



Sunny Mini Central 5000/6000

Central inverter for homogeneous PV-plants



Explanation of Symbols used in this Document

This symbol indicates information that is essential for a trouble-free and safe operation of the product. Please read these sections carefully in order to avoid any damages of the equipment and for optimal personal protection.



This symbol indicates information that is required for the optimal operation of the product. Read these sections carefully in order to ensure an optimal operation of the product and all its features.



This symbol indicates an example.



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1 Introduction

The installation of the Sunny Mini Central may only be done by qualified technicians. The installer must be approved by the utility company. Please read the installation guide carefully before you begin with the installation. The installation of utility interactive power sources must be compliant with all applicable regulations of the utility company and with all applicable regulations and standards.



The Sunny Mini Central 5000/6000 is equipped with the SMA grid guard. This is a type of independent disconnection device. It ensures that the Sunny Mini Central 5000/6000 complies with the VDEW (Verband der Elektrizitätswirtschaft – German Electricity Industry Association) regulations for the connection and parallel operation of electrical power units to the low-voltage grid of the electricity supply company and with DIN VDE 0126 (4.99) which is a part of these regulations.



This installation manual is intended solely for qualified electricians. Its aim is to help install and set up SMA Sunny Mini Central 5000/6000 inverters quickly and correctly.

For detailed information on troubleshooting and on how to use the Sunny Mini Central 5000/6000, including information about the different communication options, please see the operating instructions.

The „Sunny Design“ tool will help to dimension and check the size of your strings with respect to the inverter you intend to use. Further information about „Sunny Design“ is available at www.SMA.dSunnyMiniCentralSunnyMiniCentrale.

If you require further information, please call the Sunny Mini Central hotline on the following number:

+49 561 95 22 - 499

2 Safety Instructions



Check your plant configuration and the string sizing with „Sunny Design“ (available at www.SMA.de) or with the Sunny Mini Central Hotline before you start with the installation. Exceeding the specifications with the input voltage will destroy the Sunny Mini Central. Overvoltage on the DC side can even cause dangerous explosions of the Sunny Mini Centrals input capacitors and explosions of the electrolytes coming from the exploded capacitors.



Work on the Sunny Mini Central with the lid removed must be carried out by a qualified electrician. Hazardous and even lethal voltages can be encountered within the enclosure. Before working on the Sunny Mini Central with the lid removed, the AC and DC voltages **MUST** be disconnected from the Sunny Mini Central and it must be sure that all capacitors are discharged.



The Sunny Mini Central must be disconnected from the mains and precautions must be taken to prevent the grid being reconnected. In addition, the connections to the PV generator must be disconnected.

After isolating the AC and DC voltage you must wait approx. 30 minutes for the capacitors in the Sunny Mini Central to discharge. Only then is it safe to open the unit by removing the lid. You must also make sure that no voltage is present in the device.

The electronics inside your Sunny Mini Central 5000/6000 is vulnerable in terms of electrostatic discharge. Be sure to be connected to ground (e.g. the enclosure of the Sunny Mini Central) before handling anything within the enclosure of the Sunny Mini Central.



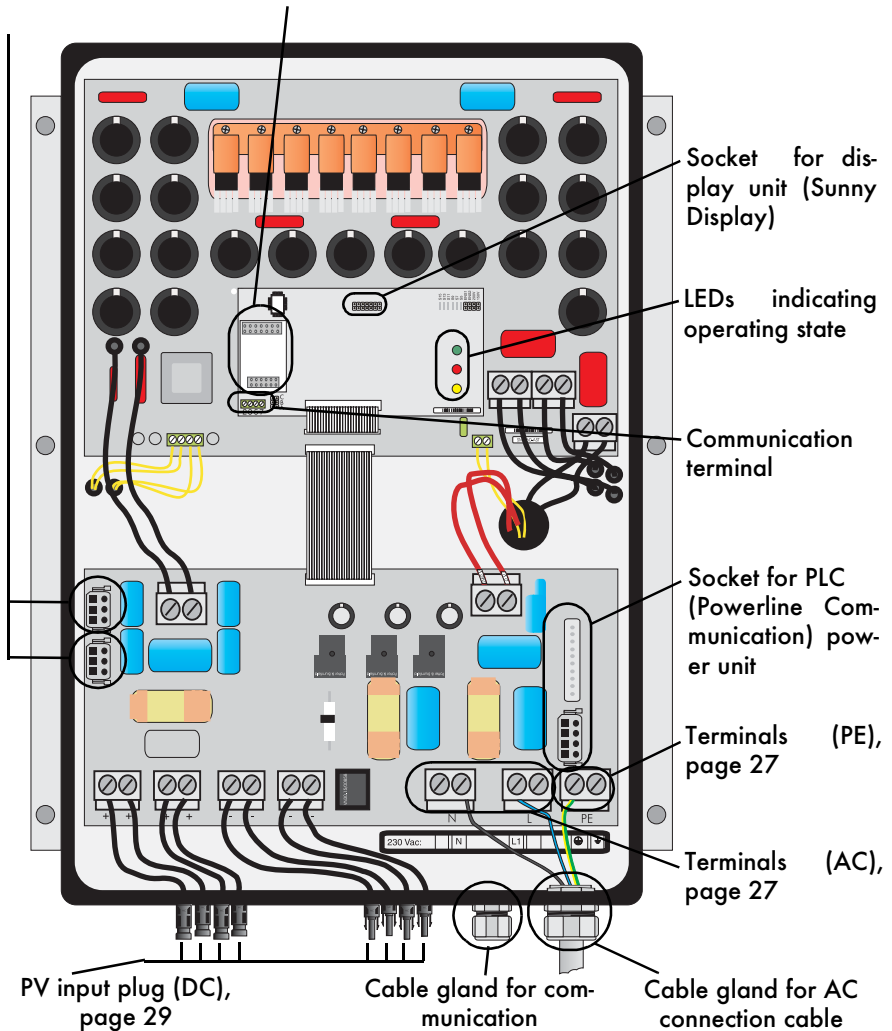
3 Overview

3.1 Device Description

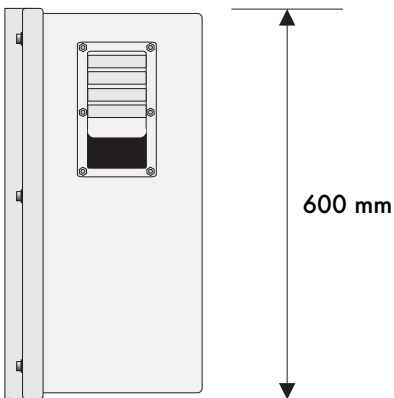
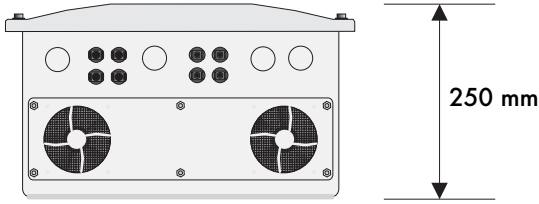
The following figure shows the different components and connection areas of an open Sunny Mini Central 5000/6000 inverter.

Varistors
page 47

Communication socket (RS232,
RS485, NLM Piggy-Back, radio)



3.2 External Dimensions



3.2.1 OptiCool Temperature Management

With the patented dual compartment cooling system OptiCool, SMA now offers a technical solution combining both passive and active cooling systems. An "intelligent temperature management" is the result.

In order to achieve maximum efficiency the whole enclosure of the inverter becomes part of the cooling system. It does not only contain and protect the components but also functions as a "cooling air distributor" and heat distributor.

The actual heat sink, as central component of the passive heat dissipation, is positioned within the enclosure in such a way as to divide it into two compartments. The highly sensitive electronics separated from the main heat sources by the heat sink is securely protected from external influences, such as moisture and dirt, in the front waterproof compartment.

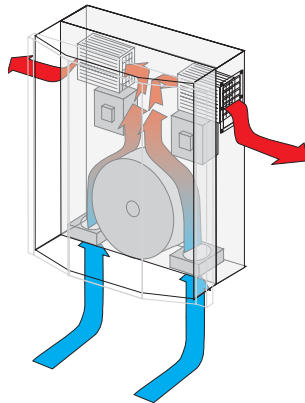
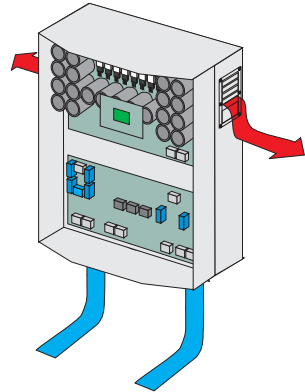
In the rear part, the temperature-intensive components, such as chokes and transformers, which are either separately sealed or are intensive to ambient influences, are installed.

A specifically designed active cooling system is positioned on the bottom of the rear compartment. Depending on the temperature of the power semiconductors and the inductive components it is automatically activated and adjusts its speed according to the requirements of a balanced heat dissipation within the device.

The air stream produced by the fans is effectively canalized through a stream tunnel. It dissipates the waste heat of the heat sink as well as the components installed in this part.

Using OptiCool reduces the components' temperature in the entire inverter resulting in high reliability and excellent overload performance. The efficiency of the inverter and thus of the entire PV plant can therefore be increased.

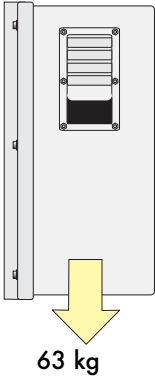
Using a dual compartment system with a waterproof area for the electronics makes the inverter suitable for inside as well as outside installation (near the PV generator).



4 Requirements for the Installation

Please make sure to fulfill all conditions below before installing and commissioning the Sunny Mini Central 5000/6000.

4.1 Requirements: Mounting Place



The Sunny Mini Central 5000/6000 has a relatively high weight of 63 kg. Please keep this in mind when selecting the place where and how to mount the Sunny Mini Central 5000/6000.

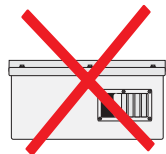
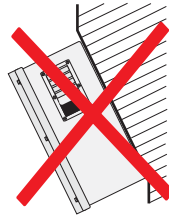
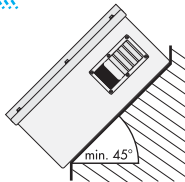
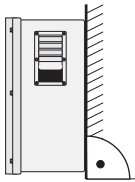
The ambient temperature must be within -25°C and $+60^{\circ}\text{C}$.



The Sunny Mini Central 5000/6000 should be installed at a place where it is not exposed to direct sunlight - otherwise this may reduce the yield of the PV plant due to the higher temperature.

The Sunny Mini Central is designed to be mounted on a vertical wall. For an optimum energy yield and the most convenient operation, vertical installation at eye-level is preferable. In case it is absolutely necessary to tilt the Sunny Mini Central to the back the maximum angle is 45° . If installing the unit outdoors, make sure that it is not slanting forwards. We advise against installing the unit in a horizontal position outdoors.

It is not recommended to install the Sunny Mini Central lying on the back side with the lid facing upwards.



Mount the Sunny Mini Central in a vertical position or with a slight angle to the back.

Do not mount the Sunny Mini Central with an angle to the front or on the back.

Important for the selection of the location:



Unintended removal of the PV plug connectors can damage the connectors and even result in serious injuries. Install the Sunny Mini Central 5000/6000 at a place where an unintended removal of the PV plug connectors (e. g. by children) is not possible.



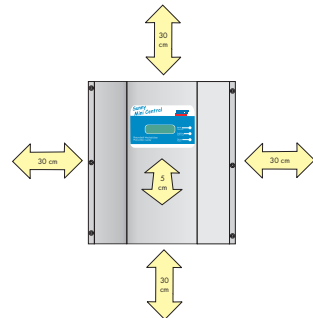
Individual components in the Sunny Mini Central can reach a temperature of more than 60 °C.



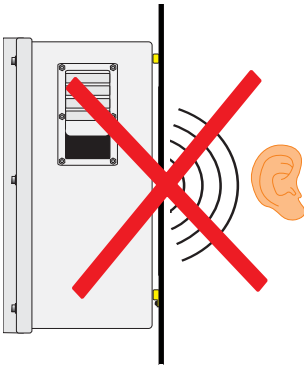
Do not install the Sunny Boy on flammable construction materials, in areas where highly inflammable materials are stored or in potentially explosive environments!

Please make sure there is a sufficient space for heat dissipation! In a normal environment the following clearances should be provided for the Sunny Mini Central 5000/6000:

	Minimum clearances
Lateral	30 cm
Top	30 cm
Bottom	30 cm
Front	5 cm



If you decide to install the Sunny Mini Central 5000/6000 in an area with high ambient temperatures, you should enlarge the clearances. Otherwise the Sunny Mini Central 5000/6000 could take air in from the devices next to it. Ensure sufficient ventilation.



In a living area the Sunny Mini Central 5000/6000 should not be mounted on plaster panels etc. in order to avoid noises.

We recommend to install the inverter on a firm and sturdy surface.

The Sunny Mini Central 5000/6000 will emit a slight noise during operation. This noise can be annoying when the Sunny Mini Central is installed within a living area.

4.2 Requirements: PV-Modules

The Sunny Mini Central 5000/6000 is designed for the connection of large scales with homogeneous structure (PV modules of the same type, same direction and slant).

The „Sunny Design“ tool will help to dimension and check the size of your strings with respect to the inverter you intend to use. The „Sunny Design“ tool is available for download at www.SMA.de.

The device has eight PV plug connectors (two for each string). The connecting cables of the PV panel therefore have to be equipped with such plug connectors as well. A connection kit for the connection of loose cable ends in a string can be purchased as an accessory. In the following you find the SMA order numbers for the different PV plug connectors:

- Multi-Contact 3 mm: „SWR-MC“
- Multi-Contact 4 mm: „MC-SET“
- Tyco: „TYCO-SET“

Limits for DC input	
max. voltage	600 V (DC)
max. input current	26 A (DC)



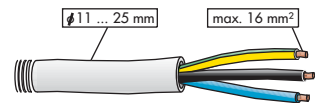
The strings are connected in parallel inside the Sunny Mini Central 5000/6000. Check if the cabling of the generator can handle high short-circuit currents. See also chapter 5.3 „Reverse Current“ (page 30).

4.3 String sizing of Sunny Mini Central PV plants

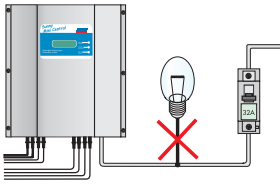
Different from the Sunny Mini Centrals you are able to connect three or more strings in parallel to the Sunny Mini Central 5000/6000. This sounds not very critical, but a consequence is that failures which are not harmful in string plants have to be considered in plants with big generators: Because of short circuits. See also chapter 5.3 „Reverse Current“ (page 30).

4.4 Requirements: Grid 230 V (AC)

The relevant technical regulations as well as specific requirements defined by the local public utility have to be complied with. The terminals of the Sunny Mini Central 5000/6000 are suitable for cables with a cross-section of up to 16 mm². Their outer diameter should be between 11 mm and 25 mm. If you choose a cable with a diameter less than 14 mm (at least 11 mm), you have to change the rubber grommet of the connection. A smaller rubber grommet is included in the shipping box.



The Sunny Mini Central 5000/6000 is connected with three wires (L, N, PE).



Each connection to a Sunny Mini Central 5000/6000 must be equipped with a separate circuit breaker 40 A. No other consumers may be connected to the cable.



Sizing of a circuit breaker for the AC line of a photovoltaic inverter for utility interaction

Several factors have to be considered when you define the size of the circuit breaker for your PV plant:



- Cable type (material and isolation)
- Ambient temperature surrounding the cable (higher temperatures reduce the conducting capacity of the cable)
- Type of installation for the cable (can also reduce the conducting capacity of the cable)
- Bundling of cables (can reduce the conducting capacity of the cable)
- Loop impedance [Z] (reduces the current that flows in case of a ground fault current through a body and has influence on the tripping characteristics of the circuit breaker)
- Adequate clearance between the circuit breakers in order to avoid excessive heating (automatic circuit breakers trip earlier when they are warmer).
- Fuse selectivity
- Protection class of the connected consumer (VDE 0100 Part 410 "Protection against electric shock"^a and/or the international standard IEC 60364-4-41:1992)

The following standards have to be complied with:



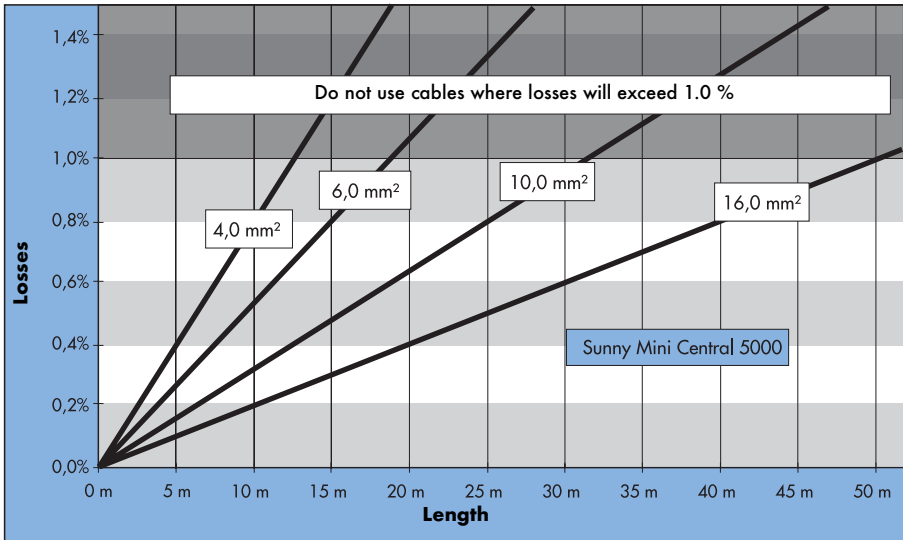
- DIN VDE 0298-4 ("Types of cable installation and conducting capacity")
- DIN VDE 0100 Part 430 ¹ ("Protection measures for protection of cables and conductors in terms of overcurrent") and/or the international standard IEC 364-4-43:1977 and IEC 364-4-473:1977
- VDE 0100 Part 410 ¹ ("Protection against electric shock") and/or the international standard IEC 60364-4-41:1992

-
- a. The standards mentioned above are to be only used as a guideline for your installation. The above mentioned standards apply for installations in Germany. Please note that other standards will apply for different countries throughout the world.

An example for determining the rating of the AC circuit breaker is specified in detail in chapter 10 „Sizing of a Circuit Breaker“ (page 51).

The system impedance at the installation site of the Sunny Mini Central 5000/6000 must be less than 1 Ohms for the islanding detection and the fuses to work properly. Furthermore you should have a suitable cable cross-section in order to keep the losses below 1 % at nominal power. The according losses with respect to cable length and cross-section are illustrated below:

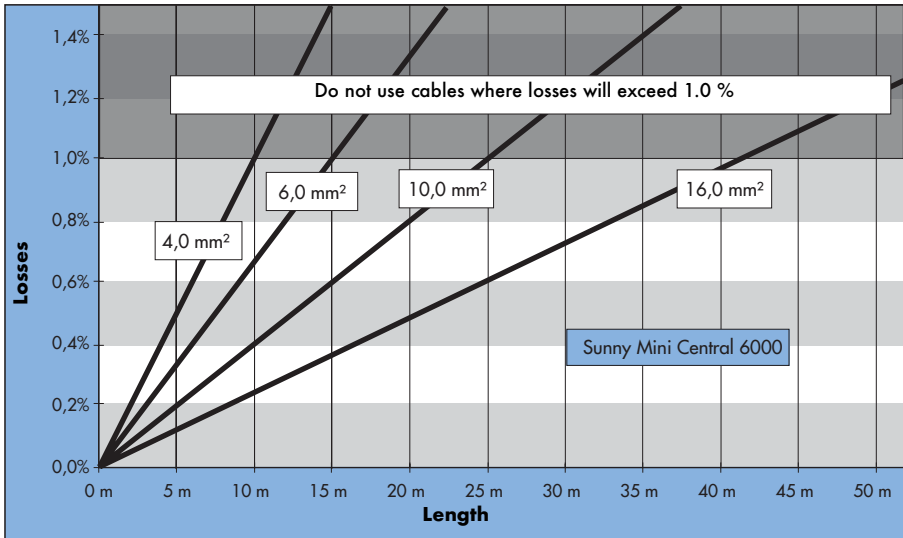
Losses of the Sunny Mini Central 5000



The maximum cable lengths for the different cable cross-sections are as follows:

Conductor cross-section	4.0 mm ²	6.0 mm ²	10.0 mm ²	16.0 mm ²
Max. length	12 m	18 m	31 m	49 m

Losses of the Sunny Mini Central 6000



The maximum cable lengths for the different cable cross-sections are as follows:

Conductor cross-section	4.0 mm ²	6.0 mm ²	10.0 mm ²	16.0 mm ²
Max. length	10 m	15 m	25 m	41 m

The Sunny Mini Central 5000/6000 is designed for 230 V grids. The voltage should be within 198 V and 260 V and the frequency should be within 49.8 Hz and 50.2 Hz. All settings shown below are based on the German standard DIN VDE 0126. You are also able to use other settings.

	Limits for AC output
Voltage range	198 V ... 260 V
Frequency range	49.8 Hz ... 50.2 Hz
Voltage range (without anti-islanding)	180 V ... 260 V
Frequency range (without anti-islanding)	45.5 Hz ... 54.5 Hz

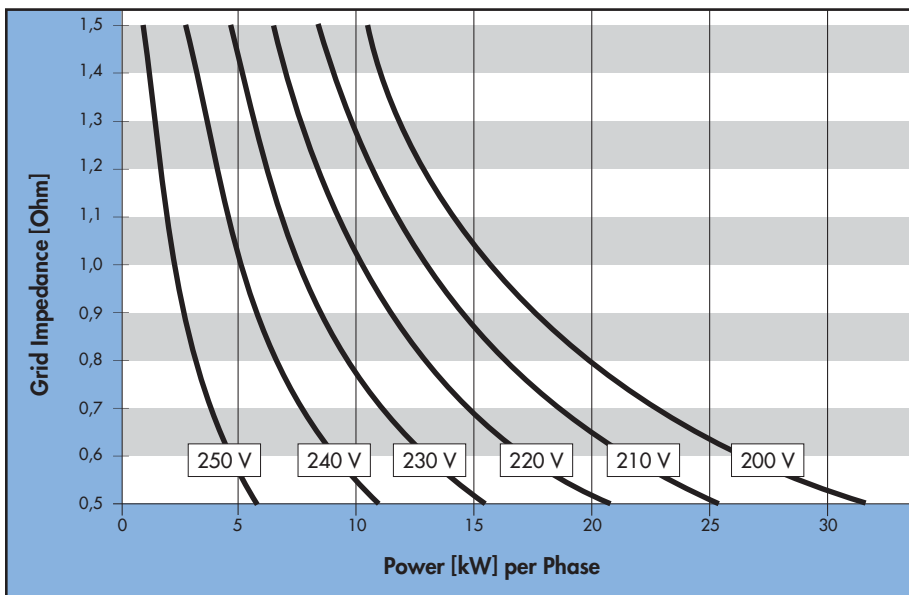
The Sunny Mini Central 5000/6000 is equipped with an automatic 50 Hz / 60 Hz utility frequency detection. It can therefore be connected to a 50 Hz or 60 Hz utility without any further configuration changes. Pay attention to the local utility regulations in any case.

Grid Impedance

In the following example the output power (U_{ac}) is reduced to 260 V. You are also able to reduce the output power of the Sunny Mini Central 5000/6000 according to the national standards.

Because of a high grid impedance the Sunny Mini Central 5000/6000 can receive a high AC voltage at the connection point. The output voltage (U_{ac}) of the Sunny Mini Central 5000/6000 is limited to 260 V. If the Sunny Mini Central 5000/6000 exceeds 260 V, it stops feeding to the grid immediately and indicates a „grid failure“.

Which power you can feed into the grid, without stopping operation because of high AC voltages, is shown in the diagram below.



To estimate how many Sunny Mini Central 5000/6000 can operate on one phase you need the following values:

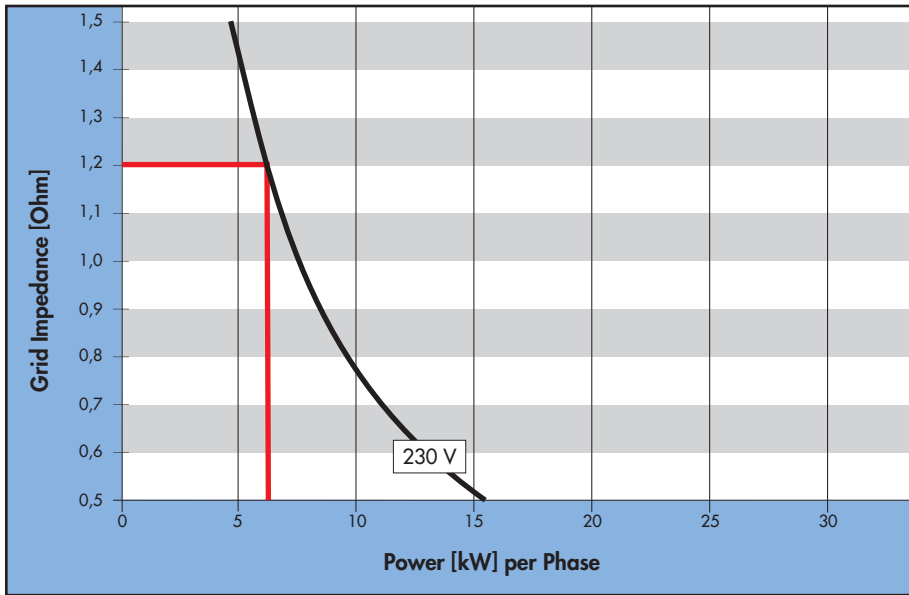
- Grid voltage without feeding
- Grid impedance at the connection point of the Sunny Mini Central 5000/6000

The diagram shows the respective curve for the AC voltage without feeding. The respective curve for power per phase (X axis) results in subject to the grid impedance (Y axis).

Example

The grid voltage without feeding averages 230 V.

The grid impedance at the connection point averages 1.2 Ohm.

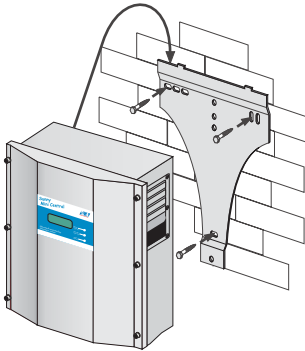


The indicated power on the x axis complies approx. 6.2 kW per phase.

In consequence you should install only one Sunny Mini Central 5000/6000 per phase. To install a plant with a higher power that does not stop feeding because of AC over voltage, you should check the connection conditions of the Sunny Mini Central 5000/6000 (e. g. by using a cable with a higher cross-section).

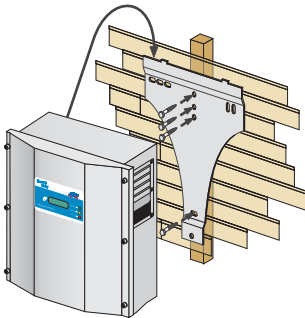
5 Installation

5.1 Mounting



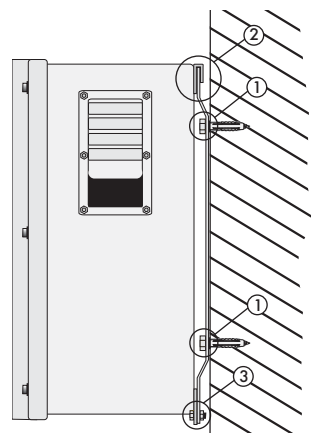
For trouble-free mounting of the Sunny Mini Central 5000/6000 we recommend to use the bracket for wall installation included in delivery. You can mount it vertically in firm concrete or stone walls with e. g. stainless steel 8 mm x 50 mm hexagon screws according to DIN 571, an apertaining washer and with a 10 mm dowel.

Keep the weight of the Sunny Mini Central 5000/6000 (63 kg) in mind.



For installing your Sunny Mini Central 5000/6000 on wooden wall studs, use the four holes in the middle of the wall-mounting bracket. Position the wall-mounting bracket against a stake of the wall. Make sure that the wall you choose to mount the Sunny Mini Central 5000/6000 on is sturdy enough to support its weight (63 kg) over a long period of time and that the wall is vertical.

1. Mount the bracket. To mark the positions for drill holes you can also use the bracket as a drilling template.
2. Hang the upper fixing straps of the Sunny Mini Central 5000/6000 into the bracket (2) so that it cannot be shifted sideways any more.
3. Secure the Sunny Mini Central 5000/6000 against lifting off by screwing the M6x10 screw (included in delivery) into the lower middle fixing strap (3).
4. Ensure the Sunny Mini Central 5000/6000 has been tightly fastened.

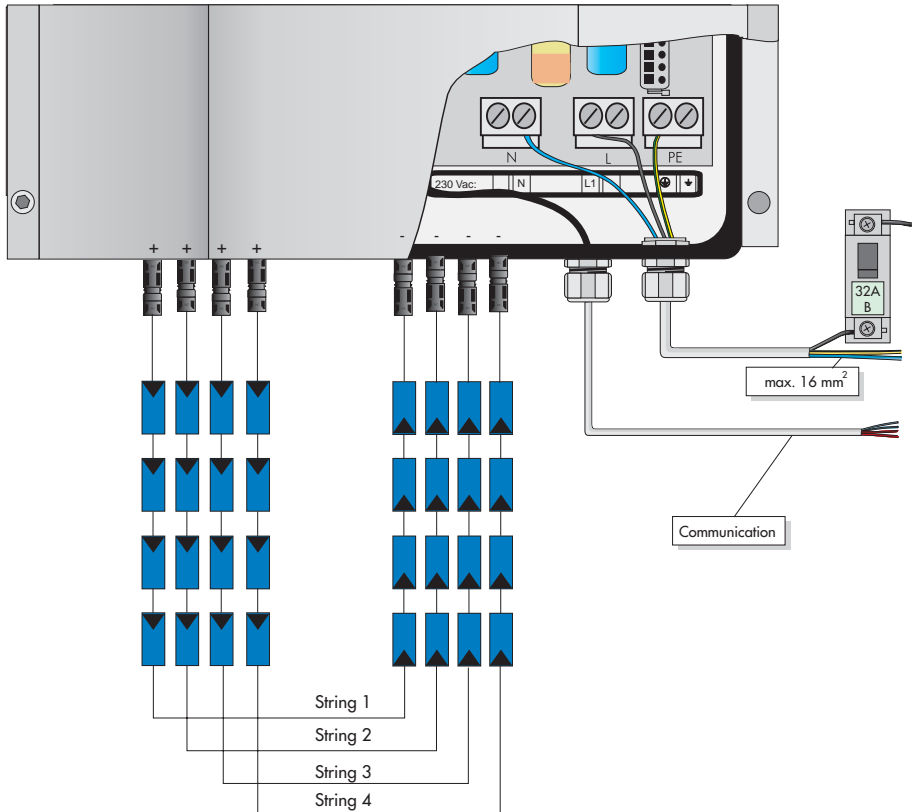


5.2 Electrical Installation

Check the correct polarity before you connect the PV strings!



The following figure shows the complete cabling of a Sunny Mini Central 5000/6000:



Connection of AC output

Please follow the steps below:

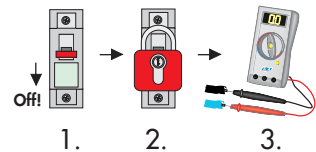
1. Check the grid voltage. If it is above 260 V (German standard), the Sunny Mini Central 5000/6000 stops operation. The local public utility company should solve this problem.



max. 260 V!

The maximum grid voltage for feeding operation is 260 V!

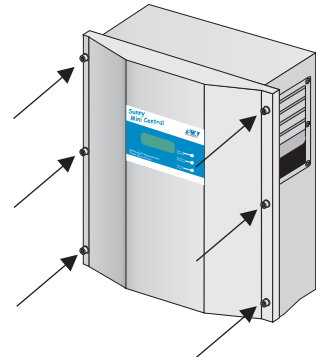
2. Disconnect the grid (switch off the circuit breaker), secure it against accidental reactivation and ensure that it is disconnected.



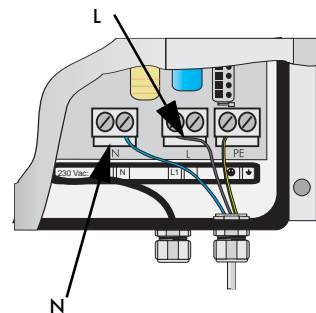
1. 2. 3.

Before opening the Sunny Mini Central 5000/6000 check whether the AC output is safely isolated from supply!

3. Unscrew the lid from the enclosure of the Sunny Mini Central 5000/6000 and remove the lid.

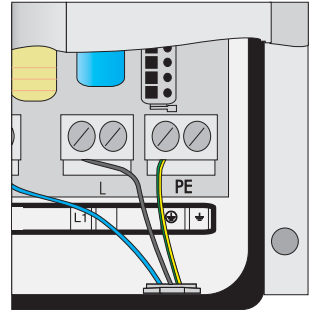


4. Connect the AC cable as illustrated in the figure on the side. Use the cable gland that is included in the delivery of your Sunny Mini Central 5000/6000. Phase (L) and Neutral (N) may not be mixed up.



Connection of „L“ and „N“

5. Connect the PE conductor of the grid cable.



Connection of PE conductor

6. Fasten the lid to the enclosure of the Sunny Mini Central 5000/6000 by tightening the six screws. Don't forget the lock washers. The notches of the lock washers should face to the lid.

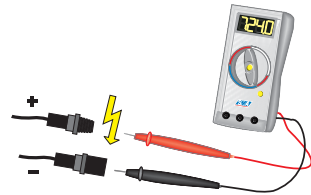


Do not switch on the circuit breaker yet! The Sunny Mini Central 5000/6000 may only be connected to the AC grid when the PV strings have been connected and the device is tightly closed.

PV String (DC) Connection

Connect the PV strings as follows:

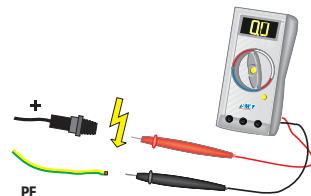
1. Check the PV generator connections on their correct polarity and compliance with the maximum string voltage of 600 V DC, see chapter 4.2 „Requirements: PV-Modules“ (page 18).



The voltage from the strings is very dangerous! Be very careful and pay attention to all applicable safety regulations!



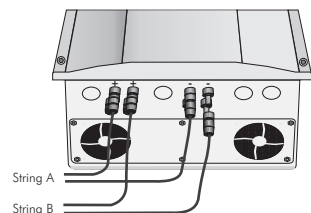
2. Measure the DC voltages between each PV plug connector of a string and ground potential. Follow the safety instructions!
3. If the measured voltages are constant and their total approximately corresponds to the open-circuit voltage of the string, a ground fault has occurred in this string. The ratios of voltages approximately indicate where the ground fault can be found.



When you have found a ground fault in a string, only connect it to the Sunny Mini Central 5000/6000 after you have removed the cause for the ground fault in the PV generator.



4. Repeat steps 2 and 3 for each string.
5. Connect the trouble-free PV strings to the Sunny Mini Central 5000/6000. Make sure to connect them with correct polarization.
6. Close off the unneeded DC input sockets using the protective caps supplied in the accessories kit.



5.3 Reverse Current

Information about the design of generators for PV plants with Sunny Mini Central

In contrast to the „Sunny Mini Central“ string inverters, mostly three and more strings are connected in parallel within a PV generator of a „Sunny Mini Central 5000/6000“ (SMC). In case of such large generators failures may occur that are uncritical in string plants: module currents misrouted by short circuits can load a PV module with a so called reverse current that may exceed the normal maximum current (short circuit current) of the PV module.

When can a reverse current occur?

In principal, a reverse current can only occur when modules are connected in parallel and the open terminal voltage (open-circuit voltage U_{oc}) of the individual parallel strings is different. In normal operation mode, this is mostly avoided due to the fact that the strings are identical. Even in the special case of shadowing no considerable reverse current occurs as shadowing has no significant impact on U_{oc} .

In normal operation no excessive reverse current can occur in a PV plant that has been accurately designed!

Thus, a reverse current can only arise in case the open terminal voltage of a module string is significantly below the open circuit voltage of the other strings connected in parallel due to a failure in the PV generator (e.g. short circuit of one or several modules). At worst, the voltage applied to the defective string is in the range of the remaining generator's MPP voltage (U_{MPP}). Due to the internal diode structure of the PV cell a reverse current flows through the defective generator string. This reverse current may cause an extreme heat all the way to the destruction of the string's modules depending on the current intensity!

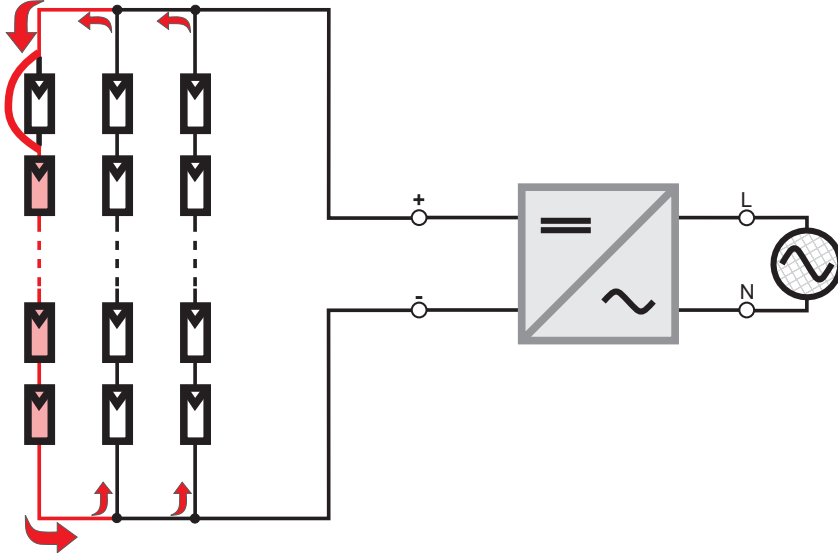
The failures indicated below may result in reduction of the open terminal voltage of a generator string and thus in a reverse current in case of connection in parallel:

- Short circuit of one or several modules,
- Short circuit of one or several cells in the module,
- Double ground fault of a module and/or the wiring.

Even if these failures are very unlikely and rare in the field precautions must be taken. This failure involves a high potential for damages and dangers. All modules of the affected Strings can be damaged and cause secondary damages due to the high

thermal impact. It is therefore not amazing that UL certifiers in the USA already consider this aspect and that the reverse current resistance is a value specified by default in US datasheets of PV modules.

Current of the defective string =
Sum of the current of the other strings



How can one avoid reverse currents within the modules?

Bypass diodes that are currently state of the art in module design have no impact on the reverse current within the module but only reduce the effects of possible shadowing.

You have the following possibilities to cope with the reverse current problems:

1. String Technology

All components of a string (modules, cables, plug connectors) must be designed for the remaining generator short-circuit current as reverse current. This always applies in case of parallel connection of a maximum of two strings as the resulting reverse current of a (damaged) string can achieve at most the value of the short circuit current of the (faultless) string.

2. String Diodes

Due to so called string diodes connected in serial circuit with the individual strings only the reverse current within the respective string is avoided. Disadvantage: the diode is permanently in serial circuit with the respective generator string and the respective string current flows through it. Respectively high permanent losses result. In addition, failure of the diode may cause a loss of the protective function or failure of the entire string.

3. String Fuses

String fuses connected in serial circuit with the individual strings allow to limit the reverse current in the respective string to the permitted maximum. The losses at the string fuses are lower than the losses you would observe with string diodes. A string fuse failure can be identified by a fuse control or an "intelligent" failure control of the PV panel.

The first option is to be considered for the design of a cost-efficient plant. The Sunny Mini Central 5000/6000 is therefore delivered with MC and Tyco plug connectors that have a rating of 30 A current.

Design Tips

The following is specifically to be checked and/or ensured:

1. Do all strings have the same number of modules connected in serial circuit?
2. What is the maximum reverse current in a defective string under nominal conditions?
Example: Generator consisting of 4 strings of modules with short circuit current of 5 A maximum reverse current is $3 \times 5 \text{ A} = 15 \text{ A}$.
3. Are the modules suitable for such a reverse current?
4. Are the plug connections of the modules and the inverter suitable for such a reverse current?
5. Is the string cabling suitable for such a reverse current?

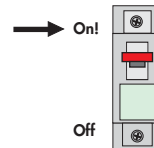
5.4 Activation

You can activate the Sunny Mini Central 5000/6000 when:

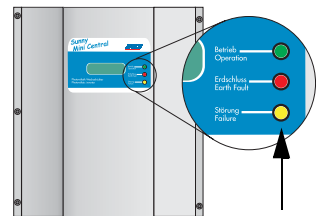
- The lid has been tightly screwed on.
- The AC (grid) cable has been correctly connected.
- All the DC (PV) strings have been connected and all unused DC plug connectors on the underside of the inverter have been closed with the protecting caps.

Proceedings for Activation

1. Switch the circuit breaker on.



2. Check whether the LEDs indicate trouble-free operation of the Sunny Mini Central 5000/6000 based on the following table. If this is the case commissioning has been successfully completed.



If the lower yellow LED repeatedly blinks once a second for four times, immediately disconnect the grid voltage and the PV generator from the Sunny Mini Central 5000/6000. The input voltage is too high. The inverter might be damaged!



Check whether string voltages comply with limiting values stated in chapter 4.2 „Requirements: PV-Modules“ (page 18). If the values are too high, the planner / installer of the PV generator must modify the strings.

If the LED blinks again when the PV plant is reconnected to the inverter although string voltages have been checked to be ok, disconnect the PV panel again and contact **SMA Technologie AG** (see chapter 11 „Contact“ (page 55)).

Green	Red	Yellow	Status
permanently on	off	off	OK (feeding)
	permanently on	off	failure
		permanently on	OK (Initialization)
blinking fast (3 x per second)	off	off	OK (Stop)
	permanently on	off	failure
blinking slowly (1 x per second)	off	off	OK (waiting, grid monitoring)
	permanently on	permanently on	failure
shortly turns off (approx. 1 x per second)	off	off	OK (derating)
	permanently on	off	failure
off	off	off	OK (stand-by)
		off / blinking	failure
	permanently on	off	failure
		off / blinking	failure

You will find a detailed description of failure messages and their causes in the „Operating Instructions“.

6 Opening and Closing the Sunny Mini Central

If the inverter has to be opened always follow the safety instructions given in chapter 2 „Safety Instructions“ (page 9).



6.1 Opening the Sunny Mini Central

Caution: Stick to the order specified below!



1. Switch off the AC connection.
2. Prevent accidental reconnection!
3. Disconnect the PV generator from the Sunny Mini Central 5000/6000 by pulling off all the connectors.
4. **Wait 30 minutes! (This is necessary to let the internal capacitors discharge.)**
5. Remove the six screws on the lid and pull the lid slightly forward.

6.2 Closing the Sunny Mini Central

Caution: Stick to the order specified below!



1. Attach the lid to the enclosure of the Sunny Mini Central 5000/6000 by tightening the six screws. Don't forget the lock washers. The notches of the lock washers should face to the lid.
2. Connect the PV generator.
3. Switch on the AC circuit breaker. This activates the Sunny Mini Central 5000/6000.
4. Check whether the LEDs of the Sunny Mini Central 5000/6000 indicate trouble-free operation.

7 Technical Documentation

7.1 Sunny Mini Central 5000

7.1.1 Data PV Generator Connection

Max. input open-circuit voltage	U_{PV0}	600 V (at -10 °C module temperature)
Input voltage, MPP operation	U_{PV}	250 V ... 600 V DC (250 V DC at 230 V AC)
Max. input current	I_{PVmax}	26 A
Max. input power	P_{PV}	5750 W
Recommended generator power		6350 W _p
All-pole disconnector on DC input side		DC plug connector
Surge voltage protection		thermally monitored varistors
Voltage ripple	U_{PP}	< 10 % of input voltage
Personnel protection		Ground Fault monitoring (Riso > 2 MΩ)
Internal consumption in operation		< 7 W (stand-by)
Pole confusion prevention		by short-circuit diode

7.1.2 Data Grid Connection

Nominal output power	P_{ACnom}	5000 W
Permanent output power at 45 °C		5500 W
Peak output power	P_{ACmax}	5500 W
Nominal output current	I_{ACnom}	21.7 A
Harmonic distortion of output (with $K_{UNom} < 2\%$, $P_{AC} > 0,5 P_{ACnom}$)	T_{HDIAC}	4 %
Short-circuit resistance		$I_{max} = 30 A$
Operating range, grid voltage	U_{AC}	198 ... 260 V AC (adjustable 180 ... 265 V)
Operating range, grid frequency	f_{AC}	49.8 ... 50.2 Hz (adjustable 45.5 ... 54.5 Hz)
All-pole disconnector on grid side		independent disconnection device (MSD), (2 independant systems)
Phase difference (related to basic wave of current)	$\cos \Phi$	1
Overvoltage category		III
Test voltage		2 kV (1 s unit / 60 s type test)
Surge voltage test		4 kV (1.2/50 μs) (serial interface: 6 kV)
Internal consumption in stand-by		0.25 W

7.2 Sunny Mini Central 6000

7.2.1 Data PV Generator Connection

Max. input open-circuit voltage	U_{PV0}	600 V (at -10 °C module temperature)
Input voltage, MPP operation	U_{PV}	250 V ... 600 V DC (250 V DC at 230 V AC)
Max. input current	I_{PVmax}	26 A
Max. input power	P_{PV}	6300 W
Recommended generator power		7000 Wp
All-pole disconnector on DC input side		DC plug connector
Surge voltage protection		thermally monitored varistors
Voltage ripple	U_{PP}	< 10 % of input voltage
Personnel protection		Ground Fault monitoring (Riso > 2 MΩ)
Internal consumption in operation		< 7 W (stand-by)
Pole confusion prevention		by short-circuit diode

7.2.2 Data Grid Connection

Nominal output power	P_{ACnom}	5500 W
Permanent output power at 45 °C		6000 W
Peak output power	P_{ACmax}	6000 W
Nominal output current	I_{ACnom}	24 A
Harmonic distortion of output (with $K_{Unom} < 2\%$, $P_{AC} > 0,5 P_{ACnom}$)	T_{HDIAC}	4 %
Short-circuit resistance		$I_{max} = 30 A$
Operating range, grid voltage	U_{AC}	198 ... 260 V AC (adjustable 180 ... 265 V)
Operating range, grid frequency	f_{AC}	49.8 ... 50.2 Hz (adjustable 45.5 ... 54.5 Hz)
All-pole disconnector on grid side		independent disconnection device (MSD), (2 independant systems)
Phase difference (related to basic wave of current)	cos Phi	1
Overvoltage category		III
Test voltage		2 kV (1 s unit / 60 s type test)
Surge voltage test		4 kV (1.2/50 μs) (serial interface: 6 kV)
Internal consumption in stand-by		0.25 W

7.3 Description of Devices

You will find a detailed device description in the Operating Instructions.

General Data

Protection Degree according to DIN EN 60529	IP54
Dimensions (width x height x depth)	approx. 430 mm x 600 mm x 250 mm
Weight	approx. 63 kg

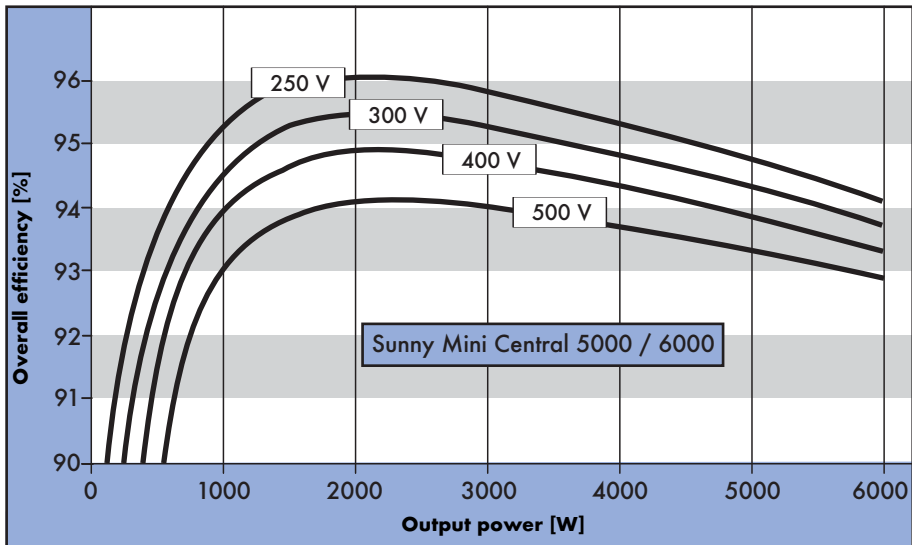
External interfaces

Data transmission via powerline	optional
Data transmission via separate data cable RS232 / RS485, electrically separated	optional,
Data transmission via radio	optional

Efficiency

Max. Efficiency	η_{\max}	96 %
European weighted efficiency	η_{euro}	> 95.1 %

The efficiency of the Sunny Mini Central depends on the input voltage coming from the PV modules. The lower the input voltage, the higher the efficiency.



7.4 Sunny Mini Central Operating Parameters



Any unauthorized modifications of the operating parameters can

- **Result in serious injuries or casualties due to altered internal safety precautions within the Sunny Mini Central**
- **Void the operating permission of the Sunny Mini Central**
- **Void the warranty of the Sunny Mini Central**

Never change the operating parameters without explicit permission and instructions!

The parameters with a grey background are only visible when in installer mode.

Name	Unit	Range	Default
Betriebsart/ Operating Mode		MPP, UKonst, Stop, Turbine, MPP	MPP
Default			GER/ENS
dFac-MAX	Hz/s	0.005 ... 4.0	0.25
dZac-MAX	mOhm	0 ... 20000	350
E_Total	kWh	0 ... 200000	
Fac-Delta-	Hz	0 ... 4.5	0.19
Fac-Delta+	Hz	0 ... 4.5	0.19
Fan test	0	1	0
h_Total	h	0 ... 200000	
Inst.-Code			
NiTest/ testcurrent Zac	mA	0 ... 25000	16000
Riso	kOhm	0 ... 10000	1000
Speicherfunktion/ Memory Function			none
Speicher / Storage		permanent / volatile	permanent
T-Max-Fan	°C	0 ... 100	90
T-Start	s	5 ... 1600	10 / 300
T-Start-Fan	°C	0 ... 100	70
T-Stop	s	1 ... 1800	2
T-Stop-Fan	°C	0 ... 100	50
Uac-Max / Vac-Max	V	180 ... 300	260
Uac-Min / Vac-Min	V	180 ... 300	198
Usoll-Konst/ Vconst-Setval	V	250 ... 600	600

The following parameters appear in parameter list but cannot be modified:

Name	Unit	Range	Description
Plimit	W	5000 / 6000	Upper limit of AC output power
SMA-SN			Serial Number of the Sunny Mini Central
Software-BFR			Firmware version of the operation control unit (BFR)
Software-SRR			Firmware version of the current control unit (SRR)

8 Checking the heat dissipation

You only need to check the heat dissipation, in case you recognize that the fans are severely clogged or the Sunny Mini Central is often in the operation mode Derating. Whether the Sunny Mini Central works in the operation mode Derating or not, depends on the ambient temperature and the efficiency of the ventilation. I. e. a device with clogged filters (insufficient ventilation) and a low ambient temperature, may seldom or even not change to the mode Derating. But a device with sufficient ventilation and a high ambient temperature may relatively often change to the mode Derating.

8.1 Cleaning the fans

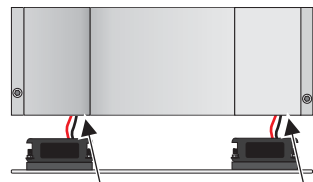
If the filters are only clogged with loose dust you can clean them with a vacuum cleaner. If the fans are still clogged, you have also the possibility to remove the fans for cleaning them.

The fans are mounted on a plate on the bottom side of the Sunny Mini Central. To clean the fans please follow the steps below:

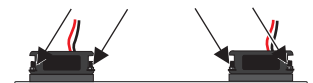
1. Remove the six screws on the bottom side of the Sunny Mini Central.



2. Carefully remove the plate with the fans and disconnect the cable leading to the inside of the inverter.
3. Unlock the connectors of the fans and remove them carefully.



4. The fans are mounted to the plate with four nuts each. Undo the four nuts and remove the fans, the spacers and filters located behind each fan.
5. To clean the fans, spacers and filters use a soft brush or cloth. Do not use air pressure for cleaning the fans. This will damage the fans.



6. When the fans are clean, reinstall them using the above steps in reverse order. Pay attention to the direction of the fans. Do not forget to reconnect the plugs of the fans. After reinstalling the fans, check their function (see following chapter).

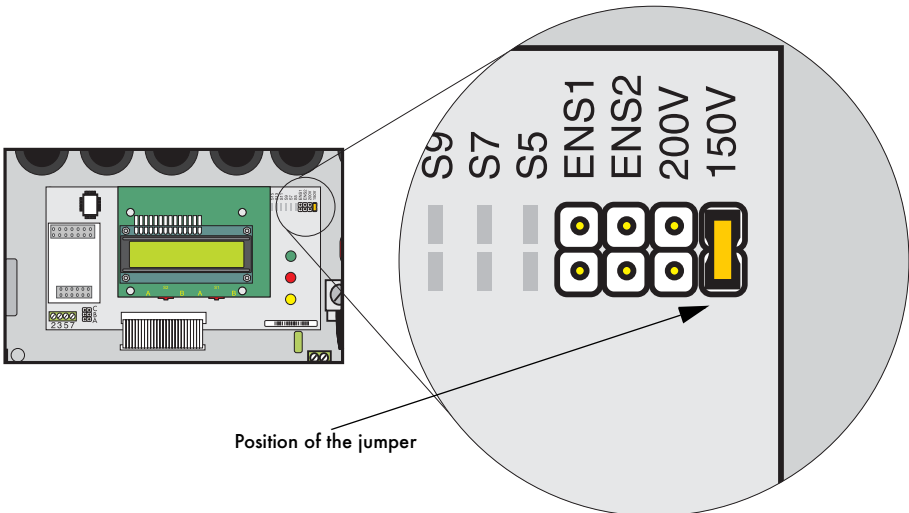
8.2 Testing the fans

You can verify the operation of the fans in two ways:

- Set the parameter „Fan Test“ to „1“ (with Sunny Data, Sunny Data Control or with the data logger Sunny Mini Central Control).
- Use the jumper on the control board of the Sunny Mini Central (see figure below).

For setting the jumper for the fan test, proceed as follows. Stick to the order specified below!

1. Open the Sunny Mini Central 5000/6000 as described in chapter 6.1 „Opening the Sunny Mini Central“ (page 35).
2. Put the jumper in the slot shown in the picture below. The jumper is included in delivery
3. Close the Sunny Mini Central as described in chapter 6.2 „Closing the Sunny Mini Central“ (page 35) and switch it on again.
4. The Sunny Mini Central can not detect the jumper, until you deactivate and re-activate it.



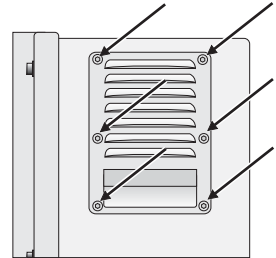
After setting the jumper, switch on the Sunny Mini Central. Check the air flow of the fans. The Sunny Mini Central aspirates the air from the bottom side and blows it out on the sides of the device. Pay attention to strange sounds, they might be a hint for an incorrect installation or a defective fan.

When you finished testing the fans you have to reset the parameter „Fan-Test“ to „0“, or you have to remove the jumper.

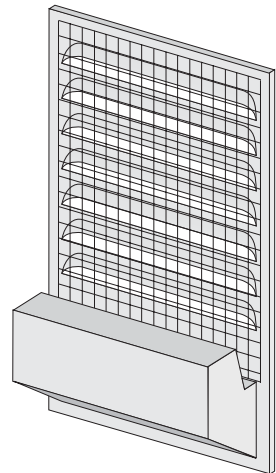
8.3 Cleaning the Fins

The fins are mounted on both sides of the Sunny Mini Central. To clean the fins follow the steps below.

1. Turn off the Sunny Mini Central by following the steps 1 to 4 of chapter 6.1 „Opening the Sunny Mini Central“ (page 35)
2. Remove the six screws on both sides of the Sunny Mini Central.



3. Take out the fins. Behind the fins are the filters. Clean the filters and fins with a soft brush, cloth or air pressure.
4. When the fins and filters are clean, reinstall them using the above steps in reverse order. Don't forget the lock washers. The notches of the lock washers should face to the enclosure.

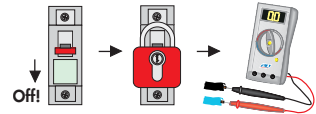


9 Exchanging Varistors

The Sunny Mini Central 5000/6000 is a very complex technical device. Therefore there are only a few possibilities to repair failures on site. Please do not try to make repairs otherwise than described in this document. Make use of our exchange service and the repair service of **SMA Technologie AG**.

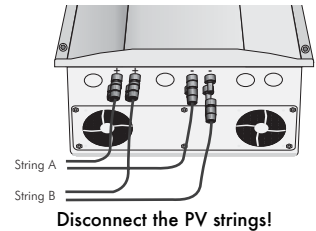
If the red status LED is permanently on during operation please first make sure that there is no ground fault in the PV generator.

1. Disconnect the grid (switch off the circuit breaker), secure it against accidental reactivation and ensure that it is disconnected.

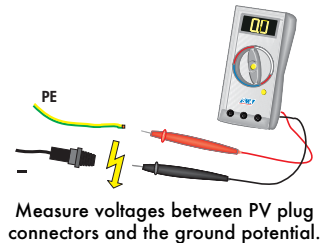


- 1.
- 2.
3. Ensure that the AC voltage is off before you open the Sunny Mini Central 5000/6000!

2. Disconnect the PV plug connectors of all strings.



3. Measure voltages between one PV plug connector of each string and the ground potential. Follow all applicable safety instructions!



The voltage from the strings is very dangerous! Be very careful and pay attention to all applicable safety regulations!

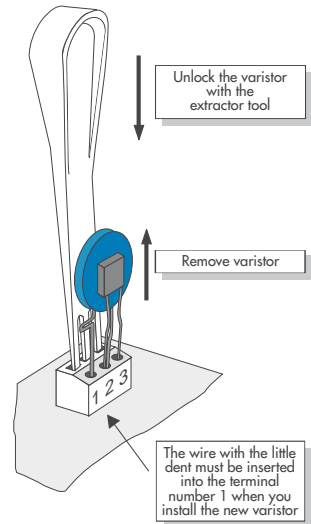


4. If the voltages measured are constant and their total is approximately equal to the open-circuit voltage of the string, there is a ground fault in this string. Its approximate position can be deduced from the ratios of voltages.

5. Repeat points 3 and 4 for each string.
If you have found a ground fault it is probably unnecessary to exchange the varistors. Make sure to remove the ground fault instead. This should normally be done by the installer of the PV plant. In this case proceed with point 10, but without reconnecting the faulty string! Protect its PV plug connectors against touching (e. g. by protective caps or insulation strip with sufficient electric strength).

If you have not found any ground fault in the PV generators, probably one of the thermally monitored varistors has lost its protective function. The varistors are subject to wear and tear and their function is reduced in the course of their aging or in case of repeated strain placed on them by surge voltages. You can now check the varistors as described below while following the safety instructions given in chapter 2 „Safety Instructions“ (page 9).

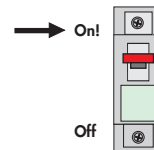
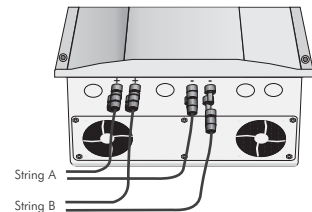
6. Unscrew the lid of the Sunny Mini Central 5000/6000 and remove it. Test safe isolation from supply.
7. Test all varistors for an electric connection between terminals 2 and 3. If there is no electric connection the varistor is useless. The position of varistors in the Sunny Mini Central 5000/6000 can be seen in chapter 3.1 „Device Description“ (page 11).
8. Replace the defective varistor by a new one as shown in the figure on the left. Ensure correct orientation of the varistor! Please contact SMA if you have not received special tools to move the terminals (included in delivery of replacement varistors). However, the terminal contacts can also provisionally be released one by one with a suitable screwdriver. The failure of a varistor is normally due to circumstances that apply to all varistors in a similar manner (temperature, age, induced surge voltages). We therefore strongly recommend not only to exchange the defective one, but all two. These varistors are specially manufactured for use in the Sunny Mini Central 5000/6000 and are not commercially available. They have to be purchased from **SMA Technologie AG** direct (SMA order name: „SB-TV4“).



In case there are no spare varistors available the Sunny Mini Central 5000/6000 still can feed electricity into the grid. The input is not protected against overvoltages in this case. Replacement varistors should be obtained as soon as possible. In systems with a high risk of overvoltages, the Sunny Mini Central 5000/6000 should not be operated with defective varistors.



9. Attach the lid to the enclosure of the Sunny Mini Central 5000/6000 by tightening the six screws. Don't forget the lock washers. The notches of the lock washers should face to the lid.
10. Connect the faultless strings of the PV panel. Ensure correct allocation to strings.
11. Close off the unneeded DC input sockets using the protective caps supplied in the accessories kit.
12. Switch on the circuit breaker.
13. Check whether the LEDs of the Sunny Mini Central 5000/6000 show trouble-free operation.

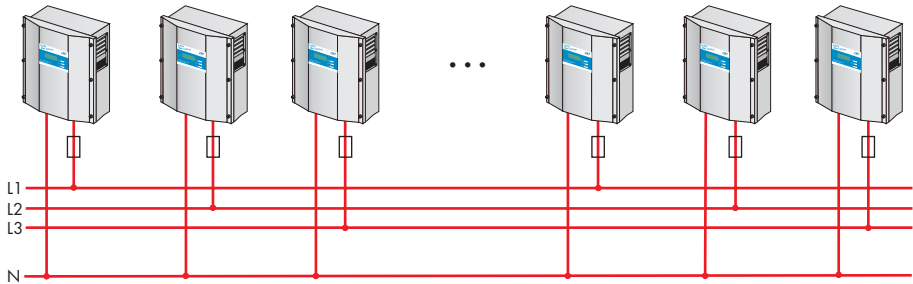


If you have found neither a ground fault nor a defective varistor there probably is a fault in the Sunny Mini Central 5000/6000. Please contact the SMA hotline in this case to discuss further proceedings.

10 Sizing of a Circuit Breaker

Example for the sizing of a circuit breaker for the AC line of a photovoltaic inverter for utility interaction in terms of temperature.

Photovoltaic plant with 9 inverters type Sunny Mini Central SMC 6000 with 3 inverters per phase



Required data of the used inverters:

- max. output current: 26 A
- max. permissible rating of the circuit breaker for one inverter: 40 A

The type of cable as well as the type of cable installation and several other conditions have influence on the maximum rating of the circuit breaker for the inverter.

In this example we assume that the cable used (6 mm^2) can be used for nominal currents up to 32.2 A in this example.

Selection of the circuit breakers:

- The maximum possible nominal current of the cable used and the maximum possible rating for the inverter now define the maximum possible nominal current of the circuit breakers.
- 32 A are possible in our example for one inverter.

However, the thermal suitability of the line circuit breaker still needs to be checked.

Several aspects that have affect on the load must be considered when you select a circuit breaker. These aspects are specified in the data sheets of the circuit breakers.



Example for the sizing of a 32 A circuit breaker with B characteristics for the AC line of a photovoltaic inverter for utility interaction while the circuit breakers are installed right next to each other without gap (with respect to the thermal conditions).

One vendor of circuit breakers for example specifies the ratings for an ambient temperature of 50 °C.

Aspects that have an affect on the load specified in the data sheets:

- Reduction of the tolerable current because of continuous load $> 1 \text{ h} = 0.9^{\text{a}}$
- Reduction of the tolerable current due to installation of 9 circuit breakers right next to each other without gap $= 0.77^{\text{b}}$
- Increase of the tolerable current resulting from ambient temperatures of 40 °C in the distribution box $= 1.07^{\text{c}}$

-
- a. In photovoltaic applications continuous loads of over 1 h are possible.
 - b. The coefficient is 1 in case there is only one single circuit breaker.
 - c. Resulting from the sizing of the circuit breakers for ambient temperatures of 50 °C.

Result:

The nominal current of the circuit breaker is

$$I_{nr} = 32 \text{ A} \times 0.9 \times 0.77 \times 1.07 = 23.7 \text{ A}$$

The circuit breaker selected for this installation is not suitable due to the fact that the maximum tolerable current of the circuit breaker is below the maximum current of the used inverter. **It will trip in normal operation.**

A solution for this plant would be the installation of the circuit breakers with an 8 mm gap between each unit. This would result in a reduction coefficient of 0.98 instead of 0.77. This would result in a maximum current of 30 A.

A further solution could be the installation of circuit breakers with a rating of 40 A. In this case all different aspects have to be evaluated again with respect to this change. An installation of the circuit breakers in the distribution box without gap between the units would result in a nominal current of $I_{nr} = 40 \text{ A} \times 0.9 \times 0.77 \times 1.07 = 29.6 \text{ A}$.

SMA recommends the installation described above with a gap between the circuit breakers.

As well as the thermal rating of the circuit breakers and all other factors as specified in section „Sizing of a circuit breaker for the AC line of a photovoltaic inverter for utility interaction“ (page 19), of course the applicable DIN VDE standards ^a also need to be taken into account. The main ones that apply here are:

- DIN VDE 0100 Part 410 and/or the international standard IEC 60364-4-41:1992
- DIN VDE 0100 Part 430 and/or the international standard IEC 364-4-43:1977 and IEC 364-4-473:1977
- DIN VDE 0298 Part 4

a. The standards listed here are standards that apply in Germany. Please note that other standards apply in other countries. Beside the standards above other standards may be applicable in special installations.

11 Contact

If you have any questions or technical problems with the Sunny Mini Central 5000/6000 our hotline will be glad to help you. Please keep the following data ready when calling SMA:

- Type of inverter used
- Number and type of connected modules
- Communication
- Serial number of Sunny Mini Central 5000/6000



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