REST OF FCs (5PCS) (WITH H2, 0 to 200 KW, 6.6KV LIVE)

Main purpose: Start the last 5 FC modules and commission

Note if FC module shutdown due to low H2 quality, VENDOR will stop activities and wait for CONTRACTOR to perform new H2 quality checks. If FC modules shutdown due to H2 pressure issues CONTRACTOR must perform pressure regulator adjustments. If H2 quality check is not completed, COMPANY takes full responsibility for potential damages or repairs caused by poor fuel quality.

- Conditioning of each individual FC modules (first start from long time out of service)
- Continue conditioning by running each individual FC modules at varies load points between 50kW and 200kW

ACTIVITY 6 (ROSETTI) – FULL REGULATOR/CONTROL VALVE VERIFICATION WITH 6 FC (WITH H2, 0 to 1000 KW, 6.6KV LIVE)

Main purpose: Give CONTRACTOR the opportunity to adjust and setup regulator control for the full power range

Note if FC modules shutdown due to low H2 quality, VENDOR will stop activities and wait for CONTRACTOR to perform new H2 quality checks. If FC modules shutdown due to H2 pressure issues CONTRACTOR must perform pressure regulator adjustments before VENDOR continue testing.

- CONTRACTOR to adjust H2 regulators
- Start FC Module No.1 to 6 tests from idle to max load (0 to 1000kW)
- Run modules – ramping up and down. At high and low storage tank pressure
- Start stop test of all modules with storage tank high and low pressure.

2.8.3.7 RFSU CERTIFICATE

Ready for Start Up Certificate to be signed by COMPANY, CONTRACTOR & VENDOR upon completion of all the above activities.

2.8.3.8 SITE ACCEPTANCE TEST

Note all activities above must be successfully completed before commencement of the SAT.

Note if FC modules shutdown due to low H2 quality, VENDOR will stop activities and wait for CONTRACTOR to perform new H2 quality checks. If FC modules shutdown due to H2 pressure issues CONTRACTOR must perform pressure regulator adjustments before VENDOR continue testing.

SAT to follow document: K559-2254-CWIWP4202202-J99-001-Rev004, Site Acceptance Test (SAT) Procedure

- Follow SAT procedure

2.9 CLASS OF WORK

2.9.1 Proposed Work Window to CONTRACTOR Yard

Refer to schedule as listed in the references.

2.9.2 Disciplines

Discipline Included in Work Scope							
Piping	Structural	Electrical	Instrument	Rigging	Scaffolding	Vendor	Insulation
X		X	X		X	X	

2.9.3 Equipment/System Affected/Impacts to Operation

N/A

2.9.4 Special Requirements

The table below shows the activities which require the attention of CONTRACTOR

Activity	Requirements
• Scaffolding for accessing cooling skid service area.	
• Scaffolding for installing drain exhaust.	
• Spill kits and containment pallets.	
• 230V utility connection (for power tools and pumps) available on platform/next to FC package.	

• Drainpipe interface connection.	
• Crane available for lifting activities – Air compressor, coolant IBCs etc..	
• Platform communication ready	
• Test Genset ready for energization	
• Commissioning test set up ready (H2 Supply, LB & 6.6kV)	

2.10 HOUSE KEEPING & DEMOBILIZATION

As per CONTRACTOR procedures.

2.11 TIME SCHEDULE

The tasks are executed in day shift, 8 working hours per day.

2.12 GENERAL SAFETY, PTW SYSTEMS & SAFETY CHECK LISTS

2.12.1 General Safety

- All construction activities shall comply with the CONTRACTOR Safety Management System.
- Safety will be the main target during the whole of the execution of works. Workers will be fullyadhered to safety requirements.
- There will be a full time safety representative from COMPANY to ensure the safety throughout the scheduled activity.
- Tool box talk shall be conducted by performing party prior to start of the job every day attended byall the concerned work party. The performing party shall make a record of the toolbox meeting in presence of HSE person.
- Make sure that all the relevant signatures are obtained in PTW and all the work group signatures inthe appropriate area after the job briefing
- All Hazardous activities shall be identified and adequate safety precautions shall be taken as per JSA/RA.
- All the personnel working at site shall wear PPE as per CONTRACTOR PPE policy.
- All Insulators shall wear special PPE such as disposable coverall, hand gloves, mask as recommendedin SDS.
- Work permit pack should include the relevant documents (MS, JSA/RA, SDS etc.)
- COMPANY's supervisor will ensure that all workers, directly or indirectly employed by it, have attended the necessary safety training required by law, safety regulations and have necessary workexperience. Documented evidence of such training shall be given upon request.

- Hygiene will be of utmost priority and the work areas will be maintained clean all rubbish and debris will be removed regularly.
- After completion of the job all waste shall be segregated and disposed separately as per RM policy & procedure for Waste Management. (PRO-HSE-28)
- Demobilize all tools and equipment from site after completion of work including housekeeping andcleaning the work location.

2.12.2 Permit To Work System

CONTRACTOR Permit to Work system (PRO-HSE-23) is a formal written Agreement and mean of Communication between CONTRACTOR and VENDOR while performing the task.

"Permit to Work system" provides a mechanism to control certain hazardous activities, non-routine activities and ensure a safe working environment so that the work carried out is conducted in a safe, coordinated & consistent manner without harm to people, Asset and Environment.

Dedicated training on PTW System will be provided by CONTRACTOR upon request.

2.12.3 PTW Office:

Original of the PTW and Original Certificates/ Documents shall be kept in the PTW Office (Project HSE office) and a copy at site in order to avoid spoil or misplaced. Also, this shall be easily accessible to both PTW holder and CONTRACTOR when it requires.

2.12.4 Lost Permit/Documents:

If any permits or associated documents are lost then the work must be stopped and new permit and associated document must be obtained before work started.

2.12.5 Operations Hold point:

Task list may have HOLD POINTS against some activities. The purpose of a hold point is to allow the intervention of CONTRACTOR before executing the activity. This can be added by CONTRACTOR Area Operator at the time of issuing the permit (on the hard copy) if required. In such cases, the PTW holder shall consult CONTRACTOR Area Operator and visit the site and obtain the signature in the task list before startingthe work. CONTRACTOR shall be informed of any special requirements after the site verification study.

2.12.6 PTW Suspension:

All permits are considered suspended at the end of the shift. If during the shift, a permit needs to be suspended due to some reasons, then CONTRACTOR shall collect the permit pack from site. PTW suspension due to Emergency situation during shift following an emergency Alarm, all PTWs shall be considered suspended and Permit receiver must leave the permits in PTW office at the work site.

CONTRACTOR Shift Supervisor shall revalidate all PTWs after "All Clear "announcement. In case of false alarm, no need of PTW revalidation if the interruption is less than one hour.

For planned emergency exercise/drill, need not required to suspend the PTWs.

2.12.7 Safety Checklist

The following activities will be carried out:

- Discuss work scope permits with the production / discipline supervisors.
- Toolbox talk with foreman / charge-hand.
- Walk job with production / discipline supervisors.
- PIC to check worksite immediately prior to work starting.
- PPE Check List.

2.13 JOB SAFETY ANALYSIS

Shall be prepared separately as an attachment to PTW. Can be replaced by a Risk Assessment of the activities required for any step to complete the scope of work.

2.14 ATTACHMENTS

2.14.1 BLPH-Ballard-Fuel-Cell_Schedule-Update_Dec-2024_Rev001 Latest Ballard Schedule

2.14.2 K559-2254-CWIWP4202202-J99-001-Rev003, Acceptance Test (SAT) Procedure

2.14.3 K559-2254-CWIWP4202202-B01-001Rev008, General Arrangement Drawing

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Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project-Ballard Risk Assessment for container solution**
Document Number:	K559-2254-CWIWP4202202-J99-10-10
Revision:	Rev001
Sequence Number:	10
File Name:	K559-2254-CWIWP4202202-J99-10-10Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-10
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Project data

Project name	601456B Crosswind BLPH

Stationary Fuel cell module. converting Hydrogen to electricity.

For stationary purposes, Also intended for the CE marking approval.

Functional description

Fuel Cell Container

The container contains 4-6 FCwave units. Each FC wave is a separate unit with full hydrogen safety and a double wall barrier to ventilate any possible hydrogen leakages directly to the outside. Ventilation is led to a level above the cooling radiators, to ensure that any hydrogen is kept away from igniting sources. This solution ensures that the interior of the container is not an Ex-zone. The fuel cell container is equipped with a ventilation system, which will ensure that the filtered process air for the FC wave is available. The ventilation system will also create a flow through the container, for cooling and ventilating the room. The container inside is kept at a small overpressure to prevent ingress of dust or fumes from the outside. The DC/DC panels for fuel cell output in the container connect each FC wave to a common DC link busbar. Each DC/DC panel for fuel cell output can be isolated electrically, to allow for maintenance on the specific cabinet or related FC wave. The system controller is a centralized unit that monitors and operates the entire FC Power Gen system and include a separate safety controller to prevent any critical failure or emergency situations to escalate. The power for auxiliary units such as water pumps, container ventilation and basic power is fed from a 400V AUX power panel during shut down.

Customer interface container

The customer interface container provides the main output AC power to the customer output. The DC power from the fuel cell container converts into 50Hz AC through the DC/AC output converter located in the customer interface container. This converter is further connected to the isolation transformer and main breakers for the customer connections. The container doors are prevented from opening during operationt. Access is restricted to instructed and trained personnel, and only after a safety procedure is followed, which will de-energize the container to a safe mode.

Cooling Unit

The purpose of the high-temperature (HT) cooling system is to dissipate the heat generated by the fuel cells. It is an open unpressurized system with an open header tank for volume changes due to temperature. The purpose of the Low-Temperature (LT) cooling system is to provide cooling for power electronics. Like HT, it is also an open unpressurized system with an open header tank for volume changes due to temperature.

Function

Functional Modes

Shut down

The hydrogen supply is manually isolated from the container. The container will be internally heated to keep temperature above freezing. Light and service plugs are available in the container, and the controller can be accessed by the customer.

Stand.by

The hydrogen supply is available to the fuel cell container when needed. Availability of hydrogen at an allowable pressure is provided by the customer hydrogen supply system. Loss of the hydrogen signal or hydrogen pressure error will place the FC Power Gen system in failure state. The FC Power Gen hydrogen manifold is closed. The main breaker of the customer grid is disconnected by the control system. The container will be internally heated to keep temperature above freezing. Light and service plugs are available in the container, and the controller can be accessed by the communication interface.If the FC Power Gen system receives an operating signal and no failures are observed, the FC Power Gen will go to operating state and perform a start-up.

Operating

The hydrogen supply is available to the fuel cell container. Availability of hydrogen at allowable pressure is provided by the customer hydrogen supply system. Loss of hydrogen signal or hydrogen pressure error will place the FC PowerGen system in failure state.The main breaker of the customer grid is controlled by the control system. The normal operating condition is the FC PowerGen operating and producing, where the main breaker is closed and the FC PowerGen system supporting the microgrid. .If the producing signal is removed, the FC Power Gen will open the main customer grid breaker and then perform a controlled shutdown going back to stand-by mode. The current available power is continuously signaled to the customers power management system together with various operating data. It is the responsibility of the customers power management system to avoid overloading the customer grid, e.g., by managing allowable consumers on the customer grid.The FC Power Gen system will allow for a FC wave fuel cell unit to be out due to service or failure, and continue supporting the customer grid with remaining fuel cells, at a lower available power level. If a critical error is seen by the FC Power Gen control system, the system will shut down to failure mode.

Failure

When an error that require the FC Power Gen to shut down is identified, the system will enter into one of the following states:

	• Emergency shutdown will immediately stop hydrogen supply and disconnect the FC power Gen from the customer grid. The FC Power Gen will remain in failure mode until the necessary action has been taken to rectify the error condition and the state has manually been cleared. The network connection will provide error data and engineering access for analyzing and correcting the		
Project number	PRJ-2024-07-04-0002		
Type	601456B Crosswind BLPH		
Serial number	601456B	**Created by**	Chaudhary Hijab
Machine number	-	**Created on**	04-07-2024
Order	601456B	**Last change**	20-08-2024 11:19
Model	FC PowerGen 1000kW ®/ TM		
Product	N/A		
Commercial name	FC PowerGen 1000kW ®/ TM		
Additional information	N/A		
Batch number	N/A		
Scheduled date of placing on the market			
	The overall project is divided into 3 subproject in order to perform risk assessment precisely. 1) Fuel cell container: This part consists of risks involved in fuel cells, fuel cell DC/DC converter system, system controller, auxiliary supply input, low temperature pump system, container ventilation and integrated safety. Following are the hazard zone in the fuel cell container: ☐Electrical cabinets (MCU, AUX,breakers) ☐Fuel' container built (inside and outside) ☐DC/DC panels for fuel cell output ☐Raised floor ☐Container ventilation system ☐Fuel cell, H2 enclosure ventilation extension and exhaust (internal) ☐External exhaust ☐Crane ☐Hydrogen supply 2) Cooling System: This part consists of risks involved in 2 HT radiators dimensioned for the specific site, 2 HT pump systems, 1 LT pump system, piping/valves/vessels and a cooling control panel/cabinets. Following are the hazard zones in the cooling system:		

Project note	☐Cooling platforms (HT & LT) ☐Pipings/valves/vessels ☐HT cooling radiators ☐HT pumps ☐Electrical cabinets ☐Inverter cabinets ☐Modem box (removable) ☐LT cooling radiators 3) Main Power output container: This part consists of risks involved in microgrid DC/AC, microgrid transformer, microgrid main breaker. Following are the hazard zones in the main power output container: ☐Electrical cabinets ☐Ventilation for power output container ☐Transformer ☐AC power connection (customer interface) ☐Main panel and control panel for power output container ☐Main power output container Besides, we have 2 interfaces are also added in the risk assessment: 1) Fuel cell container<...> Main power output container: This part consists of risks involved in the connections between two containers. Following are the hazard involved in this interface: ☐Interconnecting bridge between containers ☐Interconnection of power cables 2) Fuel cell container<...> Cooling: This part consists of risks involved in the connections between fuel cell containers and cooling. Following are the hazard involved in this interface: ☐Connecting parts (40' and cooling skid)

Limits of the machine

Intended use

The FC PowerGen system acts as a grid following power generator, providing up to 1MW at 6.6kVAC 50Hz. This system is designed and is intended to be used for offshore stationery application (fixed installed system). Hydrogen supply to the system is in the customer scope and the details about the hydrogen standards, quality etc are mentioned in the integration and other manuals that will be provided to the customers. The customer local Power Management System (PMS) requests the amount of power to be generated within the given dynamic and capacity limits of the system, which are communicated in real-time on the Modbus TCP/IP. The Modbus data is transported between the system and the PMS. The system have multiple operating data available on the same Modbus, including alarms.The FC Power Gen is placed in operation by request from PMS via Modbus, and similarly can be stopped, if necessary, which will stop power supplying the to the grid. The system can be stopped remotely on request. During normal operation, a power request of 0 is accepted by the system.

Dynamic Properties:

In order to match the response (ramping) time of the fuel cells in the FC PowerGen load should be managed as following:

Load increase ramp: Load is requested by the customer and the module/modules start up to deliver the power as demanded. One fuel cell modules takes approx 30 secs to ready to deliver the power.

Block loading can be accommodated in steps below 200 kW, with a minimum of 90 seconds between each step.
Calculated Maximum Power (CMP):
Range is 0 to 1000 kW. CMP will dynamically provide the maximum available power from the Megablock under current running conditions. The value will typically be 1000 kW.

In the following situations the CMP may be reduced:

☐ One or more fuel cells are out of service due to error or maintenance. This will reduce the CMP in steps of around 180kW.
☐ High temperature or other conditions which reduce the total capacity due to derating.
☐ Complete stop due to system failure, loss of hydrogen or remote stop from Customer control system. This will reduce CMP to 0kW

Reasonably foreseeable misuse

☐ Untrained personnel working on the system.
☐ Personnel working on the system not following proper instructions declared in the Ballard manuals
☐ Hydrogen handling: quality/temperature/pressure not aligned with the standards declared in the Ballard manuals.
☐Water/glycol mixture handling: the concentration and quality not aligned with the specification declared in the manuals.
☐System in operation without following Ballard service schedule and service bulletins.
☐Cleaning of containers from outside using high pressure water spray guns could possibly damage paint and other components.
☐Process air and/or ventilation air blocked.
☐Operation out of environmental ranges in the Ballard manuals.
☐Load ramping up/down abruptly or not according to the instruction provided.
☐Transportation of the system without proper preservation initiatives including transport safety measures.

Space limits

Space limits are defined as per the general arrangement layout drawing attached.(601456B-7 Rev007)

Time limits

Expected lifetime of the system: 10 years if maintained according to the Ballard service manual instructions.

Other limits

☐The system is designed to operate in seismic zone lower than 0.1 m/s2 according to European norm EN1998-1

Links (e.g. requirement specifications, functional specifications,...)

Type	File	Short note
Linked file	601456B-7 Rev007.pdf	

Signatory of the EC/EU-declaration

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Risk assessment

601456B Crosswind BLPH

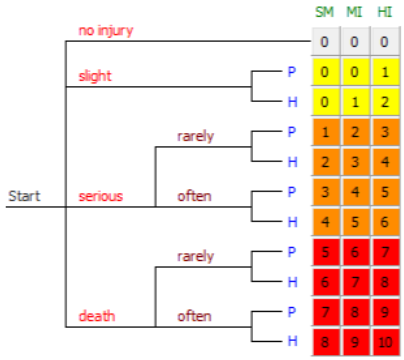
Project data			
Project name	601456B Crosswind BLPH	**Created by**	Chaudhary Hijab
Project number	PRJ-2024-07-04-0002	**Created on**	04-07-2024
Product	N/A	**Last change**	26-08-2024 13:46
Function	Stationary Fuel cell module. converting Hydrogen to electricity. For stationary purposes, Also intended for the CE marking approval. Functional description Fuel Cell Container The container contains 4-6 FCwave units. Each FC wave is a separate unit with full hydrogen safety and a double wall barrier to ventilate any possible hydrogen leakages directly to the outside. Ventilation is led to a level above the cooling radiators, to ensure that any hydrogen is kept away from igniting sources. This solution ensures that the interior of the container is not an Ex-zone. The fuel cell container is equipped with a ventilation system, which will ensure that the filtered process air for the FC wave is available. The ventilation system will also create a flow through the container, for cooling and ventilating the room. The container inside is kept at a small overpressure to prevent ingress of dust or fumes from the outside. The DC/DC panels for fuel cell output in the container connect each FC wave to a common DC link busbar. Each DC/DC panel for fuel cell output can be isolated electrically, to allow for maintenance on the specific cabinet or related FC wave. The system controller is a centralized unit that monitors and operates the entire FC Power Gen system and include a separate safety controller to prevent any critical failure or emergency situations to escalate. The power for auxiliary units such as water pumps, container ventilation and basic power is fed from a 400V AUX power panel during shut down. Customer interface container The customer interface container provides the main output AC power to the customer output. The DC power from the fuel cell container converts into 50Hz AC through the DC/AC output converter located in the customer interface container. This converter is further connected to the isolation transformer and main breakers for the customer connections. The container doors are prevented from opening during operationt. Access is restricted to instructed and trained personnel, and only after a safety procedure is followed, which will de-energize the container to a safe mode. Cooling Unit The purpose of the high-temperature (HT) cooling system is to dissipate the heat generated by the fuel cells. It is an open unpressurized system with an open header tank for volume changes due to temperature. The purpose of the Low-Temperature (LT) cooling system is to provide cooling for power electronics. Like HT, it is also an open unpressurized system with an open header tank for volume changes due to temperature.		

	Functional Modes Shut down The hydrogen supply is manually isolated from the container. The container will be internally heated to keep temperature above freezing. Light and service plugs are available in the container, and the controller can be accessed by the customer. Stand.by The hydrogen supply is available to the fuel cell container when needed. Availability of hydrogen at an allowable pressure is provided by the customer hydrogen supply system. Loss of the hydrogen signal or hydrogen pressure error will place the FC Power Gen system in failure state. The FC Power Gen hydrogen manifold is closed. The main breaker of the customer grid is disconnected by the control system. The container will be internally heated to keep temperature above freezing. Light and service plugs are available in the container, and the controller can be accessed by the communication interface.If the FC Power Gen system receives an operating signal and no failures are observed, the FC Power Gen will go to operating state and perform a start-up. Operating The hydrogen supply is available to the fuel cell container. Availability of hydrogen at allowable pressure is provided by the customer hydrogen supply system. Loss of hydrogen signal or hydrogen pressure error will place the FC PowerGen system in failure state.The main breaker of the customer grid is controlled by the control system. The normal operating condition is the FC PowerGen operating and producing, where the main breaker is closed and the FC PowerGen system supporting the microgrid. .If the producing signal is removed, the FC Power Gen will open the main customer grid breaker and then perform a controlled shutdown going back to stand-by mode. The current available power is continuously signaled to the customers power management system together with various operating data. It is the responsibility of the customers power management system to avoid overloading the customer grid, e.g., by managing allowable consumers on the customer grid.The FC Power Gen system will allow for a FC wave fuel cell unit to be out due to service or failure, and continue supporting the customer grid with remaining fuel cells, at a lower available power level. If a critical error is seen by the FC Power Gen control system, the system will shut down to failure mode. Failure When an error that require the FC Power Gen to shut down is identified, the system will enter into one of the following states: • Emergency shutdown will immediately stop hydrogen supply and disconnect the FC power Gen from the customer grid. The FC Power Gen will remain in failure mode until the necessary action has been taken to rectify the error condition and the state has manually been cleared. The network connection will provide error data and engineering access for analyzing and correcting the error condition.
Type	601456B Crosswind BLPH
Order	601456B
Commercial name	FC PowerGen 1000kW ®/ TM
Model	FC PowerGen 1000kW ®/ TM
Machine number	-
Serial number	601456B

Print options

View	Hazard zones	Display	All hazards

Legend



Safexpert risk graph

V = Value (0 - 10):
0 = Lowest Risk
10 = Highest Risk
SH = Severity of the harm:
N = no injury
SL = slight injury
SE = serious injury
D = death
DS = Duration of stay in hazard zone:
R = rarely to more often
O = often to continuously
RA = Possibility of recognition and avoidance:
P = Possible under certain circumstances
H = Hardly possible
PO = Probability of occurence:
SM = Small (improbable)
MI = Middle (probably occur a number of times during the life)
HI = High (happen often)

Measure number

Type of measure

Measure description

2	PIC	Place the spindle height indicator near the height dial	PLr / SILr	PL / SIL	Applied documents

Control engineering	Cat. = Category PLr = Performance level required (before) PL = Performance level (after) SILr = Safety integrity level required (before) SIL = Safety integrity level (after)
Types of measure	ISD = Inherently safe design measure SCP = Safeguarding / complementary protective measure PPE = Personal protection equipment PIC = Note on the machinery (Pictogram, ...) OI = Note in the Operating instruction

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601456B Crosswind BLPH

Limit of the product: Use-, space-, time- and other limits

Complete solution

1 - Mechanical hazards

in all phases of the "life"

Hazard description

The mechanical hazards of the complete solution are described in detail in the subprojects and interface risk assessments.

Risk assessment and risk reduction

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
1	ISD	Measures are presented in the subprojects along with the risks.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

in all phases of the "life"

Hazard description

The electrical hazards of the complete solution are described in detail in the subprojects and interface risk assessments.

Risk assessment and risk reduction

	0	Risk IN: SH: No injury, PO: Small			
1	ISD	Measures are also presented along with risks in the subprojects risk assessments.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

3 - Thermal hazards

in all phases of the "life"

Hazard description

The thermal hazards of complete solution are described in detail in the subprojects and interface risk assesments.

Risk assessment and risk reduction

	0	Risk IN: SH: No injury, PO: Small			
1	ISD	Measures are presented along with risk assesment in the subprojects and interfaces.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

4 - Noise hazards

in all phases of the "life"

Hazard description

The noise hazards of complete solution are described in detail in the subprojects and interface risk assesments.

Risk assessment and risk reduction

	0	Risk IN: SH: No injury, PO: Small			
1	ISD	Measures are presented along with risks in the subprojects and interfaces risk assesments.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Fuel Cell Container,40'

Limit of the product: Use-, space-, time- and other limits

Container ventilation system

1 - Mechanical hazards

1.3 - crushing

in all phases of the "life"

Hazard description

Risk of crushing individual fingers from all louver dampers inside the container.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PIC	Caution label indicating risk of crush on all louvre dampers inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

1 - Mechanical hazards

1.4 - cutting or severing

Malfunctioning

Hazard description

Ventilator failure leading to overpressure in the container (700 pa) that could possibly result in the opening of doors unintended and that rapid opening could lead to the personnel damage.

Risk assessment and risk reduction

	4	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Hardly possible, PO: Small			
1	SCP	DP Sensor will detect the overpressure and make an error in the SW.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Crane

1 - Mechanical hazards

1.3 - crushing

Maintenance

Hazard description

Moving FC wave and power electronics equipment IN/OUT during maintenance with crane operation. Errors in those crane operation could possibly result in personnel damage.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Proper marking and fences during crane operations to be arrange(	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Only relevant and trained people to be allowed in the area during installation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Lifting to be done only in a clear weather condition.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
4	OI	Proper lifting procedure to be designed to avoid any risk. Service manuals to be added in details.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 26-08-2024

1 - Mechanical hazards

1.8 - impact

in all phases of the "life"

Hazard description

Risk of hitting individuals head due to the presence of crane inside the container.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	PIC	Caution marking indicating an overhead obstacle to be pasted in the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

External exhaust

1 - Mechanical hazards

1.11 - slipping, tripping and falling

in all phases of the "life"

Hazard description

Risk of slipping/falling down due to the ice formation in cold weather as process water is sprayed out through the external exhaust during operation.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	PPE	Proper shoes and PPE to be considered below process exhaust.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	Restriction of access in the area during cold weather conditions.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

3 - Thermal hazards

3.6 - scald

Normal operation

Hazard description

The steam coming out of the process exhaust is more than 60°C. Direct personal exposure could possibly result in scalding/burning.

Risk assessment and risk reduction

	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Middle			
1	OI	Working physically on the exhaust to be declared 'not allowed' during operation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Safety caution markings to be added on the process exhaust pipings outside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Operator manual to be provided the information about the hot surface and high temperature.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

7 - Material/ substance hazards

7.1 - breathing difficulties, suffocation

Malfunctioning

Hazard description

Leakage on pipe clamps - risk of low oxygen level 10% worst case.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	ISD	set the lowest oxygen level possible >10%.	PLr / SILr	PL / SIL	Applied documents
	3	Risk OUT: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
2	SCP	Container ventilation system when in operation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

7 - Material/ substance hazards

7.5 - explosion

Malfunctioning

Hazard description

Pipe connection leakage to container room could possibly spread hydrogen in the container that could lead to a potential explosion.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Container is equipped with H2 sensor to detect potential leakage.	PLr / SILr	PL / SIL	Applied documents
	3	Risk OUT: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
2	SCP	Straub connector is constructed to 10bar to avoid leakage.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Electrical cabinets (MCU, AUX, Breaker)

2 - Electrical hazards

2.4 - electrocution

Testing

Hazard description

Risk of electrocution due to touching live parts during testing.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Lockout and tagout procedures to be followed precisely.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	OI	Residual voltage check to be done before any other work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.4 - electrocution

Assembly, installation

Hazard description

Turning on the customer auxiliary power supply during installation/commissioning due to human negligence could possibly result in electrocution if not handled carefully.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Locking out or tagging out the circuit breaker to avoid dangerous situations.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	PPE	Safety shoes, appropirate clothing, safety gloves, safety goggles etc to be considered.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	OI	Integration/Service manuals to be provided with details and followed precisely.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.4 - electrocution

Commissioning, adjustments

Hazard description

Turning on the customer auxiliary power supply during installation/commissioning due to human negligence could possibly result in electric shock if not handled carefully.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Locking out and tagging out the circuit breakers to avoid dangerous situations.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	Installation/Service manuals to be followed precisely.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	SCP	PPE to be considered for safety.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.4 - electrocution

Troubleshooting

Hazard description

No plugs for capacitor voltage measurement outside the auxiliary panel. Panel doors need to be opened for troubleshooting or maintenance and capacitors could be charged. This could result in potential electrocution if not handled safely.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Plugs to be considered outside the panel (like DC/DC panels) or an option of grounding/shorting switch to be considered for safety purposes.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	OI	Instructions to be provided and followed regarding that.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

in all phases of the "life"

Hazard description

Troubleshooting in control panel for fuel cell genset during Live operation and touching live parts has risk of potential shock.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	IP20 to be the minimum criteria declared for the components inside the panel.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	SCP	Polycarbonate covers to be added in order to avoid the shock/ touching.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	PPE	PPE to be considered during the installation/commissioning/troubleshooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	PIC	Live parts to be marked inside PLC panel.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

3 - Thermal hazards

3.1 - burn

Testing

Hazard description

Risk of burning individual fingers due to touching hot surfaces and components.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Gloves to be considered during the testing process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Hydrogen supply

3 - Thermal hazards

3.1 - burn

in all phases of the "life"

Hazard description

Risk of burning hands due to touching hot surface on the hydrogen pre-heater.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Wearing gloves to be considered near the hydrogen heater.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Caution marking to be placed on the hydrogen heater.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

7 - Material/ substance hazards

7.5 - explosion

Testing

Hazard description

Risk of explosion due to leakage of hydrogen during testing.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Proper bench testing procedures of components to be performed prior to assembly.	PLr / SILr	PL / SIL	Applied documents
	2	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
2	SCP	Proper leak test of assembly to be performed prior to hydrogen supply.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

7 - Material/ substance hazards

7.5 - explosion

Malfunctioning

Hazard description

External leakage on exhaust pipe can possibly result in the sucking of hydrogen into the container leading to a potential explosion.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Container is equipped with H2 sensors to detect potential leakage.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	intake H2 sensor to detect contaminated air entering the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

7 - Material/ substance hazards

7.5 - explosion

Reasonably foreseeable misuse

Hazard description

Hydrogen inlet pressure exceeds 10 barg could result in hydrogen release and explosion.

Risk assessment and risk reduction

	6	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Small			
1	ISD	Hydrogen pipings and valves rated for more than 15 times safely release valve pressure (>150 bar).	PLr / SILr	PL / SIL	Applied documents
	3	Risk OUT: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
2	SCP	Upstream safety pressure release valve - sized to full flow from upstream regulator requirement to integrator in BPSE Fuel cell integration manual.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	SCP	Under normal operation - un manned Fuel cell container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

7 - Material/ substance hazards

7.5 - explosion

in all phases of the "life"

Hazard description

Malfunctioning of one of the hydrogen valves could possibly keep supplying the hydrogen into the container even after making emergency shutdown. This could result in accumulation of hydrogen in the container and could possibly result in a potential explosion.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Two valves in series to be placed in order to safeguarding the failure from one valve.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	Safety output signal to be sent to the supplier of the hydrogen so the main valve could be shut off and stops supplying the hydrogen.	PLr / SILr SIL 2	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Fuel cell container built (Inside/Roof)

1 - Mechanical hazards

1.3 - crushing

Maintenance

Hazard description

Fans filter replacement requires their unassembly. During the unassembly, there is a risk of crushing due to the heavy weight of the fans. Also, during reassembly, if the screws are not tightened properly the fans won't be adjusted at their place properly and could possibly fall down. Personnel standing/working down the container could potentially get severely injured.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Only trained personnel to be working on maintenance.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Caution marking about the following the instructions to be pasted on the top of the fan.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	OI	Service manual to be provided mentioning the detailed descriptions and to be followed during the maintenance.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.3 - crushing

in all phases of the "life"

Hazard description

DC cable ducts installed on the roof inside the container have sharp corners. Could possibly result in the personnel head injury.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Rubber covers to be added to cover the sharp corners.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	PPE	PPE to be declared compulsory near the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

1 - Mechanical hazards

1.5 - drawing-in or trapping

Maintenance

Hazard description

Risk of trapping an injured individual inside the container if the access of unlocking emergency door is not available from inside.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	OI	Instruction about unlocking the emergency exit while working in the container to be added in the relevant manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.5 - drawing-in or trapping

in all phases of the "life"

Hazard description

Container gets locked outside while individual is working inside. Could cause personal disturbance.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Emergency push bars to be installed that can be unlocked from inside.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	OI	Communication device to be kept along while working inside to keep the contact and instructions about it to be provided in the relevant manual.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	PIC	Only authorized people to be given access inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

1 - Mechanical hazards

1.5 - drawing-in or trapping

Malfunctioning

Hazard description

Risk of individual trapping inside during the FCwave module moving out due to the malfunctioning.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Emergency door to be installed at the end of the container with the access to open from inside.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	OI	Mention the location of emergency door in the operator manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

	0	Risk IN: SH: No injury, PO: Small			
3	PIC	Marking indicating the emergency door to be pasted outside the emergency door.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

1 - Mechanical hazards

1.11 - slipping, tripping and falling

Troubleshooting

Hazard description

Personnel working on the top of the container during trouble shooting without suitable lifting equipment. Imbalance could potentially result in falling from almost 3m height and severe injuries.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Customer to provide suitable lift or scaffolding for all the lifting procedures on site.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	Rainy, extreme winds or snowy days to be avoided for installation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	PPE	Helmets and proper shoes (PPE) to be declared mandatory during installation/assembly.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	OI	More than one person to be present on-site during work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.11 - slipping, tripping and falling

Maintenance

Hazard description

Personnel working on the top of the container during maintenance without safe lifting equipment. Imbalance could potentially result in falling from almost 3m height and severe injuries.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Rainy, extreme winds or snowy days to be avoided for installation.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	PPE	Helmets and proper shoes (PPE) to be declared mandatory during installation/assembly.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
3	OI	Customer to provide suitable scaffolding or lift for all the lifting processes at site.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	OI	More than one person to be present on-site during work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.11 - slipping, tripping and falling

in all phases of the "life"

Hazard description

Wet shoes coming from outside could result in slippery container floor. Tripping/Falling or personal damage

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Anti-slipping floor plates to be installed inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Safety shoes to be declared mandatory inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

1 - Mechanical hazards

1.11 - slipping, tripping and falling

Assembly, installation

Hazard description

Personnel working on the top of the container during assembly without a harness. Imbalance could potentially result in falling from almost 3m height and severe injuries.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	OI	Customer to provide suitable scaffoldings, lifts during the procedure on site.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	SCP	Rainy, extreme winds or snowy days to be avoided for installation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	PPE	Helmets and proper shoes (PPE) to be declared mandatory during installation/assembly.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	OI	More than one person to be present on-site during work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.14 - other mechanical hazards

in all phases of the "life"

Hazard description

Risk of individuals falling, tripping or difficulties in access due to the unsafe entry and exit passage of the container.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	OI	Level free access inside the container to be provided by the customers.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.14 - other mechanical hazards

Normal operation

Hazard description

Snow accumulated on the top of the container during winter season turns into ice. Ice falling from the top could potentially cause personal injury to the people standing/working down.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	PPE	PPE should be considered at personnel presence near the container.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	PPE	Wearing helmets to be declared compulsory near the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
3	OI	Instructions about the severe weather precautions to be included regarding that in the operational/safety manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.8 - shock

in all phases of the "life"

Hazard description

Risk of shock due to improper grounding of the container.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Container should be grounded as presented in the general arrangement drawings.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	SCP	Grounding continuity test to be performed before starting the system.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	PIC	Caution markings as per '60204-1:2016 Clause 8 paragraph 8.2.4: Each protective conductor connecting point shall be marked or labelled as such, using the symbol IEC 60417-5019:2006-08, or with the letters PE, the graphical symbol being preferred, or by use of the bicolor combination GREEN-AND-YELLOW, or by any combination of these' to be pasted on the container	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Testing

Hazard description

Risk of shock due to the leak hoses/pipes/fittings inside the panels spraying on the live electrical parts.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Prior to first power on the system, pressure testing should be completed and approved.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Programming

Hazard description

System not responding to low insulation resistance due to the programming errors could potentially result in electric shock.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Signals from insulation resistance to be transferred directly to the safety controller to avoid any risk.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Testing of the system during commissioning.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Test interval to be added in the service manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.9 - other electrical hazards

in all phases of the "life"

Hazard description

Risk of injured individual getting trapped inside the container for long time due to the non-availability of space to enter the rescue equipment (stretchers etc).

Risk assessment and risk reduction

	4	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Hardly possible, PO: Small			
1	SCP	Emergency door with a wide opening to be installed in the container for the accessibility of bringing rescue equipment inside.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Emergency door area should be free and accessible from outside in case of emergency situations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

3 - Thermal hazards

3.1 - burn

in all phases of the "life"

Hazard description

Risk of fire and burns due to the human negligence inside the container.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Smoke detectors to be installed in order to shut down the system in case of fire.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Caution marking 'no smoking' 'no open flames' to be added on the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

3 - Thermal hazards

3.1 - burn

Malfunctioning

Hazard description

Risk of touching hot surface on the air heater cabinet if the container fans are not in operation while heating is ON.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Electrical interlock to be added to ensure that heating elements can only be operational if fans are running.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

3 - Thermal hazards

3.6 - scald

in all phases of the "life"

Hazard description

The steam coming out of the process exhaust is more than 60°C. Direct personal exposure could possibly result in scalding/burning.

Risk assessment and risk reduction

	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Middle			
1	OI	Working physically on the exhaust to be declared 'not allowed' during operation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Safety caution markings to be added on the process exhaust pipings outside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Operator manual to be provided the information about the hot surface and high temperature.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

4 - Noise hazards

4.1 - discomfort

Normal operation

Hazard description

High level noise during normal operation (all FCwave modules operational) inside the container that could possibly results in severe hearing issues

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Noise testing to be performed inside the container during operation to check the severity.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
2	PPE	PPE to be considered during inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
3	PIC	Caution marking about using hearing protections and information about automatic starting up of the system to be added.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

19 - Hazardous events: Control system

19.6 - Unintended/unexpected start-up

in all phases of the "life"

Hazard description

Customer control system remotely starts while the personnel are working inside the container could possibly result in severe personnel damage.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Locking out and tagging out the circuit breakers during assembly/installation/maintenance to avoid dangerous situations.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	PPE to be considered during installation/service/maintenance/troubleshooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	OI	Integration/Service manuals with lock out and tag out procedures to be provided.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

DC/DC panels for fuel cell output

2 - Electrical hazards

2.4 - electrocution

Maintenance

Hazard description

DC/DC cabinets consists of capacitors that could remain charged for sometime after turning off the system. Maintenance of the DC/DC panels for fuel cell output while those capacitors are charged could result in potential electrocution or electric arc.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	There are plugs available for the service personnel to measure the charge without getting in contact with the live electrical part.	PLr / SILr	PL / SIL	Applied documents
	2	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
2	OI	Detailed lock out and tag out procedures for DC/DC cabinets to be provided in service manual.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Hardly possible, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
3	PIC	Caution marking regarding the electrical hazards to be pasted on the DC/DC panels.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Malfunctioning

Hazard description

Cooling water sprayed on the live wires inside the DC/DC panels for fuel cell from the cooling hoses due to the leakage of coolant water. Possibility of short circuit and shock if the doors are open.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Hoses to be replaced into solid metal pipes.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Raised floor

1 - Mechanical hazards

1.4 - cutting or severing

Testing

Hazard description

Raised floor panel needs to be removed for maintenance/troubleshooting. The cable trays and horizontal support brackets installed down have sharp edges. Could possibly result in the personnel injury/cuts to legs/hands/arms.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Possibly minimum plates to be removed for work at a time.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	PPE	PPE should be considered during installation/commissioning/maintenance process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

1 - Mechanical hazards

1.4 - cutting or severing

Troubleshooting

Hazard description

Raised floor panel needs to be removed for maintenance/troubleshooting. The cable trays and horizontal support brackets installed down have sharp edges. Could possibly result in the personnel injury/cuts to legs/hands/arms.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Possibly minimum plates to be removed for work at a time.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	PPE	PPE should be considered during installation/commissioning/maintenance process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

1 - Mechanical hazards

1.4 - cutting or severing

Maintenance

Hazard description

Raised floor panel needs to be removed for maintenance/troubleshooting. The horizontal support brackets installed down have sharp edges. Could possibly result in the personnel injury/cuts to legs/hands/arms.

Risk assessment and risk reduction

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
1	SCP	Possibly minimum floor plates to be removed for work at a time.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	PPE	PPE to be considered to avoid injuries.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.8 - shock

Hazard description

Risk assessment and risk reduction

No measures defined!

3 - Thermal hazards

3.6 - scald

Malfunctioning

Hazard description

There are piping connections on the raised floor. Those pipes leakage could result in the spillage of hot liquid (more than 65°C) inside the container.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Thorough inspection to be done of connection points to avoid leakage.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	A complete leakage testing to be performed.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	SCP	A detailed pressure testing to be performed.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
4	PPE	PPE to be considered while working inside the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

21 - Hazardous events: Workstation and/or work process design

21.4 - Painful and tiring postures

Maintenance

Hazard description

The maintenance work below the raised floor for long time can be in a tiring posture that could result in tiredness.

Risk assessment and risk reduction

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
1	SCP	Frequent breaks during work to be considered.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Small			
2	PPE	Knee pads to be used during the maintenance work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Fuel cell, H2 enclosure ventilation system and exhaust (internal)

7 - Material/ substance hazards

7.5 - explosion

Assembly, installation

Hazard description

Leakage in the fittings between H2 supply pipe and FC modules can possibly result in the hydrogen release and therefore explosion. Also, the connection point between H2 supply and Hydrogen pipe can leak and can cause explosion.

Risk assessment and risk reduction

	6	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Small			
1	ISD	Fitting included in FCwave double wall and detection system.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	ISD	Fitting intended for Hydrogen (Double Compression Ring Fitting).	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

601456B Crosswind BLPH

Interface: Fuel Cell Container,40' <--> Power Converter container, 10'

Interconnecting bridge between containers

1 - Mechanical hazards

1.3 - crushing

Assembly, installation

Hazard description

Risk of getting injured by falling objects (pipes/wires/cable tray) during installation.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Safety helmets, shoes (PPE) to be declared mandatory during the installation process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Proper lifting plan to be provided by the customer and to be followed during installation at site.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Only authorised people to be allowed to perform crane operations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.5 - drawing-in or trapping

Assembly, installation

Hazard description

Risk of individuals falling down from the height during installation of the pipes/cables.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Safety helmets/shoes to be used during the installation process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Proper lift to be used during the installation process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Interface: Fuel Cell Container,40' <--> Cooling Unit

Interconnection of power cables

2 - Electrical hazards

2.8 - shock

Assembly, installation

Hazard description

Risk of getting a shock during installation if there is power on the cables feeding the cooling skid electric panel.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Locking out and tagging out procedure to be followed precisely.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Only trained Ballard personnel to be available for installation of the system.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Connecting parts (40' and cooling skid)

1 - Mechanical hazards

1.3 - crushing

Assembly, installation

Hazard description

Risk of crushing into personnel during the lifting of cooling skid up to the container.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	OI	Detailed installation guide and lifting procedure to be provided by the customer.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Local rules for the lifting of equipment to be followed precisely and to be mentioned in the manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

3 - Thermal hazards

3.1 - burn

Normal operation

Hazard description

Risk of getting a burn from touching hot pipes (above 65 degrees) during normal operation.

Risk assessment and risk reduction

	3	Risk IN: SH: Serious injury, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	PIC	Caution marking indication hot surface to be added on the cooling pipes.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 20-08-2024

Cooling Unit

Limit of the product: Use-, space-, time- and other limits

Cooling skid platform

1 - Mechanical hazards

1.5 - drawing-in or trapping

Assembly, installation

Hazard description

Risk of getting slipped and fall into the cooling skid frame from the platform that could possibly result in injuries to leg and trapping inside.

Risk assessment and risk reduction

	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Middle			
1	SCP	Working on platform to be avoided in snowy and rainy weather conditions.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	Safety shoes to be considered while working on the service platform.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

1 - Mechanical hazards

1.11 - slipping, tripping and falling

in all phases of the "life"

Hazard description

Risk of slipping/tripping while entering or exiting the cooling skid platform.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Middle			
1	SCP	Proper means to access (scaffolding) to be arranged for different phases of life operations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Access to the cooling platform must be according to the local rules and regulations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

3 - Thermal hazards

3.6 - scald

Troubleshooting

Hazard description

The system needs to be in operation during trouble shooting process and the water in HT cooling pipes pipes could get hot (upto 60ºC). There is a risk of being scalded with the hot water due to the leakage in the cooling pipes.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	PPE should be considered during the troubleshooting operations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

3 - Thermal hazards

3.6 - scald

Commissioning, adjustments

Hazard description

There are cooling hoses installed next to the cooling skid platform and are connected to the header tank. During the commissioning process the system is operational and the hoses contain hot water (up to 65°C). There is a risk of scalding person working on the platform due to the leakage in those hoses.

Risk assessment and risk reduction

	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Middle			
1	ISD	Metal connections have special grooves to prevent hoses from slipping off.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Metal straps around the hoses installed.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	PPE	Safety goggle and safety clothing to be used while working on the cooling skid.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	PIC	Caution marking regarding hot surface to be pasted on the hoses.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

4 - Noise hazards

4.1 - discomfort

Commissioning, adjustments

Hazard description

High noise during the system in operation could possibly result in discomfort during commissioning process on the skid platform.

Risk assessment and risk reduction

	2	Risk IN: SH: Slight injury, RA: Hardly possible, PO: High			
1	PPE	Hearing protections to be used while working on the platform.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
2	OI	Personnel working on cooling skid is not allowed during the full load operation (all FCwave running). This instruction to be mentioned in the relevant manuals.	PLr / SILr	PL / SIL	Applied documents
		Risk OUT:			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

22 - Other hazardous events

in all phases of the "life"

Hazard description

Risk of falling down from the platform due to extreme weather events.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Access to be prohibited during extreme weather conditions.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Piping/Valves/Vessels

7 - Material/ substance hazards

7.5 - explosion

Malfunctioning

Hazard description

Due to the manual valve at the inlet/outlet of the fuel cell module inadvertently closed, Loss of cooling in cooling fluid for the fuel cell module leading to loss of cooling for the fuel cell stacks. Due to continuous heat production at the membrane of the fuel cell, potential to exceed design pressure leading to failure of the packing in the membrane. Leakage of H2 in an enclosed area potential for ignition and internal explosion of H2. Potential for multiple fatalities.

Risk assessment and risk reduction

	6	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Small			
1	ISD	High temperature coolant transmitter to be used for shutting down individual Fuel Cells. Unload DC/DC converter and disconnect electrically from the power converters.	PLr / SILr	PL / SIL	Applied documents
	2	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
2	SCP	Firewire Linear Heat Detector around the Fuel Cell Modules to be added that shutdown the individual Fuel Cell via fire safety system by disconnecting electrically from the power converter and closing the Fuel Cell supplier.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

HT cooling radiators

1 - Mechanical hazards

1.3 - crushing

Malfunctioning

Hazard description

Risk of crushing personnel damage while removing HT coolers because of malfunction.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	PPE should be considered during the maintenance process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Service manuals should be provided with all the details and to be followed precisely.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

3 - Thermal hazards

3.1 - burn

Commissioning, adjustments

Hazard description

Risk of burns due to touching of the hot HT cooler pipe beside the platform when the system is in operation.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Caution markings to be added on the pipes to avoid physical touch.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	PPE to be considered and face covered helmets to be used.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

7 - Material/ substance hazards

7.5 - explosion

Malfunctioning

Hazard description

Loss of cooling in HT cooling system 1 and subsequently loss of cooling for 3 of the fuel cell modules. Due to continuous heat production at the membrane of the fuel cell, potential to exceed design pressure leading to failure of the packing in the membrane. Leakage of H2 in an enclosed area potential for ignition and internal explosion of H2. Potential for multiple fatalities.

Risk assessment and risk reduction

	6	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Small			
1	SCP	High temperature coolant transmitter to be designed for shutting down individual Fuel Cells. Unload DC/DC converter and disconnect electrically from the power converters.	PLr / SILr	PL / SIL	Applied documents
	2	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Hardly possible, PO: Small			
2	SCP	Firewire Linear Heat Detector around the Fuel Cell Modules to be used to shutdown the individual Fuel Cell via fire safety system by disconnecting electrically from the power converter and closing the Fuel Cell supplier.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

7 - Material/ substance hazards

7.10 - sensitization

in all phases of the "life"

Hazard description

Risk of allergic reaction due to skin/eyes exposure to the cooling fluid.

Risk assessment and risk reduction

	2	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Middle			
1	PPE	Safety goggles/face shield/chemical resistant gloves to be considered while working.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

HT Pump

1 - Mechanical hazards

1.3 - crushing

Maintenance

Hazard description

HT pump maintenance requires disassembly and lifting operation. Risk of crushing and personnel damage if not handled safely.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Safety shoes required during the lifting operations.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Disassembly procedure with the lifting equipment to be provided in the relevant manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Electrical cabinet

1 - Mechanical hazards

1.10 - shearing

Assembly, installation

Hazard description

Risk of getting sheared on hands/arms during the installation of cables in the lower part of the cabinet.

Risk assessment and risk reduction

	1	Risk IN: SH: Slight injury, RA: Hardly possible, PO: Middle			
1	PPE	PPE to be considered during installation process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.8 - shock

Testing

Hazard description

Risk of touching the live wires in the cooling skid panel and getting a shock during troubleshooting process.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	IP20 rated covers to be considered to avoid the touching of live wires.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	PPE should be considered necessary during the trouble shooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	PIC	Caution marking regarding the risk of electrical shock to be pasted on the cabinet.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Troubleshooting

Hazard description

Risk of touching the live wires in the cooling skid panel and getting a shock during troubleshooting process.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	IP20 rated covers to be considered to avoid the touching of live wires.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	PPE should be considered necessary during the trouble shooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
3	PIC	Caution marking regarding the risk of electrical shock to be pasted on the cabinet.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Power Converter container, 10'

Limit of the product: Use-, space-, time- and other limits

Container 10'

2 - Electrical hazards

2.8 - shock

in all phases of the "life"

Hazard description

Risk of shock due to improper grounding of the system.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Grounding should be done as presented in the general arrangement diagrams.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Ground continuity testing to be performed before starting the system.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3		Caution marking as per '60204-1:2016 Clause 8 paragraph 8.2.4: Each protective conductor connecting point shall be marked or labelled as such, using the symbol IEC 60417-5019:2006-08, or with the letters PE, the graphical symbol being preferred, or by use of the bicolor combination GREEN-AND-YELLOW, or by any combination of these' to be pasted in the container'.	PLr / SILr	PL / SIL	Applied documents
		Risk OUT:			

Risk adequately reduced ☑ No ☐ Yes

Electrical Cabinets

2 - Electrical hazards

2.8 - shock

Commissioning, adjustments

Hazard description

Risk of electric shock from control panel if the front door is opened during rainy or snowy conditions.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Trouble shooting or commissioning operations in rainy and snowy weather conditions to be avoided.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	SCP	Rain roof to be added to avoid the snow and water accumulation in the panel.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Testing

Hazard description

Risk of shock during the trouble shooting in the control panel as there are measurements wires coming in the control panel for output container (3X400V AC, 750V DC) from the main output panel and DC link.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Tools according to EN 60 900 with 'double triangle', Gloves, safety goggles, suitable clothing and shoes to be used during trouble shooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Caution labels indicating electric shock risk.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.8 - shock

Troubleshooting

Hazard description

Risk of shock during the trouble shooting in the control panel as there are measurements wires coming in the control panel for output container (3X400V AC, 750V DC) from the main output panel and DC link.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Tools according to EN 60 900 with 'double triangle', Gloves, safety goggles, suitable clothing and shoes to be used during trouble shooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Caution labels indicating electric shock risk.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Ventilation for output container

1 - Mechanical hazards

1.3 - crushing

Malfunctioning

Hazard description

Risk of crushing during disassembly of fan for the repair.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	OI	Ballard should be contacted if the fan malfunctions before disassembling it. This info to be mentioned in the relevant manual.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

Transformer

1 - Mechanical hazards

1.3 - crushing

Transport

Hazard description

Displacement of the transformer in the container during transport could possibly result in crushing personnel while opening the main door on site.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Transformer to be fixated with brackets before transport.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	OI	Visual inspection to be done from the side door before opening the main doors onsite. Follow the proper sequence mentioned in the transport manual when the container arrives.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

	0	Risk IN: SH: No injury, PO: Small			
3	OI	Manual should be provided with info about securing the transformer for transport with a steel spacer block. Prior to transformer energising, the block should be replace by the insulator.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 26-08-2024

1 - Mechanical hazards

1.11 - slipping, tripping and falling

in all phases of the "life"

Hazard description

Risk of tripping on the cable trays and hit the head against the transformer terminals or other components.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	PPE	Safety helmets to be considered during trouble shooting process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Yellow and black tapes to be pasted on the floor as a caution.	PLr / SILr	PL / SIL	Applied documents
		Risk OUT:			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.3 - effects on medical implants

Normal operation

Hazard description

Individuals with a ICD- implantable cardioverter defibrillator could possibly get disturbed due the electromagnetic field inside and outside the container.

Risk assessment and risk reduction

	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	OI	Individuals using ICD- implantable cardioverter defibrillator to be restricted near the container and to be mentioned in the safety manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PIC	Caution lables about electromagnetic fields to be pasted on the container	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

2 - Electrical hazards

2.4 - electrocution

Testing

Hazard description

Risk of electrocution while performing testing with temporary transformer connections.

Risk assessment and risk reduction

	7	Risk IN: SH: Death, DS: Often to continuously, RA: Possible under certain circumstances, PO: Small			
1	SCP	Lockout/tagout procedures to followed precisely.	PLr / SILr	PL / SIL	Applied documents
	1	Risk OUT: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	OI	Verification of no residual voltage at the terminals before proceeding the work.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

AC power connection (customer interface)

1 - Mechanical hazards

1.4 - cutting or severing

Assembly, installation

Hazard description

Risk of cutting hands/arms during the installation of the cables on the busbars.

Risk assessment and risk reduction

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
1	PPE	Proper gloves and arm coverings to be considered during installation.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☐ No ☑ Yes Chaudhary Hijab 12-08-2024

2 - Electrical hazards

2.4 - electrocution

in all phases of the "life"

Hazard description

Risk of electrocution if the system is not deenergized completely while the individuals are working on the installation.

Risk assessment and risk reduction

	0	Risk IN: SH: No injury, PO: Small			
1	PIC	Warning labels should be pasted on each container door to avoid access.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	5	Risk IN: SH: Death, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
2	OI	Locking out and tagging out the circuit breaker at the customer end to be declared mandatory and to be mentioned in the integration manual.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Main power output container

2 - Electrical hazards

2.8 - shock

Troubleshooting

Hazard description

Risk of shock if a person enters the container during the operation.

Risk assessment and risk reduction

	6	Risk IN: SH: Death, DS: Rarely to more often, RA: Hardly possible, PO: Small			
1	SCP	Two types of safety locks to be installed in the container. One for restricting access and other for disconnection of power inside the container. The latter one will not prevent the access but turns off the power in the container as a safety measure. Both main doors to be locked using padlocks.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	OI	Instructions for not allowing personnel entry in the container to be added in the manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			
	0	Risk IN: SH: No injury, PO: Small			
3	OI	Proper instructions about deenergizing equipment in the container to be added in the manuals.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: No injury, PO: Small			

	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
4	PIC	Caution stickers on the container doors marking no entry/high voltage electric shock risk as per '60204-11 clause 7 paragraph 17.2'.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

4 - Noise hazards

4.1 - discomfort

Normal operation

Hazard description

Discomfort due to the high level of noise from converters and other equipment outside and close to the container.

Risk assessment and risk reduction

	1	Risk IN: SH: Serious injury, DS: Rarely to more often, RA: Possible under certain circumstances, PO: Small			
1	SCP	Noise level to be measured during the testing process.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
	0	Risk IN: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			
2	PPE	Hearing protections to be considered near the container.	PLr / SILr	PL / SIL	Applied documents
	0	Risk OUT: SH: Slight injury, RA: Possible under certain circumstances, PO: Small			

Risk adequately reduced ☑ No ☐ Yes

Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	11/08/2023	First Issue
002	01/05/2025	Updated and ABS certificate added

Document Title:	**BLPH Project - Type Approval Certificates**
Document Number:	K559-2254-CWIWP4202202-K12-001
Revision:	Rev001
Sequence Number:	001
File Name:	K559-2254-CWIWP4202202-K12-001Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	K12
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

TYPE APPROVAL CERTIFICATE

Certificate No:
TAE00004GG
Revision No:
2

This is to certify:

That the Fuel Cell

with type designation(s)
FCwave

Issued to
Ballard Power Systems Europe A/S
Hobro, Nordjylland, Denmark

is found to comply with
DNV rules for classification – Ships

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV.

Issued at **Hamburg** on **2023-07-14**
This Certificate is valid until **2027-05-31**.
DNV local unit: **Denmark CMC**

Approval Engineer: **Sven Lellesch**

for **DNV**

Olaf Drews
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.

Product description

FCwave™ is a PEM fuel cell power module with rated power of 200 kW for marine applications. The system is comprised of an enclosure with an internal separate lower and upper cabinet. The system, lower and upper cabinet, each have individual serial numbers and can be replaced during the service lifetime of the product.

The fuel for the system is pressurized gaseous hydrogen. The hydrogen storage system is not part of Ballard Power Systems Europe scope and therefore not part of the type approval. Oxidant for the reaction is drawn from ambient air and compressed in the internal compressors to feed the fuel cell stacks.
From the stacks, the module will deliver up to 720V direct current to the output of the system. It acts as a load follower electrically. The system needs power from external power source such as the vessels power system to start up, but when running it self-powers the internal Balance of Plant components. The controller and safety system require 24 VDC continuously from the vessels power system to function.
The system requires external water cooling to remove excess heat from the exothermic reaction in the fuel cells. The heat transfer is done with the integrated heat exchanger. The heat can be used in shipboard systems or disposed of as the customer desires. The fuel cells used in the system are Low Temperature PEM fuel cells. Temperatures in the system are below 100°C. The Fuel cell system is built into a cabinet. The cabinet has an ingress protection of IP44. The system is designed to be installed inside a fuel cell installation room. FCwave™ follows the gas safe machinery space concept as per IGF Code.

System Data

Control System Hardware and Software Version

Software	2.X.X	Dated 01/06 2023
Firmware	4.0.4.0	Dated 24/11 2021 (Deif AS)

Safety System Hardware and Software Version

Software	1.1.0	Dated 01/06 2023
Firmware	4.4	01/27 2022 (Siemens)

Independent Safety triggered by

Hydrogen concentration measurement inside fuel cell
External E Stop
Heat Detection inside fuel cell
Smoke Detection inside fuel cell
Ventilation Air Flow inside fuel cell

Interfaces to vessel

Are to be coordinated for each installation
Fuel Cell installation Room and Room requirements
Vessel control system
24VDC safety power supply
24VDC power supply
DC input/output
H2 supply
Low temperature cooling supply
High temperature cooling supply
H2 Enclosure ventilation outlet
Process exhaust outlet
H2 Enclosure ventilation Inlet
Process air inlet
Water drain

Application/Limitation

Fuel cell of type FCwave™ is approved for application as per DNV-RU-SHIP Pt.6 Ch.2 Sec.3.

Installation room
The fuel cell space (H2 enclosure as part of the FCwave™ cabinet) is not equipped with A60 insulation and is not equipped with a fire extinguishing system as indicated in MSC.1/Circ.1647 para 3.1.2 and 3.3.1. Additional installation room requirements shall be defined in the detailed design phase for the vessel.

The installation room is regarded as non-hazardous space.
The free volume of the installation room shall not be less than 10m³.
Gas detection is recommended for the fuel cell installation room and in the ventilation exhaust.

The FCwave™ does not provide an emergency stop button. Adequate and accessible emergency stop buttons shall be provided and integrated to the FCwave™ emergency stop circuit.
Access to the installation room during operation shall be limited to trained service technicians and crew that have received Ballard fuel cell training. Unrestricted access to the installation room can be permitted when all fuel cell modules are powered off and otherwise deemed permissible.

Hydrogen supply
Supply piping to each cabinet shall be carried out as double walled piping following the IGF Code principles.
Each FCwave™ cabinet shall be provided with a shut-off valve with a closing time of less than 2 seconds.
The hydrogen mass flow to each FCwave™ must be restricted by suitable means in all operation scenarios to 4.9g/s.
The dimension (diameter and length) of the hydrogen supply piping from shut-off valve to module interface plate shall not exceed 5000 cm³ as per Integration Manual.

Ventilation
The fuel cell space (H2 enclosure as part of the FCwave™ cabinet) is designed with area classification according to IEC 60079-10:2020, at least suitable for zone 2 installation.
In all cases process air and ventilation exhaust must remain separated, combination of multiple systems exhaust of the same type only. If process and/or ventilation exhausts are combined from multiple systems, they must be equipped with separate isolation dampers, which must close if the module are not operating.
The integration to the vessel shall ensure the exhaust from FC modules (ventilation air) is led to a safe location free of any spark or ignition source.

Approval Conditions
For each delivery to DNV class the following documentation of the fuel cell power installation is to be submitted for approval:

Fuel cell power installation
- Reference to this type approval certificate
- Documents according to DNV RU-SHIP, Pt. 6 Ch. 2 Sec. 3, table 3 for Fuel cell power installation
- G060 Structural fire protection drawing
- G200 Fixed fire protection drawing
- MAN002 Integration Manual

The Type Approval covers hardware and software listed under product description.

When the type approved software is revised (affecting all future deliveries) DNV is to be informed by forwarding updated software version documentation. If the changes are judged to affect functionality for which rule requirements apply a new functional type test may be required and the certificate may have to be renewed to identify the new software version.

Product certificate
Each delivery of the application system is to be certified according to Pt.6, Ch.2, Sec. 3. The certification test is to be performed at the manufacturer of the application system before the system is shipped to the yard. After certification, the clause for application software control will be put into force

Application software control
All changes in software are to be recorded as long as the system is in use on board. Documentation of major changes are to be forwarded to DNV for evaluation and approval before implemented on board

Type Approval documentation

Tests carried out

Marking of product
The components shall be marked for traceability to the Type Approval.

Periodical assessment
For retention of the Type Approval, a periodical assessment as per DNV-CP-0338 Sec.4 shall be performed by a DNV Surveyor in order to verify that the conditions for the Type Approval are complied with.
To check the validity of this certificate, please look it up in https://approvalfinder.dnv.com.

Certificate No: LR23327644TA
Issue Date: 27/07/2023
Expiry Date: 26/07/2028

Type Approval Certificate

This is to certify that the undernoted product(s) has/have been tested with satisfactory results in accordance with the relevant requirements of the Lloyd's Register Type Approval System.

Manufacturer	**Ballard Power Systems Europe A/S**
Address	Majsmarken 1, Hobro, 9500, Denmark
Type	Fuel Cell Module
Description	FCwave™ is a PEM fuel cell power module with rated power of 200 kW for marine applications. The system is comprised of an enclosure with an internal separate lower and upper cabinet. The system, lower and upper cabinet, each have individual serial numbers and can be replaced during the service lifetime of the product. The fuel for the system is pressurized gaseous hydrogen. The hydrogen storage system is not part of Ballard Power Systems Europe scope and therefore not part of the type approval. Oxidant for the reaction is drawn from ambient air and compressed in the internal compressors to feed the fuel cell stacks. From the stacks, the module will deliver up to 720V DC to the output of the system. It acts as a load follower electrically. The system needs power from external power source such as the vessels power system to start up, but when running it self-powers the internal Balance of Plant components. The controller and safety system require 24V DC continuously from the vessels power system to function. The system requires external water cooling to remove excess heat from the exothermic reaction in the fuel cells. The heat transfer is done with the integrated heat exchanger. The heat can be used in shipboard systems or disposed of as the customer desires. The fuel cells used in the system are Low Temperature PEM fuel cells. Temperatures in the system are below 100°C. The Fuel cell system is built into a cabinet. The cabinet has an ingress protection of IP 44. The system is designed to be installed inside a fuel cell installation room.

Jin Meng

Electrical & Control - Senior Specialist to
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Type Approval Certificate

FCwave™ follows the gas safe machinery space concept as per IGF Code.

Trade Name

FCwave™

Application

Marine, Offshore and Industrial applications for use in environmental categories ENV1, as defined in Lloyd's Register Type Approval System, Test Specification Number 7, Fuel Cell Modules, January 2023.

Specified Standard

-Manufacturer's specification
-IACS UR E10 Rev. 8 / 2021 as applicable

Ratings

-Maximum rated output power: 200kW
-Operating voltage: 350 – 720V DC
-Rated current: 2 x 300A or 1 x 550A

Other Conditions

The Fuel Cell Module is approved subject to the following conditions:

- A risk assessment specific to fuel cell power installations is to be carried out for each installation on board.The risk assessment is to evaluate risks related to the safe operation of the ship and as such is to address the safety of the fuel cell power installation itself and, where the fuel cell installation provides power for propulsion of the ship or other essential services, the dependability of the fuel cell power installation.
- The Fuel Cell Module shall only be used in accordance with the manufacturer's instructions and recommendations.
- The Fuel Cell Module shall be installed and maintained in accordance with the applicable rules, regulations, and standards for marine applications.
- The Fuel Cell Module shall be operated and monitored in accordance with the relevant safety requirements.
- The Fuel Cell Module shall be subject to periodic inspections and maintenance, in accordance with the manufacturer's recommendations and applicable rules and regulations.

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Type Approval Certificate

Type Approval does not eliminate the need for normal inspection and survey procedures required by the Rules and Regulations.
If the specified standards are amended during the validity of this certificate, the product is to be re-approved prior to it being supplied to vessels to which the amended standards apply.

This certificate is not valid for equipment, the design, ratings or operating parameters of which have been varied from the specimen tested. The manufacturer should notify Lloyd's Register EMEA of any modification or changes to the equipment in order to obtain a valid Certificate.

The Design Appraisal Document HPC2262032/JM/PH and its supplementary Type Approval Terms and Conditions form part of this Certificate.

71 Fenchurch Street, London, EC3M 4BS, United Kingdom

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Confirmation of Product Type Approval

Company Name: BALLARD POWER SYSTEMS EUROPE A/S

Address: MAJSMARKEN 19500 HOBRO Denmark

Product: Fuel Cell

Model(s): FCwave

Endorsements:

Certificate Type	Certificate Number	Issue Date	Expiry Date
Product Design Assessment (PDA)	24-2503176-PDA	01-JUL-2024	30-JUN-2029
Manufacturing Assessment (MA)	24-6556075	26-AUG-2024	25-AUG-2029
Product Quality Assurance (PQA)	NA	NA	NA

Tier
5 - Unit Certification Required

Intended Service
Main & Auxiliary Power Generation for Marine and Offshore Applications

Description
FCwave is a low temperature PEM fuel cell power system with rated power output of 200kW for marine applications. The system is comprised of an enclosure with an internal separate lower and upper cabinets, each has individual serial numbers and can be replaced during the service lifetime of the product, as necessary.

Ratings
Power output: 200 KW

H2 Inlet Supply Pressure: 3.5 - 6.5 barg

H2 Design Temperature of operation: 0 - 80°C

Fuel Cell Hydrogen Operating Pressure: 0.2 - 1.0 barg

H2 Flowrate to Valve Block: 4.9 g/s

Ingress Protection of Cabinet: IP44

Operating Ambient Temperature: 0 -45 degree

Service Restrictions
Unit Certification is required for this product as indicated in the 4-9-3/Table 2 and 4-9-9/15.7 of the ABS Rules for Building and Classing Marine Vessels (2024).

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If the manufacturer or purchaser request an ABS Certificate for compliance with a specification or standard, the specification or standard, including inspection standards and tolerances, must be clearly defined.

Comments

1. The Manufacturer has provided a declaration about the control of, or the lack of Asbestos in this product.

2. During final installation the attending Surveyor is to verify that redundant gas detectors able to detect H2 are installed in the appropriate locations and operate properly. Any accumulation of gas to 20% LFL should trigger gas detector alarm and accumulation to 40% LFL should trigger the ESD.

3. During final installation the attending Surveyor is to verify that the FCwave is equipped with anchor mechanisms or other suitable attachments to the base structure or the hull.

4. Upon installation, the Surveyor is to verify that the door air intakes/inlets are clear to minimize the risk of complete blockage.

5. Upon installation, the Surveyor is to verify that the Chassis is properly grounded.

6. After assembled to a complete assembly unit or subassembly unit, each production unit of equipment used in control, monitoring and safety systems is to be tested at the manufacturer’s shop in the presence of the ABS Surveyor according to 4-9-9/15.7 TABLE 2 as follows:

i) Visual inspection

ii) Performance test

iii) External Power supply failure

7. FCwave system has been assigned with a Category II system classification per 4-9-3/Table 1 of the Marine Vessels Rules. Accordingly, the following tests are to be performed and are to be witnessed by the Surveyor at the Factory in accordance with 4-9-3/Table 2 of the Marine Vessels Rules (MVR).

i) 3.6: Fault Simulation.

ii) 3.7: Factory Acceptance Tests.

8. The design applies the Hazardous Zone Classification method of IEC 60079-10. The fuel cell installation room is considered as a Non-Hazardous Zone or Zone 2 with negligible extent in accordance with IEC 60079-10-1/Table D.1, with all hydrogen fuel piping entering the space and leading to or from the non-structural fuel cell space enclosure to be provided with a double-wall containment system appropriate to the fuel used by the piping.

9. Structural fire protection shall apply to the fuel cell installation room boundaries, not the fuel cell space enclosure; fire detection and fire extinguishing system requirements shall apply to the fuel cell installation room, not within the fuel cell space enclosure as per Section 3 of Fuel Cell Power Systems Requirements.

10. For each installation, safety concepts including the hazardous zone of the fuel cell installation room and multiple installation of the fuel cell units are to be declared to the flag administration for further consideration and evaluated during the risk assessment.

Notes, Drawings and Documentation

Drawing No. 120-26421-1, FCE003-4.5 EMC test report, Revision: A, Pages: 1

Drawing No. 28859 O60X2 Stainless steel pipe Cert. no. 40144, Double Wall H2 pipe, Revision: A, Pages: 1

Drawing No. 28914 O20X2 Stainless steel pipe Cert no. 466220, Double Wall H2 pipe, Revision: A, Pages: 2

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Drawing No. 4006956 Datasheet, Fire Wire, Revision: A, Pages: 1

Drawing No. 7000090 - Double Wall pipe drawing, Double Wall H2 pipe, Revision: A, Pages: 3

Drawing No. CMS001, Control and safety system description, Revision: A, Pages: 1

Drawing No. CMS003, Control systems diagrams, Revision: A, Pages: 1

Drawing No. CMS004, Power supply arrangement - Schematics, Revision: A, Pages: 1

Drawing No. CMS004-A, Power supply arrangement, Revision: A, Pages: 1

Drawing No. CMS004-B, High voltage supply arrangement , Revision: A, Pages: 1

Drawing No. CMS004-C, Sensor Single Line Diagram, Revision: A, Pages: 1

Drawing No. CMS004-E, FCWave Circuit Diagrams, Revision: A, Pages: 1

Drawing No. CMS005_SEL005, Instrument Cables and equipment list, Revision: A, Pages: 1

Drawing No. CMS006_SEL004, Electrical Datasheet, Revision: A, Pages: 1

Drawing No. CMS007_SAX001, Control Software Specification, Revision: A, Pages: 1

Drawing No. CMS008, Field Instruments periodic test plan, Revision: A, Pages: 1

Drawing No. CMS008-A, Field Instrument List, Revision: A, Pages: 1

Drawing No. CMS009, Software Quality Plan, Revision: A, Pages: 1

Drawing No. CMS010, Schematic description of input and output circuits, Revision: A, Pages: 1

Drawing No. CMS012, Control Monitoring and Safety Test Procedure, Revision: A, Pages: 1

Drawing No. CMS012-A CMS012 Test Report 4, CMS012-A CMS012 Test Report 4, Revision: -, Pages: -

Drawing No. CMS013, CAN matrix, Revision: A, Pages: 1

Drawing No. CMS014, Control System Alarm List, Revision: A, Pages: 1

Drawing No. CMS015, Safety System Documentation, Revision: A, Pages: 1

Drawing No. Correspondence, PDA Preliminary Comment Responses, Revision: 0, Pages: 26

Drawing No. Correspondence, PDA Application New PDA Fuel Cell Power System, Revision: -, Pages: -

Drawing No. FAT001, System FAT, Revision: A, Pages: 1

Drawing No. FAT002, FAT with surveyor, Revision: A, Pages: 1

Drawing No. FCE003, Test programme, Revision: A, Pages: 1

Drawing No. FCE003-2, Safety Test Programme, Revision: A, Pages: 1

Drawing No. FCE003-3, Performance Test Programme, Revision: A, Pages: 1

Drawing No. FCE003-4.1, Inclination Test Programme, Revision: A, Pages: 1

Drawing No. FCE003-4.2, Vibration Test Programme, Revision: A, Pages: 1

Drawing No. FCE003-4.3, Environmental Climate Chamber Test Programme, Revision: A, Pages: 1

Drawing No. FCE003-4.4, Power Supply Test Programme, Revision: A, Pages: 1

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Drawing No. FCE003-4.5, EMC Test Programme, Revision: A, Pages: 1

Drawing No. H2E Purge Valve Datasheet, H2E Purge Valve, Revision: A, Pages: 6

Drawing No. INT001 Explosion Analysis Report 1, INT001 Explosion Analysis Report 1, Revision: -, Pages: -

Drawing No. MAN001_SEL003, Service Manual, Revision: A, Pages: 1

Drawing No. MAN002, Integration Manual, Revision: A, Pages: 1

Drawing No. N1424AY6-A1013702, FCE003-4-4 Power supply failure test report, Revision: A, Pages: 1

Drawing No. N1427ES7-A1110380, FCE003-2 2.2 Temperature Test, Revision: A, Pages: 1

Drawing No. N1427X8Y-A1121839-rev01, FCE003-2 2.5 Safety System Test, Revision: A, Pages: 1

Drawing No. N14284B8-A1125744, FCE003-3 DV29 Nameplate power performance test, Revision: A, Pages: 1

Drawing No. N14284YU-A1127125-rev01, FCE003-2 2.3 Back Pressure Test, Revision: A, Pages: 1

Drawing No. N1428BMZ-A1133039, FCE003-2 2.6 Electric Safety Test, Revision: A, Pages: 1

Drawing No. N1428NN3-A1141771, FCE003-3 DV32_33 Response time/start-stop test, Revision: A, Pages: 1

Drawing No. N1428NN4-A1141772, FCE003-2 2.1 Safety Pressure Test, Revision: A, Pages: 1

Drawing No. N1429D4U-A1156670, FCE003-4.1 Inclination test, Revision: A, Pages: 1

Drawing No. N1429EKW-A1157845, FCE003-2 2.4 Block Airways Test, Revision: A, Pages: 1

Drawing No. PRC001…005, Design criteria for pressure containing components, Revision: A, Pages: 1

Drawing No. PWR001, Arrangement Plan, Revision: A, Pages: 1

Drawing No. PWR002, PPHA FCWave, Revision: A, Pages: 1

Drawing No. PWR003, Hazardous Area classification plan, Revision: A, Pages: 1

Drawing No. PWR004, Piping diagram, Revision: A, Pages: 1

Drawing No. PWR005, P&ID, Revision: A, Pages: 1

Drawing No. PWR005, P&ID, Revision: , Pages: 1

Drawing No. PWR006, Functional description, Revision: A, Pages: 1

Drawing No. PWR007_PWR002, Safety description (Risk asessment), Revision: A, Pages: 1

Drawing No. PWR008-C, Commissioning checklist, Revision: A, Pages: 1

Drawing No. PWR008_TES001, Commissioning procedure, Revision: A, Pages: 1

Drawing No. PWR009, Safety concept, Revision: A, Pages: 1

Drawing No. Pipes 106039 1 DOC, Double Wall H2 pipe, Revision: A, Pages: 4

Drawing No. SVE001…003, Ventilation diagram, Revision: A, Pages: 1

Drawing No. Silicon Hose Datasheet, Silicone Hose, Revision: A, Pages: 3

Drawing No. Silicone Hose 7000046 - Fuel outlet manifold, Silicone Hose, Revision: A, Pages: 2

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Drawing No. Silicone Hose 7000047 - Fuel inlet manifold, Silicone Hose, Revision: A, Pages: 3

Drawing No. TAC 44860/B2 BV, BV_Hy-Lok_Tube_Fittings_2022, Revision: -, Pages: -

Drawing No. Tube fittings catalogue, HY-LOK 7000778, Revision: -, Pages: -

Term of Validity
This Product Design Assessment (PDA) Certificate remains valid until 30/Jun/2029 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or previous to the effective date of the ABS Rules and standards applied at the time of PDA issuance. Use of the Product for non-ABS units is subject to agreement between the manufacturer and intended client.

ABS Rules
Rules for Conditions of Classification, Part 1 - 2024 Marine Vessel Rules 1-1-4/7.7, 1-1-A3, 1-1-A4, Which covers the following:

Marine Vessel Rules (MVR) 2024 :4-9-3/Table 1, 4-9-3/Table 2, 4-9-9/15.7, 5C-13-7/3, 5C-13-16/1.1

Requirements for Fuel Cell Power Systems for Marine and Offshore Applications 2023

International Standards
IEC 60079-10: Classification of Area – Explosive Gas Atmosphere

IEC 62282-2-100:2020, Fuel cell technologies - Part 2-100: Fuel cell modules – Safety

IEC 62282-3-100:2019, Fuel cell technologies - Part 3-100: Stationary fuel cell power systems - Safety

EU-MED Standards
NA

National Standards
NA

Government Standards
NA

Other Standards
NA





Corporate ABS Programs
American Bureau of Shipping

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Print Date and Time: 30-Aug-2024 2:49

ABS has used due diligence in the preparation of this certificate, and it represents the information on the product in the ABS Records as of the date and time the certificate is printed.

If the Rules and/or standards used in the PDA evaluation are revised or if there is a design modification (whichever occurs first), a PDA revalidation may be necessary.

The continued validity of the MA is dependent on completion of satisfactory audits as required by the ABS Rules. The validity of both PDA and MA entitles the product to receive a **Confirmation of Product Type Approval**.

Acceptance of product is limited to the “Intended Service” details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or prior to the effective date of the ABS Rules and standards applied at the time of PDA issuance. ABS makes no representations regarding Type Approval of the Product for use on vessels, MODUs or facilities built after the date of the ABS Rules used for this evaluation.

Type Approval requires Drawing Assessment, Prototype Testing and assessment of the manufacturer's quality assurance and quality control arrangements. The manufacturer is responsible to maintain compliance with all specifications applicable to the product design assessment. Unless specifically indicated in the description of the product, certification under type approval does not waive requirements for witnessed inspection or additional survey for product use on a vessel, MODU or facility intended to be ABS classed or that is presently in class with ABS.

Due to wide variety of specifications used in the products ABS has evaluated for Type Approval, it is part of our contract that; whether the standard is an ABS Rule or a non-ABS Rule, the Client has full responsibility for continued compliance with the standard.

Questions regarding the validity of ABS Rules or the need for supplemental testing or inspection of such products should, in all cases, be addressed to ABS.

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CROSSWIND

TECHNICAL QUERY
Hollandse Kust Noord

No. TQ :	BALL-CW-TQ-0002	Rev:	1

Originating Party	Ballard Power Systems Europe A/S					
Subject	Hydrogen interface					
Author	Rasmus Simonsen	TQ Aconex unique number: BPSE-INN-BPH-TQ-00007				
Interface TQ - from		TQ interface source Aconex unique number:				
Type	Query		x	Interface		x
	Deviation			Derogation (SHALL[PS])		
	Note: No deviations nor derogations which have an adverse effect on HSSE will be granted					
Workpackage	Fuel Cells					
Area(s) of application	Design & Eng.	x	Procurement		Construction	
	Commissioning		Operations		Other	
Issue date	03-04-2024		Urgent reply 5 days		Routine reply 10 days	x
Close-out date						
Closed-out by			TQ status:		Open	

1. Description

Reference documents / Aconex unique numbers:

- K559-2254-CWIWP4202202-C03-001 (Process and Instrumentation Diagram)

Hydrogen inlet pressure

- Ballard requests to raise the minimum hydrogen inlet pressure at =HA01+DA02-XM01 from minimum 3.5 BarG to minimum 4.0 BarG due to extended pressure losses in the system.
- Ballard requests that the nominal setting of the pressure regulator is 6 barG.
- The advantage of this is eliminating the risk of low-pressure dropout during operation at full power.
- Operation of the FC package with inlet pressures below 4.0 barG is possible with reduced power (estimated <600kW)

2. Response

Reference documents / Aconex unique numbers

This communication is issued for the recipient's information and to facilitate the obligations of the Parties under the Contract. This communication has no authority to amend or vary the Contract nor relieve either Party of any duties, obligations or responsibilities.

CW – PROCESS
Simple analysis indicates that this should not be a problem as it is within the previous operating pressure range of 3.5 to 6.5 barg.

Rosetti acknowledges above requirements and it will proceed with this change including the one reported in CW-ROS-TQ-0016

This communication is issued for the recipient's information and to facilitate the obligations of the Parties under the Contract. This communication has no authority to amend or vary the Contract nor relieve either Party of any duties, obligations or responsibilities.

Commissioning Query Form

		QUERY NUMBER	*CQ-004*		
SITE ORIGINATOR TO COMPLETE		**ORIGINATING LOCATION REF. NO**			
		DISCIPLINE:	**Electrical**	LOCATION:	**Fuel Cell FC30/6.6KV Board SG-100D1**
		WORKPACK REF:			
		SYSTEM:20-00		SUB SYSTEM:	N/A
			Print: John Mackillop	*Sign: John Mackillop*	*Date: 17.02.25*
		DESCRIPTION OF QUERY			
		While carrying out commissioning of the fuel cell package, it was noted that when an E-stop is activated only the fuel cell would trip (LV ACB FC30-400v). It was expected that a trip command would have also been sent upstream to the 6.6kV SG100D1-6.6kV-A7) supply as well. According to the documentation this trip is a available but not requested . The design philosophy of BLPH is that it will be unmanned during normal operation and 6.6kV supply shut down if personnel are required to be on-board . However this is not the case during commissioning when there will be a work team present. Therefore for the purpose of personnel safety we would request the upstream trip to the 6.6kV SG100D1-6.6kV-A7 is implemented.		
		LIST OF DOCUMENTS ATTACHED (INCLUDE NAME / DESCRIPTION / REVISION / DATE OR N/A)			
		Please see attached documents in email			
		PROPOSED SOLUTION			
		Include an inter-trip upstream to trip the 6.6kV VCB when a Fuel Cell E-Stop is activated			
		APPROVED FOR ISSUE BY SITE AUTHORISED SIGNATORY: (Y or N?)		*Print: Martin Taylor*	*Sign: Martin Taylor* / *Date: 17/02/25*
ENGINEERING TO COMPLETE		RECEIVED BY: (Y or N?)		*Print:*	*Sign:* / *Date:*
		ENGINEERING TECHNICAL RESPONSE			
		>> Detail the technical discipline response to the above query and proposal here Engineering confirm the facilities are available in all 6.6kV switchgear supply circuit breakers to provide a remote trip function. During the design process (FEED and Detailed Design), mutiple SAFOP workshops were held with KBR/Shell and CW/CPI/RM vendors. The objective of the Electrical SAFOP is to identify safety hazards or operability problems inherent in the design and operating philosophies of the electrical systems. The outcome of the study should be incorporated as much as practicable into the Design. The process applied during a SAFOP review of the electrical installation involves implementation of three studies, referred to as SAFOP studies, by a multi-disciplined team of engineers. Each of these studies is specifically structured to aid identification of deficiencies in the design of the electrical installation and remedial actions to address them: • The functioning and operation of the system and its components (SYSOP – System Operability) • The plant layout and accessibility (SAFAN – Safety Analysis) • The operability of the facilities (OPTAN – Operator Task Analysis) The SAFOP study is to complement the engineering design by providing an overall assessment of the project from the viewpoints of safety and operations. Outcome of the SAFOP did not make any recommendation to incorporate a hardwired trip to the 6.6kV switchgear supply circuit breakers on operation of the emergency stop.		

		Also during detailed design RM raised a TQ on all CPI packages (BESS, Fuel Cell, Electrolyser., Floating Solar) if any hardwired interface is required between the CPI packages and RM supply switchgear. The only hardwired trip function was requesteed by Elogen/Nidec with the Electrolyser when the DGPT2 detects a fault with Electolsyer the transformer – all other packages did not reqesust a harwired trip in the TQ responses. As such, although the trip fucntion is available, it has not been incoprporated in the design.				
		LIST OF DOCUMENTS ATTACHED (INCLUDE NAME / DESCRIPTION / REVISION / DATE OR N/A)				
		>> List any attached sketches/information required to fully describe the response here Refer SAFOP reports:				
		REQUIRES CLARIFICATIONS (Y or N?)		IF "Y", USE THE ABOVE "RESPONSE SPACE" TO DETAIL CLARIFICATION.		
		RESPONSE PREPARED BY:		*Print:*	*Sign:*	*Date:*
		APPROVED DISCIPLINE LEAD (Y or N?)		*Print:*	*Sign:*	*Date:*
		HAVE ALL RELEVANT DISCIPLINES IMPACTED BEEN INFORMED? (Y or N) PROJECT ENG TO CONFIRM.		*Print:*	*Sign:*	*Date:*
		PAC TO BE ISSUED (Y or N?)		NCR TO BE ISSUED (Y or N?)		ATRAC No.:
		APPROVED BY ASSIGNMENT ENGINEERING MANAGER (Y or N?)		*Print:*	*Sign:*	*Date:*
SITE ORIGINATOR		ORIGINATOR ACCEPTS PROPOSAL (Y or N?)		IF "NO", RETURN TO CROSSWIND WITH COMMENT		
		ORIGINATOR TO DETAIL THE ACTIONS TAKEN				
		>>Detail the actions taken here				
		SIGNATURE OF ORIGINATOR APPROVING THE PROPOSAL (Y or N?)		*Print:*	*Sign:*	*Date:*
PROJ.ENG.		TECHNICAL QUERY CLOSE OUT BY PROJECT ENGINEER (Y or N?)		*Print:*	*Sign:*	*Date:*

CROSSWIND

TECHNICAL QUERY
Hollandse Kust Noord

No. TQ :	CW-BALL-TQ-0009	Rev:	A

Originating Party	CrossWind						
Subject	Lighting and small cable trays fixing on Fuel Cell container						
Author	Stephen Bremner	TQ Aconex unique number: CWHKN-INN-BPH-TQ-00046					
Interface TQ - from	Rosetti	TQ interface source Aconex unique number: ROSMA-INN-BPH-TQ-00089					
Type	Query		X	Interface			
	Deviation			Derogation (SHALL[PS])			
	Note: No deviations nor derogations which have an adverse effect on HSSE will be granted						
Workpackage							
Area(s) of application	Design & Eng.	x	Procurement		Construction		
	Commissioning		Operations		Other		
Issue date	28-03-2024		Urgent reply 5 days	X	Routine reply 10 days		
Close-out date							
Closed-out by			TQ status:		Closed-out		

1. Description

Reference documents / Aconex unique numbers:
Attachment 1 - S-BT-HL-Data-Sheet-Technical-information

Attachment 1 - S-BT-HL-Data-Sheet-

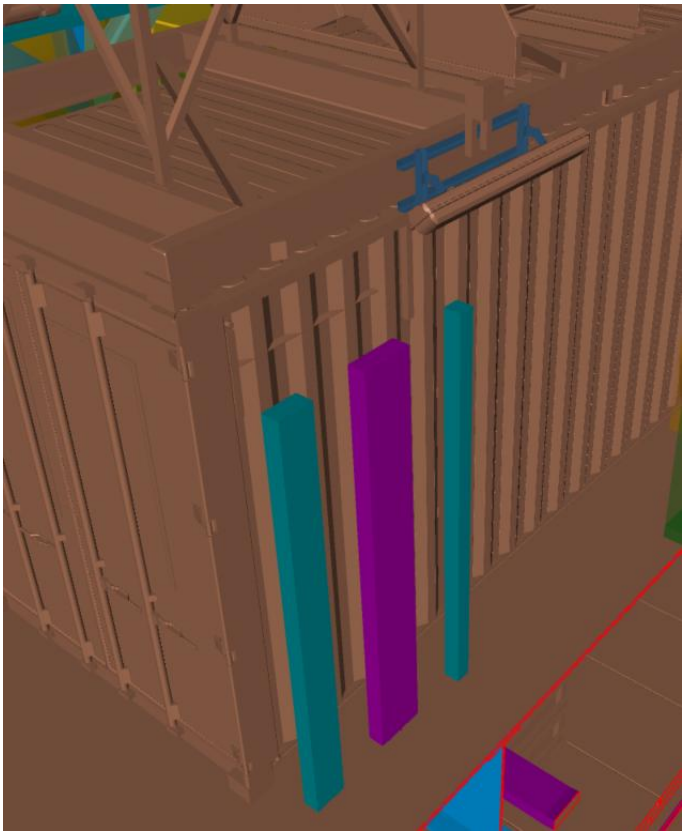
Contractor kindly asks the authorization for supporting lighting lamps and/or lightweight items and related small cable ways on Fuel Cell container, as shown in the below snapshot.

The items will be fixed on container by means of Hilti threaded studs.

Furthermore, Contractor asks to confirm whether container structure has a thickness equal or higher than 6 mm.

For a better understanding, please look at the attached threaded studs datasheet.

This communication is issued for the recipient's information and to facilitate the obligations of the Parties under the Contract. This communication has no authority to amend or vary the Contract nor relieve either Party of any duties, obligations or responsibilities.



2. Response
Reference documents / Aconex unique numbers
Ballard is unable to accommodate the request. The TQ is phrased as a blanket permission to drill and otherwise modify the container and frame. The drilling, modification, and attachment of items to the structural frame of the coolant skid and container may impact the structural strength of the frame and is highly likely to impact the integrity of the protective coating. If this issue was raised at an earlier point, Ballard could have provided pre-installed C-beams for RM to install needed items. As a suggestion, for cable trays to the interface point, the trays can be supported between the container interconnect bridge and the floor plating without any drilling or otherwise modification of the container structure. We are willing to participate in an online workshop to further understand RM desires regarding attachment of lighting, cable ladders and other small items. CW: Ballard confirmed ok in multiple tri-party meetings once more specifics were shared.

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CROSSWIND

TECHNICAL QUERY
Hollandse Kust Noord

No. TQ :	CW-BALL-TQ-0010	Rev:	A

Originating Party	CrossWind					
Subject	Hydrogen Supply Interface					
Author	Hamant Patel	TQ Aconex unique number: CWHKN-INN-BPH-TQ-00051				
Interface TQ - from		TQ interface source Aconex unique number:				
Type	Query		X	Interface		
	Deviation			Derogation (SHALL[PS])		
	Note: No deviations nor derogations which have an adverse effect on HSSE will be granted					
Work package	Fuel Cell					
Area(s) of application	Design & Eng.	X	Procurement		Construction	
	Commissioning		Operations		Other	
Issue date	17-05-2024		Urgent reply 5 days	X	Routine reply 10 days	
Close-out date						
Closed-out by			TQ status:		Closed-out	

1. Description

Reference documents / Aconex unique numbers:
Ballard P&IDs - K559-2254-CWIWP4202202-C03-001, Revision 004 08/03/2024 ;
RM BLPH P&ID HYDROGEN STORAGE VESSELS HEADER (OUTLET) - 123A90-DDL-PR-PID-80014-001, Revision 01, 24/11/2023 ;
RM BLPH P&ID FUEL CELL PACKAGE - 123A90-DDL-PR-PID-80012-001, Revision 01, 24/11/2023 ;
Attachment 1 – Basis of transient pressure increase estimation calculation; and
Attachment 2 – Sketch of Contractor / Supplier interface P&ID.

Attachement 1 : - HAZOP Action N22 Time_Calc_Rev_02.pdf

HAZOP Action N22 Time_Calc_Rev_02.pd

Attachement 2 : - H2_RM_BALLARD_Interface_P&ID_R01_HVP.pdf

H2_RM_BALLARD_Interface_P&ID_R01_H

This communication is issued for the recipient's information and to facilitate the obligations of the Parties under the Contract. This communication has no authority to amend or vary the Contract nor relieve either Party of any duties, obligations or responsibilities.

Contractor kindly asks Ballard to confirm that the transient pressure increase to 13.5 barg experienced during an infrequent lifting of PSV (80-PSV-001, Set Pressure of 10 barg), is acceptable for the piping and instrument components within Ballard scope, see Attachment 1 and Attachment 2.

Please note the lifting of the PSV is an unlikely event, and will only occur in the following scenario:

- Failure of control loop during startup of Fuel Cell (FC)with no forward flow.
  - Under this circumstance it is assumed that the FC heater has yet to come on line, thus no additional pressure increase due to thermal inertia.
- Emergency shutdown of FC resulting in no forward flow.
  - It is assumed that the 6 FC will be isolated by the closure of the 6 x two set of ESD valves (HA01-DM02-QM11 to HA01-DM02-QM16 and HA01-DM02-QM21 to HA01-DM02-QM26) to stop forward flow to FC module by Ballard internal safety system response.
  - Thermal effect needs to be considered under this scenario and this scenario has been analysed by Ballard (Ref.: Ballard, “Hydrogen Preheating System Impact Assessment”, Doc. No. K559-2254-CWIWP4202202-C99-002, Rev.001, 02/04/2024), with pressure increase to 16.2 bara (15.2 barg).

In both cases a conservative approach has been taken by only considering the volume associated with the upstream and downstream volumes at the contractor / supplier interface, respectively.

If a transient pressure increase to 13.5 barg is not acceptable, Ballard are to advise / confirm what pressure they shall accept considering the scenarios outlined above.

2. Response

Reference documents / Aconex unique numbers

Ballard can accept the transient pressure increase with the stated limitations on:

- This event only occurs as a transient event before the PSV lifts, with the PSV setpoint at 10barg
- The duration of the event is expected to be on the order of few hundreds of milliseconds, from pressure rise to PSV fully opening.

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CROSSWIND

TECHNICAL QUERY
Hollandse Kust Noord

No. TQ :	CW-ROS-TQ-0016	Rev:	1

Originating Party	CrossWind					
Subject	Design of Hydrogen Supply Pressure Control Valves : 25-PV-055 A/B					
Author	Paul Kyle	TQ Aconex unique number: CWHKN-INN-BPH-TQ-00053				
Interface TQ - from	Rosetti	TQ interface source Aconex unique number:				
Type	Query		Interface	X		
	Deviation		Derogation (SHALL[PS])			
	Note: No deviations nor derogations which have an adverse effect on HSSE will be granted					
Work package						
Area(s) of application	Design & Eng.	X	Procurement		Construction	
	Commissioning		Operations	X	Other	
Issue date	20-05-2024		Urgent reply 5 days	X	Routine reply 10 days	
Close-out date						
Closed-out by			TQ status:		Closed-out	

1. Description

Reference documents / Aconex unique numbers :

Ref.: Ballard, “Fuel Cell Package Hydrogen Usage and Fuel Cell Module Alarm Limits”, Rev.001, 24/04/2024

HydrogenFlowRates rev1.pdf

Contractor kindly asks RM to consider the below data to design the H2 control system upstream of the fuel cell interface:

- Normal Hydrogen Storage Vessel Pressure (i.e. upstream pressure): 30 barg to 5 barg.
  - Extreme pressure expected, upstream of the PVs, will be High High Pressure Alarm Point.
- Normal Hydrogen supply temperature (ambient temperatures): -8.4 ºC to 25 ºC.
- Hydrogen Supply flow range: 0.9 g/s (3.24 kg/hr) to 29.4 g/s (105.84 kg/hr).
- Hydrogen supply pressure to Fuel Cell: 4 barg to 6.5 barg.
- Normal supply pressure to be controlled at 6 barg.
- PSV (80-PSV-001) set point is 10 barg.
- Transient pressure acceptable to Fuel Cell in the event of PSV lifting, is <=13.5 barg.

Other Parameter that should be considered in determining the control response are the below Hydrogen Consumption scenarios (Ref.: Ballard, “Fuel Cell Package Hydrogen Usage and Fuel Cell Module Alarm Limits”, Rev.001, 24/04/2024):

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Scenario	Fuel Cell Modules	Description	Hydrogen Usage Initial [g/s]	Hydrogen Flowrate After [g/s]	Duration of change [s]
Startup	1	A single fuel cell module start up	0	0.9	3
Startup	3	Half (3) of the fuel cell module start up	0	2.7	3
Startup	6	All (6) of the fuel cell module start up	0	5.4	3
Ramp-up	1	Single module ramps from idle to full power	0.9	3.6	18
Ramp-up	3	Half (3) module ramps from idle to full power	2.7	10.8	18
Ramp-up	6	All (6) module ramps from idle to full power	5.4	21.6	18
Stopdown	1	A single fuel cell module performs a controlled stop	4.9 (worst) 3.9 (expected)	0	15
Stopdown	3	Half (3) fuel cell module performs a controlled stop	14.9 (worst) 10.8 (expected)	0	15
Stopdown	6	All (6) fuel cell module performs a controlled stop	29.4 (worst) 23.4 (expected)	0	15
ESD	1	A single fuel cell module performs an emergency stop	4.9 (worst) 3.6 (expected)	0	0.02 (20 ms)
ESD	6	All fuel cell modules perform an emergency stop	29.4 (worst) 23.4 (expected)	0	0.02 (20 ms)

2. Response

Reference documents / Aconex unique numbers

Rosetti acknowledges above requirements and it will proceed with this change assessing the impacts and changes.
A new control valve will be purchased and logic in split range adapted.

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