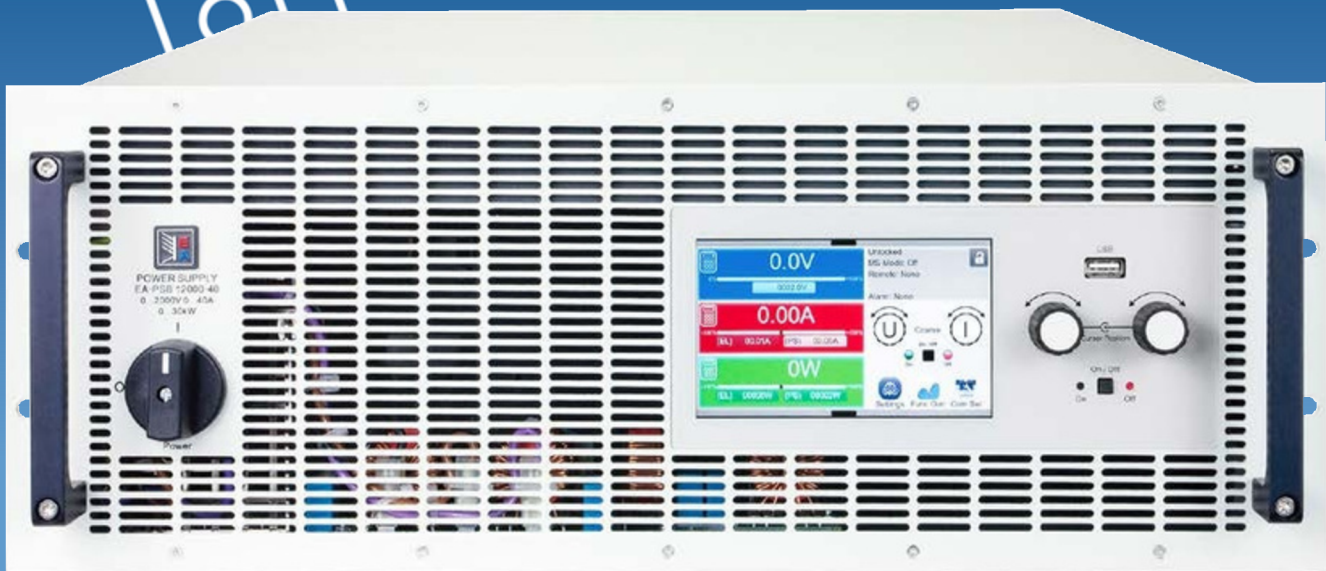




Elektro-Automatik



PSB 10000 3U

Programmable Bidirectional DC Power Supply

Bidirectional Operation: Functions as both a power source and regenerative load, with energy recovery up to 96%.

Flexible Autoranging: Broad voltage and current ranges (up to 2000 V and 510 A), maintaining full power across various configurations.

Scalable Design: Supports parallel operation of up to 64 units, enabling systems up to 960 kW for large-scale applications.

Integrated Function Generator: Predefined waveforms and custom test sequences simplify complex testing scenarios.

Intuitive Interface and Connectivity: Includes a 5" color touchscreen, built-in USB and Ethernet ports, and optional industrial communication protocols for seamless integration.

EA-PSB 10000 3U 5 kW - 10 kW - 15 kW

Programmable bidirectional DC
power supply



Features

- Wide range input: 208 V - 480 V, +10%, 3ph 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 96%
- High performance with up to 30 kW per unit
- Voltages from 0 - 10 V up to 0 - 2000 V
- Currents from 0 - 20 A up to 0 - 510 A
- Flexible power regulated DC output stages (autoranging)
- Regulation modes 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
- Battery test mode, battery and fuel cell simulation
- Photovoltaics test mode (EN 50530), MPPT
- Command languages and drivers: SCPI and ModBus, LabVIEW, IVI

Built-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



SPECIFICATIONS

AC Input

- **Voltage Phases:**
 - Range 1: 208 V, $\pm 10\%$, 3ph AC (with DC output power derating to 3 / 6 / 9 kW)
 - Range 2: 380 - 480 V, $\pm 10\%$, 3ph AC
- **Frequency:** 45 - 65 Hz
- **Power Factor:** Typical 0.99
- **Leakage Current:** <5 mA
- **Inrush Current @400 V:** ca. 40 A per phase
- **Overvoltage Category:** 2

DC Output (static)

- **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 $\pm 10\%$ input voltage, constant load and constant temperature)
- **Stability CV:** $\leq 0.02\%$ FS (during 8 hours of operation, after 30 minutes of warm-up, at constant output voltage, load, and temperature)
- **Temperature Coefficient CV:** ≤ 30 ppm/ $^{\circ}$ C (after 30 minutes of warm-up)
- **Compensation (Remote Sense):** $\leq 5\%$ UNominal
- **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 $\pm 10\%$ input voltage, constant load and constant temperature)
- **Stability CC:** $\leq 0.02\%$ FS (during 8 hours of operation, after 30 minutes of warm-up, at constant output voltage, load, and temperature)
- **Temperature Coefficient CC:** ≤ 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 of current (0 - 100% load, constant output voltage and constant temperature)

Protective Functions

- **Overvoltage Protection (OVP):** Adjustable 0 - 110% UNominal
- **Overcurrent Protection (OCP):** Adjustable 0 - 110% INominal
- **Overpower Protection (OPP):** Adjustable 0 - 110% PNominal
- **Overtemperature Protection (OT):** 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:** $\leq 0.05\%$ 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)

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: $\leq 0.2\%$, 0-5 V: $\leq 0.4\%$

Device Configuration

- **Parallel Operation:** Up to 64 units of any power class in the 10000 series, 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:** ≤ 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 3U x 668 mm (26.3 in)
- **Weight:** 5 kW unit: 18 kg (40 lb), 10 kW unit: 25.4 kg (56 lb), 15 kW unit: 32.8 kg (72 lb)

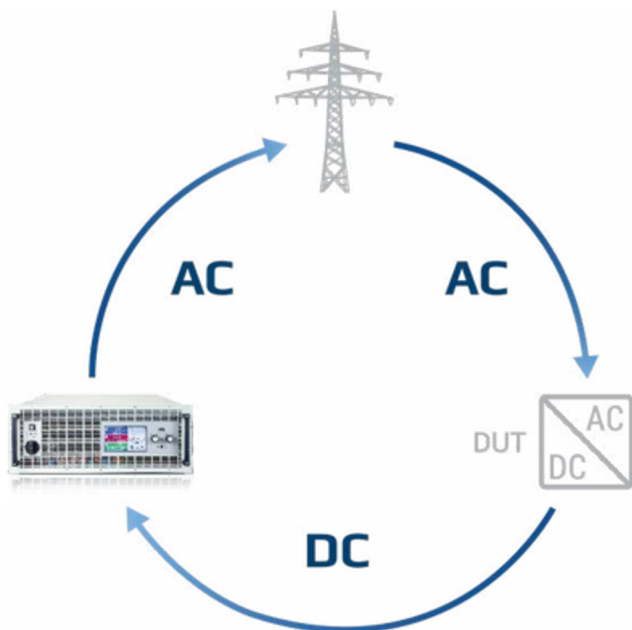
Available Models

SKU	Power (W)	Voltage (V)	Current (A)	Output Capacity	Resistance Range	Umin for I _{max}	Ripple in CV (rms)	Ripple in CV (pp)	Efficiency
PSB 10010-170	1700 W	10 V	170 A	7790 μF	0.016 Ω - 26 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	93.50%
PSB 10010-340	3400 W	10 V	340 A	15980 μF	0.008 Ω - 13 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	93.50%
PSB 10010-510	5100 W	10 V	510 A	23970 μF	0.006 Ω - 9 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	93.50%
PSB 10060-170	5000 W	60 V	170 A	7790 μF	0.016 Ω - 26 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10060-340	10000 W	60 V	340 A	15980 μF	0.008 Ω - 13 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10060-510	15000 W	60 V	510 A	23970 μF	0.006 Ω - 9 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10080-170	5000 W	80 V	170 A	7790 μF	0.016 Ω - 26 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10080-340	10000 W	80 V	340 A	15980 μF	0.008 Ω - 13 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10080-510	15000 W	80 V	510 A	23970 μF	0.006 Ω - 9 Ω	0.5 V	≤10 mV (BW 300 kHz)	≤100 mV (BW 20 MHz)	94.50%
PSB 10200-140	10000 W	200 V	140 A	5040 μF	0.05 Ω - 80 Ω	2 V	≤40 mV (BW 300 kHz)	≤300 mV (BW 20 MHz)	94.50%
PSB 10200-210	15000 W	200 V	210 A	7560 μF	0.03 Ω - 50 Ω	2 V	≤40 mV (BW 300 kHz)	≤300 mV (BW 20 MHz)	94.50%
PSB 10200-70	5000 W	200 V	70 A	2520 μF	0.1 Ω - 160 Ω	2 V	≤40 mV (BW 300 kHz)	≤300 mV (BW 20 MHz)	94.50%
PSB 10360-120	15000 W	360 V	120 A	1179 μF	0.1 Ω - 180 Ω	2 V	≤55 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	95.50%
PSB 10360-40	5000 W	360 V	40 A	393 μF	0.3 Ω - 520 Ω	2 V	≤55 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	95.50%
PSB 10360-80	10000 W	360 V	80 A	786 μF	0.15 Ω - 260 Ω	2 V	≤55 mV (BW 300 kHz)	≤320 mV (BW 20 MHz)	95.50%
PSB 10500-30	5000 W	500 V	30 A	180 μF	0.6 Ω - 1000 Ω	2.2 V	≤70 mV (BW 300 kHz)	≤350 mV (BW 20 MHz)	95.50%
PSB 10500-60	10000 W	500 V	60 A	360 μF	0.3 Ω - 500 Ω	2.2 V	≤70 mV (BW 300 kHz)	≤350 mV (BW 20 MHz)	95.50%
PSB 10500-90	15000 W	500 V	90 A	540 μF	0.2 Ω - 330 Ω	2.2 V	≤70 mV (BW 300 kHz)	≤350 mV (BW 20 MHz)	95.50%
PSB 10750-20	5000 W	750 V	20 A	180 μF	1.2 Ω - 2200 Ω	2.5 V	≤200 mV (BW 300 kHz)	≤800 mV (BW 20 MHz)	95.50%
PSB 10750-40	10000 W	750 V	40 A	360 μF	0.6 Ω - 1100 Ω	2.5 V	≤200 mV (BW 300 kHz)	≤800 mV (BW 20 MHz)	95.50%
PSB 10750-60	15000 W	750 V	60 A	540 μF	0.4 Ω - 750 Ω	2.5 V	≤200 mV (BW 300 kHz)	≤800 mV (BW 20 MHz)	95.50%
PSB 11000-30	10000 W	1000 V	30 A	90 μF	1.2 Ω - 2000 Ω	4 V	≤200 mV (BW 300 kHz)	≤1000 mV (BW 20 MHz)	95.50%
PSB 11000-40	15000 W	1000 V	40 A	90 μF	0.8 Ω - 1300 Ω	5.6 V	≤300 mV (BW 300 kHz)	≤1600 mV (BW 20 MHz)	95.50%
PSB 11500-20	10000 W	1500 V	20 A	90 μF	2.6 Ω - 4500 Ω	5 V	≤400 mV (BW 300 kHz)	≤2000 mV (BW 20 MHz)	95.50%
PSB 11500-30	15000 W	1500 V	20 A	60 μF	1.7 Ω - 3000 Ω	7.2 V	≤400 mV (BW 300 kHz)	≤2400 mV (BW 20 MHz)	95.50%
PSB 12000-20	15000 W	2000 V	20 A	60 μF	3.5 Ω - 5500 Ω	7.2 V	≤400 mV (BW 300 kHz)	≤2400 mV (BW 20 MHz)	95.50%



General

The bidirectional DC power supplies of the PSB 10000 series by EA Elektro-Automatik are highly versatile two-quadrant devices capable of functioning as both a power supply and an electronic load. In load mode, these devices are regenerative, feeding energy back into the grid with an efficiency of up to 96%, significantly reducing operational costs and heat generation. Designed for global compatibility, the PSB 10000 series supports a wide range of DC voltages and currents, from 0–10 V to 0–2000 V and 0–6 A to 0–1000 A, all within a single device. The flexible autoranging output stages ensure seamless adaptation to varied applications, while the master-slave bus enables up to 64 devices to be combined into a single, scalable system delivering up to 1920 kW and 64,000 A. This series also incorporates robust laboratory functionality, such as an integrated function generator, comprehensive alarm and warning systems, and versatile software options for seamless operation.



The Principle of Energy Recovering

The PSB 10000 series leverages advanced bidirectional technology to optimize energy flow. During operation, the device under test (DUT) draws energy from the mains, converts it to DC, and supplies it to the EA device. This bidirectional power supply then regenerates the DC energy into an AC current, efficiently feeding it back into the grid. This process ensures minimal energy loss, reducing both electricity costs and heat output, while supporting a wide range of testing and simulation applications with exceptional reliability and precision.

AC Connection

The PSB 10000 series is equipped with an active power factor correction (PFC) system, ensuring high energy efficiency and low energy consumption. These devices are compatible with a wide range of global input voltages, spanning single-phase 110 V to 240 V AC and three-phase 208 V to 480 V AC supplies. Automatic adjustment to the available mains voltage eliminates the need for manual configuration, allowing for effortless integration into diverse power environments. In lower-voltage grids, such as 110 V or 120 V, automatic output derating ensures optimal performance without compromising reliability.

Energy Recovering

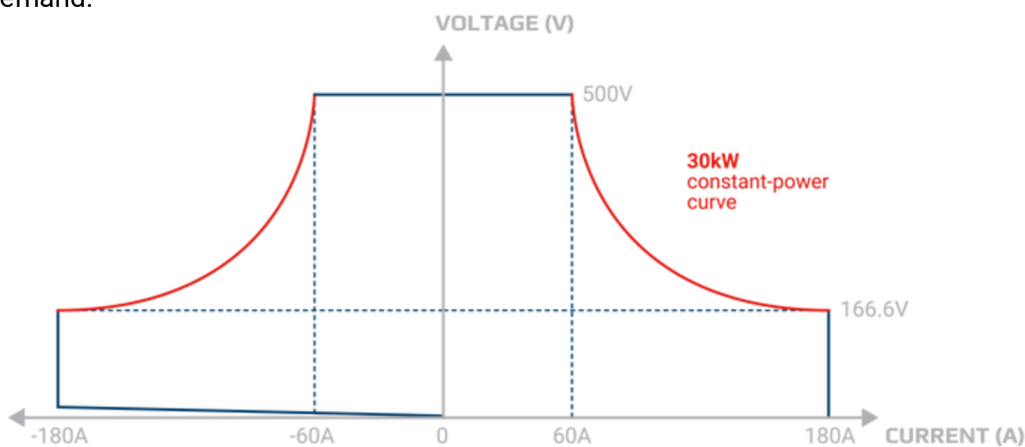
The PSB 10000 series stands out with its regenerative energy recovery system, which allows energy consumed in load mode to be efficiently fed back into the mains supply at up to 96% efficiency. Unlike conventional systems that dissipate energy as heat, these devices minimize energy waste, significantly reducing operational costs. This also results in less heat production, lowering cooling requirements and associated costs, making the PSB 10000 series an economical and environmentally friendly solution for high-performance testing applications.

DC Output

The PSB 10000 series offers a wide range of DC output capabilities, providing voltages from 0–10 V to 0–2000 V and currents from 0–6 A to 0–1000 A, depending on the model. These bidirectional devices operate as two-quadrant systems, allowing them to supply or absorb power as needed. The flexible autoranging output stages ensure a broad operational spectrum, allowing users to work efficiently across various voltage, current, and power ranges. This adaptability makes the PSB 10000 series suitable for diverse applications, from precision lab experiments to large-scale industrial operations, with the reliability and flexibility engineers demand.

DC Connection

The DC connections in the PSB 10000 series are designed for efficiency and scalability, utilizing robust copper busbars for reliable energy transfer. These connections are located at the rear of the device, allowing for seamless integration into test setups. For higher power requirements, multiple devices can be connected in parallel using vertical copper rails with minimal effort. To ensure operator safety, protective covers are provided for all exposed contacts, ensuring a secure and efficient testing environment.



The Principle of Autoranging

The autoranging technology in the PSB 10000 series enhances its adaptability by automatically optimizing the voltage and current ranges to maintain full power across a wide operational spectrum. This flexibility allows a single device to handle a variety of voltage-current combinations, replacing the need for multiple fixed-range units. By maximizing the operational range without compromising efficiency, the PSB 10000 series provides engineers with a cost-effective and versatile solution for complex testing scenarios.

Integrated Function Generator

The PSB 10000 series is equipped with an integrated function generator, allowing users to simulate real-world conditions with predefined waveforms, including sine, triangle, square, and trapezoidal curves. Additional features, such as ramp functions and arbitrary waveform programming, enable precise customization for specialized tests. The devices also support test sequence storage, allowing users to save and reload recurring procedures, significantly improving workflow efficiency. For applications such as solar and fuel cell simulations, pre-programmed PV characteristics compliant with DIN EN 50530 are available, further expanding the series' versatility.

Interfaces

The PSB 10000 series includes a comprehensive set of digital and analog interfaces, ensuring seamless integration into diverse testing environments. Standard USB, Ethernet, and analog ports are galvanically isolated for safe operation and accurate communication. The series also supports optional industrial protocols, including CAN, CANopen, RS232, EtherCAT, Profinet, and Modbus, providing robust connectivity for automated and industrial systems. These versatile interfaces, coupled with intuitive configuration options, ensure the PSB 10000 series meets the demands of modern engineering and testing applications.

High-Performance Systems

The PSB 10000 series is designed to meet the needs of high-power applications, with scalable solutions that support up to 1920 kW of power. By connecting multiple units in parallel using vertical copper rails, the system can deliver exceptional performance while occupying minimal floor space. For example, a single 19-inch rack can accommodate up to 240 kW in a compact and efficient configuration. The modular design and compatibility across different power classes allow engineers to build systems tailored to their specific requirements, ensuring flexibility and efficiency in demanding environments.

Master-Slave-Bus and Share-Bus

The PSB 10000 series incorporates an advanced Master-Slave bus and Share bus to ensure seamless operation in multi-device systems. These buses allow up to 64 units to function as a single, unified device, simplifying control and monitoring. The Master-Slave bus consolidates data such as total power and current on the master device's display, while also providing clear visibility of warnings and alarms from slave units. The Share bus ensures equal load distribution across connected devices, optimizing performance and reliability. This intelligent system architecture enhances scalability and efficiency, making the PSB 10000 series a reliable choice for high-power applications.



Example Representation

A fully assembled and operational 240 kW system.

Applications

Battery Testing for Electromobility

The PSB 10000 series is designed to address the demanding requirements of modern battery testing, making it a reliable choice for evaluating the electrical characteristics of cells, modules, and battery packs. Whether conducting State-of-Health (SOH) assessments for second-life classification or performing End-of-Line (EOL) evaluations, this power supply ensures accurate and reproducible measurements. Its advanced functionality seamlessly integrates into automated test systems, while the flexibility allows for customized configurations in integrated environments. Additionally, the device's exceptional efficiency of up to 96% reduces energy consumption and operational costs, delivering superior performance while maintaining cost-effectiveness.

Battery Simulation

The PSB 10000 series offers a robust battery simulation capability, enabling users to replicate the behavior of single cells, modules, or entire battery packs. This functionality is particularly useful for optimizing energy storage designs and ensuring the compatibility of connected components under test. With integrated safety features such as overcurrent protection and automatic alarms, the system not only protects valuable equipment but also minimizes risks during operation. These simulations provide highly reproducible data, giving engineers confidence in their designs and testing procedures while maintaining a secure working environment.

Fuel Cell Testing

The PSB 10000 series is an excellent tool for testing the electrical properties of fuel cells, whether individual units, stacks, or complete systems. Its precision and high level of accuracy ensure consistent and reliable data for resistance, performance, and durability assessments. Users can quickly integrate the system into automated test setups to streamline workflows. With its regenerative energy feedback, the device reduces operational costs by achieving up to 96% efficiency. When higher current levels are required, the system supports parallel connections through master-slave configurations, enabling scalable testing without compromising accuracy or performance.

On-board Charger Test

The PSB 10000 series provides a flexible and comprehensive solution for on-board charger (OBC) testing, catering to the wide range of conditions these devices may encounter in real-world applications. Its advanced features include adjustable voltage regulation speeds that allow users to adapt the system to the unique control characteristics of the device under test (DUT). With built-in sequencing and logging functions, users can generate dynamic and highly accurate set-point data to achieve reproducible results. The ability to export and save test data further enhances its utility, making it an essential tool for thorough and efficient OBC performance evaluations.

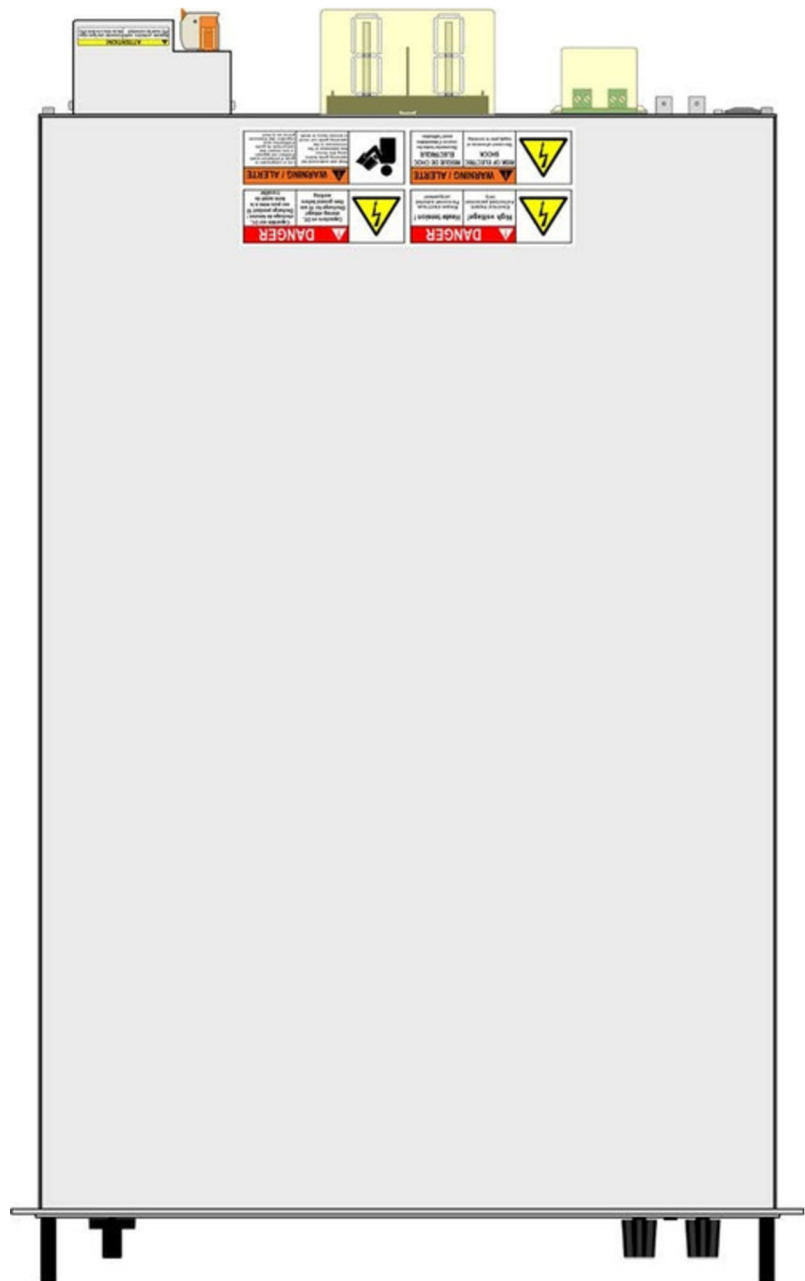
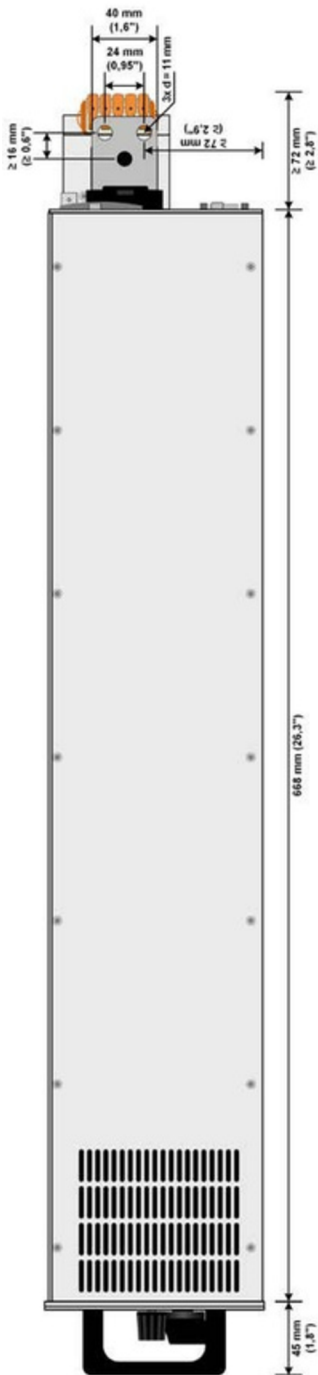
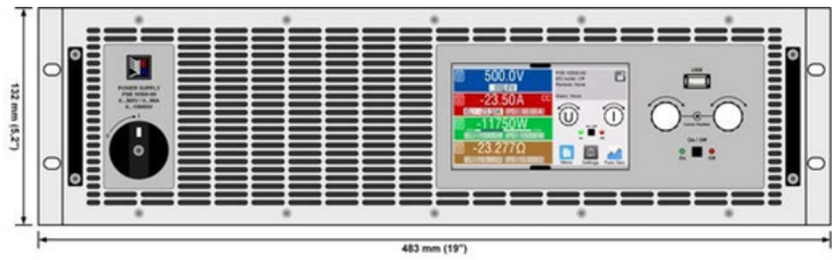
Solar Array Simulation

The PSB 10000 series is highly suited for solar array simulation, offering engineers the tools to rigorously test photovoltaic (PV) inverters under realistic conditions. By replicating solar panel behavior with high precision, it supports key simulation models that align with EN 50530 standards and even accounts for environmental variables such as irradiation, temperature, and panel technology. This flexibility enables users to thoroughly evaluate the efficiency and performance of PV inverters, ensuring compliance with industry standards. High-resolution 16-bit technology and advanced sampling rates further enhance the accuracy of test results, which can be documented and saved for analysis or reporting.

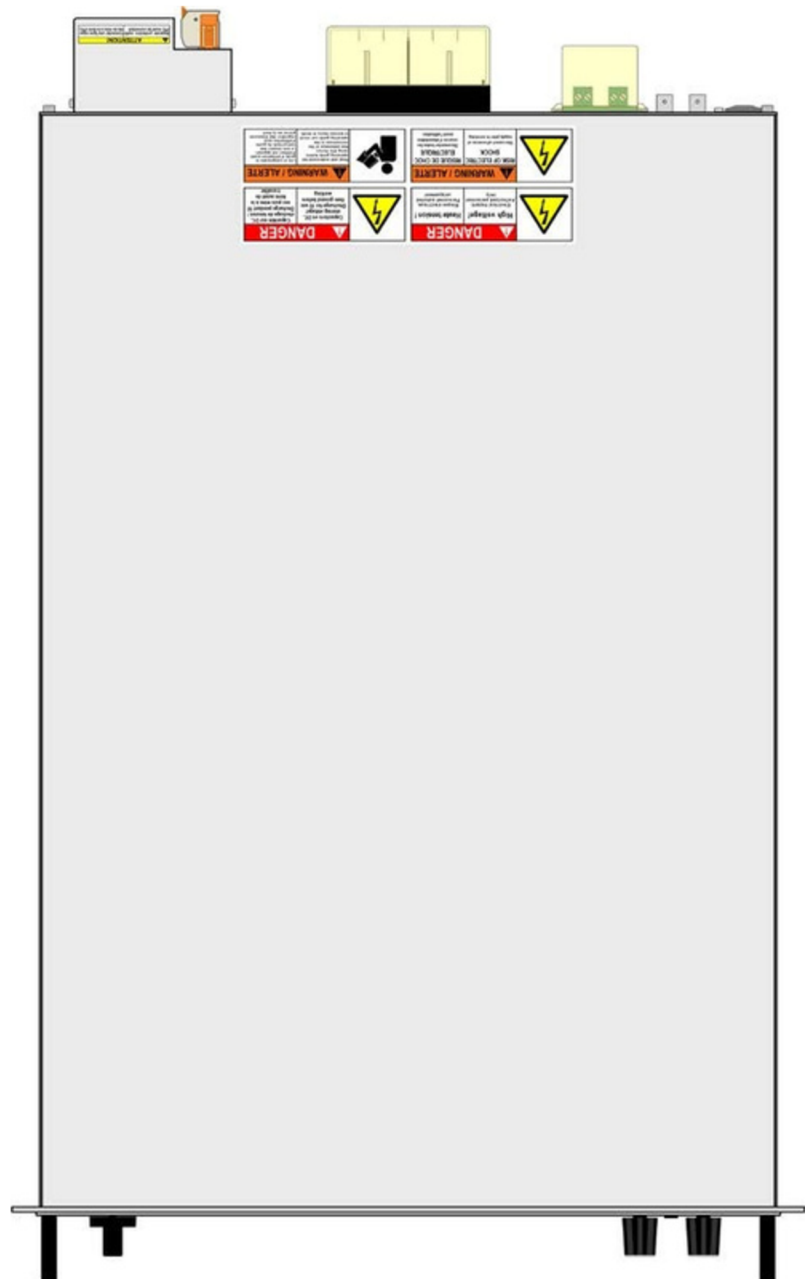
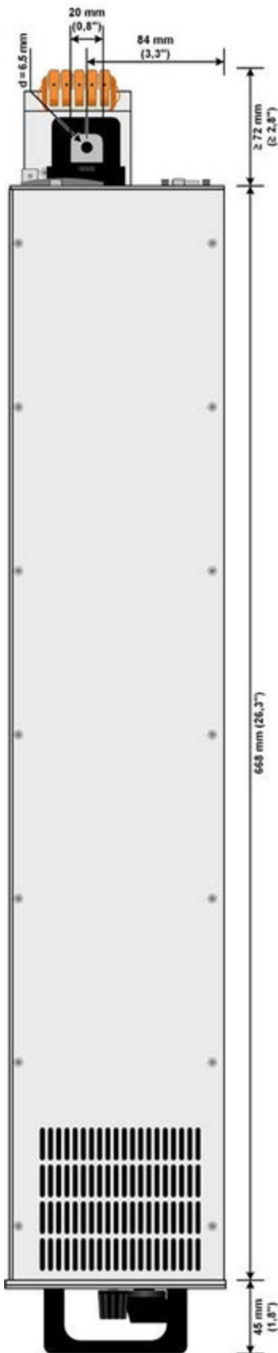
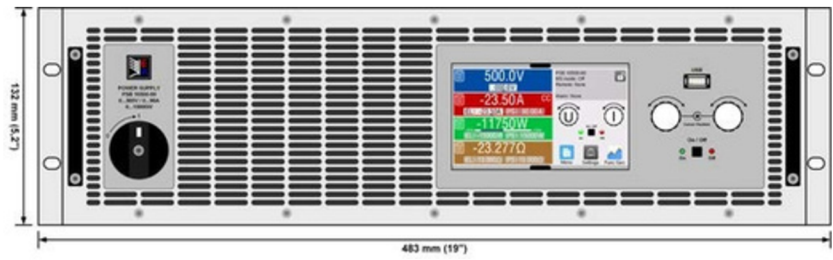
Battery Recycling

The PSB 10000 series simplifies the complex process of battery recycling by integrating advanced tools for evaluating State-of-Health (SOH) and executing complete discharges. Its autoranging capability ensures the device can handle even low-voltage batteries, maximizing the total discharge to prepare them for recycling. The process is made cost-efficient with energy recovery features that return up to 96% of the energy to the grid, reducing both waste and operating expenses. The system's intuitive operation, including a single-click initiation for SOH evaluation, streamlines workflows, making it an indispensable asset for sustainable battery management practices.

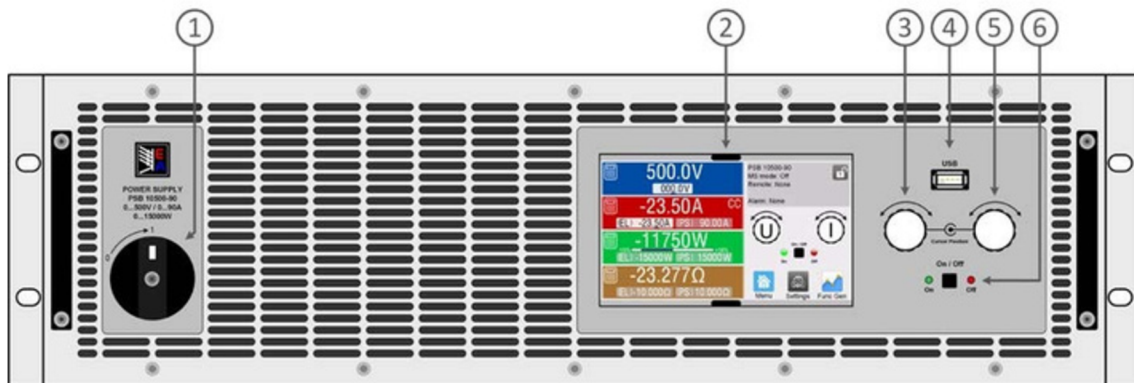
Technical drawings PSB 10000 3U <200 V



Technical drawings PSB 10000 3U >360 V

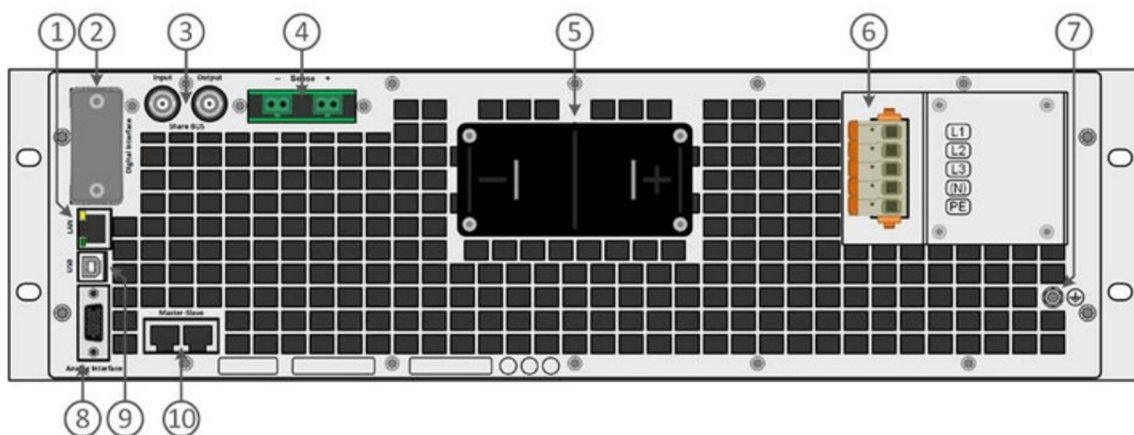


Front panel description PSB 10000 3U



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 PSB 10000 3U



1. Ethernet interface
2. Slot for interfaces
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. Grounding connection screw (PE)
8. Connector (DB15 female) for isolated analog programming, monitor and other functions
9. USB interface
10. Master-Slave bus connectors to set up a system for parallel connection

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