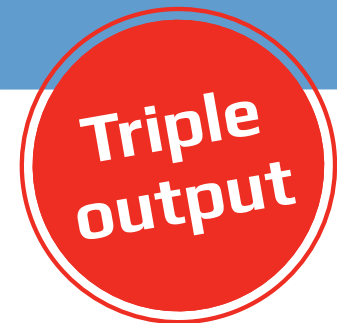




Elektro-Automatik



**DATASHEET**

# EA-BT 20000 TRIPLE

Battery Tester  
with regenerative energy recovery

# EA-BT 20000 TRIPLE

Battery Tester  
with regenerative energy recovery



## Features

- Wide range input: 208 V - 480 V,  $\pm 10\%$ , 3ph AC
- Active Power Factor Correction, typical 0.99
- Battery tester, 2-quadrants for charge and discharge
- In discharge operation regenerative with energy recovery into the grid
- Very high efficiency of up to over 96%
- Voltages from 0 - 10 V up to 0 - 920 V
- High performance with up to 10 kW per channel
- Currents from 0 - 40 A up to 0 - 600 A per channel
- Flexible power regulated DC output/input stages (autoranging)
- Regulation modes CV, CC, CP, CR with fast crossover
- Digital regulation, high resolution with 16bit ADCs and DACs, selection of control speed: Normal, Fast, Slow
- Galvanically isolated Share-Bus for parallel operation
- Master-Slave-Bus for parallel operation
- Built-in Interfaces with 1 ms communication speed
- Typical battery tester functionality integrated
- Integrated Battery test mode, battery simulation
- Command languages and drivers: SCPI and ModBus, LabVIEW, IVI

## Built-in interfaces

- USB
- Ethernet 1Gbit/s
- EtherCAT
- CAN FD
- Master-Slave-Bus
- Share-Bus
- USB Host on Front panel
- 3 digital inputs
- 3 relay contacts
- 3 temperature sensor inputs

## Software

- EA-Power Control
- EA-Battery Simulator

## Options

- Water Cooling in stainless steel

## Technical data

General specifications	
<b>AC input</b>	
Voltage, Phases	380 V - 480 V $\pm 10\%$ , 3ph AC (208 V - 240 V $\pm 10\%$ , 3ph AC with derating to 18 kW)
Frequency	45 - 65 Hz
Power factor	ca. 0.99
Leakage current	<10 mA
Phase current	$\leq 56$ A @ 400 V AC
Oversvoltage category	2
<b>DC output static</b>	
Load regulation CV	$\leq 0.05\%$ FS (0 - 100% load, constant output voltage and constant temperature)
Line regulation CV	$\leq 0.01\%$ FS (208 V - 480 V AC $\pm 10\%$ supply voltage, constant load and constant temperature)
Stability CV	$\leq 0.02\%$ FS (during 8 h of operation, after 30 minutes warm-up, at constant output voltage, load and temperature)
Temperature coefficient CV	$\leq 30$ ppm/ $^{\circ}$ C (after 30 minutes of warm-up)
Compensation (remote sense)	$\leq 5\%$ $U_{\text{Nominal}}$ , 10V-Model $\leq 30\%$ $U_{\text{Nominal}}$
Load regulation CC	$\leq 0.1\%$ FS (0 - 100% load, constant output voltage and constant temperature)
Line regulation CC	$\leq 0.01\%$ FS (208 V - 480 V AC $\pm 10\%$ supply voltage, constant load and constant temperature)
Stability CC	$\leq 0.02\%$ FS (during 8 h of operation, after 30 minutes warm-up, at constant output voltage, load and temperature)
Temperature coefficient CC	$\leq 50$ ppm/ $^{\circ}$ C (after 30 minutes of warm-up)
Load regulation CP	$\leq 0.3\%$ FS (0 - 100% load, constant output voltage and constant temperature)
Load regulation CR	$\leq 0.3\%$ FS + 0.1% FS current (0 - 100% load, constant output voltage and constant temperature)
<b>Protective functions</b>	
OVP	Overvoltage protection, adjustable 0 - 110% $U_{\text{Nominal}}$
OCP	Overcurrent protection, adjustable 0 - 110% $I_{\text{Nominal}}$
OPP	Overpower protection, adjustable 0 - 110% $P_{\text{Nominal}}$
OT	Overtemperature protection (DC output shuts down in case of insufficient cooling)
<b>DC output dynamic</b>	
Rise time 10 - 90% CV	$\leq 10$ ms
Fall time 90 - 10% CV	$\leq 10$ ms
Rise time 10 - 90% CC	$\leq 2$ ms
Fall time 90 - 10% CC	$\leq 2$ ms
<b>Display accuracy</b>	
Voltage	$\leq 0.05\%$ FS
Current	$\leq 0.1\%$ FS
<b>Insulation</b>	
AC input to DC output	3750 Vrms (1 minute, creepage distance >8 mm)
AC input to case (PE)	2500 Vrms
DC output to case (PE)	Depending on the model, see model tables
DC output to interfaces	1000 V DC (models up to 360 V rating), 1500 V DC (models from 500 V rating)
<b>Control interfaces digital</b>	
Built-in, galvanically isolated	USB, Ethernet (1 GBit), EtherCAT Slave, CAN FD, all for communication
Communication speed	1 ms
Built-in, galvanically isolated	USB Host on front panel for data acquisition

<b>General specifications</b>	
<b>Interfaces analog</b>	
Built-in, galvanically isolated	16 pole connector
Inputs	3 independent inputs
Outputs	3 independent outputs as relay contact
Temperature inputs	3 independent temperature sensor inputs
<b>Device configuration</b>	
Parallel operation	Up to 3 channels with Master-Slave-Bus and Share-Bus
<b>Safety and EMC</b>	
Safety	EN 61010-1 IEC 61010-1 UL 61010-1 CSA C22.2 No 61010-1 BS EN 61010-1
EMC	EN 55011, class B CISPR 11, class B FCC 47 CFR part 15B, unintentional radiator, class B EN 61326-1 include tests according to: - EN 61000-4-2 - EN 61000-4-3 - EN 61000-4-4 - EN 61000-4-5 - EN 61000-4-6
Safety protection class	1
Ingress Protection	IP20
<b>Environmental conditions</b>	
Operating temperature	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
<b>Mechanical construction</b>	
Cooling	Forced air flow from front to rear (temperature controlled fans), optional water cooling
Dimensions (W x H x D)	Enclosure: 19" x 4U x 668 mm (26.3 in)
Weight	50 kg (110 lb)
Weight with water cooling	56 kg (126 lb)

Technical specifications	BT 20010-400 Triple	BT 20010-600 Triple	BT 20060-340 Triple	BT 20080-340 Triple
<b>DC output per channel</b>				
Number of channels	3 channels	3 channels	3 channels	3 channels
Voltage range	0 - 10 V	0 - 10 V	0 - 60 V	0 - 80 V
Ripple in CV (rms)	≤25 mV (BW 300 kHz)	≤25 mV (BW 300 kHz)	≤25 mV (BW 300 kHz)	≤25 mV (BW 300 kHz)
Ripple in CV (pp)	≤320 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)
$U_{Min}$ for $I_{Max}$ (sink)	0.62 V	0.62 V	0.62 V	0.62 V
Current range	±400 A per channel	±600 A per channel	±340 A per channel	±340 A per channel
Power range	±4000 W per channel	±6000 W per channel	±10000 W per channel	±10000 W per channel
Device power range	±12000 W	±18000 W	±30000 W	±30000 W
Resistance range				
Output capacitance	8460 µF	8460 µF	8460 µF	8460 µF
Efficiency sink/source (up to)	95.1% *1	95.1% *1	95.1% *1	95.5% *1
<b>Insulation</b>				
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
<b>Article numbers</b>				
Standard	02133001	02133002	02133003	02133004
Standard + Water Cooling	02143001	02143002	02143003	02143004

\*1 At 100% power and 100% output voltage

Technical specifications	BT 20200-140 Triple	BT 20360-80 Triple	BT 20500-60 Triple	BT 20920-40 Triple
<b>DC output per channel</b>				
Number of channels	3 channels	3 channels	3 channels	3 channels
Voltage range	0 - 200 V	0 - 360 V	0 - 500 V	0 - 920 V
Ripple in CV (rms)	≤40 mV (BW 300 kHz)	≤55 mV (BW 300 kHz)	≤70 mV (BW 300 kHz)	≤250 mV (BW 300 kHz)
Ripple in CV (pp)	≤300 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤350 mV (BW 20 MHz)	≤1200 mV (BW 20 MHz)
$U_{Min}$ for $I_{Max}$ (sink)	1.8 V	2.5 V	1.1 V	2 V
Current range	±140 A per channel	±80 A per channel	±60 A per channel	±40 A per channel
Power range	±10000 W per channel	±10000 W per channel	±10000 W per channel	±10000 W per channel
Device power range	±30000 W	±30000 W	±30000 W	±30000 W
Resistance range				
Output capacitance	1800 µF	600 µF	225 µF	40 µF
Efficiency sink/source (up to)	95.3% *1	95.8% *1	96.5% *1	96.5% *1
<b>Insulation</b>				
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
<b>Article numbers</b>				
Standard	02133005	02133006	02133007	02133008
Standard + Water Cooling	02143005	02143006	02143007	02143008

\*1 At 100% power and 100% output voltage

## General

The battery tester with regenerative energy recovery in the BT 20000 Triple series from EA Elektro-Automatik are two quadrant devices with 3 channels which can perform the function of a charger as well as that of an electronic load (discharging). In discharging mode the device is regenerative and feeds the energy back into the local grid with an efficiency of up to over 96%. The BT 20000 triple series includes three phase units which, together with the wide input range, allows use with practically all global mains voltages. The DC voltages and currents are determined by the application and the spectrum ranges from 0 - 10 V to 0 - 920 V and from 0 - 40 A up to 0 - 600 A per channel in a single device. The DC supply operates as a flexible output stage with a constant power characteristic (autoranging) with a wide voltage and current range. To achieve higher power and current all units are equipped with a Master-Slave-Bus. This enables up to 3 parallel connected channels to be combined into one channel which can provide up to 30 kW and 1800 A. Such a combination works as a single channel and can use as a battery tester with higher power and current. In this way as an example a user can construct a battery cell tester with 3 channels of 0 - 10 V and 0 - 600 A or one channel with 0 - 10 V and 0 - 1800 A. Furthermore typical battery tester alarm and warning management, various industrial interfaces, software solutions and many more functions are available.

## AC connection

The DC battery tester in the BT 20000 Triple series are equipped with an active PFC which provides a high efficiency at a low energy consumption. Furthermore, the devices in this series provide a wide AC input voltage range. It reaches from 208 - 240 V and 380 - 480 V with 3-phases. Hence the devices can be operated in the majority of global grids. They adjust automatically, without additional configuration, to the available grid voltage.

In an AC grid with a 3-phase 208 - 240 V a derating of the DC output power is automatically set.

## Energy recovery

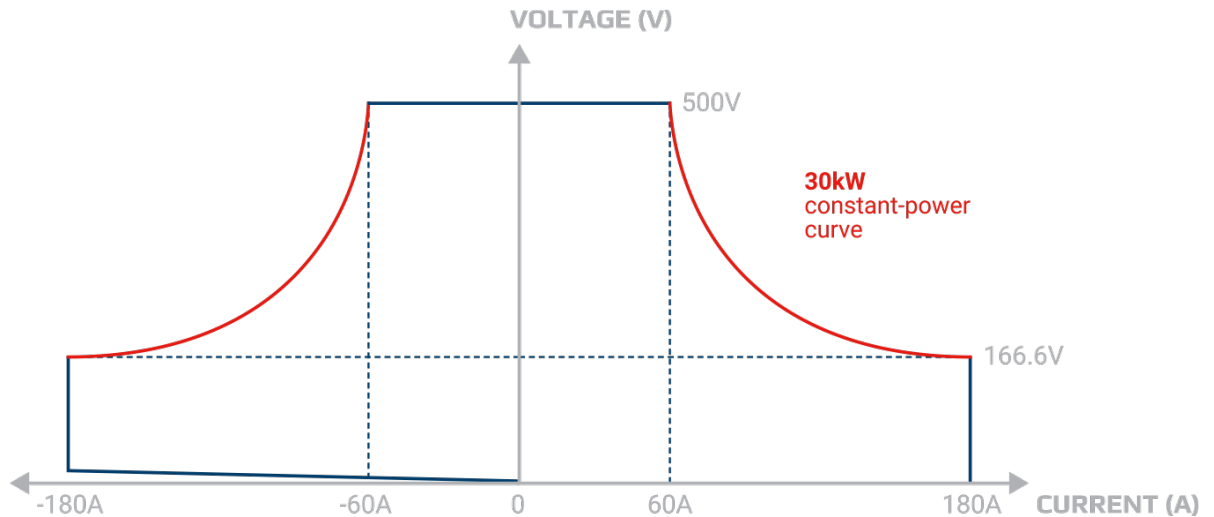
The energy consumed in discharge mode is fed back into the connected grid with an efficiency of up to over 96%. As the energy is not converted to heat as in other battery tester, the energy costs are reduced. In addition, the devices generate less heat requiring less cost intensive air conditioning.

## DC output

The output per channel of the battery tester with regenerative energy recovery BT 20000 Triple with a DC voltage of 0 - 10 V up to 0 - 920 V allows positive and negative currents of 0 - 40 A up to 0 - 600 A as a two quadrant device. The flexible output stages (autoranging) provide the user with a wide voltage, current and power range and hence a wider field of working than traditional battery tester.

## DC connection

Connection of the DC output is via a copper rail on the back side of the device. If a system with higher performance is required, the devices are simply connected in parallel. With minimal effort devices can be linked with the vertical copper rails. A cover for contact protection is provided.



## The principle of autoranging

„Autoranging“ is a term when a two quadrant battery tester automatically offers a wide output and input range of both, voltage and current, to maintain full power across a wide operation range. This type of solution allows the use of a single unit to address multiple voltage and current combinations.

## Interfaces

As standard, EA-BT 20000 Triple battery tester series devices are fitted with the most important interfaces and ports which are all galvanically isolated from the DC side. The communication speed is 1 ms. The following digital interfaces are available to the user:

- USB
- Ethernet 1Gbit/s
- EtherCAT
- CAN FD
- USB host

In addition, there are 3 digital inputs, 3 relay contacts and 3 temperature sensor inputs.

A Master-Slave-Bus and Share-Bus are available for expanding the devices as a high-performance system. With these interfaces, the system works like a single device with symmetrical load sharing.



## High performance battery test systems

High power applications can be covered with high power battery test systems of up to 240 kW in one cabinet. These are achieved by using the DC outputs of multiple BT 20000 devices with vertical copper rails in parallel. Thus, a 19" cabinet with 42 U can provide a system with 240 kW occupying only 0.6 m<sup>2</sup> (6.5 sqft) of floor space. The Master-Slave-Bus allows for up to 8 cabinets with a maximum of 64 units with 30 kW each to behave as one unit.

## Master-Slave-Bus and Share-Bus

If the integrated Master-Slave-Bus and Share-Bus are used, a multi device system behaves as a single device. The Master-Slave-Bus and Share-Bus are simply connected between each device. With the Master-Slave-Bus the system data, such as total power and total current, are collected and shown on the master device. Warnings and alarms of the slave devices are shown clearly in the display. The Share-Bus equal load distribution to the individual devices.



## Example representation

In this illustration you can see a fully assembled and wired 240 kW system



## Applications

### Battery test for electro mobility

A typical application for the battery tester with regenerative energy recovery from EA Elektro-Automatik is the testing of the electrical characteristics of a battery. The wide application spectrum covers cell, module or pack tests, the determination of the SOH (State-of-Health) for a second life classification as well as the End-of-Line (EOL) test. These applications put many demands on power electronics which are fulfilled by the BT 20000 range. The excellent features of this device range are: measurement of voltage and current with the required accuracy and performance, reproducibility and reliability of these data and the flexible usability. Whether in an automated test system or in an integrated battery test, all possibilities are open to the user. Furthermore, the devices are clearly economical with efficiencies of up to over 96%.

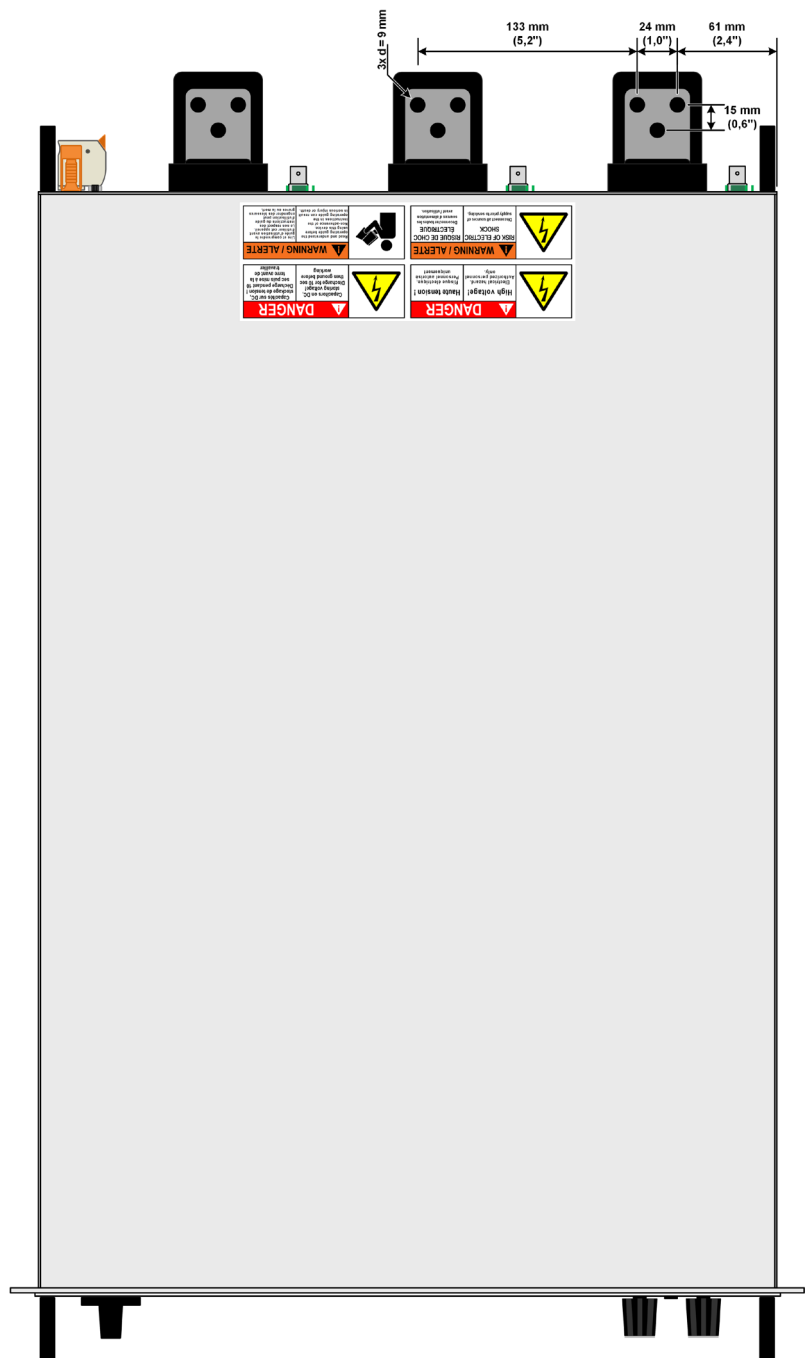
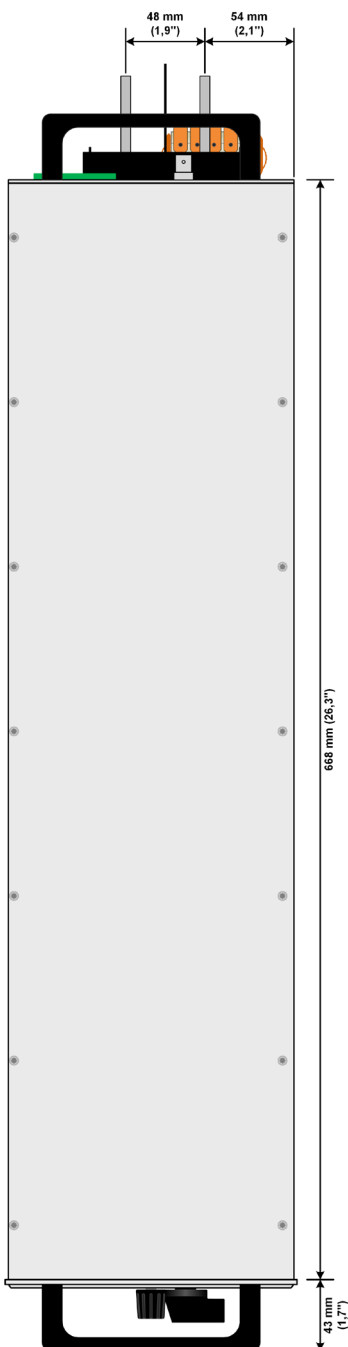
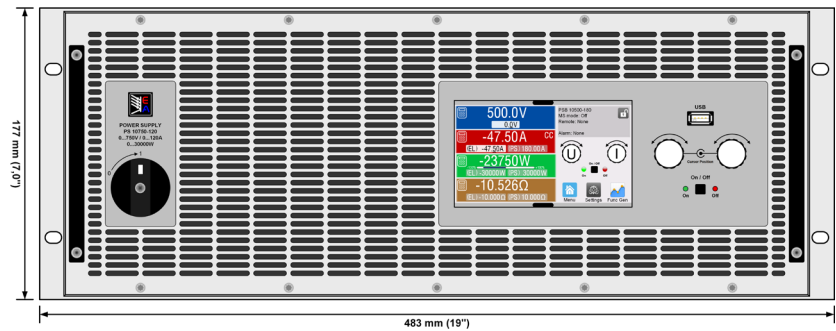
### Battery simulation

Additional applications include the simulation of batteries as single cells, modules, or packs. These simulations aid in the optimal configuration of energy storage as well as the supplied components under test. Wherever reproducible data are needed a battery simulator is the first choice. Also, the use of a battery tester as simulator provides protection for the connected consuming component. The overcurrent protection (OCP) can, like a safety fuse, switch off the output and generate an alarm. The voltage can be monitored and can, if over or under limits, trigger various functions, and also generate warnings and alarms. Thus, many integrated functions can be safely performed.

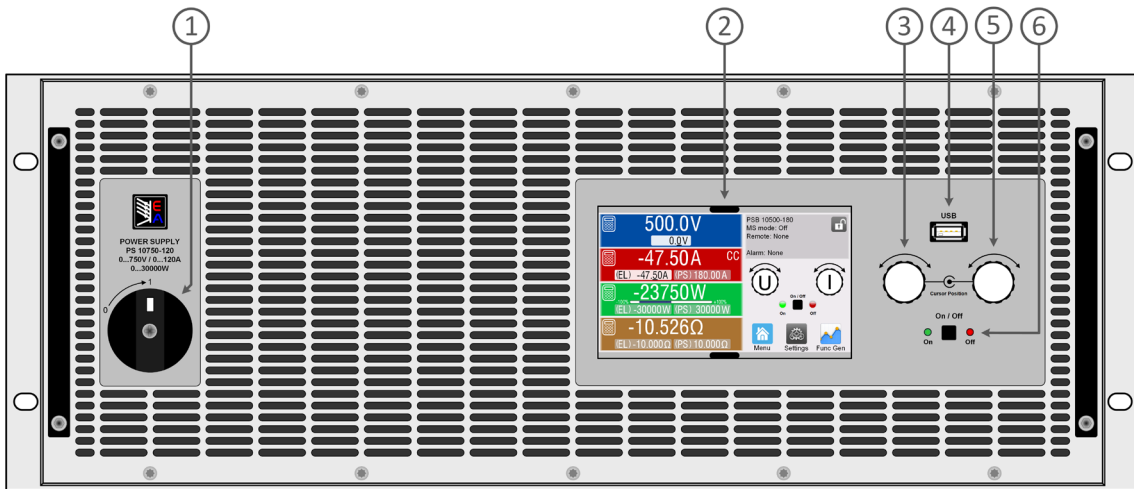
### Battery recycling

The battery tester with regenerative energy recovery of the BT 20000 range enable retired batteries from electric vehicles to be considered for a possible further use. Assessment of the battery pack starts with a State of Health (SOH) check to determine if a second life is feasible. This standard integral function can be initiated with one clic. If this check shows too little rest capacity, then the battery must be fully discharged before recycling. The autoranging of the devices guarantees the maximum possible total discharge though the high load current, even with voltages under 2 V. The regenerative energy recovery to the power grid up to over 96% efficiency makes this process highly cost effective.

# Technical drawings BT 10000 Triple 4U $\leq 200$ V

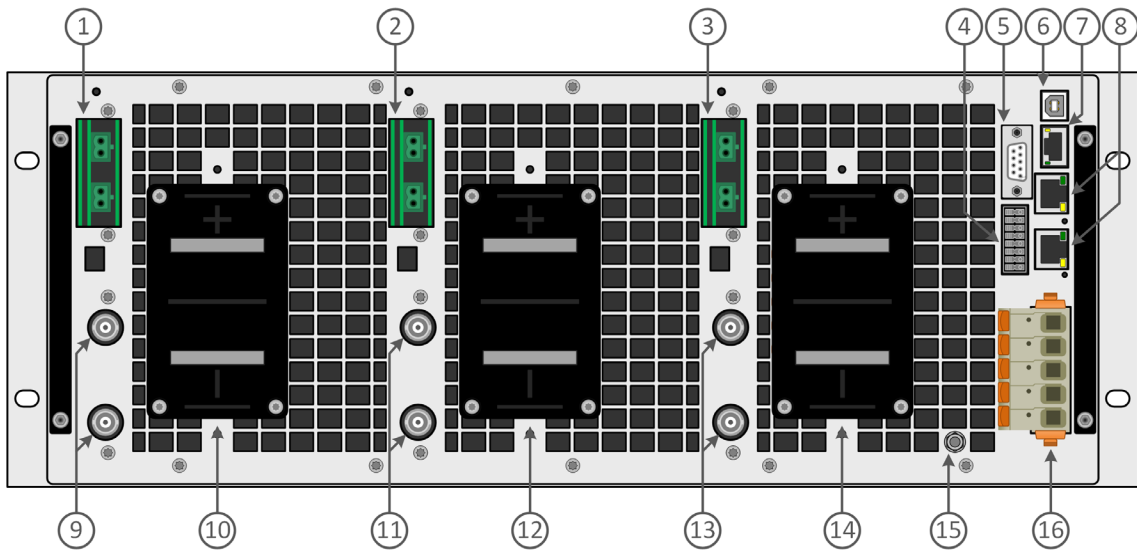


## Front panel description BT 10000 Triple 4U



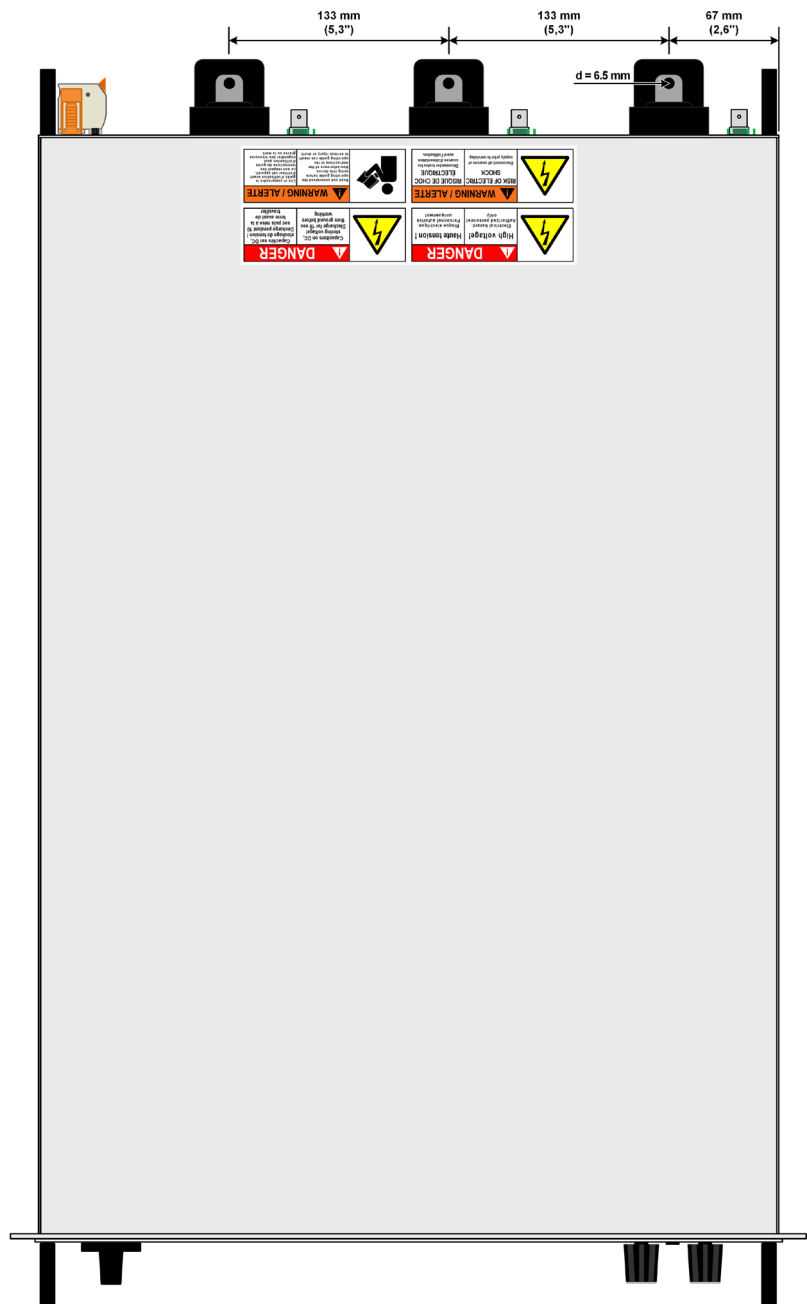
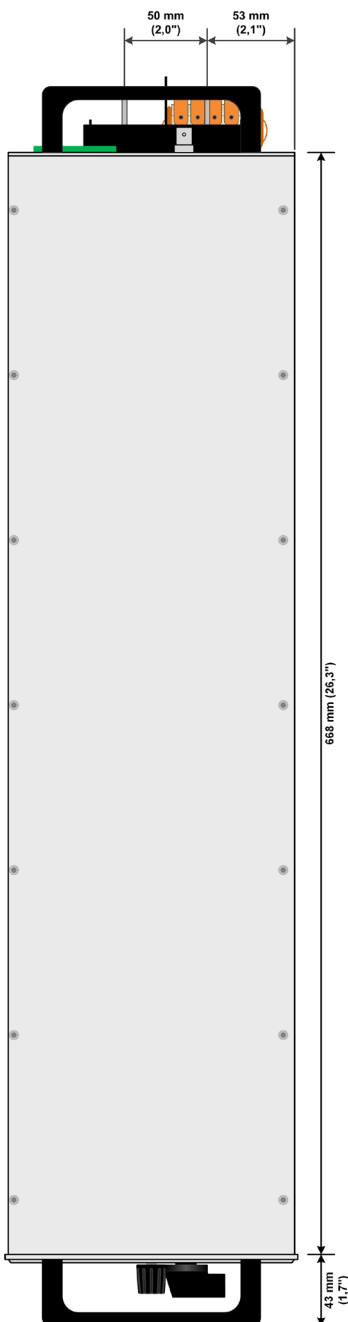
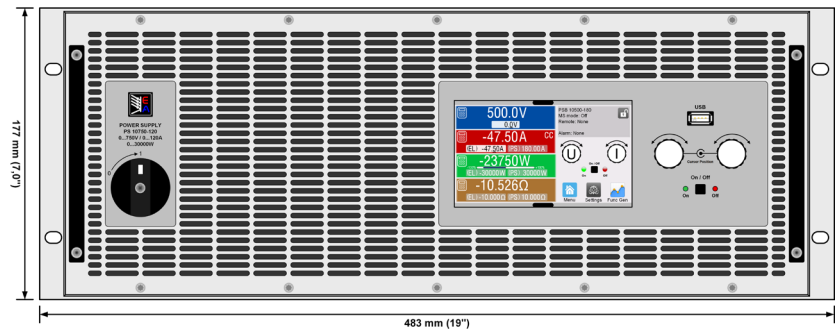
1. Power switch
2. TFT control interface, interactive operation and display
3. Rotary knob with push-button action, for settings and control
4. USB host, uses USB sticks for data logging and sequencing
5. Rotary knob with push-button action, for settings and control
6. On / Off push-button with LED status display

## Rear panel description BT 10000 Triple 4U $\leq 200\text{ V}$

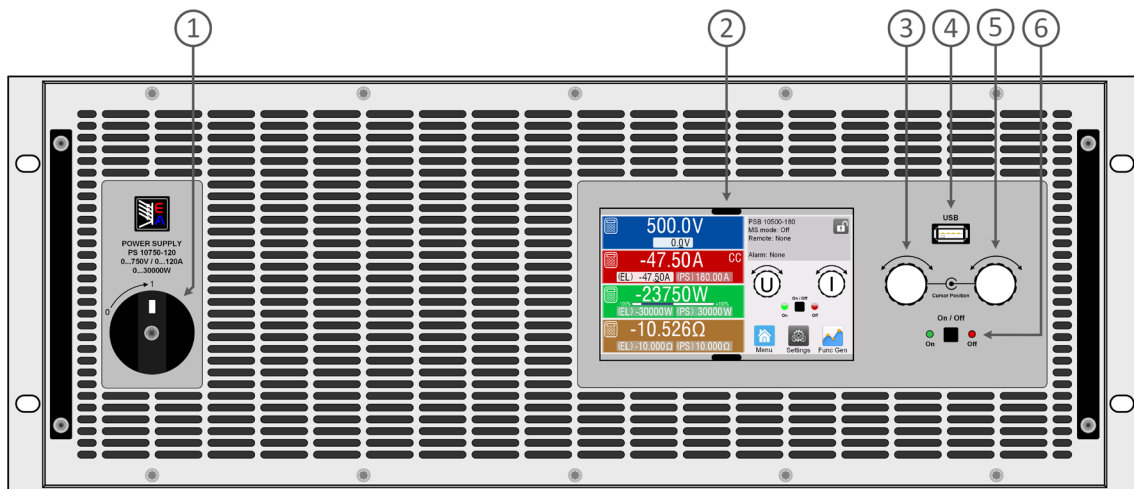


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| <ol style="list-style-type: none"> <li>1. Remote sense connectors Channel 3</li> <li>2. Remote sense connectors Channel 2</li> <li>3. Remote sense connectors Channel 1</li> <li>4. Input / Output 16 pole connector</li> <li>5. CAN FD interface</li> <li>6. USB interface</li> <li>7. Ethernet interface 1Gbit</li> <li>8. EtherCAT Slave</li> </ol> | <ol style="list-style-type: none"> <li>9. Share-Bus connectors Channel 3</li> <li>10. DC output connector (copper blades) Channel 3</li> <li>11. Share-Bus connectors Channel 2</li> <li>12. DC output connector (copper blades) Channel 2</li> <li>13. Share-Bus connectors Channel 1</li> <li>14. DC output connector (copper blades) Channel 1</li> <li>15. Grounding connection screw (PE)</li> <li>16. AC input connector</li> </ol> |
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# Technical drawings BT 10000 Triple 4U $\geq 360$ V

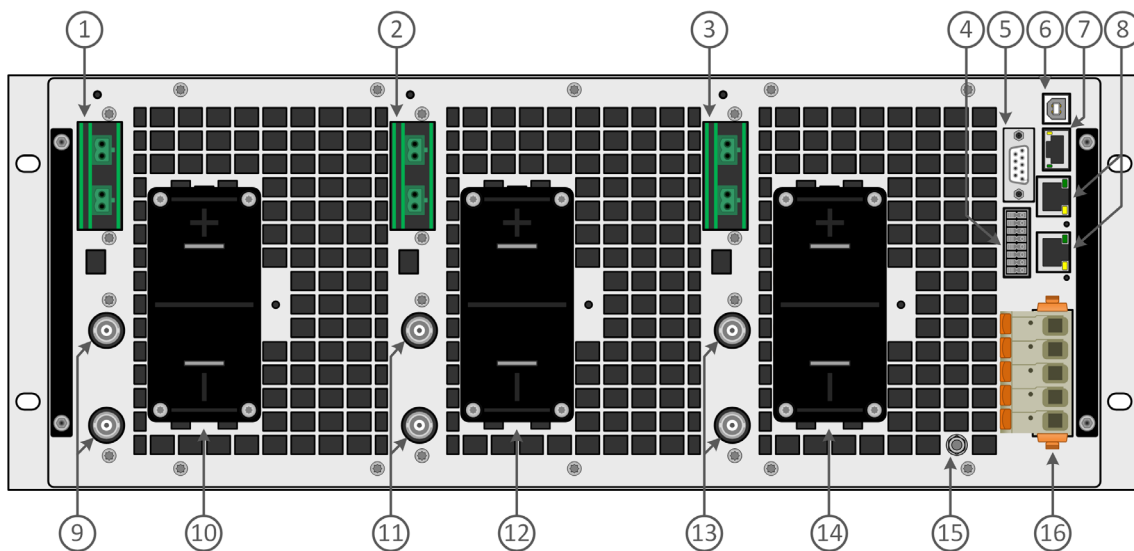


## Front panel description BT 10000 Triple 4U



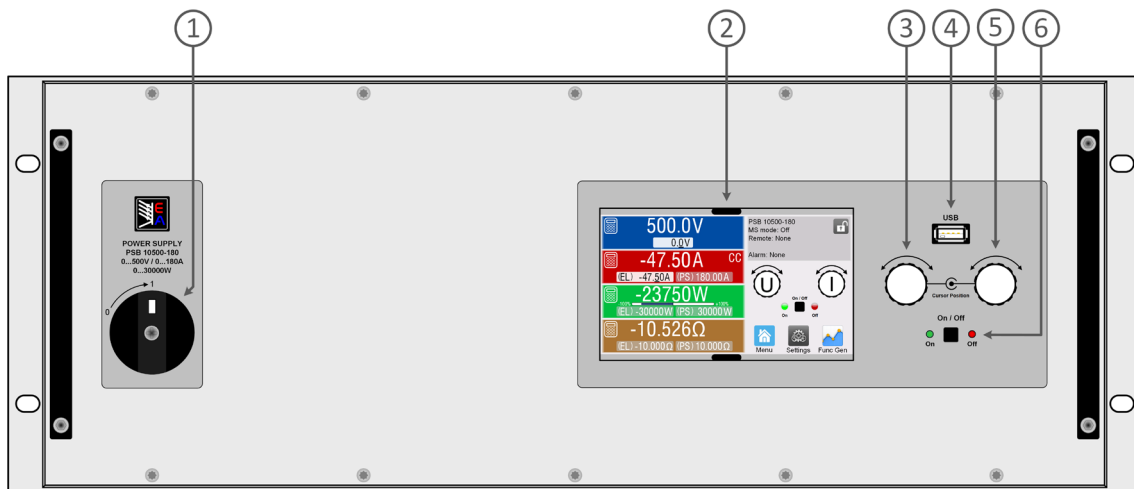
1. Power switch
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6. On / Off push-button with LED status display

## Rear panel description BT 10000 Triple 4U $\geq 360$ V



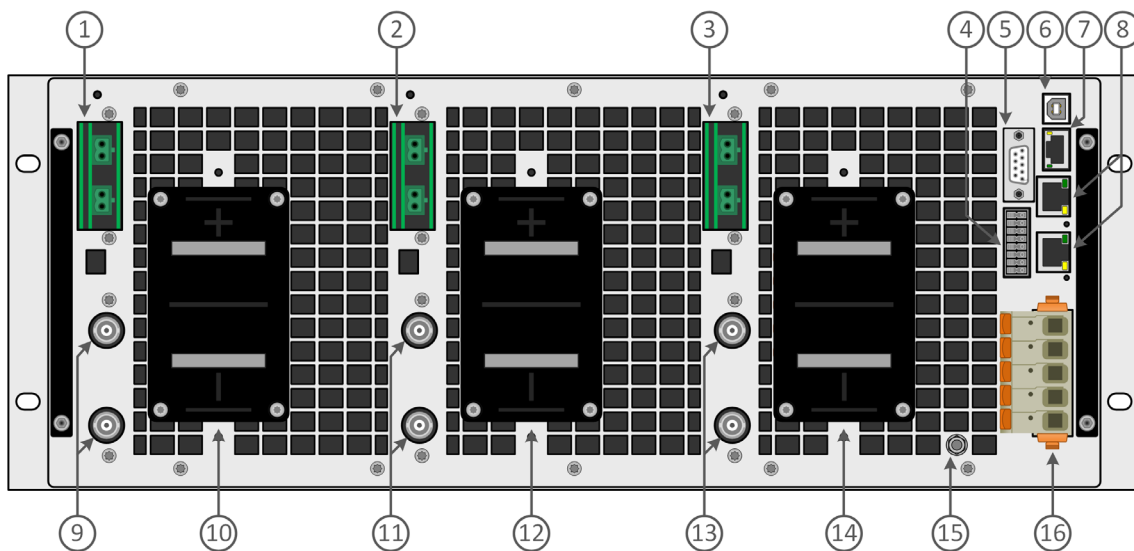
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## Front panel description BT 10000 Triple 4U with Water Cooling option



1. Power switch
2. TFT control interface, interactive operation and display
3. Rotary knob with push-button action, for settings and control
4. USB host, uses USB sticks for data logging and sequencing
5. Rotary knob with push-button action, for settings and control
6. On / Off push-button with LED status display

## Rear panel description BT 10000 Triple 4U with Water Cooling option



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**Caltest Instruments GmbH**

Binzigstrasse 21 | Tel: +49(0)7842-99722-00  
D-77876 KAPPELRODECK | Fax: +49(0)7842-99722-29  
www.caltest.de | info@caltest.de

**EA Elektro-Automatik GmbH & Co. KG**

Helmholtzstr. 31-37  
41747 Viersen

Phone +49 2162 3785 - 0  
Fax +49 2162 1623 - 0  
ea1974@elektroautomatik.com

[www.elektroautomatik.com](http://www.elektroautomatik.com)

**EA Elektro-Automatik Inc.**

9845 Via Pasar  
San Diego, CA 92126 USA

Phone +1 (858) 836 1300  
sales@elektroautomatik.com

[www.eapowered.com](http://www.eapowered.com)

