PV Inverter

SUNNY BOY 3000-US / 3800-US / 4000-US

Installation Guide

SB30-40US-IA-eng-IUS121431 | TBUS-SB30_40US | Version 3.1

US

SMA America, LLC

3801 N. Havana Street

Denver, CO 80239 U.S.A.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for Sunny Boy inverter, that must be followed during installation and maintenance of the inverter.

The Sunny Boy is designed and tested according to international safety requirements, but as with all electrical and electronic equipment, certain precautions must be observed when installing and/or operating the Sunny Boy. To reduce the risk of personal injury and to ensure the safe installation and operation of the Sunny Boy, you must carefully read and follow all instructions, cautions and warnings in this installation guide.

Warnings in this document

A warning describes a hazard to equipment or personnel. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the SMA equipment and/or other equipment connected to the SMA equipment or personal injury.

DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to personal injury.

Other Symbols in this document

In addition to the safety and hazard symbols described on the previous pages, the following symbol is also used in this installation guide:

Information

This symbol accompanies notes that call attention to supplementary information that you must know and use to ensure optimal operation of the system.

Markings on this product

The following symbols are used as product markings with the following meanings.

Warning regarding dangerous voltage

The product works with high voltages. All work on the product must only be performed as described in it's documentation.

Beware of hot surface

The product can become hot during operation. Do not touch the product during operation.

Observe the operating instructions

Read the product's documentation before working on it. Follow all safety precautions and instructions as described in the documentation.

UL1741 is the standard applied by Underwriters Laboratories to the Sunny Boy to certify that it meets the requirements of the *National Electrical Code*® and IEEE-929-2000. IEEE 929-2000 provides recommendations regarding the proper equipment and functionality necessary to ensure compatible operation when power generation is connected to the utility grid.

General Warnings

General Warnings

All electrical installations must be done in accordance with the local and *National Electrical Code*® ANSI/NFPA 70. For installation in Canada the installations must be done in accordance with applicable Canadian standards.

The Sunny Boy contains no user-serviceable parts except for the fans on the bottom of the enclosure and the filters behind the fans as well as the handle covers on the sides of the unit. For all repair and maintenance, always return the unit to an authorized SMA Service Center.

Before installing or using the Sunny Boy, read all of the instructions, cautions, and warnings on the Sunny Boy in this installation guide.

Before connecting the Sunny Boy to the electrical utility grid, contact the local utility company. This connection must be made only by qualified personnel.

Wiring of the Sunny Boy must be made by qualified personnel only.

Table of Contents

1 Notes on this manual

1.1 Validity

This manual describes the assembly, installation, commissioning and maintenance of the following SMA inverters:

- Sunny Boy 3000-US (SB 3000US and SB 3000US-12)
- Sunny Boy 3800-US (SB 3800-US-10 and SB 3800-US-12)
- Sunny Boy 4000-US (SB 4000US and SB 4000US-12)

This manual does not cover any details concerning equipment connected to the Sunny Boy (e. g. PV modules). Information concerning the connected equipment is available from the manufacturer of the equipment.

1.2 Target group

This manual is for qualified personnel. Qualified personnel have received training and have demonstrated skills and knowledge in the construction and operation of this device. Qualified personnel are trained to deal with the dangers and hazards involved in installing electric devices.

1.3 Storage of the documentation

Keep all Sunny Boy manuals in a convenient place for future reference.

1.4 Additional information

You will find further information on special topics in the download area at www.SMA-America.com.

1.5 Nomenclature

In this document SMA America Production, LLC is referred to in the following as SMA.

The syntax specified here for menus and parameters applies throughout the entire manual.

2 Safety

2.1 Appropriate usage

The Sunny Boy is a DC to AC grid-tied utility interactive inverter for use with photovoltaic (PV). The Sunny Boy is additionally UL listed for the use with fuel cell, wind turbine and other sources of DC power.

Arc Fault Circuit Interrupter AFCI

Only the following Sunny Boy types are equipped with an automatic arc fault circuit interrupter (AFCI):

- SB 3000US-12
- SB 3800-US-12
- SB 4000US-12

Edition 2011 of the National Electrical Code®, Section 690.11, requires that all PV plants attached to a building are fitted with a means of detecting and interrupting serial electric arcs (AFCI) on the PV side.

An electric arc with a power of 300 W or greater must be interrupted by the AFCI in the time specified by UL 1699B. A triggered AFCI may only be reset manually.

The arc fault circuit interrupter (AFCI) can be deactivated in the "Electrically qualified person" mode via the communication device if this function is not desired.

Anti-islanding protection

Islanding is a condition that can occur if the utility grid is disconnected while the Sunny Boy is operating and the remaining load is resonant at 60 Hz and matches the output of the Sunny Boy perfectly. This condition is highly unlikely and had never been witnessed outside of a controlled laboratory. Nevertheless, the Sunny Boy incorporates an advanced active islanding protection algorithm to ensure that the system will not export power into a balanced 60 Hz resonant load while the utility is disconnected. The Sunny Boy periodically injects both leading and lagging reactive current into the utility grid. This method has been proven by Underwriters Laboratories to effectively destabilize and disconnect from a balanced island condition.

PV ground fault detection and interruption

The Sunny Boy is equipped with a ground fault detection device. If a ground fault current greater than 1 Amp is detected, the Sunny Boy will shut down and display the fault condition on the user interface display. Once the ground fault is located and corrected, the ground fault error will need to be manually cleared and the inverter will then resume normal operation.

PV series fusing

Series fusing may be required depending on the type of PV module used in the system. See *National Electrical Code®* 690.9

Interconnection code compliance

The Sunny Boy has been tested and listed by Underwriters Laboratories to meet the requirements of UL1741 Static Inverters and Charge Controllers for use in Photovoltaic Power Systems and UL1998 Software in Programmable Components, as well as IEEE-929-2000 Recommended Practice for Utility Interface of Photovoltaic Systems and IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems. The Sunny Boy is also listed under UL1741 for Canadian UL.

UL1741 is the standard applied by Underwriters Laboratories to the Sunny Boy to certify that it meets the requirements of the *National Electrical Code®* and IEEE-929-2000. IEEE 929-2000 provides recommendations regarding the proper equipment and functionality necessary to ensure compatible operation when power generation is connected to the utility grid.

Contact the local utility and/or the authority having jurisdiction prior to connecting the Sunny Boy to the utility grid.

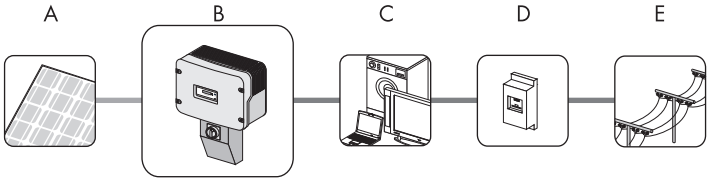
FCC compliance

The Sunny Boy has been tested and shown to conform with all FCC Part 15 B EMI/EMC emissions regulations.

Operating temperature

The Sunny Boy has been designed to maintain full power output at ambient temperatures as high as 113 °F. Fan cooling allows this level of output power to be achieved even in enclosed spaces. The Sunny Boy will continue to operate well beyond 113 °F and de-rates as needed to maintain a safe internal component temperature.

Principle of a PV plant with a Sunny Boy



Position	Description
A	PV array
B	Sunny Boy with SMA DC Disconnect
C	Local loads
D	Energy meter
E	Utility grid

2.2 Safety instructions

DANGER

High voltages are present in the Sunny Boy during operation.

Death or serious injury due to electric shock.

- All work on the Sunny Boy must only be carried out by qualified personnel.

WARNING

The Sunny Boy can become hot during operation.

Risk of burns.

- Do not touch enclosure during operation.
- Only touch lid during operation.

2.3 Installation overview

This section provides a brief overview of the installation process of a Sunny Boy.

Section 3: Unpacking and inspection

This section provides instructions and information for unpacking the Sunny Boy and inspecting it for shipping damage.

Section 4: AC Voltage configuration

This section includes information on removing the cover, locating primary components within the inverter and selecting the appropriate voltage configuration for the installation.

Section 5: Mounting

This section includes guidelines to help you select the best mounting location, suggestions to insure optimum performance, cautions and warnings that you should follow to avoid injury and/or equipment damage and step-by-step instructions for mounting the Sunny Boy inverter.

Section 6: Electrical connection

This section includes guidelines for selecting the correct wire sizes, cautions and warnings that you should follow to avoid injury and/or equipment damage and step-by-step instructions for wiring the Sunny Boy to a PV array, household electrical circuits and the utility grid. Procedures are also included for connecting optional data-communication cables.

Section 7: Commissioning

Commissioning involves applying DC input power to the Sunny Boy, observing the LED and LCD indicators on the front cover, and resolving any problems that occur.

Section 8: Displays and messages

This section provides troubleshooting tips and procedures for resolving problems that may occur during installation and operation.

Section 9: Troubleshooting

This section provides troubleshooting tips and procedures for resolving problems that may occur during installation and operation.

Section 10: Maintenance

This section includes maintenance and cleaning of the Sunny Boy and cautions and warnings you should follow to avoid injury and/or equipment damage.

Section 11: Technical specifications

This section includes technical data for the Sunny Boy, connection diagrams and torque specifications for the connection of cables and the screws of the Sunny Boy.

3 Unpacking and inspection

All Sunny Boy inverters are checked before shipping and packaged in sturdy boxes. However the sturdy boxes do not guarantee that damage will not occur during shipping and delivery.

It is important to carefully inspect the shipping box and contents prior to installation. If you detect any external damage after unpacking, report the damage immediately to your SMA dealer and to the shipping company that delivered the unit. If it becomes necessary to return the Sunny Boy, use the original packing material.

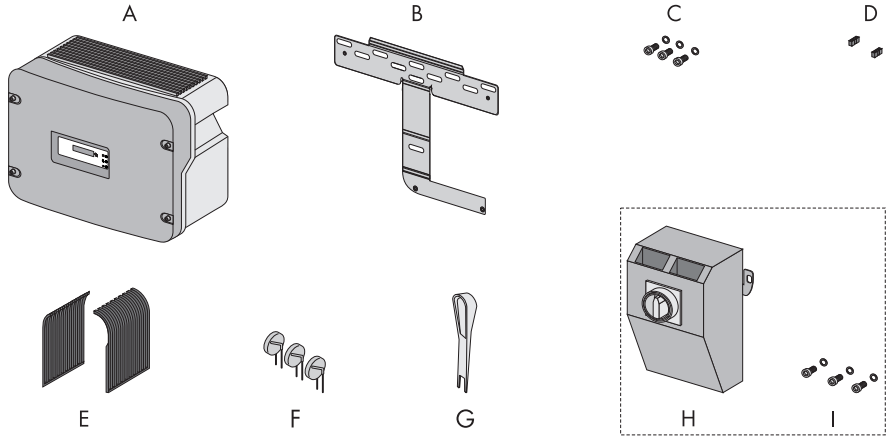
WARNING

The Sunny Boy weighs up to 88 lbs. (40 kg). To avoid injury, be sure to use proper lifting techniques and secure the help of someone to assist in the unpacking and installation of the inverter.

If you need assistance with a damaged Sunny Boy, contact your SMA dealer or SMA.

Contact information is provided in section 14 "Contact" (page 105).

3.1 Scope of delivery



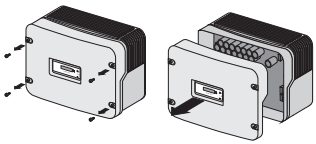
Position	Number	Description
A	1	Sunny Boy
B	1	Wall-mounting bracket
C	1	Spare screw and spare washer for closing the Sunny Boy lid
	2	Screws and washers for fastening the Sunny Boy to the wall-mounting bracket
D	2	Spare jumpers for fan test
E	2	Handle covers (left and right)
F	3	DC varistors*
G	1	Insertion tool for DC varistors*
H	1	SMA DC Disconnect
I	1	Screw and washer for closing the DC Disconnect lid
	2	Screws and washers for fastening the DC Disconnect to the wall-mounting bracket

* only SB 3000US-12/SB 3800-US-12/SB 4000US-12

4 AC Voltage configuration

4.1 Opening the Sunny Boy

1. Remove the four screws and lock washers from the housing cover and pull the cover forward smoothly.
2. Place the cover, screws, and lock washers aside where they will be out of your way while you are connecting wires and cables to the Sunny Boy.



CAUTION

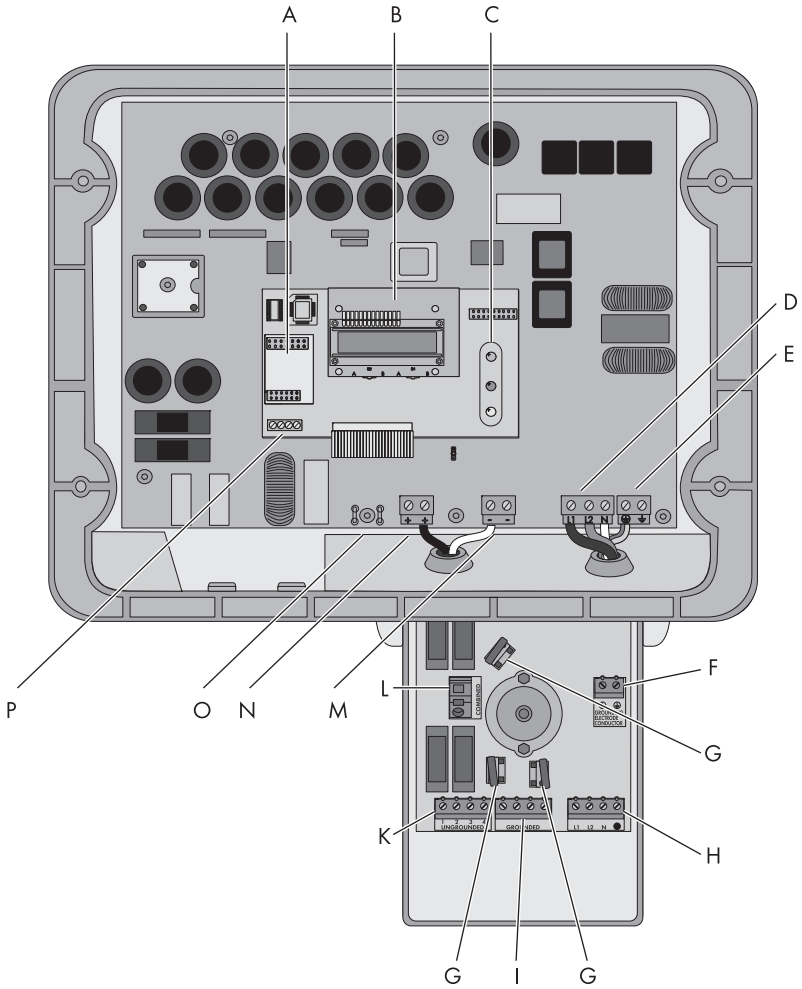
Be careful not to misplace the screws or the lock washers, as all six screws and lock washers are required to ensure that the cover is grounded properly and is fully sealed to the case. Handle the cover carefully, as even minor damage to the cover could result in an inadequate seal between the cover and the case, thus allowing moisture to enter the case and damage the sensitive electronic components.

NOTICE

Do not install the Sunny Boy during periods of precipitation or high humidity (>95 %). Moisture trapped within the enclosure may cause corrosion and damage to the electronic components.

4.2 Locating internal components

Following figure illustrates the locations of the major internal components of the Sunny Boy. Refer to this illustration to locate particular components.



Position	Description
A	Sockets for optional communication Piggy-Back (RS485 or wireless)
B	Display
C	Status LED
D	Output AC Line Terminals (N, L1 and L2)
E	Ground Terminal (PE)

Position	Description
F	PV Grounding + DC Grounding electrode conductor
G	Terminals for DC varistors*
H	Output AC Line Terminals (L1, L2, N and PE)
I	PV GROUNDED Terminal (input from PV array)
K	PV UNGROUNDED Terminal (input from PV array)
L	Combined UNGROUNDED Terminal
M	DC– Terminal (input from PV array)
N	DC+ Terminal (input from PV array)
O	Flat connection for grounding the cable shield for communication
P	Terminal for optional communication (RS485)

* only SB 3000US-12/SB 3800-US-12/SB 4000US-12

4.3 Automatic grid voltage detection

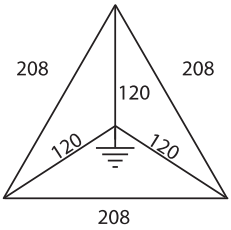
The Sunny Boy is designed to automatically detect which grid voltage it is feeding if a neutral conductor is connected to the inverter. Depending upon the voltage and phase angle between L1-N and L2-N, the inverter will determine if it is connected to a 208 V or 240 V.
The following table lists voltage and frequency limits for the AC connection.

AC connection	Range limit
208 V nominal, line to line	183 V ... 229 V
240 V nominal, line to line	211 V ... 264 V
Frequency	59.3 Hz ... 60.5 Hz

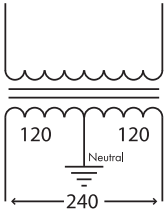
Commonly used transformer types

When connecting the Sunny Boy to the utility, the phase relationship is not important, but the voltage must be compatible.

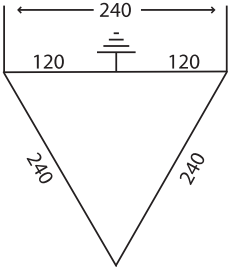
208 Delta: 120 WYE



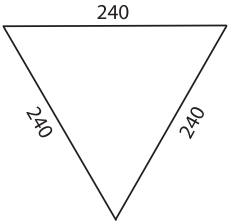
240: 120 Split Phase



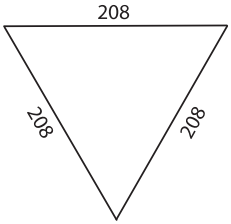
240 Delta: 120 Stinger



240 Delta

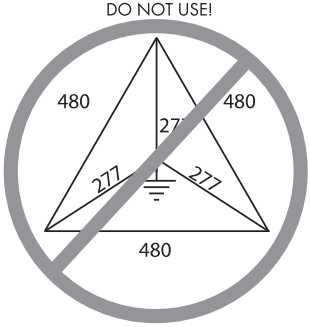


208 Delta



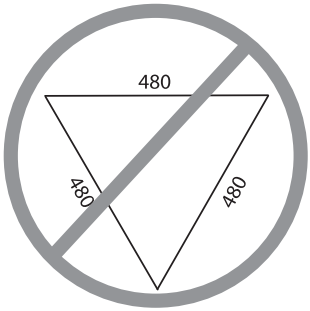
480 Delta: 277 WYE

DO NOT USE!



480 Delta

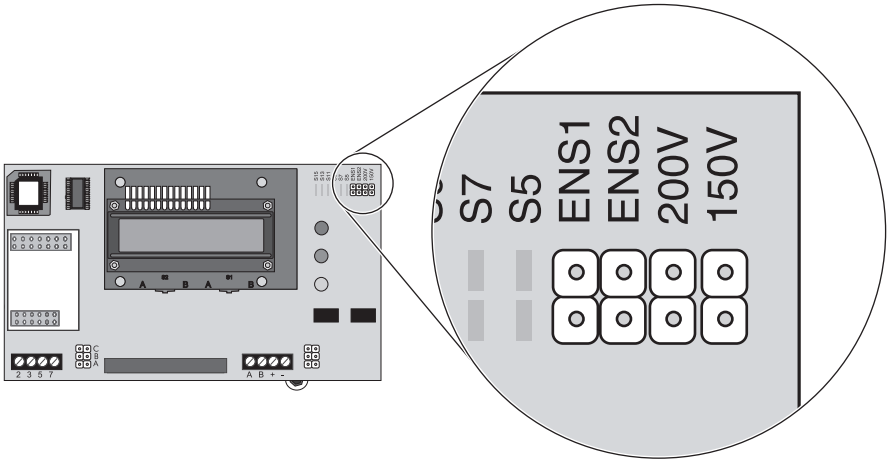
DO NOT USE!



4.4 Utility configuration jumpers

The Sunny Boy comes from the factory pre-configured for utility interconnection with neutral conductor. The Sunny Boy may be reconfigured for grids without neutral by setting the jumpers on the board of the Sunny Boy.

The utility configuration jumpers allow the Sunny Boy to be connected to transformers where the neutral is not present, such as the 208 V and 240 V Delta. Following figure shows an overview of default settings, settings for grids with no neutral, and fan test settings.



240 V/208 V AC (Default)
(With Neutral)

208 V Delta, No Neutral

240 V Delta, No Neutral

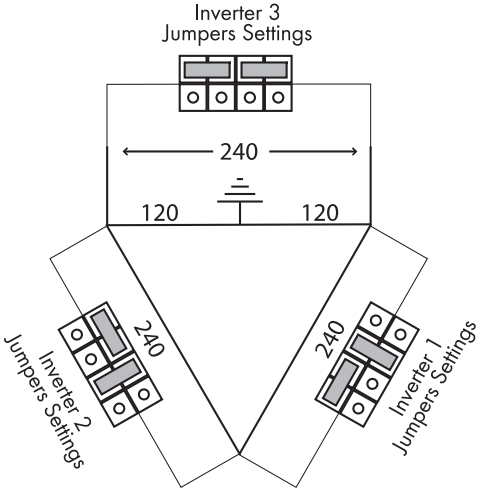
Fan Test

The Sunny Boy may be configured for two different grid types commonly found in the U.S. The Sunny Boy is compatible with:

- 208 V AC output
- 240 V AC output

Following figure illustrates the proper jumper settings when connecting to a 240 Delta: 120 V Stinger type transformer. Note the order in which inverters are connected to the phases.

240 V Delta : 120 V stinger



5 Mounting

This section provides guidelines to help you select the best mounting location, suggestions to insure optimum performance, cautions and warnings that you should follow to avoid injury and/or equipment damage, and step-by-step instructions for mounting a Sunny Boy inverter.

WARNING

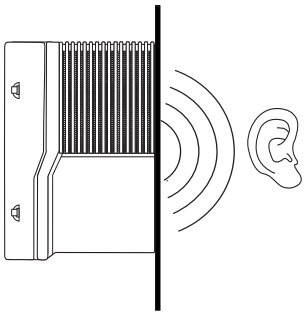
The Sunny Boy weighs 88 lb. (40 kg). To avoid injury, be sure to use proper lifting techniques and secure the help of someone to assist in the unpacking and installation of the inverter.

Occasionally, the rating label on the Sunny Boy will need to be referred to. For this reason, it is required that the inverter be mounted so that the rating label on the side of the inverter is visible.

5.1 Selecting a mounting location

Consider the following guidelines, cautions, and warnings when choosing a mounting location for the Sunny Boy:

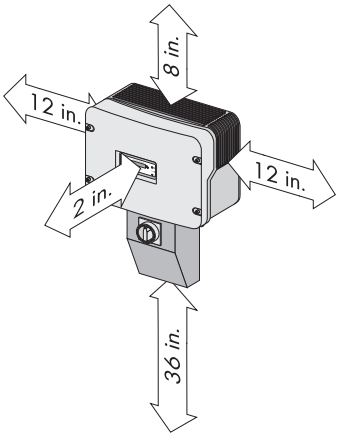
- Do not install the Sunny Boy in direct sunlight. External heating from exposure to the sun may cause excessive internal heating. This can result in reduced output power to protect the internal components from damage. You must provide sufficient air circulation to dissipate the heat generated by the inverter
- Install the Sunny Boy in a location that maintains an ambient air temperature that is less than +113 °F (+45 °C). To maintain a safe internal component temperature, the Sunny Boy may power reduce if the ambient air temperature exceeds +113 °F (+45 °C).
- Minimize the exposure to rain, snow and ice, etc. Do not install the Sunny Boy in a location exposed to sources of direct water spray such as sprinklers or downspouts. Check for existing electrical or plumbing installations in the walls before drilling mounting holes for the Sunny Boy.
- The inverter should be installed in a location that is inaccessible to children.
- The Sunny Boy emits a slight vibrating noise when operating. This vibration is normal and has no effect on performance, but it can be objectionable if the inverter is mounted on a wall in a living area, on the outside of a wall that is near a living area, or on certain types of materials, such as thin wood panelling or sheet metal.



- Observe the minimum clearances to walls, other devices or objects as shown in the diagram to ensure sufficient heat dissipation.

The *National Electrical Code®* may require significantly larger working clearances (see *National Electrical Code®* section 110.26).

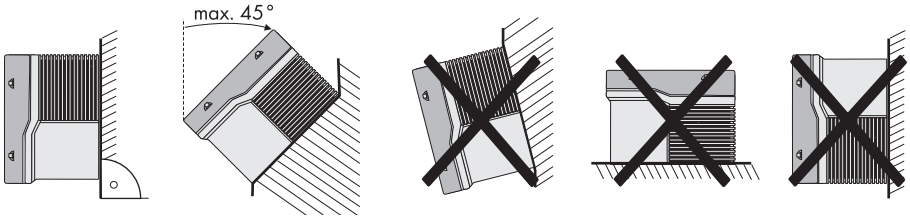
Position	Clearance
Above	8 in. (200 mm)
Below	36 in. (900 mm)
Left	12 in. (300 mm)
Right	12 in. (300 mm)
Front	2 in. (50 mm)



If the Sunny Boy is installed in an outdoor environment:

Observe a minimum clearance of 36 in. (900 mm) to the ground.

- The installation method and mounting location must be suitable for the weight and dimensions of the Sunny Boy (see section 11 "Technical specifications" (page 94)).
- Mount on a solid surface.
- The mounting location must be accessible at all times.



- Vertical installation or tilted backwards by max. 45°.
- If the inverter is installed in an outdoor environment, it should be mounted vertically.
- Never install the device with a forward tilt.
- Do not install horizontally.
- Install at eye level to allow operating status to be read at all times.
- The connection area must point downwards.

DANGER

Danger to life due to fire or explosion.

There is always a certain risk with electric devices that a fire can occur, even though greatest attention was paid to avoiding this during the development.

Do not install the inverter

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

WARNING

The Sunny Boy becomes hot during operation.

Burn injuries will result when touching the enclosure.

- Mount the Sunny Boy in such a way that it cannot be touched inadvertently.

WARNING

Risk of electrical shock due to ingress of water.

Death or serious injury can result, when touching the inverter.

- Check for existing electrical or plumbing installations in the walls before drilling mounting holes for the inverter.
- Do not install the inverter during periods of precipitation or high humidity.
- Use rain-tight or wet location hubs that comply with the requirements in the Standard for Fittings for Cable and Conduit, UL 514B.

CAUTION

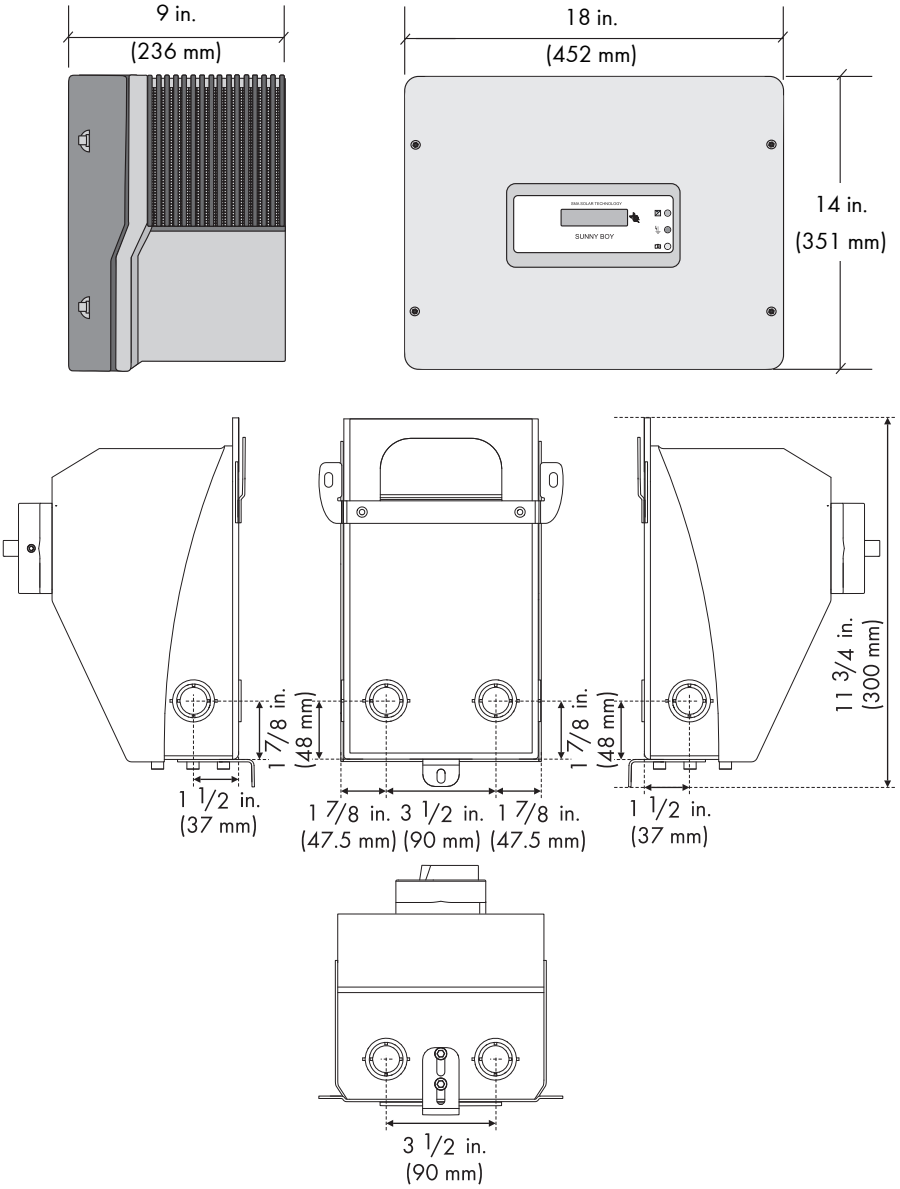
Falling of the Sunny Boy may cause injuries.

Crushing of body parts will occur.

- Take the weight of the Sunny Boy into account when mounting.
- Ensure that the mounting surface is strong enough to hold the weight of the Sunny Boy.
- Do not mount the Sunny Boy on plasterboard (sheet-rock) or thin wood panelling.

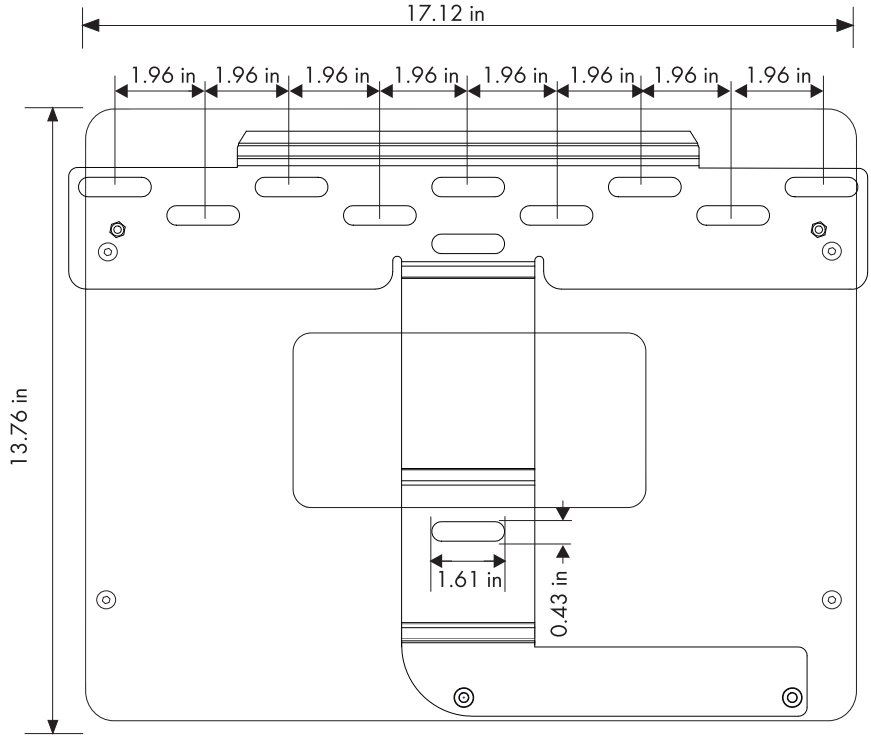
5.2 Dimensions of the Sunny Boy and DC Disconnect

The following figure shows the outer dimensions of the Sunny Boy and the DC Disconnect.



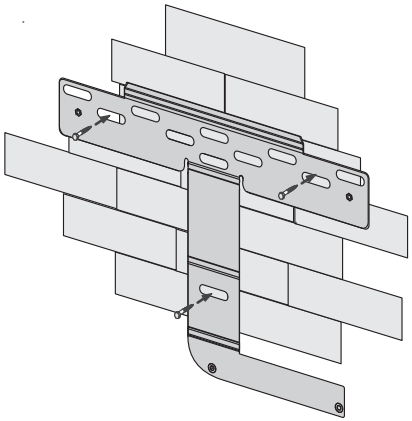
5.3 Mounting the Sunny Boy with a wall mounting bracket

The Sunny Boy is shipped with a T-shaped wall-mounting bracket that is suitable for use with most walls. The horizontal part of the bracket has 12 holes. Make sure that the wall you choose to mount the Sunny Boy on is plumb and sturdy enough to support the weight over a long period of time. Be sure to use the appropriate type of mounting hardware for the wall material. Ensure that the hardware is no smaller than ¼ in.



5.3.1 Possibilities for mounting the wall mounting bracket

Mounting on stone wall

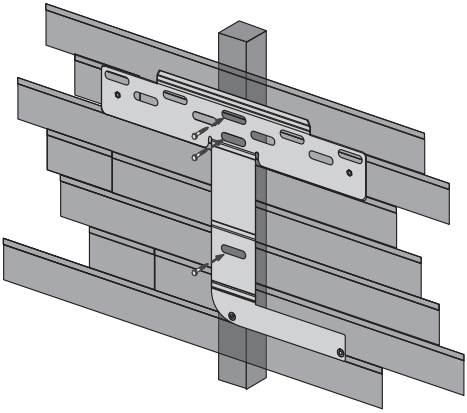


Attach the wall mounting bracket with a minimum of 3 screws. The position of the screws on the wall mounting bracket is as follows:

- 1 screw on the upper left side.
- 1 screw on the upper right side.
- 1 screw below.

Mount the wall mounting bracket as described in section 5.3.2 "Mounting the wall mounting bracket" (page 31).

Mounting on a wooden wall with a stud or on a pillar

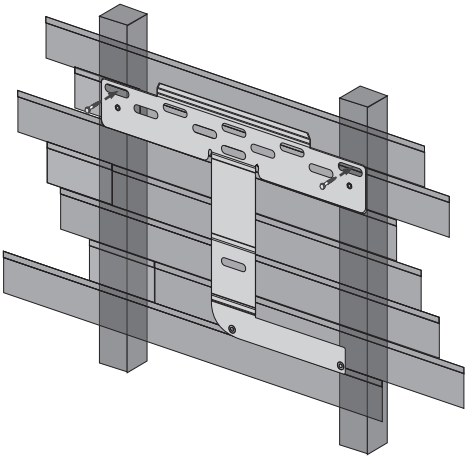


Attach the wall mounting bracket with 3 screws. The position of the screws on the wall mounting bracket is as follows:

- 2 screws on the upper middle.
- 1 screw below.

Mount the wall mounting bracket as described in section 5.3.2 "Mounting the wall mounting bracket" (page 31).

Mounting on a wooden wall with two studs



Attach the wall mounting bracket with 2 screws. The position of the screws on the wall mounting bracket is as follows:

- 1 screw on the upper left side.
- 1 screw on the upper right side.

Use the four external mounting screws on the left and right sides of the wall mounting bracket.

Mount the wall mounting bracket as described in section 5.3.2 "Mounting the wall mounting bracket" (page 31).

5.3.2 Mounting the wall mounting bracket

Tip for installing

The diameter of the holes you drill must match the hardware you are using to mount the Sunny Boy.

For example, if you are mounting the Sunny Boy to a concrete wall, the hole diameter should be approximately the same as the outside diameter of the concrete anchors you intend to use. If you are mounting the Sunny Boy on a wall that has wooden studs inside it, the hole diameter should be the correct size for the lag screws you intend to use to mount the bracket. It is recommended that the lag screws be made of stainless steel, and the diameter of the screws closely match the diameter of the holes in the wall-mounting bracket. Make sure that the screws are long enough to penetrate the wall to a depth of $1\frac{1}{2}$ in.

1. Position the wall-mounting bracket against the wall where you intend to mount the Sunny Boy. Try to mount the Sunny Boy with the display at eye-level.

2. Place a level on the top edge of the bracket. Adjust the position until it is leveled. The bottom of the bracket will be the approximate location of the bottom of the inverter.

DANGER

Risk of electric shock by drilling into power cables.

Death or serious injuries will occur.

- Before drilling, check installation location for power cables.

3. Use the wall-mounting bracket as a template. Mark the wall through at least three holes in horizontal or vertical position of the bracket (see chapter 5.3.1 "Possibilities for mounting the wall mounting bracket" (page 29)).
4. Remove the bracket, and drill holes at the marks.
5. Insert wall anchors into the drill holes.

CAUTION

Falling of the Sunny Boy may cause injuries.

Crushing of body parts will occur.

- Ensure that there are studs in the wall where you intend to drill holes.
- Do not use molly or toggle bolts to mount the Sunny Boy to sheet rock or panelling.

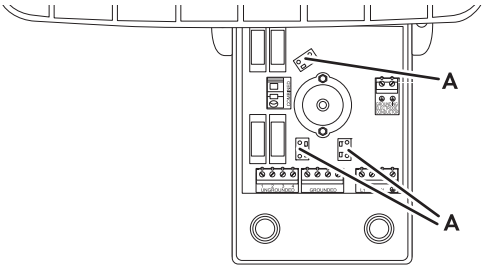
6. Insert the screws through the holes in the wall mounting bracket and into the drill holes.
7. Tighten the screws clockwise until the bracket is held firmly against the wall. Do not overtighten the screws.

☑ The wall mounting bracket is mounted.

5.4 Mounting the SMA DC Disconnect

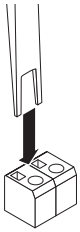
Inserting the DC varistors

The supplied DC varistors need to be used only for the following inverter types: SB 3000US-12/SB 3800-US-12/SB 4000US-12.

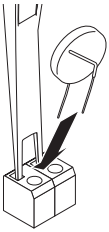


Position	Description
A	Terminals for DC varistors

1. Open the DC disconnect as described in Section 6.5 "Opening the SMA DC Disconnect" (page 39).
2. Equip the 3 terminals (A) with DC varistors:
   - Insert the insertion tool into the rectangular opening of the terminal.



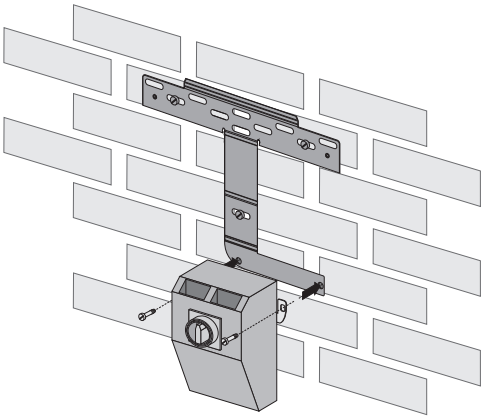
   - Insert the DC varistor into the terminal.



   - Pull the insertion tool out of the rectangular opening of the terminal.
3. Ensure that all DC varistors in the terminals are securely in place.
4. Close the DC disconnect as described in Section 6.10 "Closing the SMA DC Disconnect" (page 63).

Mounting the DC disconnect

Attach the SMA DC Disconnect to the two lower holes of the wall-mounting bracket, using two screws and washers provided.



1. Place the screws and the washers in the holes in the fastening tabs on the DC Disconnect. The teeth on the washers must lie against the DC Disconnect's fastening tabs.
2. Place the SMA DC Disconnect against the wall mounting bracket.
3. Tighten the screws with 44 in-lbs. (5 Nm) torque.

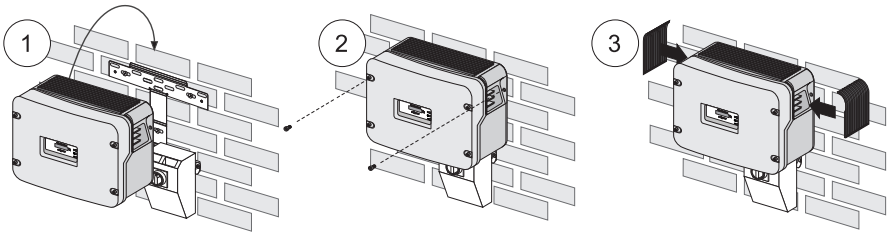
☑ The SMA DC Disconnect is mounted.

5.5 Mounting the Sunny Boy onto the wall mounting bracket

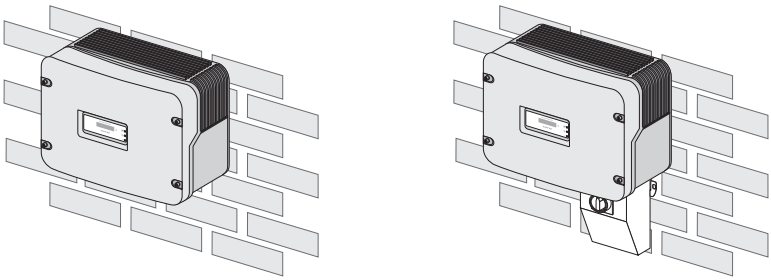
CAUTION

Risk of injury due to the heavy weight of the Sunny Boy. The Sunny Boy weighs approx. 88 lbs. (40 kg).

1. Remove the handle covers on the right and left side of the Sunny Boy.
2. Transport the Sunny Boy between two persons, using the side handles above and below.



3. Hook the Sunny Boy using the enclosure opening in the back plate into the wall bracket (1).
4. Inspect the Sunny Boy from both sides to ensure that it sits centered on the wall bracket (2).
5. Screw the Sunny Boy onto the wall mounting bracket on both sides using the screws provided (3). Tighten the screws clockwise with a torque of 44 in-lbs. (5 Nm).



6. Check that the unit is securely in place.
7. Put the handle covers over the handles.

   The air grills are marked "rechts/right" and "links/left" on the interior for proper assignment.

   The air grills prevent dirt and insects from entering the device and if necessary, can be reordered from SMA.

☑ The Sunny Boy is mounted.

6 Electrical connection

DANGER

High voltages are present on the AC and DC cables.

Death or serious injuries due to touching the voltage-conducting cables.

- Always wait a minimum of 5 minutes for stored potentials in the Sunny Boy to discharge completely before opening the enclosure.
- Always connect the wires to the Sunny Boy in the following sequence.

NOTICE

Ingress of water when mounting and installing the Sunny Boy.

Damage to the Sunny Boy.

- Do not open the Sunny Boy when it is raining or when high humidity is present (> 95 %).

NOTICE

Touching the components can result in electrostatic discharges.

Damage to components.

- Ground yourself before touching a component.

NOTICE

Ground faults, unreliable and resistive connections due to faulty wire nuts.

- Avoid using wire nuts to join any wires together or to make any connections anywhere in the PV system.

Electrical installations

All electrical installations must be done in accordance with all local electrical codes and the *National Electrical Code*®, ANSI/NFPA 70. For installation in Canada the installations must be done in accordance with applicable Canadian standards.

Before connecting the Sunny Boy to the electrical utility grid, contact the local utility company. This connection must be made only by qualified personnel.

AC Grounding DC Disconnect

The Sunny Boy must be connected to the AC grouDC Disconnectnd from the utility via the ground terminal (PE) (see 4.2 "Locating internal components" (page 19)).

PV grounding

The PV array (frame) ground should be connected to the grounding electrode terminal (see 4.2 "Locating internal components" (page 19)). The size for the conductor is usually based on the size of the largest conductor in the DC system.

DC grounding electrode conductor

A DC grounding electrode conductor may be required by the Authority Having Jurisdiction (AHJ). Use the PV grounding and DC grounding electrode conductor (see 4.2 "Locating internal components" (page 19)).

6.1 Without SMA DC Disconnect

1. De-energize all energy sources by opening all AC and DC disconnects and/or breakers.
2. Wiring from AC breaker to the AC disconnect switch.
3. Wiring from the AC disconnect switch to the Sunny Boy, follow the procedure on page 42 et seq.
4. Wiring from the PV wires to the DC disconnect.
5. Wiring from the DC disconnect to the Sunny Boy, follow the procedure on page 42 et seq.
6. Turn the DC switches and/or breakers on.
7. Turn the AC switches and/or breakers on.

Disconnecting the Sunny Boy

- First turn off all AC disconnects and then all DC disconnects.
- The AC side must always be disconnected before the DC side.
- After the Sunny Boy is de-energized, disconnect the wiring in the reverse order from above.

6.2 With SMA DC Disconnect

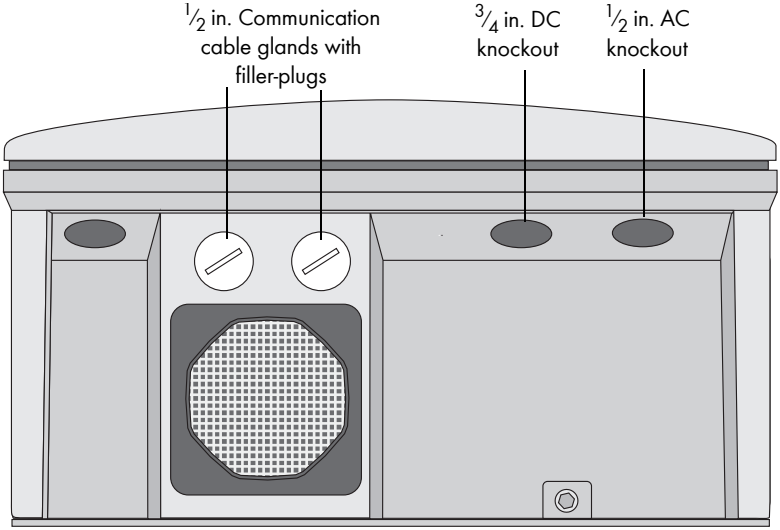
1. De-energize all energy sources by opening all AC and DC disconnects and/or breakers .
2. Wiring from the AC breaker to the SMA DC Disconnect, follow the procedure on page 40 et seq.
3. AC wiring from the SMA DC Disconnect to the Sunny Boy, follow the procedure on page 43 et seq.
4. Wiring from the PV array to the SMA DC Disconnect, follow the procedure on page 52 et seq.
5. DC wiring from the SMA DC Disconnect to the Sunny Boy, follow the procedure on page 52 et seq.
6. Switch the SMA DC Disconnect to position "1".
7. Turn the AC breaker on.

Disconnecting the Sunny Boy

- First turn off all AC disconnects and turn the SMA DC Disconnect to position "0".
- The AC side must always be disconnected before the DC side.
- After the Sunny Boy is de-energized, disconnect the wiring in the reverse order from above.

6.3 Bottom view and dimensions

The DC input from the PV array (via the DC disconnect enclosure) and the output to the AC utility grid connect to the inverter inside the case of the Sunny Boy. The internal AC and DC wiring terminals accept a maximum wire size of 6 AWG. Knockouts are provided on the bottom of the inverter.



NOTICE

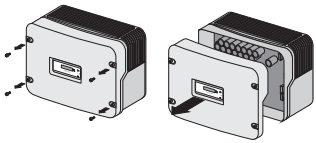
Ingress of water due to enlarged enclosure openings.

Damage to the inverter will result.

- The AC and DC knockouts are sized for $^{3}/_{4}$ in. rigid conduits.
- Do not enlarge the knockout holes.

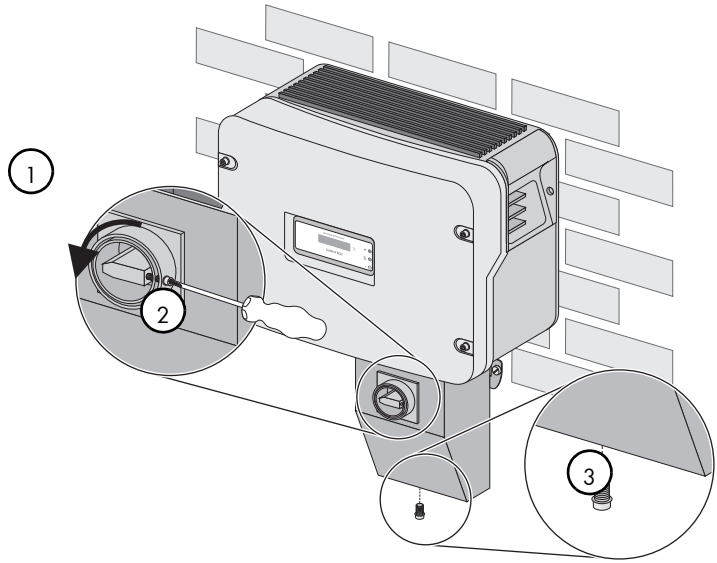
6.4 Opening the Sunny Boy

1. Remove the four screws from the housing cover.
2. Pull the cover forward smoothly.
3. Put the cover, the screws and the washers aside. Ensure that they do not get lost.



6.5 Opening the SMA DC Disconnect

1. Turn the SMA DC Disconnect to position "0".



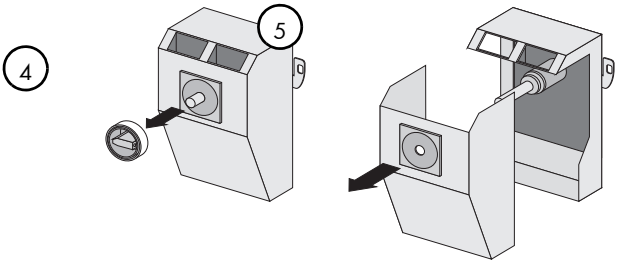
2. Loosen screw in the right area of the SMA DC Disconnect with a small phillips screwdriver.

Do not remove the screw.

- Check if you can remove the knob of the SMA DC Disconnect.
- If not, unscrew the screw further until you can remove the knob.

The screw is attached with a rubber washer in order to make the assembly easier.

3. Remove the screw and the washer from the bottom side of the SMA DC Disconnect, that fasten the cover.
4. Pull off the switch handle.
5. Remove the cover of the SMA DC Disconnect by pulling it down. At the same time, carefully move it forward at its lower edge.



6.6 AC wiring

All electrical installations must be done in accordance with the local electrical codes and with the *National Electrical Code*® (NE, ANSI/NFPA 70).

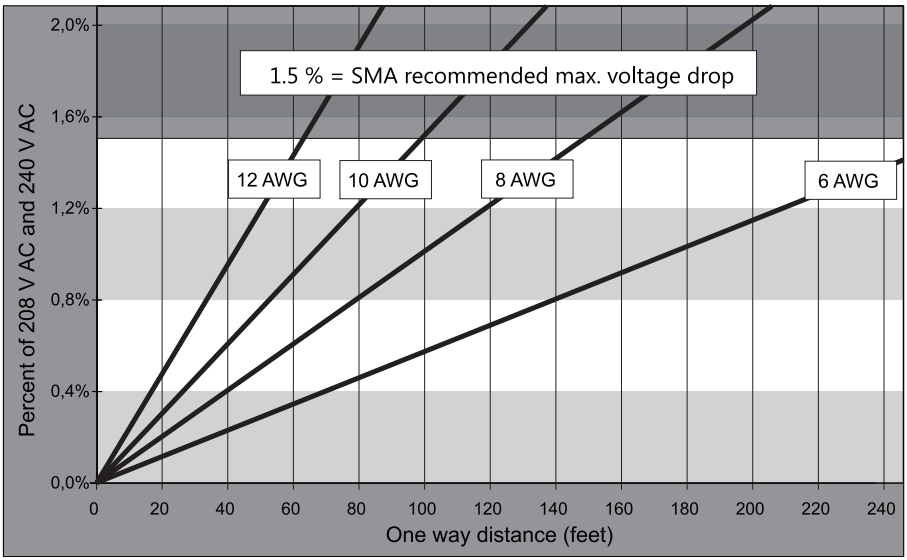
See *National Electrical Code*® section 690-64(b)(1 and 2).

Use maximum 6 AWG, +194 °F (+90 °C) rated copper wire for all AC wiring connections to the Sunny Boy, although voltage drop and other considerations may dictate that larger size wires be used. Use only solid or stranded wire but not fine stranded wire.

The following diagrams show the potential losses in AC wires related to the cable cross-section and length. Use the following diagrams to determine the best wire size to use for your particular installation.

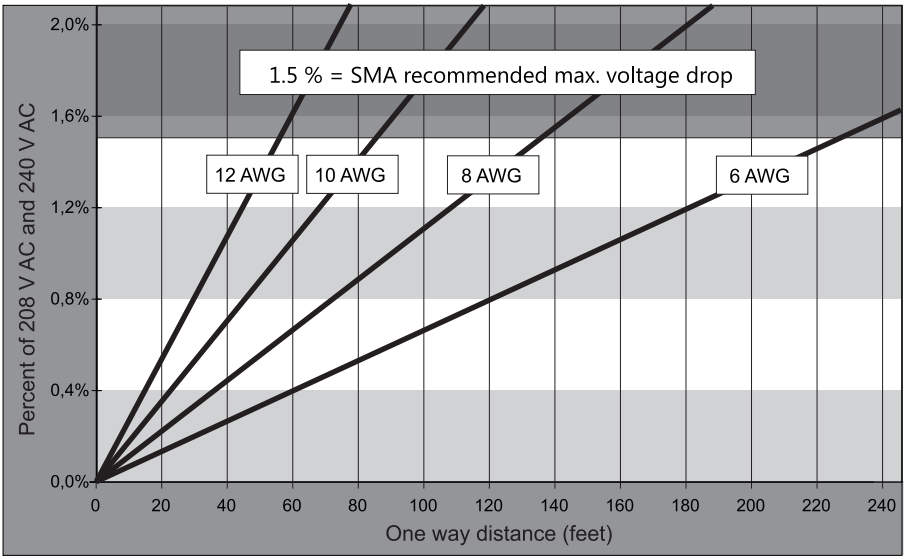
Sunny Boy 3000-US

Percent voltage drop for 208 V AC and 240 V AC service



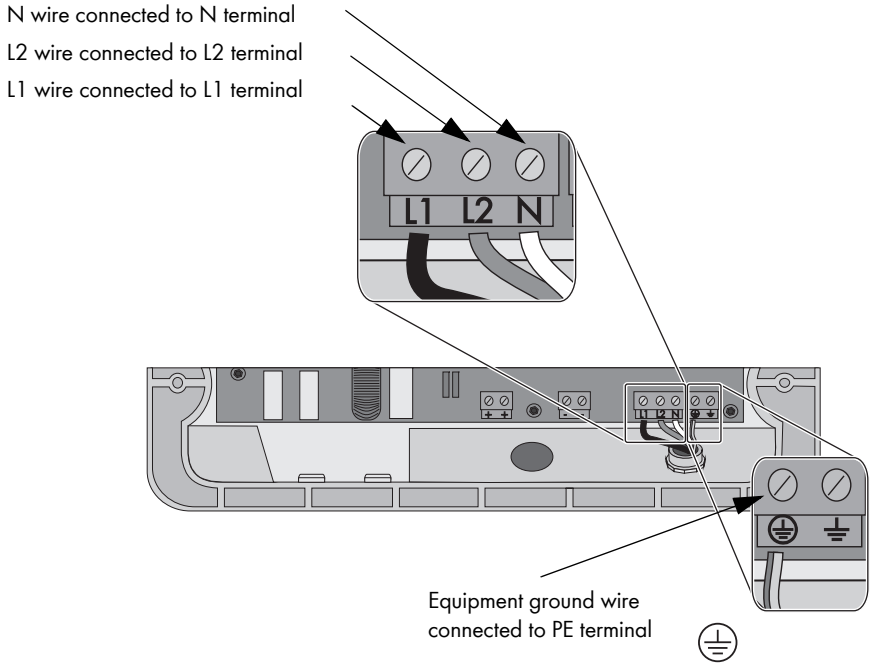
Sunny Boy 3800-US/4000-US

Percent voltage drop for 208 V AC (only for Sunny Boy 4000-US) and 240 V AC service



6.6.1 Without SMA DC Disconnect

1. Turn off the main breaker in the main utility breaker box.
2. Remove interior breaker panel cover.
3. If you are replacing an existing inverter, disconnect the wires for the AC line you are working with in the breaker box.
4. Install a $^{3}/_{4}$ in. conduit fitting in the AC wiring knockout of the inverter. Fasten the conduit fitting on the inside of the Sunny Boy with the appropriate locknut.
5. Install a $^{3}/_{4}$ in. conduit between the main breaker box and the AC wiring knockout of the inverter.
6. Pull the AC wires through the conduit from the interior of the breaker box to the interior of the Sunny Boy. Refer to the following figure.
7. Connect the AC equipment-ground wire to the PE terminal labeled ⏚ in the Sunny Boy.
8. Connect the L1 (AC line 1 or UNGROUNDED) wire to the terminal labeled L1 in the Sunny Boy.
9. Connect the L2 (AC line 2) and N (AC line N) wire to the terminal labeled L2 and N in the Sunny Boy.
10. Connect the wires to the terminal blocks in the Sunny Boy and tighten them to a torque of 15 in-lbs (1.7 Nm).
11. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

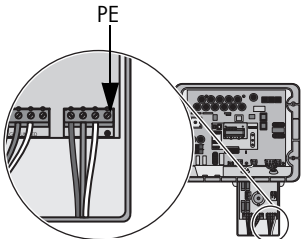


6.6.2 With SMA DC Disconnect

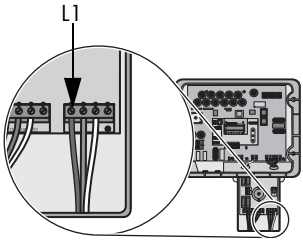
Connecting the AC cable in the DC Disconnect

1. Turn OFF the main breaker in the main utility breaker box.
2. Remove interior breaker panel cover.
3. If you are replacing an existing inverter, disconnect the wires in the breaker box for the AC line you are working with.
4. Install a $^{3}/_{4}$ in. conduit fitting in the SMA DC Disconnect AC wiring knockout. Fasten the conduit fitting on the inside of the SMA DC Disconnect with the appropriate locknut.
5. Install $^{3}/_{4}$ in. conduit between the main breaker box and the AC wiring knockout of the SMA DC-Disconnect.
6. Pull the AC wires through the conduit from the interior of the breaker box to the interior of the SMA DC Disconnect.

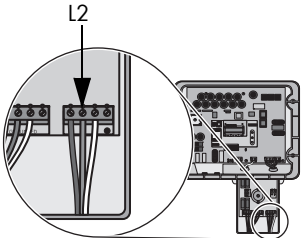
7. Connect the AC equipment-ground wire to the PE terminal labeled ⏚ in the SMA DC Disconnect.



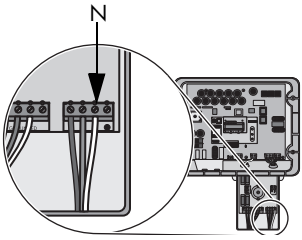
8. Connect the L1 (AC line 1 or UNGROUNDED) wire to the terminal labeled L1 in the SMA DC Disconnect.



9. Connect the L2 (AC line 2) wire to the terminal labeled L2 in the SMA DC Disconnect.



10. Connect the N (AC line N) wire to the terminal labeled N in the SMA DC Disconnect.

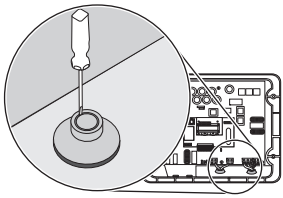


11. Connect the wires to the terminal blocks in the SMA DC Disconnect and tighten to a torque of 15 in-lbs. (1.7 Nm).
12. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

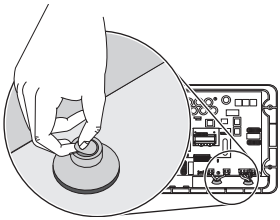
    ☑ The AC cables are now connected in the SMA DC Disconnect.

Connecting the AC cable in the Sunny Boy

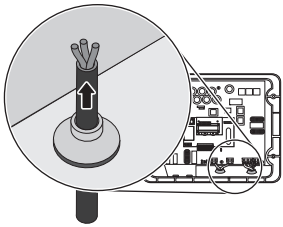
13. Use a screwdriver in order to poke a hole in the groove of the grommet inside the inverter.



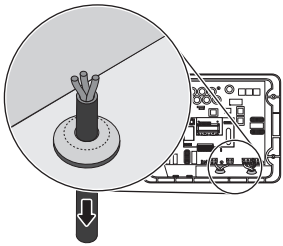
14. Remove the membrane.



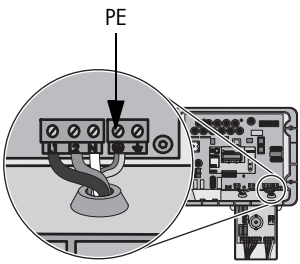
15. Pull the cable into the Sunny Boy.



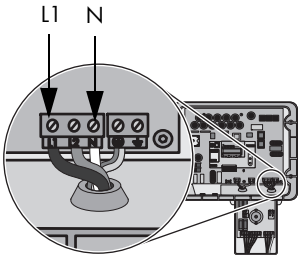
16. Pull the cable slightly back in order to seal the grommet.



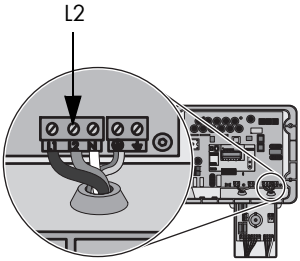
17. Connect the green/yellow cable of the Sunny Boy to the terminal labeled: ⏚



18. Connect the white wire of the SMA DC Disconnect to the terminal labeled N and the black wire to the terminal labeled L1 of the Sunny Boy.



19. Connect the red wire to the terminal labeled L2 in the Sunny Boy.



20. Connect the wires to the terminal blocks in the Sunny Boy and tighten them to a torque of 15 in-lbs. (1.7 Nm).
21. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

☑ The AC cables are connected.

6.7 DC wiring

DANGER

High voltage is present in PV modules exposed to light.

Death due to electric shock when touching a DC conductor.

- During installation, cover the PV modules with opaque material.

DANGER

High voltage is present inside the DC cables.

Death or serious injury will result when damaging a DC cable or touching a DC conductor.

- You have to connect the DC cables from the PV array to the Sunny Boy in the order described in this manual.

NOTICE

Damage to the inverter due to overvoltage.

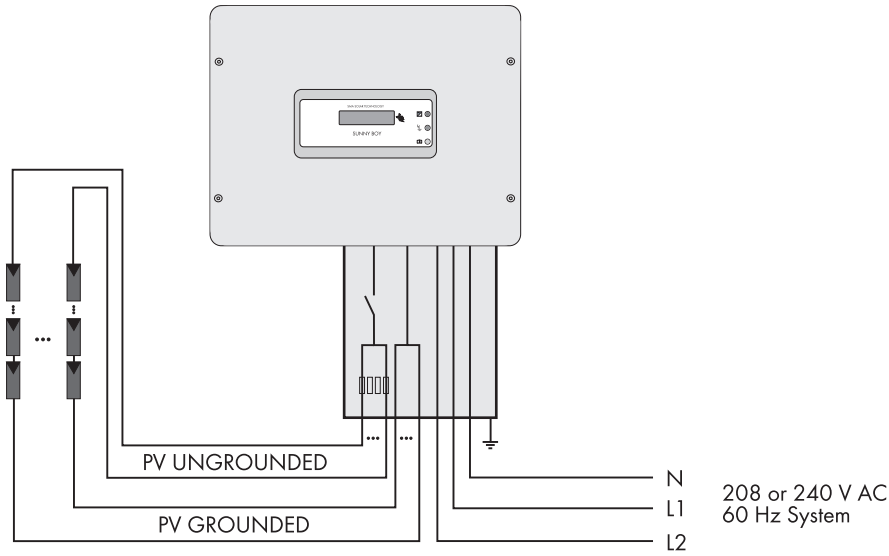
- Verify that the DC current of your installation does not exceed the maximum values specified on the type rating label.

NOTICE

Irreversible damage to the inverter due to DC-input voltage that exceeds the maximum DC-input-voltage range.

- Verify the polarity and the open-circuit voltage from the PV strings, before connecting the DC wires to the inverter.
- Check both the polarity and the open-circuit voltage from the PV strings.
- Configure the DC-input-voltage range correctly before connecting the DC-input wires from the PV array to the inverter.
- Use the free design programs "Solar Design Tools" at www.SMA-America.com to determine the correct string configuration.

Simplified electrical wiring diagram of a PV system



6.7.1 DC connection requirements

Cable sizing

All electrical installations must be done in accordance with all local electrical codes and with the *National Electrical Code®*, ANSI/NFPA 70. For installation in Canada the installations must be done in accordance with applicable Canadian standards.

When selecting the type and cross-section of the cable in accordance with the routing method, observe the following requirements:

- For all DC wiring connections use 10 ... 6 AWG (6 ... 16 mm²), +194 °F (+90 °C) rated copper wire.
- Use only solid or stranded wire but not fine stranded wire.

Use the free design programs "Solar Design Tools" at www.SMA-America.com to determine the correct string configuration.

Fusing

The DC disconnect for the inverter must have a minimum rating of 600 V DC and 30 A continuous.

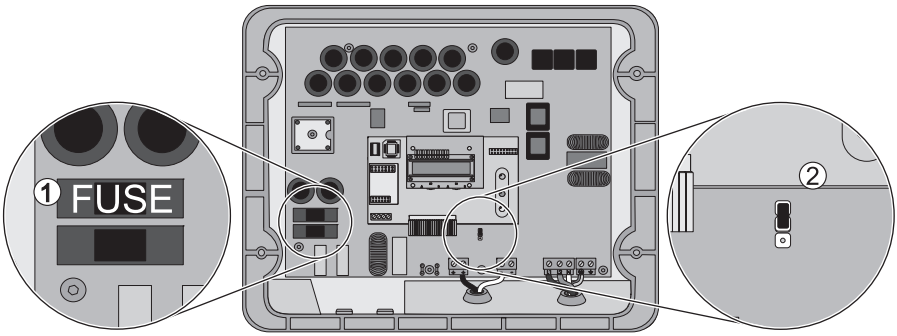
The SMA DC disconnect is shipped with four 15 A, 600 V DC fuses (one for each string). The maximum fuse rating for the four SMA DC disconnect fuses is 20 A, 600 V DC (one for each string). See "Exchanging the PV String Fuses within the SMA DC Disconnect" on page 90 for details.

Series fusing may be required depending on the type of PV module used in the system. See *National Electrical Code®* 690.9.

6.7.2 DC input grounding

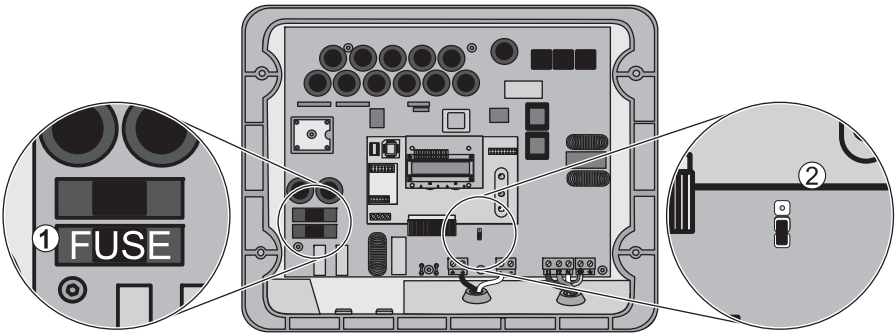
Negative grounding

The Sunny Boy comes from the factory configured for negative ground systems.



Positive grounding

Certain types of PV modules may require that the positive terminal be grounded instead of the negative terminal. To configure the Sunny Boy for positive ground, refer to the following illustration:

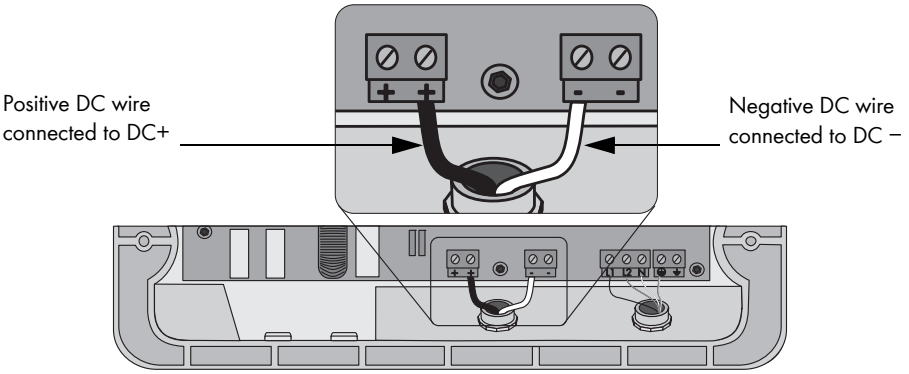


1. Insert the fuse at position (1).
2. Move the jumper to position (2).

☑ DC input is configured for negative grounding.

6.7.3 DC wiring without SMA DC Disconnect

1. Verify that the AC breaker is OFF.
2. Verify that the DC disconnect is open in the external DC disconnect enclosure.
3. Install a $^{3}/_{4}$ in. conduit fitting in the DC wiring knockout of the inverter. Fasten the conduit fitting on the inside of the inverter with the appropriate locknut.
4. Install a $^{3}/_{4}$ in. conduit between the DC disconnect enclosure and the DC wiring knockout.
5. Refer to the following figure.



6. Pull the DC wires from the DC disconnect through the conduit into the interior of the Sunny Boy.
7. Connect the positive DC wire to the terminal labeled DC+ in the Sunny Boy.
8. Connect the negative DC wire to the terminal labeled DC − in the Sunny Boy.

The Sunny Boy has provisions for up to 2 PV strings. The positive and negative terminal blocks each have two positions, so two pairs of DC-input wires can be connected in parallel.

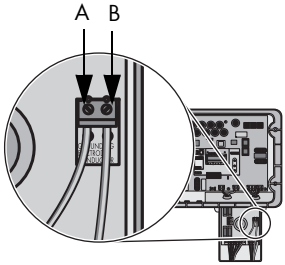
9. Connect the positive and negative DC wires to the appropriate terminals in the external DC disconnect enclosure.
10. Connect the DC equipment ground wire to the PE terminal labeled ⏚ in the Sunny Boy.
11. Torque all AC and DC wires inside the Sunny Boy to 15 in-lbs. (1.7 Nm).
12. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

6.7.4 DC wiring with SMA DC Disconnect

1. Verify that the AC breaker is OFF.
2. Install a $^{3}/_{4}$ in. conduit fitting in the SMA DC Disconnect's DC wiring knockout (the knockout on the left side of the SMA DC Disconnect). Fasten the conduit fitting on the inside of the SMA DC Disconnect with the appropriate locknut.
3. Install $^{3}/_{4}$ in. conduit between the SMA DC Disconnect and the PV array.
4. Pull the DC wires, the ground wires from the PV array and the grounding electrode wire through the conduit into the interior of the SMA DC Disconnect.

The SMA DC Disconnect has provisions for up to four PV strings. The PV UNGROUNDED and PV GROUNDED terminal block each has four positions, so four pairs of DC-input wires can be connected in parallel.

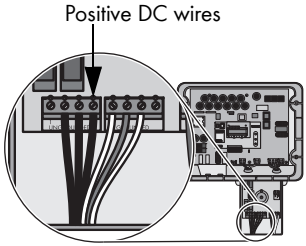
5. Connect the grounding electrode to the grounding electrode conductor terminal (B).
6. Connect the PV generator grounding to the grounding electrode conductor terminal (A).



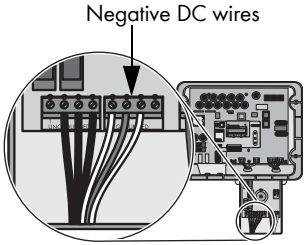
Negative grounding

1. Verify that your inverter is grounded as intended. Refer to section 6.7.2 "DC input grounding" (page 50).

2. Connect the positive DC wires to the terminal labeled PV UNGROUNDED in the SMA DC Disconnect.

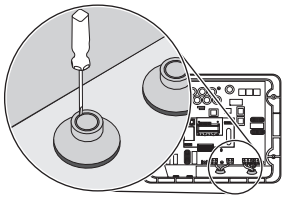


3. Connect the negative DC wires to the terminal labeled PV GROUNDED in the SMA DC Disconnect.

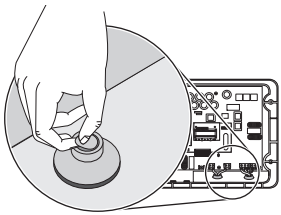


4. Torque all wires in the terminal blocks inside the SMA DC Disconnect to 15 in-lb (1.7 Nm).

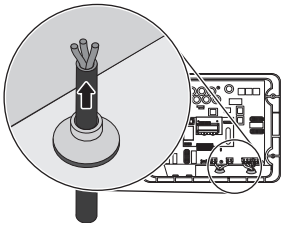
5. Use a screwdriver in order to poke a hole in the groove of the grommet.



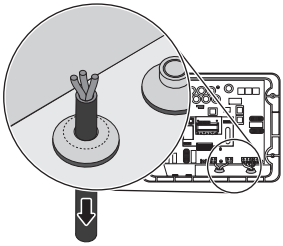
6. Remove the membrane.



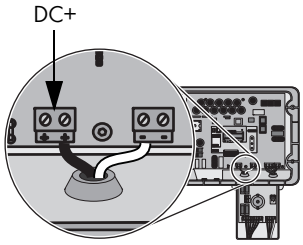
7. Pull the DC wires from the DC disconnect through the conduit into the interior of the Sunny Boy.



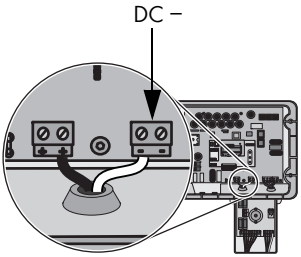
8. Pull the wires slightly back in order to seal the grommet.



9. Connect the black wire (PV UNGROUNDED) to the terminal labeled DC+ in the Sunny Boy.



10. Connect the white wire (PV GROUNDED) to the terminal labeled DC − in the Sunny Boy.

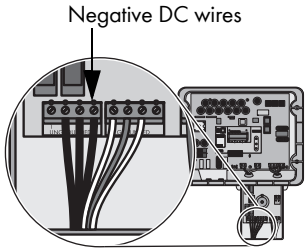


11. Torque all wires in the terminal blocks inside the Sunny Boy to 15 in-lbs. (1.7 Nm).
12. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

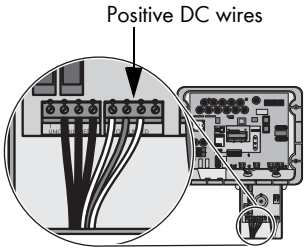
Positive grounding

1. Verify that your inverter is grounded as intended. Refer to section 6.7.2 "DC input grounding" (page 50).

2. Connect the negative DC wires to the terminal labeled PV UNGROUNDED in the SMA DC Disconnect.

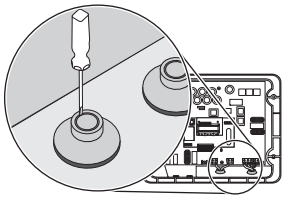


3. Connect the positive DC wires to the terminal labeled PV GROUNDED in the SMA DC Disconnect.

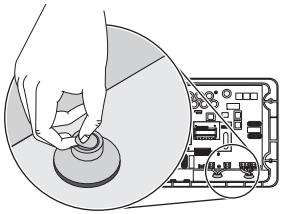


4. Torque all wires in the terminal blocks inside the SMA DC Disconnect to 15 in-lbs. (1.7 Nm).

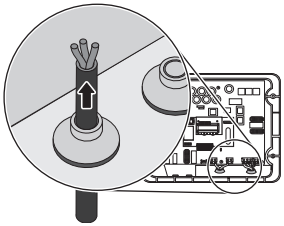
5. Use a screwdriver in order to poke a hole in the groove of the grommet.



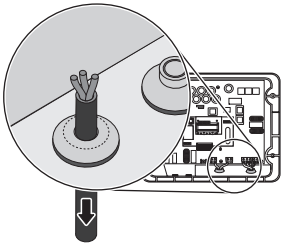
6. Remove the membrane.



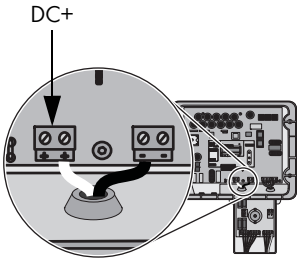
7. Pull the DC wires from the DC disconnect through the conduit into the interior of the Sunny Boy.



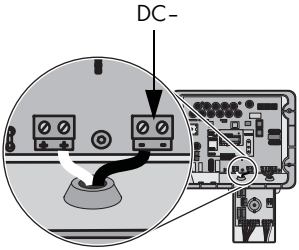
8. Pull the wires slightly back in order to seal the grommet.



9. Connect the white wire (PV GROUNDED) to the terminal labeled DC+ in the Sunny Boy.



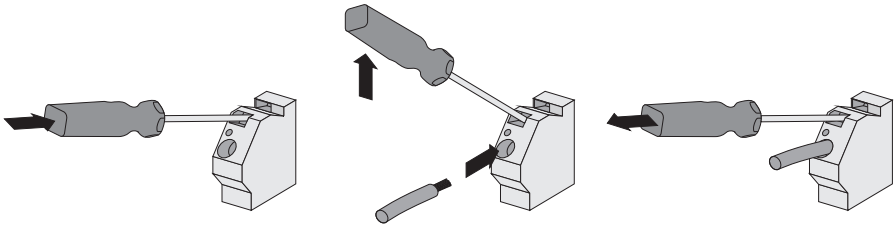
10. Connect the black wire (PV UNGROUNDED) to the terminal labeled DC- in the Sunny Boy.



11. Torque all wires in the terminal blocks inside the Sunny Boy to 15 in-lbs. (1.7 Nm).
12. Verify that all connections are correctly wired and properly torqued. Pull on the cable in order to make sure that it is sufficiently fixed in the terminal.

6.7.5 DC connection with additional DC distribution

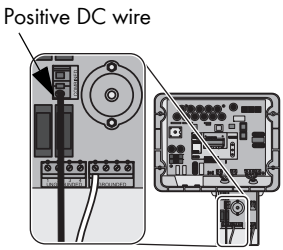
Using spring terminal labeled COMBINED



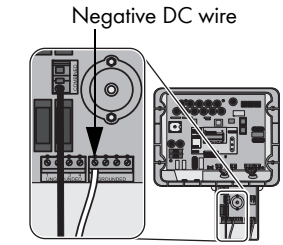
1. Insert the screwdriver into the provided slot of the spring terminal.
2. Push the screwdriver up, the spring terminal is opened.
3. Insert the stripped cable into the spring terminal.
4. Return the screwdriver to its original position.
5. Remove the screwdriver. The spring terminal is closed and the cable is fastened.

Negative grounding

1. Connect the positive DC wire to the terminal labeled COMBINED in the SMA DC Disconnect.



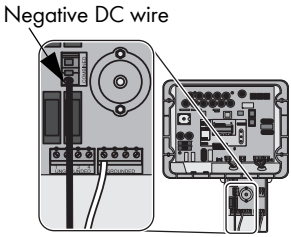
2. Connect the negative DC wire to the terminal labeled PV GROUNDED in the SMA DC Disconnect.



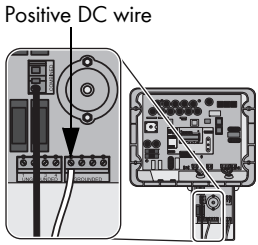
3. Torque all wires in the terminal blocks inside the SMA DC Disconnect to 15 in-lbs. (1.7 Nm).

Positive grounding

1. Connect the negative DC wire to the terminal labeled COMBINED in the SMA DC Disconnect.



2. Connect the positive DC wire to the terminal labeled PV GROUNDED in the SMA DC Disconnect.



3. Torque all wires in the terminal blocks inside the SMA DC Disconnect to 15 in-lbs. (1.7 Nm).

6.8 Communication wiring

Various data-communication options are available for the Sunny Boy. These options are provided in the form of accessory Piggy-Back modules that can be installed and connected either at the time the inverter is installed or at any time thereafter. These modules are not included with the Sunny Boy. Please contact SMA for information. Refer to the instructions included with the communication module for installation procedures.

The following subsections provide instructions for connecting the various communication cables between a Sunny Boy with a communication module and a personal computer (PC). The connection of a Sunny Boy to a communication device is shown in the respective manuals.

6.8.1 RS485 communication

RS485 is a communication standard for bidirectional transmission of data between one or more Sunny Boy inverters and a PC.

All Sunny Boy inverters are capable of RS485 communication. You can mix different Sunny Boy models on the RS485 communication bus.

For more information on connecting more than one inverter to an RS485 bus, please see "Technical Note: RS485 Communication" in the Technical Information section under Service Downloads of our web site at www.SMA-America.com.

Requirements for RS485 communication

- The Sunny Boy must be equipped with an RS485 Piggy-Back communication module.
- The cable should be no longer than a $^{3}/_{4}$ mile (1.2 km) with a common shield, and a wire size no smaller than 24 AWG. Use the cable type specified in the RS485 Tech Note on www.SMA-America.com.
- RS485 cables are available from SMA America.
- Conduit may be required for communication wiring, per local electrical code requirements.

Connecting a RS485 cable

1. Connect the three wires of the RS485 cable to terminals 2, 5, and 7 of the communication terminal block. Refer to the following figure.
2. Torque the wires to 2.5 in-lbs. (0.28 Nm).
3. Note down the wire color used for each of the terminals.
4. Connect the shield of the cable to the flat connection for grounding in the Sunny Boy. Refer to the following figure.

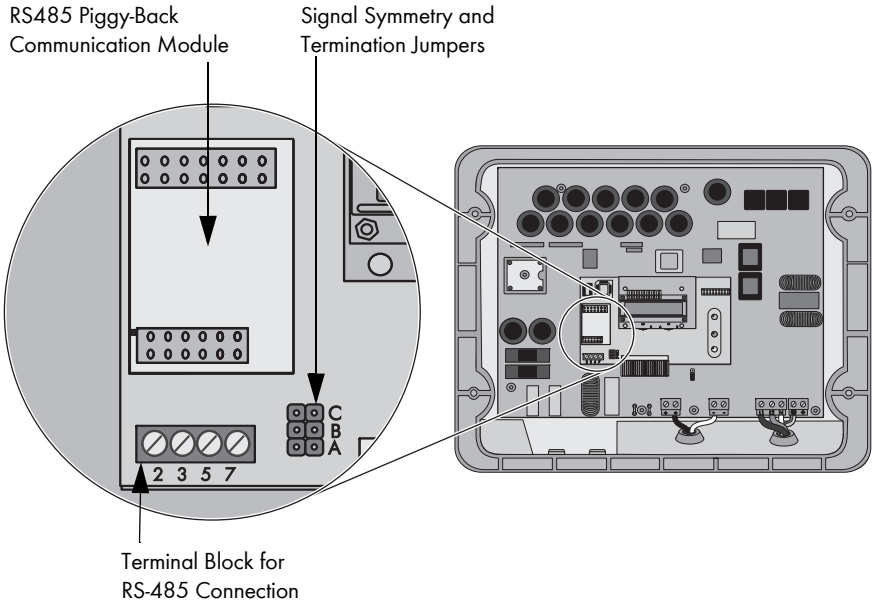
Do not connect the cable shield to the PC's DB-9 connector. The shield must remain floating at the PC.

5. Install a jumper in position A, the bottom set of pins on the communication jumper block, to set it for termination.

The termination of the other end of the RS485 cable depends on the type of device you are connecting.

For detailed information see the Technical Information section under Service Downloads of our web site at www.SMA-America.com.

Jumper configuration for RS485 communication



Jumpers B and C Installed:	Installing these jumpers puts 680 Ohm symmetry resistors between pin 2 (Data+) and +5V and between pin 7 (Data −) and Ground.
Jumper A installed:	Installing this jumper puts a 120 Ohm termination resistor across pin 2 (Data+)and pin 7 (Data −).

- Install jumper A only, if the inverter is on one of the ends of the RS485 bus.
- Install jumpers B and C only:
  - After the inverter is on the RS485 bus.
  - Only if symmetry of the signal is required.

Symmetry is already provided by the Sunny Boy Control and Sunny WebBox products.

RS485 pinouts

2 - A (+) (Data+)

7 - B (−) (Data −)

5 - SR (Signal Ref.)

6.9 Closing the Sunny Boy

NOTICE

Humidity can ingress, when mounting and installing the inverter.

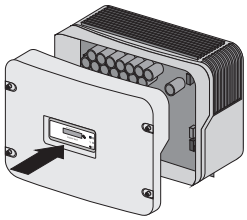
Damage to the Sunny Boy will result.

- Ensure no moisture is trapped inside the enclosure when securing the lid.

CAUTION

Be careful not to misplace the screws or the lock washers that attach the cover to the case, as all four screws and lock washers are required to ensure that the cover is grounded properly and is fully sealed to the case. Handle the cover carefully, as even minor damage to the cover could result in an inadequate seal between the cover and the case, thus allowing moisture to enter the case and damage the sensitive electronic components.

1. Ensure that all connections and knockout fittings are properly torqued.
2. Ensure that no wires can interfere with proper sealing of the cover. Check that no pressure will be exerted on the connections when the cover is replaced.
3. Locate the four screws and lock washers you removed to take the cover off. Make sure you have all four screws and lock washers. All of this hardware is necessary to ensure proper grounding and a weather-tight seal.
4. Ensure that the seal on the inside of the cover is undamaged and in correct position.
5. Carefully position the cover on the front of the inverter. Align the four holes in the cover with the four threaded holes in the case.

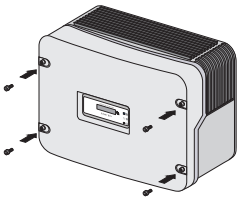


For proper grounding, the teeth of the washers must face towards the lid.

Do not cross-thread any of the screws.

Do not use power tools to start the screws.

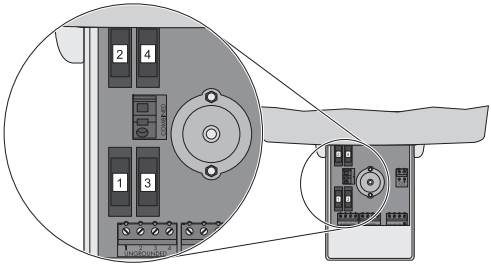
6. Carefully insert the four screws with lock washers through the holes in the cover into the threaded holes in the case. Turn them until they are finger-tight.



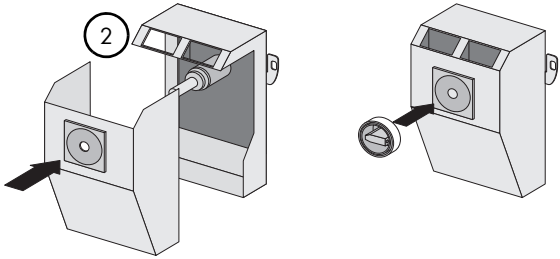
7. Verify that the cover is in the correct position and that the seal is in place between the case and the cover.
8. Tighten the cover screws to a torque of 53 in-lbs. (6 Nm).

6.10 Closing the SMA DC Disconnect

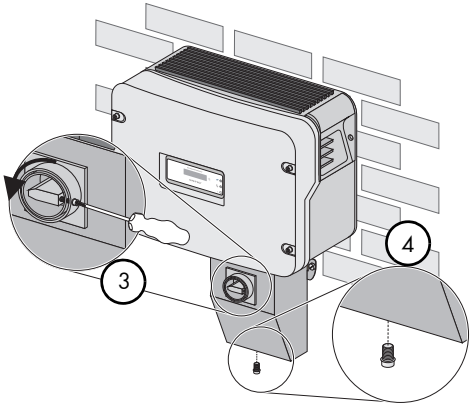
1. Make sure the string fuses are securely mounted.



2. Position the cover onto the SMA DC Disconnect and insert the switch handle into the cover.



3. Turn the switch to the "0" position and tighten the screw on the right side of the switch with a small phillips screwdriver (used screw: UNC no 5x$^{3}/_{4}$ in. cross recess Pillips pan head machine screw).



4. Install the M6x10 screw and washer on the bottom side of the SMA DC Disconnect, to fasten the cover.

For proper grounding, the teeth of the washers must face towards the lid.

5. Tighten the screw to a torque of 44 in-lbs. (5 Nm).

7 Commissioning

All Sunny Boy inverters have a sophisticated system for detecting and responding to PV array ground faults as required by National Electrical Code®. The ground fault protection device is active whenever there is sufficient DC voltage to turn on the LCD in the Sunny Boy.

Check the following requirements before commissioning:

- AC cable correctly connected
- DC cable correctly connected
- securely fastened enclosure lid
- The line circuit breaker is laid out correctly, if used.

DANGER

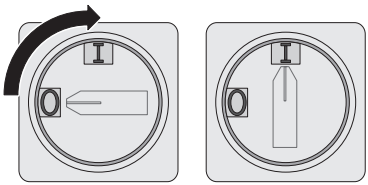
High voltages in the PV plant when exposed to sunlight.

Risk of death or serious injuries due to incorrect commissioning.

- Only commission the Sunny Boy in the following order.
- Do not insert the GFDI fuse into the Sunny Boy without a fuse holder.

7.1 Switching On the Sunny Boy

1. Remove all covers from the PV array.
2. Switch on the AC miniature circuit-breaker.
3. Turn the DC disconnect to position "1".
   ☑ The Sunny Boy performs an AFCI self-test.

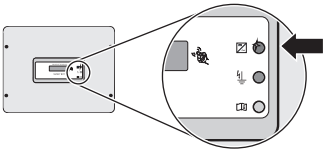


AFCI self-test

Only the following types of Sunny Boy perform an AFCI self-test:

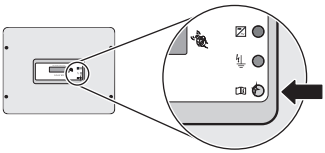
- SB 3000US-12
- SB 3800-US-12
- SB 4000US-12

☑ If the AFCI self-test is successful: The Sunny Boy goes into "Waiting" mode and the green LED flashes. The "Waiting" mode ends when solar irradiation reaches a certain level. The green LED lights up permanently and the Sunny Boy feeds into the power distribution grid.



or

☑ If the AFCI self-test fails: The yellow LED flashes. The Sunny Boy repeats the AFCI self-test until it is successful. Observe section 7.2 "The Sunny Boy Does Not Resume Operation" (page 65)).



If the feed-in to the power distribution grid was interrupted by a detected AC failure and then resumed, the inverter waits 5 minutes before feeding in again.

For this, the input voltage must be greater than the start voltage of the Sunny Boy. For the corresponding values, see section 11 "Technical specifications" (page 94).

If the inverter is not able to feed into the power distribution grid three times in a row, it waits 10 minutes before the next attempt.

7.2 The Sunny Boy Does Not Resume Operation

DANGER

Danger to life due to high voltages in the PV system.

Risk of death or serious injury due to electric shock.

- Only qualified personnel may perform work on the PV array.

- Watch the display and the LEDs.
- Observe section 8 "Displays and messages" (page 68) and section 9 "Troubleshooting" (page 82).

No Operation Despite Sufficient Irradiation

1. Check whether the input voltage is sufficient. For the input voltage values, see 11 "Technical specifications" (page 94).
2. If the input voltage is not sufficient, perform troubleshooting in the PV array and rectify the fault.

   or
3. If the input voltage is sufficient, contact the SMA Service Line. Observe section 14 "Contact" (page 105).

The Message "Error AFCI" Is Displayed

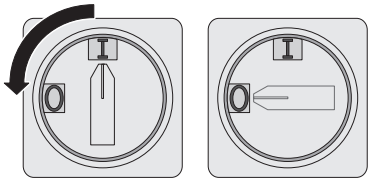
An electric arc occurred in the PV system. The yellow LED is continuously lit up. The AFCI has been triggered and operation of the Sunny Boy is permanently inhibited.

CAUTION

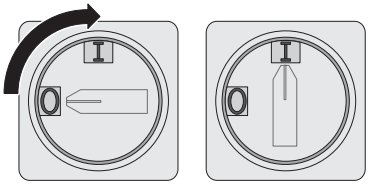
Danger of fire from electric arc

- Only test the AFCI for false triggering in the order described below.
- Do not deactivate the AFCI permanently.

1. Turn the DC disconnect to position "0".
   ☑ Wait for the display to go out.



2. Perform troubleshooting in the PV system:
   Check all PV strings for the correct open-circuit voltage.
3. After the fault is rectified, restart the Sunny Boy: Turn the DC disconnect to position "1".
   ☑ The Sunny Box starts and performs another AFCI self-test.

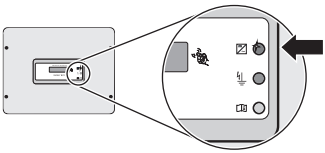


4. If the following message appears on the display, knock on the enclosure lid: "Error AFCI. Knock to reset."

The message "Error AFCI. Knock to reset." appears for only 10 seconds. After this, it is no longer possible to restart the unit by knocking on the enclosure lid.

- To restart the system, repeat step 1 to step 3.

5. If the AFCI self-test is successful: The Sunny Boy goes into "Waiting" mode and the green LED flashes.

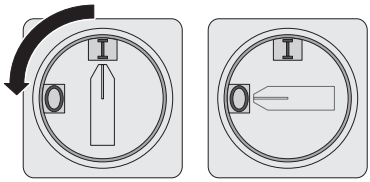


☑ The "Waiting" mode ends when solar irradiation reaches a certain level. The green LED lights up permanently and the Sunny Boy feeds into the power distribution grid.

or

6. If the AFCI self-test fails: The Sunny Boy repeats the AFCI self-test until it is successful.

7. If the AFCI self-test continues to fail: Turn the DC disconnect to position "0" and switch off the AC disconnect switch to the inverter.



If the AFCI self-test fails permanently

- Contact the SMA Service Line. Observe section 14 "Contact" (page 105).

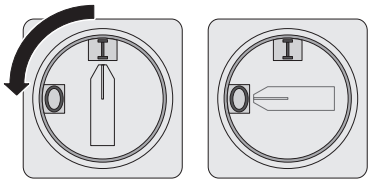
In the event of inverter inspection

1. Turn the DC disconnect to position "0".
   ☑ The Sunny Boy switches itself off.
2. Disconnect the Sunny Boy on the AC side.

The Message "EarthCurrentMax" Is Displayed

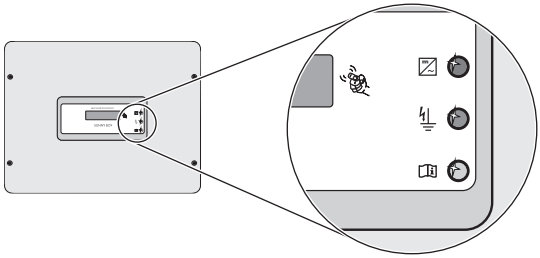
A ground fault is present in the PV array. The GFDI fuse is cleared.

1. Turn the DC disconnect to position "0" and switch off the AC disconnect switch to the inverter.



2. Perform troubleshooting in the PV array.

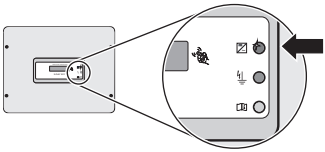
8 Displays and messages



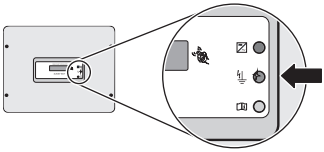
Each Sunny Boy inverter comes equipped with three LED status indicators. This allows the user to determine the operatin

g mode of the inverter at a glance.

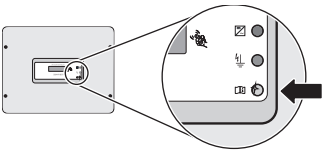
The green LED indicates normal operation of the inverter.



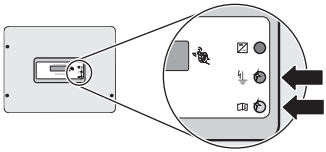
The red LED indicates the status of the GFDI fuse, located inside the Sunny Boy. If this LED is lit, the GFDI fuse has cleared or is not present.



The yellow LED indicates that there is a fault of some kind, either inside the inverter or somewhere in the PV system. The inverter will not operate until the fault has been corrected. The different error codes and possible causes are addressed later in this section and in Section 9 "Troubleshooting" (page 82).



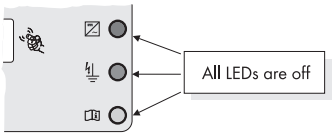
The red and yellow LEDs combined indicate that the inverter has detected a ground fault. The ground fault must be located and cleared and the inverter reset manually. The inverter will not restart automatically after detecting a ground fault. The ground fault may also clear the GFDI fuse.



All GFDI fuses are disabled in turbine mode.

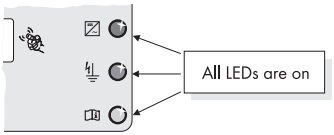
8.1 LED operation indicators

Standby (night)



The inverter is in standby mode because the input voltage is too low for operation or no DC is connected.

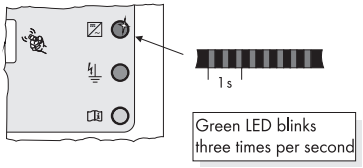
Initialization



The inverter is initializing. The power from the array is sufficient to initialize control power, but not yet powerful enough to begin normal operation. Data transmission is not possible during initialization.

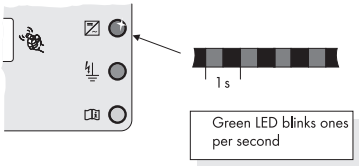
Occasionally, during inclement weather or low irradiation, the LEDs may all turn on at once and then go off again. This indicates that the inverter is trying to initialize but the power available from the array is not sufficient for normal operation. This is not a malfunction.

Starting



The inverter has sufficient PV power to calibrate its internal systems, but not enough to begin normal operation. Typically, the calibration lasts less than 10 seconds and then the inverter resumes normal operation. PV voltage must remain > PV Start Voltage setting for the period of the P-Start parameter setting (see section 8). The inverter will also show this status if it has been manually set to STOP mode.

Waiting

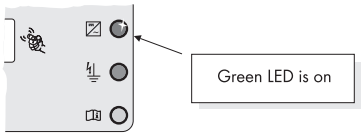


The inverter has determined that there is enough voltage from the array to operate and is checking the condition of the grid prior to connecting to it.

If the inverter fails to connect to the utility grid 3 times in a row, it will wait 10 minutes before the next attempt.

In case of a grid failure, the Sunny Boy waits 5 minutes before reconnecting to the grid.

Normal operation



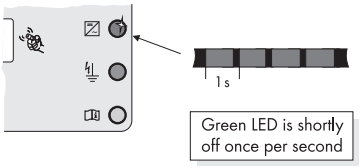
The inverter is feeding the utility grid in either "MPP", "Constant Voltage" or "Turbine" mode.

"MPP" Mode: The Sunny Boy adjusts the voltage and current from the PV array to obtain the greatest PV output power.

"Constant Voltage" Mode: The voltage from the PV array has been set to a fixed value. This value is set by using the Sunny Boy Control or the Sunny Data software. (The parameter name is "V-Const") This mode is typically used for fuel cell or micro-hydro applications.

"Turbine" Mode: This mode is used for DC rectified motor sources with a dynamic power curve (typically wind turbines). The user can set the magnitude and slope of the curve to match a particular alternator.

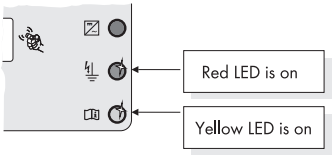
Derating



The Sunny Boy is designed to operate at full rated power up to +113 °F (+40 °C) ambient. The inverter will continue to operate beyond +113 °F (+40 °C) and will derate as required to maintain a safe internal component temperature. Unnecessary derating can be caused by blocked fan intakes. For this reason the fan intakes should be inspected often and cleaned when needed.

8.2 LED fault indicators

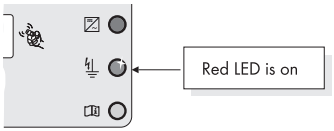
Ground fault



The inverter has detected a ground fault in the PV system and has disconnected from the grid. The ground fault must be located and fixed before the inverter will resume normal operation. Refer to section 9 "Troubleshooting" (page 82) for information on solving PV array ground faults. The inverter will not restart automatically.

All GFDI fuses are disabled in turbine mode.

Cleared GFDI fuse



The GFDI fuse located in the fuse holder on the circuit board of the inverter has been cleared or is not present. This fuse is used to protect the PV system in the event of an array ground fault. Troubleshoot the PV array for ground faults prior to replacing this fuse.

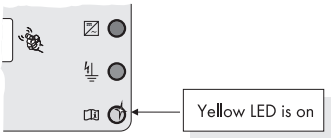
CAUTION

Risk of fire du to incorrectly dimensioned fuse.

Injuries due to fire.

For continous protection, only replace fuses with fuses of same type and size.

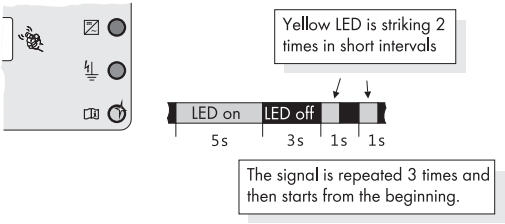
Control system fault



The yellow LED remains lit.

The Sunny Boy has detected a fault within the internal monitoring systems. When the inverter detects a fault of this kind it will no longer connect to the utility grid. To correct this, the inverter must be serviced by a qualified service technician. Contact SMA for assistance.

Grid failure



The yellow LED is on for 5 seconds, out for 3 seconds and then blinks twice. The code is repeated 3 times. This code sequence will repeat as long as there is a grid fault condition.

This code can be caused by any of the following conditions:

- Low Grid Voltage (<Vac Min)
- High Grid Voltage (>Vac Max)
- Low Grid Frequency (< fac Min)
- High Grid Frequency (>fac Max)
- Rapid change in grid frequency or voltage

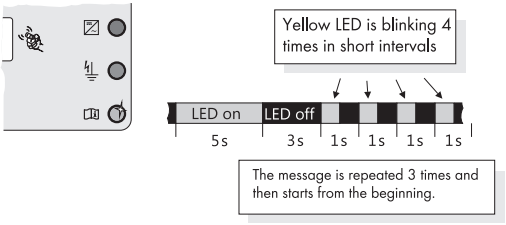
Check the condition of the grid at the AC terminal blocks within the Sunny Boy. Also inspect the AC disconnect between the Sunny Boy and the grid.

DANGER

Risk of electric shock due to high voltages inside the inverter.

- Do not touch power cables and screw termnals.
- The checking must be done by qualified personnel only.

High DC input voltage



The yellow LED is on for 5 seconds, remains off for 3 seconds and then blinks 4 times. This code is repeated 3 times. If the condition remains the code will continue to be sent.

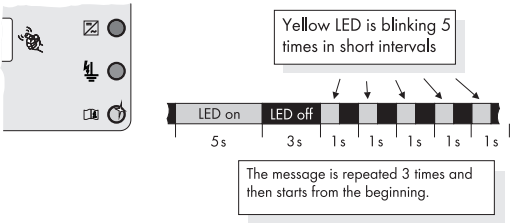
The inverter has detected a DC input voltage that is too high for safe operation.

NOTICE

Damage to the inverter due to high DC input voltage.

- Disconnect the inverter from the PV array immediately.
- Test the DC voltage at the DC disconnect switch before energizing the inverter.

Inverter fault

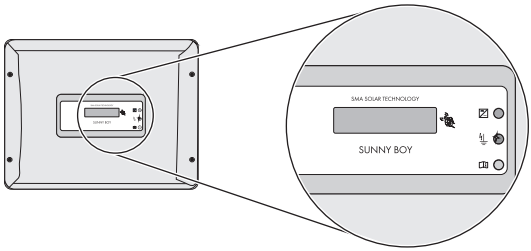


The yellow LED is on for 5 seconds, remains off for 3 seconds and then blinks 5 times. This code is repeated 3 times. If the condition remains the code will continue to be sent.

The inverter has encountered an internal fault that prohibits normal operation and will most likely require servicing.

If problems occur contact SMA for assistance.

8.3 Status messages on the LCD display



Activation of the backlight

The backlight is activated by knocking twice on the lid. Additional knocks will scroll through the display messages.

The backlight shuts off automatically after 2 minutes.

INIT messages

The following messages are displayed during initialization of the inverter:

Sunny Boy
WR4Kuxxx

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

BFR Version x.xx
SRR Version x.xx

Operation messages

The LCD continuously scrolls through all relevant operating data. Each message (MSG) is displayed for 5 seconds, after all messages have been displayed the LCD repeats from the beginning.

The screens may also be scrolled through manually by repeatedly knocking on the lid of the inverter. Each knock advances the screen to the next message.

MSG #1 "E-Today" (total energy produced on this day) is displayed together with the current operating mode:

E-today 3.86kWh
Mode MPP

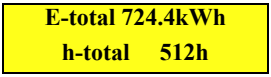
MSG #2 Nominal grid voltage configuration and actual line-to-neutral voltage measurements:

Gridtype - 208V
L1 120V L2 120V

MSG #3 Actual AC power output and DC input voltage:

Pac 3200W
Vpv 380V

MSG #4 Accumulated energy yield of the device since installation and the total operating hours:



Fault messages

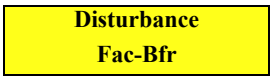
Each fault message is displayed for 5 seconds. After 5 seconds, the LCD will once again scroll through its normal operating screens. The fault condition will be included in the series of screens until the condition is cleared.

In case of a fault condition the LCD switches to "Fault" mode and the backlight is activated.

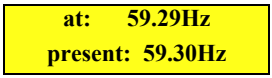
The upper display line indicates one of the three following failure types:

- Disturbance

  For example, this Disturbance message would be displayed if the Sunny Boy detected a problem with the frequency of the utility grid. The message would clear automatically once the condition was corrected. Disturbances are typically caused by a measured value exceeding a predetermined limit.

  The display will show the value of the error (at:) as well as the present value for the particular parameter (present:).

- Warning

  For example, this Warning message would be displayed if the GFDI fuse was open or cleared. Typically, Warning messages indicate a system condition that should be investigated. Warning conditions will not preclude inverter operation.

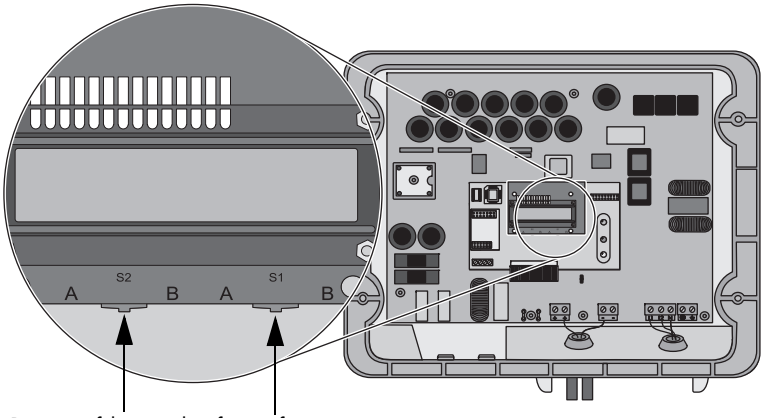
- Error

  For example, this Error message would be displayed if the inverter detected a problem with the internal ROM. An Error condition will prevent the inverter from restarting until the condition is cleared.

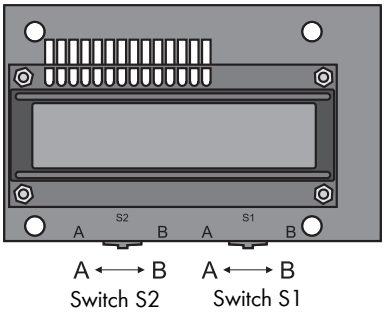
8.3.1 LCD display language selection

The LCD Display has the ability to display information in one of four different languages. Setting the language is performed by using a pair of slide switches located along the bottom edge of the display PC board. The language choices are: German, English, French and Spanish. Use the diagram and chart below for setting the display.



Position of the switches for configuration of the display language

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



8.4 Communication

The Sunny Boy can be equipped with a communication interface (socket see section 4.2 "Locating internal components" (page 19)) to communicate with special data acquisition devices (e.g. Sunny WebBox) or a PC with appropriate software (e.g. Sunny Data).

For a complete listing of all applicable communication options refer to the SMA web page or the product catalogue.

See the communication interface documentation for a detailed wiring diagram and instructions for insertion.

8.5 Measuring channels and parameters

The communication options support a number of measuring channels and messages from the Sunny Boy inverters.

The following abbreviations are used:

BFR Sequential Control System (Betriebsführungsrechner)

SRR Current Control System (Stromregelungsrechner)

The BFR and SRR are redundant processor control systems for the utility protection functions.

8.5.1 Measuring channels

Vpv:	PV input voltage
Vpv Setpoint:	MPPT DC voltage target
Iac:	Grid current
Vac:	Grid voltage L1 - L2
Vac L1:	Grid voltage L1 - N
Vac L2:	Grid voltage L2 - N
Fac:	Grid frequency
Pac:	Power fed to grid
Vpv-PE:	PV-voltage to earth (For troubleshooting PV ground faults)
Temperature:	Temperature measured at IGBT module
Ipv:	PV current
Max Temperature:	Max temperature measured at IGBT
Max Vpv:	Max PV input voltage
I-dif:	Error current
Vfan:	Fan voltage
E-Total:	Total energy yield
h-Total:	Total operation hours
h-on:	h-on indicates how long sufficient DC voltage has been applied to the Sunny Boy and the Sunny Boy has been active including the time it was not able to feed to the utility with respect to low DC voltage or operation in stop mode.
Power On:	Total system start-up counter
Event-Cnt:	Event counter
Serial Number:	Serial number of the Sunny Boy
CO2 saved:	Amount CO2 saved in operation time
Mode:	Current operating mode
Grid Type:	Type of grid the Sunny Boy is connected to
Error:	Description of fault

8.5.2 Operating mode

Stop:	Manual system stop
Offset:	Offset calibration of the electronics (at start-up)
Waiting:	PV voltage is not high enough to start
Grid monitoring:	Synchronizing to grid (at start-up)
MPP-Search:	MPPT range test (at start-up)
MPP:	Sunny Boy is in MPP mode (normal operation)
V-Const:	Sunny Boy is in constant voltage MPP mode

Derating:	Reduction of the grid feeding power due to abnormal heatsink temperatures
Disturbance:	Grid related fault condition, self clearing
Error:	Inverter fault, user interaction required
Warning:	System warning advising further investigation

8.5.3 Sunny Boy operating parameters

CAUTION

The changing of operating parameters should only be performed by qualified personnel. Changes to factory preset parameters may adversely effect inverter operation and performances.

Modifications of parameters marked with * may result in changes to conformity with IEEE 1547 and should be approved by the local utility and/or authority.

Operating parameters of the Sunny Boy

Name	Unit	Range	Default	Password Level	Description
AfciIsOn		yes/no	yes	Installer	Arc fault circuit interrupter (AFCI)
AntiIsland-Ampl*	deg	0 ... 10	0	Installer	Amplification of the Anti Island process
AntiIsland-Freq*	mHz	0 ... 2000	500	Installer	Repitition rate of the Anti Island process
CO2-Fact	lbs/kWh	0 ... 2	1.7	Installer	The Sunny Boy evaluates the yield and indicates the approximate CO2 emission avoided by your Sunny Boy. The amount of CO2 avoided is computed according to the kWh produced (E-total) multiplied by the factor defined in the parameter "CO2".
Default		USA/UL1741/ 2005, OFF_Grid, NON IEEE1547	USA/UL1741/ 2005	Installer	Used for adjusting the parameters country specific settings. Note: After changing one of the parameteres marked with "*", the parameter "default" changes to "adjusted" automatically.
E_Total	kWh	0 ... 200000	0	Installer	Total energy yield of the inverter. Changing the value can be necessary when a Sunny Boy is exchanged and you wish to match the previously acquired data.

Name	Unit	Range	Default	Password Level	Description
Fac-delta–*	Hz	0.2 ... 3.0	0.69 (for country setting USA/UL1741/ 2005)	Installer	Maximum allowable operating frequency above and below 60 Hz Default value is optimal for installations < 30 kW.
Fac-delta+*	Hz	0 ... 4.5	0.49 (for country setting USA/UL1741/ 2005)	Installer	
Fac-MinTripTime*	s	0.16 ... 300	0.16	Installer	Utility interconnection frequency trip time. Default value is optimal for installations < 30 kW.
Fan-Test		1 / 0	0	Installer	By setting this parameter to "1" you can check the function of the fans. This test turns the fans at maximum speed.
h_Total	h	0 ... 200000	0	Installer	Total operating hours of the inverter. Changing the value can be necessary when a Sunny Boy is exchanged and you wish to match the previously acquired data.
Memory Function		no function, Default param., Reset Op.Data, Reset errors	no function	Installer	Default param.: Sets all parameters to default. Reset Op.Data: Sets all parameters that are visible in user level to default values. Reset errors: Resets all permanent device disable errors.
Operating Mode		MPP-Operation, Turbine, V-const, Stop	MPP	Installer	Operating Modes of the Sunny Boy: MPP-Operation: Sets the Sunny Boy in Maximum Power Point Tracking Mode V-const: Constant Voltage Mode (Setpoint defined in "Vconst-Setval") Turbine: Operating mode for wind power plants Stop: Disconnection from utility, no operation
T-Max-Fan	°C	0 ... 100	90	Installer	Temperature for maximum fan rotation speed.
T-Start	s	5 ... 1600	10	Installer	The time the inverter waits to connect to the grid after Vpv-Start is exceeded. This value defaults to 5 minutes after a utility fault.
T-Start-Fan	°C	0 ... 100	50	Installer	Fan turn-on temperature at minimum rotating speed.
T-Stop	s	1 ... 1800	2	Installer	The time that the Sunny Boy waits to disconnect from the grid when Pac falls below minimum necessary Vpv.
T-Stop-Fan	°C	0 ... 100	50	Installer	Fan turn-off temperature

Name	Unit	Range	Default	Password Level	Description
V-Const Setval	V	SB 3000US: 185 ... 500 SB 3800-US: 230 ... 600 SB 4000US: 230 ... 600	SB 3000US: 500 SB 3800-US: 600 SB 4000US: 600	Installer	PV Setpoint voltage for constant voltage operation. These parameters only are important in case the parameter "Operating Mode" is set to "V-const".
Vac-Min*	%	0 ... 50	12	Installer	Values are used to calculate the lower limit of allowable AC voltage. Default value is optimal for installations < 30 kW. The default 12 results in a trip value of 88 % as listed under trip limits.
Vac-Max*	%	0 ... 20	10	Installer	Values are used to calculate the upper limit of allowable AC voltage. Default value is optimal for installations < 30 kW. The default 10 results in a trip value of 110 % as listed under trip limits.
Vac-Min-Fast*	%	0 ... 50	50	Installer	Values are used to calculate the lower limit of allowable AC voltage for fast disconnection. Default value is optimal for installations < 30 kW. The default 50 results in a trip value of 50 % as listed under trip limits.
Vac-Max-Fast*	%	0 ... 20	20	Installer	Values are used to calculate the upper limit of allowable AC voltage for fast disconnection. Default value is optimal for installations < 30 kW. The default 20 results in a trip value of 120 % as listed under trip limits.
Vac-Min-Recnet	%	0 ... 50	11.7	Installer	Values are used to calculate the lower and upper limits to reconnect to the grid after a grid frailure.
Vac-Max-Recnet	%	0 ... 20	5.83	Installer	
Vpv-Start	V	SB 3000US: 166 ... 480 SB 3800-US: 208 ... 580 SB 4000US: 208 ... 580	SB 3000US: 228 SB 3800-US: 285 SB 4000US: 285	Installer	Minimum DC voltage for the Sunny Boy to connect to the grid.

Fixed operating parameters

Name	Unit	Range	Default	Description
Plimit	W	fixed	SB 3000US: 3050 SB 3800-US: 4050 SB 4000US: 4050	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)

9 Troubleshooting

9.1 General

Our quality control program assures that each inverter is manufactured to exact specifications and is thoroughly tested before leaving the factory. If you encounter difficulty with the operation of your inverter, please follow the steps below in an effort to correct the problem.

- Check the blinking code of the LED display and compare the code with the blinking codes in Section 7 "Commissioning" (page 64).
- Check and record the exact "Mode" and/or "Error" messages on the LCD display or other communication system available. Take appropriate action to correct the issue.
- If necessary, check the DC and AC voltages at terminals inside the inverter. Be sure to observe all of the safety precautions listed throughout this manual when doing so, or hire a qualified professional.
- If the system problem persists, contact SMA.

In order to better assist you when contacting SMA, please provide the following information. This information is required for service assistance.

Information regarding the Sunny Boy

- Serial number
- Model Number
- Short description of the problem
- Blinking Code or display message
- What error code is indicated on the LCD?
- AC line voltage
- DC line voltage
- Check GFDI Fuse
- Can you reproduce the failure? If yes, how?
- Has this problem occurred in the past?
- What were the operating conditions when the problem occurred?

Information regarding the PV modules

- Manufacturer name and model number of the PV module
- Output power of the module
- Open circuit voltage (Voc) of the module
- Number of modules in each string
- Number of PV strings connected to the inverter

If it becomes necessary to send the Sunny Boy back to the manufacturer for service, please ship it in the original box to avoid damage during shipping.

9.2 Error messages

If a fault occurs, the Sunny Boy generates an error code according to the operating mode and the detected fault.

Error Type	Error Code	Description
Disturbance	Bfr-Srr	Communication between micro-controllers is failing. Contact SMA for assistance.
Warning	Derating	The inverter reduces the output power due to high internal temperature. Verify that the fans are operating normally and that the intake screens are clean. Check the intake vents for debris. Verify that there is adequate ventilation around the inverter. This condition may be normal in periods of high ambient temperatures above +113 °F (+45 °C).
Disturbance	Error AFCI	Electric arc in the PV system. Eliminate the fault in the PV system. Perform an AFCI self-test. Observe section "The Message "Error AFCI" Is Displayed" (page 66).
Error	EarthCurMax-B	The earth current between PV+ and GND has exceeded the maximum limit. Check the PV array for ground faults.
Error	EarthCurMax-S	The earth current between PV+ and GND has exceeded the maximum limit. Check the PV array for groud faults.
Disturbance	EEPROM	Transition failure during reading or writing of data EEPROM, the data is not essential for safe operation - this failure does not effect performance.
Error	EEPROM p	Data EEPROM defective, device is set to permanent disable due to the fact that the data loss affects important functions of the inverter. Contact SMA.
Disturbance	EeRestore	Internal failure
Disturbance	Fac-Bfr, Fac-Srr	The AC grid frequency is exceeding the allowable range. ("Bfr" or "Srr" is an internal message and is not important to the user.) The Sunny Boy assumes that the public grid is down and disconnects from the grid in order to avoid islanding. If the grid frequency is within the tolerable range and you still observe the failure message "Fac-Bfr" or "Fac-Srr", check for possible intermittent connections. For additional assistance contact SMA.
Warning	GFDI Fuse Open	The GFDI-Fuse is open or cleared. Check PV array for ground faults before replacing the fuse.

Error Type	Error Code	Description
Disturbance	Grid-Timeout, Grid-Fault-S	The type of grid could not be detected (208 V/240 V).
Disturbance	Imax	Over current on the AC side. This failure code is indicated in case the current to the AC grid exceeds the specification. This may happen in case of harmfull interference on the grid. If you observe "Imax" often, check your grid. For assistance contact SMA.
Disturbance	K1-Close	Relay test failed. Contact SMA for assistance.
Error	K1-Open, K2-Open	
Disturbance	MSD-FAC, MSD-Idif	Internal measurement comparison error: The internal BFS and SRR processors are measuring different values. Contact SMA for assistance.
Error	MSD-VAC	
Disturbance	OFFSET	Grid monitoring self-test failed. Contact SMA for assistance.
Error	ROM	The internal test of the Sunny Boy control system firmware failed. Contact SMA in case you observe this failure often.
Disturbance	Shut-Down	Internal over current continuous. Contact SMA for assistance.
Disturbance	Vac-Bfr, Vac-Srr	The AC grid voltage is exceeding the allowable range. ("Bfr" or "Srr" is an internal message and is not important for the user.) Vac can also result from a disconnected grid or a disconnected AC cable. The Sunny Boy assumes that the public grid is down and disconnects from the grid in order to avoid islanding. If the grid voltage is within the tolerable range and you still observe the failure message "Vac-Bfr" or "Vac-Srr" contact SMA.
Disturbance	VacL1-Bfr, VacL2-Bfr, VacL1-Srr, VacL2-Srr	Voltage is too high or too low on the indicated leg.
Disturbance	VpvMax !PV Overvoltage! !Disconnect DC!	DC input voltage above the maximum tolerable limit. Disconnect DC immediately!
Disturbance	Watchdog	Watchdog for operation control triggered. Contact SMA for assistance.
Disturbance	XFMR_TEMP_F	High transformer temperature. The inverter will remain stopped until the transformer has cooled.

Error Type	Error Code	Description
Warning	XFMR_TEMP_W	High transformer temperature is gone. The Sunny Boy starts working and shows the failure "XFMR_TEMP_W". Verify that the fans are operating normally and that the intake screens are clean. Check the intake vents for debris. Verify that there is adequate ventilation around the inverter. This condition may be normal in periods of high ambient temperatures above +113 °F (+45 °C).

10 Maintenance

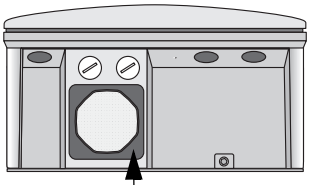
The Sunny Boy is designed to provide many years of trouble-free service. Performing regular maintenance will help ensure the long life and high efficiency of your system.

10.1 Cleaning the fans

The fan intakes and handle covers should be cleaned periodically with a vacuum cleaner. Do not blow air into the fan areas. For deeper cleanings, the fans can be removed completely.

The fan is mounted on the bottom side of the Sunny Boy. To clean or replace the fan please follow the steps below:

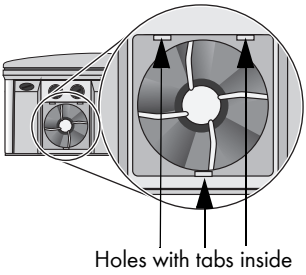
1. Turn off all DC and AC disconnects and wait for 5 minutes for any residual voltages to dissipate.
2. Disconnect the Sunny Boy from both the DC and AC connections.
3. Wait for the fans to stop rotating.
4. Carefully remove the black plastic plate and filter in front of the fan with the two plastic tabs on the right border.
   Clean the fan guard with a soft brush, a paint brush, a cloth, or compressed air.



5. To release the fan press the front latches backwards and the rear latches forwards.
6. Remove the fan by pulling it slowly and carefully downwards.
7. Unlock and remove the plugs.

   The fan cables are long enough for lifting the fans far enough out to disconnect the internal plugs in the Sunny Boy.
8. Remove the fan and clean it with a soft brush, a paint brush, or a cloth and water.

   Do not use compressed air as this can damage the fan.

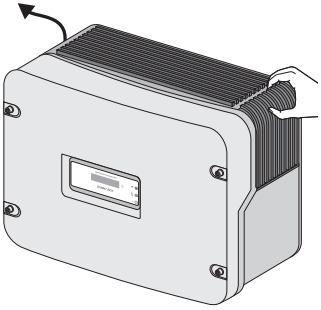


9. To clean the fan use a soft brush or cloth. Do not use air pressure for cleaning the fan. This will damage the fan.
10. When the fan is clean, reinstall it using the above steps in reverse order.
11. Do not blow air through the fan or the fan screens while the fan plate is assembled on the Sunny Boy.

10.2 Cleaning the handle covers

There are handle covers on either side of the Sunny Boy. The Sunny Boy sucks air in from underneath via the fan and blows it out again on the upper left side. For optimum heat dissipation within the device, you have to clean the left handle cover. Proceed as follows when cleaning the handle covers:

- The handle covers of the Sunny Boy are on the sides of the enclosure. Place your fingers in the space between the top of the housing and the handle covers and gently pull the handle covers out of their bracket. (It is only snapped in.)
- Clean the filter and fins with a soft brush or cloth. Use mild soap and water if necessary.
- Insert the handle covers back into the Sunny Boy. The handle covers can only be inserted on the right or left side of the Sunny Boy respectively.
  "links/left" or "rechts/right" is printed on the inside of the handle covers to help you identify the sides.



NOTICE

Insects entering the Sunny Boy can damage the device.

- The handle covers must not be removed permanently, because otherwise the device is not protected against the entrance of insects!

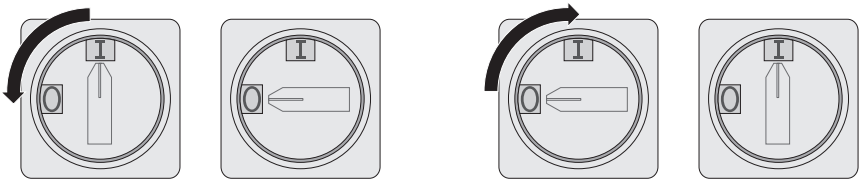
10.3 Checking the DC Disconnect

Under normal use the DC Disconnect does not need maintenance.

It is recommended, though not compulsory to:

- Check the DC Disconnect regularly.
- Operate the DC Disconnect once a year 10 times.

Operating the switch will clean the contacts and will extend the life of the DC Disconnect.



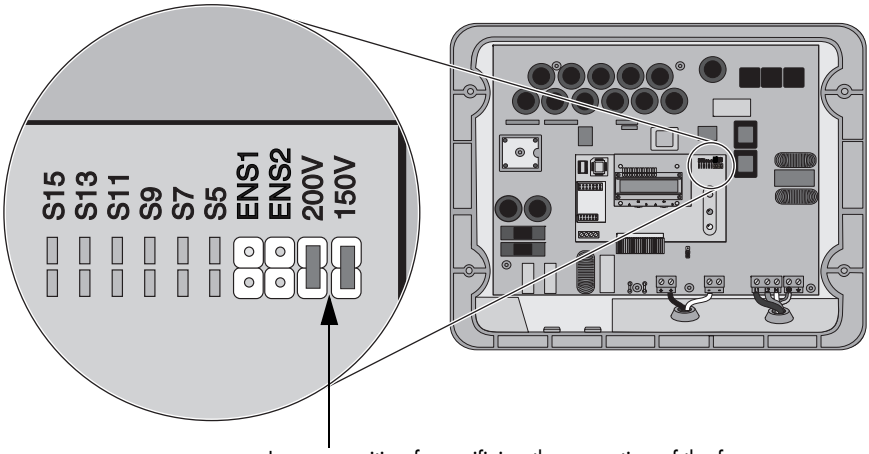
10.4 Testing the fans

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

- Set the parameter “Fan Test“ to "1" (with Sunny Data, Sunny Data Control or with the data logger Sunny Boy Control).

or

- Turn off the inverter by turning off all DC and AC disconnects and wait 5 minutes for any residual voltages to dissipate.
- Once the LEDs are off, remove the cover and set the jumpers as shown below.
- Turn on the inverter by turning on the AC disconnect and then the DC disconnect or switch the SMA DC Disconnect to the "1" position.
- After testing the fans, remove the jumpers.

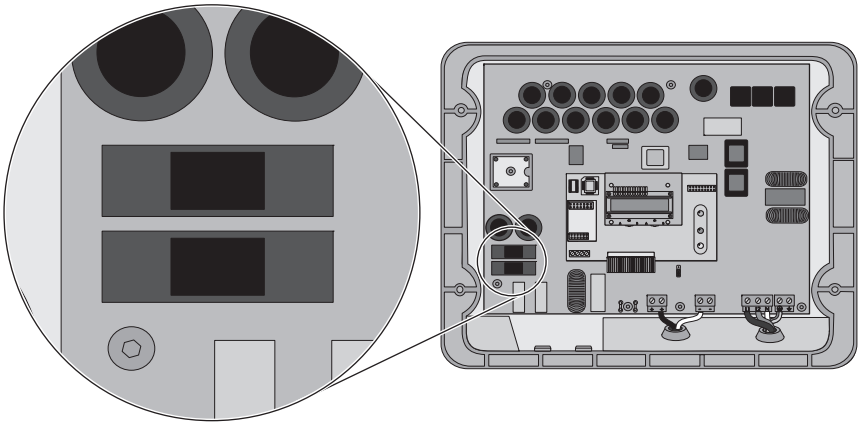


Jumper position for verifiying the operation of the fans

10.5 Exchanging the fuses

10.5.1 Exchanging the GFDI fuse within the Sunny Boy

1. Turn OFF all AC and DC switches and/or breakers.
2. Wait for at least 5 minutes.
3. Open the Sunny Boy as described in section 4.1 "Opening the Sunny Boy" (page 18).
4. Exchange the fuse.
   For correct fuse location please refer to section 6.7.2 "DC input grounding" (page 50).



CAUTION

Risk of fire due to incorrectly dimensioned fuse.

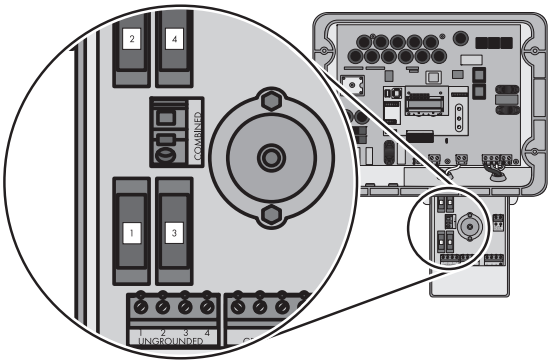
Injuries due to fire.

For continous protection, only replace fuses with fuses of same type and size.

5. Ensure that the fuse is completely inserted in the clamp.
6. Close the Sunny Boy.
7. Turn ON all AC and DC switchens and/or breakers.

10.5.2 Exchanging PV string fuses within the SMA DC Disconnect

1. Turn OFF all AC and DC switches and/or breakers.
2. Wait for at least 5 minutes.
3. Open the SMA DC Disconnect as described in section 6.5 "Opening the SMA DC Disconnect" (page 39).
4. Exchange the fuses having regard to the information on the next page.



5. Close the SMA DC Disconnect.
6. Turn ON all AC and DC switches and/or breakers.

PV string fuse sizing

In any electrical system, fuses are used to protect wiring and equipment from excessive currents that can cause damage, heating or in extreme cases even fire. If the fuse rating is too small it could open during normal operation. If the fuse rating is too large, it cannot provide the needed protection. In PV systems, the minimum and maximum size of the series fuse is determined by the electrical ratings of the PV module as well as by UL and *National Electrical Code®* requirements. Be sure to consult with your PV module manufacturer for appropriate PV string fuse ratings.

The minimum size of fuses and wiring are calculated using the Short Circuit Current Rating (Isc) of the PV module. The *National Electrical Code®* requires that all fuses and wiring be sized for a minimum of 1.56 times the Isc of the PV module used in the system. The proper size PV string fuse is determined by calculating 1.56 x Isc (of the PV module) and then rounding up to the next standard fuse size.

If the Isc of the PV module equals 6.9 Adc, then the PV string fuse size is determined by 1.56 x 6.9 = 10.76. The next standard fuse size would be a 12A, 600Vdc fuse.

The fuse size per string must not be greater than the maximum fuse size rating of the PV module. Refer to the data sheet of the PV module. If no maximum fuse size is indicated, contact the PV module manufacturer.

DC Disconnect requirements

National Electrical Code® 690.15-18 allows the use of fuse holders as a suitable means of disconnecting PV arrays for servicing. Additional DC disconnects external to the inverter may be required by the local authority having jurisdiction.

WARNING

Risk of electric shock and arc flash due to removing fuses under load.

Serious injuries will result.

Do not remove a fuse while the inverter is under load.

PV string fuses

The SMA DC Disconnect is shipped with 15 A, 600 Vdc fuses in fuse holders. The maximum string fuse rating for the SMA DC Disconnect is 20 A.

10.6 Testing and Replacing the DC Varistors

Only the following inverter types are equipped with DC varistors:
SB 3000US-12/SB 3800-US-12/SB 4000US-12.

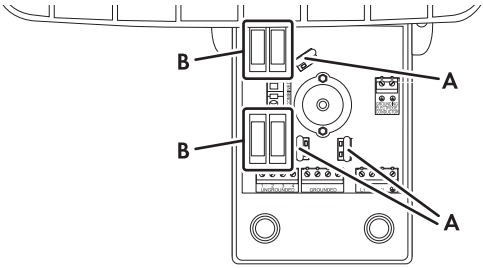
In regions where storms or other DC overvoltages frequently occur, the DC varistors loose their functionality if the PV plant is not equipped with an additional overvoltage protection. To ensure that the functionality of the DC varistors remains at a constant level, SMA recommends in such cases to replace the DC varistors after an operating time of 10 years with new ones.

Notice

No protection against overvoltage due to faulty or missing varistors

Destruction of the inverter is possible.

- Do not operate the inverter with faulty varistors or no varistors at all.
- Replace faulty varistors immediately.



Position	Description
A	Terminals for DC varistors
B	Fuse holders for fuse extractor with string fuses

1. Disconnect the Sunny Boy on the AC and DC sides.
2. Wait 5 minutes for the components to cool down.
3. Open the DC disconnect as described in Section 6.5 "Opening the SMA DC Disconnect" (page 39).

DANGER

High voltages at the DC terminals with connected PV modules

Risk of death or serious injury when touching the DC terminal.

- Do not touch any live component of the DC terminals.

4. Check the DC varistors (A) for discoloration and visible damage.

- If one of the DC varistors is discolored or damaged, replace all DC varistors.

DANGER

Danger to life due to short circuits in the DC varistors

Death or serious injury due to electric shock

- Check whether current is flowing the DC cables.

Tip: Use a current clamp to measure the current.

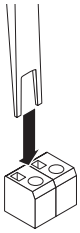
5. Disconnect the DC varistors:
   - Disconnect the string connectors of all ungrounded DC cables from the PV array.
   - Remove the four fuse extractors with the string fuses from the fuse holders (B) of the DC disconnect.
   - Remove the four string fuses from the fuse extractors.
   - Insert the four fuse extractors without the string fuses into the fuse holders (B) of the DC disconnect.
6. Ensure that no voltage is present at the DC varistors.

- If no voltage is present, replace all DC varistors:

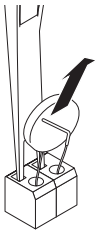
Only use spare parts from SMA

- Always replace the entire set of DC varistors.
- Order number in Section 12 "Accessories" (page 103).

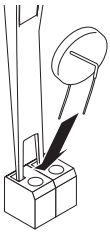
– Insert the insertion tool into the rectangular opening of the terminal.



– Remove the DC varistor.



– Insert the new DC varistor into the terminal.



– Pull the insertion tool out of the rectangular opening of the terminal.

7. Ensure that all DC varistors in the terminals are securely in place.
8. Re-insert all string fuses into the DC disconnect:
   – Remove the four fuse extractors without string fuses from the fuse holders (B) of the DC disconnect.
   – Equip the four fuse extractors with functional string fuses.
   – Insert the four fuse extractors with the string fuses in the fuse holders (B) of the DC disconnect.
9. Re-connect the string connectors of all ungrounded DC cables to the PV array.
10. Close the DC disconnect as described in Section 6.10 "Closing the SMA DC Disconnect" (page 63).

☑ Testing and replacement of the DC varistors is completed.

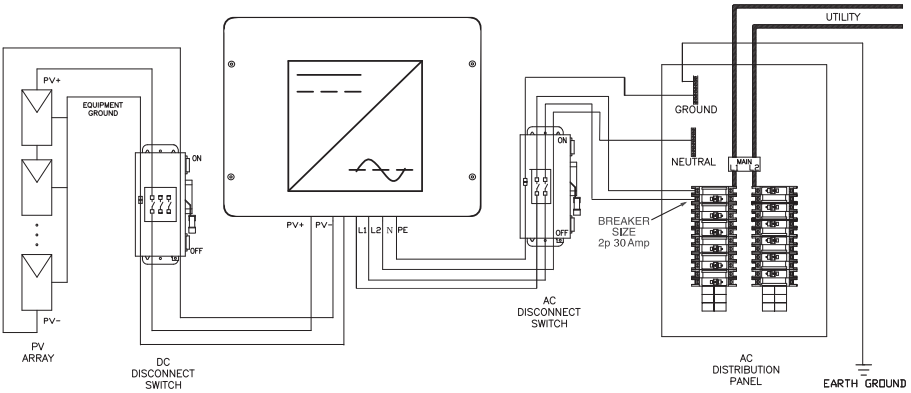
11 Technical specifications

11.1 Sunny Boy wiring diagrams

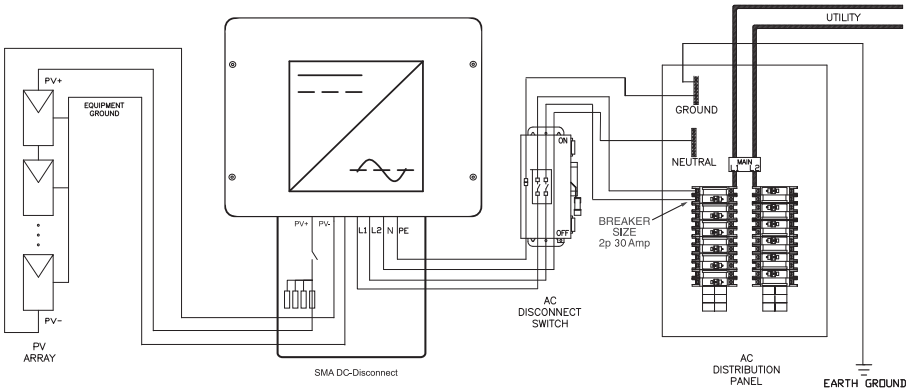
Sunny Boy connection to 208 V and 240 V AC utility grids.

The AC disconnect switch shown below may or may not be required by the local utility grid operator.

Wiring diagram without SMA DC Disconnect



Wiring diagram with SMA DC Disconnect



11.2 Sunny Boy 3000-US

PV generator connection

Peak Power Tracking Voltage at 208 V nominal	180 V ... 400 V
Peak Power Tracking Voltage at 240 V nominal	200 V ... 400 V
Range of Input Operating Voltage	200 V ... 500 V
Maximum Array Input Power	3,750 W
Maximum DC Power	3,250 W
PV Start Voltage	230 V
Maximum DC Input Current	17 A
Maximum Input Short Circuit Current	24 A
DC Voltage Ripple	< 10 %

Grid connection

AC Operating Voltage Range at 208 V nominal	183 V ... 229 V
AC Operating Voltage Range at 240 V nominal	211 V ... 264 V
AC Operating Frequency Range	59.3 Hz ... 60.5 Hz
AC Frequency Nominal	60 Hz
AC Maximum Continous Output Power	3,000 W
Current THD	< 4 %
AC Maximum Continous Output Current at 208 V	15 A
AC Maximum Continous Output Current at 240 V	13 A
Maximum Output Fault Current	30 A
Maximum Output Overcurrent Protection	30 A
Maximun Utility Backfeed Current to PV array	30 A AC
Synchronization In-Rush Current	8 A
Trip Limit Accuracy	±2 %
Trip Time Accuracy	±0.1 %
Power Consumption at Night	0.1 W

Mechanical data

Width x Height x Depth	17.80 in. x 13.83 in. x 9.30 in. (462 mm x 351 mm x 236 mm)
Weight	88 lbs. (40 kg)
Noise Emission	40 dB(A)

Efficiency

Power factor at nominal power	1
Peak Inverter Efficiency	96.8 %
CEC Weighted Efficiency at 208 V nominal	95.0 %
CEC Weighted Efficiency at 240 V nominal	95.5 %

Ambient conditions

Ambient Temperature Range	– 13 °F ... +113 °F (– 25 °C ... +45 °C)

Protection Devices

DC reverse polarity protection	Short circuit diode
AC short circuit protection	Software controlled
AC overcurrent protection	Current controlled
Grid monitoring (SMA grid guard® 2)	Yes

General data

Inverter Technology	Low frequency transformer
Cooling Concept	OptiCool, forced active cooling

11.3 Sunny Boy 3800-US

PV generator connection

Peak Power Tracking Voltage at 240 V nominal	250 V ... 480 V
Range of Input Operating Voltage	250 V ... 600 V
Maximum Array Input Power	5,000 W
Maximum DC Power	4,250 W
PV Start Voltage	285 V
Maximum DC Input Current	18 A
Maximum Input Short Circuit Current	25 A
DC Voltage Ripple	< 10 %

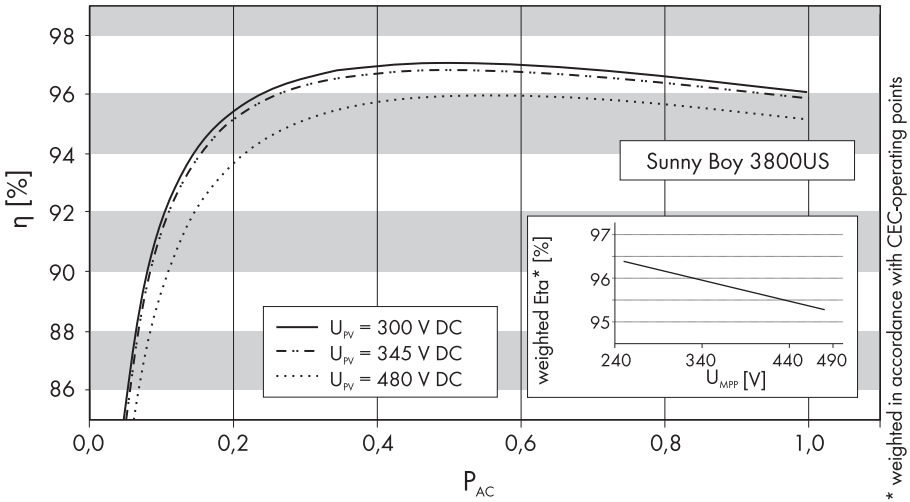
Grid connection

AC Operating Voltage Range at 240 V nominal	211 V ... 264 V
AC Operating Frequency Range	59.3 Hz ... 60.5 Hz
AC Frequency Nominal	60 Hz
AC Maximum Continous Output Power	3,800 W
Current THD	< 4 %
AC Maximum Continous Output Current at 240 V	16 A
Maximum Output Fault Current	30 A
Maximum Output Overcurrent Protection	30 A
Maximun Utility Backfeed Current to PV array	30 A AC
Synchronization In-Rush Current	8 A
Trip Limit Accuracy	±2 %
Trip Time Accuracy	±0.1 %
Power Consumption at Night	0.1 W

Mechanical data

Width x Height x Depth	17.80 in. x 13.83 in. x 9.30 in. (462 mm x 351 mm x 236 mm)
Weight	88 lbs. (40 kg)
Noise Emission	40 dB(A)

Efficiency



Power factor at nominal power	1
Peak Inverter Efficiency	96.8 %
CEC Weighted Efficiency at 240 V nominal	96.0 %

Ambient conditions

Ambient Temperature Range	– 13 °F ... +113 °F (– 25 °C ... +45 °C)

Protection Devices

DC reverse polarity protection	Short circuit diode
AC short circuit protection	Software controlled
AC overcurrent protection	Current controlled
Grid monitoring (SMA grid guard® 2)	Yes

General data

Inverter Technology	Low frequency transformer
Cooling Concept	OptiCool, forced active cooling

11.4 Sunny Boy 4000-US

PV generator connection

Peak Power Tracking Voltage at 208 V nominal	220 V ... 480 V
Peak Power Tracking Voltage at 240 V nominal	250 V ... 480 V
Range of Input Operating Voltage	250 V ... 600 V
Maximum Array Input Power	5,000 W
Maximum DC Power	4,300 W
PV Start Voltage	285 V
Maximum DC Input Current	18 A
Maximum Input Short Circuit Current	25 A
Maximun Utility Backfeed Current to PV array	30 A AC
DC Voltage Ripple	< 10 %

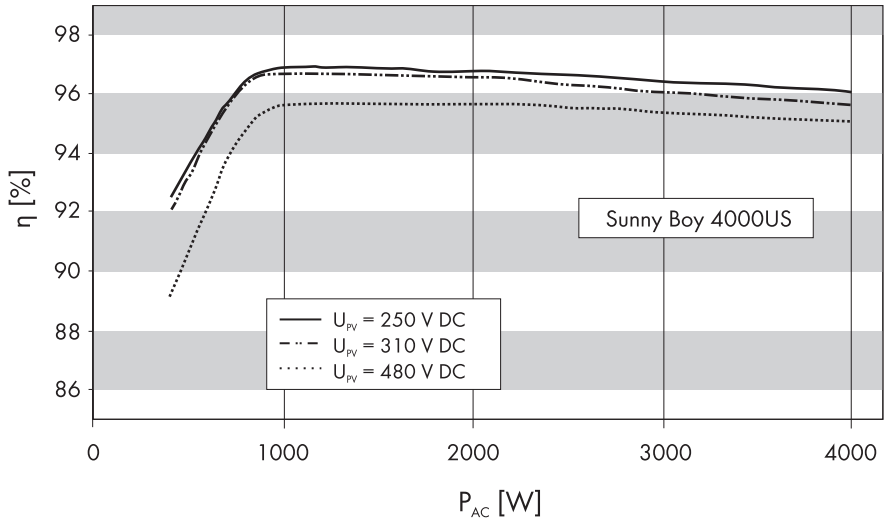
Grid connection

AC Operating Voltage Range at 208 V nominal	183 V ... 229 V
AC Operating Voltage Range at 240 V nominal	211 V ... 264 V
AC Operating Frequency Range	59.3 Hz ... 60.5 Hz
AC Frequency Nominal	60 Hz
AC Maximum Continous Output Power	4,000 W
Current THD	< 4 %
AC Maximum Continous Output Current at 208 V	17 A
AC Maximum Continous Output Current at 240 V	17 A
Maximum Output Fault Current	30 A
Maximum Output Overcurrent Protection	30 A
Synchronization In-Rush Current	8 A
Trip Limit Accuracy	±2 %
Trip Time Accuracy	±0.1 %
Power Consumption at Night	0.1 W

Mechanical data

Width x Height x Depth	17.80 in. x 13.83 in. x 9.30 in. (462 mm x 351 mm x 236 mm)
Weight	88 lbs. (40 kg)
Noise Emission	40 dB(A)

Efficiency



Power factor at nominal power	1
Peak Inverter Efficiency	96.8 %
CEC Weighted Efficiency at 208 V nominal	95.5 %
CEC Weighted Efficiency at 240 V nominal	96.0 %

Ambient conditions

Ambient Temperature Range	– 13 °F ... +113 °F (– 25 °C ... +45 °C)

Protection Devices

DC reverse polarity protection	Short circuit diode
AC short circuit protection	Software controlled
AC overcurrent protection	Current controlled
Grid monitoring (SMA grid guard® 2)	Yes

General data

Inverter Technology	Low frequency transformer
Cooling Concept	OptiCool, forced active cooling

11.4.1 SMA DC Disconnect

Maximum DC Input Current	36 A DC
Maximum System Voltage	600 V DC
Maximum String Fuse Rating	20 A DC
Maximum AC Operating Current	40 A AC
Dimensions W x H x D	7.87 in. x 12.20 in. x 7.48 in. (200 mm x 310 mm x 190 mm)
Weight	8 lbs. (3.5 kg)
Enclosure	3R rated

Specifications subject to change without notice.

11.5 Trip limits/trip times

Nominal frequency	Trip limit	Trip frequencies	Trip times
60 HZ	> 60.5 Hz	60.45 Hz ... 60.55 Hz	max. 0.1602 s
	< 57.0 Hz ... 59.8 Hz (default 59.3 Hz)	56.95 Hz ... 59.85 Hz (default 59.25 Hz ... 59.35 Hz)	adjustable 0.16 s ... 300 s (default max. 0.1602 s)
	< 57.0 Hz	56.95 Hz ... 57.05 Hz	max. 0.1602 s

Nominal voltage	Trip limit	Trip voltages line-to-neutral*	Trip voltages line-to-line*	Trip times
208 V	50 %	57.6 V ... 62.4 V	99.8 V ... 108.2 V	max. 0.1602 s
	88 %	103.2 V ... 108.0 V	178.9 V ... 187.2 V	max. 2.002 s
	110 %	129.6 V ... 134.4 V	224.6 V ... 233.0 V	max. 1.001 s
	120 %	141.6 V ... 146.4 V	245.4 V ... 253.8 V	max. 0.1602 s
240 V	50 %	57.6 V ... 62.4 V	115.2 V ... 124.8 V	max. 0.1602 s
	88 %	103.2 V ... 108.0 V	206.4 V ... 216.0 V	max. 2.002 s
	110 %	129.6 V ... 134.4 V	259.2 V ... 268.8 V	max. 1.001 s
	120 %	141.6 V ... 146.4 V	283.2 V ... 292.8 V	max. 0.1602 s

Manufacturer's accuracies:

Trip limit accuracy: ±2 % of nominal grid voltage

Trip time accuracy: ±0.1 % of nominal trip time

Trip frequency accuracy: ±0.1 % of nominal frequency

11.6 Torque values and wire sizes

Terminal	Torque	Wire Size
Grey AC & DC terminal blocks inverter	15 in-lbs. (1.7 Nm)	10 ... 6 AWG
AC & DC terminal blocks SMA DC Disconnect	15 in-lbs. (1.7 Nm)	10 ... 6 AWG
Combined terminal block SMA DC Disconnect	Spring terminal	10 ... 6 AWG
Grounding electrode conductor terminal block SMA DC Disconnect	15 in-lbs. (1.7 Nm)	10 ... 6 AWG
Screws for fastening the Sunny Boy and the SMA DC Disconnect to the wall mounting bracket and closing the SMA DC Disconnect cover	44 in-lbs. (5 Nm)	–
Cover screws	53 in-lbs. (6 Nm)	–

12 Accessories

You will find the corresponding accessories and replacement parts for your product in the following overview. If needed, you can order these from SMA or your SMA dealer.

Name	Brief description	SMA order number
DC varistors*	1 set varistors (DC), including insertion tool	SB-VDC-US01
RS485 upgrade kit	RS485 interface	485 USPB-NR
Bluetooth upgrade set	*Bluetooth* communication interface	BTPBINV-NR
Air grills	Air grill set "right and left" as replacement part	45-7202

* only SB 3000US-12/SB 3800-US-12/SB 4000US-12

13 Compliance Information

FCC Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The user is cautioned that changes or modifications not expressly approved by SMA America, Inc. could void the user's authority to operate this equipment.

IC Compliance

This device complies with Industry of Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- This device may not cause interference, and
- This device must accept any interference, including interferences that may cause undesired operation of the device.

14 Contact

If you have technical problems concerning our products, contact the SMA Serviceline. We require the following information in order to provide you with the necessary assistance:

- Type of inverter, if applicable
- Type and number of modules connected, if applicable
- Communication method, where necessary
- Serial number of the Sunny Boy
- Sunny Boy failure or warning number
- Display message of the Sunny Boy

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