SUNNY BOY 4200TL HC / SB 5000TL HC
PV Inverter

Installation Guide | Version 1.1 | SBTLHCMS-IEN080411
IME-SB42-50-TLHC

Table of Contents

1 Explanation of the Symbols Used

To ensure optimum use of this document, note the following explanation of the symbols used.

This symbol indicates an example.

This symbol indicates a notice which, if ignored, will make the procedure or operation more difficult.

This symbol indicates a fact which, if not observed, could result in damage to components or represent a danger to persons. Read these passages especially carefully.

2 Foreword

The Sunny Boy inverters are equipped with the "SMA grid guard". This is a type of automatic disconnection device. It ensures that the Sunny Boy 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 0126-1-1, which forms a part of these regulations.

For detailed information on troubleshooting and on how to use the Sunny Boy and the various communications options, please see the operating instructions.

"Sunny Design" helps you design the system and check string size taking the relevant inverter into consideration. Further information on Sunny Design is available at www.SMA.de.

If you require further information, please call the SMA Service Line on the following number:

(0561) 95 22 - 499

2. 1 Target Group

Notice!

The Sunny Boy may only be installed by qualified personnel. The installer must be approved by the local energy supplier. Read this "installation guide" carefully. All prescribed safety regulations, the technical connection requirements of the local energy supplier and all applicable provisions must be adhered to.

This installation manual is intended solely for qualified personnel. Its aim is to help install and set up SMA inverters type "SB 4200TL HC Multi-String" or "Sunny Boy SB 5000TL HC Multi-String" quickly and correctly.

2. 2 Appropriate Usage

The Sunny Boy is designed for operation in grid-connected PV systems. Any other use of the leads to loss of the right to all warranty claims and may lead to a fault in the device. This includes, among other things, the operation at voltage sources without any current limit. When in doubt, contact SMA.

Plant Design

The Sunny Boy may only be operated with PV-generators (Modules and according cables) with protection class II.

It is mandatory to ensure that all components will operate within the specified operating range. The free design tool "Sunny Design" (www.SMA.de/SunnyDesign) will help you with this.

The manufacturer of the modules should have approved the modules for operation with this Sunny Boy. It is furthermore advisable to implement all measures for maintaining the module performance (see also Application Note 2 "Module Technology" in the download area of www.SMA.de).

2. 3 Validity of the Documentation

The Sunny Boy SB 4200TL HC Multi-String and Sunny Boy SB 5000TL HC Multi-String are identical except for the technical data. The devices are referred to as Sunny Boy in case the information applies for both models. The full device name is used in case of device specific information.

3 Safety Instructions

Caution! Overvoltage!

Check the system design using the "Sunny Design" design tool (www.SMA.de) or by calling the SMA Service Line. Overvoltage damages the Sunny Boy and results in the exclusion of all warranty claims!

Warning! High voltages!

Work on the Sunny Boy with the cover removed must be carried out by a qualified electrician. High voltages are present in the device. Before working on the Sunny Boy with the cover removed, the AC and DC voltages must be disconnected from the Sunny Boy and the capacitors must be discharged.

The Sunny Boy must be disconnected from the mains grid and precautions must be taken to prevent the grid being inadvertently 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 Boy to discharge. Only then is it safe to open the unit by removing the cover. You must also make sure that no voltage is present in the device.

Caution! Electrostatic charge!

When working on the Sunny Boy and handling the components, remember to observe all ESD safety regulations. Electronic components are vulnerable in terms of electrostatic charge. Discharge any electrostatic charge by touching the grounded enclosure before handling any electronic component.

Notice! Entry of water and dirt!

Once the handle of the Electronic Solar Switch has been pulled out, the Sunny Boy provides protection degree IP21. The Sunny Boy is then no longer protected against water and contamination with dirt!

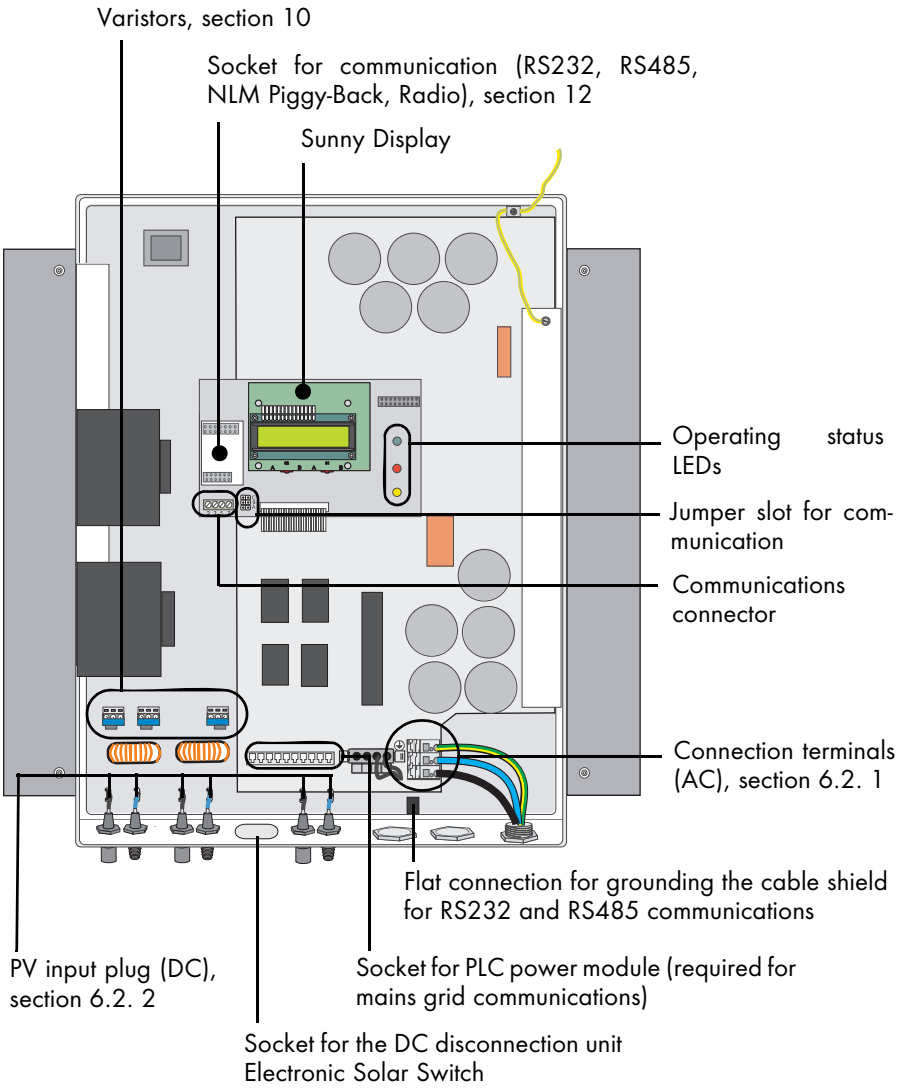
Grounding the PV generator

Pay attention to local regulations for the grounding of the modules and the PV-generator. SMA reccomends to electrically bond the module frames, the racks and all metal surfaces and ground these in order to have optimal protection of the system and personnel.

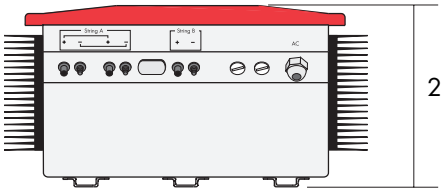
4 overview

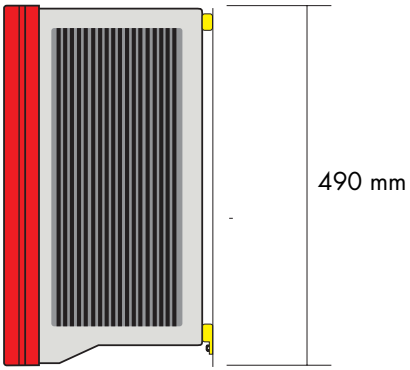
4. 1 Unit Description

The following diagram gives a schematic overview of the various components and connection points inside the Sunny Boy with the cover removed:



4. 2 External dimensions

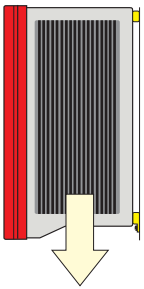




5 Installation Requirements

Please check that all of the conditions listed below are met before installing and setting up the Sunny Boy.

5. 1 Installation Site Requirements



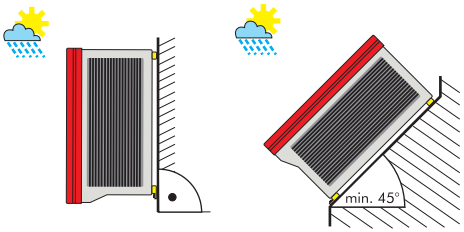
The Sunny Boy weighs more than 31 kg. Please take this weight into account when choosing the installation site and method of installation.

The ambient temperature must not be outside the -25 °C to +60 °C range.

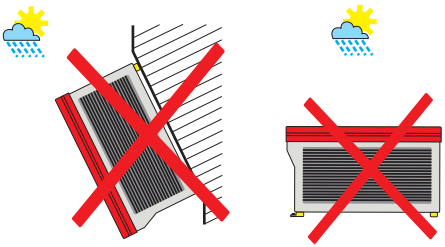
The Sunny Boy is designed for outdoor installation and should be installed in a place where it is not exposed to direct sunlight. An increased ambient temperature can reduce the yield of the PV system.

The Sunny Boy is designed to be mounted on a vertical wall. If absolutely necessary, however, the Sunny Boy can be installed tilted back at a maximum angle of 45°. For an optimum energy yield and the most convenient operation, vertical installation at eye-level is preferable. If installing the unit outdoors, make sure that it is not slanting forward.

A horizontal installation of devices in outside locations is not permissible.



Install the inverter vertically or tilting backward.



Never install the inverter horizontally or so that it tilts forward.

When choosing the installation site, be sure to note the following:

Caution: high voltage!

Unintentionally pulling out the DC plug connector under load can damage the plug and result in bodily injury or death! Install the Sunny Boy in such a way that it is not possible (e.g. for children) to unplug the DC plug connector unintentionally.

Caution: risk of burns!

The temperature of individual parts of the enclosure - in particular the temperature of the heatsink and the components within the Sunny Boy - can reach more than 60 °C. Touching could result in burns!

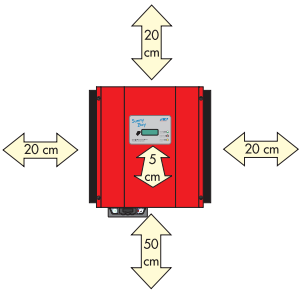
Warning!

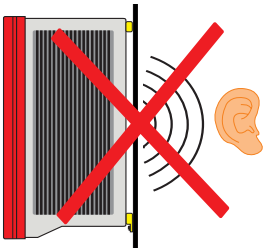
Do not install the Sunny Boy

- **on flammable construction materials,**
- **in areas where highly flammable materials are stored,**
- **in potentially explosive areas!**

When choosing the installation location, ensure there is enough space for heat to dissipate! Under normal conditions, the following guidelines should be followed to provide enough clearance around the inverter.

	Minimum Clearance
Sides	20 cm
Top	20 cm
Underneath	50 cm
Front	5 cm





In domestic installations, the unit should not be mounted on plasterboard walls or similar as otherwise audible vibrations are likely to result.

We recommend securing the unit to a solid surface.

The Sunny Boy makes noises when in use which can, in the domestic setting, be seen as a nuisance.

5. 2 PV Generator Requirements

The Sunny Boys have two input areas "String A" and "String B", each equipped with a separate MPP-tracker. The input area "String A" can be used for the connection of up to two strings (modules connected in series) with identical properties (modules with identical orientation, identical type, slant and number). The input area "String B" can be used for a single string, while this string can be different from the strings connected to "String A".

"Sunny Design" helps you design the system and check string size taking the relevant inverter into consideration. Further information on "Sunny Design" is available at www.SMA.de.

The unit has six DC plug connectors (four for String A and two for String B) for connecting the PV generators. The connecting cables from the PV generators must also be fitted with this type of plug connector. The SMA order codes for the various connectors are as follows:

- Multi-contact 3 mm: "SWR-MC"
- Multi-contact 4 mm: "MC-SET"
- Tyco: "TYCO-SET"

Limit values for DC input	Input Values „String A“	Input Values „String B“
Max. voltage	750 V (DC)	750 V (DC)
Max. input current	11 A (DC)	11 A (DC)

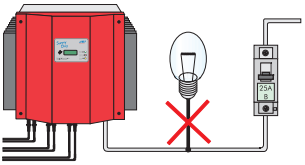
Notice!

Parallel connection of the "String A" and "String B" is not permitted!

5. 3 Low-voltage Grid (AC)

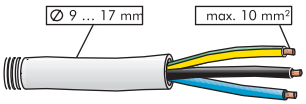
Caution!

The feed-in connection is fused by a 25 A circuit breaker type B. No further devices must be connected to the secured cable.



The relevant technical regulations and the special instructions of the local grid operator must be followed.

The connection terminals of the Sunny Boy are suitable for wire cross-sections of up to 10 mm². The external diameter of the cable must be between 9 mm and 17 mm. The connection is made with three wires (L, N, PE).



Rating for a Line Circuit Breaker in a Photovoltaic Electrical Power Unit Operated in Grid-parallel Mode

Various factors should be taken into account when selecting line circuit breakers. These include, for example:

- The type of cable used (conductor material and insulation)
- Ambient temperatures affect the cables (higher temperatures result in a reduced maximum current load)
- Method of routing the cable (reduces the ampacity of the conductor)
- Bundling cables together (reduces the ampacity of the conductor)
- Loop impedance [Z] (in the event of a body contact this limits the current that can flow and therefore determines the response behavior of the circuit breaker)
- Sufficient distance between the circuit breakers so as to avoid undue heating (heat can trigger the circuit breakers early).
- Selectivity
- Protection class of the connected load (VDE 0100, part 410, protection against electric shock)

The following standards should be followed in all cases:

- *DIN VDE 0298-4 (Cable routing and current-carrying capacity)*
- *DIN VDE 0100; part 430 (Protective measures "Protection of cable and cords against overcurrent")*
- *DIN VDE 0100; part 410 (Protective measures "Protection against electric shock")*

For examples for the rating of a line circuit breaker, please refer to section 11 "Rating for a Line Circuit Breaker" (Page 51)

A 30 mA RCD or FI circuit breaker must not be installed.

The Sunny Boy is equipped with an integrated universal current sensitive leakage-current monitoring unit. The Sunny Boy can automatically differ between real fault currents and "normal" capacitive leakage currents.

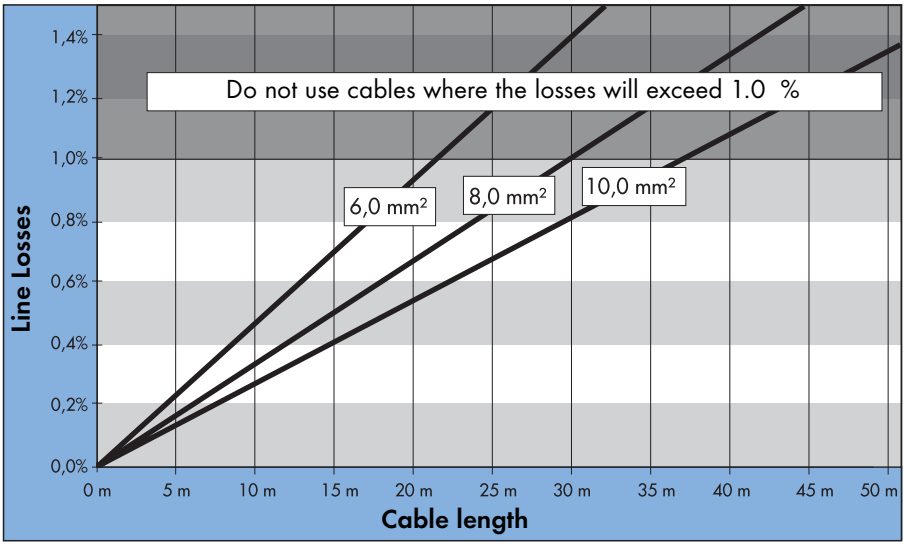
The Sunny Boy does not generate any extraordinary leakage currents in normal operation. In some operating states (e.g. during self-test of the protection units) discharge currents can occur which would trip a standard 30 mA RCD or ground fault circuit interrupter.

In case an RCD or ground fault circuit interrupter is imperative, you must use a circuit breaker with a sensitivity of 100 mA or more.

5.3. 1 Line Losses

AC cable system impedance should not exceed 1 ohm. This is necessary, amongst other things, for the correct operation of impedance observation. In addition, we recommend dimensioning the conductor cross-section so that line losses do not exceed 1 % at the nominal power. Line losses depending on the cable length and cross-section are shown in the graph below. Multi-wire cables with copper forward and return conductors are used.

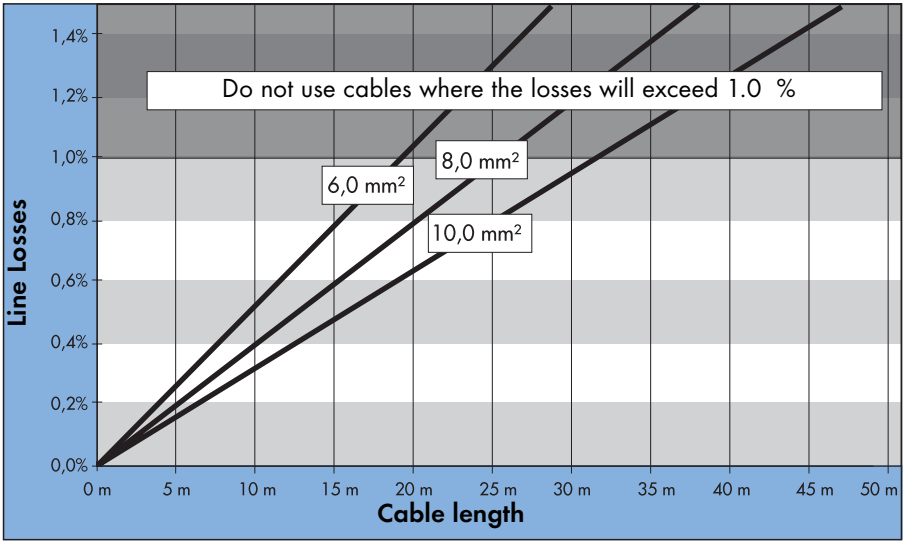
Sunny Boy SB 4200TL HC Multi-String



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

Cable cross-section	6.0 mm²	8.0 mm²	10.0 mm²
Max. length	22 m	30 m	37 m

Sunny Boy SB 5000TL HC Multi-String



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

Cable cross-section	6.0 mm²	8.0 mm²	10.0 mm²
Max. length	19 m	26 m	32 m

The Sunny Boy is designed for operation on 220 - 240 V grids at a grid frequency of 50 Hz. When connecting an inverter to the public grid, follow the connection requirements of the local grid operator.

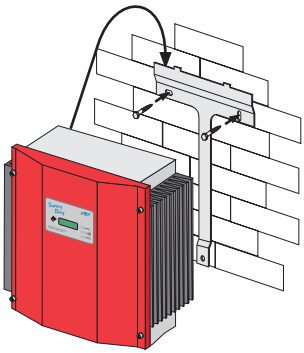
	Limit values for AC output
Voltage range (in the area of application of DIN VDE 0126-1-1)	198 V ... 260 V [a)]
Frequency range (in the area of application of DIN VDE 0126-1-1)	47.55 Hz ... 50.2Hz
Voltage range (extended operating range)	180V ... 260 V
Frequency range (extended operating range)	45.5 Hz ... 52.5Hz

a) The Sunny Boy can temporarily feed power into the grid with a maximum output voltage of 260 V. However, DIN VDE 0126-1-1 stipulates that the 10-minute average must not exceed a voltage of 253 V. That means, if the grid voltage is continuously 254 V (e.g.), the inverter disconnects itself from the grid. In this case, contact the local grid operator for assistance.

DIN VDE 0126-1-1 only applies in Germany. See section 8.4. 3 "Country-specific Parameter Settings" (Page 43) for all other preset country values of your inverter.

6 Installation

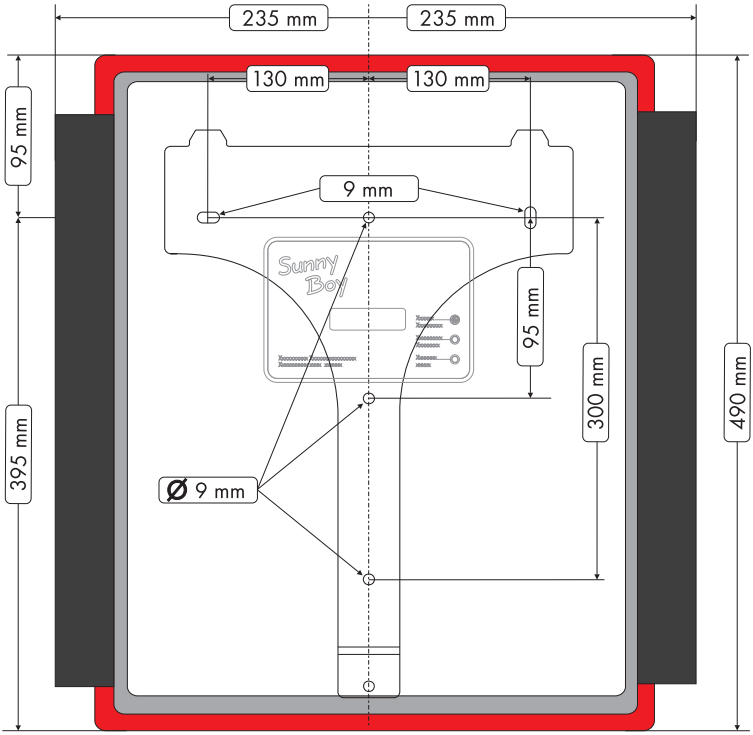
6. 1 Mounting the Unit



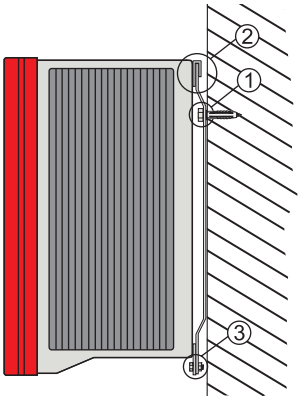
To make the job easier, we recommend you use the supplied wall bracket to mount the Sunny Boy. For vertical installation on solid concrete or block walls, for example, you can fit the bracket using 8 mm x 50 mm hexagon bolts to DIN 571 standard, stainless steel type, and with wall plugs type SX10.

When selecting the mounting materials, be sure to take into account the weight of the Sunny Boy (31 kg).

If you do not wish to use the wall bracket provided as a template, then use the dimensions specified in the drawing below. The installation of the inverter using the wall bracket is described on the following page.



1. Mount the wall bracket (1). To mark the positions to drill the holes, you can use the wall bracket as a drilling template.
2. Now hook the Sunny Boy onto the wall bracket (2) at its upper mounting plate so that it cannot be moved sideways.
3. Fix the Sunny Boy onto its bracket by screwing the supplied M6x10 bolt into the central threaded hole at the bottom of the bracket (3).
4. Make sure that the Sunny Boy is positioned securely on the bracket.

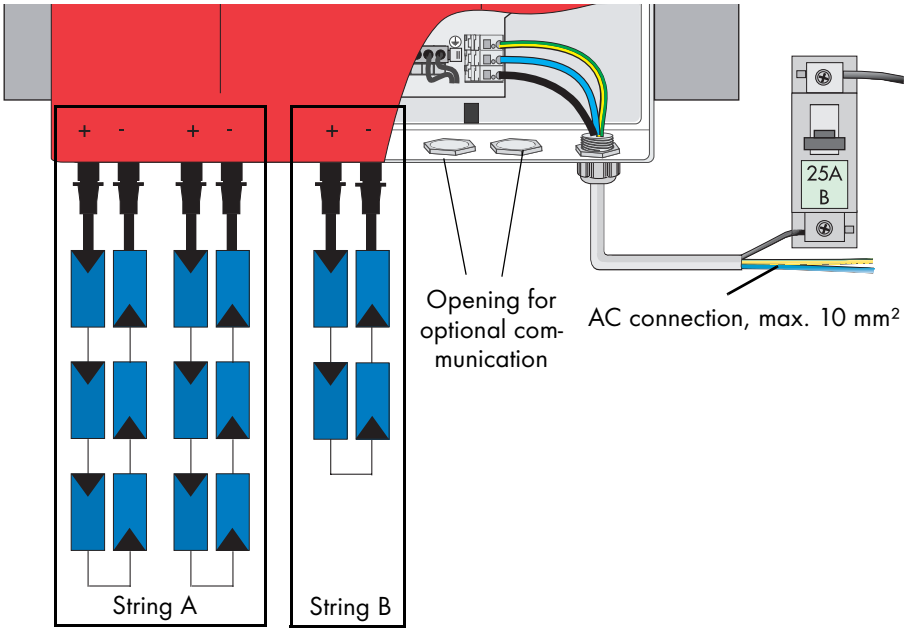


6. 2 Electrical Installation

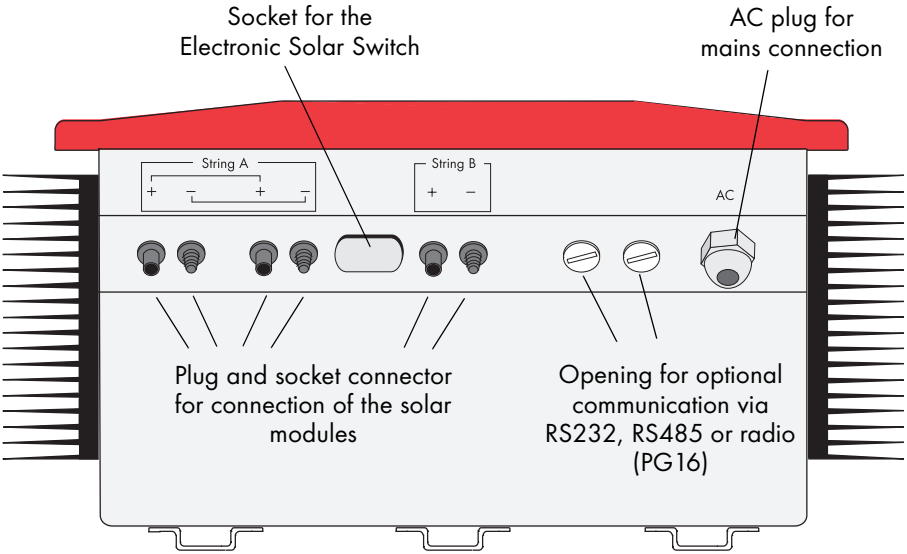
Notice!

Make sure to check the polarity of the strings before connecting them!

The complete wiring for a Sunny Boy is shown schematically in the following diagram:



View from below



6.2. 1 Connecting the AC Output

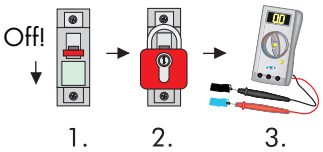
To connect the AC cable, proceed as follows:

1. Check the grid voltage. The Sunny Boys were prepared for the DIN VDE 0126–1-1 in two steps. In the first step the inverter disconnects from the grid when the grid voltage exceeds 253 V.

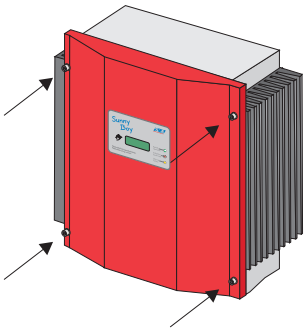
   In the second step the Sunny Boy can feed into the public grid at a maximum output voltage of 260 V for brief periods. However, DIN VDE 0126-1-1 stipulates that the 10-minute average must not exceed a voltage of 253 V. That means, if the grid voltage is constantly 254 V (e.g.), the inverter disconnects itself from the grid. In this case, contact the local grid operator for assistance.

   DIN VDE 0126-1-1 only applies in Germany. See section 8.4. 3 "Country-specific Parameter Settings" (Page 43) for all other preset country values of your inverter.

2. Isolate the grid connection (switch the line circuit breaker to its "off" position), make sure it cannot be switched back on, and test to make sure no voltage is present.

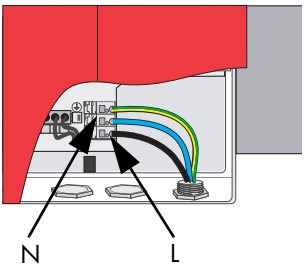


3. Remove the screws that secure the case of the Sunny Boy and carefully remove the cover. Remove the PE connection from the cover.

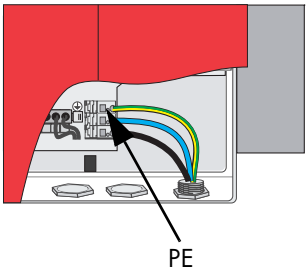


4. Connect the main cables as shown in the figure. Use the supplied cable feed-through.

   "L" and "N" must not be swapped.



5. Connect the earth wire (PE) of the mains cable to the upper screw terminal with the earth sign.



6. Reconnect the PE connection on the cover. Fix the housing cover of the and tighten the four screws evenly.

Notice!

A normal operation of your Sunny Boy requires, among other things, connecting the PE conductor to the equipotential bonding of the building. Please check the prescribed PE connection from the Sunny Boy enclosure to protective earth when commissioning the device!

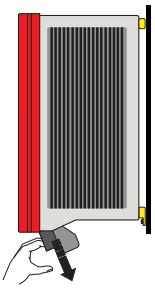
Notice!

Do not switch the line circuit breaker on yet! The Sunny Boy may only be connected to the AC grid once the PV strings are connected and the device is securely closed.

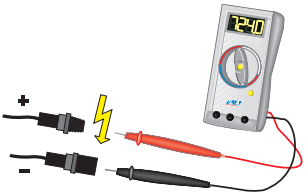
6.2. 2 PV String (DC) Connection

To connect up the DC input, follow these steps:

1. Remove the Electronic Solar Switch.



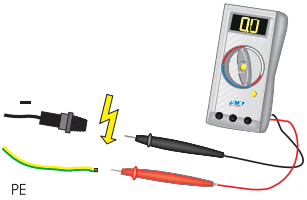
2. Make sure the PV generator connectors have the right polarity and do not exceed the maximum string voltage of 750 V (DC). See also section 5. 2 "PV Generator Requirements" (Page 15).



Warning!

Dangerous high voltages may be present. Danger of death!

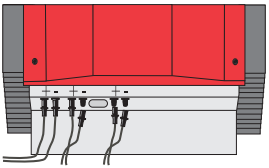
3. Taking one DC plug connector at a time, measure the direct current voltage between one DC plug connector of a string and earth potential.
4. If the measured voltages are constant and if their total is roughly the same as the open circuit voltage of the string, then there is a ground fault in this string. Its approximate location can be deduced from the relationships between the voltages.



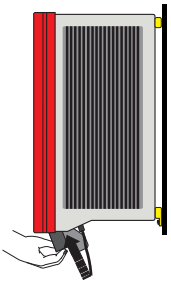
Notice!

Do not connect strings to the Sunny Boy that contain a ground fault until you have fixed the earth fault in the PV generator!

5. Repeat points 2 and 3 for each string.
6. Connect up the faultless PV generator strings to the inverter. Ensure the assignment of the strings is correct.
7. Close the unnecessary DC input sockets with the caps included in the delivery.



8. Attach the handle of the Electronic Solar Switch.



Notice!

The Electronic Solar Switch can become damaged if it has not been attached properly.

Firmly insert the handle all the way into the socket in the Sunny Boy and check that it is firmly inserted. Never tighten the screws of the socket inside the Sunny Boy in order to avoid that the socket locks in place.

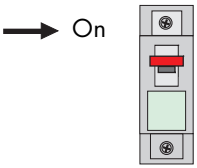
6. 3 Startup

You can start up the Sunny Boy when

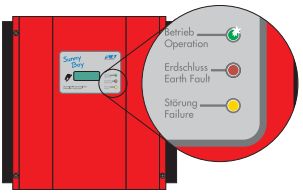
- the enclosure's cover is securely screwed shut,
- the AC (mains) cable is connected correctly,
- the DC cables (PV strings) are fully connected and the unused DC plug connectors on the bottom of the enclosure are closed using the protective caps.

How to Start up the Inverter

1. First of all, switch the line circuit breaker to the "on" position.



2. Now look at the LED display and consult the table on the following page to check whether the Sunny Boy is in a fault-free and expedient operating mode. Once the inverter is in a fault-free operating status, commissioning is successfully completed.



Notice!

If the bottom yellow LED flashes four times at intervals of one second, the grid voltage and the PV generator must be disconnected from the Sunny Boy immediately! There is a risk of damage to the inverter resulting from excessive DC input voltage.

Check the string voltages again to make sure they are within the limits stated in section 5. 2 "PV Generator Requirements" (Page 15). If the string voltages are too high, the PV generator's planner/installer should be called upon for assistance.

If despite checking the string voltages the LED signal occurs again when the PV generator is connected to the SUnny Boy, disconnect the PV generator from the Sunny Boy again and contact **SMA** Technologie AG (see section 13 "Contact" (Page 61)).

Green	Red	Yellow	Status
Illuminates continuously	Is not illuminated	Is not illuminated	OK (working mode)
	Illuminates continuously	Is not illuminated	Disturbance
		Illuminates continuously	OK (initialization)
Flashes quickly (3 x per second)	Is not illuminated	Is not illuminated	OK (stop)
	Illuminates continuously	Is not illuminated	Disturbance
Flashes slowly (1x per second)	Is not illuminated	Is not illuminated	OK (waiting, grid monitoring)
Briefly goes out (approx. 1 x per second)	Illuminates continuously	Is not illuminated	Disturbance
	Is not illuminated	Is not illuminated	OK (derating)
Is not illuminated	Is not illuminated	Is not illuminated	OK (night shutdown)
		Illuminating/flashing	Disturbance
	Illuminates continuously	Is not illuminated	Disturbance
		Illuminating/flashing	Disturbance

For a detailed description of the fault messages and their causes, see the operating instructions.

7 Opening and Closing the Sunny Boy

Notice!

If you need to open the device for whatever reason, please pay attention to section 3 "Safety Instructions" (Page 9).

7. 1 Opening the Sunny Boy

Notice!

Follow the sequence below under all circumstances.

1. Switch the line circuit breaker to the "off" position.
2. Remove the Electronic Solar Switch.
3. Immediately remove the DC cables from the Sunny Boy in order to completely disconnect the PV-generator from the Sunny Boy.
4. **Wait 30 minutes!**
5. Remove the four screws from the enclosure cover and pull the cover forward smoothly. Remove the PE connection from the cover. Loosen the locking on the PE connectors on the cover when you remove them.

7. 2 Closing the Sunny Boy

Caution!

Follow the sequence below under all circumstances.

1. Reconnect the earth wire (PE) to the housing cover. Now secure the housing cover to the Sunny Boy by tightening the four screws evenly. The screws must be tightened with approximately 4 Nm torque in order to guarantee the sealing of the enclosure.
2. Connect the PV generator. Ensure the assignment of the strings is correct.
3. Check the Electronic Solar Switch for wear as described in chapter 9 "Inspection of the Electronic Solar Switch" (Page 45).
4. Firmly insert the handle into the socket of the Electronic Solar Switch's in the bottom of the Sunny Boy.

Notice!

The Electronic Solar Switch can become damaged if it has not been attached properly.

Firmly insert the handle all the way into the socket in the Sunny Boy and check that it is firmly inserted. Never tighten the screws of the socket inside the Sunny Boy in order to avoid that the socket locks in place.

5. Switch the line circuit breaker to the "on" position.
6. Now check whether the LED display indicates that the Sunny Boy is functioning correctly.

8 Technical Data

8. 1 PV generator connection data

Description	Short description	Setting	
		SB 4200TL HC	SB 5000TL HC
Max. input voltage	$U_{DC, max}$	750 V [a]	
Input voltage, MPP range	U_{PV}	125V ... 750 V	
Max. input current	$I_{PV max}$	11 A for each input area "String A" and "String B"	
Max. input power	P_{DC}	4400 W	5300 W
Voltage ripple	U_{pp}	< 10 % of the input voltage	
Operating consumption		< 10 W (standby)	

a) Ensure that the maximum input open-circuit voltage occurring at a cell temperature of -10 °C does not exceed the specified maximum input voltage.

8. 2 Grid connection data

Description	Short description	Setting	
		SB 4200TL HC	SB 5000TL HC
Nominal output power	P_{ACnom}	4000 W	4600 W
Max. output power	P_{ACmax}	4200 W	5000 W
Nominal output current	I_{ACnom}	17.5A	20A
Harmonic distortion of output current (at K_{Ugrid} < 2 %, P_{AC} > 0.5 P_{ACnom})	K_{IAC}	< 3 %	
Operating range, grid voltage	U_{AC}	180 - 260 V AC Germany: 198 - 260 V AC [b]	
Operating range, grid frequency	f_{AC}	45.5 - 52.5 Hz Germany: 47.55 - 50.2 Hz	
Phase shift angle (based on the current's fundamental frequency)	cos phi	1 (at nominal power output)	
Overvoltage category		III	
Test voltage (50 Hz)		1.65 kV (1 s routine testing / 5 s type testing)	
Test surge voltage		4 kV (1.2/50 ms) (serial interface: 6 kV)	
Internal consumption in night mode		0.25 W	

b) The Sunny Boy can temporarily feed power into the grid with a maximum output voltage of 260 V. However, DIN VDE 0126-1-1 stipulates that the 10-minute average must not exceed a voltage of 253 V. That means, if the grid voltage is continuously 254 V (e.g.), the inverter disconnects itself from the grid. In this case, contact the local grid operator for assistance.

DIN VDE 0126-1-1 only applies in Germany. See section 8.4. 3 "Country-specific Parameter Settings" (Page 43) for all other preset country values of your inverter.

8. 3 General Data

For a detailed description of the devices, see the operating instructions.

General data	
Protection rating per EN 60529	IP65
Dimensions (w x h x d)	470 mm x 490 mm x 225 mm (approx.)
Weight	approx. 31 kg

Protective function DC side	
All-pole isolator on the DC input side	DC plug connector (ESS optional)
Overvoltage protection	Thermally monitored varistors
Personal protection	Ground fault monitoring (Riso > 1 MOhm)
Reverse polarity protection	Via short circuit diode

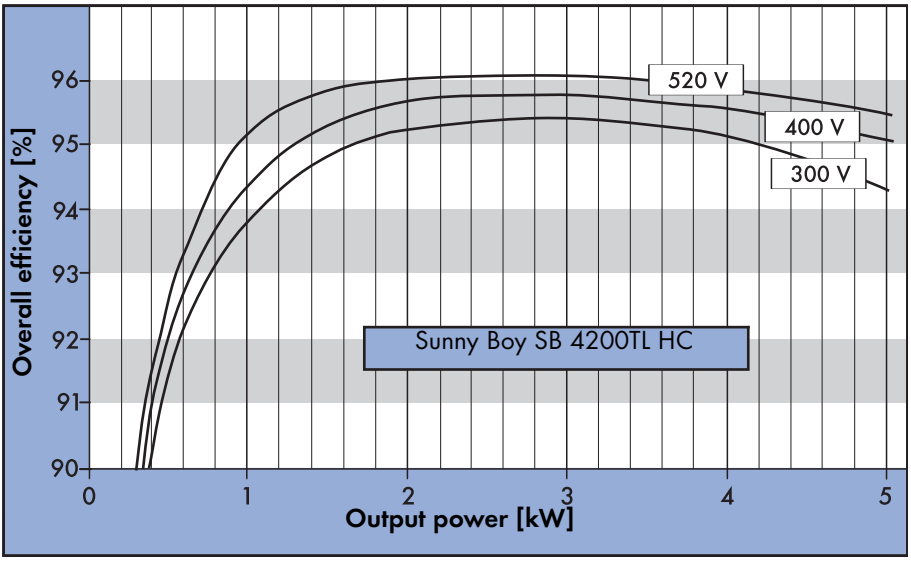
Protective function AC side	
Short-circuit proofing	Grid-side via current regulation
All-pole isolation on grid side	Independent disconnection device (SMA grid guard), double implementation

External interfaces	
Data transmission over mains power line	optional
Data transmission over separate data cable	Optional, RS232 / RS485, electrically separated
Wireless data transmission	optional

Efficiency Sunny Boy SB 4200TL HC Multi-String

Efficiency		
Max. efficiency	ηmax	96.1 %
European efficiency	ηeuro	95.5 %

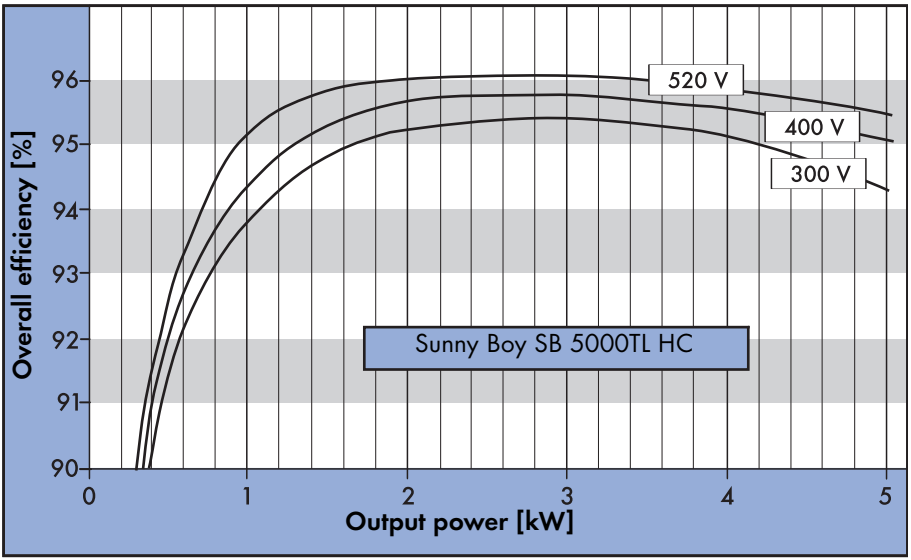
The efficiency of the Sunny Boy SB 4200TL HC depends greatly on the input voltage of the connected PV strings. The higher the input voltage, the higher the efficiency.



Efficiency Sunny Boy SB 5000TL HC Multi-String

Efficiency		
Max. efficiency	ηmax	96.2 %
European efficiency	ηeuro	95.6 %

The efficiency of the Sunny Boy SB 5000TL HC depends greatly on the input voltage of the connected PV strings. The higher the input voltage, the higher the efficiency.



8. 4 Operating parameters

Warning!

Unauthorized changes to the operating parameters may result in:

- **injury or accidents as a result of changing the internal safety routines in the Sunny Boy,**
- **voiding the Sunny Boy's operating approval certificate,**
- **voiding the Sunny Boy's guarantee.**

Never change the parameters of your Sunny Boy without express authorization and instructions.

8.4. 1 Explanation of the Operating Parameters

Name	Explanation
ACVtgRPro	Surge voltage protection (only relevant for Germany). In Germany, Sunny Boys can feed into the public grid with up to 260 V AC. However, DIN VDE 10-0126-1 stipulates that the average AC voltage over 1 minutes must not exceed 253 V. If the average over 10 minutes exceeds the threshold value of 253 V, the inverter disconnects itself from the grid. Once the average over 10 minutes returns to a value of less than 253 V, the inverter returns to "Working" mode. If surge voltage protection is not required in the relevant grid area (outside Germany), it can be deactivated by means of presetting the LDVtgC parameter. In this event, only the fast cut-off via the Uac-Max parameter intervenes.
AntiIsland-Ampl	Amplification of the AntiIsland process (alternative AntiIslanding process, which is deactivated for Germany).
AntiIsland-Freq	Repetition rate of the AntiIsland process (alternative AntiIslanding process, which is deactivated for Germany).
Betriebsart	Operating mode of the Sunny Boy: MPP: Maximum Power Point UKonst: constant voltage mode (desired voltage is defined in "Usoll-Konst") IKonst: Operating mode for test purposes Stopp: disconnection from grid, no operation

Name	Explanation
Default	Used for setting the country-specific information. GER/VDE0126-1-1: Country-specific parameter settings for Germany in accordance with DIN VDE 0126-1-1 GB: Country-specific parameter settings for Great Britain IT: Country-specific parameter settings for Italy Other: Here, parameter settings can be defined for countries for which no predefined setting exists. Trimmed: If country-specific parameters have been changed, "trimmed" is shown in the display.
dFac-Max	Maximum "mains frequency change" before the mains monitoring system disconnects the device from the mains supply.
dZac-Max	Maximum "grid impedance change" before the grid monitoring system disconnects the device from the grid.
E_Total	Total energy yield for the inverter. This change may be necessary when you exchange the Sunny Boy and want to use the data from the old device.
Fac-delta-	Maximum frequency, above (Fac-delta+) and below (Fac-delta-) the mains frequency, before the mains monitoring system disconnects the device from the mains supply.
Fac-delta+	
Fac-Tavg	Averaging time of grid frequency gaging
Firmware-BFR	Firmware version of the operation control unit (BFR)
Firmware-DC-BFR	Firmware version of the DC operation control unit (DC-BFR)
FirmwareSRR	Firmware version of the current control unit (SRR)
h_Total	Total hours of operation for the inverter. This change may be necessary when you exchange the Sunny Boy and want to use the data from the old device.
Hardware-DC-BFS	Hardware version of the DC operation control unit (DC-BFR)
Inst.-Code	Parameters for self contained power system recognition can only be changed after entering the SMA grid guard password.

Name	Explanation
LDVtgC	Compensation for the voltage drop in the cabling. With this parameter, the voltage drop between the inverter and the grid connection point is taken into account. The average voltage over 10 minutes at the inverter connection must not exceed the sum of ACVtgRPro plus LDVtgC. The parameter LDVtgC is preset to 0 V for Germany. In grid areas in which the additional surge voltage protection (see parameter ACVtgRPro) is not required, the parameter LDVtgC is preset to 50 V. Thus, the surge voltage protection is deactivated for these grid areas (253 V + 50 V = 303 V) and only the fast cut-off via the Uac-Max parameter intervenes.
Ni-Test	Impulse setting for impedance monitoring. This parameter takes effect when the Sunny Boy is deactivated (disconnected on the AC side) or put to "Stopp" mode.
Plimit	Upper limit for AC output power
Ripple-Ctl-Frq Ripple-Ctl-Lev Ripple-Ctl-Rcvr	The Ripple-Ctl-Frq, Ripple-Ctl-Lev, Ripple-Ctl-Rcvr parameters are intended to handle ripple control signals from the SMA inverters. These parameters are not available for all inverters. These parameters may only be changed after prior agreement with **SMA** Technologie AG.
Riso-Min	Lower limit of the allowable insulation resistance
SMA-Grid-Guard	SMA grid guard version number
SMA-SN	Serial number of the Sunny Boy
Speicherfunkt.	Default Parameter: Returns all parameter values to the factory setting. Reset Betriebsdaten: Returns all user level parameter values to the factory setting. Reset Fehler: Resets a permanent fault.
Storage	Permanent: Modified parameters are stored in the EEPROM and can be used even when the Sunny Boy has been restarted. Volatil: Prevents the parameters being stored in the EEPROM, the parameters are only stored until the next restart.
T-Start	The period the Sunny Boy waits after all switch-on conditions have been satisfied.
Uac-Min Uac-Max	Lower (Uac-Min) and upper (Uac-Max) limits of the allowable AC voltage (self contained power system recognition), before the grid monitoring system disconnects the device from the grid.

Name	Explanation
Uac-Tavg	Averaging time of grid frequency gaging
Uzwk-Start	The DC voltage required before the Sunny Boy begins feeding power into the mains supply.
Usoll-Konst A	PV desired voltage for constant operational voltage. These parameters are only important when the "Betriebsart" parameter is set to U-konst.
Usoll-Konst B	

8.4. 2 Parameter settings for Germany

Grayed out parameters are only displayed in installer mode. The table below contains the parameters that are applicable in Germany. The Sunny Boys were prepared for the DIN VDE 0126-1-1 in two steps. The table specifies the settings that are respectively valid.

Name	Short descr.	Value range	Factory setting
ACVtgRPro	V	230 ... 300	253
AntiIsland-Ampl *	grd	0 ... 10	0
AntiIsland-Freq *	mHz	0 ... 2000	500
Betriebsart		MPP, IKonst, UKonst, Stopp,	MPP
Default *		GER/VDE0126-1-1, IT/DK5950, Other, trimmed	GER/VDE0126-1-1
dFac-MAX *	Hz/s	0.1 ... 4.0	4.0
dZac-MAX *	mOhm	350 ... 20000	600
E_Total	kWh	0 ... 200000	0
Fac-delta- *	Hz	0.1 ... 4.5	2.45
Fac-delta+ *	Hz	0.1 ... 4.5	0.19
h_Total	h	0 ... 200000	0
Inst.-Code			
LDVtgC	V	0 ... 50	0
Ni-Test *		0 / 1	1
Ripple-Ctl-Frq	Hz	110 ... 1605	1605
Ripple-Ctl-Lev	%	0.5 ... 8.00	8

Name	Short descr.	Value range	Factory setting
Ripple-Ctl-Rcvr		enable, disable, auto	auto
Riso-Min	kOhm	1500 ... 30000	1500
Speicherfunkt.		Default Parameter, Reset Betriebsdaten, Reset Fehler	none
T-Start *	s	2 ... 300	2
Uac-Min *	V	160 ... 230	198
Uac-Max *	V	230 ... 300	260
Usoll-Konst A	V	0 ... 750	290
Usoll-Konst B	V	0 ... 750	290

*Parameters designated with * are safety-related grid monitoring parameters. To change the SMA grid guard parameters, you must enter your personal SMA grid guard password (Inst.-Code). Please call the SMA Service Line to obtain your personal SMA grid guard password.*

8.4. 3 Country-specific Parameter Settings

The parameters listed below represent country-specific settings and are only displayed in installer mode. All other parameters are international and can be viewed in the table in section 8.4. 2.

Name	**Short descr.**	**Country settings**		
		Germany	**Italy**	**Great Britain**
Default		GER/VDE0126-1-1	IT	GB
dFac-Max	Hz/s	4.0	0.20	0.25
dZac-Max	mOhm	600	350	350
Fac-delta-	Hz	2.45	0.29	0.5
Fac-delta+	Hz	0.19	0.29	0.5
Ni-Test		1	0	0
T-Start	s	2	2	180
Uac-Min	V	198	198	209
Uac-Max	V	260	260	261

8.4. 4 Non-modifiable Parameters

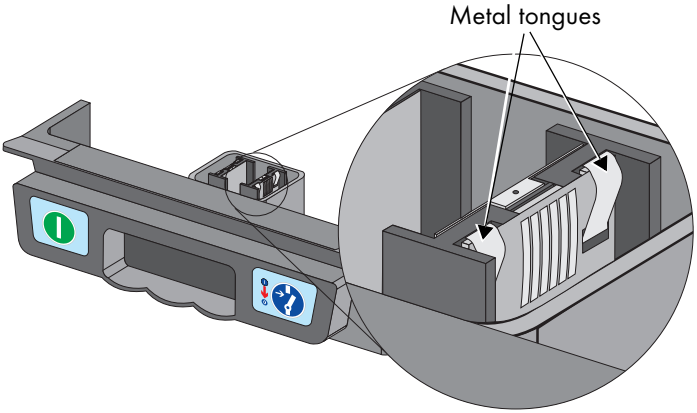
The following parameters are displayed in the parameter list but cannot be changed:

Name	**Short descr.**	**Factory setting**	
		SB 4200TL HC	**SB 5000TL HC**
Fac-Tavg	ms	160	160
Firmware-DC-BFR			
Hardware-DC-BFR			
Plimit	W	4200	5100
SMA-SN			
Software-BFR			
Software-SRR			
Uac-Tavg	ms	80	80

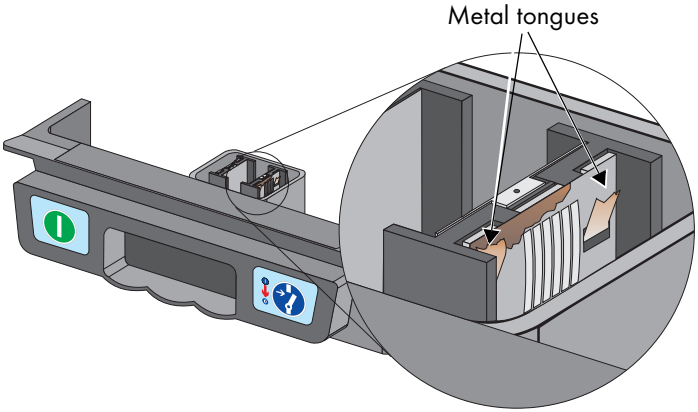
9 Inspection of the Electronic Solar Switch

Check the Electronic Solar Switch for wear before plugging it in.

Check if the metal tongues inside the plug show brown discolorations.



The Electronic Solar Switch can no longer safely disconnect the DC side if one of the metal tongues is completely worn out (see figure below). The Electronic Solar Switch must then be exchanged.



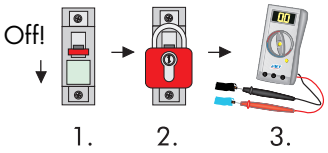
Replacements for damaged Electronic Solar Switch handles are available from SMA.

10 Replacing the Varistors

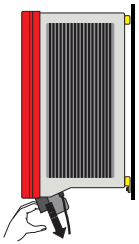
The Sunny Boy is a complex high-technology device. As a result, the possibilities for fixing faults on site are limited to just a few items. Do not attempt to carry out repairs other than those described here. Use the **SMA** Technologie AG 24-hour exchange service and repair service instead.

If the red LED on the status display glows continuously during operation, you should first of all make sure that there is no ground fault in the PV generator. Only skip points 3 to 5 if the green LED is permanently lit at the same time.

1. Disconnect the Sunny Boy from the low-voltage grid (switch the line circuit breaker to its "off" position). Make sure the grid cannot be inadvertently reconnected and test to make sure no voltage is present at the AC output.

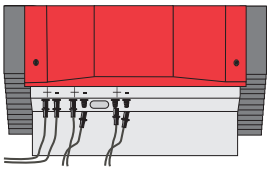


2. Remove the Electronic Solar Switch.

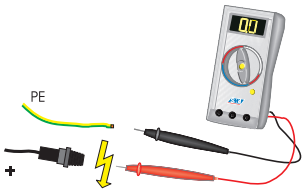


3. Immediately remove the DC cables from the Sunny Boy in order to completely disconnect the PV-generator from the Sunny Boy.

   Make sure you note the order of the individual inverter inputs so you can put them back in the right place later!



4. Taking one DC plug connector at a time, measure the voltages between one DC plug connector of a string and earth potential. Pay attention to the safety instructions!



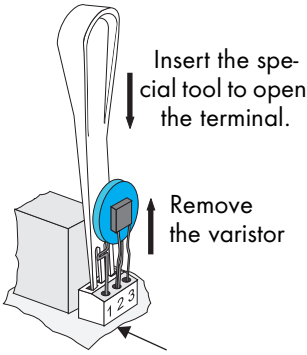
Warning!

Dangerous high voltages may be present. Danger of death!

5. If the measured voltages are constant and if their total is roughly the same as the open-circuit voltage of the string, then there is an ground fault in this string. Its approximate location can be deduced from the relationships between the voltages.
6. Repeat points 3 and 4 for each string.

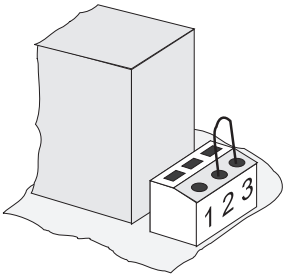
   If you found a ground fault, it is probably not necessary to replace the varistors. Instead, make sure the ground fault is fixed. Generally the PV generator's installation engineer should be hired for this job. In this case continue as described under point 10, but without reconnecting the faulty string. Instead of reconnecting the string, protect its DC plug against accidental touch contact (e.g. by fitting the protective caps or using sufficient high-voltage insulating tape).

   If you did not find any ground fault in the PV generators, it is likely that one of the thermally monitored varistors has lost its protective function. These components are wearing parts. Their functioning diminishes with age or following repeated responses as a result of overvoltages. You can now check these varistors in the following way, paying attention to the safety instructions in section :3 "Safety Instructions" (Page 9)
7. Remove the screws that secure the cover and remove the cover from the Sunny Boy. Disconnect the PE connection from the cover. Make sure that no voltage is present.
8. Using a continuity tester, check all the varistors to see if there is a conducting connection between connectors 2 and 3. If there is no connection, then that varistor is not working. The positions of the varistors in the Sunny Boy can be seen in the diagram in section 4. 1 "Unit Description" (Page 11).
9. Replace the varistor concerned with a new one as shown in the drawing to the right. Ensure the varistor is installed the right way round! If you do not receive a special tool for operating the terminal clamps with your replacement varistors, contact SMA. As an alternative, the terminal contacts can be operated using a suitable screwdriver. Since the failure of one varistor is generally due to factors that affect all varistors in a similar way (temperature, age, inductive overvoltages), it is highly recommended that you replace all three varistors, not just the one that is obviously defective. The varistors are specially manufactured for use in the of the Sunny Boy SB 4200TL HC Multi-String and SB 5000TL HC Multi-String and are not commercially available. They must be ordered directly from SMA Technologie AG (**SMA** order code: „MSWR-TV6“).



The pole with the small loop (crimp) must be fitted to terminal 1 when replacing the varistor.

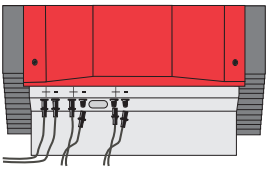
10. If no replacement varistors are available on site, the Sunny Boy can temporarily run without them. To do this, remove the varistors you identified as being faulty and in their place, bridge the terminals 2 and 3 with a length of wire.



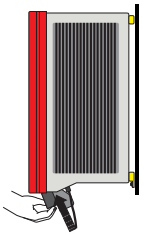
Notice!

The input modified in this way is no longer protected against overvoltages! Replacement varistors should be obtained as soon as possible. In systems with a high risk of overvoltages, the Sunny Boy should not be operated without varistors.

11. Reconnect the PE connection to the cover and close the Sunny Boy.
12. Connect up the faultless PV generator strings to the inverter. Ensure the assignment of the strings is correct.
13. Close the unnecessary DC input sockets with the caps included in the delivery.



14. Attach the handle of the Electronic Solar Switch.

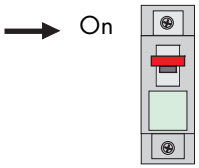


Notice!

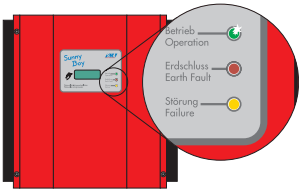
The Electronic Solar Switch can become damaged if it has not been attached properly.

Firmly insert the handle all the way into the socket in the Sunny Boy and check that it is firmly inserted. Never tighten the screws of the socket inside the Sunny Boy in order to avoid that the socket locks in place.

15. Switch the line circuit breaker to the "on" position.



16. Now check whether the LED display indicates that the Sunny Boy is functioning correctly.

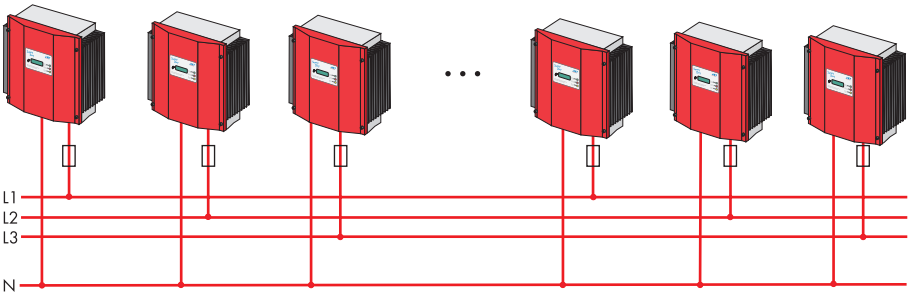


If no ground fault and no defective varistor were found, there is probably a fault in the Sunny Boy. In this case, contact the SMA Service Line to discuss what to do next.

11 Rating for a Line Circuit Breaker

Example for the thermal rating for a line circuit breaker in a photovoltaic electrical power unit operated in grid-parallel mode.

A PV system with 9 inverters type Sunny Boy SB 4200TL HC Multi-String or Sunny Boy SB 5000TL HC Multi-String is assumed, with 3 inverters per phase.



Required technical information for the inverters used

- Maximum output current = 19 A (Sunny Boy SB 4200TL HC Multi-String)
  22 A (Sunny Boy SB 5000TL HC Multi-String)
- Maximum permissible fuse protection for the inverter = 25 A

The choice of cable together with the way it is routed, ambient temperatures and other underlying conditions limit the maximum fuse protection for the cable.

- In our example we assume that the chosen cable (6 mm²) is ideally routed and can take a nominal current of 32.2 A.

Selecting a line circuit breaker:

- The maximum possible nominal current for the cable used and the maximum possible fuse protection for the inverter now limit the maximum possible nominal current for the line circuit breaker.
- In our example, 25 A is possible.

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

When selecting line circuit breakers, a number of load factors need to be taken into account. These can be found in the respective data sheets.

Example for the thermal selection of a 25 A line circuit breaker with B sensitivity with no gap between the circuit breakers:

For example, one manufacturer's circuit breaker may be designed for an ambient temperature of 50 °C.

Load factors according to data sheet specifications:

- Reduction through permanent load >1h = 0.9[a]
- Reduction when 9 circuit breakers are arranged side-by-side without gaps = 0.77 [b]
- Increase in nominal current as a result of ambient temperatures of 40 °C in the circuit breaker panel = 1.07 [c]

Result:

The nominal load current for the line circuit breaker is calculated as:

Ibn = 25 A x 0.9 x 0.77 x 1.07 = 18.5 A

Summary:

The selected line circuit breaker cannot be used in our example case since the maximum current-carrying capacity for fault-free operation is lower than the maximum output current of the inverter used. **It will trip under rated operating conditions!**

In this case one solution would be to ensure there is an 8 mm gap between the circuit breakers. This would mean that the reduction factor is 0.77 instead of 0.98. As a result, the maximum current-carrying capacity would be 23.6 A.

In addition to the thermal rating of the circuit breakers, the boundary conditions as laid out in section "Rating for a Line Circuit Breaker in a Photovoltaic Electrical Power Unit Operated in Grid-parallel Mode" (Page 17) and the applicable DIN VDE standards also need to be taken into account, of course. The main ones that apply here are:

- DIN VDE 0100, part 410
- DIN VDE 0100, part 430
- DIN VDE 0298, part 4

In special applications the relevant standards must be followed.

a. Permanent loads longer than 1 hour are possible in photovoltaics.
b. When only one circuit breaker is used, this factor = 1
c. Due to the fact that the circuit breakers are rated for 50 °C.

12 The Communications Interface

Installation or replacement of the communications interface is only to be carried out by a qualified electrician.

The communications interface is used to communicate with SMA communication devices (e.g. Sunny Boy Control, Sunny WebBox) or a PC with appropriate software (e.g. Sunny Data). Depending on the selected communications interface, up to 2500 inverters can be interconnected. Detailed information on this topic can be found in the communication device manual, the software, or on the Internet at www.SMA.de.

Depending on the type of interface, there are two different ways to install the communications interfaces:

- RS232, RS485, Radio Piggy-Back
  (see section 12. 1 "Connection RS232, RS485, Radio Piggy-Back" (Page 54))
- Powerline
  (see section 12. 2 "Powerline Connection" (Page 56))

The detailed wiring diagram for the individual communications interfaces can be found in the communication device manual. This wiring diagram includes the following information:

- Details on the required cable type
- Which of the inverter's connections are used
- Whether jumpers need to be mounted, and if so, which jumpers
- Whether the PE needs to be connected to the cable shield

The next pages will describe the following:

- The enclosure feed-throughs for the communications interface
- The permitted cable route in the Sunny Boy
- The location of the PE connector
- The location of the screw terminals for connection of communication wires
- The location of the jumper slots
- The location of the interface port
- The location of the interface port for the PLC power module and the powerline modem

12. 1 Connection RS232, RS485, Radio Piggy-Back

This section describes the installation of the Piggy-Backs for the different Sunny Boy communication systems. RS232 Piggy-Back (SMA-Order No: 232PB-MS-NR), RS485 Piggy-Back (SMA-Order No:: 485PB-MS-NR), Funk Piggy-Back (SMA-Order No: BEAMPB-NR).

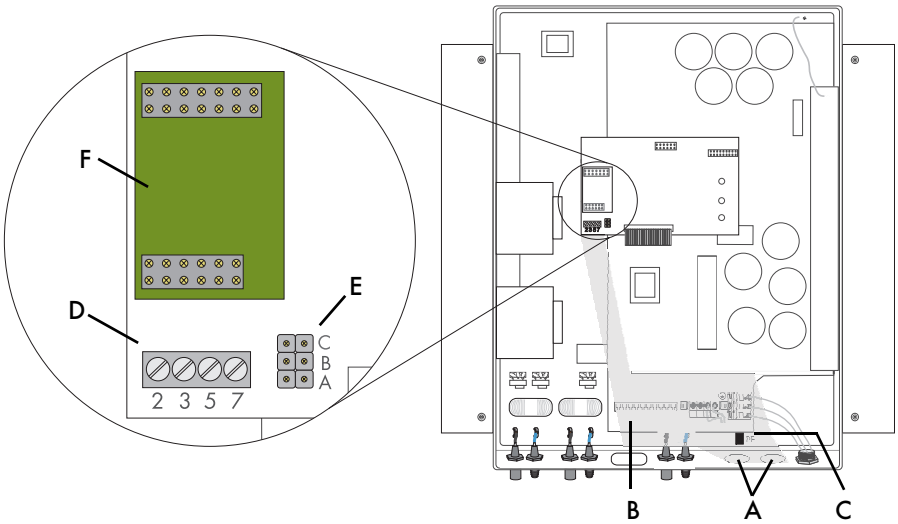
When opening the Sunny Boy, follow all the safety instructions as described in section 3.

Electrostatic discharges are an acute danger to the Sunny Boy and to the communications interface. Ground yourself by touching PE before removing the communications interface from the packaging, and before touching any components within the Sunny Boy.

Read the communication device manual before beginning installation work. Further wiring details can be found there.

1. Open the inverter as described in section 7. 1.
2. Guide the PG screw fitting over the communication cable.
3. Thread the cable through one of the cable feed-throughs (A) on the Sunny Boy. Use one or two cable feed-throughs, depending on the type of cable. Use the right-hand housing feed-through for the Radio Piggy-Back.
4. Screw the PG screw fitting onto the Sunny Boy.
5. Sheathe the cable inside the Sunny Boy using the silicon tube provided. The silicone tube is imperative for safety reasons. The interface is not to be operated without this silicone tube (with the exception of the Radio Piggy-Back).
6. Lay the cable in area (B) as shown in the figure to the right.
7. Ground the cable shield at the PE connector (C) if the connection diagram of the communication device indicates this as necessary.
8. Connect the communication wires to the screw terminal strip (D) as described in the terminal connection diagram of the communication device. Take note of the conductors' color coding. The devices can be damaged in case the cables are not connected correctly.
   - Pin 2 Color: _____
   - Pin 3 Color: _____
   - Pin 5 Color: _____
   - Pin 7 Color: _____

9. Connect the jumpers (E) if the connection diagram of the communication device indicates this as necessary. The table shown to the right provides an overview of the jumper functions.
10. Plug the communications interface to the left of the board (F).
11. Close the Sunny Boy as described in section 7. 2.



A Enclosure feed-throughs in the base of the Sunny Boy

B Cable route (gray surface)

C PE connector

D Screw terminals for connection of the communication wires

E Jumper slots

F Interface port

12.1. 1 Jumper Functions

	Jumper A	Jumper B	Jumper C
RS232	-	-	-
RS485	termination	bias 1	bias 2
Radio Piggy-Back	-	-	-

A detailed description of the jumper functions can be found in the communication device manual.

12. 2 Powerline Connection

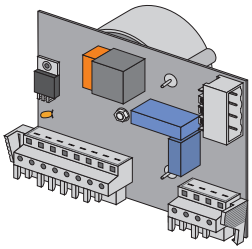
This chapter describes the installation of the "Powerline Kit" (SMA order number: NLMPB-MS-NR) for the mains grid communication in a Sunny Boy.

When opening the Sunny Boy, follow all the safety instructions as described in section 3.

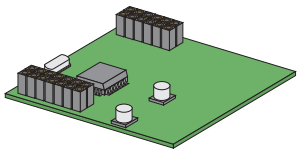
Electrostatic discharges are an acute danger to the Sunny Boy and to the communications interface. Ground yourself by touching PE before removing the communications interface from the packaging, and before touching any components within the Sunny Boy.

Read the communication device manual before beginning installation work. Further wiring details can be found there.

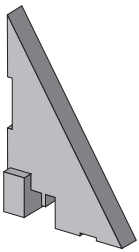
Two component groups must be installed in the Sunny Boy in order to make the mains grid communication possible. These component groups and a support for the power module are included in the "Powerline Kit" (SMA order number: NLMPB-MS-NR):



PLC power module

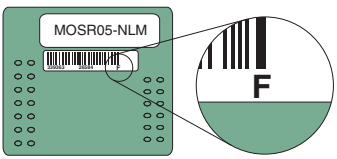


Powerline modem (NLM Piggy-Back)

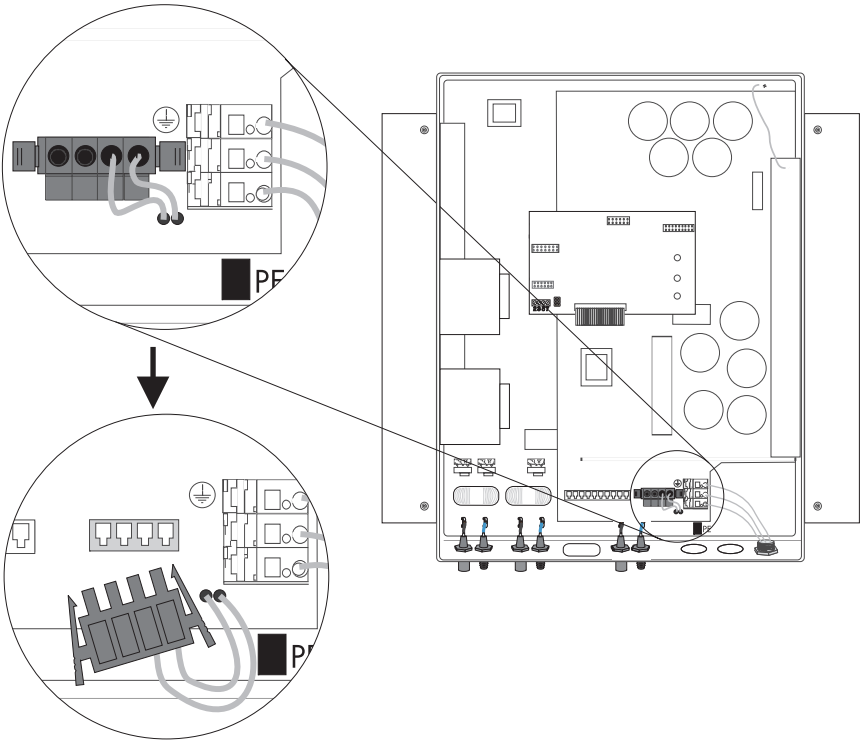


Support for the PLC power module

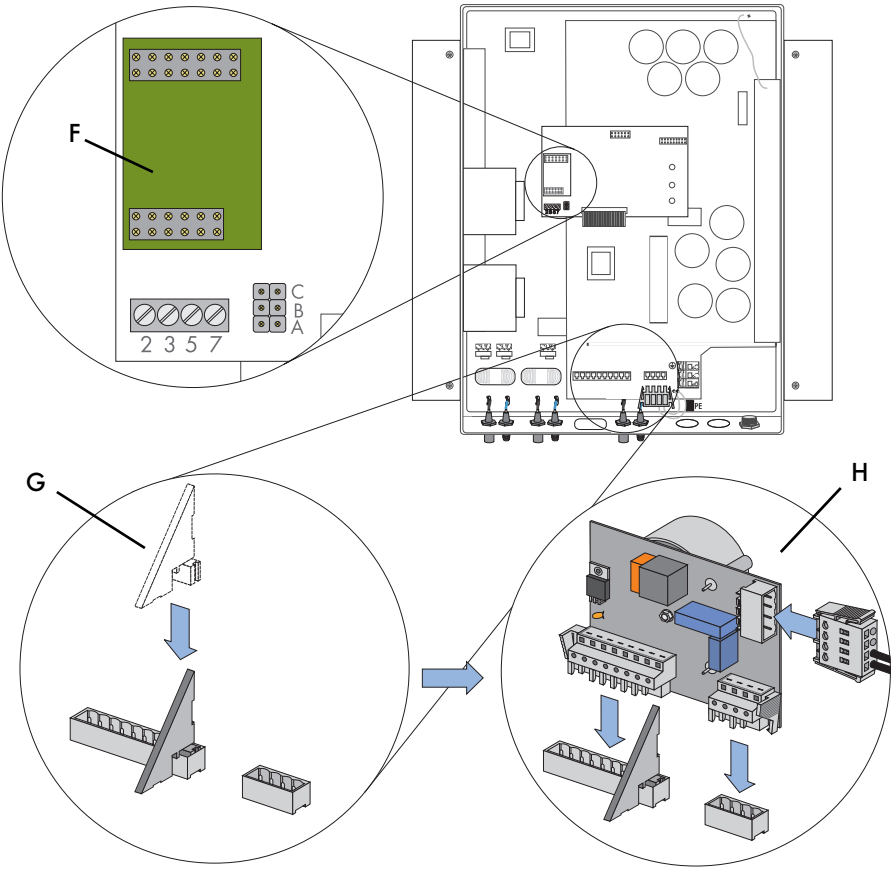
The Sunny Boy can only be operated with a powerline modem (NLM Piggy-Back) with version identifier "F" or higher. When installing the other (older) Piggy-Backs, mains grid connection is not possible. Please use therefore the powerline modem (NLM Piggy-Back) which is included in the "Powerline Kit".



1. Open the inverter as described in section 7. 1.
2. Press the lockings at the sides of the plug connector and remove them as displayed in the figure below.



3. Plug the NLM Piggy-Back into the board (F). Do not mount any jumpers.
4. Place the included support (G) of the PLC power module in the socket as seen in the figure (the rightmost). It must snap into place.
5. Then place the PLC power module (H) in the socket as seen in the figure. The PLC power module must snap into place.
6. Place the plug connector in the free socket of the PLC power module.
7. Close the Sunny Boy as described in section 7. 2.



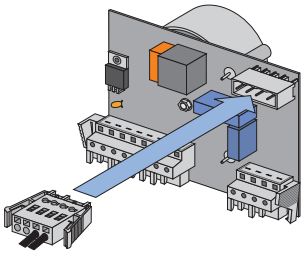
F Interface port

G Support

H PLC power module

Note on the Different PLC Power Module Variants

Different variants of the PLC power module may be delivered. The modules only differ in the location of the sockets for the plug connectors, which may be either horizontally or vertically arranged (see figure).



13 Contact

If you have any questions or technical problems concerning the Sunny Boy, contact the SMA Service Line. Have the following information available when you contact SMA:

- Inverter type
- Type and number of modules connected
- Communication
- Serial number of the Sunny Boy
- Blink code or display of the Sunny Boy

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Hannoversche Strasse 1 - 5
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