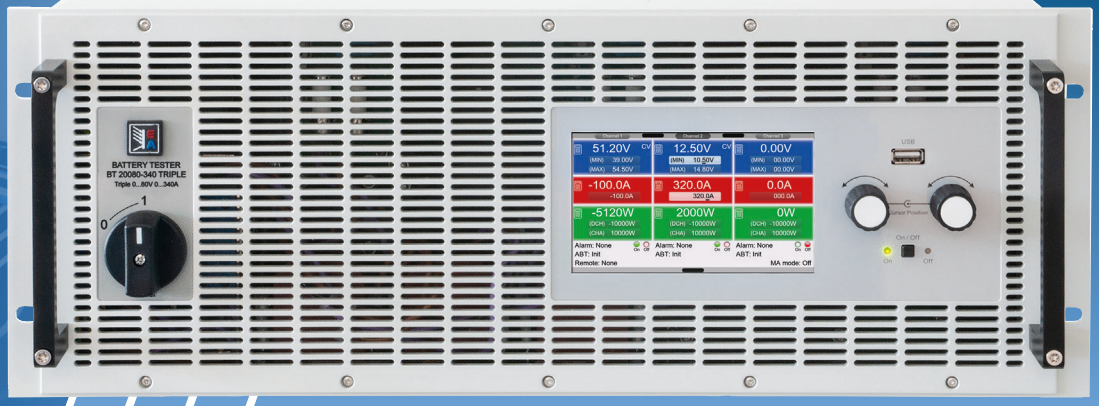
Elektro-Automatik



Three channels

INSTALLATION MANUAL

EA-BT 20000 TRIPLE 4U

Battery tester with regenerative energy recovery

Safety instructions, installation, commissioning

Revision: 03

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1. About this document

You must read this document before you operate the battery tester with energy recovery for the first time or if you are tasked with other work on the battery tester with energy recovery.

1.1 General information

This document serves as installation instructions for the device models listed in *«1.1.3 Application area»* and for their commissioning. The safety instructions in section *«2.5 Safety»* must be observed and implemented in particular. Operation and use are explained in a separate document, the user manual.

1.1.1 Storage and use

This document should be kept for future reference and, if possible, in the vicinity of the device. It explains how to use the device. This document must be carried along when changing location and/or user.

The latest version of this document can be found online on our website.

1.1.2 Copyright protection

Reproduction, duplication or use of this document for purposes other than its intended purpose is not permitted and may result in legal action if this is not complied with.

1.1.3 Application area

This document applies to the following models and their variants:

Model	Model
EA-BT 20010-400 4U Triple	EA-BT 20200-140 4U Triple
EA-BT 20010-600 4U Triple	EA-BT 20360-80 4U Triple
EA-BT 20060-340 4U Triple	EA-BT 20500-60 4U Triple
EA-BT 20080-340 4U Triple	EA-BT 20920-40 4U Triple

1.1.4 Characters and symbols used in this document

The following signs and symbols are used in this document:

- Listing: The text after this symbol describes the list of individual points.

1. Numbers: The text after this symbol describes instructions that must be carried out in the specified order from top to bottom.

1.1.5 Structure of the warnings

Warnings and safety instructions as well as general instructions in this document are always in a framed box and provided with a symbol.

Signal word	Use for ...	Possible consequences if the safety instructions are not observed:
DANGER	Personal injury (imminent danger)	Death or serious injury!
WARNING	Personal injury (potentially dangerous situation)	Death or serious injury!
CAUTION	Personal injury	Slight or minor injuries!

The warnings are structured as follows:

- Pictogram with signal word corresponding to warning level
- Description of the hazard (type of hazard)
- Description of the consequences of the hazard (hazard consequences)

DANGER

Type of hazard (text)

- Consequences of danger (Text)

Special safety instructions are provided at the relevant points. They are labeled with the following symbols.

	**Warning of dangerous electrical voltage - This symbol indicates activities where there is a risk of electric shock, possibly with fatal consequences.**
	**Information symbol for a risk of damage to the device - If attached to the device, the symbol prompts the user to consult the device documentation.**
	**General danger zone** - This sign is placed in front of activities where there is a risk of personal injury and extensive damage to property.
	*General note - Additional information*

1.2 Warranty and guarantee

EA Elektro-Automatik GmbH guarantees the functionality of the applied process technology and the specified performance parameters. The warranty period begins with defect-free handover. The warranty provisions can be found in the General Terms and Conditions (GTC) of EA Elektro-Automatik GmbH.

1.3 Limitations of liability

All information and instructions in this manual have been compiled taking into account applicable standards and regulations, the state of the art and our many years of knowledge and experience. The manufacturer accepts no liability for damage due to:

- Improper use
- Use of untrained and uninstructed personnel
- Unauthorized conversions
- Technical changes
- Use of unauthorized spare parts

The actual scope of delivery may differ from the explanations and illustrations described here in the case of special versions, the utilization of additional ordering options or due to the latest technical changes.

1.4 Product key

Breakdown of the product designation on the rating plate using an example:

EA-BT 20010 - 600 Triple 4U xxx

xxx	Options and special versions: **WC** = Water cooling installed
4U	Design/construction (only indicated on type plate): **4U** = 19" design with 4 U
Triple	**Triple** = Triple output
600	Maximum current per channel in Amperes
20010	Maximum voltage per channel in Volts (“20010” = 10 V)
20	Series labeling: **20** = 20000 series
EA-BT	Type labeling: **BT** = Battery Tester

2. General safety regulations

The battery tester with energy recovery may only be operated when in perfect technical condition and with functioning safety devices.

2.1 Intended use

The device is intended exclusively for use as a variable voltage or current source or as a variable current sink. Furthermore, it is only intended for operation as a device permanently installed in appropriate devices (19" cabinets, etc.), together with a permanent connection to the AC supply.

A typical area of application for a power supply unit as a source is the DC power supply of corresponding consumers of all kinds, for a battery tester the charging or discharging of various battery types, as well as for electronic loads the replacement of an ohmic resistor in the form of an adjustable DC current sink for the purpose of loading corresponding voltage and current sources of all kinds.

In addition to their functionality as a source or sink of electrical energy on the DC side, all these devices are also sources or sinks of electrical energy on the AC side. This is where the term “bidirectional power supply” comes from. In sink mode, all models become energy recovery units. By definition, however, such a device is not considered an energy generation system.

- Claims of any kind due to damage resulting from improper use are excluded
- The operator alone is liable for all damage caused by improper use

2.2 Foreseeable incorrect instruction

Any use other than that specified under “intended use” or use beyond this is considered improper use.

For damage resulting from improper use

- the operator bears sole responsibility,
- The manufacturer accepts no liability whatsoever.

2.3 Obligations of the operator

The operator is any natural or legal person who uses the device or allows third parties to use it and is responsible for the safety of the user, staff or third parties during use.

The device is used in the commercial sector. The operator of the device is therefore subject to the legal obligations regarding occupational safety. In addition to the warnings and safety instructions in this manual, the safety, accident prevention and environmental protection regulations applicable to the area of use of the device must be observed. In particular, the operator must:

- inform themselves about the applicable health and safety regulations.
- carry out a risk assessment to determine possible additional hazards arising from the specific application conditions at the place of use of the device.
- implement the necessary behavioral requirements for operating the device at the place of use in operating instructions.
- check regularly whether the operating instructions drawn up by him correspond to the current status of the regulations during the entire period of use of the device.
- adapt the operating instructions to new regulations, standards and operating conditions where necessary.
- clearly and unambiguously regulate the responsibilities for the installation, operation, maintenance and cleaning of the device.
- ensure that all employees working on the device have read and understood the device documentation. In addition, he must train staff in the use of the device at regular intervals and inform them of the potential hazards.
- Provide the prescribed and recommended protective equipment to the personnel authorized to work on the device.

Furthermore, the operator is responsible for ensuring that the device is always in perfect technical condition.

2.4 Requirements for the operating personnel

Only persons who are able to carry out their work properly and reliably and who fulfill the relevant specified requirements may carry out any work on devices of this type.

- Persons whose ability to react is impaired, e.g. by drugs, alcohol or medication, must not carry out any work.
- When deploying personnel, always observe the age and occupation-specific regulations applicable at the place of deployment.

RISK OF INJURY DUE TO INSUFFICIENT QUALIFICATION!

Improper work can lead to personal injury and damage to property.

Only persons who have the necessary training, knowledge and experience may carry out any activities.

In addition, the authorized group of users is restricted to two groups of people:

Instructed personnel: These are persons who have been instructed in detail and verifiably by the operator about the tasks assigned to them and possible hazards.

Specialist personnel: Such personnel are those who, on the basis of their professional training, knowledge and experience as well as knowledge of the relevant regulations, are able to carry out the assigned work properly, recognize possible dangers independently and avoid personal injury or damage to property.

2.4.1 Responsibility of the operator

The device is in commercial use. Staff are therefore subject to the legal obligations regarding occupational safety. In addition to the warnings and safety instructions in this manual, the safety, accident prevention and environmental protection regulations applicable to the area of use must be observed. In particular, the persons operating the device must:

- inform themselves about the applicable health and safety regulations.
- properly fulfil the assigned responsibilities for operating, maintaining and cleaning the device.
- have read and understood the device documentation in full before starting work

2.5 Safety

2.5.1 Safety instructions

Danger to life - dangerous voltage

When operating electrical devices, certain externally accessible parts of the device are inevitably live, sometimes dangerously so, with the exception of the 10 V and 60 V models, which are intrinsically safe in accordance with SELV. Therefore, all live parts must be covered during operation!

Danger to life - dangerous voltage

The DC terminal is insulated from the mains supply and is not earthed in the device. Therefore, there can always be dangerous potential between the DC poles and PE, e.g. due to the application. Due to charged, internal capacitors, even when the DC terminal is already switched off.

Danger to life - dangerous voltage

Air-cooled models: Do not insert any mechanical parts, especially metal parts, into the device through the ventilation slots.

Danger to life - dangerous voltage

For any type of reconfiguration on the AC and DC terminals, i.e. all connections that could carry a voltage that is dangerous to touch, the device must be completely de-energised, i.e. it must be disconnected from the AC supply (main switch at the other end of the AC line); it is not sufficient to operate the mains switch.

Danger to life - dangerous voltage

Always observe the five safety rules when connecting and disconnecting electrical devices:

- **Disconnect (physical disconnection of all voltage sources from the device)**
- **Secure against being switched on again**
- **Determine absence of voltage**
- **Earthing and short-circuiting**
- **Cover or physically separate neighboring live parts**

Air-cooled devices: avoid using liquids of any kind in the vicinity of the device, as these could get into the device. Protect the device from moisture, humidity and condensation.

Do not connect external voltage sources with reversed polarity to the DC terminal! This will damage the device, even if it is completely switched off.

Do not connect any external voltage sources to the DC terminal that can generate a higher voltage than the nominal voltage of the device!

When working with sources that are not current-limited (e.g. battery, fuel cell), at least one fuse must be integrated in the DC circuit for each channel to which such a source is connected; this fuse must either correspond to the nominal current of the channel or less!

The device may only be used for its intended purpose!

The device is only authorized for operation within the connected loads and technical data specified on the rating plate.

Always configure protection functions against overcurrent, overvoltage etc. that the device offers for the load to be connected to suit the respective application!

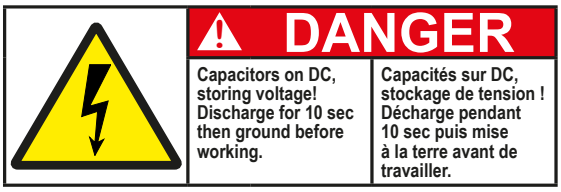
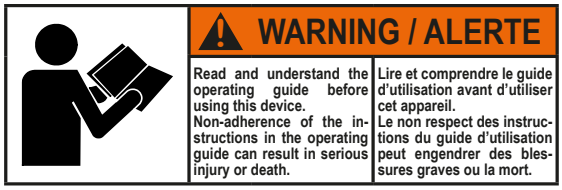
When operating as an electronic load: always ensure that the regenerative function can always safely dissipate the converted energy and that no island operation occurs. A monitoring device (mains and system protection) must be installed for stand-alone operation.

All types of generators or AC UPS power supplies are not permitted as AC connection sources for this device. It may only be operated directly from a mains supply!

With manual operation on the HMI and if the device is connected via any interface, an external control unit (PLC, PC, etc.) could take over the remote control at any time and set a dangerous voltage; it is recommended to disable the remote control when operating on the HMI by activating the so-called local mode (see *«2.4.2 Control locations»* and *«2.3.1 Configuration in the menu»* in the user manual).

The device is not intended for use in residential areas and cannot guarantee adequate protection of radio reception in such environments.

2.5.2 Symbols and instructions on the device

Sticker	Explanation
	Refers to connecting or reconfiguring the DC and/or AC connection. The AC supply must always be disconnected (main switch) so that the AC supply line is de-energized.
	Even after disconnecting the DC terminal from an external source, voltage may continue to be present between the DC poles or to the housing for an indefinite period of time. To be on the safe side, check that there is no voltage, and discharge, short-circuit and earth if necessary.
	In principle, electrical devices with metallic, touchable points can have voltage potentials, even if they are not life-threatening. There is still a risk of electric shock or sparking.
	Applies to the handling of the device in every respect.

2.6 Residual risks

The battery tester with energy recovery is built according to the state of the art and recognized safety regulations.

Even if all safety regulations are observed, a residual risk remains when operating the battery tester with energy recovery.

3. Technical description

3.1 General description

The BT 20000 4U series battery testers are based on bidirectional technology, which combines the function of a power supply unit (source) and an electronic load (sink), in this case with three identical but separate channels, each with a DC terminal. If required, the channels can be interconnected to form a channel with a higher current and higher power.

The main area of application for these devices is the targeted charging and discharging of batteries during tests in development and production, as well as recycling. Several new interfaces have been added to this new series. One of these is a digital I/O connection that provides terminals for controlling three contactors to isolate the batteries from the battery tester's DC terminals. This can be used to realize reverse polarity protection, among other things. While the device is in a discharging phase, it converts the absorbed energy and feeds it back into the local grid with a high degree of efficiency.

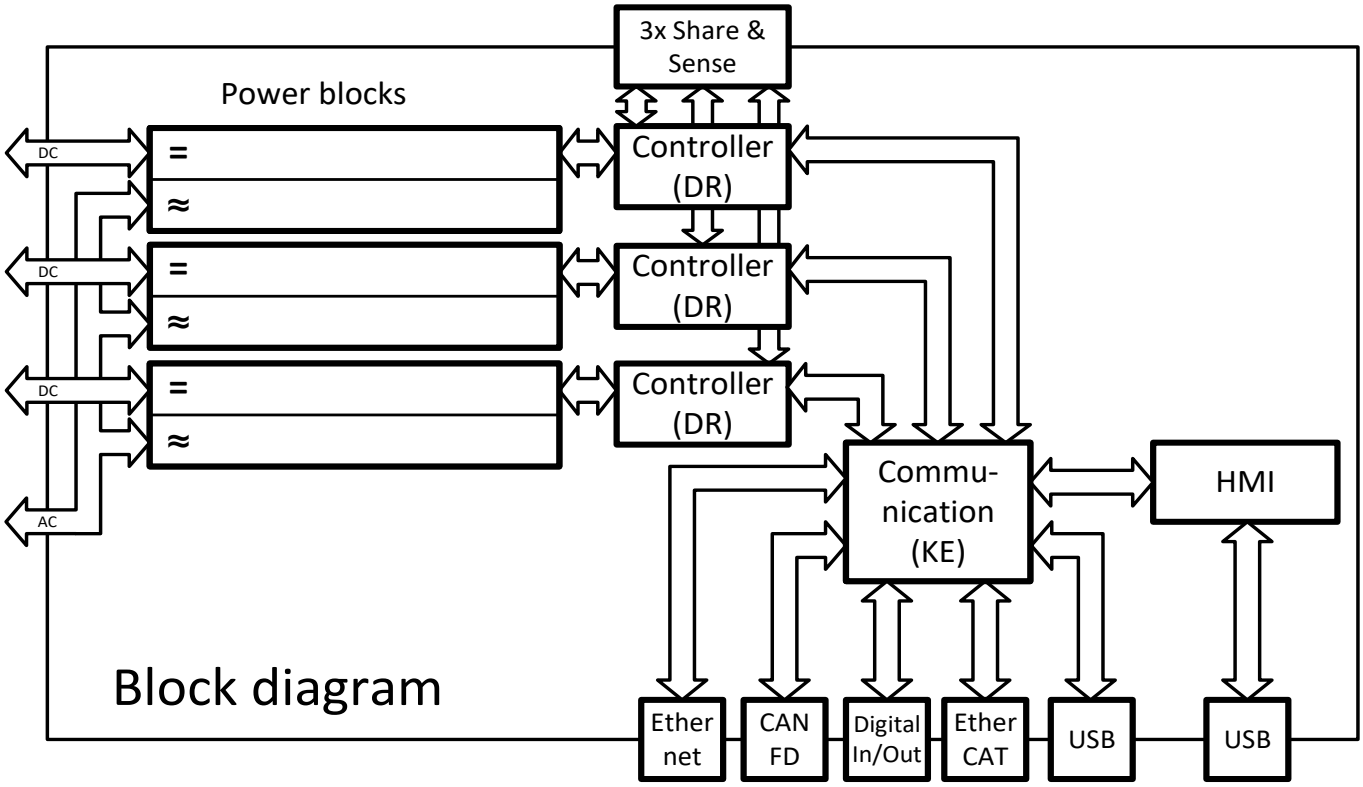
In addition to its function as a battery tester, the device is also a complete power supply unit and electronic load. In addition to the standard functions of power supplies, the integrated function generator can be used to generate sine, rectangular or triangular set value curves as well as other waveforms. Curves for the so-called arbitrary generator (99 interpolation points) can be saved to or loaded from a USB stick. For some functions, the function sequence can switch dynamically between source and sink mode by defining positive or negative current set values.

For remote control, all models have ports for USB, Ethernet, EtherCAT and CAN FD on the rear as standard. The EtherCAT ports also offer the option of setting up a parallel system consisting of several devices in order to increase the overall performance.

Water-cooled versions can be used as an alternative to the air-cooled versions. These are usually configured and offered in 19" enclosures to form a cabinet system with water cooling. Individual devices for self-construction of a corresponding system are available on request.

3.2 Block diagram

The block diagram is intended to illustrate the individual main components and their interaction. There are three digital, microcontroller-controlled components (KE, DR, HMI) that can be affected by firmware updates.



3.3 Scope of delivery

1 x battery tester
6 x connectors for remote sensing (2x per channel)
3 x connectors for polarity detection (1x per channel)
1 x 16-pin plug for the digital I/O connection
1 x USB cable 1.8 m
3 x DC terminal cover (1x per channel)
3 x sense terminal cover (1x per channel)
1 x USB stick with documentation and software
1 x AC connection plug (terminal type)
1 x set for AC cable strain relief

3.4 Accessories

As of 01/2025, no accessories are available.

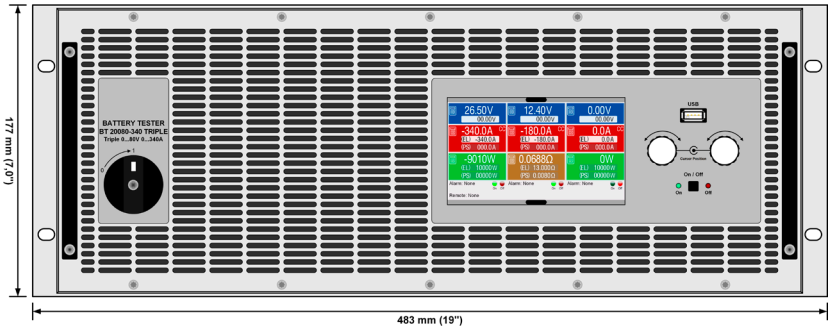
3.5 Options

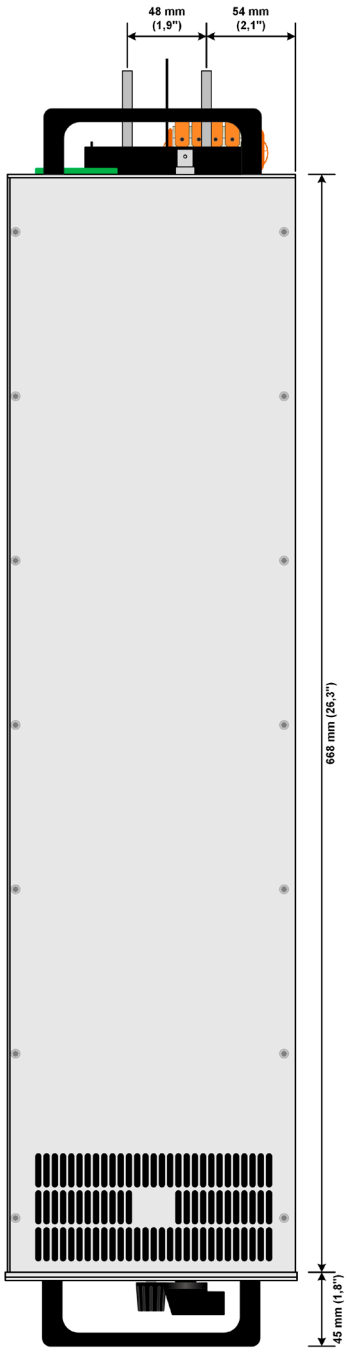
These options cannot be retrofitted, as they are permanently installed or preconfigured at the factory.

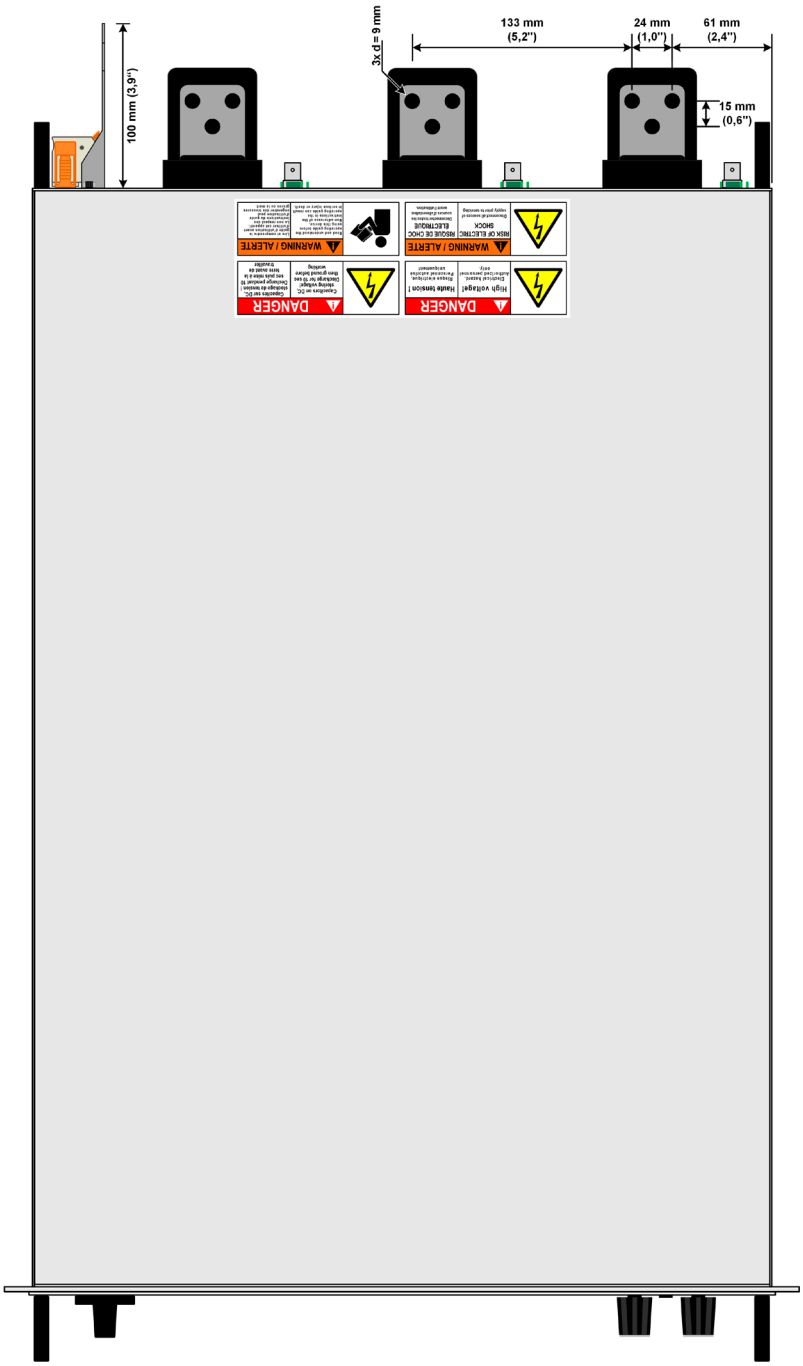
POWER RACKS 19" cabinets	Cabinets are available in various configurations up to 42 U as a parallel circuit system, also mixed with electronic loads to realist test systems. For further information see our website or make an inquiry.
WC Water cooling	Replaces the internal, air-cooled cooling blocks of the power stages with three connected, water-cooled blocks with two screw connections at the rear of the device. Water cooling helps to prevent the environment from heating up due to a certain, unavoidable loss of power, which inevitably occurs when a device or an entire system operates at high power in a cabinet. As a side effect, this type of cooling also reduces noise levels and is especially suitanle for dust-free operation.

4. Views of the device

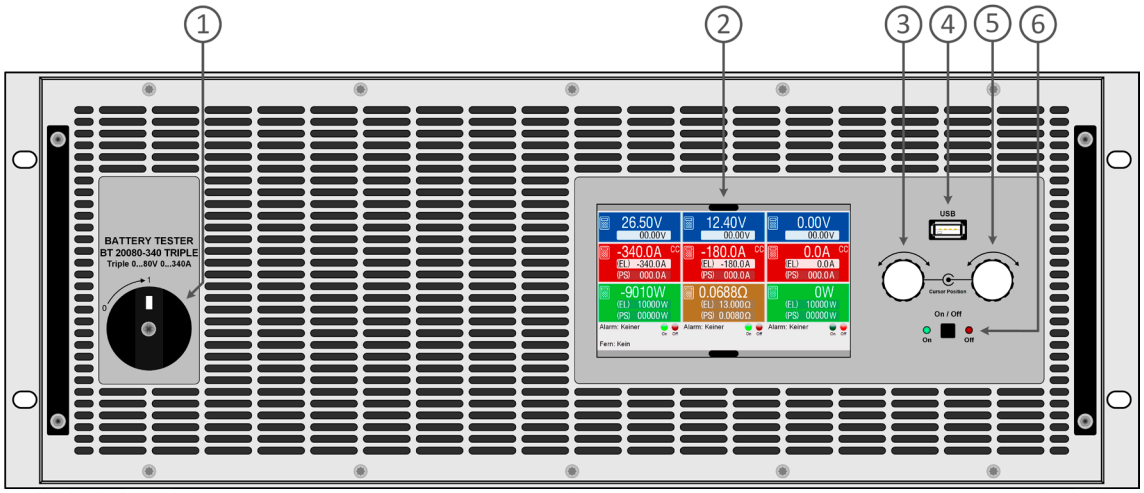
4.1 Technical drawings BT 20000 Triple 4U ≤200 V





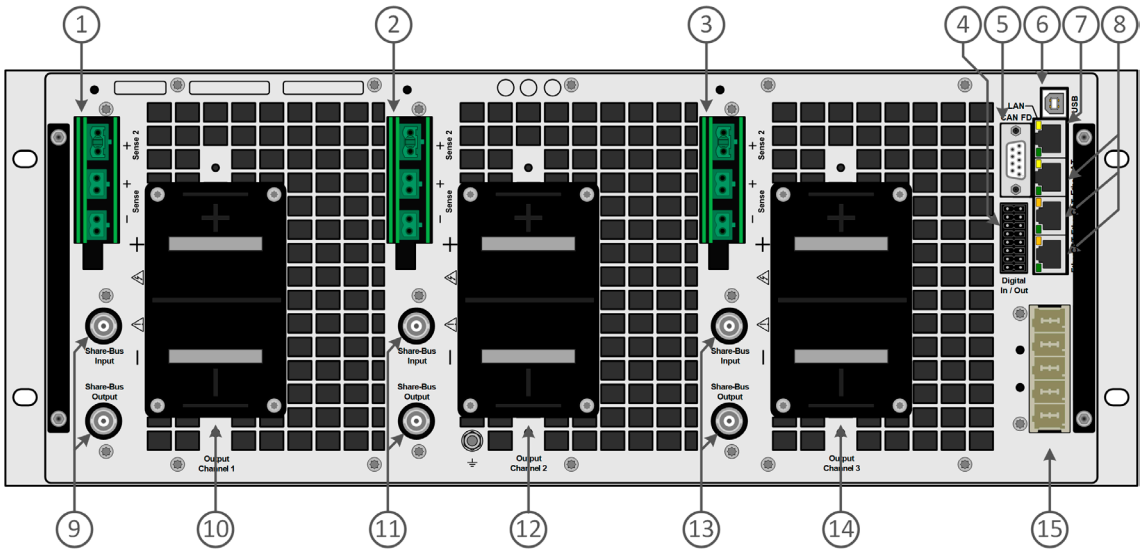


4.2 Front plate description BT 20000 Triple 4U



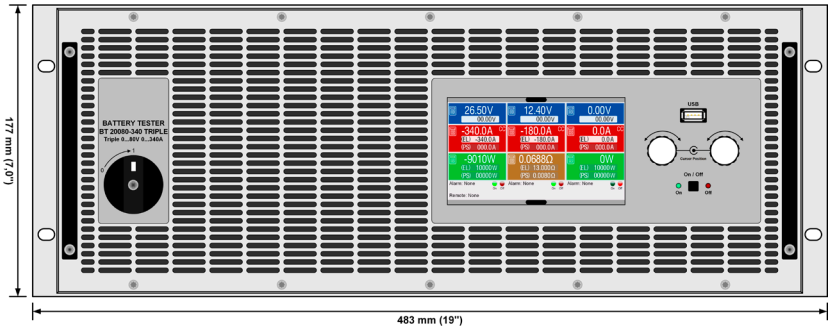
1. Mains switch
2. TFT display with touch-sensitive surface (touchscreen)
3. Rotary knob with touch function for settings
4. USB host for USB sticks for recording and reading data
5. Rotary knob with touch function for settings
6. On/off button with LED status indicator

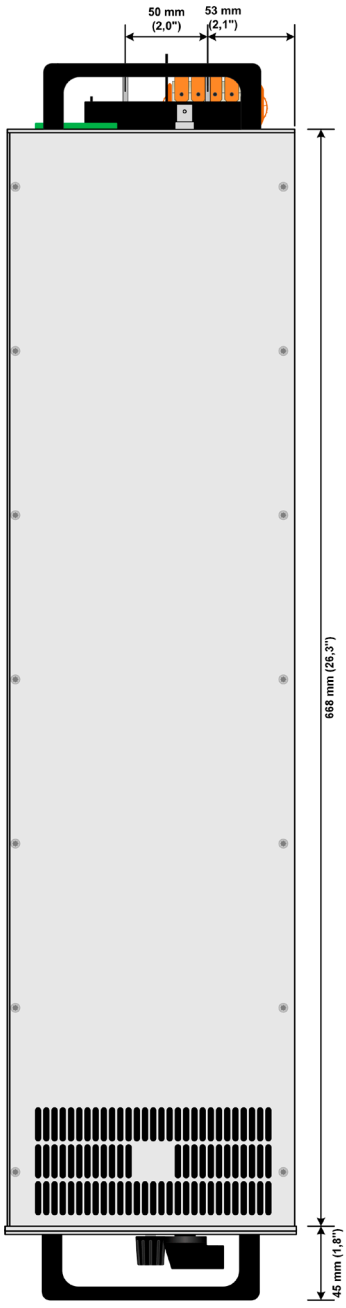
4.3 Back plate description BT 20000 Triple 4U ≤200 V

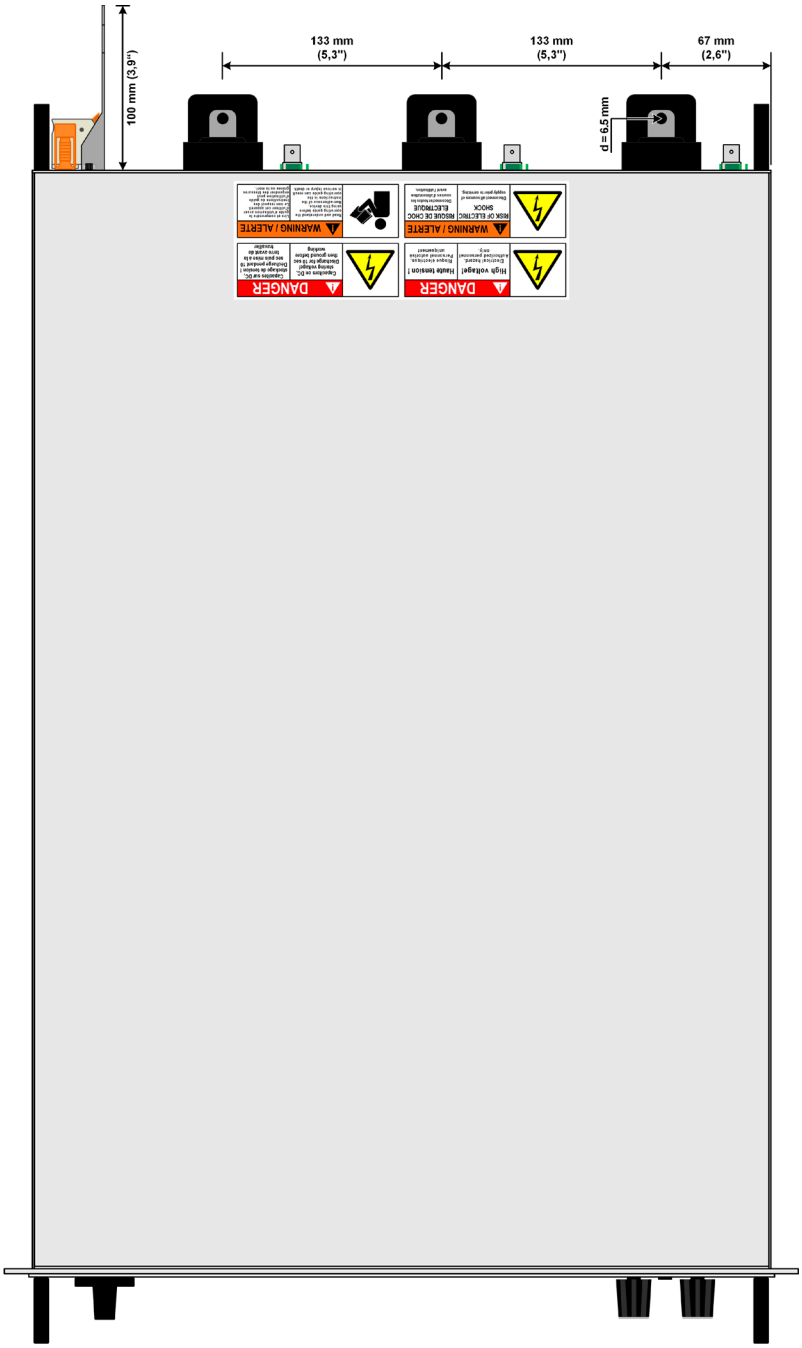


1. Remote sense connectors (Channel 1)
2. Remote sense connectors (Channel 2)
3. Remote sense connectors (Channel 3)
4. Digital In / Out (16-pin socket)
5. CAN FD interface
6. USB interface
7. Ethernet port
8. EtherCAT ports
9. Share-Bus connectors (Channel 1)
10. DC terminal with copper blades (Channel 1)
11. Share-Bus connectors (Channel 2)
12. DC terminal with copper blades (Channel 2)
13. Share-Bus connectors (Channel 3)
14. DC terminal with copper blades (Channel 3)
15. AC connector

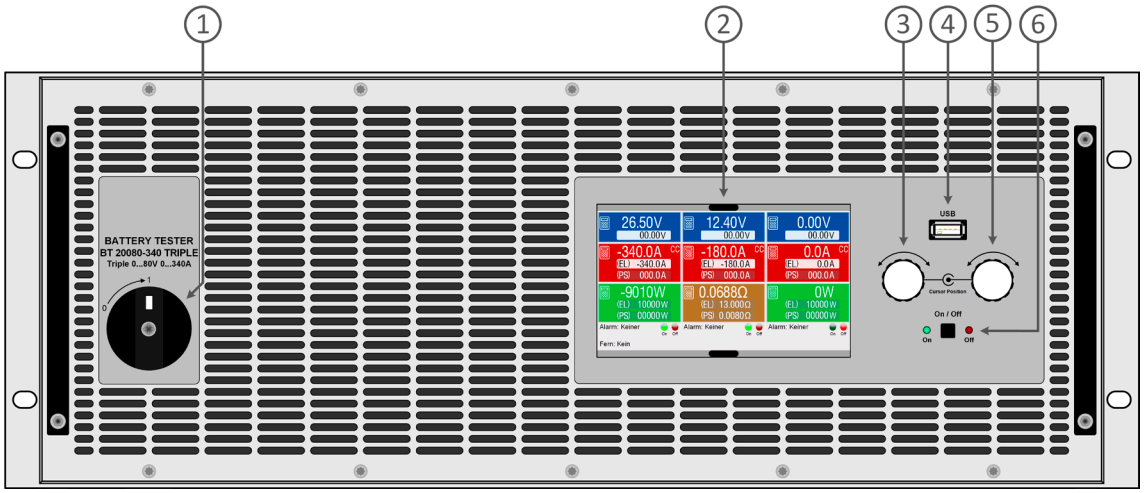
4.4 Technical drawings BT 20000 Triple 4U ≥360 V





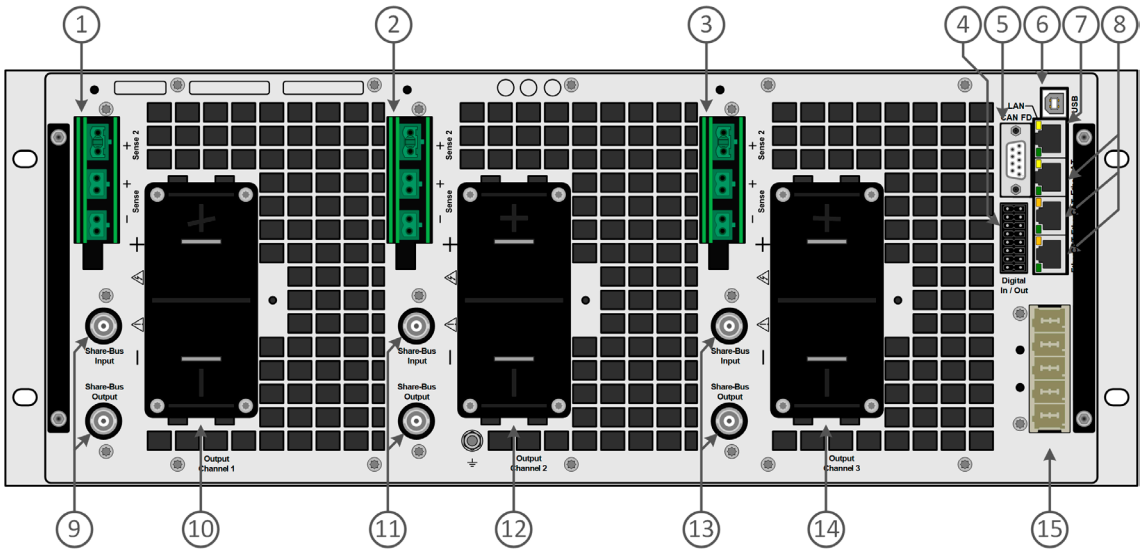


4.5 Front plate description BT 20000 Triple 4U



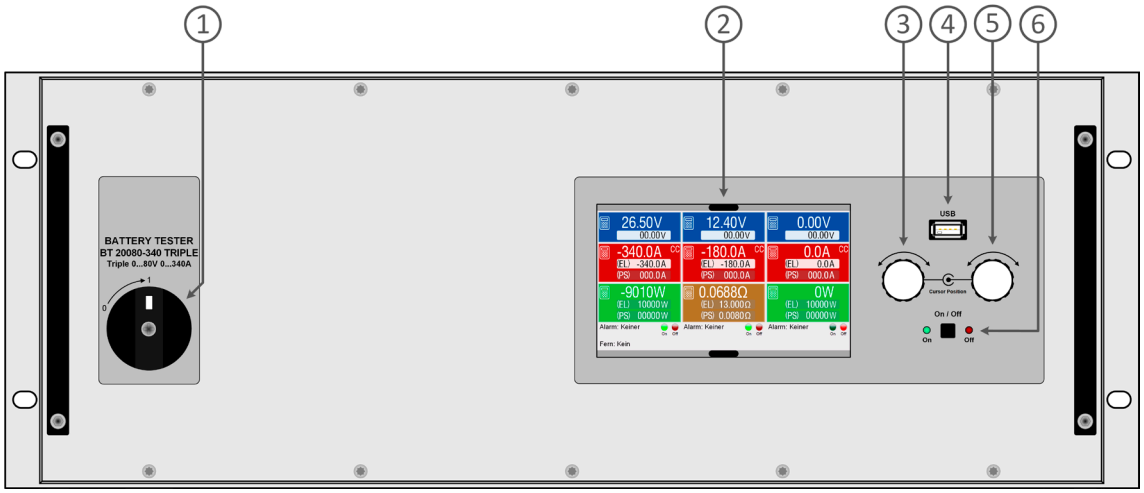
1. Mains switch
2. TFT display with touch-sensitive surface (touchscreen)
3. Rotary knob with touch function for settings
4. USB host for USB sticks for recording and reading data
5. Rotary knob with touch function for settings
6. On/off button with LED status indicator

4.6 Back plate description BT 20000 Triple 4U ≥360 V



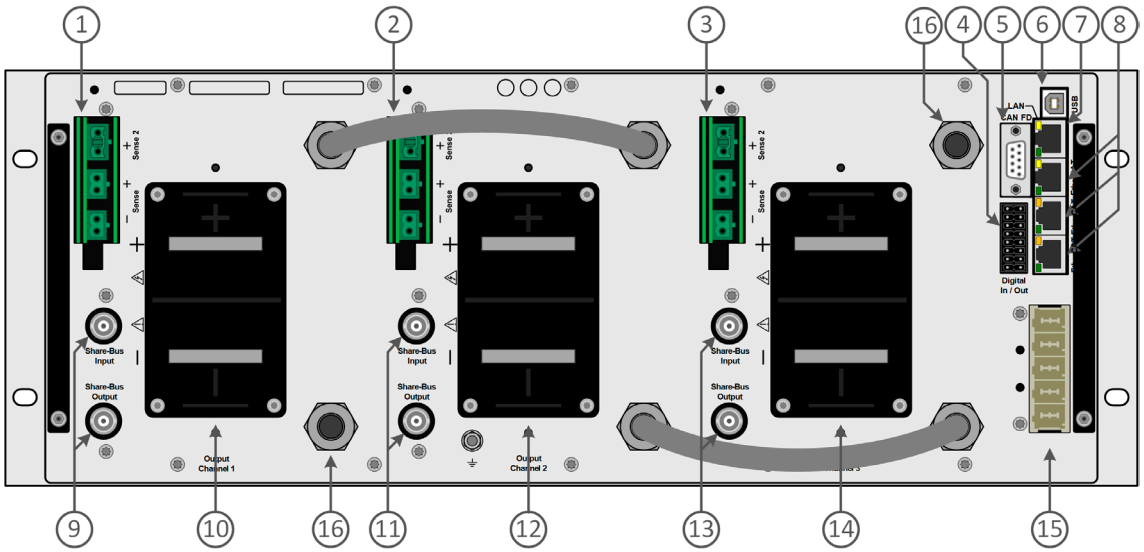
1. Remote sense connectors (Channel 1)
2. Remote sense connectors (Channel 2)
3. Remote sense connectors (Channel 3)
4. Digital In / Out (16-pin socket)
5. CAN FD interface
6. USB interface
7. Ethernet port
8. EtherCAT ports
9. Share-Bus connectors (Channel 1)
10. DC terminal with copper blades (Channel 1)
11. Share-Bus connectors (Channel 2)
12. DC terminal with copper blades (Channel 2)
13. Share-Bus connectors (Channel 3)
14. DC terminal with copper blades (Channel 3)
15. AC connector

4.7 Front plate description BT 20000 Triple 4U WC (water cooling)



1. Mains switch
2. TFT display with touch-sensitive surface (touchscreen)
3. Rotary knob with touch function for settings
4. USB host for USB sticks for recording and reading data
5. Rotary knob with touch function for settings
6. On/off button with LED status indicator

4.8 Back plate description BT 20000 Triple 4U WC (water cooling)



1. Remote sense connectors (Channel 1)
2. Remote sense connectors (Channel 2)
3. Remote sense connectors (Channel 3)
4. Digital In / Out (16-pin socket)
5. CAN FD interface
6. USB interface
7. Ethernet port
8. EtherCAT ports
9. Share-Bus connectors (Channel 1)
10. DC terminal with copper blades (Channel 1)
11. Share-Bus connectors (Channel 2)
12. DC terminal with copper blades (Channel 2)
13. Share-Bus connectors (Channel 3)
14. DC terminal with copper blades (Channel 3)
15. AC connector
16. Water connections

5. Control elements

5.1 Overview

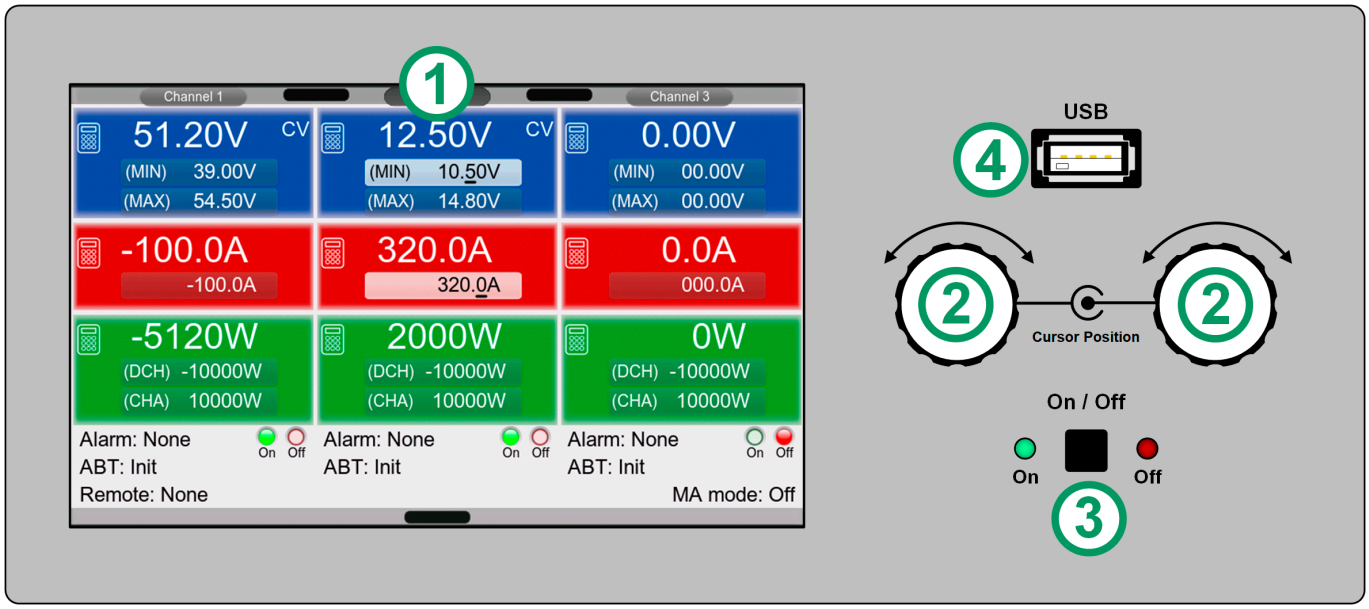


Figure 1 - Control panel

Overview of the control elements on the control panel

For a more detailed explanation, see section *«5.2 The control panel (HMI)»*.

(1)	**Display with touch-sensitive surface (touchscreen)** Used to select or enter set values, call up menus and display the actual values and status. The touchscreen can be operated with your fingers or with a pen (stylus).
(2)	**Rotary knobs with touch function** Left rotary knob (turn): Adjust the voltage set value Left rotary knob (press): Move the decimal point (cursor) of the voltage set value Right rotary knob (turn): Adjust the current or power set value Right rotary knob (press): Move the decimal point (cursor) of the assigned value
(3)	**Button for switching the DC terminals on and off** Used to switch the DC terminal of the currently selected channel on or off during manual operation and to start or stop a function. The two LEDs “On” and “Off” always indicate a summarized status of all three DC terminals. This means that the “On” LED would be on if at least one of the three DC terminals is on. On the other hand, the “Off” LED would only be on if all three are off at the same time. The on/off status of the individual channels can be read on the display either in the individual channel view or in the all channels view. An exception to the “On” LED and when it indicates what is the so-called active idle mode, if this has been enabled on at least one of the three channels. See *«2.2.1 Active idle mode»* in the user manual. Then the LED would also be on when the DC terminal is actually switched off.
(4)	**Slot for USB sticks** Used to hold commercially available USB sticks. See section *«5.2.5 USB port (front)»* for more information.

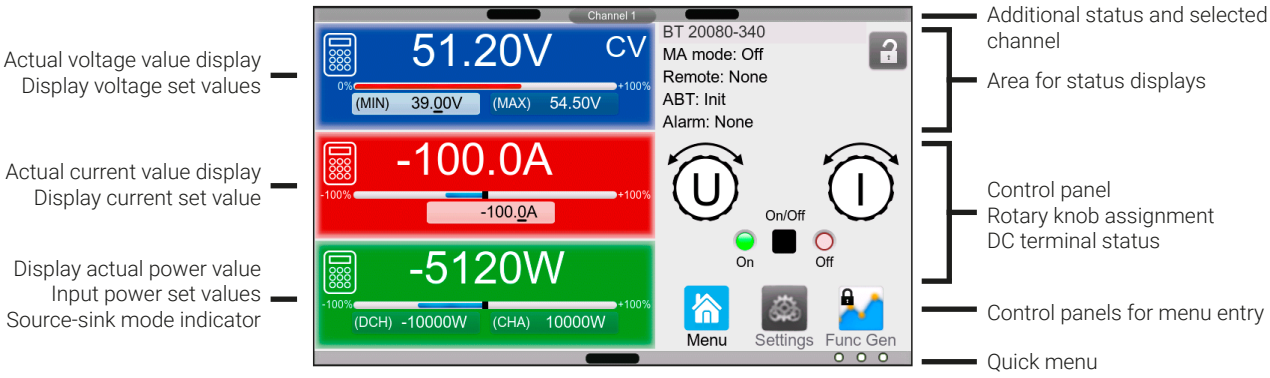
5.2 The control panel (HMI)

HMI stands for **H**uman **M**achine **I**nterface and consists of a display with a touch-sensitive surface (touchscreen), two rotary knobs, a button and a port for USB sticks.

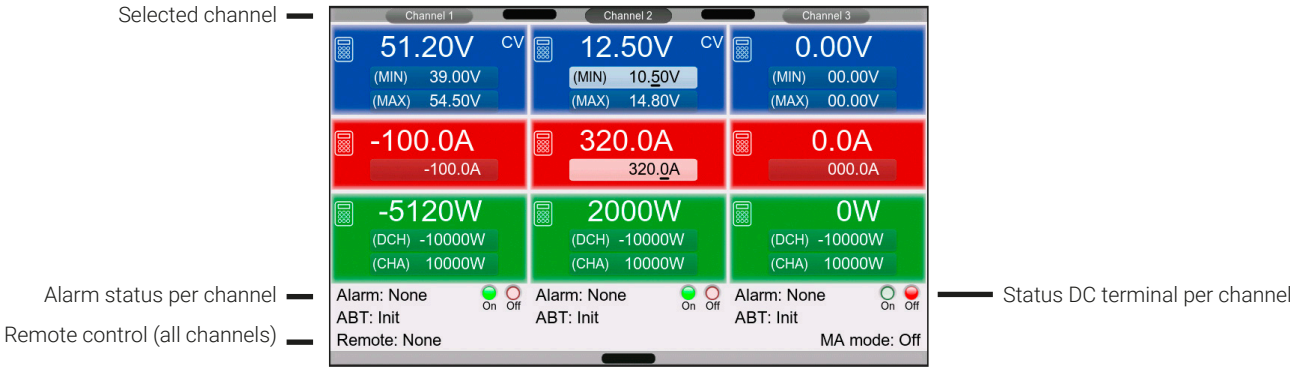
5.2.1 Display with touchscreen

The graphic display with touchscreen is divided into several areas. The entire surface is touch-sensitive and can be operated with a finger or a suitable pen (stylus) to control the device. In this series with three channels, the display can show either **single channel view** (channel 1, 2 or 3) or **multi-channel view** (channels 1-3).

In normal operation and **single channel view** , the display is divided as follows:



In normal operation and **multi-channel view** , the display is divided as follows:



Control panels can be locked or unlocked:

Menu — *Text black = released*

Func Gen — *Text greyed out = control panel currently locked*

This applies to all control panels. Some may also contain a lock symbol. The lock symbol means that the connected function is permanently blocked, e.g. by a specific setting.

- **Set values/actual value range (left part for single channel view, upper part for multi-channel view)**

In normal operation, the actual values (large numbers) and set values (small numbers) of voltage (blue background), current (red background) and power (green background) at the DC terminal of the respective channel are displayed here. There are two set values each for voltage and power, end-of-charge voltage (**MAX**) and end-of-discharge voltage (**MIN**), as well as charging (**CHA**) and discharging power (**DCH**). The current is specified via a signed value.

The actual values of current and power can be displayed as positive or negative (with sign). Negative values are assigned to discharge mode and indicate that the device is currently operating as an electronic load. In addition to the respective actual values, the current regulation mode **CV**, **CC** or **CP** is displayed when the DC terminal is switched on, as shown in the images above with **CC** as an example.

The set values can be adjusted using the rotary knobs to the right of the display or by direct input via the touchscreen, whereby the decimal point can be shifted by pressing the respective rotary knob when adjusting via the rotary knobs. The set values are each increased logically by 1 by turning to the right until they jump back to 0 after reaching the maximum value of 9. When turning clockwise, the set value decreases logically by one until it jumps back to 9 after reaching the minimum value of 0. When turning anti-clockwise, the adjustment works in the same way in the opposite direction.

General display and adjustment ranges:

Display value	Unit	Range	Description
Voltage actual value	V	0-125% U_{Nom}	Current value of the DC voltage
Voltage set value	V	0-102% U_{Nom}	Set value for limiting the DC voltage
Current actual value	A	0-125% I_{Nom}	Current value of the DC current
Current set values	A	0-102% I_{Nom}	Set value for limiting the DC current
Power actual value	W	0-125% P_{Nom}	Current value of the DC power according to P = U * I
Power set values	W, kW	0-102% P_{Nom}	Set value for limiting the DC power
Actual value ampere hours	Ah	0-99999.99 Ah	Capacity counter
Preset Ah limit	Ah	0-999.99 Ah	Ampere hour limit (CHA, DCH)
Adjustment limits U/I/P	various	0-102% of the nominal value	U-max, I-min etc., always related to a set value
Protection settings	various	0-110% of the nominal value	OVP, OCP, OPP (related to U, I and P)

- **Status displays**

In the **single channel view**, there is a status area in the top-right corner which, in the **multi-channel view**, is located beneath the set values of the three channels. This field displays various status texts and symbols.

Only available in **single channel view**:

Display	Description
	The HMI is locked (only displayed in single channel view)
	The HMI is not locked (only displayed in single channel view)

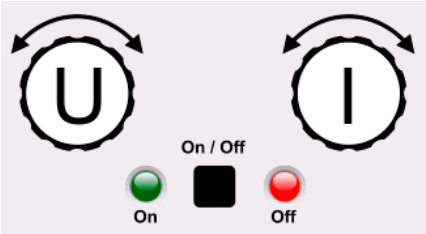
Available in **both view modes**:

Display	Description
Remote control:	The device is remotely controlled by...
Ethernet	...the built-in Ethernet interface
EtherCAT	...the built-in EtherCAT interface
CAN	...the built-in CAN interface
USB	...the built-in USB interface
Profinet	...the built-in Ethernet interface via Profinet
Local:	The device has been explicitly locked against remote control by user input
Alarm:	A device alarm has occurred that is still present or has not yet been acknowledged
Event:	A user-defined event has been triggered
MA mode: Master (n Aux)	Master-auxiliary mode activated, device is master of n auxiliary units
MA mode: Auxiliary	Master-auxiliary mode activated, device is auxiliary unit
FG:	Function generator enabled, function loaded (only in remote control)
	Data logging to USB stick active or failed

- **Field for assigning the rotary knobs and status of the DC terminals**

The two rotary knobs next to the display can be assigned to different functions. In normal operation and when the main display is visible, the assignment of the rotary knobs is shown in the area below the status. This can only be seen in the **individual channel view** and can be selected per channel. This means that it could change when switching to another displayed channel.

The assignment can be changed by tapping the right-hand button image if the control panel is not locked.



The physical quantities on the button illustrations show the assignment. The left rotary knob is permanently assigned to the voltage (U). The right rotary knob can be switched by tapping the graphic on the touchscreen. The status of the DC terminal of the currently selected channel is also indicated by the two LEDs (lights up green = on).

The following rotary knob assignments are possible:

U I	**U P**
Left rotary knob: Voltage	Left rotary knob: Voltage
Right rotary knob: Current	Right rotary knob: Power

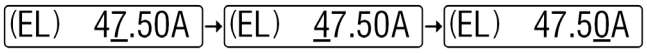
As the device has two current and power set values per channel, you can switch between the 4 set values by tapping several times, whereby I and P can each appear twice on the rotary knob. The non-selected set values cannot be set using the rotary knobs, but you can tap on the set values for voltage, current or power to change the assignment or to enter values directly using a numeric keypad. To do this, tap the small numeric keypad symbol ( ). **This input form allows for set value jumps**.

5.2.2 Rotary knobs

As long as the device is operated manually, the two rotary knobs can be used to set the set values in the main display. For a more detailed explanation of the individual functions, see *«7.3 Manual operation (1)»*.

5.2.3 Touch function of the rotary knobs

The rotary knobs have a push-button function that is used to move the cursor from lower to higher decimal positions (rotating) when adjusting values manually:



5.2.4 Resolution of the display values

Set values can be set in the display in defined increments. The number of decimal places depends on the device model. The values have 4 or 5 digits. Actual values and set values have the same number of digits.

Adjustment resolution and display width of the set values in the display:

Voltage, OVP, UVD, OVD, U-min, U-max		
Nominal value	**Digits**	**Min. increment**
≤80 V	4	0.01 V
200 V	5	0.01 V
360 V	4	0.1 V
500 V	4	0.1 V
920 V	4	0.1 V

Current, OCP, UCD, OCD, I-min, I-max		
Nominal value*	**Digits**	**Min. increment**
<100 A	4	0.01 A
>100 A	4	0.1 A
MA <100 A	4	0.01 A
MA >100 A	4	0.1 A

Power, OPP, OPD, P-max		
Nominal value*	**Digits**	**Min. increment**
<10000 W	4	1 W
10000 W	5	1 W
MA ≤20 kW	4	0.01 kW

Ampere hours		
Value	**Digits**	**Min. increment**
Ah limit	5	0.01 Ah

* MA = Master-Auxiliary

5.2.5 USB port (front)

The USB port on the front, which is located above the two rotary knobs, is used to accommodate standard USB sticks. These can be used to load or save your own sequences for the arbitrary and XY function generator.

USB 2.0 and USB 3.0 standard sticks are accepted, which must be formatted in **FAT32** . All supported files must be located in a folder called **HMI_FILES** in the main path of the USB drive, so that, for example, a path G:\HMI_FILES would result if the USB stick was connected to a PC and assigned the drive letter G:. Subfolders are permitted. If a folder contains files of a certain type, e.g. files beginning with “wave”, the device will only ever list the first 20 that it can find.

The control panel of the device can read the following file types and names from the USB stick:

File name	Description	Section in the user manual
wave_u<arbitrary>.csv wave_i<arbitrary>.csv	Function Generator arbitrary function for the voltage U or current I. The name must start with ***wave_u*** or ***wave_i*** , the rest is arbitrary.	*3.9.1*
profile_<arbitrary>.csv	Previously saved user profile. A maximum of 10 profiles are displayed for selection when loading.	*2.3.7*
psb_fc<arbitrary>.csv	FC table for the XY Function Generator. The name must start with ***psb_fc*** , the rest is arbitrary.	*3.12*
iu<arbitrary>.csv	IU table for the XY function generator. The name must contain ***iu*** at the beginning, the rest is arbitrary.	*3.11.1*

The control panel of the device can write the following file types and names to the USB stick:

File name	Description	Section in the user manual
usb_log_<nr>.csv	Recording file (log) for normal USB data recording in all operating modes. The structure of the log file is identical to that of the logging function in the **EA Power Control** software. The <nr> field in the file name is automatically incremented if there are already files with the same name in the folder.	*2.3.5*
profile_<nr>.csv	Saved user profile. The number at the end is a consecutive number (1-10) and is not linked to the number of a user profile in the HMI. A maximum of 10 profiles are displayed for selection when loading.	*2.3.7*
wave_u<nr>.csv wave_i<nr>.csv	Data of the 99 interpolation points (sequences) of the arbitrary function for voltage U or current I.	*3.9.1*
battery_test_log_<nr>.csv	File with log data recorded from the battery test function. For a battery test log, data different and/or additional to log data of normal USB logging is recorded.	*3.13.10*
psb_fc<nr>.csv	Table values of the FC function as calculated by the device. The table can be reloaded.	*3.12*

5.3 USB port (rear)

The USB port on the back of the device is used for communication with the device. The device can be connected to a PC using the USB cable supplied (USB 2.0, USB 3.0). The driver is supplied and installs a virtual COM port. Details on remote control can be found in further documentation on the USB stick supplied or on the device manufacturer's website.

The device can be addressed via this port either via the internationally standardized ModBus RTU protocol or via SCPI language. It automatically recognizes the protocol used in a message.

If the remote control is to be enabled, the USB interface has no priority over one of the other remote control interfaces and can therefore only be used alternately with these. However, monitoring is always possible.

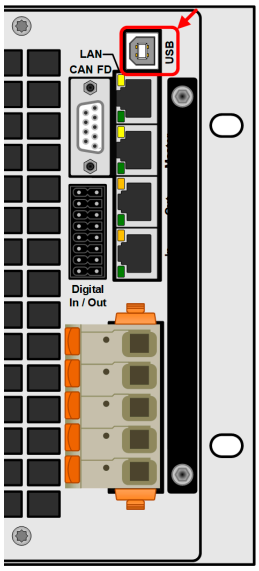


Figure 2 - USB

5.4 CAN FD port (rear)

This 9-pin Sub-D connector with the standard pin layout for CAN offers CAN 2.0 A&B and CAN FD functionality. The standard operating mode is CAN. However, the mode can be switched to CAN FD via a setting in the menu or via a remote control command, or the enable bit rate switch (BRS for short) associated with CAN FD can be enabled.

In **CAN** mode, the port supports the common baud rates from 10 kbit/s to 1 Mbit/s, as well as 11- or 29-bit ID formats.

In **CAN FD** mode, two additional data rates of 2 Mbit/s and 5 Mbit/s are added, both of which are linked to a 500 kbit/s bus baud rate.

The port also contains an electronically switchable bus terminating resistor (120 Ω), which is controlled by a setting in the menu.

If the remote control is to be enabled, the CAN interface has no priority over one of the other remote control interfaces and can therefore only be used alternately with the others. However, monitoring is always possible.

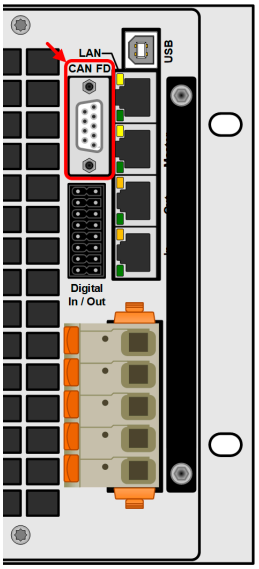


Figure 3 - CAN FD

5.5 Share-Bus connectors (rear)

There are two BNC sockets (50 Ω type) per channel on the back of the device for the digital Share-Bus associated with each channel. This Share-Bus is bidirectional and, when the three channels are connected in parallel in the so-called **channel grouping** mode, the channels are connected to each other for fast equalization. The master channel, i.e. the channel that is operated or remote-controlled, is always channel 1.

Another form of parallel connection, called master-auxiliary, is the connection of the individual channels of several devices to each other, on the one hand at their DC terminals and on the other hand at the Share-Bus. This results in a multi-channel master-auxiliary system.

BNC cables of suitable length can be purchased in electronics stores.

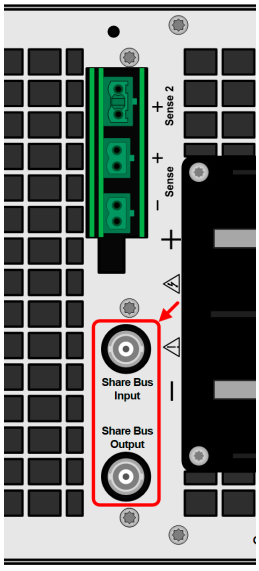


Figure 4 - Share-Bus

5.6 Sense connections, remote sensing (rear)

To compensate for the voltage drop across the lines from the source or to the load, the separate input for each channel, labeled **Sense**, can be connected to the external source or load of the channel with the correct polarity using two dual plugs, one each for plus and minus (included in the scope of delivery).

If the device is connected correctly and while the DC terminal is switched on, the device will measure the voltage to be regulated at the **Sense** input. The maximum possible regulation is specified in the technical data.

The other input “Sense 2” belongs to a functionality called “False polarity detection”. See section *«2.5.2 False polarity detection»* in the user manual.

Electrical voltage

For safety reasons, the covers supplied for the sense connections must always be fitted during operation if cables are connected to the sense input. Reason: these remote sensor cables can carry dangerously high voltages!

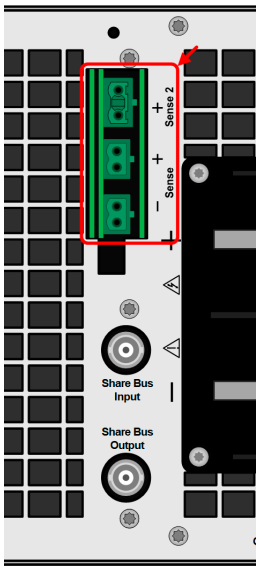


Figure 5 - Remote sense

5.7 EtherCAT ports (rear)

All models in this series have three EtherCAT connections on the rear. The connection, referred to as **Master**, is used exclusively to control other units in the sense of a **Master-Auxiliary System** (**MA** for short). The auxiliary units (auxiliary, **aux** for short) are controlled and monitored by the master via this connection, from which it creates a totalization of the actual values and summary of the status, presents it on its display and outputs it on its digital interfaces. This series therefore results in a three-channel MA system.

The user can enable or disable MA mode on the master or the aux units as required.

The EtherCAT ports, labelled **EtherCAT In** and **EtherCAT Out,** offer the typical functionality of an EtherCATslave. A single device or a master of an MA system can be controlled remotely via these ports if it is part of a higher-level EtherCAT network.

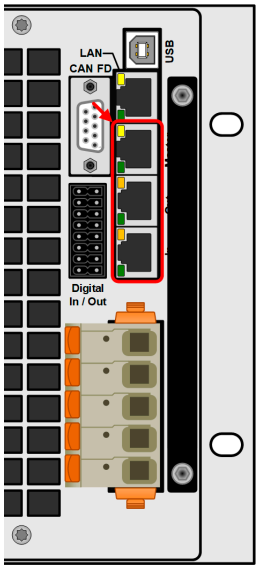


Figure 6 - EtherCAT

5.8 Ethernet port (rear)

The Ethernet/LAN port (type: RJ45) on the back of the device is used for communication with the device in terms of remote control or monitoring, as well as for firmware updates. It supports the internationally standardized ModBus RTU protocol as well as SCPI and ModBus TCP, in this case via the dedicated socket port 502.

The network parameters can be configured manually or via DHCP. Transmission speed (10/100/1000 MBit/s) and duplex mode are set automatically, independent of DHCP.

If remote control is to be enabled, the Ethernet interface has no priority over one of the other remote control interfaces and can therefore only be used alternately with these. However, monitoring is always possible.

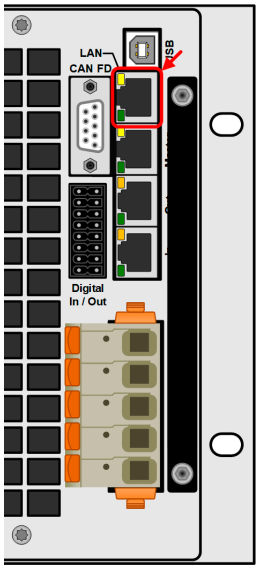


Figure 7 - LAN

5.9 Digital In / Out port (rear)

This connection is used to record and control various signals relating to the battery test. It offers several outputs and inputs for e.g. temperature monitoring of the battery body or another component involved in the battery test, such as a contactor, via a digital 1-wire temperature sensor. The monitoring can switch off the DC terminal of the affected channel when an adjustable threshold is reached to prevent overheating. A fast-stop function can be realized via a digital-in port, which disables the DC terminals independently of other default values (see section *«2.4.5 Quick Stop»* In the user manual). Another function of the port is to control an external switch (contactor) as part of reverse polarity protection. All inputs and outputs are available in triplicate, once per channel.

A suitable plug is included in the scope of delivery.

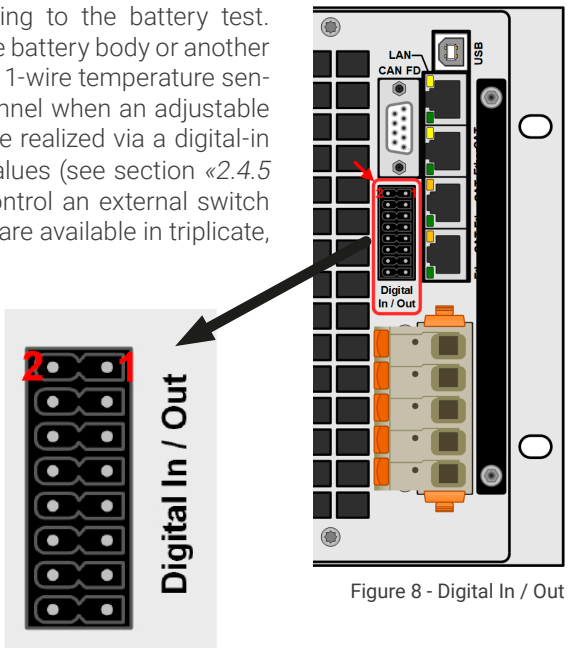


Figure 8 - Digital In / Out

5.9.1 Technical data of the "Digital In / Out" port

Pin	Name	Type	Description	Electrical properties
1	**DI1**	Input	Universal, digital input 1	Nominal voltage: 24 V DC Logically high: 15...35 V DC Logically low: 0...5 V DC
2	**DI1_GND**	Potential	Reference potential for the digital input DI1	
3	**DI2**	Input	Universal, digital input 2	
4	**DI2_GND**	Potential	Reference potential for the digital input DI2	
5	**DI3**	Input	Universal, digital input 3	
6	**DI3_GND**	Potential	Reference potential for the digital input DI3	
7	**REL1_1**	Contact	Potential-free normally open contact of relay 1, associated with channel 1	Switching voltage: 24 V DC Continuous switching current: 2 A Switching cycles: 100,000
8	**REL1_2**	Contact		
9	**REL2_1**	Contact	Potential-free normally open contact of relay 2, associated with channel 2	
10	**REL2_2**	Contact		
11	**REL3_1**	Contact	Potential-free normally open contact of relay 3, associated with channel 3	
12	**REL3_2**	Contact		
13	**TEMP1**	Input	Temperature sensor input, belonging to channel 1. Supported sensor type: Analogue devices DS18B20, MAX31820. Reference: TGND	1-wire supply: 3.3 V DC Logically high: 1.9...3.3 V DC Logically low: 0...0.9 V DC Temperature range: -55...+125°C
14	**TGND**	Potential	Reference potential for TEMP1, TEMP2 and TEMP3	
15	**TEMP3**	Input	Temperature sensor input, belonging to channel 3. Supported sensor type: Analogue devices DS18B20, MAX31820. Reference: TGND	
16	**TEMP2**	Input	Temperature sensor input, belonging to channel 2. Supported sensor type: Analogue devices DS18B20, MAX31820. Reference: TGND	

A matching **plug** is included with the device. Follow the manufacturer's instructions for installation.

Order designation: Phoenix Contact DFMC 1.5/ 8-ST-3.5

Maximum conductor cross-section: 1.5 mm²

5.10 Water cooling

In contrast to the air-cooled version of the models in this series, water cooling is an optional cooling alternative that is permanently installed during production and therefore cannot be retrofitted. Cooling the device with water instead of air has the following advantages:

- Less noise due to a closed housing
- No direct heat emission into the ambiance of the device

The following are disadvantages compared to conventional air cooling:

- The device must not be operated without a constant water supply
- Water poses an increased risk of damage to the electronics, e.g. due to leaks or condensation in the device caused by humidity (condensation)

The water connection is located on the back of the device, see also the drawing in section *4.* More information on connection, specifications and operation of water cooling can be found in section *«6.3.4 Connecting the water supply (WC models)».*

6. Installation and commissioning

6.1 Transport and storage

6.1.1 Transport

- The handles on the front and rear of the device are **not** for carrying!
- Due to its heavy weight, the device should not be transported by hand if possible or, if transport by hand is unavoidable, it should only be held by the housing and not by the attachments (handles, DC terminal, rotary knobs)
- Do not transport the device when it is switched on or connected!
- If the device is moved to another location, we recommend using the original transport packaging
- The device should always be set up or carried horizontally
- If possible, wear suitable protective clothing, especially safety shoes, when carrying the device, as the sometimes heavy weight can cause serious injuries in the event of a fall

6.1.2 Packaging

It is recommended that the complete transport packaging (delivery packaging) is kept for the lifetime of the device so that it can be reused for subsequent transport of the device to another location or return of the device to the manufacturer for repair. Otherwise, the packaging must be disposed of in an environmentally friendly manner.

6.1.3 Storage

For longer storage of the device when not in use, we recommend using the transport packaging or similar packaging. The device must be stored in dry rooms and packed as airtight as possible to prevent corrosion caused by humidity, especially inside the device.

6.2 Unpacking and visual inspection

After each transport with or without transport packaging or before initial installation, the device must be inspected for visible damage and completeness of the delivery. To do this, compare the delivery with the delivery note and the scope of delivery, see section *«3.3 Scope of delivery»*. An obviously damaged device (e.g. loose parts inside, external damage) must not be put into operation under any circumstances.

6.3 Installation

6.3.1 Safety measures before installation and use

- The device has a considerable weight. Therefore, before setting up the device, make sure that the installation location (cabinet, shelf, 19" rack) can bear the weight of the device without restrictions.
- When installing in a 19" enclosure, mounting rails suitable for the width and weight of the enclosure (see *«10. Technical data»*) must be fitted.
- Before connecting the device to the AC power supply, ensure that the connection data specified on the device's rating plate is observed. Overvoltage at the AC connection can damage the device.
- The device includes an energy recovery function that feeds energy back into the local or public grid, similar to a solar system. Feeding back into the public grid must not take place without observing the applicable guidelines of the local energy supplier and, if necessary, it must be checked before installation, but at the latest before commissioning, whether so-called grid and system protection must be installed!

6.3.2 Preparation

6.3.2.1 Choice of connection cable

A fixed connection is provided for all models in this series, for which there is a 5-pin connection on the rear of the device. A suitable, touch-safe plug is included in the scope of delivery. At least one 4-pole (3x L, PE) supply cable with an appropriate cross-section and length must be provided for wiring the plug. A full assignment with an additional N conductor is permissible. For recommendations on the cross-section, see *«6.3.5 Connecting to the mains supply (AC)»*. There are several things to consider when dimensioning the DC cables to match the load:

- The cross-section of the cables should always be designed for at least the maximum current of the device
- Continuous current loading of the cables at the permissible limit generates heat that may have to be dissipated, as well as a voltage drop that depends on the cable length and the heating of the cable. To compensate for this, the cross-section must be increased or the cable length reduced.

6.3.2.2 Additional measures for grid-feeding devices

All models in this series function as so-called mains regenerative devices when they are operating in sink mode.

With grid-feeding devices, energy is fed into the local grid or the grid operator's grid, otherwise sink operation is not possible. If the energy fed back into the grid exceeds local demand, the surplus is fed into the public grid. Without prior consultation with the local energy supplier, this feed-back may be unauthorized under certain circumstances.

Under certain circumstances, it may be useful to monitor the grid connection for grid irregularities (e.g. deviations in grid voltage, grid frequency) using a special safety module (network and system protection, for short: NS). This can also prevent so-called “isolated operation”. It refers to a self-sufficient energy system that operates without a connection to the public power grid. This is conceivable if an upstream circuit breaker or fuse trips.

Concept of NS protection:

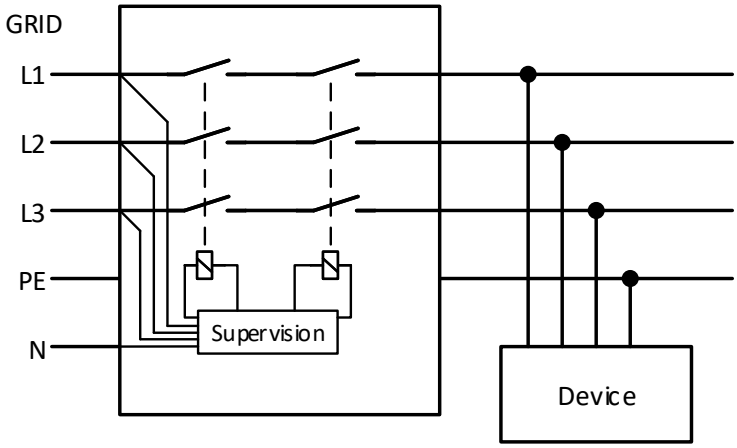
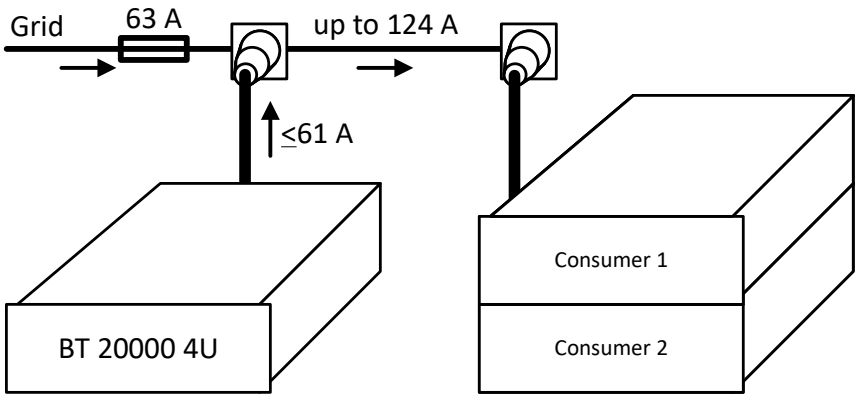


Figure 9 - Principle of an NS protection

6.3.2.3 System protection for regenerative power supply

A BT20000 feeds the energy back into the local grid at the installation site in sink mode. The regenerative current of a BT20000 can add to the current fed in from the power supply network and this could overload the existing electrical installation. The connection concept on site must therefore be considered accordingly to avoid damage and accidents.

Illustration with a regenerative device and loads:



With a larger number of regenerative devices on the same line of the installation, the total current per phase increases accordingly.

6.3.3 Setting up the device

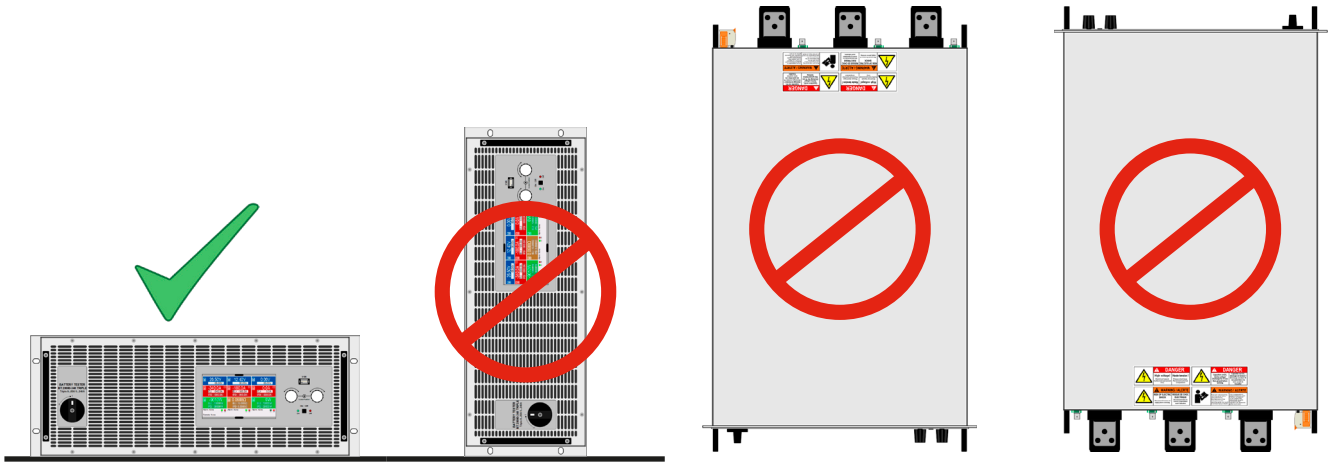
- Select the installation location so that the supply lines to the load or source can be kept as short as possible
- Leave sufficient space behind the device, but at least 30 cm, for the exhaust air to escape from the rear (standard version, air-cooled)
- The device must not be operated without adequate, double contact protection for the AC side, which can only be achieved either by installing it in a cabinet with lockable doors or by installing additional protective measures (covers or similar) that are not supplied with the device

All models in this series require fixed installation in a suitable device (cabinet, etc.) and a fixed connection (AC). Operation on a table is not permitted.

A device in 19" design is usually installed on corresponding mounting rails and in 19" racks or cabinets. Attention must be paid to the installation depth of the device and its weight. The handles on the front are used to push the cupboard in and pull it out. Slotted holes on the front panel are used for mounting in the 19" cabinet (mounting screws not included).

The unauthorized installation positions shown below also refer to installation on a vertical surface, such as a wall (room or in a cabinet). The necessary air flow is then not guaranteed.

Permitted and unauthorized installation positions (with or without water cooling, air cooling is shown):



Floor space Wall

6.3.4 Connecting the water supply (WC models)

If present, the water cooling system and all other associated measures should be connected before the device is even connected to AC, let alone switched on. Correct connection, **leak test** and subsequent operation of the device with running water cooling are the responsibility of the operator or user.

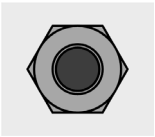
6.3.4.1 Requirements

The design of the watercourse is identical for all models. However, depending on the nominal current of a model and the resulting different speeds at which the internal heat sinks heat up, there are model-dependent requirements for the water and the environment that must be met:

Model	10 V / 60 V / 80 V	200 V to 920 V
Inner flow course:	Series	Series
Ambient temperature:	Max. +50 °C	Max. +50 °C
Water flow temperature (min):	See dew point table below	See dew point table below
Water flow temperature (max):	+33 °C	+26 °C
Flow rate:	Min. 12 l/min	Min. 7 l/min
Corrosion protection:	Ethylene glycol	Ethylene glycol
Water hardness:	Soft (calcium carbonate < 2 mmol/l)	Soft (calcium carbonate < 2 mmol/l)
Water pressure:	At least 1 bar, max. 4 bar	At least 1 bar, max. 4 bar

6.3.4.2 Connection point

The device has three separate internal power levels, each with its own cooling coil, which are led out at the rear and connected to each other on the outside. The water therefore flows through the three cooling coils in parallel. There are two connections on the outside for the inlet and outlet:



Connection: 10 mm hose, M19 nut

You are free to choose which of these is the outlet and which is the inlet. The only important thing for the operation of the device later on is that water flows through the heat sinks in sufficient quantities and at a certain inlet temperature.

The hose is connected either directly to the end piece or via an elbow fitting with hose nozzle, e.g. type Schwer Fittings SA-DKL90, which already has a metallic seal (24° internal cone). Only the outer diameter of 9 or max. 10 mm is important for the hose itself.

6.3.4.3 Operation and monitoring

For later operation, the so-called **dew point** must be taken into account, especially with regard to the flow temperature of the water. The cooled water at the inlet, together with the humidity of the air in the device, can cause water to condense in the device, which must be avoided at all costs. This means that it should be possible to regulate the flow temperature in order to adapt it to the environment. Ideally, this is done via an electronic control system that works with a humidity meter and temperature sensors and monitors and regulates the flow temperature.

The dew point is defined in the DIN 4108 standard using a table. This specifies the minimum flow temperature of the water in °C at a certain humidity and ambient temperature:

Ambience	Relative humidity in per cent										
	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
14°C	2.2	3.76	5.1	6.4	7.58	8.67	9.7	10.71	11.64	12.55	13.36
15°C	3.12	4.65	6.07	7.36	8.52	9.63	10.7	11.69	12.62	13.52	14.42
16°C	4.07	5.59	6.98	8.29	9.47	10.61	11.68	12.66	13.63	14.58	15.54
17°C	5	6.48	7.92	9.18	10.39	11.48	12.54	13.57	14.5	15.36	16.19
18°C	5.9	7.43	8.83	10.12	11.33	12.44	13.48	14.56	15.41	16.31	17.25
19°C	6.8	8.33	9.75	11.09	12.26	13.37	14.49	15.47	16.4	17.37	18.22
20°C	7.73	9.3	10.72	12	13.22	14.4	15.48	16.46	17.44	18.36	19.18
21°C	8.6	10.22	11.59	12.92	14.21	15.36	16.4	17.44	18.41	19.27	20.19
22°C	9.54	11.16	12.52	13.89	15.19	16.27	17.41	18.42	19.39	20.28	21.22
23°C	10.44	12.02	13.47	14.87	16.04	17.29	18.37	19.37	20.37	21.34	22.23
24°C	11.34	12.93	14.44	15.73	17.06	18.21	19.22	20.33	21.37	22.32	23.18
25°C	12.2	13.83	15.37	16.69	17.99	19.11	20.24	21.35	22.27	23.3	24.22
26°C	13.15	14.84	16.26	17.67	18.9	20.09	21.29	22.32	23.32	24.31	25.16

Ambience	Relative humidity in per cent										
	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
27°C	14.08	15.68	17.24	18.57	19.83	21.11	22.23	23.31	24.32	25.22	26.1
28°C	14.96	16.61	18.14	19.38	20.86	22.07	23.18	24.28	25.25	26.2	27.18
29°C	15.85	17.58	19.04	20.48	21.83	22.97	24.2	25.23	26.21	27.26	28.18
30°C	16.79	18.44	19.96	21.44	23.71	23.94	25.11	26.1	27.21	28.19	29.09
32°C	18.62	20.28	21.9	23.26	24.65	25.79	27.08	28.24	29.23	30.16	31.17
34°C	20.42	22.19	23.77	25.19	26.54	27.85	28.94	30.09	31.19	32.13	33.11
36°C	22.23	24.08	25.5	27	28.41	29.65	30.88	31.97	33.05	34.23	35.06
38°C	23.97	25.74	27.44	28.87	30.31	31.62	32.78	33.96	35.01	36.05	37.03
40°C	25.79	27.66	29.22	30.81	32.16	33.48	34.69	35.86	36.98	38.05	39.11
45°C	30.29	32.17	33.86	35.38	36.85	38.24	39.54	40.74	41.87	42.97	44.03
50°C	34.76	36.63	38.46	40.09	41.58	42.99	44.33	45.55	46.75	47.9	48.98

6.3.4.4 Notes

- The water flow should always be started before the device is switched on, but at the latest before the DC terminal is switched on

6.3.5 Connecting to the mains supply (AC)

- The device must be permanently connected to an AC distribution board. Connection may only be carried out by appropriately trained personnel!
- In addition, the device may only be operated directly from a mains supply, but not from generators or UPS systems!
- AC connection cables must be dimensioned according to the maximum AC current of the device! See section *«6.3.5.2 Cross-sections».*
- The device must be externally fused on the AC side in accordance with standard EN 61010-1, taking into account the maximum AC current and the cross-section of the AC connection cable
- Ensure that all regulations for the operation and connection of a device that feeds back into a (public) power grid have been observed and that all necessary measures have been taken!
- WC models: For safety reasons, the installation of one 30 mA RCD per water-cooled device (WC option) is recommended, but at least one for every three devices

All standard models in this series are suitable for operation on typical mains voltages such as 380 V, 400 V or 480 V, as well as 208 V (USA and Japan mains) thanks to a wide-range AC input. With the 30 kW models, when operated at 208 V mains voltage, a power reduction to 18 kW is automatically enabled in order to keep the AC current in approximately the same maximum range as with 400 V supply voltage and 30 kW power.

6.3.5.1 AC Connection

The nominal voltages specified on the rating plate apply, regardless of the variant and hardware revision. The devices require a three-phase main connection without an N conductor:

DC nominal power per channel	Pins on the AC plug	Connection type	Circuit
4 kW / 6 kW / 10 kW	L1, L2, L3, (N), PE	Three-phase current (3P)	Triangle

PE is mandatory and must always be connected to the AC plug!

6.3.5.2 Cross-sections

The maximum AC current and the intended length of the connecting cable are decisive for the dimensioning of the cross-section of the connecting cables. Based on the connection of a **single device** , the table indicates the maximum input current of the device on each phase of minimum supply voltage, as well as a recommended minimum cross-section per conductor:

	L1		L2		L3		PE [1]
Available power per channel	ø	I_{max}	ø	I_{max}	ø	I_{max}	ø
4 kW at 208 V	≥6 mm²	41 A	≥6 mm²	41 A	≥6 mm²	41 A	≥6 mm²
4 kW at 380 - 480 V	≥2.5 mm²	23 A	≥2.5 mm²	23 A	≥2.5 mm²	23 A	≥2.5 mm²
6 kW (nominal power or reduced) at 208 V	≥10 mm²	61 A	≥10 mm²	61 A	≥10 mm²	61 A	≥10 mm²
6 kW at 380 - 480 V	≥6 mm²	34 A	≥6 mm²	34 A	≥6 mm²	34 A	≥6 mm²
10 kW (nominal power, at 380 - 480 V))	≥10 mm²	56 A	≥10 mm²	56 A	≥10 mm²	56 A	≥10 mm²

6.3.5.3 Connecting plug & connecting cable

The supplied connector plug can accommodate cable ends up to 25 mm². The longer the connecting cable, the higher the voltage drop due to the cable resistance. Therefore, the mains cable should always be kept as short as possible. 4- or 5-core cables are permitted. In the case of a cable with an N conductor, this can be fixed in the free pin of the AC plug. Nominal data of the connector plug:

- Max. conductor cross-section without ferrule: 25 mm²
- Max. conductor cross-section with ferrule: 16 mm²
- Stripping length without ferrule: 18- 20 mm

1 Applies to both conductors, the PE conductor in the AC connection cable and the separate PE conductor for the housing earthing

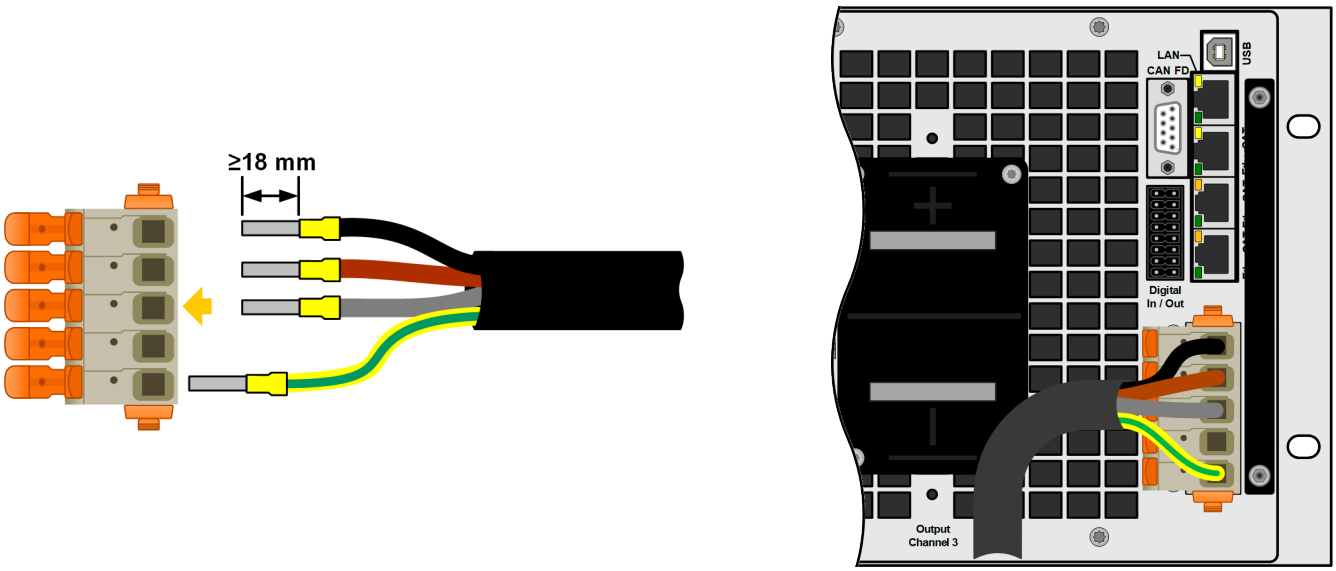


Figure 10 - Example of a mains connection cable with 4 cores (not included in the scope of delivery)

6.3.5.4 Attaching strain relief

All models and variants are supplied with a mechanical strain relief for the AC cable, which should be fitted by the installer of the device if no other measures are provided for strain relief of this cable at the installation site. Installation steps:

1. Loosen the four screws next to the AC socket as marked in *Figure 11* .
2. Attach the mounting bracket and secure it with the temporarily removed screws (M3x8) and two additional screws (M3x8) and clamping discs supplied. See *Figure 12*.
3. Insert the AC cable with the plug and, viewed from above, guide it length-ways past the mounting bracket and secure it with at least one, but preferably both, of the cable ties supplied. See *Figure 13*.

The mounting bracket and the cable ties can remain permanently connected. If the device needs to be removed from the installation (cabinet), the procedure for removing the plug and the strain relief is the other way round.

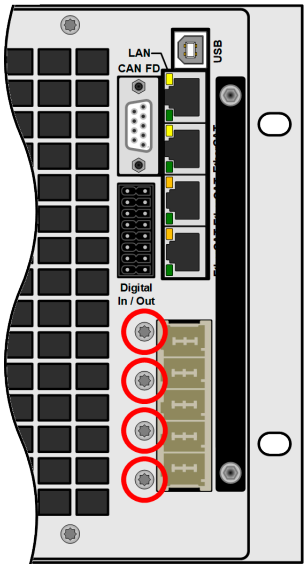


Figure 11 - Screws to be temporarily removed

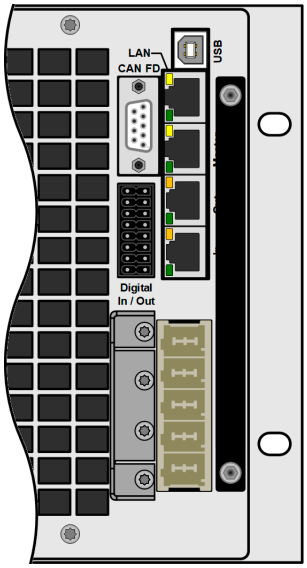


Figure 12 - Mounting position of the mounting bracket

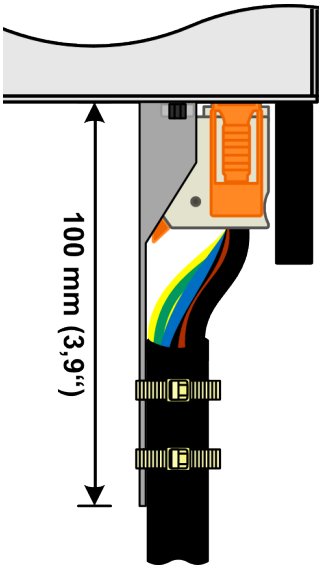


Figure 13 - Pre-assembled strain relief

6.3.5.5 Enclosure earthing

All devices in this series have an earthing point on the back of the housing, as shown on the right. Seen from behind, it is located under the DC terminal of channel 2.

The housing can be earthed separately, mainly to minimize the leakage current for personal protection. This means that a separately laid protective earth conductor (PE) can be connected to the earthing point if required. The cross-section should be at least the same as in the AC connection cable.

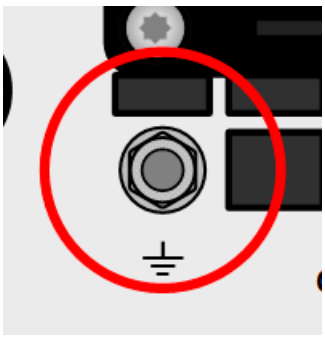


Figure 14 - Earthing point

6.3.6 Connecting DC loads or DC sources

- In the case of a device with a high DC nominal current and correspondingly thick and heavy DC terminal cables, the weight of the cables and the mechanical load on the DC terminal must be taken into account and strain relief must be provided, especially if the device is installed in a 19" cabinet or similar, where the cables may hang from the DC terminal.
- In addition to the appropriate cross-section of the DC cables, the appropriate dielectric strength must also be ensured

No reverse polarity protection available! Sources connected with reverse polarity will damage the device, even if it is not switched on!

An external source charges the internal capacities available at the DC terminal, even if the device is not switched on. Hazardous voltages may still be present here even after disconnection from the external source!

The DC terminal is located on the back of the device and is **not protected** by a fuse. The cross-section of the supply cables depends on the current consumption, the cable length and the ambient temperature.

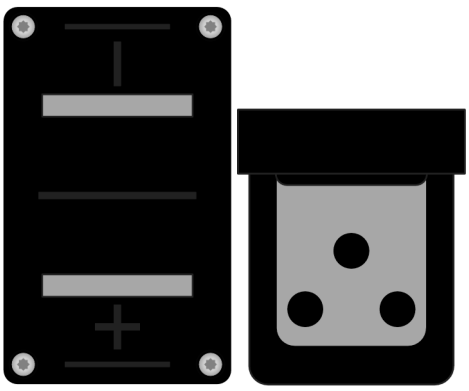
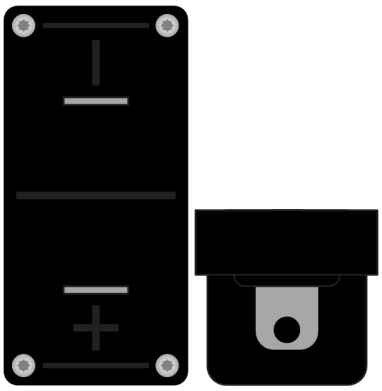
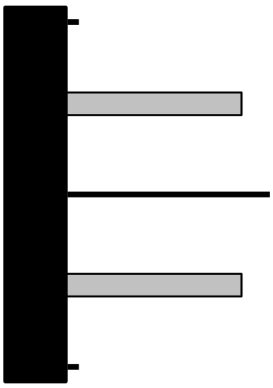
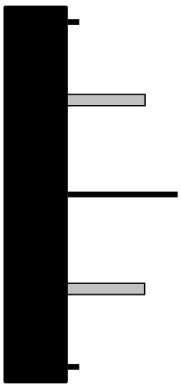
For load cables **up to 5 m** and average ambient temperatures up to **30°C** we recommend:

Up to **40 A**:	6 mm²	Up to **60 A**:	16 mm²
Up to **80 A**:	25 mm²	Up to **120 A**:	35 mm²
Up to **180 A**:	70 mm²	Up to **240 A**:	2x 35 mm²
Up to **420 A**:	2x 95 mm²	Up to **600 A**:	2x 150 mm²

per connection pole (multi-core, insulated, freely laid) must be used as a minimum. Individual cables, e.g. 70 mm², can be replaced by 2x 35 mm², etc. For longer load cables, the cross-section must be increased accordingly to avoid a voltage drop across the cables and unnecessary heating.

6.3.6.1 Connection terminal types

The table below contains an overview of the different DC terminal types. Flexible cables with ring cable lugs are always recommended for connecting load cables.

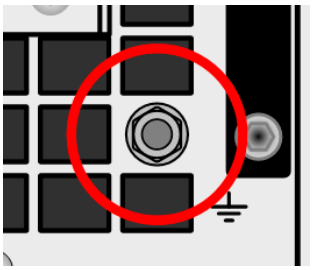
Type 1: Models up to 80 V	**Type 2: Models from 200 V**
	
M8 screw connection to metal rail Recommendation: M8 ring cable lugs with 8.4 hole	M6 screw connection to metal rail Recommendation: Ring cable lugs with 6.5 hole
	

6.3.6.2 Protective covers

A plastic cover for each of the DC terminals is supplied, to protect against accidental contact. They must always be installed on the device. There are cut-outs in the covers (top, bottom, front) that can be broken out as required in order to lay supply lines from different directions.

The connection angle and the required bending radius for the DC supply cables must be taken into account when planning the overall depth of the device, especially when installing it in 19" cabinets and similar structures.

6.3.7 Earthing the DC terminal



The earthing connection point, as shown on the right in the illustration, is used to earth one of the two DC terminal poles in addition to earthing the housing. This is generally permissible, but please note that this always results in a potential shift of the other pole in relation to PE. For insulation reasons, however, only certain model-dependent potential shifts are permitted at the DC negative pole. See *«10.3 Specific technical data»*

Both poles of a DC terminal are also potential-free, which provides basic protection in terms of contact safety. This is canceled as soon as a DC pole is earthed.

If more than one of the three DC terminals is earthed, the galvanic isolation of the DC channels from each other is also canceled because they are then connected to each other via PE. This would also be the case if the DC terminals for the channel grouping were connected in parallel, with or without earthing.

Models with 10 V or 60 V nominal voltage fulfill the criteria of SELV (safety extra-low voltage). If there is a potential shift at the DC terminal on these models, it may not be possible to maintain the SELV status. The DC terminals could then become dangerous to touch and must be covered.

In the event that a DC pole has been earthed, the user must personally ensure the basic protection for contact safety for persons, e.g. by fitting suitable covers wherever the potential of the DC terminal has been connected.

6.3.8 Connecting the remote sensor

6.3.8.1 Remote sensing for voltage compensation

- *Remote sensing is primarily effective in constant voltage mode (CV).*
- *The cross-section of cables for remote sensing is not critical. Recommended for cable lengths up to 5 m: 0.5 mm².*
- *The cables for remote sensing should not be twisted together, but should be laid close to the DC cables to the respective DC terminal of the channels that use remote sensing. So lay the cable to Sense(-) close to the cable to DC (-) to suppress the tendency to oscillate. If oscillation still occurs, an additional capacitor can be fitted either at the load/source or at the channel DC terminal to suppress the tendency to oscillate, depending on the best result.*
- *(+) Sense may only be connected to the (+) of the load/source and (-) Sense only to the (-) of the load/source. Otherwise both systems may be damaged. See Figure 15.*
- *Always ensure that the cables for remote sensing have the appropriate dielectric strength!*

Remote sensing is used to compensate for voltage losses via the load line, regardless of whether in source or sink mode. It is connected to **Sense -** and **Sense +**, as shown in Fig. 15. The three channels normally operate separately on the DC side and can be operated with or without remote sensing.

The exception is channel grouping, where the DC terminals are connected to each other. The device then becomes a single-channel source/sink and only requires one reference for remote sensing, which in this case is connected to channel 1, as shown in *Figure 16*. Any existing connections to the Sense terminal on channels 2 and 3 must be removed.

Dangerous voltage possible at the sense connections!

The sense terminal covers must always be installed.

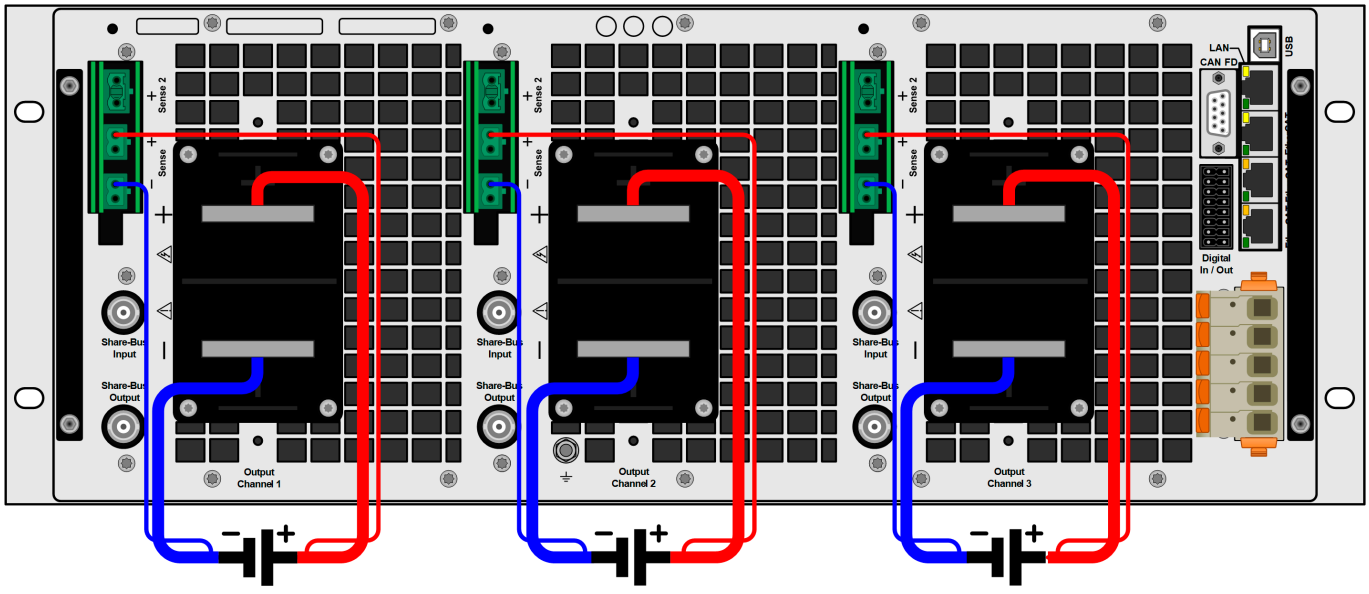
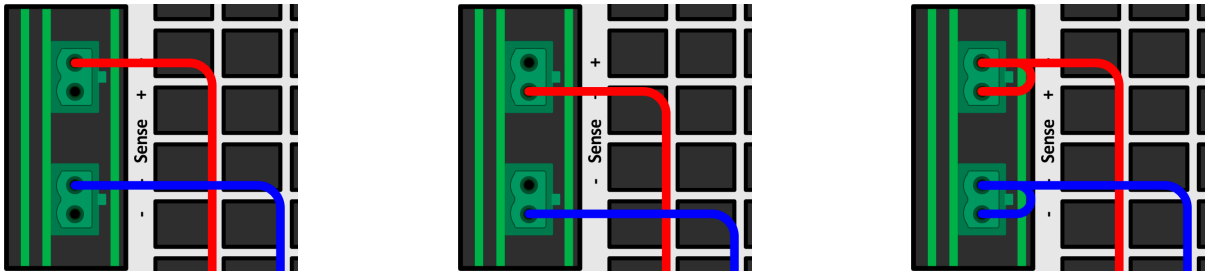


Figure 15 - Example of sense wiring of a battery on each channel (covers omitted for illustrative purposes)

Permissible connection forms:



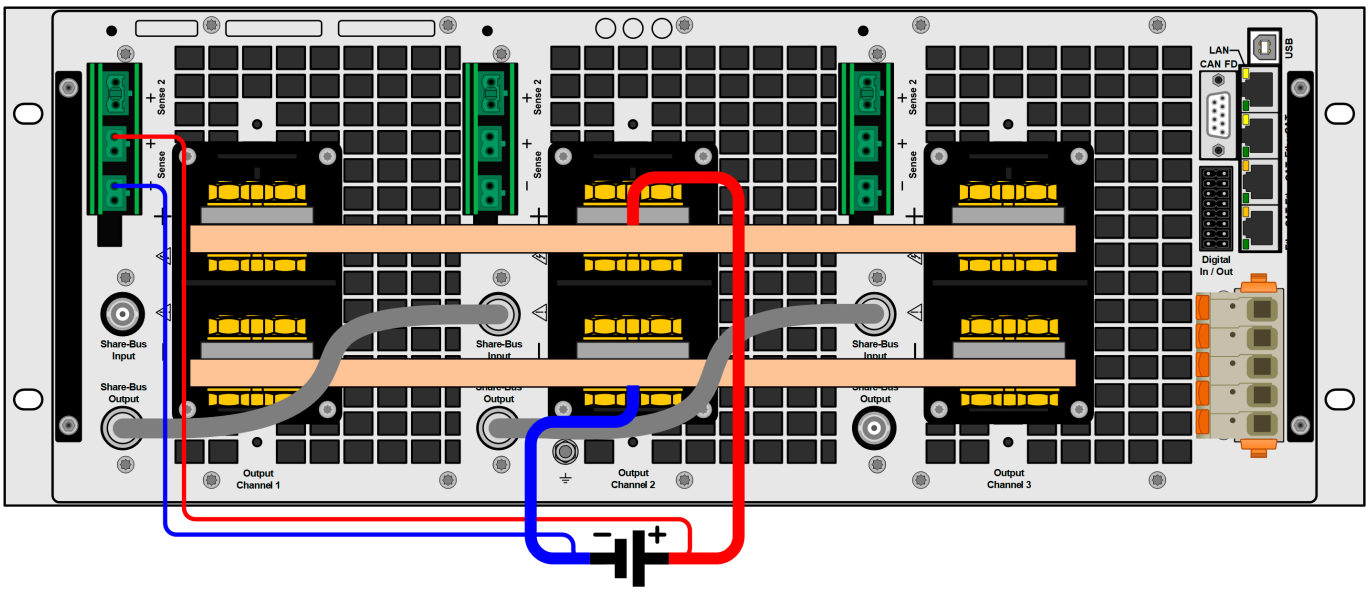


Figure 16 - Example of sense wiring of a load in channel grouping mode (covers omitted for illustrative purposes)

6.3.9 Precharging, contactor control, contactor monitoring and polarity detection

The battery tester offers additional functions for testing batteries, such as precharging, contactor control and contactor monitoring, as well as polarity detection for each channel separately. Detailed information can be found in the user manual.

Precharging requires the use of switchable galvanic isolation (contactor) between the DC terminal and the battery. Precharging minimizes the voltage difference between the output terminals of the BT and the device under test, thereby minimizing the occurrence of equalizing currents when establishing the galvanic connection. Contacting the Sense input is absolutely essential for the precharging function, as the corresponding measured voltage value is required as a reference value for precharging.

Contactor control and monitoring is carried out via the digital I/Os of the device. Here, the digital outputs are used for switching and the digital inputs for monitoring the contactor.

Input Sense 2 is used to recognize whether a battery is connected with the correct polarity. Sensing takes place at the battery and behind the contactor, as shown in *Figure 17*. If a polarity reversal is detected, precharging and closing of the contactor are prevented.

Illustration:

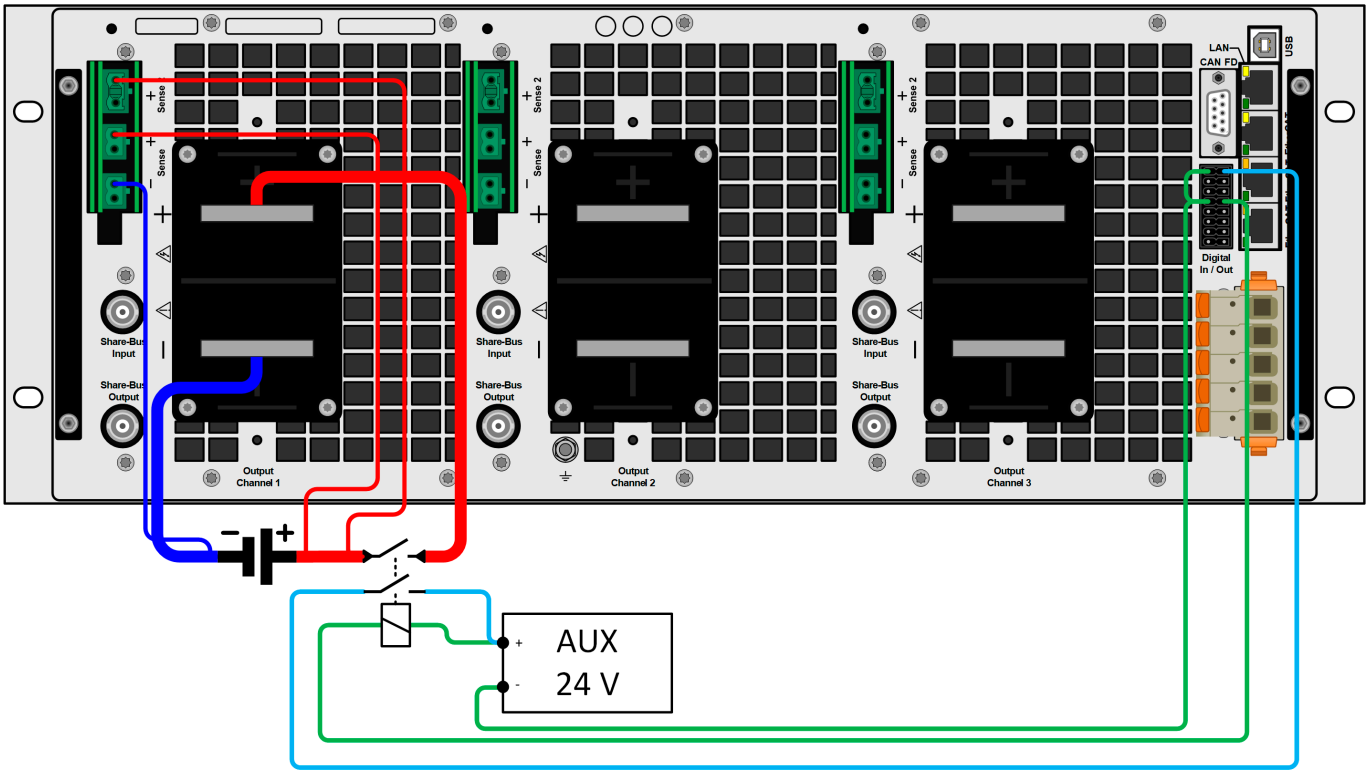


Figure 17 - Example of wiring a battery to channel 1, with polarity detection (Sense 2), precharging (Sense) and contactor control (Digital In / Out)

6.3.10 Connecting the Share-Bus

The “Share-Bus” terminals (type BNC, 6x available) on the rear of the device are used to connect the Share-Bus between the channels in order to achieve voltage balancing and fast equalization of the channels with each other, especially in function generator operation (sine, etc.), when the DC terminals are operated in parallel, known as **channel grouping**. Information on channel grouping can be found in section *«4.2 Parallel connection as master-auxiliary system»* in the user manual.

6.3.11 Connecting the USB port (rear)

To be able to control the device remotely via this connection, connect the device and PC using the USB cable supplied and switch on the device if it is still switched off.

6.3.11.1 Driver installation (Windows)

When connecting to the PC for the very first time, the operating system should recognize the device as new and want to install a driver. The driver is of the Communications Device Class (CDC) type and is normally integrated in current operating systems such as Windows 10 or 11. However, we recommend installing the driver supplied on the USB stick to ensure the best possible compatibility of the device with our software.

6.3.11.2 Driver installation (Linux, MacOS)

We cannot provide drivers or installation instructions for these operating systems. The user can find out whether and how a suitable driver is available by searching the Internet.

6.3.11.3 Driver alternatives

If the CDC driver described above is not available on your system or does not work properly for some reason, commercial providers can help. Search and find various providers on the Internet with the keywords “cdc driver windows” or “cdc driver linux” or “cdc driver macos”.

6.3.12 Connecting the CAN FD port

To be able to control the device remotely via this connection, connect any CAN FD-capable CAN adapter, ideally with a D-Sub 9-pin connection, to the device using a standard 1:1 D-Sub cable. An external bus terminating resistor is not required as an electronically switchable one is installed.

6.3.13 Initial commissioning

Additional measures must be taken when commissioning the device for the very first time and during initial installation:

- Check that the connection cables you are using for AC and DC have a sufficient cross-section!
- Check the settings for set values, safety and monitoring functions and communication to ensure that they are suitable for the planned application and adjust them according to the instructions if necessary!
- When controlling the device remotely via PC, also read the available documentation on interfaces and software!

6.3.14 Recommissioning after firmware updates or longer periods of non-use

When recommissioning after a firmware update, recovering the device after a repair or after changing the position or configuration of the device’s environment, similar measures must be taken as for initial commissioning. See *«6.3.13 Initial commissioning»*.

Only after the device has been successfully checked in accordance with the listed points may it be put into operation as usual.

6.3.15 Disposal of the device

According to European laws and regulations (ElektroG, WEEE), a device that is intended for disposal must be taken back and disposed of by the manufacturer, unless the operator of the appliance or a person authorized by him does this himself. Our devices are subject to these regulations and are labeled accordingly with this symbol:

The device contains a lithium battery. They are disposed of in accordance with the above specifications or in accordance with separate, local regulations.

7. Operation and use (1)

7.1 Terms

All models in this series are multi-channel, bidirectional devices. This means that each channel is a combination of power supply unit and electronic load. The channels can work alternately in one of two higher-level operating modes, which must be differentiated in places below:

- **Source / Source mode / Source mode**
  - as a power supply unit, the device generates DC voltage for an external DC load
  - In this operating mode, the DC terminal is regarded as a DC output
  - In the battery test, a source mode corresponds to a charge/charge mode
- **Sink / Sink mode / Sink mode**
  - The device operates as an electronic load and draws DC energy from an external DC source
  - In this operating mode, the DC terminal is regarded as a DC-input
  - In the battery test, a sink mode corresponds to a discharge/discharge mode

7.2 Important notes

7.2.1 Personal protection

- To ensure safety when using the device, it may only be operated by persons who have been instructed in the necessary safety measures for handling dangerous electrical voltages
- Always fit the supplied cover for the DC terminal or a similar, sufficiently safe cover for devices that can generate a voltage that is dangerous to touch or are connected to it

7.2.2 General

- Idle mode, i.e. operation of the device in source mode without any load, is not a normal operating mode to be considered and can lead to incorrect measurement results.
- It is recommended that the device is not operated below 10% voltage and current so that the technical data such as ripple and stabilization times can be maintained.
- Due to the design of the devices, one channel could be in source mode while one or both others are in sink mode, if you look at the DC side. As all three channels share the AC side, energy can be circulated within the device.

7.3 Manual operation (1)

With manual operation and if the device is connected to a controlling unit (e.g. PC) via at least one of the available interfaces, the controlling unit could take over control at any time without warning or a confirmation prompt. For safety reasons, it is recommended to lock the remote by activating 'Local' mode, at least for the duration of manual operation.

7.3.1 Switching on the device

If possible, the device should always be switched on at the mains switch (rotary switch, front) by setting it to position 1. Alternatively, it can be switched on the mains side via an external disconnecting device (main switch, contactor) with an appropriate current carrying capacity.

After switching on, the device shows some device-specific information (model, firmware version(s) etc.) on the display for a few seconds, then a language selection that can be hidden by ticking the box for 3 seconds and is then ready for operation. The HMI is then in the so-called **All channels** display mode.

In the settings menu (see section *«2.3.1 Configuration in the menu»* in the user manual), there is an option **Settings** in the **DC terminal** submenu under **State after power ON**, with which the user can determine the state of the DC terminals after switching on the device. **Restore** remembers the last state when switching off and restores it, in contrast to **Off**. This setting must therefore be made carefully.

All set values, as well as a master-auxiliary or channel grouping mode enabled during the last use, are always restored.

7.3.2 Switching off the device

The device is switched off by turning the mains switch to position 0. This triggers two actions: a) the status of the DC terminals and the last adjusted set values are saved and b) an **Alarm: PF** is reported, which can be ignored in this situation. The DC terminals are also switched off immediately and the fans and display stop after a certain run-on time (up to 30 seconds). The device is then completely switched off.

In position 0, the mains switch on the front physically disconnects the device from the mains. It therefore qualifies as a separator. Position 1 means that the device is switched on.

7.3.3 Manual set value adjustment in BT mode

Adjusting the set values for voltage, current and power is the basic operating option of the battery tester and therefore the two rotary knobs on the front of the device are always assigned two set values of the currently selected channel when operated manually.

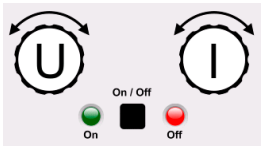
Each channel has separately adjustable set values for voltage and power for charging and discharging operation, which are designated accordingly in the display. For the voltage, (**MAX**) indicates the end-of-charge voltage and (**MIN**) the end-of-discharge voltage. The power values (**CHA**) denote the power set value for charging mode, (**DCH**) for discharging mode.

The set values can be set manually in two ways, by **rotary knob** or **direct input**. When using the rotary knobs, values are adjusted continuously; direct input creates jumps.

Entering set values, whether by button or touchscreen, always sets the set value immediately, regardless of whether the DC terminal is switched on or off.

The adjustment of the set values can be limited upwards or downwards by the adjustment limits. See also «2.3.3 Adjustment limits» in the user manual. When one of the limits is reached, a message "Limit: U-max" etc. is briefly displayed.

► How to manually adjust set values using the rotary knobs

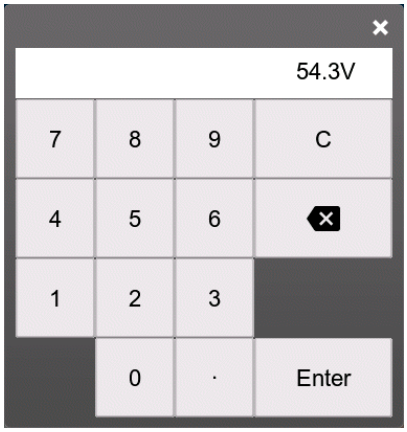


1. First check whether the set value (U, I, P) that you want to set is already assigned to one of the rotary knobs. The main screen shows the assignment in single channel view as shown in the example on the right.
2. If, as shown in the example on the right, the voltage (U) is assigned to the left rotary knob and the current (I) is assigned to the right rotary knob. To set the power,

   you can change the assignment by tapping the image of the right rotary knob until a "P" (power) is displayed on it. In the left-hand area of the display, either the power set value for sink or source operation is selected, marked by the inverted field.
3. Once the selection has been made, the desired set value can be set within the specified limits. To change the position, press the respective rotary knob. Turning the rotary knob moves the cursor (underlined digit) from the lower to the higher decimal positions:

   (DCH) 47.50A → (DCH) 47.50A → (DCH) 47.50A

► How to manually adjust set values via direct input



1. In the main display, depending on the assignment of the rotary knobs, you can set the set values for voltage (U), current (I) or power (P) by direct input by tapping on the small numeric keypad symbols. For example, click on the symbol in the blue field to set the voltage and so on.
2. Enter the desired value using the numeric keypad. Similar to a calculator, control panel C deletes the input.

   Decimal places can be entered by tapping the decimal point control field. For example, if you wanted to enter 54.3 V, type in 5 4 · 3 and Enter.
3. Unless the new value is rejected for some reason, the display would jump back to the main page and the set value is applied to the DC terminal.

If a value is entered that is higher than the respective adjustment limit, a message appears and the entered value is reset to 0 and is not accepted.

7.3.4 Manual set value adjustment in PSB mode

Adjusting the set values for voltage, current and power is the basic operating option of a power supply unit and therefore the two rotary knobs on the front of the device are always assigned to two set values of the currently selected channel when operated manually.

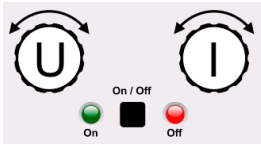
Each channel has separately adjustable set values for current and power for source and sink operation, which are labeled accordingly on the display. **(PS)** stands for **source mode** and **(EL)** for **sink mode**.

The set values can be set manually in two ways, by **rotary knob** or **direct input**. When using the rotary knobs, values are adjusted continuously; direct input creates jumps.

Entering set values, whether by button or touchscreen, always sets the set value immediately, regardless of whether the DC terminal is switched on or off.

The adjustment of the set values can be limited upwards or downwards by the adjustment limits. See also «2.3.3 Adjustment limits» in the user manual. When one of the limits is reached, a message "Limit: U-max" etc. is briefly displayed.

► How to manually adjust set values using the rotary knobs

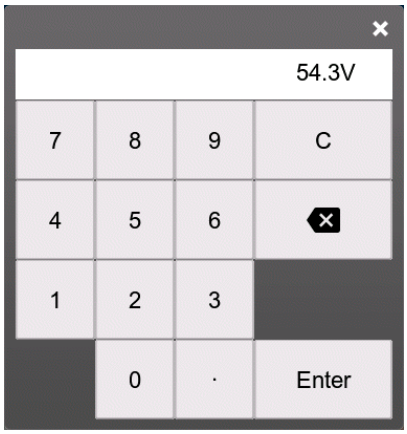


1. First check whether the set value (U, I, P) that you want to set is already assigned to one of the rotary knobs. The main screen shows the assignment in single channel view as shown in the example on the right.
2. If, as shown in the example on the right, the voltage (U) is assigned to the left rotary knob and the current (I) is assigned to the right rotary knob. To set the power,

   you can change the assignment by tapping the image of the right rotary knob until a "P" (power) is displayed on it. In the left-hand area of the display, either the power set value for sink or source operation is selected, marked by the inverted field.
3. Once the selection has been made, the desired set value can be set within the specified limits. To change the position, press the respective rotary knob. Turning the rotary knob moves the cursor (underlined digit) from lower to higher decimal positions:

   (EL) 47.50A → (EL) 47.50A → (EL) 47.50A

► How to manually adjust set values via direct input



1. In the main display, depending on the assignment of the rotary knobs, you can set the set values for voltage (U), current (I) or power (P) by direct input by tapping on the small numeric keypad symbols. For example, click on the symbol in the blue field to set the voltage, etc.
2. Enter the desired value using the numeric keypad. Similar to a calculator, control panel C deletes the input.

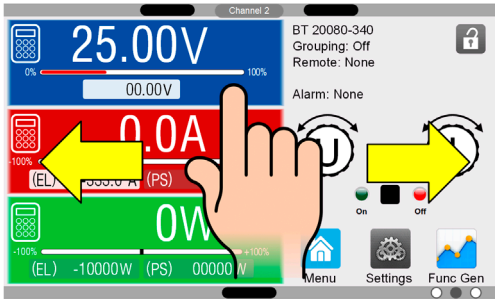
   Decimal places can be entered by tapping the decimal point control field. For example, if you wanted to enter 54.3 V, type in 5 4 · 3 and Enter.
3. Unless the new value is rejected for some reason, the display would jump back to the main page and the set value is applied to the DC terminal.

If a value is entered that is higher than the respective adjustment limit, a message appears and the entered value is reset to 0 and is not accepted.

7.3.5 Channel selection

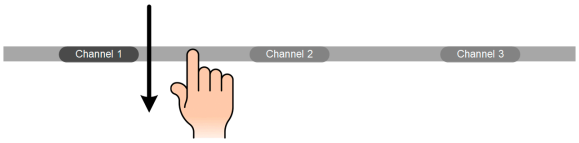
Three options can be used for manual operation and to switch to another channel, the first of which is only available in the single-channel view and the third only in the multi-channel view:

1. **Horizontal swipe (single channel view only)**: The next channel can be accessed by swiping left or right on the display.

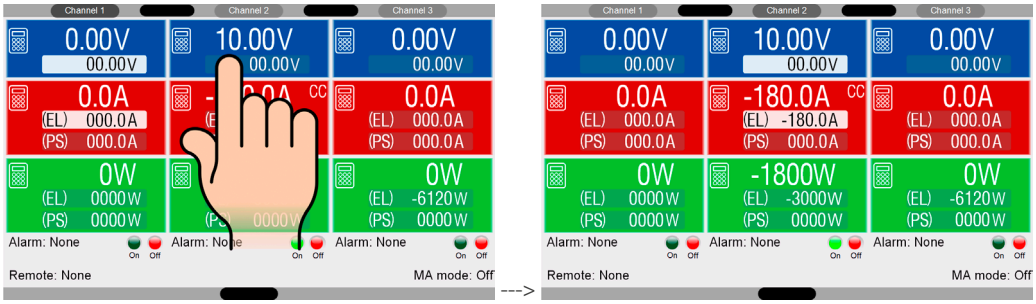


> *Swiping can be blocked for various reasons, e.g. if the "Channel grouping" mode is active.*

2. **Channel selection menu**. This menu can be accessed by swiping vertically, both in the main display and partly in the menu, at least when the top gray bar is visible, which is not the case on every view page in the menu. The view type can also be changed to **All channels** in the channel selection. If the **All channels** view is active, you can change channels by tapping, see **Tap 3rd channel (multi-channel view only)**. Otherwise you can switch to the single view.



3. **Tap channel (multi-channel view only)**: this option is available in the multi-channel view **All channels** . All three channels are displayed next to each other, where you can switch between the channels by tapping on the gray-transparent set value fields of the desired channel, which change to a white-transparent background after switching.



> *The device memorizes the respective view for each channel. This means, for example, that if you go to channel 1 in the Function Generator and start it and then switch to channel 3, which was last in the "Settings" menu, via the channel selection, then channel 3 shows the menu while the function continues to run in the background on channel 1.*

7.3.6 Switching the DC terminals on or off

The DC terminal of each channel can be switched off or on manually or remotely. After switching on, the DC terminal of each channel operates either as a DC-input (sink/discharge mode) or DC output (source/charge mode). More information on this can be found in section *«2.1.5 Switching the source <-> sink operating mode»* in the user manual.

	Manual switching on is always carried out using the "On/Off" button and only for the currently selected channel. The DC terminals cannot be switched on or off at the same time using the button.

► How to switch a DC terminal on or off manually

1. If the control panel is not completely locked, press the **On/Off** button. Otherwise, you will first be asked to cancel the lock.
2. Depending on whether the DC terminal was switched on or off before the button was pressed, the opposite state is enabled, unless this is prevented by an alarm or the state of the remote control.

► How to switch the DC terminal on or off remotely via a digital interface

1. See further documentation, e.g. the separate programming instructions if you are using your own software or the help for the LabView VIs or the manual for the control software. These should all be included on the USB stick supplied.

7.3.7 Locking the control panel (HMI)

To prevent accidental adjustment of a value during manual operation, the rotary knobs and the touchscreen can be locked so that no adjustment of a value via the rotary knob or operation via the touchscreen is accepted without first canceling the lock. This lock can only be enabled in the individual channel view of any channel.

► How to lock the HMI

1. Tap the lock symbol  on the main page of the individual channel view of the current channel. If the DC terminal is switched on, the lock is enabled immediately.
2. Otherwise, the **Lock** menu page appears, on which you can specify whether you want to lock the HMI completely or with the exception of the **On/Off** button (setting: **On/ off possible during HMI lock**) or whether the lock should also be assigned a PIN (**PIN for HMI lock**). This PIN must always be entered again later when unlocking as long as it is enabled.
3. Activate the lock with **Start**. The device switches to the main screen and dims it.

As soon as an attempt is made to change something when the HMI is locked, a prompt appears on the display asking whether you want to unlock it.

► How to unlock the HMI

1. Tap in any area of the touchscreen of the locked HMI or press one of the rotary knobs or press the "On/Off" button (only when completely locked).
2. A query appears: 

3. Unlock the HMI using the control panel **Unlock**. If no entry is made within 5 seconds, the prompt disappears again and the HMI remains locked. If the additional PIN lock (see group **Lock**) has been enabled, a further prompt to enter the PIN appears. If this has been entered correctly, the HMI is unlocked.

7.3.8 Locking the adjustment limits and user profiles

To prevent the person working with the device from setting incorrect set values by accidental or deliberate adjustment, adjustment limits can be defined (see also *«2.3.3 Adjustment limits»* in the user manual) and locked against changes using a PIN. This locks the **Limits** group in the **Settings** menu and the **Profiles** menu. The lock can only be removed by entering the correct PIN or resetting the device.

► How to block the limits and profiles

1. While the DC terminal of the currently selected channel is switched off, tap the lock symbol  on the main page in single channel view, provided the HMI is not locked. The **Lock** menu page then appears. Alternatively, you can also navigate to the menu **HMI setup** and group **Lock**. If the HMI is locked, it must first be unlocked by tapping anywhere on the touchscreen, if necessary by entering the PIN.
2. Activate the switch next to **Lock limits and profiles with user PIN**. The lock becomes active immediately.
3. Exit the menu.

The same user PIN is used for the limit and profile lock as for the HMI lock. See also «7.3.7 Locking the control panel (HMI)».

Caution! Do not activate the lock if you are not sure which PIN is currently set or change it beforehand! The PIN can be set in the **Lock** menu.

► How unlock the limits and profiles

1. With the DC terminal of the currently selected channel switched off, tap the 

control panel on the main page. In multi-channel view, the quick menu can alternatively be used to go directly to the **HMI setup** menu page, which eliminates the first part of step 2.
2. In the menu, tap **HMI setup**, then tap **Lock group**.
3. In the group, tap **Unlock limits and profiles** on the right. You will then be asked to enter the four-digit PIN.
4. Disable the lock after entering the correct PIN.

7.4 Alarms and monitoring (1)

7.4.1 Definition of terms

A basic distinction is made between device alarms (see *«9.2.1 Alarm signals»*), such as overvoltage (**OVP**) or overtemperature (**OT**), and user-defined events such as **OVD** (overvoltage monitoring). Device alarms and user events are channel-specific. While device alarms, in which the DC terminal of the affected channel is always switched off immediately, serve to protect the device and the connected load/source, user-defined events can switch off the DC terminal (with **Action = alarm**), but can also only emit an acoustic signal that alerts the user to something.

The action can be selected for **user-defined events**:

Action	Response	Example
None	User event is disabled	
Signal	When the condition that triggers an event with action **Signal** is reached, a text is only output in the display (status field) of the device.	
Warning	When the condition that triggers an event with action **Warning** is reached, a text and an additional message that can be seen from a greater distance are shown in the display (status field) of the device.	
Alarm	When the condition that triggers an event with action **Alarm** or an alarm is reached, a text and an additional message are only shown in the display (status field) of the device and an acoustic signal is emitted (if the alarm sound is enabled). The DC terminal of the affected channel is also switched off. Device alarms can also be queried at any time via the digital interfaces.	

7.4.2 Handling device alarms and events

Important to know:

When switching off the DC terminal of a channel that operates in sink mode on a current-limited source, its output voltage can rise abruptly and have a voltage overshoot lasting a few milliseconds due to control delays, which can trigger an overvoltage alarm (OVP) or voltage monitoring (OVD) on the BT 20000 if their thresholds are set correspondingly low.

If a device alarm occurs, the DC terminal of the respective channel is usually switched off first, a message is output in the center of the display and, if enabled, an acoustic signal is generated to draw the user's attention to the alarm. Alarms and the associated alarm counters can also be called up via all interfaces. An alarm must be confirmed for acknowledgment and cancellation.

► How to acknowledge an alarm in the display (during manual operation)

1. If an alarm is shown on the display as a superimposed message and acknowledge with **Acknowledge** .
2. If the alarm has already been acknowledged once with OK but is still displayed in the status field, first tap on the status field so that the overlaying message is displayed again and then acknowledge with **Confirm** .

To acknowledge alarms with digital remote control, see the separate programming instructions supplied.

Short	Long	Description	Range
OVP	**O**ver**V**oltage **P**rotection	Overvoltage protection. Triggers an alarm when the voltage at the DC terminal reaches the set threshold. The alarm causes the DC terminal to be switched off.	0 V...1.1*U_{Nenn}
OCP	**O**ver**C**urrent **P**rotection	Overcurrent protection. Triggers an alarm when the current in the DC terminal reaches the set threshold. The alarm causes the DC terminal to be switched off.	0 A...1.1*I_{Nenn}
OPP	**O**ver**P**ower **P**rotection	Over-power protection. Triggers an alarm when the output or input power reaches the set threshold. The alarm causes the DC terminal to be switched off.	0 W...1.1*P_{Nenn}
COP	**C**onnection **O**verload **P**rotection	Cable overload protection. DC cables may be overloaded. Occurs when the determined voltage drop has reached the adjustable threshold for **COP** . The alarm causes the DC terminal to be switched off and a message to appear on the display.	0 V...U_{Nom}

Short	Long	Description	Range
ETP	**E**xternal **T**emperature **P**rotection	External overtemperature protection. Occurs when the external temperature detected by a sensor, e.g. of a battery, has reached the adjustable threshold for **ETP**. The alarm leads to the affected DC terminal being switched off and to a message on the display.	-55...+125 °C

These device alarms cannot be configured as they are hardware-related:

Short	Long	Description
PF	**P**ower **F**ail	Mains error. Triggers an alarm if the AC supply should operate outside the specifications of the device (undervoltage) or if the device is disconnected from the AC supply, e.g. by switching off at the mains rotary switch. In addition, at least two DC terminals are switched off if all three were on. The status of the DC terminal of a channel after a temporary PF alarm has disappeared can be defined separately for each channel with the setting **DC terminal -> State after PF alarm** .
		The acknowledgment and thus cancellation of a PF alarm during runtime can only take place approx. 15 seconds after the cause of the alarm has subsided, and the DC terminal of the affected channel can only be switched on again after a further 5 seconds.
OT	**O**ver**T**emperature	Overtemperature. Triggers an alarm when the internal temperature of the device reaches a certain threshold. All DC terminals are also switched off. The status of the DC terminal of each channel after cooling can be specified separately for each channel by using the **DC terminal -> State after OT alarm** setting
MAP	**M**aster-**A**uxiliary **P**rotection	Is triggered if the master in an initialized master-auxiliary network loses contact with one or more auxiliary units or if an auxiliary unit has not yet been initialized. The DC terminal of all channels is also switched off. The alarm can be canceled by reinitializing the MA system or disabling MA.
Safety OVP	**Safety O**ver**V**oltage **P**rotection	Only available in the 60 V model: Safety OVP. Triggers a special OVP alarm if the voltage at one of the DC terminals exceeds the threshold of 101% nominal voltage and then switches off all DC terminals. For details, see section *«9.2.1 Alarm signals»*.
SF	**S**hare-Bus **F**ail	Share-Bus error. Can occur in channel grouping mode if the signal on the Share-Bus is disturbed by a short circuit or excessive attenuation. In this case, the cable should be removed. The alarm causes the DC terminals of all channels to be switched off. For details, see section *«9.2.1 Alarm signals»*.

► How to configure the thresholds of the adjustable device alarms

1. With the DC terminal of the currently selected channel switched off, tap 

on the control panel on the main page if single channel view is active, or call up the settings menu via the quick menu.
2. Tap the **Protection** group on the left-hand side. All adjustable device alarms and their threshold values for the currently selected channel are displayed on the right-hand side. The device constantly compares these thresholds with the actual values of current, voltage and power at the respective DC terminal. A distinction is also made between source and sink operation.
3. Set the threshold values for the device alarms here according to your application if the default values of 110% are not suitable.

The user can also choose whether to receive an additional acoustic message when an alarm or user-defined event (user event) occurs.

► How to configure the "Alarm sound" (see also *«2.3.1 Configuration in the menu»* in the user manual)

1. On the main page, swipe your finger upwards from the bottom edge or tap  .
2. A quick menu opens. Click on the  field to switch the alarm sound on or on  to switch it off.
3. Exit the quick menu.

7.5 User-definable events

The monitoring function of the device can be configured separately for each channel via user-definable events, which are referred to below as "events" for short. Events are disabled by default (**Action** set to **None**) and, unlike device alarms, only work as long as the associated DC terminal is switched on. This means, for example, that undervoltage is no longer detected after the DC terminal has been switched off and the voltage is still falling during source operation.

The following events can be configured independently of each other and separately for source and sink operation for each channel:

Short	Long	Description	Range
UVD	**U**nder**V**oltage **D**etection	Undervoltage detection. Triggers the event if the voltage at the DC terminal falls below the set threshold.	0 V...U_{Nom}
OVD	**O**ver**V**oltage **D**etection	Overvoltage detection. Triggers the event if the voltage at the DC terminal exceeds the set threshold.	0 V...U_{Nom}
UCD	**U**nder**C**urrent **D**etection	Undercurrent detection. Triggers the event if the current in the DC terminal falls below the set threshold.	0 A...I_{Nom}
OCD	**O**ver**C**urrent **D**etection	Overcurrent detection. Triggers the event if the current in the DC terminal exceeds the set threshold.	0 A...I_{Nom}
OPD	**O**ver**P**ower **D**etection	Overpower detection. Triggers the event if the power at the DC terminal exceeds the set threshold.	0 W...P_{Nom}

These events should not be confused with alarms such as OT and OVP, which are used to protect the device. If set to the "Alarm" action, events can also switch off the associated DC terminal and thus protect the load/source.

► How to configure the user events

1. With the DC terminal of the currently selected channel switched off, tap 

on the control panel on the main page if single channel view is active, or call up the settings menu via the quick menu.

2. Tap on the **User events** group on the left-hand side. All adjustable values and actions are displayed on the right-hand side. The values represent monitoring thresholds that are constantly compared with the actual values of current, voltage and power at the DC terminal of the currently selected channel. A distinction is also made between source (PS) and sink (EL) operation.
3. Tap on the values to change them using the numeric keypad that appears. The adjustment range of these values is not limited by the adjustment limits. The **Action** associated with each event can be set via a scroll selection. For the meaning of actions available to select, see section *«7.4.1 Definition of terms»*.

The events are part of the currently selected user profile. This means that if a different user profile or the default profile is loaded, the events are either configured differently or not configured at all.

8. Other applications (1)

8.1 Series connection

- In addition to its function as a power supply unit, the device is also an electronic load.
- A series connection must not be operated in an extension for sink operation (warranty claim may be invalidated)!
- A series connection in source mode can be set up at your own risk and peril (warranty claim may be invalidated)!

Series connection of the individual channels in source mode is possible to a limited extent. To do this, it must be ensured that the device cannot switch to sink mode, which is achieved by setting the current and power set value for sink mode to zero.

Whether the series connection of two or all three channels is permissible is primarily determined by the insulation voltages specified in the technical data, as a series connection shifts the positive and negative poles of the next channel relative to earth (PE) by the maximum amount of 102% of the nominal voltage of the previous channel. For the model with a nominal voltage of 920 V, two of the channels could therefore be connected in series, but not all three, because the third channel at the DC minus could then already have a potential of >1800 V to earth. A value that significantly exceeds the specified 1500 V insulation voltage for the DC negative pole. For a model with a nominal voltage of 80 V, even more than three channels could be connected in series.

Basic rule: when models with different nominal voltages are connected in series, they usually also have different nominal currents and nominal power. This results in an upper current and power limit, which is determined by the device with the lowest nominal current or the lowest nominal power.

9. Troubleshooting

9.1 Maintenance / cleaning

The devices do not require regular maintenance. Cleaning the internal fans may be necessary sooner or later, depending on the environment in which they are operated. Heavily contaminated fans can lead to insufficient air supply and thus to premature shutdown of the DC terminals due to overheating or to premature defects.

Please contact us for this type of maintenance.

9.1.1 Battery replacement

The device contains a CR2032 lithium button cell, which is located on the so-called KE board, which is attached to the side panel at the rear left of the device (viewed from the front). The battery buffers the real-time clock and is designed for a service life of at least 5 years. However, the service life is also determined by external influences such as temperature and may be shorter. If it is necessary to replace the battery, this can be carried out by a suitable person on site, taking ESD protection measures into account. To do this, loosen the KE board and carefully pull it out a little with the cables plugged in.

9.2 Troubleshooting / fault diagnosis / repair

In the event that the device suddenly behaves unexpectedly, indicating a possible defect, or has an obvious defect, it cannot and must not be repaired by the user. In case of suspicion, please consult the supplier and clarify further steps with them.

It will then usually be necessary to send the device to the manufacturer for repair (with or without warranty). In the event that the device needs to be sent in for inspection or repair, please ensure that...

- you have contacted your supplier beforehand and clarified with them how and where the device is to be sent
- it is packed securely for transport in its assembled state, ideally in the original packaging.
- options operated together with the device, such as a digital interface module, are sent in with the device if they are related to the problem.
- a detailed description of the fault is enclosed.
- all documents required for customs clearance are enclosed when sending to the manufacturer in another country.

9.2.1 Alarm signals

The device offers various options for signaling alarm situations, but not dangerous situations. Signaling is visual (on the display as text or via LED) and optionally also acoustic (piezo buzzer). All these alarms cause at least one DC terminal to be switched off.

Meaning of the alarm signals:

Signal **PF** (mains error)	• Disconnection of the DC terminal of the affected channel due to mains undervoltage or defect in the AC section • Critical in case of overvoltage! AC part could be damaged
Signal **OT** (excess temperature)	• Overheating of the device • DC terminal of the affected channel is switched off • Uncritical
Signal **OVP / SOVP** (overvoltage)	• Overvoltage switch-off of the DC terminal occurred due to excessive voltage reaching the device from outside or generated by a defect in the device • Critical! The device and/or the load could be damaged
Signal **OCP** (overcurrent)	• Overcurrent shutdown of the DC terminal of the affected channel occurred because an adjustable threshold was reached • Non-critical, serves to protect the load or source from excessive current consumption
Signal **OPP** (excess power)	• Overload switch-off of the DC terminal of the affected channel occurred because an adjustable threshold was reached • Non-critical, serves to protect the load or source from excessive power consumption
Signal **SF** (Share-Bus error)	• Switch-off of the DC terminal of the affected channel due to a signal fault on the Share-Bus • Uncritical
Signal **MAP** (Master-auxiliary protection)	• Switch-off of all DC terminals of a master-auxiliary system due to communication problems on the master-auxiliary bus • Uncritical
Signal **COP** (line overload)	• Disconnection of the DC terminal of the affected channel due to a voltage drop on load lines • Non-critical for the device, serves to protect DC cables

Signal **ETP** (External overtemperature)	• Overheating of the battery or another external component • DC terminal of the affected channel is switched off • Non-critical for the device, but critical for the test specimen
Signal **Polarity** (Reverse Polarity Detection)	• Polarity reversal detected on Sense 2 • DC terminal of the affected channel is switched off/not switched on • Critical! The device may be damaged

9.2.2 Power fail alarm

Power Fail (short: PF) indicates an alarm status of a channel, which can have several causes:

- AC input voltage generally too low (mains undervoltage, mains failure) or on at least one phase
- Internal defect in the AC input stage (PFC)

In the event of a power fail, at least one channel stops the power output or input and switches off its DC terminal if it was on. In the event that a single phase fails, two channels would report a PF alarm, otherwise all three. If the PF alarm was only a temporary mains undervoltage, the channels can continue their work, i.e. automatically switch their DC terminal back on. The response is determined via the setting **DC terminal -> State after PF alarm**, whereby the default setting is **Off**.

Disconnecting the device from the power supply is interpreted as a power failure. Therefore, an "Alarm: PF" on the channels, which can be ignored in this case.

9.2.3 Overtemperature alarm

An overtemperature alarm (short: OT) occurs when an device automatically switches off one or more of the three channels due to excessive internal temperature. After cooling down, the affected channels can switch their DC terminals back on automatically, depending on what was selected in the settings for **DC terminal -> State after OT alarm** . For more information, see section *«2.3.2 "Settings" submenu»* in the user manual.

9.2.4 Overvoltage alarm

An overvoltage alarm (short: OVP) leads to the DC terminal of a channel being switched off if

- the channel itself (source mode) or an external source (sink mode) brings a higher output voltage to its DC terminal than specified with the adjustable overvoltage alarm threshold (OVP, 0...110% U_{Nom}), which can be set for each channel.
- The OVP threshold value was set too close to the voltage set value, the channel is in source mode and CC mode and a voltage jump occurs due to sudden relief, which leads to a brief voltage overshoot, which is regulated shortly afterwards, but may still trigger the OV alarm.

This function is used to inform the operator of the device acoustically or visually that it may have generated an excessive voltage or experienced an excessive voltage from outside and that either the device or the connected load may be defective.

- The device is not equipped with protective measures against external overvoltage
- Changing the operating mode CC -> CV can lead to voltage overshoot in source mode

9.2.5 Safety OVP alarm

This extra protection is only installed in the **60 V model**, in addition to the normal overvoltage alarm (see section *«9.2.4 Overvoltage»*). The safety OVP (short: SOVP) is intended to switch off the DC terminal of the affected channel in a hardware-triggered manner to protect the application or persons and also to prevent the device from emitting an output voltage of more than 60 V (protection limit according to SELV) in source mode. The alarm can, however, also be triggered by external sources if they supply more than this limit value to one of the three DC terminals.

A safety OVP alarm occurs when

- the voltage at any of the device's DC terminals reaches a fixed threshold slightly above 60 V, whether generated by the device itself or applied to the device from outside.

If the alarm occurs, the connection of the affected channel is switched off and **Alarm: Safety OVP** is shown on the display. It cannot be acknowledged and reset like other alarms. In this case, it is necessary to switch the device off and on again in order to be able to operate the affected channel(s) again.

The alarm should not be triggered during normal operation. However, there are situations where it could still trip, e.g. when working with voltages close to the tripping threshold or when the device suddenly leaves the current limit when the voltage is set at or near 60 V.

If remote sensing is connected, the output voltage is higher than the set value by the amount of the compensation, at least in source mode. The Safety OVP may therefore take effect earlier.

9.2.6 Overcurrent alarm

An overcurrent alarm (short: OCP) leads to the DC terminal of a channel being switched off if

- the current flowing in the DC terminal channel reaches the set, channel-specific OCP threshold

This protective function is not intended to protect the device, but to protect the connected load in source mode or the external source in sink mode so that it is not damaged by excessive current or irreparably destroyed in the event of a fault that results in excessive current.

9.2.7 Overpower alarm

An overload alarm (short: OPP) leads to the DC terminal of a channel being switched off if

- the product of the voltage and current present at the DC terminal reaches the set, channel-specific OPP threshold

This protective function is not intended to protect the device, but to protect the connected load (source mode) or the external source (sink mode) if it could be damaged by excessive power consumption.

9.2.8 Share-Bus fail

A Share-Bus fail alarm (short: SF) leads to the disconnection of the DC terminals of the channels connected via the Share-Bus, regardless of which channel causes it and also regardless of whether in master-auxiliary mode or channel grouping, if

- a short circuit has occurred on the Share-Bus, e.g. due to a defective BNC cable

This protective function is intended to prevent the channels among each other or subordinate units from receiving irregular control values via the Share-Bus or behaving differently in master-auxiliary mode. The alarm must be acknowledged after the cause of the fault has been rectified.

9.2.9 Master-auxiliary protection

A master-auxiliary protection alarm (short: MAP) causes the DC terminals of devices in master-auxiliary operation to switch off the DC terminals of the affected channel(s) if

- a short circuit has occurred in the master-auxiliary connection, e.g. due to a defective cable,
- communication between the master and auxiliary devices is disrupted.

This protective function is intended to prevent the units of the master-auxiliary network from entering an irregular operating state. The alarm must be acknowledged after the cause of the fault has been rectified.

9.2.10 Connection overload alarm

A connection (line, cable) overload alarm (short: COP) leads to disconnection of the DC terminal and can occur if

- the voltage drop on the load lines has exceeded the adjustable threshold for COP.

9.2.11 External overtemperature alarm

An alarm from the external temperature protection (short: ETP) leads to disconnection of the DC terminal and can occur if

- the measured value of at least one of the temperature sensors that can be connected to the ”Digital In / Out” port has exceeded the threshold for ETP that can be set separately for the respective channel.

9.2.12 Reverse polarity detection alarm

A reverse polarity detection alarm (displayed as: Polarity), can occur when

- a battery connected with reverse polarity is detected using input “Sense 2”.

The device would then not switch on the DC terminal of the affected channel and the related DC contactor won’t be closed. The alarm must be acknowledged after the cause of the fault has been rectified.

10. Technical data

10.1 Permissible operating conditions

10.1.1 Ambiance

The permissible ambient temperature range during operation is from 0 °C to 50 °C. During storage or transport, an extended range of -20 °C to 70 °C is permitted. If condensation has formed during storage or transport, the device must be acclimatised for at least 2 hours before use or dried by suitable air circulation.

The device is generally intended for operation in dry rooms. It must not be operated where there is a particularly high dust or moisture content in the air, where there is a risk of explosion or where there is an aggressive chemical effect. The operating position is not arbitrary (see *«6.3.3 Setting up the device»*), but sufficient air circulation must be ensured. The device may be operated up to an altitude of 2000 m above sea level. Nominal data with tolerance apply after a warm-up time of at least 30 minutes and at an ambient temperature of 23 °C. Values without tolerance are standard values for an average device.

10.1.2 Cooling

Power loss generated in the device heats the air flowing through the device. The flow direction is from the front (inlet) to the rear (outlet). The fan speed is regulated up or down depending on the internal temperature of the device. A certain minimum speed is required, as internal components heat up even when the device is idling.

Dust in the air settles on all parts in the air path and can impair the air flow to a certain extent. It is therefore important to ensure an unobstructed air flow, at least outside the device, by leaving sufficient space behind the device or, if the device is installed in a cabinet, ensuring that the doors of the cabinet have meshes.

At the same time, the ambient temperature should be kept as low as possible, if necessary using external measures such as air conditioning. Should the device nevertheless heat up internally to such an extent that the heat sink temperature rises above 80 °C, it protects itself by automatically switching off the DC terminal and only switching on again once it has cooled down.

In water-cooled versions, water is the main cooling medium that flows through the internal heat sinks. The air inside the otherwise almost hermetically sealed housing is circulated by internal fans to cool the remaining components, which also heat up but are not located on the heat sink.

10.2 General technical data

Display:	Color TFT touchscreen with Gorilla glass, 5", 800 x 480 dots, capacitive
Control elements:	2 rotary knobs with push-button function, 1 push-button

10.3 Specific technical data

General specifications	
AC input	
Voltage, Phases	Range 1: 208 V, ±10%, 3ph AC Range 2: 380 - 480 V, ±10%, 3ph AC
Frequency	45 - 65 Hz
Power factor	ca. 0.99
Leakage current	<10 mA
Inrush current *1	@208 V: ca. 28 A per phase @400 V: ca. 54 A per phase
Overvoltage category	II
DC input/output static	
Load regulation CV	≤0.05% FS (0 - 100% load, at constant AC input voltage and temperature)
Line regulation CV	≤0.01% FS (208 V - 480 V AC ±10%, at constant load and constant temperature)
Stability CV	≤0.02% FS (during 8 h of operation, after 30 minutes of warm-up, at constant AC input voltage, load and temperature)
Temperature coefficient CV	≤30ppm/°C (after 30 minutes of warm-up)
Compensation (remote sense)	Models with 10 V: ≤15% FS Models from 60 V: ≤5% FS
Load regulation CC	≤0.1% FS (0 - 100% load, at constant AC input voltage and temperature)
Line regulation CC	≤0.01% FS (208 V - 480 V AC ±10%, at constant load and constant temperature)
Stability CC	≤0.02% FS (during 8 h of operation, after 30 minutes of warm-up, at constant AC input voltage, load and temperature)
Temperature coefficient CC	≤50ppm/°C (after 30 minutes of warm-up)
Load regulation CP	≤0.3% FS (0 - 100% load, at constant AC input voltage and temperature)
Load regulation CR *3	≤0.3% FS + 0.1% FS of current (0 - 100% load, at constant AC input voltage and temperature)
Protective functions	
OVP	Overvoltage protection, adjustable 0 - 110% $U_{Nominal}$
OCP	Overcurrent protection, adjustable 0 - 110% $I_{Nominal}$
OPP	Overpower protection, adjustable 0 - 110% $P_{Nominal}$
OT	Overtemperature protection (DC terminal shuts down in case of insufficient cooling)
DC input/output dynamic	
Rise time 10 - 90% / Fall time 90 - 10%	CV: ≤10 ms CC: ≤2 ms
Display & measurement accuracy	
Voltage	≤0.05% FS
Current	≤0.1% FS
Insulation	
AC input to DC terminal	3750 Vrms (1 minute, creepage distance >8 mm) *2
AC input to case (PE)	2500 Vrms
DC terminal to case (PE)	Depending on the model, see model tables
DC terminal to interfaces	1000 V DC (models up to 360 V rating), 1500 V DC (models from 500 V rating)
Communication interfaces	
Rear, galvanically isolated	USB, Ethernet (1 GBit), EtherCAT, CAN FD, all for communication
Communication speed	≤1 ms *4
Front, galvanically isolated	USB host, for data acquisition
Digital In/Out	
Built-in, galvanically isolated	16 pole
Inputs	3x independent, user-configurable
Outputs	3x independent, as dry contact
Sensor inputs	3x independent, for temperature sensor

*1 Calculated for the peak value of the stated voltage including 10% tolerance, at 23°C ambient and first switch-on (cold start)
*2 Models with up to 80 V DC rating have reinforced insulation while all other models from 200 V DC rating have basic insulation
*3 Where featured
*4 When using EtherCAT

General specifications	
Device configuration	
Parallel operation with Share bus	Single channel models: up to 64 units of the same series Triple channel models: 2 units per channel or grouping of all 3 channels of one device
Safety and EMC	
Safety	EN 61010-1 IEC 61010-1 UL 61010-1 CSA C22.2 No 61010-1 BS EN 61010-1
EMC	EN 55011, class A, group 1 CISPR 11, class A, group 1 FCC 47 CFR part 15B, unintentional radiator, class A EN 61326-1 including tests according to: - EN 61000-4-2 - EN 61000-4-3 - EN 61000-4-4 - EN 61000-4-5 - EN 61000-4-6
Appliance class	I
Ingress protection	IP20
Environmental conditions	
Operating temperature *5	0 - 50 °C (32 - 122 °F)
Storage temperature	-20 - 70 °C (-4 - 158 °F)
Humidity	≤80% relative humidity, non-condensing
Altitude	≤2000 m (≤6,600 ft)
Pollution degree	2
Mechanical construction	
Cooling	Forced air flow from front to rear (temperature controlled fans), optional water cooling
Dimensions (W x H x D)	Chassis: 483 mm (19 in) x 177 mm (4U) x 668 mm (26.3 in) Overall depth: min. 802 mm (min. 31.6 in)
Weight	50 kg (110 lb)
Weight with water cooling	56 kg (126 lb)

*5 The rated power of the device is only permanently available up to approximately +40 °C (104 °F)

Technical specifications	BT 20010-400 Triple	BT 20010-600 Triple	BT 20060-340 Triple	BT 20080-340 Triple
Number of channels	3	3	3	3
Total device power range *2	0 - 12000 W	0 - 18000 W	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)
DC output per channel				
Voltage range	0 - 10 V	0 - 10 V	0 - 60 V	0 - 80 V
Ripple in CV (rms)	≤25 mV (BWL 300 kHz *1)	≤30 mV (BWL 300 kHz *1)	≤25 mV (BWL 300 kHz *1)	≤25 mV (BWL 300 kHz *1)
Ripple in CV (pp)	≤150mV (BWL 20 MHz *1)	≤200 mV (BWL 20 MHz *1)	≤320 mV (BWL 20 MHz *1)	≤320 mV (BWL 20 MHz *1)
U_{Min} for I_{Max} (sink)	0.5 V	0.5 V	0.65 V	0.65 V
Current range	0 - 400 A	0 - 600 A	0 - 340 A	0 - 340 A
Power range *2	0 - 4000 W	0 - 6000 W	0 - 10000 W (0 - 6000 W)	0 - 10000 W (0 - 6000 W)
Output capacitance	8460 µF	8460 µF	8460 µF	8460 µF
Efficiency sink/source (up to)	90.0%	90.5%	94.5%	95.0%
AC input				
P_{Max}	Range 1: 13 kW Range 2: 13 kW	Range 1: 19 kW Range 2: 19 kW	Range 1: 19 kW Range 2: 31 kW	Range 1: 19 kW Range 2: 31 kW
Phase current *4	Range 1: ≤41 A Range 2: ≤22 A	Range 1: ≤61 A Range 2: ≤32 A	Range 1: ≤61 A Range 2: ≤53 A	Range 1: ≤61 A Range 2: ≤53 A
Insulation				
Negative DC pole <-> PE	±600 V DC	±600 V DC	±600 V DC	±600 V DC
Positive DC pole <-> PE	+600 V DC	+600 V DC	+600 V DC	+600 V DC
Channel DC <-> Channel DC	±1200 V DC	±1200 V DC	±1200 V DC	±1200 V DC
Product codes				
Standard	02133001	02133002	02133003	02133004
Standard + Water cooling	02143001	02143002	02143003	02143004

*1 BWL = Bandwidth limit on the measuring oscilloscope
*2 The value in brackets applies to the state of derating (power reduction) when standard models run on 208 V ±10% utility
*3 At 100% power and 100% output voltage
*4 Calculated for the default AC supply voltage in the stated range, minus 10% tolerance, at maximum output power and 10% power loss from AC to DC

Technical specifications	BT 20200-140 Triple	BT 20360-80 Triple	BT 20500-60 Triple	BT 20920-40 Triple
Number of channels	3	3	3	3
Total device power range *2	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)
DC output per channel				
Voltage range	0 - 200 V	0 - 360 V	0 - 500 V	0 - 920 V
Ripple in CV (rms)	≤40 mV (BWL 300 kHz *1)	≤55 mV (BWL 300 kHz *1)	≤70 mV (BWL 300 kHz *1)	≤70 mV (BWL 300 kHz *1)
Ripple in CV (pp)	≤300 mV (BWL 20 MHz *1)	≤300 mV (BWL 20 MHz *1)	≤350 mV (BWL 20 MHz *1)	≤700 mV (BWL 20 MHz *1)
U_{Min} for I_{Max} (sink)	1.8 V	2.5 V	2.5 V	2.5 V
Current range	0 - 140 A	0 - 80 A	0 - 60 A	0 - 40 A
Power range *2	0 - 10000 W (0 - 6000 W)	0 - 10000 W (0 - 6000 W)	0 - 10000 W (0 - 6000 W)	0 - 10000 W (0 - 6000 W)
Output capacitance	1800 µF	600 µF	225 µF	100 µF
Efficiency sink/source (up to)	95.1%	95.5%	96.0%	96.0%
AC input				
P_{Max}	Range 1: 19 kW Range 2: 31 kW	Range 1: 19 kW Range 2: 31 kW	Range 1: 19 kW Range 2: 31 kW	Range 1: 19 kW Range 2: 31 kW
Phase current *4	Range 1: ≤61 A Range 2: ≤53 A	Range 1: ≤61 A Range 2: ≤53 A	Range 1: ≤61 A Range 2: ≤53 A	Range 1: ≤61 A Range 2: ≤53 A
Insulation				
Negative DC pole <-> PE	±1000 V DC	±1000 V DC	±1500 V DC	±1500 V DC
Positive DC pole <-> PE	+1000 V DC	+1000 V DC	+2000 V DC	+2000 V DC
Channel DC <-> Channel DC	±2000 V DC	±2000 V DC	±2000 V DC	±2000 V DC
Product codes				
Standard	02133005	02133006	02133007	02133008
Standard + Water cooling	02143005	02143006	02143007	02143008

*1 BWL = Bandwidth limit on the measuring oscilloscope
*2 The value in brackets applies to the state of derating (power reduction) when standard models run on 208 V ±10% utility
*3 At 100% power and 100% output voltage
*4 Calculated for the default AC supply voltage in the stated range, minus 10% tolerance, at maximum output power and 10% power loss from AC to DC

11. Contact and support

11.1 Repairs/technical support

Repairs, unless otherwise agreed between user and supplier, are carried out by the manufacturer. To do this, the device must be sent to the manufacturer. To ensure that a support request or repair is processed as quickly and smoothly as possible, please visit the support area of our website at **www.elektroautomatik.com/service** and submit your support or repair request by filling in the relevant form field (“Support Request” or “Repair Request”). No service order can be generated without this data input.

11.2 Contact options

If you have any questions or problems with the operation of the device, use of optional components, documentation or software, you can contact technical support by phone or e-mail.

Head office	E-mail addresses	Telephone numbers
EA Elektro-Automatik GmbH Helmholtzstr. 31-37 41747 Viersen	Technical assistance: support@elektroautomatik.de All other topics: ea1974@elektroautomatik.de	Switchboard: 02162 / 37850 Support: 02162 / 378566

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Revision: 03