commeo
energy storage solutions

Commeo HV-C System

Lithium-ion battery system

Operating instructions

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1 About these operating instructions

This document describes the installation, commissioning, use, maintenance and disposal of the high-voltage battery system (HV battery system) as a purely industrial or commercial battery system.

These operating instructions contain all the information required for safe and effective installation and use of the HV battery system in industrial or commercial applications.

➤ Read these instructions carefully before installing, commissioning or servicing the battery system.

➤ Keep these operating instructions close to the battery system so that the required information can be obtained quickly if necessary.

1.1 Intended audience

These operating instructions are intended exclusively for trained personnel and electricians who install, commission or maintain HV battery systems from Commeo and have the relevant specialist knowledge.

1.1.1 Trained personnel

Trained personnel must have the following qualifications:

- Training in dealing with hazards and risks when using Commeo energy storage blocks
- Knowledge of handling and sources of danger during transport, storage and disposal of lithium-ion batteries
- Knowledge of and compliance with this document and the documentation related to the product, including all safety instructions

1.1.2 Qualified electricians

Qualified electricians must have the following qualifications in addition to the qualifications for trained personnel:

- Training for the installation and commissioning of electrical equipment
- Knowledge of and compliance with applicable technical connection conditions, standards and directives
- Additional qualification “Live working”

1.2 Other applicable documents

- Safety information from Commeo
- Commeo data sheets with the operation windows of the energy storage blocks
- Data sheets with technical data on the specific battery system
- Data sheet from Commeo for the specific control unit ccuHV
- Interface description "ccuHV Interface Description" from Commeo
- Specific circuit diagrams from Commeo for the wiring of the energy storage rack
- Any special instructions for the maintenance and disposal of lithium-ion batteries that may exist in your company

1.3 Glossary

Term	Explanation
Balancing	Automatic balancing of the states of charge of all energy storage blocks within an energy storage rack
Operation window	Operating conditions under which the device may be used (see Section "Other applicable documents" on page 6)
BMS	Battery Management System
ccuHV	Commeo control unit for HV battery systems
Derating	Reduction of the maximum charge/discharge rate depending on temperature and state of charge of the energy storage blocks in accordance with the operating window limits
esbC	Energy storage block
Interlock	Interlocking against restarting, activated after safety-related disconnection
SELV	Safety Extra Low Voltage
SoC	State of Charge
SoH	State of Health
SoP	State of Power

2 Explanation of symbols

2.1 Symbols in the instructions

The device described in this manual contains residual dangers that cannot be prevented by design. Warnings in this manual and on the device indicate these residual dangers and describe how dangerous situations can be avoided.

DANGER!
Safety notice: Non-compliance leads to death or serious injury.

WARNING!
Safety notice: Non-compliance may result in death or serious injury.

CAUTION!
Safety notice: Non-compliance can lead to injury.

NOTICE!
Note: Non-compliance can lead to material damage and impair the function of the device.

NOTE
Supplementary information on use

2.2 Symbols on the battery system

The energy storage blocks may catch fire due to incorrect handling. Observe all instructions for the correct handling of the energy storage blocks.

The battery system is dangerous. Only qualified and authorised personnel are responsible for handling of the battery system.

The battery system is energised as soon as energy storage blocks are inserted. Do not touch live parts.

The energy storage blocks may experience "thermal runaway" due to mechanical damage, thermal load, short circuit, overcharging or commissioning after deep discharge. Observe all instructions for correct handling.

Read the technical documentation of the battery system and observe all instructions.

Protect all components of the battery system against open fire and sparks.

3 Safety

The manufacturer accepts no liability for damage in the following cases:

- Use of the battery system outside the operation window defined by the manufacturer
- Damage to the product due to mechanical influences
- Changes to the product without the express permission of the manufacturer
- Use for purposes other than those described in the instructions
- Disregard of the installation conditions
- Installation, commissioning, maintenance or repair of the system by untrained or unqualified personnel

3.1 General safety instructions

DANGER!

Danger to life due to electric current

➤ Never reach into the energy storage rack when the energy storage blocks are plugged in.

Explosion hazard

- **Risk of injury from bursting components if permissible temperature limits are exceeded**

WARNING!

➤ Observe the safety instructions in this document.

➤ The battery system may only be used/installed by personnel who can demonstrate that they have undergone suitable technical training and are familiar with the operating mode and basic principles of the battery system.

➤ Persons who do not belong to the operating personnel may only be in the hazardous area of the battery system under supervision, unless they have been adequately informed in advance about the possible hazards of the battery system.

➤ Only use the energy storage block for the specified purpose and within the limits of the operation window.

➤ The housing of the energy storage blocks must not be loaded with more than 5 kg.

➤ Prevent points of the housing and the cover from being loaded during assembly or operation.

CAUTION!

➤ Do not make any changes or modifications to the battery system.

3.2 Safety when installing or removing the system

WARNING!

➤ The device may only be installed and removed by qualified and authorised personnel from suitable specialist companies certified by Commeo.

➤ The battery system must **not** be stored or installed outdoors.

➤ Protect the battery system from rain and moisture.

➤ Wear safety clothing (safety shoes, protective gloves) when installing or removing the energy storage blocks. Follow the installation, maintenance and dismantling instructions.

➤ All cables must be guided out of the energy storage rack by a qualified specialist. Contact Commeo Service for further information.

3.3 Safety when operating the system

WARNING!

➤ The battery system may only be operated by personnel who have demonstrably received sufficient technical training and who are familiar with the mode of operation and basic principles of the battery system.

➤ Do not operate the battery system in a potentially explosive environment (for example, a welding booth).

➤ The device may only be maintained and repaired by qualified and authorised personnel from suitable specialist companies certified by Commeo.

CAUTION!

➤ Only start up the battery system if the system and all connecting lines are undamaged.

➤ Lay the cables in such a way that they do not present a tripping hazard for other persons.

➤ Always use the ccu48V control unit to control the battery system. Do not leave the system unattended while it is switched on.

NOTICE!

➤ Do not use the system in damp conditions.

➤ Do not operate the system outdoors.

➤ Do not operate the system near heat sources (for example, heaters, open flame) or in direct sunlight.

3.4 Safety when handling lithium-ion storage units

DANGER!

Cells inside the lithium-ion storage unit can experience thermal runaway. If a cell experiences thermal runaway, temperatures > 800 °C are generated on the surface. Conductive salts contained in the batteries decompose when exposed to heat.

Hydrofluoric acid (HF) or other toxic/corrosive gases that are contained in the white-grey mist or in the flame gases are frequently formed. It may cause chain reactions and runaway of adjacent cells.

➤ In the event of a pungent or foul-smelling odour or visible outgassing of the lithium-ion storage unit, leave the danger zone immediately.

➤ Avoid the following loads on the lithium-ion storage unit:
- Thermal load (starting at approx. 130 °C)
- Electrical overload (short circuit, overcharging of batteries, start-up after deep discharge)
- Mechanical load (for example, traffic accidents)

➤ **Do not** put the lithium-ion storage unit back into operation if it
- was deeply discharged,
- has been short-circuited,
- is mechanically damaged,
- is otherwise identifiable as defective, or
- if the system indicates a critical error.

CAUTION!

➤ Wear personal protective equipment (safety goggles and protective gloves).

➤ Never replace energy storage blocks while the battery system is in operation.

NOTE

- For specific information on lithium-ion batteries and safety measures, as well as protecting personnel and property, including fire protection, please refer to the Commeo safety information. The Commeo safety information can be found in the Service/Downloads section on www.commeo.com.

3.5 Operational measures when using the system

3.5.1 Measures to be taken by the operator of the battery system

The battery system operating instructions must be used to instruct operator's employees on how to use the battery system.

The operator must ensure that employees are instructed in the following points at least once a year:

- Special hazards when handling the battery system
- Safety regulations when handling the battery system
- Health measures when handling battery-powered machines
- Carrying out service work on the battery system

The operator of the device must ensure that personnel who are commissioned with service and repair work are trained in handling Commeo battery systems.

Knowledge of the applicable regulations and standards can be acquired in a training course, e.g. at Commeo or another recognised training centre.

The operator must ensure that all cables are laid in such a way that they cannot be damaged when using the system.

3.6 Safety devices

3.6.1 Safety concept

The battery system is protected by a 3-layer procedure.

- If the current operating point approaches the limits of the permissible operation window of the battery system, the system first issues a warning message so that the operator can initiate appropriate countermeasures to prevent a safety-related shutdown of the battery system.
- If the permissible operation window is exceeded, the battery system triggers a safety-related shutdown of the HV relays to prevent damage to the battery cells due to improper operation. After all parameters have been brought back into the permissible operating range, the operator can acknowledge the error message and put the system back into operation. In this way, economic damage can be averted.
- If the critical system limits are exceeded, the battery system triggers an immediate shutdown of the HV relays (if not already done). The affected energy storage block permanently stores the fault condition in the error memory and is thus considered defective. As long as the energy storage block is installed in the battery system, restarting is prevented by the ccuHV control unit.

3.6.2 Safety devices

Energy storage block

- Fuse to protect the energy storage block in the event of a short circuit
- Monitoring of the cell operation window
  Each energy storage block has its own battery management system (BMS). The BMS monitors the cells of the energy storage block and communicates with the ccuHV control unit via the internal CAN bus. In the following cases, the ccuHV control unit switches off the battery system:
  – Operation outside the operation window of the energy storage block (voltage, current, temperature)
  – Failure or malfunction of the CAN communication to the energy storage block
  – Internal error in the BMS of the energy storage block

ccuHV control unit

- All-pole disconnection of the load contacts by means of HV relays (contactor contacts)
- Emergency shutdown of the HV relays from external via EPO contact
- Integrated precharging circuit (Precharge)
- Fuse to protect the battery system in the event of a short circuit
- Monitoring of the battery system
  In addition to the individual monitoring of the energy storage blocks by the BMS, the ccuHV control unit also monitors the overall group of the energy storage blocks in the battery system. In the following cases, the ccuHV control unit switches off the battery system:
  – Excessive voltage or current differences between the energy storage blocks.
  – Interruption or malfunction of communication with energy storage blocks
  – Implausible measured values of current or voltage between energy storage blocks and ccuHV control unit
  – Internal error in the ccuHV control unit

4 Intended use

The HV battery system with low voltage (< 1000 V⎓) serves as a component for energy storage systems for applications in commercial and industrial environments.

Up to 48 energy storage blocks from the following model families can be interconnected in parallel and in series in a standardised energy storage rack from the esr product family with a ccuHV control unit approved for the respective system:

- esbC15 (model version esbC15P, esbC15E and esbC15S)
- esbC11 (model version esbC11P, esbC11E and esbC11S)
- esbC112 (model version esbC112P, esbC112E and esbC112S)
- esbC141 (model version esbC141P, esbC141E and esbC141S)
- esbC152 (model version esbC152P, esbC152E and esbC152S)

The control unit of the ccuHV product series is used to monitor and configure the battery system. The control unit has standardised interfaces for connecting external operating or control elements.

The operation window of the battery system and the energy storage blocks as well as the limit values and parameters of a spatial (in particular installation conditions, Section “Installation site and conditions” on page 54), technical (voltage, current, power, energy, temperature, etc.) and temporal nature specified in the operating instructions supplied must be observed.

5 Improper use

- Operation outside the operating window of the battery system or the energy storage blocks
- Operation in a defective condition or without protective cladding or safety devices
- Operation outside of the spatial, temporal and technical limits
- Operation in end products that have not been developed and constructed in accordance with applicable guidelines
- Operation in enclosures that have no protection against excessive pressure
- Operation of the energy storage blocks outside the intended energy storage rack
- Operation of the energy storage blocks without the intended control unit
- Structural changes to the battery system, unless these are expressly permitted by Commeo (for example, wall penetrations)
- Operation with safety devices that are not in perfect working order, have short-circuited, are out of order, have been bridged, are inactive, defective or obsolete
- Unauthorised changes to the limit values (for example, temperature values, voltage values, currents)
- Unauthorised changes of any type to the software in the control unit or the firmware in the battery management system of the energy storage blocks

6 Technical description

The following chapters explain the operation of the HV battery system as a complete system, the Commeo ccuHV control unit and the individual energy storage blocks.

6.1 Functional overview

A Commeo HV battery system consists of multiple energy storage blocks (esbC), with a control unit (ccuHV) installed in an energy storage rack (esr).

The strings of the energy storage blocks are connected in series or parallel to transfer the load to the back of the energy storage rack and connected internally to the control unit via the BATTERY IN + and BATTERY IN – connections.

The energy storage blocks communicate with the control unit via a CAN bus. A ring circuit with junctions to the individual energy storage blocks is used for the communication connection.

The control unit in an HV battery system features internal relays for switching the current flow on and off. The relays are automatically switched by the control unit when required.

The maximum charge/discharge rate of an HV battery system depends on the temperature and the state of charge (SoC) of the energy storage blocks as well as other parameters (derating).

The parameters are determined by the BMS and the ccuHV control unit.

Derating

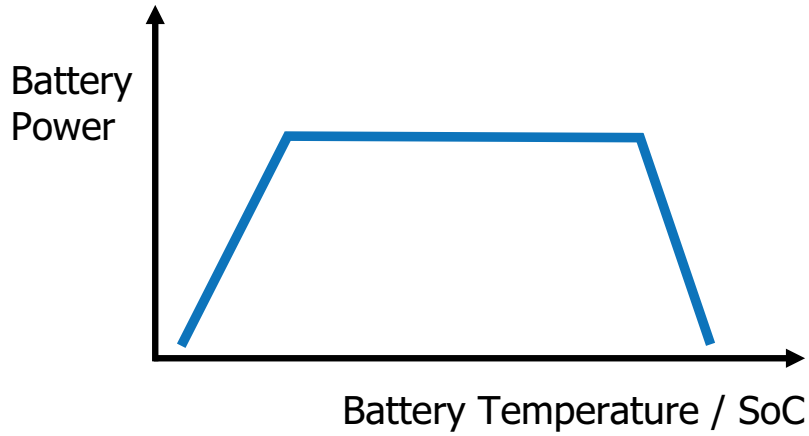


Fig. 1: Derating

The ccuHV control unit automatically controls the maximum applicable charge/discharge rate for the battery system (derating) and communicates this as a control parameter (SoP) to connected components via the data interface.

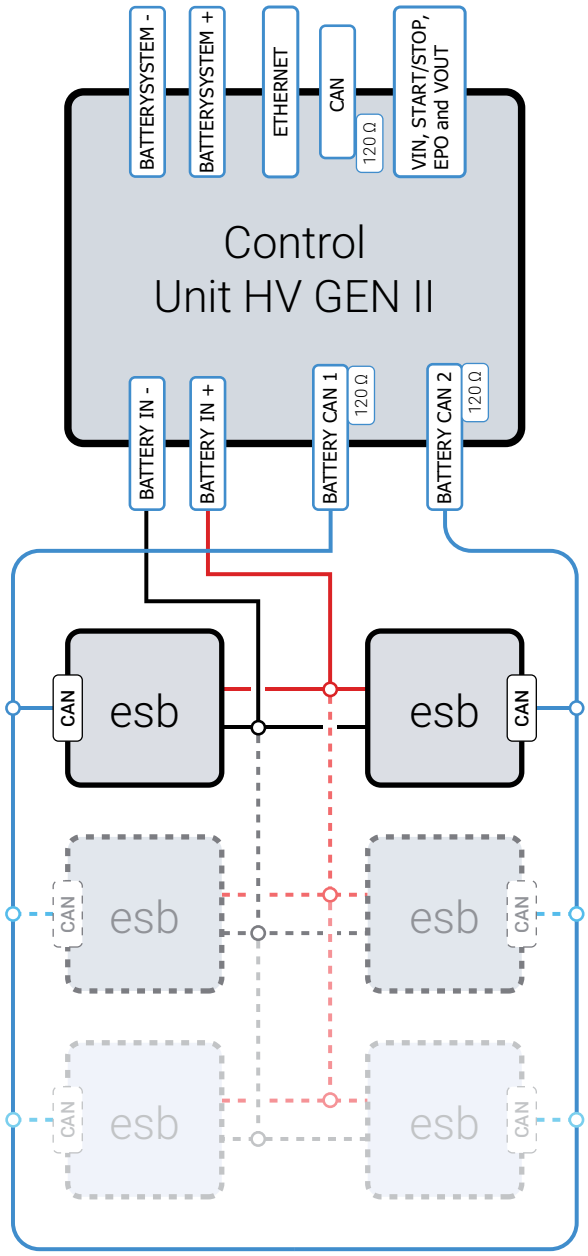


Fig. 2: Battery system wiring

NOTICE!

When the battery system is operated outside the operation window, the control unit interrupts the current flow from or to the energy storage blocks.

This safety-related shutdown can lead to a defect in the control unit.

➤ Only use the battery system within the operation window.

The control unit monitors the energy storage blocks and forms the interface of the battery system to the external periphery (loads, generators, control devices, etc.).

Among other information, the following system states are transmitted:

- Temperature

- State of Charge, SoC
- State-of-power (SoP, control parameter for the battery system)
- Error messages
- Warning messages

The ccuHV control unit is switched on when an external 24 V power supply is connected or by using the POWER ON button on the front panel.

The Ethernet interface on the control unit is the communication interface to the user interface. The HV battery system can be monitored and configured using the UserInterface.

Parallel connection of multiple HV battery systems

- Multiple HV battery systems can be interconnected in parallel to increase the total capacity.
- Each HV battery system must be configured and controlled independently.
- The HV battery systems are interconnected by connecting the external load contacts BATTERYSYSTEM + and – (see Section "Parallel connection of HV battery systems" on page 61) in parallel.

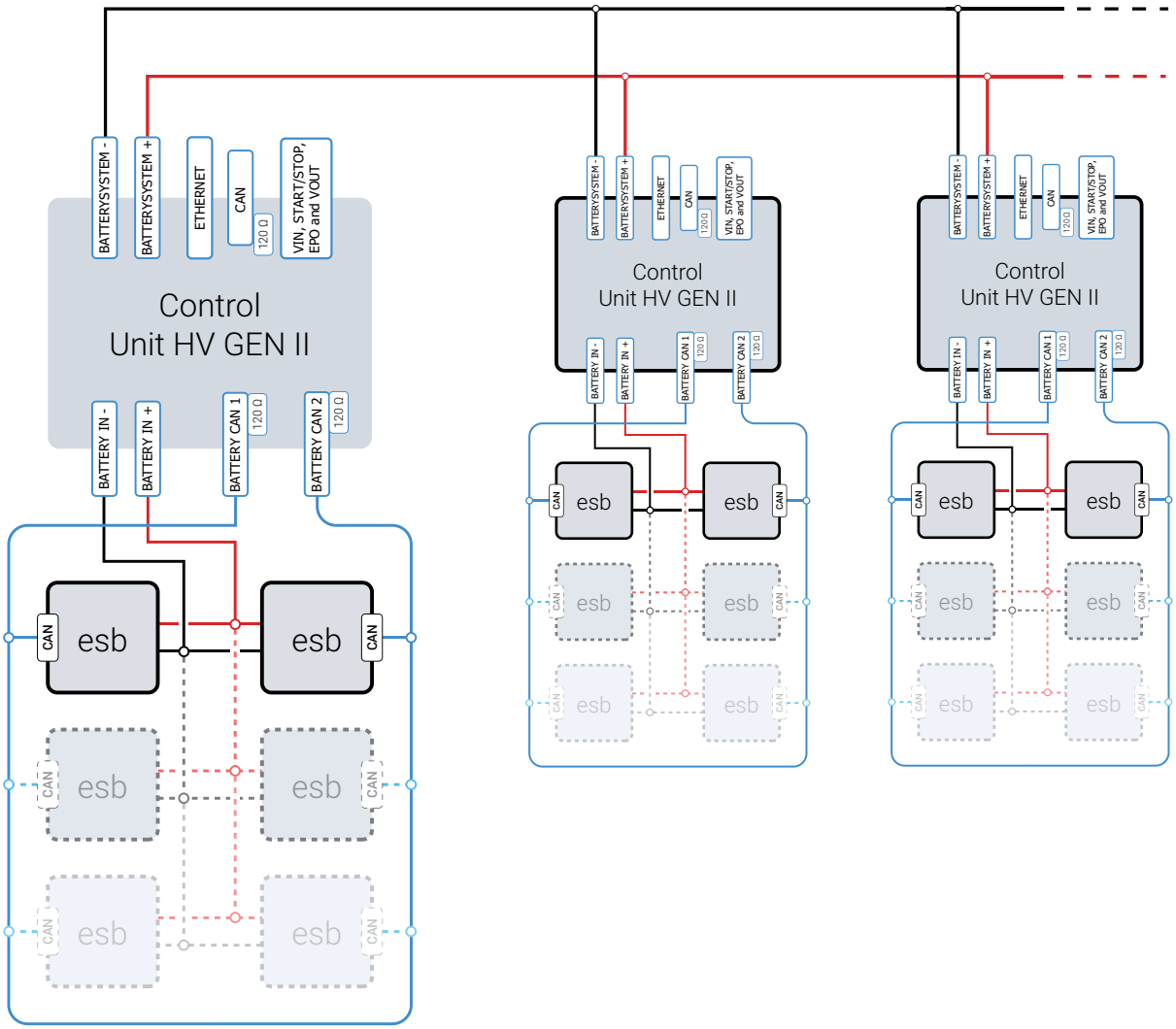


Fig. 3: Parallel connection of multiple HV battery systems

6.2 Performance features

BlackStart

The battery system powers the ccuHV control unit independent of other power sources. In addition, the battery system provides a supply voltage for external devices. In the event of a power failure, the external devices are supplied with voltage via the battery system, for example, to set up an island network.

DeepDischargeProtection

The DeepDischargeProtection function protects energy storage blocks from deep discharge, where the control unit switches the battery system off when a deep discharge is imminent. After a further 10 minutes, the control unit is switched off. The battery system must not be switched on again after it has been switched off by the DeepDischargeProtection function until the battery system is supplied with power by a charger. The battery system must be restarted manually after it has been switched off by the DeepDischargeProtection function.

AuxiliaryPower

The AuxiliaryPower function supplies power for external components even when the battery system is switched off.

For connections, see Section “VOUT” on page 30.

TrueModularity:

Due to the various interconnection configurations and the composition of the battery system from individual energy storage blocks, the battery system achieves true modularity up to 800 V.

7 ccuHV control unit

The Commeo ccuHV control unit monitors and configures an HV battery system consisting of multiple energy storage blocks. The necessary information from the energy storage blocks is collected and used to calculate the system properties for this purpose. The values collected and calculated are transferred to downstream external components via defined interfaces.

7.1 Functionality

The ccuHV control unit is switched on when an external 24 V power supply is connected or by using the POWER ON button on the front panel.

The battery system can be started as follows:

- When the START/STOP contact is closed > 1 s.
- When a switch-on command is sent to the ccuHV control unit via CAN or ETH (see "ccuHV Interface Description").

In the event of a fault, the ccuHV control unit de-energises the battery system at the BATTERYSYSTEM + and – contacts.

DANGER!
Danger to life due to electric current
The switch on the back of the energy storage racks is not disconnected from the power supply by the control unit.
➤ Do not make any changes to the battery system structure.

Faults in the battery system or in individual energy storage blocks cause the battery system to be de-energised at its load contacts with the aid of the internal HV relays and to switch to ERROR mode (see Section "Error and warning messages" on page 73).

NOTE
The system has an HV fuse. This fuse protects the user and the system in the event of an external short circuit.

NOTE
Depending on the severity of the error that has occurred, this can be reset after the cause of the error has been eliminated.
➤ See Section "Error and warning messages" on page 73.

Before each connection of the battery system, the ccuHV control unit checks whether precharging of the external DC circuit is necessary and, if so, performs a routine for precharging the external DC circuit in order to protect the HV battery system and connected external components (Precharge, see Section “Starting/stopping the battery system” on page 69).

The amount of maximum input capacity of connected external components for which the ccuHV control unit can perform a successful precharge routine depends on the HV battery system design.

Nominal voltage battery system	Maximum voltage battery system	Maximum prechargeable input capacity
850 V	1000 V	2 mF
750 V	880 V	2.5 mF
600 V	700 V	4 mF
300 V	350 V	16 mF

NOTE
After a faulty precharge operation, the system switches to ERROR mode. The cooling time can be up to 5 min. During this time, no new start attempt of the HV battery system can be made.

7.1.1 Variants

Depending on the design of the battery system, a suitable control unit must be used:

Product	Fuse
ccuHV80U	80 A
ccuHV100U	100 A
ccuHV160U	160 A
ccuHV200U	200 A

7.2 Connections and controls

7.2.1 Front

Fig. 4: Front ccuHV control unit

DANGER!
Danger to life due to electric current
The control unit must only be connected to an external 24 V power supply or enabled via the POWER ON button when the entire system is set up and the load contacts with plugs are covered so that they are safe to touch.

The following connections and operating elements can be found on the front of the control unit:

LEDs	System state
"STATUS" LED	• The LED flashes green when the control unit is started. • The LED is green when the control unit is in operation. • The LED is red when there is an error.
"HV ACTIVE" LED	• The LED flashes green when the battery system is being precharged. • The LED is green when the relays are closed. • The LED is red when the relays are open.
"EPO READY" LED	• The LED is green when the EPO contact is closed. • The LED is red when the EPO contact is open.
"COM INTERN" LED	• The LED is green when the communication between the control unit and the energy storage blocks is active and functioning without errors. • The LED is red if there is an error in the communication (CAN error or block count mismatch).
"POWER ON" LED	• The LED lights up when the control unit is in operation.

Connections/ switches	Description
VIN	• External 24 V power supply of the ccuHV control unit (optional) (Section "VIN" on page 29)

START/STOP	• Start/stop contact (Section "START/STOP" on page 29):
	  • If the contact is closed potential-free > 1 s by a relay or a switch, the ccuHV control unit switches on the battery system.
	  • If the contact is closed potential-free > 5 s by a relay or a switch, the ccuHV control unit switches off the battery system.

EPO (External Power Off)	• Emergency shutdown: Closed in normal condition. If the contact is interrupted, the relays open and the ccuHV control unit switches the battery system off (Section "EPO" on page 30).
VOUT	• 24 V auxiliary voltage for an external control unit (Section "VOUT" on page 30)

TR	• The TR switch can be used to terminate the external CAN bus. Only the first and the last station of a CAN bus must be terminated, for example, first battery system (terminated), second battery system (not terminated), monitoring system customer (terminated).
	  • **ON**: external CAN bus termination on
	  • **OFF**: external CAN bus termination off

CAN	• Communication interface for downstream external components (Section "CAN" on page 31)
ETH	• Communication interface for the user interface or downstream external components (Section "ETH" on page 32)
BATTERYSYSTEM + and –	• Load contacts for the battery system (Section "BATTERYSYSTEM + and –" on page 32)
POWER ON	• Button for switching on the control unit when the ccuHV control unit is self-sufficient (switching off not possible)

7.3 Back

The control unit has 4 connections on the back to connect it to the energy storage blocks.

Fig. 5: Rear of ccuHV control unit

Connections	Explanation
BATTERY – BATTERY +	• Load inputs from the energy storage blocks to the control unit
Battery CAN 1	• Communication cable output from the control unit to the energy storage blocks
Battery CAN 2	• Communication cable output from the control unit to the energy storage blocks

WARNING!
Danger to life due to electric current

➤ Never remove the BATTERY connectors when the energy storage blocks are connected.

7.4 Data interface

NOTE
The protocol is described in detail in the CAN bus definition "ccuHV Interface Description" from Commeo.

The ccuHV control unit supplies battery system operating data for controlling the connected charging equipment.

Category	Example
System state	• Average temperature • State of Charge, SoC • State of Power, SoP • State of Health, SoH
Warning messages	• Overcurrent • Overvoltage • Undervoltage • Excess temperature • Insufficient temperature • 0 % SoC
Error messages	• Overcurrent • Overvoltage • Undervoltage • Excess temperature • Insufficient temperature

Parallel connection

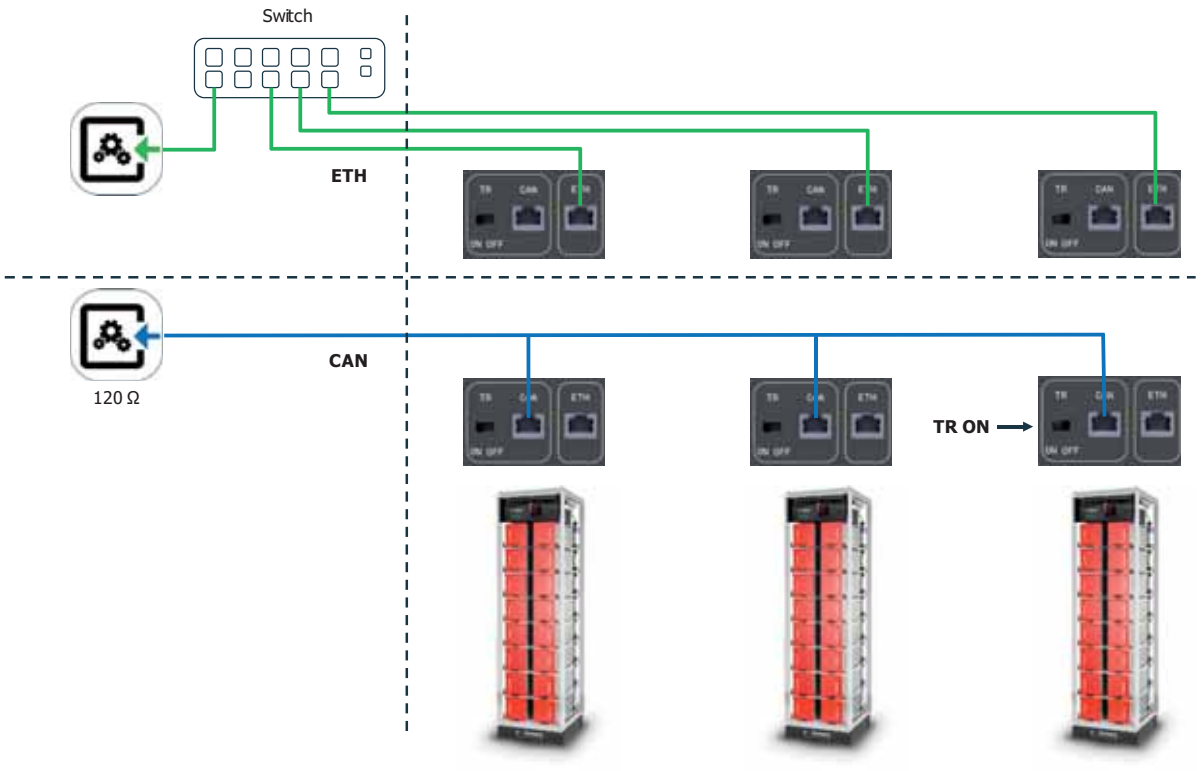


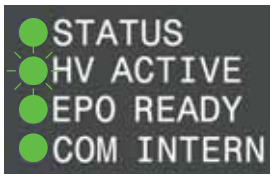
Fig. 6: ccuHV control units connected in parallel

Interconnection of the communication interfaces:

Multiple HV battery systems can be connected via CAN (see Section "CAN" on page 31) or Ethernet (see Section "ETH" on page 32) to form a common network. The individual battery systems can be distinguished and addressed within the network as follows:

- CAN: using the respective ccuHV ID
- Ethernet: using the respective IP address and the ccuHV ID

7.5 State

State	LED
Boot 	• "STATUS" LED flashes green. • "HV ACTIVE" LED lights up red. • "EPO READY" LED lights up green or red. • "COM INTERN" LED lights up green or red.
Idle 	• "STATUS" LED lights up green. • "HV ACTIVE" LED lights up red. • "EPO READY" LED lights up green. • "COM INTERN" LED lights up green.
Precharge 	• "STATUS" LED lights up green. • "HV ACTIVE" LED flashes green. • "EPO READY" LED lights up green. • "COM INTERN" LED lights up green.
On 	• "STATUS" LED lights up green. • "HV ACTIVE" LED lights up green. • "EPO READY" LED lights up green. • "COM INTERN" LED lights up green.
Error 	• "STATUS" LED lights up red. • "HV ACTIVE" LED lights up red. • "EPO READY" LED lights up green or red. • "COM INTERN" LED lights up green or red.
Off 	• "STATUS" LED is off. • "HV ACTIVE" LED is off. • "EPO READY" LED is off. • "COM INTERN" LED is off.

7.6 External connections

7.6.1 VIN

The control unit is supplied with power via the VIN connection.

NOTICE!

➤ Never disconnect VIN during ongoing operation. This can damage internal components.

NOTE

The battery system can be used without an external power supply. The connection of an external power supply to VIN is only necessary if a self-discharge of the battery system by the no-load current of the ccuHV control unit needs to be prevented.

Features of the VIN connection:

- Supply voltage range: 24 V⎓ ±5 % (SELV)
- Control unit power consumption: max. 30 W
- Recommended parameters for connection cable: Conductor cross-section 1 mm^2

7.6.2 START/STOP

The START/STOP connection is used to start or stop the battery system.

Closing the START/STOP contact for > 1 s starts the precharge process of the system.

After successful precharge, the battery system is started. Voltage is applied to BATTERYSYSTEM + and –.

Closing the START/STOP contact for > 5 s switches the battery system off. If the shutdown is successful, there is no voltage present at BATTERYSYSTEM + and –.

NOTICE!

24 V DC is present at both START/STOP contacts. Connecting a switching device that is not potential-free can cause damage to the ccuHV control unit or the switching device.

➤ Only close the START/STOP contact using potential-free switching devices (relays or switches).

7.6.3 EPO

NOTE

The EPO connection is not intended for regular disconnection of the battery system.

The ccuHV control unit switches to the fault state,

- If the EPO terminal is opened while the load contacts are closed, or
- If a command to switch on the load contacts is sent while the load contacts are open and the EPO contact is open.

The error message can be acknowledged as soon as the EPO contact is closed again.

The EPO connection can be used as an emergency shutdown or as an interlock mechanism of the battery system during maintenance work. If the EPO contact is opened, the voltage supply to the HV relays is interrupted and the load contacts of the battery system are de-energised as quickly as possible.

The EPO jumper is inserted in the EPO contact of the ccuHV control unit:

- The EPO contact is closed.
- The battery system can be operated.

The EPO jumper is inserted in the EPO contact of the ccuHV control unit:

- The EPO contact is interrupted.
- The battery system is de-energised at the BATTERYSYSTEM + and - outputs.
- The battery system is protected against being switched on again.

NOTICE!

24 V DC is present at both EPO contacts. Connecting a switching device that is not potential-free can cause damage to the ccuHV control unit or the switching device.

➤ Only close the EPO contact using potential-free switching devices (relay, switch, jumper).

7.6.4 VOUT

External control elements can be supplied with voltage via the VOUT connection (24 V⎓, max. 10 W).

7.6.5 CAN

The connection is used for communication of the control unit with the optional downstream external components.

Features of the CAN connection:

- Termination via switch TR (120 Ω terminating resistor) possible
- Max. bus cable length: 30 m
- Max. stub length: 10 m
- Total length of all stubs: 30 m
- Connection cable recommendation:
  CAT. 6 cable with S-FTP shielding against interference

NOTICE!

➤ The CAN bus must be terminated at the end by an additional 120 Ω terminating resistor. Ensure there is sufficient shielding and observe the maximum bus length for the CAN bus cable.

NOTE

For further information on CAN communication, refer to the specification of the CAN bus protocol (document "ccuHV Interface Description").

PIN no.	Signal	
1	CAN_H	CAN bus signal (dominant high)
2	CAN_L	CAN bus signal (dominant low)
3	CAN_GND	CAN ground
4	–	Reserved
5	–	Reserved
6	CAN_SHLD	Optional shield
7	GND	Ground
8	–	Reserved

NOTE

Example application:

- Communication of switch-on command to control unit
- Communication of predefined warning messages on the status of the battery system to downstream external components
- Communication of errors to external components
- Transmission of system parameters to optimise the charging process

7.6.6 ETH

The connector is used to transfer data between the control unit and optional downstream external components.

Features of the ETH connection:

- Standardised RJ45 Ethernet connection
- Max. length of connection cable 30 m
- Connection cable recommendation
  CAT. 6 cable with S-FTP shielding against interference

NOTE

Example applications:

- Connection for computer to access the user interface of the control unit (for example, configuration and monitoring of the battery system)
- Interface for transmitting data to downstream external components
- Control unit firmware update

7.6.7 BATTERYSYSTEM + and –

The BATTERYSYSTEM + and – load contacts serve to receive power from the battery system for external applications.

Features of the BATTERYSYSTEM + and – load contacts:

- Necessary parameters for load connection cables
  - Nominal cross-section 50 mm^2
  - Double or reinforced insulation for 1 kV operating voltage
  - Max. length of connection cable 30 m
- Recommendation
  - Manufacturer Druseidt Elektrotechnik
  - Type: silicone-coated round stranded wires, 50 mm² (No. 15028)

NOTE

Example applications:

- Receipt of power from the battery system
- Charging connection for the battery system
  (See Section “Setting up an energy storage rack” on page 54)

For instructions on how to lay the load connection cables, see Section “Installing the energy storage block” on page 61.

8 The energy storage block at a glance

8.1 Models

The Commeo energy storage blocks with cylindrical cells (esbC) vary in their applications and power capacity:

Name	Model
Series block, 1.1 kWh for HV systems	esbC11S
Parallel block, 1.1 kWh for HV systems	esbC11P
End block, 1.1 kWh for HV systems	esbC11E
Series block, 1.1 kWh for HV systems	esbC112S
Parallel block, 1.1 kWh for HV systems	esbC112P
End block, 1.1 kWh for HV systems	esbC112E
Series block, 1.45 kWh for HV systems	esbC141S
Parallel block, 1.45 kWh for HV systems	esbC141P
End block, 1.45 kWh for HV systems	esbC141E
Series block, 1.5 kWh for HV systems	esbC15S
Parallel block, 1.5 kWh for HV systems	esbC15P
End block, 1.5 kWh for HV systems	esbC15E
Series block, 1.5 kWh for HV systems	esbC152S
Parallel block, 1.5 kWh for HV systems	esbC152P
End block, 1.5 kWh for HV systems	esbC152E

NOTICE!

The energy storage blocks can only be combined within a model family.

➤ Do not interconnect energy storage blocks of one model family (for example, esbC112) with energy storage blocks of another model family (for example, esbC141).

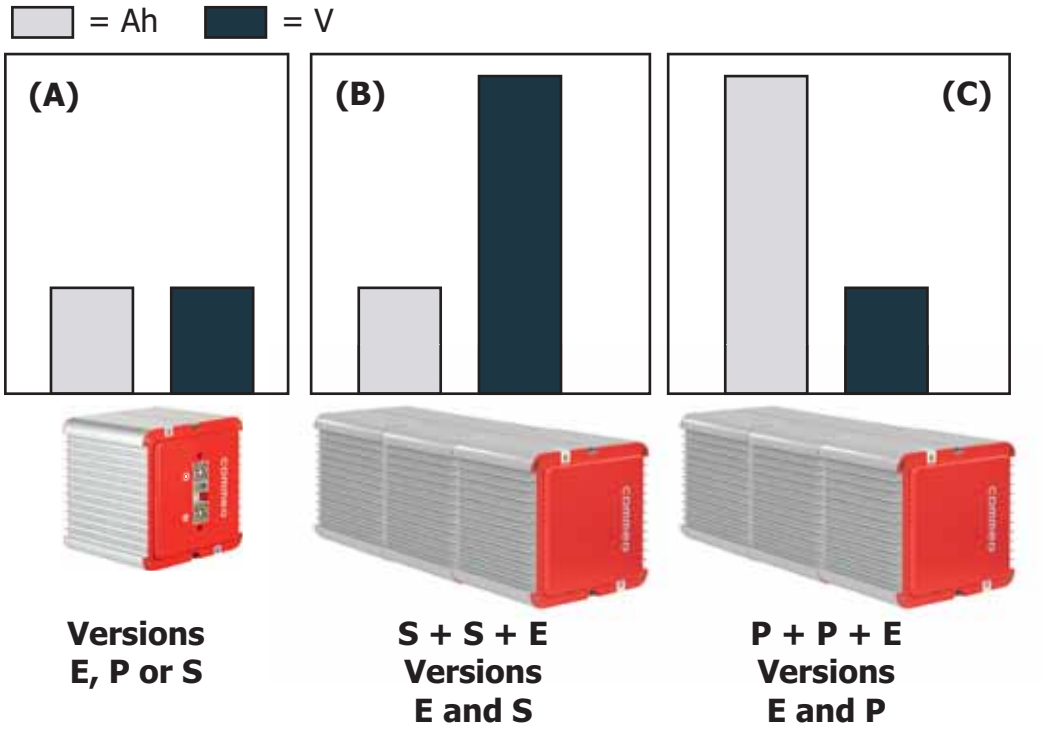


Fig. 7: Connection options for the energy storage blocks

An individual energy storage block has a specified voltage and capacity (A). A string with up to 2 series energy storage blocks and one end block totals up the voltage of the energy storage blocks (B).

A string with up to 2 parallel energy storage blocks and one end block totals up the capacity of the energy storage blocks (C).

They are connected by Commeo when configuring the battery systems. Different voltage levels or capacities can be achieved by connecting the individual levels in series or parallel.

8.1.1 Compatibility

The following energy storage block versions can be interconnected:

	esbC11E	esbC11P	esbC11S
esbC11E	**x**	4	4
esbC11P	4	4	**x**
esbC11S	4	**x**	4

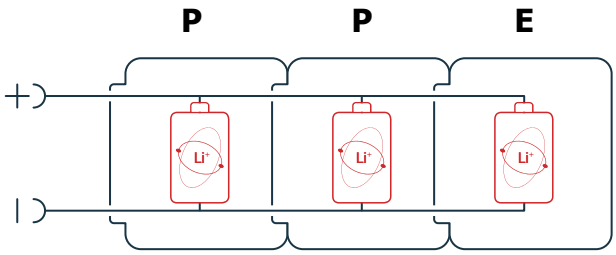
	esbC112E	esbC112P	esbC112S
esbC112E	**x**	4	4
esbC112P	4	4	**x**
esbC112S	4	**x**	4

	esbC141E	esbC141P	esbC141S
esbC141E	**x**	4	4
esbC141P	4	4	**x**
esbC141S	4	**x**	4

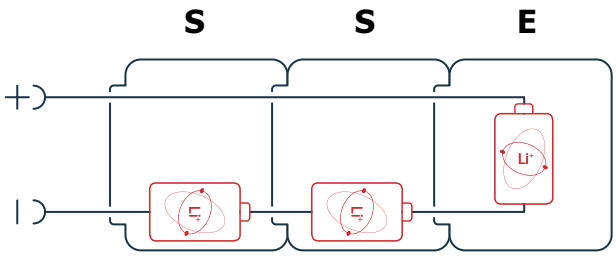
	esbC15E	esbC15P	esbC15S
esbC15E	**x**	4	4
esbC15P	4	4	**x**
esbC15S	4	**x**	4

	esbC152E	esbC152P	esbC152S
esbC152E	**x**	4	4
esbC152P	4	4	**x**
esbC152S	4	**x**	4

Parallel connection:



Series connection:



NOTE
The combination of energy storage blocks and control unit in the energy storage rack is defined by Commeo for each system and may not be changed.

➤ If you have any questions, please contact Commeo Sales.

8.2 Rear side contact

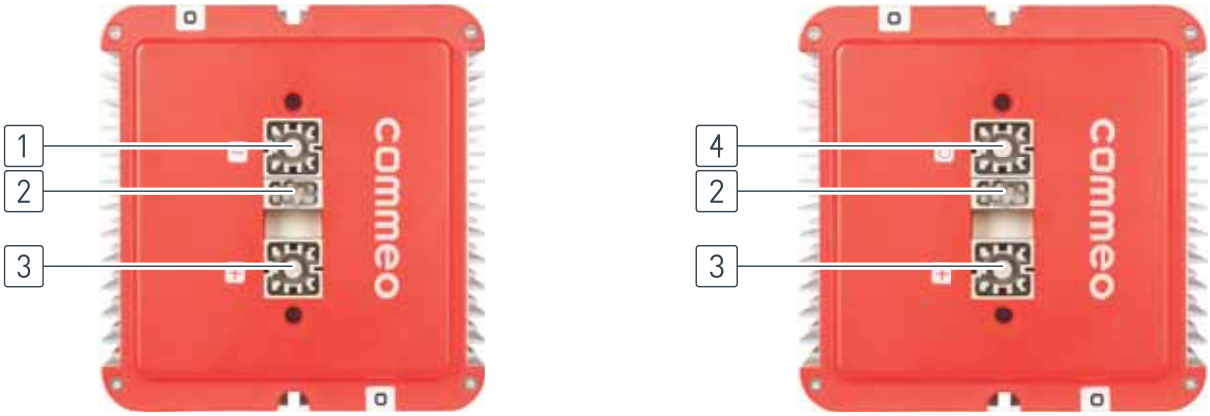


Fig. 8: Rear side of the energy storage block

No.	Assignment (P, E versions)	Assignment (S version)
1.	Power connector L– (negative pole)	–
2.	Communication connector	Communication connector
3.	Power connector L+ (positive pole)	Power connector L+ (positive pole)
4.	–	Power connector 0 (neutral conductor)

NOTE
In all versions, the power connector L+ is always separated from the communication connector by an empty field on the rear side.

8.3 Front side contact

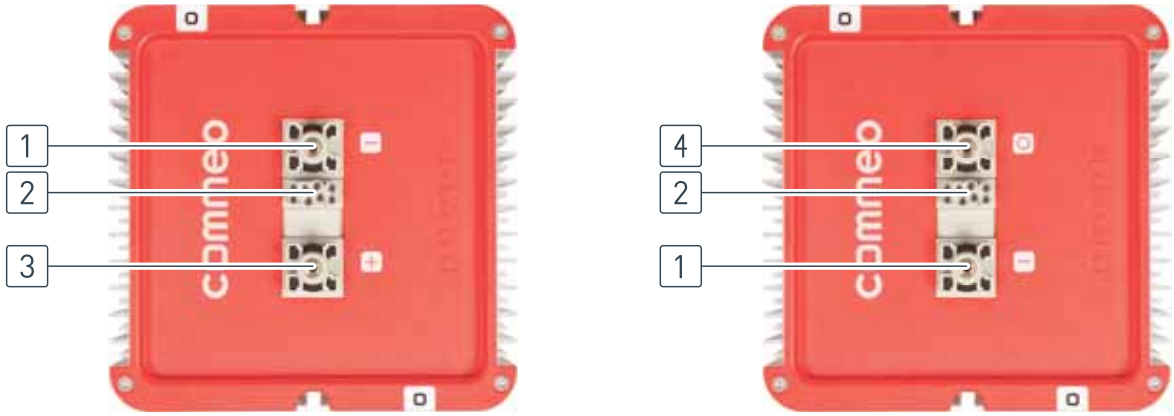


Fig. 9: Front side of the energy storage block

No.	Assignment (P version)	Assignment (S version)
1.	Power socket L– (negative pole)	Power socket L– (negative pole)
2.	Communication socket	Communication socket
3.	Power socket L+ (positive pole)	–
4.	–	Power socket 0 (neutral conductor)

8.4 Power contacts

The power plugs and power sockets are used for transmitting power between the individual energy storage blocks.

WARNING!

➤ Observe the block-specific current limits for the system wiring.

The power contacts are designed for a maximum continuous current of 200 A.

CAUTION!

The power contacts are safe to touch.

➤ The power plugs must be insulated for transport or disposal.

- Power socket - type: Harting Han 200 A female
  Product number: 09140013102 with 09110006222
- Power connector - type: Harting Han 200 A male
  Product number: 09140013002 with 09110007122

8.5 Communication contacts

The plugs and sockets are used for communication between the individual energy storage blocks and for external communication.

esbC S

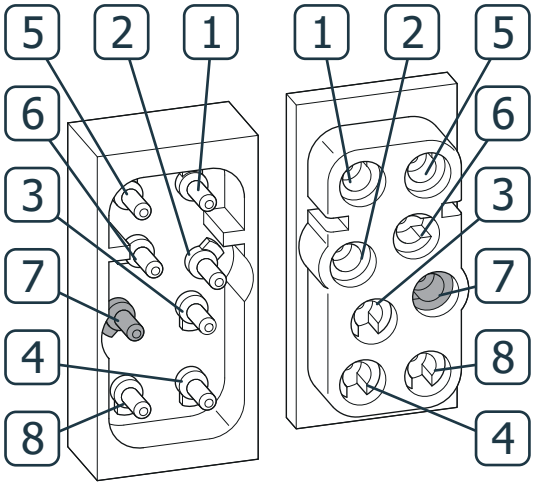


Fig. 10: Energy storage block esbC S communication contacts

esbC P

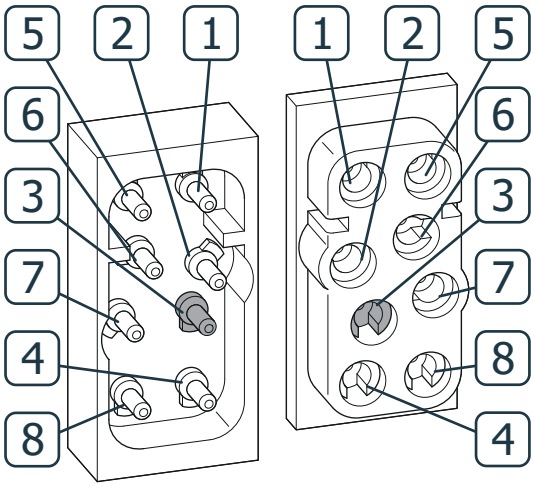


Fig. 11: Energy storage block esbC P communication contacts

esbC E

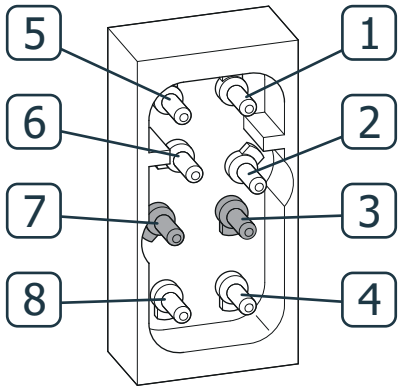


Fig. 12: Energy storage block esbC E communication contacts

No.	Assignment (S, P, E versions)
1.	CAN_VCC Input (5 V ⎓)
2.	CAN_High
3.	n/c
4.	n/c
5.	CAN_Low
6.	CAN_GND/Shield
7.	n/c
8.	n/c

8.6 LED display front

On the front of the energy storage block, the current status of the energy storage block is displayed via 5 LEDs.

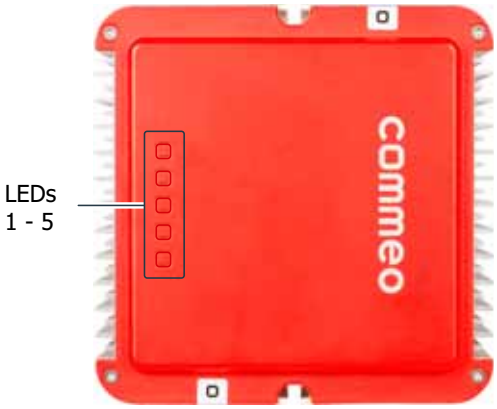


Fig. 13: Front of energy storage block

NOTE
The LED display of the energy storage block is described in detail in Section "Overview of the LED messages" on page 52.

9 UserInterface

The Commeo UserInterface enables the system to be configured and is used to monitor operating data via Ethernet.

NOTE
For more detailed information on the user interface and lists of messages, see the document "ccuHV Interface Description".

9.1 Starting the UserInterface

➤ Connect a network-capable computer to the ETH port on the control unit.

➤ Open a browser and enter the IP address of the UserInterface in the address line (factory setting: 192.168.205.20).

✔ The UserInterface starts with the dashboard display.

9.2 General

9.2.1 Tooltips

Help texts are available in tooltips for many terms.

➤ Drag the mouse pointer onto the term.

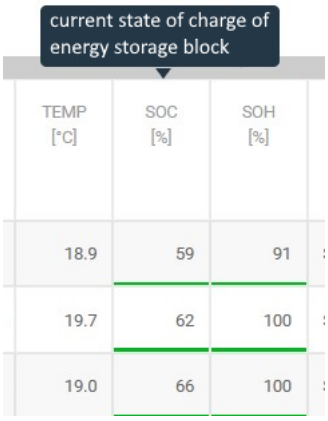


Fig. 14: Tooltip (white font on blue background)

✔ The tooltip for the term appears above the term.

9.2.2 Symbols

Symbol	Explanation
	opens the navigation bar
	closes the navigation bar
	Drag and drop handles to organise the dashboard
	Options for the dashboard tiles (see Section "Configuring the dashboard" on page 67)

9.3 Dashboard

Essential information of the battery system is displayed in the DASHBOARD.

Error and warning messages are displayed as text in the respective tiles.

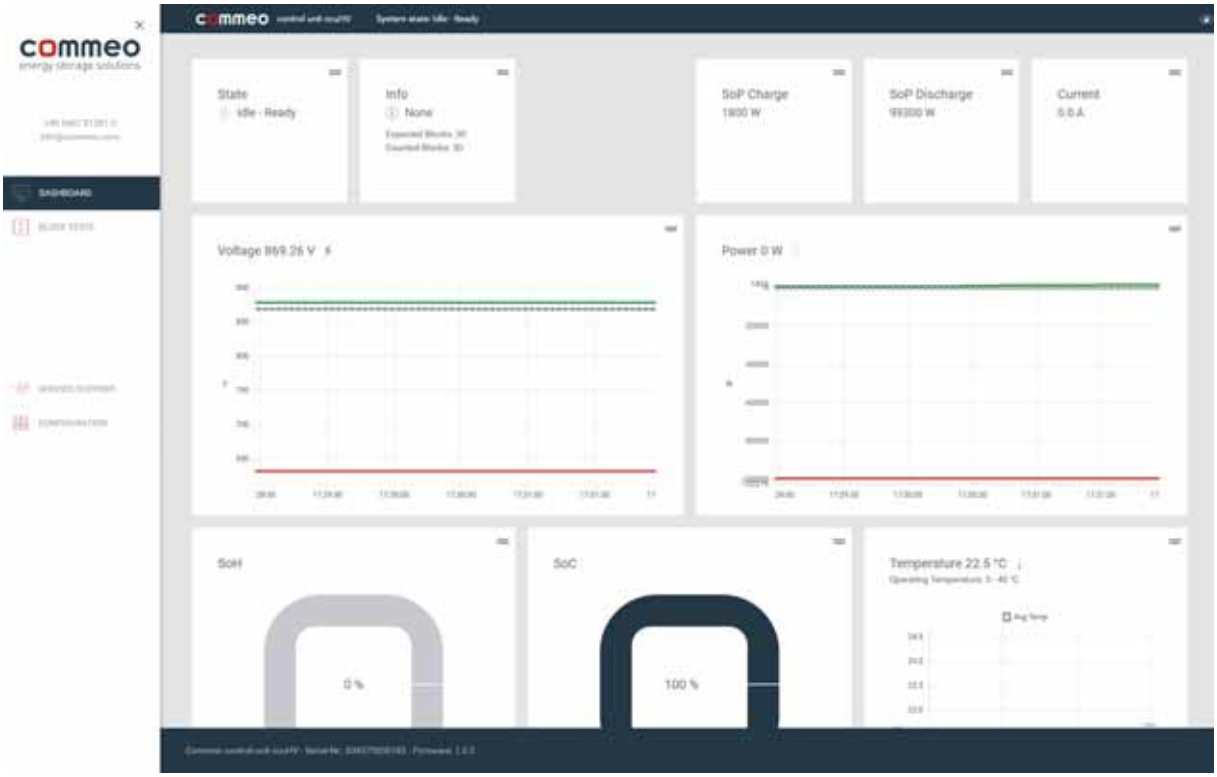


Fig. 15: Dashboard

Tile	Explanation
Info	Current information about the battery system
Warning	Current warning messages of the battery system
Operational Error	Current operational error messages of the battery system
Operational Error Memory	Stored operational error message: remains set, even if the error condition is no longer present
Critical Error	Current critical error messages of the battery system
State	Current operating mode of the battery system

Tile	Explanation
Power	Present power to the battery system or consumer (positive values = charging, negative values = discharging) The graph shows the power curve over time.
Temperature	Current temperature of the battery system The graph shows the temperature curve of the battery system over time.
SoC	Current charge level of the battery system in percent
SoH	Indication of the residual capacity in relation to the ageing state of the overall system in percent
Voltage	Current voltage of the battery system The graph shows the voltage curve of the battery system over time.
Current	Present current to the battery system or to the consumer (positive values = charging, negative values = discharging)
SoP discharge	Currently available power that the battery system can deliver (positive values)
SoP charge	Current permissible charging capacity for the battery system (positive values)
Humidity Map [%]	Visualises the current humidity in the respective energy storage blocks in the energy storage rack
Temperature Map [°C]	Visualises the current temperature in the respective energy storage blocks in the energy storage rack

9.4 Block State

The “Block State” page displays detailed information about each energy storage block in the system.

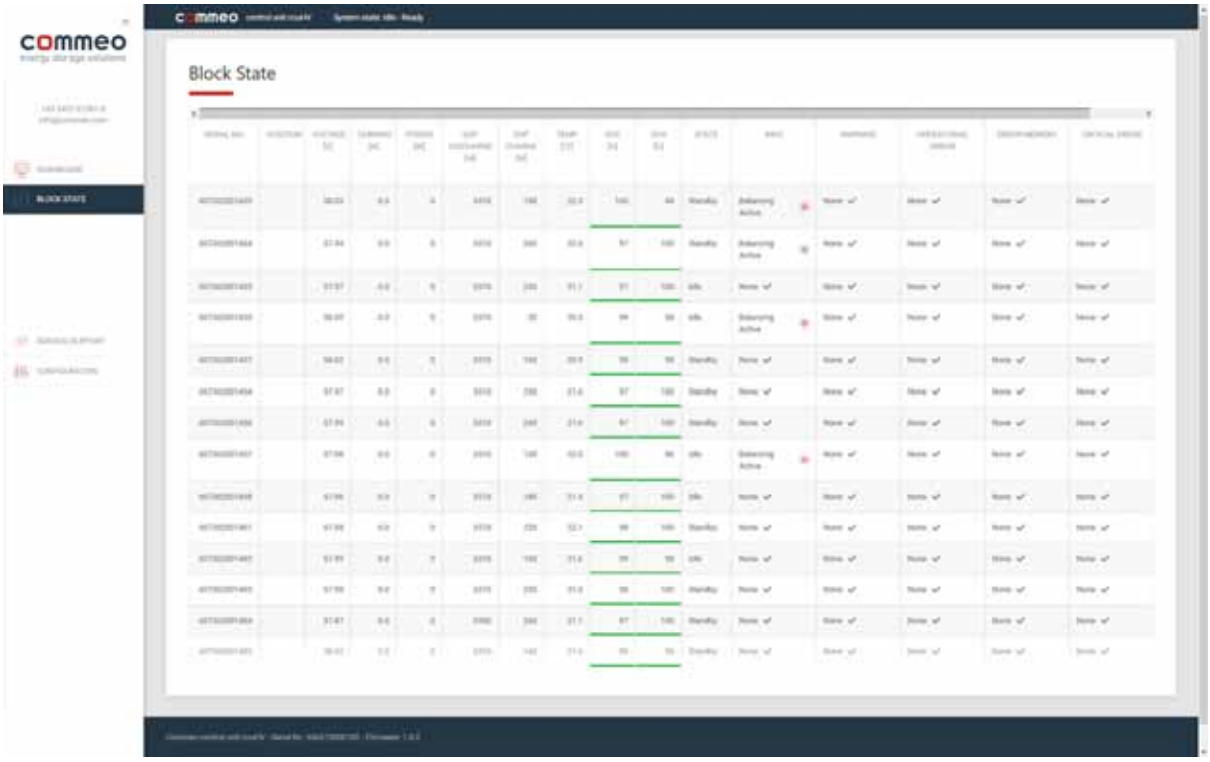


Fig. 16: Block State

Category	Explanation
Serial no.	Serial number of the energy storage block
Position	Position of the energy storage block in the energy storage rack: 1. Position: Row from bottom to top 2. Position: Left or right column (L or R) 3. Position: Position within the row from back to front (1 – 3). Example: 2R3 is the third block from the back, in the second row from the bottom, in the right column.
Voltage [V]	Current voltage of the energy storage block
Current [A]	Present current to the energy storage block or consumer (positive values = charging, negative values = discharging)
Power [W]	Present power to the energy storage block or consumer (positive values = charging, negative values = discharging)
SoP discharge [W]	Currently available power that the energy storage block can supply
SoP charge [W]	Current permissible charging power for the energy storage block
Temp [°C]	Temperature inside the energy storage block
SoC [%]	Current charge level of the energy storage block

Category	Explanation
SoH [%]	Indication of the residual capacity in relation to the ageing state of the energy storage block
State	Current mode of the energy storage block (Section “Overview of the LED messages” on page 52)
Info	Current information about the energy storage block
Warning	Current warning messages of the energy storage block
Operational Error	Current operational error messages of the energy storage block
Error Memory	Stored operational error messages: remain set, even if the error condition is no longer present
Critical Error	Current critical error messages of the system
Max. charge current [A]	Current maximum permissible charge current for the energy storage block

9.5 Service/Support

On the SERVICE/SUPPORT page, under "Log Download", battery system state data can be downloaded to a connected computer.

- System Log: generates binary file for evaluation by Commeo (approx. 50 MB).
- System Events: generates a log of system events as a text file (approx. 1 MB).

Under "Error Reset" it is possible to acknowledge operating errors that have occurred in order to put the HV battery system back into operation.

The page also contains a direct link to the Commeo "Documentation Server".

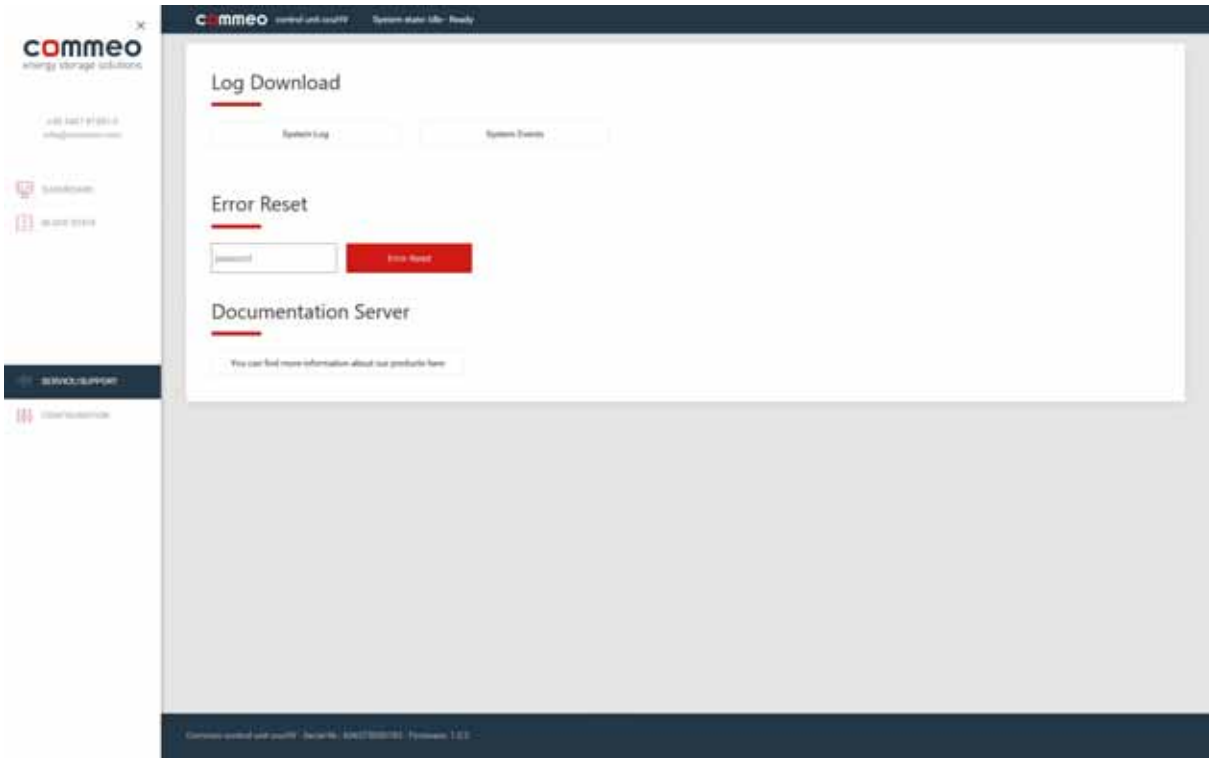


Fig. 17: Service/Support

NOTE
To be able to acknowledge operational errors, the password of the system must be entered ("ChangeConfigNow").

NOTE
A complete listing and explanation of all error and warning messages can be found in the CAN bus definition document "ccuHV Interface Description" from Commeo.

9.6 Configuration

The Configuration page is for setting up the battery system.

NOTE
Changes to the battery system configuration may only be made in IDLE mode (with HV relay open).

NOTE
To accept the parameters entered, the password must be entered ("ChangeConfigNow").

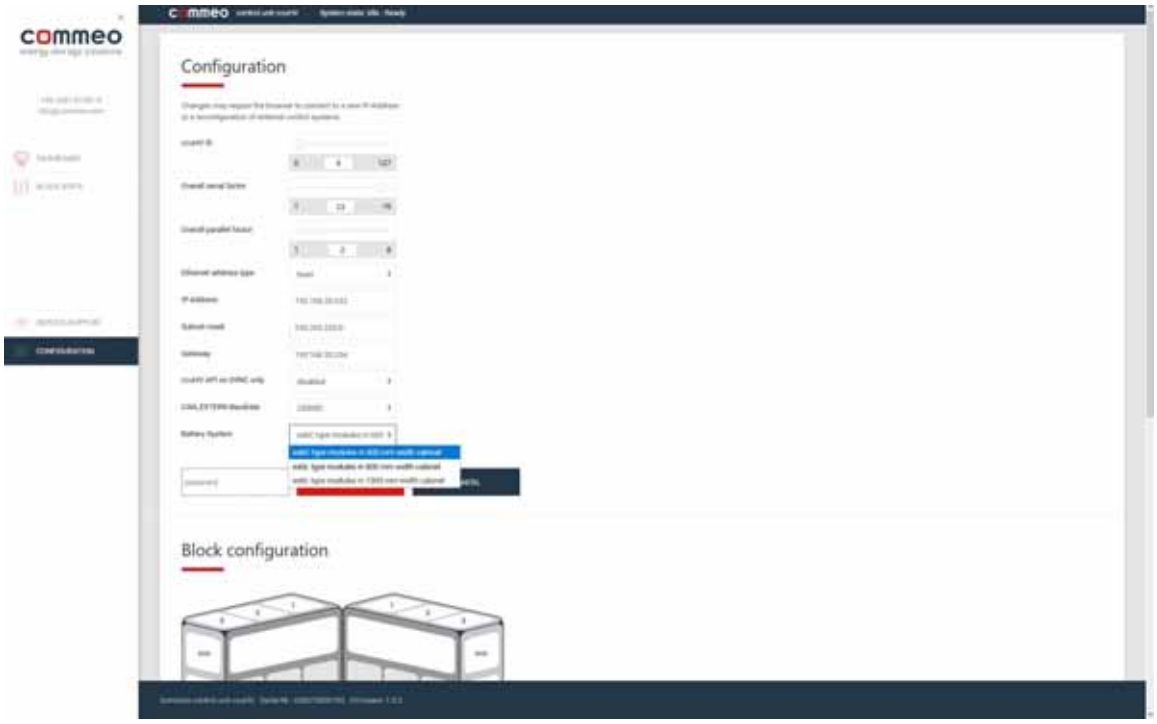


Fig. 18: Configuration

Category	Explanation
ccuHV ID	Identification number of the control unit
Overall serial factor	Serial factor calculated over all energy storage blocks in this system
Overall parallel factor	Parallel factor, calculated over all energy storage blocks in this system
Ethernet address type (IP address assignment)	Select between a fixed IP address or an IP address assigned by a DHCP server for the battery system
IP address (IP address)	Input of the fixed IP address Factory IP address: 192.168.205.20

Category	Explanation
Subnet mask (Subnet mask)	Input of the subnet mask Factory subnet mask: 255.255.255.0
Gateway	Input of the IP address of the gateway
ccuHV API on SYNC only (ccuHV API messages only for SYNC request)	This setting determines whether the ccuHV API should only send messages on SYNC request: • disabled (automatically and on SYNC request) • enabled (only with SYNC request)
CAN EXTERNAL baud rate	Defines the baud rate at which communication via the CAN EXTERNAL interface takes place: • 125000 • 250000 • 500000 • 1000000
Battery System	Selection of the energy storage system with the appropriate battery modules and the appropriate width of the energy storage rack • esbC type modules in 600 mm width rack • esbL type modules in 800 mm width rack • esbCL type modules in 1000 mm width rack

9.6.1 Block configuration

In the "Block configuration" area, the energy storage blocks are assigned to the respective positions in the energy storage rack via the serial number.

NOTE
To save the created layout, the password must be entered ("ChangeConfigNow"). The changes to the configuration are accepted by clicking on "SAVE LAYOUT".

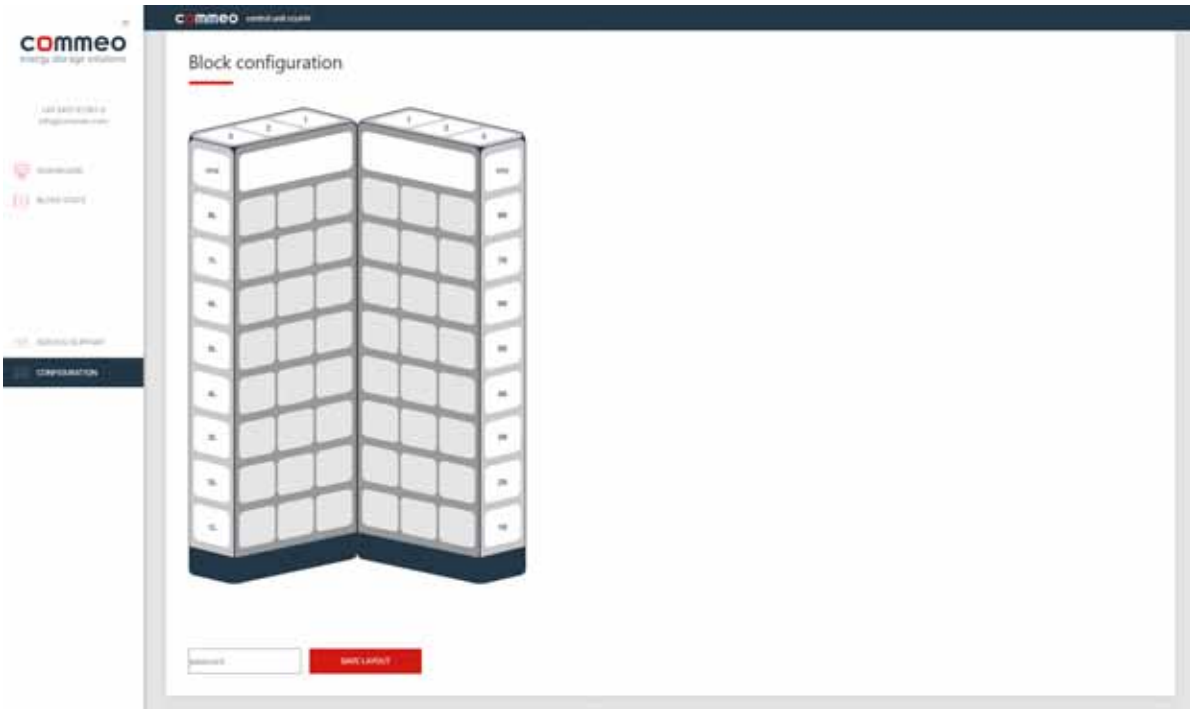


Fig. 19: Block configuration

10 Scope of delivery

Designation	Value
Energy storage rack esrC	1
ccuHV control unit (installed in energy storage rack)	1
Energy storage block (quantity depending on configuration)	4 – 48

NOTICE!

Incorrectly assembled battery systems can damage the energy storage blocks and the control unit.

➤ The energy storage blocks and the control unit may only be installed in the energy storage racks intended for this purpose.

11 Transporting the battery system

Transport conditions:

Designation	Value
Temperature	-20 °C to +45 °C
Max. relative humidity	< 80 %, non-condensing

12 Storing the battery system

The specific storage conditions of the energy storage blocks can be found in the data sheet of the respective energy storage blocks.

The maximum storage period for the energy storage blocks is 6 months.

NOTE
The state of charge (SoC) of the energy storage blocks must be above 40 % at the beginning of a longer storage period.

13 Monitoring the energy storage block

The energy storage block outputs state messages via the 5 LEDs on the front. The main monitoring of the entire system is performed via the user interface (Section "Error and warning messages" on page 73). The state messages on the energy storage block always apply only to the respective energy storage block, not to the string.

WARNING!
Fire hazard
If the internal temperature of the energy storage block is more than 70 °C, the energy storage block may catch fire.

➤ In this case, immediately leave the area of the battery system and inform the person responsible for the system.

NOTICE!

➤ Only operate the energy storage blocks within the scope of their intended use and the defined operation window. The lifetime of the energy storage blocks depends on the type of use (charging and discharging cycles and discharge load, etc.) and the ambient variables (ambient temperature and storage, etc.).

➤ Observe the operating instructions of the machine manufacturer.

NOTE
During operation, the energy storage blocks heat up to 50°C.

13.1 Overview of the LED messages

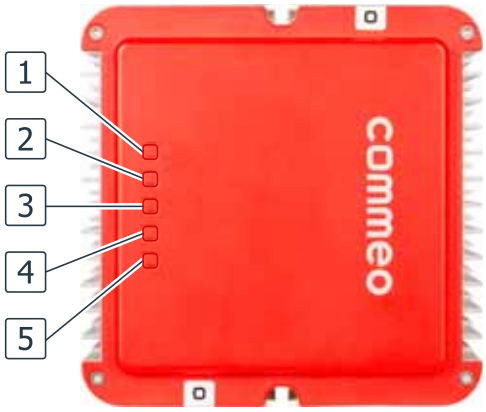


Fig. 20: Front of energy storage block

Five LEDs on the front of the energy storage blocks indicate the current mode of the respective energy storage block.

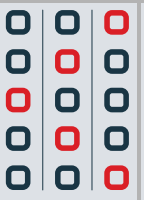
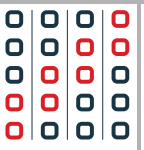
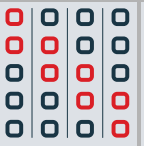
NOTICE!
If the energy storage block is in error mode or no LED is permanently illuminated, the energy storage block must not be used.

➤ Please inform the manufacturer Commeo immediately.

NOTE
The LED display changes between the mode display and the charge level display of the energy storage block.
If the battery is charged to 20 %, LED 5 illuminates. If the battery is charged to 40 %, LED 5 and LED 4 illuminate, etc.

The LEDs indicate the mode of the energy storage block:

Mode	Description	LED display	
DeepSleep Storage mode	• The mode starts when the energy storage block has not detected any CAN bus communication for more than 30 minutes. • The internal temperature of the energy storage block is outside the temperature range of +10 °C to +35 °C.		• LED 3 lights up 1x per minute for 2 seconds.
	• The internal temperature of the energy block is within the temperature range of +10 °C to +35 °C.		• LEDs 2 and 4 light up for 2 seconds once per minute.

Mode	Description	LED display	
Standby Power saving mode	• The CAN bus communication is active.		• LED 3 lights up 4x at an interval of 2 seconds • LEDs 5 to 1 indicate the state of the energy storage block charge (SoC) (duration 1 second).
Idle esb active	• The CAN bus communication is active. • No power is flowing.		• Running light from LED 3 to LED 4 + LED 2 to LED 5 + LED 1 (2 passes) • LEDs 5 to 1 indicate the state of the energy storage block charge (SoC) (duration 1 second).
Charge Charging mode	• The CAN bus communication is active. • The energy storage block is charging.		• One running light consisting of 2 LEDs (2 passes) • LEDs 5 to 1 indicate the state of the energy storage block charge (SoC) (duration 1 second).
Discharge Discharge mode	• The CAN bus communication is active. • The energy storage block is being discharged.		• One running light consisting of 2 LEDs (2 passes) • LEDs 5 to 1 indicate the state of the energy storage block charge (SoC) (duration 1 second).
Error Error mode	• An error prevents the energy storage block from functioning properly.		• All 5 LEDs flash simultaneously. ➤ **Contact Commeo Support.**

14 Setting up an energy storage rack

WARNING!
Danger to life due to electric current

- The battery system may only be installed by qualified personnel (Section "Qualified electricians" on page 5).
- All cables must be led out of the energy storage rack by using standardised Commeo system modules (sbs9KVD / sbs9KVB). For further information contact Commeo Sales.

14.1 Installation site and conditions

WARNING!
Fire hazard

The battery system may catch fire under improper environmental conditions.

➤ Select an appropriate installation location to avoid the situations listed above.

NOTE

To achieve the required environmental conditions, Commeo offers various outdoor and air conditioning options. Contact Commeo Sales for more information.

The following ambient conditions must be observed when using the battery system:

- Use inside industrial or commercial buildings
- Use on commercial or industrial sites in enclosures (for example, outdoor racks) or containers that allow continuous compliance with all otherwise required environmental conditions and provide pressure relief to the outside in the event of a fire.
- Use in places of assembly or sales premises only within a room as defined in §29 Para. 2 No. 2 German Model Building Code (Musterbauordnung)
- Inside buildings, a fire detector must be installed in the installation room.
- A well-ventilated or air-conditioned installation location without external heat sources
- Always install on a sufficiently dry, load-bearing, horizontal, level surface.
- Ensure adequate rodent protection.

- Distance to sources of heat > 100 mm. Select a distance large enough to ensure that the battery system is not exposed to heat in the event of a heat source defect.
- Distance to sources of humidity > 100 mm. Select a distance large enough to ensure that the battery system is not exposed to heat in the event of a heat source defect.
- No heat-sensitive surfaces in the area adjacent to the energy storage blocks
- Ambient temperature permanently above 0 °C and below +40 °C, ideally +20 °C
- Relative humidity below 80 %, non-condensing
- Maximum degree of pollution 2
- Altitude below 2000 m
- In flooded areas it is important to ensure that the battery cabinet is always raised and installed out of reach of flooding
- Use in earthquake-prone areas is only permitted if a separate risk assessment has been carried out by the operator, taking into account the risks due to earthquakes, and the use has been approved by Commeo.
- Sufficient means of escape must be provided at the installation site, at minimum according to the model guideline of the respective special construction.
- The space requirement of the battery system results from the dimensions of the energy storage rack as well as the swivel range of any attached rack doors or flaps of the energy storage rack.
- Mount the product firmly and securely and prevent it from slipping or falling over. Follow the installation instructions.

The battery system must **not** be used in the following situations:

- Salty moisture
- Corrosive ambient conditions
- Explosive atmosphere
- Direct sunshine
- Large fluctuations in the ambient temperature
- In escape and rescue routes
- On travel routes or in locations with an increased risk of accidents

14.2 Requirements for installation

After longer storage periods, the energy storage blocks can discharge to varying degrees.

➤ Before assembly, ensure that the energy storage blocks have the same state-of-charge.

➤ Check the voltage of the energy storage blocks.

The difference between the energy storage block with the highest voltage and the energy storage block with the lowest voltage must not exceed 500 mV when installed.

NOTICE!

If the voltage of an energy storage block is less than 48.0 V, the energy storage block must not be used.

➤ Please inform the manufacturer Commeo immediately.

All energy storage blocks must have an internal temperature between +10 °C and +35 °C before installation.

➤ Check the LED display of the energy storage block in DeepSleep storage mode, see Section "Overview of the LED messages" on page 52.

NOTICE!

➤ Only install the energy storage block if the indicator LEDs 2 and 4 light up simultaneously for 2 s once per min in DeepSleep storage mode.

➤ If the indicator LEDs of the energy storage block do not indicate the required internal temperature, store the energy storage block before installation at an ambient temperature between +10 °C and +35 °C until the indicator LEDs 2 and 4 of the energy storage block indicate the required internal temperature.

14.2.1 Parallel connection of HV battery systems

NOTICE!

Before connecting 2 or more HV battery systems in parallel, they must be brought to the same voltage level (voltage difference +/– 3 % maximum), otherwise the precharge process cannot be completed successfully.

➤ Before connecting, first check the voltage of the HV battery systems via the communication interface and charge the HV battery systems separately if necessary until the voltage difference is a maximum of +/– 3 %.

14.3 Connecting the energy storage rack

The cables for the electrical connections of the battery system can be routed either through the top or the bottom of the energy storage rack.

NOTE

To minimise noise coupling on the battery cables, observe the following points:

- ➤ When operating multiple battery systems, each with its own inverter (battery systems not directly connected in parallel), route the battery cables of the battery systems in parallel separately and not in direct proximity to each other.
- ➤ Keep the battery cables as short as possible and do not install them over longer distances.

NOTE

- ➤ When integrating the battery system electrically, ensure that the electrical installation is correct and low in EMC, depending on the local connection conditions and the earthing configuration (TN, TT, IT).

14.3.1 Cable routing at the top

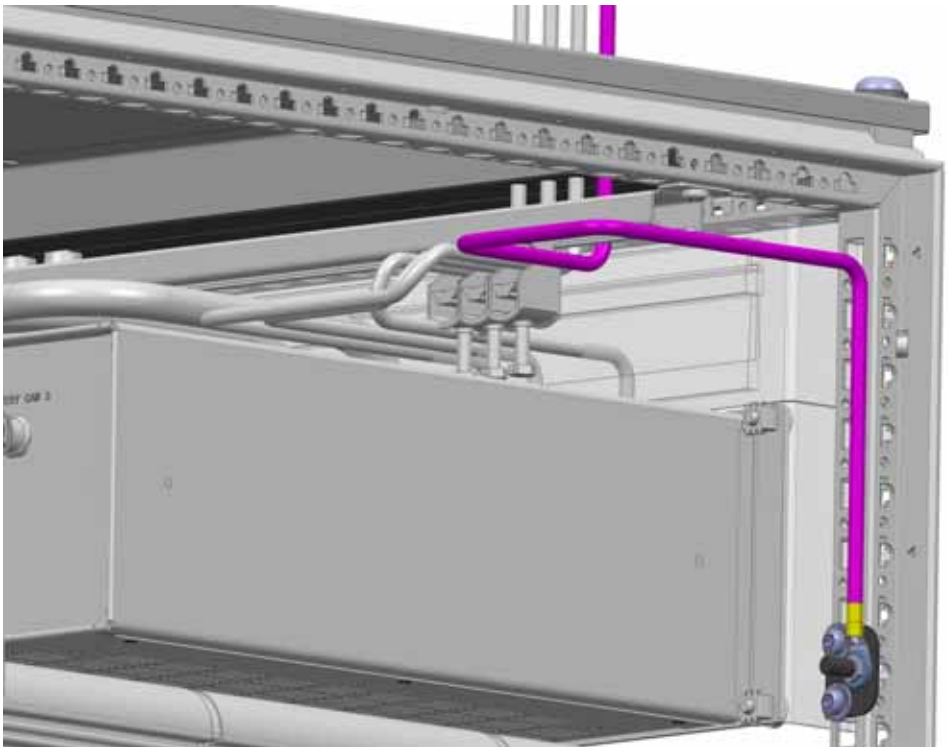


Fig. 21: Equipotential bonding in the energy storage rack

- ➤ Connect equipotential bonding.
- ➤ Check the connection of the equipotential bonding for continuity (< 100 mΩ).

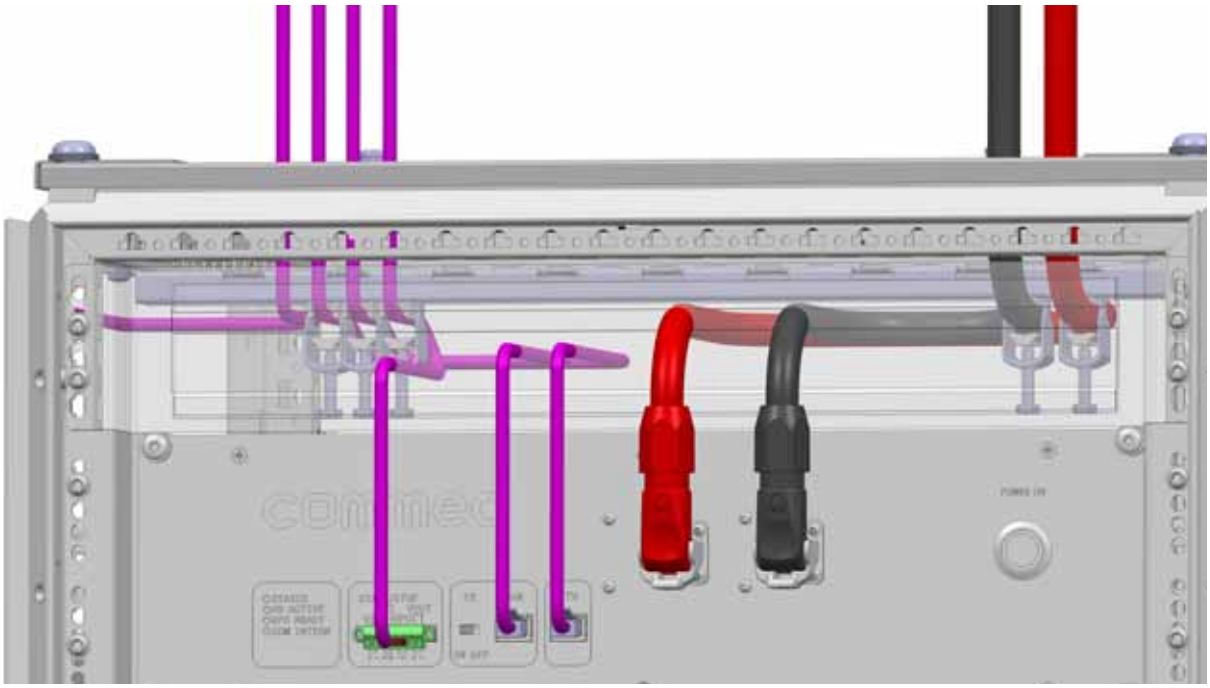


Fig. 22: Energy storage rack cable routing

- ➤ Guide battery cable and communication cable (CAN, ETH, if applicable relay control) through the opening in the top of the housing.
- ➤ Connect battery cable and communication cable (CAN, ETH, if applicable relay control) to the ccuHV control unit.
- ➤ Ensure sufficient strain relief for the battery cables, the communication cables and the equipotential bonding.
- ➤ Snap in the covers of the connectors.
- ➤ Insert the jumper (EPO).
- ➤ Check the wiring of the battery strings according to the circuit diagram.

14.3.2 Cable routing at the bottom

NOTE
A base of sufficient height is required for routing the external power connection through the bottom of the housing.

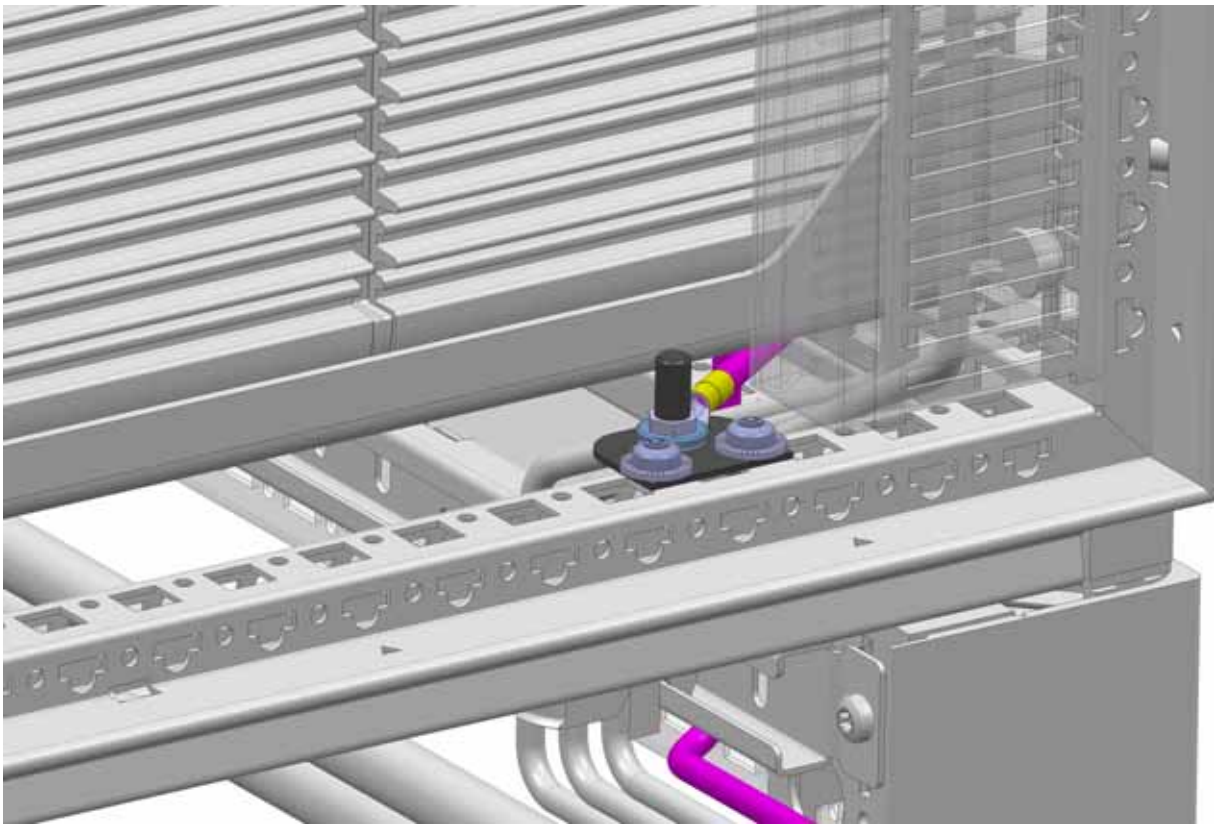


Fig. 23: Equipotential bonding in the energy storage rack

➤ Connect equipotential bonding.

➤ Check the connection of the equipotential bonding for continuity (< 100 mΩ).

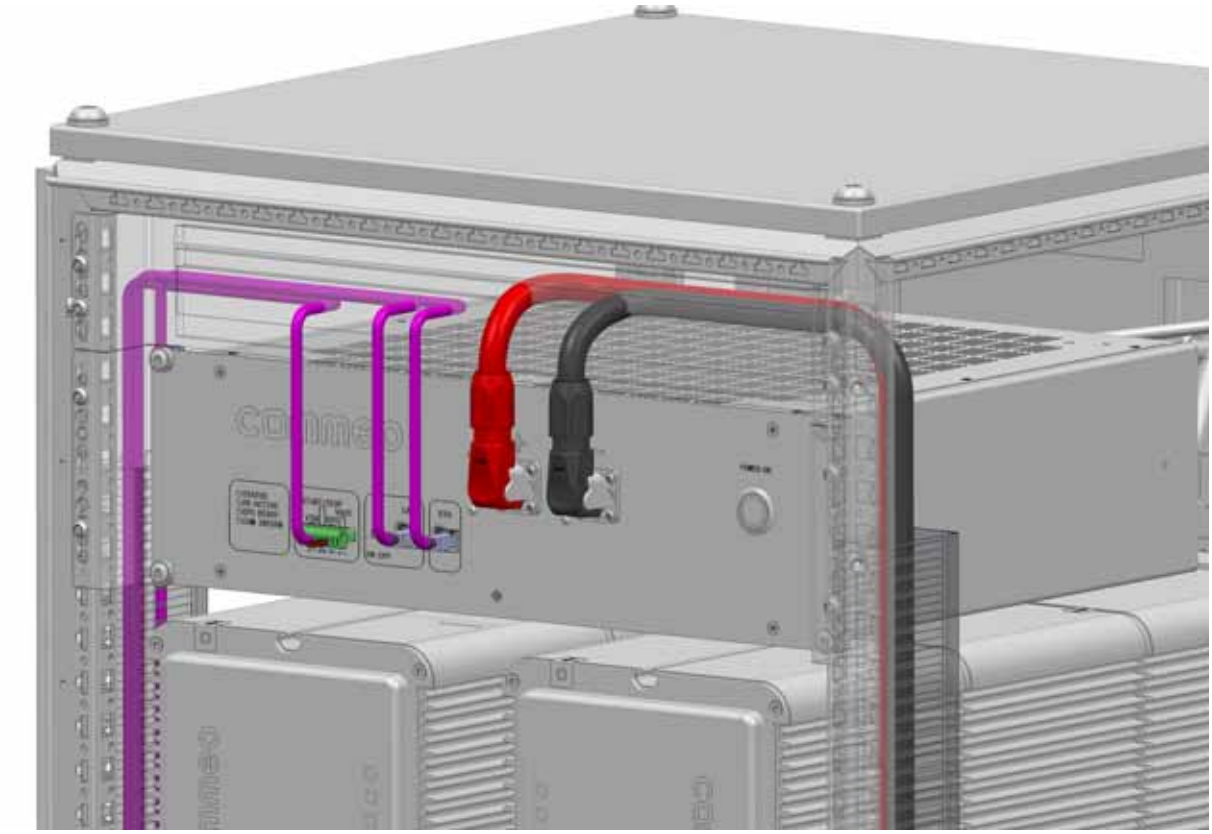


Fig. 24: Energy storage rack cable routing

- ➤ Route battery cable and communication cable (CAN, ETH, if applicable relay control) separately from each other through the cable ducts on the left and right side.
- ➤ Connect battery cable and communication cable (CAN, ETH, if applicable relay control) to the ccuHV control unit.
- ➤ Ensure sufficient strain relief for the battery cables, the communication cables and the equipotential bonding.
- ➤ Snap in the covers of the connectors.
- ➤ Insert the jumper (EPO).
- ➤ Check the wiring of the battery strings according to the circuit diagram.

14.3.3 Parallel connection of HV battery systems

The HV battery systems are interconnected by connecting the external BATTERYSYSTEM + and – load contacts on suitable components for current distribution, see Section "Functional overview" on page 16.

DANGER!
Danger to life due to electric shock and arc fault
Safety tolerances of the internal wiring can be exceeded by excessive voltages.
➤ HV battery systems should only be connected in parallel!

WARNING!
Fire hazard
➤ Ensure sufficiently large cross-sections of the connecting cables and suitable connections.

NOTE
➤ Use Commeo system module sbs9AR (optional) for baying and parallel connection of HV battery systems. Maximum dimension of the busbar: 30x10 mm. Maximum current carrying capacity: 800 A.
➤ Take into account the continuous current levels of the busbars.

14.4 Installing the energy storage block

DANGER!
Danger to life due to electric current
➤ Only use fully insulated tools during installation.

WARNING!
Fire hazard
➤ When installing at a height of more than 1 m, the energy storage block should only be moved with great care and using fall protection.

CAUTION!
➤ Do not exert pressure on the housing cover of the energy storage blocks during installation.
➤ When fastening, no pressure must be exerted on the contacts of the energy storage block. The sockets and plugs on the energy storage block are used exclusively as contacts.

CAUTION!

- ➤ Before installing the energy storage blocks, observe the circuit diagram of the battery system.
- ➤ Only install the energy storage blocks in the energy storage rack in accordance with the specified positioning plan.
- ➤ Observe parallel connections of the energy storage blocks within the energy storage rack.

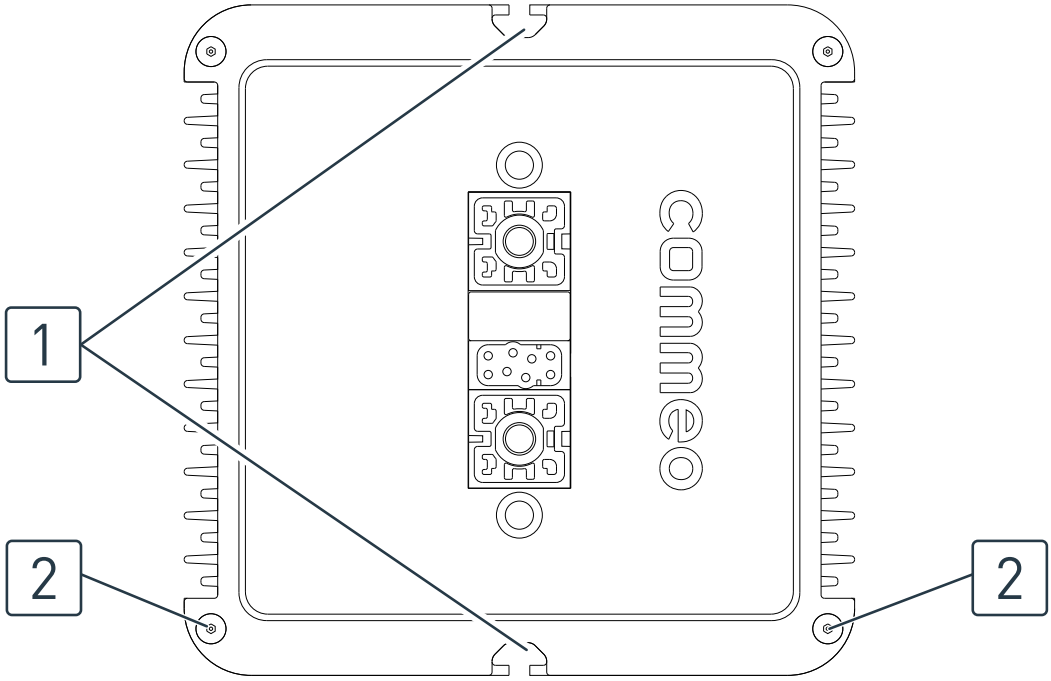


Fig. 25: T-slots in the energy storage block

The T-slots in the housing (see figure above, position 1) are used to lock an energy storage block to prevent it slipping sideways or lifting off from the mounting surface. The energy storage block must always be pushed on the T-rail on the heavy-duty shelves. Push the energy storage block forward evenly at the two defined points (see figure above, position 2).

NOTE

The assignment of the serial number of the energy storage block to the position in the energy storage rack is done via the user interface. Commeo provides a corresponding list with the position of the respective serial number in the energy storage rack.

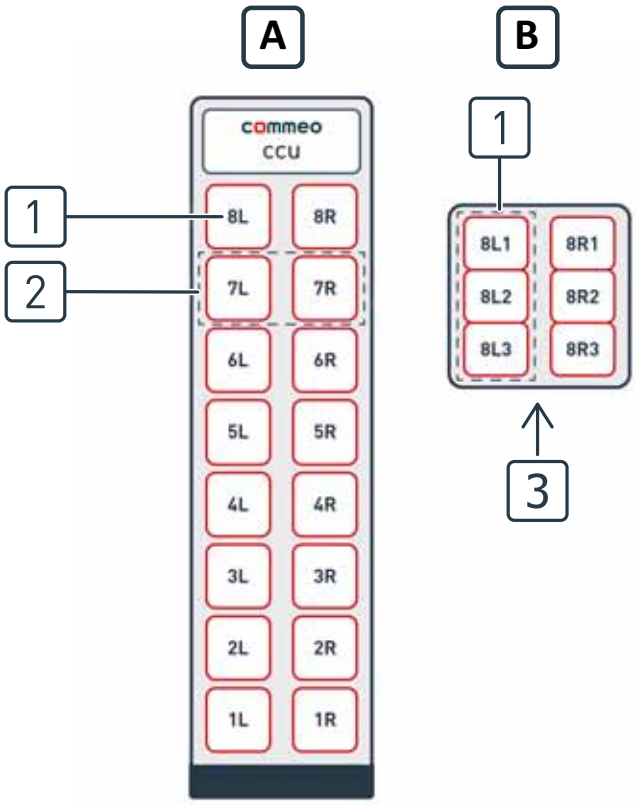


Fig. 26: Schematic diagram of energy storage rack

No.	Description
A	Front view
B	Top view
1	String (example: String 8L)
2	Level (example: Level 7)
3	Front side

➤ Fill the heavy duty shelves according to the positioning plan (included). Each heavy duty shelf forms a level (see figure above, position 2).

➤ Install the energy storage blocks on the levels in strings of up to 2 energy storage blocks of type P or S and one energy storage block of type E (see figure above, position 1 as well as Section "The energy storage block at a glance" on page 33). First install the type P and S energy storage blocks. When all type P and S energy storage blocks have been installed, install the type E energy storage blocks.

WARNING!
Fire hazard
When energy storage blocks are connected in parallel within an energy storage rack, high equalizing currents can occur if they are fitted incorrectly, generating dangerous thermal loads.

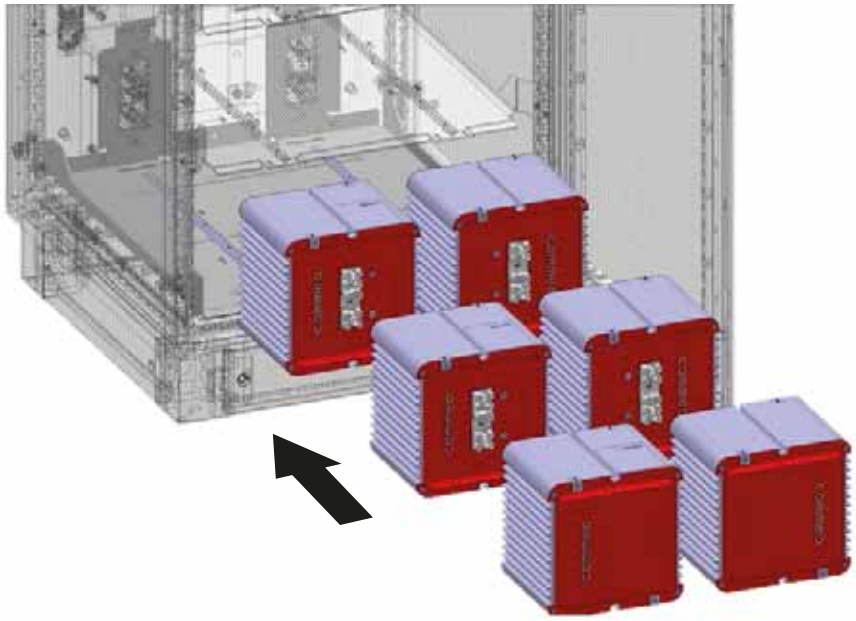


Fig. 27: Install energy storage blocks in the energy storage rack

➤ Install the energy storage blocks on a T-rail. The position of the communication contact is determined by the orientation of the docking frame on the heavy-duty base for each block of a string.

NOTE

➤ When pushing in the blocks, make sure that the contacts of the blocks and the docking frame are pushed completely into each other.

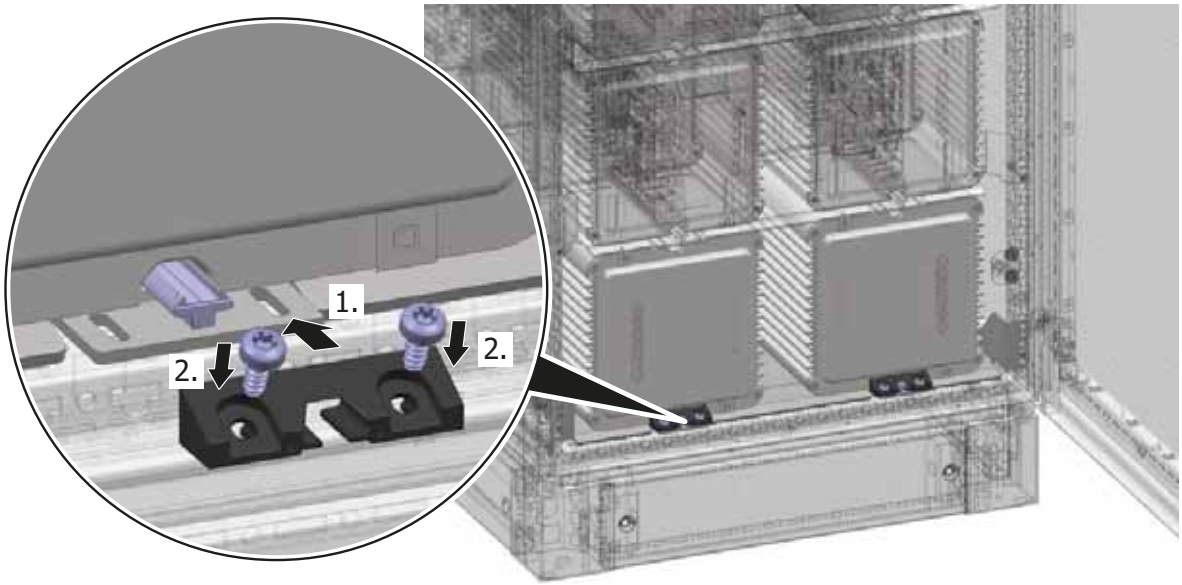


Fig. 28: Install the end wedges in the energy storage rack

➤ Install the end wedge on a T-rail (tightening torque 3 Nm).

✔ The energy storage blocks are fixed on the T-rail.

15 Commissioning

To put the system into operation, the energy storage blocks must be inserted into the energy storage rack. To connect the external components, observe the description in Section "External connections" on page 29.

➤ Press the POWER ON button for longer than 5 s to supply the ccuHV control unit with voltage from the energy storage blocks.

✔ The POWER ON LED lights up red.

NOTE
The control unit cannot be switched off using the POWER ON button.

15.1 Configuring the system

NOTE
The detailed explanation of the parameters can be found in Section "UserInterface" on page 40.

➤ Assign a fixed IP address to the network adapter of the control PC.
IP address: 192.168.205.1
Subnet mask: 255.255.255.0

➤ Open the "Dashboard" page in the browser. The default address at delivery is:
http://192.168.205.20/

✔ The operating state of the battery system is "Idle-OFF" (standby mode, relay closed).

NOTICE!

➤ In case of an error, check the exact error message in the dashboard (see Section "Error and warning messages" on page 73).

➤ Go to the "Configuration" page.

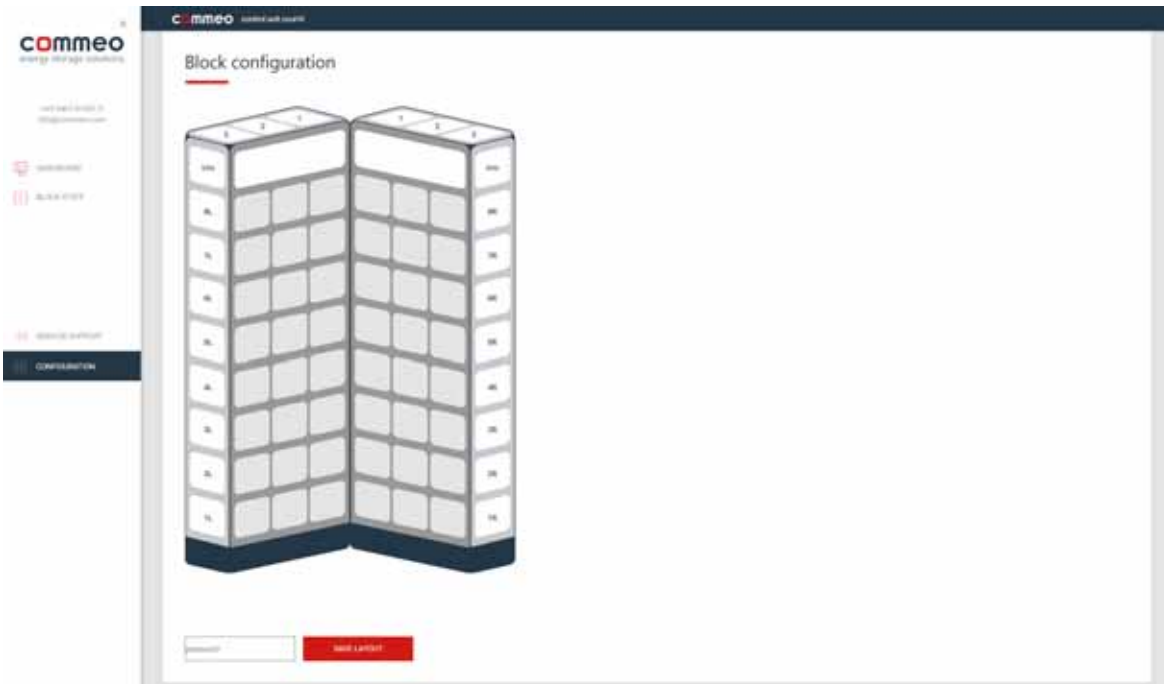


Fig. 29: Configuration

➤ Enter the position of the energy storage blocks in the schematic diagram as follows:

➤ Select the position of the energy storage block, starting with the position at the rear left or rear right.

➤ Select the serial number of the energy storage block from the list.

➤ Save the position with the "Save" button.

NOTE
If the serial number of an energy storage block has been entered at an incorrect position in the schematic representation of the battery system, this can be corrected in 2 ways:
- Switch with: Swaps the serial number of the current energy storage block with the selected serial number.
- Unassign: The serial number of the current energy storage block is unassigned, and the position of the energy storage block in the schematic diagram is displayed blank.

➤ When all energy storage blocks have been entered correctly, save with "Save Layout" (password-protected).

✔ The layout is saved and used for the heatmap in the dashboard, among other things.

➤ Make user-specific settings:
- ccuHV ID (factory setting: ccuHV ID = 1)
- Enter wiring from battery system datasheet:
  S: Overall serial factor
  P: Overall parallel factor
- Network address
- Communication settings

➤ Save settings via "Set Configuration" (password-protected).

✔ The ccuHV control unit adopts the new settings.

➤ Open the "Block State" page.

➤ Check whether all connected energy storage blocks are displayed.

➤ Check the configuration against the data sheet and the position list.

➤ Check external communication (CAN or ETH).

➤ Sign the identification label of the battery system and attach it to the energy storage rack so that it is clearly visible.

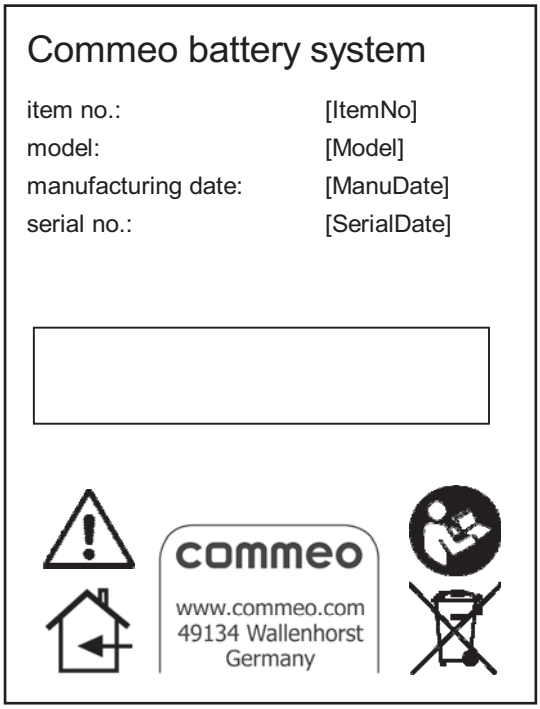


Fig. 30: Identification label

15.1.1 Configuring the dashboard

Selecting a predefined view

➤ A predefined view (default) exists for the dashboard. Additional customised views can be saved as predefined views.

➤ Press .

➤ Select the desired predefined view from the "Presets" drop-down menu.

Customising the dashboard

The dashboard can be customised.

NOTE

Only one custom layout can be saved per computer and browser.

The custom layout applies to all systems accessed via the same IP address or hostname.

Fig. 31: Dashboard

➤ Drag tile to the desired position by clicking and holding ═.

➤ Press 👁 for more options:
- 👁: Tile is displayed. Click to hide the tile.
- 🙈: Tile is hidden. Click to show the tile.
- ↔: Cycle through tile width. When the maximum width is reached, the tile jumps to the minimum width.
- ↕: Cycle through tile height. When the maximum height is reached, the tile jumps to the minimum height.

➤ Save the layout with "Save Layout".

✔ The layout is saved in the "Presets" selection menu under the name "Saved Layout".

15.2 Starting/stopping the battery system

Starting the battery system

➤ Start the HV battery system in one of the following ways:
  – Close the START/STOP contact > 1 s potential free by a relay or a switch, or
  – send a start command via CAN or ETH to the ccuHV control unit (see "ccuHV Interface Description").

If the voltage difference between the HV battery system and the DC circuit connected via the BATTERYSYSTEM + and – load contacts is too high (for example, in a de-energised state), the ccuHV control unit first carries out an automatic precharge process.

NOTICE!

➤ For proper operation, it is imperative to observe the correct switching logics and switching sequences of the components in the energy storage system (for example, consisting of battery system, inverter, AC and DC disconnectors).

NOTICE!

During the precharge process, no power may be accessed by connected external components via the HV battery system (charging or discharging). This can damage internal components.

NOTE

The precharge function of the ccuHV control unit limits the magnitude of the inrush current to protect connected external components.
The precharge process may take a few seconds depending on the system.

NOTE

If the DC input capacity of the connected external components is too large, the precharge process is aborted prematurely and the battery system reports an error.

➤ Observe the maximum prechargeable DC input capacity of connected external components, see Section "Functionality" on page 21.

NOTE

If the precharge process is faulty, the system must cool down before being switched on again. Depending on the load, this can take between 30 s and up to 5 min.

If the precharging process is completed and the status of all energy storage blocks is within the operation window, the HV battery system is started.

✔ The HV ACTIVE LED lights up green.

✔ Voltage is applied to BATTERYSYSTEM + and –.

● The ccuHV control unit automatically adjusts the charge states of the energy storage blocks to each other (balancing).

➤ Fully charge the HV battery system after commissioning.

➤ Do not use the HV battery system one time for the automatic balancing of the energy storage blocks for at least 24 h after it has been commissioned and fully charged for the first time.

Switching off the battery system

NOTICE!
To protect the internal and external components, switching off should take place in a de-energised state. No more power should be accessed by connected external components via the HV battery system (charging or discharging).

NOTICE!
Switching off under load leads to increased wear of the HV relays. If the relays are switched off too often under load, the ccuHV control unit permanently locks the battery system against being switched on again (critical error).

➤ Switch off the HV battery system in one of the following ways:
– Close the START/STOP contact > 5 s potential free by a relay or a switch, or
– Send a switch-off command via CAN or ETH to the ccuHV control unit (see "ccuHV Interface Description")

✔ The HV battery system switches off.

✔ The HV ACTIVE LED lights up red.

✔ If the shutdown is successful, there is no voltage present at BATTERYSYSTEM + and –.

NOTE
After switching off, the HV battery system is initially blocked against being switched on again for a period of at least 30 seconds.

15.3 Starting/stopping HV battery systems connected in parallel

NOTE
For additional information on controlling parallel systems refer to the "ccuHV Interface Description".

Starting battery systems

➤ When connecting 2 or more battery systems directly connected in parallel, start the HV battery systems one at a time.

NOTE
Before connecting 2 or more HV battery systems in parallel, they must be brought to the same voltage level (voltage difference +/– 3 % maximum), otherwise the precharge process cannot be completed successfully.

✔ If all HV battery systems have switched on without an error message (the HV ACTIVE LED lights up green and system state "ON" is reported), the connection was successful.

Switching off battery systems

➤ Switch off all battery systems independently of each other according to the specifications for a single battery system (Section "Starting/stopping the battery system" on page 69).

15.4 Operating the battery system

When switched on, the battery system can be charged and discharged within the permissible operation window. The maximum permissible charging and discharging power for the current operating state of the battery system is recalculated at high frequency by the ccuHV control unit and communicated to connected components via the State of Power (SoP) using the data interface (see document "ccuHV Interface Description"). The SoP thus serves as the central control parameter for the battery system. Other operation modes, such as fixed IU characteristics, are also possible in principle, provided these remain within the specifications of the SoP at all times.

NOTE
The battery system tolerates ripple currents on the battery cables only to a limited extent.

➤ Limit AC components to < 3 A when charging or discharging the battery system in order to avoid a fault disconnection by the ccuHV control unit.

NOTE

Exceeding the SoP results in an operating fault and immediate shutdown by the ccuHV control unit.

A power control response time of 1 second or less is therefore recommended in order to be able to react as quickly as possible to changes in the SoP and to prevent an error shutdown by the ccuHV control unit.

16 Error and warning messages

The control unit transmits error and warning messages to external components via the CAN and ETH connections (Section "CAN" on page 31 and Section "ETH" on page 32). The current error messages and unacknowledged errors are displayed in the user interface (Section "UserInterface" on page 40).

NOTE
A list of current and historical system events can be downloaded from the user interface on the "Service/Support" page under "System Events" (Section "Service/Support" on page 45).

The safety concept includes 3 consecutive fault categories to protect the battery system:

- Warning messages: Current operating conditions may cause an operational error or critical error to occur and cause an automatic shutdown by the ccuHV control unit.
  The ccuHV control unit reports the warning message to the user interface.
- Operational error: Application error, the device is not working properly.
  The ccuHV control unit reports the error to the user interface and de-energises the battery system.
- Critical error (safety relevant): serious error.
  The ccuHV control unit reports the error to the user interface, de-energises the battery system and switches to the interlock.

WARNING!
Fire hazard
Batteries operated outside the operation window may catch fire.

NOTE
A complete listing and explanation of all error and warning messages can be found in the CAN bus definition document "ccuHV Interface Description" from Commeo.

16.1 Critical errors

Critical errors indicate irreparable damage to individual system components, such as energy storage blocks.

A critical error of an energy storage block in the battery system always leads to a shutdown of the entire battery system ("Error" status). In addition, the battery system is set to interlock.

If the battery system is in the interlock status, it cannot be switched on via the software. The defective energy storage block prevents the battery system from operating.

DANGER!
Danger to life due to electric current
The switch on the back of the energy storage racks is not disconnected from the power supply by the control unit.

➤ Do not make any changes to the battery system structure.

NOTICE!

➤ After shutting down your battery system due to a critical error, contact Commeo support immediately

NOTE
A complete description of the error and warning messages can be found in the document "ccuHV Interface Description".

NOTE
Switching off due to excessive humidity within an energy storage block depends on the temperature. The maximum relative humidity is 80 %.

16.2 Operational error

Operational errors indicate errors in the application. Operational errors can be corrected by specialists in handling Commeo HV battery systems.

After the cause of an operational error has been eliminated and the error condition is no longer present, the operational error can be acknowledged. If multiple operational errors are present whose causes have been corrected, then these can be acknowledged together.

The HV battery system can only be put back into operation when all pending operating faults have been acknowledged.

Operational errors can be acknowledged in different ways:

- Pressing the error reset button in the user interface.
- Sending an error reset command via CAN or ETH to the ccuHV control unit (see "ccuHV Interface Description").

Operational errors can cause irreparable damage to individual system components if the cause of the error is not corrected.

NOTE
A complete description of the error and warning messages can be found in the document "ccuHV Interface Description".

16.3 Warning messages

Warning messages indicate changes in technical parameters in the direction of the limits of the operation window.

➤ Observe the operation window to prevent a safety-relevant shutdown of the battery system.

NOTE
A complete description of the error and warning messages can be found in the document "ccuHV Interface Description".

17 Maintenance

➤ Check the following points once a year:
- The ccuHV control unit is operated with current software.
- Energy storage blocks and ccuHV control unit are externally in perfect condition.
- Air circulation outside the energy storage blocks is possible without any problems.
- The log of system events in the user interface ("System Events"; see Section "Service/Support" on page 45) shows no recurring error and warning messages.
- Permissible installation conditions at the installation site are complied with (see Section "Installation site and conditions" on page 54).

NOTE
In case of recurring error and warning messages in the "System Events" log, contact Commeo Sales to obtain more comprehensive, historical information on the status of the system from the "System Log".

17.1 Updating the software of the control unit

The software of the control unit is constantly developed and improved. When a new software version is available, Commeo will provide it together with the installation instructions.

➤ Follow the installation instructions regarding the software update of the control unit.

17.2 Calibrating the battery system

If the message "Calibration Recommended" is displayed, the battery system should be calibrated.

NOTE
The accuracy of the calibration is increased if the battery system is discharged to exactly 0 %.

➤ Discharge the battery system to < 10 %.

➤ Charge the battery system until the SoC of the battery system reaches 100 %.

✔ "Calibration Recommended" is automatically reset.

➤ Switch off the battery system.

✔ The "HV ACTIVE LED" lights up red.

➤ Let the battery system rest for 10 minutes.

➤ Start the battery system.

18 Cleaning and care

WARNING!
Danger to life due to electric current

➤ Never wipe over the contacts with damp cloths.

➤ Do not use a high pressure cleaner.

NOTICE!

➤ Do not use harsh detergents, compressed air or hard objects for cleaning, as these can damage the device.

➤ Clean the outside of the energy storage rack with a dry cloth.

➤ Verify compliance with the permissible degree of contamination of the installation site (maximum degree of contamination 2, see Section "Installation site and conditions" on page 54).

19 Decommissioning/disassembly

An energy storage block has reached its maximum operating time (end of life) as soon as one of the following conditions occurs:

- Residual capacity of the energy storage block < 80 %
- Operating time of the energy storage block > 12 years

The ccuHV control unit has reached its maximum operating time (end of life) as soon as the following condition occurs:

- Operating time of the control unit > 12 years

WARNING!
Fire hazard

➤ When performing removal at a height of more than 1 m, the energy storage block should only be moved with great care and fall protection.

WARNING!
Danger to life due to electric current

➤ Only use fully insulated tools during disassembly.

NOTICE!

➤ Do not exert pressure on the housing of the energy storage blocks during disassembly.

Carry out the disassembly as follows:

➤ Switch off the load that is operated via the load contacts of the ccuHV control unit.

➤ Disconnect the external 24 V power supply from the ccuHV control unit.

➤ Switch off the battery system.

➤ Disconnect the EPO connector from the ccuHV control unit.

➤ Disconnect all remaining plugs and cables from the connectors on the front of the ccuHV control unit.

NOTE
The use of the optional handles or the optional lifting device from Commeo to install the energy storage blocks is recommended.

➤ Contact Commeo Sales.

➤ Disassemble the energy storage blocks from the top to the bottom of the heavy duty shelves.

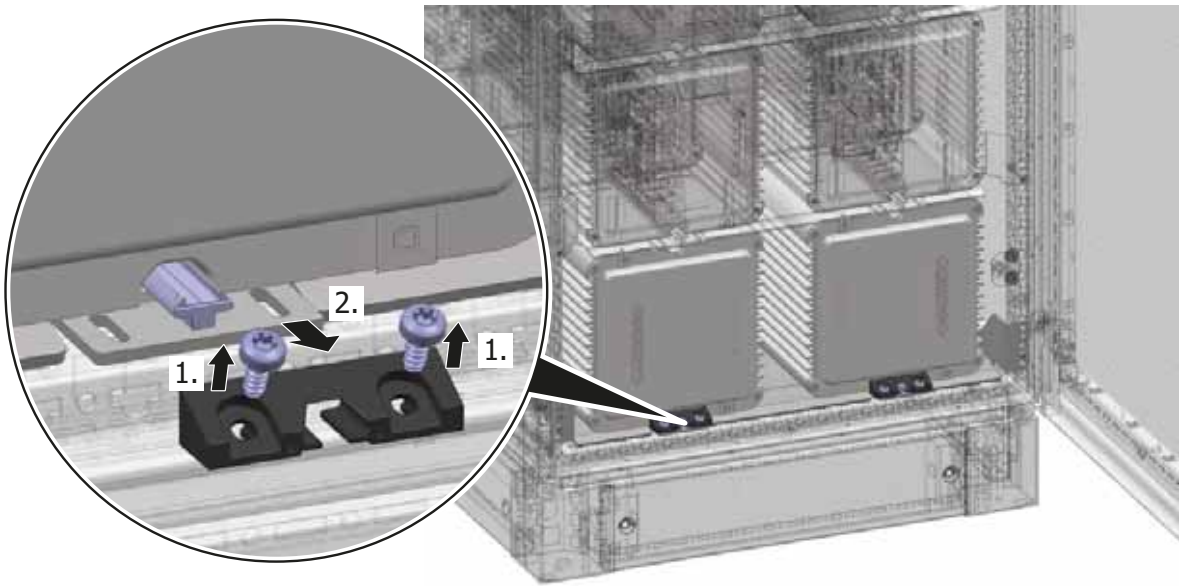


Fig. 32: Loosen the end wedges in the energy storage rack

➤ Loosen the end wedges behind the last respective energy storage block.

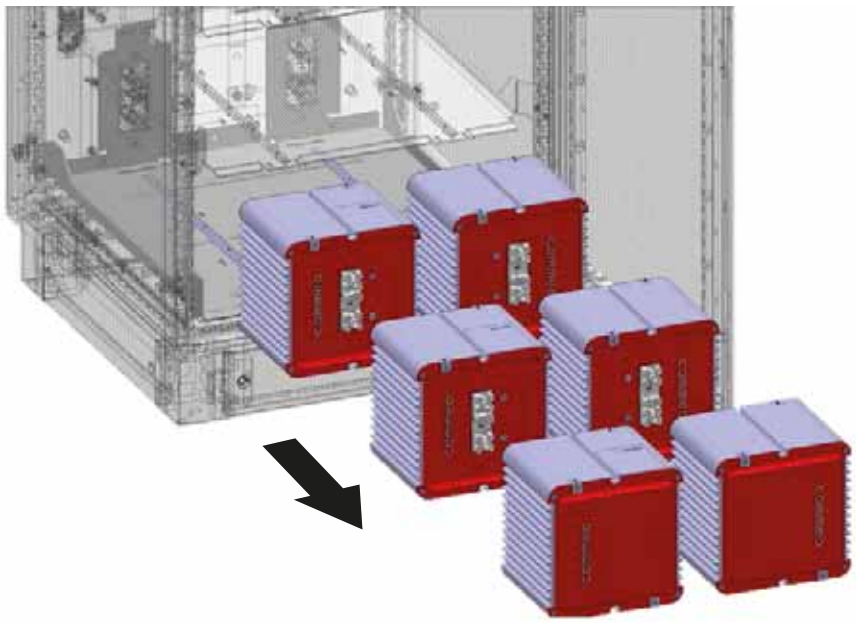


Fig. 33: Pull the energy storage blocks out of the energy storage rack

➤ Pull the end block from the T-section.

➤ When all type E energy storage blocks have been disassembled, disassemble all type P or S energy storage blocks from top to bottom:

➤ Pull the energy storage block from the T-section.

➤ Remove the screws on the ccuHV control unit.

➤ Pull the ccuHV control unit forward in the energy storage rack until the contacts of the ccuHV control unit are accessible.

➤ Loosen the following contacts:
- BATTERY –
- BATTERY +
- Battery CAN 1
- Battery CAN 2

➤ Pull the ccuHV control unit out of the energy storage rack.

✔ Further dismantling work can now begin.

20 Disposal

Batteries must be disposed of or recycled properly.

➤ If the battery is damaged or at the end of its life, take it out of service and contact Commeo.

➤ Do not expose the battery to moisture or direct sunlight.

➤ Ensure rapid removal by the installer or Commeo.

21 Software licenses

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Germany

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- GPL Version 2.0
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22 Technical data

See data sheet of the respective device.

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energy storage solutions

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