Elektro-Automatik

DATASHEET

EA-PSB 10000 2U

Programmable Bidirectional DC Power Supply

EA-PSB 10000 2U
1.5 kW / 3 kW

Programmable bidirectional DC power supply

Features

- Wide range input: 110 V - 240 V, ±10%, 1ph AC
- Active Power-Factor-Correction, typical 0.99
- Bidirectional power supply, 2-quadrants in source and sink
- In load operation, regenerative with energy recovery into the grid
- Very high efficiency of up to 95%
- Voltages from 0 - 10 V up to 0 - 1500 V
- Currents from 0 - 6 A up to 0 - 120 A
- Flexible power regulated DC input/output stages (autoranging)
- Regulation mode CV, CC, CP, CR with fast crossover
- Digital regulation, high resolution with 16bit ADCs and DACs, selection of voltage regulation speed: Normal, Fast, Slow
- Color 5“ TFT display with touch control and intuitive user interface
- Galvanically isolated Share bus for parallel operation of all power classes in the 10000 series
- Master-slave bus for parallel operation of up to 64 units of all power classes in the 10000 series
- Integrated function generator with predefined curves
- Automotive test procedures for LV123, LV124 and LV148
- Integrated battery test mode, battery and fuel cell simulation
- Photovoltaics test mode (EN 50530), MPPT
- Command languages and drivers: SCPI and ModBus, LabVIEW, IVI

Build-in Interfaces

- USB
- Ethernet
- Analog
- USB Host
- Master-Slave-Bus
- Share-Bus

Optional Interfaces

- CAN
- CANopen
- RS232
- Profibus
- EtherCAT
- Profinet, with one or two ports
- Modbus, with one or two ports
- Ethernet, with one or two ports

Software

- EA-Power Control
- EA-Battery Simulator

Technical data

General specifications	
AC input	
Voltage, Phases	Range 1: 110 - 127 V, ±10%, 1ph AC (with DC output power derating to 1.2 kW or 1.5 kW) Range 2: 208 - 240 V, ±10%, 1ph AC
Frequency	45 - 65 Hz
Power factor	ca. 0.99
Leakage current	<3.5 mA
Inrush current	@230 V: ca. 23 A
Overvoltage category	2
DC output static	
Load regulation CV	≤0.05% FS (0 - 100% load, constant output voltage and constant temperature)
Line regulation CV	≤0.01% FS (110 V - 240 V AC ±10%, constant load and constant temperature)
Stability CV	≤0.02% FS (during 8 h of operation, after 30 minutes warm-up, at constant output 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, constant output voltage and constant temperature)
Line regulation CC	≤0.01% FS (110 V - 240 V AC ±10%, constant load and constant temperature)
Stability CC	≤0.02% FS (during 8 h of operation, after 30 minutes warm-up, at constant output voltage, load and temperature)
Temperature coefficient CC	≤50ppm/°C (after 30 minutes of warm-up)
Load regulation CP	≤0.3% FS (0 - 100% load, constant output voltage and constant temperature)
Load regulation CR	≤0.3% FS + 0.1% FS current (0 - 100% load, constant output voltage and constant 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 output shuts down in case of insufficient cooling)
DC output dynamic	
Rise time 10 - 90% CV	≤20 ms
Fall time 90 - 10% CV	≤20 ms
Rise time 10 - 90% CC	≤10 ms
Fall time 90 - 10% CC	≤10 ms
Display accuracy	
Voltage	≤0.05% FS
Current	≤0.1% FS
Insulation	
AC input to DC output	3750 Vrms (1 minute, creepage distance >8 mm) *1
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)
Interfaces digital	
Built-in, galvanically isolated	USB, Ethernet (100 MBit) for communication, 1x USB host for data acquisition
Optional, galvanically isolated	CAN, CANopen, RS232, ModBus TCP, Profinet, Profibus, EtherCAT, Ethernet
Interfaces analog	
Built-in, galvanically isolated	15 pole D-Sub
Signal range	0 - 10 V or 0 - 5 V (switchable)
Inputs	U, I, P, R, remote control on/off, DC output on/off, resistance mode on/off
Outputs	Monitor U and I, alarms, reference voltage, DC output status, CV/CC regulation mode
Accuracy U / I / P / R	0 - 10 V: ≤0.2%, 0 - 5 V: ≤0.4%

*1 Models 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	Up to 64 units of any power class in series 10000, with master-slave bus and Share bus	
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 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	
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)	
Dimensions (W x H x D)	Enclosure: 19" x 2U x 462 mm (18.2 in) Total: 19" x 2U x min. 559 mm (22 in)	
Weight	1500 W unit: 9.5 kg (21 lb)	3000 W unit: 12.7 kg (28 lb)

Technical specifications	PSB 10010-60	PSB 10060-60	PSB 10080-60	PSB 10200-25	PSB 10360-15
DC output					
Voltage range	0 - 10 V	0 - 60 V	0 - 80 V	0 -200 V	0 - 360 V
Ripple in CV (rms)	10 mV (BW 300 kHz)	10 mV (BW 300 kHz)	10 mV (BW 300 kHz)	30 mV (BW 300 kHz)	30 mV (BW 300 kHz)
Ripple in CV (pp)	100 mV (BW 20 MHz)	100 mV (BW 20 MHz)	100 mV (BW 20 MHz)	300 mV (BW 20 MHz)	300 mV (BW 20 MHz)
U_{Min} for I_{Max} (sink)	0.8 V	0.8 V	0.8 V	2 V	2 V
Current range	0 - 60 A	0 - 60 A	0 - 60 A	0 - 25 A	0 - 15 A
Power range *1	0 - 600 W	0 - 1500 W (0 - 1200 W)	0 - 1500 W (0 - 1200 W)	0 - 1500 W (0 - 1200 W)	0 - 1500 W (0 - 1200 W)
Resistance range	0.04 Ω - 80 Ω	0.04 Ω - 80 Ω	0.04 Ω - 80 Ω	0.25 Ω - 500 Ω	0.8 Ω - 1600 Ω
Output capacity	8640 µF	8640 µF	8640 µF	800 µF	330 µF
Efficiency sink/source	≤93% *2	≤94% *2	≤94% *2	≤94.5% *2	≤94.5% *2
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 number	30000734	30000720	30000721	30000722	30000723

*1 The value in brackets applies to the state of derating (power reduction) for 110 to 127 V ±10% utility
*2 At 100% power and 100% output voltage

Technical specifications	PSB 10500-10	PSB 10750-06			
DC output					
Voltage range	0 - 500 V	0 - 750 V			
Ripple in CV (rms)	40 mV (BW 300 kHz)	50 mV (BW 300 kHz)			
Ripple in CV (pp)	500 mV (BW 20 MHz)	500 mV (BW 20 MHz)			
U_{Min} for I_{Max} (sink)	2.5 V	2.5 V			
Current range	0 - 10 A	0 - 6 A			
Power range *1	0 - 1500 W (0 - 1200 W)	0 - 1500 W (0 - 1200 W)			
Resistance range	2 Ω - 3000 Ω	4 Ω - 6000 Ω			
Output capacity	120 µF	40 µF			
Efficiency sink/source	≤95% *2	≤95% *2			
Insulation					
Negative DC pole <-> PE	±1000 V DC	±1000 V DC			
Positive DC pole <-> PE	+1500 V DC	+1500 V DC			
Article number	30000724	30000725			

*1 The value in brackets applies to the state of derating (power reduction) for 110 to 127 V ±10% utility
*2 At 100% power and 100% output voltage

Technical specifications	PSB 10010-120	PSB 10060-120	PSB 10080-120	PSB 10200-50	PSB 10360-30
DC output					
Voltage range	0 - 10 V	0 - 60 V	0 - 80 V	0 -200 V	0 - 360 V
Ripple in CV (rms)	10 mV (BW 300 kHz)	10 mV (BW 300 kHz)	10 mV (BW 300 kHz)	30 mV (BW 300 kHz)	30 mV (BW 300 kHz)
Ripple in CV (pp)	100 mV (BW 20 MHz)	100 mV (BW 20 MHz)	100 mV (BW 20 MHz)	300 mV (BW 20 MHz)	300 mV (BW 20 MHz)
U_{Min} for I_{Max} (sink)	0.8 V	0.8 V	0.8 V	2 V	2 V
Current range	0 - 120 A	0 - 120 A	0 - 120 A	0 - 50 A	0 - 30 A
Power range *1	0 - 1200 W	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)
Resistance range	0.02 Ω - 24 Ω	0.02 Ω - 24 Ω	0.02 Ω - 40 Ω	0.1 Ω - 250 Ω	0.4 Ω -800 Ω
Output capacity	17280 µF	17280 µF	17280 µF	1600 µF	660 µF
Efficiency sink/source	≤93% *2	≤94% *2	≤94% *2	≤94.5% *2	≤94.5% *2
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 number	30000735	30000726	30000727	30000728	30000729

*1 The value in brackets applies to the state of derating (power reduction) for 110 to 127 V ±10% utility
*2 At 100% power and 100% output voltage

Technical specifications	PSB 10500-20	PSB 10750-12	PSB 11000-10	PSB 11500-06	
DC output					
Voltage range	0 - 500 V	0 - 750 V	0 - 1000 V	0 - 1500 V	
Ripple in CV (rms)	40 mV (BW 300 kHz)	50 mV (BW 300 kHz)	100 mV (BW 300 kHz)	150 mV (BW 300 kHz)	
Ripple in CV (pp)	500 mV (BW 20 MHz)	500 mV (BW 20 MHz)	2000 mV (BW 20 MHz)	6500 mV (BW 20 MHz)	
U_{Min} for I_{Max} (sink)	2.5 V	2.5 V	4 V	4.2 V	
Current range	0 - 20 A	0 - 12 A	0 - 10 A	0 - 6 A	
Power range *1	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)	0 - 3000 W (0 - 1500 W)	
Resistance range	1 Ω - 1500 Ω	2 Ω - 3000 Ω	3 Ω - 6000 Ω	8 Ω -6000 Ω	
Output capacity	240 µF	80 µF	60 µF	20 µF	
Efficiency sink/source	≤95% *2	≤95% *2	≤95% *2	≤95% *2	
Insulation					
Negative DC pole <-> PE	±1000 V DC	±1000 V DC	±1000 V DC	±1000 V DC	
Positive DC pole <-> PE	+1500 V DC	+1500 V DC	+1500 V DC	+1500 V DC	
Article number	30000730	30000731	30000732	30000733	

*1 The value in brackets applies to the state of derating (power reduction) for 110 to 127 V ±10% utility
*2 At 100% power and 100% output voltage

General

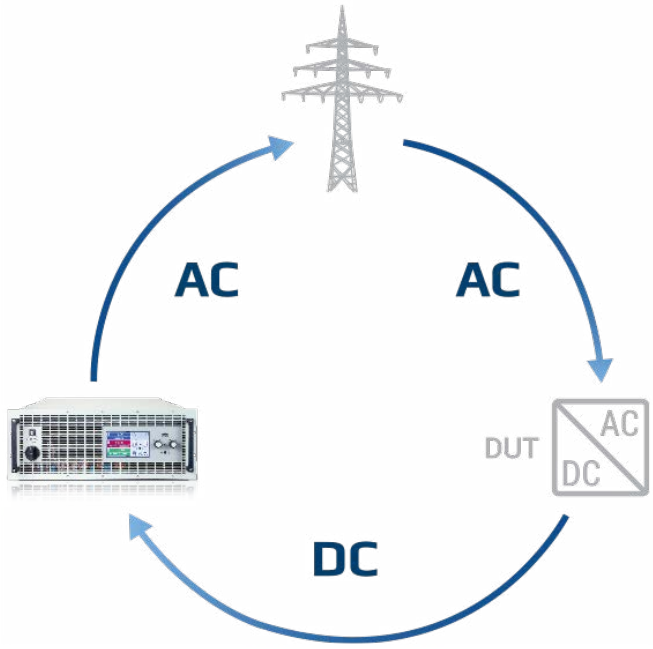
The bidirectional DC laboratory power supplies in the PSB 10000 series from EA Elektro-Automatik are two quadrant devices which can perform the function of a power supply (source) as well as that of an electronic load (sink). In sink mode the device is regenerative and feeds the energy back into the local grid with an efficiency of up to 96%. The PSB 10000 series includes single and 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 - 6 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 different power classes, only the voltage class must remain constant. In this way a user can construct a 75 kW system from two 30 kW 4U and one 15 kW 3U device from the PSB or PSBE 10000 range. Furthermore, typical laboratory functionality is provided. This includes an extensive function generator, alarm and warning management, various industrial interfaces, software solutions and many more functions.

AC connection

The DC power supplies in the PSB 10000 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 input voltage range. It reaches from 110/120 V up to 240 V with 1-phase models and from 208 V to 380/400/480 V with 3-phase models. Hence the devices can be operated in the majority of global grids. They adjust automatically, without additional configuration, to the available grid voltage. In a 110/120 V and 208 V AC grid a derating of the DC output power is automatically set.

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

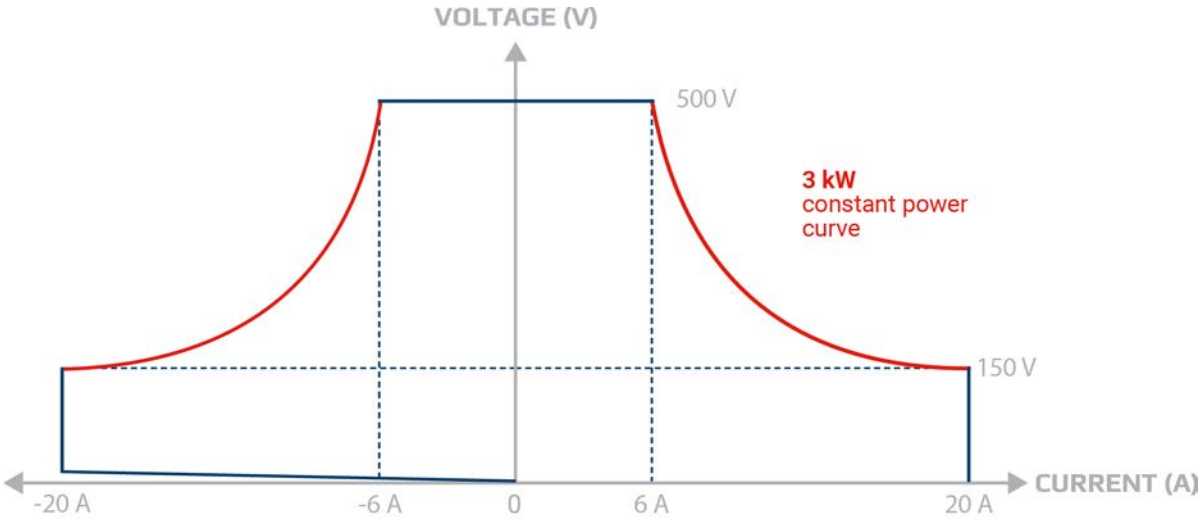
The figure above demonstrates, based on a typical application, how a „device under test“ consumes energy from the mains, converts it to DC and feeds that into an EA device. The bidirectional power supply PSB 10000 converts this energy back into an AC current and feeds it back into the grid.

DC output

The DC output of the bidirectional power supply series PSB 10000 2U is rated for DC voltages of 0 - 10 V up to 0 - 1500 V, allowing positive or negative currents of 0 - 6 A up to 0 - 120 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 power supplies.

DC connection

Connection of the DC output is done via copper blades 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 used when a bidirectional programmable DC power supply automatically offers a wider 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.

Function generator

All models in the PSB 10000 series are equipped with a function generator. This allows waveforms such as sine, triangle, square or trapezoid to be simply called up and applied to either the voltage or the current. A ramp function and a arbitrary generator allow voltage and current progression to be freely programmable. Test sequences for repeated tests can be saved and reloaded when needed, which saves time. For simulation of a photovoltaics system or fuel cells, adaptable tables are provided. With the integrated and adjustable PV characteristics curve DIN EN 50530 various solar modules can be defined and entire day trend progression can be simulated.
Conclusion: the user is supported by a multitude of useful functions.

Interfaces

As standard, 10000s series devices are fitted with the most important interfaces and ports which are all galvanically isolated from the DC input. There is an analog interface which can be parameterized for input and output, control and monitoring, of 0 - 5 V or 0 - 10 V for voltage, current, power and resistance, assorted inputs and outputs as well as USB and Ethernet ports. Further optional industrial interface for plug & play slot complete the portfolio:

- CAN
- CANopen
- RS232
- Profibus
- EtherCAT
- Profinet, with one or two ports
- Modbus, with one or two ports
- Ethernet, with one or two ports

High performance systems

High power applications can be covered with high power systems of up to 192 kW. These are achieved by using the outputs of many PSB 10000 2U devices and connecting them in parallel using copper rails. A 19” cabinet with a height of 42U can hold up to 16 units of 2U and thus form a system of up to 48 kW occupying only 0.6 m² (6.5 sqft) of floor space. The master/slave bus allows for up to 6 cabinets with a maximum of 64 units and up to 3 kW each to behave as one unit.

Master-slave bus and Share bus

When the integrated master-slave bus and Share bus are used, a multi device system behaves as a single device. The buses are simply connected between each device. With the master-slave bus the system data, such as total power and total current, are collected and displayed on the master unit. Warnings and alarms of the slave devices are also clearly displayed. The Share bus cares for a balanced load distribution between the individual units.

Example representation

In this illustration you can see a fully assembled and wired 240 kW system, realized with 30 kW 4U units.

Applications

Battery test for electro mobility

A typical application for the bidirectional power supplies 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 PSB 10000 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 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 power source 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.

Fuel cell test

The devices in the PSB 10000 range may be used for testing the electrical features of fuel cells, fuel cell stacks and fuel cell systems. Here they generate highly accurate and reproducible results in all electrical modes. To test the resistance, performance, and active life of a fuel cell quickly and economically users can readily incorporate the devices into an automatic test system. The feedback capability guarantees high level of energy and cost efficiency. If higher currents are needed for testing a complete fuel cell system, then multiple devices can be connected in parallel in a master-slave system. High accuracy and performance are maintained here.

On-board charger test

In an on-board charger (OBC) test the electrical features must be tested under various conditions. This requires a flexible test system which also provides test data. With the sequencing and logging functions of the software EA-Power Control it allows data to be exported and saved. In this way applications can instantly generate reproducible test results based on dynamic and highly accurate set point and measurement data. To avoid competition between two separate control loops of the device under test (DUT) and the testing device, the voltage regulation speed of the bidirectional power supply is adjustable. The modes Normal, Fast and Slow allow the PSB 10000 devices to be adapted the control characteristics of the on-board charger.

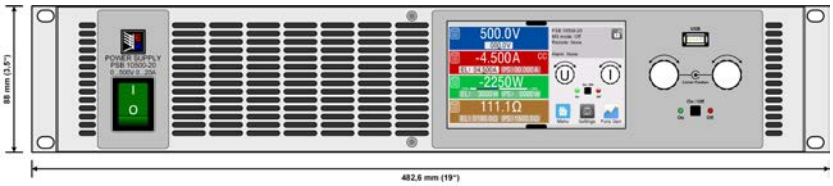
Solar array simulation

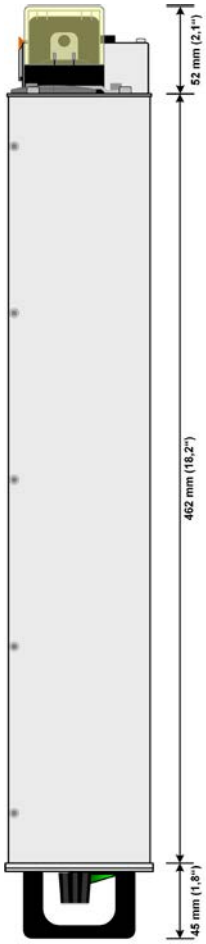
The programmable power supplies of the PSB 10000 range are highly suited to use as test systems for PV inverters as they can provide the necessary simulation for solar panels. Users can quickly access simulation models according to EN 50530 or Sandia while it supports diverse solar panel types. Parameters such as irradiation (varying with shadows), panel technology and temperature can be included. Thus the devices can test all the relevant electrical features of a PV inverter including the important efficiency value.
The high resolution of 16-bit technology and a high sampling rate enable the programmable power supply to deliver accurate results which can be documented and saved to an Excel file.

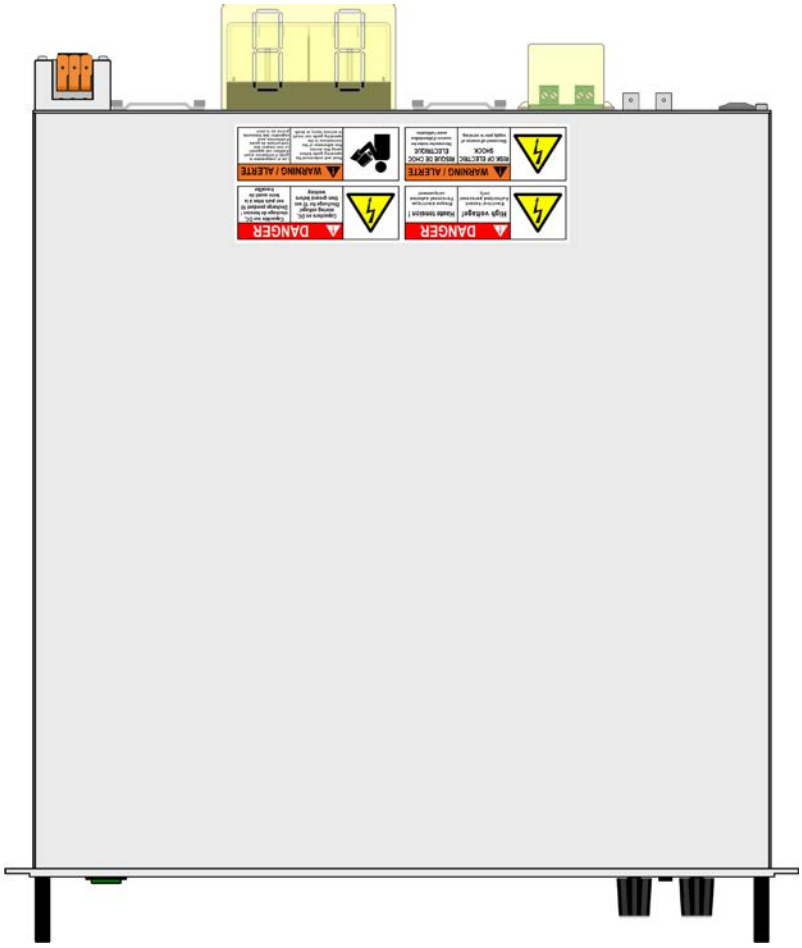
Battery recycling

In combination with the software EA-Power Control it's possible to assess retired batteries from electric vehicles for a possible further use. Assessment of a battery pack starts with a state of health (SOH) check to determine if a second life is feasible. This integrated function can be initiated with one click. 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, even with voltages under 2 V. The mains feedback to the power grid at up to 96% efficiency makes this process highly cost effective.

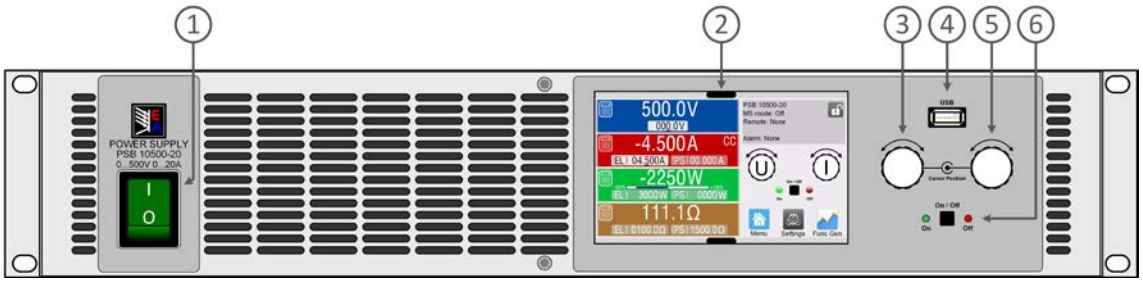
Technical drawings PSB 10000 2U





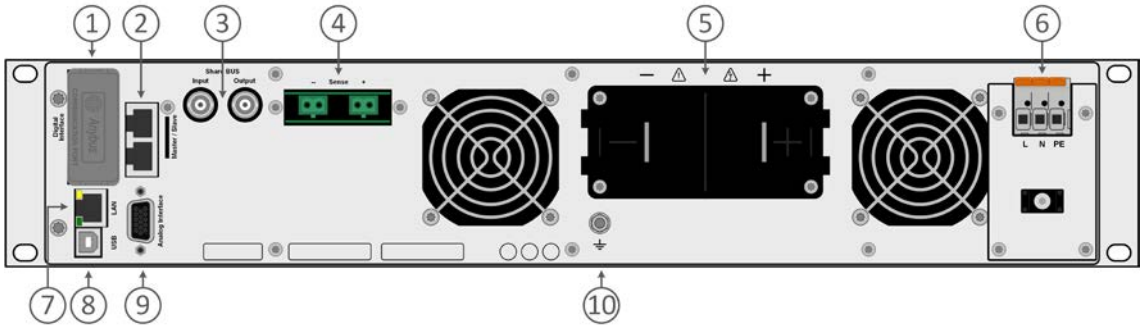


Front panel description PSB 10000 2U



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

Rear panel description PSB 10000 2U



1. Slot for interfaces
2. Master-slave bus connectors to set up a system for parallel connection
3. Share bus connectors to set up a system for parallel connection
4. Remote sense connectors
5. DC output terminal (copper blades)
6. AC input connector
7. Ethernet interface
8. USB interface
9. Connector (DB15 female) for isolated analog programming, monitor and other functions
10. Grounding connection screw (PE)

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