Sunny Boy 4200TL Multi-String Transformerless Solar Inverter for Two Independent PV Strings

Revision History

| Document number	Changes	Author
SB4200-11:FE2303	First Issue	Salisbury
SB4200-11:FE0904	Failure Messages	Siebert
SB4200-12:FE4804	Firmware Modifications	Siebert

Table of Contents

1 Introduction

You have decided to use one of the most advanced de-
vices for modular PV system technology by purchasing
a Sunny Boy 4200TL Multi-String. The Sunny Boy
4200TL Multi-String is one of the first inverters that uti-
lizes the Multi-String Technology from SMA and convin-
ces with its outstanding qualities concerning efficiency
and reliability.

The Sunny Boys comply with all regulations from the
VDEW (Association of German Electricity Producers)
for supplementary grid feeding to the low voltage elec-
tricity grid of the utility. This includes the regulations of
the employee association (Berufsgenossenschaft für
Feinmechanik und Elektrotechnik) concerning the „In-
dependent Disconnection Device" known as MSD (Mains monitoring device with al-
located Switching Devices) and the regulations of the DIN VDE 0126. Furthermore
the Sunny Boy complies with the according harmonized standards and the low volta-
ge regulations as certified in the CE declaration (see chapter 6.5 "Declaration of Con-
formity (CE)" (page 54)).

This document contains the „Operating Instructions" of the Sunny Boy 4200TL Multi-
String. They are meant as guidelines on how to use all functions of the Sunny Boy
4200TL Multi-String optimally and how you can 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 4200TL Multi-String. For the installation of the Sun-
ny Boy 4200TL Multi-String please have a look at the „Installation Guide".
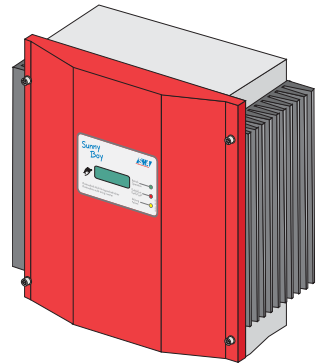
2 Safety Instructions

Opening the device and by that

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

of the Sunny Boy 4200TL Multi-String 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 4200TL Multi-String – 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 4200TL Multi-String is equipped with the anti-islanding unit „SMA grid guard". The Sunny Boy 4200TL Multi-String therefore complies with the VDEW guidelines for grid interactive inverters and the DIN VDE 0126 (4.99) specified in this regulation.

3 Device Description

The Sunny Boy 4200TL Multi-String 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 are specified in chapter 6 "Technical Documentation" (page 41) of this document.
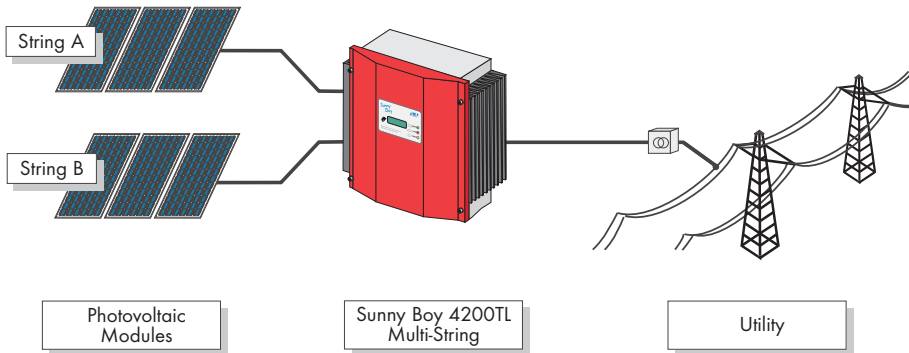

Fig. 3.1:   Basic Principle of an Utility Interactive PV Plant with a Sunny Boy 4200TL Multi-String

Usage of the Sunny Boy 4200TL Multi-String in any applications different from this will void the warranty.

3.1 Device Design

We have focused on a simple functional design when we developed the Sunny Boy string inverters. In its basic design the Sunny Boy 4200TL Multi-String does not need more than three LEDs for status display. A display unit is available. The display can be already installed when your Sunny Boy is delivered as well as it can be additionally installed later.

The Sunny Boy 4200TL Multi-String 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 5 "Plant Monitoring" (page 33) for details.

As shown in Fig. 3.2: "Block circuit diagram and typical use of the Sunny Boy 4200TL Multi-String" (page 12) up to two independent strings of a PV generator can be connected to the Sunny Boy 4200TL Multi-String. As each of the two input ports has its own separate MPP tracker, it is no problem to connect strings with different orientation and different modules.

Even nominal data of current, voltage and power of the two strings may be different as long as they do not exceed the specifications listed in chapter 6 "Technical Documentation" (page 41).
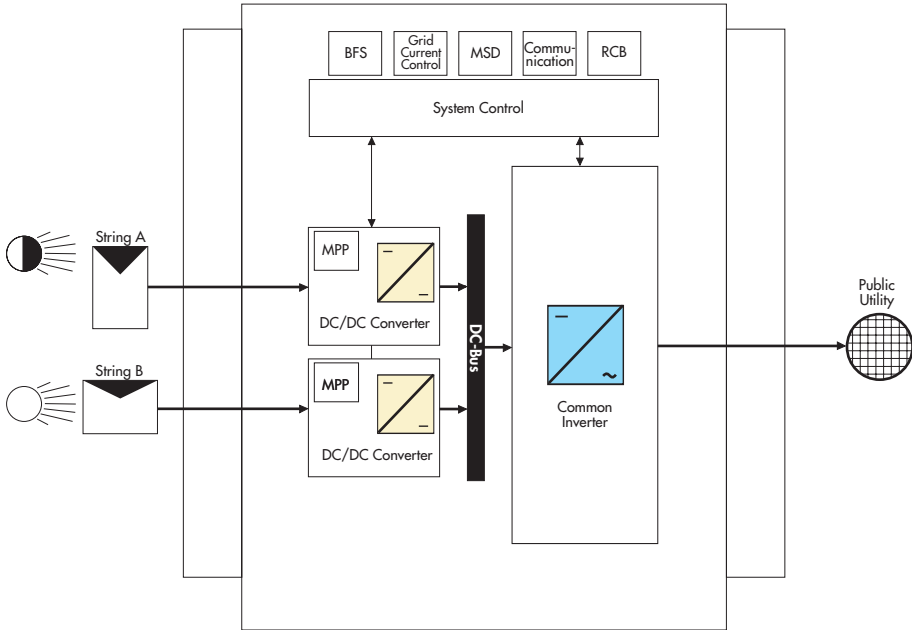
Fig. 3.2:   Block circuit diagram and typical use of the Sunny Boy 4200TL Multi-String

The power converted in all two input units (DC/DC converters) is fed to the connected grid with one common inverter module.

Due to this design the specific costs are kept low and system management can be optimized.

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 4200TL Multi-String.
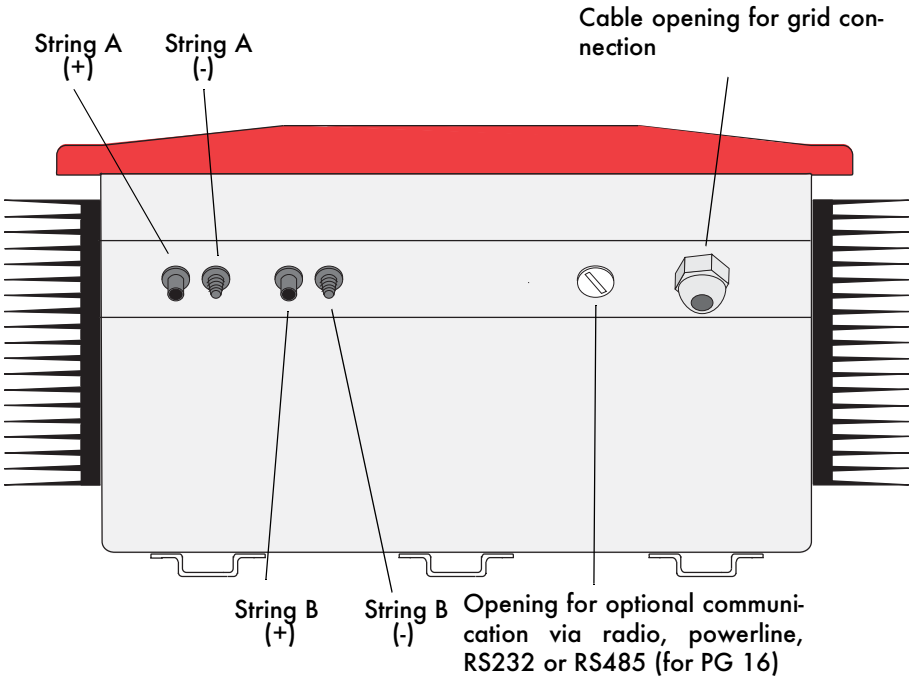
Fig. 3.3:   Bottom view of the Sunny Boy 4200TL Multi-String

3.2 Operating States

The different operating states are displayed with three LEDs in the lid of the Sunny Boy 4200TL Multi-String.
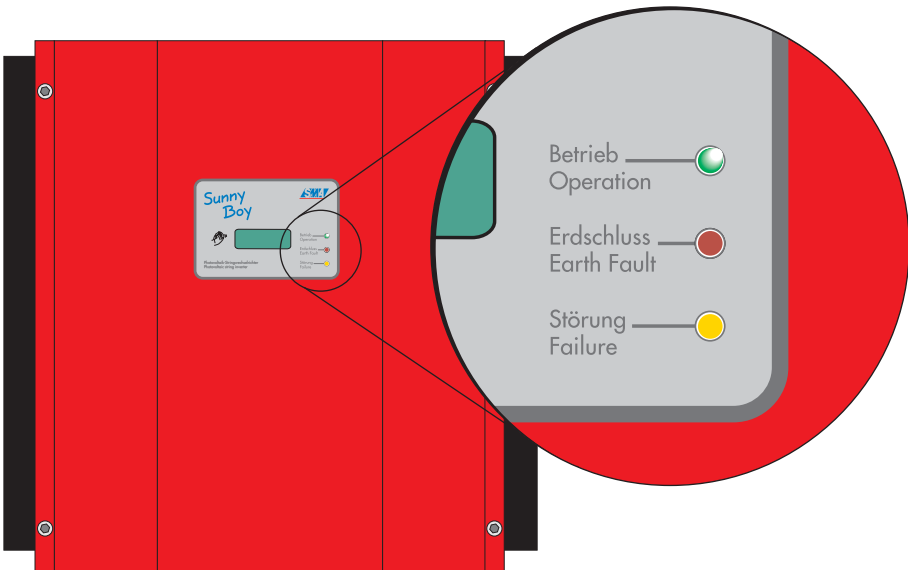
Especially in the first year after installation the operator of the plant should regularly have a look at this display at different times of the day and at different insolation.

You will find a complete description of all signal codes in chapter 3.2.4 "Description of Operating States" (page 16). The operating states can be divided into three categories:

3.2.1 Normal Operating States

As long as no LED or only the green LED is blinking, the Sunny Boy 4200TL Multi-String 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.

3.2.2 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:

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

Yellow LED is blinking 4 times in short intervals.

LED on   LED off

5 s   3 s   1 s   1 s   1 s   1 s

The signal is repeated 3 times and then starts from the beginning.
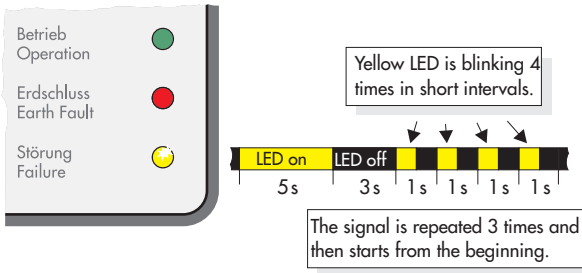
When the failure occurs, the yellow failure LED is on for five seconds and then starts to send the blinking code by remaining off for three senconds and blinking four times in short intervals. The code is sent three times. If the failure persists the code is repeated.

Immediately disconnect the PV generator from the inverter! The Sunny Boy can otherwise be severly damaged.

3.2.3 Uncritical Failure States

All other signaling codes show uncritical operating states. These normally do not mean any high danger of people or device, but their cause must be found and removed immediately in order to avoid yield losses.

Despite all the necessary precaution it is possible that there are additional faults which can not be signaled (e. g. failure of the status display). 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 3.2.4 "Description of Operating States" (page 16). For example if the green LED is on in the middle of the night, this means as much a failure as if no LED is on in full sunlight.

You can diagnose the states in much more detail with one of the communication interfaces described in chapter 5 "Plant Monitoring" (page 33).

3.2.4 Description of Operating States

Stand-by at Night

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

All LEDs are off
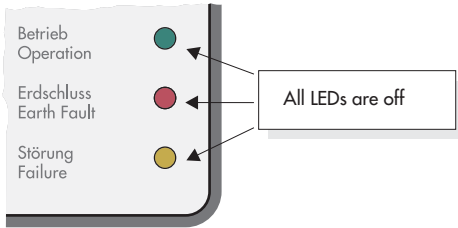
The Sunny Boy 4200TL Multi-String is in so-called stand-by operation. This state is reached if the input power at the inverter is too low for feeding operation (all string voltages are below 125 V) and not sufficient for normal operation.

Initialization

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

All LEDs are on
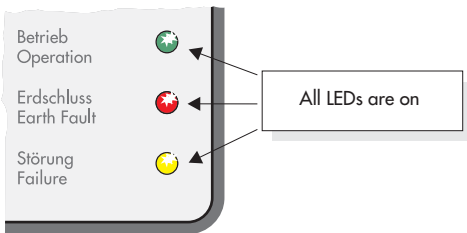
The on-board computer of the Sunny Boy 4200TL Multi-String is in the initialization phase. At least one of the string voltages on the inverter is between approx. 125 V and approx. 750 V. Power is already supplied to the internal board, but is not yet sufficient for grid feeding. Data transmission is not possible yet.

Feeding Operation

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

Green LED is on
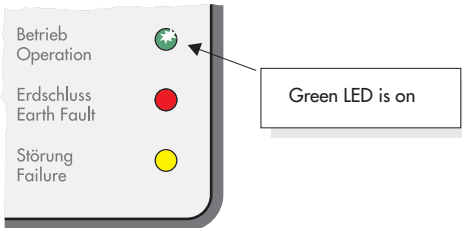
The Sunny Boy 4200TL Multi-String has successfully completed the self-test of the measurement electronics and the MSD and starts feeding to the grid.

MPP operation (default):

The Sunny Boy 4200TL Multi-String automatically determines the MPP voltage of the PV generator.

Constant voltage operation:

The operating state „U-Konst" can be manually defined by the plant operator with Sunny Boy Control or the PC programs Sunny Data or Sunny Data Control. In the „U-Konst" operating mode, the Sunny Boy 4200TL Multi-String uses this externally defined PV setpoint voltage for its internal control.

Stop

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

| 1 s

Green LED blinks
3 times per second
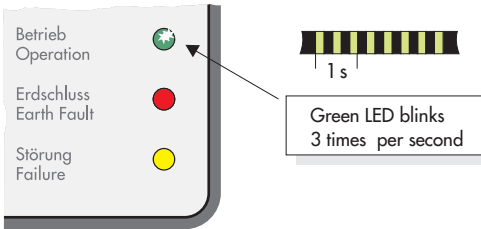
The Sunny Boy 4200TL Multi-String is in stop state. This is to calibrate the measurement electronics, subsequently the inverter switches into „Waiting" state.

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 4200TL Multi-String remains in „Stop" state until a new operating state is defined („MPP operation" or „Constant voltage operation").

Waiting, Grid Monitoring

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

| 1 s

Green LED blinks
once per second
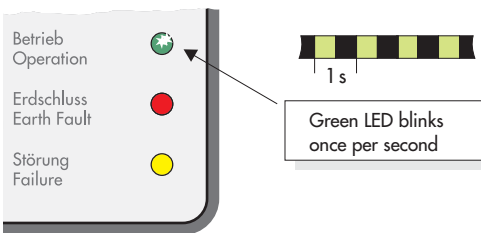
The Sunny Boy 4200TL Multi-String is testing whether start-up conditions for feeding operation are fulfilled (starting voltage, starting time) and then starts to monitor the grid.

Derating
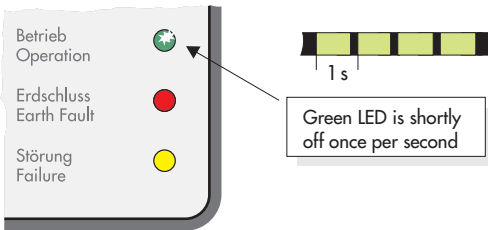
The operating state „Derating" can have several causes:

- The temperature monitoring of the Sunny Boy 4200TL Multi-String has reduced the output power to prevent the device from overheating. If this happens often, heat dissipation might be insufficient.
- To avoid unnecessary yield losses, it should be checked in this case whether the Sunny Boy 4200TL Multi-String can be mounted at a more appropriate place with better ventilation.
- The input power is too high and the Sunny Boy 4200TL Multi-String is operating at its operating limits.
- The current from one of the strings is about to exceed 7.5 A and the Sunny Boy 4200TL Multi-String is reducing this current to 7.5 A in order to prevent any damage.
- The input power from the different strings is being internally reconfigured. In this case the message should dissapear within a few moments.

Insulation Failure
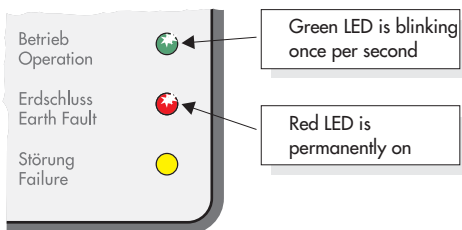
The red LED on the Sunny Boy 4200TL Multi-String is on, which indicates an earth fault.

![warning] **Please contact a qualified electrician who will remove the failure following the instructions in the „Installation Guide".**

Varistor Defective

Betrieb Operation	Green LED is permanently on
Erdschluss Earth Fault	Red LED is permanently on
Störung Failure	
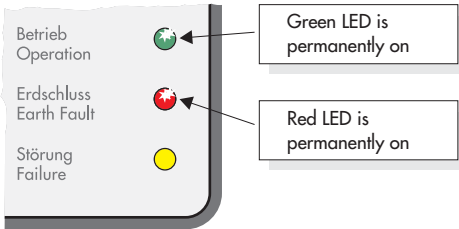
At least one of the four thermally monitored varistors on the DC input side has developed high resistance and is therefore defective.

Please contact a qualified electrician who will remove the failure following the instructions in the „Installation Guide".

Permanent Device Disable

Betrieb Operation	
Erdschluss Earth Fault	
Störung Failure	Yellow LED is permanently on
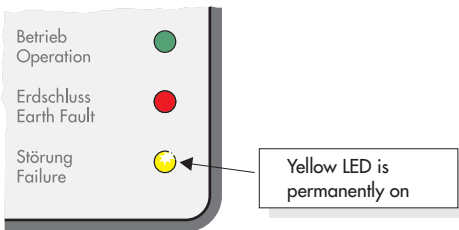
This signal appears if there is a failure of the grid monitoring / the independent disconnection device (MSD). During the internal test, the inverter has detected a malfunction of the MSD and has stopped feeding to the grid.

Normally this is a failure which cannot be removed on site. Please contact the manufacturer (see chapter 8 "Contact" (page 61)) to discuss further proceedings.

DC Input Defective

Betrieb Operation	
Erdschluss Earth Fault	1 s
Störung Failure	Red LED blinks once per second
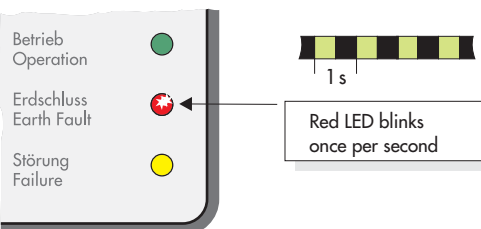
The red LED blinks once per second, the green and yellow LED are not relevant for this blinking code. At least one of the two DC inputs is defective.

Normally this is a failure which cannot be removed on site. Please contact the manufacturer (see chapter 8 "Contact" (page 61)) to discuss further proceedings.

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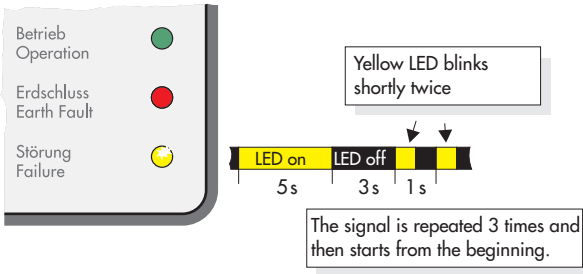
When a grid failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking shortly twice. The code is repeated three times.

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

With the above signal the Sunny Boy 4200TL Multi-String indicates a grid failure which can be caused by:

- Grid undervoltage   (UAC < „Uac-Min")
- Grid overvoltage   (UAC > „Uac-Max")
- Grid underfrequency   (fAC < „Fac-Min")
- Grid overfrequency   (fAC > „Fac-Max").
- Grid frequency change   („|dFac|")
- Defective grid connection
  (e. g. if N and L have been mixed up)

First find out whether there is a general power shutdown (by checking the function of other consumers) and whether 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
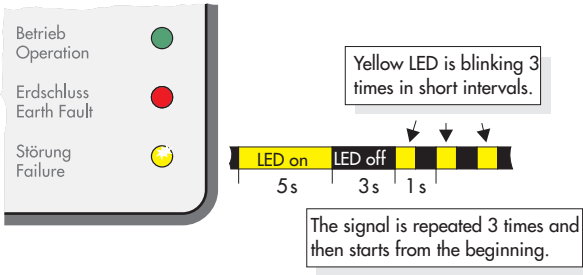
When this failure occurs, the yellow failure LED is on for five seconds and then starts the blinking code by staying off for three seconds and then blinking three times in short intervals. The code is sent three times.

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, the reason might be that grid impedance is too high. A qualified electrician can normally solve this problem by increasing the cross-section of the grid cable. Other actions are possible as well. Any modifications of the operating parameters require the explicit permission of the public utility company.

Input Voltage (PV Generator) too High

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

Yellow LED is blinking 4 times in short intervals.

LED on   LED off
5s   3s   1s 1s 1s 1s

The signal is repeated 3 times and then starts from the beginning.

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 4200TL Multi-String. Too high voltage may lead to irrepairable damages!

Have your installer examine your plant configuration.

Device Failure

Betrieb
Operation

Erdschluss
Earth Fault

Störung
Failure

Yellow LED is blinking 5 times in short intervals.

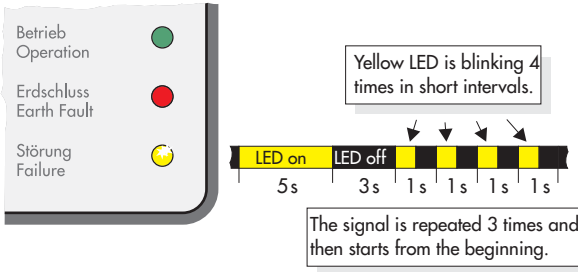| LED on | LED off | | | | |
| 5 s | 3 s | 1 s | 1 s | 1 s | 1 s |

The signal is repeated 3 times and then start from the beginning.

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 it cannot leave for normal operation. Presumably there is an internal failure in the device.

A qualified electrician has to examine the device.

Discharge Current too High

Betrieb Operation

Erdschluss Earth Fault

Störung Failure

Yellow LED is blinking 6 times in short intervals.

LED on　LED off

5s　3s　1s　1s　1s　1s　1s　1s

The signal is repeated 3 times and then starts from the beginning.

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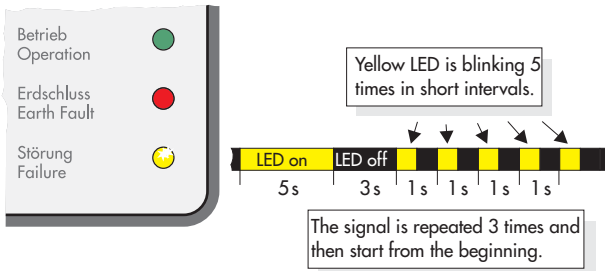
If the failure persists, the signal starts from beginning.

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 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 4200TL Multi-String 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

Betrieb Operation

Erdschluss Earth Fault

Störung Failure

Yellow LED is blinking 7 times in short

LED on | LED off
5 s | 3 s | 1 s | 1 s | 1 s | 1 s | 1 s | 1 s

The signal is repeated 3 times and then starts from the beginning.

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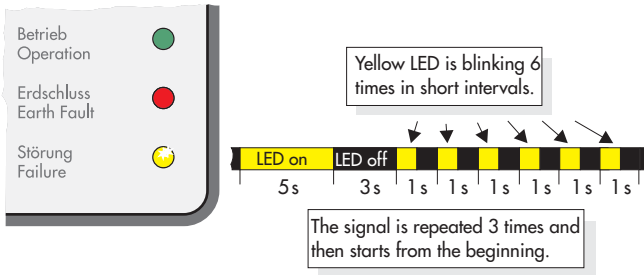
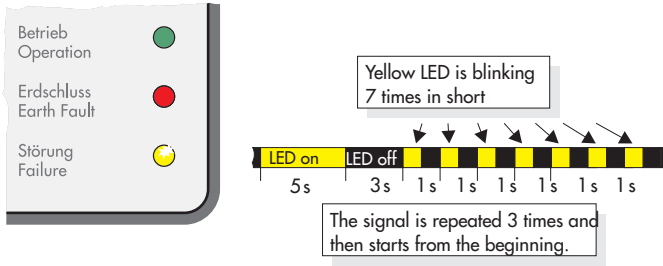If failure persists, the signal starts from the beginning.

The Sunny Boy 4200TL Multi-String has 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 mA and disconnects the inverter from grid within 0.2 seconds.

3.3 Status Messages on the Optional Display

The Sunny Boy 4200TL Multi-String can be optionally equipped with the „Sunny Dis-play" LCD in the lid.
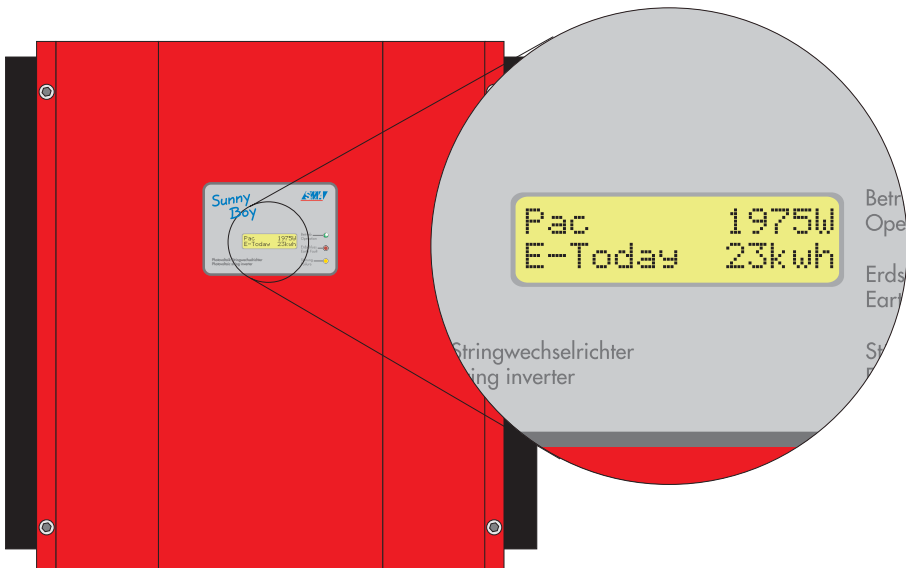
A Sunny Boy 4200TL Multi-String without the „Sunny Display" can be upgraded.

(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 4200TL WR42MS02

Initialization of the display on the
Sunny Boy 4200TL Multi-String

The following messages are displayed during initiali-zation of the Sunny Boy 4200TL Multi-String.

BFR Version 2.00 SRR Version 2.00

Initialization of the display on the
Sunny Boy 4200TL Multi-String

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 one screen after the other. The images on the side indicate the messages. Each message is displayed for 5 seconds. After all messages have been displayed the display starts from the beginning again.

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

```
E-today  3.86kWh
Mode         MPP
```
Energy produced today
and current operating status

The message is followed by the current power and the current grid voltage.

```
Pac         903W
Uac         230V
```
Current AC Power
and AC voltage

The incoming voltage for the two input strings is listed separately,

```
UPVA UPVB
600V 575V
```
Current DC voltages of the
separate strings

as well as the incoming DC power:

```
PA/W PB/W
1325 1275
```
Different currents from the 2 strings

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

```
E-Total 724.4kWh
h-Total     512h
```
Total energy yield and
total operating hours

Messages 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.

```
      Error
      Uac-Bfr
```
Indication of a failure
and failure type

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

```
 at:          261V
 present:     245V
```
Display of the value that caused the
failure and the current value

Failures that result 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.

The normal operating data are displayed after 5 seconds.

The display starts from the beginning again in case the failure is still present. Chapter 6.4 "Measurement Channels and Messages" (page 44) gives more detailed information concerning the failure messages.

```
      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 remove this failure.

Indication of DC Overvoltage

```
 !PV-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 with a blinking background illumination and the display shown on the side.

Disconnect the Sunny Boy from the supply voltage immediately! The Sunny Boy can otherwise be severely damaged!

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

3.4 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
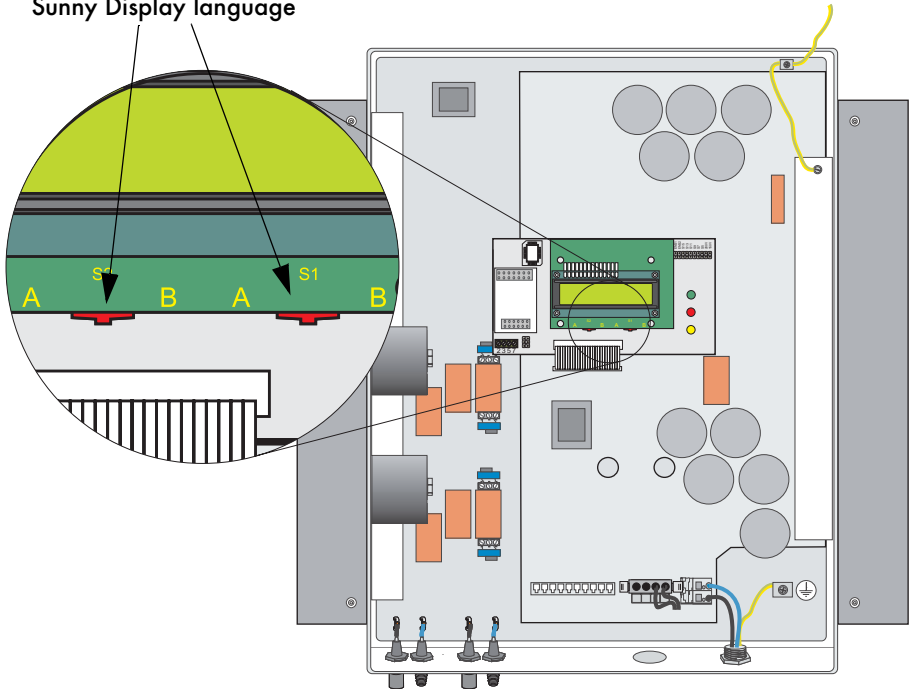
Language	Switch S2	Switch S1
German	B	B
English	B	A
French	A	B
Spanish	A	A
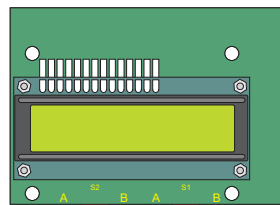
4 Service and Maintenance

To be able to use the Sunny Boy 4200TL Multi-String even outdoors at places hard to reach, the device was designed so as to ensure minimum maintenance. 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 examine the performance with respect to different irradiation whether the LEDs of the Sunny Boy 4200TL Multi-String signals plausible normal operation (see chapter 3.2.4 "Description of Operating States" (page 16)). Of course you can also check this 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 heatsink 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!

5 Plant Monitoring

You can monitor your PV plant with your Sunny Boy 4200TL Multi-String in different ways. SMA offers different products, which allow you to install a customized plant monitoring. Please order the Sunny Family Catalogue for detailed information of our Sunny Boy 4200TL Multi-String products or visit our homepage www.SMA.de. In the following chapters you find the descriptions of our available communication options.

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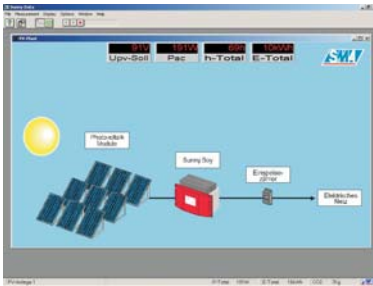
Sunny Data is a PC program for monitoring your PV plant. The connection of your Sunny Boy or Sunny Mini Central is described in the following chapters.

5.1.1 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.
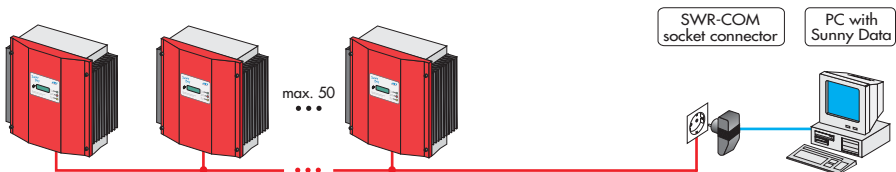
5.1.2 Sunny Data via RS232

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 4200TL Multi-String.

5.1.3 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. For the connection to the PC you need an RS485/RS232 interface converter at the COM1 or COM2 port. The installation of the RS485 cable is described in the Installation Guide of the Sunny Boy 4200TL Multi-String.
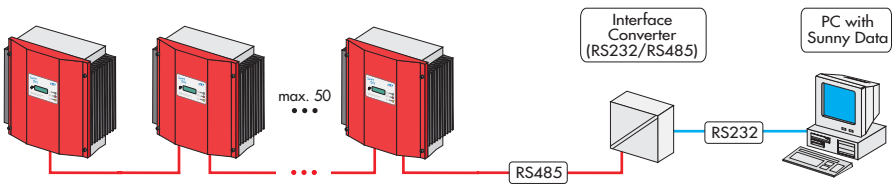
5.1.4 Sunny Data via Sunny Beam

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 for the plant monitoring they have to be detected by the Sunny
Beam. Use a USB cable for the connection between the Sunny Beam and 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.
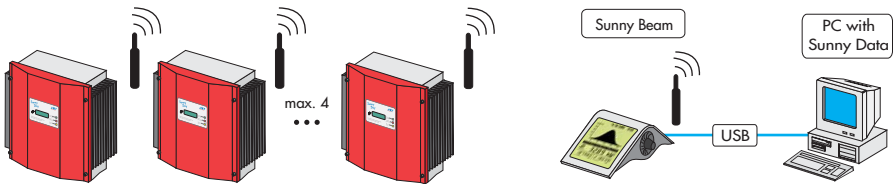
5.2 Sunny Beam

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 placed in an appropriate distance.

5.3 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 are 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.
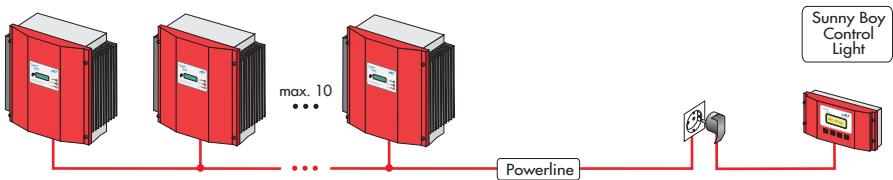
5.4 Sunny Boy Control

The Sunny Boy Control is a data logger for PV plants with up to 50 Sunny Boys or Sunny Mini Centrals. You can 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.
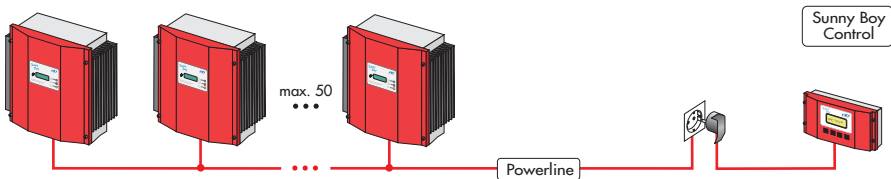
RS485 communication via cable
Requirements: All Sunny Boys and Sunny Mini Centrals have to be equipped with an RS485 Piggy-Back. The Sunny Boy Control has to be equipped with an RS485 Piggy-Back at the interface „COM-1 Sunny Boy".
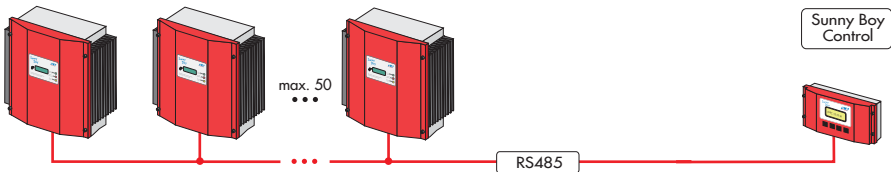
5.5 Sunny Boy Control Plus

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 more interface for a PC or external display and additional interfaces for digital and analog in- and outputs.

Requirements: See Sunny Boy Control

5.6 Sunny Data Control

Sunny Data Control is a PC programm 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 a connection to PC.
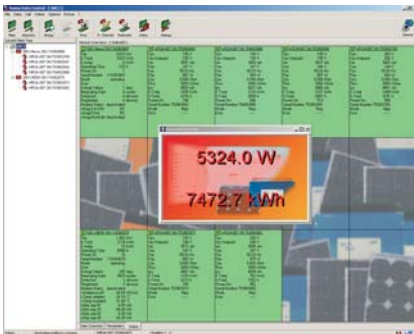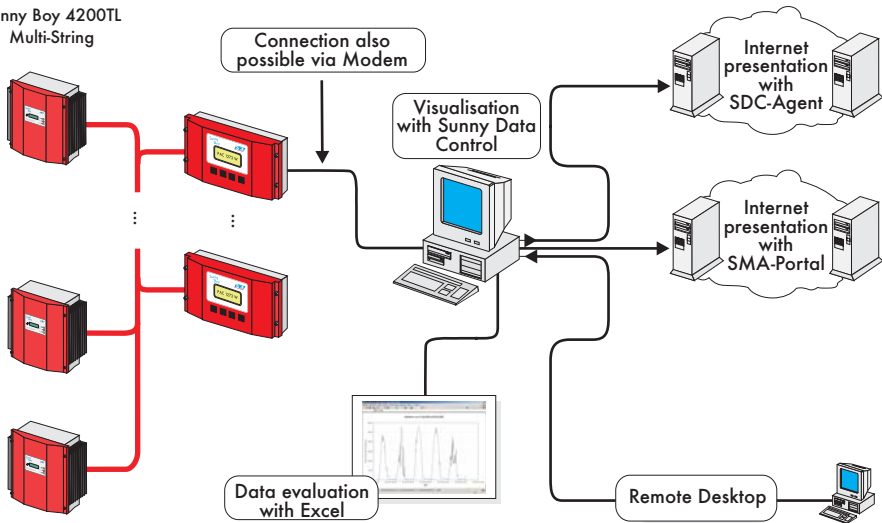
If required you can also use a modem for the connection between PC and Sunny Boy Control. By connecting several Sunny Boy Controls, it is possible to monitor large scale plants with more than 50 Sunny Boys or Sunny Mini Centrals.

5.7 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.
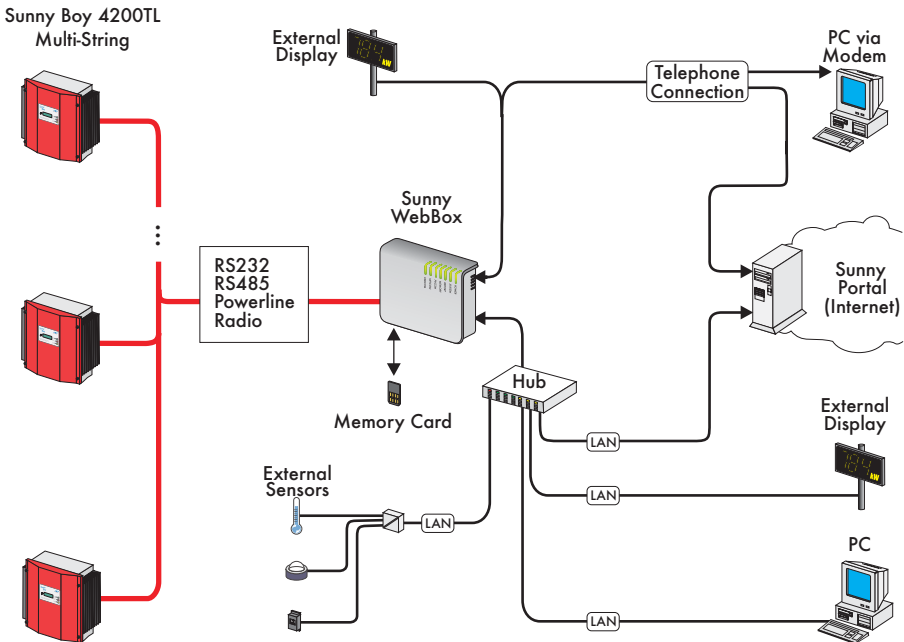
5.8 Sunny Portal
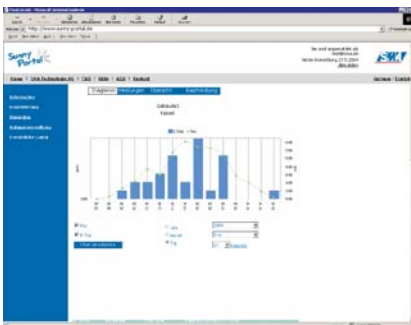
Sunny Portal is a powerful internet presentation platform from SMA, which allows you to monitor and present your PV plant in the internet. For detailed information please have a look at the Sunny Family Catalogue or at www.SUNNY-PORTAL.de.

5.9 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 the presentation of large scale PV plants in entrance areas and lobbies or for privacy. Sunny TV is available at the 2nd quarter of 2005.
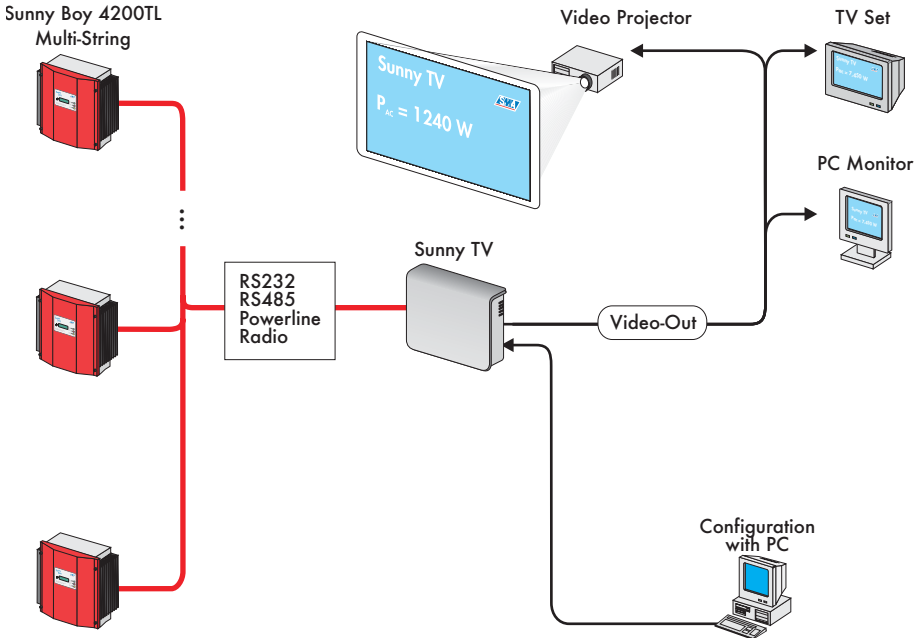
6 Technical Documentation

6.1 Data PV Generator Connection

Max. input open-circuit voltage	$U_{PV\,0}$	750 V (at -10 °C module temperature)
Input voltage, MPP operation	U_{PV}	125 V ... 750 V DC
Max. input current	$I_{PV\,max}$	7,5 A per input port
Max. input power	P_{PV}	3800 W per String
Recommended max. generator power		4400 W
All-pole disconnector on DC input side		Multi-Contact® plug connector (standard - other snap cable connectors optional)
Surge voltage protection		thermally monitored varistors
Voltage ripple	U_{PP}	< 10 % of input voltage
Personnel protection		Ground Fault monitoring (Riso > 1 MΩ)
Internal consumption in operation		< 10 W (stand-by)
Pole confusion prevention		by short-circuit diode

6.2 Data Grid Connection

Nominal output power	P_{ACnom}	4000 VA
Peak output power	P_{ACmax}	4200 W
Nominal output current	I_{ACnom}	17.5 A
Harmonic distortion of output (with THD_{IAC} K_{Unom} < 2 %, P_{AC} > 0,5 P_{ACnom})		4 %
Short-circuit resistance		Imax = 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 disconnector on grid side		independent disconnection device (MSD), (2 independant systems)
Phase difference (related to basic wave of current)	j	0°
Overvoltage 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		0.25 W

6.3 Description of Device

You will find a detailed device description in chapter 3 "Device Description" (page 11) of these Operating Instructions.

General Data

Protection Degree according to DIN EN 60529	IP65
Dimensions (width x height x depth)	approx. 470 mm x 490 mm x 225 mm
Weight	approx. 29 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}	> 94.9 %

The efficiency of the Sunny Boy 4200TL Multi-String depends on the DC input voltage coming from the PV modules. The higher the voltage the higher is the efficiency of the Sunny Boy 4200TL Multi-String.
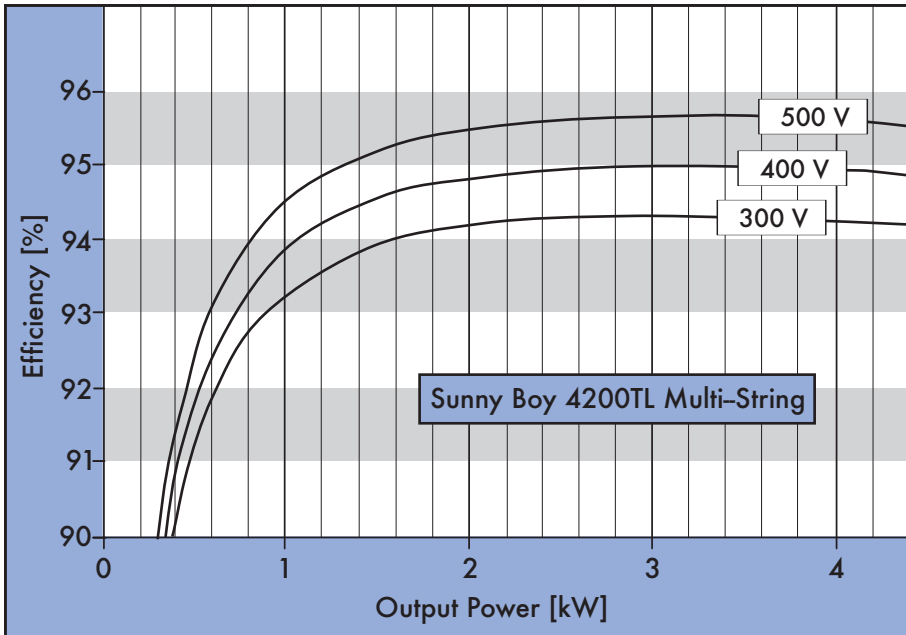
Fig. 6.4: Efficiency of the Sunny Boy 4200TL Multi-String with respect to the input voltage

6.4 Measurement Channels and Messages

If your Sunny Boy 4200TL Multi-String has been equipped with a communication interface, numerous measurement channels and messages can be acquired. These can help improve the performance as well as eliminate failures of your plant.

BFR: System control
SRR: Current control

6.4.1 Measurement Channels

Channel	Description
dI	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-A	Total DC Yield, String A
E-Total DC-B	Total DC Yield, String B
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
h-Total DC-A	Total sum of operating hours in feeding operation, String A
h-Total DC-B	Total sum of operating hours in feeding operation, String B
Iac	Current fed to the grid
Netz-Ein/Power ON	Total number of connections to the grid
Pac	Present output power
Riso	Insulation resistance of PV plant before the 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 DC-A/ Vpv DC-A	PV input voltage (string A)
Upv-Ist DC-B/ Vpv DC-B	PV input voltage (string B)

Channel	Description
Upv-Soll DC-A/ Vconst-SetpointA	PV setpoint voltage (String A)
Upv-Soll DC-B/ Vconst-SetpointB	PV setpoint voltage (String B)
Zac	Grid impedance
PPV DC-A	Present power from String A
PPV DC-B	Present power from String B

6.4.2 Status Messages

The Sunny Boy 4200TL Multi-String generates a number of status messages according to the mode it currently operates in. The status messages that you see 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 4200TL Multi-String is operating in MPP mode. The input voltage setpoint is constantly 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 4200TL Multi-String 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 fixed to a defined setpoint. The Sunny Boy 4200TL Multi-String 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 4200TL Multi-String can process.
Derating Idc / derat. Idc	The Sunny Boy 4200TL Multi-String is reducing the output power due to overcurrent on the DC side. This is not a critical status, but you should keep in mind that your plant is loosing 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 4200TL Multi-String 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.

Message	Description
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 occur often 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")
Stop	A safety relevant failure or similar occured 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.

6.4.3 Sunny Boy 4200TL 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 A/ Vconst-SetpointA	V	0 ... 750	290	PV setpoint voltage for constant voltage operation for String A and B. These parameters only are important in case the parameter „Operating Mode" is set to „U-konst".
Usoll-Konst B/ Vconst-SetpointB	V	0 ... 750	290	
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 trips
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 trips
dZac-MAX	mOhm	0 ... 2000	350	Maximal „rate of change of grid impedance" before anti-islanding trips
Riso-Min	kOhm	1000 ... 30000	1000	Minimum irradiation 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 that are visible in user level to default values. Reset Failure: Resets all permanent device disable (dBh)
Default			GER/ ENS	Used for adjusting the parameters 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.

Table 6.1: Operating Parameters of the Sunny Boy 4200TL (changeable)

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

Name	Unit	Range	Default	Description
Plimit	W	5100		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)

Table 6.2: Operating Parameters of the Sunny Boy 4200TL Multi-String (fixed)

6.4.4 Precision of Measured Value Acquisition

Acquisition of measured values always is imprecise within a certain margin. The measued values acquired by the Sunny Boy 4200TL Multi-String are required for its system management and control of current to be fed to the grid. This is why measured values of the Sunny Boy 4200TL Multi-String 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, TU=25°C)
Input voltage	UPV1-3 [V]	0 ... 800 V	1 V	0.78 V	±2 %
Input current	IPV1-3 [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 %
Power fed to grid	PAC [W]	0 ... 7367 W	1 W	1 W	±3 %
Energy fed to grid	E [kWh]	0 ... $4.29*10^9$ Wmin	1 Wmin	20 Wmin	±3 %
Operating hours	h [h]	0 ... $4.299*10^9$ s	1 s	375 ns	±0.1 %

Table 6.3: Measured value acquisition of the Sunny Boy 4200TL Multi-String

6.4.5 Failure Messages

In case of a failure the Sunny Boy 4200TL Multi-String 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.
DC-A def. DC-B def.	DC input is defective. Contact SMA in case you observe this failure.
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 4200TL Multi-String measured values of BFR and SRR are too different from each other.
dFac-Bfr dFac-Srr	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. Check the grid frequency and the rate of fluctuation. If the grid frequency fluctuates often and you therefore often observe „dFac-Bfr" or „dFac-Srr" consult the utility company and ask if it is permissable to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy.
dI-Bfr dI-Srr	The Sunny Boy 4200TL Multi-String has detected a drastic change of the discharge current. As the Sunny Boy 4200TL Multi-String is a transformerless inverter there is no electric separation. A sophisticated and effective discharge current monitoring is an important element of the personnel protection. A drastic change of the discharge current can be the result of a malfunction or a sudden dangerous ground fault and the Sunny Boy disconnects all poles (DC and AC). Have a qualified technician check the isolation and the ground connection in case you observe „dI-Bfr" or „dI-Srr" without any obvious cause in your system.

Failure Code	Descipition
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 put the Sunny Boy to normal operation as well.
dI-Test	Failure of differential current converter
dZac-Bfr dZac-Srr	The rate of change of the AC grid impedance is exceeding the permissable 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. Check the grid impedance and the rate of fluctuation. If the grid frequency fluctuates often and you therefore often observe „dZac-Bfr" or „dZac-Srr" consult the utility company and ask if it is permissable to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy.
EEPROM	Transition failure during reading or writing of data EEPROM, the data are 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	The AC grid frequency is exceeding the permissable range („Bfr" or „Srr" is an internal message and is not important for the user). The Sunny Boy 4200TL Multi-String assumes that the public grid is down and disconnects from the grid in order to avoid islanding. 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 contact the utility company and ask if it is permissable to change the grid monitoring parameters of the Sunny Boy. Contact SMA about how to change the grid monitoring parameters of your Sunny Boy. If the grid frequency is within the tolerable range and you still observe the failure message „Fac-Bfr" or „Fac-Srr", contact SMA.
IGBTs	The internal hardware monitoring has detected a defect of an inverter part. Contact SMA in case you observe this failure often.
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.

Failure Code	Description
Imax DC	Overcurrent in the intermediate DC circuit of the Sunny Boy 4200TL Multi-String. 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.
L<->N	L and N mixed up on AC connection. Have 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. If this failure occurs often the Sunny Boy is internally set to „permanent disable". Contact SMA in case you observe this failure often.
Riso	The electric isolation of the PV system to the ground is leaking. 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 you observe this failure often.
Uac-Bfr/ Uac-Srr	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: • A disconnected grid (circuit breaker, fuse) • A disconnected AC cable • AC cable is high-resistance The Sunny Boy 4200TL Multi-String 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 contact the utility company and ask if it is possible to modify the utility conditions. If the grid voltage is within the tolerable range and you still observe the failure message „Uac-Bfr" or „Uac-Srr" contact SMA.
UDiff Uzkposneg<10	Defective DC link. Contact SMA in case you observe this failure often.

Failure Code	Description
Uzwk	Overvoltage on the DC input. Disconnect the Sunny Boy from the PV Modules immediately! The Sunny Boy can be severly damaged! Have your plant configuration checked before you reconnect the DC voltage.
Watchdog Watchdog Srr	Internal Watchdog function triggered.
Zac-Bfr/ Zac-Srr	The AC grid impedance is exceeding the permissable 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. The impedance is the sum of the grids internal impedance and the impedance of the AC cable that connects the Sunny Boy to the grid. 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 connection of the Sunny Boy to the grid. If the grid impedance is out of range due to your local grid conditions contact the utility company and ask if it is possible to modify the utility conditions.

6.5 Declaration of Conformity (CE)

CE Declaration of Conformity
for utility interactive inverters

Product: **Sunny Boy**
Type: **SB 4200TL Multi-String, SB 5000TL Multi-String**

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
Harmonics: DIN EN 61000-3-11: 2001-04
                                   DIN EN 61000-3-12: 2004-06 (Draft)
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, 29th of September 2004

SMA Technologie AG

i. V. Frank Greizer

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

SB-G16A-CE12:BE4604

SMA Technologie AG
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www.SMA.de
info@SMA.de

6.6 Clean Report of Findings (Grid Guard)

The Sunny Boy 4200TL Multi-String 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 – BGZ
des Hauptverbandes der gewerblichen Berufsgenossenschaften

Fachausschuss Elektrotechnik, Postfach 51 05 80, 50941 Köln

BG

Federführung:
Berufsgenossenschaft
der Feinmechanik
und Elektrotechnik

SMA Regelsysteme GmbH
Hannoversche Straße 1-5

34266 Niestetal

Ihre Zeichen/Nachricht vom	Unser Zeichen (Bitte stets angeben)	Bearbeiter	☎ (02 21) 37 78-	Datum
	UB.010.17	Pl/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

Hausadresse	Gustav-Heinemann-Ufer 130	50968 Köln	Tel. (02 21) 37.78.-365	Fax (02 21) 37.78.-366

7 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 so as to make the generator operate in its maximum power point.

MSD
The „**M**ains monitoring with allocated **S**witching **D**evices" 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

Abbrevation for „Power Line Communication", term for data transmission via the grid cable

PV

Abbrevation 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-crystaline, poly-crystaline, 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 manufacture or a different degree of shading of solar modules.

8 Contact

If you have any questions about or technical problems with the Sunny Boy 4200TL Multi-String our hotline will be happy to assist you. Please keep the following data ready when contacting SMA:

- Type of inverter
- Type of Modules connected
- Communication Interfaces
- Serial number of the Sunny Boy

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