



Sunny Boy 3300TL

Transformerless String Inverter



Revision History

Document number	Changes	Author
SB3300TL-11:FE1905	First Issue	Riemenschneider

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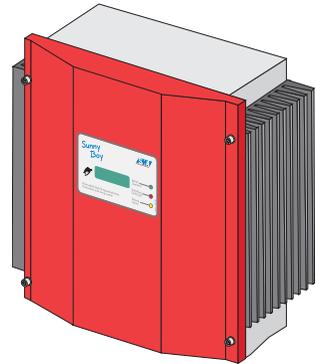
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1 Introduction

You have decided to use one of the most advanced devices for modular PV-system technology by purchasing a Sunny Boy 3300TL.

The Sunny Boys comply with all regulations from the VDEW (Association of German Electricity Utilities) for supplementary grid feeding to the low voltage electricity grid of the utility. This includes the regulations of the employee association (Berufsgenossenschaft für Feinmechanik und Elektrotechnik) concerning the „Independent Disconnection Device“ known as MSD (Mains monitoring device with allocated Switching Devices) and the regulations of the DIN VDE 0126. Furthermore, the Sunny Boy complies with the according harmonized standards and the low voltage regulations as certified in the CE declaration (see chapter 7.5 "Declaration of Conformity (CE)" (page 49)).



This document contains the „Operating Instructions“ of the Sunny Boy 3300TL. They are meant as guidelines on how to use all functions of the Sunny Boy 3300TL optimally and how to extend your existing PV-plant.

This part of device documentation especially deals with those topics that are relevant to the operation of the Sunny Boy 3300TL. For the installation of the Sunny Boy 3300TL please see the „Installation Guide“.

2 Safety Instructions

Opening the device and by that

- the electrical installation,
- the repair or
- the modification



of the Sunny Boy 3300TL may only be done by a qualified technician. Even if there are no external voltages on the device there may be high voltages that are hazardous to touch.

The temperature of individual parts of the enclosure of the Sunny Boy 3300TL – especially the one of the heat sinks – can reach 85 °C even in normal operation. There is a danger of burning yourself when touching the Sunny Boy.



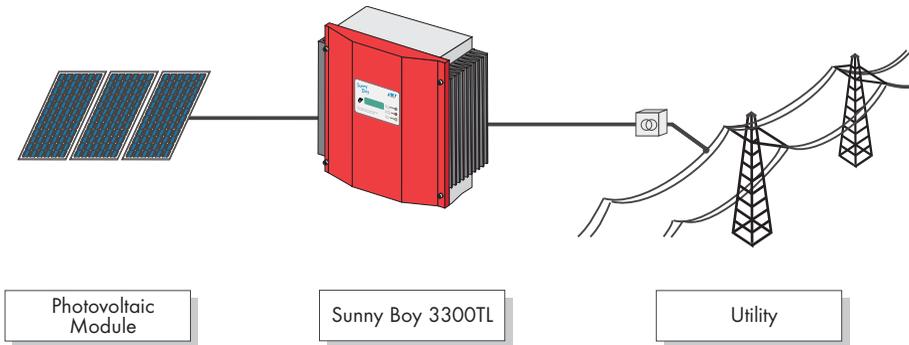
The Sunny Boy 3300TL is equipped with the self disconnecting electricity grid „SMA grid guard“. The Sunny Boy 3300TL therefore complies with the VDEW guidelines for grid interactive inverters and the DIN VDE 0126 (4.99) specified in this regulation.



3 Device Description

3.1 Application of the Sunny Boy

The Sunny Boy 3300TL is used in order to convert DC power from photovoltaic modules to AC voltage and subsequently feed this to the 230 V / 50 Hz utility. The technical data is specified in chapter 7 "Technical Documentation" (page 37) of this document.

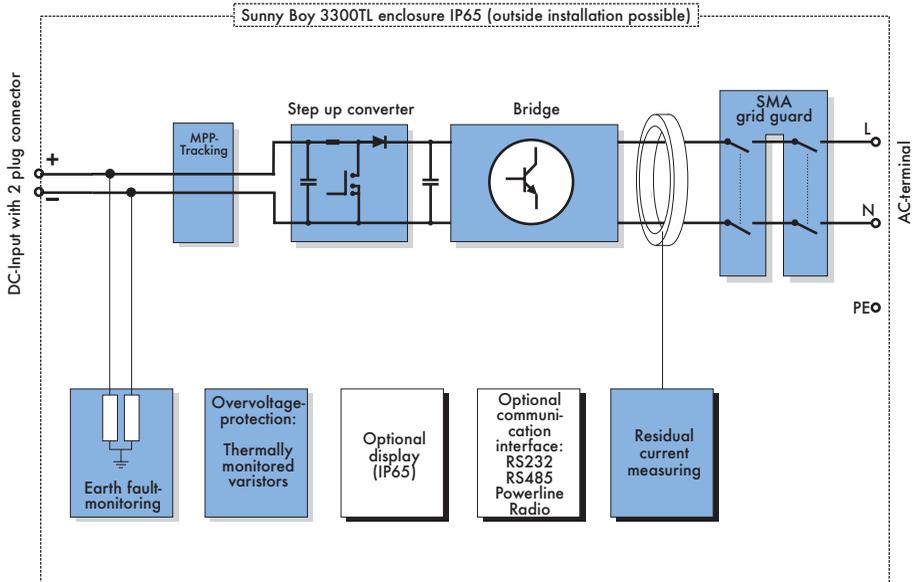


Usage of the Sunny Boy 3300TL in any other applications will void the warranty.

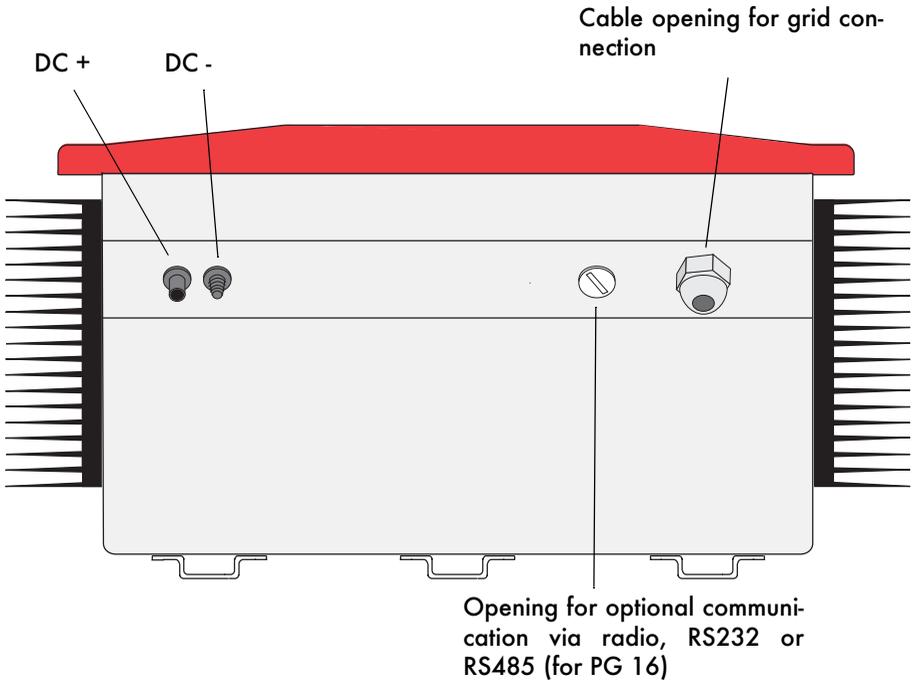
3.2 Device Design

We have focused on a simple functional design when developing the Sunny Boy string inverters. In its basic design the Sunny Boy 3300TL does not need more than three LEDs for status display. A display unit is available. The display can already be installed when your Sunny Boy is delivered or installed later.

The Sunny Boy 3300TL will operate fully automatically without any modification or configuration as long as it is installed and commissioned according to the technical specifications. It can nevertheless be modified in terms of operating parameters if necessary. An additional communication interface is required for this, which also can be used in order to acquire operating data for performance evaluation. Please have a look at chapter 6 "Plant Monitoring" (page 29) for details.

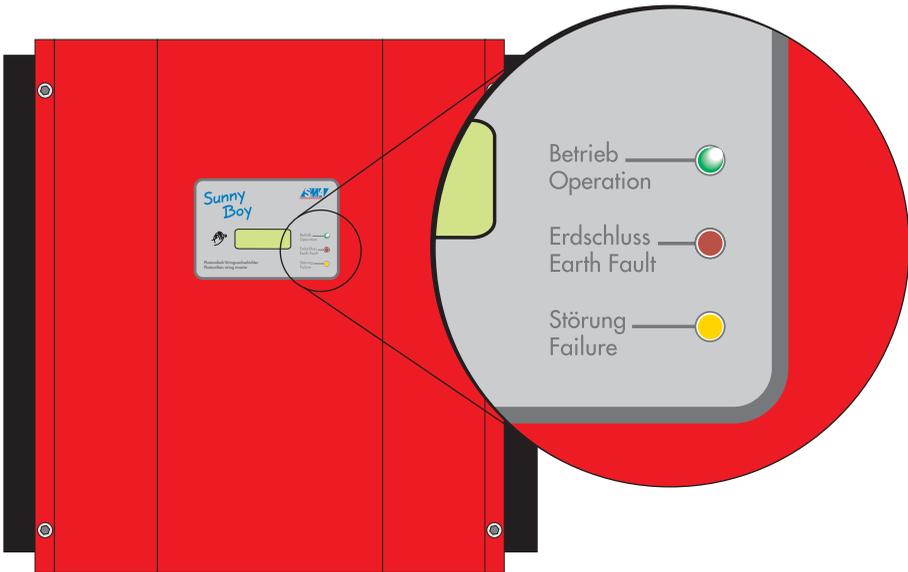


All connections to the PV-strings and the public grid as well as the optional communication cables are on the bottom of the Sunny Boy 3300TL.



3.3 Operating States

The different operating states are displayed with three LEDs in the lid of the Sunny Boy 3300TL.



Especially in the first year after installation the operator of the plant should regularly have a look at this display at different times of the day and at different irradiation.

You will find a complete description of all signal codes in chapter 3.3.4 "Description of Operating States" (page 12). The operating states can be divided into three categories:

3.3.1 Normal Operating States

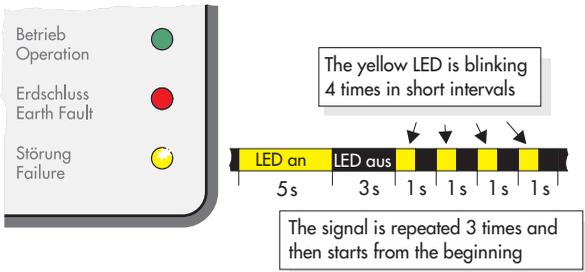
As long as no LED or only the green LED is blinking, the Sunny Boy 3300TL is in one of its normal operating states. If all three LEDs are on, the inverter is in its initialization phase which is a normal operating state as well. All other signals indicate a disturbed operating state.

3.3.2 Critical Failure States

Due to a comprehensive safety concept, the number of critical operating states can be reduced to one:

Input voltage exceeding specification

This is shown with the following blinking code of the yellow LED:



When the failure occurs, the yellow failure LED is on for five seconds and then starts to send the blinking code by remaining off for three seconds and blinking four times in short intervals. The code is sent three times. If the failure persists the code is repeated.

**Immediately disconnect the PV
The Sunny Boy can otherwise be damaged!**

3.3.3 Uncritical Failure States

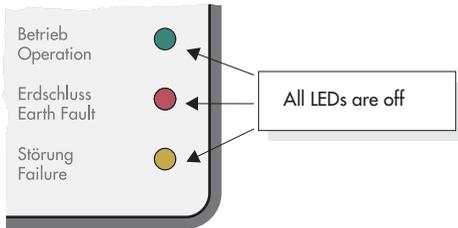
All other signaling codes show uncritical operating states that normally do not pose imminent danger of people or devices. However, their cause must be immediately found and removed in order to avoid yield losses.

Despite all necessary precautions additional failures which can not be signaled (e. g. failure of the status display) can occur. In order to be able to detect such failures as well, the operator should check the display of normal operating states for plausibility based on the explanations given in chapter 3.3.4 "Description of Operating States" (page 12). For example if the green LED is on at night, it indicates a failure in the same way as if no LED is on in full sunlight.

More detailed diagnoses are possible by one of the communication interfaces described in chapter 6 "Plant Monitoring" (page 29).

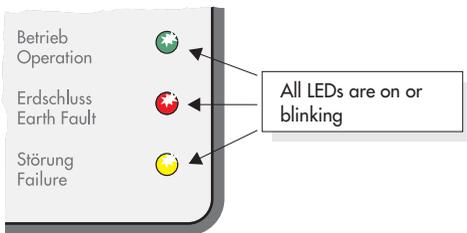
3.3.4 Description of Operating States

Stand-by at Night



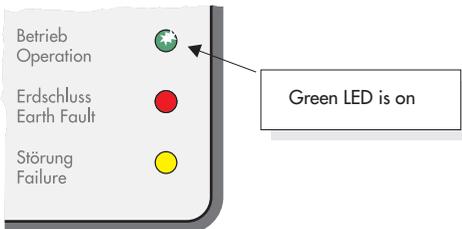
The Sunny Boy 3300TL is in so-called stand-by operation. This state is reached if the input power at the inverter is too low for feeding operation (all string voltages are below 125 V) and not sufficient for normal operation.

Initialization



The on-board computer of the Sunny Boy 3300TL is in the initialization phase. The DC input voltage at the Sunny Boy is above approx. 125 V. Power is already supplied to the internal board, but is not yet sufficient for grid feeding. Data transmission is not possible yet.

Feeding Operation

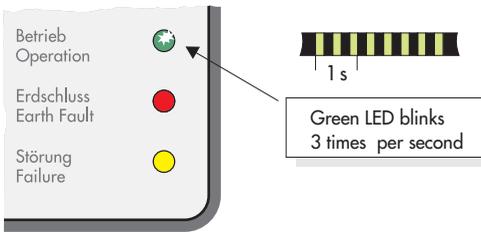


The Sunny Boy 3300TL has successfully completed the self-test of the measurement electronics and the MSD and starts feeding to the grid.

MPP operation (default):

The Sunny Boy 3300TL automatically determines the MPP voltage of the PV-generator.

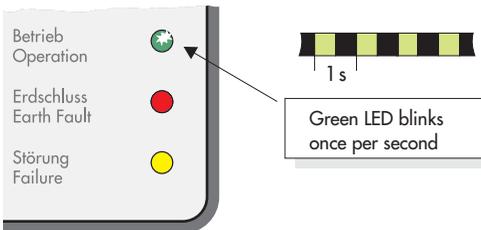
Stop



The Sunny Boy 3300TL is in stop state. This is to calibrate the measurement electronics, subsequently the inverter switches to „Waiting“ state.

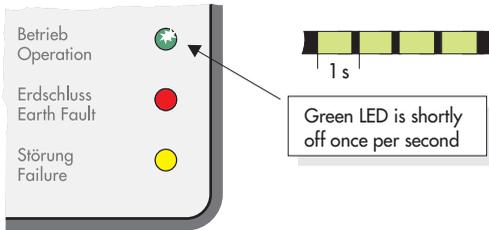
The „Stop“ state can also be set manually by the plant operator using the Sunny Boy Control or the PC program Sunny Data or Sunny Data Control. In this case, the Sunny Boy 3300TL remains in „Stop“ state until a new operating state is defined („MPP operation“ or „Constant voltage operation“).

Waiting, Grid Monitoring



The Sunny Boy 3300TL is testing whether start-up conditions for feeding operation are fulfilled (starting voltage, starting time) and then starts to monitor the grid.

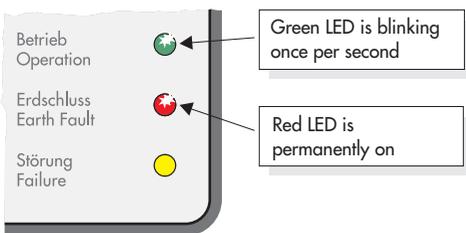
Derating



The operating state „Derating“ can have several causes:

- The temperature monitoring of the Sunny Boy 3300TL has reduced the output power to prevent the device from overheating. If this happens often, heat dissipation might be insufficient. In order to avoid unnecessary yield losses, it should be checked if the Sunny Boy 3300TL can be mounted at a more appropriate place with better ventilation.
- The input power is too high and the Sunny Boy 3300TL is operating at its operating limits.
- The current from one of the strings is about to exceed 8 A and the Sunny Boy 3300TL reduces this current to 8 A in order to prevent any damage.

Insulation Failure

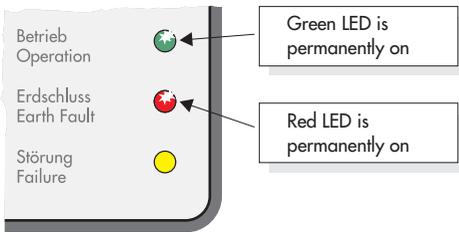


The red LED on the Sunny Boy 3300TL is on, which indicates an earth fault.



Please contact a qualified electrician who will remove the failure. For further information see the „Installation Guide“.

Varistor Defective

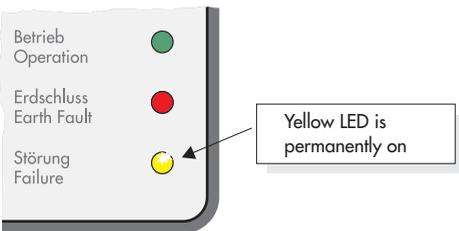


At least one of the four thermally monitored varistors on the DC input side has developed high resistance and is therefore defective.

Please contact a qualified electrician who will remove the failure. For further information see the „Installation Guide“.



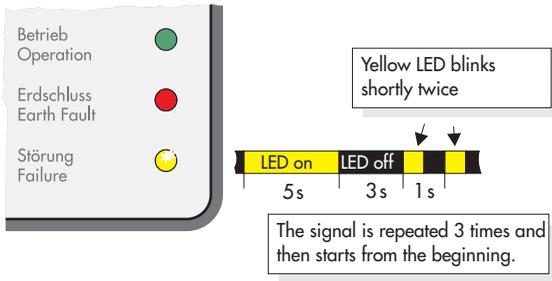
Permanent Device Disable



This signal appears in case of a failure of the grid monitoring / the independent disconnection device (MSD). During the internal test, the inverter has detected a malfunction of the MSD and has stopped feeding to the grid.

Normally this is a failure which cannot be removed on site. Please contact the manufacturer (see chapter 9 "Contact" (page 55)) to discuss further proceedings.

Grid Failure



When a grid failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking shortly twice. The code is repeated three times.

If the failure persists, the signal starts from the beginning.

The Sunny Boy 3300TL indicates a grid failure by the signal described above which can be caused by:

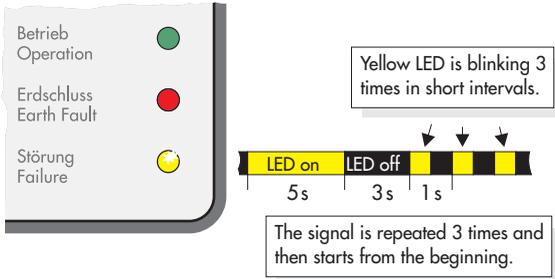
- Grid undervoltage ($U_{AC} < „U_{ac-Min}“$)
- Grid overvoltage ($U_{AC} > „U_{ac-Max}“$)
- Grid underfrequency ($f_{AC} < „f_{ac-Min}“$)
- Grid overfrequency ($f_{AC} > „f_{ac-Max}“$).
- Grid frequency change („|dFac|“)
- Defective grid connection (e. g. if N and L have been mixed up)

Find out if there is a general power shutdown (by checking the function of other consumers) and if the fuse of the inverter feeding cable is OK.



If you do not find any failure, the grid connection of the inverter has to be checked by a qualified electrician.

Grid Impedance too high

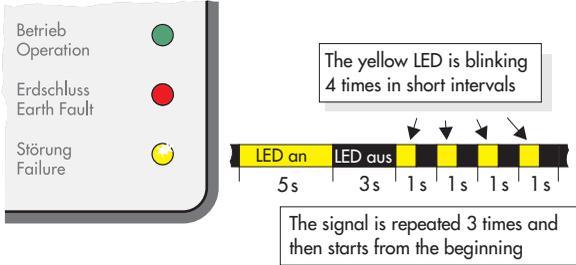


When this failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking three times in short intervals. The code is sent three times.

If the failure persists, the signal starts from the beginning.

The Sunny Boy has detected a failure as the grid impedance values are out of permissible range. If the inverter switches off frequently during grid monitoring because of the above failure, a too high grid impedance might be the cause. A qualified electrician can normally solve this problem by increasing the cross-section of the grid cable. Other measures can be taken as well. Any modifications of the operating parameters require the explicit permission of the public utility company.

Input Voltage (PV-Generator) too high



When the failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking four times in short intervals. The code is sent three times.

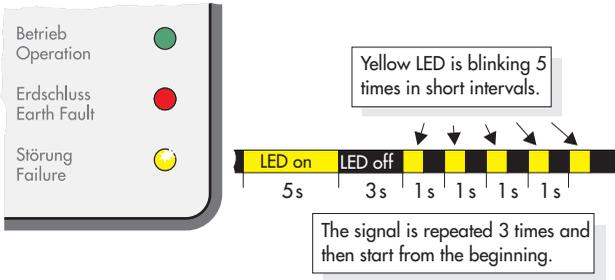
The Sunny Boy indicates that the input voltage is too high. The voltage of the PV-generator exceeds 750 V DC the respectively admissible voltage!



Immediately disconnect the PV-generator from the Sunny Boy 3300TL. Too high voltage may lead to irreparable damages!

Have your installer check your plant configuration.

Device Failure



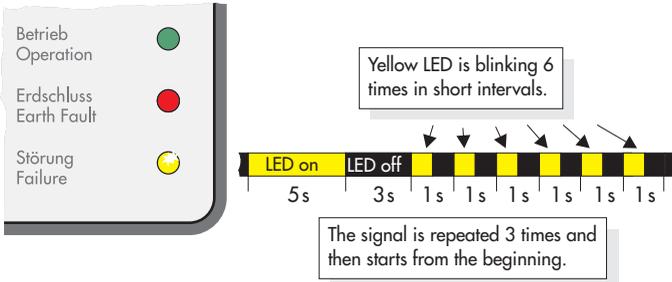
When the failure occurs, the yellow LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking five times in short intervals. The code is sent three times. If the failure persists, the signal starts from the beginning.

The Sunny Boy is in a state where it cannot return to normal operation. Presumably an internal failure exists in the device.

A qualified electrician has to check the device.



Discharge Current too high



When the failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking six times in short intervals. The code is sent three times. If the failure persists, the signal starts from the beginning.

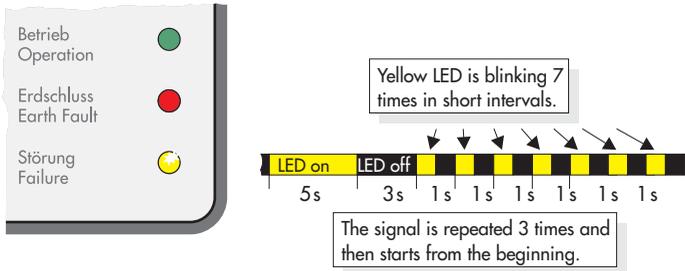
The discharge current of the inverter and the PV-generator exceeds 95 mA. The device immediately interrupts feeding operation when this limit has been exceeded and then automatically reconnects to the grid.

The discharge current depends on the capacity of the PV-generator towards ground. This depends on the way how the modules are installed as well as on weather conditions. It is therefore normal that this value varies over time.

This failure can also occur when the PE connection (protective ground) is defective.

Should the Sunny Boy 3300TL indicate this failure often, please ask the installer of your PV-plant to find the cause of the high fault current.

Drastic Change of Differential Current

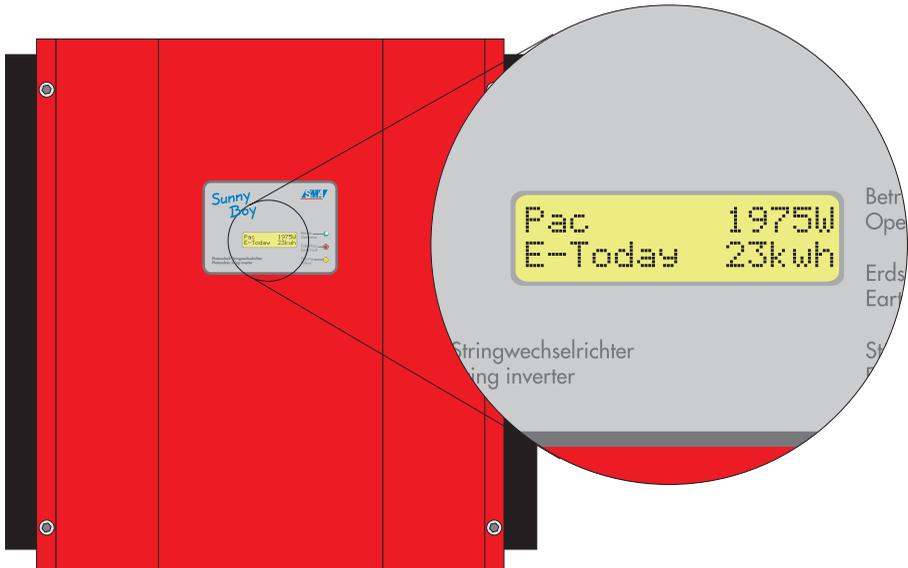


When the failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking seven times in short intervals. The code is sent three times. If the failure persists, the signal starts from the beginning.

The Sunny Boy 3300TL detected a drastic change of differential current and immediately interrupted its connection to the grid. The all-pole sensitive differential current monitoring integrated in the inverter monitors the discharge current to ground from the grid connection of the inverter to the PV-generator. This additional personnel safety concept reacts to a change of differential current of $IDN > 30 \text{ mA}$ and disconnects the inverter from grid within 0.2 seconds.

3.4 Status Messages on the Optional Display

The Sunny Boy 3300TL can be optionally equipped with the „Sunny Display“ LCD in the lid.



A Sunny Boy 3300TL without the „Sunny Display“ can be upgraded. (SMA order code: MS-Display, please specify the language setting together with your order.)

Activation of the Background Illumination

The background illumination is activated by slightly knocking on the lid. Knocking once more activates the next message on the display.

The background illumination is automatically deactivated after 2 minutes.

Messages of the Sunny Display during Initialization

SunnyBoy 3300TL
WR33MS02

Initialization of the display on the
Sunny Boy 3300TL

The following messages are displayed during initialization of the Sunny Boy 3300TL.

BFR Version 1.00
SRR Version 1.00

Initialization of the display on the
Sunny Boy 3300TL

The installed firmware versions of the control system (BFR) and the current control processor (SRR) are displayed after 6 seconds.

Messages of the Sunny Display during Operation

The Sunny Display presents all relevant operating data on one screen after the other. The four images below indicate the messages. Each message is displayed for 5 seconds. After all messages have been displayed the display restarts from the beginning.

First the total energy produced this day („E-Today“) is displayed together with the current operating status.

```
E-today 3.86kWh
Mode      MPP
```

Energy produced today
and current operating status

Then the current power and the current grid voltage are displayed.

```
Pac      903W
Uac      230V
```

Current AC Power
and AC voltage

Next, the input (DC) power and the DC voltage are displayed.

```
PPV      1325W
UPV      600V
```

Current DC power and
DC voltage

Finally, the accumulated yield of the device since installation together with the total operating hours are displayed:

```
E-Total 724.4kWh
h-Total 512h
```

Total energy yield and
total operating hours

Message of the Sunny Display in case of a Failure

In case of a failure the Sunny Display switches to „Failure“ and the background illumination is activated.

The bottom line indicates the type of failure for 5 seconds.

```
Error
Uac-Bfr
```

Indication of a failure
and failure type

Failures resulting from a specific value that e.g. exceeds a limiting are specified with the value that caused the failure as well as the current value.

```
at:      261V
Present: 245V
```

Display of the value that caused the
failure and the current value

The normal operating data is displayed after 5 seconds.

The display restarts from the beginning in case the failure is still present. For detailed information concerning the failure messages see chapter 7.4 "Measurement Channels and Messages" (page 39).



Error
ROM

Indication of defective firmware

“Error ROM” indicates that the Sunny Boy has detected a defective firmware in the EEPROM. Contact SMA in order to fix this failure.

Indication of DC Overvoltage



!PU-Overvoltage!
!DISCONNECT DC!

Indication of an overvoltage on one of the DC input connectors

A too high voltage on the input (DC) side is indicated by a blinking background illumination and the display shown on the left side.

Disconnect the Sunny Boy from the supply voltage immediately! Otherwise, the Sunny Boy can be severely damaged!



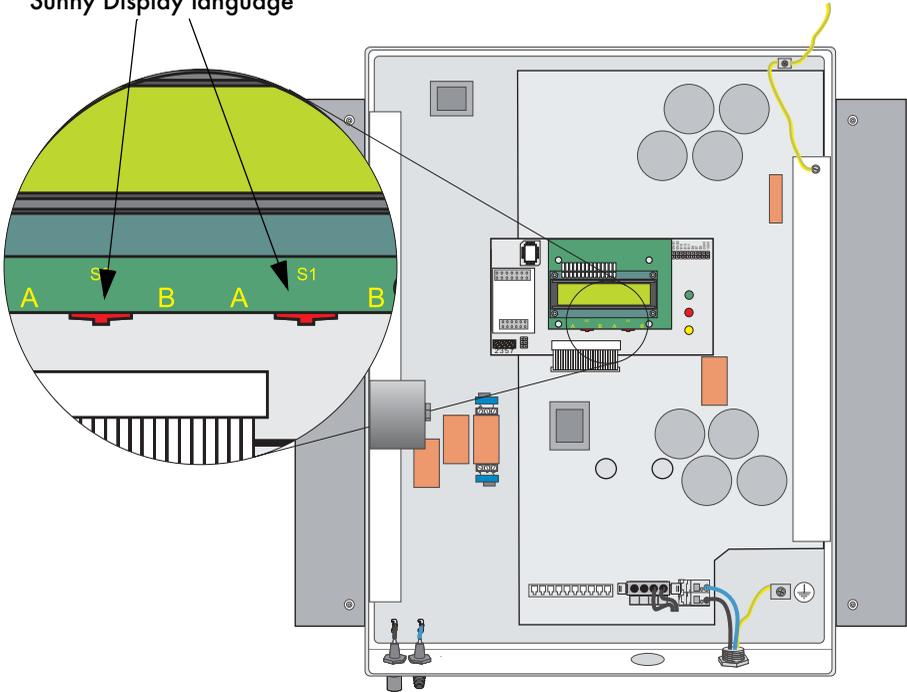
Check the input voltage and your module configuration before you reconnect the DC voltage to the Sunny Boy!

4 Configuration of the Display Language

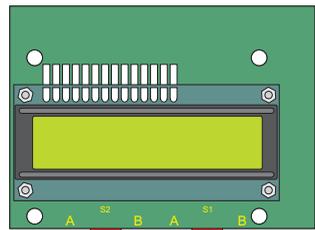
The language of the Sunny Display is configured with the switches on the bottom of the display unit.

Disconnect both DC and AC from the Sunny Boy as described in the „Installation Guide“ and remove the lid.

Position of the switches for configuration of the Sunny Display language



Language	Switch S2	Switch S1
German	B	B
English	B	A
French	A	B
Spanish	A	A



5 Service and Maintenance

In order to be able to use the Sunny Boy 3300TL even outdoors at places hard to reach, the device was designed to ensure minimum maintenance. In order to ensure safe operation it is normally sufficient to check the device approximately every two months for visible damages. Also check if the red LED is on.

To obtain optimum yield the plant operator should check the performance under different irradiation conditions by controlling if the LEDs of the Sunny Boy 3300TL signals plausible normal operation (see chapter 3.3.4 "Description of Operating States" (page 12)). Of course, this can also be checked with one of the optional communication devices.

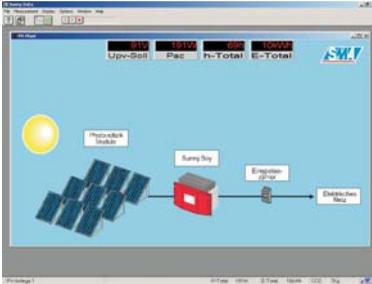
It is only necessary to clean the Sunny Boy if heat dissipation is disturbed by dirt particles on the fins of the heatsinks or in the space between the inverter and the wall. Carefully remove the dirt with an appropriate soft brush.

If the status LEDs are dirty and no longer clearly visible, remove the dirt with a moist cloth. Solving agents, abrasives or corrosives may not be used for cleaning!

6 Plant Monitoring

You can monitor your PV-plant with your Sunny Boy 3300TL in different ways. SMA offers different products allowing you to install a customized plant monitoring. Please order the Sunny Family Catalog for detailed information of our Sunny Boy 3300TL products or visit our homepage at www.SMA.de. Our available communication options are described in the chapters below.

6.1 Sunny Data

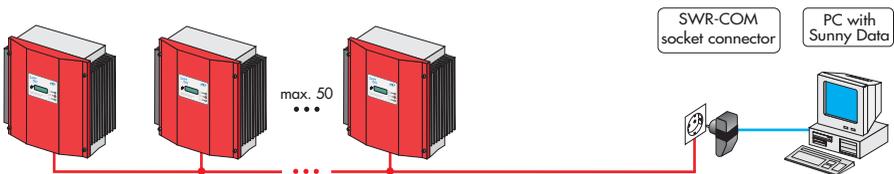


Sunny Data is a PC program for monitoring your PV-plant. The connection of your Sunny Boy or Sunny Mini Central is described in the following chapters.

6.1.1 Sunny Data via Power Line

„Wireless“ communication via power line
(with up to 50 Sunny Boys or Sunny Mini Centrals)

Requirements: The Sunny Boys and Sunny Mini Centrals have to be equipped with the Powerline Kit and the PC with an SWR-COM socket modem. How to connect the PC via SWR-COM is described in the documentation of the SWR-COM.



6.1.2 Sunny Data via RS232

Communication via cable

(one single Sunny Boy or Sunny Mini Central)

Requirements: The Sunny Boy or Sunny Mini Central has to be equipped with the RS232 Piggy-Back. The PC is connected directly to the COM1 or COM2 port of the PC. The installation of the RS232 cable is described in the Installation Guide of the Sunny Boy 3300TL.

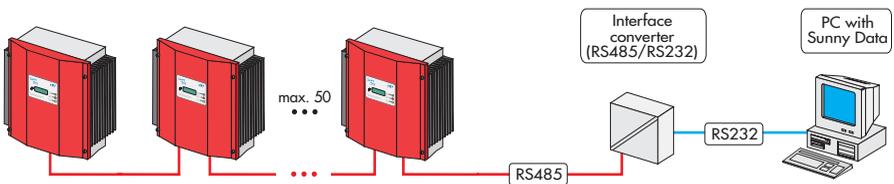


6.1.3 Sunny Data via RS485

Communication via cable

(with up to 50 Sunny Boys or Sunny Mini Centrals)

Requirements: All Sunny Boys and Sunny Mini Centrals have to be equipped with an RS485 Piggy-Back. The PC is connected to the COM1 or COM2 power via an RS485/RS232 interface converter. The installation of the RS485 cable is described in the Installation Guide of the Sunny Boy 3300TL.



6.1.4 Sunny Data via Sunny Beam

Communication with a PC via Sunny Beam
(with up to 4 Sunny Boys or Sunny Mini Centrals)

Requirements: All Sunny Boys and Sunny Mini Centrals have to be equipped with a Radio Piggy-Back and to be detected by the Sunny Beam for plant monitoring. Use a USB cable for connecting the Sunny Beam with the PC. The installation of the Radio Piggy-Back and the connection to the PC is described in the „Operating Instructions“ of the Sunny Beam.



6.2 Sunny Beam

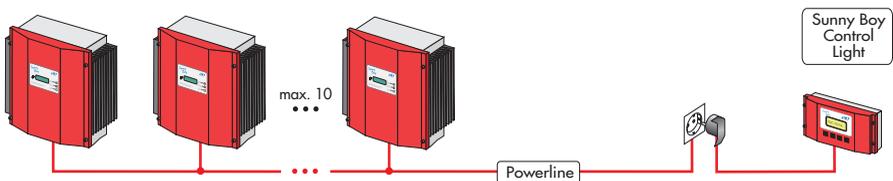
Simple plant monitoring via radio with up to 4 Sunny Boys or Sunny Mini Centrals.
Requirements: The Sunny Boys and Sunny Mini Centrals have to be equipped with a Radio Piggy-Back and a Sunny Beam has to be positioned in appropriate distance.



6.3 Sunny Boy Control Light

The Sunny Boy Control Light is a basic data logger for PV-plants with up to 10 Sunny Boys or Sunny Mini Centrals. The data between the Sunny Boy Control Light and the Sunny Boys and/or Sunny Mini Centrals is transmitted via power line.

Requirements: Sunny Boys and Sunny Mini Centrals have to be equipped with the Powerline Kit. The installation is described in the documentation of the Sunny Boy Control Light.

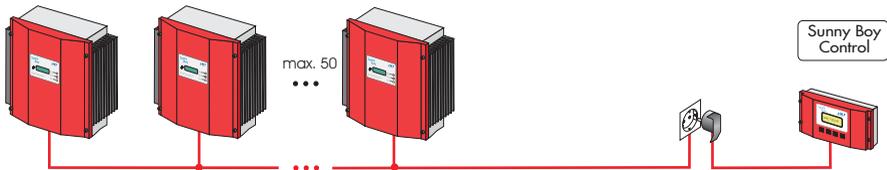


6.4 Sunny Boy Control

The Sunny Boy Control is a data logger for PV-plants with up to 50 Sunny Boys or Sunny Mini Centrals. It is possible to connect the Sunny Boys and / or Sunny Mini Centrals as follows:

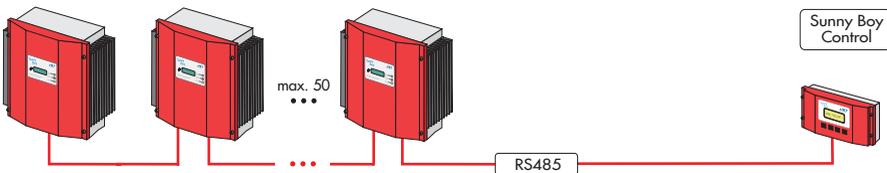
Powerline - „Wireless“ communication via power line

Requirements: All Sunny Boys and Sunny Mini Centrals have to be equipped with the Powerline Kit.



RS485 communication via cable

Requirements: All Sunny Boys and Sunny Mini Centrals have to be equipped with an RS485 Piggy-Back. The Sunny Boy Control has to be equipped with an RS485 Piggy-Back at the interface „COM-1 Sunny Boy“.



6.5 Sunny Boy Control Plus

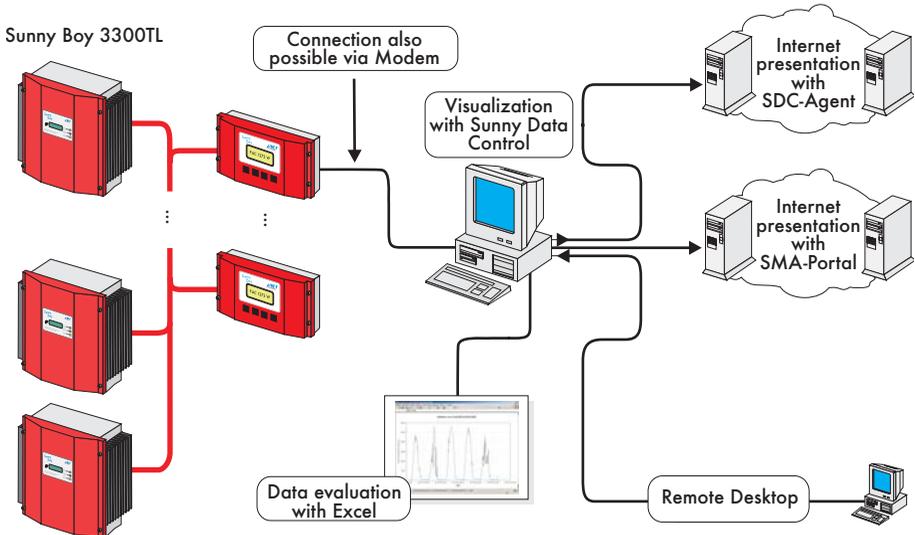
The Sunny Boy Control Plus is a data logger for PV-plants with up to 50 Sunny Boys or Sunny Mini Centrals. It has one additional interface for a PC or external display and additional interfaces for digital and analog in- and outputs.

Requirements: See Sunny Boy Control

6.6 Sunny Data Control

Sunny Data Control is a PC program for plant monitoring and visualization with the PC for plants with Sunny Boy Control.

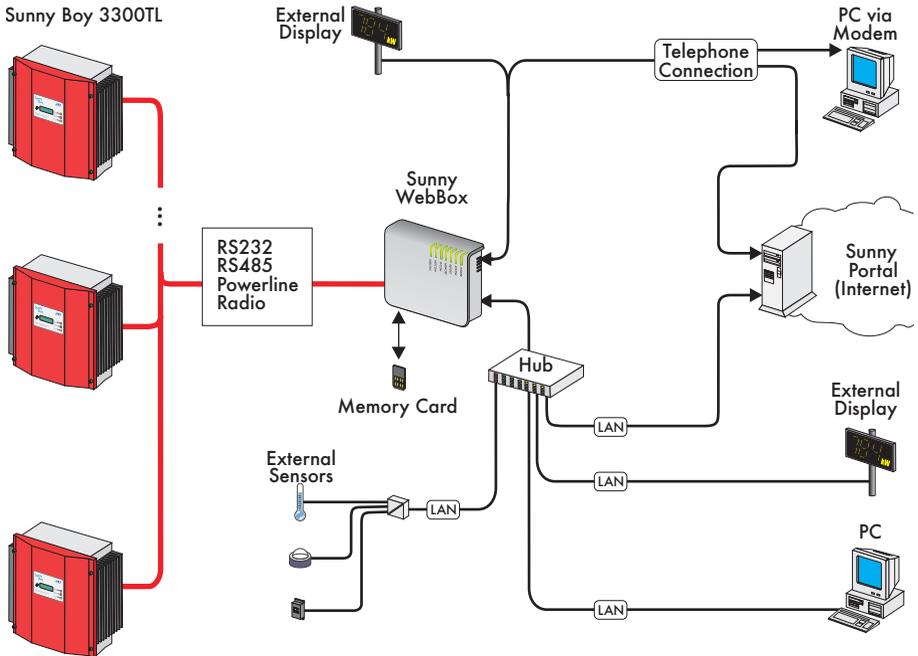
Requirements: PV-plant with Sunny Boy Control, Sunny Boy Control Plus or Sunny Boy Control Light with connection to a PC.



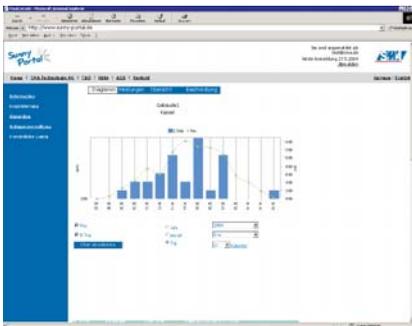
If required, the PC can also be connected with the Sunny Boy Control via modem. By connecting several Sunny Boy Controls, it is possible to monitor large scale plants with more than 50 Sunny Boys or Sunny Mini Centrals.

6.7 Sunny WebBox

Sunny WebBox is a multifunctional and cost effective device for the plant monitoring directly on the PC or via internet with Sunny Portal. The Sunny WebBox will be available at the 2nd quarter of 2005.



6.8 Sunny Portal

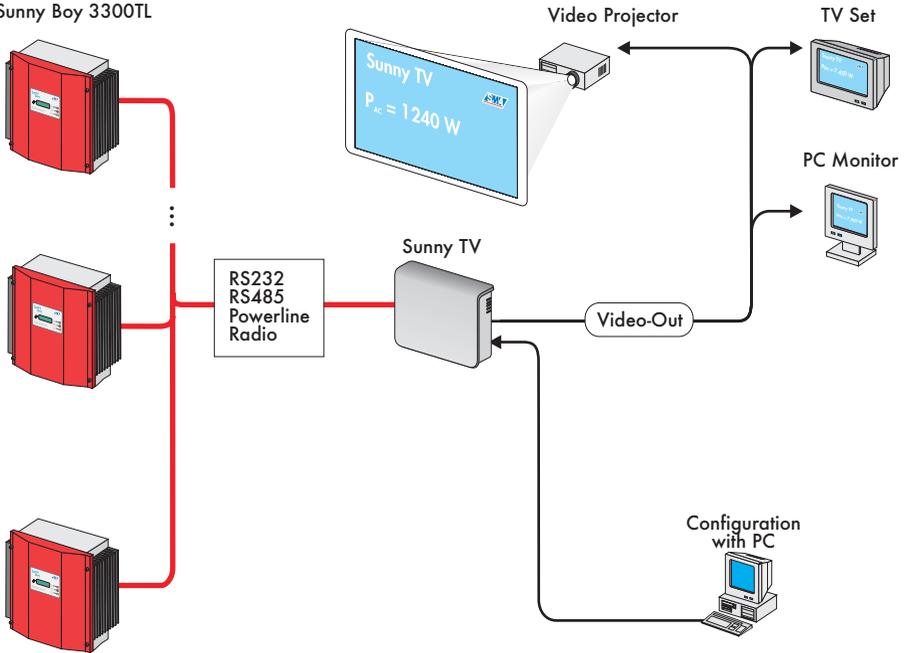


Sunny Portal is SMA's powerful internet presentation platform from SMA, which allows you to monitor and present your PV-plant in the internet. For detailed information please see the Sunny Family Catalog or www.SUNNY-PORTAL.de.

6.9 Sunny TV

Sunny TV is an accessory kit for Sunny Boys and Sunny Mini Centrals which displays the plant data and current power on a display or video projector. You can use the Sunny TV for presenting large-scale PV-plants in entrance areas and lobbies or for private purposes. Sunny TV is available at the 2nd quarter of 2005.

Sunny Boy 3300TL



7 Technical Documentation

7.1 Data PV-Generator Connection

Max. input open-circuit voltage	U_{PV0}	750 V (at -10 °C module temperature)
Input voltage, MPP operation	U_{PV}	125 V ... 750 V DC
Max. input current	I_{PVmax}	8 A
Max. input power	P_{PV}	3450 W
Recommended max. generator power		3850 W
All-pole disconnecter on DC input side		snap cable connectors
Surge voltage protection		thermally monitored varistors
Voltage ripple	U_{PP}	< 10 % of input voltage
Personnel protection		Ground Fault monitoring (Riso > 1 M Ω)
Internal consumption in operation		< 10 W (stand-by)
Pole confusion prevention		by short-circuit diode

7.2 Data Grid Connection

Nominal output power	P_{ACnom}	3000 VA
Peak output power	P_{ACmax}	3300 W
Nominal output current	I_{ACnom}	13 A
Harmonic distortion of output (with $K_{U_{nom}} < 2\%$, $P_{AC} > 0,5 P_{ACnom}$)	THD_{IAC}	4 %
Short-circuit resistance		$I_{max} = 30$ A
Operating range, grid voltage	U_{AC}	198 ... 260 V AC
Operating range, grid frequency	f_{AC}	49.8 ... 50.2 Hz
All-pole disconnecter on grid side		independent disconnection device (MSD), (2 independent systems)
Phase difference (related to basic wave of current)	$\cos \varphi$	1
Overtoltage category		III
Test voltage (50 Hz)		1.65 kV (5 s unit / type test)
Surge voltage test		4 kV (1.2/50 ms) (serial interface: 6 kV)
Internal consumption in stand-by		0.3 W

7.3 Description of Device

You will find a detailed device description in chapter 3 "Device Description" (page 7) of these Operating Instructions.

General Data

Protection degree (DIN EN 60529)	IP65
Dimensions (width x height x depth)	approx. 470 mm x 490 mm x 225 mm
Weight	approx. 28 kg

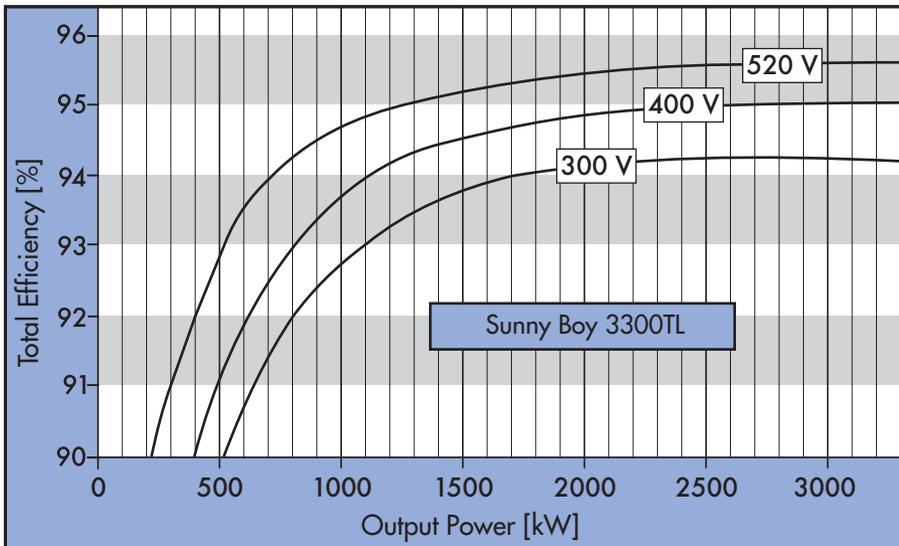
External interfaces

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

Efficiency

Max. efficiency at nominal voltage	η_{max}	95.6 %
European weighted efficiency	η_{euro}	> 94.7 %

The efficiency of the Sunny Boy 3300TL depends on the DC input voltage from the PV-modules. The higher the voltage the higher is the efficiency of the Sunny Boy 3300TL.



7.4 Measurement Channels and Messages

If your Sunny Boy 3300TL has been equipped with a communication interface, numerous measurement channels and messages can be acquired. These can help to improve the performance as well as eliminate failures of your plant.

BFR: System control

SRR: Current control

7.4.1 Measurement Channels

dl	Residual currents between the modules and the Sunny Boy
E-Total	Total power fed to the grid accumulated from the day of installation
E-Total DC	Total DC Yield
Fac	Grid frequency
Fehler/Failure	Display of failure type in „Failure“ state
Fehler-Cnt/ Error-Cnt	Total number of errors
h-On	Total sum of operating hours
h-Total	Total sum of operating hours in feeding operation
Iac	Current fed to the grid
Netz-Ein/ Power ON	Total number of connections to the grid
Pac	Current output power
Riso	Insulation resistance of PV-plant before connection to the grid
Seriennummer/ Serial Number	Serial number of the Sunny Boy
Status/Mode	Display of current operating state
Uac/Vac	Grid voltage
Upv-Ist / Vpv	PV-input voltage
Upv-Soll / Vconst-Setpoint	PV setpoint voltage
Zac	Grid impedance
PPV DC-A	Current power from String A

7.4.2 Status Messages

The Sunny Boy 3300TL generates a number of status messages according to the mode it currently operates in. The status messages displayed can differ depending on the type of communication you are currently using (Sunny Display, Sunny Data, Sunny Boy Control, Sunny Data Control).

Message	Description
MPP	The Sunny Boy 3300TL is operating in MPP mode. The input voltage setpoint is permanently adjusted in order to obtain the maximum energy from the different strings. This is the default operating mode in normal operation with normal irradiation.
U-Konst	Constant voltage operation. (The input voltage from the PV-modules is fixed to a defined setpoint. The Sunny Boy 3300TL is not operating in MPP mode.) This mode can be defined as operating mode in special applications.
I-Konst	Constant current operation. (The input current from the PV-modules is specified to a defined setpoint. The Sunny Boy 3300TL is not operating in MPP mode.) This mode can be defined as operating mode in special applications.
Derating	PV-generator power is higher than the amount the Sunny Boy 3300TL can process.
Derating Idc / derat. Idc	The Sunny Boy 3300TL is reducing the output power due to overcurrent on the DC side. This is not a critical status, but your plant is losing energy in this mode. Have your installer check the configuration of your plant if this occurs regularly.
Derating WR (T°) Derating DC (T°)	The Sunny Boy 3300TL is reducing the output power due to overtemperature of the DC converters („DC“) or the inverter bridge („WR“). Have your configuration and your string size checked if this occurs regularly. Ventilation and sufficient clearance can solve this problem.
Fehler/ Error	A failure has been detected and a failure message has been generated (see following table „Failure messages“).
Netzueb. / grid. mon.	Test of grid status for subsequent connection (grid impedance), relay test etc. This mode only occurs during startup, before the Sunny Boy connects to the grid. This status can often occur during the morning and evening with varying irradiation.
Offset	Offset adjustment of measurement electronics
Riso	Measurement of irradiation resistance of PV-plant
Stoer./disturb.	Failure (see following table „Failure messages“)

Message	Description
Stop	A safety relevant failure or similar occurred preventing that the Sunny Boy connects to the grid. This status can also be set manually.
Warten/waiting	Conditions for connection have not (yet) been fulfilled.

7.4.3 Sunny Boy 3300TL 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 Boy**
- **void the operating permission of the Sunny Boy**
- **void the warranty of the Sunny Boy.**

Never change the operating parameters without explicit permission and instructions!

Name	Unit	Range	Default	Description
E_Total	kWh	0 ... 200000		Total energy yield (E_Total) and total operating hours (h_Total) of the inverter. Changing the value can be necessary when a Sunny Boy is exchanged and you wish to match the previously acquired data.
h_Total	h	0 ... 200000		
Usoll-Konst / Vconst-Setpoint	V	0 ... 750	290	PV setpoint voltage for constant voltage operation for String A. These parameters are only important in case the parameter „Operating Mode“ is set to „U-konst“.
NiTest/ impedance test		0 / 1	1	Activates (1) and deactivates (0) the automatic failure current measurement. This parameter only takes effect when the Sunny Boy was deactivated (by disconnecting from the AC utility) or set to operating mode „Stop“.
Uac-Min	V	180 ... 300	198	Lower (Uac-Min) and upper (Uac-Max) limit of permissible AC voltage (Anti-Islanding)
Uac-Max	V	180 ... 300	260	
Fac-Delta-	Hz	0 ... 4.5 (0.19)	0.19	Maximal frequency above (Fac-Delta+) and below (Fac-Delta-) 50 Hz grid frequency before anti-islanding is triggered
Fac-Delta+	Hz	0 ... 4.5	0.19	
dFac-MAX	Hz/s	0.005 ... 4.0	0.25	Maximal „rate of change of frequency“ before anti-islanding is triggered
dZac-MAX	mOhm	0 ... 2000	350	Maximal „rate of change of grid impedance“ before anti-islanding is triggered
Riso-Min	kOhm	1000 ... 30000	1000	Minimum insulation resistance
Betriebsart/ Operating Mode		MPP/ Ikonst/ UKonst/ Stop	MPP	Operating Mode of the Sunny Boy: MPP: Maximum Power Point Ukonst: Constant Voltage Mode (Setpoint defined in „Usoll-Konst“) Ikonst: Experimental mode/special applications Stop: Disconnection from utility, no operation

Name	Unit	Range	Default	Description
Speicherfunktion Memory Function		Default parameter/ Reset Operating Data/ Reset Failure	none	Default parameter: Sets all parameters to default. Reset Operating Data: Sets all parameters visible in user level to default values. Reset Failure: Resets all permanent device failure (dBh)
Default			GER/ ENS	Used for adjusting the country specific settings
Storage		permanent/ volatile	perma- nent	permanent: changed parameters are stored in EEPROM and are still available after restarting the Sunny Boys volatile: prevents storing the parameters in EEPROM, i. e. parameters are only saved until next startup
Inst.-Code				The parameters concerning anti-islanding can only be changed after entering the installers password here.

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

Name	Unit	Range	Default	Description
Plimit	W	3300		Upper limit of AC output power
SMA-SN				Serial Number of the Sunny Boy
Software-BFR				Firmware version of the operation control unit (BFR)
Software-SRR				Firmware version of the current control unit (SRR)
Hardware-DC-BFR				Hardware version of the DC converter control unit (DC-BFR)
Firmware-DC-BFR				Firmware version of the DC converter control unit (DC-BFR)

7.4.4 Precision of Measured Value Acquisition

Acquisition of measured values is always more or less imprecise. The measured values acquired by the Sunny Boy 3300TL are required for its system management and control of current to be fed into the grid. This is why measured values of the Sunny Boy 3300TL must be reproducible. The maximum error of measured value acquisition is specified for an ambient temperature T_U of 25 °C. A temperature coefficient failure must be accounted for with other ambient temperatures.

Physical variable	Unit	Measurement range	Resolution of display	Resolution of measurement	Max. failure (of final value, $T_U=25\text{ °C}$)
Input voltage	UPV [V]	0 ... 800 V	1 V	0.78 V	±2 %
Input current	IPV [mA]	0 ... 10000 mA	1 mA	9.8 mA	±2 %
Grid voltage	UAC [V]	180 ... 278 V_{eff}	1 V	0.27 V_{eff}	±1 %
Grid current	IAC [mA]	0 ... 26.5 A_{eff}	1 mA	13 mA_{eff}	±2 %
Grid frequency	fAC [Hz]	45 ... 55 Hz	0.01 Hz	0.01 Hz	±0.1 %
Current power fed to grid	PAC [W]	0 ... 7367 W	1 W	1 W	±3 %
Total energy fed to grid	E [kWh]	0 ... $4.29 \cdot 10^9 \text{ Wmin}$	1 Wmin	20 Wmin	±3 %
Operating hours	h [h]	0 ... $4.299 \cdot 10^9 \text{ s}$	1 s	375 ns	±0.1 %

7.4.5 Failure Messages

In case of a failure the Sunny Boy 3300TL generates the failure code according to the operating mode and the detected failure.

Failure Code	Description
CAN Kom DC-BFS DC-BFS-Startup	Internal communication failure. Contact SMA in case you observe this failure very often.
DCBFS Version	The DC-BFS has a wrong firmware. Contact SMA in case you observe this failure.
Delta Bfr-Srr NUW-dI NUW-FAC NUW-UAC NUW-ZAC NUW-Timeout	Internal measurement comparison error: The Sunny Boy 3300TL measured values of BFR and SRR are too different from each other.
dFac-Bfr dFac-Srr	<p>The rate of change of the AC grid frequency is exceeding the permissible range („Bfr“ or „Srr“ is an internal message and is not important for the user). The Sunny Boy assumes that the public grid is down and disconnects from the grid in order to avoid islanding.</p> <p>Check the grid frequency and the rate of fluctuation. If the grid frequency fluctuates often and thus „dFac-Bfr“ or „dFac-Srr“ failures often occur consult the utility company if it is permissible to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy.</p>
dI-Bfr dI-Srr	<p>The Sunny Boy 3300TL has detected a drastic change of the discharge current. As the Sunny Boy 3300TL is a transformerless inverter there is no electric separation. A sophisticated and effective discharge current monitoring is an important element of the personnel protection.</p> <p>A drastic change of the discharge current can be the result of a malfunction or a sudden dangerous ground fault. The Sunny Boy disconnects all poles (DC and AC). Have a qualified technician check the isolation and the ground connection in case the message „dI-Bfr“ or „dI-Srr“ is displayed without any obvious cause in your system.</p>
dI-Mess	Defective acquisition of differential current / fault current - the Sunny Boy is deactivated for the rest of the day and will return to normal operation on the next day. A restart will reset the Sunny Boy to normal operation as well.

Failure Code	Description
dl-Test	Failure of differential current converter
dZac-Bfr dZac-Srr	<p>The rate of change of the AC grid impedance is exceeding the permissible range („Bfr“ or „Srr“ is an internal message and is not important for the user). The Sunny Boy assumes that the public grid is down and disconnects from the grid in order to avoid islanding.</p> <p>Check the grid impedance and the rate of fluctuation. If the grid frequency fluctuates often and thus „dZac-Bfr“ or „dZac-Srr“ failures often occur consult the utility company if it is permissible to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy.</p>
EEPROM	Transition failure during reading or writing of data EEPROM, the data is not essential for safe operation - this failure does not effect performance.
EEPROM dBh	Data EEPROM defective, device is set to permanent disable due to the fact that the data loss affects important functions of the Sunny Boy. Contact SMA.
EeRestore	A data record was defective and was reconstructed.
Fac-Bfr Fac-Srr	<p>The AC grid frequency is exceeding the permissible range („Bfr“ or „Srr“ is an internal message and is not important for the user). The Sunny Boy 3300TL assumes that the public grid is down and disconnects from the grid in order to avoid islanding.</p> <p>Check the grid frequency and the grid cable connection in the Sunny Boy enclosure. If the grid frequency is out of range due to your local grid conditions consult the utility company if it is permissible to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy.</p> <p>If the grid frequency is within the tolerable range and the failure message „Fac-Bfr“ or „Fac-Srr“ is still displayed, contact SMA.</p>
IGBTs	The internal hardware monitoring has detected a defect of an inverter part. Contact SMA in case this failure often occurs.
Imax	Overcurrent on the AC side. This failure code is indicated in case the current to the AC grid exceeds the specification. Have your plant configuration checked.
Imax DC	Overcurrent in the intermediate DC circuit of the Sunny Boy 3300TL. The Sunny Boy is detecting a current exceeding the specifications within its intermediate circuit. This is the result of a too high current on the DC input. Have your plant configuration checked.

Failure Code	Description
L<->N	L and N mixed up on AC connection. Have an installer check installation.
Offset	Grid monitoring self-test failed.
Rechner	Failure in operation of one of the two microcontrollers
Relais1 Relais2 Relais3 Relais4 L-Netz/ N-WR/ N-Netz	Grid connection relay self test failed. The Sunny Boy checks the relays that connect the Sunny Boy to the grid before it starts feeding to the grid. In case the grid relays do not function correctly the safe and reliable disconnection cannot be guaranteed and the Sunny Boy does not connect to the grid. Contact SMA in case this failure often occurs.
Riso	The PV-system is not electrically separated from ground. The resistance between one of the poles and ground is below a defined threshold.
Shutdown	Serious failure, device shut down until next switch-on.
ROM	The internal test of the Sunny Boy control system firmware failed. Contact SMA in case this failure occurs often.
Uac-Bfr/ Uac-Srr	<p>The AC grid voltage is exceeding the permissible range („Bfr“ or „Srr“ is an internal message and is not important for the user). Uac can result from:</p> <ul style="list-style-type: none"> • a disconnected grid (circuit breaker, fuse) • a disconnected AC cable • high-resistant AC cable <p>The Sunny Boy 3300TL assumes that the public grid is down and disconnects from the grid in order to avoid islanding. Check the grid voltage and the grid cable connection in the Sunny Boy enclosure. If the grid voltage is out of range due to your local grid conditions consult the utility company if it is possible to modify the utility conditions.</p> <p>If the grid voltage is within the tolerable range and the failure message „Uac-Bfr“ or „Uac-Srr“ is still displayed, contact SMA.</p>
UDiff Uzkposneg<10	Defective DC link. Contact SMA in case you observe this failure often.

Failure Code	Description
Uzwk	<p>Overvoltage on the DC input.</p> <p>Disconnect the Sunny Boy from the PV-modules immediately! The Sunny Boy can be severely damaged!</p> <p>Have your plant configuration checked before you reconnect the DC voltage.</p>
Watchdog Watchdog Srr	<p>Internal Watchdog function triggered.</p>
Zac-Bfr/ Zac-Srr	<p>The AC grid impedance is exceeding the permissible range („Bfr“ or „Srr“ is an internal message and is not important for the user). The Sunny Boy assumes that the public grid is down and disconnects from the grid in order to avoid islanding.</p> <p>The impedance is the sum of the grid’s internal impedance and the impedance of the AC cable that connects the Sunny Boy to the grid.</p> <p>Check the grid impedance and the grid cable connection in the Sunny Boy enclosure. Use a cable with a higher cross section (=lower impedance) for connecting the Sunny Boy to the grid. If the grid impedance is out of range due to your local grid conditions consult the utility company if it is possible to modify the utility conditions.</p>

7.5 Declaration of Conformity (CE)

CE Declaration of Conformity for utility interactive inverters



Produkt: Sunny Boy
Typ: SB 700, SB 1100, SB 1700, SB 2100TL, SB 2500, SB 2800i, SB 3000,
SB 3300TL

We declare that the above specified devices are compliant with the regulations of the European Community, in terms of the design and the version fabricated by SMA. This especially applies for the EMC Regulation defined in 89/336/EWG and the low voltage regulation defined in 73/23/EWG.

The devices are compliant with the following standards:

EMC:	
Emission:	DIN EN 61000-6-3: 2002-08 DIN EN 61000-6-4: 2002-08 DIN EN 55022: 2003-09, class B
Utility Interference:	DIN EN 61000-3-3: 2002-05 DIN EN 61000-3-2: 2001-12
Immunity:	DIN EN 61000-6-1: 2002-08 DIN EN 61000-6-2: 2002-08
Safety:	DIN EN 50178: 1998-04
Semiconductor-Converter:	DIN EN 60146-1-1: 1994-03

The above mentioned devices are therefore marked with a CE sign.

Niestetal, 19th of January 2005

SMA Technologie AG

i. V. Frank Greizer

i.V. Frank Greizer
(Head of Development Department Solar Technology)

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SB-K16A-CE12-BE0305

7.6 Clean Report of Findings (Grid Guard)

The Sunny Boy 3300TL is equipped with the automatic anti-islanding unit „SMA grid guard“. The following „clean report of findings“ applies for this unit.

Fachausschuss Elektrotechnik der Berufsgenossenschaftlichen Zentrale für Sicherheit und Gesundheit – BGSZ des Hauptverbandes der gewerblichen Berufsgenossenschaften		 BG Federführung: Berufsgenossenschaft der Feinmechanik und Elektrotechnik	
Fachauschuss Elektrotechnik, Postfach 5105 80, 50941 Köln			
SMA Regelsysteme GmbH Hannoversche Straße 1-5 34266 Niestetal			
Ihre Zeichen/Pflichtschicht vom	Unser Zeichen (Bitte stets angeben)	Bearbeiter	☎ (02 21) 37 78- Datum
	UB.010.17	PI/Ow	357 30.08.2004
Unbedenklichkeitsbescheinigung			
Erzeugnis:	Selbsttätig wirkende Freischaltstelle		
Typ:	SMA grid guard		
Bestimmungsgemäße Verwendung:	Parallelbetrieb von Photovoltaikanlagen am EVU-Niederspannungsnetz		
Prüfgrundlagen:			
E DIN VDE 0126 (04.99)	„Selbsttätige Freischaltstelle für Photovoltaikanlagen einer Nennleistung ≤ 4,6 kVA und einphasiger Paralleleinspeisung über Wechselrichter in das Netz der öffentlichen Versorgung“		
Die elektrische Sicherheit o.g. Erzeugnisse entspricht den zum Zeitpunkt der Ausstellung dieser Bescheinigung geltenden Bestimmungen.			
Die Unbedenklichkeitsbescheinigung gilt befristet bis			
31.12.2007			
 - Martin Mehlem - Leiter der Prüf- und Zertifizierungsstelle			
Postadresse:	Gußtr./Heinemann-Ufer 130	50968 Köln	☎ (02 21) 37 78-365 Fax (02 21) 37 78-366

8 Glossary

AC

Abbreviation for „Alternating Current“

Central inverter

Inverter concept where all PV-modules are wired among each other (switching in series and/or in parallel). One single inverter feeds into the external grid. Costs for a central inverter concept are lower, but installation might be much more complicated and yield losses may occur due to shadowing of individual solar modules.

DC

Abbreviation for „Direct Current“

Derating

Controlled reduction of power, mostly depending on temperatures of certain modules. Compared to a complete shutdown of a device, which is a usual procedure as well, the negative impact on the external grid is lower with derating.

Grid-tied plant

PV-plant connected to a public electricity grid run by an external supplier company.

Inverter

Device to convert the direct current (DC) supplied by the PV-generator into alternating current (AC) which is required for the supply of most consumers and especially for feeding into the public grid. Inverters for PV-plants usually include one or more MPP trackers.

Maximum Power Point „MPP“

The operating point (current / voltage) of the PV-generator where this generates maximum power under the current conditions. The position of the MPP changes continuously, e. g. depending on irradiation and temperature.

MPP tracker

Unit that adjusts current and voltage of the PV-generator in a way as to make the generator operate in its maximum power point.

MSD

The „Mains monitoring with allocated **S**witching **D**evice“ is an obligatory safety device which interrupts the inverter's feeding of PV-power to the grid if the external power generators have shut down.

Multi-String inverter

Inverter which combines the advantages of using several string inverters (separate MPP tracking of individual strings) with those using one central inverter (low power-specific costs).

PLC

Abbreviation for „Power Line Communication“, term for data transmission via the grid cable

PV

Abbreviation for „Photovoltaics“, term for the conversion of light energy into electrical energy.

PV-generator

Technical facility to convert light energy into electrical energy. Usually the term includes all PV-modules of a PV-plant that have been mounted and electrically wired.

PV-module

See „Solar module“

PV-plant

A system consisting of components required for the generation and utilization of solar energy. In the case of grid-tied plants these components include the PV-generator and the inverter.

Solar cell

Electronic component which can supply electrical energy when in sunlight. As the electric voltage of one single solar cell is very low (approx. 0.5 V) several cells are combined into solar modules. The material mostly used for solar cells at the moment is silicon. It is upgraded in different ways (mono-crystalline, poly-crystalline, amorph) before use. There are also various ways to increase efficiency mechanically. In addition totally new materials are currently tested (Cadmium-Tellurid, Cadmium-Indium-sulfide, titan dioxide etc.).

Solar energy

Energy supplied by the sun, i. e. energy from sunlight or other irradiation (heat, UV radiation)

Solar module

Combination of individual solar cells in one enclosure which protects the delicate cells against mechanical strain and guarantees easy installation.

Stand-alone plant, island plant

Power supply system which is totally independent from external power supply.

String

A group of solar modules switched in series. Usually a PV-plant consists of several strings. Thus it is possible to avoid too high yield losses if the modules are shadowed to a different extent.

String inverter

Inverter concept avoiding the disadvantages of a concept with one central inverter. The PV-generator is divided into individual strings which are each connected to the external grid with their own string inverter. This considerably simplifies installation and reduces yield losses due to variations in manufacturing or a different degree of shading of solar modules.

9 Contact

If you have any questions or technical problems concerning the Sunny Boy 3300TL our hotline will be happy to assist you. Please hold the following data ready when contacting SMA:

- Type of inverter
- Type of modules connected and number of modules
- Communication interfaces
- Serial number of the Sunny Boy



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