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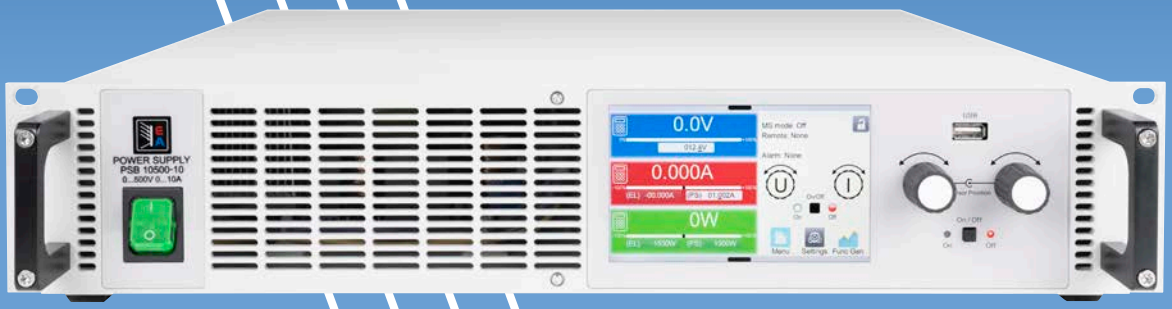

EA-PSB 10000 2U

Programmable Bidirectional DC-Power Supply

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EA-PSB 10000 2U
1.5 KW / 3.0 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 up to over 95 %
- Voltage 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
- 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
- Predefined automotive test procedures for LV123, LV124 and LV148
- Integrated battery test mode, battery and fuel cell simulation
- Photovoltaics test mode, MPPT, EN 50530
- 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

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General specifications	
AC-Input	
Voltage, Phases	110 V / 120 V / 208 V / 220 V / 230 V / 240 V ±10%, 1ph AC (110 V / 120 V 1ph with Derating, see model table)
Frequency	45-66 Hz
Power factor	>0.99
Leakage current	< 3.5 mA
Overvoltage category	2
Pollution degree	2
DC-Output static	
Load regulation CV	≤0.05% FS (0 - 100% load, constant input voltage and constant temperature)
Line regulation CV	≤0.01% FS (110 V - 240 V AC ±10% input voltage, constant load and constant temperature)
Stability CV	≤0.02% FS (Over 8hrs interval following 30 minutes warm-up, constant input voltage, load and temperature)
Temperature coefficient CV	≤30ppm/°C (Following 30 minutes warm up)
Compensation (Remote Sense)	≤5% $U_{Nominal}$
Load regulation CC	≤0.1% FS (0 - 100% load, constant input voltage and constant temperature)
Line regulation CC	≤0.01% FS (110 V - 240 V AC ±10% input voltage, constant load and constant temperature)
Stability CC	≤0.02% FS (Over 8hrs interval following 30 minutes warm-up, constant input voltage, load and temperature)
Temperature coefficient CC	≤50ppm/°C (Following 30 minutes warm up)
Load regulation CP	≤0.3% FS (0 - 100% load, constant input voltage and constant temperature)
Load regulation CR	≤0.3% FS + 0.1% FS current (0 - 100% load, constant input 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, 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 >8 mm
AC-Input to case (PE)	2500 Vrms
DC-Output to case (PE)	Depending on the model, see model table
DC-Output to Interfaces	1000 V DC (Model up to 360 V output), 1500 V DC (Model from 500 V output)
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, status DC, status CV/CC
Accuracy U / I / P / R	0 - 10 V ≤0.2%, 0 - 5 V ≤0.4%
Device configuration	
Parallel operation	Up to 64 units of any power class in series 10000, with Master-Slave-Bus and Share-Bus

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General specifications		
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	
Storage temperature	-20 - 70 °C	
Humidity	≤80% RH, non-condensing	
Altitude	≤2000 m (≤6600 ft)	
Mechanical construction		
Cooling	Forced air flow from front to rear, temperature controlled fans	
Dimensions (B x H x T)	19" x 2U x 462 mm (Enclosure only, not over all)	
Weight	9,5 kg (21 Lbs) 1500 W unit	12,7 kg (28 Lbs) 3000 W unit

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 rms CV	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 and noise p-p CV	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 up to	93.0% *2	94.0% *2	94.0% *2	94.5% *2	94.5% *2
Isolation					
Negative DC-Pol <-> PE	±1000 V DC	±1000 V DC	±1000 V DC	±1000 V DC	±1000 V DC
Positive DC-Pol <-> PE	+1000 V DC	+1000 V DC	+1000 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 V AC and 120 V AC grid
*2 100% Power and 100% Output voltage

Technical Specifications	PSB 10500-10	PSB 10750-06			
DC-Output					
Voltage range	0 - 500 V	0 - 750 V			
Ripple rms CV	40 mV BW 300 kHz	50 mV BW 300 kHz			
Ripple and noise p-p CV	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 up to	95.0% *2	95.0% *2			
Isolation					
Negative DC-Pol <-> PE	±1500 V DC	±1500 V DC			
Positive DC-Pol <-> PE	+2000 V DC	+2000 V DC			
Article number	30000724	30000725			

*1 The value in brackets applies to the state of derating (power reduction) for 110 V AC and 120 V AC grid
*2 100% 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 rms CV	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 and noise p-p CV	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 up to	93.0% *2	94.0% *2	94.0% *2	94.5% *2	94.5% *2
Isolation					
Negative DC-Pol <-> PE	±1000 V DC	±1000 V DC	±1000 V DC	±1000 V DC	±1000 V DC
Positive DC-Pol <-> PE	+1000 V DC	+1000 V DC	+1000 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 V AC and 120 V AC grid
*2 100% 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 rms CV	40 mV BW 300 kHz	50 mV BW 300 kHz	100 mV BW 300 kHz	150 mV BW 300 kHz	
Ripple and noise p-p CV	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 up to	95.0% *2	95.0% *2	95.0% *2	95.0% *2	
Isolation					
Negative DC-Pol <-> PE	±1500 V DC	±1500 V DC	±1500 V DC	±1500 V DC	
Positive DC-Pol <-> PE	+2000 V DC	+2000 V DC	+2000 V DC	+2000 V DC	
Article number	30000730	30000731	30000732	30000733	

*1 The value in brackets applies to the state of derating (power reduction) for 110 V AC and 120 V AC grid
*2 100% Power and 100% Output voltage

General

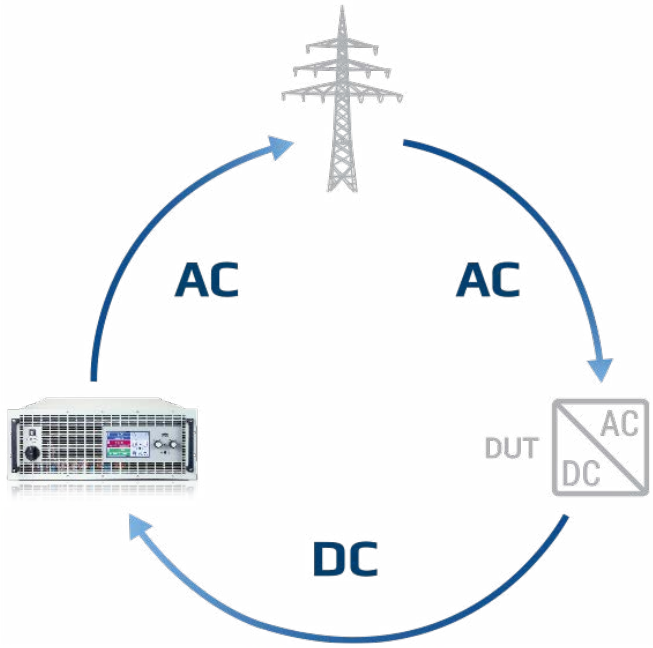
The bidirectional DC laboratory power supplies in the PSB 10000 series from EA Elektro-Automatik are two quadrant devices which can perform the function of power supply as well as that of an electronic load. In load mode the device is regenerative and feeds the energy back into the local grid with an efficiency up to over 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 voltage and current are directed 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), and a wide voltage, current and power 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 W 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 and one 15 kW devices from the PSB 10000 range. Furthermore, typical laboratory functionality is provided. This includes an extensive function generator, alarm and warning management, assorted interfaces and ports, software solutions and many more functions.

AC Connection

The bidirectional 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. This extends from 1-phase 110/120 V up to 240 V AC mains supply and 3-phase 208 V to 380 V, 400 V and 480 V AC mains supply. The devices can be operated in the majority of global mains supply. They adjust automatically, without additional configuration, to the available supply. In a 110/120 V and 208 V AC grid a derating of the output power is set.

Energy recovering

The energy consumed in load mode is feed back into the connected mains supply with an efficiency of over 96 %. This reduces cost: 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 is sufficient for the whole application, reducing investment and installation costs.



The principle of Energy recovering

This demonstrates, based on an application, how a ‘device under test’ takes 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 mains..

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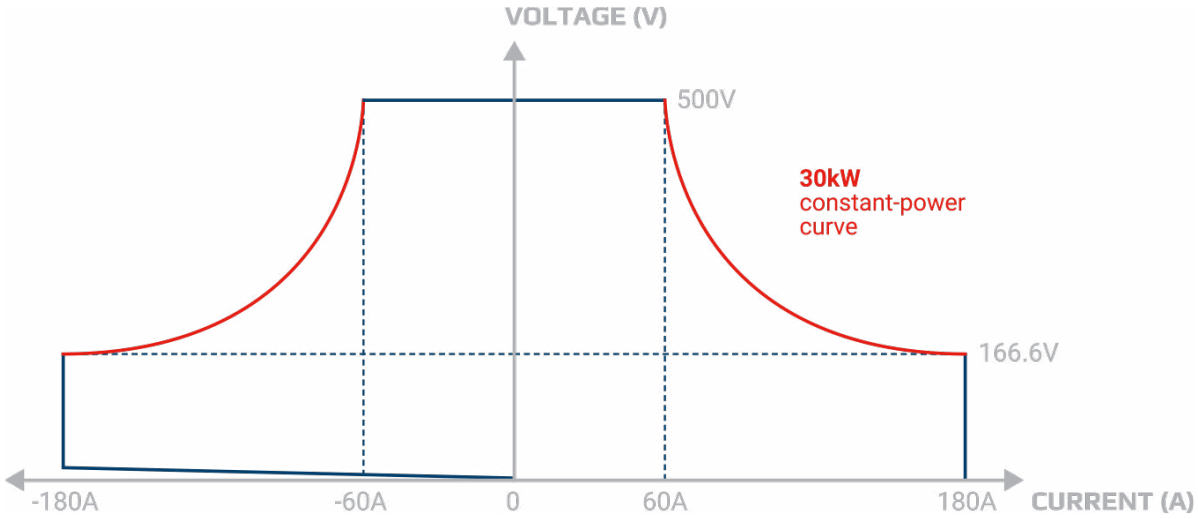
DC Output

The output of the bidirectional power supply PSB 10000 with a DC voltage of 0 - 10 V up to 0 - 2000 V allows positive and negative currents of 0 - 6 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 power supplies.

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

This description should clarify the availability the voltage and current ranges within the power hyperbole.

Function generator

All models in the PSB 10000 series are equipped with a function generator. This allows curve processes such as sine, triangle, square or trapeze to be simply called up. 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, that´s saving time. A LUT allows IU and UI reference lines to be stored. For simulation of a photovoltaic system or fuel cells, adaptable tables are provided. With the standard PV characteristic curve (DIN EN 50530) various solar cells and many other technology parameters can be selected and set. In short, the user is supported by a multitude of useful functions.

Interfaces

As standard EA devices are fitted with the most important digital and analogue interfaces and ports which are galvanically isolated. These include an analogue interface which can be parameterised 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. The following options which use a 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

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High performance systems

High power applications can be covered with high power systems of up to 1920 kW. These are achieved by using the outputs of many PSB 10000 devices, changing the copper rails to vertical, and connecting in parallel. Thus, a 19" cabinet with 42 HE can provide a system with 240 kW occupying 0.6 m² floorspace. The master/slave bus enables up to 8 cabinets with a maximum of 64 units of 30 kW each to behave as one unit.

Master-Slave-Bus and Share-Bus

If the integral master-slave bus and share bus are used, a multi device system behaves as a single device. The master-slave bus and the share bus are simply connected to each device. With the master-slave bus the system data such as total power and total current are collected and shown in the master device. Warnings and alarms of the slave devices are shown clearly in the display. The share bus provides an equal load distribution to the individual devices.

Example representation

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

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Application

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 dynamism, reproducibility and reliability of these data and the economic and flexible usage. Whether in an automated test system or in an integrated battery test, all possibilities are open to the user. Furthermore, the devices are clearly economic with efficiencies of 96% or more.

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 components to be supplied. Wherever reproducible data are needed a battery simulator is the first choice. Also, the use of a simulator as a power source provides protection for the connected consuming component. The Over-Current-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. Here high accuracy and dynamism are maintained.

On-board charger test

In an on-board charger test (OBC) 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 PSB 10000 devices test procedures allow data to be read out and saved. In this way applications can promptly 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 test device, the control frequency of the power supply is adjustable. The modes Normal, Fast and Slow allow the PSB 10000 devices to match 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 cells. Users can readily program simulation models according to EN 50530 or Sandia using diverse solar cell materials. An IU curve can be accurately reproduced, parameters such as irradiation, shadow, temperature, clouds, and rain can be included. Thus, the devices can test all the relevant electrical features of a PV inverter including the particularly important determination of the efficiency. Users can select a static or dynamic Maximum-Power-Point-Tracking (MPPT). The high resolution of 16-bit technology and a sampling rate of 1µs enables the programmable power supply to deliver exact results which can be documented and saved to an Excel file.

Battery recycling

The bidirectional power supplies of the PSB 10000 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 by press button. 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 mains feedback of the power grid consumed of 96% efficiency makes this process highly cost effective.

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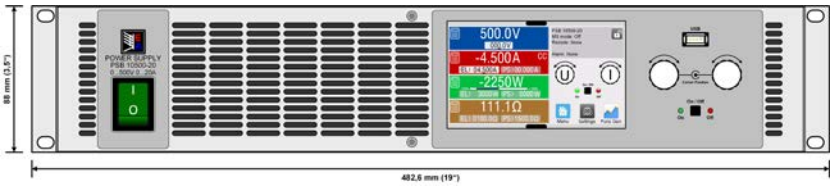
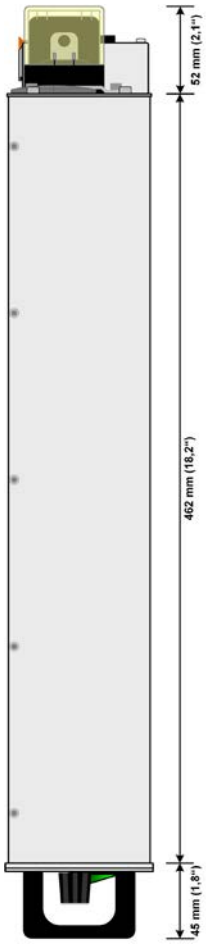
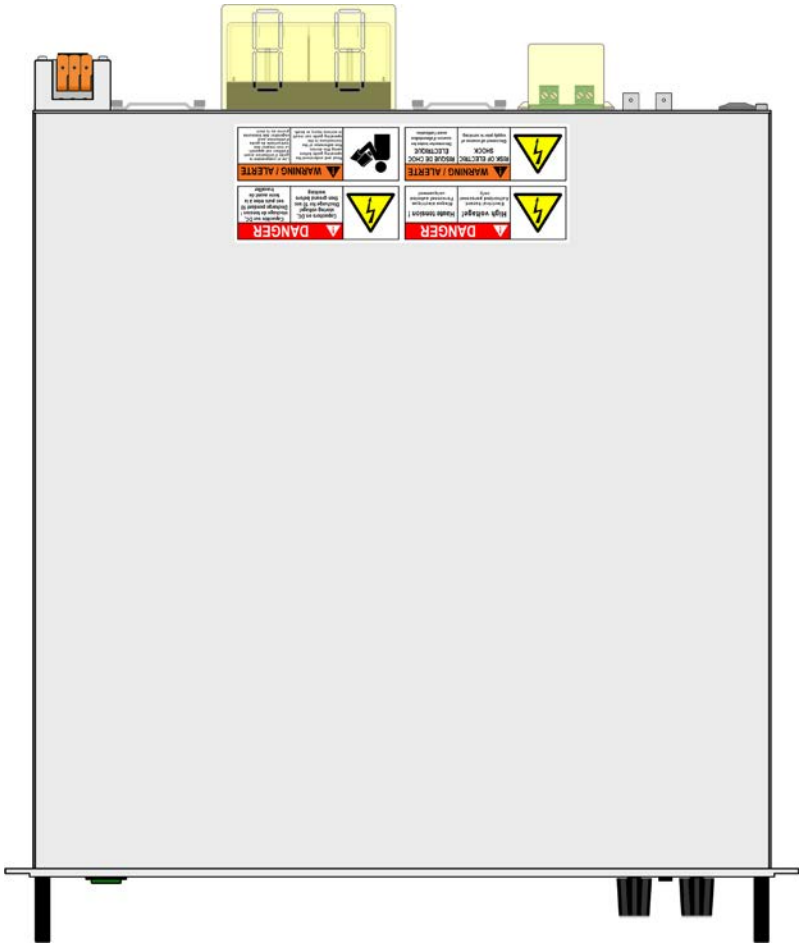
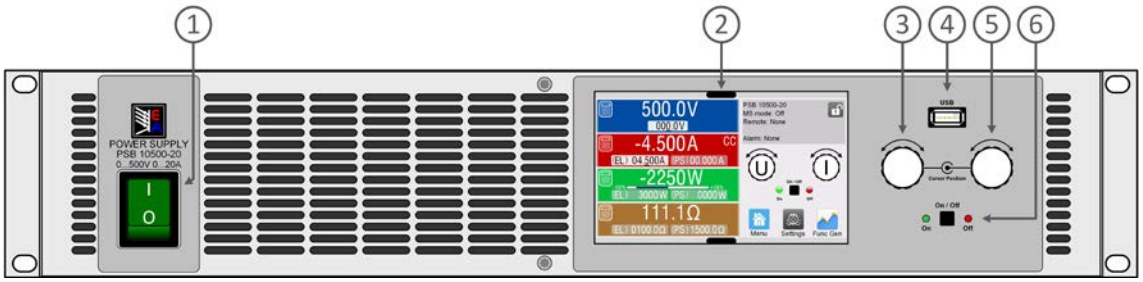
Technical Drawing PSB 10000 2U





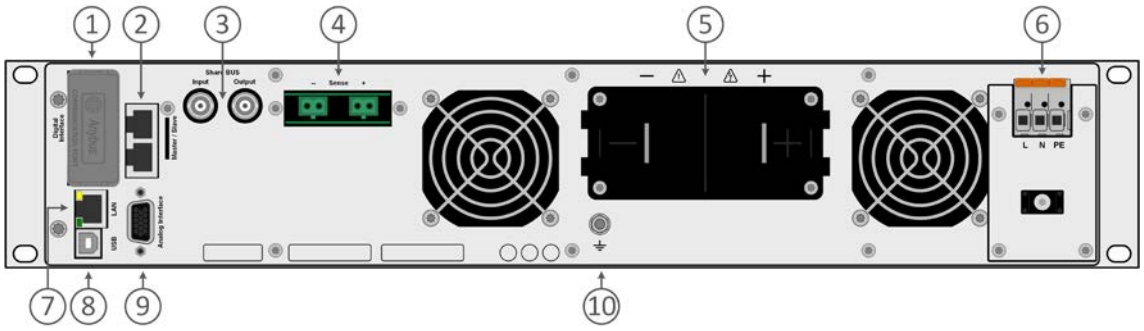


Front Panel Description PSB 10000 2U



1. Main switch
2. TFT Control Interface, interactive operation and display
3. Rotary knob with push-button for settings and control
4. USB Host, use USB-stick 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 interface to set up a system for parallel connection
3. Share-Bus Interface to set up a system for parallel connection
4. Output voltage Remote Sense input terminal
5. Output terminal, Copper busbar
6. Mains input terminal
7. Ethernet interface
8. USB interface
9. Connector (DB15 Female) for isolated analog program, monitor and other functions
10. Grounding connection screw (PE)

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