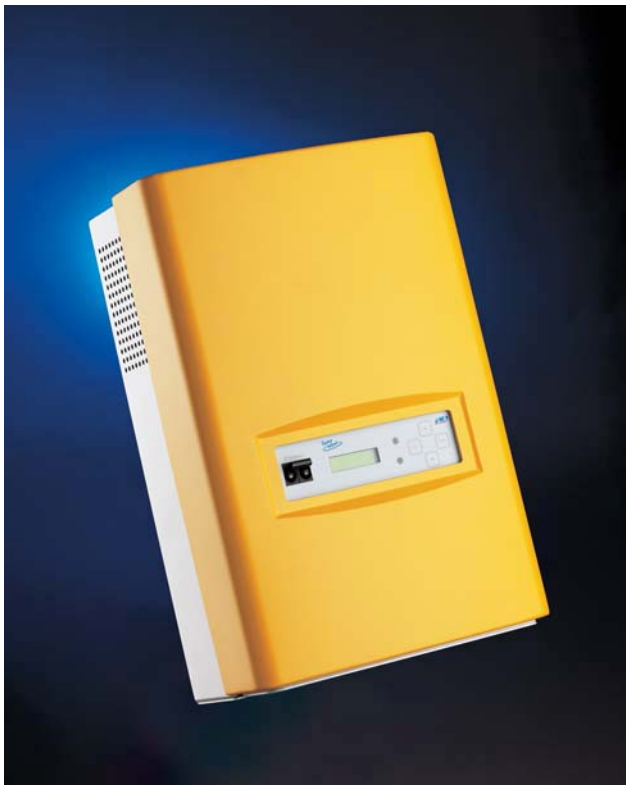
Sunny Island 4248U

Battery Inverter/Charger for
Stand-Alone and Back-up Applications



Installation & Operating Instructions

Revision History

Rev. No.	Date	By	Description
0.1	Feb. 2, 2004	Jeffrey Philpott	Alpha draft
1.0	Sept. 24, 2004	Jeffrey Philpott	Preliminary Release
1.1	Feb. 25, 2005	Yvonne Siebert	New chapter: “Split-phase”
1.2	Sep. 13, 2005	Jeffrey Philpott	Generator Update/Com. Update

SMA America, Incorporated
12438-C Loma Rica Drive
Grass Valley, California 95945
Tel 530.273.4895
Fax 530.274.7271
www.sma-america.com

IMPORTANT SAFETY INSTRUCTIONS
SAVE THESE INSTRUCTIONS

This manual contains important instructions for the Sunny Island SI4248U that must be followed during the installation, operating and maintenance of the inverter.

The Sunny Island 4248U 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 Island 4248U. To reduce the risk of personal injury and to ensure the safe installation and operation of the Sunny Island 4248U, you must carefully read and follow all instructions and warnings in this *Installation Guide*.

Safety and Hazard Symbols

This symbol is used to call attention to important information that you must have when installing and/or operating the Sunny Island 4248U. Failure to read and follow instructions marked with this symbol could result in serious injury and/or damage to the equipment.

This symbol appears beside instructions and warnings that deal with dangerous voltages that can injure people who come in contact with them.

Warnings

WARNING: 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.

Warnings may also be accompanied by one or more of the safety and hazard symbols described above to indicate the type of hazard described therein.

Other Symbols

In addition to the safety and hazard symbols described previously, the following symbol is also used in this *Installation Guide*:

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

Warranty

All Sunny Island 4248U inverters sold in the USA have a five-year warranty, as indicated on the warranty card included in the shipping container. For warranty coverage, or if you have questions about the Sunny Island 4248U warranty, contact SMA America at the address, telephone number or Web site listed on page iii (to send E-mail, see the Contact section of the SMA America Web site: www.sma-america.com).

WARNING: All electrical installation must be done by qualified personnel and in accordance with the National Electrical Code ANSI/NFPA 70, local building codes and the requirements of the authority having jurisdiction.

WARNING: The Sunny Island 4248U contains no user serviceable parts. Always contact an SMA authorized service center for repairs and maintenance.

WARNING: Other than the cooling fans, the Sunny Island 4248U contains no user-serviceable parts. Always contact an SMA authorized Service Center for repairs and maintenance other than those detailed in this manual.

WARNING: Before installing or using the Sunny Island 4248U, read all of the instructions and warnings on the Sunny Island 4248U and in this Installation Guide.

WARNING: Do **NOT** connect the **AC OUPUT** of the Sunny Island 4248U to the utility grid. Doing so will damage the inverter and void the warranty.

WARNING: The Sunny Island 4248U is designed for use in Negative Ground DC systems only.

WARNING: Always wait a minimum of 5 minutes for any stored potentials in the Sunny Island 4248U to discharge completely before opening the enclosure.

WARNING: This device is not intended for use with emergency systems or essential equipment such as fire pumps, operating room or life support equipment. See NEC 700/701.

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Section 1: Installation Manual

Introduction

Features

Congratulations! You've purchased the finest inverter/charger available today. Over twenty years of inverter manufacturing experience has gone into the design of the Sunny Island 4248U. As a result, the Sunny Island 4248U represents state-of-the-art technology, high reliability and overall ease of use, all the things you've come to expect from SMA, the industry leader in inverter manufacturing. Some of the features included are:

- Optimized for high ambient temperature operation
- Very high efficiency
- Integrated DC breaker
- Near silent operation
- Non-volatile memory
- Compatible with all Sunny Boy and SMA Control products
- Advanced battery management system
- Sealed electronics compartment
- Generator overload protection
- Generator reactive power compensation

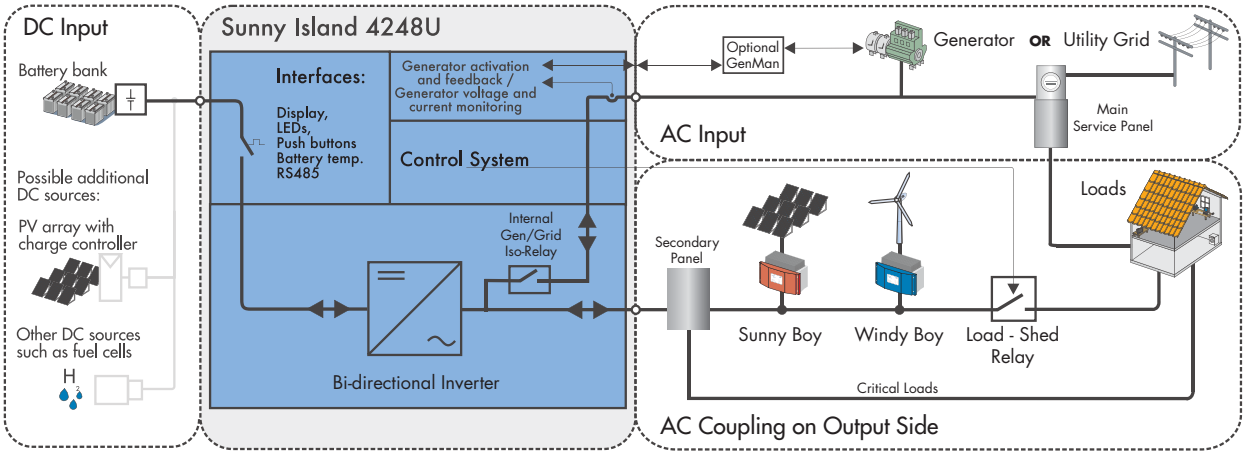


Figure 1-1 Sunny Island 4248U System Block Diagram

Code Compliance

The Sunny Island 4248U has been tested and listed by **ETL** to meet the requirements of **UL 1741 Static Inverters and Charge Controllers for use in Photovoltaic Power Systems**. The Sunny Island 4248U also meets all RFI/EMI requirements of **FCC Part 15, part b**.

Specifications

DC Nominal Voltage	48 V DC
DC Input Voltage Range (With Full Power Output)	43 to 63 V DC
DC Maximum Output Voltage	63 V DC (67 V DC for max. 100 ms)
DC Minimum Output Voltage	41 V DC
AC Nominal Output Voltage	120 V AC
AC Maximum Input Voltage	150 V AC
AC Minimum Input Voltage	80 V AC
THD of Output Voltage	< 3 %
AC Nominal Output Frequency	60 Hz
AC Maximum Input Frequency	66 Hz
AC Minimum Input Frequency	54 Hz
AC Maximum Input Current (Battery Charging)	40 A @ 77 °F (25 °C) 28 A @ 113 °F (45 °C)
DC Maximum Charge Current	100 A
AC Maximum Continuous Output Current	35 A @ 77 °F (25 °C)
AC Maximum Pass-Through Current	56 A
Idle Power Consumption	approx. 22 W
Standby Power Consumption	approx. 4 W
Enclosure	NEMA 1(Indoor Installation) / IP30
Weight	86 lbs. (39 kg)
Dimensions	H 23 x W 15.25 x D 8.75 inches
Operating Temperature	-4 to +113 °F (-20 to +45 °C)
Cooling	Low noise temperature controlled fan

Interfaces	2 LEDs, 2-line LCD, 4 Buttons, Serial Port (optional), Generator Request (N.O. dry contact), Generator Ready (isolated input), Load Shed (N.C. dry contact)
Max. Voltage G_Req / Load_S	see Figure 1-14
Max. Current G_Req / Load_S	see Figure 1-14

Table 1-1: Sunny Island 4248U Specifications

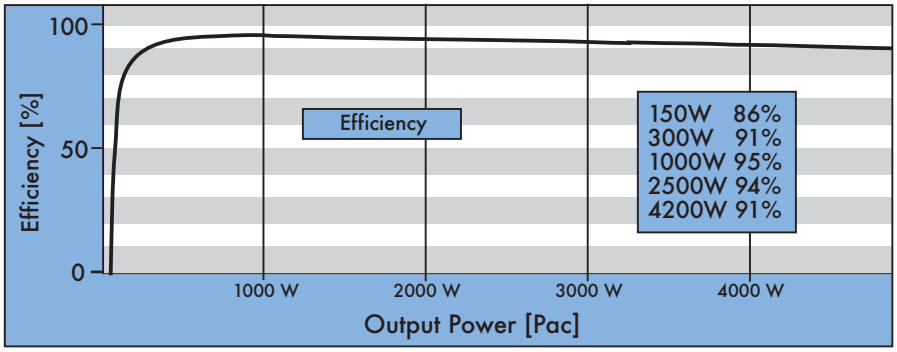


Figure 1-2 Sunny Island 4248U Efficiency Curve

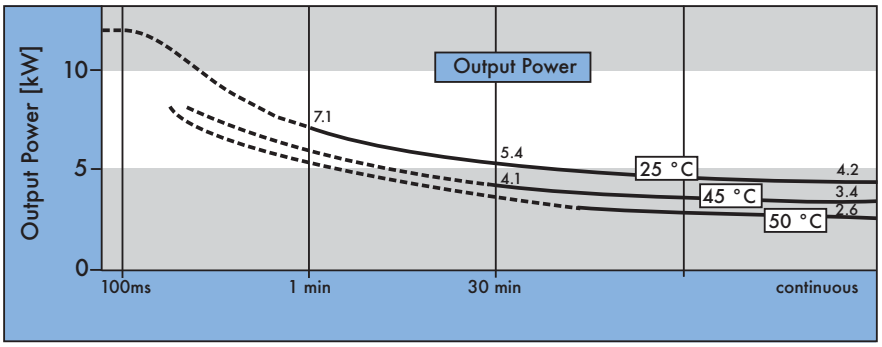


Figure 1-3 Sunny Island 4248U Output Power Curves

Safety

Safety Features

The Sunny Island 4248U is equipped with several safety related components. Some of the safety features included are:

- Built in DC disconnect
- AC input current limiting to protect generator
- Automatic fan control
- Over and under-voltage monitoring of both AC and DC voltages
- Input and output AC frequency monitoring
- Generator relay failure detection
- Over-temperature protection

WARNING: There is an inherent risk of electrical shock or injury to personnel, or potential damage to the components of the system when working on and around electrical equipment. Be sure that you have read and understand the safety instructions in the front section of this manual and any other safety documentation provided with other equipment in your system before beginning installation.

Battery Safety

Special care should be taken when working around batteries. Battery banks have the potential to deliver extremely large amounts of current when shorted. Wires can melt, tools can be welded, fires can start. Even small battery banks deserve your utmost respect.

- Read, understand and follow the battery manufacturer's safety and installation instructions.
- Always wear protective clothing and eye protection when working with the batteries.
- Be sure that the battery enclosure is made from a dielectric, corrosion resistant material and is well ventilated.
- Use the correct cable size for your system. Using cables that are too small will create a fire hazard.
- Ensure that an approved DC disconnect and over-current protection is installed between the batteries and inverter(s), if the inverter is located more than 5 ft. away from the batteries.

RFI/EMI

The Sunny Island 4248U has been tested and complies with the requirements of FCC part 15 rules for Class B digital devices. FCC part 15 was written to provide reasonable protection against harmful interference caused by electronic devices in a residential installation.

The Sunny Island 4248U generates and can radiate radio frequency energy that can cause interference to radio communications if the inverter is not installed according to these instructions. Even so, there is no way to guarantee that radio interference will not be generated in a given installation.

If the inverter is found to be causing harmful radio or television interference, (easily verified by switching the inverter on and off), the situation can usually be corrected by implementing one or more of the following:

- Move the equipment being effected further from the inverter
- Ensure that all conduit runs and the inverter enclosure are grounded
- Move or relocate the receiving antenna
- Connect the equipment to a different receptacle on a different circuit
- Secure the services of an experienced radio/TV technician for assistance

Preparation

Lifting/Moving

The Sunny Island 4248U weighs 86 lbs. (39 kg) Be sure to use proper lifting techniques and secure the help of someone to assist in the installation of the inverter.

Unpacking

Retain the shipping container in case it becomes necessary to ship the inverter.

Before installing the Sunny Island 4248U, carefully unpack it and make sure that all of the following items are included. If anything is missing or if the inverter has been damaged in shipping, contact SMA America immediately. Contact information is located in the front and back of this manual.

- Closely inspect the shipping container and inverter for any damage
- Verify that the mounting bracket, manual and warranty card are all present
- Fill out the warranty card with the model number and serial number of the unit
- Keep all receipts together for future reference

The lid of the Sunny Island 4248U is not mounted when you receive the device. The lid is packed in a bag to prevent damages during shipping. You have to unpack the lid and fasten it to the enclosure of the Sunny Island 4248U after the installation.

Bottom Mounting Tab

The tab on the bottom of the inverter is installed upside down to prevent damage during transport. This tab needs to be removed and remounted so that the flange points downward and is flush with the back of the inverter. See illustration below.

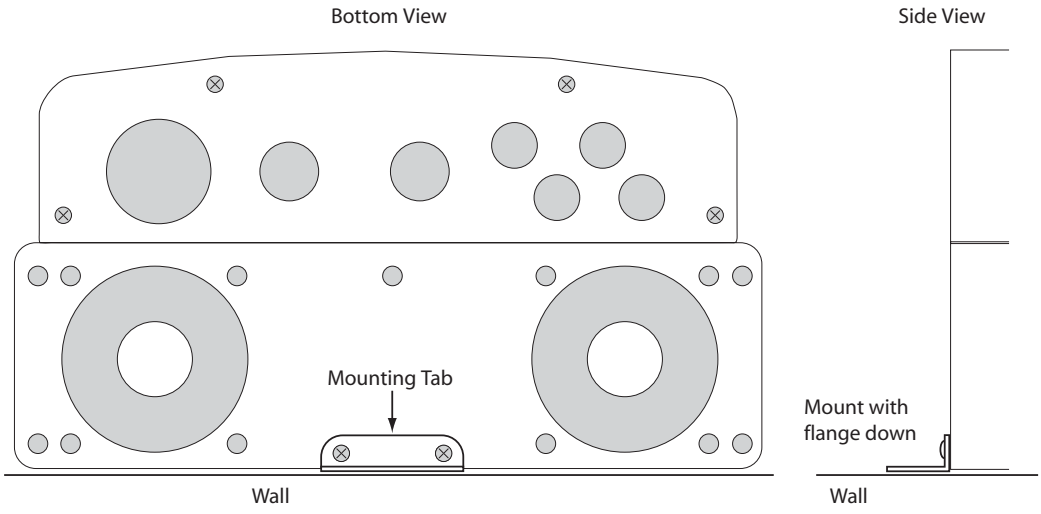
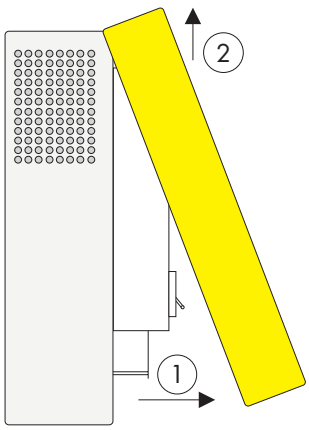


Figure 1-4 Mounting Tab Orientation

Removing the Cover

WARNING: Care should be taken when removing the front cover. See illustration below.



It is important when removing the cover to make sure that you swing the bottom of the cover out far enough to clear the DC breaker on the front of the inverter (step 1) before lifting the cover off (step 2). Failure to do so can result in the DC breaker being accidentally switched on.

Figure 1-5Proper Cover Removal

The cover of the Sunny Island 4248U is not mounted at the factory. Mount the cover once installation is complete. To mount the cover, install the four screws in the bottom of the inverter as shown below.

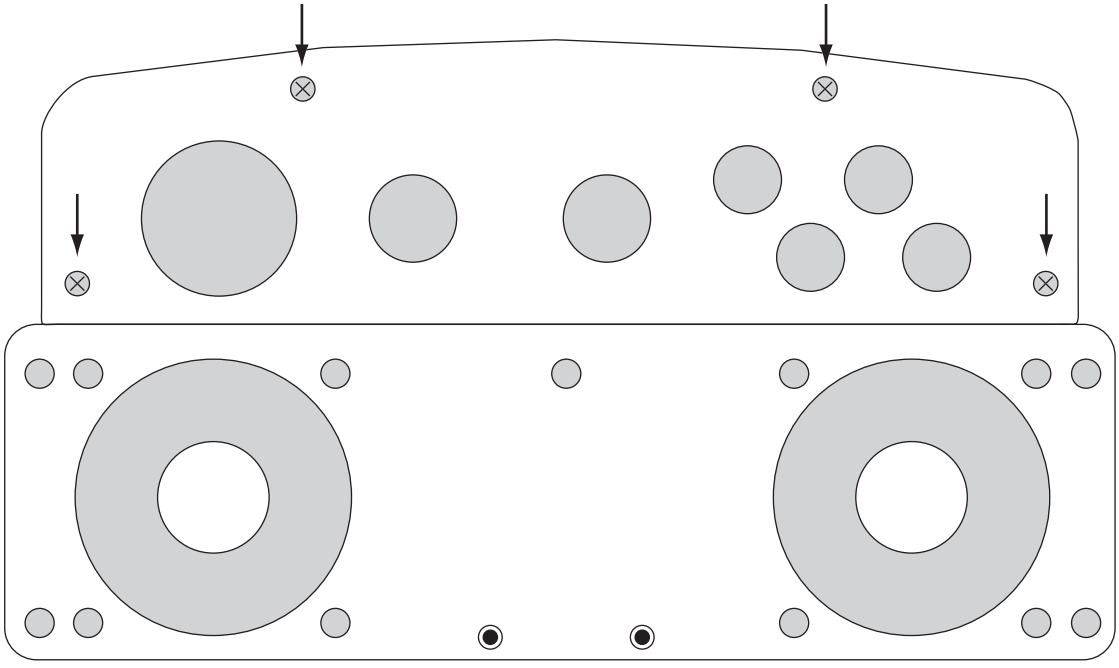


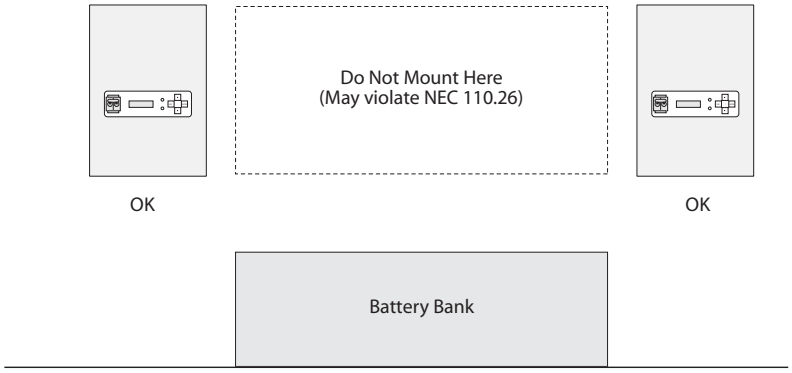
Figure 1-6 Bottom View with Location of Cover Mounting Screws

Mounting Location

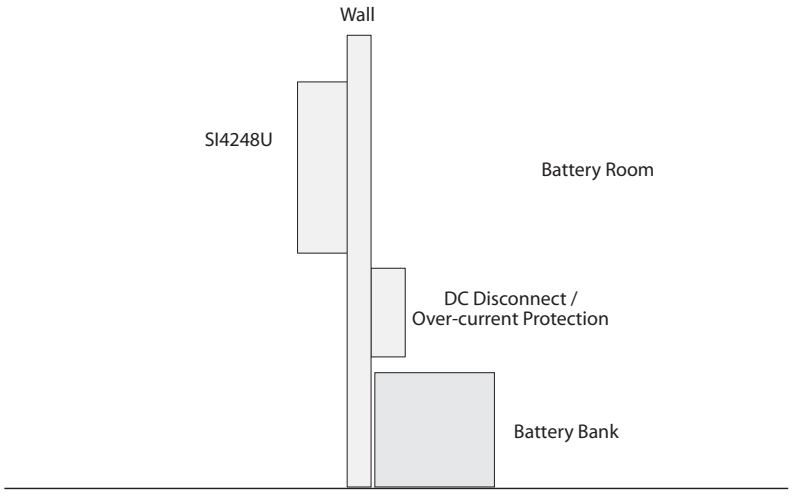
The Sunny Island 4248U must be mounted **indoors** in an area where it is easily accessible and out of the elements. It is important that the Sunny Island 4248U **not** be mounted directly over the battery bank for corrosion and safety reasons. Mount the inverter off to one side of the battery bank or perhaps on the other side of the same wall if convenient. The following diagram shows possible mounting locations.

WARNING: NEC Article 110.26 clearance requirements may be violated if the inverter is mounted directly over the battery enclosure.

WARNING: If the inverter is mounted in a separate room from the batteries, there must be an additional DC disconnect mounted inside the room containing the batteries. Over-current protection (at the battery location) for the cable between the batteries and the inverter is also required when the batteries are in a separate room from the inverter or more than about 5 feet away.



Mounting in same room with the battery bank.



Mounting on opposite side of the wall from the battery bank.

Figure 1-7 Mounting Locations

Mounting Method

The Sunny Island 4248U was designed to be wall-mounted in a vertical position. Drywall, or "wallboard", is not strong enough to support the weight of the Sunny Island 4248U by itself. Do not attempt to install the inverter on wallboard without additional support. The inverter can be mounted on a single wall stud provided that three 1/4 inch lag bolts with washers are used and provided that the lag screws are long enough to penetrate the stud to a depth of 1 1/2 inches. For additional support, the Sunny Island 4248U may be mounted to 2 x 4 braces, Uni-Strut or a sheet of plywood that is secured to the building support structure.

Clearances

Air is drawn into the bottom of the inverter and exits through the sides near the top of the enclosure. To maintain proper air flow, a distance of 6 inches must be maintained on the sides of the inverter and a distance of 4 inches should be maintained on top of the inverter. All wire terminations will be made through the bottom of the enclosure, therefore a minimum of 3 feet of clearance should be maintained below the inverter. For best viewing of the LCD display, mount the inverter so that the display will be near eye-level. (To help accomplish this, position the mounting bracket so that the top edge is approximately 8" above eye-level.)

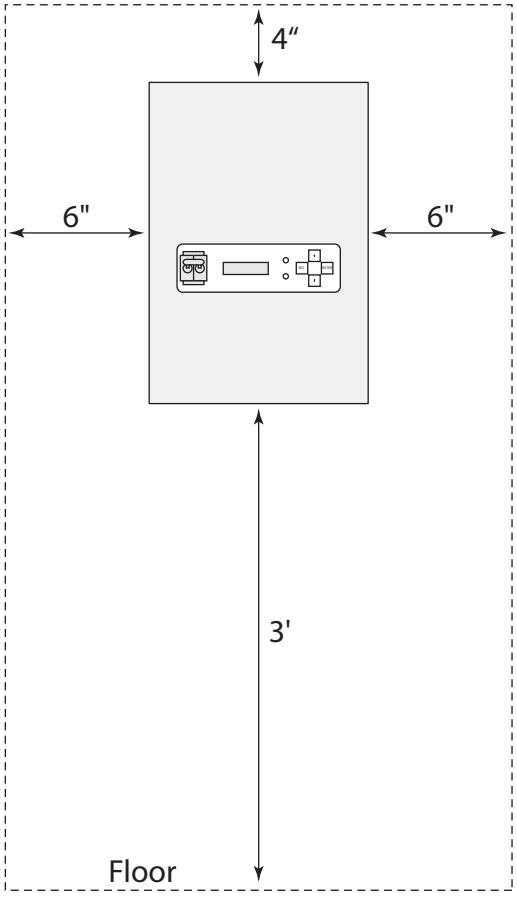
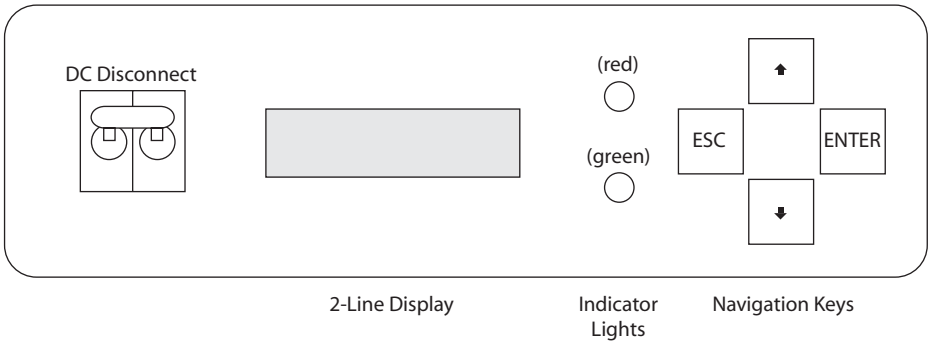


Figure 1-8 Recommended Clearances for the Sunny Island 4248U

User Interface Overview

The following illustration shows the names and locations of the components that make up the Sunny Island 4248U's user interface.



Installation

WARNING: The Sunny Island 4248U is extremely heavy and it is recommended that the installer obtain assistance from another person when mounting the inverter.

Special Tools

It is helpful to have a laptop on hand with the Sunny Data software installed, a communication cable and an RS232 Piggy-Back module for communication with the Sunny Island 4248U (but is not required to complete installation).

Hardware

The type of hardware required to mount the inverter will vary depending upon the mounting method used. See the Mounting Method section for details on recommended mounting options for the inverter.

The Mounting Bracket

The mounting bracket provided has an assortment of holes and slots punched in it for various mounting needs. Horizontally, there are 5 slots to be used for mounting to wall studs when the stud spacing is appropriate. There are also several holes along the vertical portion of the bracket for use in single stud mounting and in conjunction with the other holes when needed.

Mounting

Single Stud Mounting

The Sunny Island 4248U can be mounted to a single wall stud if necessary. It must be mounted with the holes centered on the stud and the lag bolts must penetrate the stud to a depth of at least 1 1/2″.

- Locate the **center** of the wall stud and mark its location on the wall
- Locate desired height of inverter remembering to keep the user interface near eye level
- Place the mounting bracket in position and using the bracket as a template, making sure the bracket is level, mark the mounting holes for the bracket on the wall
- Drill 3/16″ pilot holes in the wall and stud to a depth of 1 1/2″
- Mount the bracket to the wall using at least three 1/4″ lag bolts with washers that are long enough to penetrate the stud to a depth of 1 1/2″
- Verify that the threaded screw at the bottom of the bracket is removed
- With assistance, lift the inverter onto the mounting bracket and secure it by fastening the threaded screw through the tab on the bottom edge of the inverter
- Verify that the inverter is securely mounted in place before proceeding

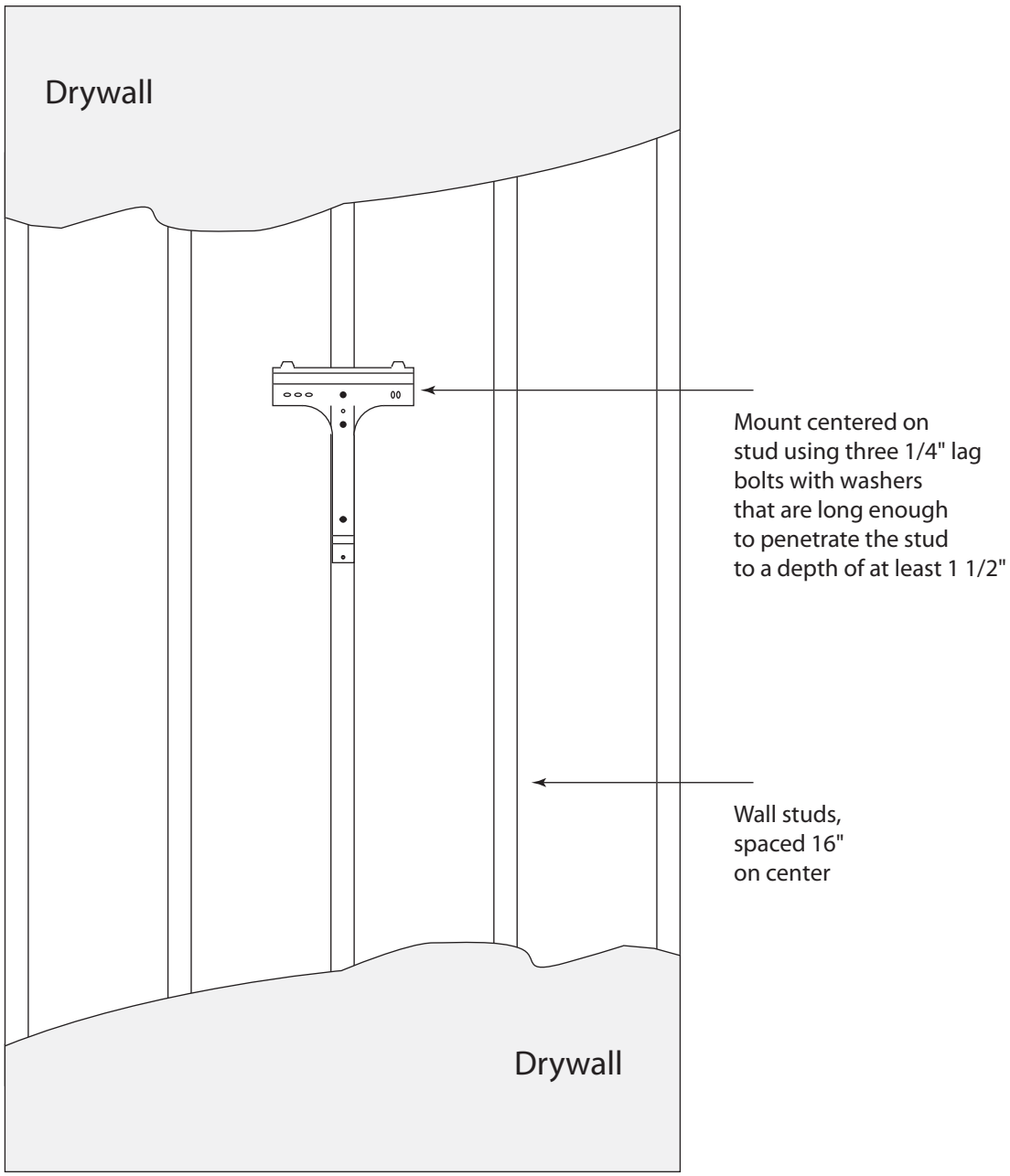


Figure 1-9 Mounting Bracket to Single Stud

Using Wall Braces

For additional security, the Sunny Island 4248U may be mounted by attaching a pair of wall braces horizontally. It is recommended that the wall braces span three studs for secure mounting.

- Locate the wall studs and mark their location on the wall
- Locate desired height of inverter remembering to keep the user interface near eye level
- Use a level to draw the horizontal lines across three studs
- Place a pre-cut wall braces on the location marked and drill pilot holes through the wall braces and the studs
- Mount the wall braces to the wall using 16D nails or 3 1/2″ lag bolts
- Repeat the process for the other wall brace
- Place the mounting bracket in position and using the bracket as a template, mark the mounting holes for the bracket on the wall braces
- Drill pilot holes in the wall braces
- Mount bracket to the wall braces using at least three 1/4 x 3 inch lag bolts with washers
- Verify that the threaded screw at the bottom of the bracket is removed
- With assistance, lift the inverter onto the mounting bracket and secure it by fastening the threaded screw through the tab on the bottom edge of the inverter
- Verify that the inverter is securely mounted in place before proceeding

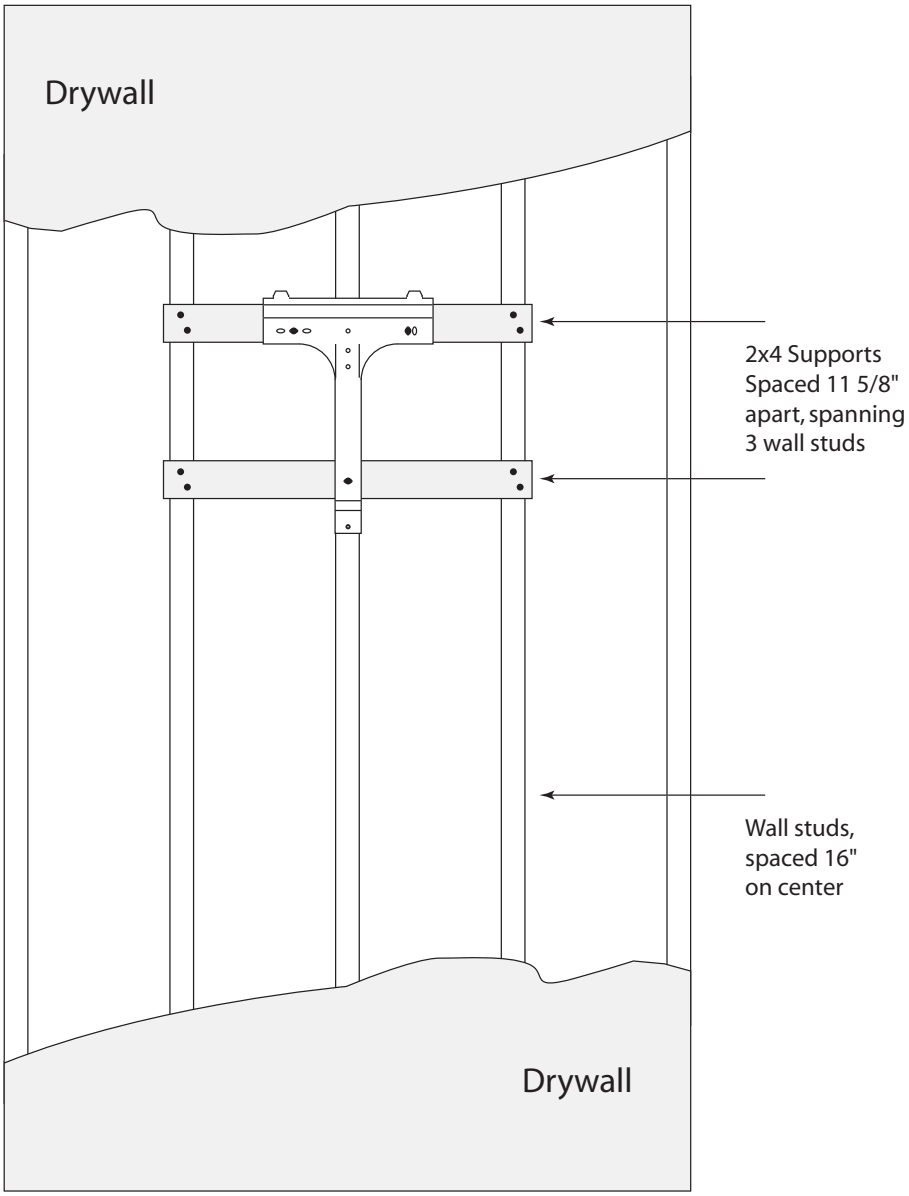


Figure 1-10 Mounting With 2x4 Braces

Mounting with Plywood

NOTE: To mount the inverter with plywood, a sheet of 3/4″ plywood should be used. (Do **not** use laminated pressboard or MDF, etc.)

- Locate the wall studs and mark their location on the wall
- Locate desired height of inverter remembering to keep the user interface near eye level
- Use a level to draw the horizontal lines across three studs
- Place the sheet of plywood on the location marked, making sure the long edge of the sheet is horizontal, and drill pilot holes through the plywood and the studs
- Mount the sheet of plywood to the wall using #10 wood screws that penetrate a minimum of 1 1/2″ into the wall studs
- Place the mounting bracket in position and using the bracket as a template, making sure the bracket is level, mark the mounting holes for the bracket on the plywood
- Drill pilot holes in the plywood
- Mount the bracket to the plywood using at least three 1/4 x 1 1/2 inch lag bolts with washers
- Verify that the threaded screw at the bottom of the bracket is removed
- With assistance, lift the inverter onto the mounting bracket and secure it by fastening the threaded screw through the tab on the bottom edge of the inverter
- Verify that the inverter is securely mounted in place before proceeding

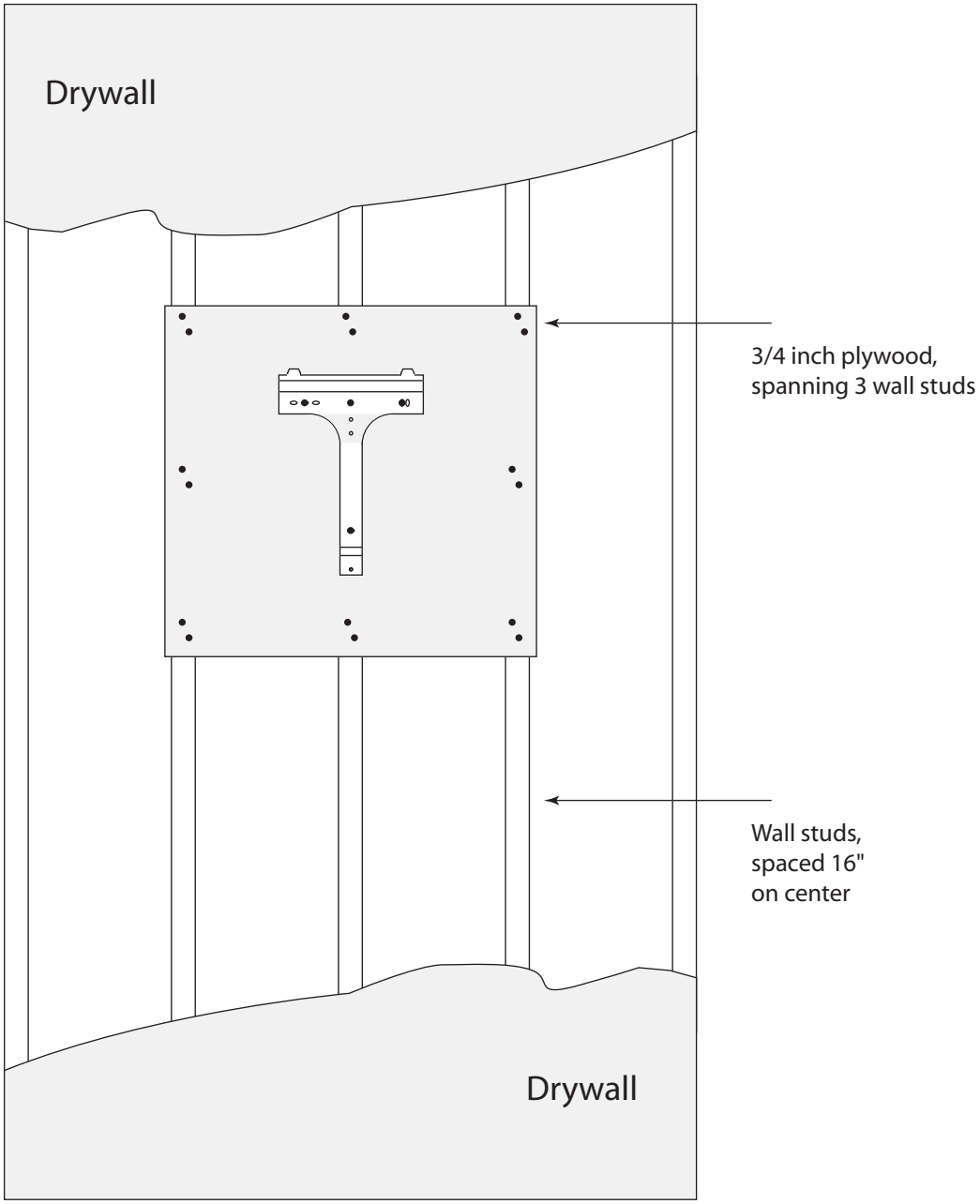


Figure 1-11 Mounting With Sheet of Plywood

System Configuration

The system installer and the user or owner of the system should discuss the various configurations that are possible with the Sunny Island 4248U and decide which options will be installed and connected. The system configuration will significantly affect how the inverter is connected and set up to work harmoniously with the other components in the system.

Off-Grid / Stand Alone Systems

By definition, off-grid or stand alone systems are systems where electrical power is generated and stored without assistance from the utility grid. These systems typically consist of one or more power generation sources such as a PV array, a wind generator, a hydro-electric generator or a gas powered generator.

Typically, there is a need to store the power that is generated. Without a storage method, power would only be available when one or more of the generating devices were active (i.e. when the sun was shining for a PV array, or when the wind was blowing for a wind generator). Batteries are the most common device used for power storage. The size and type of batteries used depends greatly on the system power requirements.

Because many of the loads that will be powered by the system require AC power as opposed to DC power, an inverter is needed to change the DC voltage to an AC voltage that can be used by the AC loads. This is exactly what the Sunny Island 4248U was designed to do.

The Sunny Island 4248U can also function as a battery charger for charging the battery bank. This mode operates by connecting an AC power source to the inverter's AC power input. The AC power source could be a gas powered generator or even the utility grid, if available at the system's location. The power generated by the external source can be used to power AC loads via the Sunny Island 4248U while the batteries are being charged at the same time. The Sunny Island 4248U watches the battery voltage and only applies the amount of power necessary to bring the batteries up to a full state of charge after all power required by the loads is supplied.

Frequency Shift Power Control (FSPC) for Off-Grid Applications Only

When the Sunny Island 4248U is coupled to Sunny Boy inverters on the AC output, it requires a method in which to control the power output of the Sunny Boys. To do this, it employs a type of control referred to as Frequency Shift Power Control (FSPC). Using the FSPC feature, the Sunny Island 4248U is able to increase the frequency of its AC output. This increase in frequency causes the Sunny Boys to decrease their power output.

Although the Sunny Island 4248U increases its output frequency during these periods, it keeps track of how much frequency shifting has taken place. Shortly afterwards, the inverter will automatically compensate for the frequency shifting and bring any appliances such as electric clocks back to normal. In this way, users don't have to worry about any inaccuracies in their electronic equipment.

The activation of the FSPC feature is controlled by the "SunnyBoys" parameter in the Sunny Island 4248U. When this parameter is set to "Yes", the FSPC feature is enabled.

When the FSPC feature is enabled and the generator in the system is operating, the generator becomes the frequency reference and the Sunny Boys will respond to any shifts in frequency by the output of the generator. Typically, generators run at 60Hz when loaded and therefore, in most cases, the Sunny Boys will be allowed to run at full power when the generator is operating.

NOTE: Some Sunny Boy models may require a firmware upgrade to be compatible with the FSPC. Please contact SMA-America for details.

Back-Up Systems

A back-up system is configured differently from an off-grid system. The purpose of a back-up system is to supply power when the primary source of electrical power, such as the utility grid, fails for some reason. When used as a back-up system, the Sunny Island 4248U is designed to begin providing AC power automatically whenever the primary source of AC power shuts down.

In a back-up configuration, the Sunny Island 4248U still requires a source for its power. This is accomplished through the use of a large battery bank. Again, the size and type of batteries used will be determined by the intended operation of the system.

When using the Sunny Island 4248U in a back-up system configuration, the utility grid needs to be connected to the grid isolation relay in the inverter via the AC input terminals. Please refer to the AC wiring section of this manual.

CAUTION: Any AC power sources coupled to the AC output side of the inverter must meet UL 1741 requirements. In addition, the GridConnected parameter in Generator Settings must be set to GridFeed-PV (if this parameter is set to GridCharge when AC sources are coupled to the AC Output side, the inverter will generate an error). Make sure, the maximum power of installed feeders is not higher than the max. allowed power for the generator relay (56 A per phase)!

CAUTION: The Sunny Island 4248U is not a grid interactive inverter and therefore does not provide any active anti-islanding features. It will however, allow power generated by grid interactive inverters such as the Sunny Boy, to be passed through it to the grid via its grid-isolation relay. The Sunny Island 4248U will not supply power to the grid from its batteries and therefore can not create and island on the utility grid.

During times of normal operation where the primary source of AC power is active, the Sunny Island 4248U maintains the charge of the battery bank so that they are ready in the event of an outage. The Sunny Island 4248U applies a sophisticated charging algorithm to ensure that full charge capacity is maintained and that the life of the battery bank is maximized.

Once the batteries are fully charged, the Sunny Island 4248U will automatically enter “Silent Mode”. Silent Mode is a standby mode during which most of the electronics in the inverter are turned off to reduce power loss during periods of inactivity. The metering functions of the

inverter are still active so the inverter will “wake up” and charge the batteries if needed. It will also respond immediately to a grid failure. When the inverter is in Silent Mode, it is indicated on the display by “Silent”.

The Sunny Island 4248U also has the ability to connect external sources of power, such as a gas powered generator to assist in powering the loads and charging the battery bank during extended outages. Using a generator with the utility present requires special wiring considerations and should only be designed and installed by qualified personnel.

Control of Sunny Boy Inverters in a Grid-Tied Configuration

In grid-tied applications frequency shifting alone cannot be used because it would require that the Sunny Boy inverters allow changes in frequency to occur which exceed UL safety limits for grid-tied inverters. Therefore, in grid-tied applications, primary control of the Sunny Boys is accomplished through the use of the RS-485 communication line. The Sunny Island sends commands via the RS-485 bus to the Sunny Boys that limits the output of the Sunny Boys when required to prevent overcharging the batteries.

Setting the GridConnected parameter in the Sunny Island to GridFeedPV automatically activates the communication bus.

NOTE: To further protect against system shut-down due to over voltage, the Sunny Boy parameter in the Sunny Island should still be set to YES so that in the event that the battery voltage increases more rapidly than the RS-485 bus can communicate, the frequency shift will activate and prevent the Sunny Island from shutting down due to over-voltage.

Options Overview

The Sunny Island 4248U allows you to connect a variety of options to it for remote metering, load control and controlling optional equipment such as a generator.

The Sunny Island 4248U supports all of the SMA Control series of metering and data acquisition devices through the use of the optional “Communication Piggy-Back” unit. This enables the inverter to communicate in either the RS-232 or RS-485 formats.

A variety of communication options are available to connect multiple Sunny Island 4248U's together, or combine other SMA products on the same communication bus.

For customers desiring remote access to the Sunny Island 4248U, various modems and Ethernet options are also available. Local access to the Sunny Island 4248U is a simple wire connection between a PC and the Sunny Island 4248U (The Sunny Data application and a MS Windows PC are necessary to communicate with the Sunny Island 4248U from local or remote locations. Sunny Data is available free-of-charge on the SMA America web site: www.sma-america.com).

The Sunny Island 4248U also supports the automatic operation of 2-wire start generators as a standard feature. The optional GenMan unit enables the inverter to operate multiple-wire-start generators. The GenMan option is available from your local distributor/dealer. Manual-start type generators may also be used.

The terminal blocks are grouped according to function. This helps keep the wires for the different options together and makes for a more organized wiring compartment.

Conductor Types and Sizes

Generator AC Input

The inverter can accept and pass through up to 56 Amps from an external generator. Per the NEC, a factor of 1.25 must be applied when sizing conductors and overcurrent devices. Therefor, a value of 70 Amps must be used when sizing conductors and devices. Circuit conductors from the generator, operating at 56 Amps, should be sized at 6 AWG and the circuit should be protected with a 70 Amp overcurrent device (circuit breaker or fused disconnect). The inverter will accept 4 AWG conductors. All wire should be rated at 75° C minimum. For further information, see NEC Table 310-16.

Typical conductors for this application would be THHN or THWN-2 installed in conduit. Long distances between the generator and the inverter may require larger conductors to compensate for excessive voltage drops.

With a 70 Amp overcurrent device in the generator-to-inverter circuit, an 8 AWG equipment grounding conductor will be needed in this circuit. (See NEC Table 250.122.) The conductor can be bare or have green insulation or green markings.

If the circuit conductors are oversized to compensate for voltage drop, the equipment-grounding conductor must also be oversized. (See NEC 250.122(B)).

AC Output Circuit

NOTE: All electrical installation must be done in accordance with the local and National Electrical Code ANSI/NFPA 70. **The maximum continuous AC current of the Sunny Island 4248U is 35 A AC.**

The rated inverter output is 4200 W at 120 V AC. The continuous AC output current is 35 A. For sizing conductors, the NEC requires that this current be increased by a factor of 1.25 yielding a current of 43.75 amps. The output conductors should be sized to carry at least 50 amps and protected by a 50 amp overcurrent device. Therefore, the minimum conductor size required by the NEC is 8 AWG at 70 °C, even if the inverter is not used at full power.

However, if the inverter is going to be connected to a generator capable of delivering 56 A to the inverter, then the inverter output conductors must be sized at 6 AWG and protected with a 70 A overcurrent device. See above and NEC Table 310.16.

Typical conductors for this application would be THHN or THWN-2 installed in conduit.

If the inverter and any connected generator are to operate at an output current of 35 A or less and be protected by a 50 A overcurrent device, the equipment-grounding conductor for the AC output can be 10 AWG bare, green-insulated or have green markings.

However, if the full 56 A pass-through current is to be used, the equipment-grounding conductor must be increased to 8 AWG (see NEC 250.122.).

If the circuit conductors are oversized to compensate for voltage drop, the equipment-grounding conductor must also be oversized (see NEC 250.122(B)).

If the full 56 A pass-through rating of the Sunny Island 4248U is to be used, then 6 AWG conductors and 70 A circuit breakers must be used in the AC input and output circuits (The commonly used 60 A inverter disconnect switch cannot be used in this application).

DC Input Circuit (Battery to Inverter)

WARNING: The Sunny Island 4248U is designed to operate at a nominal voltage of 48 V DC. Verify with a volt meter that the battery bank is wired correctly for 48 V DC prior to connecting the inverter.

NOTE: All electrical installation must be done in accordance with the local and National Electrical Code ANSI/NFPA 70. **The maximum continuous DC current of the Sunny Island 4248U is 100 A DC.**

NOTE: The recommended length for the DC battery cables is <10 ft and should not exceed 20 feet.

The Sunny Island 4248U comes equipped with a 175 A DC circuit breaker which allows for improved transient surge capability. The battery conductors must be sized in accordance with this circuit breaker and should be sized at 2/0 AWG (which has a rating of 175 A at 30 °C).

Paralleled smaller cables having a total ampacity of 175 A can also be used. For example, two 1/0 AWG THHN conductors connected in parallel would have a total ampacity of 240 A at 30 °C and four 1/0 AWG conductors will fit in1-1/2" trade size conduit (TSC). (Do not use USE, XHHW or RHW insulated cables as they will exceed conduit fill ratings.)

For higher ambient operating temperatures, larger conductors may be required. The Sunny Island 4248U will accept two 2/0 AWG conductors for both positive and negative DC inputs. Refer to the NEC for more information.

If the batteries are located more than about 5 feet from the inverter or in another room, an additional 175 A overcurrent device and disconnect should be located near the batteries.

Typical conductors for this application would be THHN or THWN-2 installed in conduit.

If the batteries are mounted on conductive racks or in metallic enclosures and/or there is a metal enclosure for the battery disconnect/overcurrent device, then an equipment-grounding conductor must be installed. For a 175 A overcurrent device, the equipment-grounding conductor will be a 6 AWG bare, green-insulated or green marked copper conductor (see NEC 250.122).

If the circuit conductors are oversized to compensate for voltage drop, the equipment-grounding conductor must also be oversized (see NEC 250.122(B)).

System Grounding

NOTE: Grounding practices must be performed in accordance with the NEC. Consult the NEC and local ordinances with regard to the system grounding requirements for your specific installation.

The AC output of the typical stand-alone inverter system is grounded at the AC panel board (load center) serving as the AC distribution system for the output of the inverter. See Figure 1-12. In this panel board, the AC neutral is bonded to the AC equipment-grounding conductors and to the AC grounding electrode conductor (GEC). From this bonding point, the AC GEC is run to the AC grounding electrode or grounding system (see NEC 250.).

The DC part of the system must also be bonded to ground. The Sunny Island 4248U is designed to work with a **negatively** grounded DC electrical system.

The inverter does not make the negative conductor-to-ground bond and this connection must be made external to the inverter. From the external DC bonding point, a DC GEC must be run to 1) a DC grounding system that is bonded to the AC grounding system or 2) directly to the AC grounding system. (See NEC 250.)

If a PV array is mounted on the roof of a dwelling, NEC 690.5 requires that a ground-fault protection device be installed which will modify the DC system grounding instructions presented above. Follow the manufacturer's instructions when installing this device.

The size of the GEC will be between 8 AWG and 4 AWG depending on the type of grounding electrode used (see NEC 250.166.).

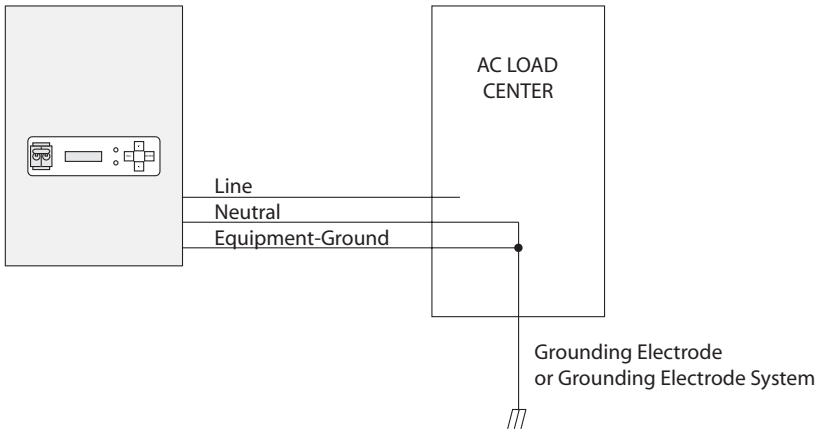


Figure 1-12 AC System and Equipment Grounding

Auxiliary Wiring

This section contains information on the auxiliary wiring terminal blocks and their functionality. More detailed information regarding the setup of the different parameters for these functions can be found in following sections.

Automatic Load Shedding

The Sunny Island 4248U is capable of shutting off specified loads automatically if a low battery condition is present. The relay that controls those loads is connected to the NC contact terminals. When the battery voltage reaches a low set point, the inverter will open the load shed relay contacts. This relay can be connected directly to loads or to other relays to shut off no critical loads during a low battery condition.

Generator Control

The Sunny Island 4248U has the ability to control back-up generators automatically. The Sunny Island 4248U can operate two-wire gen-start circuits with the G-REQ relay alone. When the generator is needed, this contact is closed. Two-wire start generators will start at this time and the inverter will use its' power to charge the batteries and power loads. When the generator is no longer required, the relay contacts are opened and the generator will stop.

NOTE: This two-wire system is not directly compatible with any three-wire starting systems such as those used by Honda and Onan. Damage to the generator and/or the Sunny Island 4248U may result if a three-wire start system connection is made. The operation of other types of generators with three-wire start systems is accomplished through the use of the optional GenMan generator management device. The GenMan unit, if required, would also connect to the G-REQ terminals. The GenMan is available from SMA America or your local supplier.

Terminal	Function
LOAD_S	Load Relay: N.C.
G_REQ	Generator Start Relay: N.O.
LOAD_S	Load Relay: Common
G_REQ	Generator Start Relay: Common

Table 1-2: Load Shed and Generator Relay Connections

The maximum current that can be switched by either the load shed or generator request relay differs a great deal depending on voltage and wether it's AC or DC. The detailed load limit curve is shown in the following graph.

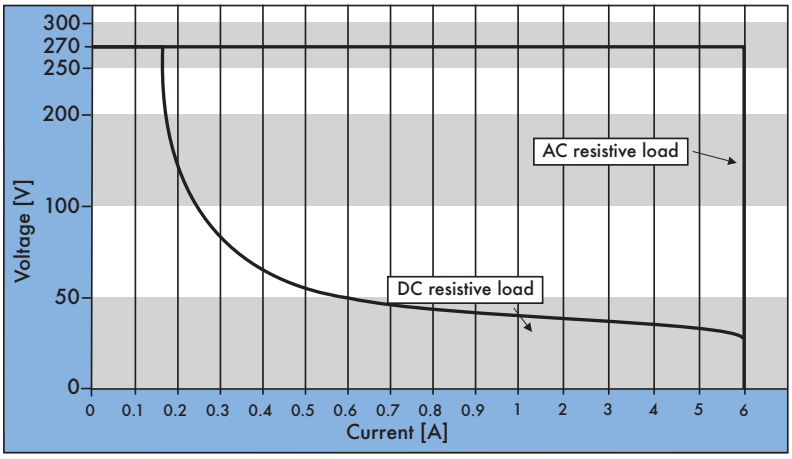


Figure 1-13 Load Limit Curve for Load Shed and Generator Request Relays

Generator Run Confirmation

The Sunny Island 4248U has the ability to operate multi-wire start generators automatically when used with the GenMan option (GenMan is an optional unit available from SMA America). When the generator has been started, the GenMan will confirm operation by sending a signal to these terminals. In this way, the Sunny Island 4248U can determine wether the generator is functioning properly or not.

Terminal	Function
SHIELD	Shield
G_RUN -	From Generator Ready negative output on optional GenMan unit
SHIELD	Shield
G_RUN +	From Generator Ready positive output on optional GenMan unit

Table 1-3: Generator Run Confirmation

Synchronization

These terminals were designed for use as inverter synchronization ports for future communication capabilities and are **not used at this time**. Make no terminations here.

Terminal	Function
S_IN -	Synchronization IN, Negative
S_OUT -	Synchronization OUT, Negative
S_IN +	Synchronization IN, Positive
S_OUT +	Synchronization OUT, Positive

Table 1-4: Synchronization

Internal Fans and Battery Temperature Compensation

NOTE: The battery temperature sensor must be connected for the inverter to function properly. If it is not connected, the inverter generates an error that can not be cleared until the battery temperature sensor is connected.

The Sunny Island 4248U is equipped with fans to help maintain efficiency during high loads or high ambient temperatures. Power for the fans is provided here. Also, the external battery temperature sensor is connected here to monitor the battery temperature and make adjustments to the charge level accordingly.

Terminal	Function
FAN +	Positive power lead of the fans
TBAT 2	Battery temperature sensor lead #2
FAN -	Negative power lead of the fans
TBAT 1	Battery temperature sensor lead #1

Table 1-5: Auxiliary Fans and Battery Temperature Sensor

Serial Port

The Serial Port is used to communicate with external metering devices such as the Sunny Boy Control. Use of this port requires that the optional communications Piggy-Back unit be installed. This port can be configured for RS485 or RS232 formats.

Terminal	RS485	RS232
2	A +	RXD
3	not used	TXD
5	GND	GND
7	B -	not used

Table 1-6: Serial Port

Controller Area Network (CAN)

The CAN connections are used when two Sunny Island 4248U's are used in split-phase configuration. Please see the split-phase section of this manual for further details.

Terminal	Function
SHIELD	Communication cable shield
CAN_H	CAN Bus High
C_GND	CAN Bus Common
CAN_L	CAN Bus Low

Table 1-7: Controller Area Network (CAN)

Wiring Instructions

Conduit

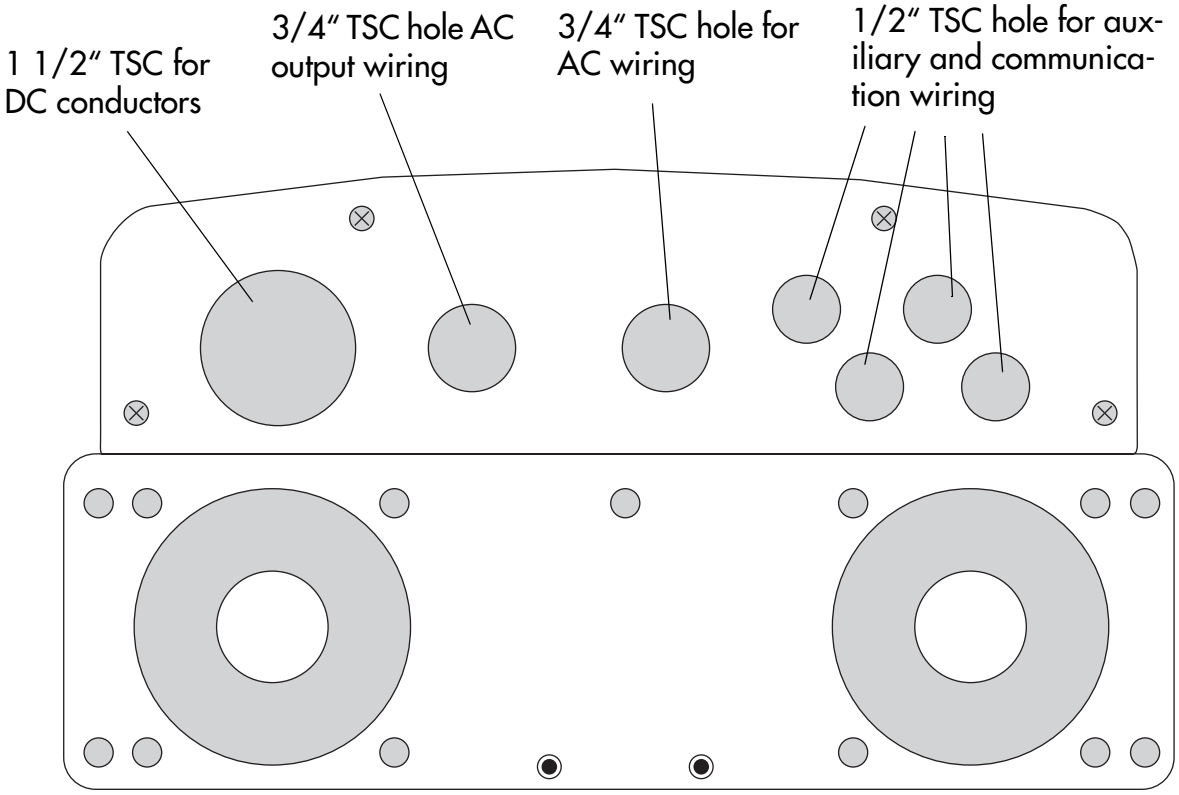
Begin by installing conduits in the appropriate holes in the bottom of the inverter.

NOTE: All conduit used should be metallic (EMT).

NOTE: All DC conduit from the inverter to the battery should be metallic to meet US FCC and European EN electromagnetic radiation requirements. See RFI/EMI statement on page 5.

WARNING: Any unused holes must be filled by an appropriate hole plug to meet NEC and listing requirements before the inverter is turned on.

There is one 1 1/2″ trade size conduit (TSC) hole for the DC conductors from the battery, one 3/4″ TSC hole for the AC output wiring and one 3/4″ TSC hole for the AC wiring from the generator. Four 1/2″ TSC holes are provided for auxiliary and communication wiring. They are to be used as needed depending on the options installed. All unused holes must be plugged with an approved device.



Torque Specifications

Torque all terminations to the following values.

Terminal	Torque Value
DC Positive DC Negative Equipment Ground	35 - 50 ft. lbs.
AC Power In/Out	18 - 35 in. lbs.
Auxiliary/Communication	4 in. lbs.

Table 1-8: Torque Specifications

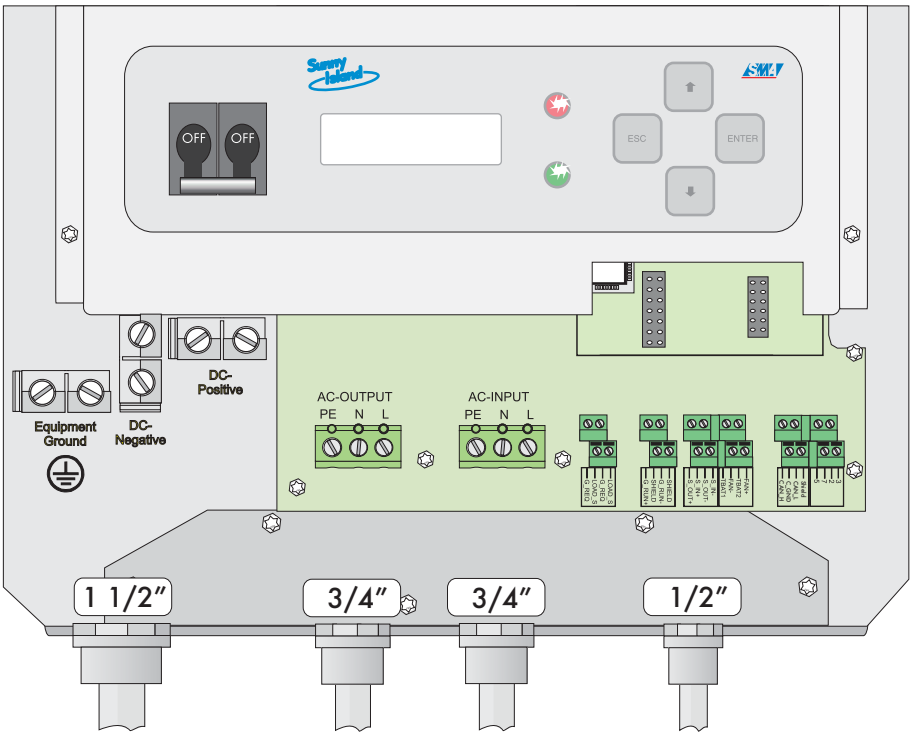


Figure 1-14 Conduit Installation

Once the conduits are in place, pull the appropriate wires into the correct conduit runs, being sure to allow enough extra wire at the ends for termination.

Equipment Ground

The equipment-grounding conductors (AC and DC) terminate at the terminals marked equipment ground. If there are more than two equipment-grounding conductors, the additional conductor should be spliced together with an appropriate splicing device before connecting only a single conductor to each terminal.

DC Grounding

The National Electrical Code requires that the DC side of this 48 V system be grounded.

The equipment grounding conductor between the inverter and the equipment where the DC bonding jumper (the single connection between the DC negative and the grounding system) is located should be at least 6 AWG to carry all possible fault currents from the battery. The bonding jumper might be located in a battery disconnect enclosure, a PV disconnect enclosure, or in a ground-fault protection device enclosure.

PV systems (with modules on the roof of a dwelling) that charge the batteries directly (not via a Sunny Boy inverter) will usually have an external NEC 690.5 Ground-Fault Protection Device (GFPD). In this case, the DC grounding-electrode conductor must be connected to the GFPD following the directions for that device.

WARNING: The Sunny Island 4248U does not make any connection between the DC positive or negative circuits and ground. The required connection must be made by the installer. The Sunny Island 4248U is designed to operate in negative-grounded systems.

Auxiliary Wiring

Connect any auxiliary wires to the appropriate terminal blocks following the instructions that accompanied the particular option(s) that you will install. Note that the auxiliary terminal blocks are offset and arranged in layers. Some of the connections will terminate to both layers.

Battery Temperature Sensor

Install the battery temperature sensor (BTS) in the battery compartment where it makes contact with the case of a battery near the center of the battery bank.

The battery temperature sensor must be connected for the inverter to function properly.

- Use only the BTS that came with the Sunny Island 4248U
- Do not lengthen the BTS cable
- Do not drill holes in any part of the batteries to mount the sensor unless instructed to do so by the battery manufacturer
- Although the BTS terminals are numbered and the wires are color coded, there is no polarity to the BTS so it may be wired in any configuration

If the inverter is powered up without the battery temperature sensor connected, the display will show a "CBT Open" error and will not let the user proceed with normal operation. To clear this, switch off the inverter and connect the battery temperature sensor cable to the appropiate terminals.

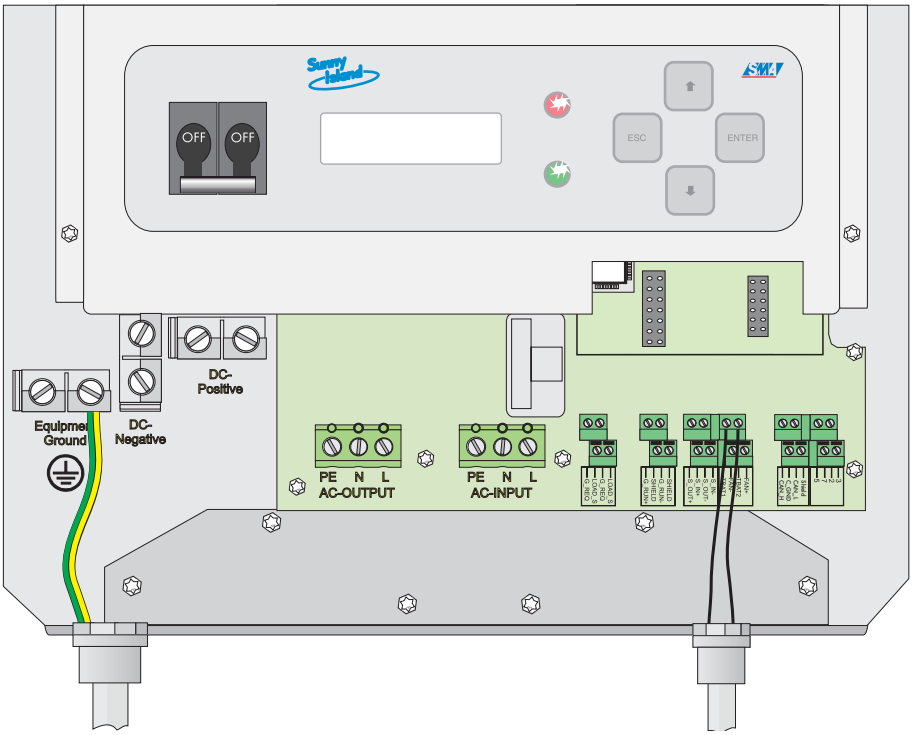


Figure 1-15 Equipment Ground and Auxiliary Wiring

NOTE: In split-phase mode with two Sunny Island 4248U's connected together, the slave unit **must** have the battery temperature sensor connected to set the inverter to "slave" mode. Once the inverter is set to "slave" mode, it does not require the battery temperature sensor and can be removed. The slave unit sensor may be installed temporarily; it does not need to be run through conduit.

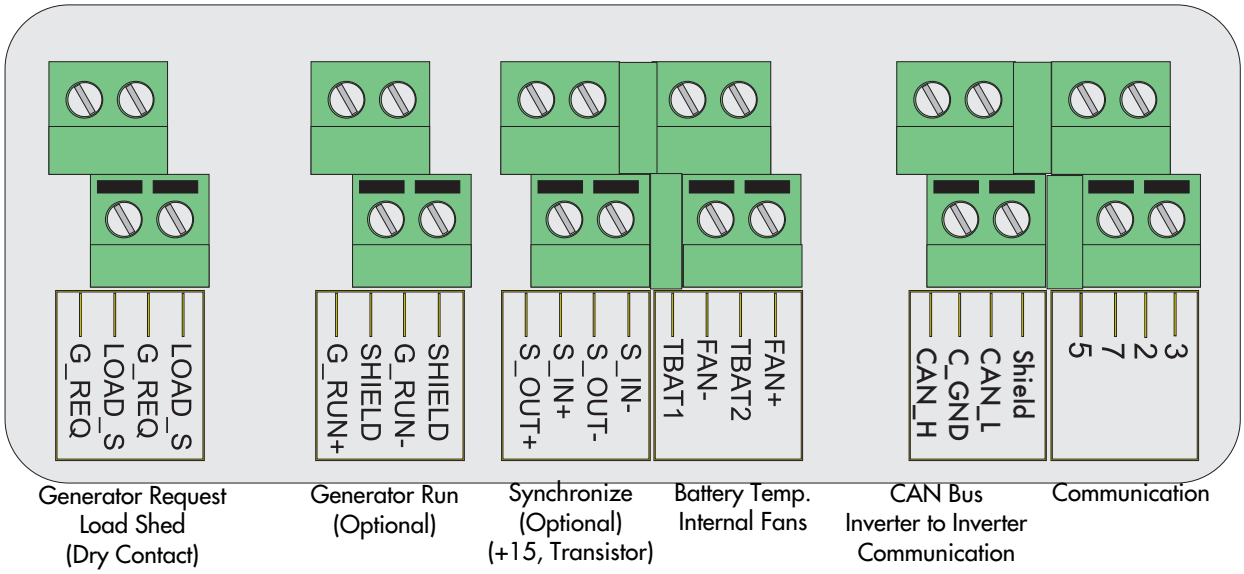


Figure 1-16 Auxiliary Wiring Terminals

AC Wiring

Begin the AC wiring by connecting the equipment ground conductor (green or bare) to the PE terminal, followed by the neutral conductor (white) to the N terminal and finally the line conductor (black) to the L terminal.

If your system is equipped with a generator, connect the incoming AC wires from the generator in the same order as above.

If your system will use the utility grid, be sure the AC source is safely disconnected and then connect the wires in the same order as above.

Typical color coding for AC connections are:

- Line (hot ungrounded conductor): Black
- Neutral (grounded conductor): White
- Equipment-Grounding Conductor: Bare, green or green with yellow stripes

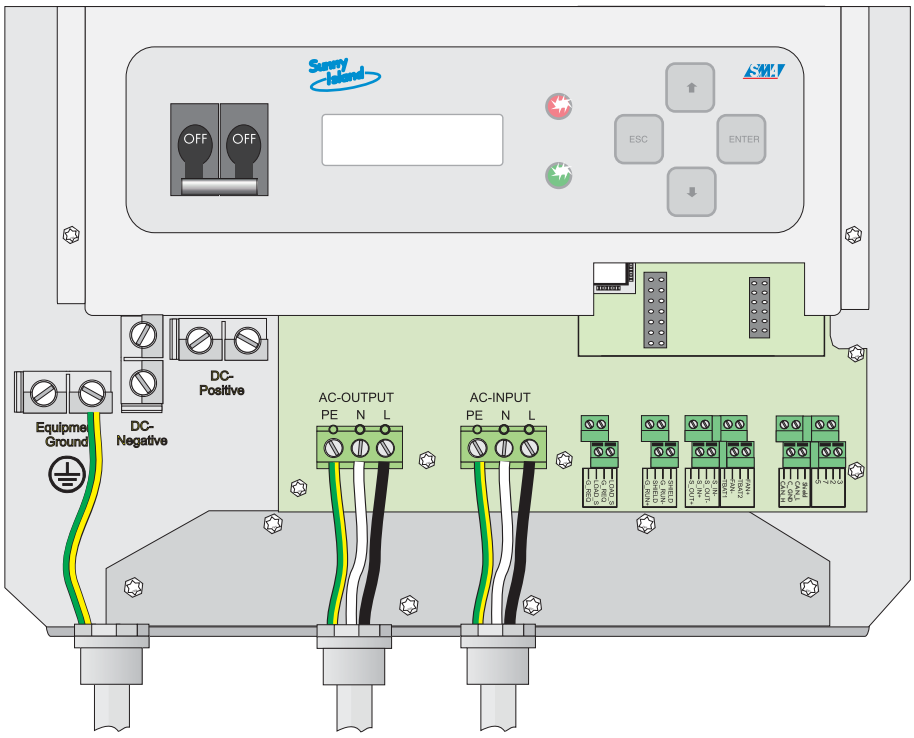


Figure 1-17 AC Load and Generator Wiring

DC Wiring

WARNING: To reduce the risk of shock, injury, or equipment damage, make certain that the internal inverter DC disconnect has been switched OFF and any external DC disconnect switched OFF or the DC battery cables are disconnected from the battery before attempting to attach or remove the DC input cables to the inverter.

NOTE: Tools used for tightening the DC input terminals may contact the chassis. No damage will result if the above warning is heeded and the inverter has not been powered on for at least five minutes.

NOTE: The DC cables that supply power to the Sunny Island 4248U should be connected directly between the inverter and the battery bank only (via additional disconnect and over-current protection if required). The DC power circuit should not be, nor supply power to, a branch DC circuit.

Connect the Positive DC cable, and then the Negative DC cable to the appropriate terminals.

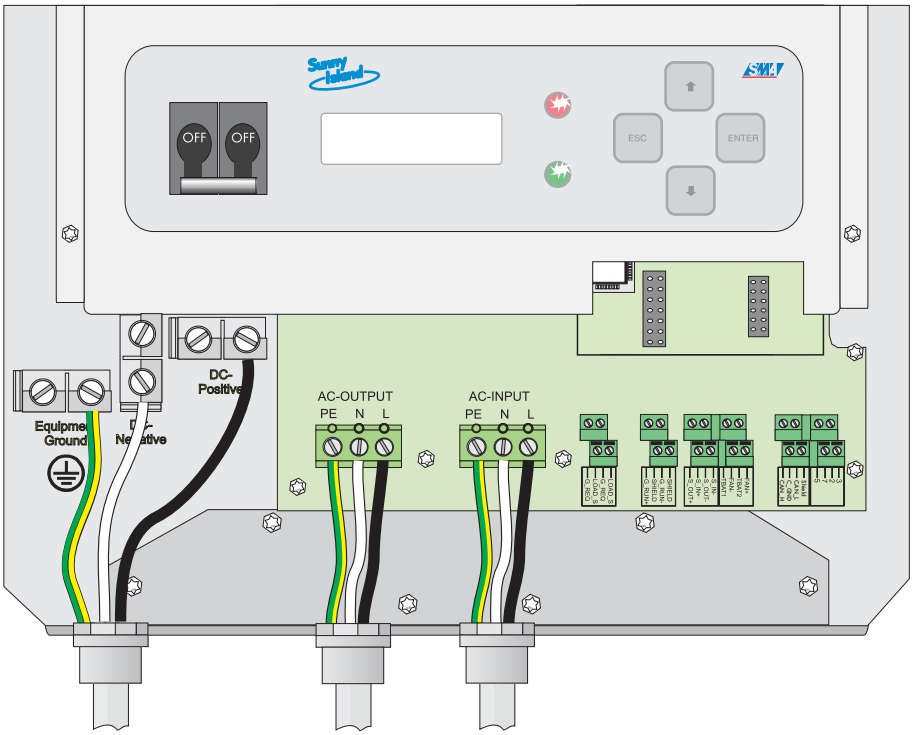


Figure 1-18 DC Power Wiring

Split-Phase

Split-phase Systems

The Sunny Island 4248U has the ability to work together in split-phase mode with another Sunny Island 4248U to provide 240 V AC capabilities.

When used in split-phase mode, one inverter is set up to be the "Master" unit, and the other the "Slave" unit. Basically, the master unit controls all functions of the inverters as a whole, and the slave unit merely provides the other 120 V AC leg. For example, all the battery charging functions are controlled only by the master unit.

To set the inverters up for split-phase mode, they must first be completely wired and ready to operate. Both inverters need to have a battery temperature sensor connected to them (the slave unit's battery temperature sensor is only required for set-up and then it can be removed. There is no need to place the slave unit's battery temperature sensor in conduit, it is temporary). Use the following wiring diagrams for guides when wiring the inverters for split-phase.

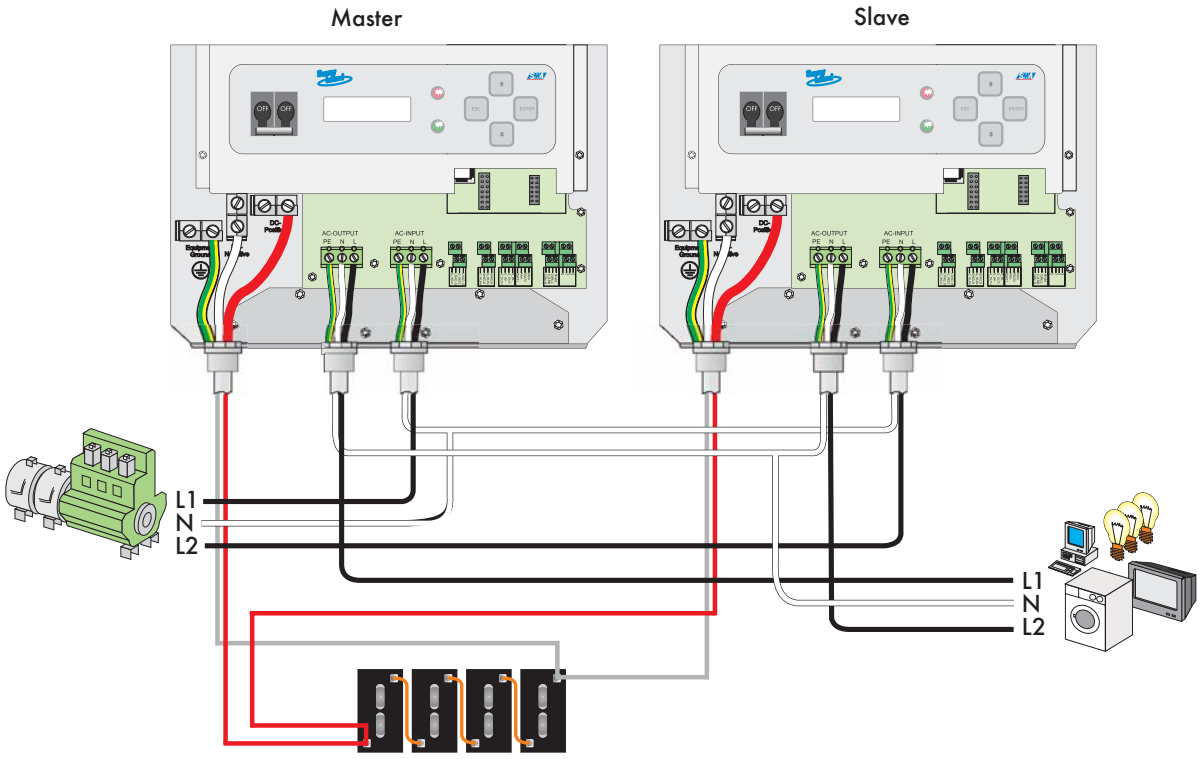


Figure 1-19 AC and DC Wiring for Split-Phase

Only 240 V generators with center tap (or 120 V with autoformer) may be used and connected to the system as shown in figure above.

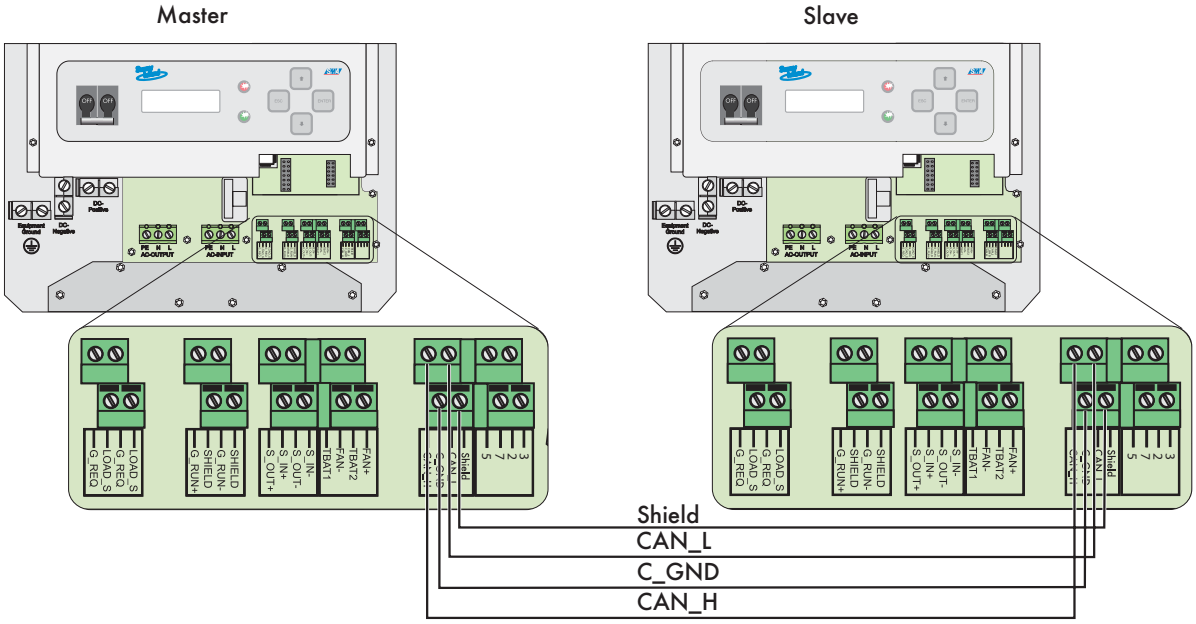
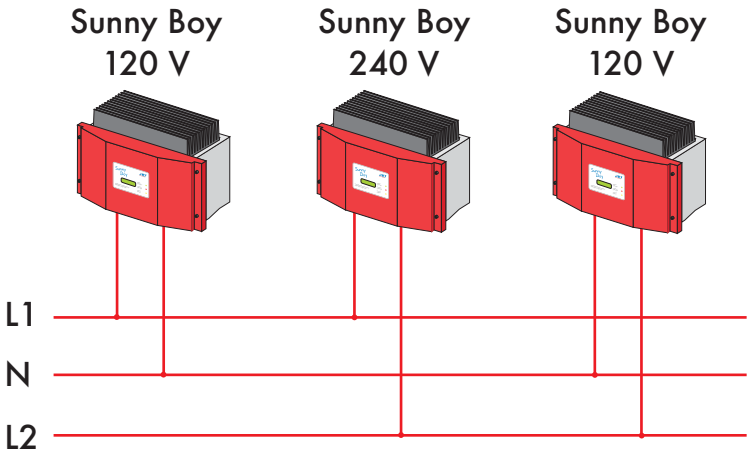


Figure 1-20 Sync Connection for Split-Phase

AC coupled energy sources can be connected either to the Master and/or Slave Sunny Island 4248U (L1-N, L2-N, 120 V) or to both outer conductors (L1-L2, 240 V).



Once the wiring is complete, the units must be set for split-phase operation.

- Power up the Master inverter and go to parameter 41-5, “Splitphase” and set it for Master. Power down the master inverter.
- Power up the Slave inverter and set the same parameter for Slave. Power down the slave inverter. (You may now disconnect the battery temperature sensor cable from the slave inverter.)

Now, when the inverters are restarted, they will operate in split-phase configuration.

Commissioning

Preparation

NOTE: Before beginning, recheck all of the power connections for correct polarity and assure that they are torqued to specification.

Once the wiring is complete, the system parameters need to be set. You will be setting parameters for battery type, battery capacity, and generator configuration.

For your convenience, we've provided space here for you to enter that information before beginning.

Battery Type: _____ Valve Regulated Lead Acid (VRLA) or Flooded Lead Acid (FLA)

**Battery Capacity: _____ Amp Hours (100 to 6000)

**The Sunny Island 4248U assumes a C20 (twenty hour capacity) value for capacity

NOTE: Some batteries list the amp-hour capacity in the 10 hr. rate on the label. To calculate the 20 hr. rate the 10 hr. rate has to be multiplied by 1.1.

**The Sunny Island 4248U defaults to a 100 amp-hour battery capacity

Generator: _ None _Manual _Two-Wire _GenMan Option Installed

Maximum Generator Output Current: ___Amps (0.0 to 60.0)

User Interface Overview

To commission the Sunny Island 4248U, you will need to interact with the user interface. The basic configuration of the user interface is shown in the figure below. The user interface consists of a DC disconnect, a 2-line digital display, two status indicators, up and down arrows, an Escape and an Enter key. You will use combinations of the arrow keys and the Escape and Enter keys to navigate, display information and change parameters. See the User Interface section for detailed information.

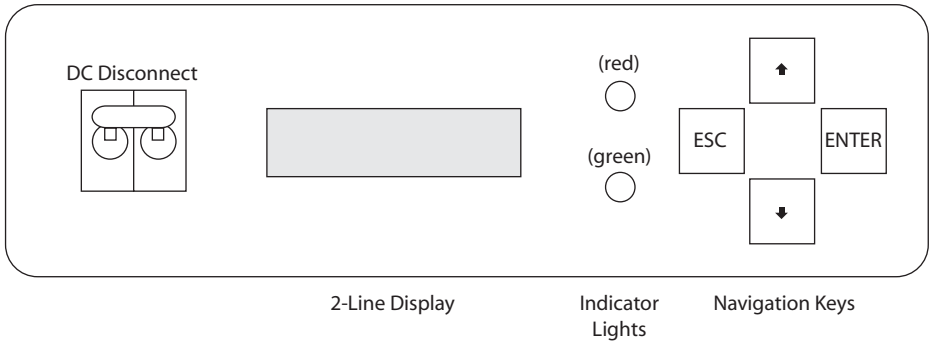


Figure 1-21 Sunny Island 4248U User Interface

The following table outlines the key functions.

Key	Function
ESC	Cancel, Answer NO, Move up one menu level
UP Arrow	Scroll Upward, Increase Value
DOWN Arrow	Scroll Downward, Decrease Value
ENTER	Select Function, Select Value, Confirm Changes, Answer YES

Table 1-9: Key Functionality

Changing Parameters

When a parameter is reached via the navigation keys, the current value of that parameter will be displayed. Next to that value will be a "return" character ↵. This character represents a parameter that may be changed. To change the parameter, press ENTER and the "return" character will begin to blink next to the value. Once the "return" character is blinking, the value can then be adjusted by using the arrow keys. Once the desired value is reached, press ENTER to store the new value.

LED Indicators

There are two LED indicators on the front of the Sunny Island 4248U, one red and one green. The following table describes their functionality.

Operating Condition	Red LED	Green LED
INIT (Initialization)	ON	ON
Stop	ON	OFF
Operating	OFF	ON
Derating	BLINKING	ON
Warning	BLINKING	BLINKING
Fault	BLINKING	OFF

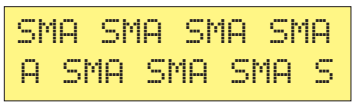
Table 1-10: LED Indicator Functionality

Powering Up

Begin by verifying that the AC breaker is in the OFF position. Turn the inverter on by switching the DC breaker on the front of the inverter to the ON position. The display will show "INIT"

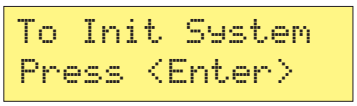
When the inverter is powered up initially, it will require that you set two parameters: Battery Type and Battery Capacity. First, the inverter will automatically execute an initiation sequence. When the inverter has completed this sequence, the display will show any errors it may have encountered during the self test (Any errors will need to be corrected before continuing). If no errors are detected, the display will show: "To Init System Press <Enter>" Refer to the following diagram for a description of the initialization sequence and for instructions on entering the battery type and battery capacity values.

When the inverter is switched on for the first time, it will display SMA.



Wait

Once the Initialization process is complete it will ask that you press Enter to begin the setup process.

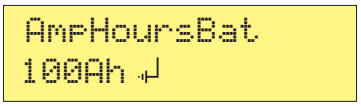


Press: Enter

The first parameter to set is the battery type. Begin by pressing Enter so that the „return" character begins to blink. Then use the up and down arrows to select the correct battery type and press Enter to store the new value.

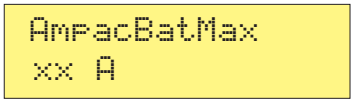
Press: Enter/Arrow Keys/Enter

The second parameter is the capacity of the battery bank in amp-hours. Begin by pressing Enter so that the „return" character begins to blink. Then use the up and down arrows to select the correct value. (Holding the arrows will cause the value to change more quickly.) Then press Enter to store the new value.



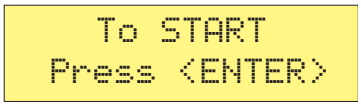
Press: Enter/Arrow Keys/Enter

The Sunny Island 4248U shows the maximum charging current.



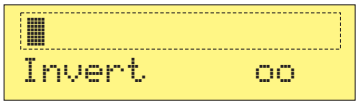
Press: Enter

The inverter is now ready to run. To start the inverter, press Enter.



Press: Enter

The inverter will then begin to operate and display the home screen.



During normal operation, the inverter will display the home screen. See the figure below for a description of the items found on the home screen.

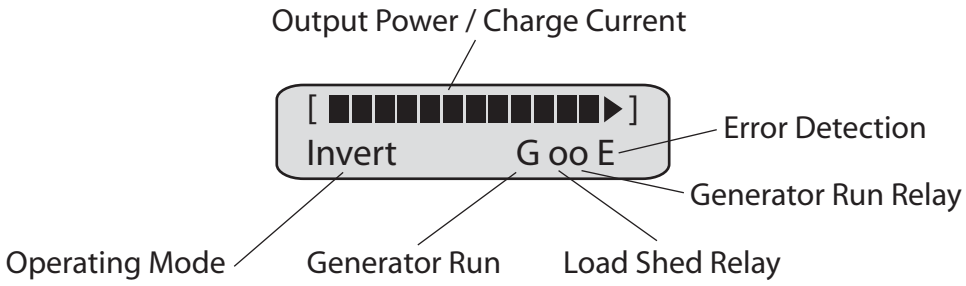


Figure 1-22 Home Screen Elements

Reset Sunny Island 4248U to factory settings

In order to reset the Sunny Island 4248U to its delivery status, switch the inverter off with the DC disconnect. Press and hold [ESC] and [Arrow Up] button. Switch the DC disconnect on, still pressing the buttons. When "NEWSYS" appears in the display you can let off the buttons and proceed as if the inverter was new (it will show "To init System Press <Enter>").

Generator Set Up

There are three sets of parameters that need to be set based upon system configuration and type of generator used to allow the Sunny Island to operate the generator automatically: GenControl, GenOperation and GridConnected.

GenControl

The GenControl parameter tells the Sunny Island what type of control is required to operate the generator that is connected to it. There are three possible settings: Manual, Direct and GenMan

Manual: (Default) When Manual is selected, the Sunny Island assumes that it has no control over the generator whatsoever. This setting is to be used when the generator has no autostart capability and must be started and stopped manually.

NOTE: When the Sunny Island GenControl parameter is set to Manual, the Sunny Island will automatically connect to the generator whenever it sees voltage on the AC input terminals (provided the voltage and frequency of the power is within tolerances.)

NOTE: Because the GenRequest relay is not utilized with manual start generators, it can be used to activate a indicator light that would notify the user that the Sunny Island is requesting that the generator be switched on.

Direct: The Direct setting is used when the generator is a two-wire start type that can be started by the closing of a relay. The two-wire start circuit would be wired to the G_REQ relay terminals. In Direct mode, the generator will be started automatically be the Sunny Island when

a low battery voltage condition exists. The generator can also be started manually by changing the GenOperation parameter to START. The generator can then be stopped manually by setting the GenOperation parameter to STOP or by returning it to AUTO.

NOTE: Leaving the GenOperation parameter in the STOP position will not allow the Sunny Island to operate the generator automatically. If automatic control is desired, set the GenOperation parameter to AUTO.

GenMan: The GenMan is an optional unit that may be purchased through your SMA supplier. The GenMan provides the additional functionality required by generators that are more complex and need more than a two-wire connection to operate. The GenMan provides the additional connections as well as warm-up and cool-down functionality. (See the GenMan manual for more details.) Set the GenControl parameter to GenMan if a GenMan unit is connected to the Sunny Island.

NOTE: When a GenMan unit is used, manual control of the generator may be accomplished through the control on the GenMan unit in addition to the GenOperation parameter in the Sunny Island.

GenOperation

The GenOperation parameter is used to control the generator manually or return it to automatic control via the Sunny Island. It has five possible settings: Start, Stop, Auto, Run1h and Release.

Start & Stop: These settings are used as manual overrides to force the Sunny Island to start or stop the generator regardless of the Sunny Island's mode.

NOTE: For the Start & Stop functionality to work, GenControl must be set to Direct or GenMan.

NOTE: Remember, once either of these settings are chosen, the generator will remain in that state until another command is given. The Sunny Island will NOT be able to start or stop the generator automatically.

Auto: The Auto setting returns control of the generator to the Sunny Island. Leave the GenOperation parameter set to AUTO if automatic operation of the generator by the Sunny Island is desired.

Run1h: The Run1h setting allows the generator to run for 1 hour from the time it is selected and then it is shut off automatically. This can be a useful feature if a heavy load is going to be operated or for a brief charge of the batteries.

NOTE: After the hour of run-time has completed, the Sunny Island will return the GenOperation parameter to whichever parameter was selected previously. For example, if the parameter was set to AUTO and Run1h is selected, when the hour is completed the Sunny Island will return to AUTO. If STOP was selected previously, then after one hour the Sunny Island would return to STOP.

Release: The Sunny Island contains circuitry that prevents power from being fed back into the generator. If this condition is detected by the Sunny Island, it shuts off the generator and then locks the generator out for 20 minutes. This 20 minute wait time can be cancelled by selecting Release.

GridConnected

The GridConnected parameter tells the Sunny Island if there is a utility grid present and if so, what role it will play. It also tells the Sunny Island wether the power source connected to the AC input is a generator or the utility grid. It has three possible settings: GridNone, GridCharge and GridFeedPV.

GridNone: Set GridConnected to GridNone if there is a generator connected to the AC input of the Sunny Island.

GridCharge: Set GridConnected to GridCharge when the utility grid is connected to the AC input of the Sunny Island.

NOTE: When setting GridConnected to GridCharge, make sure that GenControl is set to Manual and that GenOperation is set to Auto.

GridFeedPV: Use the GridFeedPV setting when grid connected Sunny Boys are present in the system.

NOTE: When selecting GridFeedPV, make sure that GenControl is set to Manual and that GenOperation is set to Auto.

Generator Status Displays

The Sunny Island 4248U display a variety of symbols to indicate the status and quality of the power being produced as well as the condition that caused the generator to start. Refer to the following two tables for details.

Icon	Description
*	Indicates that the generator input voltage and frequency are within the limits set by parameters 24-4 to 24-8
?	Indicates that the generator input voltage and frequency are outside of the limits set by parameters 24-4 to 24-8
!	The maximum reverse power limit as determined by the value of PGen-Reverse has been exceeded and the generator function locked out for 20 minutes.

Table 1-11: Generator Power Quality Icons

Icon	Description
T	The generator has been activated by the Run1H parameter. The generator will run for an hour and then stop automatically
B	The battery management system has requested that the generator start
S	GenRequest was manually set to START. The generator will NOT stop automatically
R	The generator was started by an external source, (manually, at the generator)

Table 1-12: Generator Activation Icons

Sunny Boy Set Up

NOTE: When using Sunny Boy inverters together with the Sunny Island 4248U, it is recommended that the battery bank contain at least 100 Amp hours of capacity per 1000 W of PV modules installed. For example, if there is a pair of SB2500U inverters and 5 kW of PV, the minimum recommended battery capacity would be 500 Amp hours.

Off-Grid Systems

If you're using Sunny Boy inverters in the system you will need to set the Sunny Island 4248U to interface with the Sunny Boys. You will also have to set a parameter in the Sunny Boys to work with the Sunny Island 4248U.

To prepare the Sunny Island 4248U for use with Sunny Boy inverters, set the "SunnyBoys" parameter to "YES".

On the Sunny Boy(s), set the "Default" parameter to "off grid".

Back-Up Systems

In both Back-Up modes, ("GridConnected" set to "GridCharge or set to "Grid-FeedPV"), the Sunny Island 4248U will disconnect from grid, if the voltage or frequency is out of the ranges defined by UL1741 (as shown in the table below).

Voltage Range	106 V to 131 V
Frequency Range	59.32 Hz to 60.48 Hz

- GridFeedPV
  If excess power generated by the grid interactive inverters such as Sunny Boys is to be fed to the grid, setting the GridConnected parameter to GridFeedPV will allow the power to be fed to the grid via the grid-isolation relay in the Sunny Island. Remember, the Sunny Island will not supply power to the grid from its batteries.

NOTE: To protect the grid-isolation relay in the Sunny Island 4248U from overload, the maximum power that can be fed to grid is limited to 6.72 kW, or 56 A at 120 V AC per Sunny Island. To prevent interruptions in the operation of your system, the total power of the PV array for the grid interactive inverters should not exceed this value. If this value is exceeded for longer than 30 seconds, the Sunny Island 4248U will switch to island mode immediately.

- GridCharge
  When the "GridConnected" parameter is set to "GridCharge", the Sunny Island 4248U will not allow power to be passed through its grid-isolation relay and into the grid. If for any reason it detects power being fed to the grid, it will trigger an error and immediately switch to island mode.

AC Output Voltage Verification

Once the system parameters are set, the inverter is ready to begin operating. The AC output must be tested to make sure that it is within specifications.

Switch the inverter on and then, using an AC incandescent lamp as a load, measure the output voltage of the inverter to verify that the AC voltage is approximately 120 V AC.

Well Done! The Sunny Island 4248U is now ready to operate normally (If perchance the inverter is not running at this point, refer to the Troubleshooting guide and correct the error indicated by the code on the display).

Sunny Island 4248U Menu Tree

The installer menus are arranged in four simple groups: Meters, Settings, Diagnose and Operation. Using the information from the previous section, each of the parameters can be navigated to and changed if needed. The following diagram shows a simple map of the parameters that are viewable at the installer level.

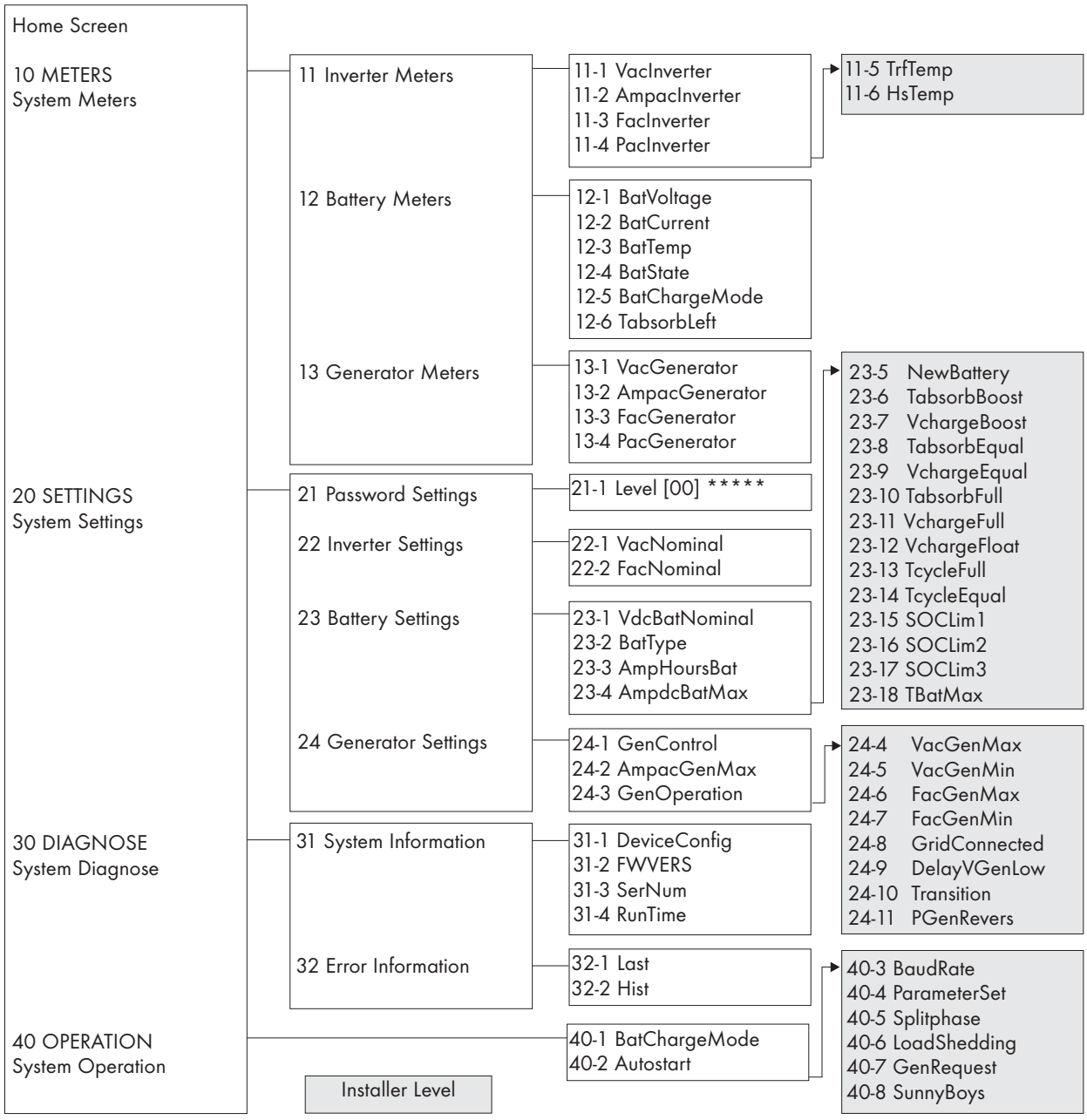


Figure 1-23 Installer Level Menu Map

Installer Level Menu Guide

The following tables contain information on each of the menu items which are intended to be modified only by the installer (A guide to the menu items available to the user is found in the user's section of this manual). Some items display information where others are operating parameters and can be changed. Please use caution when setting parameters as incorrect settings may cause undesirable operation of the inverter.

Once the second inverter is switched to slave mode, all main functions for the two inverters will appear only on the master display. All information that appears on the slave display should be disregarded as it will behave differently while the inverter performs slave-only functions.

NOTE: It is recommended that you record the value of any parameter change in the margin of these pages for future reference. Installer level parameter changes should only be performed by qualified personnel.

Meters

Inverter Meters (11)

Name	Range/ Unit	Default	Description
VacInverter	0 - 300 VAC	N/A	The VacInverter menu displays the AC output operating voltage of the inverter.
AmpacInverter	-70 - +70 AAC	N/A	The AmpacInverter menu displays the output current of the inverter.
FacInverter	45 - 70 Hz	N/A	The FacInverter menu displays the operating frequency of the AC output.
PacInverter	-10000 - +10000 WAC	N/A	The PacInverter menu displays the operating power of the AC ouput.
TrfTemp	-327 - +327 °C	N/A	The TrfTemp menu displays the temperature of the transformer.
HsTemp	-327 - +327 °C	N/A	The HsTemp menu displays the temperature of the heat sink.

Battery Meters (12)

Name	Range/ Unit	Default	Description
BatVoltage	0 - 80 VDC	N/A	The BatVoltage menu displays the battery voltage.
BatCurrent	-200 - +200 ADC	N/A	The BatCurrent menu displays the DC current.
BatTemp	-40 - +200 °C	N/A	The BatTemp menu displays the battery temperature.
BatState	Norm, Warn, Low, Crit	N/A	Battery state (BMS) The BatState menu displays the current state of charge of the batteries.
BatCharge-Mode	-----, Auto, Boost, Full, Float, Equalize	N/A	The BatChargMode meter allows you to monitor the charge mode of the inverter. **-----:** will be shown on Slaves in Split-Phase Mode only. **Auto:** Inverter maintains charge automatically. For details about the special charge modes see "*Battery Management*" on page 88.
TabsorbLeft	0 - Max min	N/A	Every charge mode has a dedicated absorption time that might have been adjusted by your system installer. For this time normally the Sunny Island will have to keep the generator running, even if it seems that there is enough energy in the system and the generator is hardly loaded. The counted down value of "TabsorbLeft" shows the remaining time for this state.
BatChargeVolt	0 - 80 VDC	N/A	The BatChargeVolt menu shows the setpoint value of the active battery charge mode (BatCharge-Mode)

Generator Meters (13)

Name	Range/ Unit	Default	Description
VacGenerator	0 - 260 VAC	N/A	The VacGenerator menu displays the AC voltage at the inverter generator input.
AmpacGenerat	0 - 60 AAC	N/A	The AmpacGenerator menu displays the AC current at the inverter generator input.
FacGenerator	0 - 70 Hz	N/A	The FacGenerator menu displays the AC frequency at the inverter generator input.
PacGenerator	0 - 20 kWAC	N/A	The PacGenerator menu displays the AC power at the inverter generator input.

Settings

Inverter Settings (22)

Name	Range/ Unit	Default	Description
VacNominal	105 - 130 VAC	120	The VacNominal parameter sets the nominal output voltage of the inverter.
FacNominal	55 - 65 Hz	60	The FacNominal parameter sets the nominal output frequency of the inverter.

Battery Settings (23)

Name	Range/ Unit	Default	Description
VdcBatNominal	42 - 48 VDC	48	The VdcBatNominal parameter sets the nominal operating voltage of the inverter.
BatType	VRLA FLA	VRLA	The BatType parameter selects the type of battery used in the system. **VRLA** = Valve Regulated Lead Acid **FLA** = Flooded Lead Acid This parameter needs to be set when the inverter is first commissioned. Once the system is configured, this parameter can only be changed after selecting „Reset“ in „NewBattery“ (23-5).

Name	Range/ Unit	Default	Description
AmpHoursBat	100 - 6000 Ah	100	The BatCapacity parameter sets the total amp-hour capacity of the battery bank. This parameter needs to be set when the inverter is first commissioned. Once the system is configured, this parameter can only be changed after selecting „Reset“ in „New-Battery“ (23-5).
AmpdcBatMax	0 - 100 ADC	30	The AmpdcBatMax parameter sets the DC charge current limit to the batteries.
NewBattery	--- Reset	---	The NewBattery parameter resets the battery history stored in the inverter. Only reset this if replacing your battery bank with new batteries. Selecting „Reset“ will lead to a restart of the Sunny Island 4248U. This is intended.
TabsorbBoost	1 - 600 min	45 (FLA)/ 60 (VRLA)	The TabsorbBoost parameter adjusts the length of time in which the inverter will charge the batteries in boost-charge mode.
VchargeBoost	44 - 62.4 VDC	60 (FLA)/ 56.8 (VRLA)	The VchargeBoost parameter adjusts the high voltage setpoint used for charging in the boost-charge mode.
TabsorbEqual	1 - 1200 min	360	The TabsorbEqual parameter adjusts the length of time the inverter will charge the batteries in equalize-charge mode.
VchargeEqual	44 - 62.4 VDC	60 (FLA)/ 56.8 (VRLA)	The VchargeEqual parameter adjusts the high voltage setpoint used when charging in equalize-charge mode.
TabsorbFull	1 - 1200 min	180 (FLA)/ 180 (VRLA)	The TabsorbFull parameter adjusts the duration of the absorbtion-charge mode.
VchargeFull	44 - 62.4 VDC	60 (FLA)/ 56.8 (VRLA)	The VchargeFull parameter adjusts the high voltage setpoint at which the inverter considers the bank fully charged.
VchargeFloat	44 - 62.4 VDC	54	The VchargeFloat parameter adjusts the voltage at which the inverter will floatcharge the battery bank.

Name	Range/ Unit	Default	Description
TcycleFull	1 - 180 D	14	The TcycleFull parameter selects the number of days between the last boost charge and the next full charge cycle.
TcycleEqual	7 - 365 D	60	The TcycleEqual parameter selects the number of days between the last boost-charge and the next equalize charge.
SOCLim1	0 - 100 %	40	State of charge generator start
SOCLim2	0 - 100 %	30	State of charge load shedding
SOCLim3	0 - 100 %	20	State of charge system shutdown
TBatMax	0 - 55 °C	45	Maximun battery temperature

Generator Settings (24)

Name	Range/ Unit	Default	Description
GenControl	Manual, Direct, GenMan	Manual	The GenControl parameter selects the type of generator control to be used with your system. **Manual**: Manual start type or no generator connected. **Direct**: Two-wire start generator connected to the dry contacts in the inverter. **GenMan**: GenMan option installed.
AmpacGen-Max	2 - 60 AAC	10	The AmpGenMax Parameter should be set to about 85 % of the maximum AC current of your generator. In Charge Mode the Sunny Island 4248U will then limit the total current (loads in the system + Sunny Island) to this value in order to prevent the generator from stalling. **Note:** If the load in the system is above this value in Voltage Mode, the Sunny Island 4248U will not switch to Charge Mode for the same reason.

Name	Range/ Unit	Default	Description
GenOperation	Auto, Start, Stop, Run1h, Release	Auto	The GenOperation parameter forces the generator to react immediately: **Auto:** Normal control by Sunny Island is active (the display might show "G" or "*"). **Start:** Generator will be started by the Sunny Island immediately (the display will show "R"). Remember to stop the generator when not needed anymore (by selecting either "Stop" or "Auto"). **Stop:** Generator will be stopped by the Sunny Island immediately (the display will show "S"). Remember to set the generator back to "Auto"-mode if you want the Sunny Island to take over control again. **Run1h:** Generator will be started immediately and will kept running for one hour (the display will show "T"). Afterwards the Sunny Island will switch back to the previous mode. If "Run1h" was selected from "Start" mode the Sunny Island will switch back to "Start" after one hour time. **Release:** Aborts the lock time (20 min.) for the generator after a "ReversePower" failure has occurred.
VacGenMax	120 - 150 VAC	130	The VacGenMax parameter selects the maximum AC voltage the inverter will accept from the generator. If the generator voltage is higher than this limit when running unloaded the Sunny Island 4248U will not connect, or, if the generator voltage exceeds this limit while connected the Sunny Island 4248U will disconnect the generator.
VacGenMin	80 - 120 VAC	106	The VacGenMin parameter selects the minimum AC voltage the inverter will accept from the generator. If the generator voltage is lower than this limit when running unloaded the Sunny Island 4248U will not connect, or, if the generator voltage goes below this limit while connected the Sunny Island 4248U will disconnect the generator.

Name	Range/ Unit	Default	Description
FacGenMax	60 - 66 Hz	65	The FacGenMax parameter selects the maximum frequency the inverter will accept from the generator. If the generator frequency is greater than this limit when running unloaded the Sunny Island 4248U will not connect, or, if the generator frequency goes above this limit while connected the Sunny Island 4248U will disconnect the generator.
FacGenMin	54 - 60 Hz	55	The FacGenMin parameter selects the minimum frequency the inverter will accept from the generator. If the generator frequency is lower than this limit when running unloaded the Sunny Island 4248U will not connect, or, if the generator frequency goes below this limit while connected the Sunny Island 4248U will disconnect the generator.
GridConnected	Grid-None, Grid-Charge, Grid-FeedPV	Grid-None	Grid connection mode. **GridNone:** No grid operation - Generator limits; apply (VacGenMin, VacGenMax, FacGenMin, FacGenMax, DelayVGenLow, PGenRevers). **GridCharge:** Charge only from grid - UL limits; apply (voltage range 106 V - 131 V, frequency range 59.32 Hz - 60.48 Hz), no reverse power accepted. **GridFeedPV:** Charge from grid and feed grid with Sunny Boy via Sunny Island; (voltage range 106 V - 131 V, frequency range 59.32 Hz - 60.48 Hz), reverse power limit is 6.72 kW.
DelayVGenLow	500 - 6000 Ms	3000	The DelayVGenLow parameter selects the amount of time the Sunny Island 4248U will wait before disconnecting when the generator voltage or frequency drops below the VacGenMin or FacGenMin limits.
Transition	Ramp/ Fast	Fast	The Transition parameter selects the way in which the Sunny Island 4248U will transition from charge to invert mode when it detects a grid or generator fault. Select **Ramp** when Sunny Boy inverters are connected to the system. Select **Fast** when no Sunny Boy inverters are connected to the system.
PGenRevers	0 - 1000 W	300	Max. reverse power limitation

Diagnose

System Information (31)

Name	Range/ Unit	Default	Description
DeviceConfig	N/A	SI4248 U	The DeviceConfig parameter displays the name of the device.
FWVers	N/A	N/A	The FWVers menu displays the version number of the firmware installed in the inverter.
SerNum	N/A	N/A	The SerNum menu displays the serial number of the inverter.
RunTime	N/A Hours	N/A	The RunTime menu displays the total time the inverter has been operating.

Error Information (32)

Name	Range/ Unit	Default	Description
Last	N/A	N/A	The Last menu displays the most recent error that occurred in the system.
Hist	N/A	N/A	The Hist menu displays the last 10 errors to occur in the system. This is a revolving list, the first item in is the last out and it is only cleared when a system reset is performed.

Operation

Name	Range/ Unit	Default	Description
BatCharge-Mode	Auto, Boost, Full, Equalize, Manual	Auto	The BatChargMode parameter allows you to override the Auto charge mode of the inverter. **Auto:** Inverter maintains charge automatically. Selecting any of the other modes will automatically place the inverter into that mode. For example, if you wanted to perform an equalize charge on your flooded batteries, you would select Equalize in this menu to put the inverter into equalize mode. For details about the special charge modes see "*Battery Management*" on page 88. **Manual:** For future use. Please do not select.
Autostart	Off, On	Off	The Autostart parameter allows the inverter to start automatically whenever DC power is applied to it or after a fault has been detected (up to 10 times). If AutoStart is OFF, the inverter will always have to be started manually.
BaudRate	1200, 2400, 4800, 9600, 19200	1200	The BaudRate parameter selects the baud rate that the Sunny Island 4248U will use to communicate with external devices.
ParameterSet	None, Load, Save	None	The ParameterSet parameter allows the current set of parameters to be saved, or a saved set of parameters to be loaded. Select **None** to operate the inverter with the current set of parameters. Select **Save** to save the current set of parameters (When the system is operating optimally, it is a good idea to save that set of parameters. This is particularly useful when experimenting and the inverter needs to be restored to the previous settings.). Select **Load** to load the saved set of parameters into the Sunny Island 4248U
Splitphase	None, Master, Slave	None	The Splitphase parameter selects the role each inverter has to play when used in split-phase mode. This parameter should remain set to **None** unless the inverter is to be used in Split-Phase mode. (See Split-Phase section for details).

Name	Range/ Unit	Default	Description
LoadShedding	Off, On, Auto	Off	The LoadShedding parameter selects the operating mode of the load shedding relay. Select **Off** when the load shedding option is not being used or to manually switch the load shedding relay to the off position. Select **On** to manually switch the load shedding relay to the on position. Select **Auto** to allow automatic control of the load shedding relay by the Sunny Island. Loads are shed when SOCLim2 is reached.
GenRequest	Off/ On/ Auto	Auto	The GenRequest parameter manually toggles the generator request relay. This is intended to be used for testing purposes to confirm operation of the generator start circuit. Select **Off** when no generator is present or to manually switch the generator relay off. Select **On** to manually switch the generator relay to the on position. Select **Auto** to allow automatic control of the generator request relay by the Sunny Island 4248U.
SunnyBoys	No/ Yes	No	The Sunny Boys parameter is used when the Sunny Island 4248U will be connected to Sunny Boy inverters in the same system. Select **No** when there are no Sunny Boy inverters in the system. Select **Yes** when there are Sunny Boy inverters used in the same system with the Sunny Island 4248U. (**NOTE:** When Sunny Boys are used in off-grid systems, there are parameters in the Sunny Boy inverters that must also be set. See the **Sunny Boy** paragraph in this manual for more information.)

Troubleshooting

Refer to the following table as a guide to the errors codes generated by the Sunny Island 4248U.

Name	Cause	Release	Description
CBT-Open	T >= 70°C	T < 70°C	Battery temp-sensor cable broken
CBT-Short	T <= -40°C	T > -40°C	Battery temp-sensor shorted
ChargeLow	SOC < SOCLim3	SOC > SOCLim3	Battery SOC critical
CHS-Open	T >= 150°C	T < 150°C	Heatsink temp-sensor cable broken
CHS-Short	T <= -40°C	T > -40°C	Heatsink temp-sensor shorted
CTR-Open	T >= 150°C	T < 150°C	Transformer temp-sensor cable broken
CTR-Short	T <= -40°C	T > -40°C	Transformer temp-sensor shorted
FailSet	TrfDerateTemp >= TrfMax-Temp or HSDerate Temp >= HSMaxTemp	Set parameter correctly	Derating settings incorrect
HS-TempOV	T >=85°C	T <= 80°C	Heatsink over temperature
INTERNAL01			AST- Short
INTERNAL02			AST- Open
INTERNAL03	Demand-State not equal to DSP state	Automatic acknowledge. Restart	No reaction of DSP to change of demand state
INTERNAL04	Lost Two hand-shakes from DSP (T >= 1 sec.)	Automatic reset	Lost DSP Handshake
INTERNAL05	Measurement out of valid range	Automatic acknowledge. Restart	DSP measurement failure. Breakdown bit-coded error-info at DSPE_SY
INTERNAL06	Over current detected by DSP	Automatic acknowledge. Restart	DSP over current

Name	Cause	Release	Description
NoMaster	NA	NA	Splitphase configuration no master found (on slave device)
NoSlave	NA	NA	Splitphase configuration no slave found (on master device)
RelayFail	VacInverter VacGenreator	Automatic acknowledge. Restart	Relay Failure
TBatHigh	BatTemp > TBatMax	BatTemp < TBatMax-2°C	Battery temperature too high
TR-TempOV	T >=101°C	T <= 96°C	Transformer over temperature
TwoMaster	Receive hand-shake from Master device	Automatic acknowledge. Restart	Two master devices in splitphase con-figuration
TwoSlave	Receive hand-shake from slave device	Automatic acknowledge. Restart	Two slave devices in splitphase config-uration
VAC-High	VAC > VAC-Max	VAC < VAC-Max	High output voltage
VAC-Low	VAC< VAC-Min	Automatic acknowledge. Restart	Low output voltage
VBatHigh	VBat > VBat-Max	VBat > VBat-Max	High battery voltage
VBatLow	VBat < VBat-Min (for 30 sec-onds)	VBat > VBat-Min	Low battery voltage
Watchdog		Automatic reset	Watchdog reset

Table 1-13: Error Codes

Battery Management

Charging Operations used by the Sunny Island

The battery management system allows automatic operation (without user interference required) of 3 different charging operations:

- Boost Charge:
  fast charging operation with short generator run time for quick battery charge (to state of charge of approximately 85 ... 95 %)
- Full Charge:
  charging the battery full – requiring longer generator run time (absorption time) at low generator load condition (to state of charge of approximately 92 ... 97%)
- Equalizing Charge:
  equalizing all cells with long generator run time at low load condition (to state of charge of approximately 95 ... 100 %)

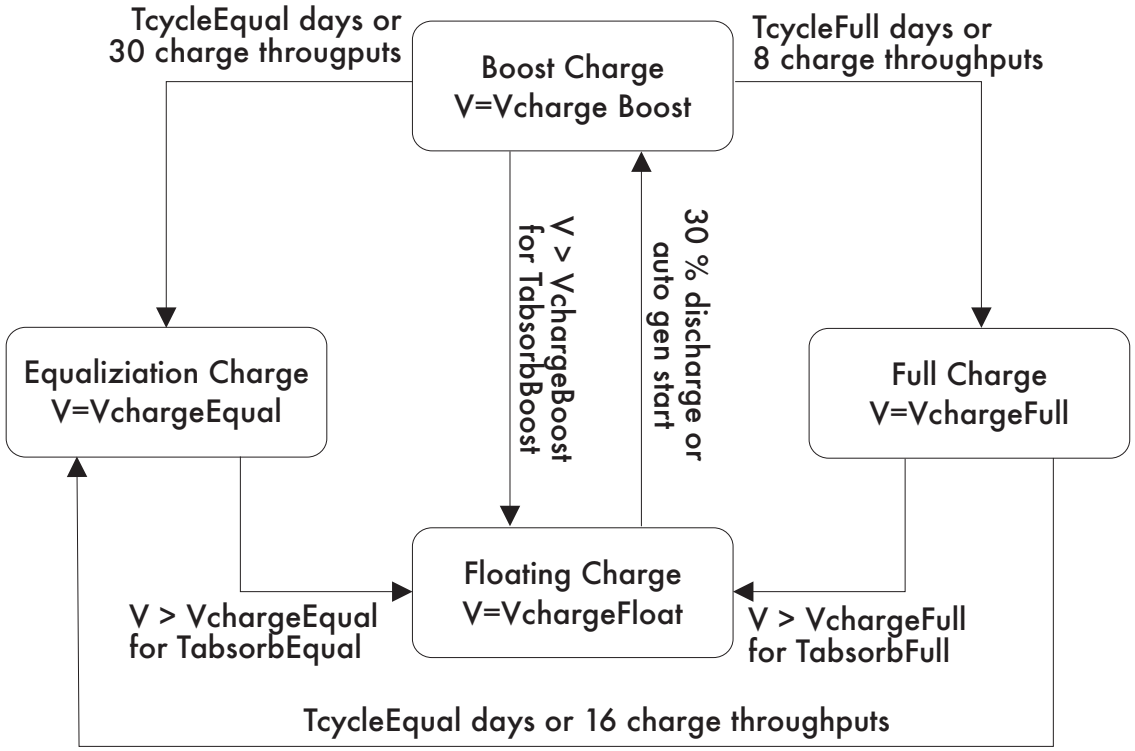


Figure 1-24 Battery Management System State Transitions in Back-Up Mode

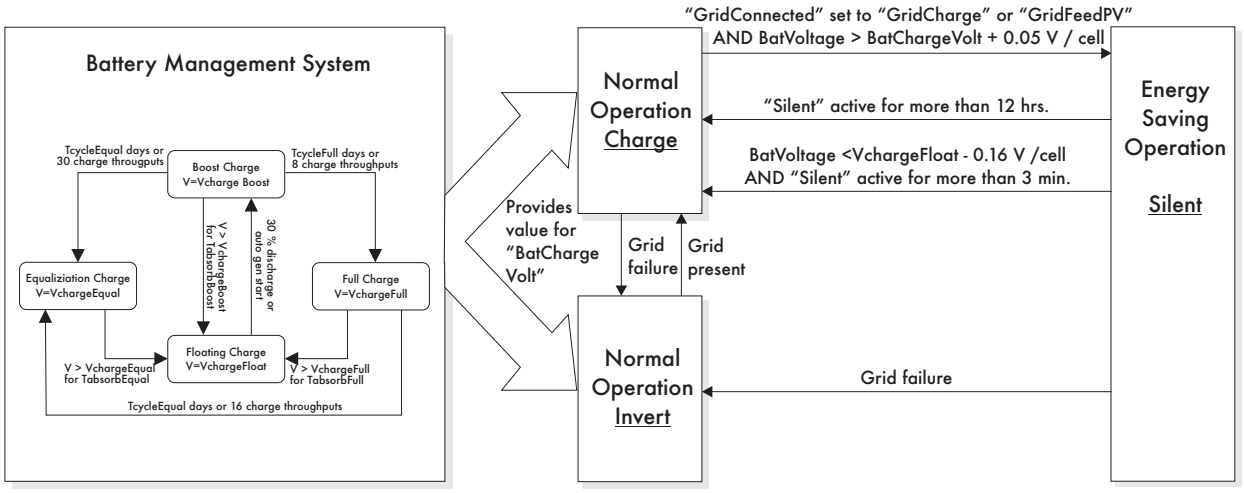


Figure 1-25 Battery Management System State Transitions in Off-Grid Mode

Each charging operation (Boost charge, Full charge, Equalizing charge, and Floating Charge) can also be activated manually. For customer convenience all transitions are done automatically and cycle times are adjustable (TcycleFull, TcycleEqual). The number of charge throughputs (of Amp hours of nominal battery capacity – C20 passed through the battery) are fixed and not adjustable. Charge throughputs are only calculated from energy passing through the Sunny Island 4248U. Other DC coupled sources or loads are not taken into account by the Sunny Island 4248U. On rare occasions, it is possible to meet the requirements of two charge operations causing the order of the processes to be: Boost, Full and then Equalization for that charge cycle.

Each charge operation consists of a full charge phase with limited current (by generator maximum AmpacGenMax current or by maximum DC charge current AmpdcBatMax) and an absorption phase after the battery voltage has reached the charge voltage set point. The remaining time for the absorption phase is displayed as a meter (in the Battery section) as "TabsorbLeft".

After completion of the absorption phase, the generator is switched off (if a generator is used). The charge operation is then finished and the charge voltage set point is set to Float. The Float State only effects the operation of the Sunny Island 4248U in systems with AC coupled PV (Sunny Boys). The generator is stopped in this state and the control loop which controls the charge current is inactive. For AC coupled PV, a different control loop stays active while the Sunny Island 4248U is in Voltage Mode (no Generator running) which controls the output power of the Sunny Boys by the calculated charge voltage set point (in all charging processes including Float).

Generator, Load Shedding Control and Battery State of Charge

State of Charge

Generator start and load shedding are controlled by the State of Charge (derived from current compensated battery voltage). The generator control also considers the battery size.

Generator and Load Shedding Control distinguishes between four states (see Battery Meters BatState and figure below):

- Normal
- Start Generator
- Start Load shedding (includes Start Generator)
- Critical Battery State (Shut down)

The transitions between these states are controlled by the State of Charge calculated from the battery voltage and a timer (see "*State transition for generator start and load shedding*" on page 63). The mentioned time of 2 minutes is active when Sunny Island 4248U sees discharging. The 30 minutes time is active for charging or for discharging with currents less than 0.5 A per 100 Ah battery capacity. The 6 minutes time is active with charging currents of 0.5 to 2 A per 100 Ah capacity. The 30 minutes time is active with charging current above 2 A per 100 Ah.

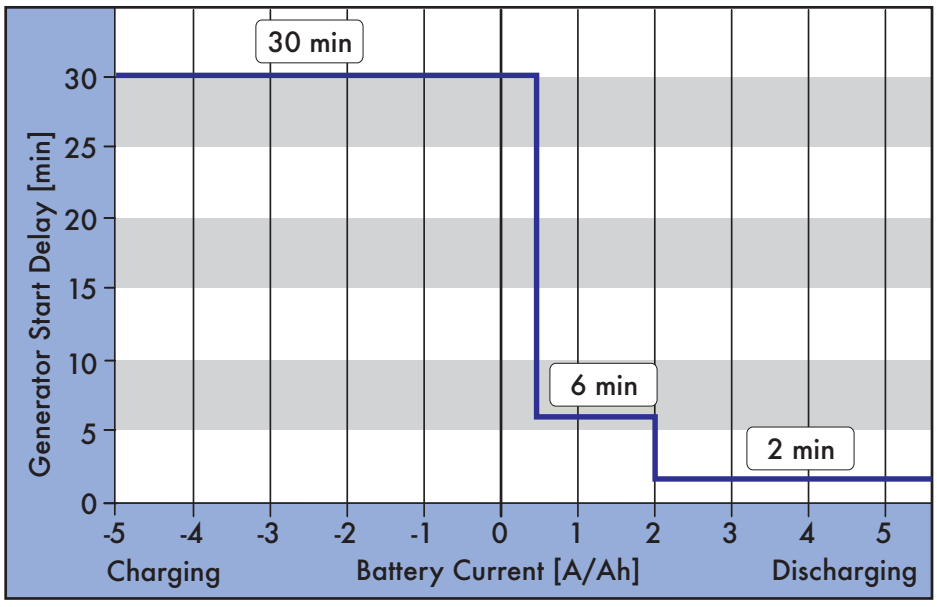


Figure 1-26 Generator Start Delay vs. Normalized Battery Current

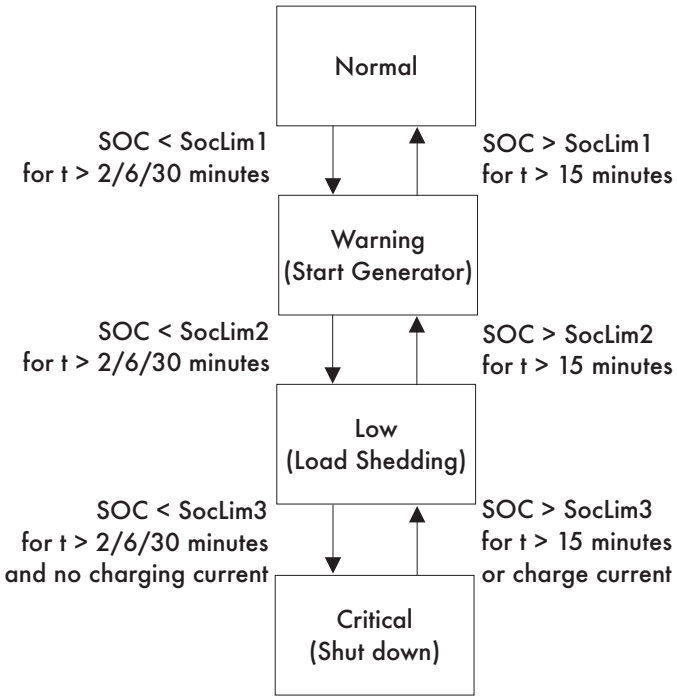


Figure 1-27 State transition for generator start and load shedding

When critical state is reached (and no charge current is detected) the Sunny Island 4248U will shut down for battery protection. After that a manual restart of the Sunny Island 4248U is required. If no charge current flows the inverter will shutdown after 5 minutes. Independent from the Generator and Load Shedding control the battery voltage monitoring stays active and will shut down Sunny Island 4248U, if the battery voltage falls below the minimum voltage level VbatMin.

How to set up State of Charge Limits

NOTE: This process applies to FLA type batteries with accessible cells only. For sealed batteries, please refer to the manufacturer's guidelines for acid density values.

The 3 limits for generator start, load shedding and shut down, can be set as State of Charge (SOC) values (SocLim1, SocLim2, SocLim3). The battery management assumes the acid density to 1.28 kg/l. If the Acid Density of the used battery is different, user must adapt the desired SOC value.

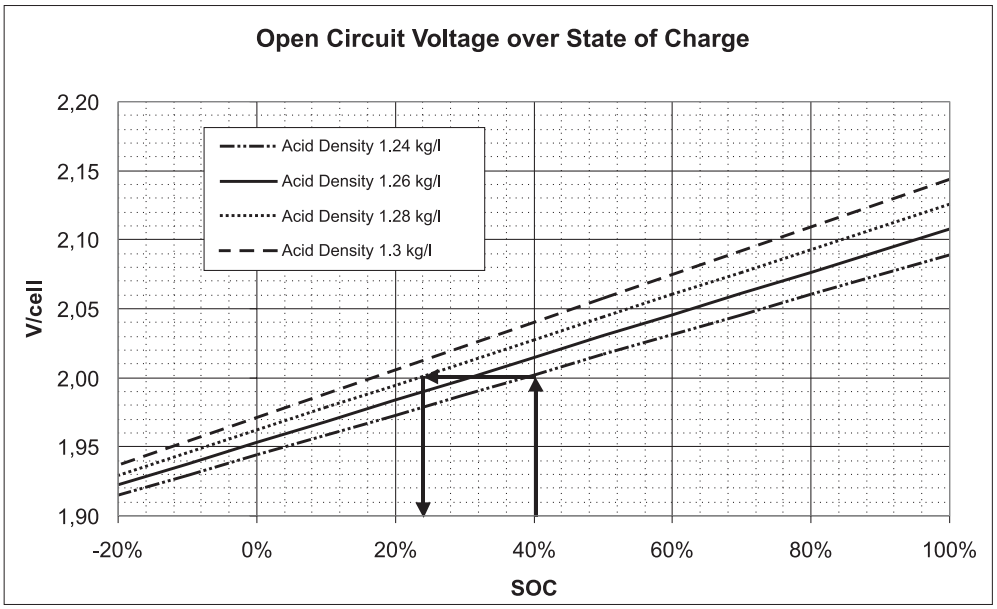


Figure 1-28 State of Charge and Open Circuit Voltage Levels depending on Acid

Example:

If the generator should start at a SOC of 40% or when the battery has a specific gravity of 1.24 kg/l, then:

The SocLim1 should be set to 25%. To determine this value, begin at 40% SOC, go up to the blue curve (which represents 1,24 kg/l), go left to meet the red line, go down and find 25%.

The firmware always assigns the SOC parameter with the highest value to SocLim1 (generator start) and the lowest to SocLim3 (shutdown) and the remaining value to SocLim2 (load shedding) to ensure reasonable order of SOC thresholds.

If the generator is started by the Sunny Island 4248U due to reaching a voltage level corresponding to SocLim1 State of Charge, it will run until the charge operation has completed, (i.e. completion of the absorption phase and then switching to float). If the generator starts during Float, (e.g. with DC-loads only), the BMS will automatically switch to boost charge and

complete a boost charge cycle. If the generator is started manually (without a request from the Sunny Island 4248U, by rope for example) and the BMS is in Float, it will not switch to Boost mode. This allows the generator to supply some large loads without always changing the charge state. When using a manual start generator, the user may set the charge operation state as needed, (e.g. Full Charge).

The Sunny Island 4248U internal control loop looks at the difference between the actual battery voltage and the charge voltage set point for the current charge state. The result of this control loop determines the current to be drawn from the generator. This current value is limited by the maximum generator current as set by the AmpacGenMax parameter, and the maximum battery charge current allowed as set by the AmpdcBatMax parameter. The Sunny Island 4248U prevents the generator from overloading by reducing the amount of charge current that is drawn from the generator.

Because a PV system cannot deliver energy at night or during cloudy conditions, it is sometimes difficult to maintain the battery voltage for a long enough time to complete a Full Charge or Equalizing Charge cycle in a single day. However, the Sunny Island is capable of tracking the absorption time and will continue the process from where it left off when enough power is available to do so.

Section 2: User Manual

Introduction

Inverter Description

The Sunny Island 4248U is a DC-AC inverter and battery charger.
DC power is converted to AC utility grade power through a single-stage, high-frequency, pulse-width-modulated (PWM) MOSFET bridge. The AC power is filtered to provide safe, high-fidelity, low EMI/EMC emission power to the AC loads. Excess energy on the AC side is used to recharge the battery in a sophisticated manner ensuring the longest life possible for the batteries.

Features

The Sunny Island 4248U not only provides up to 4200W of continuous true sine-wave AC power, but is equipped with the latest features and technology to ensure that you get the most from your battery based system. Some of the features included are:

- Optimized for high ambient temperature operation
- Very high efficiency
- Integrated DC breaker
- Near silent operation
- Non-volatile memory for system settings
- Compatible with all Sunny Boy and SMA Control products
- Advanced battery management system
- Sealed electronic compartment
- Generator overload protection
- Generator reactive power compensation

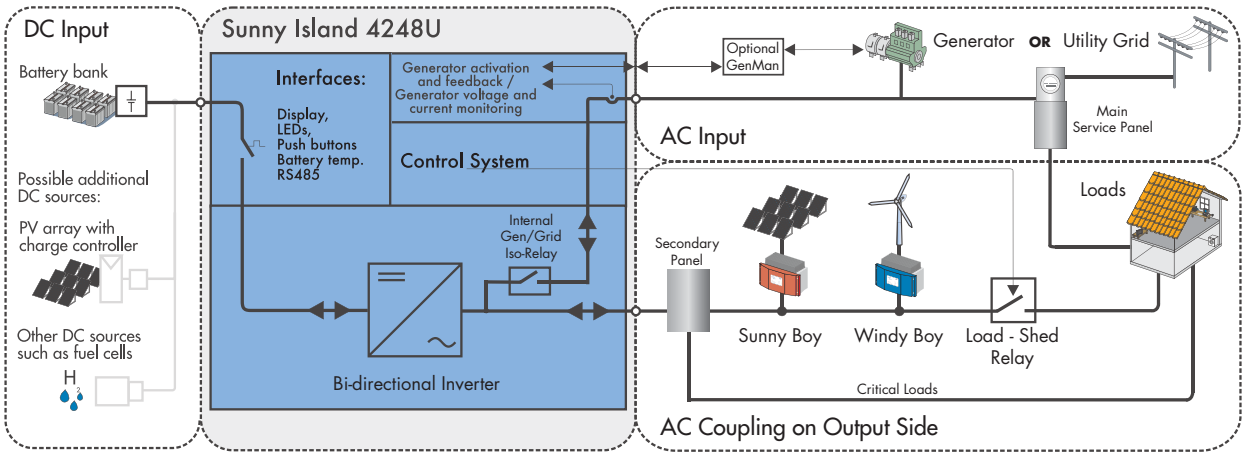


Figure 2-1 Sunny Island 4248U System Block Diagram

User Interface Overview

The basic configuration of the user interface is shown in the figure below. The user interface consists of a DC disconnect, a 2-line digital display, two status indicators, up and down arrows, an Escape and an Enter key. You will use combinations of the arrow keys and the Escape and Enter keys to navigate, display information and change parameters. See the **User Interface Functionality** section for detailed information.

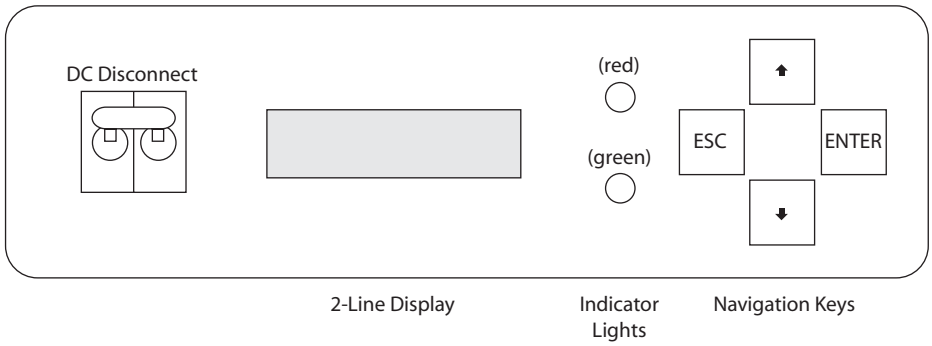


Figure 2-2 Sunny Island 4248U User Interface

Options

The Sunny Island 4248U allows you to connect a variety of options to it for remote metering, load control and controlling optional equipment such as a generator.

The Sunny Island 4248U supports all of the SMA Control series of metering and data acquisition devices through the use of the optional "Communication Piggy Back" unit. This enables the inverter to communicate in either the RS232 or RS485 formats.

A variety of communication options are available to connect multiple Sunny Island 4248U's together or combine other SMA products on the same communication bus.

For customers desiring remote access to the Sunny Island 4248U, various modems and Ethernet options are also available. With an (optional) RS232 Piggy-Back local access to the Sunny Island 4248U is a simple wire connection between a PC and the Sunny Island 4248U (The Sunny Data application and a MS Windows PC are necessary to communicate with the Sunny Island 4248U from local or remote locations. Sunny Data is available free-of-charge on the SMA-America web site: www.sma-america.com).

The Sunny Island 4248U also supports the automatic operation of 2-wire start generators as a standard feature. The optional GenMan unit enables the inverter to operate multiple-wire-start generators. The GenMan option is available from your local distributor/dealer. Manual-start type generators may also be used.

The terminal blocks are grouped according to function. This helps keep the wires for the different options together and makes for a more organized wiring compartment.

Sunny Island Applications

Off-Grid / Stand Alone Systems

By definition, off-grid or stand alone systems are systems where electrical power is generated and stored without assistance from the utility grid. These systems typically consist of one or more power generation sources such as a PV array, a wind generator, a hydro-electric generator or a gas powered generator.

Typically, there is a need to store the power that is generated. Without a storage method, power would only be available when one or more of the generating devices were active. (i.e. when the sun was shining for a PV array, or when the wind was blowing for a wind generator.) Batteries are the most common device used for power storage. The size and type of batteries used depends greatly on the system power requirements.

Because many of the loads that will be powered by the system require AC power as opposed to DC power, an inverter is needed to change the DC voltage to an AC voltage that can be used by the AC loads. This is exactly what the Sunny Island 4248U was designed to do.

The Sunny Island 4248U can also function as a battery charger for charging the battery bank. This mode operates by connecting an AC power source to the inverter's AC power input. The AC power source could be a gas powered generator or even the utility grid, if available at the system's location. The power generated by the external source can be used to power AC loads via the Sunny Island 4248U while the batteries are being charged at the same time. The Sunny Island 4248U watches the battery voltage and only applies the amount of power necessary to bring the batteries up to a full state of charge after all power required by the loads is supplied.

Back-Up Systems

A back-up system is configured differently from an off-grid system. The purpose of a back-up system is to supply power when the primary source of electrical power, such as the utility grid, fails for some reason. When used as a back-up system, the Sunny Island 4248U is designed to begin providing AC power automatically whenever the primary source of AC power shuts down.

In a back-up configuration, the Sunny Island 4248U still requires a source for its power. This is accomplished through the use of a large battery bank. Again, the size and type of batteries used will be determined by the intended operation of the system.

During times of normal operation where the primary source of AC power is active, the Sunny Island 4248U maintains the charge of the battery bank so that they are ready in the event of an outage. The Sunny Island 4248U applies a sophisticated charging algorithm to ensure that full charge capacity is maintained and that the life of the battery bank is maximized.

The Sunny Island 4248U also has the ability to connect external sources of power, such as a gas powered generator to assist in powering the loads and charging the battery bank during extended outages.

For security reasons all energy sources installed on the AC output side should meet all regulations for utility interaction.

Generators

Gas powered generators are a common component found in both off-grid and back-up systems. Generators come in many different sizes and determining the correct one will depend on the needs of the system. More importantly however, generators are divided into two basic groups: Auto-Start and Manual Start.

Auto-Start

Basically, an auto-start generator is designed to start and run automatically without personnel intervention. This requires that the generator is much more sophisticated in terms of its operation. For example, auto-start generators typically have much larger engine oil and gas capacities. They have sophisticated starting procedures such as crank times, retry counts and exercise routines. It is highly recommended that this type of generator be used if you require that the Sunny Island 4248U start a generator automatically. Please consult your installer or system designer for generator recommendations.

Manual-Start

Manual start generators require that they have to be started by hand using a key, button or pull-start system. These generators are less sophisticated and assume that there is personnel on hand to monitor its operation.

NOTE: Both types of generators will generate electrical power reliably, but care should be taken when selecting the type of generator to use in your system. Seek the advice of a qualified technician if you are unsure.

Safety

WARNING: There is an inherent risk of electrical shock or injury to personnel, or potential damage to the components to the system when working on and around electrical equipment. Be sure that you have read and understand the safety instructions in the front section of this manual and any other safety documentation provided with other equipment in your system. If you are unsure, secure the services of a qualified technician.

Battery Safety

Special care should be taken when working around batteries. Battery banks contain the potential to deliver extremely large amounts of current when shorted. Wires can be melted, tools can be welded, fires can be started. Even small battery banks deserve your utmost respect. In addition to the safety instructions in the front section of this manual, here are some helpful hints:

- Read, understand and follow the safety instructions provided with your batteries.
- Always wear safety glasses or goggles, gloves and protective clothing when working with batteries. Some batteries contain acid that may splash on you or into your eyes.
- Make sure that the batteries are in a well ventilated area. Batteries give off explosive gases which can detonate if allowed to accumulate.
- Always keep the battery area free of sparks or open flames.
- Make sure that an approved DC disconnect and over-current device is used between the battery bank and any equipment.

User Interface Functionality

The functions, modes, parameters and historical data within the Sunny Island 4248U are all displayed and accessed through the user interface menu system. To navigate to the different menus throughout the interface, you will use the arrow keys and both the ESC and ENTER keys. The functionality for each of the components found in the user interface area of the inverter is described in the table below.

Component	Functionality
DC Disconnect	Switches inverter on and off. In order to definitely switch off the inverter also disconnect all connections on the AC side!
2-Line Display	Displays status, parameters, historical data and errors
Red Indicator Light	Activates when inverter detects a fault, when stopped or derating
Green Indicator Light	Activates when inverter is operating
ESC Key	Cancel, answer NO, return to previous menu
UP Arrow Key	Scroll upward, increase value
Down Arrow Key	Scroll downward, decrease value
ENTER Key	Confirm changes, answer YES, go to next menu

Table 2-1: Sunny Island 4248U User Interface Component Functionality

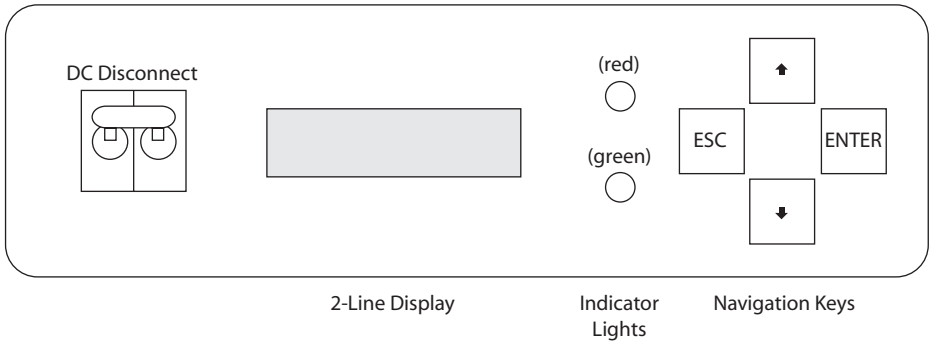


Figure 2-3 User Interface

The following table outlines the key functions.

Key	Function
ESC	Cancel, Answer NO, Move up one menu level
UP Arrow	Scroll Upward, Increase Value
DOWN Arrow	Scroll Downward, Decrease Value
ENTER	Select Function, Select Value, Confirm Changes, Answer YES

Table 2-2: Key Functionality

Changing Parameters

When a parameter is reached via the navigation keys, the current value of that parameter will be displayed. Next to that value will be a "return" character. This character represents a parameter that may be changed. To change the parameter, press ENTER and the "return" character will begin to blink next to the value. Once the "return" character is blinking, the value can then be adjusted by using the arrow keys. Once the desired value is reached, press ENTER to store the new value.

How Information is Displayed

Information from the Sunny Island 4248U is displayed on a 2-line LCD display. As you move up and down through the menus, 2 lines of information will be visible at a time.

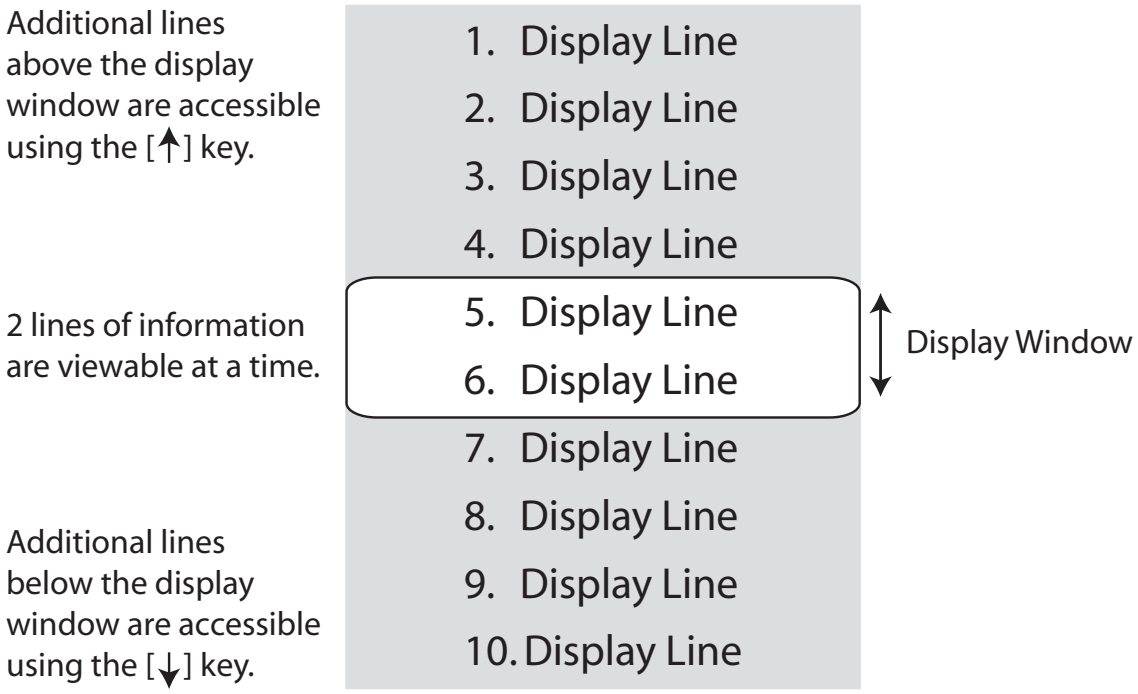


Figure 2-4 LCD Display Information

Home Screen

During normal operation, the Sunny Island 4248U displays the Home Screen. This screen shows relative output power, the operating mode of the inverter, if the generator start request has been sent, fault notification and the status of the load shedding and generator relays.

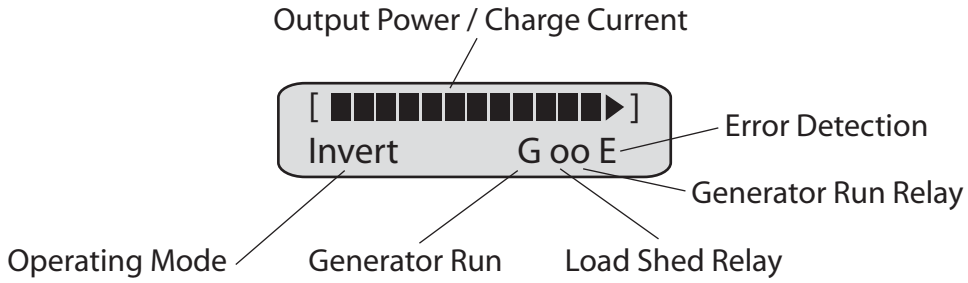


Figure 2-5 Home Screen

Power Output / Battery Charge Indicator

The output power and the battery charging power of the inverter are indicated by a series of blocks that run across the top of the display. This is a relative representation of the power of the inverter, so blocks that reach the halfway point on the scale represent the inverter running at half of its capacity.

The last indicator is an arrow rather than a block. If this indicator is lit it represents an overload condition on the inverter.

Operating Modes

In the lower left corner of the screen, the operating mode of the inverter will be displayed. The different operating modes of the inverter are:

- **Invert** Voltage mode
- **Charge** Current mode
- **DerInvert** Derated voltage mode
- **DerCharge** Derated current mode

Generator Request

Whenever the Sunny Island 4248U sends a request that the generator be started, it will display a **G** in the lower right area of the home screen. Once the generator is up to speed and the voltage and frequency of the power being produced by the generator is satisfactory, the **G** is replaced with an asterisk. "*" The asterisk will remain visible for as long as the generator is running.

The user has the opportunity to force starting and stopping of the generator in different ways (see "*Generator Settings (24)*" on page 82).

Note: In case of a "ReversePower"-failure the generator will be locked for 20 minutes. The lock time can be aborted manually (see chapter "*Generator Settings (24)*" on page 82).

Fault Detection

Whenever the Sunny Island 4248U detects a fault it will display the error code on the home screen for 10 seconds (and then restart if AutoStart is enabled). If the error is not acknowledged within that time, and the fault was not one that caused the inverter to shut down, an **E** (for Error) will be displayed in the lower right of the home screen to notify the user that an error has occurred. This **E** will remain visible until the fault is viewed by the user in the error menu. After the error has been viewed, the **E** will be cleared from the home screen.

The inverter maintains a log of the 10 most recent errors in the Error History menu. This menu is preserved when the inverter is powered down and is only cleared when performing a total system reset.

The inverter will detect the fault without acknowledgement up to 9 times and still continue to operate. (Provided the error type does not result in the shut down of the inverter.) On the 10th error detection without acknowledgement, the inverter will shut down and remain shut down until the error is viewed by the user.

Relay Status

Load Shedding: As you face the inverter, you will see two small **O**'s in the lower right of the home screen. The left **O** represents the state of the Load Shedding relay in the Sunny Island 4248U. **O** represents the Off or Open state. When the relay closes the **O** becomes solid like a dot, indicating that the relay is On or Closed.

Generator Start: The **O** to the right represents the state of the Generator Start relay in the same way as described above for the Load Shedding relay. It closes whenever the inverter is requesting that the generator runs.

Status LEDs

The RED and GREEN status LEDs work together to provide you with a variety of status information. Refer to the following table.

Operating Condition	Red LED	Green LED
INIT (Initialization)	ON	ON
Standby	OFF	OFF
Operating	OFF	ON
Derating	OFF	BLINKING
Fault	ON	OFF

Table 2-3: User Interface LED Indicators

Sunny Island 4248U User Menu Tree

The user menus are arranged in four simple groups: Meters, Settings, Diagnose and Operation. Using the information from the previous section, each of the parameters can be navigated to and changed if needed. The following diagram shows a simple map of the parameters that are viewable at the user level.

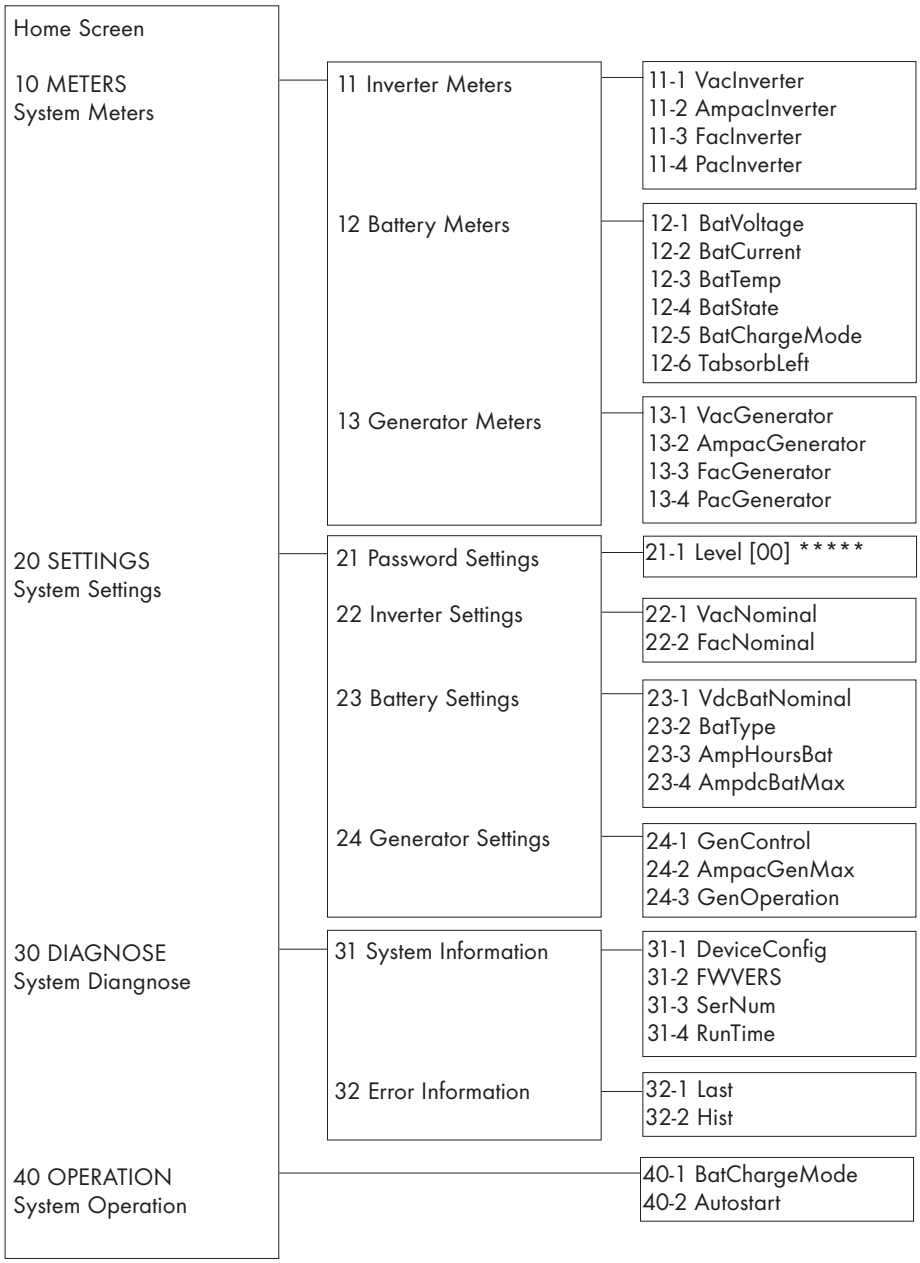


Figure 2-6 User Level Menu Map

User Menu Guide

The following tables contain information on each of the menu items available to the user in the Sunny Island 4248U. There are other items in the Sunny Island 4248U that are visible to the user, but the following items are those which do not require a password to change. Some items display information (meters) where others are operating parameters and can be changed. Please be careful when setting parameters as incorrect settings may cause undesirable operation of the inverter.

Once the second inverter is switched to slave mode, all main functions for the two inverters will appear only on the master display. All information that appears on the slave display should be disregarded as it will behave differently while the inverter performs slave-only functions.

NOTE: It is recommended that you record the value of every parameter change in the margin of these pages for future reference.

Meters

Inverter Meters (11)

Name	Range/ Unit	Default	Description
VacInverter	0 - 300 VAC	N/A	The VacInverter menu displays the AC output operating voltage of the inverter.
AmpacInverter	-70 - +70 AAC	N/A	The AmpacInverter menu displays the output current of the inverter.
FacInverter	45 - 70 Hz	N/A	The FacInverter menu displays the operating frequency of the AC output.
Pac	-10000 - +10000 WAC	N/A	The PacInverter menu displays the operating power of the AC ouput.

Battery Meters (12)

Name	Range/ Unit	Default	Description
BatVoltage	0 - 80 VDC	N/A	The BatVoltage menu displays the battery voltage.
BatCurrent	-200 - +200 ADC	N/A	The BatCurrent menu displays the DC current.
BatTemp	-40 - +200 °C	N/A	The BatTemp menu displays the battery temperature.
BatState	Norm, Warn, Low, Crit	N/A	Battery state (BMS) The BatState menu displays the current state of charge of the batteries.
BatChargeMode	-----, Auto, Boost, Full, Float, Equalize	N/A	The BatChargeMode menu displays the charging mode of the inverter. For detailed information about charge modes see chapter “Battery Management” on page 60 **-----:** will be shown on Slaves in Split-Phase Mode only.
TabsorbLeft	0 - Max min	N/A	Every charge mode has a dedicated absorption time that might have been adjusted by your system installer. For this time normally the Sunny Island will have to keep the generator running, even if it seems that there is enough energy in the system and the generator is hardly loaded. The counted down value of "TabsorbLeft" shows the remaining time for this state.

Generator Meters (13)

Name	Range/ Unit	Default	Description
VacGenerator	0 - 260 VAC	N/A	The VacGenerator menu displays the AC voltage at the inverter generator input.
AmpacGenerator	-60 - 60 AAC	N/A	The AmpacGenerator menu displays the AC current at the inverter generator input.
FacGenerator	0 - 70 Hz	N/A	The FacGenerator menu displays the AC frequency at the inverter generator input.

Name	Range/ Unit	Default	Description
PacGenerator	-20 - 20 kWAC	N/A	The PacGenerator menu displays the AC power at the inverter generator input.

Settings

Inverter Settings (22)

Name	Range/ Unit	Default	Description
VacNominal	105 - 130 VAC	120	The VacNominal parameter sets the nominal output voltage of the inverter.
FacNominal	55 - 65 Hz	60	The FacNominal parameter sets the nominal output frequency of the inverter.

Battery Settings (23)

Name	Range/ Unit	Default	Description
VdcBatNominal	42 - 48 VDC	48	The VdcBatNominal parameter sets the nominal operating voltage of the inverter.
BatType	VRLA FLA	VRLA	The BatType parameter selects the type of battery used in the system. **VRLA** = Valve Regulated Lead Acid **FLA** = Flooded Lead Acid Once the system is configured, this parameter can only be changed via „NewBattery“ (installer password required).
AmpHoursBat	100 - 6000 Ah	100	The BatCapacity parameter sets the total amp-hour capacity of the battery bank. This parameter needs to be set when the inverter is first commissioned. Once the system is configured, this parameter can only be changed via „NewBattery“ (installer password required).
AmpdcBatMax	0 - 100 ADC	10	The AmpdcBatMax parameter sets the DC charge current limit to the batteries.

Generator Settings (24)

Name	Range/ Unit	Default	Description
GenControl	Manual, Direct, GenMan	Manual	The GenControl parameter selects the type of generator control to be used with your system. **Manual**: Manual start type or no generator connected. **Direct**: Two-wire start generator connected to the dry contacts in the inverter. **GenMan**: GenMan option installed.
AmpacGen-Max	2 - 60 AAC	10	The AmpacGenMax Parameter should be set to about 85 % of the maximum AC current of your generator. In Charge Mode the Sunny Island 4248U will then limit the total current (loads in the system + Sunny Island) to this value in order to prevent the generator from stalling. **Note:** If the load in the system is above this value in Voltage Mode, the Sunny Island 4248U will not switch to Charge Mode for the same reason.
GenOperation	Auto, Start, Stop, Run1h, Release	Auto	The GenOperation parameter forces the generator to react immediately: **Auto:** Normal control by Sunny Island is active (the display might show "G" or "*") **Start:** Generator will be started by the Sunny Island immediately (the display will show "R"). Remember to stop the generator when not needed anymore (by selecting either "Stop" or "Auto") **Stop:** Generator will be stopped by the Sunny Island immediately (the display will show "S"). Remember to set the generator back to "Auto"-mode if you want the Sunny Island to take over control again. **Run1h:** Generator will be started immediately and will kept running for one hour (the display will show "T"). This might be useful in order to conserve battery lifetime if you can forsee that the generator can run at rather full capacity within the next hour. Afterwards the Sunny Island will switch back to the mode it has been in before. If "Run1h" was selected from "Start" mode the Sunny Island will switch back to "Auto" after one hour time. **Release:** Aborts the lock time (20 min) for the generator after a "ReversePower" failure has occurred.

Diagnose

System Information (31)

Name	Range/ Unit	Default	Description
DeviceConfig	N/A	SI4248 U	The DeviceConfig parameter displays the name of the device.
FWVers	N/A	N/A	The FWVers menu displays the version number of the firmware installed in the inverter.
SerNum	N/A	N/A	The SerNum menu displays the serial number of the inverter.
RunTime	N/A Hours	N/A	The RunTime menu displays the total time the inverter has been operating.

Error Information (32)

Name	Range/ Unit	Default	Description
Last	N/A	N/A	The Last menu displays the most recent error that occurred in the system.
Hist	N/A	N/A	The Hist menu displays the last 10 errors to occur in the system. This is a revolving list, the first item in is the last out and it is only cleared when a system reset is performed.

Operation

Name	Range/ Unit	Default	Description
BatChargMode	Auto, Boost, Full, Float, Equalize, Manual	Auto	The BatChargMode parameter allows you to override the Auto charge mode of the inverter. **Auto:** Inverter maintains charge automatically. Selecting any of the other modes will automatically place the inverter into that mode. For example, if you want to perform an equalize charge on your flooded batteries, you would select Equalize in this menu to put the inverter into equalize mode. For details about the special charge modes see "*Battery Management*" on page 88. **Manual:** For future use. Please do not select.
Autostart	Off/ On	Off	The Autostart parameter allows the inverter to start automatically whenever DC power is applied to it or after a fault has been detected (up to 10 times). If AutoStart is OFF, the inverter will always have to be started manually.

Start Up

Powering Up

WARNING: This step in the User's Manual assumes that the Sunny Island 4248U has already been checked for proper connections, voltages, polarities and has been commissioned by your installer. If this is the first time the inverter will be powered up, refer to the Commissioning instructions in the Installation part of this manual. If you are not qualified to perform the commissioning of the inverter, secure the services of qualified personnel.

To turn on the Sunny Island 4248U, switch the DC disconnect on the front of the inverter to the ON position. This will cause the inverter to come on and enter the INIT phase of start up. During this phase the inverter performs a series of self tests to determine that there are no faults present in the system before beginning operation.

Once the INIT phase is complete, the inverter will display "Press <Enter>". Pressing the ENTER key will start the inverter.

If the AUTOSTART parameter is set to ON, once the DC disconnect is switched to the ON position, the inverter will begin operating automatically after a short delay.

Once the inverter begins operating, it displays the home screen which shows the current operating mode and power throughput.

As described previously, use the User Interface to navigate and view parameter settings. If in doubt, refer to the User Interface section of this manual.

Shutting Down

To turn off the inverter press and hold the ESC key. When prompted to turn off the inverter, press ENTER. The inverter will then remain in standby mode.

To power down the inverter, switch the DC disconnect on the front of the inverter to the OFF position.

CAUTION: Even then the inverter may start, if any voltage source is accidentally applied to the AC side. To be sure the inverter will remain off, also disconnect it on the AC side.

Maintenance

Sunny Island 4248U

The inverter has been designed to provide years of trouble-free service. As such, the only maintenance required is the periodic cleaning of the filters for the cooling fans. The actual cleaning interval for these filters will depend on the air quality at each installation. We recommend a visual inspection of the filters monthly at the minimum. To clean the fan filters, use a vacuum (recommended) or a whisk broom to clear any debris from the screens. Perform screen cleaning only when the fans are OFF.

If it becomes necessary to replace a fan, the instructions for performing the replacement will be provided with the new fans. **Replacement of the fans should only be performed by qualified personnel.**

Enclosure

Check the enclosure of the Sunny Island 4248U for mechanical integrity. Should there be any damages reducing the Sunny Island 4248U's operating safety (cracks, holes, fissures, missing covers) the Sunny Island 4248U has to be decommissioned immediately!

Large dirt particles should be removed from the device with a soft hand brush or a similar tool. Fine dust can be wiped off the enclosure parts with a soft moistened cloth. Cleaning agents containing solvents or abrasives should not be used to avoid scratching the paint layer.

Batteries

The battery bank will also require periodic maintenance. They may need to be topped off with water and have the tops of the battery cases and terminals cleaned and clamps inspected for tightness. Refer to the manufacturer's care instructions that came with the batteries and be sure to wear protective clothing.

State Machine

The following diagram shows the state relationships for the Sunny Island 4248U.

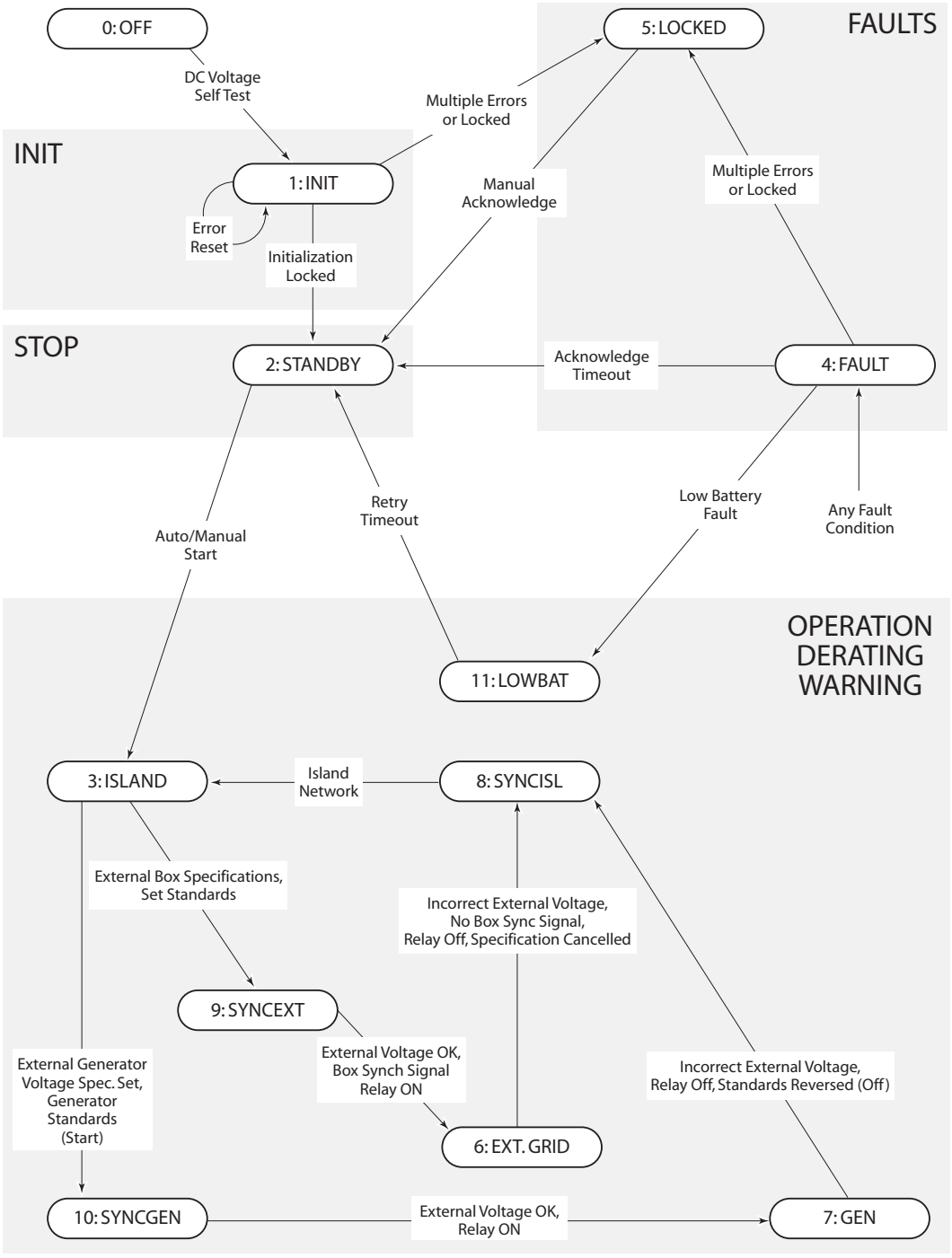


Figure 2-7 Sunny Island 4248U State Machine

Battery Management

Charging Operations used by the Sunny Island

The battery management system allows automatic operation (without user interference required) of 3 different charging operations:

- Boost Charge:
  fast charging operation with short generator run time for quick battery charge (to state of charge of approximately 85 ... 95 %)
- Full Charge:
  charging the battery full – requiring longer generator run time (absorption time) at low generator load condition (to state of charge of approximately 92 ... 97%)
- Equalizing Charge:
  equalizing all cells with long generator run time at low load condition (to state of charge of approximately 95 ... 100 %)

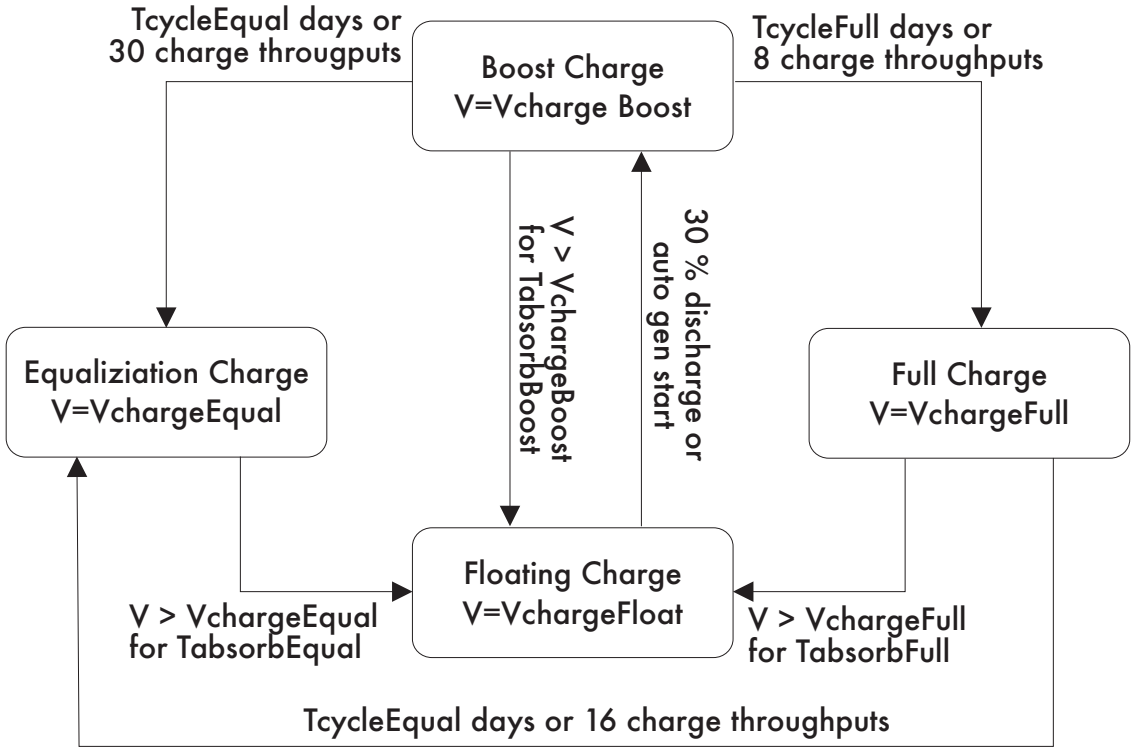


Figure 2-8 State Transition Chart for charge processes: Charging voltage setpoint depending on charging process and transitions

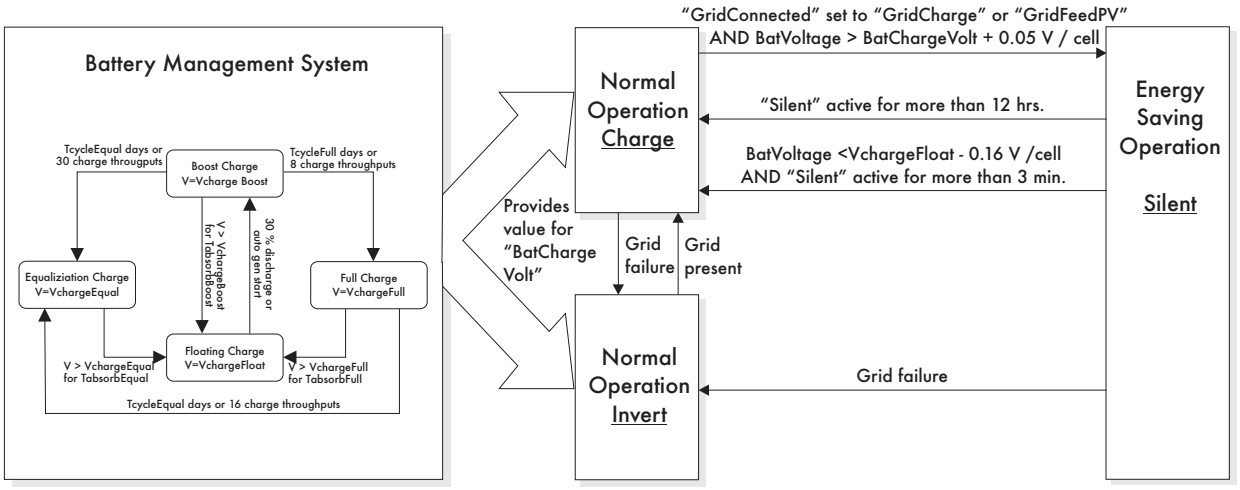


Figure 2-9 Battery Management System

Each charging operation (Boost charge, Full charge and Equalizing charge, and Floating Charge too) can also be activated manually. For customer convenience all transitions are done automatically (see "*State Transition Chart for charge processes: Charging voltage setpoint depending on charging process and transitions*" on page 88) – with cycle times adjustable (TcycleFull, TcycleEqual). The number of charge throughputs (of Amp hours of nominal battery capacity – C20 passed through the battery) are fixed and not adjustable. Charge throughputs are only calculated from energy passing through the Sunny Island 4248U. Each additional energy (DC charger or DC loads) are not regarded by Sunny Island 4248U. In rare case, where conditions for two charging operations are met, Boost Charge come before Full Charge before Equalization Charge. The charging processes will then appear in this order.

Each charge operation consists of a full charge phase with limited current (by generator maximum AmpacGenMax current or by maximum DC charge current AmpdcBatMax) and an absorption phase after battery voltage has reached the charge voltage setpoint. The remaining time for the absorption phase is displayed as the meter (Battery) "TabsorbLeft".

After completion of the absorption phase the generator is switched off (in case of operation together with a generator). The charge operation is finished and charge voltage setpoint goes to Float State. The Float State affects the operation of the Sunny Island 4248U only in systems with AC coupled PV (Sunny Boys) as the generator is stopped in this state and the control loop which controls the charge current is inactive. For AC coupled PV a different control loop stays active while Sunny Island 4248U is in Voltage Mode (no Generator running) which controls the output power of the Sunny Boys by the calculated charge voltage setpoint (in all charging processes and Float state).

SMA America. Inc.

www.sma-america.com

12438-C Loma Rica Drive
Grass Valley, CA 95945
USA
Phone +1 530 273 4895
Fax +1 530 274 7271
www.sma-america.com

Headquarters:
Hannoversche Str. 1-5
34266 Niestetal
Germany
Phone +49 561 9522 0
Fax +49 561 9522 100
www.SMA.de