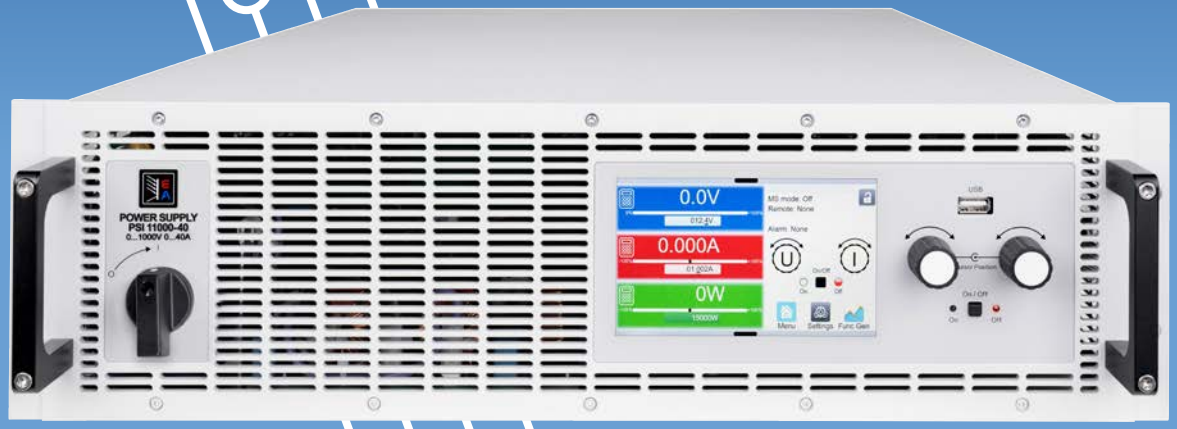
Elektro-Automatik



DATASHEET

EA-PSI 10000 3U

Programmable
DC Power Supply

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EA-PSI 10000 3U
5 KW - 10 KW - 15 KW

Programmable
DC power supply

Features

- Wide range input: 208 V - 480 V, ±10%, 3ph AC
- Active Power Factor Correction, typical 0.99
- Very high efficiency of up to 96 %
- High performance of up to 15 kW per unit
- Voltages from 0 - 60 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 control 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
- Photovoltaics test mode (EN 50530)
- 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

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Technical data

General specifications	
AC input	
Voltage, Phases	Range 1: 208 V, ±10%, 3ph AC (with DC output power derating to 3 / 6 / 9 kW) Range 2: 380 - 480 V, ±10%, 3ph AC
Frequency	45 - 65 Hz
Power factor	ca. 0.99
Leakage current	<5 mA
Inrush current	@400 V: ca. 40 A per phase
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 (208 V - 480 V AC ±10% input voltage, constant load and constant temperature)
Stability CV	≤0.02% FS (during 8 h of operation, after 30 minutes of 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 (208 V - 480 V AC ±10% input voltage, constant load and constant temperature)
Stability CC	≤0.02% FS (during 8 h of operation, after 30 minutes of 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 of 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
Interface 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 3U x 668 mm (26.3 in) Total: 19" x 3U x min. 777 mm (30.6 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)

Technical specifications	PSI 10060-170	PSI 10080-170	PSI 10200-70	PSI 10360-40	PSI 10500-30
DC output					
Voltage range	0 - 60 V	0 - 80 V	0 -200 V	0 - 360 V	0 - 500 V
Ripple in CV (rms)	≤10 mV (BW 300 kHz)	≤10 mV (BW 300 kHz)	≤40 mV (BW 300 kHz)	≤55 mV (BW 300 kHz)	≤70 mV (BW 300 kHz)
Ripple in CV (pp)	≤100 mV (BW 20 MHz)	≤100 mV (BW 20 MHz)	≤300 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤350 mV (BW 20 MHz)
Current range	0 - 170 A	0 - 170 A	0 - 70 A	0 - 40 A	0 - 30 A
Power range	0 - 5000 W (0 - 3000 W) *2	0 - 5000 W (0 - 3000 W) *2	0 - 5000 W (0 - 3000 W) *2	0 - 5000 W (0 - 3000 W) *2	0 - 5000 W (0 - 3000 W) *2
Resistance range	0.016 Ω - 26 Ω	0.016 Ω - 26 Ω	0.1 Ω - 160 Ω	0.3 Ω - 520 Ω	0.6 Ω - 1000 Ω
Output capacitance	7790 µF	7790 µF	2520 µF	393 µF	180 µF
Efficiency (up to)	94.5% *1	94.5% *1	94.5% *1	95.5% *1	95.5% *1
Insulation					
Negative DC pole <-> PE	±600 V DC	±600 V DC	±1000 V DC	±1000 V DC	±1500 V DC
Positive DC pole <-> PE	+600 V DC	+600 V DC	+1000 V DC	+1000 V DC	+2000 V DC
Article number	06230829	06230830	06230831	06230832	06230833

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

Technical specifications	PSI 10750-20				
DC output					
Voltage range	0 - 750 V				
Ripple in CV (rms)	≤200 mV (BW 300 kHz)				
Ripple in CV (pp)	≤800 mV (BW 20 MHz)				
Current range	0 - 20 A				
Power range	0 - 5000 W (0 - 3000 W) *2				
Resistance range	1.2 Ω - 2200 Ω				
Output capacitance	180 µF				
Efficiency (up to)	95.5% *1				
Insulation					
Negative DC pole <-> PE	±1500 V DC				
Positive DC pole <-> PE	+2000 V DC				
Article number	06230834				

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

Technical specifications	PSI 10060-340	PSI 10080-340	PSI 10200-140	PSI 10360-80	PSI 10500-60
DC output					
Voltage range	0 - 60 V	0 - 80 V	0 -200 V	0 - 360 V	0 - 500 V
Ripple in CV (rms)	≤10 mV (BW 300 kHz)	≤10 mV (BW 300 kHz)	≤40 mV (BW 300 kHz)	≤55 mV (BW 300 kHz)	≤70 mV (BW 300 kHz)
Ripple in CV (pp)	≤100 mV (BW 20 MHz)	≤100 mV (BW 20 MHz)	≤300 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤350 mV (BW 20 MHz)
Current range	0 - 340 A	0 - 340 A	0 - 140 A	0 - 80 A	0 - 60 A
Power range	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2
Resistance range	0.008 Ω - 13 Ω	0.008 Ω - 13 Ω	0.05 Ω - 80 Ω	0.15 Ω - 260 Ω	0.3 Ω - 500 Ω
Output capacitance	15980 µF	15980 µF	5040 µF	786 µF	360 µF
Efficiency (up to)	94.5% *1	94.5% *1	94.5% *1	95.5% *1	95.5% *1
Insulation					
Negative DC pole <-> PE	±600 V DC	±600 V DC	±1000 V DC	±1000 V DC	±1500 V DC
Positive DC pole <-> PE	+600 V DC	+600 V DC	+1000 V DC	+1000 V DC	+2000 V DC
Article number	06230835	06230836	06230837	06230838	06230839

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

Technical specifications	PSI 10750-40	PSI 11000-30	PSI 11500-20		
DC output					
Voltage range	0 - 750 V	0 - 1000 V	0 - 1500 V		
Ripple in CV (rms)	≤200 mV (BW 300 kHz)	≤200 mV (BW 300 kHz)	≤400 mV (BW 300 kHz)		
Ripple in CV (pp)	≤800 mV (BW 20 MHz)	≤1000 mV (BW 20 MHz)	≤2000 mV (BW 20 MHz)		
Current range	0 - 40 A	0 - 30 A	0 - 20 A		
Power range	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2	0 - 10000 W (0 - 6000 W) *2		
Resistance range	0.6 Ω - 1100 Ω	1.2 Ω - 2000 Ω	2.6 Ω - 4500 Ω		
Output capacitance	360 µF	90 µF	90 µF		
Efficiency (up to)	95.5% *1	95.5% *1	95.5% *1		
Insulation					
Negative DC pole <-> PE	±1500 V DC	±1500 V DC	±1500 V DC		
Positive DC pole <-> PE	+2000 V DC	+2000 V DC	+2000 V DC		
Article number	06230854	06230855	06230856		

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

Technical specifications	PSI 10060-510	PSI 10080-510	PSI 10200-210	PSI 10360-120	PSI 10500-90
DC output					
Voltage range	0 - 60 V	0 - 80 V	0 -200 V	0 - 360 V	0 - 500 V
Ripple in CV (rms)	≤10 mV (BW 300 kHz)	≤10 mV (BW 300 kHz)	≤40 mV (BW 300 kHz)	≤55 mV (BW 300 kHz)	≤70 mV (BW 300 kHz)
Ripple in CV (pp)	≤100 mV (BW 20 MHz)	≤100 mV (BW 20 MHz)	≤300 mV (BW 20 MHz)	≤320 mV (BW 20 MHz)	≤350 mV (BW 20 MHz)
Current range	0 - 510 A	0 - 510 A	0 - 210 A	0 - 120 A	0 - 90 A
Power range	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2
Resistance range	0.006 Ω - 9 Ω	0.006 Ω - 9 Ω	0.03 Ω - 50 Ω	0.1 Ω - 180 Ω	0.2 Ω - 330 Ω
Output capacitance	23970 µF	23970 µF	7560 µF	1179 µF	540 µF
Efficiency (up to)	94.5% *1	94.5% *1	94.5% *1	95.5% *1	95.5% *1
Insulation					
Negative DC pole <-> PE	±600 V DC	±600 V DC	±1000 V DC	±1000 V DC	±1500 V DC
Positive DC pole <-> PE	+600 V DC	+600 V DC	+1000 V DC	+1000 V DC	+2000 V DC
Article number	06230820	06230821	06230822	06230823	06230824

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

Technical specifications	PSI 10750-60	PSI 11000-40	PSI 11500-30	PSI 12000-20	
DC output					
Voltage range	0 - 750 V	0 - 1000 V	0 - 1500 V	0 - 2000 V	
Ripple in CV (rms)	≤200 mV (BW 300 kHz)	≤300 mV (BW 300 kHz)	≤400 mV (BW 300 kHz)	≤400 mV (BW 300 kHz)	
Ripple in CV (pp)	≤800 mV (BW 20 MHz)	≤1600 mV (BW 20 MHz)	≤2400 mV (BW 20 MHz)	≤2400 mV (BW 20 MHz)	
Current range	0 - 60 A	0 - 40 A	0 - 30 A	0 - 20 A	
Power range	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	0 - 15000 W (0 - 9000 W) *2	
Resistance range	0.4 Ω - 750 Ω	0.8 Ω - 1300 Ω	1.7 Ω - 3000 Ω	3.5 Ω - 5300 Ω	
Output capacitance	540 µF	131 µF	60 µF	60 µF	
Efficiency (up to)	95.5% *1	95.5% *1	95.5% *1	95.5% *1	
Insulation					
Negative DC pole <-> PE	±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	
Article number	06230825	06230826	06230827	06230828	

*1 At 100% power and 100% output voltage
*2 In AC voltage depending DC power derating mode

General

The DC laboratory power supplies in the PSI 10000 series from EA Elektro-Automatik convert the energy from the grid into a regulated DC voltage with an efficiency of over 96%. The PSI 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 ratings are determined by typical applications and the spectrum ranges from 0 - 60 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 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 PSI 10000 range.

Furthermore, typical laboratory functionality is provided. This includes an extensive function generator, alarm and warning management, various optional industrial interfaces, software solutions and many more functions.

AC connection

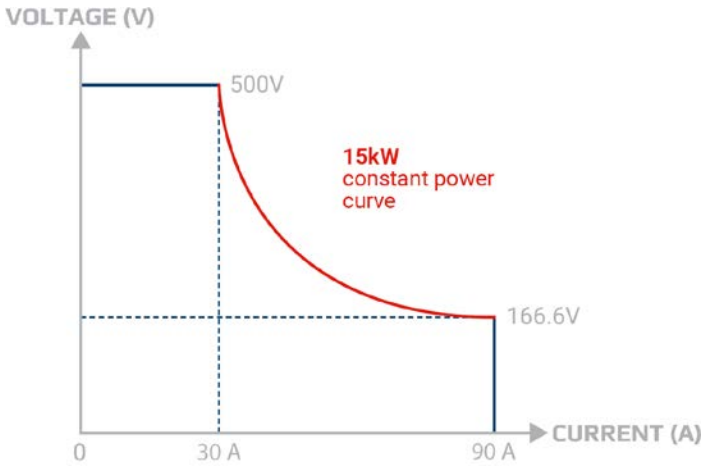
The DC power supplies in the PSI 10000 series are equipped with an active PFC which provides a high efficiency at a low energy consumption. Furthermore, the devices in this series provide a wide input voltage range. It reaches from 110/120 V up to 240 V with 1-phase models and from 208 V to 380/400/480 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.

DC output

The DC output of the power supply series PSI 10000 3U is rated for DC voltages of 0 - 60 V up to 0 - 2000 V and currents of 0 - 20 A up to 0 - 510 A. 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 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 PSI 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 960 kW. These are achieved by using the outputs of many PSI 10000 3U devices and connecting them in parallel using copper rails. A 19” cabinet with a height of 42U can hold up to 12 units of 3U and thus form a system of up to 180 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 15 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

Relay test in the production

Relay manufacturers must carry out assorted tests on their products during production. For these the coils and contacts are provided with exactly defined voltage and current. For the coil tests, important parameters such as operating, holding and decay current, together with the associated voltages must be checked and documented. For the contacts, not only are the current carrying capability and contact resistance important parameters, but also voltage consistency and disconnect threshold indicate much about the product quality. Testing all these is best supported by an automatic test system. A part of such a system can be the devices of the PSI 10000 series with their exact, dynamic, controls of voltage, current, power, and resistance, providing optimal values for the best test results. With their diverse interface connections, they can be integrated into any test system and deliver the necessary data without the need for additional measuring equipment.

Fuel cell simulation

One of further applications where programmable DC power supplies are used for is the simulation of fuel cells. It allows for optimal definition of these energy storages, as well of components powered by these fuel cells. In every application where reproducible data is required, the use of a simulator is typically first choice. This is mainly due to the various built-in mechanisms for the protection of connected consumers. 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.

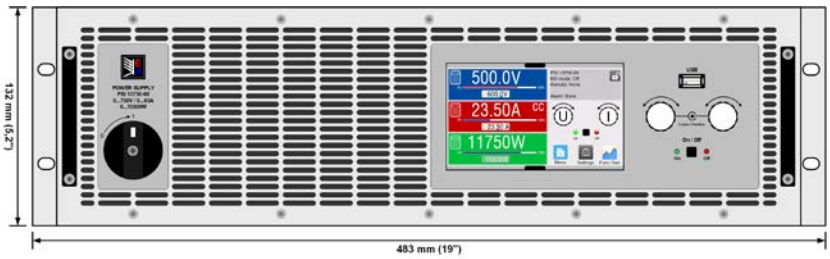
On-board charger test

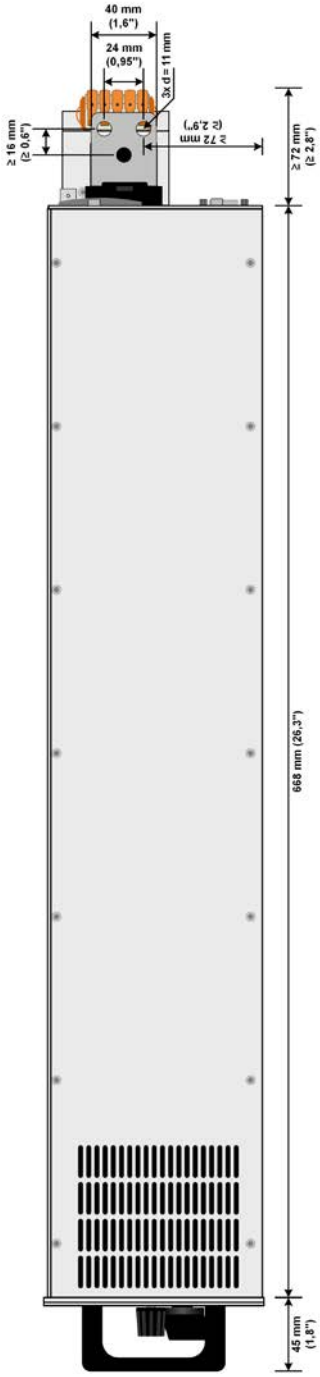
In an on-board charger test (OBC) the electrical features of the charger must be tested under various conditions. This requires a flexible test system which also provides test data. With the sequencing and logging functions of the software EA-Power Control it allows data to be exported and saved. In 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 power supply is adjustable. The modes Normal, Fast and Slow allow the PSI 10000 devices to be adapted the control characteristics of the on-board charger. Due to the fact that a power supply can only operate as a source, the combination with a sink, here an electronic DC load of ELR 10000 series, might be required.

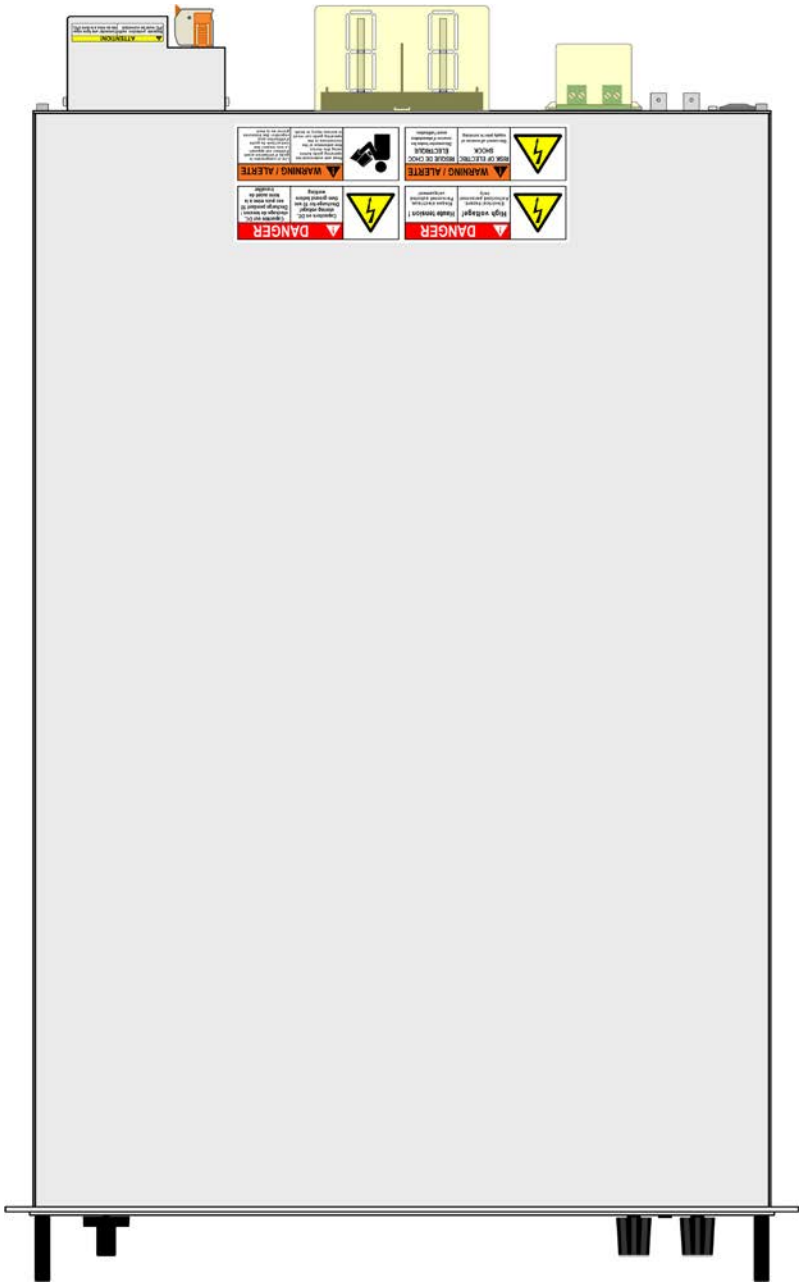
Solar array simulation

The programmable power supplies of the PSI 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.

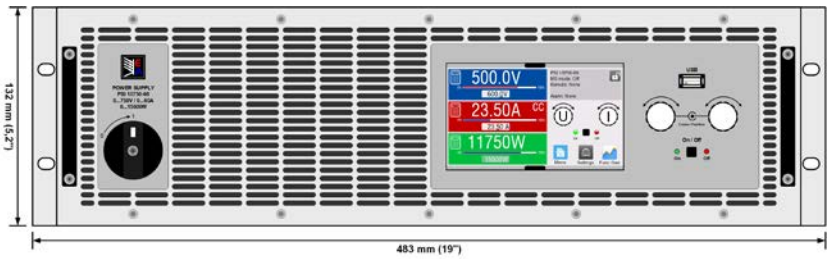
Technical drawings PSI 10000 3U ≤200 V

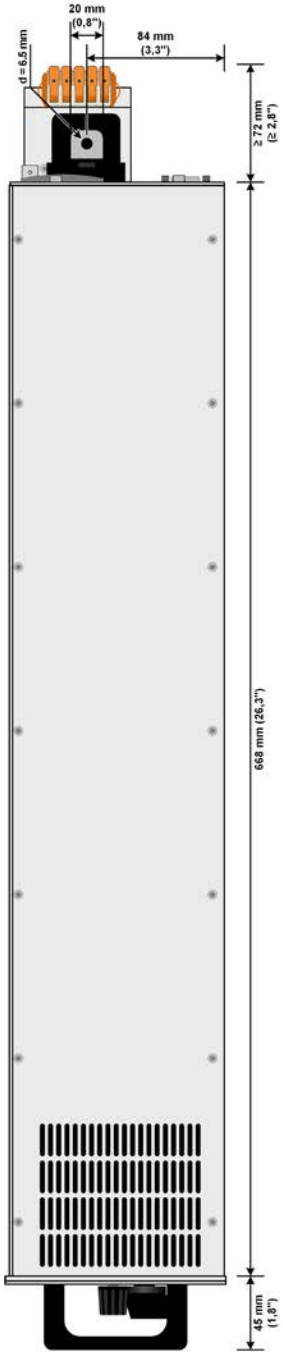


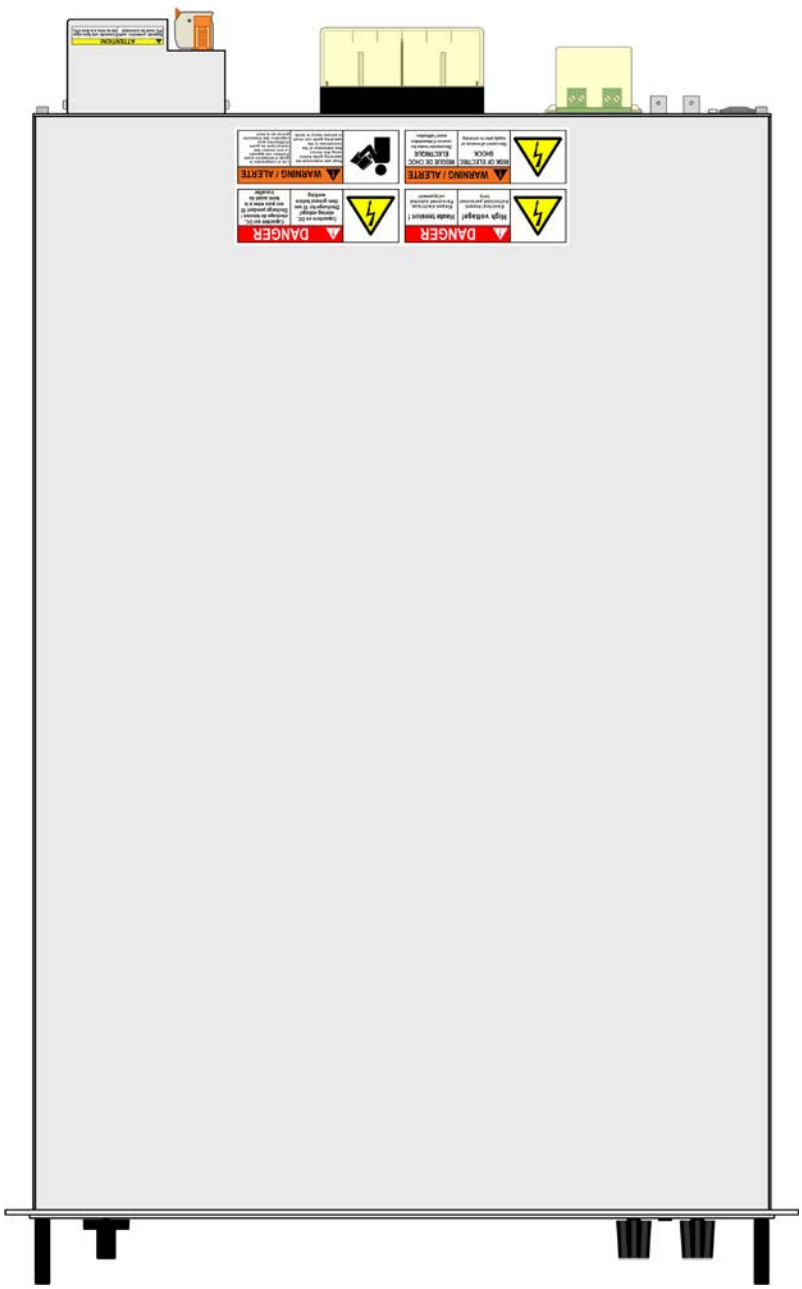




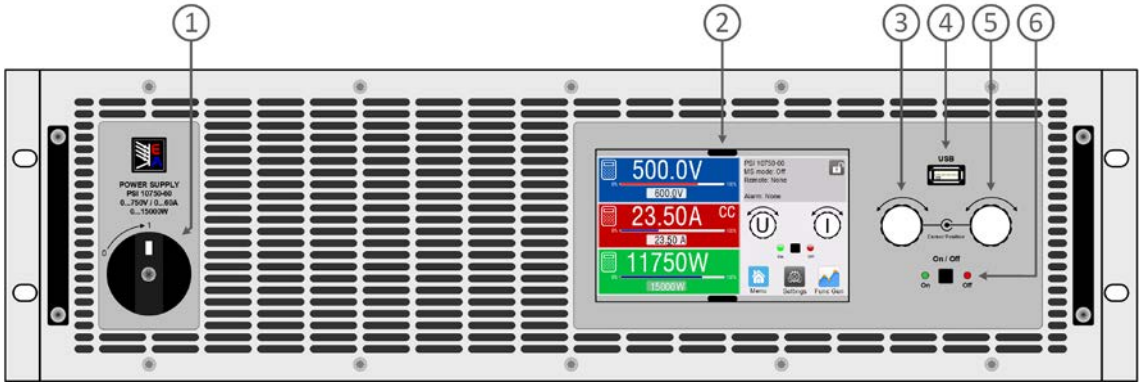
Technical drawings PSI 10000 3U ≥360 V





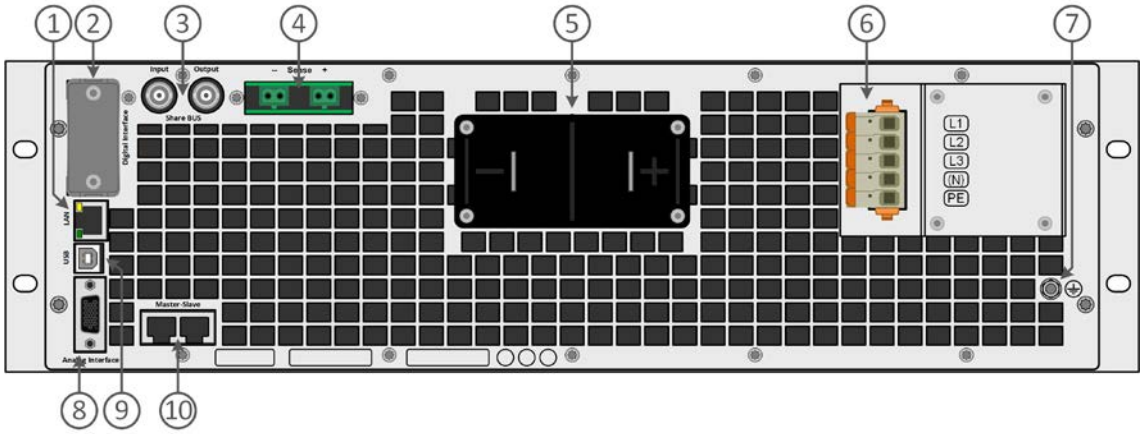


Front panel description PSI 10000 3U



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 PSI 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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