



Elektro-Automatik



EA-BT 20000

High-Efficiency Battery Tester with
Advanced Recovery Features

30 kW

30 kW Battery Tester: Efficient Sustainable, and Ready for the Future

Regenerative Energy Recovery: Achieves over 96% efficiency, reducing energy costs.

Wide Voltage & Current Range: Operates from 0–2000 V and up to 1000 A.

Flexible Autoranging: Delivers full power across a broad range of applications.

Integrated Battery Testing & Simulation: Built-in modes streamline testing processes.

Scalable to 1920 kW: Parallel up to 64 units with seamless load sharing.

EA-BT 20000 30 kW

Battery Tester
with regenerative energy recovery



Features

- Wide range input: 208 V - 480 V, +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%
- High performance with up to 30 kW per unit
- Voltages from 0 - 10 V up to 0 - 2000 V
- Currents from 0 - 40 A up to 0 - 1000 A
- Flexible power regulated DC output/input stages (autoranging)
- Regulation modes CV, CC, CP, CR with fast crossover
- Digital regulation, high resolution with 16-bit 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 1 Gbit/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



SPECIFICATIONS

AC Input

- **Voltage, Phases:** 380–480 V \pm 10%, 3-phase AC (208–240 V \pm 10%, 3-phase AC with derating to 18 kW)
- **Frequency:** 45–65 Hz
- **Power Factor:** Typical 0.99
- **Leakage Current:** <10 mA
- **Phase Current:** \leq 56 A @ 400 V AC
- **Overvoltage Category:** 2

DC Output (static)

- **Load Regulation (CV):** \leq 0.05% FS (0–100% load, constant AC input voltage and constant temperature)
- **Line Regulation (CV):** \leq 0.01% FS (208–480 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 AC input voltage, load, and temperature)
- **Temperature Coefficient (CV):** \leq 30 ppm/ $^{\circ}$ C (after 30 minutes of warm-up)
- **Load Regulation (CC):** \leq 0.1% FS (0–100% load, constant AC input voltage and constant temperature)
- **Line Regulation (CC):** \leq 0.01% FS (208–480 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 AC input voltage, load, and temperature)
- **Temperature Coefficient (CC):** \leq 50 ppm/ $^{\circ}$ C (after 30 minutes of warm-up)
- **Load Regulation (CP/CR):** \leq 0.3% FS + 0.1% FS current

Protective Functions

- **Overvoltage Protection (OVP):** Adjustable 0–110% $U_{Nominal}$
- **Overcurrent Protection (OCP):** Adjustable 0–110% $I_{Nominal}$
- **Overpower Protection (OPP):** Adjustable 0–110% $P_{Nominal}$
- **Overtemperature Protection (OT):** DC output shuts down in case of insufficient cooling

DC Output (Dynamic)

- **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

Display Accuracy

- **Voltage:** \leq 0.05% FS
- **Current:** \leq 0.1% FS

Insulation

- **AC Input to DC Output:** 3750 Vrms (1 minute, creepage distance >8 mm)
- **AC Input to Case (PE):** 2500 Vrms
- **DC Output to Interfaces:** 1000 V DC (models up to 360 V rating), 1500 V DC (models from 500 V rating)

Control Interfaces (Digital)

- **Built-in, Galvanically Isolated:** USB, Ethernet (1 Gbit), EtherCAT Slave, CAN FD
- **Communication Speed:** 1 ms
- **USB Host (Front Panel):** For data acquisition

Control Interfaces (Analog)

- **Built-in, Galvanically Isolated:** 16-pole connector
- **Inputs:** 3 independent inputs
- **Outputs:** 3 independent relay contacts
- **Temperature Inputs:** 3 independent temperature sensor inputs

Device Configuration

- **Parallel Operation:** Up to 64 units with Master-Slave-Bus and Share-Bus

Safety and EMC

- **Safety Standards:** EN 61010-1, IEC 61010-1, UL 61010-1, CSA C22.2 No 61010-1, BS EN 61010-1
- **EMC Compliance:** EN 55011 (Class B), CISPR 11 (Class B), FCC 47 CFR part 15B (Class B), EN 61326-1
- **Includes tests:** EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
- **Safety Protection Class:** Class 1
- **Ingress Protection:** IP20

Environmental Conditions

- **Operating Temperature:** 0–50 $^{\circ}$ C (32–122 $^{\circ}$ F)
- **Storage Temperature:** -20–70 $^{\circ}$ C (-4–158 $^{\circ}$ F)
- **Humidity:** \leq 80% relative humidity, non-condensing
- **Altitude:** \leq 2000 m (\leq 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):** 19" x 4U x 668 mm (26.3 in)
- **Weight:** 50 kg (110 lb)
- **Weight with Water Cooling:** 56 kg (126 lb)

Available Models

Model	Power (W)	Voltage (V)	Current (A)	Ripple (rms)	Ripple (pp)	Umin for I _{max} (V)	Resistance Range (Ω)	Output Capacity (μF)	Efficiency	Standard P/N	Water Cooling P/N
BT 20010-1000	10000 W	10 V	1000 A	≤25 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	0.62 V	0.003 - 5 Ω	25380 μF	95.1%	02113011	02123001
BT 20060-1000	30000 W	60 V	1000 A	≤25 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	0.62 V	0.003 - 5 Ω	25380 μF	95.1%	02113012	02123002
BT 20080-1000	30000 W	80 V	1000 A	≤25 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	0.62 V	0.003 - 5 Ω	25380 μF	95.5%	02113013	02123003
BT 20200-420	30000 W	200 V	420 A	≤40 mV (BW 300 kHz)	≤300 mV (BW 20 MHz)	1.8 V	0.0165 - 25 Ω	5400 μF	95.3%	02113014	02123004
BT 20360-240	30000 W	360 V	240 A	≤55 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	2.5 V	0.05 - 90 Ω	1800 μF	95.8%	02113015	02123005
BT 20500-180	30000 W	500 V	180 A	≤70 mV (BW 300 kHz)	≤350 mV (BW 20 MHz)	1.1 V	0.08 - 170 Ω	675 μF	96.5%	02113016	02123006
BT 20920-120	30000 W	920 V	120 A	≤250 mV (BW 300 kHz)	≤1200 mV (BW 20 MHz)	2 V	0.25 - 550 Ω	120 μF	96.5%	02113017	02123007
BT 21000-80	30000 W	1000 V	80 A	≤300 mV (BW 300 kHz)	≤1600 mV (BW 20 MHz)	3.4 V	0.4 - 650 Ω	200 μF	95.8%	02113018	02123008
BT 21500-60	30000 W	1500 V	60 A	≤400 mV (BW 300 kHz)	≤2400 mV (BW 20 MHz)	3.2 V	0.8 - 1500 Ω	75 μF	96.5%	02113019	02123009
BT 22000-40	30000 W	2000 V	40 A	≤500 mV (BW 300 kHz)	≤3000 mV (BW 20 MHz)	3.7 V	1.7 - 2700 Ω	50 μF	96.5%	02113020	02123010



General

The BT 20000 Series battery tester with regenerative energy recovery from EA Elektro-Automatik is a two-quadrant device capable of functioning as both a charger and an electronic load for discharging. In discharge mode, the device is regenerative, feeding energy back into the local grid with efficiency rates of up to over 96%. These three-phase units, combined with a wide input range, are compatible with nearly all global mains voltages. The DC voltage and current range of the device depends on the application, spanning from 0–10 V to 0–2000 V and from 0–40 A to 0–1000 A, all within a single device.

The flexible DC supply operates with a constant power characteristic (autoranging), offering a broad voltage and current range. For higher power and current demands, the units include a Master-Slave-Bus that allows up to 64 devices to connect in parallel, creating a system capable of delivering up to 1920 kW and 64,000 A. This combined system operates as a single unit, suitable for applications such as battery module or pack testing. For example, a 150 kW battery pack tester system can be constructed using five 30 kW BT 20000 4U units. Additionally, these devices feature integrated alarm and warning management, support for various industrial interfaces, and software solutions to streamline operation.

AC Connection

The BT 20000 Series battery tester features an active Power Factor Correction (PFC), ensuring high efficiency and low energy consumption. The wide AC input voltage range (208–240 V or 380–480 V, 3-phase) enables operation in most global grids. The device automatically adjusts to the available grid voltage without requiring additional configuration. For 3-phase 208–240 V grids, the device automatically derates the DC output power.

Energy Recovery

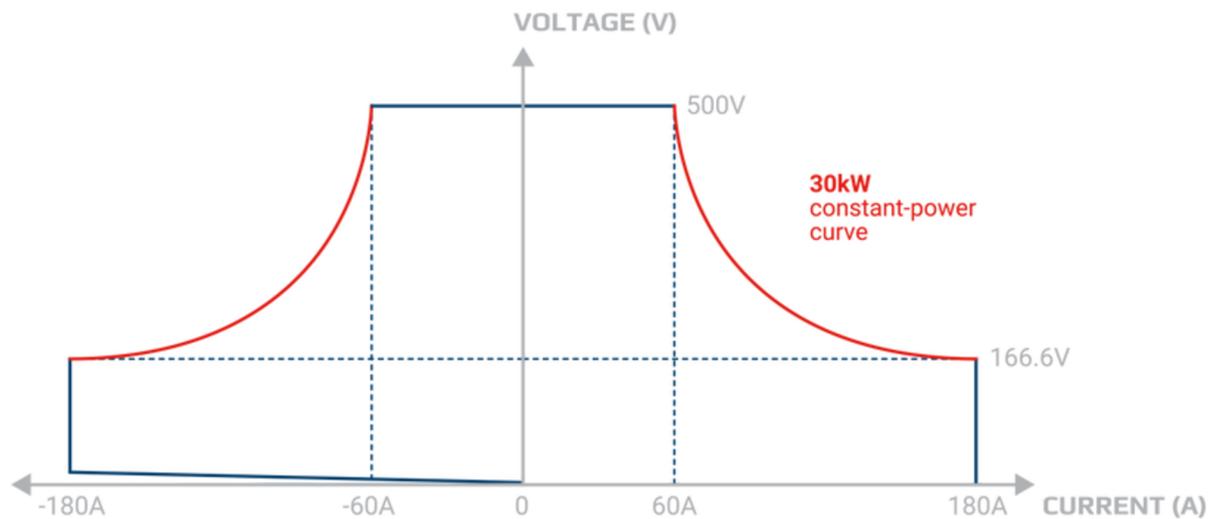
In discharge mode, the BT 20000 Series recovers energy and feeds it back into the grid with efficiency rates of up to over 96%. Unlike traditional battery testers that convert discharge energy into heat, this system reduces energy costs and minimizes heat output. This feature also lowers air conditioning requirements, resulting in cost savings and enhanced energy efficiency.

DC Output

The BT 20000 Series provides DC output with a voltage range from 0–10 V to 0–2000 V and positive or negative currents from 0–40 A to 0–1000 A. As a two-quadrant device, it supports both charging and discharging modes. The autoranging output stages deliver a broad range of voltage, current, and power, giving users greater flexibility compared to conventional battery testers.

DC Connection

The DC output is connected via a copper rail located on the back of the device. For applications requiring higher performance, multiple units can be connected in parallel with minimal effort. The vertical copper rails simplify linking the devices, and a protective cover ensures safe operation.



The Principle of Autoranging

The BT 20000 Series battery tester features an active Power Factor Correction (PFC), ensuring high efficiency and low energy consumption. The wide AC input voltage range (208–240 V or 380–480 V, 3-phase) enables operation in most global grids. The device automatically adjusts to the available grid voltage without requiring additional configuration. For 3-phase 208–240 V grids, the device automatically derates the DC output power.

Interfaces

The BT 20000 Series includes all essential interfaces as standard, ensuring seamless communication with other systems. These interfaces are galvanically isolated from the DC side and support a communication speed of 1 ms.

Available interfaces include:

- USB
- Ethernet 1 Gbit/s
- EtherCAT
- CAN FD
- USB Host (front panel)

Additionally, the device features 3 digital inputs, 3 relay contacts, and 3 temperature sensor inputs. For high-performance systems, the Master-Slave-Bus and Share-Bus enable multiple units to work as a single system with symmetrical load sharing. This functionality ensures efficient system scalability and centralized monitoring.

High-Performance Battery Test Systems

The BT 20000 Series supports high-power applications with systems of up to 240 kW in a single cabinet. By connecting multiple BT 20000 devices in parallel using vertical copper rails, users can achieve significant power density. For example, a 19" cabinet with 42U can provide 240 kW while occupying only 0.6 m² (6.5 sqft) of floor space. The integrated Master-Slave-Bus allows up to 8 cabinets with a total of 64 units (30 kW each) to function as a single device, delivering a combined output of up to 1920 kW.

Master-Slave-Bus and Share-Bus

When using the Master-Slave-Bus and Share-Bus, multiple devices can operate as a single, cohesive system. The Master-Slave-Bus collects system data, such as total power and total current, and displays it on the master device. Warnings and alarms from the slave devices are also consolidated and clearly shown on the master's display. The Share-Bus ensures equal load distribution across all connected devices, optimizing system performance and reliability.



Example Representation

A fully assembled and wired 240 kW system demonstrates the scalability and efficiency of the BT 20000 Series. This setup exemplifies how the system can be tailored to meet high-power testing requirements within a compact footprint.

Applications

Battery Testing for Electromobility

The BT 20000 Series is ideal for testing the electrical characteristics of batteries across a wide range of applications. From individual cells to modules and complete battery packs, the system supports determining the State of Health (SOH) for second-life classification and performing End-of-Line (EOL) tests. The BT 20000 Series meets the high demands of power electronics testing with precise voltage and current measurement, reproducibility, and reliability. Its flexibility allows for use in automated test systems or integrated battery testing setups, making it a versatile solution for electromobility applications. With efficiencies of over 96%, it also delivers cost-effective performance.

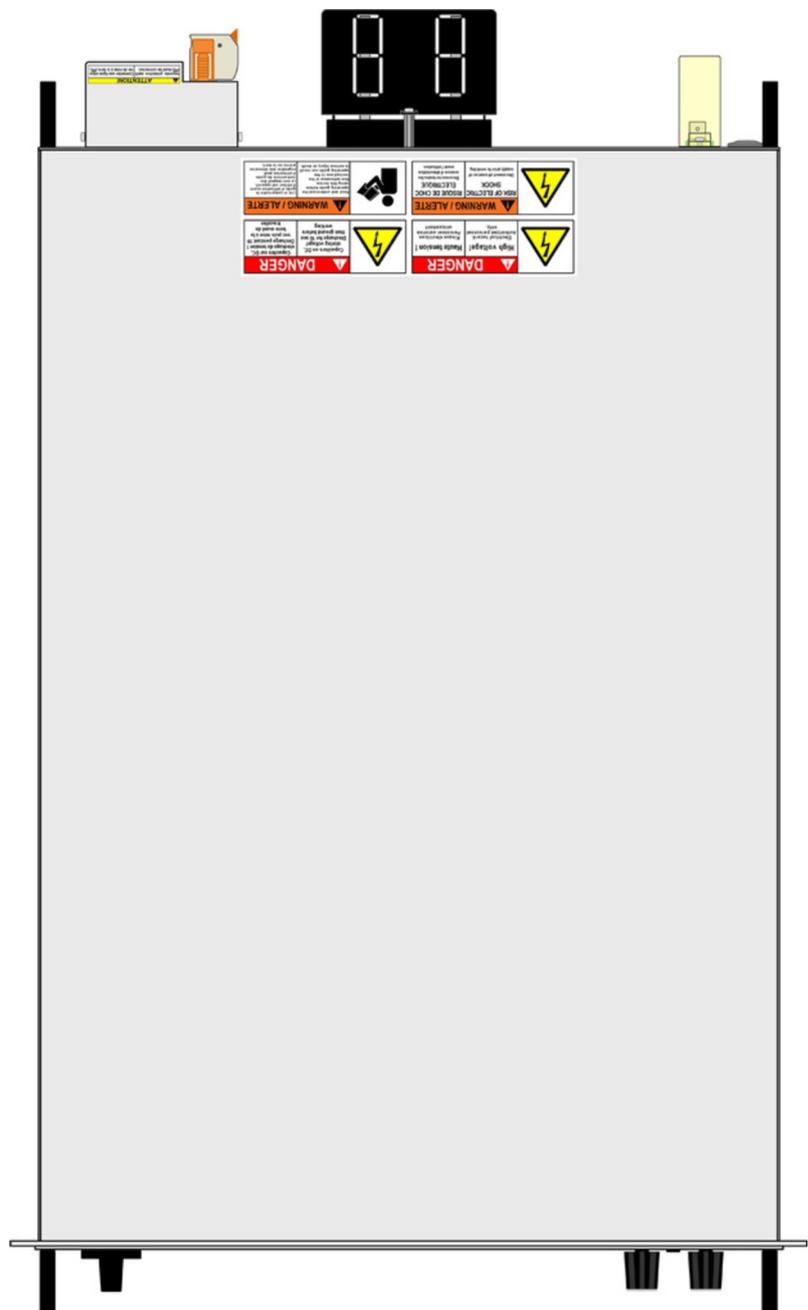
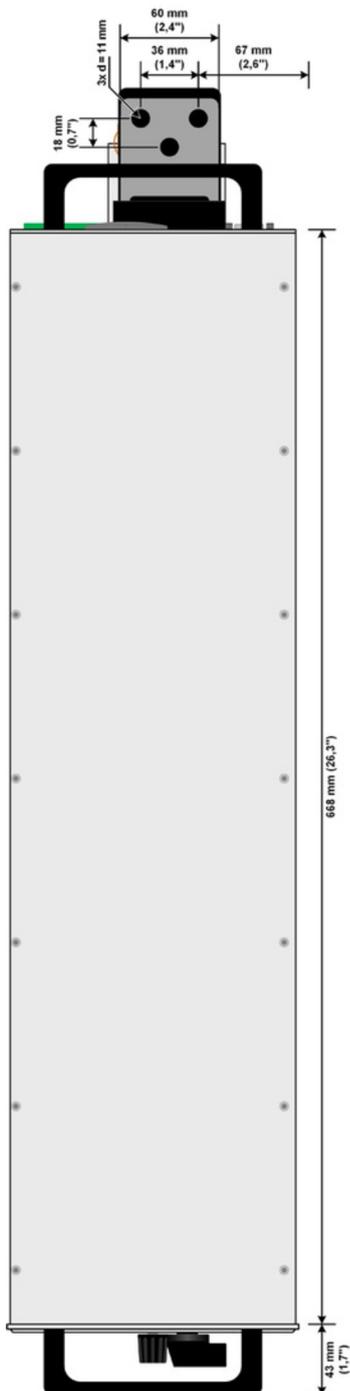
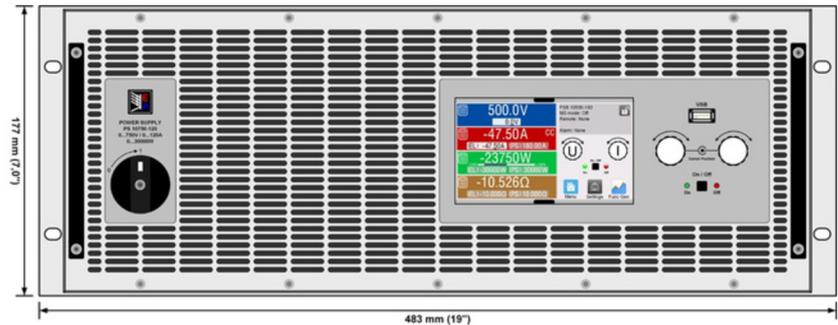
Battery Simulation

The BT 20000 Series can simulate batteries, whether as individual cells, modules, or complete packs. This functionality supports the optimization of energy storage systems and ensures compatibility with connected components under test. The integrated overcurrent protection (OCP) acts like a safety fuse, automatically shutting off output and generating alarms in case of overload. Voltage monitoring ensures safe operation, triggering functions, warnings, or alarms if predefined limits are exceeded. These built-in safety and monitoring features provide a reliable testing and simulation environment.

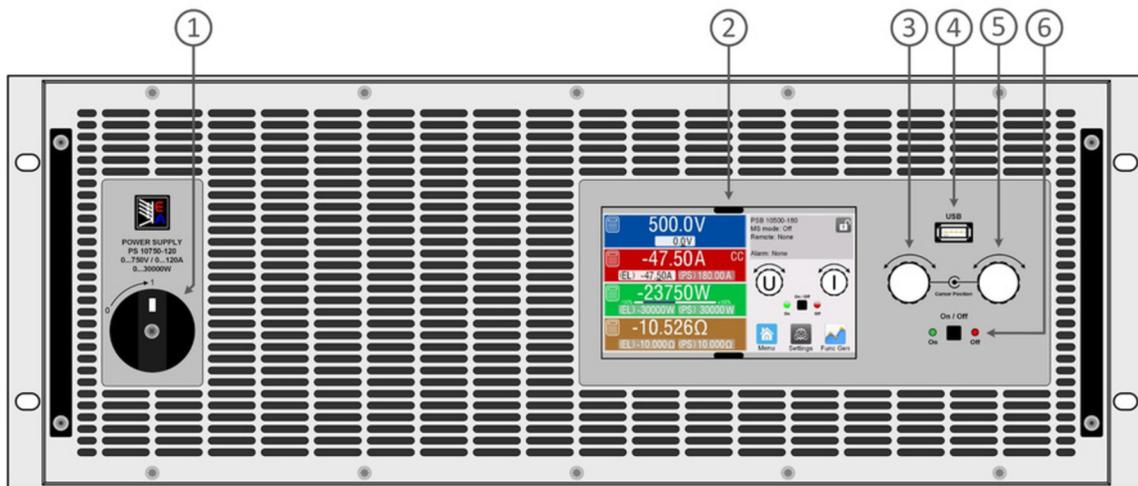
Battery Recycling

The BT 20000 Series facilitates battery recycling by supporting the safe discharge of retired batteries from electric vehicles. The State of Health (SOH) function can quickly determine whether a battery pack is viable for second-life applications. If the battery's remaining capacity is insufficient, the system enables full discharge at high load currents, even at voltages below 2 V, ensuring maximum energy recovery. The regenerative energy recovery feature returns up to 96% of the discharged energy to the power grid, making the process highly cost-effective and environmentally friendly.

Technical drawings BT 10000 4U <200 V

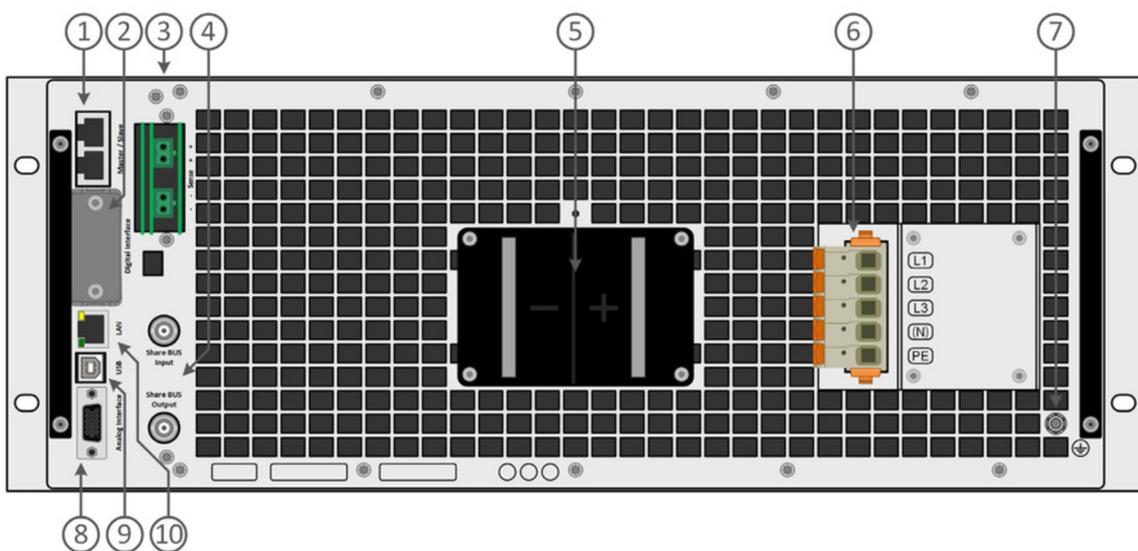


Front panel description BT 10000 4U



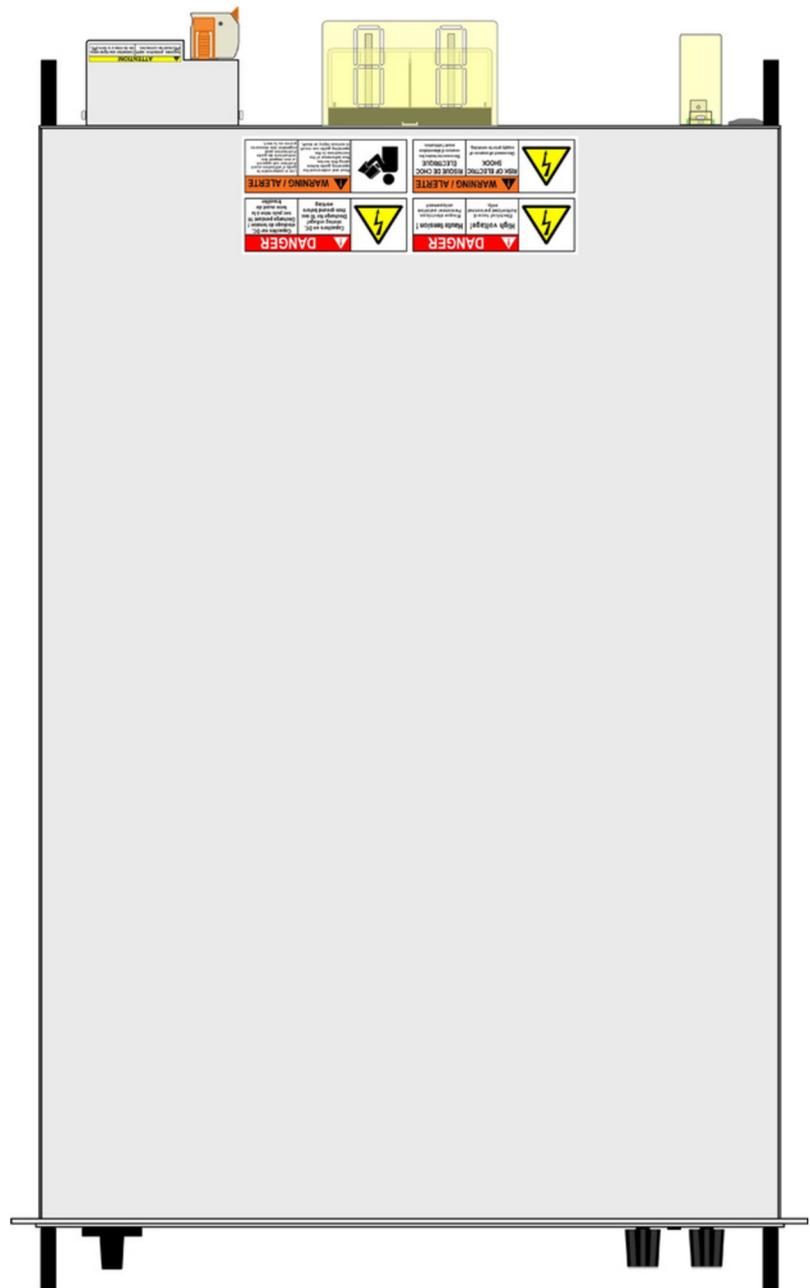
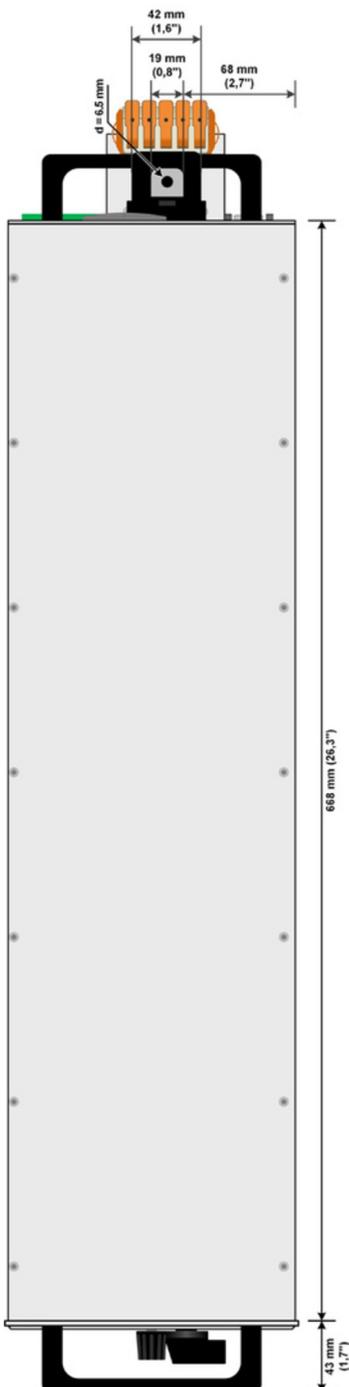
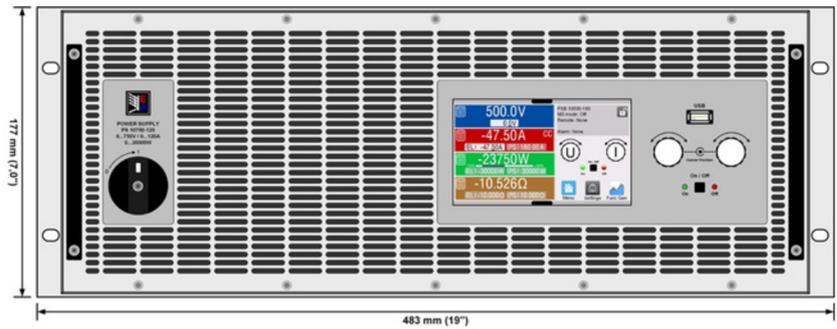
1. Power switch
2. TFT control interface, interactive operation and display
3. Rotary knob with push-button action, for settings and control
4. USB host, uses USB sticks for data logging and sequencing
5. Rotary knob with push-button action, for settings and control
6. On / Off push-button with LED status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

Front panel description BT 10000 4U <200 V

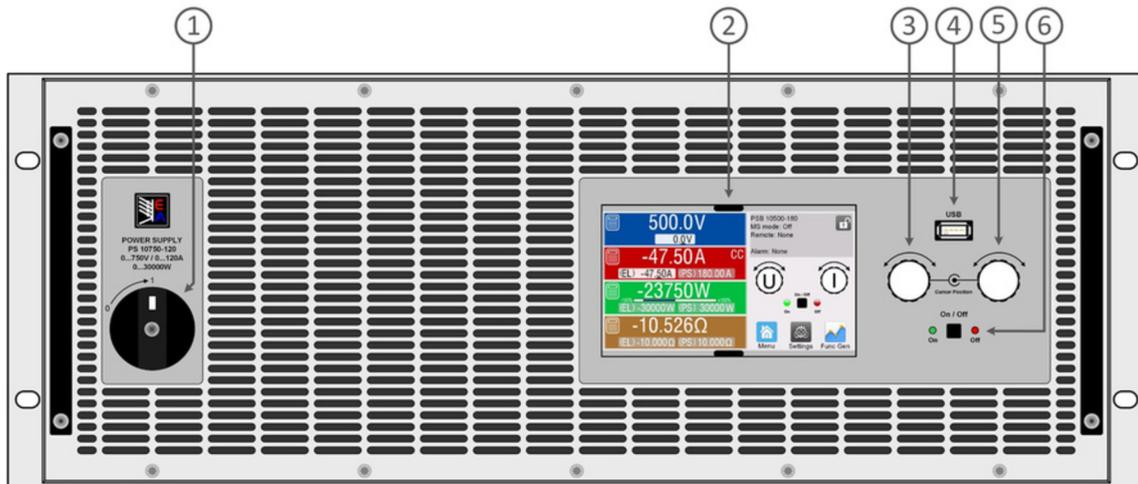


1. EtherCAT Slave
2. Input / Output 16 pole connector
3. Remote sense connectors
4. Share bus connectors to set up a system for parallel connection
5. DC output connector (copper blades)
6. AC input connector
7. Grounding connection screw (PE)
8. CAN FD interface
9. USB interface
10. Ethernet interface

Technical drawings BT 10000 4U >360 V

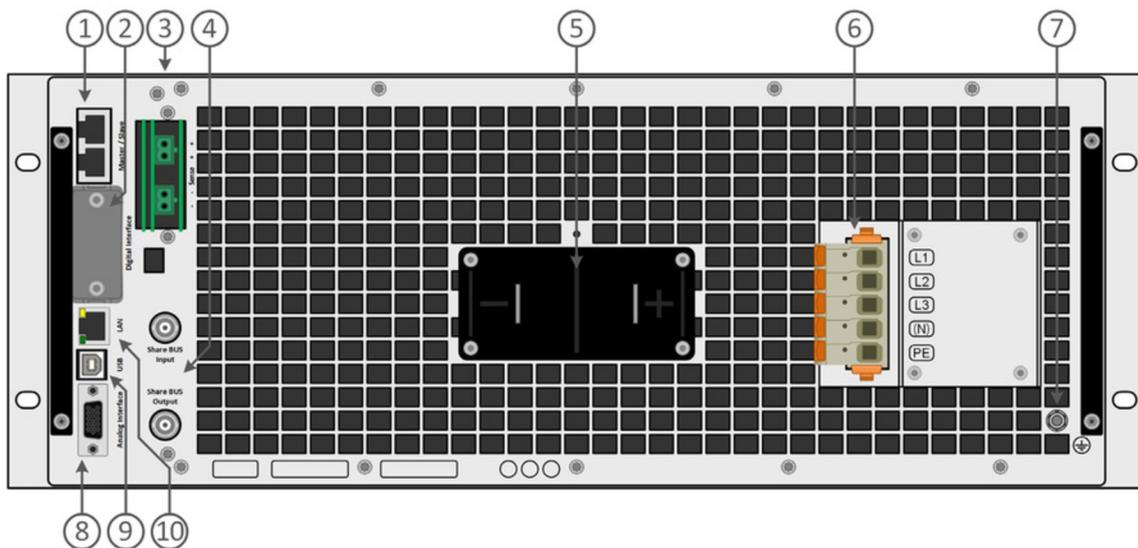


Front panel description BT 10000 4U



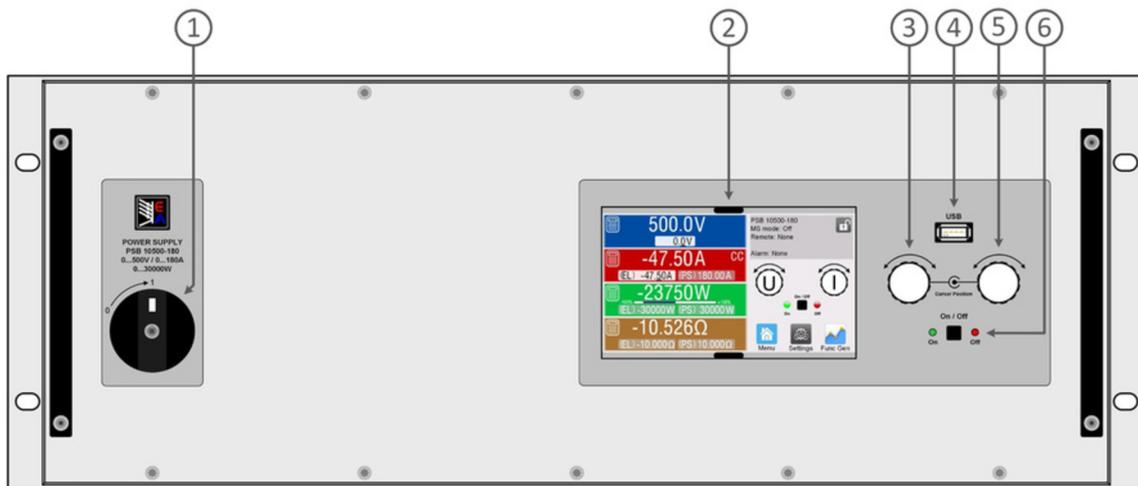
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Rear panel description BT 10000 4U >360 V



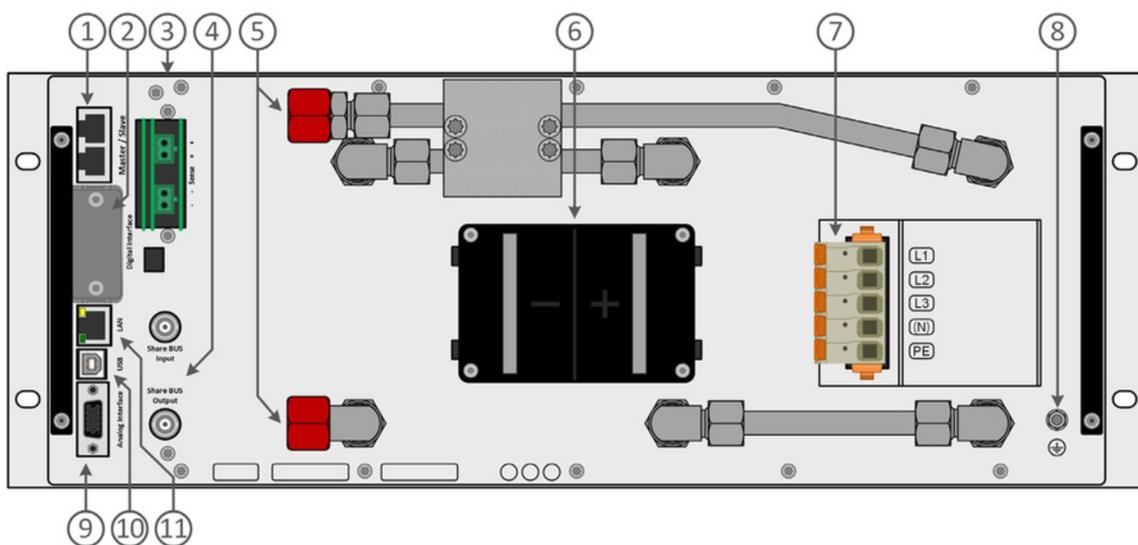
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7. Grounding connection screw (PE)
8. CAN FD interface
9. USB interface
10. Ethernet interface

Front panel description BT 10000 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 4U with Water Cooling option



1. EtherCAT Slave
2. Input / Output 16 pole connector
3. Remote sense connectors
4. Share bus connectors to set up a system for parallel connection
5. Inlets and outlets for water-cooling
6. DC output connector (copper blades)
7. AC input connector
8. Grounding connection screw (PE)
9. CAN FD interface
10. USB interface
11. Ethernet interface

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