



Elektro-Automatik



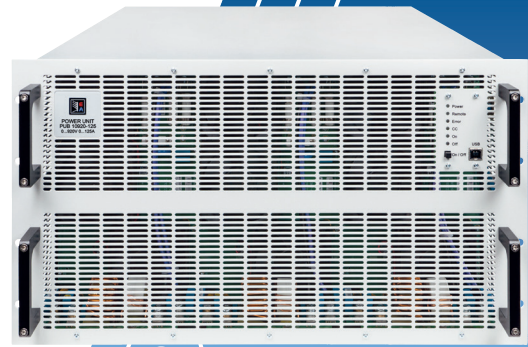
**DATASHEET**

# EA-PU 10000 6U

Programmable DC power units

# EA-PU 10000 6U 60 KW

Programmable DC power units



## Features

- Wide range input: 380 V - 480 V, +10%, 3ph AC
- Active Power Factor Correction, typical 0.99
- Very high efficiency of up to 96%
- High performance with up to 60 kW per unit
- Voltages from 0 - 360 V up to 0 - 2000 V
- Currents from 0 - 80 A up to 0 - 480 A
- Flexible power regulated DC output stages (autoranging)
- Regulation modes CV, CC, CP, CR with fast crossover
- Digital regulation, high resolution with 16 Bit ADCs and DACs, selection of voltage controller speed
- 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
- Command languages and drivers: SCPI and ModBus, LabVIEW, IVI

## Built-in interfaces

- USB
- Ethernet
- Analog
- Master-Slave-Bus
- Share-Bus
- USB (front panel)

## 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

## Options

- Water Cooling in stainless steel
- Function generator

## Technical data

| General specifications                  |  |
|---|--|
| <b>AC input</b>                         |  |
| Voltage, Phases                         | 380 V - 480 V $\pm 10\%$ , 3ph AC  |
| Frequency                               | 45 - 65 Hz   |
| Power factor                            | ca. 0.99   |
| Leakage current                         | <10 mA   |
| Inrush current *1                       | @400 V: ca. 54 A per phase   |
| Phase current *4                        | $\leq 106$ A   |
| Overvoltage category                    | III  |
| <b>DC input/output static</b>           |  |
| Load regulation CV                      | $\leq 0.05\%$ FS (0 - 100% load, at constant AC input voltage and temperature)   |
| Line regulation CV                      | $\leq 0.01\%$ FS (380 V - 480 V AC $\pm 10\%$ , at constant load and temperature)  |
| Stability CV                            | $\leq 0.02\%$ FS (during 8 h of operation, after 30 minutes warm-up, at constant AC input voltage, load and temperature) |
| Temperature coefficient CV              | $\leq 30$ ppm/ $^{\circ}$ C (after 30 minutes of warm-up)  |
| Compensation (remote sense)             | $\leq 5\%$ U <sub>Nominal</sub>  |
| Load regulation CC                      | $\leq 0.1\%$ FS (0 - 100% load, at constant AC input voltage and temperature)  |
| Line regulation CC                      | $\leq 0.01\%$ FS (380 V - 480 V AC $\pm 10\%$ , at constant load and temperature)  |
| Stability CC                            | $\leq 0.02\%$ FS (during 8 h of operation, after 30 minutes warm-up, at constant AC input voltage, load and temperature) |
| Temperature coefficient CC              | $\leq 50$ ppm/ $^{\circ}$ C (after 30 minutes of warm-up)  |
| Load regulation CP                      | $\leq 0.3\%$ FS (0 - 100% load, constant AC input voltage and constant temperature)                                      |
| Load regulation CR                      | $\leq 0.3\%$ FS + 0.1% FS of current (0 - 100% load, constant AC input voltage and constant temperature)                 |
| <b>Protective functions</b>             |  |
| OVP                                     | Overvoltage protection, adjustable 0 - 110% U <sub>Nominal</sub>   |
| OCP                                     | Overcurrent protection, adjustable 0 - 110% I <sub>Nominal</sub>   |
| OPP                                     | Overpower protection, adjustable 0 - 110% P <sub>Nominal</sub>   |
| OT                                      | Overtemperature protection (DC terminal shuts down in case of insufficient cooling)                                      |
| <b>DC input/output dynamic</b>          |  |
| Rise time 10 - 90% / Fall time 90 - 10% | CV *2: $\leq 10$ ms<br>CC *3: $\leq 2$ ms  |
| <b>Measurement accuracy</b>             |  |
| Voltage                                 | $\leq 0.05\%$ FS   |
| Current                                 | $\leq 0.1\%$ FS  |
| <b>Insulation</b>                       |  |
| AC input to DC terminal                 | 3750 Vrms (1 minute, creepage distance >8 mm)  |
| AC input to case (PE)                   | 2500 Vrms  |
| DC terminal to case (PE)                | Depending on the model, see model tables   |
| DC terminal to interfaces               | 1000 V DC (360 V model), 1500 V DC (models from 500 V output)  |
| <b>Interfaces digital</b>               |  |
| Built-in, galvanically isolated         | USB, Ethernet (100 MBit), USB front panel, all for communication   |
| Optional, galvanically isolated         | CAN, CANopen, RS232, ModBus TCP, Profinet, Profibus, EtherCAT, Ethernet  |
| <b>Interface analog</b>                 |  |
| 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 input/output on/off, resistance mode on/off  |
| Outputs                                 | Monitor U and I, alarms, reference voltage, DC input/output status, CV/CC regulation mode                                |
| Accuracy U / I / P / R                  | 0 - 10 V: $\leq 0.2\%$ , 0 - 5 V: $\leq 0.4\%$   |

\*1 Calculated for the peak value of the stated voltage including 10% tolerance, at 23°C ambient and first switch-on (cold start)

\*2 Valid for power supplies, unidirectional or bidirectional, in source mode operation

\*3 Valid for electronic loads or bidirectional power supplies in sink mode operation

\*4 Calculated for the default AC supply voltage in the stated range, minus 10% tolerance, at maximum output power and 10% power loss from AC to DC

| General specifications    |  |
|---------------------------|--|
| Device configuration      |  |
| Parallel operation        | Up to 64 units of any power class in series 10000 starting from 5 kW, with Master-Slave bus and Share-Bus  |
| Safety and EMC            |  |
| Safety                    | EN 61010-1<br>IEC 61010-1<br>UL 61010-1<br>CSA C22.2 No 61010-1<br>BS EN 61010-1   |
| EMC                       | EN 55011, class A, group 1<br>CISPR 11, class A, group 1<br>FCC 47 CFR part 15B, unintentional radiator, class A<br>EN 61326-1 include tests according to:<br>- EN 61000-4-2<br>- EN 61000-4-3<br>- EN 61000-4-4<br>- EN 61000-4-5<br>- EN 61000-4-6 |
| Appliance class           | I  |
| Ingress Protection        | IP20   |
| Environmental conditions  |  |
| Operating temperature     | 0 - 50 °C (32 - 122 °F)  |
| Storage temperature       | -20 - 70 °C (-4 - 158 °F)  |
| Humidity                  | ≤80% relative humidity, non-condensing   |
| Altitude                  | ≤2000 m (≤6,600 ft)  |
| Pollution degree          | 2  |
| Mechanical construction   |  |
| Cooling                   | Forced air flow from front to rear (temperature controlled fans), optional: water cooling  |
| Dimensions (W x H x D)    | Enclosure: 483 mm (19 in) x 266 mm (6U) x 668 mm (26.3 in)<br>Overall depth: min. 818 mm (min. 32.2 in)  |
| Weight                    | 76 kg (168 lb)   |
| Weight with water cooling | 82 kg (180 lb)   |

| Technical specifications | PU 10360-480            | PU 10500-360            | PU 10750-240             | PU 10920-250             |
|--------------------------|-------------------------|-------------------------|--------------------------|--------------------------|
| <b>DC output</b>         |                         |                         |                          |                          |
| Voltage range            | 0 - 360 V               | 0 - 500 V               | 0 - 750 V                | 0 - 920 V                |
| Ripple in CV (rms)       | ≤55 mV (BWL 300 kHz *1) | ≤70 mV (BWL 300 kHz *1) | ≤200 mV (BWL 300 kHz *1) | ≤250 mV (BWL 300 kHz *1) |
| Ripple in CV (pp)        | ≤320 mV (BWL 20 MHz *1) | ≤350 mV (BWL 20 MHz *1) | ≤800 mV (BWL 20 MHz *1)  | ≤1200 mV (BWL 20 MHz *1) |
| Current range            | 0 - 480 A               | 0 - 360 A               | 0 - 240 A                | 0 - 250 A                |
| Power range              | 0 - 60000 W             | 0 - 60000 W             | 0 - 60000 W              | 0 - 60000 W              |
| Resistance range         | 0.025 Ω - 45 Ω          | 0.04 Ω - 85 Ω           | 0.1 Ω - 185 Ω            | 0.125 Ω - 275 Ω          |
| Output capacitance       | 3480 µF                 | 1560µF                  | 765 µF                   | 465 µF                   |
| Efficiency (up to)       | 95.8% *2                | 96.5% *2                | 96.5% *2                 | 96.5% *2                 |
| <b>AC input</b>          |                         |                         |                          |                          |
| P <sub>Max</sub>         | 63 kW                   | 63 kW                   | 63 kW                    | 63 kW                    |
| <b>Insulation</b>        |                         |                         |                          |                          |
| Negative DC pole <-> PE  | ±1000 V DC              | ±1500 V DC              | ±1500 V DC               | ±1500 V DC               |
| Positive DC pole <-> PE  | +1000 V DC              | +2000 V DC              | +2000 V DC               | +2000 V DC               |
| <b>Article numbers</b>   |                         |                         |                          |                          |
| Standard                 | 01113010                | 01113011                | 01113012                 | 01113013                 |
| Standard + Water Cooling | 01463001                | 01463002                | 01463003                 | 01463004                 |

| Technical specifications | PU 11000-160             | PU 11500-120             | PU 12000-80              |  |
|--------------------------|--------------------------|--------------------------|--------------------------|--|
| <b>DC output</b>         |                          |                          |                          |  |
| Voltage range            | 0 - 1000 V               | 0 - 1500 V               | 0 - 2000 V               |  |
| Ripple in CV (rms)       | ≤300 mV (BWL 300 kHz *1) | ≤400 mV (BWL 300 kHz *1) | ≤500 mV (BWL 300 kHz *1) |  |
| Ripple in CV (pp)        | ≤1600 mV (BWL 20 MHz *1) | ≤2400 mV (BWL 20 MHz *1) | ≤3000 mV (BWL 20 MHz *1) |  |
| Current range            | 0 - 160 A                | 0 - 120 A                | 0 - 80 A                 |  |
| Power range              | 0 - 60000 W              | 0 - 60000 W              | 0 - 60000 W              |  |
| Resistance range         | 0.2 Ω - 325 Ω            | 0.4 Ω - 750 Ω            | 0.85 Ω - 1350 Ω          |  |
| Output capacitance       | 387 µF                   | 173 µF                   | 85 µF                    |  |
| Efficiency (up to)       | 95.8% *2                 | 96.5% *2                 | 96.5% *2                 |  |
| <b>AC input</b>          |                          |                          |                          |  |
| P <sub>Max</sub>         | 63 kW                    | 63 kW                    | 63 kW                    |  |
| <b>Insulation</b>        |                          |                          |                          |  |
| 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               |  |
| <b>Article numbers</b>   |                          |                          |                          |  |
| Standard                 | 01113014                 | 01113015                 | 01113016                 |  |
| Standard + Water Cooling | 01463005                 | 01463006                 | 01463007                 |  |

\*1 BWL = Bandwidth limit on the measuring oscilloscope  
\*3 At 100% power and 100% output voltage

## General

The DC power supplies in the PU 10000 series from EA Elektro-Automatik convert the energy from the grid into a regulated DC voltage with an efficiency up to over 96%. The PU 10000 series are 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 - 60 V to 0 - 2000 V and from 0 - 40 A up to 0 - 1000 A in a single device. The DC supply operates as a flexible output stage with a constant power characteristic (autoranging) with a wide voltage and current range. To achieve higher power and current all units are equipped with a Master-Slave-Bus. This enables up to 64 parallel connected devices to be combined into one system which can provide up to 3840 kW and 64000 A. Such a system works as a single unit and can use different power classes start from 5kW, only the voltage class must remain constant. In this way a user can construct a 150 kW system from two 60 kW 6U and one 30 kW 4U device from the PU 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

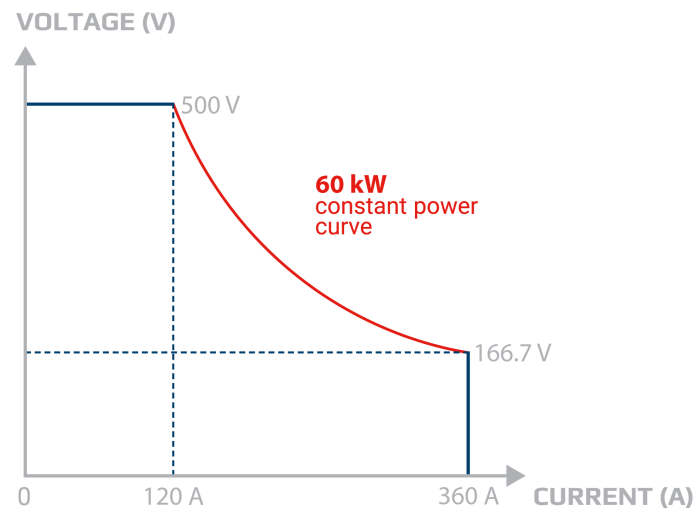
The DC power supplies in the PU 10000 series with 60 kW are equipped with an active PFC which provides a high efficiency at a low energy consumption. Furthermore, the devices in this series provide a wide input voltage range. It reaches from 380 - 480 V with 3-phases. Hence the devices can be operated in the majority of global grids.

## DC output

The output of the power supply PU 10000 6U with 60 kW with a DC voltage of 0 - 360 V up to 0 - 2000 V allows currents of 0 - 80 A up to 0 - 480 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 via a copper rail on the back side of the device. If a system with higher performance is required, the devices are simply connected in parallel. With minimal effort devices can be linked with the vertical copper rails. A cover for contact protection is provided.



## The principle of autoranging

„Autoranging“ is a term when a programmable DC power supply automatically offers a wide output range of both, voltage and current, to maintain full power across a wide operation range. This type of solution allows the use of a single unit to address multiple voltage and current combinations.

## Interfaces

As standard, 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 3840 kW. These are achieved by using the DC outputs of multiple PU 10000 devices with vertical copper rails in parallel. Thus, a 19" cabinet with 42 U can provide a system with 300 kW occupying only 0.6 m<sup>2</sup> (6.5 sqft) of floor space. The Master-Slave-Bus allows for up to 13 cabinets with a maximum of 64 units with 60 kW each to behave as one unit.

## Master-slave bus and Share-Bus

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



## Example representation

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



## Applications

### 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.

### Power supply for electrolysis

Hydrogen is considered as an important energy carrier to counter climate change. It can be used to power cars, trucks and even aircrafts. In addition, hydrogen can be used as an energy carrier for a wide range of industrial processes. Green and therefore climate-neutral hydrogen is produced by electrolysis. The programmable power supplies of the PU 10000 series are ideally suited as energy supply systems for the electrolysis process. Systems of up to 3.84 MW can be set up by parallel connection, either in air-cooled or water-cooled versions. The systems are characterized by good accuracy and dynamics and can be operated in different control modes (CC, CP, CV). In addition, the high efficiency and the excellent reliability of the units help to reduce the production costs of hydrogen production.

### Electric car components

The programmable power supplies of the PU 10000 series can be used to test a wide range of components installed in an electric car, such as fuses, relays, traction inverters or DC-DC converters. The integrated function generator allows real load profiles to be mapped and thus realistic test results to be achieved. In addition, the built-in autoranging functionality offers maximum flexibility when testing a wide range of components.

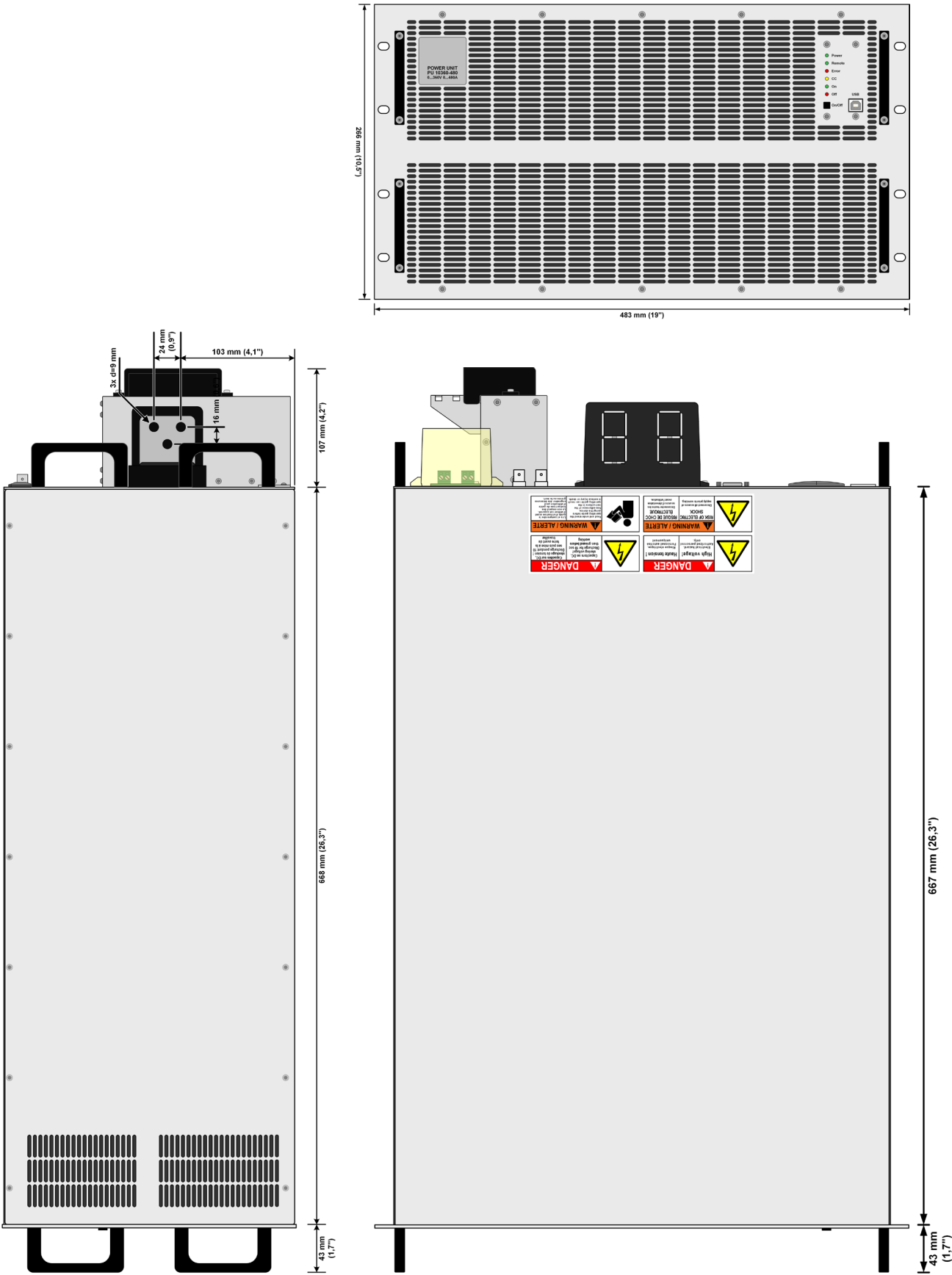
### Solar array simulation

The programmable power supplies of the PU 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.

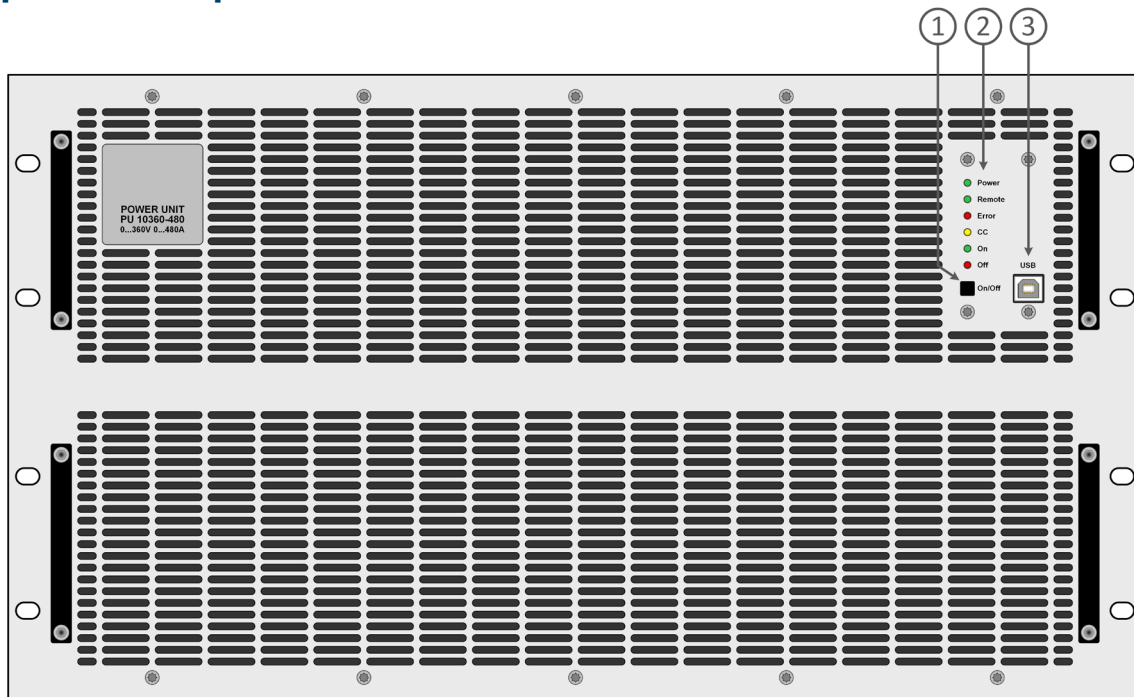
### Relay test in the production

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 PU 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.

Technical drawings PU 10000 6U

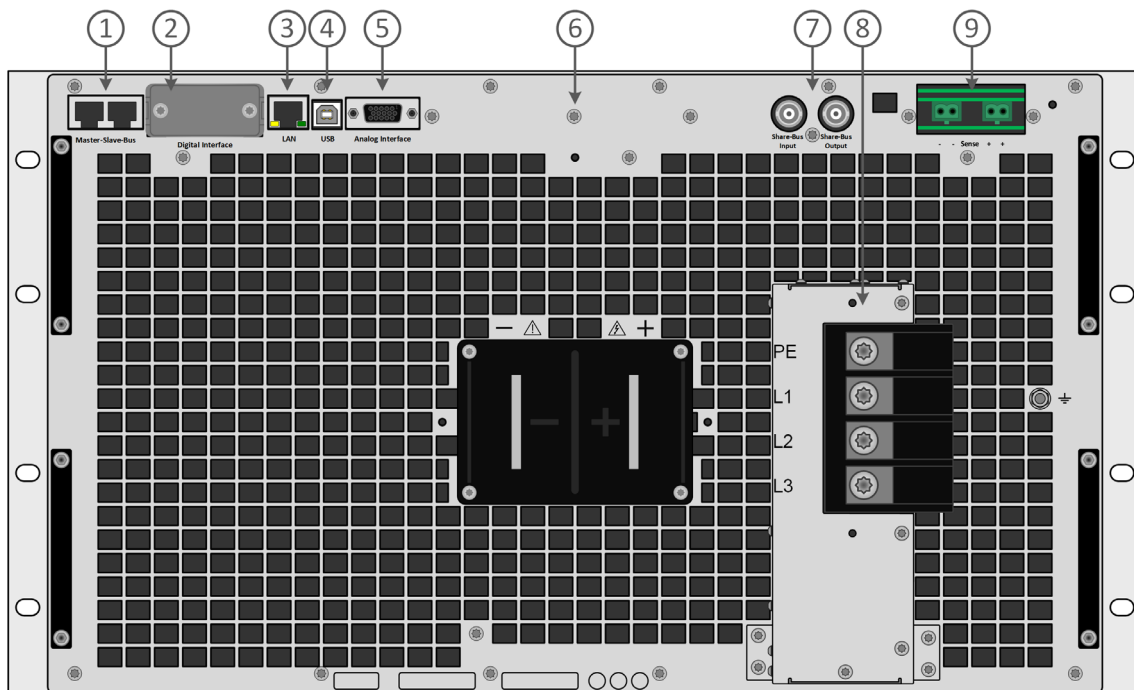


## Front panel description PU 10000 6U



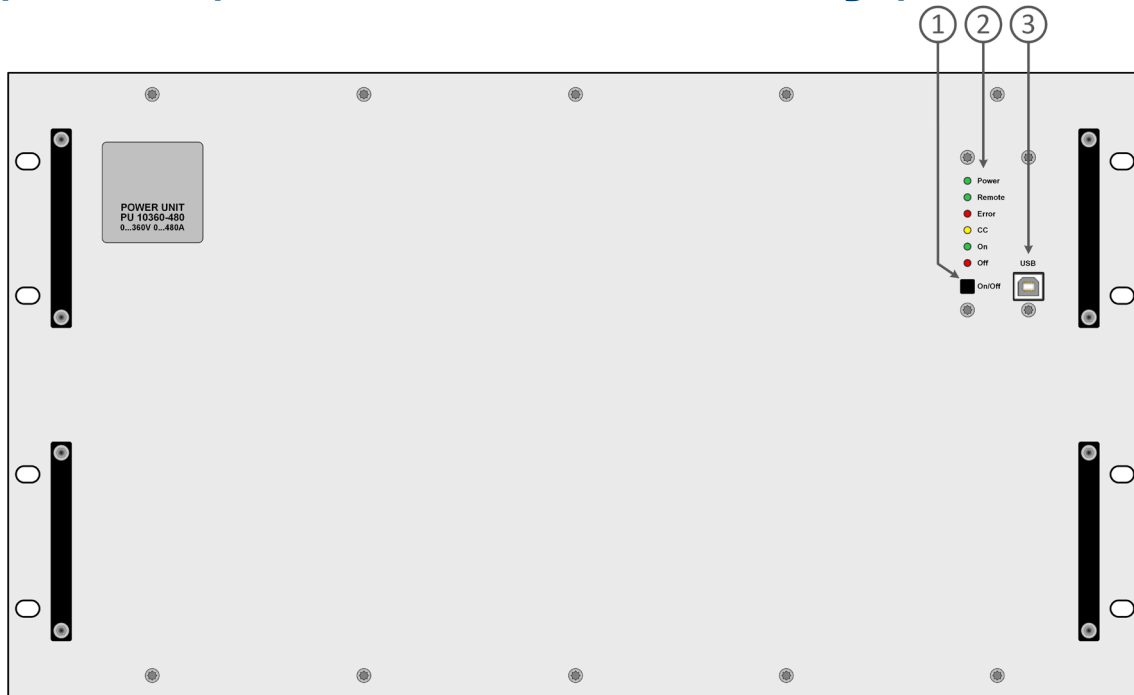
1. On / Off push-button
2. LED status display
3. USB Interface

## Rear panel description PU 10000 6U



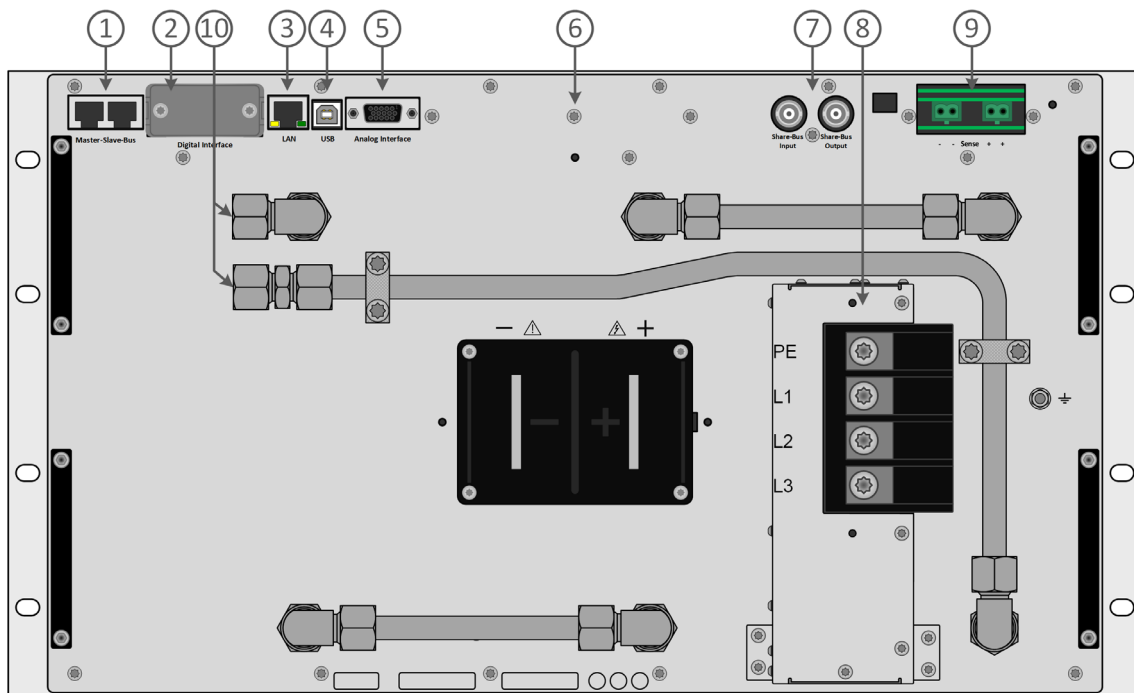
1. Master-Slave-Bus connectors to set up a system for parallel connection
2. Slot for interfaces
3. Ethernet interface
4. USB interface
5. Connector (DB15 female) for isolated analog programming, monitoring and other functions
6. DC output connector (copper blades)
7. Share-Bus connectors to set up a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

## Front panel description PU 10000 6U WC (water cooling option)



1. On / Off push-button
2. LED status display
3. USB Interface

## Rear panel description PU 10000 6U WC (water cooling option)



1. Master-Slave-Bus connectors to set up a system for parallel connection
2. Slot for interfaces
3. Ethernet interface
4. USB interface
5. Connector (DB15 female) for isolated analog programming, monitoring and other functions
6. DC output connector (copper blades)
7. Share-Bus connectors to set up a system for parallel connection
8. AC input connector
9. Remote sense connectors
10. Water inlet and outlet

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