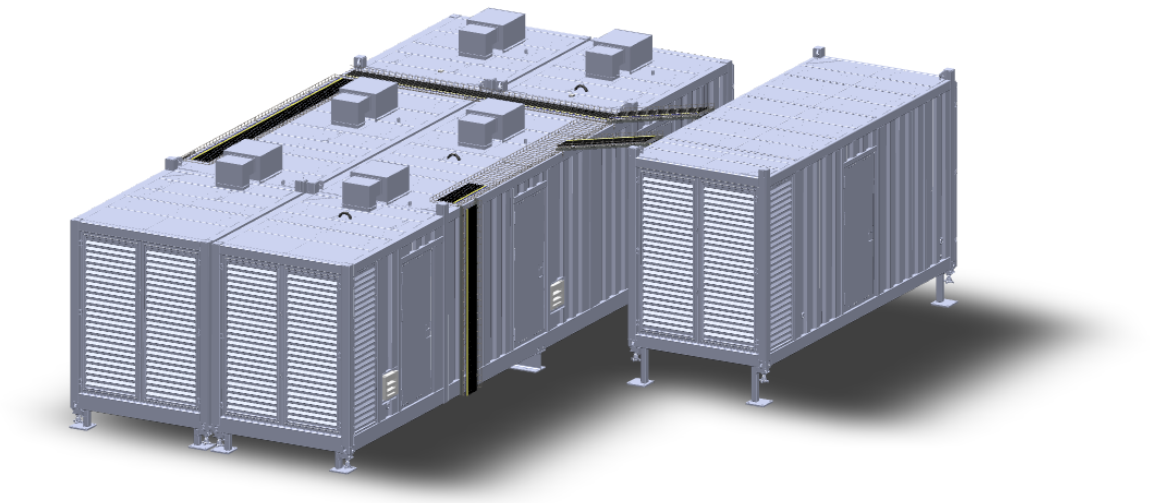
FREQCON

Operating and Maintenance Manual
BESS PRO

1 MW/ 5 MWh
6.6 kV AC

Stationary Battery Energy Storage System (BESS)



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Identification

Product and Type Designation

Type
BESS 1 MW / 5 MWh / 6.6 kV / 620 V AC

Serial number

PCS	FRQ-53396000001
BESS 1	FRQ-53406000001
BESS 2	FRQ-53412000001

Product family
BESS Energy Storage System

Product Version / Document Version

Product version
Prototype

Document release date
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Name and Address of Manufacturer and Supplier

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Original document

This document is an original document of FREQCON GmbH.

1 About these Instructions

This manual is part of the product and applies exclusively to the system described in this document.

This operating manual contains the necessary information for the proper use of the described system. The operating manual is supplied together with the product and is considered as an important part of the product.

Please read this manual carefully, as it contains important information on the installation and operation of the product.
Please pay particular attention to the notes regarding the safe use of the system.
The manufacturer accepts no liability for any damage caused by failure to observe these instructions.

Keep this manual and provide it to the new owner in case of a change of the operating company.
All personnel who have any relation of handling or operating the product must always have direct access to this manual.

All personnel who have any relation of operating the unit are obligated to read all related manuals regarding the system described in this document. The employed personnel must declare that they have fully read and understood all contents of the manuals and agree to follow all instructions, especially issues regarding safety and accident prevention.

Additional Documents

The instructions of this operating manual must be supplemented with the necessary, customary local and current accident prevention regulations, environmental protection rules and laws.

Location of the Manual

Always keep this manual within direct reach when operating or handling the unit. The operator must have direct access to the manual. The operator must have direct access to the manual.

Display Elements

Symbol	Significance
➜	Action with one or several steps for which the sequence is irrelevant.
Step 1 : **Step 2 :**	Action with several steps for which the sequence is relevant.
•	First level of list.
-	Second level of list.

1.1 Disclaimer of Liability

The contents of this publication have been reviewed to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, any necessary corrections are included in subsequent editions.

1.2 Applicable Documents

The delivery scope of the product includes the following documents:

Document	Document Name
Circuit diagram BESS 1 MW / 5 MWh (FREQCON)	10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20250123_V1.3
Data interface description (FREQCON)	23A2007_250116_Modbus_Register BESS_V1_0_0_1
Maintenance schedule – BESS (FREQCON)	EED_0000_20_Maintenance_Schedule_BESS_LFP_v1.3_EN
Operating and Maintenance Manual -AC circuit breaker 3WL (Siemens)	3ZX1812-0WL00-0AN4_online_201806140915326928
Operating Manual -DC circuit breaker 3NP1 (Siemens)	System_Manual_3NP1_3ZX1012-0NP10-1AC1_en-US
Operating, commissioning and maintenance instructions PLC Simotion P320-4 (Siemens)	P320_4_commissioning_en-US P320_4_operating_en-US
MSDS Battery Cells LF280 (EVE)	LF280K MSDS
Aerosol Safety Data Sheet (Stat-X)	Stat-X Aerosol Safety Sheet 19010.3_SDSR_Stat-X_1
Stat-X operating instructions (Stat-X)	19001 1.2.5 Owners Manual Electric DE
Operating and Maintenance Manual – exhaust units (Puma)	TFE_Direct_Driven_Unit_Run_&_Standby_O_&_M_1030
Operating and Maintenance Manual – fire dampers (Puma)	Air_Make_Up_Dampers_O&M_1032
Operating and Maintenance Manual – H2 sensors (Dräger)	Dräger Polytron 8200 manual 9033302_01_2011_enus
Operating Instructions – cable hoist	manual_2255140

Table 3: Applicable documents

1.3 Abbreviations

The following list provides descriptions about the generic terms and abbreviations used in this document:

Generic Term and Abbreviation	Significance
AC	Alternating current
Identifier	Equipment labeling
BESS	Battery Energy Storage System
BMS	Battery management system
BSU	Blackstart unit
DC	Direct current
DC-link	Direct current link
EMC	Electromagnetic compatibility
EMF	Electromagnetic fields
EMS	Energy management system
FRQ	FRFEQCON GmbH
HMI	Human-Machine Interface
HV	High voltage

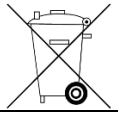
HVIO	High Voltage I/O Module
MB	Modbus
RTU	Remote Terminal Unit
TCP	Transmission control protocol
MSC	Multi-Source Converter
MV	Medium voltage
LFP	Lithium iron phosphate
LV	Low voltage
PCS	Power conversion system
PLC	Programmable Logic Controller
PPE	Personal safety equipment
IGBT	Insulated-Gate Bipolar Transistor
IEC	International Electrotechnical Commission
I/O	Input/output
IP	Internet protocol
SoC	State of charge
TR	Thermal runway
UPS	Uninterruptable power supply

Table 4: List of Abbreviations

1.4 Warning Symbols

Observe the warning symbols in this document and those attached on the device. The warning symbols have the following meaning:

Symbols	Significance
	Hazard (general)
	Hazard by voltage
	Hazard by high temperature
	Hazard by batteries
	Hazard by fire
	Maintenance lockout tagout, do not switch!
	Acute toxicity (oral, dermal, inhalation) (hazard. category 4)
	Respiratory sensitization (hazard category 1, 1A and 1B)
	Prohibition for people with pacemakers

	Hazard by heavy load
	Do not dispose in household waste. (See section 24 “Dismantling and Disposal”)

1.5 Information Symbols

Symbol	Significance
	Important technical information for this product

1.6 Warning Levels / Signal Words

DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE	Indicates that property damage can result, if proper precautions are not taken.

1.7 Target Groups

⚠ DANGER	
	**Danger from and for unauthorized persons** Unauthorized persons are not aware of the dangers in the work area and may endanger themselves and third parties. ➜ Keep unauthorized persons away from the work area. ➜ If in doubt, speak to persons and direct them away from the work area. ➜ Interrupt the work as long as unauthorized persons are in the work area. ➜ Always keep the entrance door(s) locked when not performing work on the system to prevent unauthorized persons from entering the container.

Group	Significance
Operator	• Uses the product himself for commercial or economic purposes or lets a third-party use/apply it. • During operation, bears legal product responsibility for the protection of the user, personnel and third parties. • May not open control cabinets and/or perform maintenance.
Trained person	• Has been demonstrably trained and instructed by the operator about the assigned tasks and possible dangers in case of improper behavior. • Is authorized to operate the plant. • May not open control cabinets and/or perform maintenance.
Service Personnel	• FREQCON GmbH service personnel • Personnel trained and authorized by FREQCON and authorized specialist personnel. • Carries out all other work on the plant, e. g. commissioning, maintenance work, transport, and troubleshooting.
Manufacturer	• Person who was/is involved in the development of the energy storage system and has detailed knowledge of the structure and function of the modules or the entire system - in accordance with the relevant specialist area.

Table 5: Target groups

2 Safety Instructions

2.1 The Five Safety Rules

For your own personal safety and to prevent material damage when carrying out any work, always observe the safety-relevant instructions and the following five safety rules according to EN 50110-1 "Working in a voltage-free state".



2.2 Basic Safety Information

Do not operate!	**Lock and tag power switches and controller devices**
	Follow national laws regarding occupational safety and health. ➜ Identify the energy source(s). ➜ Isolate the energy source(s). ➜ Determine voltage-free status. ➜ Ground device or equipment to protect from short circuiting and from shocks. ➜ Lock and Tag the energy source(s). ➜ Prove that the equipment isolation is effective. ➜ When required, apply lock-out device or clamp and secure with padlock(s).

Important!	
	➜ Read the instructions of this manual thoroughly before use! ➜ Keep manual within reach. ➜ All personnel who have to perform any task on the BESS (on-site or remotely) with respect to operation of the unit are obligated to read all related manuals regarding the BESS. By proceeding with work on the BESS, the personnel declare that they have fully read and understood all contents of the manuals and agree to follow all instructions, especially issues regarding safety and accident prevention.

⚠ DANGER	
	**Hazard by voltage** Always respect all the safety instructions and, in particular: ➜ Always use protective devices suitable and approved for each type of activity. ➜ The instructions in this manual must be strictly followed. ➜ Use of the equipment must comply with all national and local regulations. ➜ Access to internal components is only allowed after the converter has been de-energized and disconnected from all power supplies.

⚠ DANGER	
	**Hazard by voltage** ➜ Electric shock hazard. ➜ Only electricians may perform work on electrical components. ➜ Do not touch live components! ➜ Disconnect the device from all power supplies, before performing work on the device. ➜ Do not short circuit any conductive parts that are not de-energized before. (Take care with jewellery, tools, instruments, etc. which can cause short circuits accidentally.)

⚠ DANGER	
	**Hazard by voltage** ➜ Before opening the cabinet doors de-energize the converter. ➜ Even if the main circuit breaker is switched off, the cabinets are not completely voltage-free.

⚠ DANGER	
	**Risk of burns on hot surfaces** ➜ Avoid contact with hot surfaces or wear protective clothing (e.g. protective gloves).

⚠ DANGER	
	**General risk of injury due to improper handling** ➜ Only perform work on the device if you have expert knowledge of the respective activity. ➜ Follow the operating instructions and warnings stated in this manual.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on a live system.** After switching off the converter, the DC-link of the converter still carries dangerous voltages, which may cause death or severe injuries if touched or short circuit. ➜ Before performing work on the converter, deenergize the converter, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ It is not allowed to open the cabinet doors before the converter system has been de-energized and the capacitors are discharged. ➜ It is not allowed to perform any work on the converter before the system has been de-energized.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on the converter system, before the converter system has been disconnected from all power sources.** After switching off the converter, the connected DC power cables of the battery strings, the DC connection busbars in the AC_DC cabinet and the DC switch & fuse units continue to carry dangerous voltages that can cause death or serious injury if touched or short-circuited. ➜ Before starting work inside the converter cabinets, de-energize the converter system as described in section 14.6 “De-Energizing”, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ Disconnect the DC power cables from the converter system using suitable DC disconnecting devices before carrying out any work in the cabinets of the converter system. ➜ Before disconnecting the DC power cables from the DC connection busbars, always check for voltage-free status of the DC power cables, since dangerous electric arcs may lead to severe injuries or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any work on the MV switchgear and the MV transformer before the PLC container has been disconnected from all voltage sources.** After switching off the converter, the connected MV transformer, the MV switchgear, its connecting cables and terminals continue to carry dangerous voltages which, if touched or short-circuited, can cause death or serious injury. ➜ Before working on the medium voltage components of the converter container, de-energize the converter system as described in section 14.6 “De-Energizing”. ➜ Disconnect the AC mains connection by opening the MV switchgear. ➜ Before disconnecting the AC power cables from the AC connection busbars, always check the voltage-free status of the AC power cables, otherwise dangerous arcs can cause serious injury or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any maintenance work on the converter system before the AC circuit breaker and MV switchgear have been switched off and protected against unintentional reclosure.** ➜ Before starting work inside the converter cabinets, the AC circuit breaker 80Q1 must be switched off and protected against unintentional reclosure as described in section 14.8.3 “Protect the CB Against Unintentional Reclosing”. ➜ Before you start working inside the control cabinets, the medium-voltage switchgear must be switched off and protected against unintentional reclosure.

⚠ DANGER	
	**Danger to life through electric arcs** Danger by electric arcs could occur by: • Exceedance of the maximum input current • Faulty design of circuit breakers or transformers • Faulty or not connected cables • Excessive contamination Electric arcs may lead to death, severe injuries or material damage. ➜ Make sure the system is properly designed and all power cables are connected correctly. The maximum permissible input current is provided in the table "Technical Data". ➜ Excessive contamination must be removed.

⚠ DANGER	
	**General risk of injury due to improper handling.** Always respect all the safety instructions and, in particular: ➜ Always use protective devices suitable and approved for each type of activity. ➜ The instructions in this manual must be strictly followed. ➜ Use of the equipment must comply with all national and local regulations. ➜ Access to internal components is only allowed after the converter has been de-energized and disconnected from all power supplies. ➜ It is not allowed to perform work on a live converter. ➜ The converter and all connected systems/components must be electrical grounded properly. ➜ All installation work and maintenance on the BESS must be carried out by qualified personnel. ➜ Improper use or handling of the BESS during transportation, installation or during operation may result in damage to the equipment or cause severe, even fatal injury. ➜ Maintenance work on the converter unit must be performed with reasonable care. ➜ Non-compliance with the present instructions may cause damage to the product and could lead to serious injuries of the personnel.

⚠ DANGER	
	**Danger to life when live parts are touched on damaged devices** Improper handling of devices can cause damage. For damaged devices, hazardous voltages can be present at the enclosure or at exposed components. If touched, this can result in death or severe injury. ➜ Ensure compliance with the limit values specified in the technical data during transport, storage and operation. ➜ Do not use any damaged devices.

⚠ DANGER	
	**Danger to life through electric shock due to unconnected cable shields** Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields. ➜ As a minimum, connect cable shields and the conductors of power cables that are not used (e.g. brake cores) at one end at the grounded housing potential.

⚠ DANGER	
	**Danger to life due to electric shock when not grounded** If the protective conductor connection is missing or incorrect, high voltages can occur at open, exposed parts when using devices of protection class I. Touching these parts can result in death or serious injury. ➜ Ground the device in compliance with the applicable regulations.

⚠ DANGER	
	**Danger to life due to electric shock when opening plug connections in operation** When opening plug connections in operation, arcs can result in death or severe injuries. ➜ Only open plug connections when the equipment is de-energized, unless it has been explicitly stated that they can be opened in operation.

⚠ DANGER	
	**Danger to life through electric shock due to the residual charge of the power component capacitors** Due to the use of capacitors, a dangerous voltage is present even up to 5 minutes after the power supply has been switched off. Contact with live parts can result in death or serious injury. ➜ Wait for 5 minutes and then check the de-energized state of the system. Only then should you start working on the device.

⚠ DANGER	
	**Danger to life from electromagnetic fields** Electromagnetic fields (EMF) are generated by the operation of electrical power equipment, such as transformers, converters, or motors. People with pacemakers or implants are at particular risk in the immediate vicinity of this equipment. ➜ If you have a heart pacemaker or implant, maintain a minimum distance of 2 m from electrical power equipment.

⚠ DANGER	
	**Danger to life when safety functions are inactive** Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death. ➜ Observe the information in the appropriate product documentation before commissioning. ➜ Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components. ➜ Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing. ➜ Perform a function test. ➜ Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

⚠ DANGER	
	**Danger to life due to fire if overheating occurs because of insufficient ventilation clearances** Inadequate ventilation clearances can cause overheating of components with subsequent fire and smoke. This can cause severe injury or even death. This can also result in increased downtime and reduced service lives for devices/systems. ➜ Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

⚠ DANGER	
	**Danger of an accident occurring due to missing or illegible warning labels** Missing or illegible warning labels can result in accidents involving death or serious injury. Check that the warning labels are complete based on the documentation. ➜ Attach any missing warning labels to the components, in the national language if necessary. ➜ Replace illegible warning labels.

⚠ WARNING	
	**Hazard by hot surfaces of components** During operation, some components may heat up significantly, e.g. heat sinks and inductors. These components can still be very hot for some time after operation. In case of contact, severe bodily injuries, such as skin burns, may result. ➜ Do not touch hot surfaces even after shutdown of the converter system.

⚠ WARNING	
	**Danger to life or malfunctions of the BESS as a result of incorrect or changed parameterization** As a result of incorrect or changed parameterization, the system can malfunction, which in turn can lead to injuries or death. ➜ Protect the parameterization (parameter assignments) against unauthorized access. ➜ Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

⚠ WARNING	
 	**Hazard by cooling liquid** The coolant used in the internal cooling system of the converter is harmful to human or animal health when touched or swallowed. ➜ Avoid oral ingestion of the coolant since it can lead to harm to human or animal health. In case of accidental ingestion or eye contact with the coolant, seek immediate medical attention. ➜ Avoid skin contact with the coolant. ➜ Use appropriate eye protectors and protective gloves when working on the cooling system and during filling and draining of the cooling liquid.

⚠ CAUTION	
	**Hazard by sharp edges on packaging** Improper handling during unpacking can cause injuries. ➜ Use appropriate safety gloves to protect your hands from possible cuts.

NOTICE	
	**Material damage due to loose power connections** Insufficient tightening torques or vibrations can result in loose electrical connections. This can result in damage due to fire, device defects or malfunctions. ➜ Tighten all power connections with the specified tightening torques, e.g. grid supply connection. ➜ Check all power connections at regular intervals. This applies in particular after transport.

NOTICE	
	**Device damage caused by incorrect voltage/insulation tests** Incorrect voltage/insulation tests can damage the device. ➜ Before performing voltage/insulation tests on the equipment, disconnect all equipment as high voltage tests have been performed on inverters and motors by their manufacturers. Therefore, it is not necessary to perform a retest on the system.

NOTICE

Material damage due to overloading of DC devices and connecting cables

The DC paths and the connection cables are not protected against overload by the BESS.

Select external components according to the specified nominal and maximum currents of the BESS.

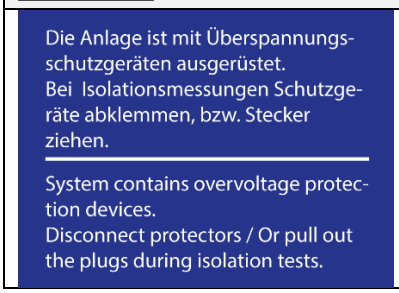
➜ If necessary, use appropriate protective equipment for the external components.

NOTICE

Material damage due to improper use of the transformer

For your safety, carefully read the delivered operating instructions of the transformer and observe the instructions. Technical specifications of the transformer which are provided on its´ type plate like rated current, rated power etc. must be strictly observed when commissioning and feeding power to the grid. All electrical connection work must be carried out onsite and by trained, qualified personnel, provided with the required safety devices in accordance with the national occupational safety regulations. Please pay attention to the proper protection of the transformer during unloading, installation at the place of operation, feeding and operation The transgression of the voltage or power and the presence of external factors (such as condensation, solar radiation, plants and animals) can affect the proper functioning of the transformer).

NOTICE



General risk of damage

During isolation tests disconnect overvoltage protection devices or pull out the plugs otherwise they will be activated or destroyed.

2.3 Safety Instructions Battery Storage Unit

⚠ DANGER	
	**Hazard by electrolyte** Work on the battery storage system is only allowed to be performed by FREQCON service personnel or qualified personnel trained and authorized by FREQCON. It is not allowed to modify or manipulate the battery storage unit and its components. ➜ Do not open, disassemble or puncture the battery storage cabinets or battery modules. ➜ Do not short circuit the battery storage unit. ➜ Do not expose the battery storage system to vibrations or shock. ➜ Do not a use defective or damaged battery storage system or battery modules. ➜ Do not touch defective or damaged batteries with bare hands. Defective or damaged batteries must only be handled by FREQCON personnel.

⚠ DANGER	
	**Hazard by electrolyte** The material/media required for intended operation of the battery storage system are procured and provided by the manufacturer. ➜ The proper handling of these materials/media and the associated risks underly the sole responsibility of the manufacturer. ➜ Hazard and disposal information must be provided by the manufacturer. ➜ The safety data sheets of the material and media manufacturers are to be observed.

⚠ WARNING	
	**Health hazards due to negligent use of personal protective equipment** Serious injuries can occur when working without personal protective equipment. ➜ Wear personal protective equipment (PPE) when working on the BESS. Refer to section 2.7 "Personal Protection Equipment (PPE)" for information regarding the required PPE.

⚠ WARNING	
	**Possible danger to life due to electric shock when extinguishing fire or due to flooding!** If the following instructions are not observed, this can lead to damage to property and personal injury, for which FREQCON GmbH accepts no liability whatsoever. ➜ In the event of a fire, switch off the battery storage system if safe to do so. ➜ Immediately alert the fire department. ➜ Immediately remove yourself and other persons from the danger zone. ➜ Inform the fire department about the presence of lithium iron phosphate batteries.

⚠ CAUTION	
	**Danger due to fire breaking out** During operation, fire may break out, e.g. due to sparks or heated surfaces. ➜ Observe the relevant safety regulations (5 safety rules). ➜ Note the risk of arcing when operating the NH isolators installed inside the battery storage cabinets. ➜ Never install or operate a potentially defective or obviously defective battery storage unit.

⚠ CAUTION	
	**Hazard by burns (electric arcs)** When working on the electrical equipment, you may come into direct contact with faulty or overloaded parts which can cause burns. ➜ Always observe the relevant country-specific safety regulations. ➜ Note the risk of arcing when operating the NH isolators installed inside the battery storage cabinets. ➜ Note the risk of arcing when operating the NH isolators installed inside the battery storage cabinets.

2.3.1 Safety Data Sheet

Observe the information provided in the Material Safety Data Sheet (MSDS) of the battery cells (*see section 1.2 "Applicable Documents"*).

2.3.2 Personal Protection

This chapter describes the personal protection for FREQCON battery converter systems in the event of fire or the occurrence of a toxic gas concentration.

Basic safety measures

- No person may remain inside the container or in the safety area of the container while the system is in operation.
- All container doors must be locked while the system is in operation.
- Maintenance and repair work may only be carried out when the system is switched off and all energy sources are disconnected from the system.

Critical situation regarding personal safety

A person enters the container for maintenance/repair work in which there is a fire (risk of deflagration when opening the container door) or a toxic concentration of carbon monoxide due to outgassing batteries.

Definition of the protection objective

Under all circumstances, a person must be prevented from entering the container if the critical situation mentioned before exists.

Technical measures to achieve the protection objective

- Reliable detection of a fire or toxic gas concentration using suitable sensors (smoke detectors, CO sensors, temperature sensors).
- The sensors are redundant. Smoke detectors, CO sensors and temperature sensors are installed in each battery room.
- One H2 sensor is installed inside each battery room of the BESS containers.
- If the system is shut down by emergency shutdown, no person may enter the container.
- If a hazardous situation exists, an infrared thermometer must first be used to check whether there is a fire in the container. A temperature above 60 °C is a sure sign of a fire inside the container. If this is the case, the container doors must not be opened (risk of deflagration) and the fire brigade must be alerted.
- If a fire can be ruled out as the cause of the emergency shutdown, a toxic gas concentration could be present. Entering the container is not permitted in this situation. Active ventilation (exhaust units in the BESS container roof) reduces the gas concentration in the container.

2.3.3 Fire Fighting Measures

1) Fire protection / early fire detection
   a. Spatial conditions:
      Primarily through the structural measure; Space between modules, air conditioning and ventilation reduces the risk of thermal stress to a minimum
   b. It must be ensured that there is no additional fire load in the battery rooms. Unauthorized access must be strictly prevented.
   c. Sensors for detecting smoke, heat and CO gas are redundantly built into the alarm system.
   d. At 300 °C automatic fire suppression using an aerosol mist triggers itself.

Important: Extinguishing an internal cell fire is not possible. Due to the chemical release of bound oxygen in the cathodes, the fire inside the cell sustains itself. The aerosol extinguishing system is intended to prevent the flames from spreading to the outer surroundings of the battery module!

2) Behavior in case of fire
   a. Upon detecting a fire in the battery room, the battery container is immediately and automatically disconnected from the grid. The circuit breaker opens its contacts to prevent any further external energy supply.
   b. Toxic and hazardous substances are released by the battery in the event of a fire.
      Harmful gases include:
      Hydrogen (H_2) 48%
      Carbon dioxide (CO_2) 27%
      Carbon monoxide (CO) 11%
   c. Remove all persons from the danger area.
   d. Clear affected area and secure from entry.
   e. Disconnect all supply voltages of the BESS at the disconnection points of the external voltage sources.
   f. Only start active measures in the event of visible flame development outside the energy storage unit.
   g. Do not enter any electrolyte cloud that may form in the external area (near the floor).
   h. Wait at least 48 hours before starting firefighting measures inside the container. First open the access door and wait another 2 h.

⚠ DANGER	
	**Poisoning and chemical burns hazard** Escaping electrolyte gases contain chemicals which are harmful to humans. ➜ Keep away from electrolyte mist clouds. ➜ Approach electrolyte mist clouds only under full protection. ➜ Observe the instructions in the Material Safety Data Sheet of the battery cells *(see applicable documents)*. ➜ Follow the following instructions

3) Recommendation for rescue units

   Firefighting should be conducted according to regional standards and guidelines.
   (EN 15182-1:2019-11).
   The distance for the fire hose nozzle must be maintained.

Ensure full protective gear according to DGUV Information 205-014 (e.g. DIN EN 469 ; Protective clothing for the fire brigade - performance requirements for protective clothing for fire brigade activities) and recirculating air independent respirator is worn.
For firefighting protective equipment, thermal risk is given more priority than chemical hazard.

4) Instructions after fire extinction

Once the fire brigade has cleared the fire site and the fire has been extinguished, an electrically trained specialist must immediately ensure and verify the absence of voltage (measure all poles) and secure against re-energization.
5 safety rules!
Attention: Batteries continue to maintain voltage even after disconnection!
In addition, ventilate the rooms adequately to eliminate any remaining hazardous fire gases.
According to the technical data sheet, the battery modules must be stored/disposed.

Rules of Conduct for the Fire Brigade

The following notice board must be kept outside the container or handed over to the local fire department. A laminated copy is included in the scope of delivery.

Rules of conduct for the fire brigade



Attention electrical voltage!

Batteries are still live after disconnection!!!

Batteries can outgas when heated

CO = carbon monoxide
H2 = Hydrogen







Unauthorized access is strictly prohibited.

Keep doors closed in case of fire

The use of respiratory protection is strongly recommended





Battery fire cannot be extinguished!

Container cooling from outside

Extinguishing agents: water

2.3.4 Disposal Considerations

Lithium-ion cell batteries are labeled in compliance with the EU Battery Directive 2006/66/EC.

For instructions regarding the disposal of the battery storage system and its battery storage modules, refer to section 24 ”Dismantling and Disposal”.

2.3.5 Transport Information

For information regarding the transport of the battery storage system and its battery storage modules, refer to section 10.2 "Transport”.

2.4 Handling Electrostatic Sensitive Devices (ESD)

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.

NOTICE



Damage through electric fields or electrostatic discharge

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- ➜ Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g. conductive foam rubber of aluminum foil.
- ➜ Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- ➜ Place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam. ESD packaging, ESD transport container).

⚠ DANGER



Danger to life as a result of unsafe operating states resulting from software manipulation

Software manipulations (e.g. viruses, trojans, malware or worms) can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- ➜ Keep the software up to date.
- ➜ Incorporate all installed products, especially the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation.
- ➜ Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.

2.5 Warnings and Symbols on the Device



2.6 Qualification of Personnel

Installation, service and operating personnel must be sufficiently trained before installing, operating and handling the equipment.

2.7 Personal Protection Equipment (PPE)

Always wear safety equipment when working on the product.

When carrying out maintenance and service work, secure controllers, devices and units of designated area against accidental activation.

Symbol	Meaning and Application
	Gloves made of nitrile rubber against chemicals and microorganisms (at least protection index 2 according to EN 374-1) • for removal of electrolyte or hydrofluoric acid (only by FREQCON service) • Gloves according to EN 60903 - up to 1000 V AC for live working activities
	Safety shoes (toe protection, non-slip, ESD) • Operation • Cleaning Safety shoes (acid resistant) or rubber boots • for removal of electrolyte or hydrofluoric acid (only by FREQCON service)
	Tightly fitting safety goggles/basket goggles/face shield • for removal of electrolyte and hydrofluoric acid (only by FREQCON service)
	Chemical protective suit • for removal of electrolyte and hydrofluoric acid (only by FREQCON service) • for fire fighting
	Ambient air-independent breathing apparatus • for firefighting in case of smoke formation inside or outside the building (by rescue forces)

Table 6: Personal Protection Equipment (PPE)

2.8 Changes of the Product

Modifications to the product and/or mounting of parts from other manufacturers can endanger the operating safety of the product. This especially applies to tampering with safety-relevant parts.

Any modification carried out without prior written approval by the manufacturer will result in the manufacturer's declaration of conformity becoming void. The responsibility for damage and accidents caused by modifications of this kind shall be borne solely by the user.

2.9 Proper Use

The Battery Energy Storage System (BESS) described in this document is intended to feed into or draw power out of a connected electric grid by means of a power conversion system connected between both. The system specifications are listed in section 3 of this document.

The system is properly constructed, installed and commissioned by FREQCON service personnel according to manufacturer specifications. The operator ensures that the required environmental conditions are met (*see section 8 and 9*).

Modification of the device by the operator or integrator is not permitted. Only use the device in accordance with the specifications in this manual and the locally applicable standards and directives. Use contrary to the specifications and specified operating limits as well as any modification of the energy storage unit by the user is not permitted and will void the warranty!

Deviations from this manual are not permitted or require the separate written approval of FREQCON GmbH.

The system is intended for stationary use as a fixed installation. Any other or additional use is considered improper and increases the risk of personal injury and property damage when handling the energy storage system. The manufacturer rejects any liability and warranty claims for damage caused by improper use.

Access to the container is only permitted for instructed personnel. The access doors of the container must be locked if no instructed personnel are on site. The access doors of the container must be locked if no instructed personnel is on site.

Proper use also includes the following measures:

- ➜ Observe the operating manual.
- ➜ Comply with technical data.
- ➜ Comply with maintenance conditions.
- ➜ Immediately eliminate faults which hamper safety.
- ➜ Operate the unit only when it is in technically flawless condition.

2.10 Misuse

Any use which goes beyond the proper use is considered to be misuse. It can result in serious injuries or damage and is therefore prohibited.

The responsibility for damage resulting from misuse shall be borne solely by the operating company of the product.

2.11 Duties of the Operating Company

To ensure safe, smooth operation of the unit, you as the operator must comply with the following:

Personnel

- ➜ Only allow personnel with corresponding knowledge to operate and clean the product.
- ➜ Only allow a trained electrician or person with electro technical instruction to work on the electrical system. The regulations given in section 1.7 “Target Groups” must be observed.
- ➜ Clearly and bindingly specify the responsibilities for operation, service and maintenance work.

Operating Manual

- ➜ Always keep this operating manual available near the device.
- ➜ Make sure that the personnel have read and understood this operating manual before working on the device.

Safety

- ➜ Monitor the compliance with the generally valid legal and other binding safety and accident prevention regulations.
- ➜ Make sure that the users of the product wear the necessary, personal safety equipment in accordance with their job.
- ➜ Ensure that all safety and danger warnings on the product and in the installation room are kept complete and in legible condition.

Inspection and Maintenance

- ➜ Observe the adherence of the inspection and maintenance intervals in section 16 „Maintenance“.
- ➜ Operate the product only if it is flawless.

2.12 Duties of the User

The following are referred to as users:

- Persons, who install and configure the product.
- Persons, who operate the product and eliminate errors during the process.
- Persons, who carry out checking, maintenance and inspection activities.

Follow the instructions below in the interest of your own safety and for fault-free operation of the product:

➜ Read this operating manual before using the product. If you have questions, contact your superior or the safety officer.
➜ Always carry out activities based on the complete operating manual. Missing information due to an incomplete operating manual can result in serious or fatal injuries and in damage.
➜ Familiarize yourself with the safety devices of the product. Do not make any modifications to it.
➜ Do not operate the product until you have received a complete user training course for this product from an authorized person.
➜ Report any fault in the product to your superior if you cannot and may not eliminate it yourself.

3 Product Description

The battery energy storage system described in this document (BESS) is designed as a battery-to-grid system.

The BESS system is generally capable to provide the following functions, but the specific functions depend on the contractually agreed specifications:



Figure 1: BESS Functions Overview

The BESS consisting of a battery storage system with battery modules, battery control system and air conditioning systems are integrated in two (2) 40" HC containers with an active fire suppression system (*see section 4, "Design"*).

The PCS hardware and software control system as well as the converter technology incl. water cooling system with heat exchangers and air conditioning systems for the interior temperature are integrated in one (1) separate 20" container with a passive fire suppression system. The BESS is connected to the AC grid via busbars at the HV side of a 6.6 kV /620 V AC MV transformer inside the PCS container. The cable entries into the containers are located in the container floors.

It is not permitted to use the BESS system for purposes other than those specified in this manual.

Only sufficiently trained personnel are permitted to run, handle, and operate the unit (*see section 1.7* "*Target* Groups").

3.1 Working Principle

The BESS consists of a converter system with a total output of 1 MW and a battery storage system with a usable storage capacity of 5 MWh (5.5 MWh installed).

The BESS is passively charged by the energy taken from the AC grid via contactors and resistors from the DC link of the PCS as soon as the voltage level of the battery storage system falls below a value predefined in the PCS controller.

3.2 Control

A Programmable Logic Controller (PLC) is used as system controller. After commissioning and parameterization, the BESS operates automatically. The control system provides remote monitoring and access to the converter functions and set point adjustment via IT network. For detailed information regarding the control system, refer to section 6 “Control System”.

3.3 PCS

The BESS system is equipped with an integrated power conversion system (PCS), the FREQCON MSC converter system.

The key component of the converter system is a DC link converter with a control unit, generating a controlled DC voltage from the AC infeed, the so-called DC link voltage. The DC link voltage is kept to a constant level independently from the grid voltage (also in case of power feedback into the grid). It is required that the specified DC voltage setpoint is within a defined operational range.

3.4 Decoupling Protection

The decoupling protection of the converter system consists of the main controller, which evaluates the signals and controls the coupling switch (circuit breaker). In addition, peripherals for measuring the grid voltage are installed. The periphery consists of a HVIO that divides the grid voltage to a lower voltage and a PIII converter interface that digitizes the measured voltage and provides it to the main controller.

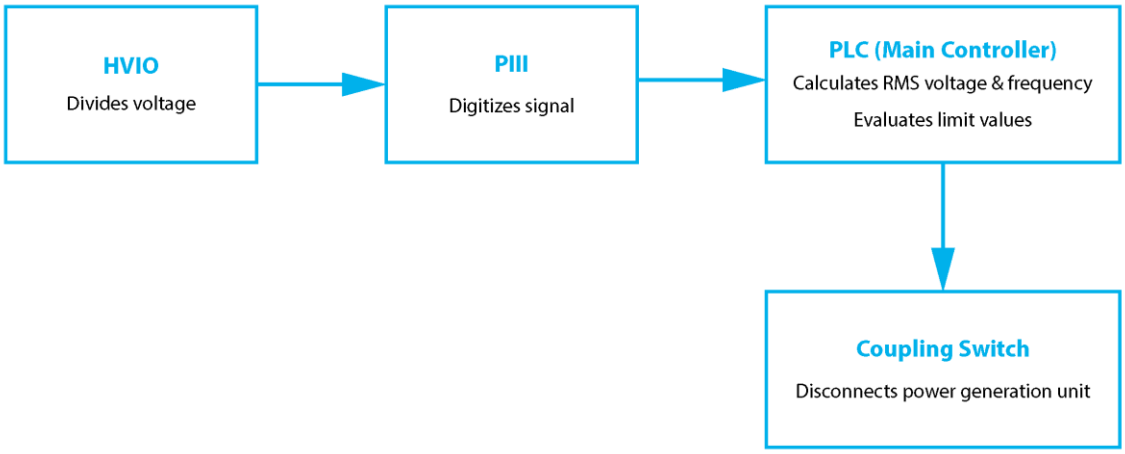


Figure 2: Decoupling protection scheme

The grid phases are measured by an HVIO board that is connected to a PIII. The voltages evaluated are phase-neutral voltages.

The measured instantaneous voltages are used to determine the RMS value, the phase angle and the frequency in the main controller. The currents are recorded directly at IGBT half bridges and also digitized via the PIII. RMS currents are calculated in the main controller.

RMS voltages, RMS currents and frequency are monitored for limit values in the main controller and the coupling switch is switched off if these are exceeded.

3.5 Auxiliary Power Supply of Protective Devices

The entire control system is buffered via a UPS. This is set so that the control and protection system is supplied with energy for at least 15 minutes.

In the event of a faulty UPS and a grid failure, the main controller fails, the grid switch opens, and the converter disconnects from the grid.

3.6 Behavior in the event of a supply voltage failure

If the supply voltage of the converter system fails, the following steps are carried out:

1. The failure of the supply voltage is immediately detected by the main controller.
2. A level 4 error is triggered. This means:
   a. All IGBTs (both DC and AC side) are switched off (500 µs after the fault occurs).
   b. The switches to the energy sources are opened (30 ms after the fault occurs), which disconnects the converter system from all AC and DC networks.
   c. The DC link of the converter system is discharged.
   d. The cooling system of the converter system is switched off (30 ms after the error occurs). This is possible because there are no more heat losses.
3. The UPS supplies the converter control system for another 15 minutes. A backup copy of the init files and parameters is created in the non-volatile memory.
   a. When the power supply is restored, this data is automatically reloaded. It is neither possible nor necessary for the customer to access the data.
   b. Important operating data of the converter system at the time of the power failure (voltages, currents, temperatures, etc.) are logged in a buffer file as long as the UPS is running. Which data is logged in detail depends on the converter type.
   c. The buffer file can be displayed via the FREQCON buffer analysis tool (subject to license) as soon as the supply voltage is available again.
4. If a battery storage system is present, the battery control is switched off immediately so that the battery storage is transferred to a safe state. No operating data of the battery system is saved.
5. Before the switch cabinet doors are opened for a visual inspection after the supply voltage has failed, it is essential to wait for the DC link to discharge.

⚠ DANGER	
	**Risk of injury due to electric shock** Discharging the DC link takes several minutes. The "Ready for Operation" signal light is not an indicator of a fully discharged DC link. Do not carry out any work on the converter before the DC link has been completely discharged. ➜ Wait until the DC link is completely discharged and check that it is de-energized as described in section 14.7 "Check Voltage-Free Status of DC Link ".

4 Design

For better handling and to increase system flexibility, all components of the BESS system are housed in containers.

BESS main components:

- BESS with installed battery modules, control systems and integrated fire protection and suppression system
- Integrated climate control system
- Integrated emergency fan system
- Several sensor systems (H2, CO; temperature and smoke)

PCS main components

- Converter system consisting of AC/DC battery converter, control system and converter cooling system
- Integrated water-air cooling system
- Integrated climate control system
- Several sensor systems (temperature and smoke)

Both the PCS and the BESS are controlled and monitored by the same main control system, which is installed in the control cabinet (CTRL) of the PCS container.

The waste heat in the interior of the containers is conducted via internal air conditioning (AC) units from the interior to external AC units at the front side of the container (*see section 4.8 "Cooling System"*).

The BESS containers are equipped with recesses on its underside for the passage of cables (*see section 11.2.2 "Cable Outlets"*). Furthermore, the PCS container is also provided with cutouts on the bottom side to connect the external AC and DC line cables to the converter system.

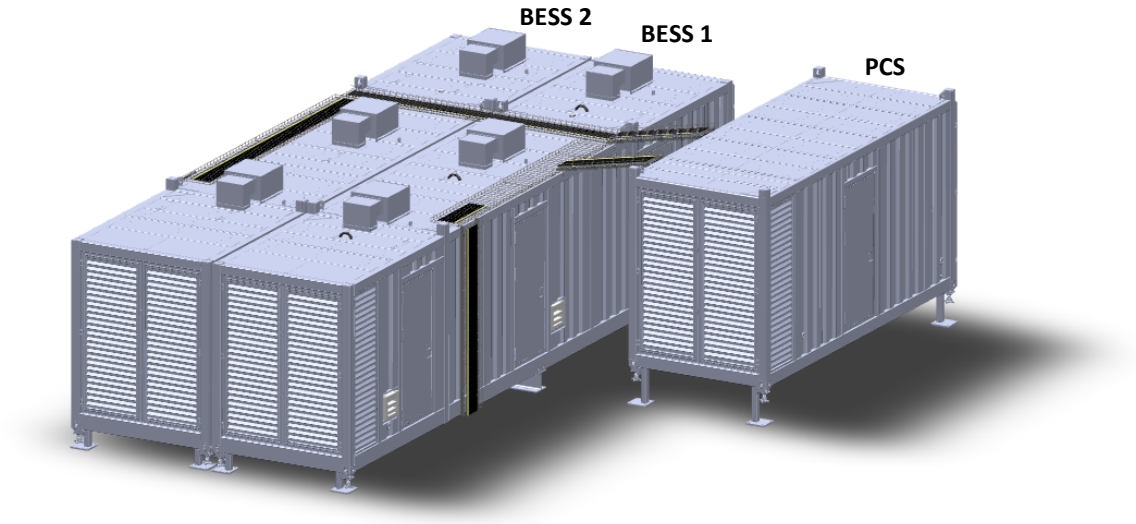


Figure 3: Design

4.1 AC Grid Connection

The BESS is equipped with AC busbars for connection of a 620 V AC grid. The AC busbars are located inside the AC_DC cabinet (*see section 4.4.3*) of the converter system.

Cutouts for inserting the AC power cables into the container are located in the container floor (*see section 11.2.2 "Cable Outlets"*). Through these cutouts, the AC power cables can be fed directly from below into the converter cabinets and connected to the corresponding AC connection busbars inside the cabinets of the converter system.

Further information and a description of the connection of the AC mains supply cables to the converter system are provided in section 11.2.4 "AC Connection".

Note:
The electrical connection must only be performed by personnel trained by FREQCON or by FREQCON service personnel.

4.2 Data Interface

The BESS system can be connected to an electronic higher-level control unit (control room) via a PROFINET interface. The required parameters (current, voltages, frequency, power) are provided by the BESS main control system and transmitted via PROFINET protocol.

The higher-level control unit is connected to the main control unit via a network isolator (114A1) in the CTRL_1 control cabinet (*see section 11.2.5 "Higher-Level Controller Connection"*).

For external control and monitoring of the converter, it is necessary that the customer has access to selected control and status variables stored in the BESS main control system, which can be read and overwritten by the customer's higher-level control. For this purpose, predefined control profiles with the relevant control variables and status profiles with all relevant status variables are stored for the data transfer between the customer's higher-level controller and the converter system.

For a detailed description of the individual data profiles, see the applicable document "23A2007_250116_Modbus_Register BESS_Vx_x_x_x".

4.3 Safety Design

4.3.1 Safety Chain Battery Cell

The battery monitoring system, BMS interface UI and BMS interface RS485, signal error messages via potential-free contacts. See also the documentation for the "BMS interface UI" and "BMS inter-face RS485" hardware modules.

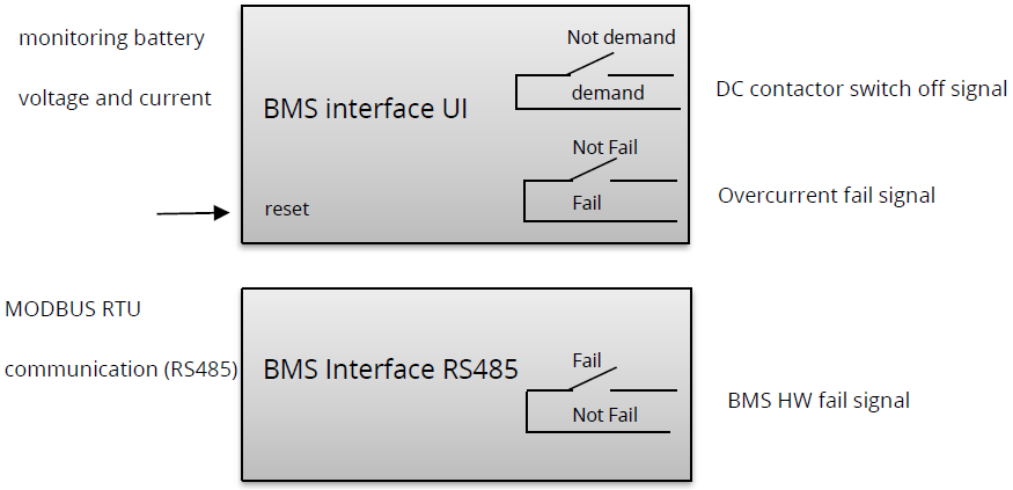


Figure 4: Safety chain battery cell

4.3.1.1 BMS Interface UI

The BMS interface UI monitors the total voltage of a battery rack and the current of the rack.
The BMS interface UI independently monitors the global battery voltage and the battery current. There is a potential-free contact for both errors which opens the contact in the event of an error.
The BMS interface UI has its own digital input for resetting an error message. If an error has been signaled and acknowledged manually via the visualization or MODBUS TCP, this digital input is set briefly.

4.3.1.2 BMS Module

The signals of the BMS interface are monitored in FB_battery_monitoring.
BMS interface RS485 HW error signal. The BMS monitors the battery cells for overvoltage, undervoltage and overtemperature.
If an error is detected locally by a BMS board, the safety chain is opened and an error is signaled.

4.3.2 Safety BMS Rack (S7)

The BMS rack monitors the following states:

- Modbus RTU communication error: The MODBUS RTU master cyclically queries the data of all BMS battery modules (MODBUS RTU slaves).
  If a MODBUS RTU slave [nmodule] is not reached or supplies faulty data, this is evaluated as a communication error. There is a communication error counter for each battery module. While a communication error increments the counter reading, successful communication re-sets the counter to 0.

- Battery voltage monitoring (cmp): The measured battery voltage is cyclically compared with the sum of the individual battery module voltages. If the absolute value of the difference be-tween the two voltages exceeds the 16 V limit value for more than 30 s, an error signal is is-sued.
- Battery monitoring cell voltage: Monitoring of all cell voltages to the maximum value of the measured voltages.
- Battery monitoring current: Monitoring of the battery current.
- Battery monitoring cell temperature: The maximum battery cell temperature is determined cyclically, approximately every 2.5 s, from all battery module cell temperatures recorded. A peak filter suppresses temperature jumps greater than 5 °C for a maximum of 8 cycles. If the average cell temperature is already close to the switch-off limit, incorrect measurements (jump) would result in a warning or error signal.
- Battery monitoring Balancer Temperature and ambient temperature Balancer
- Monitoring the battery pack connections + and - for overtemperature
- Smoke detector
- Gas sensor
- Line protection (fuses) of the auxiliary systems
- Main fuse (battery current)
- Modbus-TCP communication error: An error is triggered in the event of a communication timeout with the charging system (inverter control).
- Contactor feedback: Monitoring whether the status of the contactors matches the target status

If a fault is detected, the DC contactors open after 0.5 seconds.
In addition to errors, warnings can also be generated for cell voltages and cell currents.

4.3.3 Safety Converter Control

The converter system constantly communicates with the connected battery racks and continuously checks the following statuses:

- Modbus-TCP communication: In the event of a communication timeout with the battery racks, a corresponding rack is switched off or an error is triggered at converter level.
- Fault conditions: All faults at BMS rack level are signaled to the converter and the current is briefly set to zero to enable the DC contactors in the racks to be switched without current. Every fault reported by a rack prompts the converter system to disconnect the corresponding rack. Some error states also trigger a switch-off of the converter. The following error messages trigger a switch-off of the converter:
  - Error with the DC contactors in a rack
  - Tripping of a DC fuse in a rack
  - Triggering a smoke detector in a rack
  - Triggering a gas alarm in a rack
- Overvoltage (cell voltage): In the event of a cell overvoltage, the current setpoint value is also set to zero independently of the lookup tables.
- Undervoltage (cell voltage): If a cell is undervoltage, the batteries are charged with a low current to prevent deep discharge. If the cell voltage drops further, the corresponding rack is dis-connected.
- Warning messages: If a warning message is generated by a rack, the charging system re-quests a disconnection of the corresponding rack. As soon as the warning is no longer pre-sent, an attempt is made to reconnect the rack.

- Charge control system: To protect the cells from fault conditions, the following limits are available for charging and discharging the system. The respective limit values can be stored via lookup tables and thus set graduated limit values for the charging and discharging current. All limits are analyzed separately and the lowest limit is selected for the current limit. The limits are parameterized so that the charging or discharging current can be reduced to 0 A.
  - Maximum cell voltage
  - Maximum cell temperature
  - Maximum balance temperature
  - SOC (real)
  - Customer SOC (adjusted to capacity sold)

4.3.4 Overview of the Safety Concept

The safety aspects described in chapters 4.3.1 to 4.3.3 result in a three-stage safety concept:

1. Module level:
   - Detection of cell voltages and temperatures and opening of the safety chain in the event of a limit value violation.
2. Rack level:
   - Evaluation the safety chain and open the DC contactors if necessary.
   - In-house evaluation of cell voltages, cell currents, cell temperatures, smoke sensors, gas sensors and communication with the modules and the charging system. If required, fault generation and opening of the DC contactors.
   - Option to disconnect the rack independently if the safety chain is triggered or a self-detected fault condition occurs.
3. Converter level:
   - Evaluation of the cell voltages, currents and temperatures as well as the error states of a rack. Triggering of a converter error for selected error states of individual racks.
   - Reduction of the charging and discharging currents according to lookup tables depending on the cell voltage and temperatures.
   - Request to switch off the rack or the inverter in the event of a rack fault.

4.3.5 Fire Protection System and Suppression System

FREQCON uses highly safe lithium-ion battery cell technology: Lithium iron phosphate (LiFePO4) cells are, among other things, highly temperature resistant and significantly safer compared to cells based on other lithium-ion technologies. The use of these technologies significantly reduces the probability of a thermal runaway, as they do not catch fire even in the event of a short circuit or overcharging.

Furthermore, in addition to controlling and monitoring the state of charge at cell and system level, the FREQCON BMS (Battery Management System) also handles temperature management during charging and discharging. Every second, the temperature, state of charge and all other important operating parameters of each individual battery cell, as well as of the battery modules, are collected and analyzed by the FREQCON BMS.

This means that a potential problem of the cells is already detected at approx. 60 °C, and thus much earlier than the actual fire development the battery storage is brought back into a safe operating condition by segmental or complete shutdown.

In addition to CO sensors and smoke detectors, there are a total of 339 temperature sensors in one battery cabinet alone. This ensures that the cells are always kept within the defined and safe operating range and that, in addition to achieving high efficiency and low degradation, the probability of overloading is also excluded.

The fire protection system meets the thermal runaway propagation containment requirements of IEC 62619 as well as requirements of the EN 54 Fire detection and fire alarm systems standard.

4.3.5.1 Detection and Response

The fire protection system aims to detect malfunction as early as possible and suppress the problem before it results in a fire hazard. The system is divided into two parts. One part is primarily designed for plant protection and the other part has the aim of personal safety. For both purposes the BESS containers are equipped with several automatic detectors:

Personal safety:

- 3x H2 sensor per BESS container
- 3x emergency exhaust unit per BESS container

Plant protection:

- 1x CO sensor per battery cabinet
- 2x smoke detectors per battery cabinet
- Temperature sensors (in cells)

The carbon monoxide (CO) sensors for the battery cabinets are an extra measure to detect malfunctioning even before smoke detection (VESDA). Its primary objective is to detect outgassing from battery cells. With the cell chemistry known, the specific reactions that occur during outgassing are well understood. The relative proportions of these gases can be predicted based on the known reactions. For the used battery cells up to 169.7 liters of gas mixture of a single battery cell are released in the unlikely event of outgassing. The main components of this gas mixture being approximately:

- Carbon monoxide (CO): 11 %
- Carbon dioxide (CO2): 27 %
- Hydrogen (H2): 48 %

The CO sensors trigger an alarm based on the measured CO concentration as specified in DIN EN 50291-1:

Co concentration	No alarm within	Alarm not later than
30 ppm	120 min	-
50 ppm	60 min	90 min
100 ppm	10 min	40 min
300 ppm	-	3 min

As the complete outgassing of a single battery cell results in about 500 ppm CO in the battery room the CO sensor will be triggered in such an event based on the thresholds in table given above. The CO sensor alarm will reset when the CO concentration falls below approximately 50 ppm.

The alarm level of the analog CO sensor is set to 1000 ppm which is equivalent to a H_2 concentration of about 10 % LEL (lower explosive limit).

The smoke detector has an optical work principle and is getting triggered by (smoke) particles. It is getting also triggered from the aerosol which is released during the outgassing of a battery cell, being thereby independent of the gas concentration.

Personal safety - If an incident should occur and one sensor of the security chain for personal safety is triggered the system responds as follows:

- The complete system (BESS and PCS) is switched off and disconnected from the mains via a control system. The AC connection of the converter is disconnected, the DC connection to the battery storage system is cut off, and if existing, the MV switchgear with the transformer and low voltage distribution are disconnected from the mains.
- H2 concentration > 4000 ppm of analog H2 sensor (equivalent to about 4 % LEL H_2):
  - Battery cabinets are switched off
  - Stop charging/discharging
  - Ventilation starting (Exhaust units)
  - Error message (Error level 4)

Plant protection - Depending on which sensors are triggered the system responds as follows:

- Temperature >55 °C:
  - Battery cabinet is switched off
  - Stop charging/discharging
  - Warning message
- Temperature >56 °C:
  - Same as temperature >55 °C
  - Error message
- 1x CO sensor in the battery cabinets is triggered:
  - Battery cabinet is switched off

  - Stop charging/discharging
  - Warning message
- 2x smoke detectors are triggered:
  - Disconnects battery DC connection (contactors)
  - Deactivate converter IGBTs
  - Disconnect converter from AC connection
  - Error message
- Temperature > 300 °C:
  - StatX fire suppression triggers itself
- CO concentration > 300 ppm of analog CO sensor:
  - Battery cabinet is switched off
  - Stop charging/discharging
  - Error message

The active emergency exhaust system of the container ensures the gas concentration decreases over time. Based on the assumption of a slight overpressure of 1 Pa which is reasonable in the event of an outgassing battery cell, the estimated time for a complete air exchange in the battery room is less than an hour.

4.3.5.2 Active Fire Suppression inside Battery Cabinets

The fire protection system actively fights the fire only in the affected area (battery cabinet). This is achieved by using condensed aerosol, a compact and effective solution compared to CO2 or halocarbons. The aerosol is contained in Stat-X 60 E cartridges, which are triggered by a 12 VDC signal from the control system or self-triggered due to rupture of a temperature sensitive seal, releasing ultrafine cloud of condensed aerosol to chemically extinguish the fire. These cartridges are non-pressurized, leave minimal residue after discharge, and approved for halon and hydrofluorocarbons (HFCs). The cartridges meet the standards dictated by NFPA 2010 and UL 2775.

Each battery cabinet contains two (2) Stat-X aerosol cartridges and two (2) smoke detectors *(see figure below*). Furthermore, the battery cabinets are also equipped with temperature sensors and CO detectors. As soon as a temperature of >300°C has been reached inside the affected cabinet, the aerosol fire suppression cartridges are self-activated and the affected battery cabinet is filled with an aerosol cloud, extinguishing the fire. Aerosol is not released in other cabinets where the sensors have not been triggered, thereby eliminating the fault at the source, and preventing it from spreading to other parts of the system. The aerosol remaining in the air provides additional extended protection for a finite time against re-flash of any fire in case of lithium-ion batteries. The aerosol remains in the cabinet until it is certain that the fire hazard has been eliminated.



① Aerosol cartridge
② Smoke detector

For safety reasons, the container may not be entered for 48 hours after the extinguishing system has been triggered. The defective battery module must then be replaced by the manufacturer and the entire system is put back into operation.

The Stat-X aerosol cartridges are easily replaceable and are connected to the fire protection system again for future events.

Fire detectors will have to be cleaned and tested after a Stat-X discharge event.

After discharge there may be some minimal residue in the immediate vicinity of the generator or underneath it. This should clean up easily with water or detergent as any residue is water soluble. The Stat-X agent does not require hazmat procedures after discharge for cleanup and there are no hazardous materials in the generators themselves

Figure 5: Battery cabinet (1000 mm wide) with Stat-X fire extinguishing cartridges (front view)

4.4 PCS Container

4.4.1 Container Overview

Side view

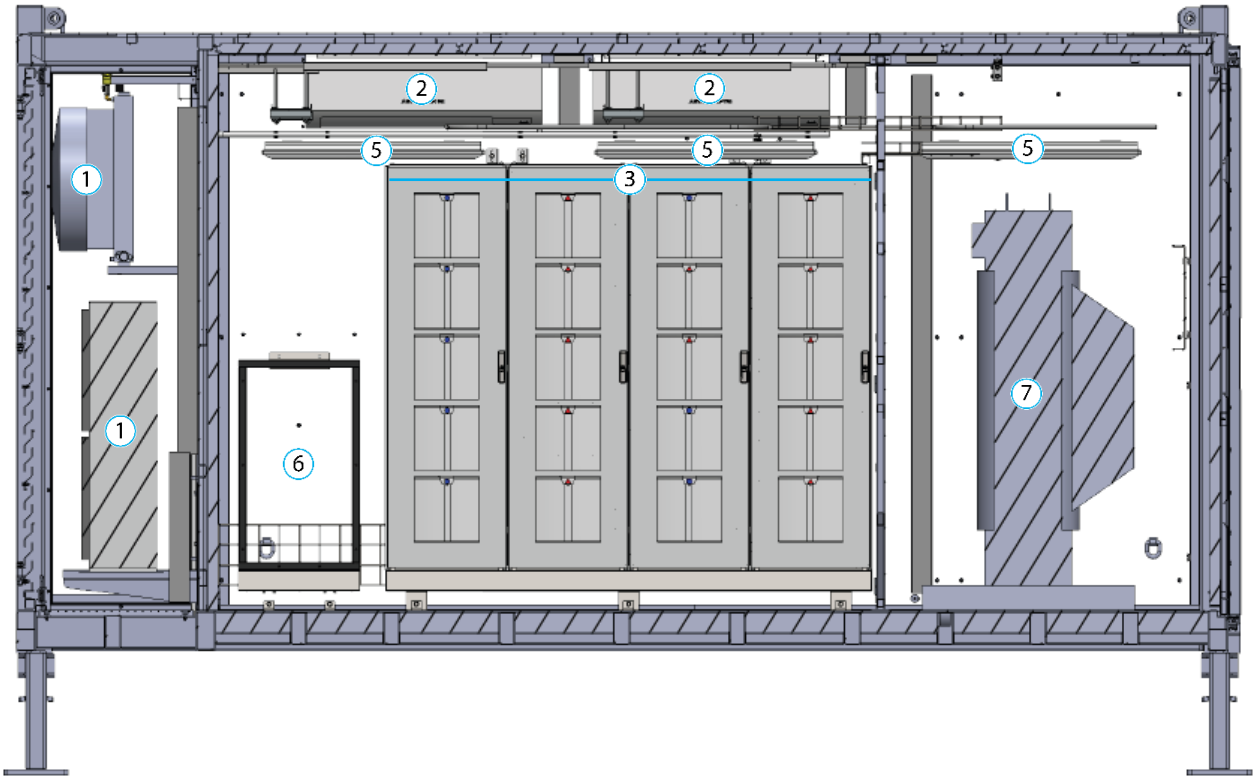


Figure 6: Container overview – side view

Position	Component
①	External cooling system components (*for details see section 4.8 "Cooling System"*)
②	Internal cooling system components (*for details see section 4.8 "Cooling System"*)
③	Converter cabinets (CONV)
④	Control cabinets (CTRL_1 & CTRL_2)
⑤	Container lights
⑥	Cooling system cabinet (COSY)
⑦	MV Transformer

Table 7: Container overview – components

Top View

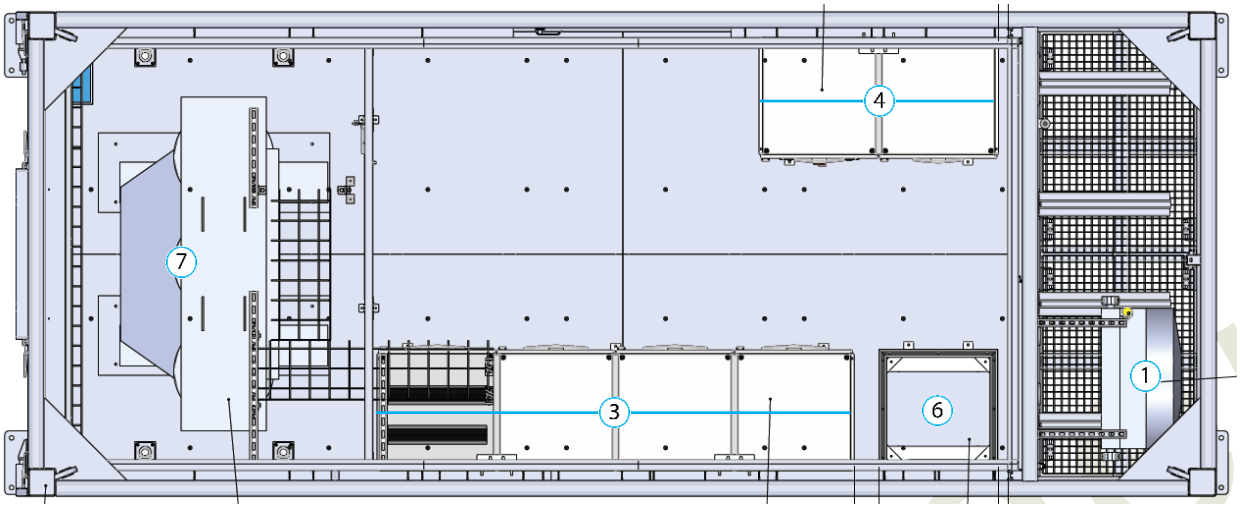


Figure 7: Container overview – side view

Perspective view

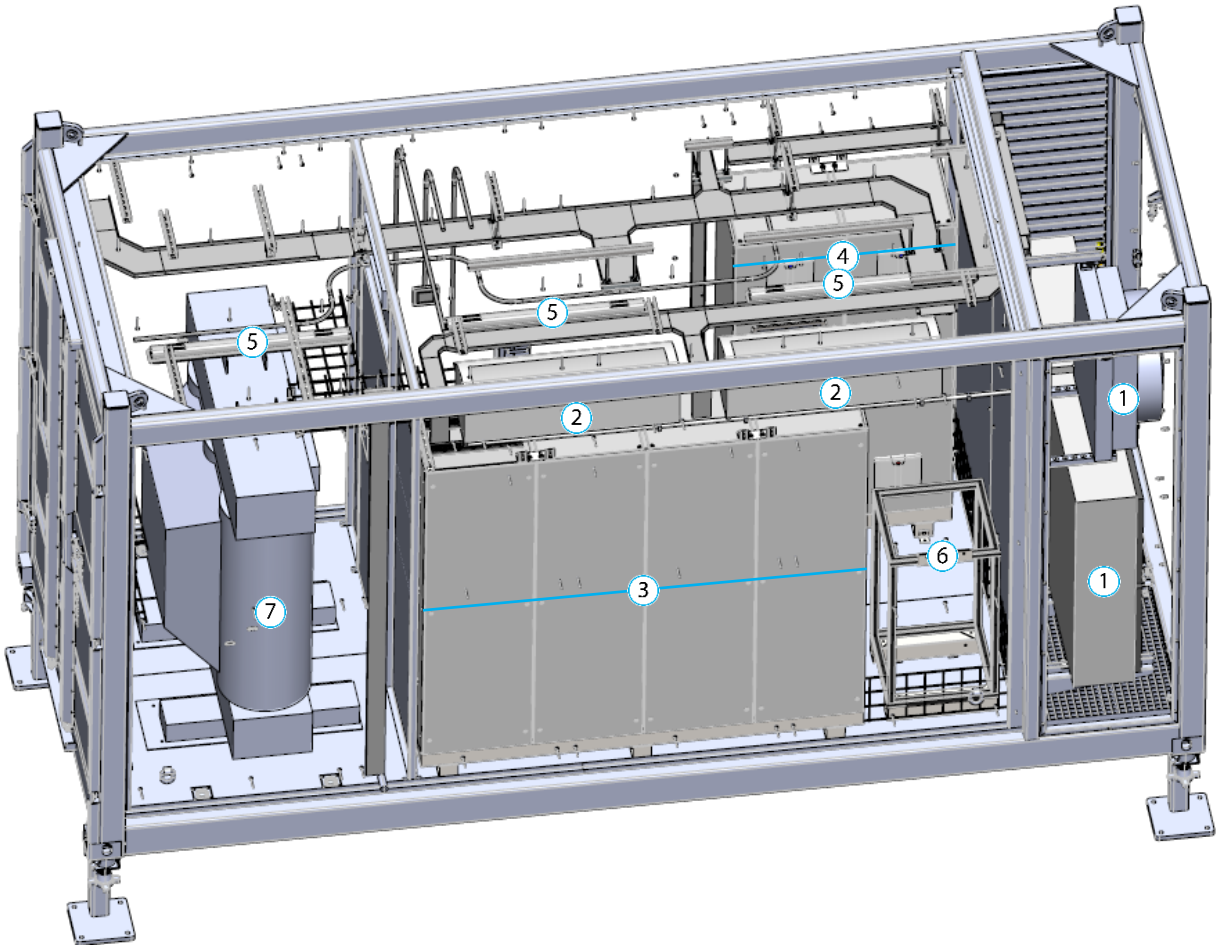


Figure 8: Container overview- perspective view

Side View Left

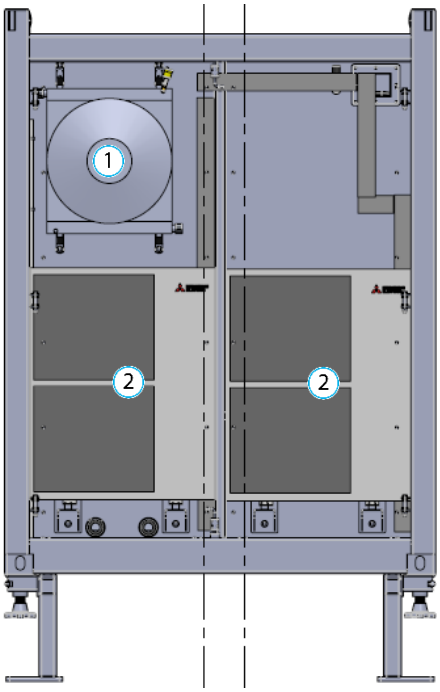


Figure 9: Container overview – side view left

Position	Component
①	Heat exchanger
②	External AC unit

Side View Right

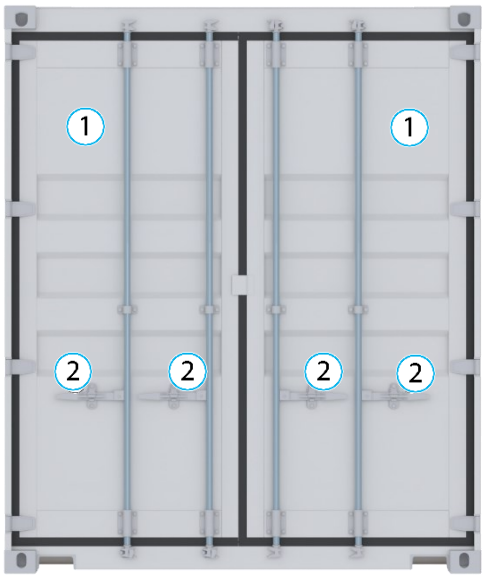


Figure 10: Container overview – side view right

Position	Component
①	Container doors
②	Door lock

Table 8: Container overview – side view left

4.4.2 Cabinet Overview- Converter Cabinets



Figure 11: Cabinet overview – converter unit

Position	Cabinet Designation	Abbreviation
①	Converter cabinet	CON
②	Inductor cabinet	IND
③	Circuit breaker cabinet	CIR
④	AC and DC connection cabinet	AC_DC

Table 9: Cabinet Overview – converter unit

4.4.3 Internal Components – Converter Cabinets

The following internal components are installed in the control cabinets of the AC/DC converter unit:

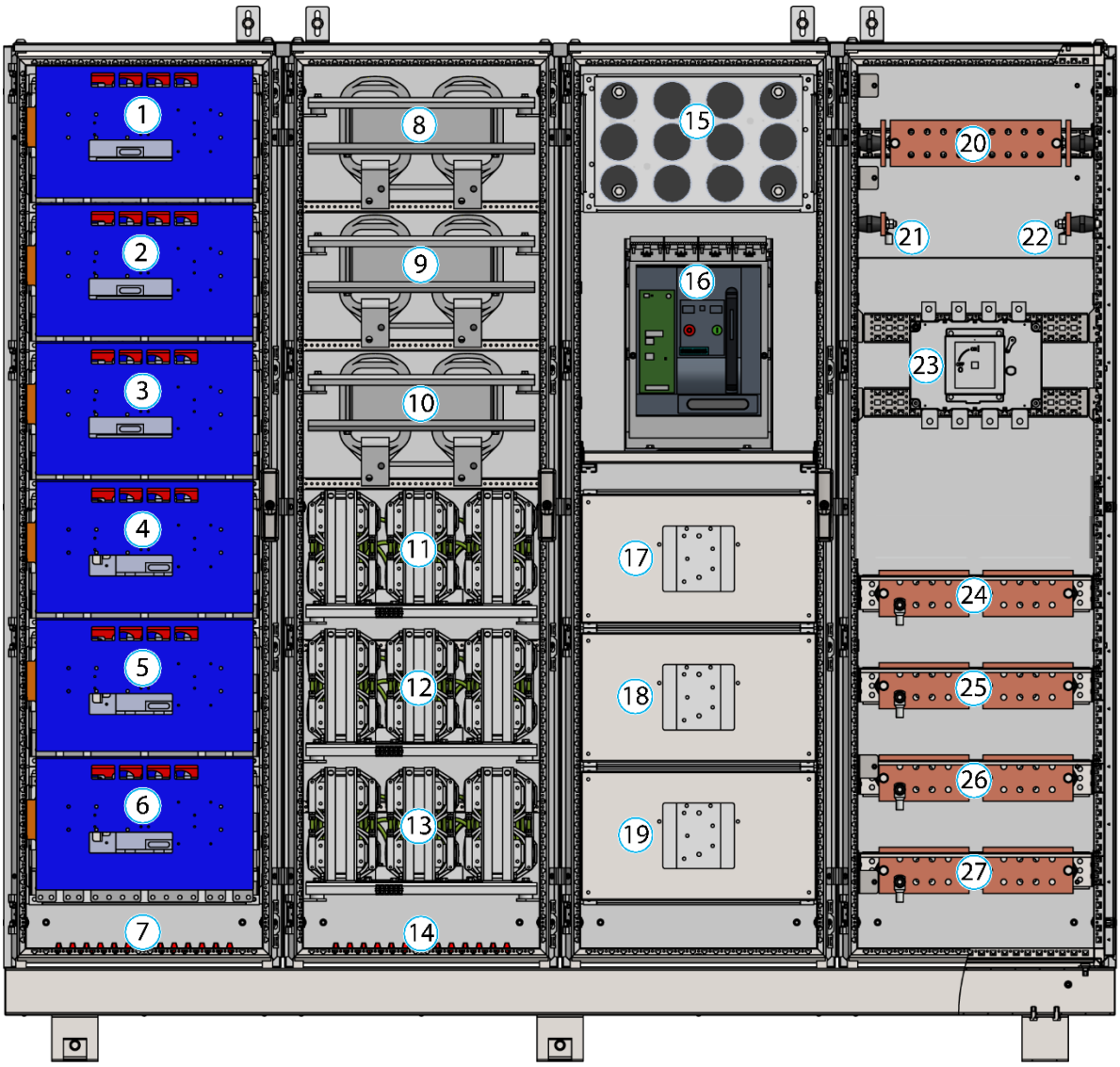


Figure 12: Internal components – converter unit

Pos.	Component	Part number	Identifier
1	AC IGBT Power Stack 1* 1000 A	52872	201Q1
2	AC IGBT Power Stack 1* 1000 A	52872	202Q1
3	AC IGBT Power Stack 1* 1000 A	52872	203Q1
4	DC IGBT Power Stack 3* 250 A	52867	207Q1
5	DC IGBT Power Stack 3* 250 A	52867	211Q1

6	DC IGBT Power Stack 3* 250 A	52867	217Q1
7	Coolant dispenser	--	--
8	AC Single phase line inductor 1000 A / 0.2 mH	53053	201L1
9	AC Single phase line inductor 1000 A / 0.2 mH	53053	202L1
10	AC Single phase line inductor 1000 A / 0.2 mH	53053	203L1
11	DC Single phase line inductor 3x 250 A / 0.6 mH	53046	207L1
12	DC Single phase line inductor 3x 250 A / 0.6 mH	53046	211L1
13	DC Single phase line inductor 3x 250 A / 0.6 mH	53046	217L1
14	Coolant dispenser	--	--
15	AC Filter 1000 A / 3*600 µF	52918	83U1
16	AC Main circuit breaker IEC 1000 A	52955	80Q1
17	DC Switch & Fuse 3* 250 A / 1000 V	52882	227U1
18	DC Switch & Fuse 3* 250 A / 1000 V	52882	231U1
19	DC Switch & Fuse 3* 250 A / 1000 V	52882	237U1
20	AC Grid connection busbars L1/L2/L3	--	78W1 - 78W3
21	N - Connection busbar	--	78W4
22	PE - Connection busbar	--	78W5
23	Switch for earthing and short-circuiting 600 A / 690 V	10172	18Q1
24	DC connection busbars + / - BESS 1 string 1 - 8	--	227W10 – 227W15
25	DC connection busbars + / - BESS 1 string 9 - 11	--	231W10 – 231W11
26	DC connection busbars + / - BESS 2 string 1 – 3 DC connection busbars + / - BESS 2 string 4 - 6	--	231W14 / 231W15 237W10 / 237W11
27	DC connection busbars + / - BESS 2 string 7 - 11	--	237W12 – 237W15

Table 10: Internal components – converter unit

4.4.4 Cabinet Overview - Control Cabinets

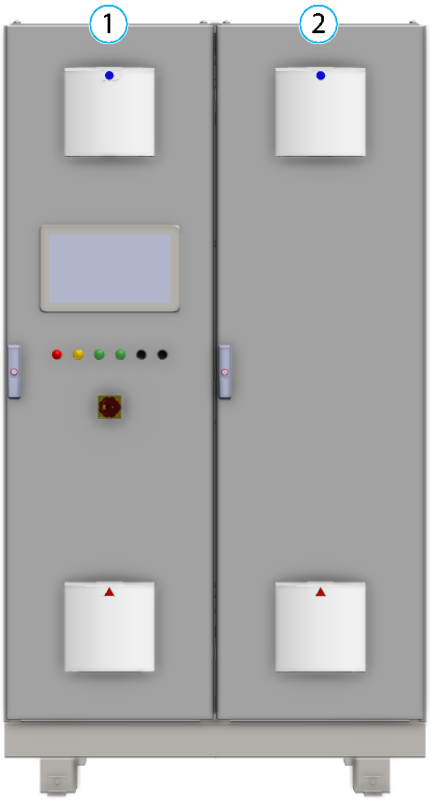


Figure 13: Cabinet overview – control cabinets

Position	Cabinet Designation	Abbreviation
①	Control cabinet 1	CTRL_1
②	Control cabinet 2	CTRL_2

Table 11: Cabinet Overview – control cabinets

4.4.5 Internal Components – Control Cabinets (CTRL_1 and CTRL_2)

The following internal components are contained within the control cabinets (CTRL_1 and CTRL_2).

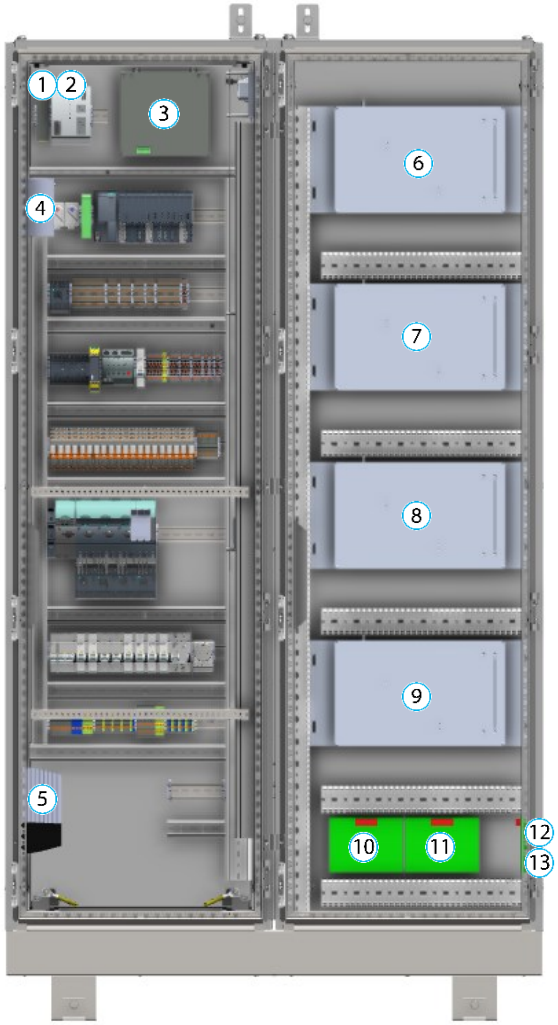


Figure 14: Internal components – control cabinets (CTRL_1 and CTRL_2)

Pos.	Component	Part number	Identifier
1	UPS unit 24 V DC	501836	102G1
2	24 V DC power supply for UPS unit	502745	101T1
3	Energy storage 24 V DC / 12 Ah for UPS unit	501229	102G2
4	Main controller PLC SIMOTION P320-4	500789	110U1
5	Cabinet heater 800 W	500621	185R1
6	PIII IGBT IRT Interface 2.6 V4	504890	240U1
7	PIII IGBT IRT Interface 2.6 V4	504890	241U1
8	PIII IGBT IRT Interface 2.6 V4	504890	242U1
9	PIII IGBT IRT Interface 2.6 V4	504890	243U1

10	HVIO Modul V5.0	500390	161U1
11	HVIO Modul V5.0	500390	162U1
12	HVIO Modul V5.0	500390	163U1
13	HVIO Modul V5.0	500390	164U1

4.4.6 External Components – Control Cabinet

The following internal components are contained within the control cabinet 1 (CTRL_1).

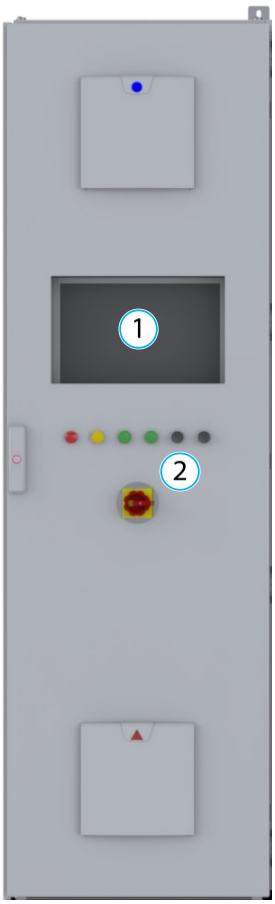


Figure 15: Internal components - control cabinet 1

Pos.	Component
1	HMI panel
2	Operating panel *(see 14.1 "Operating* Panel*")*

Table 12: Internal components - control cabinet

4.5 BESS 1 Container

4.5.1 Container Overview

Side view

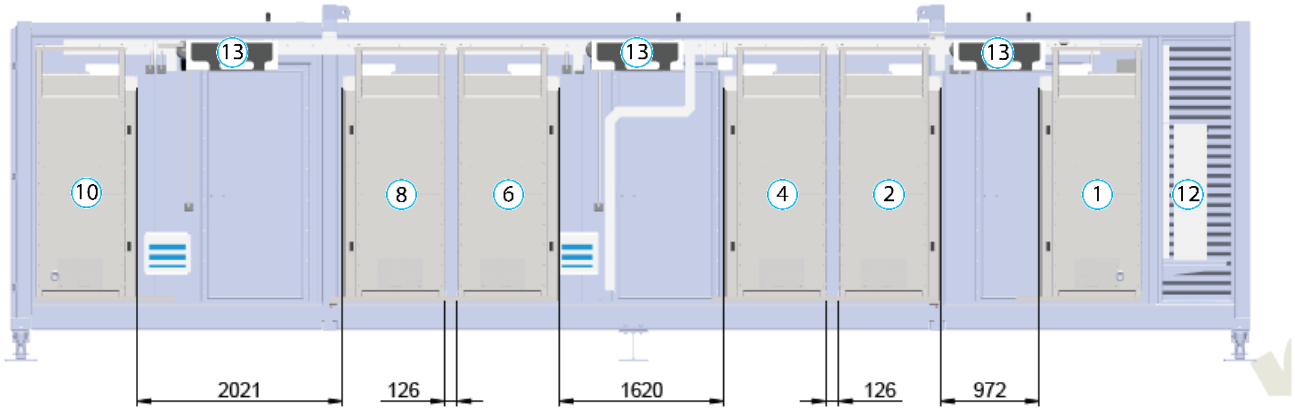


Figure 16: Container overview – side view

Position	Component
①	Battery storage cabinet (BESS 1 string 1)
②	Battery storage cabinet (BESS 1 string 2)
③	Battery storage cabinet (BESS 1 string 3)
④	Battery storage cabinet (BESS 1 string 4)
⑤	Battery storage cabinet (BESS 1 string 5)
⑥	Battery storage cabinet (BESS 1 string 6)
⑦	Battery storage cabinet (BESS 1 string 7)
⑧	Battery storage cabinet (BESS 1 string 8)
⑨	Battery storage cabinet (BESS 1 string 9)
⑩	Battery storage cabinet (BESS 1 string 10)
⑪	Battery storage cabinet (BESS 1 string 11)
⑫	External cooling system component (*for details see section 4.8 "Cooling System"*)
⑬	Internal cooling system component (*for details see section 4.8 "Cooling System"*)
⑭	Container lights
⑮	Lifting device (*for details see section 4.7.5 "Lifting Device"*)

Table 13: Container overview – components

Top View

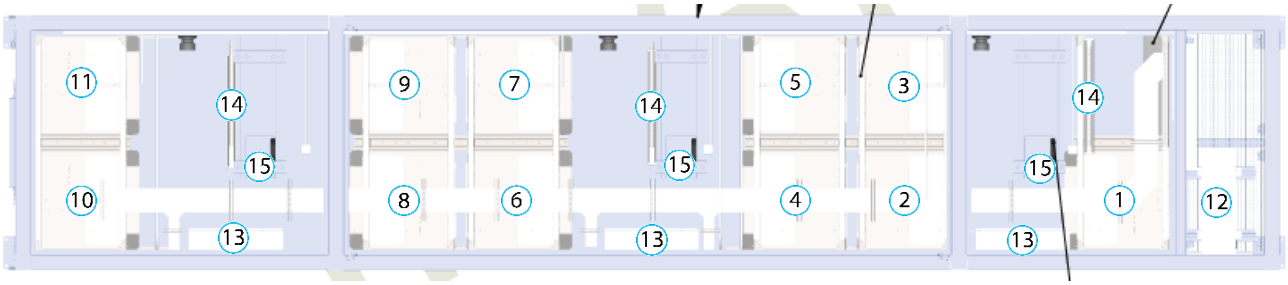


Figure 17: Container overview – top view

Perspective view

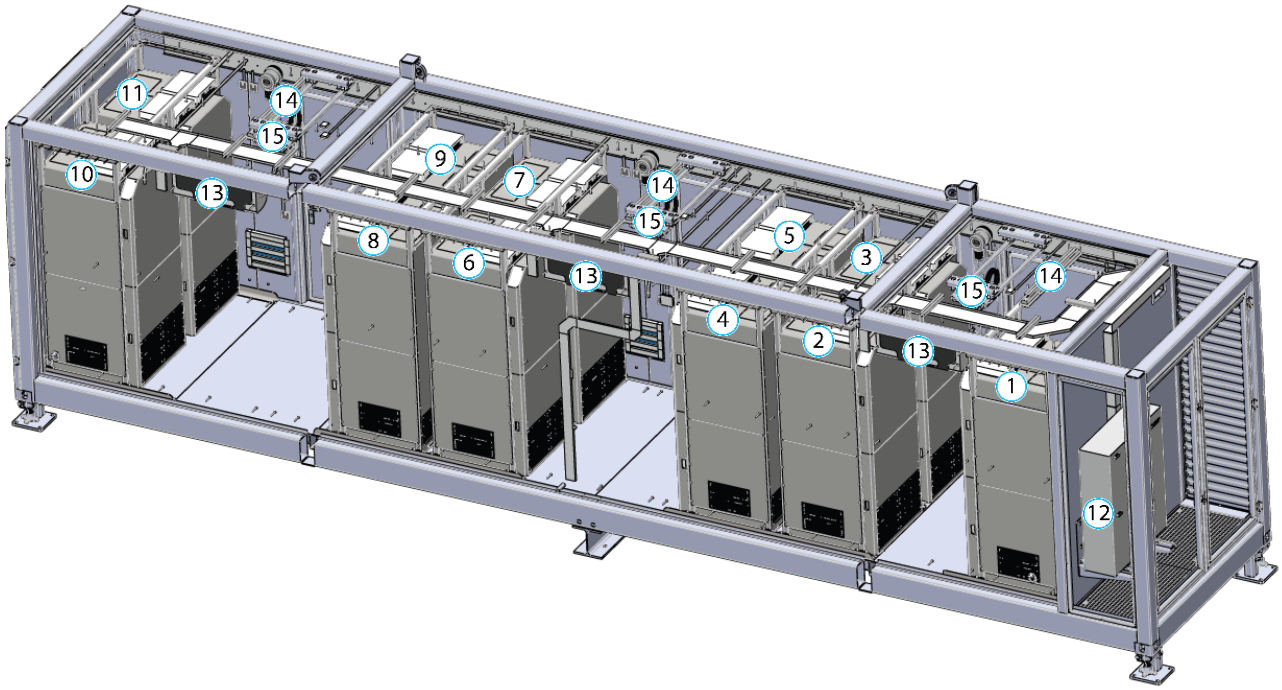


Figure 18: Container overview- perspective view

Side View Left

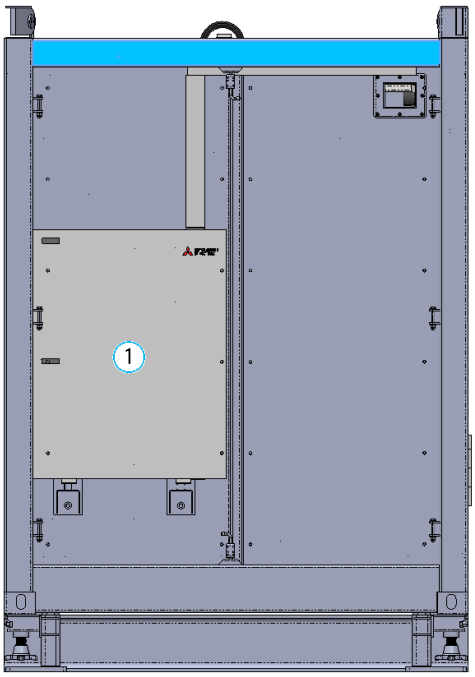


Figure 19: Container overview – side view left

Position	Component
①	External AC unit

Table 14: Container overview – side view left

Side View Right

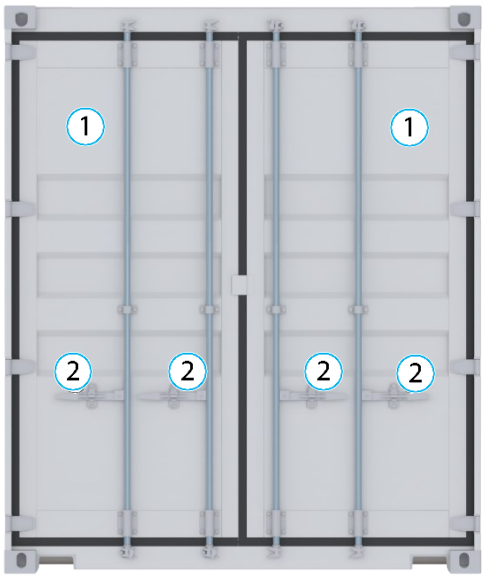


Figure 20: Container overview – side view right

Position	Component
①	Container doors
②	Door lock

Table 15: Container overview – side view left

4.5.2 Cabinet Overview- BESS 1 Battery Cabinets

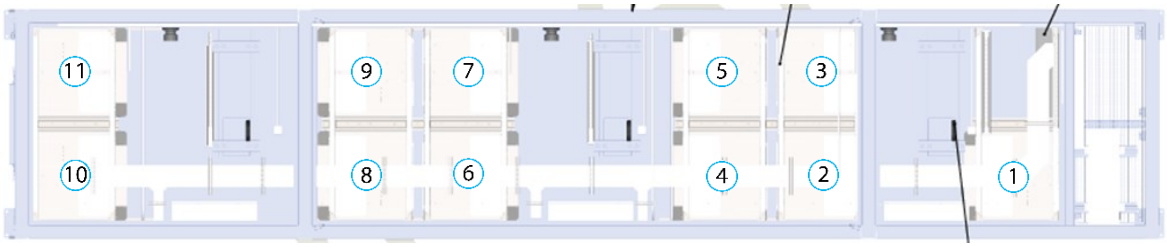


Figure 21: Cabinet overview – BESS 1 battery cabinets (Container top view)

Position	Cabinet Designation	Abbreviation
①	Battery cabinet 1	BESS.STR_1
②	Battery cabinet 2	BESS.STR_2
③	Battery cabinet 3	BESS.STR_3
④	Battery cabinet 4	BESS.STR_4
⑤	Battery cabinet 5	BESS.STR_5
⑥	Battery cabinet 6	BESS.STR_6
⑦	Battery cabinet 7	BESS.STR_7
⑧	Battery cabinet 8	BESS.STR_8
⑨	Battery cabinet 9	BESS.STR_9
⑩	Battery cabinet 10	BESS.STR_10
⑪	Battery cabinet 11	BESS.STR_11

Table 16: Cabinet Overview – BESS 1 battery cabinets

4.5.3 Internal Components – Battery Cabinets

The following internal components are contained within the battery cabinets:



Figure 22: Internal components – battery storage cabinets

Pos.	Component	Part number
①	Cabinet fan	505587
②	Battery module LF 280	508972
③	Aerosol cartridge of fire extinguishing unit Aero-X Stat-X 60E	506501
④	Optical smoke detector 12 V	500713
⑤	DC fuse switch disconnector 3NP1, 3-pole, NH2, 400 A	10226
⑥	Mounting plate with cabinet control system, DC, contactors etc.	52422

Table 17: Internal components – battery storage cabinets

4.6 BESS 2 Container

4.6.1 Container Overview

Side view

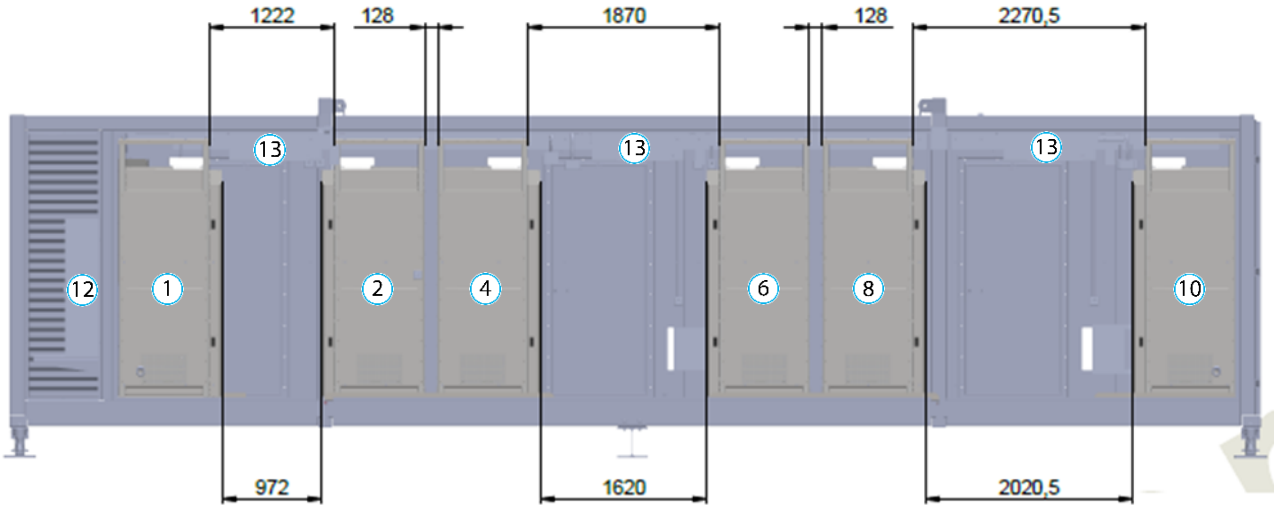


Figure 23: Container overview – side view

Position	Component
①	Battery storage cabinet (BESS 2 string 1)
②	Battery storage cabinet (BESS 2 string 2)
③	Battery storage cabinet (BESS 2 string 3)
④	Battery storage cabinet (BESS 2 string 4)
⑤	Battery storage cabinet (BESS 2 string 5)
⑥	Battery storage cabinet (BESS 2 string 6)
⑦	Battery storage cabinet (BESS 2 string 7)
⑧	Battery storage cabinet (BESS 2 string 8)
⑨	Battery storage cabinet (BESS 2 string 9)
⑩	Battery storage cabinet (BESS 2 string 10)
⑪	Battery storage cabinet (BESS 2 string 11)
⑫	External cooling system component (*for details see section 4.8 "Cooling System"*)
⑬	Internal cooling system component (*for details see section 4.8 "Cooling System"*)
⑭	Container lights
⑮	Lifting device (*for details see section 4.7.5 "Lifting Device"*)

Table 18: Container overview – components

Top View

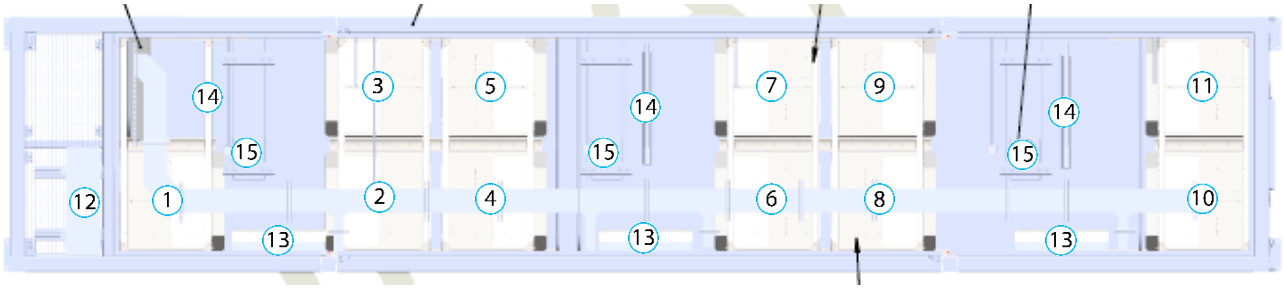


Figure 24: Container overview – top view

Perspective view

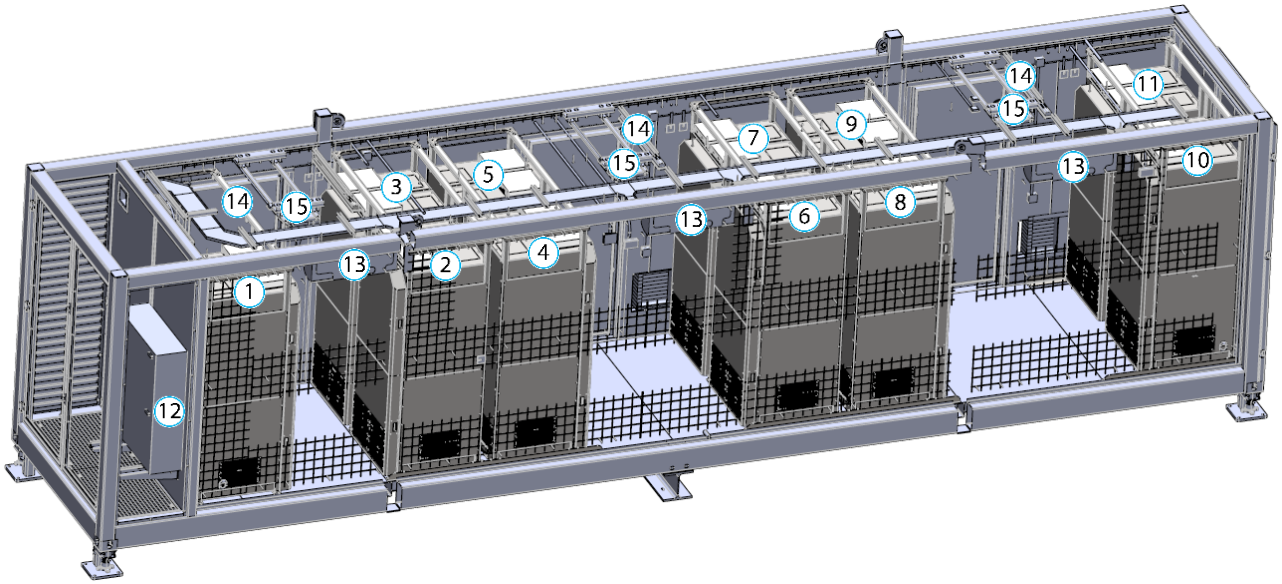


Figure 25: Container overview- perspective view

Side View Left

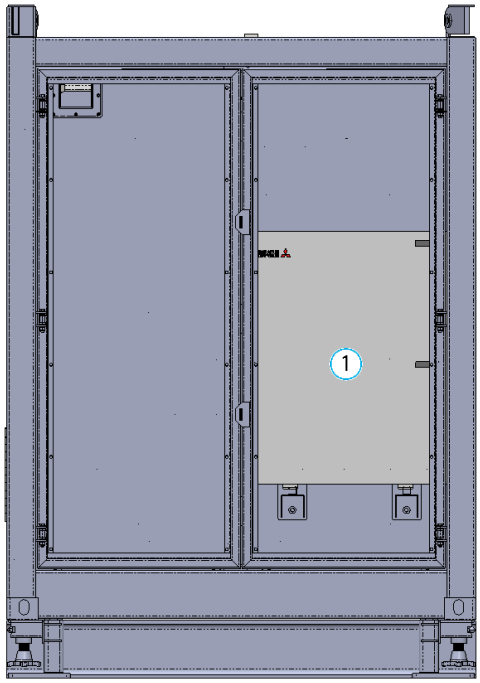


Figure 26: Container overview – side view left

Position	Component
①	External AC unit

Table 19: Container overview – side view left

Side View Right

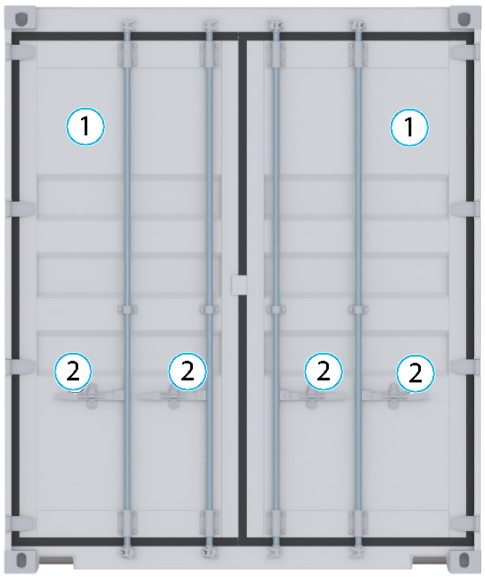


Figure 27: Container overview – side view right

Position	Component
①	Container doors
②	Door lock

Table 20: Container overview – side view left

4.6.2 Cabinet Overview- BESS 2 Battery Cabinets

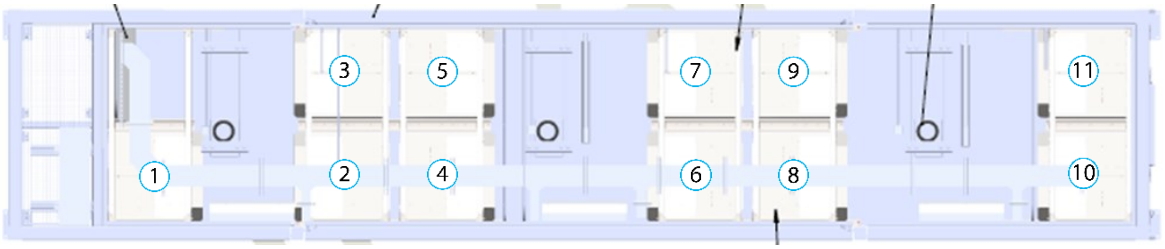


Figure 28: Cabinet overview – BESS 2 battery cabinets (Container top view)

Position	Cabinet Designation	Abbreviation
①	Battery cabinet 1	BESS.STR_1
②	Battery cabinet 2	BESS.STR_2
③	Battery cabinet 3	BESS.STR_3
④	Battery cabinet 4	BESS.STR_4
⑤	Battery cabinet 5	BESS.STR_5
⑥	Battery cabinet 6	BESS.STR_6
⑦	Battery cabinet 7	BESS.STR_7
⑧	Battery cabinet 8	BESS.STR_8
⑨	Battery cabinet 9	BESS.STR_9
⑩	Battery cabinet 10	BESS.STR_10
⑪	Battery cabinet 11	BESS.STR_11

Table 21: Cabinet Overview – BESS 2 battery cabinets

4.6.3 Internal Components – Battery Cabinets

The following internal components are contained within the battery cabinets:



Figure 29: Internal components – battery storage cabinets

Pos.	Component	Part number
①	Cabinet fan	505587
②	Battery module LF 280	508972
③	Aerosol cartridge of fire extinguishing unit Aero-X Stat-X 60E	506501
④	Optical smoke detector 12 V	500713
⑤	DC fuse switch disconnector 3NP1, 3-pole, NH2, 400 A	10226
⑥	Mounting plate with cabinet control system, DC, contactors etc.	52422

Table 22: Internal components – battery storage cabinets

4.7 Battery Modules



Figure 30: Battery module LF 280

4.7.1 Design

The lithium iron phosphate cells (LiFePO4) inside the LF 280 battery modules are connected in series and provide a total energy content of 8.96 kWh per module.

Each module is equipped with a monitoring PCB, providing the following functions:

- Voltage monitoring of single cells for charging and discharging
- Battery temperature monitoring
- Selective cell balancing
- Data exchange with central BESS controller
- Local insulation measurement
- Robust industrial design for transport, assembly und operation



Figure 31: Battery module design

No.	Component
①	Battery module LF280
②	Boreholes for lifting device (M6)
③	DC positive (+) socket
④	DC negative (-) socket
⑤	COM-Connection RJ45 and 24 V DC power supply
⑥	Boreholes for transport handle mounting
⑦	Label with safety and warning instructions

Table 23: Battery module design

4.7.2 Technical Data

Technical Data Battery Module LF 280	
Part number	508972
Rated Voltage	32 V DC
Total capacity	280 Ah
Number of cells per battery module	10
Stored Energy	8960 Wh
Maximum voltage	36 V DC
Max. current	280 A
Max. charge and discharge rate	1 C
Temperature range storage	-20 °C … +45 °C (long-term storage at 0…35°C)
Temperature range operation	0 °C … +55 °C
Connections for DC+ / DC-	Surlock Plus
Communication connections	RJ 45
Protection class	IP 20
Weight	65.3 kg
Dimensions (WxHxD)	188 mm x 239 mm x 908 mm
Cell Data (Single Cell)	
Type	Prismatic cells
Capacity (typ.)	280 Ah
Voltage (typ.)	3.2 V
Voltage (max.)	3.65 V
Voltage (min.)	2.5 V
Battery life	>3500 cycles (80% remaining capacity)
Impedance (AC)	<0.25 mΩ
BMS Pack Universal	
Power supply (external)	24 V DC (rated), <0.5 W
Power supply (internal)	36 V DC (max.), < 0.2 W
Communication	EIA-485, Modbus RTU
Baud rate (max.)	19200 Bit/s
Bus participants (max.)	32
Balancer design	Load resistor
Balancer current @3.5 V	1.06 A
Voltage measurement	10 measurements per 14-bit resolution
Temperature measurements	8x NTC 10 kΩ (up to 14 bit analogue/digital converter) 1x PT100 (12 bit analogue/digital converter)
Isolation measurement	Earth fault monitoring

Table 24: Technical data - Battery module LF280

4.7.3 Connection Elements



Figure 32:Connection elements

Pos.	Terminal	Description	Connection type	Cable
①	X1	DC + Battery module	10.3 mm Surlock Plus	Pay attention to cable routing in cabinet
②	X2	DC – Battery module	10.3 mm Surlock Plus	Pay attention to cable routing in cabinet
④	X3	Communication (input)	RJ45, 45°	PiMF, 4x2 min. AWG 27/7
⑤	X4	Communication (Output)	RJ45, 45°	PiMF, 4x2 min. AWG 27/7
⑤	X5	24 V DC power supply	2-pole male terminal	Pay attention to cable routing in cabinet

Table 25: Connection elements

4.7.4 Communication Scheme

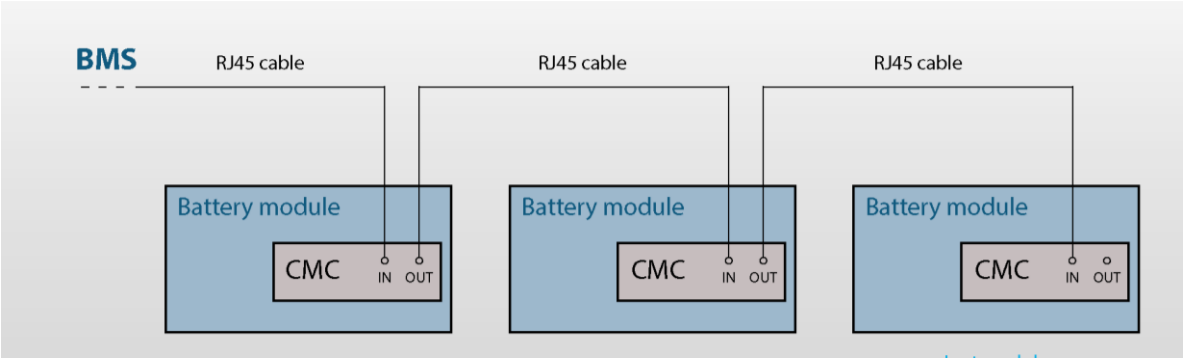


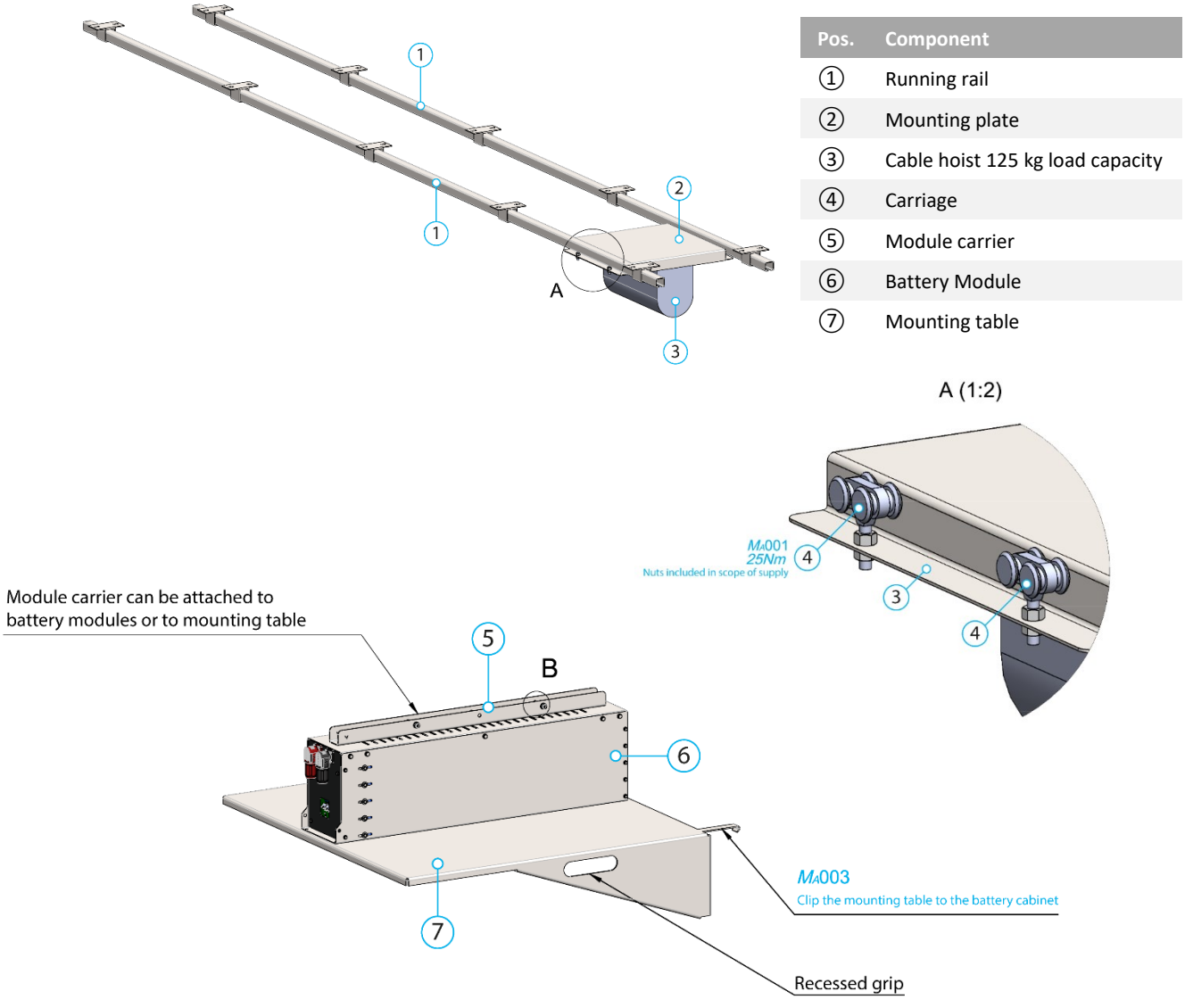
Figure 33: BMS communication scheme

4.7.5 Lifting Device and Mounting Table

For the lifting of battery modules, a lifting device is installed at the container ceiling, allowing safe handling and installation of the battery modules.

The lifting device mainly consist of a cable hoist which is mounted to a mounting plate with carriers, allowing to move the cable hoist through running rails to each end of the container. The cable hoist is operated via cable remote control.
For better handling of the battery modules when inserting them to the battery storage cabinet, a mounting table is provided, that can be attached to the battery storage cabinets.

For detailed information and operating instructions regarding the cable hoist, please refer to the original cable hoist manufacturer's original operating manual (*see section 1.2 "Applicable Documents"*).



Pos.	Component
①	Running rail
②	Mounting plate
③	Cable hoist 125 kg load capacity
④	Carriage
⑤	Module carrier
⑥	Battery Module
⑦	Mounting table

Figure 34: Lifting device and mounting table

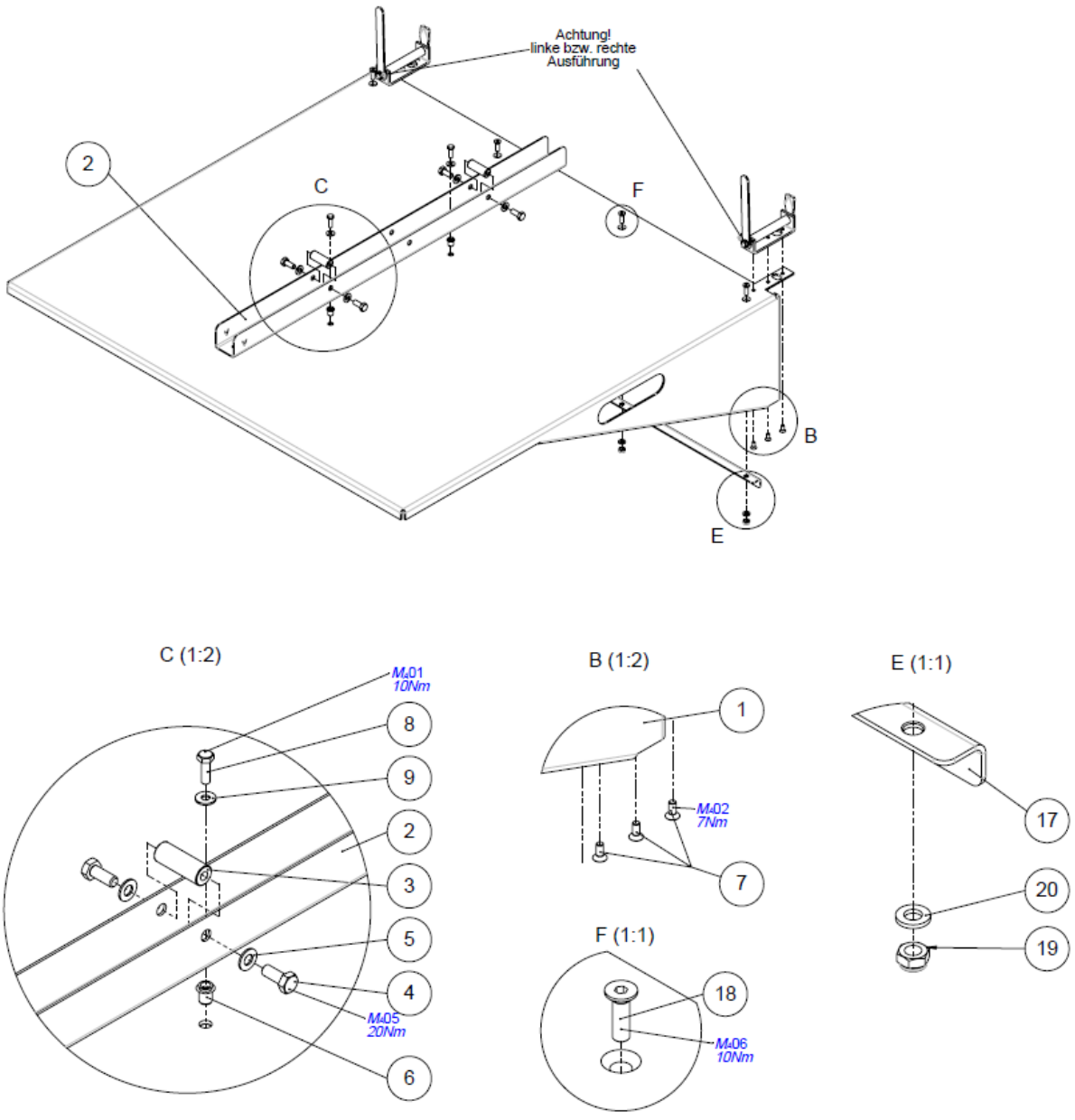


Figure 35: Mounting table

4.7.6 Mobile Lifting Device

A mobile lifting device for moving battery modules inside the BESS containers can be used. The mobile lifting device “Material-Lift GUIL ELC-725” or other models are suitable to lift and mount battery modules inside FREQCON BESS containers.

One (1) battery module can be placed onto the table of the mobile lifting device at once. The module needs to be pushed from the pallet of the forklift truck in front of the BESS container door onto the table of the mobile lifting device.

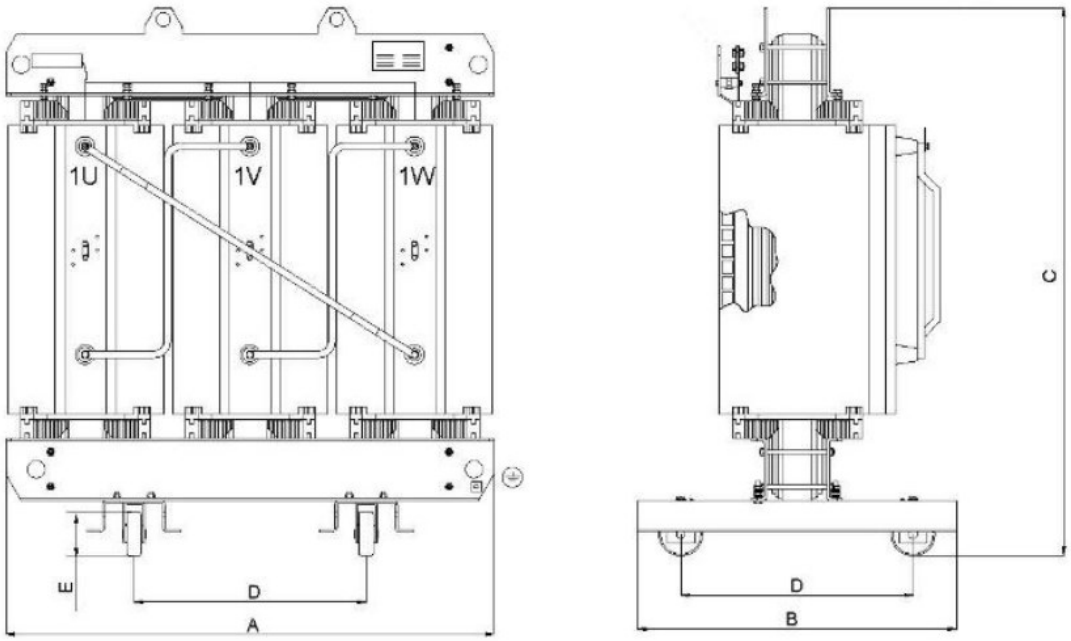
The mobile lifting device can then be moved to the battery cabinet where the battery module needs to be installed.



Figure 36: Mobile lifting device “Material-Lift GUIL ELC-725”

Technical details	
Dimensions L x W x H	400 mm x 550 mm x 1320 mm
Type of construction	Material lift
Overall height	1320 mm
Dead weight	51 kg
Lifting function	Cable winch
Lifting height	4000 mm
Platform dimensions L x W	550 x 500 mm
Table height max.	3940 mm
Table height min.	1320 mm
Load capacity:	125 kg

4.7.7 MV Transformer



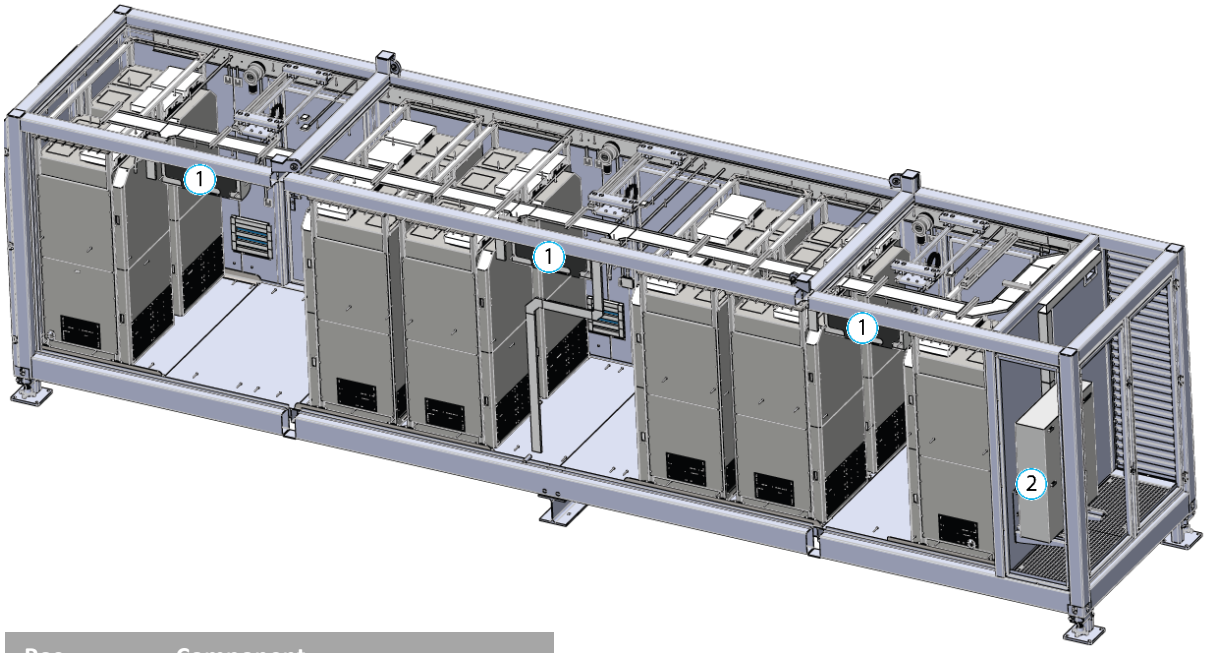
Position	1			
Reference Standards	IEC 60076-1,IEC 60076-11, EU 548/2014,EN 50588-1			
Type	TPZ3K7.2.1250	**Application**	Converter	6 Pulse
Rated Power – AN	1250 kVA	**Duty Class**	I	
Type of Cooling	AN	**Frequency**	50 Hz	
Degree of Protection	IP00			

CHARACTERISTICS

	HV	**LV**
Voltage	7 kV	0,62 kV
Insulation Class	7.2/20/60 kV	1,1/3/- kV
Tapping	±2x2,5%	-
Material	Aluminium	Aluminium
Insulation class	F	F
Temperature rise	100 K	100 K
Connections location	Top	Top
Vector Group	Dyn5	
Level of losses	EcoDesign TIER II	
No-Load Losses (Po)	1620 W	
On-Load Losses 120°C (Pcc)	11000 W	
Tolerance on the losses	0%	
Impedance 120°C (Uk%)	6%	
Power Noise (Lwa)	≤ 66 dB(A)	
Pressure Noise (Lpa)	≤ 52 dB(A)	
Ambient Temperature	-25°C ; + 40°C	
Installation	≤ 1.000 m	
Fire (F), Environmental (E), Climatic (C) Classes	F1/E2/C2	
HV/LV earth screen	YES	
Dimensions IP00 (AxBxC)	1680x1050x1990 mm	**Wheel Base (D)** 820 mm
Wheels Dimensions (E)	160 mm	**Total Weight IP00** 3600 Kg

4.8 Cooling System

4.8.1 BESS 1 / BESS 2 Container



Pos	Component
①	Internal AC unit
②	External AC unit

Table 26: BESS 1 / BESS 2: Cooling system components

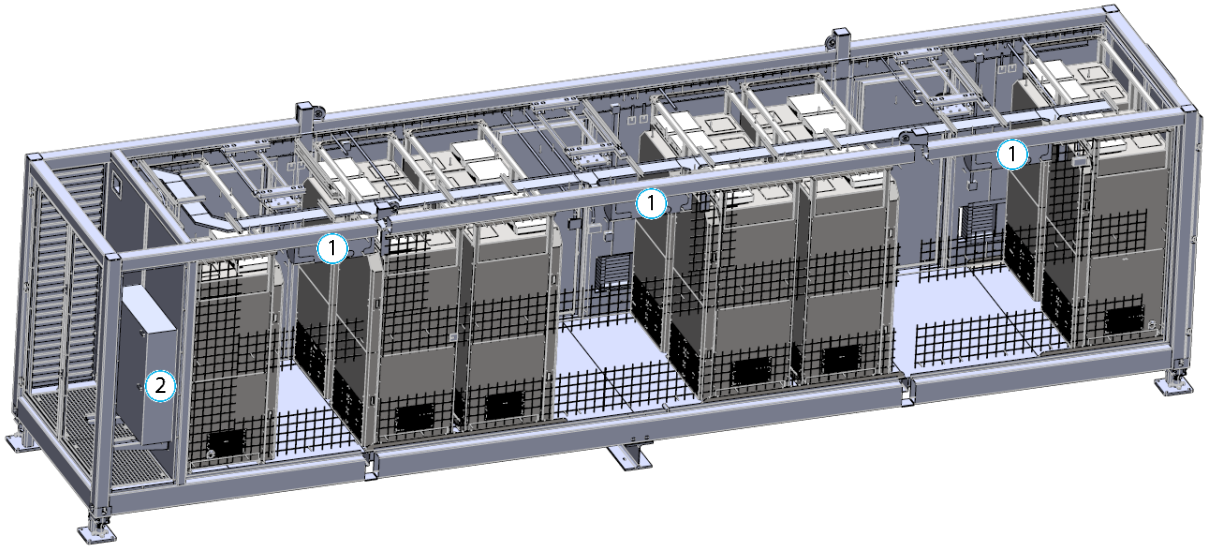


Figure 37: BESS 1 (above) / BESS 2 (below): Cooling system components

4.8.1.1 Battery Cabinets Cooling

The waste heat inside the battery cabinets is actively dissipated by two fans in the roof of each battery cabinet. The heated air is pushed out of the cabinet to the inside of the BESS container.

4.8.1.2 Container Cooling

The waste heat in the interior of the container is conducted via the three internal air conditioning (AC) units (*see Figure 37*) from the interior to the external air conditioning units of the container.

The container is equipped with several temperature sensors for monitoring the internal container temperature.

4.8.2 PCS Container

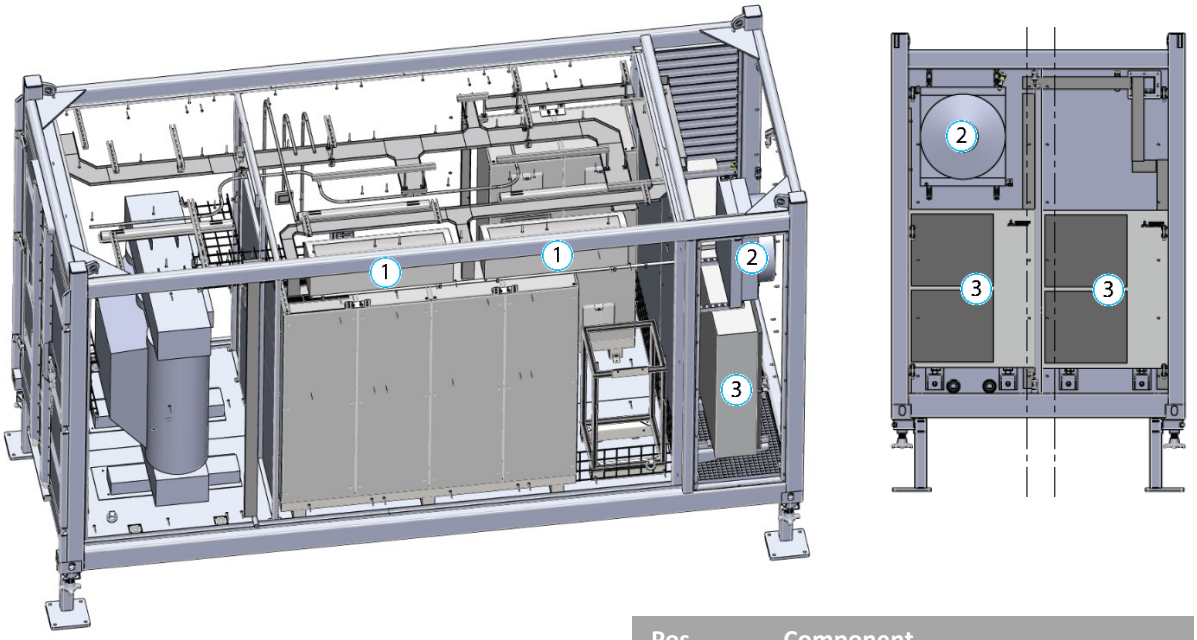


Figure 38: PCS: Cooling system components

Pos	Component
①	Internal AC unit
②	Heat exchanger
③	External AC unit

Table 27: PCS: Cooling system components

4.8.2.1 Container Cooling

The waste heat in the interior of the container is conducted via the three internal air conditioning (AC) units (*see Figure 38*) from the interior to the external air conditioning units of the container.

The container is equipped with several temperature sensors for monitoring the internal container temperature.

4.8.2.2 Converter Cooling System

To dissipate the waste heat from the IGBT power modules and inductors installed in the converter, these components are cooled down to the required operating temperature by an internal cooling system consisting of cooling hoses, coolant pumps, water distributors and four air/water heat exchangers.

The water-glycol-circulation (WGC) is designed as a closed cooling circuit. A water-glycol mix flows through the cooling modules of the converter and dissipates the heat produced by the IGBT modules. Additionally, the IGBT modules need a minimum temperature to operate properly. To heat up the IGBT modules from a cold start, the water-cooling system is pre-heated by an electrical heating element which is flange-mounted to the coolant manifold. The pre-heating process is performed to achieve an operational temperature of 25 °C, which takes about 20 minutes. After the IGBT modules have reached the temperature of about 25 °C, the converter is permitted to begin its normal operation.

The electrical pre-heater will be switched off automatically by a control unit at a temperature of > 28 °C of the coolant temperature sensor. The heating element is switched off at least 2 minutes before the pump is switched off. This procedure avoids overheating of the heating element since there must be a permanent flow around the heating element during heating.

A 3/2 directional mixing valve at the WGC unit controls the inlet temperature to the converter by mixing the water-glycol mixture of the heat exchanger and a bypass circuit. The 3/2 directional mixing valve opens at 36°C (mechanically set at mixing valve) and leads the cooling water to the heat exchanger.

Pre-heater on-off temperature hysteresis (sensor measures the inlet temperature to the converter)	
Coolant temperature > 28 °C	Heaters will be turned off
Coolant temperature < 25 °C	Heater will be turned back on

Table 28: Pre-heater on-off temperature hysteresis

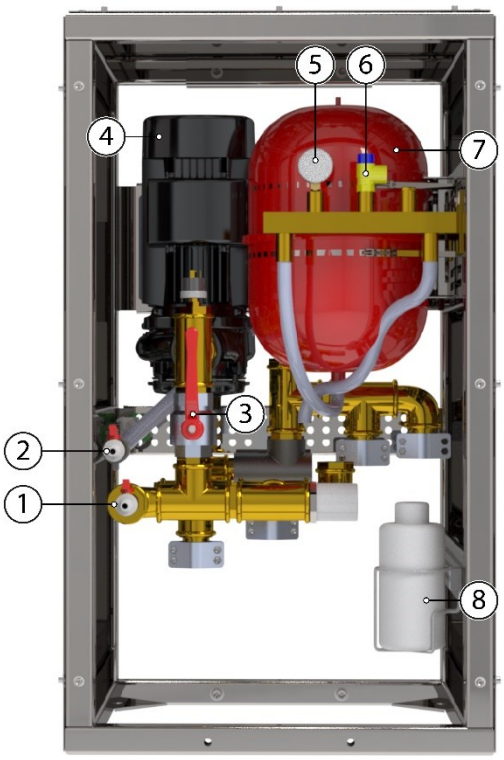


Figure 39: Cooling system cabinet (COSY) components

Position	Component
①	¾“ inlet flow connection with valve
②	"¾“ return flow connection with valve
③	Stop cock
④	Coolant pump
⑤	Manometer
⑥	Overpressure valve
⑦	Expansion vessel
⑧	Overflow vessel

Table 29: Cooling system enclosure (COSY) components

4.8.2.3 IGBT modules cooling

The cooling system dissipates the heat generated during normal operation of the converter.
The IGBT modules are mounted on heat sinks through which coolant flows. Tubing connectors provide the connection to the inlet and outlet of coolant.

4.8.2.4 Coolant Specifications

Coolant		
	Manufacturer	**Description**
Allowed Coolants	NALCO AG	Varidos FSK
	BASF AG	Glysantin G30
	Clariant	Antifrogen N
	Clariant	Antifrogen L
	DOW	Dowcal 20
Coolant concentration mixed with water	> 40 % to 60 % (depending on manufacturer recommendation)	
Coolant change interval	Every 5 years	

Table 30: Coolant specifications

5 Operating Interfaces

The BESS is operated and controlled either via

- The control panel on the control cabinet CTRL of the converter (*see section 14.1)*
  - Push-buttons
    - RESET (restart emergency stop circuit)
  - Indication lights:
    - Fault (red; controller error is active)
    - Preheating (yellow; preheating of coolant)
    - Ready for Operation (green; converter is ready for operation)
    - Operating (green; converter is active)
  - Other control elements:
    - Main switch
    - Emergency-stop push button
- interface to the customer's higher-level control system (*see section 6*).

6 Control System

6.1 Main Control System

The system is controlled and monitored by a main control system installed on the P320 PLC inside the control cabinet (CTRL). Both the converter and the BESS control system are installed on the same PLC.

Data exchange between the individual cabinet control systems and BESS main control system is performed via MODBUS TCP protocol.

BESS Main Control System Overview

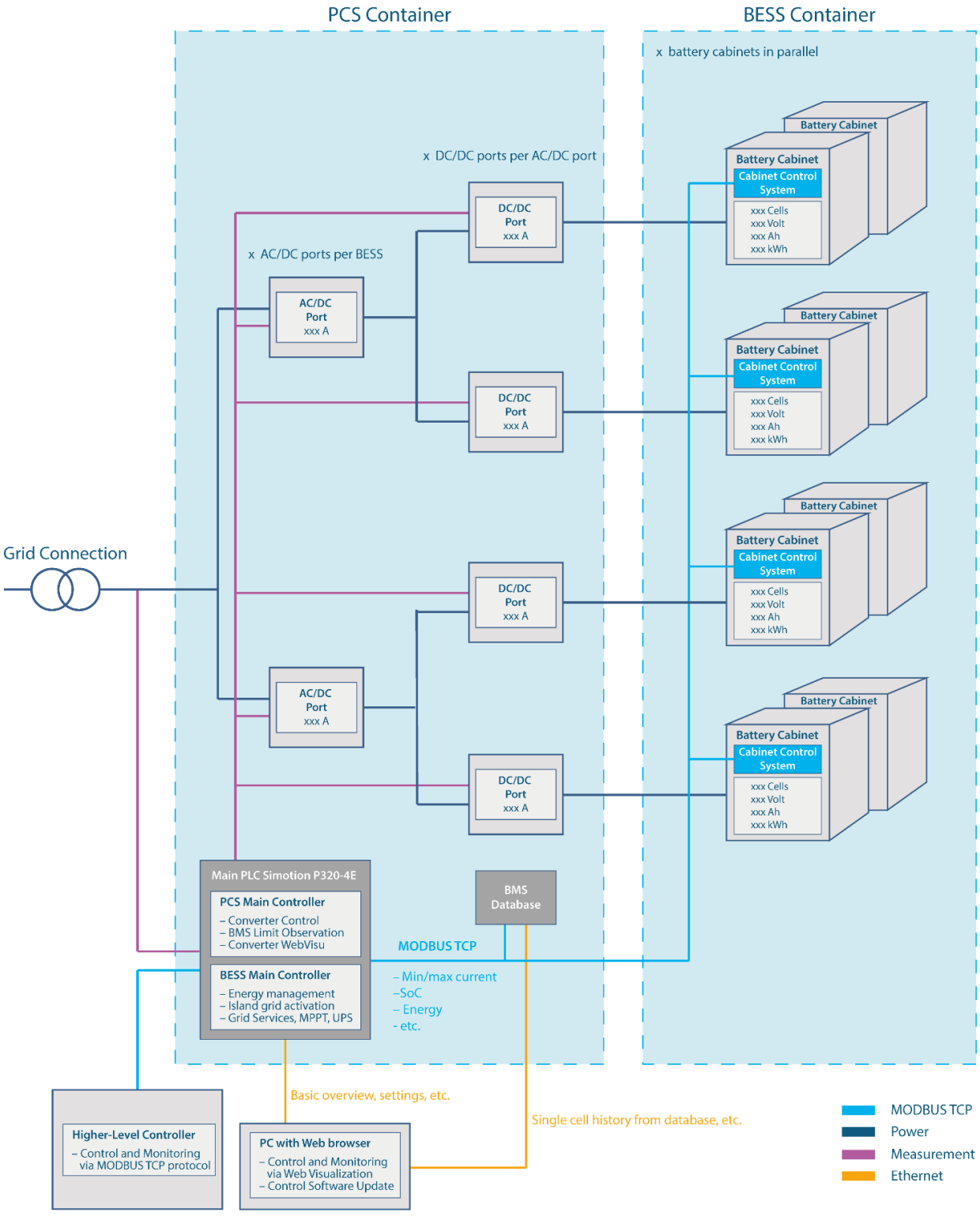


Figure 40: Main control system overview

6.2 Battery Cabinet Control System

Each battery cabinet is equipped with its own control system (Siemens S7) collecting the relevant data from the individual battery modules and providing these to the main control system (*see section 6.1*).

The tasks and features of the cabinet control system are the following:

- Monitoring of battery cell voltages and temperatures
- Monitoring of the battery charging and discharging current
- Control of DC switches
- Monitoring of line protection and smoke detectors
- MODBUS RTU Master for communication with BMS system (battery monitoring system)
- MODBUS TCP Server provides the communication interface to other systems. For example, for the external charger or the consumers

Cabinet Control System Overview

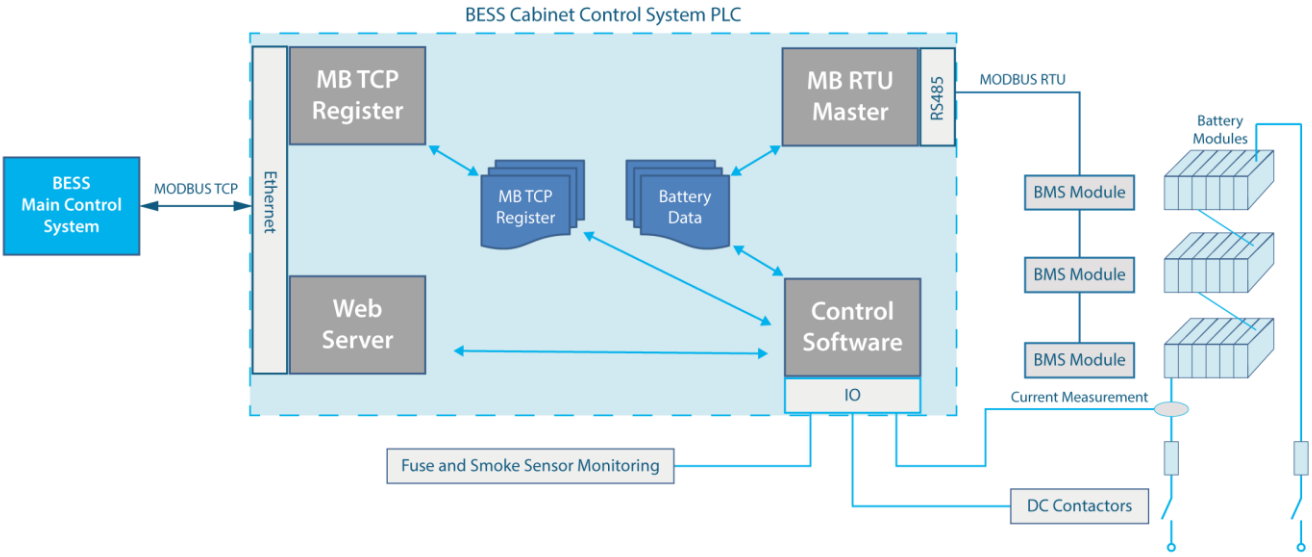


Figure 41: BESS cabinet control system overview

Data exchange between the cabinet control system and the individual battery modules is performed via MODBUS RTU protocol. Therefore, each battery cabinet is provided with several MODBUS RTU interfaces for Modbus connection of the battery modules.

6.3 Network Structure

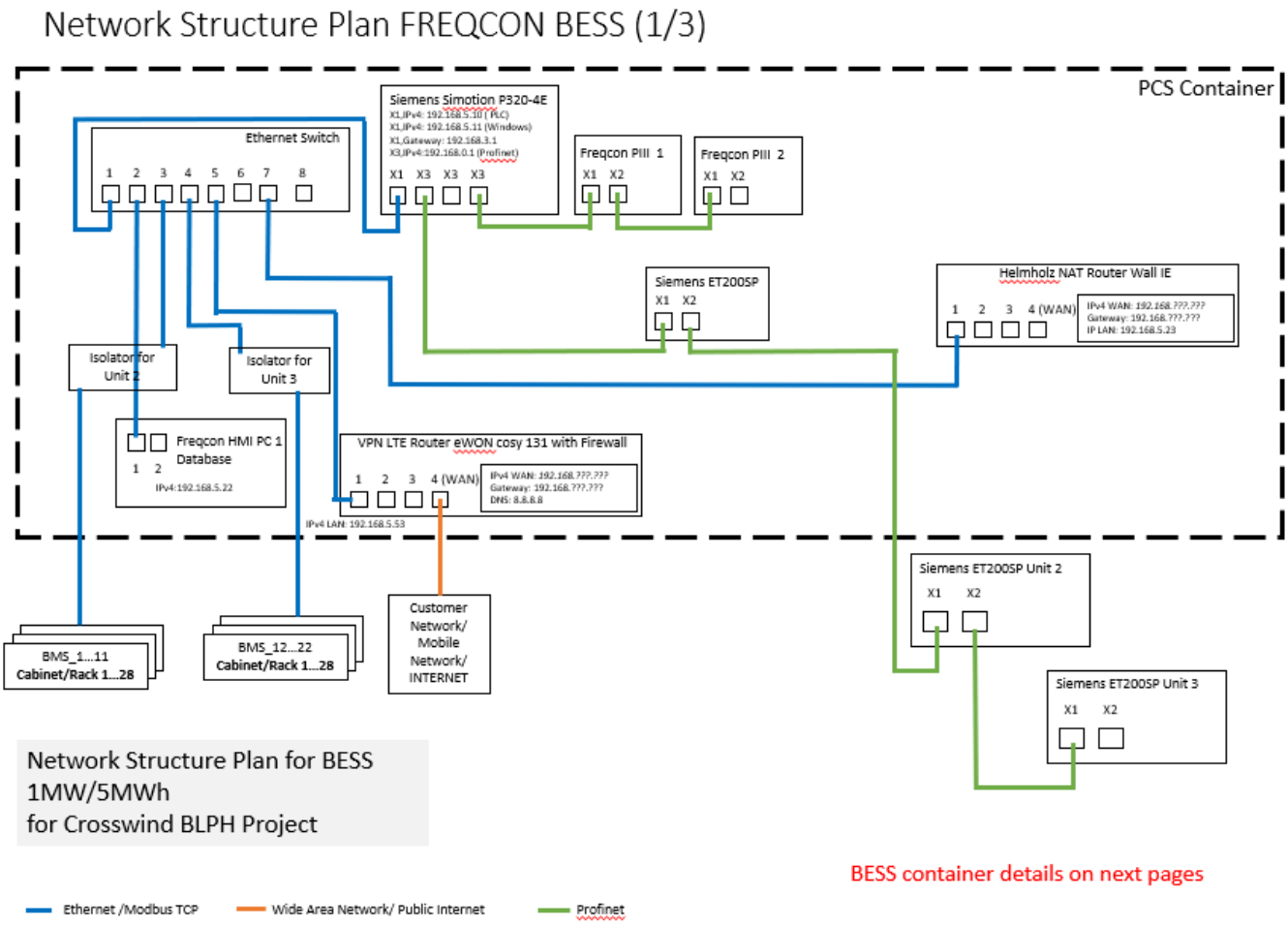


Figure 42: MSC network structure (1/3)

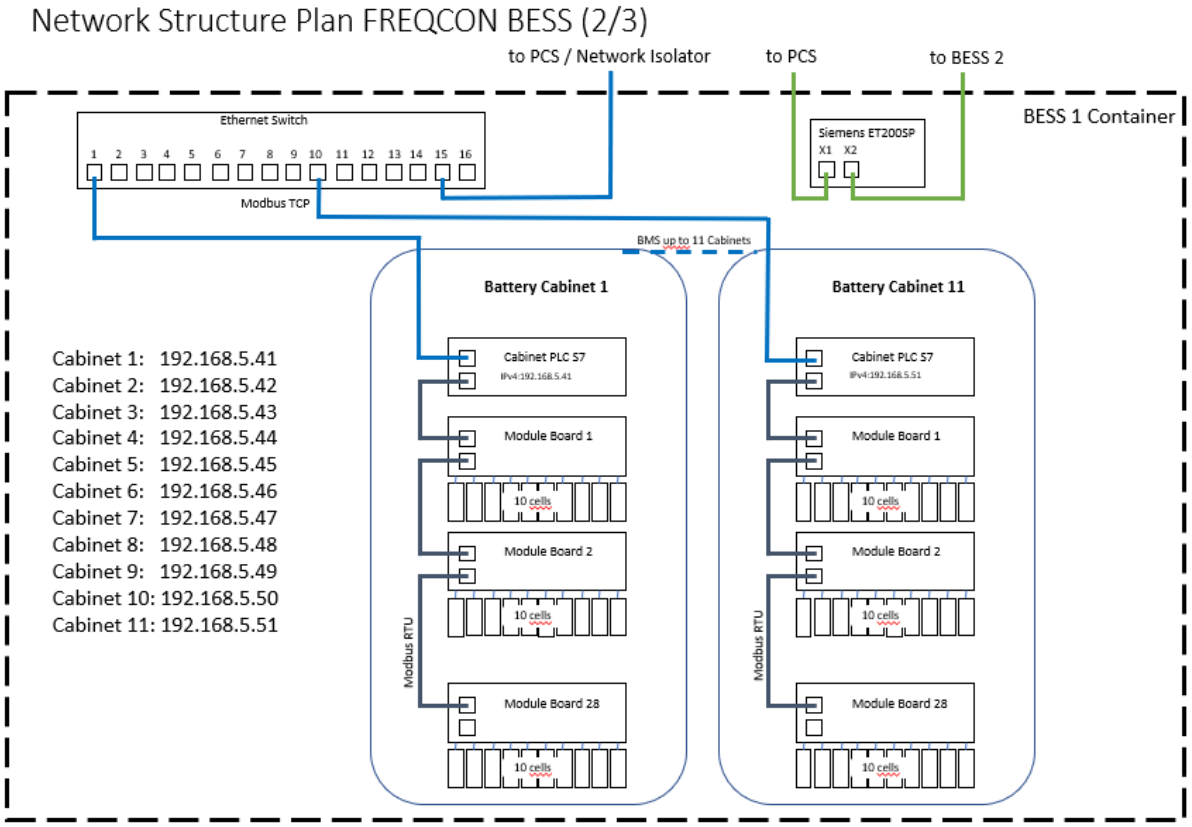


Figure 43: BESS network structure (2/3)

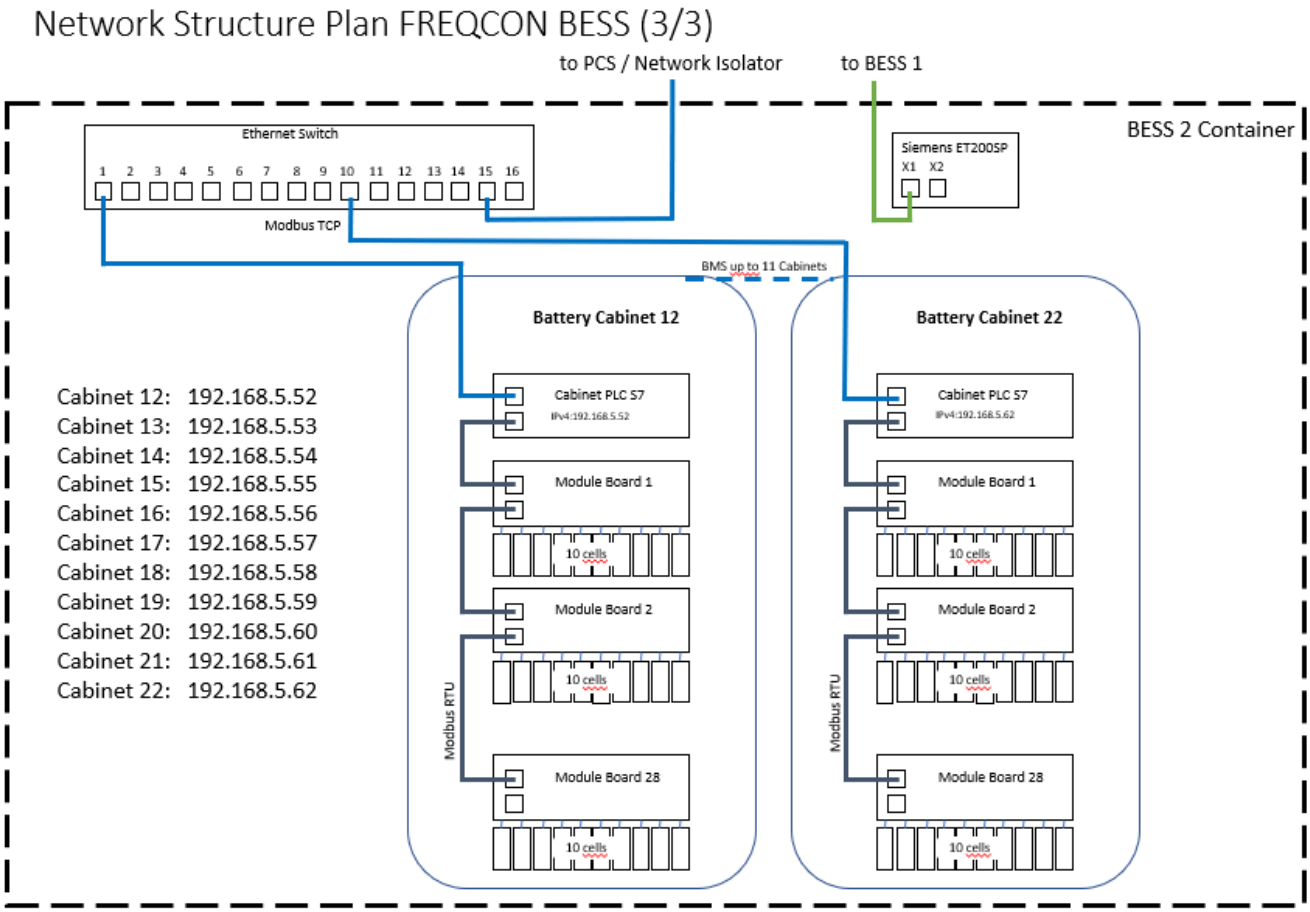


Figure 44: BESS network structure (3/3)

7 Converter Main States

The individual converter main states are depicted in the flow diagram below and described in section 7.2.

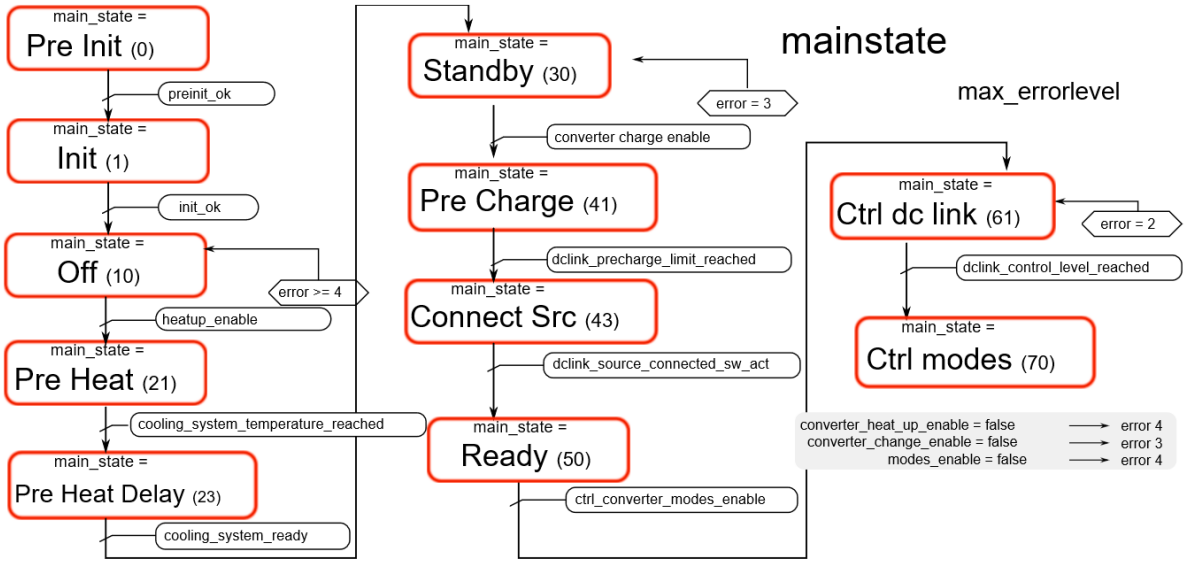


Figure 45: Converter main states

7.1 Error Levels

Error Level	Description
0	No error, logging information
1	Warning category, a warning limit is reached
2	Error category, stop subsystems
3	Error category, stop system and discharge DC-link, cooling system enable
4	Error category, stop system and also the cooling system

Table 31: Error levels

7.2 Main States

INIT

The system was turned on and the stored initialization parameters are read. Cooling and converter system are stopped.

OFF

DC link is discharged. The converter and cooling system are not in operation.

Pre-Heat

The converter is switched-off and is preparing for operation. The cooling system regulates to the optimum temperature of the cooling water, IGBT, capacitors and inductors.

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

Heat-Delay

The converter is preparing for operation. The operation temperatures of the components are reached and maintained for a defined time span.

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

STANDBY

Standby mode – converter is off, but the cooling system is in operation.

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

Pre-Charge

The converter´s main DC-link is pre-charged to a defined voltage level.

An error level 3, such as detection of wrong grid conditions, is leading to a change to main state STANDBY (converter is off, cooling system is in operation).

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

Connect SW

Source contactor is closed.

An error level 3, such as switching error of the source contactor, is leading to a change to main state "STANDBY" (converter is off, cooling system is in operation).

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

READY

Converter is ready for operation. Cooling system is operating, the DC link is charged and source is connected.

An error level 3, such as grid faults, is leading to a change to main state STANDBY (converter is off, cooling system is in operation).

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

DC link Ctrl

The converter power module that is set to "DC link control" mode is activated.

An error level 2, such as derating, DC link errors or over temperature, are leading to a change to main state READY (converter is off, cooling system is in operation).

An error level 3, such as grid faults, is leading to a change to main state STANDBY (converter is off, cooling system is in operation).

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

Ctrl Mode

The remaining converter power modules that are enabled are activated. The converter is operating.

An error level 1, such as power module over temperature, over-current or over-voltage, is leading to a stop of the respective power module.

An error level 2, such as derating, DC link errors or over temperature, are leading to a change to main state READY (converter is off, cooling system is in operation).

An error level 3, such as grid faults, is leading to a change to main state STANDBY (converter is off, cooling system is in operation).

An error level 4, such as a cooling system leak, leads to a change to main state "OFF" (stop cooling system and converter).

8 Technical Data

Container	
Container type	PCS: Customer-specific container BESS: Customer-specific container
Transport weight	PCS: approx. 13.7 t BESS: approx. 15 t (Batteries not installed)
Total weight	BESS: approx. 35 t (Batteries installed)
Container dimensions (L x W x H)	PCS: 6058 mm x 2438 mm x 3200 mm BESS: 12310 mm x 2438 mm x 3783 mm

PCS	
Type	MSC-1000-620-8
Manufacturer	FREQCON GmbH
Nominal AC voltage	620 VAC + 10% - 20%
AC power frequency (nominal)	50 Hz ± 5 Hz
Nominal apparent power	1000 kVA
Nominal active power	1000 kW
Nominal AC current	931 A
Maximum AC current	1050 A
Power factor at rated power / adjustable	1 / 0.03 overexcited to 0.0 underexcited
IGBT switching frequency	2 to 4 kHz
DC link voltage	1175 VDC
Number of DC outputs	8
Current per DC output	250 ADC
DC voltage range	700 VDC to 1022 VDC
HVAC system	included

BESS	
Battery Module	1C LFP Battery 280Ah
Cell manufacturer	EVE
Battery cells per cabinet	28
Battery capacity per cabinet	250.88 kWh
Number of battery cabinets	22
BESS capacity (installed)	5500 kWh
BESS capacity (usable at 0.2 C operation)	5000 kWh
Storage temperature range battery storage (> 1 month)	0 °C to 35 °C (30% to 50% SoC)
Ambient temperature range	-20 °C to +40 °C
Battery management system	FREQCON BMS

Controller	
Main control system	Siemens Simotion P320-4
Control software	FREQCON Framework
Internal communication	Profinet IRT
External communication interfaces	Ethernet, RS485, RS232, MODBUS TCP, Profibus, Profinet
Maximum total harmonic distortion	< 3% at nominal power

Converter Cooling System	
Cooling principle	Liquid and air cooled, air heat exchanger
Maximum cooling water inlet temperature	65°C
Operating pressure range cooling system	2.5 … 3.5 bar
Nominal cooling system pressure	3 bar
Coolant capacity (without hoses)	Approx. 80 l
Heat exchanger weight (without cooling liquid)	Approx. 75 kg

Protective Devices and Standards	
Battery (DC)	Fuse and DC load break switch
AC side disconnection point	Air circuit breaker
DC overvoltage protection	Surge arrester, type I
AC overvoltage protection	Surge arrester, class I
Ground fault monitoring	Yes
Insulation monitoring	Yes
Fire protection (converter)	Smoke and arc detection
Fire protection (batteries)	Active Fire Protection System
Maximum permissible value for relative humidity (condensing / non-condensing)	95% to 100% (2 month/year) / 0% to 95%
Inverter Life (rated conditions)	20 years

Table 32: Technical data

9 Environmental Conditions

	Stationary Operation	Storage packaging with protected layers	Transportation packaging with protected layers
Relative Humidity	Max. 95% No condensation; Relative Humidity <60% under corrosive atmosphere	Max. 95%	Max. 95%
Pollution level IEC60721-3-3 IEC60721-3-2 IEC60721-3-1	No conductive dust		
	3S2 coated PCB: Chemical Air: 3C2 Solid Particulate: 3S2	1S3 coated PCB: Chemical Air: 1C2 Solid Particulate: 1S3	2S2 coated PCB: Chemical Air: 2C2 Solid Particulate: 2S2
Atmospheric pressure	70 … 106 kPa	70 … 106 kPa	70 … 106 kPa
Vibration amplitude	Max 1 mm (5 … 13.2 Hz)	Max 1 mm (5 … 13.2 Hz)	Max. 3.5 mm (5 … 13.2 Hz)
IEC60068-2	Max. 7 m/s^2 (13.2 … 100 Hz) sinusoidal	Max. 7m/s^2 (13.2 … 100 Hz) sinusoidal	Max. 15 m/s^2 (9 … 200 Hz) sinusoidal
Impact IEC60068-2-29	Impermissible	Max. 100 m/s^2, 11 ms	Max. 100 m/s2, 11 ms
Free-fall	Impermissible	Impermissible	Impermissible

Table 33: Environmental conditions

10 Transport, Storage and Commissioning



Please observe the instructions for transport in section 10.2 and for storage and professional handling in section 10.3.

10.1 Unpacking

⚠ CAUTION



Hazard by sharp edges on packaging
Improper handling during unpacking can cause injuries.
➜ Use appropriate safety gloves to protect your hands from possible cuts.

The packaging of the system consists of cardboard, plastic and corrugated board. After usage the packaging must be disposed according to the local regulations for the disposal of paper products (e.g. recycling). After delivery, the delivered units and components must be checked for completeness and damage. If any damage on the delivered units and components have been found, contact the delivery service or FREQCON GmbH immediately.

10.2 Transport

Regarding the transport of the battery modules, refer to the battery module manual.

⚠ DANGER	
	**Hazard by electrolyte release due to mechanical damage to battery modules** Severe burns, long-term physical damage, and environmental damage due to electrolyte. ➜ The device must be disconnected before maintenance work. Work under voltage is not permitted. ➜ Observe the safety data sheet of the battery module and keep it accessible at all times. ➜ Never open battery modules by force. ➜ Avoid contact with escaping electrolyte at all costs, leave the danger area immediately. ➜ In case of ingestion, immediately alert the emergency services! ➜ In case of eye contact: Rinse cautiously with water for several minutes. Remove any contact lenses and continue rinsing. Call poison information center or doctor! ➜ In case of skin contact: Remove contaminated clothing immediately. Wash/shower skin with plenty of water. Call poison control center or doctor! ➜ Prevent release of electrolyte into the environment at all costs. ➜ Wear suitable protective equipment when disposing of electrolyte *(see section* 2.7 "Personal Protection Equipment (PPE)").

⚠ DANGER	
	**Fire due to short circuits in the event of mechanical damage to the battery modules.** Severe burns or death due to short circuits that may result in fire. The electrolyte used is highly flammable as a liquid or vapor. ➜ Avoid mechanical damage. ➜ Never open battery modules by force. ➜ Protect the system against vandalism. ➜ Fire loads or sources of fire near the installation site are not permitted. ➜ In the event of damage, press the emergency OFF button immediately. ➜ In case of fire, leave the danger area immediately and alert the fire department!

NOTICE
Inadequate transportation of the device and all of its components may cause damage to the installed components. ➜ Vibrations and jolts must be avoided during transportation. ➜ The container must be transported in a horizontal position (lying down). ➜ Make sure to observe the specific national safety precautions for transport by truck, train or ship´.

NOTICE
Do not transport the containers with installed batteries ➜ Lifting or Moving of the Container is not allowed if battery modules are inside the container ➜ Remove every battery module from the container before lifting or mowing the container

The container must be transported to the installation site by instructed personnel.

The container weight is specified in section 8, "Technical Data" on page 93. Make sure that the components can be placed at ground level.

For information regarding the dimensions and center of gravity of the container, see section 10.2.2. The container weight is specified in section 8, "Technical Data". Make sure that the components can be placed at ground level.
Vibrations and jolts must be avoided during transportation. If the system was damaged during transport, you must immediately inform the responsible transport company.

The cabinet must be transported in a horizontal position (lying down). It is not permitted to tip over the container during transportation or in any other scenario.
Applied assemblies (if existing) must be protected against damage by external influences during transportation and storage.



All persons involved in the transport of lithium batteries must be trained and certified according to regulations.

The information provided below is for informational purposes only.

10.2.1 Container Lifting

⚠ DANGER	
	**Heavy load** **Improper lifting can result in death, serious injury or property damage.** Never lift the container above people. Use only lifting and personal protective equipment approved by OSHA or other national institutions.

NOTICE
Only use an appropriate crane to lift the container, capable to withstand the loads specified as follows: Total weight of cabinet combination *see section 8, „Technical Data“ page 93.*

NOTICE
Observe the container´s center of gravity during lifting: Observe the container´s center of gravity during lifting with crane, shown in section 10.2.2.

To lift the containers with a crane, use the four transport lugs on the top corners of the container (*see following illustration*).

PCS

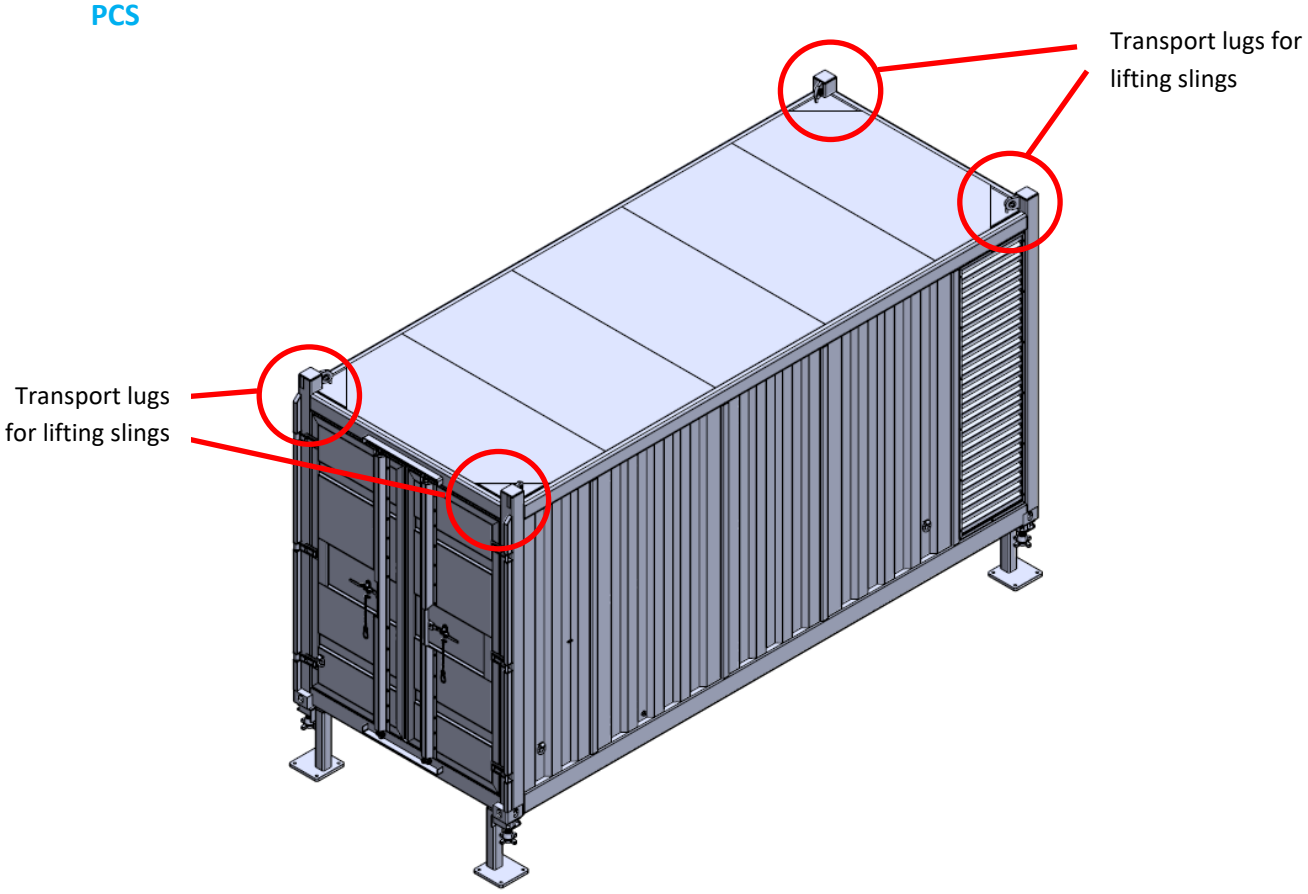


Figure 46: PCS container transport lugs

BESS 1

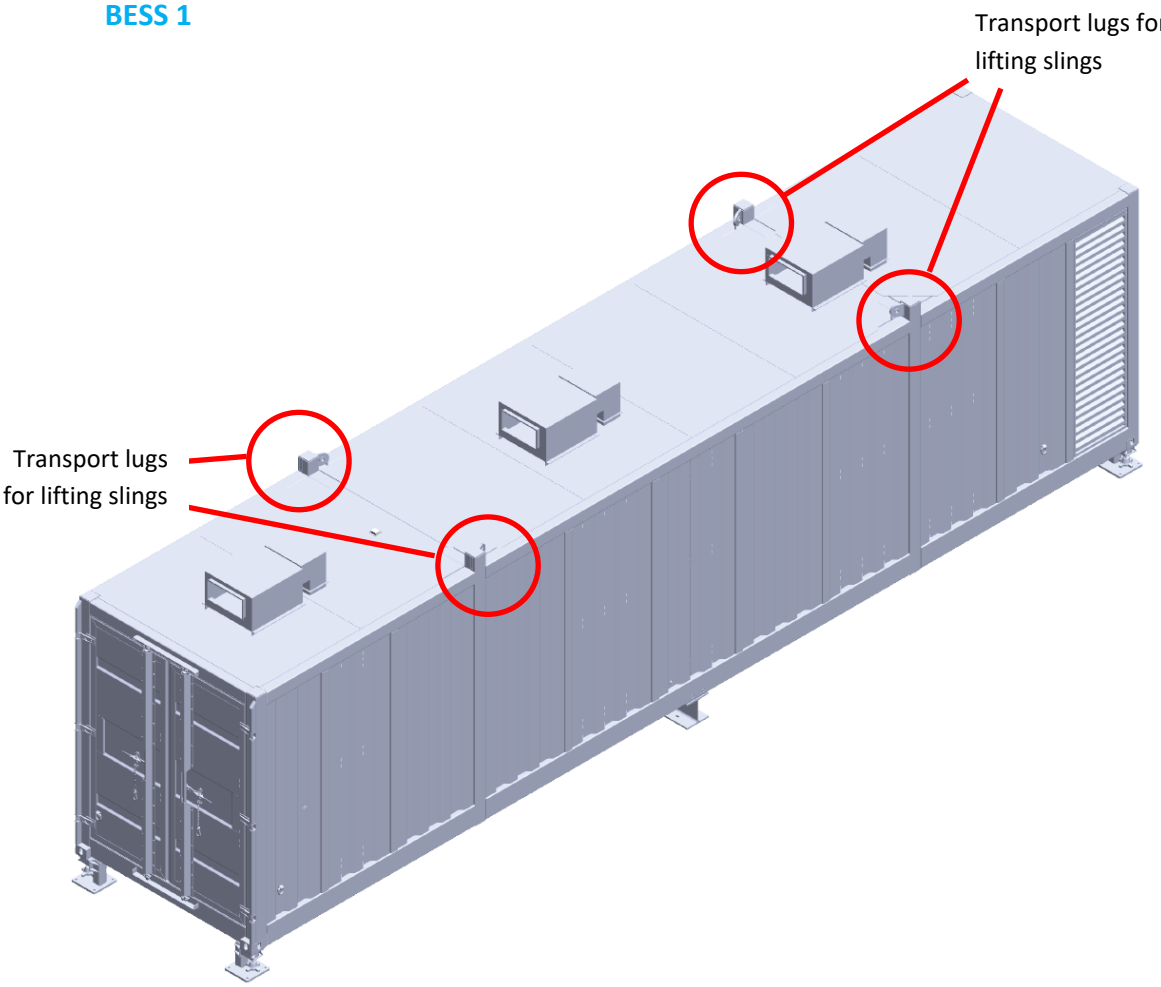


Figure 47: BESS 1 container transport lugs

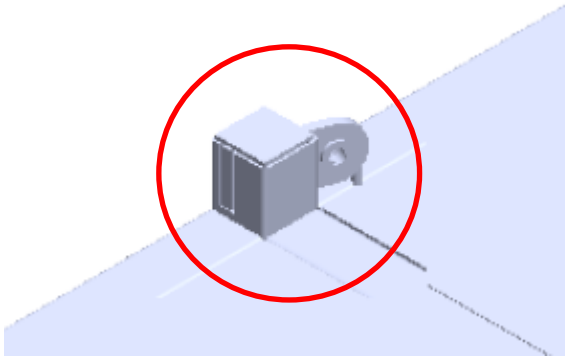


Figure 48: Transport lug

BESS 2

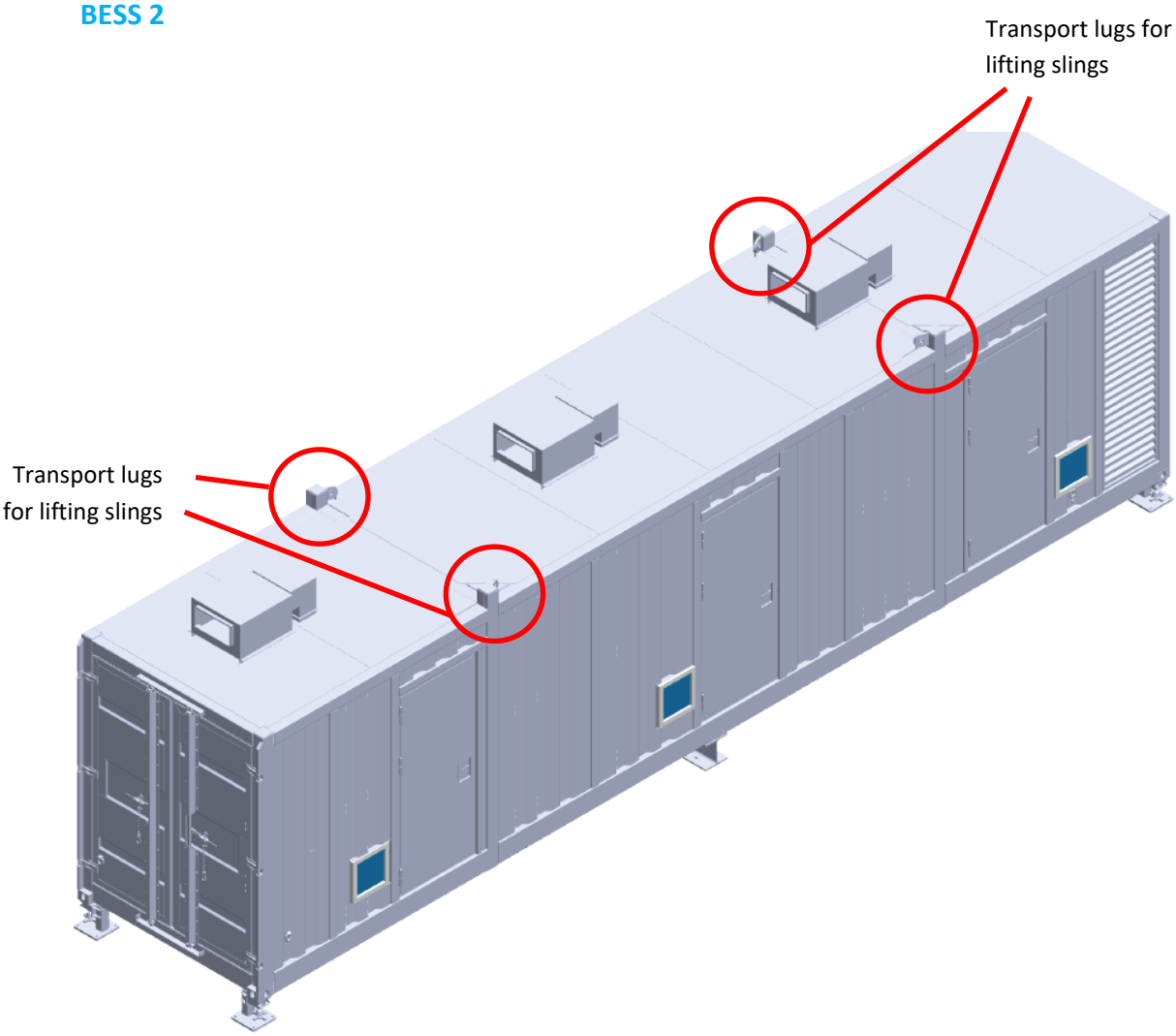


Figure 49: BESS 2 container transport lugs

10.2.2 Dimensions and Center of Gravity

10.2.2.1 PCS Container

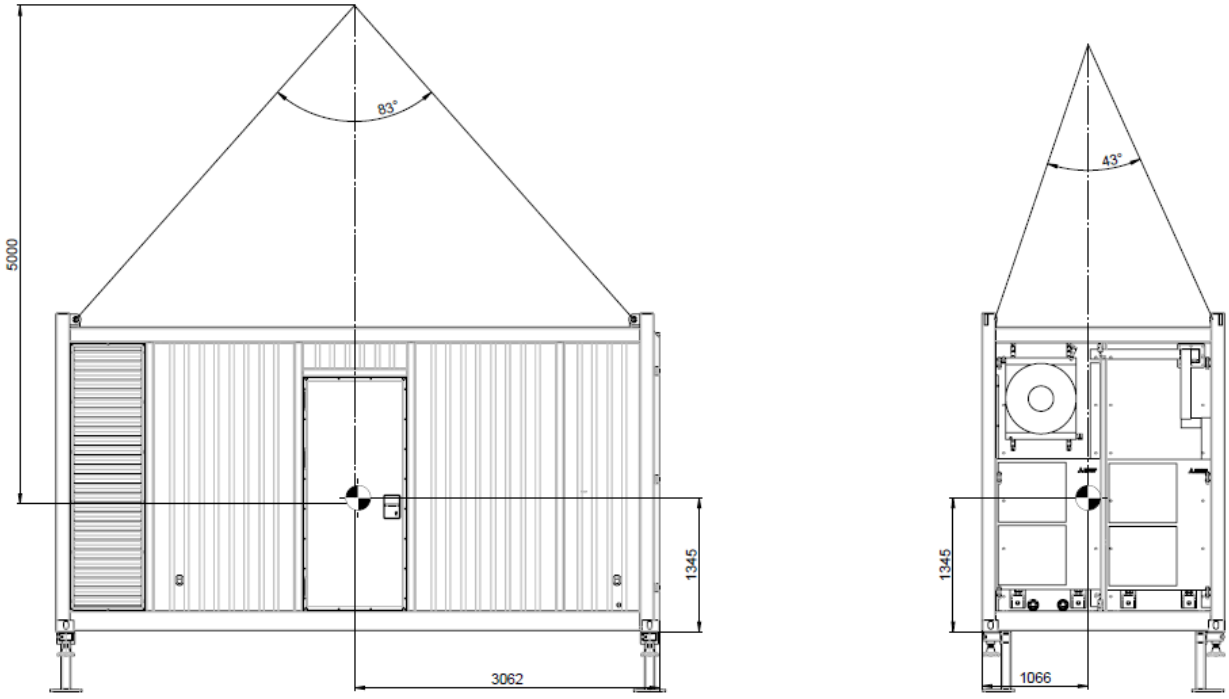
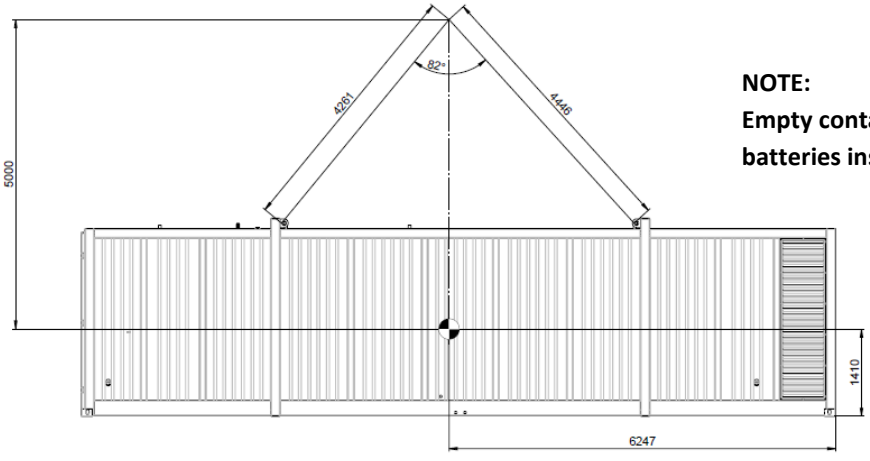


Figure 50: PCS Container – dimensions and center of gravity

10.2.2.2 BESS 1 Container



NOTE:
Empty container, no batteries installed

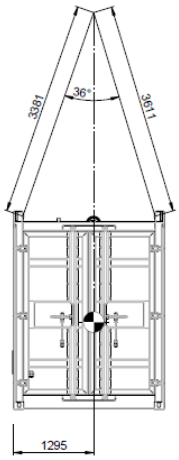
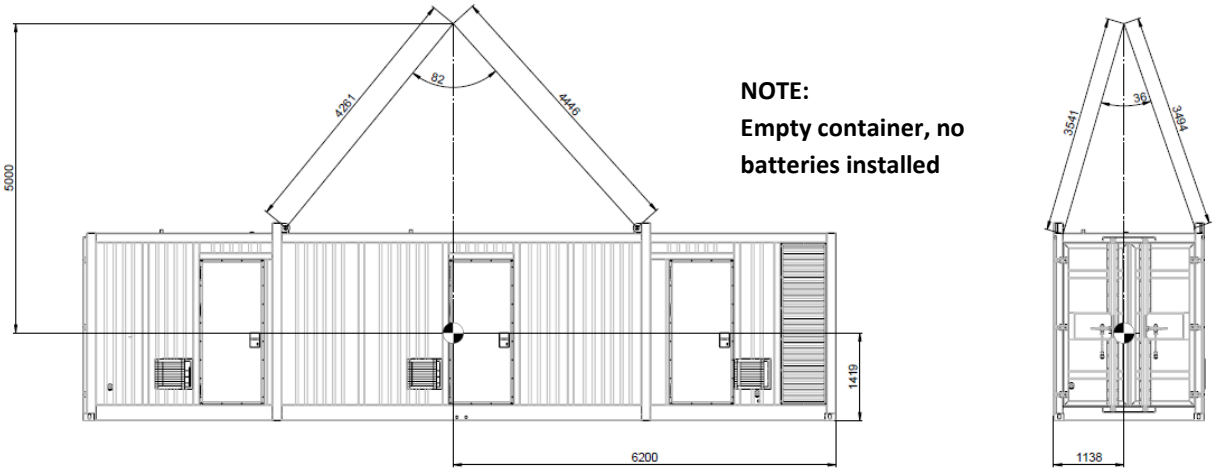


Figure 51: BESS 1 Container – dimensions and center of gravity

10.2.2.3 BESS 2 Container



NOTE:
Empty container, no batteries installed

Figure 52: BESS 2 Container – dimensions and center of gravity

10.3 Storage

10.3.1 Storage Condition

NOTICE	
	Damage to components in the event of improper storage. The storage conditions of the energy storage device are only maintained when the climate control of the container is active. ➜ Keep air conditioning activated/enabled even in case of storage. ➜ Supply energy storage with power even if it is out of operation. ➜ Only deactivate air conditioning if storage conditions are maintained by other measures. ➜ Condensing must be avoided.

NOTICE
The cooling liquid inside the cooling system must be removed at least once every five years. ➜ Check the pressure on the expansion tank every time the cooling liquid is exchanged. The cooling system must be completely drained during a pressure test of the expansion vessel *(see section 17.8.1.3 "Draining the cooling* system*")*.

NOTICE
➜ The BESS container must not be exposed to strong vibrations. ➜ Condensing must be avoided.

NOTICE
The battery of the UPS unit of the converter system must be removed from the battery module at storage temperatures of <0°C. ➜ The removal of the UPS battery is described at 17.3.2.

Store the components of the energy storage system under the following conditions:

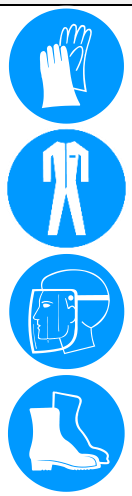
➜ Store the components of the energy storage device according to pollution degree 2 (no conductive pollution).
➜ Do not expose components of the energy storage device to aggressive media.

Storage Condition	Value
Storage temperature	*see technical data in section 8*
Max. relative humidity	*see technical data in section 8*
Positioning of the product during storage	laying down, horizontal

Table 34: Storage conditions

10.4 Assembly and Initial Commissioning

⚠ DANGER	
	**Electric shock due to low voltage and arcing on loose wires.** Severe irreparable damage to the nervous system, burns and death. ➜ Access to control cabinets and string cabinets only by FREQCON service personnel or by FREQCON instructed and authorized maintenance personnel. ➜ Plant control units may also be opened by instructed persons with the qualification of a qualified electrician. ➜ Work on electrical and electronic components as well as cables of the battery system may only be carried out by FREQCON service personnel!

⚠ DANGER	
	**Electric shock due to low voltage and arcing on loose wires.** Severe irreparable damage to the nervous system, burns and death. ➜ Access to control cabinets and string cabinets only by FREQCON service personnel or by FREQCON instructed and authorized maintenance personnel. ➜ Work on electrical and electronic components as well as cables of the battery system may only be carried out by FREQCON service personnel! ➜ Wear personal protection equipment (Electrician's gloves, protective visor, safety shoes, hearing protection)

The energy storage system may only be installed and commissioned by trained service personnel or by FREQCON instructed and authorized maintenance personnel.

11 Mounting

11.1 General

The BESS container must be set up and positioned safely at the installation site and may only be installed by instructed FREQCON service personnel.

Service personnel must at least have the following tools in reach before starting the installation:

Pos.	Installation Tools	Amount
	Basic Tools	
1.	Flashlight	1
2.	Pliers set	1
3.	Ratchet set	1
4.	Torque wrench (1 - 100 Nm)	1
5.	Socket wrench set (with sockets 7 – 19 mm)	1
6.	Wrench set	1
7.	Cross-section screw drivers set	1
8.	Flat-section screw drivers set	1
9.	Allen key / Hex socket key set	1
10.	Cutter	1
11.	First-aid kit	1
12.	Multi-meter instrument	1
13.	Two-pole voltage tester	

Table 35: Installation tools

⚠ DANGER	
	**Electric shock due to low voltage and arcing on loose wires.** Severe irreparable damage to the nervous system, burns and death. ➜ Access to control cabinets and string cabinets only by FREQCON service personnel or by FREQCON instructed and authorized maintenance personnel. ➜ Plant control units may also be opened by instructed persons with the qualification of a qualified electrician. ➜ Work on electrical and electronic components as well as cables of the battery system may only be carried out by FREQCON service personnel or by FREQCON instructed and authorized maintenance personnel.

⚠ DANGER
Make sure that the energy source is locked and tagged and ensure that the isolation is effective before conducting work on the system. After switching-off the voltage supply, some components might still carry a charge. Check all poles using a suitable device.

⚠ WARNING
The electrical connection must be carried out in accordance with the local regulations of the utility company and /or VDE (in Germany).

Do not operate!	Lock and tag power switches and controller devices
	Observe national laws regarding Occupational Safety and Health, as well as Industrial Standards. ➢ DIN VDE 0105-100; VDE 0105-100:2009-10 Operation of electrical installations - General requirements.

11.1.1 Cable Routing

It is recommended that the power cables and the control cables are installed in separate trays. Avoid long parallel runs of power cables with other cables in order to decrease electromagnetic interference.
Where control cables must cross power cables, make sure they are arranged at an angle as near to 90 degrees as possible.
The cable trays must have good electrical connection to each other and to the grounding/earthing.

11.1.2 Coding

11.1.2.1 Coding Terminal Strip

Terminal designation	Description
-XE1	Main power supply 600 V AC
-XE2	DC power supply 1000 V DC
-XE	Main power supply 400 V AC
-X1	Main power 400 V / 230 VAC
-X2	Light cabinet 230 V AC
-X3	Control voltage 24 V DC
-14X1	Control voltage 24 V DC (to DC contactors)
-X5	Low-voltage signals
-XDC0	24 V DC power supply
-XDC1-4	Control voltage 24 VDC (UPS)
-XT	Transfer terminal block 24 V DC / 230 V AC

11.1.2.2 Coding Wiring colors

Cable	Color
L1/L2/L3	Black
N	Light blue
PE	Yellow-green
External voltage	Orange
Control voltage 24 VDC	Dark blue
Analog signals	White

11.1.2.3 Coding Power Supply

Terminal	Phase
U1	L1
V1	L2
W1	L3

11.2 Installation location

⚠ DANGER

Danger to life due to electric shock!
The DC paths and the connection cables are not protected against overload by the BESS.
Select external components according to the specified nominal and maximum currents of the BESS.
➜ If necessary, use appropriate protective equipment for the external components.

⚠ DANGER

Danger from and for unauthorized persons
Unauthorized persons are not aware of the dangers in the work area and may endanger themselves and third parties danger.
➜ Keep unauthorized persons away from the work area.
➜ If in doubt, speak to persons and direct them away from the work area.
➜ Interrupt the work as long as unauthorized persons are in the work area.
➜ Always keep the entrance door(s) locked when not performing work on the system to prevent unauthorized persons from entering the container.

⚠ WARNING

Danger to life due to unsuitable lifting material
While lifting the battery modules use only suitable lifting equipment and lifting tackle
➜ Make sure that all the material and equipment is designed for the weight and all required inspections have been done.
➜ Make sure that no person is under the battery module during lifting.

⚠ CAUTION

Danger to life due to unsuitable lifting material
While lifting the container and/or battery modules use only suitable lifting equipment and lifting tackle
➜ Make sure that all the material and equipment is designed for the weight and all required inspections have been done.
➜ Make sure that no person is under the container or battery module during lifting.

NOTICE

Equipment damage due to intruding animals
Prevent animals from entering the interior of the container from below through the cable glands or recesses.
➜ Secure the container from the outside with suitable protection against the entry of animals.

The BESS containers are designed for outdoor installation, on a flat and ground level surface. Make sure that the environmental conditions meet the values of section 8 „Technical Data“ and section 9 “Environmental Conditions”.

The entrances to the containers must be accessible from every side to allow for visual inspections or maintenance and repair work, if necessary

Air inlets and outlets of the containers, as well as on the cabinets inside the container, must always be kept free and cleaned of dirt in order to ensure the required air flow of the installed fans.

11.2.1 Distances Between Containers

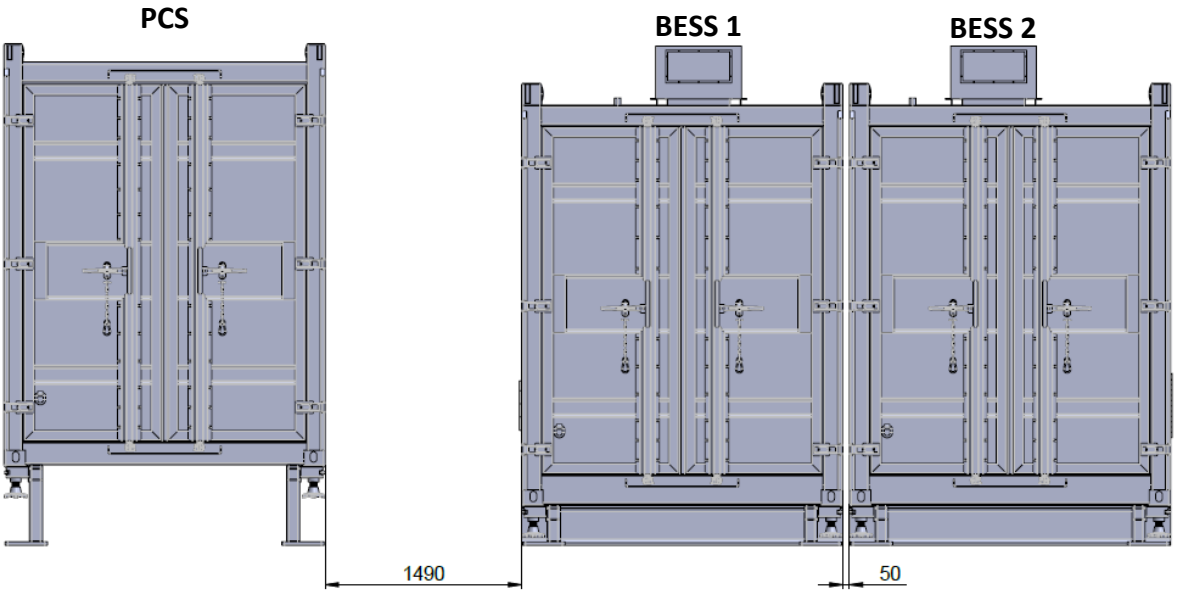


Figure 53: Distances between containers

11.2.2 Cable Outlets

Overall System

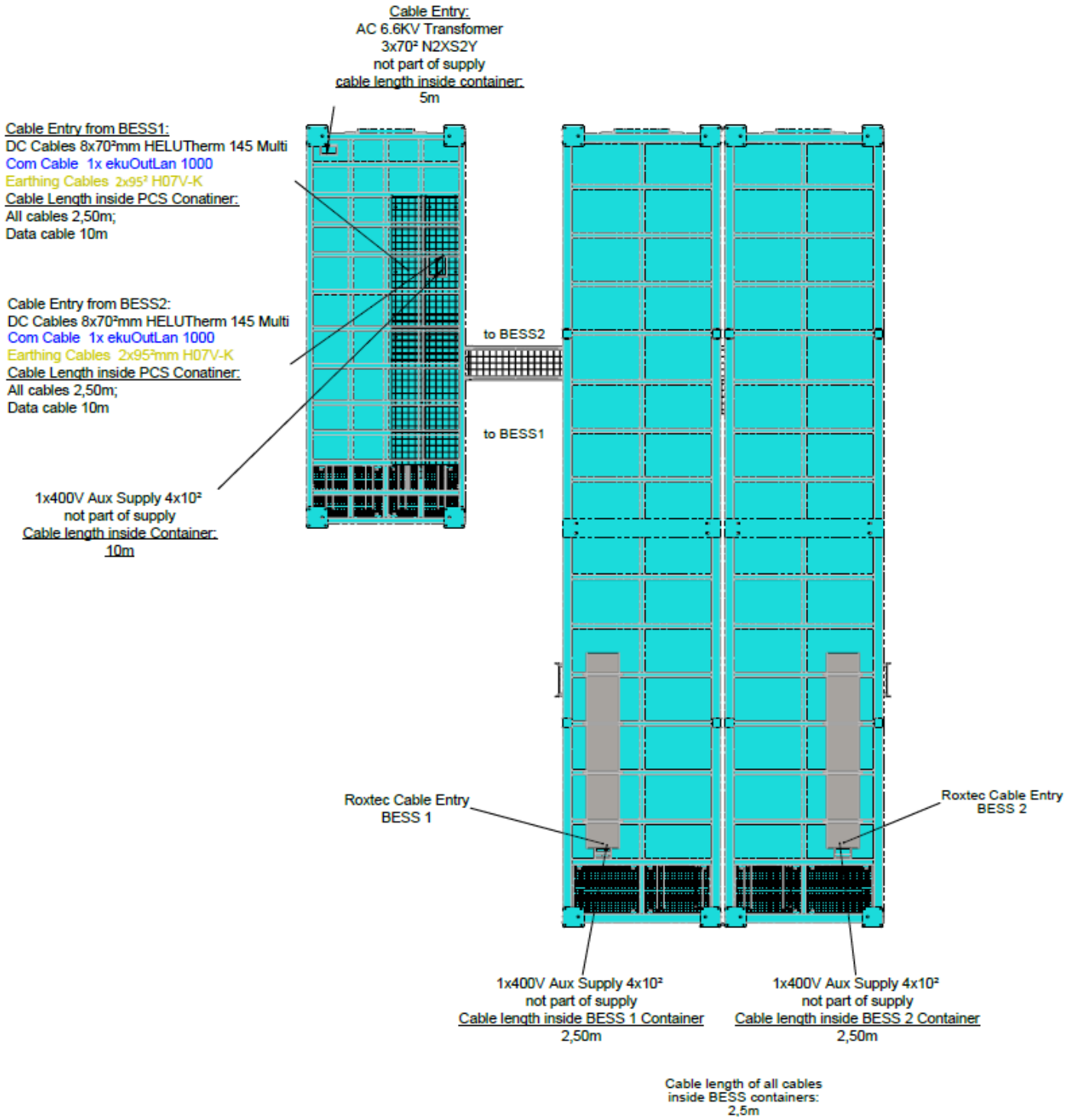


Figure 54: Cable outlets – Overall system (Bottom view)

11.2.2.1 PCS Container

Cable interface 1 (Roxtec cable gland)
- DC power cables
- Communication cables
- 400 V AC aux. cables

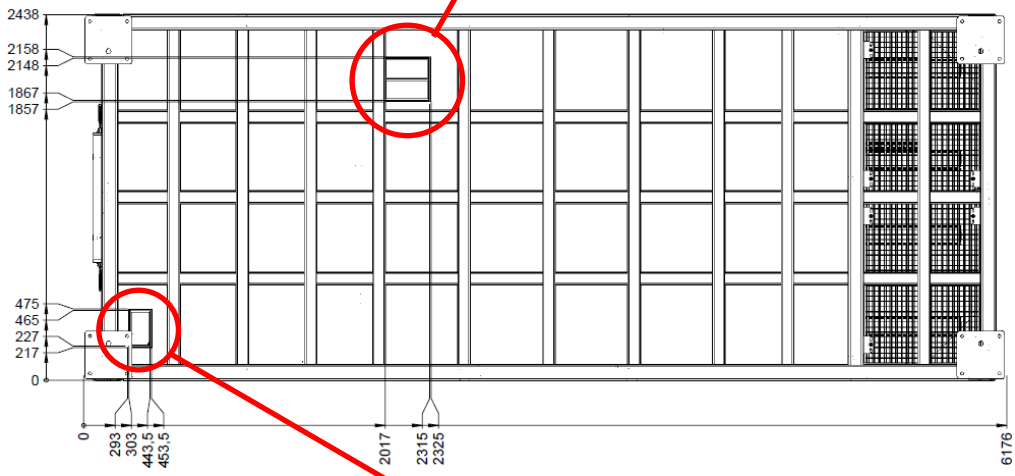


Figure 55: Cable outlets – PCS (Bottom view)

Cable interface 2 (Roxtec cable gland)
- 6.6 kV MV cables

11.2.2.2 BESS 1 Container

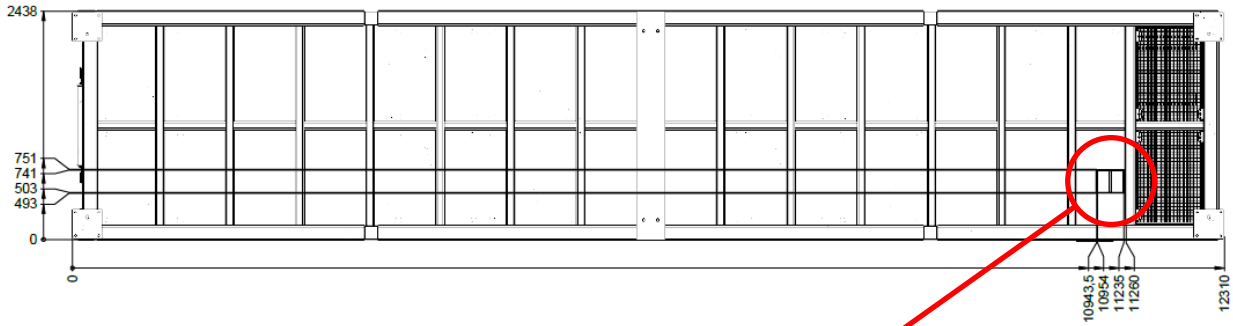


Figure 56: Cable outlets – BESS 1 (Bottom view)

Cable interface (Roxtec cable gland)
- DC power cables
- Communication cables
- 400 V AC aux. cables

11.2.2.3 BESS 2 Container

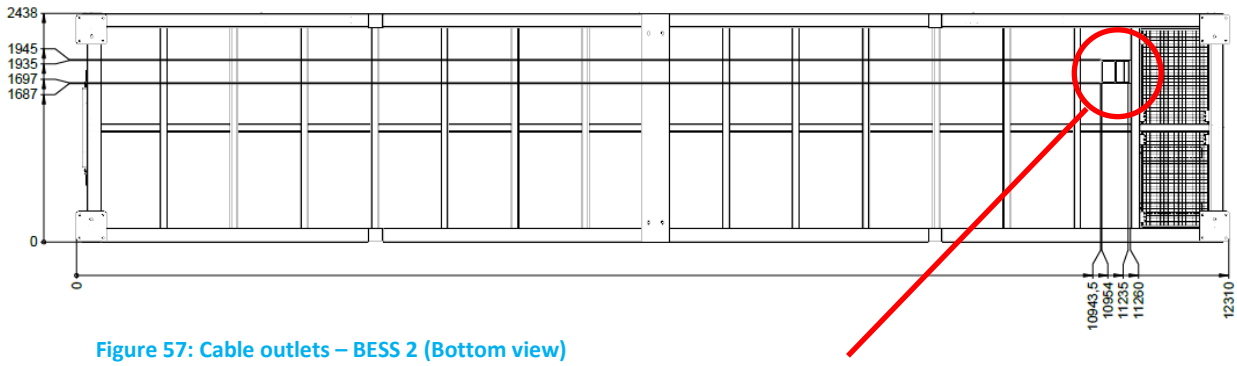


Figure 57: Cable outlets – BESS 2 (Bottom view)

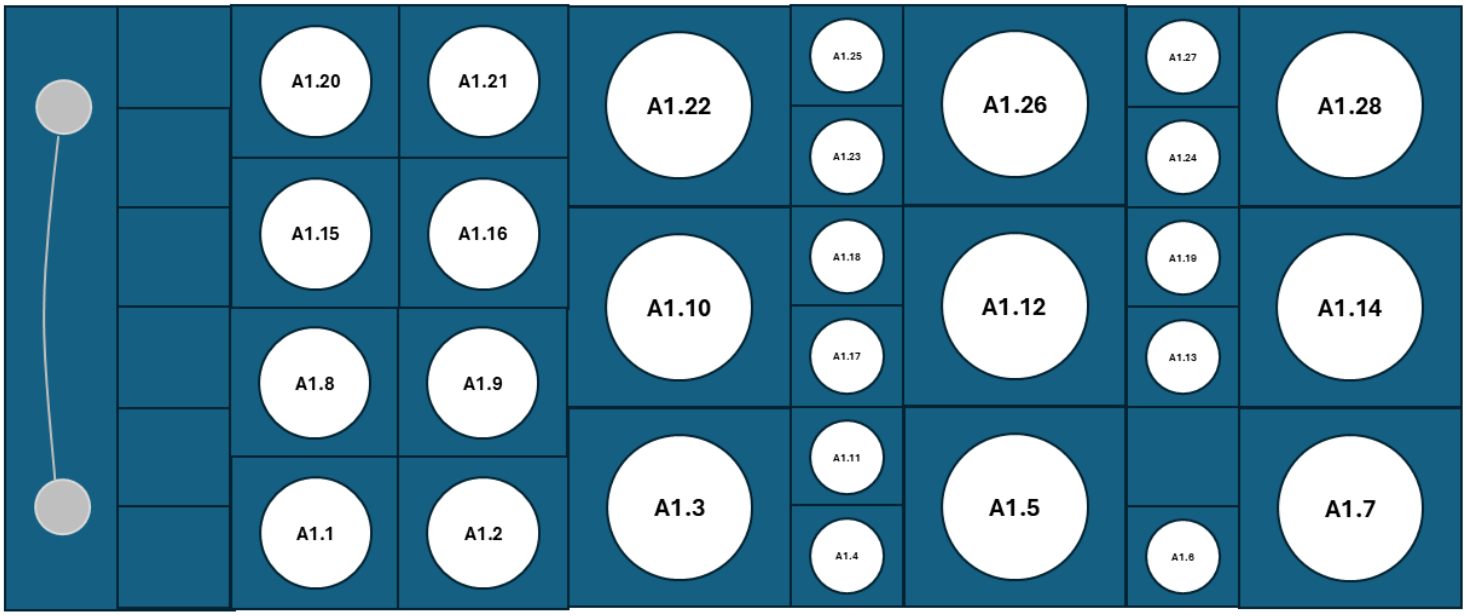
Cable interface (Roxtec cable gland)

- DC power cables
- Communication cables
- 400 V AC aux. cables

11.2.3 Cable Gland Description

11.2.3.1 PCS Container

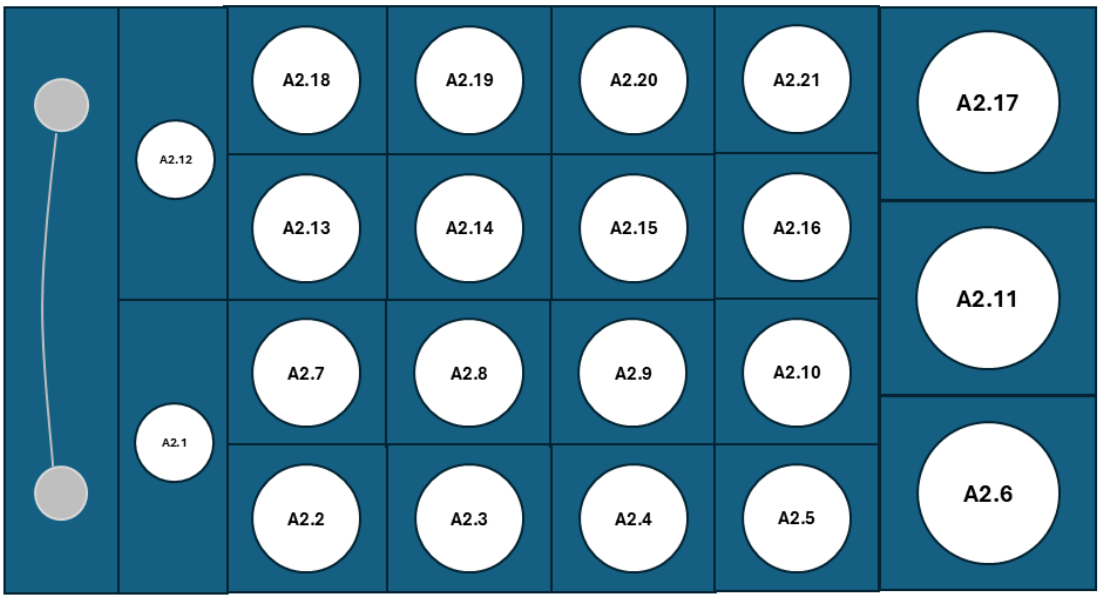
Cable interface – PCS – Comm and Aux 1



PCS – Comm and Aux 1

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A1:2		COM Cable Ethernet	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:4	*	P320 PLC / B400-NET-001.01	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:5		85002CEC	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:9		COM Cable Ethernet	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:11	*	P320 PLC / B400-NET-001.02	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:12		85001-CEC	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:13	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:15		COM Cable Ethernet	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:16	**	P320 PLC / B400-FGS-002	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:18		C-85-XS-001 / B400-SIS-001	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:19	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:20		COM Cable Ethernet	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:21	**	P320 PLC / B400-SIS-001	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:23	***	82006-CEC	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:24	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:25	***	82007-CEC	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:26		83011-CEL / 84W2	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:27	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

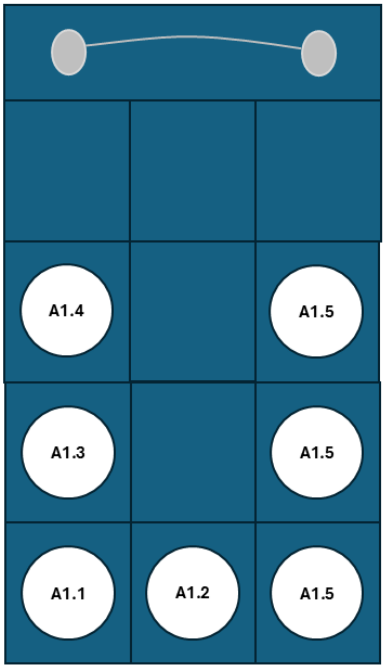
Cable interface – PCS – Comm and Aux 2



PCS – Comm and Aux 2

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A2:2	Solarflex-X 1x 70	DC Cable - DC+4_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:3	Solarflex-X 1x 70	DC Cable - DC-4_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:4	Solarflex-X 1x 70	DC Cable - DC+3_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:5	Solarflex-X 1x 70	DC Cable - DC-3_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:7	Solarflex-X 1x 70	DC Cable - DC+4_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:8	Solarflex-X 1x 70	DC Cable - DC-4_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:9	Solarflex-X 1x 70	DC Cable - DC+2_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:10	Solarflex-X 1x 70	DC Cable - DC-2_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:13	Solarflex-X 1x 70	DC Cable - DC+4_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:14	Solarflex-X 1x 70	DC Cable - DC-4_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:15	Solarflex-X 1x 70	DC Cable - DC+2_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:16	Solarflex-X 1x 70	DC Cable - DC-2_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:18	Solarflex-X 1x 70	DC Cable - DC+3_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:19	Solarflex-X 1x 70	DC Cable - DC-3_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:20	Solarflex-X 1x 70	DC Cable - DC+2_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:21	Solarflex-X 1x 70	DC Cable - DC-2_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

Cable interface 2 (MV Transformer)

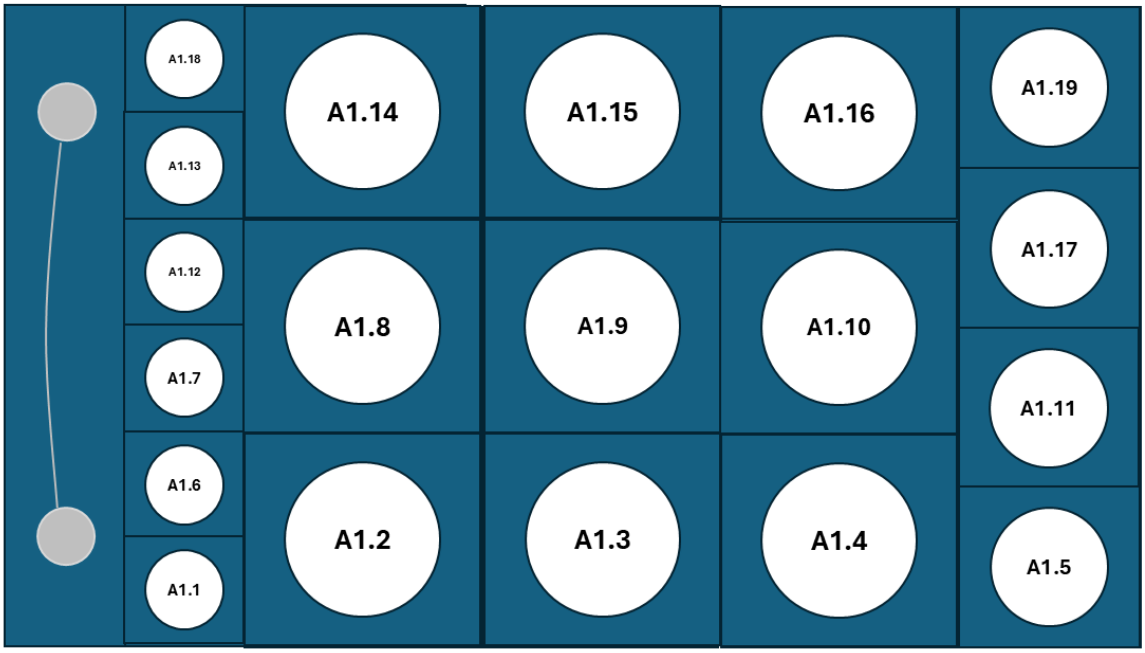


PCS – MV Transformer

Pos.	Cable ID	Name	Cable Category	OD (mm / [“])	Module Type
A1:1	1	82005 – L2	AC 6.6 kV Transformer	10 [0.394“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:2	4	82005 – L3	AC 6.6 kV Transformer	10 [0.394“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:3	5	82005 – L1	AC 6.6 kV Transformer	10 [0.394“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

11.2.3.2 BESS 1

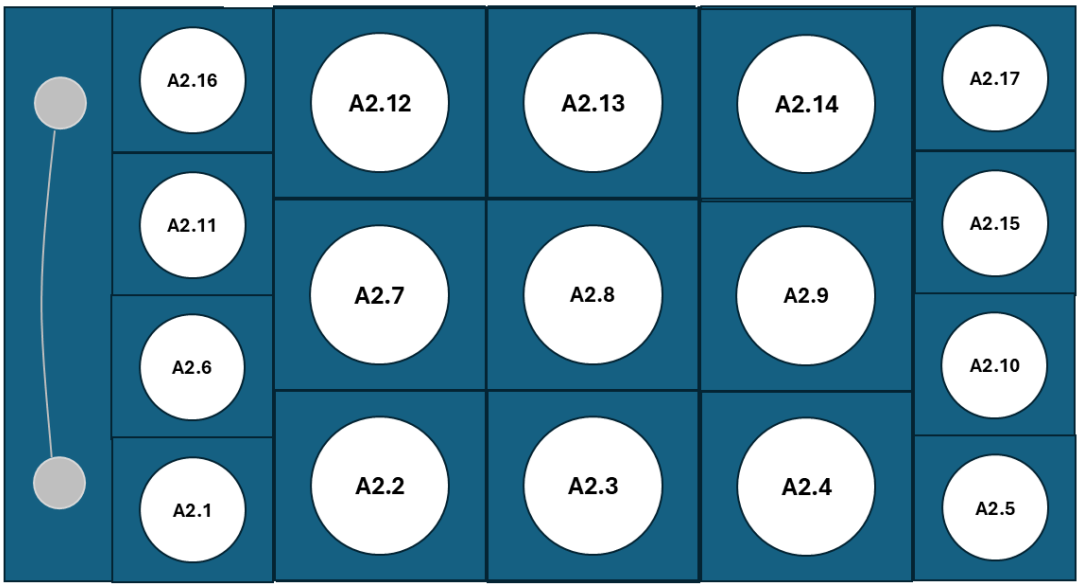
Cable interface 1 - BESS 1



BESS 1 - 1

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A1:1	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:5	4x 10 mm²	400 V Aux Supply – 83015-CEL	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:6	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:7		COM Cable - ETH	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:12		COM Cable - UNIT_1 PROFINET	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:13		COM Cable - UNIT_3 PROFINET	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

Cable interface 2 - BESS 1

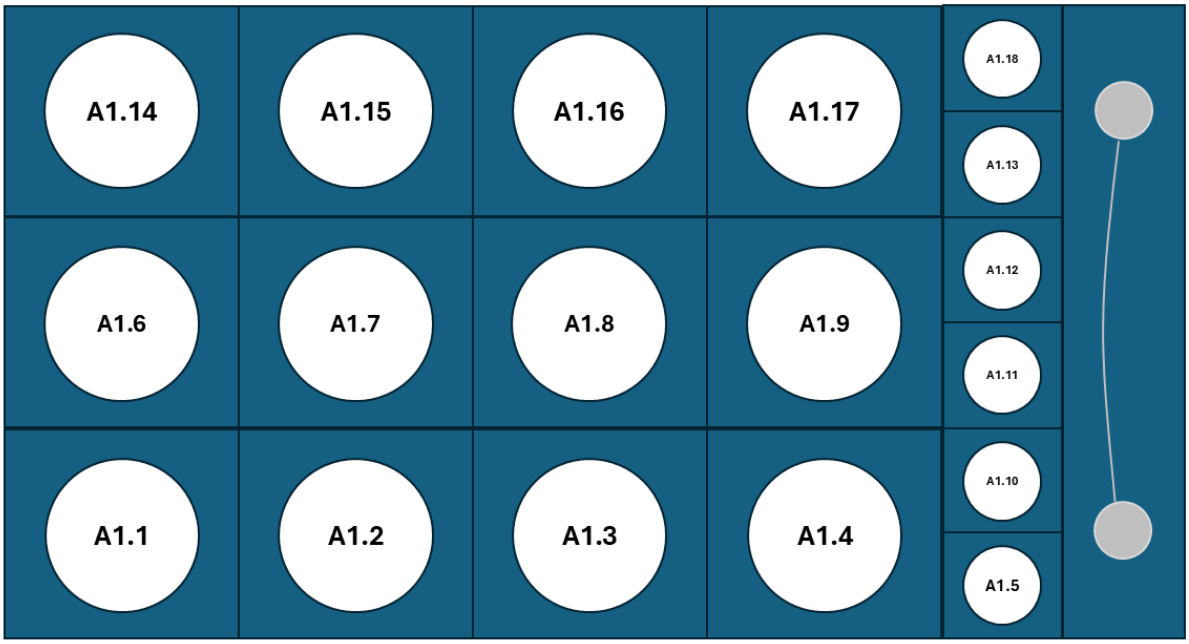


BESS 1 - 2

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A2:1	Solarflex-X 1x 70	DC Cable - DC-2_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:5	Solarflex-X 1x 70	DC Cable - DC+2_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:6	Solarflex-X 1x 70	DC Cable - DC+2_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:10	Solarflex-X 1x 70	DC Cable - DC-2_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:11	Solarflex-X 1x 70	DC Cable - DC-2_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:15	Solarflex-X 1x 70	DC Cable - DC-3_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:16	Solarflex-X 1x 70	DC Cable - DC+2_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:17	Solarflex-X 1x 70	DC Cable - DC+3_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

11.2.3.3 BESS 2

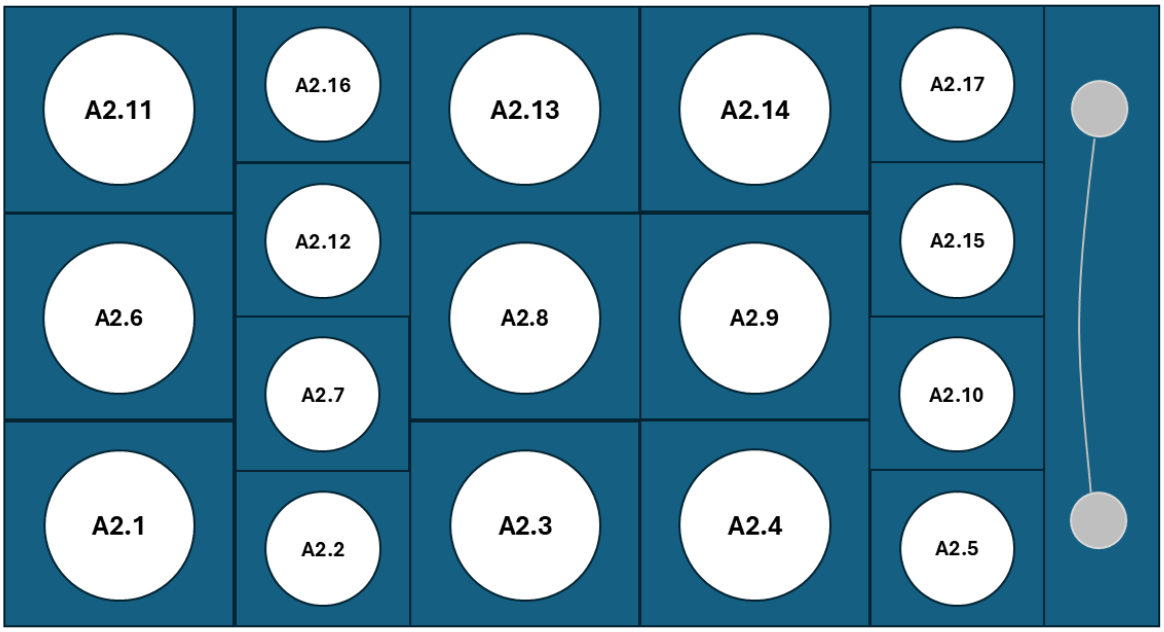
Cable interface 1 - BESS 2



BESS 2 - 1

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A1:1	4x 10 mm²	400 V Aux Supply – 83014-CEL	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:5	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:10	H07V-K 1x 95 mm²	Earthing Cable	11 [0.433“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:12		COM Cable - ETH	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:13		COM Cable - UNIT_2 PROFINET	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A1:18		COM Cable – ET200 Unit_1 (not connected)	4 [0.157“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

Cable interface 2 - BESS 2



BESS 2 - 2

Pos.	Cable Type	Cable Category	OD (mm / [“])	Module Type
A2:2	Solarflex-X 1x 70	DC Cable - DC+4_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:5	Solarflex-X 1x 70	DC Cable - DC+3_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:7	Solarflex-X 1x 70	DC Cable - DC-4_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:10	Solarflex-X 1x 70	DC Cable - DC-3_3 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:12	Solarflex-X 1x 70	DC Cable - DC-4_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:15	Solarflex-X 1x 70	DC Cable - DC+4_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:16	Solarflex-X 1x 70	DC Cable - DC+4_2 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]
A2:17	Solarflex-X 1x 70	DC Cable - DC-4_1 BAT	9.5 [0.374“]	RM 20W40 3.5-16.5 [0.138“-0.650“]

11.2.4 AC Connection

⚠ DANGER

Before performing work on the BESS, make sure the system is disconnected from all power supplies, the feed-in disconnectors are open and secured against unintentional reclosing.

NOTICE

- ➜ Comply with the minimum cable cross-sections indicated in the wiring diagram provided.
- ➜ Always secure AC power cables with adequate strain relief in order to prevent the removal of the power cables from the AC connections after installation.

To connect the 620 V AC network, the system provides AC, PE and N connection busbars within the **AC_DC cabinet** *(see circuit diagram and following figure, ① to ⑤)*.

Also refer to the provided circuit diagram (*see section 1.2 "Applicable Documents"*) when connecting the BESS to the AC grid.

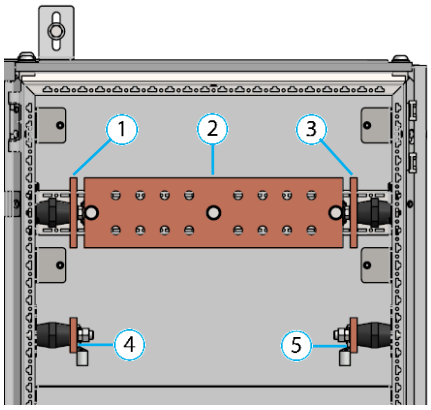


Figure 58: AC grid connection busbars inside AC_DC cabinet

Pos.	Description	Identifier
①	AC grid connection busbar L1	78W1
②	AC grid connection busbar L2	78W2
③	AC grid connection busbar L3	78W3
④	AC grid connection busbar N	78W5
⑤	AC grid connection busbar PE	78W4

Table 36: AC grid connection busbars inside AC_DC cabinet

Task 1: **Connect the AC grid supply cables to the designated AC grid connection busbars inside the AC_DC cabinet *(see wiring diagram and illustration below)*.**

Step 1 : Lead the customer-side AC grid supply cables through the recess provided in the container floor from below into the container interior.

Step 2 : Lead AC grid supply cables through the recess provided in the cabinet floor of the AC_DC cabinet from below to the inside of the cabinet.

Step 3 : Locate the 78W1, 78W2 and 78W3 AC connection and the PE and N busbars inside the AC_DC cabinet (*see illustration above,* ① - ⑤).

Step 4 : Screw the three grid phase cables L1, L2, L3 and the PE and N cable to the corresponding connection busbars inside the AC_DC cabinet (*see illustration and table above,* ① - ⑤) using appropriate cable lugs, screws, nuts and washers.

Step 5 : Apply the torque specified by the screw connection manufacturer to the connection.

Step 6 : Check connections for tightness.

✓ **The AC grid supply cables were successfully connected to the corresponding AC grid connection busbars in the AC_DC cabinet.**

11.2.5 Higher-Level Controller Connection

⚠ DANGER

Before performing work on the BESS, make sure the system is disconnected from all power supplies, the feed-in disconnectors are open and secured against unintentional reclosing.

The converter system is mainly controlled and monitored via the customers´ higher-level controller. The higher-level controller is connected to the BESS main controller via a PROFINET interface. Therefore, a network isolator (114A1) is provided inside the control cabinet 1 (CTRL_1) of the converter system, to which the higher-level controller can be connected via an Ethernet line.

To connect the higher-level controller to the converter controller via Ethernet line, proceed as follows:

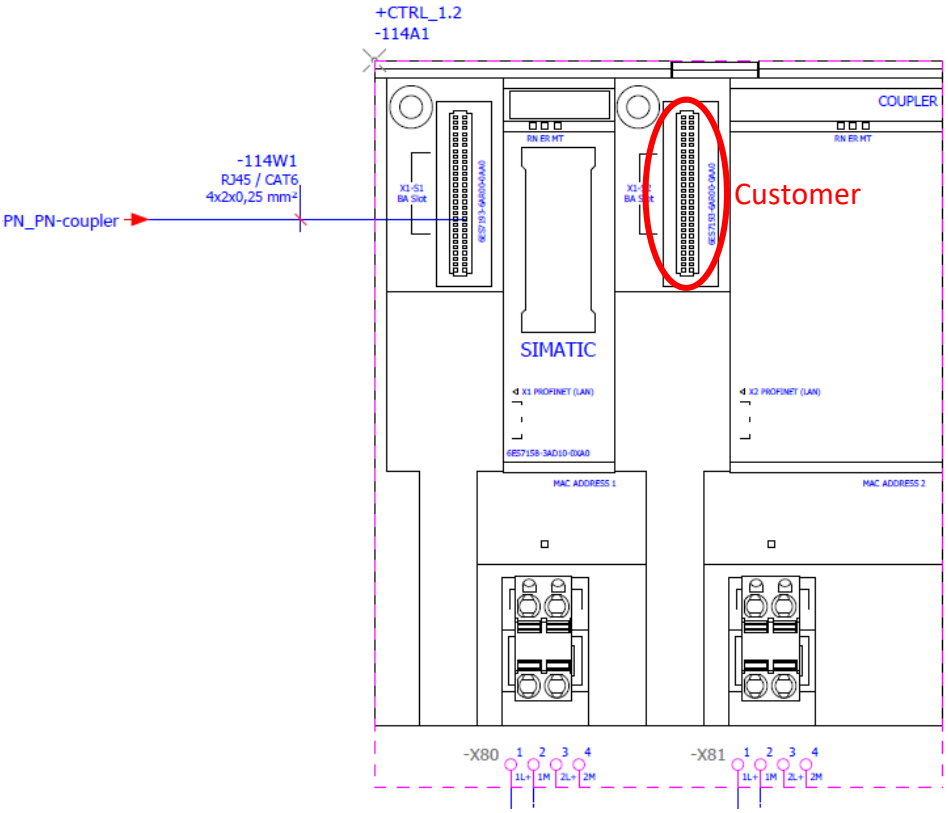


Figure 59: Network isolator 114A1 inside CTRL_1 cabinet

Task 1: **Connect the customer-side higher-level controller to the BESS main controller cabinet (*see circuit diagram and illustration above*).**

Step 1 : Lead the Ethernet cable coming from the external, higher-level controller through the recess in the bottom of the control cabinet 1 (CTRL_1) into the cabinet interior.

Step 2 : Locate the network isolator (114A1) inside the control cabinet.

Step 3 : Connect the external Ethernet cable to the free port of the network isolator.

✓ **The higher-level controller has been successfully connected to the BESS main controller via Ethernet cable.**

12 Pre-Commissioning

Follow the steps below for preparations prior to commissioning of the converter:

Do not operate!	Lock and tag power switches and controller devices
⚠ DANGER 	Disconnect power and block operation controller devices. Follow national laws regarding Occupational Safety and Health. 1. Identify the energy source(s). 2. Isolate the energy source(s). 3. Determine voltage-free status. 4. Ground device or equipment to protect from short circuiting and from shocks. 5. Lock and Tag the energy source(s). 6. Prove that the equipment isolation is effective. 7. When required, apply lock-out device or clamp and secure with padlock(s).

12.1 Activate Motor Contactors and Fuses

Task 1: Activate motor contactors and test auxiliary voltages

Set the main switch on the control cabinet door to ON position. ☐

Activate the motor contactors inside the converters system cabinets. ☐

Check the 400 V AC power supply using the corresponding terminals inside CTRL cabinet. ☐

Task 2: Switch on fuses

Switch on all 24/230/400V AC/DC fuses inside the cabinets. ☐

Install the fuses for the UPS supply. ☐

Check, whether the 24 V DC voltage has the correct polarity and magnitude. ☐

Switch on all the 24 V DC fuses (130F1) if not already activated (green indicator lights indicate activated fuse). ☐

After this action all the control devices indicator lights in the control cabinet including the main PLC Siemens SIMOTION P320 should glow green, indicating that these parts are activated and working.

12.2 Check Power Cables

Inspect wiring for proper installation and connection. See wiring diagram for detailed information about the wiring. ☐

12.3 Check Communication Cables

Inspect wiring for proper installation and connection. See wiring diagram for detailed information about the wiring. ☐

Communication between main PLC and converter is established. ☐

12.4 Cooling System Preparations

The cooling system is set under 3 bar air pressure for at least 1 hour. The system pressure must not decrease within that time. ☐

The system is filled with coolant under working pressure of 3 bar and checked for leakage for at least an hour. ☐

13 Commissioning

Follow the steps below for commissioning of the BESS:

Task 1: **Converter Commissioning**

Step 1 : Make sure that the customer-side mains is switched off and decoupled from the converter system.

Step 2 : Make sure that all the work and action instructions listed in section 11 "Mounting" have been carried out.

Step 3 : Follow all instructions listed in section 14.4.

✓ **The BESS is now ready for operation.**

14 Operation

⚠ DANGER	
	Do not enter the container if the warning light is on (red light) ➜ It is only allowed to enter the container if the warning light indicated that it is safe to enter the container (green light) ➜ If the warning light is completely off (no green or red light) consider that it is not safe to enter the container. Before entering the container, make sure that there is no fire inside and no harmful atmosphere

NOTICE	
	• Staying in the container during operation is not permitted, except to turn-off the system in case of emergency • Use the remote interface to start the converter • Do always switch off the converter if you go inside the container

14.1 Operating Panel

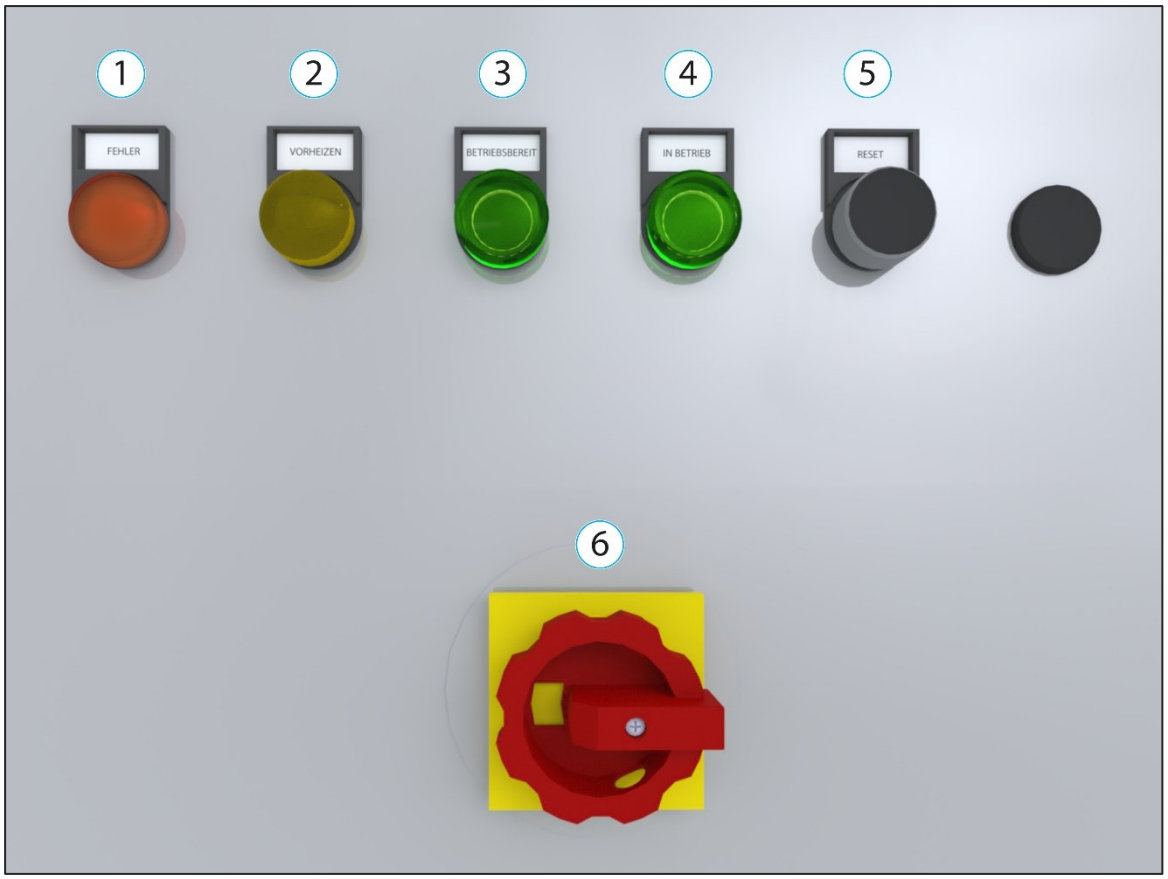


Figure 60: Operating panel

14.2 Indicator Lights

Pos.	Indicator Light	Description
①	**Fault**	**Flashing light** A warning of the converter main controller is present. The converter remains in operation. Constantly glowing: A fault has been detected by the converter main controller. The BESS does not function correctly.
②	**Preheating**	**Flashing light** The cooling liquid is preheated until the set cooling liquid temperature has been reached. Constantly glowing: The coolant temperature has reached the set temperature and is maintained for a set time span (defined in controller). **Light off:** The cooling liquid temperature was maintained for the time span defined in the controller. The preheating process is finished.
③	**Ready for Operation**	**Flashing light** The DC-link of the converter is pre-charging until the set voltage has been reached. **Constantly glowing:**

		The DC-link is precharged to the set voltage and the power switches are closed.
④	**Operating**	**Constantly glowing:** The converter´s IGBTs are enabled. The converter is operating.

Table 37: Indicator lights

14.3 Control Elements

Pos.	Control Element	Description
⑤	**Reset** *Push button*	Resets an existing fault of the main controller and the emergency stop relay.
⑥	**Main switch** *Rotary Switch*	Main switch 480 V power supply for converter control electronics.

Table 38: Control Elements

14.4 Switching on the BESS

Carry out the following steps to switch on the BESS:

Task 1: **Switch on the BESS**
Step 1 : Make sure that the external emergency stop button (customer side, if present) is not activated.
Step 2 : Switch the main switch (*see figure 60,* ⑥) to the "ON" position.

Note 1: If the temperature inside the control cabinet falls below 15°C, the internal control cabinet heating is automatically switched on. The main control is only enabled after the temperature limit value of >5°C has been reached.
Note 2: Once the BESS control system has started up, the function commands transmitted by the higher-level control system are executed.
Note 3: If the BESS control unit detects an error, the red "Fault" indicator (①) lights up.

Step 3 : Check the BESS control system for error messages via the higher-level control system (customer side using WebVisu or communication interface).
Step 4 : Resolve the error(s) if possible.
Step 5 : After successful troubleshooting, acknowledge the error by sending a "Reset" command via the higher-level control system (customer side via WebVisu or communication interface) or the reset button on the CTRL cabinet (⑤*)*.

	For detailed information on the control commands, such as the reset command, which are transmitted to the BESS control system via the customer's higher-level control system, please refer to the document "Description of data profiles" (*see section 1.2 "Applicable Documents"*).

	The control bits described below can be set simultaneously and are automatically processed by the control system in the correct sequence.

Step 6 : Set the **converter_heatup_enable** bit to **TRUE** via the communication interface of the external control room or via the WebVisu. The signal initiates the preheating process of the cooling system. This process normally takes 20 minutes. The "Preheating" indication light illuminates (*see figure 60,* ②).
Step 7 : As soon as all temperatures are within the permissible range, the "Preheating" indication light goes off.
Step 8 : Set the **converter_charge_enable** bit to **TRUE** via the communication interface of the external control room or via the WebVisu. The signal initiates precharging of the DC link and the "Ready for operation" indication light (③) starts to flash. As soon as the DC link is pre-charged, the main switch responsible for the DC link control is switched on and the "Ready for operation" indication light (③) starts to light up constantly.
Step 9 : Set the **converter_modes_enable** bit to **TRUE** via the communication interface of the external control room or via the WebVisu. The signal activates the pulse enable of the grid IGBT´s.
Step 10 : If no errors have occurred, the BESS starts normal operation and the "Operation" indication light (④) lights up constantly.

Step 11 : The detailed procedure for switching on the converter system must be carried out in accordance with the document "Description of data profiles" (*see section 1.2 "Applicable Documents")*. The sequence of the individual steps is shown on the "Flow Chart" tab.

✓ **The BESS is now switched on and in operation.**

14.5 Switching off the BESS

Follow the steps below in order to switch-off the converter:

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on a live system.** After switching off the converter, the DC-link of the converter still carries dangerous voltages, which may cause death or severe injuries if touched or short circuit. ➜ Before performing work on the converter, deenergize the converter, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ It is not allowed to open the cabinet doors before the converter system has been de-energized and the capacitors are discharged. ➜ It is not allowed to perform any work on the converter before the system has been de-energized.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on the converter system, before the converter system has been disconnected from all power sources.** After switching off the converter, the connected DC power cables of the battery strings, the DC connection busbars in the AC_DC cabinet and the DC switch & fuse units continue to carry dangerous voltages that can cause death or serious injury if touched or short-circuited. ➜ Before starting work inside the converter cabinets, de-energize the converter system as described in section 14.6 “De-Energizing”, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ Disconnect the DC power cables from the converter system using suitable DC disconnecting devices before carrying out any work in the cabinets of the converter system. ➜ Before disconnecting the DC power cables from the DC connection busbars, always check for voltage-free status of the DC power cables, since dangerous electric arcs may lead to severe injuries or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any work on the MV switchgear and the MV transformer before the PLC container has been disconnected from all voltage sources.** After switching off the converter, the connected MV transformer, the MV switchgear, its connecting cables and terminals continue to carry dangerous voltages which, if touched or short-circuited, can cause death or serious injury. ➜ Before working on the medium voltage components of the converter container, de-energize the converter system as described in section 14.6 “De-Energizing”. ➜ Disconnect the AC mains connection by opening the MV switchgear. ➜ Before disconnecting the AC power cables from the AC connection busbars, always check the voltage-free status of the AC power cables, otherwise dangerous arcs can cause serious injury or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any maintenance work on the converter system before the AC circuit breaker and MV switchgear have been switched off and protected against unintentional reclosure.** ➜ Before starting work inside the converter cabinets, the AC circuit breaker 80Q1 must be switched off and protected against unintentional reclosure as described in section 14.8.3 “Protect the CB Against Unintentional Reclosing”. ➜ Before you start working inside the control cabinets, the medium-voltage switchgear must be switched off and protected against unintentional reclosure.

Task 1: **Switch off the BESS.**

Step 1 : To switch off the converter, carry out the steps in reverse order according to the document "Description of the data profiles" in the "Flow chart" tab (*see section 1.2 “Applicable Documents”*).

Step 2 : Set the **converter_modes_enable** bit to **FALSE** via the communication interface of the external control room or via the WebVisu. The signal deactivates the pulse enable of the grid IGBT´s.

Step 3 : Set the **converter_charge_enable** bit to **FALSE** via the communication interface of the external control room or via the WebVisu. The signal opens the main switch and initiates the discharge of the DC link. As soon as the main switch is open, the "Ready for operation" indication light goes off (*see figure 60,* ③).

⚠ DANGER	
	**Risk of injury due to electric shock!** **Discharging the DC link takes several minutes. The "Ready for operation" indication light is not an indicator of a fully discharged DC link. Do not carry out any work on BESS before the DC link has been completely discharged.** ➜ Wait until the DC link is completely discharged and check that it is de-energized as described in section 14.7 "Check Voltage-Free Status of DC Link ".

Step 4 : Set the **converter_heatup_enable** bit to **FALSE** via the communication interface of the external control room or via the WebVisu. The signal switches off the water cooling of the converter after a run-on time of 2 minutes.

Step 5 : Switch the main switch on the converter control cabinet (*see figure 60,* ⑥) to the "OFF" position.

✓ **The BESS is now switched off.**



The UPS can be switched off by pulling the blade type fuse of the UPS unit.

14.6 De-Energizing

Carry out the following steps to de-energize the BESS system:

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on a live system.** After switching off the converter, the DC-link of the converter still carries dangerous voltages, which may cause death or severe injuries if touched or short circuit. ➜ Before performing work on the converter, deenergize the converter, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ It is not allowed to open the cabinet doors before the converter system has been de-energized and the capacitors are discharged. ➜ It is not allowed to perform any work on the converter before the system has been de-energized.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on the converter system, before the converter system has been disconnected from all power sources.** After switching off the converter, the connected DC power cables of the battery strings, the DC connection busbars in the AC_DC cabinet and the DC switch & fuse units continue to carry dangerous voltages that can cause death or serious injury if touched or short-circuited. ➜ Before starting work inside the converter cabinets, de-energize the converter system as described in section 14.6 “De-Energizing”, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ Disconnect the DC power cables from the converter system using suitable DC disconnecting devices before carrying out any work in the cabinets of the converter system. ➜ Before disconnecting the DC power cables from the DC connection busbars, always check for voltage-free status of the DC power cables, since dangerous electric arcs may lead to severe injuries or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any work on the MV switchgear and the MV transformer before the PLC container has been disconnected from all voltage sources.** After switching off the converter, the connected MV transformer, the MV switchgear, its connecting cables and terminals continue to carry dangerous voltages which, if touched or short-circuited, can cause death or serious injury. ➜ Before working on the medium voltage components of the converter container, de-energize the converter system as described in section 14.6 “De-Energizing”. ➜ Disconnect the AC mains connection by opening the MV switchgear. ➜ Before disconnecting the AC power cables from the AC connection busbars, always check the voltage-free status of the AC power cables, otherwise dangerous arcs can cause serious injury or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any maintenance work on the converter system before the AC circuit breaker and MV switchgear have been switched off and protected against unintentional reclosure.** ➜ Before starting work inside the converter cabinets, the AC circuit breaker 80Q1 must be switched off and protected against unintentional reclosure as described in section 14.8.3 "Protect the CB Against Unintentional Reclosing". ➜ Before you start working inside the control cabinets, the medium-voltage switchgear must be switched off and protected against unintentional reclosure.

Task 1: **De-energize the BESS**

Step 1 : Switch-off the converter system like explained in section 14.4.

Step 2 : Secure the AC circuit breaker(s) from unintentional reclosure, like explained in section 14.9.3.

Step 3 : Decouple the customer AC connection from the converter system using a suitable disconnection device.

Step 4 : Wait for 30 minutes until the converters´ DC link is discharged and check the voltage-free status of the DC-link by using a suitable 2-pole voltage tester.

✓ **The BESS is now switched off and de-energized.**

14.7 Check Voltage-Free Status of DC Link



The DC link voltage can be up to 1300 VDC. Make sure that the measuring device for testing the absence of voltage in the DC link is suitable for this voltage range.



For converter systems with more than one DC link, the following steps must be carried out to check the absence of DC link voltage on each DC link.

The following steps must be followed to check that the DC link is de-energized:

Step 1 : After switching off the system, check the DC link voltage on the WebVisu or via the communication interface of the external control room.

Step 2 : Check that the DC link is de-energized at the HVIO measuring fuse 173F2 between connections 2 and 4 in the CTRL cabinet.

Step 3 : In addition, check that the DC link is de-energized at the HVIO measuring fuse 173F2 by measuring between connection 2 and N (or PE) in the CTRL cabinet.

Step 4 : In addition, check that the DC link is de-energized at the HVIO measuring fuse 173F2 by measuring between connection 4 and N (or PE) in the CTRL cabinet.

Step 5 : Check that there is no voltage on the DC link between a DC- connection (*see figure below*, ①) and DC+ connection (②) of the PowerStack.

➜ For switch cabinets with more than one installed PowerStack, access to the DC link connections is at the bottom stack.
➜ The DC+ connections are positioned slightly to the rear compared to the DC connections.

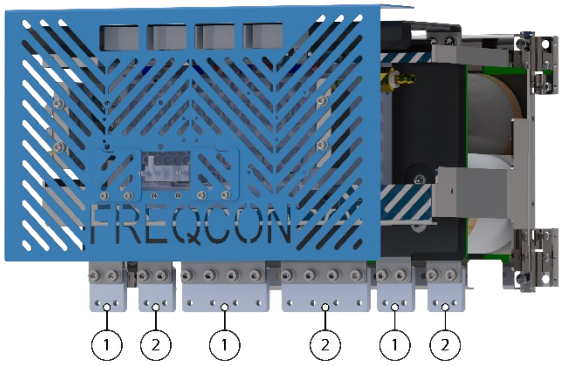


Figure 61: DC- connections ① and DC+ connections ② on the PowerStack (figure may differ from the actual design)

14.8 AC Circuit Breaker

NOTICE

The AC main circuit breaker(s) must not be switched manually!
Do not switch the AC main circuit breaker manually under any circumstances, as this could damage the breaker and the equipment.

The converter system is equipped with an individual 3WL circuit breaker, in order to disconnect the connected grid from the BESS systems electric circuit.

The main circuit-breaker(s) is/are located in the CIR cabinet (*see section 4.4.3 "Internal Components"*).

To protect the circuit breaker against unauthorized switching and to protect the maintenance and operator personnel, the circuit breakers contain a number of locking devices.

For instructions on how to secure the circuit-breaker(s) against reclosing, see section 14.8.3.

Detailed information can be found in the manufacturer's documentation for the circuit-breaker (*see also section 1.2 "Applicable documents"*):

Document type	Document Name	File Name
Operating instructions AC circuit breaker	3ZX1812-0WL00-0AN4	3ZX1812-0WL00-0AN4_online_201806140915326928

14.8.1 Circuit Breaker Components

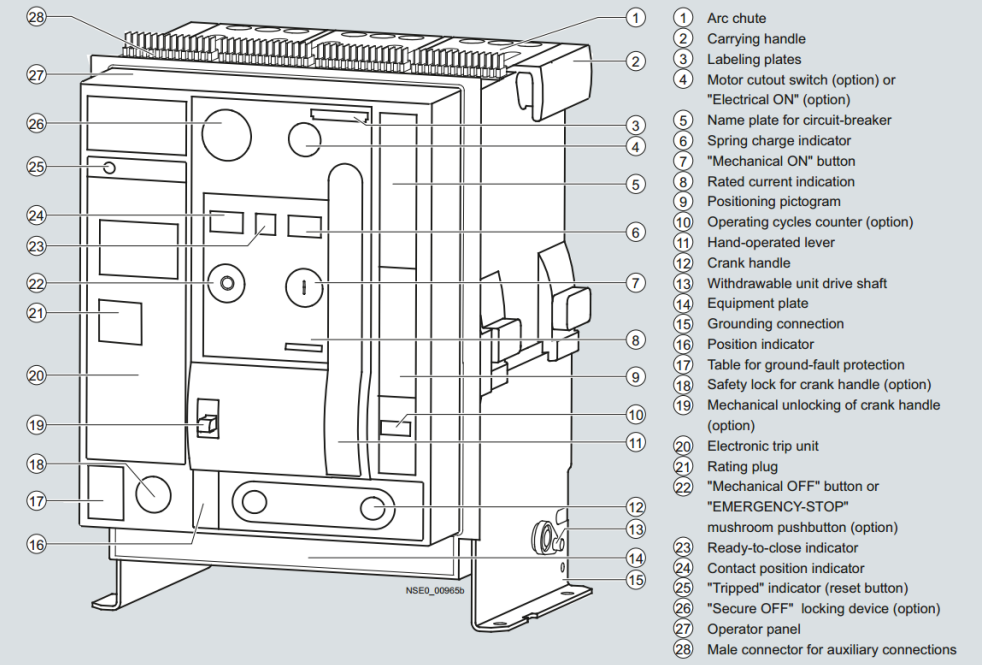
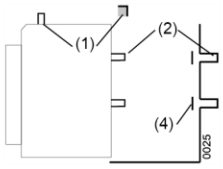
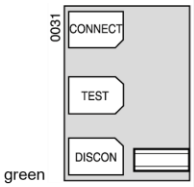
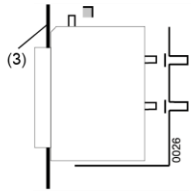
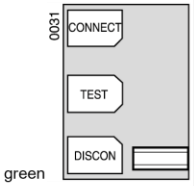
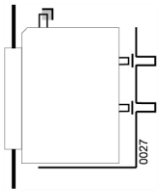
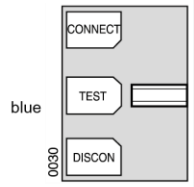
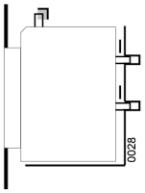
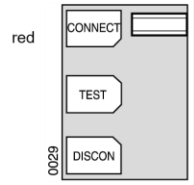


Figure 62: Circuit breaker components

14.8.2 Positions of CB in the Guide Frame

	Diagram	Positon indicator	Power circuit	Auxiliary circuit	Cubicle door	Shutter
Maintenance position			disconnected	disconnected	open	closed
Disconnected position			disconnected	disconnected	closed	closed
Test position			disconnected	connected	closed	closed
Connected position			connected	connected	closed	open

(1) Auxiliary circuit
(2) Primary circuit
(3) Cubicle door
(4) Shutter

Figure 63: Circuit breaker positions

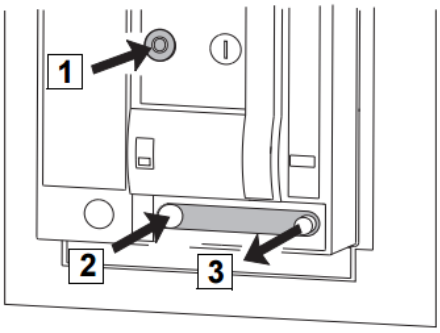
14.8.3 Protect the CB Against Unintentional Reclosing

Drawing out of the racking handle can be prevented by fitting a maximum of three padlocks. The circuit breaker is then locked against moving.

Task 1: **Unlocking the racking handle/ Withdrawing racking handle.**

Step 1 : OPEN circuit breaker.

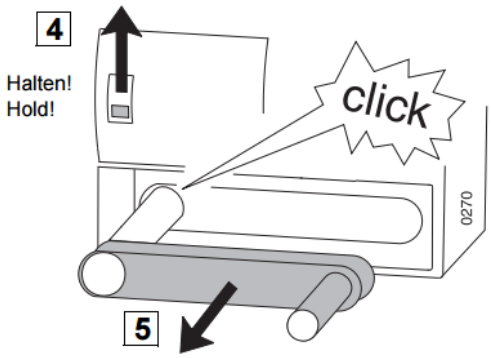
Step 2 : Push the crank.



Step 3 : Pull out handle.

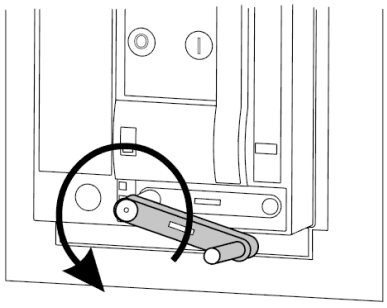
Step 4 : Lift and hold the control lever.

Step 5 : Pull out the crank.

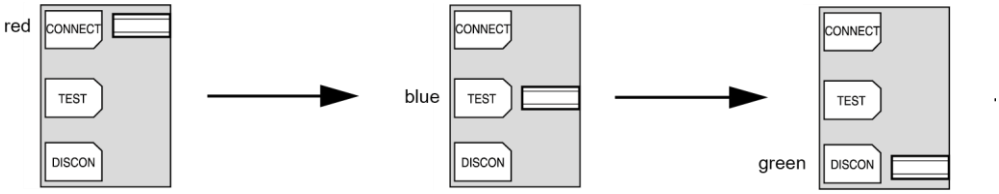


Task 2: Racking circuit breaker into the disconnected position.

Step 1 : Rack the handle until the disconnected position is indicated by the position indicator (green).



Position indicatior

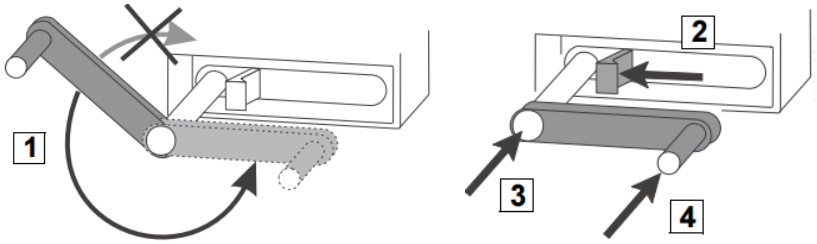


Task 3: Push in the racking handle.

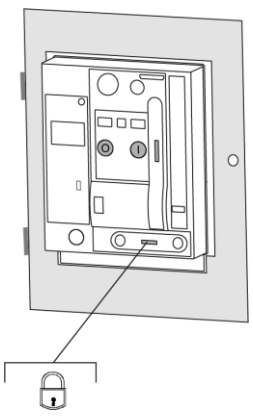
Step 1 : Bring the racking handle to the position indicated in the illustration below.

Step 2 : Push in the crank.

Step 3 : Push in the handle.



Task 4: Lock the racking handle with one or more padlocks.



14.9 DC Fuse Switch Disconnectors

NOTICE	
	**The DC fuse switch disconnectors must not be switched manually!** Do not switch the DC fuse switch disconnectors manually under any circumstances, as this could damage the breaker and the equipment.

Each of the battery storage cabinets is equipped with a DC fuse switch disconnector, in order to disconnect the corresponding battery cabinet from the electric circuit of the BESS.

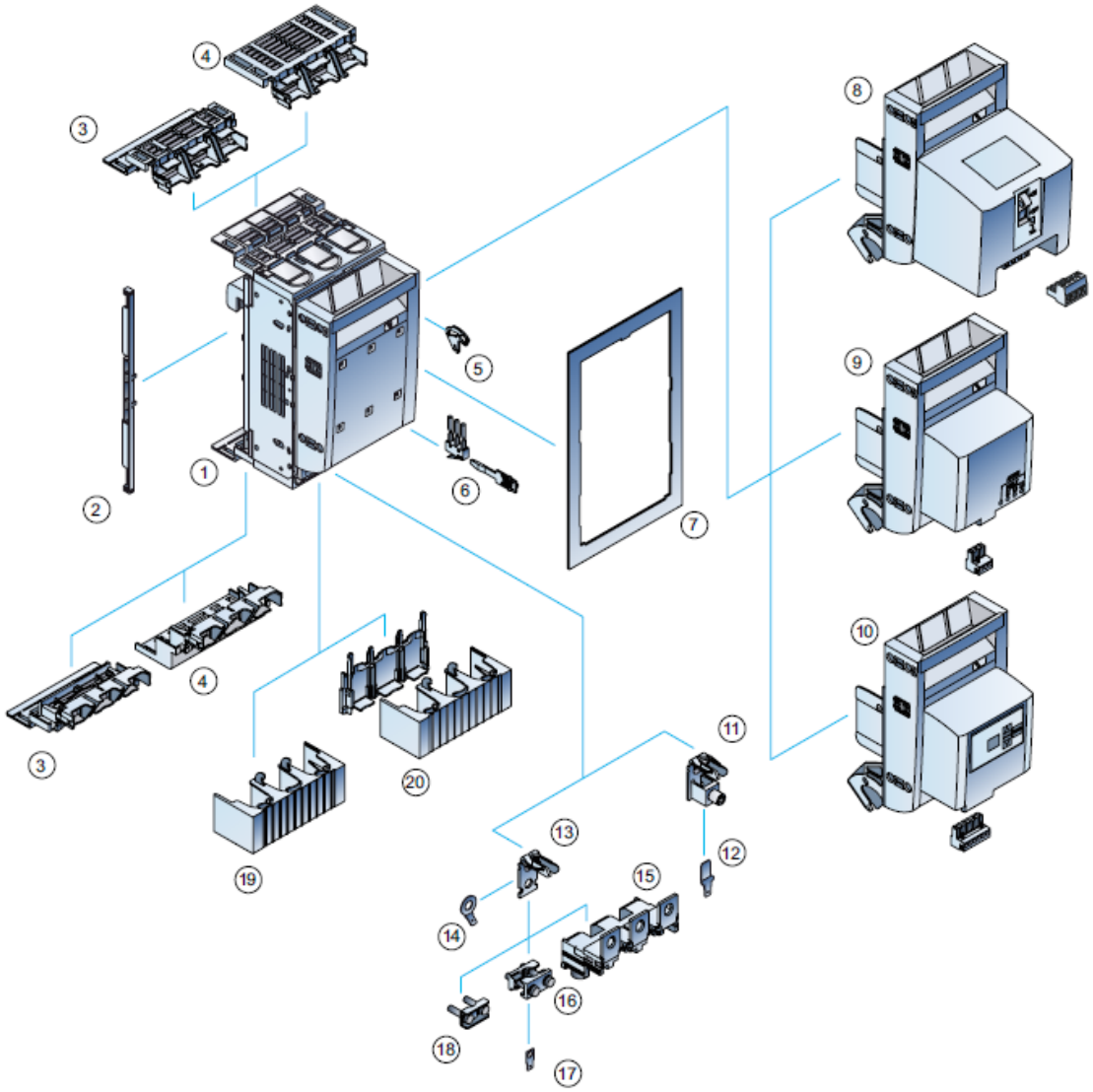
A DC fuse switch-disconnector is located on the mounting plate at the bottom of each battery cabinet.

To protect the DC fuse switch disconnector against unauthorized switching and to protect the maintenance personnel, the disconnector is provided with locking devices.

For instructions on how to prevent unintentional reclosing of the DC fuse switch disconnector, *see section 14.9.3, "Protect the DC Disconnector Against Unintentional Reclosing"*.

For detailed information regarding the DC fuse switch disconnector, refer to the original manufacturer manual (*see section 1.2 "Applicable Documents"*).

14.9.1 Fuse Disconnector Components



① SENTRON 3NP1 fuse switch disconnector
② Cover support
③ Reach-round protection for mounting onto Siemens busbar system
④ Reach-round protection for mounting onto Rittal busbar system
⑤ Locking device
⑥ Auxiliary switch with actuator
⑦ Molded plastic cover
⑧ Handle unit with mechanical fuse monitoring (MFM)
⑨ Handle unit with electronic fuse monitoring (EFM 10)
⑩ Handle unit with electronic fuse monitoring (EFM 20/25)
⑪ Box terminal
⑫ Auxiliary conductor terminal for box terminal
⑬ Blade terminal
⑭ Auxiliary conductor terminal for blade terminal
⑮ Deep-drawn terminal module
⑯ Prism terminal
⑰ Auxiliary conductor terminal for prism terminal
⑱ Saddle terminal
⑲ Terminal cover
⑳ Terminal cover with reach-round protection on the back

Figure 64: Circuit breaker components

14.9.2 Locking Device

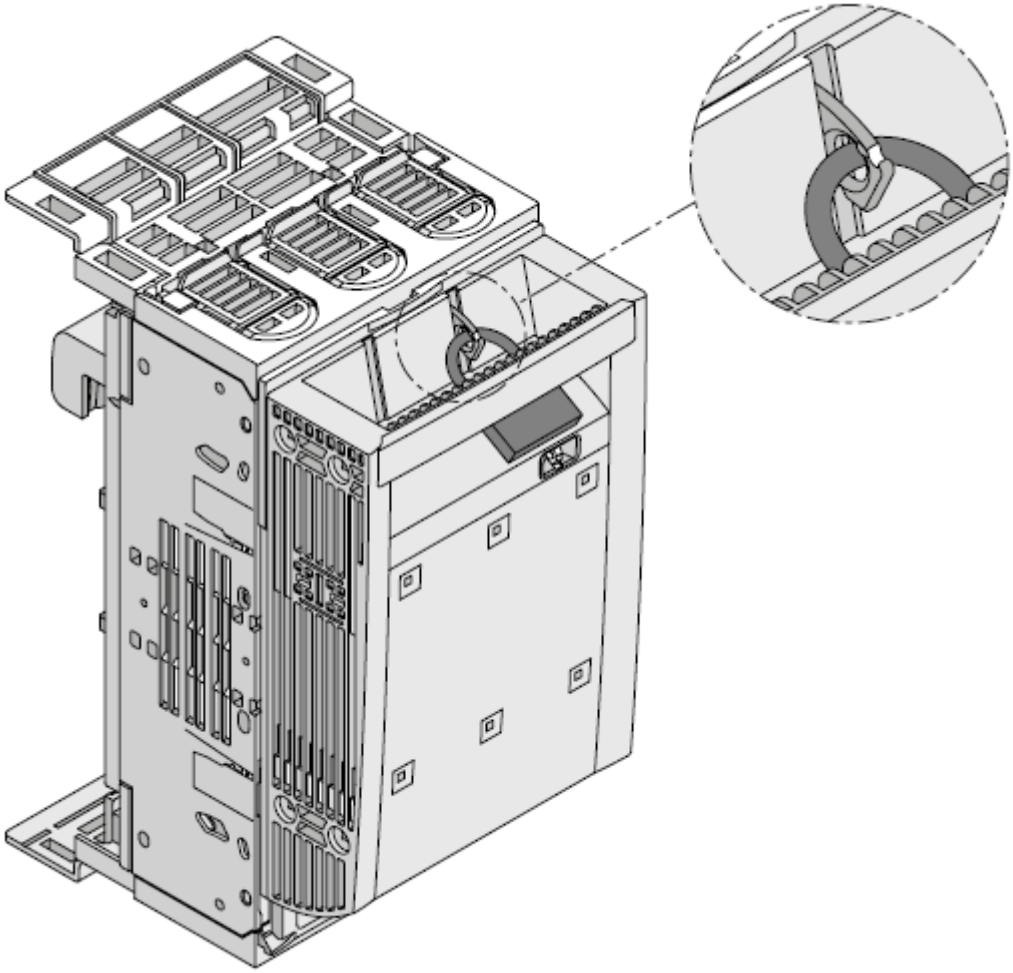


Figure 65: Locking device

14.9.3 Protect the DC Disconnector Against Unintentional Reclosing

You can lock the 3NP1 fuse switch disconnector to protect it against unauthorized actuation.
Either an eye (optional accessory, see below) and a padlock (shackle diameter: 6 mm) or two padlocks (shackle diameter: 2x 3 mm) are required for this purpose. The padlocks are not supplied with the fuse switch disconnector.

NOTICE
You can open the handle unit of a fuse switch disconnector that has been locked with an eye and one padlock by force in order to trip an emergency stop (rupture point on the eye).

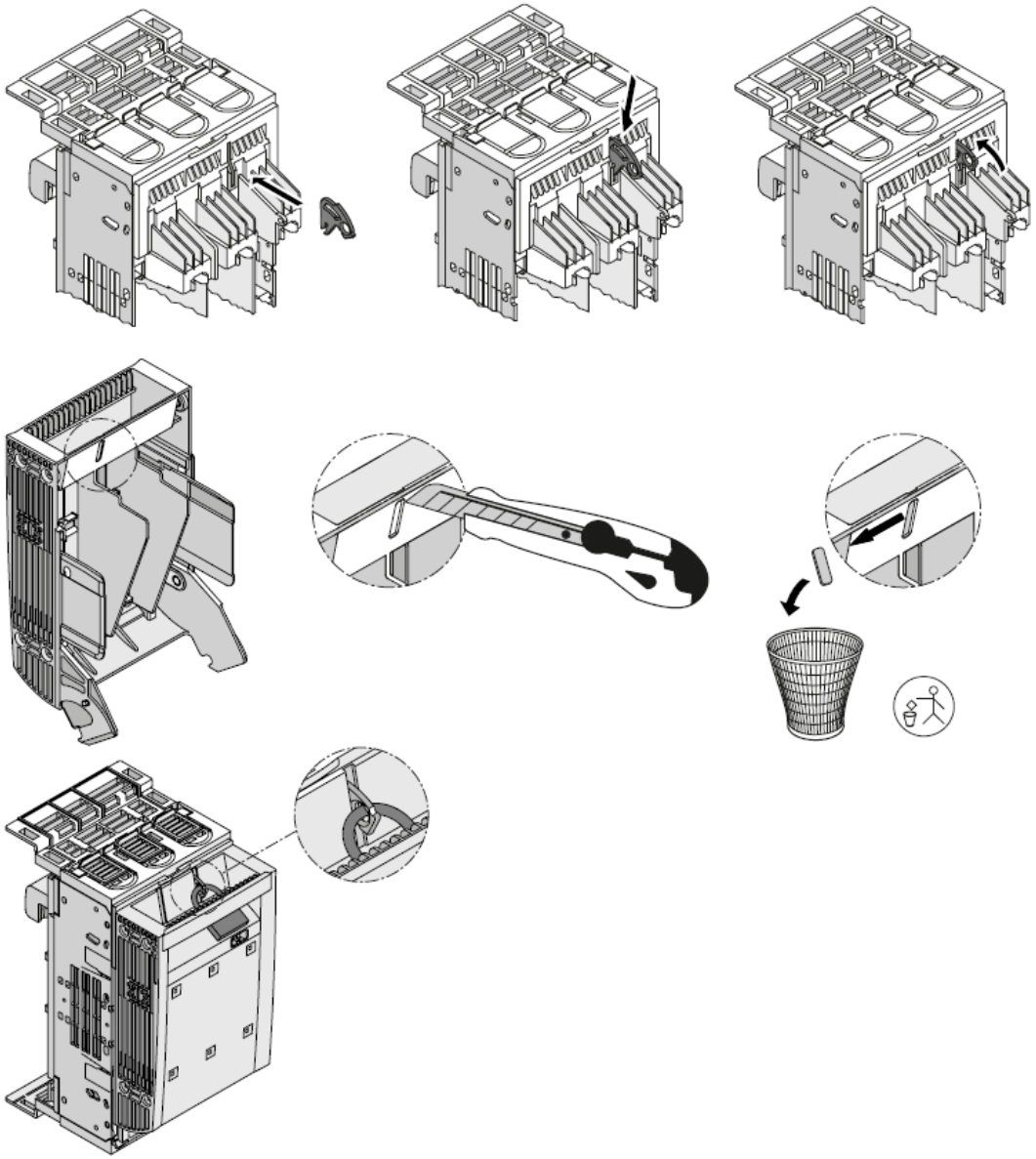


Figure 66: Secure fuse switch-disconnector against unintentional reclosing

15 Monitoring

PIII Converter Control Module

The converter system is equipped with two converter control interfaces.

PIII Indicator Lights

LED	Color	Label	Description
1	red	**UDC max**	DC-link voltage exceeded maximum value
2	red	**Imod max**	Current of one or more IGBT´s exceeded maximum value
3	red	**Error IGBT 1**	Error detected on IGBT 1
4	red	**Error IGBT 2**	Error detected on IGBT 2
5	red	**Error IGBT 3**	Error detected on IGBT 3
6	red	**Error IGBT 4**	Error detected on IGBT 4
7	red	**Error IGBT 5**	Error detected on IGBT 5
8	red	**Error IGBT 6**	Error detected on IGBT 6
9	red	**Error IGBT 7**	Error detected on IGBT 7
10	green	**PWM Mode**	IGBT 1, IGBT 2 and IGBT 3 are working in PWM mode
11	green	**Enable**	IGBT 1 - 6 ready for operation
12	green	**Top 1**	Top 1 active
13	green	**Bot 1**	Bot 1 active
14	green	**Top 2**	Top 2 active
15	green	**Bot 2**	Bot 2 active
16	green	**Top 3**	Top 3 active
17	green	**Bot 3**	Bot 3 active
18	green	**Top 4**	Top 4 active
19	green	**Bot 4**	Bot 4 active
20	green	**Top 5**	Top 5 active
21	green	**Bot 5**	Bot 5 active
22	green	**Top 6**	Top 6 active
23	green	**Bot 6**	Bot 6 active
24	green	**Chopper Active**	Brake chopper is active
25	green	**Blinki**	Profinet communication between main PLC and PIII is established
26	green	**24 V Supply**	24V supply connected
27	green	**UL 1**	L1 voltage apparent
28	green	**UL 2**	L2 voltage apparent
29	green	**UL 3**	L3 voltage apparent
30	green	**Urec**	Booster voltage is apparent on rectifier
31	green	**UDC +**	DC link voltage is apparent
32	green	**Arc Detect**	Arc detection has tripped

Table 39: PIII indicator lights

16 Data transfer with higher-level controller

As described in section 4.2 "Data Interface", the BESS is controlled and monitored via the transfer of data with the customer's higher-level control system. Data transfer between BESS and the higher-level control system is performed via PROFINET protocol.

For external control and monitoring of the converter, it is necessary for the customer to have access to selected control and status variables stored in the converter controller, which can be read and overwritten by the customer's higher-level controller. For this purpose, predefined control profiles with the relevant control variables and status profiles with all relevant status variables are stored for the data transfer from BESS to the customer's higher-level controller.

For a detailed description of the individual data profiles, see Description of data profiles (*see section 1.2 "Applicable Documents"*).

17 Maintenance

The following describes the maintenance work that is necessary for trouble-free operation of the converter system (PCS) and Battery Energy Storage System (BESS). Maintenance intervals must be observed (*see section 17.2 "Maintenance* Schedule*"*).

If increased wear of individual components or functional groups is determined during regular inspections, the operator has to reduce the required maintenance intervals on the basis of the actual signs of wear. Changes compared to the normal operation (increased power consumption, temperatures, vibrations, noises, etc. or respond of monitoring systems) might indicate the functionality of the device is impaired. These then have to be subjected to an inspection by qualified personnel.

For information regarding maintenance of the BESS battery cabinets refer to document „20_Maintenance_Schedule“ (*see section 1.2 "Applicable Documents"*). Maintenance intervals provided in the maintenance schedule must be adhered.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on a live system.** After switching off the converter, the DC-link of the converter still carries dangerous voltages, which may cause death or severe injuries if touched or short circuit. ➜ Before performing work on the converter, deenergize the converter, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ It is not allowed to open the cabinet doors before the converter system has been de-energized and the capacitors are discharged. ➜ It is not allowed to perform any work on the converter before the system has been de-energized.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform maintenance work on the converter system, before the converter system has been disconnected from all power sources.** After switching off the converter, the connected DC power cables of the battery strings, the DC connection busbars in the AC_DC cabinet and the DC switch & fuse units continue to carry dangerous voltages that can cause death or serious injury if touched or short-circuited. ➜ Before starting work inside the converter cabinets, de-energize the converter system as described in section 14.6 “De-Energizing”, wait for 30 minutes until the installed capacitors are discharged and check the voltage-free status of the DC-link by using a 2-pole voltage tester. ➜ Disconnect the DC power cables from the converter system using suitable DC disconnecting devices before carrying out any work in the cabinets of the converter system. ➜ Before disconnecting the DC power cables from the DC connection busbars, always check for voltage-free status of the DC power cables, since dangerous electric arcs may lead to severe injuries or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any work on the MV switchgear and the MV transformer before the PLC container has been disconnected from all voltage sources.** After switching off the converter, the connected MV transformer, the MV switchgear, its connecting cables and terminals continue to carry dangerous voltages which, if touched or short-circuited, can cause death or serious injury. ➜ Before working on the medium voltage components of the converter container, de-energize the converter system as described in section 14.6 “De-Energizing”. ➜ Disconnect the AC mains connection by opening the MV switchgear. ➜ Before disconnecting the AC power cables from the AC connection busbars, always check the voltage-free status of the AC power cables, otherwise dangerous arcs can cause serious injury or death when disconnecting the power cables.

⚠ DANGER	
	**Electric shock hazard!** **Do not perform any maintenance work on the converter system before the AC circuit breaker and MV switchgear have been switched off and protected against unintentional reclosure.** ➜ Before starting work inside the converter cabinets, the AC circuit breaker 80Q1 must be switched off and protected against unintentional reclosure as described in section 14.8.3 “Protect the CB Against Unintentional Reclosing”. ➜ Before you start working inside the control cabinets, the medium-voltage switchgear must be switched off and protected against unintentional reclosure.

⚠ WARNING	
 	**Hazard by cooling liquid** The coolant used in the internal cooling system of the converter is harmful to human or animal health when touched or swallowed. ➜ Avoid oral ingestion of the coolant, since it can lead to harm to human or animal health. In case of accidental ingestion or eye contact with the coolant, seek immediate medical attention. ➜ Avoid skin contact with the coolant. ➜ Use appropriate eye protectors and protective gloves when working on the cooling system and during filling and draining of the cooling liquid.

NOTICE
Service and maintenance work on the BESS and cooling system must only be carried out by qualified and authorized personnel.

17.1 Preparations Prior Maintenance

The following safety precautions must be carried out before commencing service and maintenance work.

Non-observation of these safety instructions can cause injury to persons, damage to objects or malfunction or damage to the device itself.

Do not operate!	**Lock and tag power switches and controller devices**
⚠ DANGER 	Disconnect power and block operation controller devices. Follow national laws regarding Occupational Safety and Health. 1. Identify the energy source(s). 2. Isolate the energy source(s). 3. Determine voltage-free status. 4. Ground device or equipment to protect from short circuiting and from shocks. 5. Lock and Tag the energy source(s). 6. Prove that the equipment isolation is effective. 7. When required, apply lock-out device or clamp and secure with padlock(s).

17.2 Maintenance Schedule

Location	Component	Maintenance Work	Maintenance Interval	Description in
PCS Container CTRL cabinet	UPS battery	Functionality check	Once every 6 months	Section 17.3.1
PCS Container CTRL cabinet	UPS battery	Remove battery from battery unit	At storage temperatures below 0°C	Section 17.3.2
PCS Container All switch cabinets	Intake fan filters	Check the fan filters for contamination and replace if necessary	Once every 6 months	Section 17.4
All containers	Complete BESS system	Visual inspection	Once every 6 months / in case of a fault	Section 17.5
PCS Container CIR cabinet	Circuit breaker 3WL	Inspection	Once every 12 months	Section 17.6.1
		Replace arc-chute covers	After no more than three short-circuit interruptions	
		Replace arc chutes and contact system	Depending upon their condition	
		Replace operating system	Depending upon their condition	
PCS Container CTRL cabinet	PLC	Replace backup battery of Simotion PLC	Once every 4 years	Section 17.7
PCS Container COSY	Coolant	Exchange cooling liquid	Once every 5 years	Section 17.6
PCS Container COSY	Expansion vessel	Check pressure	Once every 5 years / When exchanging the cooling liquid / When error "pressure low" is apparent	Section 17.9
BESS Containers	Exhaust units	Inspection	Once every 6 months / in accordance with existing maintenance schedule	Section 17.11
BESS Containers	Fire dampers	Inspection	Once every 6 months / in accordance with existing maintenance schedule	Section 17.12
BESS Containers	H2 Sensors	Inspection	Once every 6 months	Section 17.13

Table 40: PCS Maintenance Schedule

17.3 UPS

17.3.1 UPS Functionality Check

(once every 6 months)

In order to check the functionality of the UPS device, the following steps must be performed:

Task 1: **Perform functionality check of the UPS device**

Step 1 : Set the main switch on the door of the control cabinet (*see figure 60,* ⑥) to the "OFF" position.

Step 2 : Locate the UPS module 102G1 inside the control cabinet (*see section 4.4.3*).
The yellow LED (*see figure below,* ④) on the front of the UPS module should glow, indicating that battery mode is active and the battery is discharging because the power supply is not available.

Step 3 : Wait for the buffer time set on the potentiometer on the front of the UPS module (②, default value: 6.6 min.).
During this time, check if the SoC bar graph (①) is displaying the current state of charge (SoC).

Note 4: During and after the test, the red LED (③) displaying an UPS alarm should not start glowing, since this would indicate an faulty or almost empty battery. In this case, the UPS battery must be replaced as described in the original manufacturer documentation.

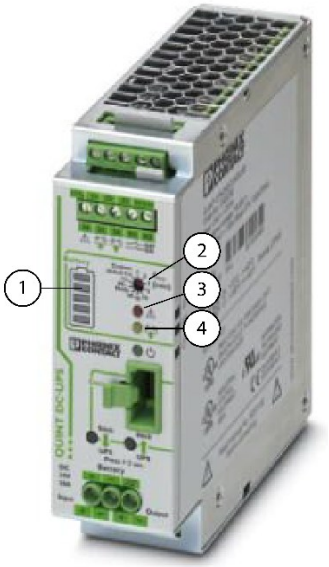


Figure 67: UPS module

Pos.	Description
①	Bar graph for displaying the current charging state of the power storage device
②	Buffer time setting: default: 6.6 min.
③	Red LED: alarm
④	Yellow LED: battery mode

Icon	Meaning of LEDs
⚠	Red LED on: UPS alarm due to one of the reasons: • battery almost empty • battery not detected • battery replacement required LED off: No UPS alarm, power supply available, normal operation.
🔋	Yellow LED on: Battery mode is ON, battery is discharging because power supply failed. LED off: Battery mode is OFF, i.e. mains available.
⏻	Green LED on: Mains is ON. LED off: Mains is OFF.

17.3.2 Removing the UPS battery

(At storage temperatures below 0°C)

NOTICE
The battery of the UPS unit must be removed at temperatures below 0°C.

In order to remove the battery from the energy storage device UPS-BAT/VRLA/24DC/12AH, the service mode of the UPS device must be activated.

Task 1: Activate service mode

The corresponding activation rights have to be granted for service mode activation and deactivation.

The service mode cannot be activated, while the QUINT-UPS runs in battery mode. The power supply must be available.

Step 1 : Depending on the granted activation rights, the service mode can be activated in three different ways:

1. By holding down both push buttons on the QUINT-UPS named "Stick -> UPS" and "UPS -> Stick" for at least 6 seconds.

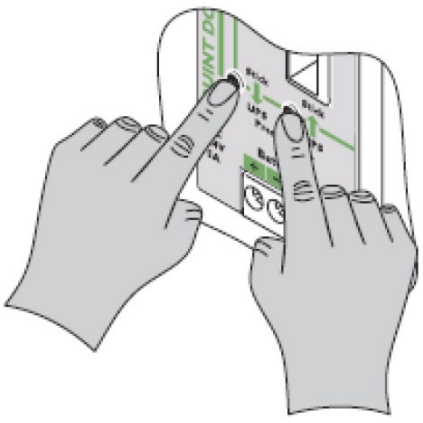


Figure 68: UPS control elements

2. By connecting a service stick (*see manufacturer manual*) to the Data port of the UPS.
3. By using the UPS-CONF (*see manufacturer manual*) software as follows:
   In the "Settings" group, select the "Service" item, and click the "On / Off" button near the "Activate service mode" text.

While the service mode is active

- the alarm status is activated,
- the charging current is interrupted,
- the status LED "Service mode active" in the UPS-CONF software ("Settings" group /"Service" item) is green

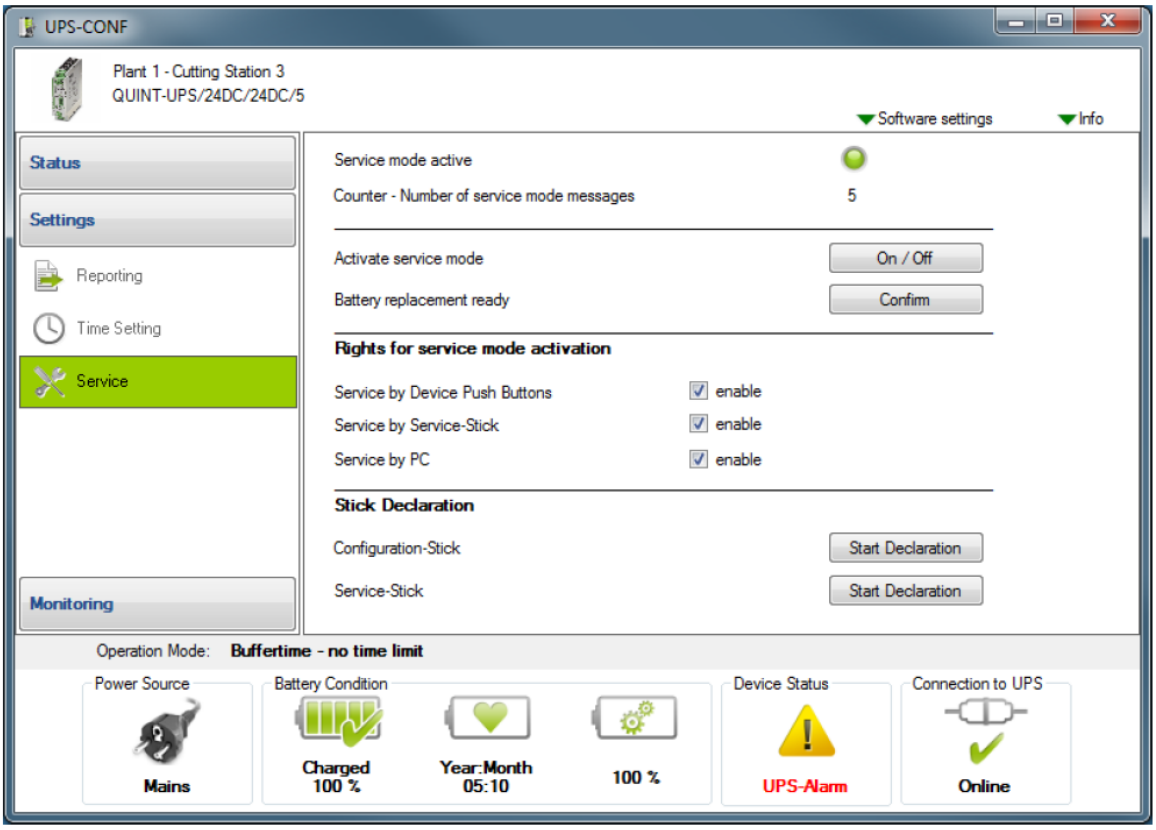


Figure 69: UPS CONF software

Task 2: Remove battery

⚠ DANGER
Before activating the service mode, read and obey carefully the safety instructions in the topic “Important safety notes” of the manufacturer manual.

⚠ DANGER
Watch polarity when connecting cables!

Step 1 : Activate the service mode by one of the ways described in Task 1.
Step 2 : Open battery module housing.
Step 3 : Remove fuses *(see illustration below)*.

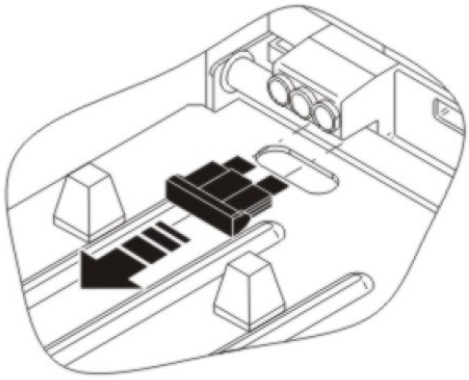


Figure 70: Remove UPS battery fuses

Step 4 : Remove cabling.
Step 5 : Remove battery.
Step 6 : Fix cabling inside housing.
Step 7 : Store the battery module together with the fuses.
Step 8 : Close battery module housing.

NOTICE
The battery and the fuses of the UPS unit must be reassembled before commissioning, recommissioning and operation of the MSC converter unit.

17.4 Changing the Intake Fan Filters

Check every 6 months, replace depending on degree of soiling)

The fan-and-filter unit and outlet filter are supplied as standard with a standard filter mat for the pre-filtering of dry, coarse dust and lint. In order to increase the protection category, and in the case of dust with a grain size of < 10 µm, we recommend the use of fine filter mats (optionally available).
The filter must be checked in regular intervals in accordance to the level of dust exposure and replaced as necessary.

⚠ DANGER

➜ Only change the filter mat while the fan rotor is stationary.
➜ Never insert your fingers into the fan rotor.

⚠ DANGER

The unit is live. Switch off the power supply before opening, and take suitable precautions against it being accidently switched back on.

NOTICE

Use only original Rittal filters which bear the Rittal logo in order to safeguard the designated protection category, air throughout and operating approvals.

To insert or replace the filter, proceed as follows (direction of airflow: drawing from outside and blowing into the enclosure):

Task 1: **Replace intake filter**
Step 1 : First press the catch of the louvred grill (Rittal logo) up slightly with one finger.
Step 2 : Once it is released, the louvred grill can be dropped open by approx. 70° or 90°.
Step 3 : If necessary, first place the fine filter mat into the housing.
Step 4 : Ensure that the open (roughened) side faces towards the louvred grill.
Step 5 : Insert the enclosed standard filter mat.
Step 6 : Ensure that the open side (without Rittal logo) faces towards the louvred grill.
Step 7 : Push the louvred grill back onto the enclosure until it snaps audibly into position.

17.5 Visual Inspection

(once every 12 months/in case of a fault)

Check the fan filters for contamination. Replace filters if necessary (*see section 17.4*).

Visually inspect the BESS cabinets for:

- Corrosion
- Damage
- Contamination

Electrical connections
Electrical connections must be checked for proper connection in order to ensure safe operation of the system and to prevent personnel from injuries due to electrical shock.

Corrosion
Corroded electrical connections must be replaced in order to maintain safe operation of the system and to prevent personnel from injuries due to electrical shock.

Damage
Damaged wires and clamps must be replaced immediately in order to maintain safe operation of the converter system and to prevent personnel from injuries due to electrical shock.

Contamination
Check the interior of the converter unit for contamination and dirt in order to prevent the internal components from short-circuiting and damage.

NOTICE
Do not use solvents for cleaning – especially on polycarbonate plastics. Use a vacuum cleaner to remove dirt or dust.

17.6 AC Circuit Breaker(s)

17.6.1 Inspection work

(once every 12 months)

The arc chutes and contact system of the circuit breaker(s) must be inspected according to these operation instructions. If a fault condition opens the circuit breaker(s), the circuit breaker(s) should be inspected before it is put back into service. Contact assemblies need to be changed according to their condition.

The switchgear operator has to determine inspection intervals depending on the breaker application conditions:

- min. 1 x per annum
- after interruption of heavy loads

During the inspection the following items must be examined:

- arc chutes and contact systems
- electrical and mechanical functionality of the breaker
- mechanical on- / off-functionality
- main and auxiliary circuits, function and connecting quality
- plausibility control of trip unit settings and correction, if necessary

Draw-Out guide frames with arc-chute covers installed, have to be replaced after no more than three short-circuit interruptions of the circuit breaker. If the breaker endurance is exhausted, then the breaker and old spare parts need to be disposed off, according to the effective legal regulations.
The arc chutes and the contact system must be replaced depending upon their condition.

Depending on the circuit breaker stress it may also be necessary to replace the operating system.

For detailed regarding the maintenance of the circuit breaker, refer to original manufacturers´ documentation (*see section 1.2 "Applicable Documents"*):

Document type	Document Name	File Name
Operating instructions	3ZX1812-0WL00-0AN4	3ZX1812-0WL00-0AN4_online_201806140915326928

17.7 Replace PLC Buffer Battery

17.7.1 Preventive maintenance

(every 4 years)

To maintain the high system availability, the manufacturer recommends the preventive replacement of the CMOS buffer battery, which is installed in the system PLC.

Component	Replacement interval
CMOS buffer battery	4 years

17.7.2 Replacing Backup Battery

NOTICE

The service life of the backup battery is approx. 5 - 8 years, depending on the ambient conditions.

Detailed information on maintenance can be found in the manufacturer's documentation for the Simotion P320-4 PLC *(see also section "Other applicable documents")*:

Document type	Document Name	File Name
Operating instructions	P320- 4 Commissioning and installation manual	P320_4_commissioning_en-EN

17.8 Exchanging the Cooling Liquid

(Every 5 years)

The cooling liquid inside the converter cooling system is to be exchanged as described in the following sections.

Like described in section 0, the converter cooling system is split up into two independent cooling systems for each converter system, allowing Converter System 1 and 2 independently from one another.

Therefore, each of the following steps must be performed for each cooling system separately.

NOTICE

- The cooling liquid inside the cooling system must be removed at least once every five years.
- Check the pressure on the expansion tank every time the cooling liquid is exchanged. The cooling system must be completely drained in order to perform a pressure check of the expansion tank (*see section17.9*).

NOTICE

The pump must not run dry as it might damage the pump.

17.8.1.1 Required Tools

The following table provides you with information regarding the tools required to perform maintenance work on the cooling system:

Amount	Tool	Description	Preferred Type	Manufacturer
3	Hose ½"	Length: 2 m, max. 50 bar	Variolux Silverline	Gardena
1	Filling pump	For glycol use, min. 2 bar pressure	Unistar 2000 A	ZUWA
1	Cooling liquid vessel	Min. 55 l capacity		
1	Inlet pressure gauge	For expansion tanks, digital	Art. No.: 512240122	OEG
1	Tank filler 400 ml	For increasing and testing the pressure in expansion tanks	Art. No.: 311779100	OEG
1	Adapter for tank filler	Adapter for screwing on the tank filler can	Art. No.: 512240126	OEG

Table 41: Required tools for cooling system maintenance

17.8.1.2 Allowed Coolants

The following table lists the suitable coolants for using in the cooling system. When exchanging the cooling liquid of the cooling system, only use a coolant listed in the table.

Please observe the manufacture's information regarding the cooling range of the designated cooling liquid.

Manufacturer	Type
NALCO AG	Varidos FSK
BASF AG	Glysantin G30
Clariant	Antifrogen N
Clariant	Antifrogen L
DOW	Dowcal 20
Zitrec	M-25 C

Table 42: Allowed coolants

17.8.1.3 Draining the cooling system

NOTICE

Check the pressure on the expansion tank every time the cooling liquid is exchanged. The cooling system must be empty in order to perform a pressure check of the expansion tank (*see section 17.9*).

⚠ WARNING



Hazard by cooling liquid

The coolant used in the internal cooling system of the converter is harmful to human or animal health when touched or swallowed.

- ➜ Avoid oral ingestion of the coolant, since it can lead to harm to human or animal health. In case of accidental ingestion or eye contact with the coolant, seek immediate medical attention.
- ➜ Avoid skin contact with the coolant.
- ➜ Use appropriate eye protectors and protective gloves when working on the cooling system and during filling and draining of the cooling liquid.

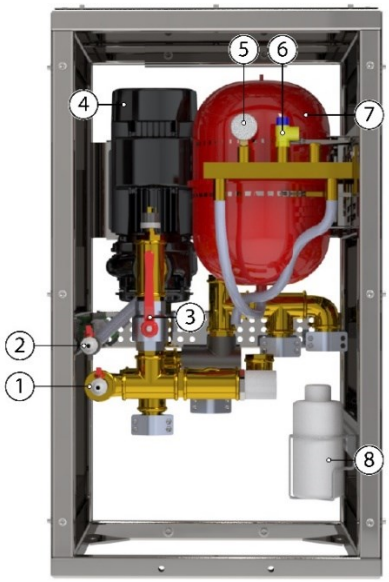


Figure 71: Cooling system components inside cooling system cabinet (COSY)

Pos.	Cooling system components
①	¾“ inlet flow connection with valve
②	"¾“ return flow connection with valve
③	Stop cock
④	Coolant pump
⑤	Manometer
⑥	Overpressure valve
⑦	Expansion vessel
⑧	Overflow vessel

Table 43: Cooling system components

Task 1: **Draining the cooling system**

Step 1 : Connect a pressure hose to the return flow connection of the cooling system inside the COSY cabinet (*see figure 71,* ②) and lead the end of the hose inside a suitable vessel.

Step 2 : Open the return flow valve (②).

Step 3 : The cooling liquid drains through the hose inside the vessel.

Step 4 : Wait until the cooling system is completely drained and then check it for any liquid remaining in the system.

17.8.2 Filling the Cooling System

⚠ WARNING	
	**Hazard by cooling liquid** The coolant used in the internal cooling system of the converter is harmful to human or animal health when touched or swallowed. ➜ Avoid oral ingestion of the coolant, since it can lead to harm to human or animal health. In case of accidental ingestion or eye contact with the coolant, seek immediate medical attention. ➜ Avoid skin contact with the coolant. ➜ Use appropriate eye protectors and protective gloves when working on the cooling system and during filling and draining of the cooling liquid.

Task 1: **Prepare Coolant**

Step 1 : The expansion tank must be pre-charged to 1 bar at approx. 20 °C on the gas side.

Step 2 : Use a suitable container to prepare approx. 55 liters of coolant with a ratio of 60% water and 40% glycol (with Antifrogen N). The actual amount needed depends on the length of the hoses used to connect the heat exchanger.

Step 3 : Open the cooling liquid container (e.g. Antifrogen N) and place it in close proximity to the converter cooling system.

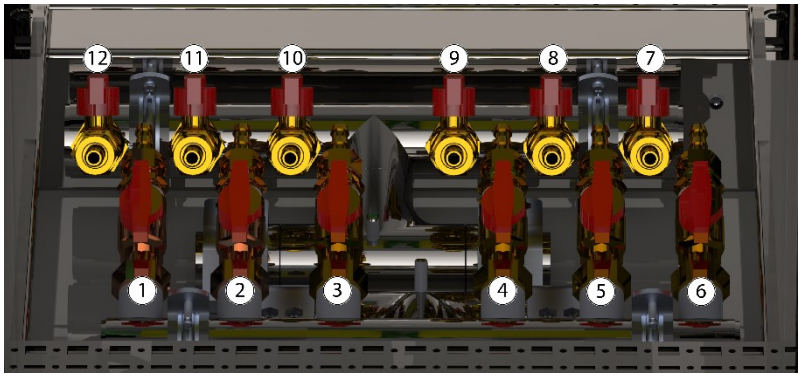


Figure 72: Water distributor, connections and valves in CON Cabinet

Pos.	Cooling System Component
①	Sub circuit with valve 1 - inlet flow
②	Sub circuit with valve 2 - inlet flow
③	Sub circuit with valve 3 - inlet flow
④	Sub circuit with valve 4 - inlet flow
⑤	Sub circuit with valve 5 - inlet flow

⑥	Sub circuit with valve 6 - inlet flow
⑦	Sub circuit with valve 6 - return flow
⑧	Sub circuit with valve 5 - return flow
⑨	Sub circuit with valve 4 - return flow
⑩	Sub circuit with valve 3 - return flow
⑪	Sub circuit with valve 2 - return flow
⑫	Sub circuit with valve 1 - return flow

Table 44: Cooling system – Coolant dispenser connections and valves inside CON cabinet

Task 2: Fill cooling system

NOTICE

Make sure that the pressure and suction hoses are completely immersed in the cooling liquid inside the cooling liquid container throughout the whole filling process, to avoid suction of air into the cooling circuit.

Step 1 : Connect the external filling pump and the cooling liquid canister using a suction hose.

Step 2 : Connect the external filling pump to the inlet flow connection *(see figure 71, ①)* with a pressure hose.

Step 3 : Open the valve on the top of the heat exchanger - if there are several heat exchangers, the valve of each heat exchanger must be opened *(see illustration below)*.

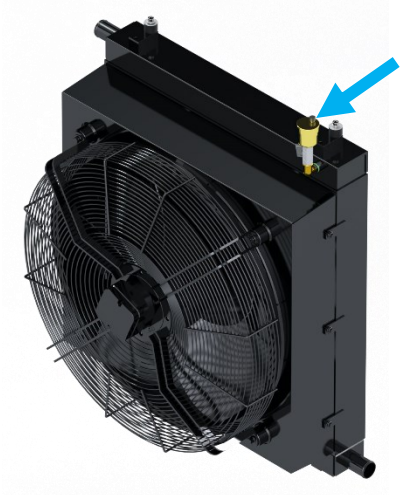


Figure 73: Valve on heat exchanger

Step 4 : Connect the return flow connection (*see figure 71,* ②) and the coolant canister with a pressure hose.

Step 5 : Close ALL valves of the sub-circuits on the water distributor of the CON cabinet (*see figure 72* ① - ⑥, ⑦ - ⑫).

Step 6 : Open the stop cock of the converter cooling system (*see figure 71,* ③).

Step 7 : Open the valves on the inlet flow connection and on the return flow connection.

Step 8 : Switch on the external filling pump and make sure that the intake hose is completely immersed in the cooling liquid inside the cooling liquid canister, so no air is sucked into the cooling circuit.

Step 9 : The main cooling circuit will be filled with coolant and the air will be removed from the circuit during this time. Wait until no more air bubbles are inside the cooling liquid canister.

Step 10 : Open the inlet flow and return flow valves of sub-circuit 1 (*see figure 72,* ① *and* ⑫).

Step 11 : Wait for 3 minutes. The sub cooling circuit will be filled with coolant and the air will be removed from the circuit during this time.

Step 12 : Shut off the inlet and return flow valve of sub circuit 1.

Step 13 : Proceed the same way for the remaining IGBT cooling circuits inside the CON cabinet.

Step 14 : Proceed the same way for the cooling circuits inside the IND cabinet.

Step 15 : Close the stopcock (*see figure 71,*③).

Step 16 : Open the valves of all connected sub-circuits.

Step 17 : Close the valve of the return flow connection (*see figure 71,* ②).

Step 18 : Wait until a pressure of 3 bar is indicated by the cooling systems´ manometer (*see figure 71,* ⑤). As soon as 3 bar have been reached, immediately shut off the inlet flow valve (*see figure 71,* ①).

Step 19 : Shut-off the external filling pump, but make sure the suction and pressure hose are still immersed in the cooling liquid inside the cooling liquid container.

Step 20 : Activate the coolant pump of the cooling system by switching on the motor protection circuit breaker 181Q1 inside the control cabinet and activate the contactor 139K2 inside the control cabinet using a suitable insulated tool.

Step 21 : Let the coolant pump run for 120 min.

Step 22 : Close the valve on the top of the heat exchanger(s) (*see figure 73*).

Step 23 : Deactivate the coolant pump of the cooling system by removing the insulated tool.

Step 24 : Check if the pressure on the cooling system manometer is indicated with 3 bar.

Step 25 : If the pressure indicated by the manometer is below 3 bar, switch the external filling pump back on an open the inlet flow valve.

Step 26 : As soon as a pressure of 3 bar has been reached, immediately shut-off the inlet flow valve and switch off the external filling pump.

Task 3: Perform a visual check of the entire cooling circuit for leaks.

17.9 Check pressure of expansion tank

Once every 5 years / When exchanging the cooling liquid / When error "pressure low" is apparent

NOTICE

The cooling system must be empty in order to perform a pressure check of the expansion tank (*see section 17.9*).

➜ Check the pressure on the expansion tank every time the cooling liquid is exchanged.

⚠ WARNING

Before performing maintenance work, make sure the system is off, cooled and not pressurized, all the electric parts are not energized, and the vessel is completely empty.

Maintenance of the expansion tank is to be performed according to the manual of the manufacturer.
ZILMET: manual_expansion_tank_537L_zilmet

Perform a pressure check of the expansion, checking that the pre-charge is at 1.5 bar.

- At least once every 5 years
- whenever the coolant of the water-cooling system is exchanged
- when converter controller reports the error message “pressure low”

The cooling system must be reduced to 0 bar in order to perform a pressure check of the expansion tank. **The necessary gas pressure is 1.5 bar**. If necessary, refill gas to 1.5 bar with compressed nitrogen. Exceptionally, the expansion tank can be filled up with compressed air. At the next maintenance the gas pre-charge pressure must be corrected with nitrogen.
The filling valve is similar to a filling valve of a car tire. Check the pressure with a tire gauge. Avoid unnecessary gas losses during testing.
See instructions below on how to perform a pressure check of the expansion tank and how to refill gas if necessary.

Task 1: **Check pressure of expansion tank**
In order to check the pressure of the expansion tank, the coolant inside the cooling systems´ circuits must be drained, until the manometer of the water-cooling system indicates a pressure of **0 bar**.

Step 1 : Drain the converter´s water cooling system like explained in section 17.8.1.3 until the manometer of the cooling system indicates a system pressure of 0 bar.

Step 2 : Connect the supplied tank filler with manometer and adapter (*see figure 75*) to the filling valve connection of the expansion vessel (*see figure 74*) and check if the nominal pressure of 1.5 bar is apparent.



Figure 74: Filling valve connection on expansion tank



Figure 75: Tank filler with manometer and adapter

NOTE: If the pressure indicated by the pressure gauge is below 1.5 bar, refill the expansion tank with gas, as described in the following:

Task 2: **Refill gas of expansion tank to 1.5 bar**

Step 1 : Connect the supplied tank filler with manometer and adapter to the filling valve connection of the expansion tank.

> **⚠ WARNING**
>
> Hold the tank filler bottle in upright position during the filling process. Don´t hold the bottle horizontally or tip the bottle during the filling process, since it could lead to injuries due to bursting material.

Step 2 : Refill gas until the connected pressure gauge is indicating a pressure of 1.5 bar.

Task 3: **Refill converter cooling system with coolant**

Step 1 : Refill the converter water-cooling system with cooling liquid like described in section 17.8.2 until the manometer of the water-cooling system indicates a pressure of 3 bar.

Step 2 : Let the coolant pump run for at least 1 hour.

Step 3 : Turn off- the internal coolant pump and check if the pressure indicated by the cooling system manometer is 3 bar.

Note: If the pressure is below 3 bar, refill cooling liquid until a pressure of 3 bar is indicated by the manometer of the water-cooling system.

17.10 Pump

⚠ WARNING

Make sure that escaping cooling water does not cause injury to persons or damage to the equipment.

- The internal pump parts are maintenance-free.
- It is important to keep the motor clean in order to ensure adequate cooling of the motor.
- If the pump is installed in dusty environments, it must be cleaned and checked regularly.
- Take the enclosure class of the motor into account when cleaning.
- The motor has maintenance-free, greased-for-life bearings.
- Pump bearings and shaft seal are maintenance free.

Maintenance of the pump is to be performed according to the manual of the manufacturer

Manufacturer:	Grundfos
Type:	CM10-2 A-R-A-E-AQQE
Manufacturer article no.:	99080211

Frost Protection

NOTICE

Before start-up after a period of inactivity, the pump and the suction pipe should be completely filled with liquid.

Pumps which are not being used during periods of frost should be drained to avoid damage.
Remove the filling and drain plugs from the pump (*see illustration below).*

Do not refit the plugs until the pump is taken into operation again.

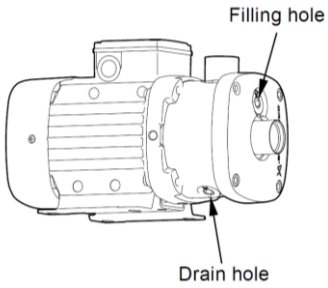


Figure 76: Position of filling hole and drain hole

17.11 Exhaust Units

Once every 6 months / fit in with existing service and maintenance plan

Periodically the extract unit must be electrically tested to ensure that the supply to the unit is continuous and that mechanically the FSD and motor open and close effectively.

It is recommended that this test be carried out twice yearly or to fit in with existing service and maintenance contracts.

The air flow failure switch should be checked for free movement and electrical conductance.

Refer to Puma technical sales leaflet for further information regarding dimensions, weights and unit performance and fan curves.

17.12 Fire Dampers

Once every 6 months / fit in with existing service and maintenance plan

The damper and motor require no service as such, but a periodic mechanical and electrical test of the working mechanisms should be carried out at least twice yearly, or to coincide with existing service and maintenance contracts.

See appropriate certified drawing of units for further information re: sizes etc.

17.13 H2 Sensors

Once every 6 months

The inspection must be carried out by trained service personnel.

The inspection intervals must be established in each individual case and shortened if necessary, depending on technical safety considerations, engineering conditions and the technical requirements of the equipment.

Contact Dräger service if you wish to take out a service contract and have any repairs carried out.

18 Container Repair

In case the container surface is damaged, repair the damaged surface as described in the following, to maintain the surface protection of the container.

18.1 Process Instructions (New Application)

Surface preparation according to DIN EN ISO 12944-4 sandblasting to surface preparation standard SA 2.5 (40 µm minimum roughness depth, medium roughness grade (G), angular blasting grit).

Primer:
REESA 2K-HS-Filling-Primer ZP
Material Nr.: 3D061
Color: ca. RAL 7035
Dry film thickness (DFT): 80 - 100 µm

Application process: spray application
Compressed air spraying, airless-spraying or electrostatic spraying according to technical data sheet.

- Processing is possible above ä minimum temperature of +8 °C. The critical dew point temperature must be exceeded by 3 °C.
- The mixing process of the 2K material must be carried out according to the enclosed technical data sheet.
- After a period of seven hours the mixed material must no longer be used and has to be disposed of, according to the legal regulations.

Topcoat:
REESA 2K-HS-PUR-OneCoat-Paint
Material Nr.: 6D062
Color: n. a.
Dry film thickness: 60 µm

Application process: spray application
Compressed air spraying, airless-spraying or electrostatic spraying according to technical data sheet.

- Furthermore, a forced drying period of 60 minutes at a temperature of +60 °C is possible. Processing is possible above ä minimum temperature of +8 °C. The critical dew point temperature must be exceeded by 3 °C. The complete reaction period of the topcoat is 7 days.
- The mixing process of the 2K material must be carried out according to the enclosed technical data sheet.
- After a period of seven hours the mixed material must no longer be used and has to be disposed of, according to the legal regulations.

18.2 Process instructions (Repair - damage down to the steel)

Surface preparation according to DIN EN ISO 12944-4 surface preparation standard PSt2:

- Removal of loose and labile coating particles.
- Removal of rust using a wire brush or sandpaper (grain size 180).
- Surface grinding of the damaged and uneven areas, as well as edge areas, using sandpaper (grain size 180) until even.
- Removal of all foreign and separating substances.

Primer:
REESA 2K-HS-Filling-Primer ZP
Material nr.: 30061
Color: ca. RAL 7035
Dry film thickness: 80 - 100 µm

Application process: spray application
Compressed air spraying, airless-spraying or electrostatic spraying according to technical data sheet.

Application process: brush application
Up to 3 coats may be required to achieve the DFT.
Intermediate drying time of the individual coats: 30 min.
Drying time between primer and topcoat: 2 hours.

- Processing is possible above ä minimum temperature of +8 °C. The critical dew point temperature must be exceeded by 3 °C.
- The mixing process of the 2K material must be carried out according to the enclosed technical data sheet.
- After a period of seven hours the mixed material must no longer be used and has to be disposed of, according to the legal regulations.

Topcoat:
REESA 2K-HS-PUR-One-Coat-Paint
Material Nr.: 60062
Color: n. a.
Dry film thickness: 60 µm

Application process: spray application
Compressed air spraying, airless-spraying or electrostatic spraying according to technical data sheet.

Application process: brush application
Up to two coats may be required to achieve the DFT.
Intermediate drying time of the individual coats: 30 min.

- Furthermore, a forced drying period of 60 minutes at a temperature of +60 °C is possible. Processing is possible above ä minimum temperature of +8 °C. The critical dew point temperature must be exceeded by 3 °C. The complete reaction period of the topcoat is 7 days.
- The mixing process of the 2K material must be carried out according to the enclosed technical data sheet.
- After a period of seven hours the mixed material must no longer be used and has to be disposed of, according to the legal regulations.

18.3 Process instructions (Repair - damage only within the topcoat)

Surface preparation according to DIN EN ISO 12944-4 surface preparation standard PSt2:

- Removal of loose and labile coating particles.
- Surface grinding of the damaged and uneven areas, as well as edge areas, using sandpaper (grain size 180) until even.
- Removal of all foreign and separating substances.

Topcoat:
REESA 2K-HS-PUR-One-Coat-Paint
Material Nr.: 60062
Color: n. a.
Dry film thickness: 60 - 80 µm

Application process: spray application
Compressed air spraying, airless-spraying or electrostatic spraying according to technical data sheet.

- Furthermore, a forced drying period of 60 minutes at a temperature of 60 °C is possible. Processing is possible above ä minimum temperature of +8 °C. The critical dew point temperature must be exceeded by 3 °C. The complete reaction period of the topcoat is 7 days.
- The mixing process of the 2K material must be carried out according to the enclosed technical data sheet.
- After a period of seven hours the mixed material must no longer be used and has to be disposed of, according to the legal regulations.

19 Settable Devices

The following table provides the manufacturer settings of the components listed in the table.

Location	Identifier	Settable Device	Setting
CIR	80Q1	AC circuit breaker 3WL I_N=1250 A / 690 V	$I_R = I_N \times 1.0$ $I_i = I_N \times 2.0$
CTRL_1	101Q1	Circuit-breaker for motor protection, 2.2 ... 3.2 A	3 A
CTRL_1	181Q1	Circuit-breaker for motor protection, 3.5 ... 5 A	5 A
CTRL_1	181Q2	Circuit-breaker for motor protection, 4.5 ... 6.3 A	4.5 A
CTRL_1	182Q1	Circuit-breaker for motor protection, 3.5 ... 5 A	5 A
CTRL_1	185B1	Thermostat -10°C … +50°C	15°C
CTRL_1	186B1	Thermostat -10°C … +50°C	5°C
CTRL_1	102G1	USV QUINT 24 V DC / 20 A	6.6 min
CTRL_1	101T1	TRIO-PS/3AC/24DC/40	26 V DC
BESS_1	101T1	TRIO-PS/3AC/24DC/40	26 V DC
BESS_1	101Q1	Circuit-breaker for motor protection, 2.2 ... 3.2 A	3 A
BESS_1	102G1	USV QUINT 24 V DC / 20 A	6.6 min
BESS_2	101T1	TRIO-PS/3AC/24DC/40	26 V DC
BESS_2	101Q1	Circuit-breaker for motor protection, 2.2 ... 3.2 A	3 A
BESS_2	102G1	USV QUINT 24 V DC / 20 A	6.6 min

Table 45: Settable devices

20 IP Addresses

The following table provides the IP-addresses set at delivery state of the listed components.

Component	IP Address
Main controller P320	192.168.5.10

Table 46: IP addresses of components

21 PLC

The following sections provide you with a description of the connection elements and the indicator lights of the PLC and gives you information regarding the handling of the unit.

For further information regarding the PLC, see device manual SIMOTION_P320-4 of the manufacturer.

21.1 Indicator Lights

The following table describes the indicator lights at the front panel of the P320 PLC.

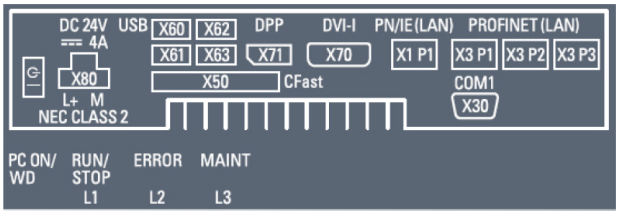


Figure 77: P320 PLC indicator lights

LED	Significance	State	Description
PC ON/ WD	Power supply	Green	BIOS ready to boot. Indicates the correct supply voltage of 3.3 V, 5 V and 12 V from the integrated power unit.
		OFF	Not relevant.
		Green/yellow flashing (1 Hz)	BIOS in POST, power switch on.
		Yellow	Idle state
RUN/STOP or L1	RUN STOP	Off	SIMOTION P Runtime is not running.
		Green	SIMOTION P320-4 in RUN.
		Yellow	SIMOTION P320-4 in STOP.
		Green/yellow: Flashes quickly (2 Hz)	DCP flashing
		Yellow: Flashes quickly (5 Hz)	FAULT state (only in combination with L2 and L3)
ERROR or L2 (SF PROFINET LED)	-	Off	SIMOTION P320-4 is working error-free.
	Error	Red: Continuous light	Bus error at the PROFINET interface.
		Red: Flashes quickly (2 Hz)	Erroneous configuration.

		Red: Flashes quickly (5 Hz)	FAULT state (only in combination with L1 and L3)
	INIT	Red: Flashes slowly (0.5 Hz)	During the INIT process, the SF PROFINET LED is con- trolled by the boot loader. The precise flashing behavior therefore cannot be determined and displayed. In the INIT state, 0.5 Hz flashing is displayed in the SI- MOTION P State. If no project has yet been loaded, 0.5 Hz flashing is also displayed for the INIT, which, in this case, is also retained in the Running state.
MAINT or L3 (SF LED)	-	Off	SIMOTION P320-4 is working error-free.
	Error	Red	An event has occurred which needs to be acknowledged (alarm, message, notification). (See Diagnostics Guide)
		Red: Flashes slowly (0.5 Hz)	License missing for licensed technology objects. Carry out the licensing to correct the error. Further information on the licensing can be found in the SIMOTION P320-4 E / SIMOTION P320-4 S Commissioning and Hardware Installation Manual.
		Red: Flashes quickly (5 Hz)	FAULT state (only in combination with L1 and L2) A fault has occurred to which the user program cannot respond. The following actions may be required to rectify the fault: ● Power OFF/ON ● Recommissioning

Table 47: P320 Indicator lights

21.2 Connection Elements

The following table describes the connection elements at the back side of the P320 PLC.

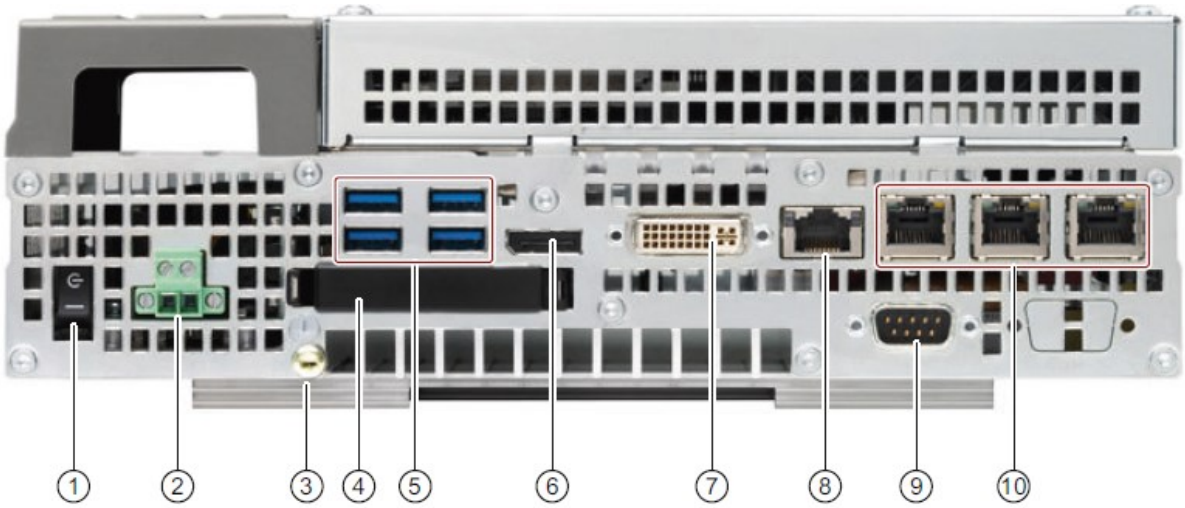


Figure 78: PLC connection elements

Pos.	Description	Description
①	On/off switch	Position OFF is the delivery state. The on/off switch does not isolate the device from the power supply.
②	24 VDC	24 VDC power supply connection
③	Protective conductor	Protective conductor terminal
④	Memory card slot	Cover for the CFast card
⑤	4 × USB 3.0	USB 3.0 high current, backward compatible with USB 2.0/1.1
⑥	Display port	Display port connection for digital monitor
⑦	DVI-I	DVI connector for CRT or LCD monitor with DVI interface
⑧	Ethernet	RJ45 Ethernet connection for 10/100/1000 Mbps
⑨	COM1	Serial interface
⑩	3 × PROFINET	PROFINET ports with three RJ45 sockets

Table 48: Table 38: PLC connection elements

21.3 PLC Connection

Follow the following steps to connect to the main PLC via PC or laptop.

Task 1: **Establish a connection to the PLC via PC or Laptop.**

Step 1 : Connect a PC or laptop via Ethernet cable to port X5 of Ethernet Switch 111A1 inside the CTRL cabinet (*see illustration below*).

Note 1: The connected PC or laptop and the converter PLC must be set to the same IP range.

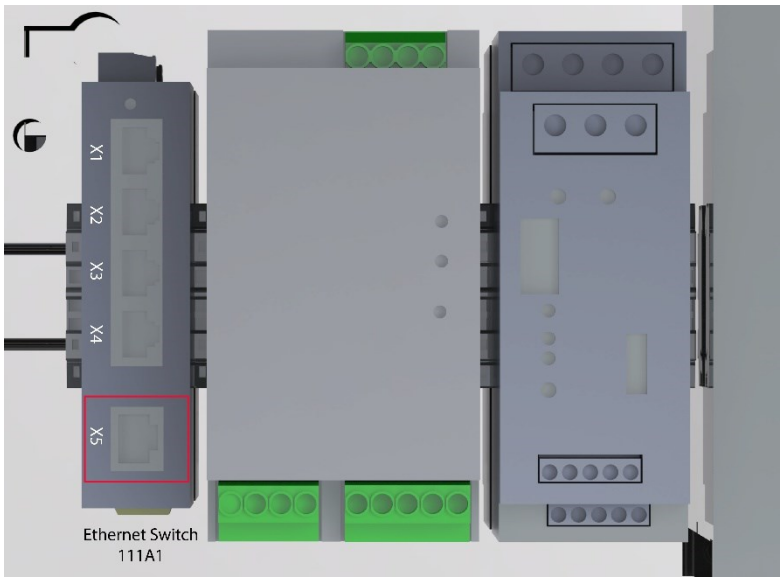


Figure 79: Ethernet Switch 111A1 - Port X5

21.4 Compiled Project Update

In case the PLC control software is not up to date at the time of commissioning, the control software must be updated.

Follow the following steps to perform a compiled project update of the main PLC.

Task 1: **Access the PLC user interface**
Step 1 : Connect to the PLC like described in section 21.3 “PLC“.
Step 2 : Open a web browser of your choice on the connected PLC or laptop
Step 3 : Type in the IP address of the PLC in the address field of your PC´s or laptop´s browser, followed by **/index.mwsl**.

Beispiel 1: 192.168.5.10/index.mwsl

The main controllers´ IP address set at delivery state is provided in Table 46.

Step 4 : The Simotion page “Home” will be displayed in the web browser of the connected PC or laptop.
✓ **The PLC user interface has been successfully accessed.**

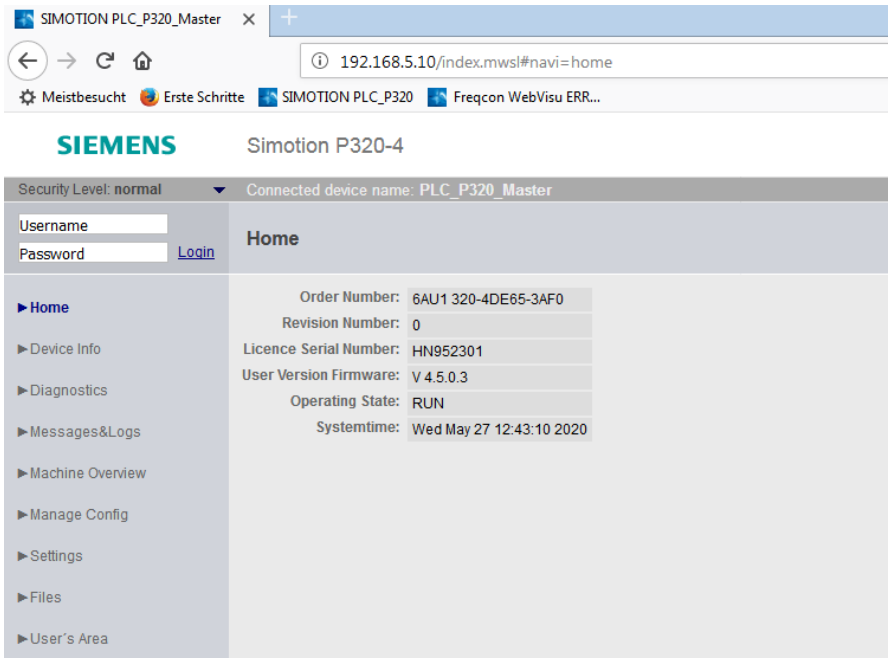


Figure 80: Connecting to the PLC user interface

Task 2: **Stop SIMOTION P320 operation.**

Step 1 : Connect to the PLC like described in section 21.3 “PLC“.

Step 2 : Select the "Settings" tab on the left-hand side of the visualization page (*see figure below,* ①).

Step 3 : In the new window, enter the following user data in the fields provided (case-sensitive):

Username: simotion

Password: simotion

Step 4 : Stop the PLC from running by clicking on the "STOP" button (②).

✓ **The PLC has been successfully stopped from operation.**

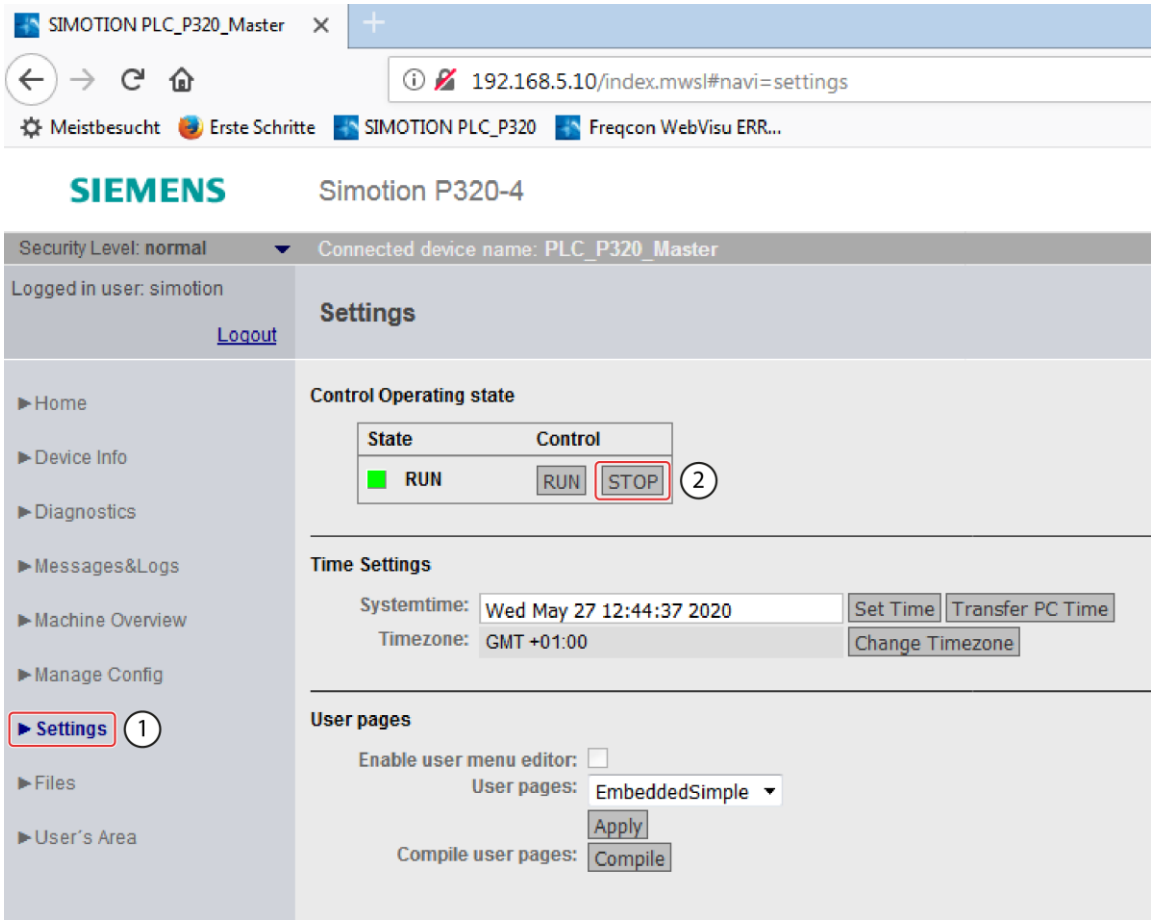


Figure 81: „Settings“ page

Task 3: **Load the compiled project ZIP archive to the SIMOTION P320 PLC**

Step 1 : Select “Manage Config” on the left site of the page (see *figure* below , ③).

Step 2 : Load the compiled project to the system by selecting the folder symbol (④).

Step 3 : Transfer the compiled project to the PLC by selecting the "Send update data" button (⑤).

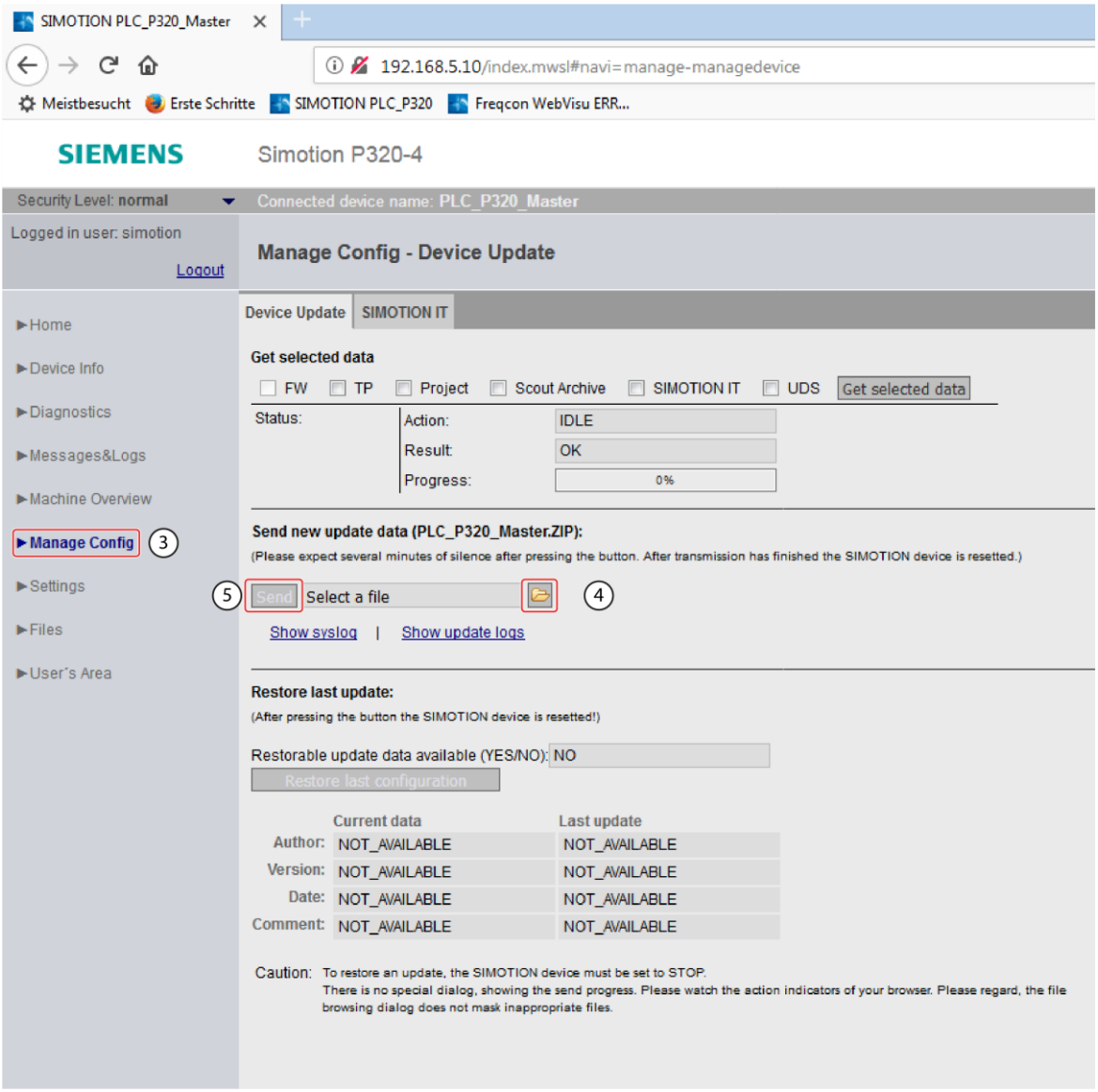


Figure 82: "Manage Config" page

Step 4 : Wait until the confirmation screen appears. The PLC reboots.

Step 5 : Wait for 5-7 minutes until the PLC has completed the reboot process.

Step 6 : Select the "Settings" tab.

Step 7 : Start the PLC by selecting the "RUN" button.

✓ **The PLC software has been successfully updated.**

22 WebVisu

FREQCON Web Visualization (WebVisu) provides granular control, real-time monitoring and visualization of key BESS functions. The WebVisu can be accessed either via the HMI touch panel on the control cabinet of the BESS or via a remote connection using a PC or laptop *(see section 22.1 "WebVisu remote connection")*.

The following sections provide you with information on handling and functionality and offer information on the individual WebVisu pages:

- Overview
- Overview DC-DC
- AC-DC Converter
- DC Link
- DC-DC Converter
- Converter Control
- Cooling
- Battery Overview
- Grid Protection Settings
- Init List
- Error List
- Action List

The individual pages can be selected by using the corresponding navigation buttons on the left side of every WebVisu page.

Note:

- Fields highlighted in grey can be adjusted by entering values inside the fields. Adjusted values are accepted by pressing the "Enter" key.
- Values must be entered in the fields without a unit.
- Fields with a white background indicate actual values.
- The selection of individual WebVisu pages depends on the user rights of the currently logged in user profile.

22.1 WebVisu remote connection

To connect to the WebVisu of the BESS via remote connection, carry out the following steps:

Task 1: **Establish a remote connection to the WebVisu of BESS**

Step 1 : Establish a connection to the PLC (main controller) in the control cabinet of the BESS by connecting a PC or laptop to the RJ45 socket of the network isolator (113T1) using an Ethernet cable.

Note 1: The connected PC or laptop and the PLC must be in the same IP range.

Step 2 : Open a web browser of your choice on the connected PLC or laptop.

Step 3 : Enter the IP address of the PLC in the address field of your PC´s or laptop´s browser.

Example: http://192.168.5.30

Note 2: The IP address of the main controller set at delivery is specified in Table 46.

Step 4 : The WebVisu page "Overview" is displayed in the web browser of the connected PC or laptop.

✓ **The remote connection to the WebVisu of BESS has been successfully established.**

22.2 Navigation

22.2.1 Home Button

The WebVisu "Overview" page can be displayed by selecting the "Home" button that appears on the left side of each WebVisu page *(see figure below)*.

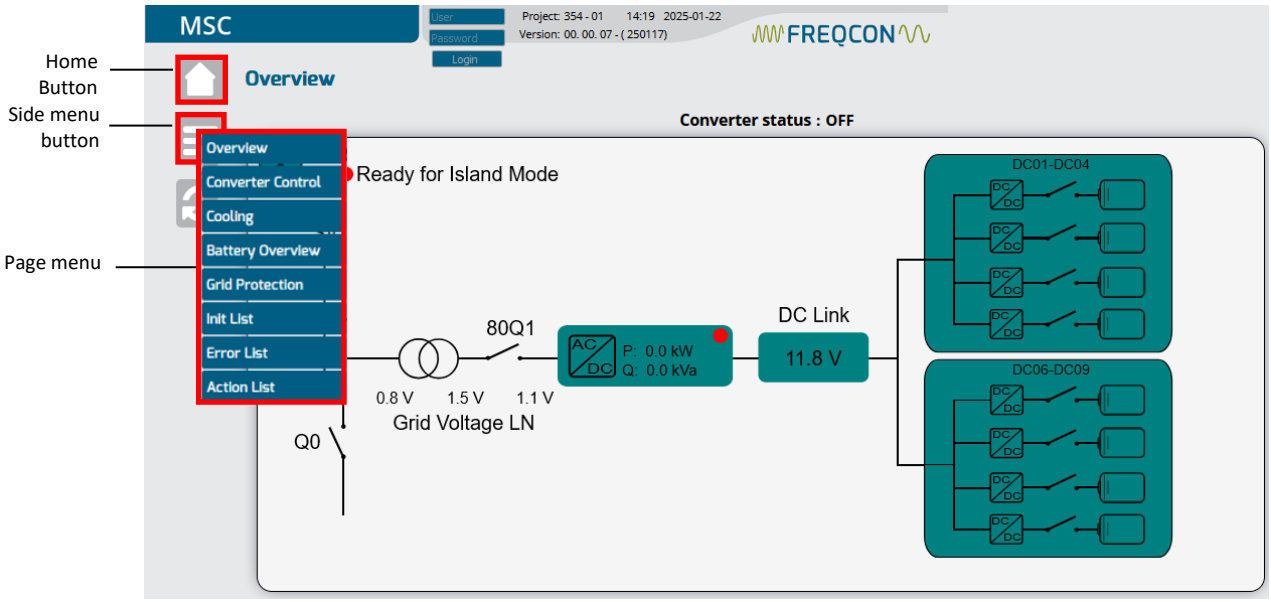


Figure 83: Navigation

22.2.2 Page Menu Button

The Page Menu is displayed via the Page Menu button that appears on every WebVisu page (*see figure 83*).

After selecting the Page Menu button, the Page Menu appears, where all WebVisu pages that can be selected with the respective user profile.

22.3 WebVisu User Interface

At the top of each WebVisu page, a user interface appears for each user (*see figure below*):

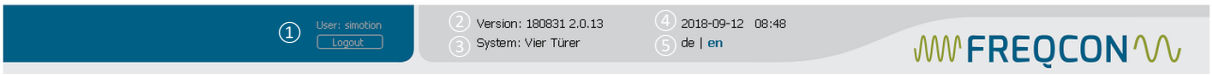


Figure 84: WebVisu user interface

The user interface provides the following information:

	Notification/Function	Description
①	User login	Type in the user profile name and password here. Press "Enter" to log in with a user profile. If a user profile is logged in, the current user profile is displayed here.
②	Version	Software version currently installed in the main control of the BESS
③	System	BESS-Identification number
④	Time/Date	Current time and date
⑤	Language selection	Choice between German and English display language

22.4 WebVisu Pages

22.4.1 Overview

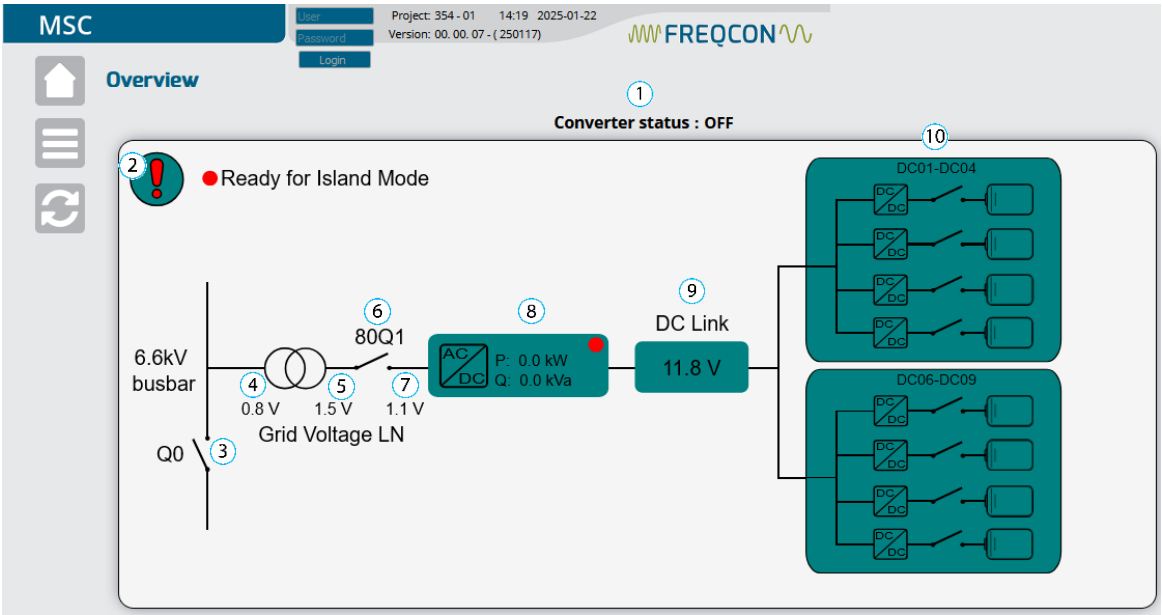


Figure 85: WebVisu page "Overview"

The "Overview" WebVisu page (*see figure above*) provides the user with a graphical overview of the main components of the BESS system and displays the following actual values:

	Description	Value
1	Converter status; for more detailed description see page “Converter control”	--
2	Green: no errors, red: errors; Clicking on the symbol takes you to the page "Error list"	--
3	MV Switch status	Open / closed
4	Voltage at the high-voltage side of the MV transformer	V
5	Voltage at the low-voltage side of the MV transformer	V
6	AC Circuit breaker 80Q1 (Switching state)	Open / closed
7	Voltage at the AC output of the converter	V
8	AC/DC Converter: active power and reactive power; Red: off, green: operation; Clicking on the symbol takes you to the page "AC-DC converter"	kW / kVA
9	DC Link voltage; Clicking on the symbol takes you to the page “DC Link”	V
10	DC/DC Converter; Clicking on the symbol takes you to the page "Overview DC-DC" of the DC Subsystems DC01-DC04 respectively DC06-DC09	--

22.4.2 Overview DC-DC

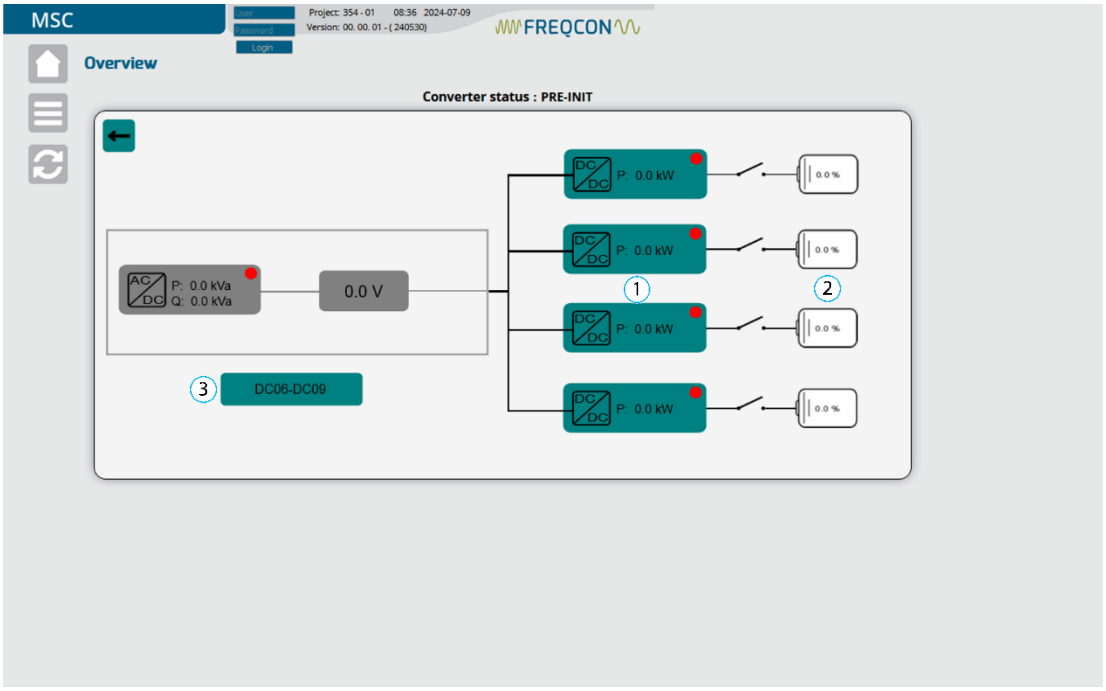


Figure 86: WebVisu page "Overview DC-DC"

The "Overview DC-DC" WebVisu page (*see figure above*) provides the user with a graphical overview of the main components of the BESS system and displays the following actual values:

	Description	Value
1	DC/DC Converter: active power (positive value: battery is charging, negative value: battery is discharging) Red: off; green: operation; Clicking on the symbol takes you to the page "DC-DC Converter" of the respective battery string	kW
2	State of charge	%
3	Switch to the page “Overview DC-DC” of the other DC Subsystem	--

22.4.3 AC-DC Converter

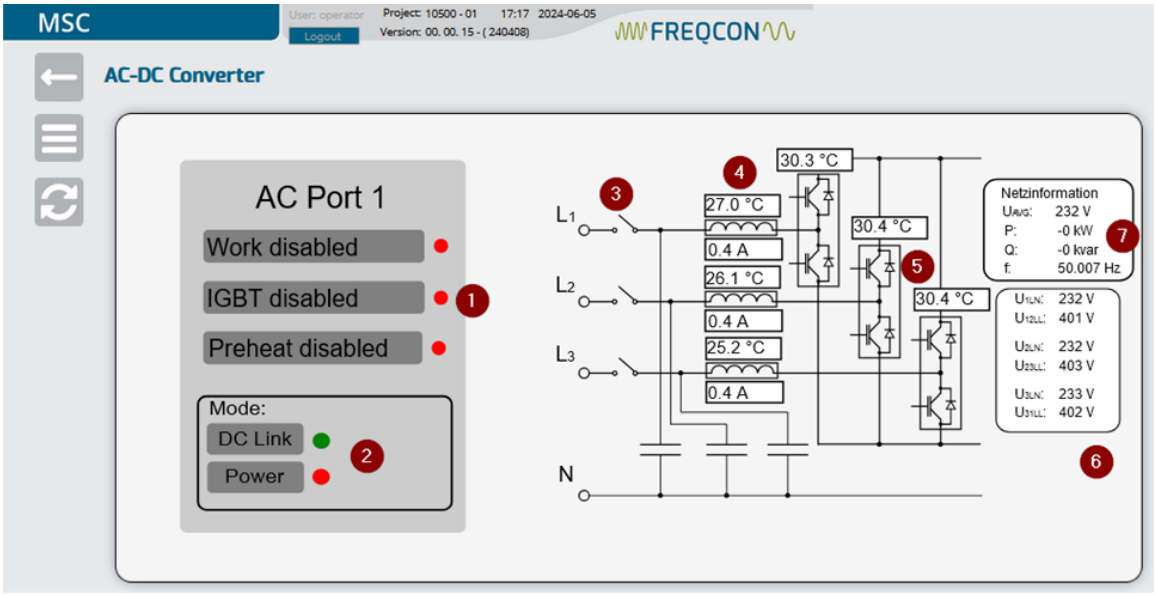


Figure 87: WebVisu page “AC-DC Converter"

	Description	Value
1	Working mode, not changeable	--
2	Control mode, not changeable	--
3	AC Circuit breaker	Open / closed
4	Inductor temperatures and phase currents through the IGBT and inductors	°C / A
5	IGBT temperatures	°C
6	String voltages and phase voltages at grid connection point	V
7	Grid information: Average voltage, active power, reactive power, grid frequency	V / kW / kvar / Hz

22.4.4 DC Link

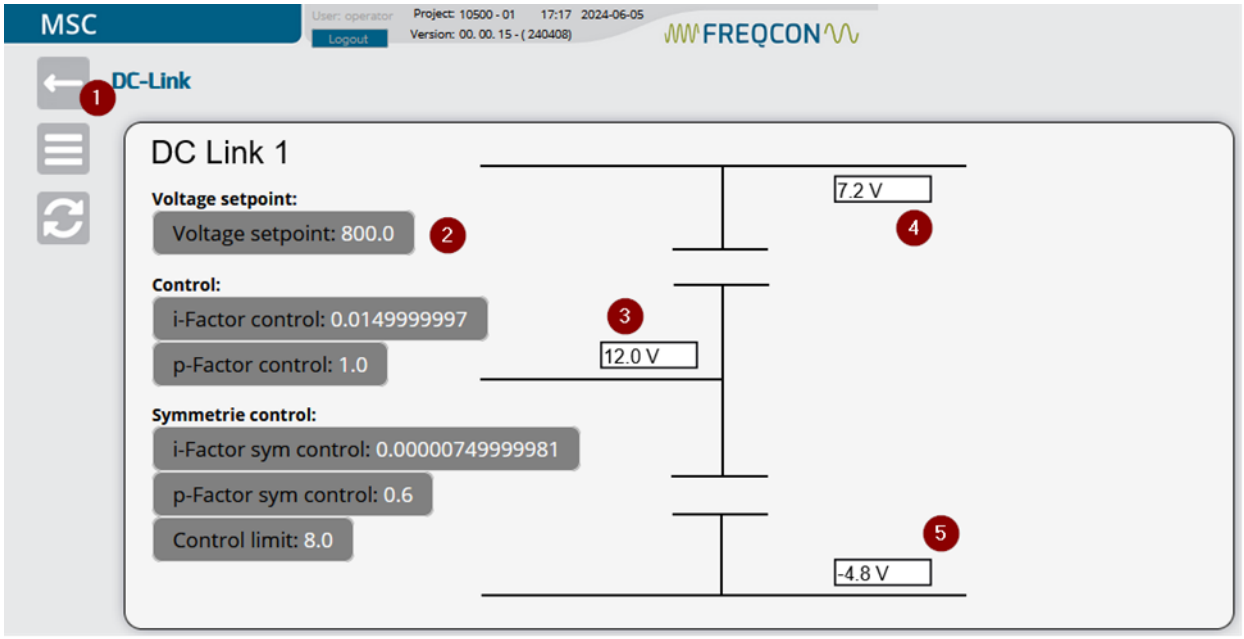


Figure 88: WebVisu page “DC Link"

	Description	Value
1	Back to “Overview”	--
2	DC link voltage setpoint, fixed value	V
3	Total DC link voltage	V
4	Positive DC link voltage	V
5	Negative DC link voltage	V

22.4.5 DC-DC Converter

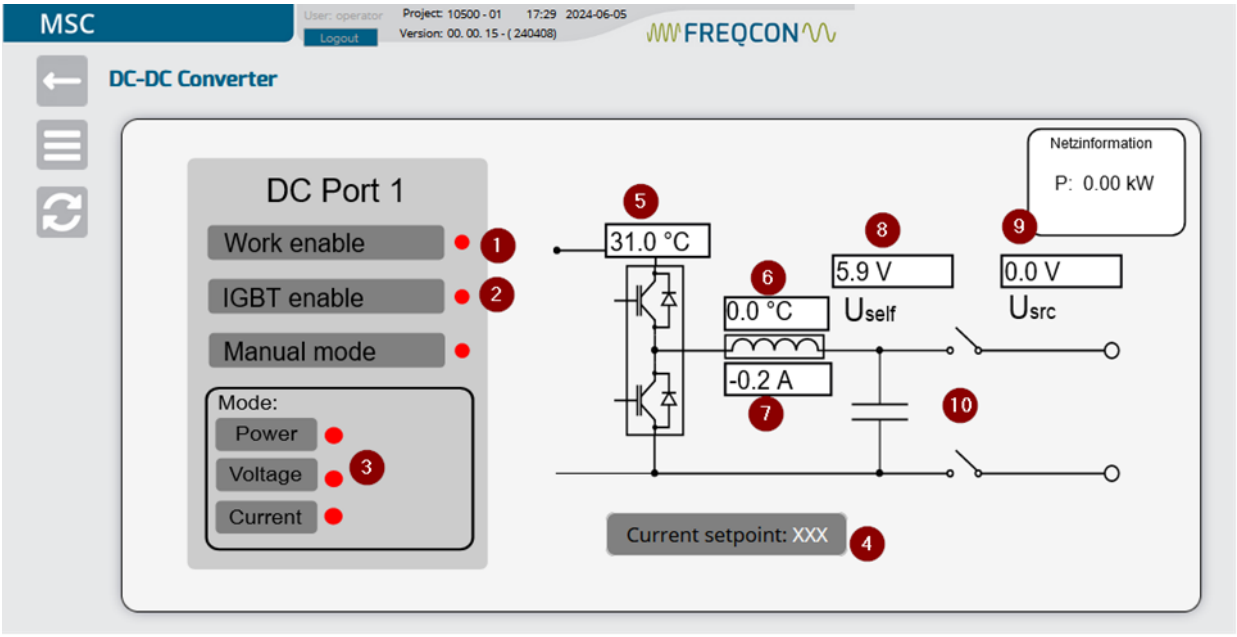


Figure 89: WebVisu page “DC-DC Converter"

	Description	Value
1	Status, not manually changeable	--
2	IGBT enabled	--
3	Control mode, not manually changeable	--
4	Manual setpoint, not available here	--
5	IGBT temperature	°C
6	Inductor temperature	°C
7	Current, filtered	A
8	Voltage at the filter capacitor	V
9	Voltage at the source	V
10	DC contactor (positive and negative)	Open / closed

22.4.6 Converter Control

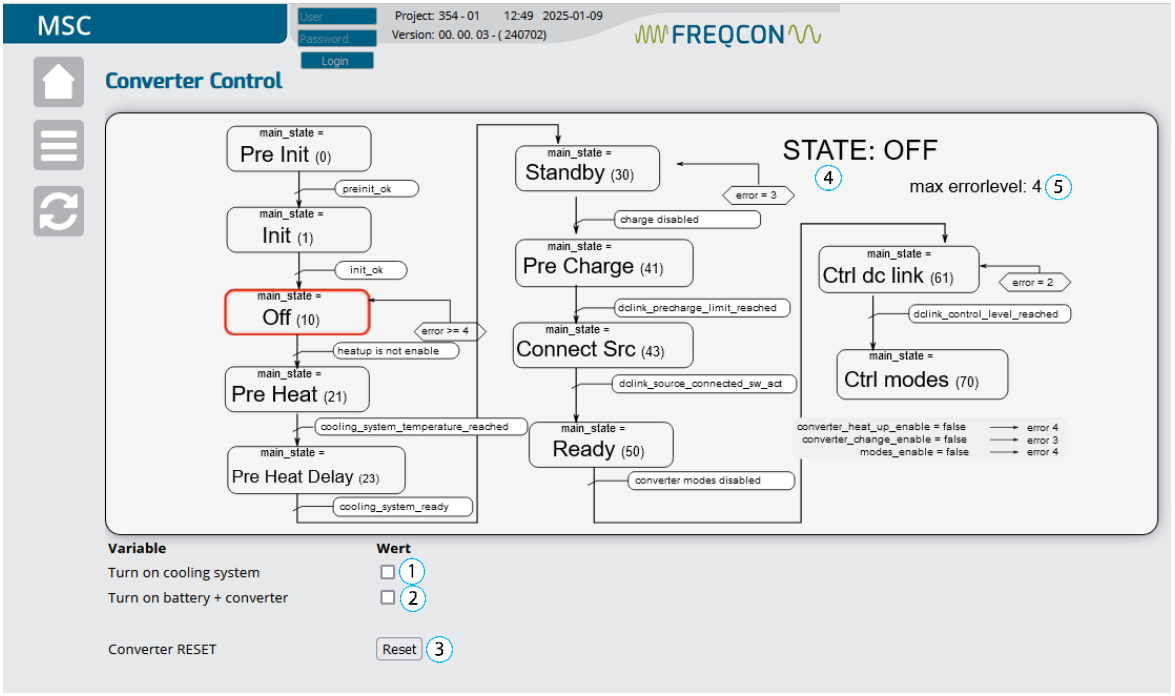


Figure 90: WebVisu page "Converter Control"

	Description	Value
1	Switch on cooling system, converter starts up to standby	--
2	Switch on converter and connect battery system	--
3	Reset converter error	--
4	The converter follows a step chain when it is switched on: Preinit: After switching on the PLC Init: Loading the initialization parameters from the memory card OFF: Converter is off Preheat: Coolant is heated to minimum temperature Preheat Delay: Temperature is held for a few minutes to reduce humidity caused by condensation on the components Standby: Cooling system is ready for use PreCharge: Charging of the DC link via resistors Connect Source: Switching on the mains switch S1 Ready: DC link is pre-charged and converter is connected to the mains, but IGBT is still off Ctrl DC Link: Switch on IGBT and regulate DC link voltage to nominal value Ctrl Modes: Normal operation	--
5	Error level 0 ... 1: Messages, warnings Error level 2: Shutdown of subsystems, e.g. a DC port Error level 3: Shutdown to standby, e.g. in the event of current or voltage overshoots, overtemperatures, etc.	--

22.4.7 Cooling

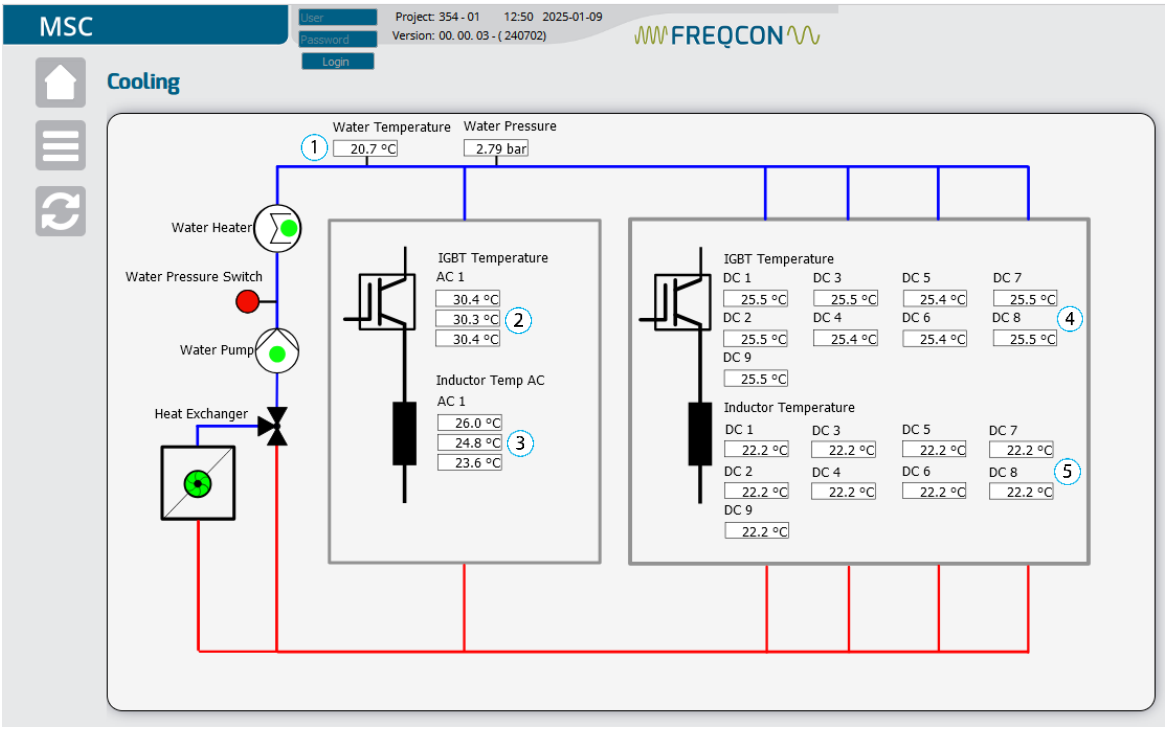


Figure 91: WebVisu page "Cooling"

The "Cooling" WebVisu pages provide the user with a graphical overview of the main components of the BESS cooling system:

- Cooling water heating element (water heater)
- Pressure switch
- Cooling water pump (water pump)
- Heat exchanger

The following actual values are displayed on the "Cooling" WebVisu page:

	Description	Value
1	Cooling water temperature inside the cooling system	°C
2	Temperatures of the AC IGBTs 1/2/3	°C
3	Temperatures of AC inductors 1/2/3	°C
4	IGBT temperatures of DC ports 1 - 8	°C
5	Inductor temperatures of DC ports 1 - 8	°C

22.4.8 Battery Overview

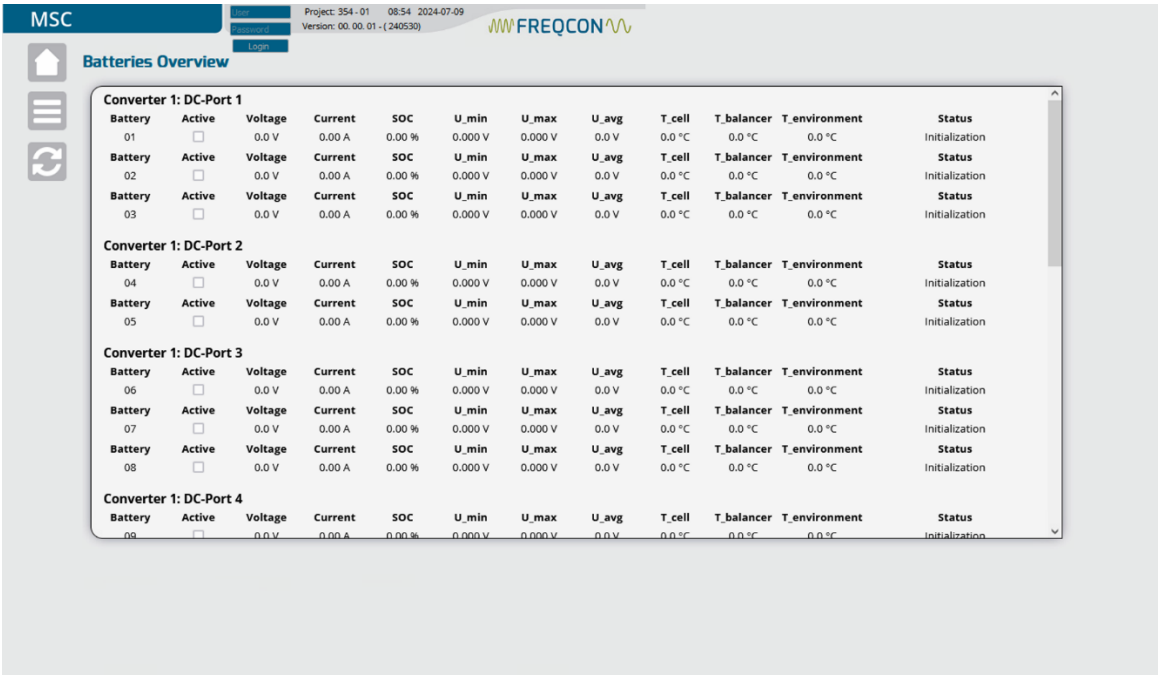


Figure 92: WebVisu page “Battery Overview"

The data is transmitted by the BMS as soon as the respective battery string is connected. If the string is disconnected from the converter system, the value "0" is displayed for current, voltage and SOC.

22.4.9 Grid Protection Settings

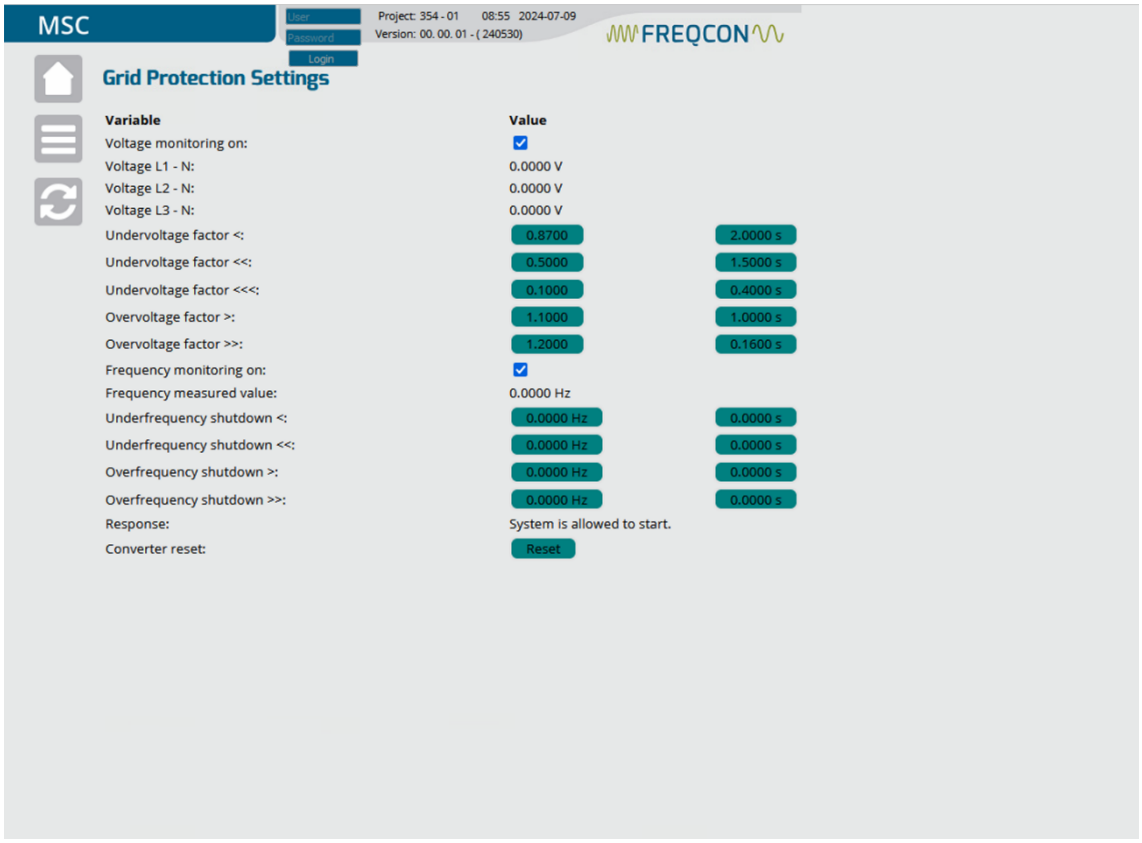


Figure 93: WebVisu page "Grid Protection Settings"

Changing the settings requires a logged in user "operator".

22.4.10 Init List

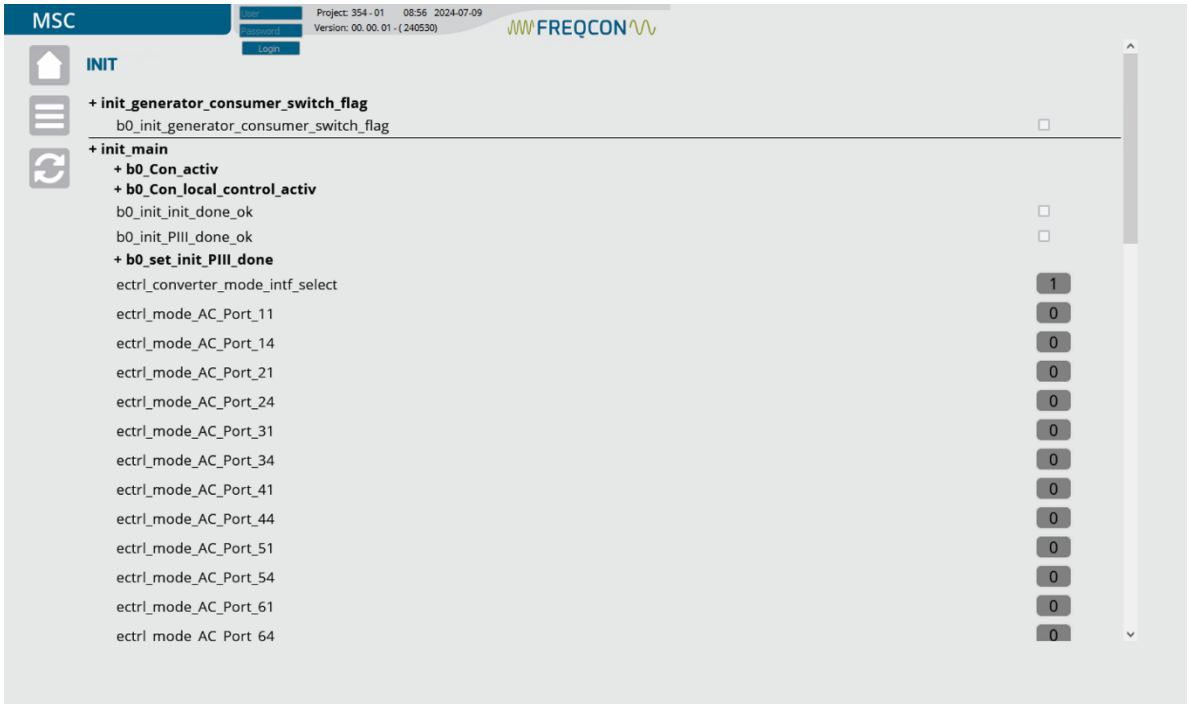


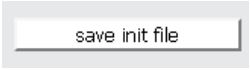
Figure 94: WebVisu page "Init List"

The WebVisu page "Init List" provides the user with an overview of all initialization values (Init values) stored in the BESS main controller.

The "Operator" user profile, as well as users who are not logged in with a profile, can only **check** the set Init values.
Only the **"Service"** and **"Factory"** user profiles can **adjust init values by** changing the value of the corresponding variable in the value field.

- ➜ To expand the parameter overview, click on the "+" sign in front of the corresponding init value.
- ➜ Fixed Init values are displayed on the right side of the corresponding Init parameter.
- ➜ To change the value, change the value inside the box and press „Enter“ on the keyboard of your PC or Laptop.
- ➜ The new value is set, but will be reset after a reboot of the controller.

Note:
To **permanently** adjust the init value, press "Enter" on your PC or laptop keyboard and then select the "Save init file" button at the bottom of the "Init" page. The selected value now remains saved even if the controller is restarted



22.4.11 Error List

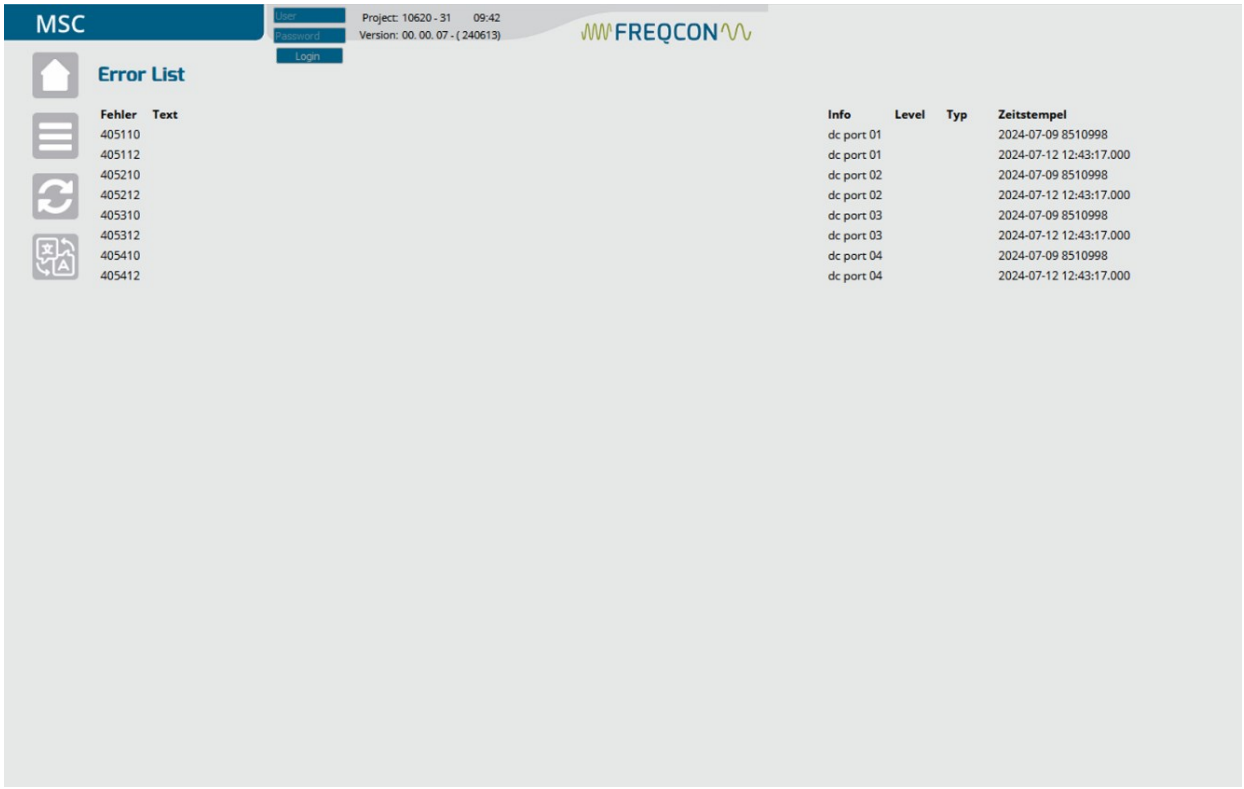


Figure 95: WebVisu page "Error list"

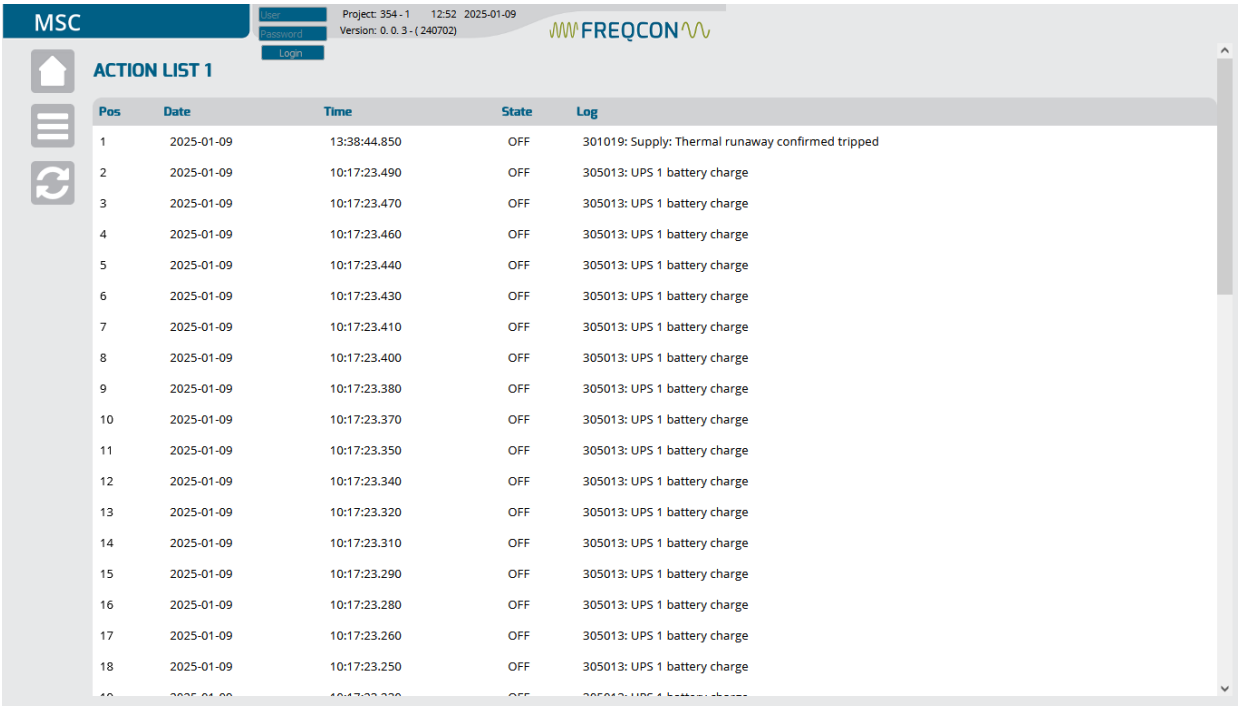
The WebVisu "Error List" page provides the user with a list of current system messages, warnings and errors.

The Error List shows only **current** system messages, warnings and errors. After a reset of a warning or error, these warning and error messages will not be any more displayed in the error list, if the warning or error is not anymore apparent.

The following information are provided inside the error list.

Name	Description
Error	Code of the individual message, warning or error.
Text	Description text for the individual message, warning or error.
Info	Additional information regarding the individual message, warning or error.
Level	Level of message, warning or error. **Note:** Level 1 to 4 are error levels and lead to a stop of the BESS system. For additional information regarding individual error messages, *see section 7.1* "Error Levels": Levels 0 and below are reporting and warning levels and do not cause the BESS system to stop.
Type	Indicates the message type of the individual message. Possible message types are: message, warning or error.
Time stamp	Indicates the time, at when the message, warning or error was detected by the controller.

22.4.12 Action List



Pos	Date	Time	State	Log
1	2025-01-09	13:38:44.850	OFF	301019: Supply: Thermal runaway confirmed tripped
2	2025-01-09	10:17:23.490	OFF	305013: UPS 1 battery charge
3	2025-01-09	10:17:23.470	OFF	305013: UPS 1 battery charge
4	2025-01-09	10:17:23.460	OFF	305013: UPS 1 battery charge
5	2025-01-09	10:17:23.440	OFF	305013: UPS 1 battery charge
6	2025-01-09	10:17:23.430	OFF	305013: UPS 1 battery charge
7	2025-01-09	10:17:23.410	OFF	305013: UPS 1 battery charge
8	2025-01-09	10:17:23.400	OFF	305013: UPS 1 battery charge
9	2025-01-09	10:17:23.380	OFF	305013: UPS 1 battery charge
10	2025-01-09	10:17:23.370	OFF	305013: UPS 1 battery charge
11	2025-01-09	10:17:23.350	OFF	305013: UPS 1 battery charge
12	2025-01-09	10:17:23.340	OFF	305013: UPS 1 battery charge
13	2025-01-09	10:17:23.320	OFF	305013: UPS 1 battery charge
14	2025-01-09	10:17:23.310	OFF	305013: UPS 1 battery charge
15	2025-01-09	10:17:23.290	OFF	305013: UPS 1 battery charge
16	2025-01-09	10:17:23.280	OFF	305013: UPS 1 battery charge
17	2025-01-09	10:17:23.260	OFF	305013: UPS 1 battery charge
18	2025-01-09	10:17:23.250	OFF	305013: UPS 1 battery charge

Figure 96: WebVisu page "Action list"

The WebVisu page "Action list" provides the user with an overview of the system events stored by the BESS controller.

The event list records the most important events and information of the BESS system, such as

- Plant operation
- Error messages
- Event messages
- Status messages

23 Troubleshooting

⚠ DANGER	
	**Electric shock due to low voltage** Severe irreparable damage to the nervous system, severe burns and death. ➜ In the event of faults, contact customer support. ➜ Have work on the energy storage device performed by service personnel only.

24 Dismantling and Disposal

24.1 Safety

For all work on the BESS observe the „Safety Instructions“ in section 2.

24.2 Dismantling

The end user is responsible for dismantling the energy storage device.

24.3 Disposal of Packaging Material

The proper disposal of packing materials is subject to national regulations and laws. If there are any doubts regarding the proper disposal of the packaging materials, ask a local disposal specialist or consult the local authorities.

The packaging my consist of the following materials:

- wooden frames
- pallets
- polyethylene foil
- plywood
- plastics
- silica gel

24.4 BESS Disposal

Always adhere the national regulations and laws regarding disposal or recycling.

⚠ WARNING	
	**Danger to life due to improper dismantling** In the case of improper dismantling, materials can slip, tip or shift, which can result in death, severe personal injury or material damage. ➜ Only qualified personal is allowed to dismantle and dispose, wearing suitable protective clothing. ➜ Before starting to dismantle, deenergize and ground the device. ➜ Also refer to section 10.1 "Unpacking" and section 10.2 “Transport”.

⚠ WARNING	
	Do not dispose the refrigerant of the external cooling unit in the atmosphere. It should be disposed of by companies dealing with special waste collection and recovery.

The batteries installed in the FREQCON BESS Container are subject to EU Directive 2006/66/EC on batteries and accumulators as well as spent batteries and accumulators.
They must be disposed of separately.
For this purpose, the batteries categorized as industrial batteries are not to be returned to the common take-back system but directly to the manufacturer FREQCON GmbH or a third-party company, qualified for this service.

Please note that the existing regulations for the transport of hazardous materials must be observed. The transport is the responsibility of the end user.

The end user is responsible for the following when disposing of batteries:

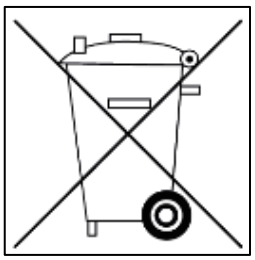
- Packaging
- Labeling
- Return transport to the manufacturer

After transport, the battery storage system must be disposed according to local regulations.
The energy storage device also contains electrical and electronic components that must be disposed of separately from other waste in accordance with local regulations and laws.

Pay particular care for the disposal or recycling of the following components:

- Batteries
- Circuit boards
- Electrical components
- Refrigerants

NOTE:
The transport of the battery modules installed inside the battery storage system underly strict regulations (UN 3480) and are only allowed to be transported by companies, qualified for this purpose.



The energy storage device also contains electrical and electronic components that must be disposed of separately from other waste in accordance with local regulations and laws.