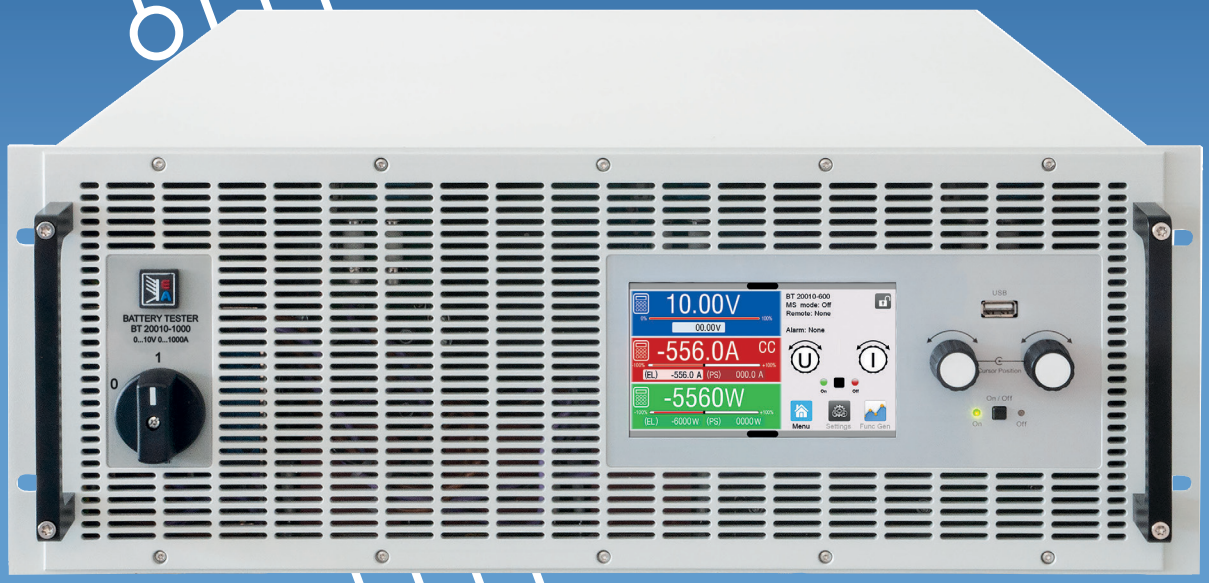
Elektro-Automatik



30 kW

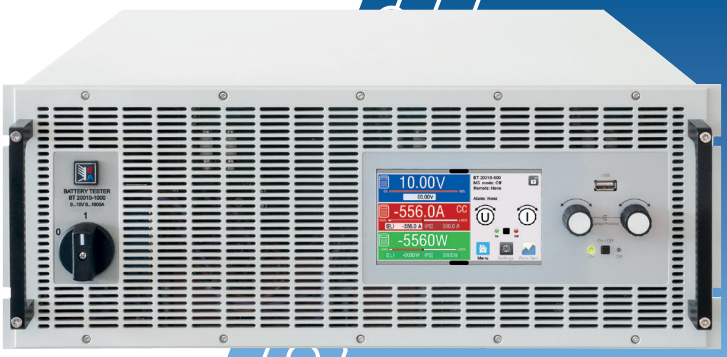
DATASHEET

EA-BT 20000

Battery Tester
with regenerative energy recovery

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 (auto-ranging)
- Regulation modes CV, CC, CP, CR with fast crossover
- Digital regulation, high resolution with 16 bit ADCs and DACs, selection of voltage control speed
- Galvanically isolated Share-Bus for parallel operation
- Master-Auxiliary 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, ModBus, LabVIEW, IVI

Built-in interfaces

- USB
- Ethernet 1Gbit/s
- EtherCAT
- CAN FD
- Master-Auxiliary bus
- Share-Bus
- USB Host on front panel
- Battery control

Software

- EA-Power Control
- EA-Battery Simulator

Options

- Water Cooling in stainless steel

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. 17 A per phase @400 V: ca. 32 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)	≤5% $U_{Nominal}$
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	≤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 *2: ≤10 ms CC *3: ≤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) *4
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
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 Valid for power supplies, unidirectional or bidirectional, in source mode operation
*3 Valid for electronic loads or bidirectional power supplies in sink mode operation
*4 Models with up to 80 V DC rating have reinforced insulation while all other models from 200 V DC rating have basic insulation

General specifications	
Device configuration	
Parallel operation with Share bus	BT 20000 series: up to 64 units of this series BT 20000 Triple series: max. 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	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)	Enclosure: 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)

Technical specifications	BT 20010-1000	BT 20060-1000	BT 20080-1000	BT 20200-420	BT 20360-240
DC output					
Voltage range	0 - 10 V	0 - 60 V	0 - 80 V	0 - 200 V	0 - 360 V
Ripple in CV (rms)	≤25 mV (BWL 300 kHz *1)	≤25 mV (BWL 300 kHz *1)	≤25 mV (BWL 300 kHz *1)	≤40 mV (BWL 300 kHz *1)	≤55 mV (BWL 300 kHz *1)
Ripple in CV (pp)	≤320 mV (BWL 20 MHz *1)	≤320 mV (BWL 20 MHz *1)	≤320 mV (BWL 20 MHz *1)	≤300 mV (BWL 20 MHz *1)	≤320 mV (BWL 20 MHz *1)
U_{Min} for I_{Max} (sink)	0.62 V	1.6 V	1.6 V	1.8 V	2.5 V
Current range	0 - 1000 A	0 - 1000 A	0 - 1000 A	0 - 420 A	0 - 240 A
Power range *2	0 - 10000 W	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)	0 - 30000 W (0 - 18000 W)
Output capacitance	25380 µF	25380 µF	25380 µF	5400 µF	1800 µF
Efficiency sink/source (up to)	95.1%	95.1%	95.5%	95.3%	95.8%
AC input					
P_{Max}	Range 1: 11 kW Range 2: 11 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	Range 1: 19 kW Range 2: 31 kW
Phase current *4	Range 1: ≤34 A Range 2: ≤18 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	Range 1: ≤61 A Range 2: ≤53 A
Insulation					
Negative DC pole <-> PE	±600 V DC	±600 V DC	±600 V DC	±1000 V DC	±1000 V DC
Positive DC pole <-> PE	+600 V DC	+600 V DC	+600 V DC	+1000 V DC	+1000 V DC
Article numbers					
Standard	02113011	02113012	02113013	02113014	02113015
Standard + Water Cooling	02123001	02123002	02123003	02123004	02123005

*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 20500-180	BT 20920-120	BT 21000-80	BT 21500-60	BT 22000-40
DC output					
Voltage range	0 - 500 V	0 - 920 V	0 - 1000 V	0 - 1500 V	0 - 2000 V
Ripple in CV (rms)	≤70 mV (BWL 300 kHz *1)	≤250 mV (BWL 300 kHz *1)	≤300 mV (BWL 300 kHz *1)	≤400 mV (BWL 300 kHz *1)	≤500 mV (BWL 300 kHz *1)
Ripple in CV (pp)	≤350 mV (BWL 20 MHz *1)	≤1200 mV (BWL 20 MHz *1)	≤1600 mV (BWL 20 MHz *1)	≤2400 mV (BWL 20 MHz *1)	≤3000 mV (BWL 20 MHz *1)
U_{Min} for I_{Max} (sink)	2.5 V	2.5 V	3.4 V	3.8 V	4.8 V
Current range	0 - 180 A	0 - 120 A	0 - 80 A	0 - 60 A	0 - 40 A
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)	0 - 30000 W (0 - 18000 W)
Output capacitance	675 µF	120 µF	200 µF	75 µF	50 µF
Efficiency sink/source (up to)	96.5%	96.5%	95.8%	96.5%	96.5%
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	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	Range 1: ≤61 A Range 2: ≤53 A
Insulation					
Negative DC pole <-> PE	±1500 V DC	±1500 V DC	±1500 V DC	±1500 V DC	±1500 V DC
Positive DC pole <-> PE	+2000 V DC	+2000 V DC	+2000 V DC	+2000 V DC	+2000 V DC
Article numbers					
Standard	02113016	02113017	02113018	02113019	02113020
Standard + Water Cooling	02123006	02123007	02123008	02123009	02123010

*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

General

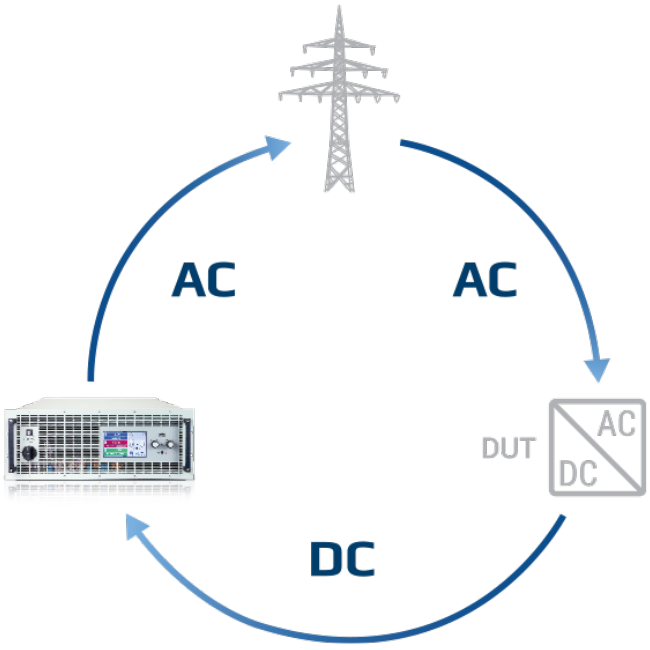
The battery tester with regenerative energy recovery in the BT 20000 series from EA Elektro-Automatik are two quadrant devices which can perform the function of a charger as well as that of an electronic load (discharging). In discharging mode the device is regenerative and feeds the energy back into the local grid with an efficiency of up to over 96%. The BT 20000 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 - 2000 V and from 0 - 40 A up to 0 - 1000 A 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 64 parallel connected devices to be combined into one system which can provide up to 1920 kW and 64000 A. Such a system works as a single unit and can use as a battery module tester or as a battery pack tester. In this way as an example a user can construct a 150 kW battery pack tester system from five 30 kW 4U units BT 20000. 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 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, the models rated with 30 kW will automatically set a derating of the DC output power.

Energy recovery

The energy consumed in load mode is fed back into the connected grid with an efficiency of up to 96%. As the energy is not converted to heat as in other loads, the energy costs are reduced. In addition, the devices generate less heat requiring less cost intensive air conditioning. One device can already be sufficient for a while range of applications, reducing investment and installation costs.



The principle of energy recovery

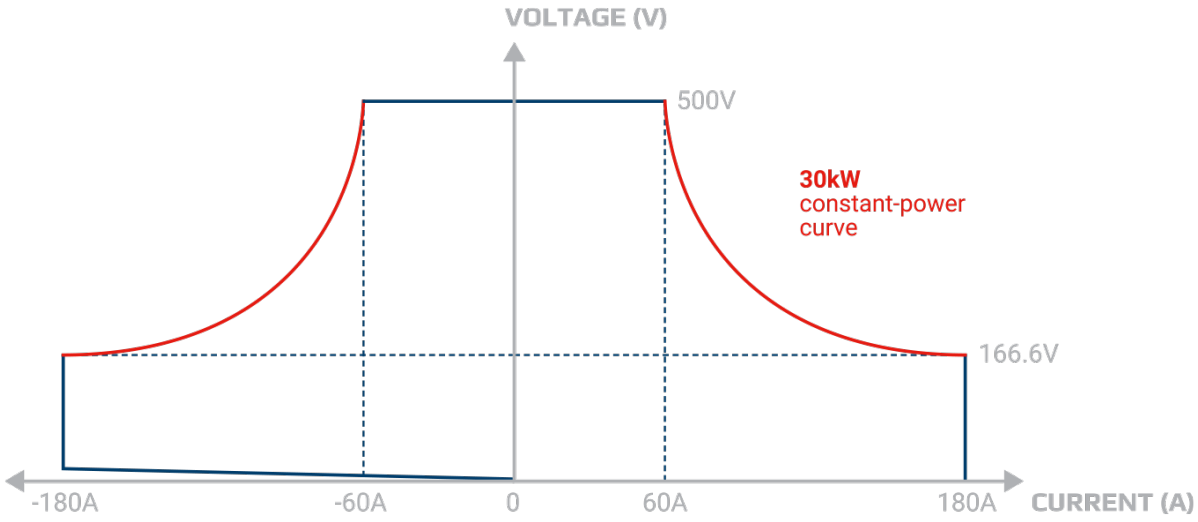
The figure above demonstrates, based on a typical application, how a „device under test“ consumes energy from the mains, converts it to DC and feeds that into an EA device. The bidirectional power supply PSB 10000 converts this energy back into an AC current and feeds it back into the grid.

DC output

The output of the battery tester with regenerative energy recovery BT 20000 with a DC voltage of 0 - 10 V up to 0 - 2000 V allows positive and negative currents of 0 - 40 A up to 0 - 1000 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 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 m² (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%.

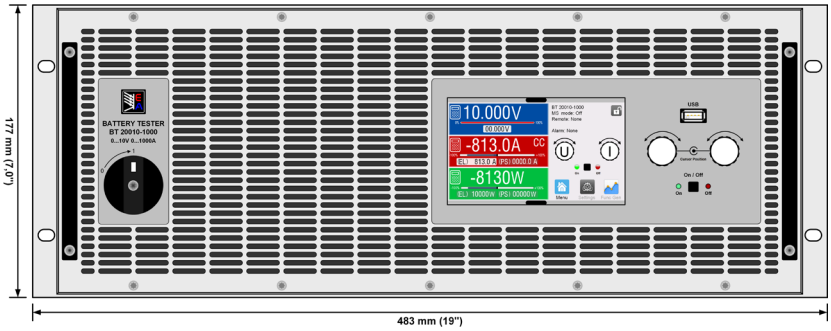
Battery simulation

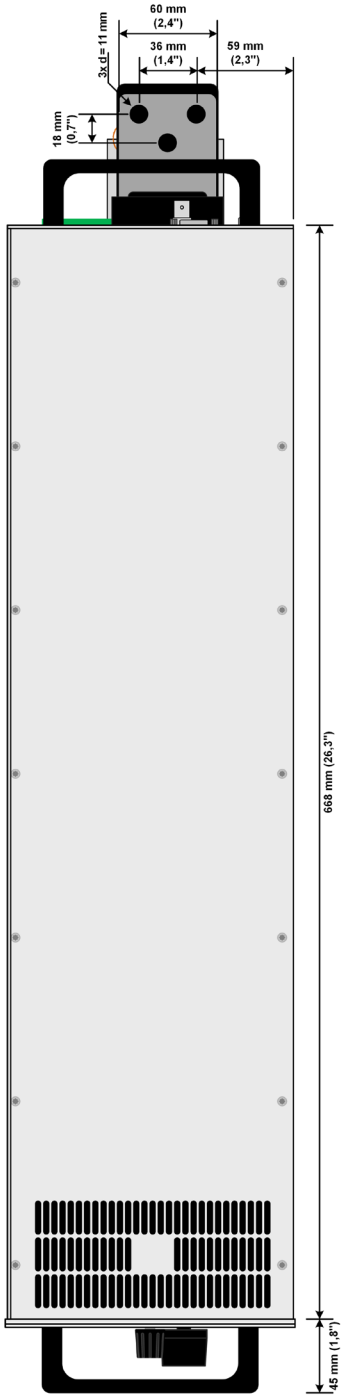
Additional applications include the simulation of batteries as single cells, modules, or packs. These simulations aid in the optimal configuration of energy storage as well as the supplied components under test. Wherever reproducible data are needed a battery simulator is the first choice. Also, the 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.

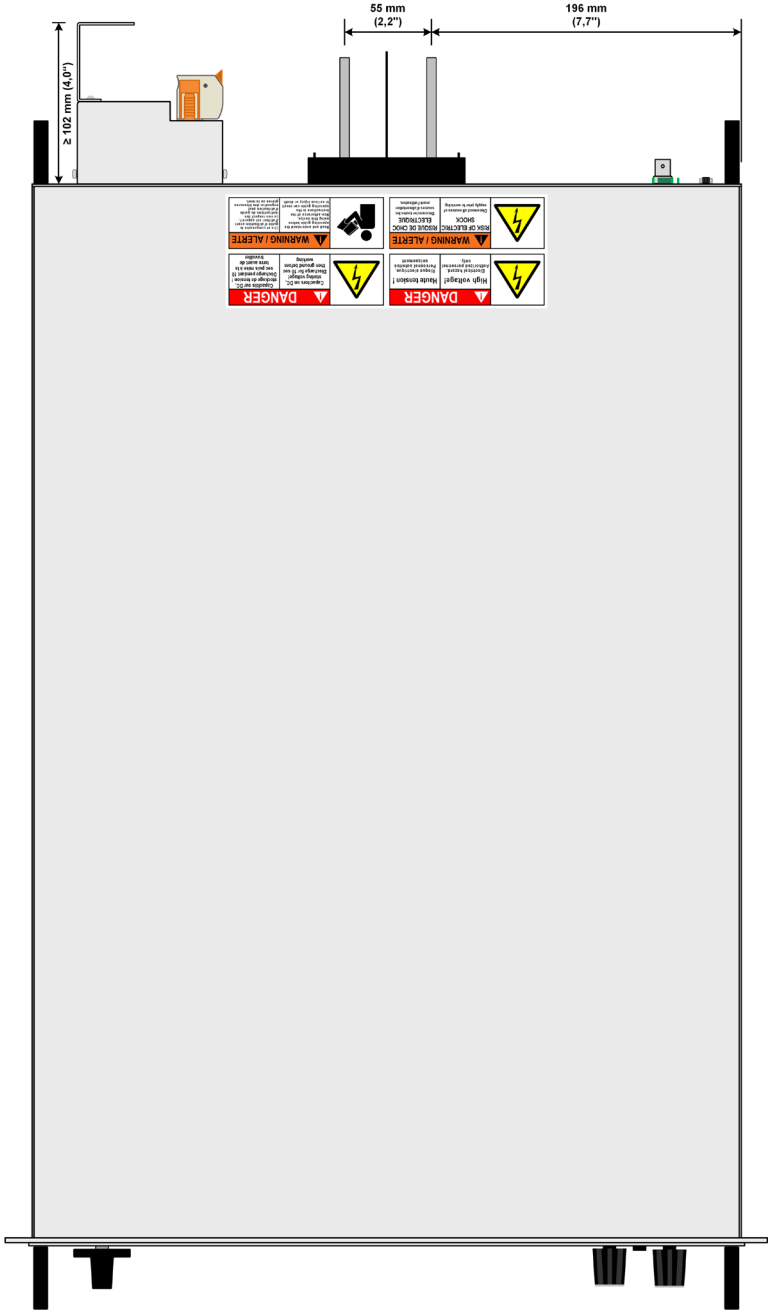
Battery recycling

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 20000 4U ≤200 V

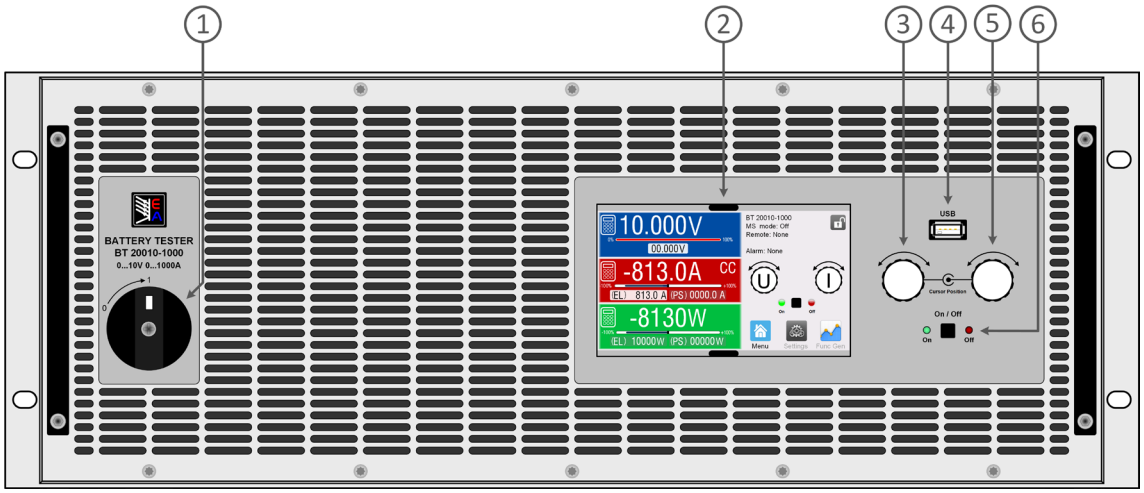






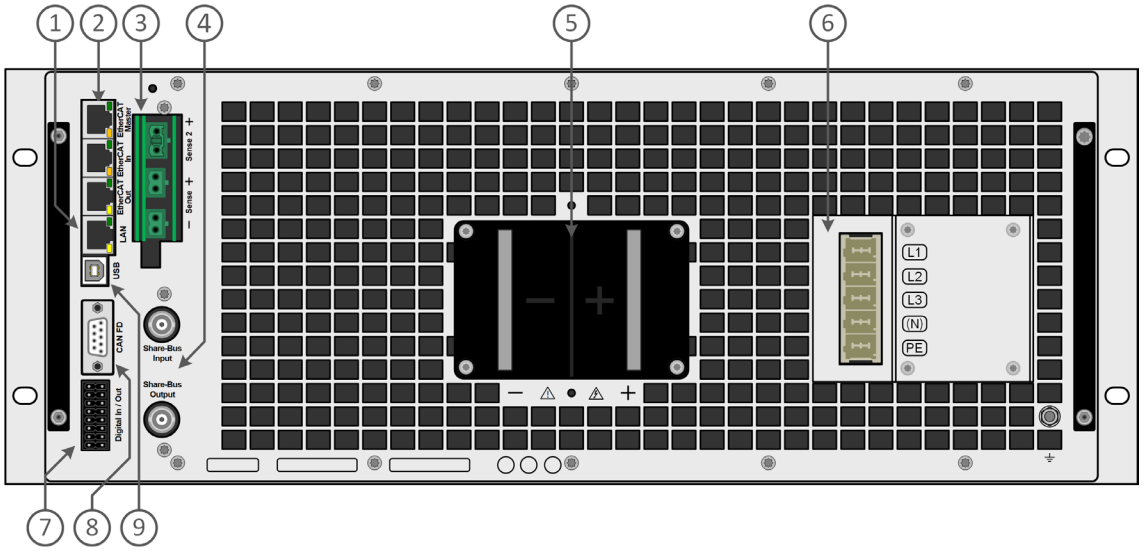
(side view of standard version shown)

Front panel description BT 20000 4U



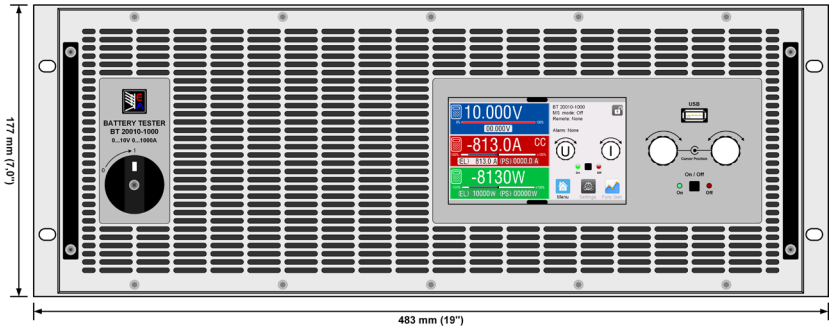
1. Power switch
2. TFT control interface, interactive operation and display
3. Rotary knob with push-button action, for settings and control
4. USB host, uses USB sticks for data logging and sequencing
5. Rotary knob with push-button action, for settings and control
6. On / Off push-button with LED status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

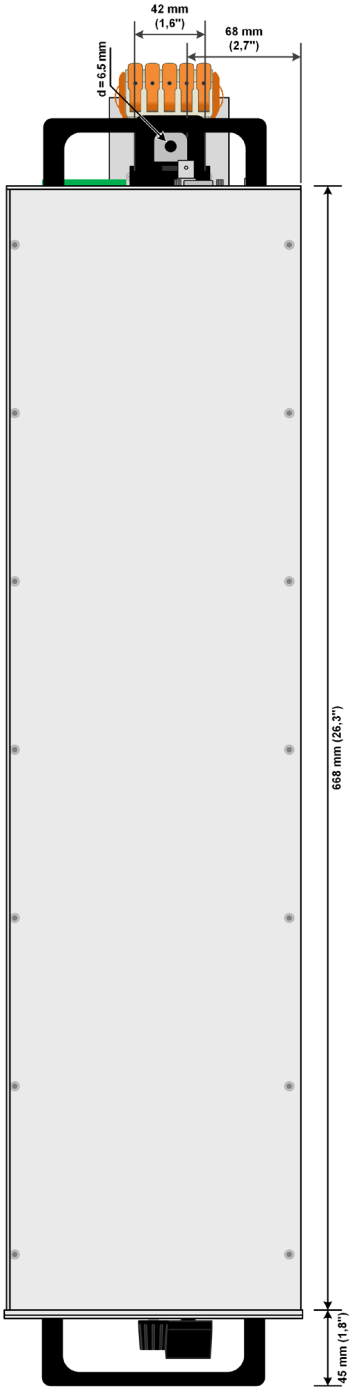
Rear panel description BT 20000 4U ≤200 V

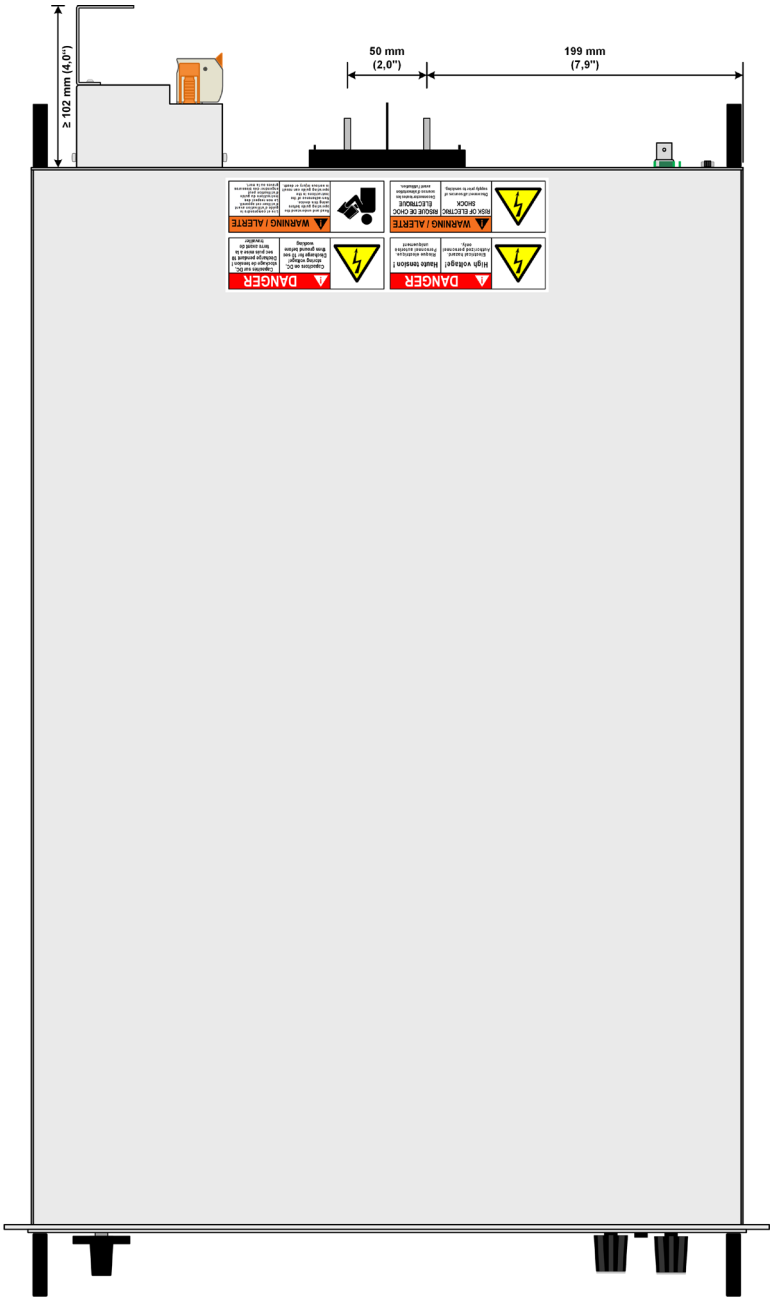


1. Ethernet interface
2. EtherCAT ports
3. Remote sense connectors
4. Share bus connectors to set up a system for parallel connection
5. DC output connector (copper blades)
6. AC input connector
7. Digital In/Out (16 pole connector)
8. CAN FD interface
9. USB interface

Technical drawings BT 20000 4U ≥360 V

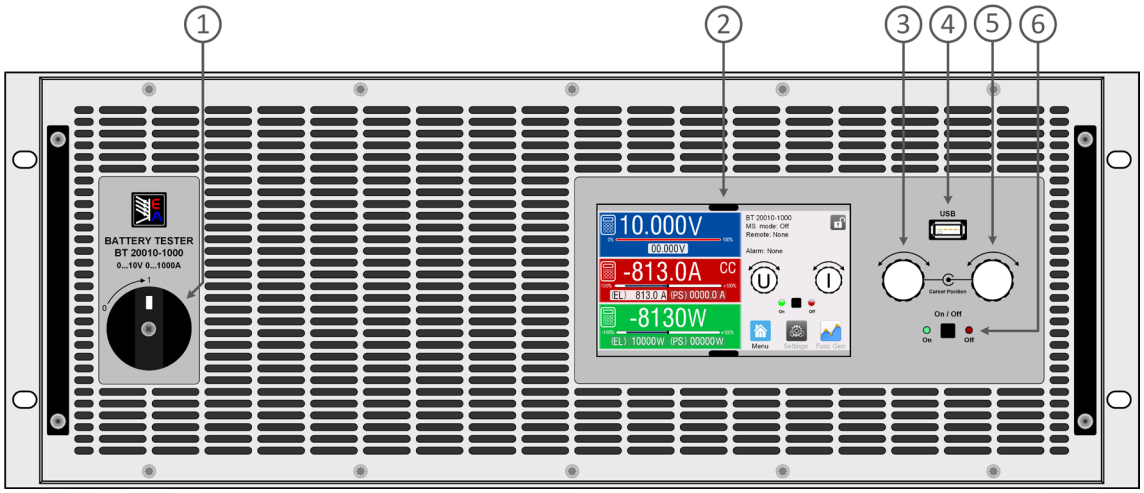






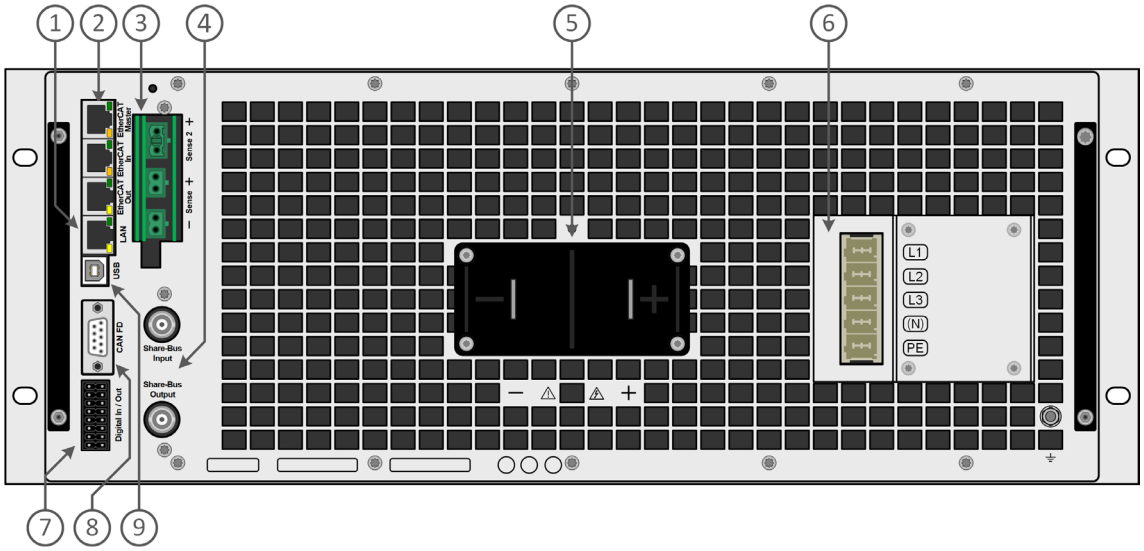
(side view of standard version shown)

Front panel description BT 20000 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 20000 4U ≥360 V



1. Ethernet interface
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4. Share bus connectors to set up a system for parallel connection
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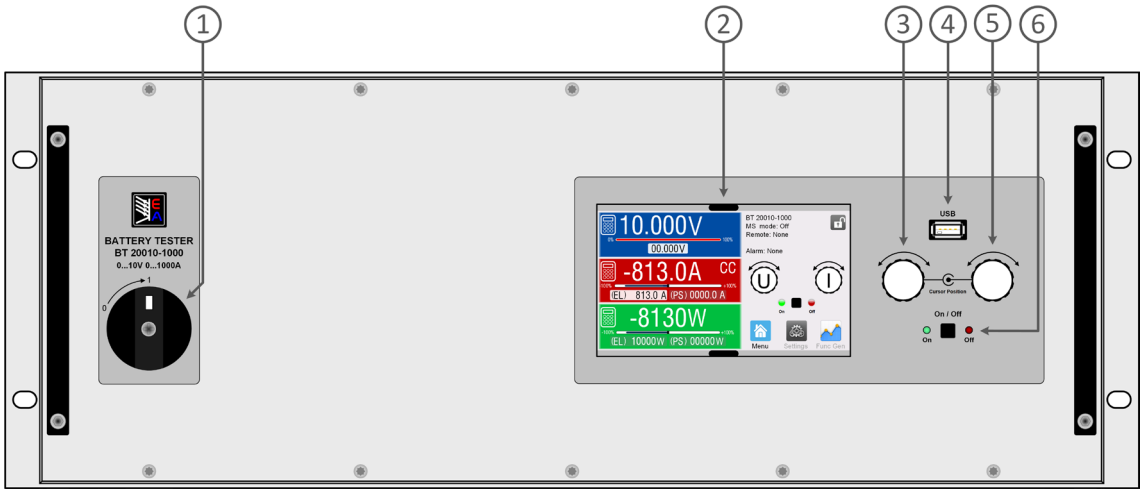
6. AC input connector
7. Digital In/Out (16 pole connector)
8. CAN FD interface
9. USB interface

Front panel description BT 20000 4U with Water Cooling option



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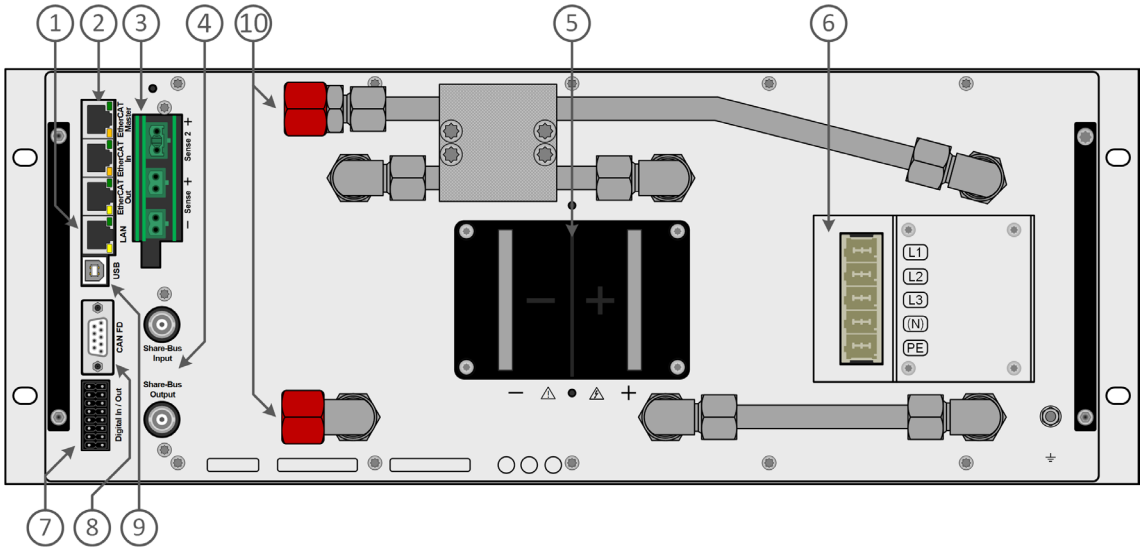
3. Rotary knob with push-button action, for settings and control
4. USB host, uses USB sticks for data logging and sequencing
5. Rotary knob with push-button action, for settings and control
6. On / Off push-button with LED status display

Rear panel description BT 20000 4U with Water Cooling option



1. Ethernet interface
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4. Share bus connectors to set up a system for parallel connection
5. DC output connector (copper blades)
6. AC input connector
7. Digital In/Out (16 pole connector)
8. CAN FD interface
9. USB interface
10. Water inlet/outet

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