SOLAR STIK®

SYSTEM SETUP, OPERATION AND MAINTENANCE MANUAL FOR WORLD HOUSING SOLUTIONS POWER SYSTEMS

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Important Safety Information and Instructions

This manual contains important instructions that must be followed during the installation and operation of the System. Read all instructions and information contained in this manual.

Thoroughly read and understand the operator manual for each of the components in this System PRIOR to assembly and use of this System. Important information regarding the safe setup and use of each component and this System is contained in each of the operator manuals. DO NOT begin assembly or use of this System without first reading and understanding the individual operator manuals.

While the System components are designed for indoor/outdoor operation, the User Interface (control panels) must not be exposed to rain, snow, moisture, or liquids. Close and latch and/or lock the cases when the components are unattended.

Exercise caution when handling or operating the System. Live power may be present.

Safety Information Labels

Your safety and the safety of others is very important.

Many important safety messages have been provided in this manual and directly on the System components. Always read and obey all safety messages.

This is the safety alert symbol. This symbol is an alert to potential hazards that can cause death or injury. All safety messages will follow the safety alert symbol and the word “DANGER”, “WARNING”, or “CAUTION”. These words are defined as:

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

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

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

All safety messages will describe what the potential hazard is, how to reduce the chance of injury, and what can happen if the instructions are not followed.

Fire Hazard

Fire Types

Class A fire - Fires in ordinary combustibles such as wood, paper, cloth, trash, and plastics.

Class B fire - Fires in flammable liquids such as gasoline, petroleum, oil, and paint.

Class C fire - Fires involving energized electrical equipment such as motors, transformers, and appliances. Remove the power source and the class C fire becomes a class A or B fire.

Recommended Fire Extinguisher

NSN 4210-00-288-7219 Fire Extinguisher, Carbon Dioxide, 10 lb
Carbon dioxide is a liquefied gas, which is highly effective fighting class B and C fires. These extinguishers are ideal for areas where contamination and/or cleanup are a concern, such as data processing centers, labs, and telecommunication rooms.

⚠ WARNING

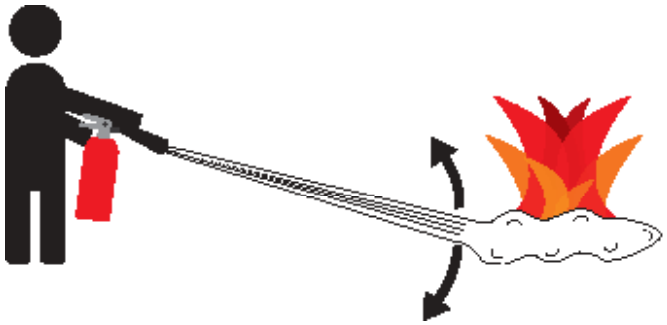
Only CO_2 (carbon dioxide) fire extinguishers should be used with this equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

Pull the pin.
Aim the nozzle or hose at the base of the fire from a safe distance.
Squeeze the operating lever to discharge the fire extinguishing agent.
Sweep the nozzle or hose from side to side until the fire is out. Move forward or around the fire as the fire diminishes.

Watch the area for reignition until the cause has been fixed.



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

- System components should not be operated in standing water.
- Close and latch the component lids if it is precipitating.
- System cables should not be routed through standing water.
- Cable connections should remain dry.
- Unused ports on System components should be covered when not in use to reduce the possibility of water intrusion.

Electric Shock Hazard

⚠ WARNING

Standing water around the electrical equipment and/or intrusion of water into the System components can increase the risk of electrical shock.

DON'T LET THIS BE YOU!

HIGH VOLTAGE: System components, PV arrays, and generators may produce lethal line voltages. Extreme care should be taken to protect against electrocution. Always work with another person in case an emergency occurs. Disconnect power before performing maintenance. Wear safety glasses whenever working on any part of a system that requires exposure to mechanical or direct electrical contacts.

⚠ WARNING

The System is NOT GFCI protected.

Grounding the System

Grounding the PRO-Verter at the grounding lug is an important safety measure. The PRO-Verter and the generator (if included) should be bonded to an earth grounding rod. When the generator is running, the AC neutral and equipment ground automatically are bonded internally at the generator. When running off battery, the AC neutral and equipment ground are automatically bonded internally at the PRO-Verter.

If the System is ever connected to grid power, the AC neutral must be bonded to the earth ground at the main breaker panel of the grid power. Any generator connected to the System must have a neutral-to-ground bond.

Figure 1. PRO-Verter grounding lug

Environmental and Handling Precautions

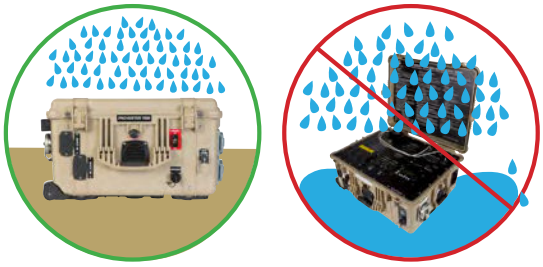
All Solar Stik components are ruggedized, yet there are a few things the operator can do to prevent failures and prolong the operational life of the Solar Stik System.

Wind

It is imperative to properly secure PV panels to the ground using sandbags so they do not become dangerous projectiles in high winds.

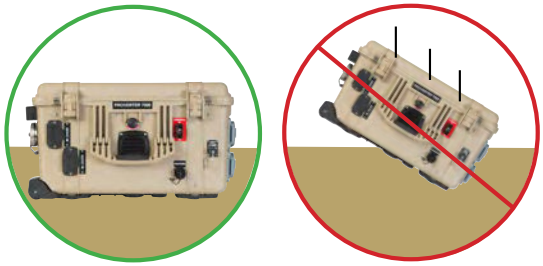
Water

If outdoor operation is necessary, the lids of all components should be closed and latched. During operation, cases should be placed upright, especially during inclement weather. Lids should be open only to access operator controls and closed at all other times.



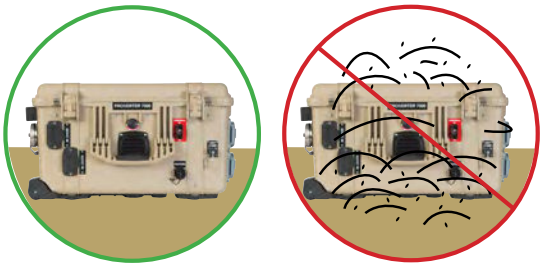
Impact

Equipment should not be dropped onto hard surfaces at a height greater than one foot when transporting or during operation.



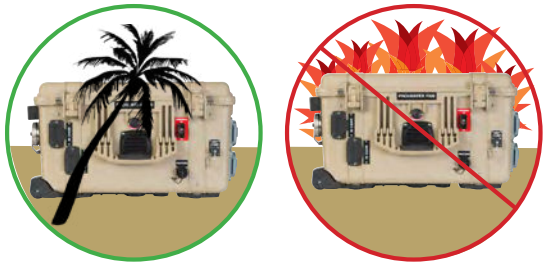
Dust/Foreign Object Intrusion

Air intake filters should be cleaned once per month, or more frequently when conditions warrant. As a general rule, minimize exposure to high levels of particulates and foreign object debris by exercising common-sense placement and protection during both operation **and** storage.



Heat

Heat and solar loading reduces efficiency and life expectancy. Shade components (except PV panels) to prevent the negative effects of heat.



THEORY OF OPERATION

Hybrid Power System Models of Operation

Depending on the application, there are several operational models that can be configured using a PRO-Verter.

> **Note:** The PRO-Verter settings used in each model of operation are unique and not interchangeable. The PRO-Verter must be programmed specifically for the model of operation in which the System is functioning. Damage to System components may occur if a PRO-Verter is not properly programmed for the model of operation in which the System is functioning.

DC-only/Inverter (Automatic Functions)

Operating conditions – All power generated is from DC generators, and AC loads are supported by the PRO-Verter's Inverter function using energy stored in batteries.

Hybrid (Automatic Functions)

Operating conditions: The "Continuous Load" AC power requirement is LESS than the individual inverter or generator/grid AC power output ratings.

In the Hybrid Model, the PRO-Verter serves as the primary power management device in a System, using either inverter AC power or generator/grid AC power to maintain the load. In the Hybrid Model, the batteries will cycle regularly to mitigate generator runtime and logistical support often associated with operation in remote locations. Hybrid systems also provide the operator with a flexible architecture that allows for the addition of multiple power sources, such as renewable power generation.

Load Support (Automatic Functions)

Operating conditions: The "Surge Load" AC requirement is MORE than the generator or grid AC output, but less than the inverter AC output rating.

The Load Support Model allows the use of a smaller generator based on total loads operating over 24-hour period rather than a larger generator that is required for the "peak" loads, which may only last for a brief period. The PRO-Verter can be used to provide supplemental "surge" AC power to a generator or grid AC source during brief or intermittent periods while allowing the "continuous" loads to be supported in the Hybrid Model.

Peak Power Delivery (manual functions)

Operating conditions: The "Peak Load" AC requirement is MORE than the PRO-Verter AC continuous output ratings.

In the Peak Power Delivery Model, the PRO-Verter combines generator or grid AC power with Inverter AC power to support "peak" AC for brief periods. This mode can only be supported for limited durations and is directly dependent on the total battery capacity and battery SOC.

UPS (Automatic Functions)

Operating conditions: A PRO-Verter connects critical AC loads directly to grid utility or prime AC power when it is available, and provides backup power for the load by supplying inverter AC (using energy from a connected battery bank) when the Grid utility or prime AC source is interrupted.

In the UPS Model, “peak shaving” and the use of renewable power sources are also possible by connecting a Power Hub.

> **Note about PRO-Verter Model Programming:** The PRO-Verter is programmed at the factory for use in the application in which it is to be used. It is possible for the Operator to alter any of the programmed settings when operating conditions change and/or System architecture changes are necessary. To learn more, contact Solar Stik Technical Support.

The HPS Architecture, Function, and Operation

The Solar Stik HPS incorporates three technologies that comprise a network:

- Energy storage
- Power management
- Power generation

The PRO-Verter, Power Hub, and Expander Paks are designed to operate in concert and provides uninterrupted pure sine wave AC and DC power to the loads. The HPS is a powerful solution for the following conditions:

1. The generator requires protection from adverse operating conditions.
2. Grid or generator AC power sources are not present or only intermittently available.
3. Power requirements for the load may exceed an existing power source’s daily power output, requiring multiple power sources to operate in concert to meet the daily demand
4. The reduction of fuel-driven generator “runtime” is necessary, due to logistics concerns or to simply to reduce the cost burdens of operating a generator.

It is important to follow two rules when configuring power generation and energy storage technologies to serve in an application:

1. The power generated over 24 hours must be greater than or equal to the power consumed
2. The energy storage capacity must be able to power the load over 24 hours (with no recharging)

Energy Storage—The Foundation of the HPS

Operating a generator may have significant cost burdens (logistics, support, etc.). The HPS alleviates those cost burdens by redirecting the financial investment into a battery-based platform.

Batteries in a hybrid system are designed to “cycle”. A full cycle is defined as one complete discharge and recharge over a specific period of time. With every cycle that occurs, the HPS is providing a return on the financial investment.

All batteries have a cycle-life and therefore should be considered the “consumable” part of the HPS. The health of the battery can directly affect the function of the HPS over time, so proper cycling and cell-health management practices are strongly encouraged.

Minimum Battery Capacity Required for Optimal System Operation

A HPS will function most efficiently when proper balance is achieved within the System’s architecture (energy storage, power management, and power generation). The central power management device is the PRO-Verter, so any components connected to it need to be rated for the amount of power that will be processed by it.

For example, the PRO-Verter can require extremely high current (amperage) ***from*** the battery bank when AC loads require power from the inverter, but it can also push high current ***into*** the bank when it is in charge mode.

Each ESMhas a built-in circuit breaker that will trip at a value ***less than*** the maximum rated current to/from the PRO-Verter. For this reason, multiple Expander Paks must be connected to a PRO-Verter for the System to function at its rated power. **The combined values of the ESMcircuit breakers must be greater than the rated inverter/charger current required from the PRO-Verter**.

In the HPS, the PRO-Verter 5000 inverter can require up to 200 A from the batteries, and the charger has a rated output of 110 A. Four (4) 24VDC Expander Paks is the MINIMUM number required to support the inverter’s full inverter output and be charged effectively and safely when the PRO-Verter 5000 is in charge mode.

Connecting an insufficient number of Expander Paks (energy storage modules, or ESMs) to a PRO-Verter will result in a situation where the batteries are charged or discharged too quickly:

- Charging $LiFePO_4$ Expander Paks too quickly may result in an artificially high battery voltage reading and signal the PRO-Verter to turn off the generator before the batteries are actually charged sufficiently.

- Discharging $LiFePO_4$ Expander Paks too quickly may cause the battery temperature to rise to a point that the battery management system (BMS) disconnects the batteries from the whole system.

Refer to the “Minimum Battery Capacity Recommendations” on the PRO-Verter I-Plate to ensure trouble-free operation.

System Cycling

During normal operation, the generator runs only to charge the ESMs and support the load while doing so; the batteries and generator will cycle 1–2 times daily.

The overall health of the HPS can be determined by the amount of cycling that occurs in a 24-hour period. If the HPS cycles more than twice daily, or is experiencing irregular cycling, there are several factors that may be causing it:

- Excessive load
- Inadequate battery capacity
- Heat-derated performance
- Disparity in battery SOC

Consult the troubleshooting sections for more details on causes of irregular or excessive cycling.

Load Prioritization

When the HPS is fully functioning, providing power to the load is always prioritized over other functions.

If renewable DC generators (i.e., PV arrays, wind, etc.) are producing power, it is immediately directed to to the load once it flows into the HPS. The batteries will begin to charge ONLY when the DC generation exceeds the demand from the load.

During periods of peak renewable DC power production, it may be exclusively used to support the load while excess energy charges the batteries simultaneously. This function reduces the demand on the batteries, prolongs battery operation time, and promotes healthy cycling of the battery.

This same function also occurs when the HPS is connected to an AC source. If the HPS is connected to an active generator or grid utility, the load is always supported FIRST before any AC is used for charging the HPS batteries. If the PRO-Verter is controlling a connected generator and the battery bank reaches a low state-of-charge, the PRO-Verter can be programmed to auto-start the generator to keep AC flowing to the load, charging the connected batteries only after the load is fully supported by the generator.

Real-time Load Management

When connected to an active AC source, the PRO-Verter can automatically adjust (in real time) its battery charging rate to keep the total load value under the AC INPUT setting value.

If the load is dynamic, the PRO-Verter can make immediate adjustments and keep the total load on the AC source from exceeding the value of the AC INPUT setting while still maintaining a 100% load at the external AC source (generator or grid utility).

It is incumbent on the Operator to ensure the sum of all loads does not exceed the limit of the AC source (generator or grid utility) or the connections or circuit protections in the network. The AC INPUT (FAVS 03) setting should be set to the same value of the maximum AC output rating of the source. For example, if a generator is rated for 7000 W continuous output, then the AC INPUT should be set for 26 A* (25-30 A @ 230 VAC = 6000-7000 W).

“Overload” Conditions

Over loading of the System can occur under the following conditions:

- Load AC power demand is greater than the inverter’s rated output.
- Load AC and DC power demand is greater than the connected AC source (generator or grid utility).
- Load AC power demand is greater than the AC INPUT setting, which may cause the PRO-Verter to disconnect from the AC source when in pass-through (charging) mode.
- Load AC and DC power demand is greater than the output of the connected AC source (generator or grid utility), causing it to shut down.

In each of these scenarios, the solution is simply a reduction in the total load demand (AC and DC). Use the AC and DC METERS to confirm the load is reduced to prescribed levels and proceed with normal operation.

Managing Lag Time and Surge Rates

The PRO-Verter’s inverter function can provide up to 130% of its rated power output for brief surges that may be required to support a load. Most generators are also rated to support brief surge loads. A PRO-Verter should be paired with an appropriately rated generator, but if it is paired with a smaller generator, the AC INPUT setting must be set to limit the AC power the PRO-Verter will expect from the AC source. In this scenario, it is possible for the PRO-Verter to put up to 130% load on the AC source (generator or grid utility), which can occur when charging mode is engaged and a sudden AC surge is demanded by the load. Since the PRO-Verter can’t determine in advance how much power will be demanded at the time of the surge, it can only “react” to the surge condition. It may take up to 1 full second for the PRO-Verter to react, and this period is known as “lag time”. Lag time results in 130% of the AC INPUT setting being demanded from a generator for up to 1 second.

If the generator can’t handle 130% surge, it will likely crash the System in the following ways:

- The generator AC output voltage may drop below the VAC DROPOUT setting in the PRO-Verter.
- The generator AC contactor (if present) or circuit breaker may open, causing a loss of AC at the PRO-Verter.
- If the generator has an electronic protection circuit, it may cause the unit to shut down entirely.

All of these issues are resolved by dropping the AC INPUT setting less than 130% of the output rating of the connected AC source.

EQUIPMENT DESCRIPTION

The Inter-Connect System

The System is comprised of three (3) distinct types of technologies:

- Energy storage
- Power management
- Power generation

All of the individual components that operate in these categories utilize a unique connection architecture known as the Inter-Connect Circuit.

The Inter-Connect Circuit is the connection framework of the System's DC power network. It uses a simple, polarized, locking connection that is common throughout the architecture. All power management, energy storage, and power generation components are compatible with the Inter-Connect Circuit.

Using a common, polarized connector allows rapid "Plug & Play" scaling of components, adaptation of capabilities within the architecture, technology refreshment, and swapping of components when conditions warrant. It also ensures that there is no unsafe way to make connections.

Circuit Breaker Protections
The Inter-Connect network is protected from overloads and short circuits through a network of circuit breakers strategically placed throughout the circuit. It ensures the potential for a reverse polarity connection within the circuit is minimized. If a problem occurs in a leg of the Inter-Connect Circuit, the affected leg will disconnect from the primary network, leaving the other circuits functioning. If a major failure occurs in the circuit, then the entire network will shut down for System and Operator protection.

Operate with Voltage
The Inter-Connect Circuit communicates simple battery voltage to all components on the network, allowing them to independently coordinate their respective functions. Battery voltage is used to trigger actions such as Automatic Generator Start/Stop (AGS) function, power distribution timing, and more. Therefore, the proper setup of the Inter-Connect Circuit is critical to properly communicate voltage to all points in the System and to ensure all of the components operate together to provide seamless power to the load.

Optimize with Data
Data collection for a System occurs through the Inter-Connect network. Power management devices such as Power Hubs and PRO-Verters meter voltage, current and time through the circuit, providing critical real-time data the Operator can use to troubleshoot and verify System performance. Data collection enables programming/architectural changes to optimize performance based on evolving conditions.

The Standard Inter-Connect Plug

- Polarized
- 200 A maximum current
- 24 VDC connection only
- Mechanically “locks” into place
- Rotate knob clockwise to lock, counterclockwise to release
- Can be repaired or modified in the field

Figure 2. Inter-Connect Plug

PRO-Verter Faceplate

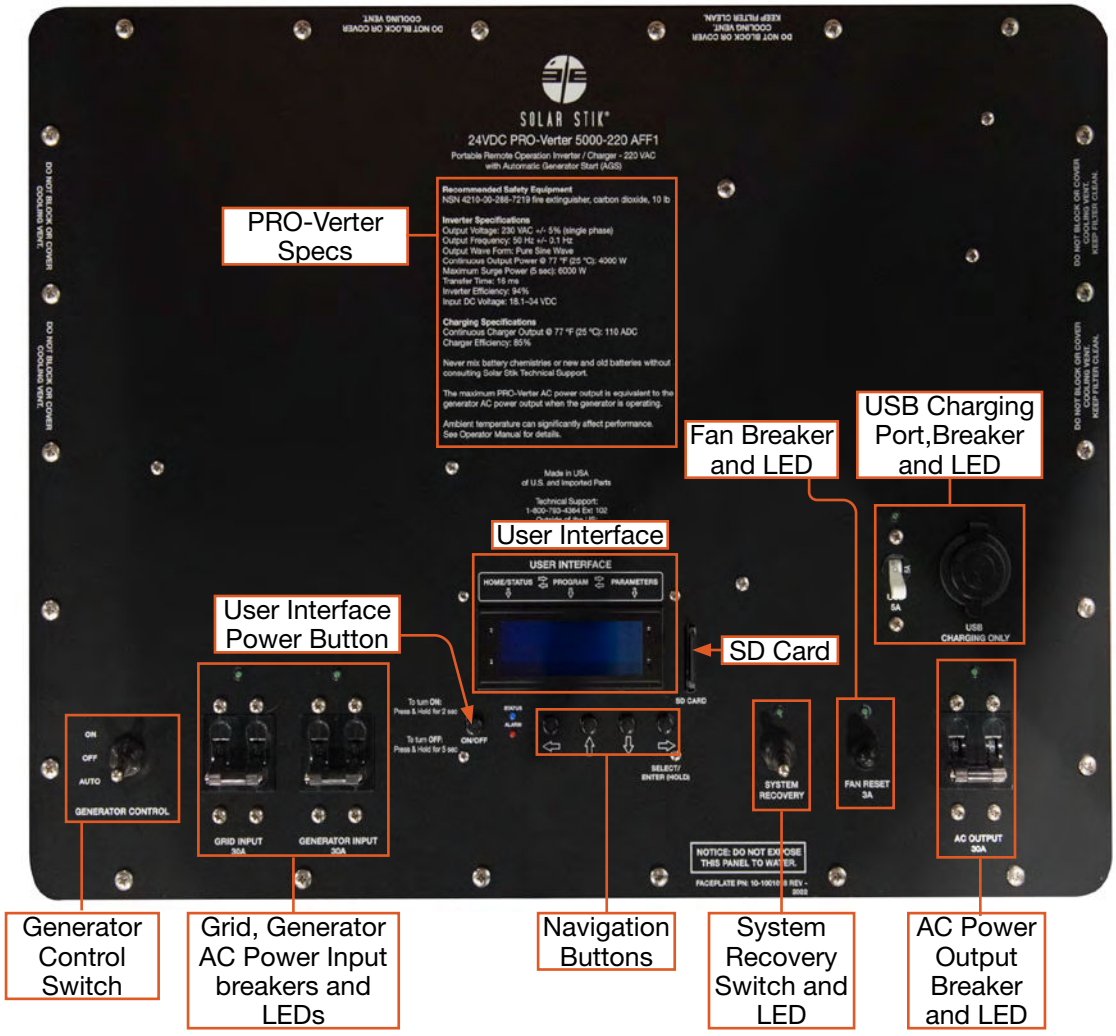


Figure 3. PRO-Verter Faceplate features

User Interface – The user interface is used to program and control the PRO-Verter and to monitor System status. The PRO-Verter is programmed at Solar Stik to meet the specifications of a specific application. Programming mode can be accessed if reprogramming is required. Contact Solar Stik Technical Support.

SD Card Port – An SD card must be installed for PRO-Verter to log data. This is an optional function. A dummy SD card is installed prior to shipment from Solar Stik.

Auto Generator Start/Stop (AGS) Switches – The “On” position manually turns on a connected generator; the “Auto” position automatically starts and stops the connected generator based on programmed, battery voltage values. The “Off” position defeats AGS communication with any connected generator.

In/Out Breakers/Switches – The breakers serve as switches to activate circuits and to turn off circuits not in use. Circuit breakers protect against overcurrent conditions in dedicated circuits. If too much amperage flows due to short-circuit, inadequate or improper loading, or component failure, these will protect the System and Operator. The green LED over each breaker will be lit if the circuit is active and the breaker is not tripped.

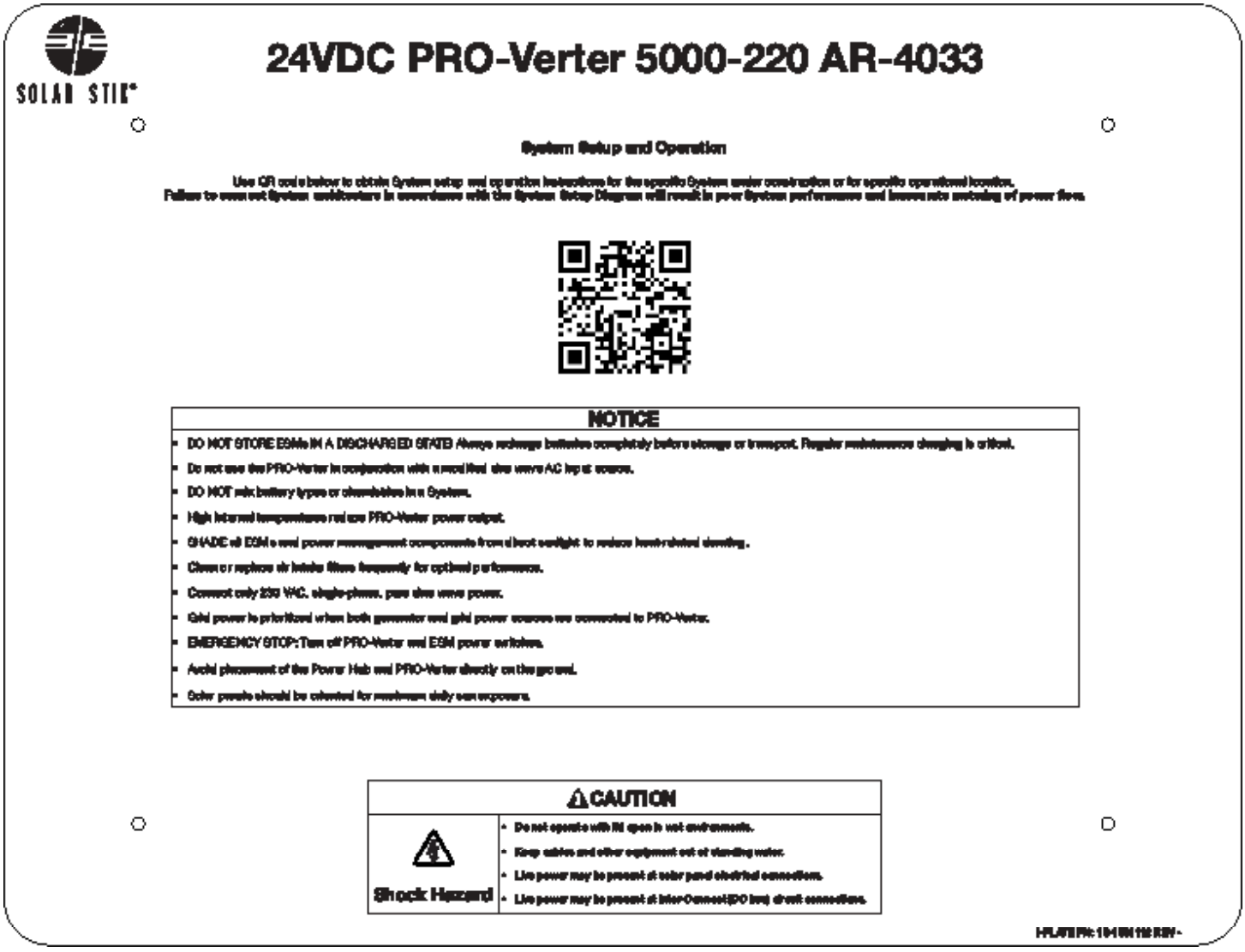
USB Charging Ports and 5 A Breaker – The USB ports are for charging only; no data are transmitted via these ports. Push to reset the breaker if either of the USB ports is not operating while the PRO-Verter is turned on.

Cooling Fan 3A Breaker – The internal cooling fans are audible when functioning. The LED above the breaker will be illuminated when fans are active. If LED is off during operation, press button to reset.

System Recovery Switch – This switch provides a method to start the PRO-Verter when the System batteries have been overdischarged. Connect the PRO-Verter to a 230 VAC power source. Press and hold the System Recovery button. Turn on the PRO-verter user interface. Continue pressing the System Recovery button until the user interface reports “Charging”.

The Information Plate (I-Plate)

The PRO-Verter I Plate provides critical setup and safety information for the Operator. The QR Code brings an operator to an online downloadable PDF of this and other supporting manuals.



OPERATOR INSTRUCTIONS

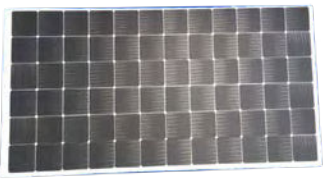
System Setup

Inventory System components.

Inventory for Two (2) Systems

☐ Two (2)
24VDC PRO-Verter 5000-220

☐ Two (2)
24VDC Power Hub 3500
(includes one 5’ Inter-
Connect Cable)



☐ Twelve (12)
Glass 340 W Solar Panels and
mounting hardware

☐ Ten (10)
24VDC Li ESM 2700s

☐ Four (4)
Inter-Connect
Strip 7

☐ One (1)
Cable Transport Case

☐ Four (8)
24VDC 5’
Inter-Connect Cables

☐ Ten (10)
24VDC 5’
Inter-Connect Battery Cables

☐ Six (6)
30’ Solar Cable

Figure 4. Inventory for two (2) Systems

System Connection Map

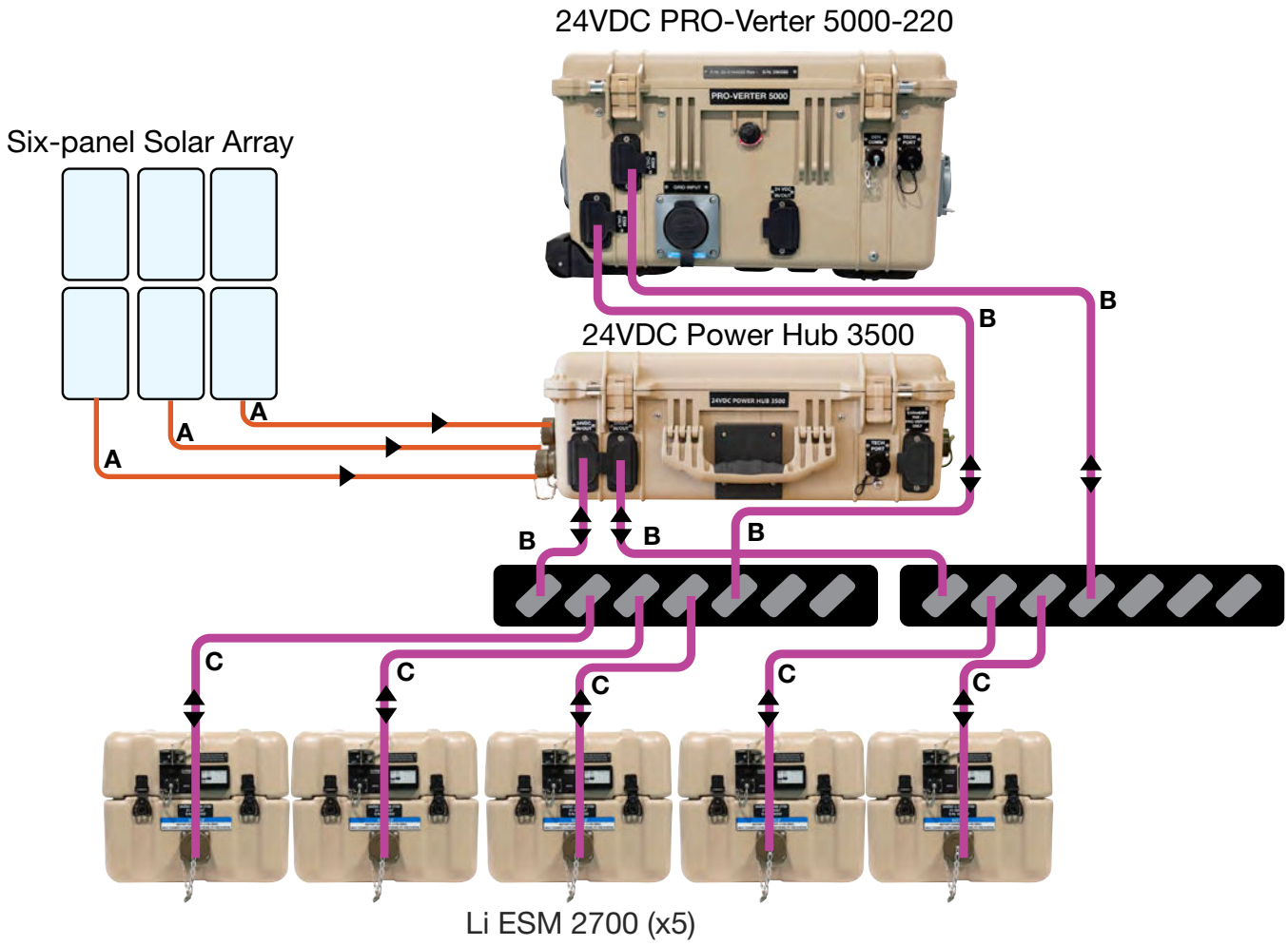


Figure 5. System connection diagram and Cable ID Table

	Item #	Cable Name
A	16-0800102	24VDC 30' Solar Leash, 30'
B	13-0000032	24VDC Inter-Connect Cable, 5'
C	13-1000294	24VDC Battery Inter-Connect Cable, 5'

Identify locations for System components.

Component Shading and Working Radius

It is critically important to shade all of the components (except the Solar Arrays) as much as possible to reduce heat buildup inside the components (solar loading). Higher temperatures will result in derating, or diminished capacity and efficiency, of the components.

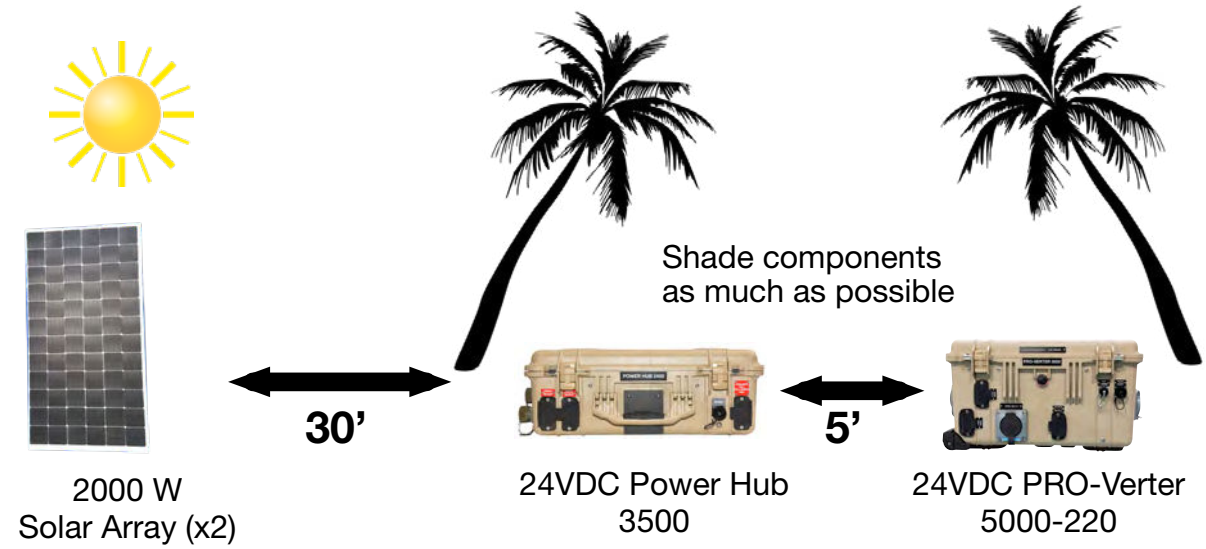


Figure 6. Working-space distance for the Solar Arrays, Power Hub, and the trailer

Minimize Potential for Water and Dust Intrusion

ALL Solar Stik equipment is designed for operation in adverse conditions; however, certain rules apply:

1. If operating in wet environments, use common-sense placement to avoid water intrusion by either flooding or precipitation.

2. If operating in dusty environments, ensure good airflow by keeping air filters clean and placing unit in a location that minimizes exposure to particulates. Clogged air filters reduce airflow, which can result in tripped breakers.

Direct ground placement of any power management or energy storage component is not recommended, but possible if no other option is available. If it is necessary, preventive measures for water and dust should be taken.

Connect System components.

Note: Turn off all main breakers and power switches before connecting the components of the SYstem.

Connect PRO-Verter to ESM 2700s

The position of the cable connections on the Inter-Connect Strip 7 as illustrated below is literal and deliberate. The arrangement shown provides a balanced flow of current through the DC bus.

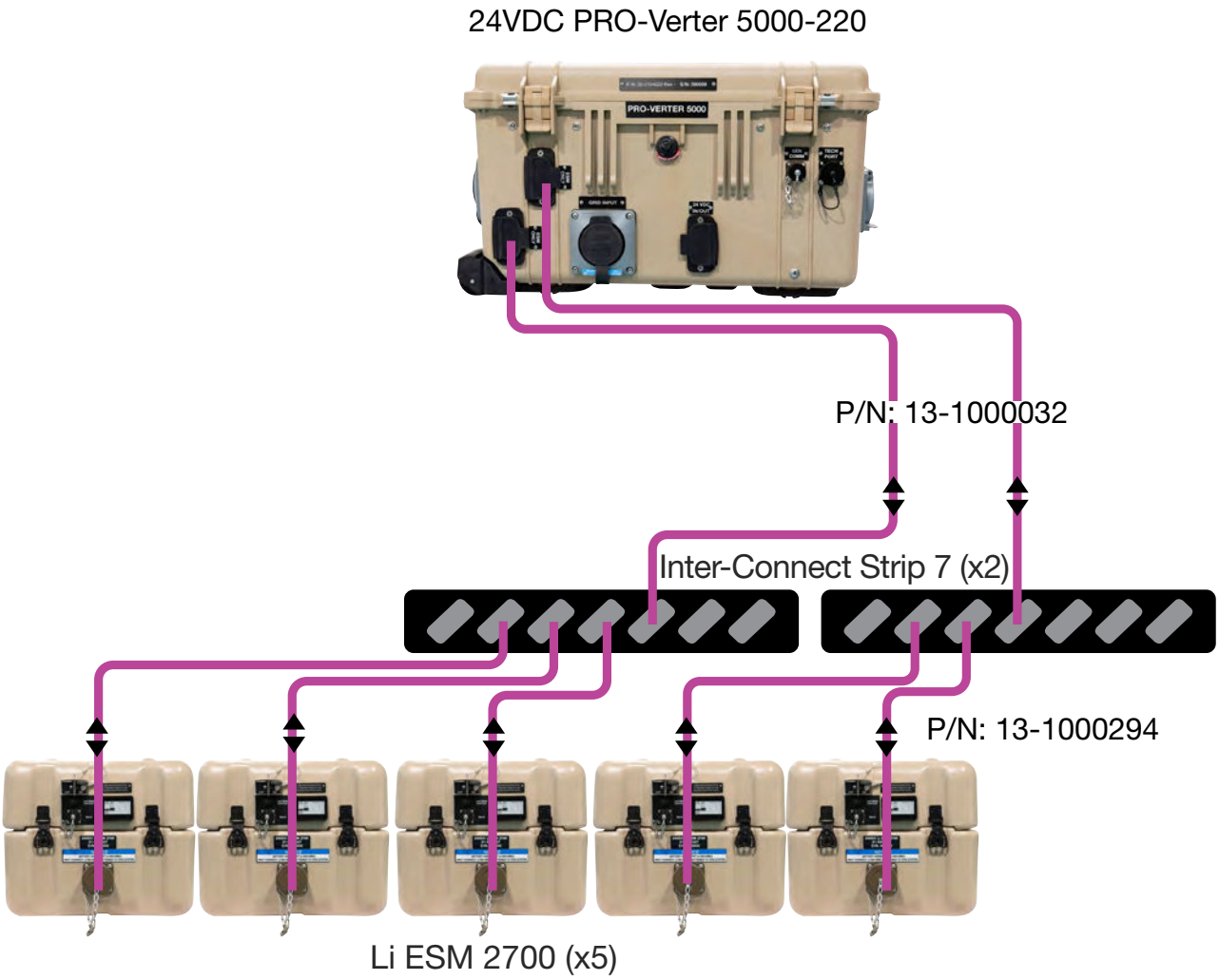


Figure 7. PRO-Verter to ESM connections

Connect Power Hub to Inter-Connect Strips

The position of the cable connections on the Inter-Connect Strip 7 from the Power Hub, as illustrated below, is literal and deliberate. The arrangement shown provides a balanced flow of current through the DC bus.

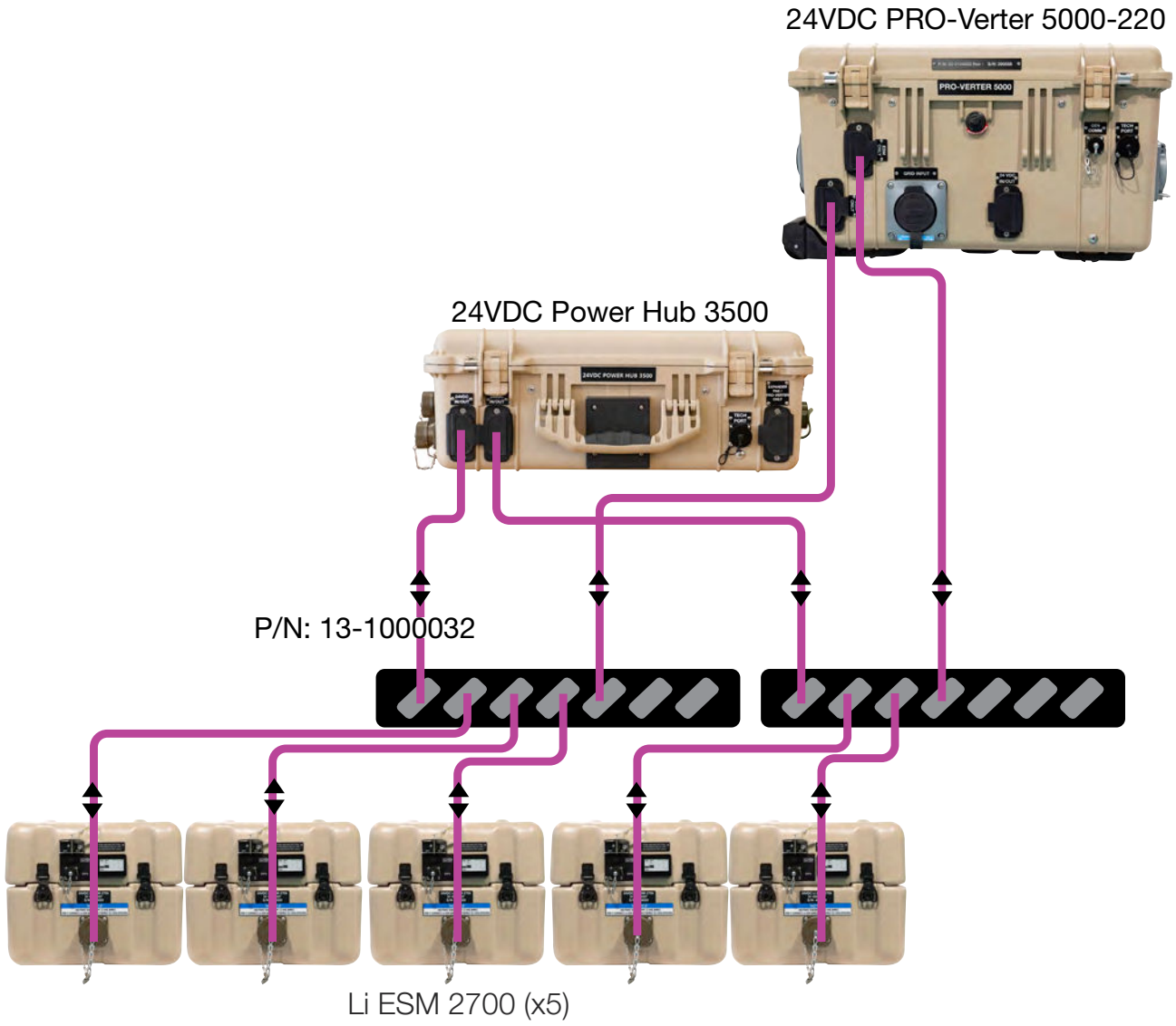


Figure 8. Power Hub to DC bus connection

Connect / Assemble Solar Arrays

In the images below there are six (6) individual panels per array. Pairs of panels will be connected in series so that there are three (3) pairs of panels per array. Three (3) solar cables will connect each array to the Power Hub.

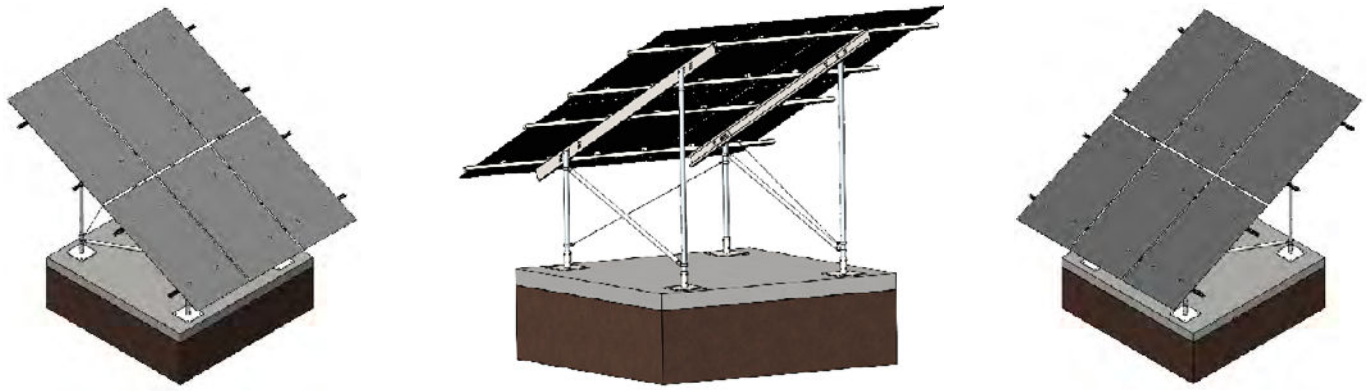
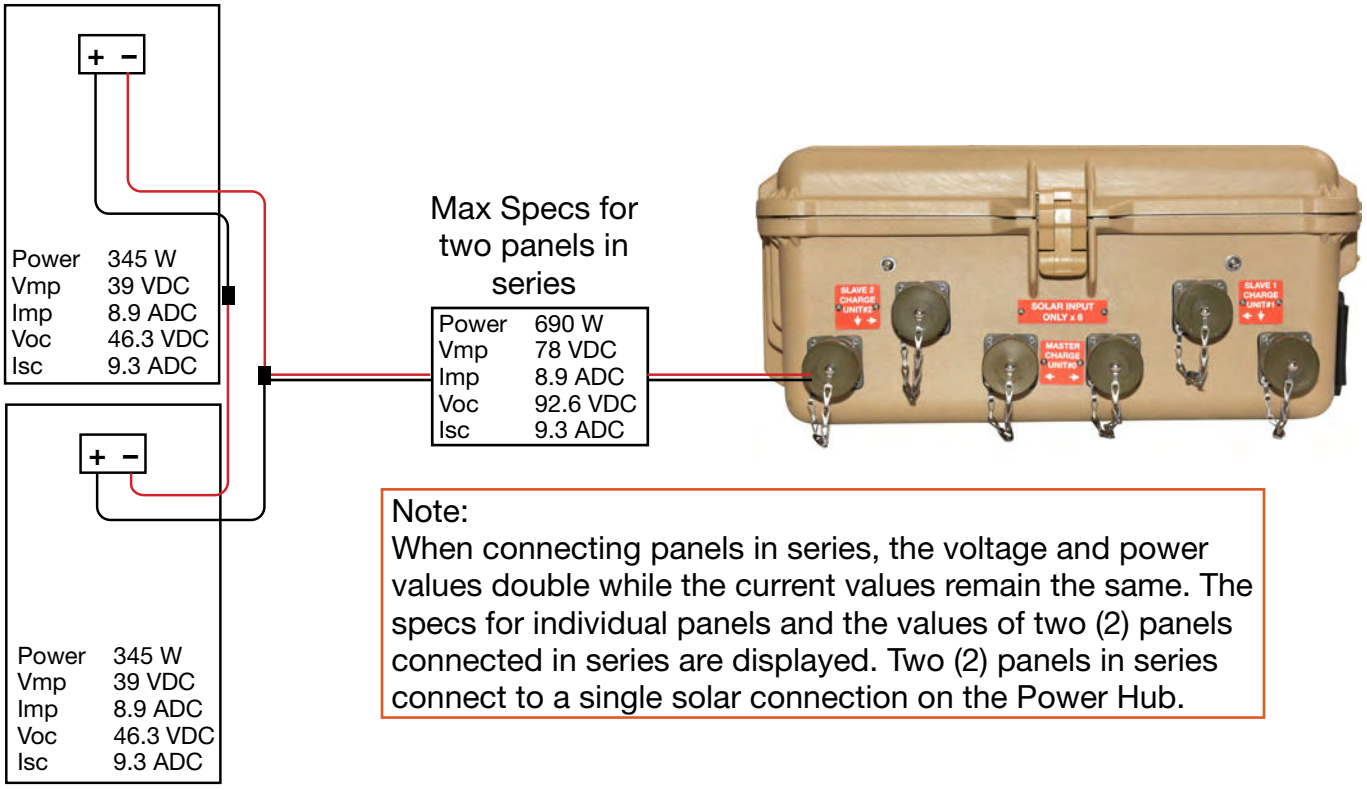


Figure 9. Solar arrays on rack support

Connect Two Solar Panels in Series

After the arrays are assembled, connect pairs of solar panels in series per the illustration below.



Note:
When connecting panels in series, the voltage and power values double while the current values remain the same. The specs for individual panels and the values of two (2) panels connected in series are displayed. Two (2) panels in series connect to a single solar connection on the Power Hub.

Figure 10. Solar panels connections within an array

Connect Arrays to Power Hub

The Power Hub 3500 has three (3) MPPT solar charge controllers. Two (2) pairs of panels connect to each of the chargers in a parallel connection. Connect the Solar Arrays as shown below. Connecting in any other configuration may overload an individual solar charge controller.

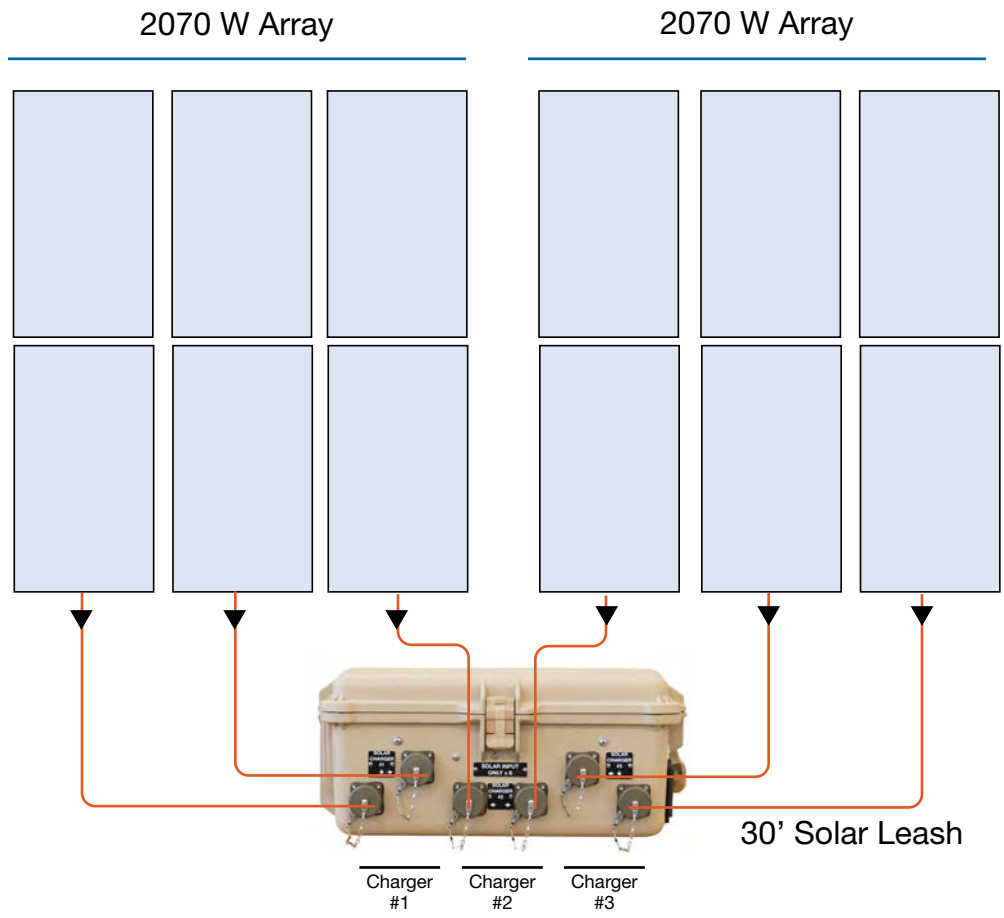


Figure 11. Solar Array connections to Power Hub

Note: The Power Hub is cooled by forced air. The air intake vent is on the back side of the Power Hub. This vent must be protected, as much as possible, from exposure to particulate matter (dust, sand, etc.). The air filter under the louvered vent cover must be kept clean to maximize the efficiency of the Power Hub.

Note: Solar Stik advises against ground placement and operation of the Power Hub because such placement will increase exposure to water and particulate matter.

Figure 12. Power Hub air intake port and vent filter

Ground the System

Grounding the PRO-Verter at the grounding lug is a critical safety measure. The PRO-Verter should be connected to the earth grounding rod. If the System is ever connected to grid power, there must be a neutral to ground bond at the main breaker panel of the grid power. Ensure that the PRO-Verter/ System is grounded properly for your specific application.

Figure 13. PRO-Verter grounding lug

Connect PRO-Verter to 230 VAC loads

It is critical to ensure that the loads connected to the System do not exceed the limits of power that can be supplied by System. This System was designed to support a specific set of loads. Adding additional loads, beyond what the System was designed to support can destabilize the System and result in anomolous behavior.

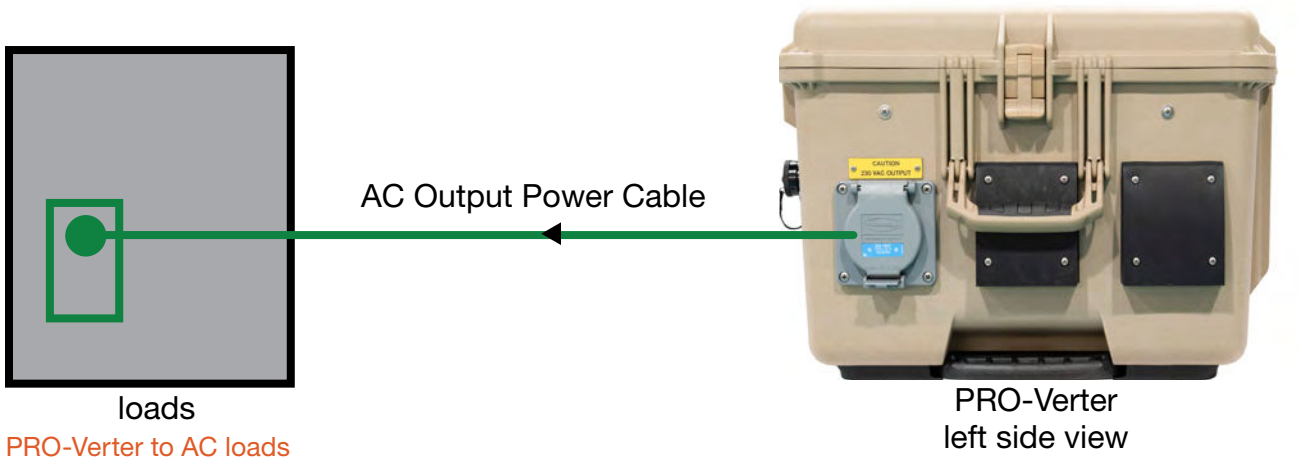


Figure 14. PRO-Verter to AC loads

System Activation

1. Toggle ON all ESM 2700 Power Switches
2. Power Hub will Power up automatically
3. Press and Hold the The PRO-Verter User Interface ON/OFF button for 2 sec. to start up PRO-Verter.
4. Set PRO-Verter clock to local time (see below).
5. Allow batteries to charge fully before supporting loads.

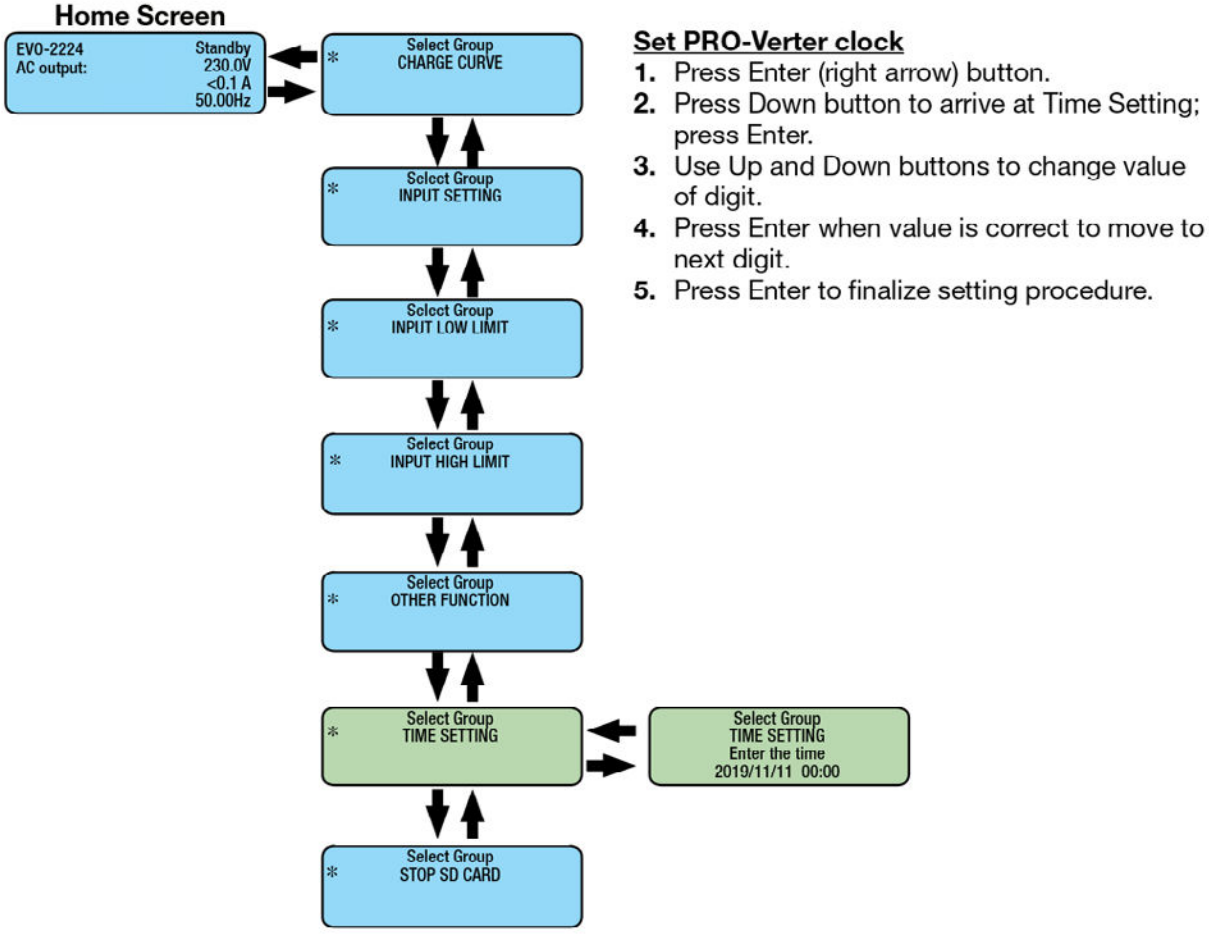


Figure 15. Guide to setting PRO-Verter Clock

To support loads
After System batteries are charged fully, toggle ON PRO-Verter AC OUTPUT breaker/switch.

Operating the PRO-Verter User Interface

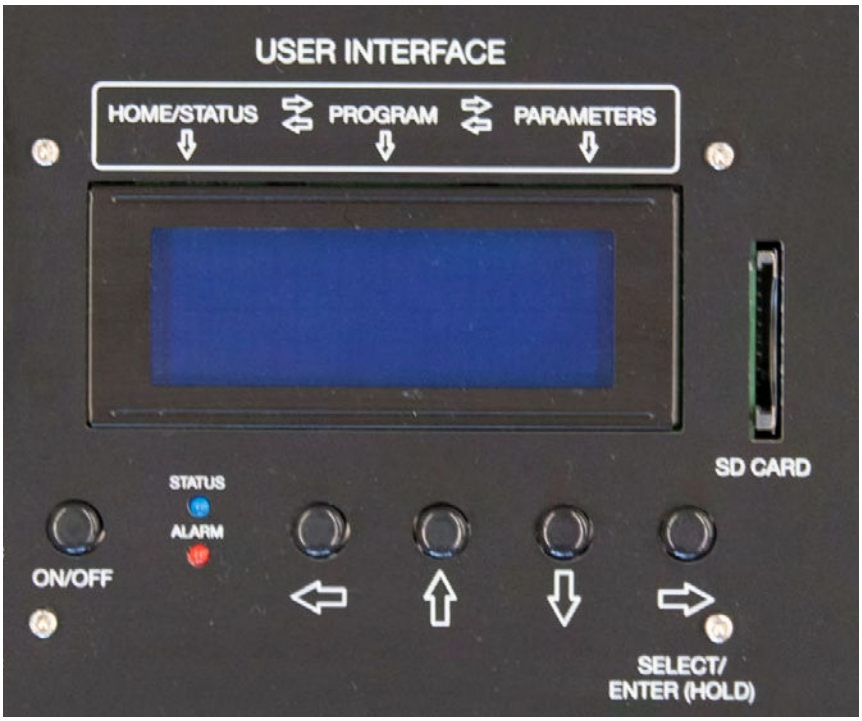


Figure 16. PRO-Verter user interface power and navigation buttons

- **On/Off Key**—The On/Off key is used for switching on/off the PRO-Verter and also to enter/exit Standby mode.
- **Navigation Keys**—These four keys allow simple access to menu items that assist in configuring, monitoring, and troubleshooting the PRO-Verter.

  Navigation Key Functions

  - **Back** (left arrow)—Return to previous selection
  - **Up**—Move from lower to upper menu screen in various menu maps
  - **Down**—Move from upper to lower menu screen in various menu maps
  - **Enter** (right arrow)—Select/write a particular value or option. Access programmable settings.
- **Status LED**—Blue LED indicator for indicating operating status
- **Alarm/Fault LED**—Red LED indicator for indicating fault conditions
- **SD Card Slot**—This slot supports an SD memory card (up to 16GB, FAT16/32). The SD card is used for data logging of PRO-Verter operational statistics and events and saving and uploading of programmed parameters. A “dummy” SD card is installed at the factory prior to shipment.

PRO-Verter Operating Modes

When the PRO-Verter is operating normally, the user interface will display the name of the operating mode and values of operating parameters. Because all the operating parameters associated with a particular operating mode cannot be displayed in one screen, multiple screens are available that can be accessed using the Up and Down keys. Table 1 provides names and descriptions of the operating modes.

The user interface will automatically display the current mode in which the PRO-Verter is operating. Use the Up and Down buttons to view the values of parameters associated with the current mode.

The operating modes windows and subwindows are READ ONLY.

Table 1. Operating Modes: Descriptions

Operating Mode Display	Description
Standby	In **Standby mode** there is no output, no AC bypass, and no charging. The parameters available for viewing when the PRO-Verter is in Standby mode are shown in this map.
Inverting	In **Invert mode**, the PRO-Verter is supporting the load by converting energy stored in the batteries into AC power. The batteries are not being charged when the PRO-Verter is in Invert mode.
Charging	In **Charge mode**, the PRO-Verter is charging the batteries and supporting the AC load. The degree to which the batteries are charged will depend on the demand of the AC load; supporting the load is prioritized over charging the batteries.
Power Save	The PRO-Verter enters Power Save mode when demand from the PRO-Verter inverting and charging functions drop below programmed thresholds.
Online	This option is also called “Online UPS Mode”. In this mode, the inverter is the primary source of power to an AC load, drawing energy stored in the batteries. The AC power input source is the back up power source to support AC loads.
Chrg Only [1]	Under “Online mode” only (Option 2 = Charger Only). Provides charging and pass-through when the AC input is available. The PRO-Verter inverter is inactive when AC input is not available.

[1] It is not recommended to put the PRO-Verter into charge-only mode when the PRO-Verter is part of a functioning HPS with both AC and DC loads. AC loads connected to the PRO-Verter will not be supported if the AC power source connected to the PRO-Verter fails. Charge-only mode may be used in an HPS with DC-only loads.

PRO-Verter Status and Alarm LEDs

The Status LED indicates the operating status of the PRO-Verter; the Alarm LED indicates a fault has occurred; specific information about the fault is reported on the user interface LCD screen. To clear faults see Clearing PRO-Verter Faults. The table below explains the meaning tied to each state for both LEDs.

Figure 17. PRO-Verter S 3000 user interface

Table 2. User Interface LED Indicators

LED INDICATIONS		
Status	**STATUS LED**	**ALARM LED**
Seen during power-on sequence Indicates completion of power-on sequence after power On/Off button is pressed for 2 seconds (sec)	Flash 3 times	Off
Seen during power-off sequence Indicates completion of power-off sequence after power On/Off button is pressed for 5 s	On	On
Normal charging	Flash 1 time/sec	Off
Equalization charging	Flash 2 times/sec	Off
Inverting (discharging) Alarm beep/3 sec (default off)	On	Off
Low battery alarm Alarm beep/1 sec	On	Flash 1/sec
Power saving	Flash 1 time/3 sec	Off
Standby	Flash 1 time/5 sec	Off
Fault	Off	On

PRO-Verter Programmable Settings

Navigating “Select Group” and “Select Parameter” Menu Maps

The Enter key is used to enter “Select Group” menu map from any operating mode screen.

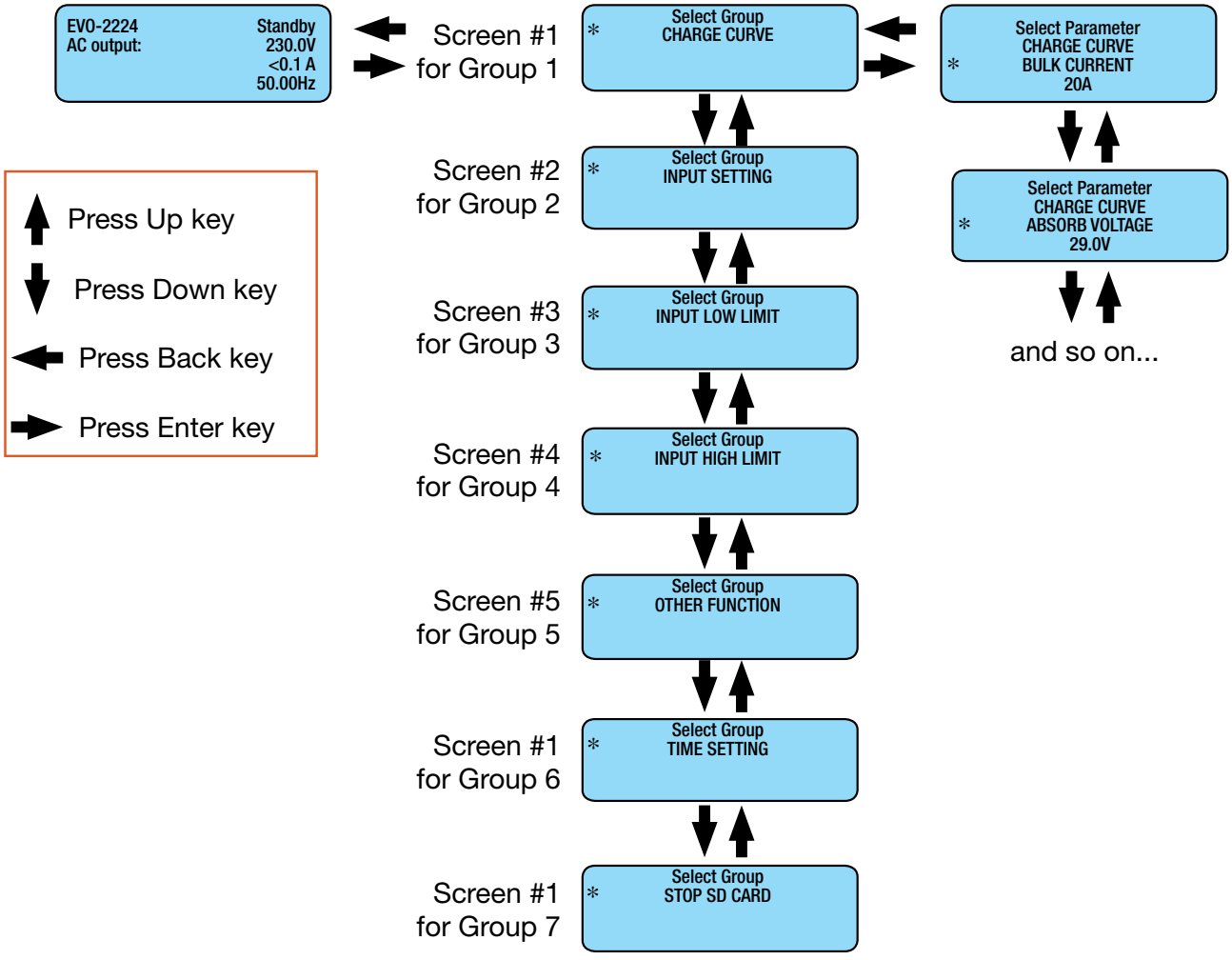
After the Enter key is pressed, the Up/Down keys are used to navigate to one of the seven (7) “Select Group” screens.

When the group for the desired setting is displayed on the LCD, the Enter key is used again to select this group. The Up and Down keys are used to move to the individual screens within the group.

The third line shows the name of the name of the parameter that can be varied with an asterisk sign “*” next to it. The asterisk sign * indicates this parameter will be selected when the Enter key is pressed and the associated value can be changed.

Pressing the Back key will exit to the previous level.

There is a 30-second time-out for setting parameters; after 30 seconds, the setting mode will be cancelled and the display will revert to the operating mode screen associated with current operation.



Parameter Groups: PRO-Verter Programmable Settings

“Parameter Groups” are the top-level categories of PRO-Verter programming.

Table 3. Programmable Parameter Groups: Descriptions

List of Parameter Groups 1 to 7		
Parameter	**Group Name**	**Description**
Group 1	Charge Curve	Parameters for battery charging/battery protection.
Group 2	Input Setting	Parameters for grid/generator input current level, frequency range.
Group 3	Input Low Limit	Parameters for grid/generator input low voltage level.
Group 4	Input High Limit	Parameters for grid/generator input high voltage level.
Group 5	Other Function	Power Saving/Alarm/Remote Switch/Multi-function Relay/etc.
Group 6	Time Setting	Local time clock setting.
Group 7	Stop SD Card	Shown only when SD card is inserted. To stop SD card accessed and to remove the SD card.

Charge Curve Programmable Settings

Parameters in this group define System battery charging protocols. Not all programming values will apply to Systems that do not incorporate a generator.

Table 4. Parameters for Battery Charging/Battery Protection

GROUP 1: CHARGE CURVE		
Parameter	**Parameter Value**	**Description**
Bulk Current	100 A	Sets the maximum charging current during the Bulk Charging Stage.
Absorp Voltage	29.4 V	Sets the charging voltage in the Constant Voltage Absorption Stage.
Equalize Voltage	29.4 V	Not applicable when using $LiFePO_4$ batteries.
Float Voltage	28.0 V	Sets the charging voltage in the Constant Voltage Float Stage.
Compensate	-3mV /°C/Cell	Sets the temperature compensation for the battery.
Batt Over Volt (Shut Down)	32.0 V	Sets the upper battery voltage threshold at which inverting/charging operations are switched off to protect the PRO-Verter.
Reset Voltage (Low Voltage Reset)	29.4 V	The PRO-Verter inverter will restart when the battery voltage rises to this set value or above after “Battery low voltage!” shutdown occurs.
Low Volt Alarm	24.0 V	Battery voltage at which the “Alarm” triggers AGS to start generator.
Batt Low Voltage	22.2 V	Sets the battery low voltage threshold at which the PRO-Verter inverter will shut down to protect the battery from overdischarge.
LV Detect Time	60 sec	This is the timer for shutting off the inverter. Battery voltage must be at the low voltage set point for this period of time before the inverter shuts off.
LV Cut Off Time	3600 sec	This timer shuts off everything including the charger. (The load on the inverter will already be cut off during this time.)
Equalize-4 Stages	0=NO	Equalize disabled with $LiFePO_4$ batteries.
Online Mode	0 = Option 1 (Default) Offline	
Reset To Bulk	26.0 V	Sets battery voltage at which the charger will terminate current charging stage of the selected Charging Profile and restart charging from the beginning.
Gs Detect Time	60 sec	A timer that sets the duration the battery voltage has to remain at threshold of Low Volt Alarm or lower before generator auto start/stop.
Gen On Time	30 minutes	N/A as programmed
Gen Off Delay	1 minute	Must be in the generator-stop condition for 1 minute before opening the relay
Absorp Time	10 min	
Absorp Exit Amps	6 A	Set to ~10% of battery bank capacity.) Value not in play with 2 Stage Type 1 charging
Charging Profile	3 = 2 Stage Type 1	Mimics CC/CV-type charging. Affects when generator turns off.

Continued on following page.

GROUP 1: CHARGE CURVE (Continued from previous page)		
Parameter	**Parameter Value**	**Description**
BATTERY TYPE	1 = lithium iron phosphate	N/A. A CC/CV charging profile appropriate for $LiFePO_4$ batteries has been programmed. Do not change.
SAFE CHARGING	0 Min	This timer, if set, will protect a depleted battery from being exposed to potentially heavy load if AC input is intermittent when first reacquired.
EXTERNAL CHARGER	1 = NOT AFFECT	The “external charger” is PV.

Input Setting Programmable Settings

Table 5. Parameters for Grid/Generator Input Current Level, Frequency Range

GROUP 2: INPUT SETTING		
Parameter	**Setting Value**	**Description**
Default Freq	50 Hz	Default frequency sets the Inverter frequency, which is also the standard frequency for AC input.
Grid Max Current	30 A	Value set to rated output current of grid power source.
Gen Max Current	28 A	Value must be set to match generator(s) output/number of connected PRO-Verters. The 13 kW generator can supply 56 A @230 VAC. Most Systems have two connected PRO-Verters.
High Cut Off	55 Hz	If the AC input frequency is over the value of High Cut Off when in Charge mode, the PRO-Verter will transfer to Invert mode.
High Reset	54 Hz	This is the reset frequency at which the unit will revert to Charge mode after it has switched over to Invert mode due to input frequency rising above High Cut Off.
Low Cut Off	45 Hz	If the AC input frequency is below Low Cut Off value when in Charge mode, the PRO-Verter will transfer to Invert mode.
Low Reset	46 Hz	This is the reset frequency at which the unit will revert to Charge mode after it has switched over to Invert mode due to input frequency falling below Low Cut Off.
Sync Grid	0 = Fine	Sets “syncing” algorithm for AC input 0 = Stable AC Input; 1 = not Stable AC input
Sync Gen	0 = Fine	Sets “syncing” algorithm for AC input 0 = Stable AC Input; 1 = not Stable AC Input
Input OC Protect	0 = INV Mode	If the AC input current is 1 A more than the programmed value of Grid Max Current/Gen Max Current for more than 5 sec, the PRO-Verter will switch over to Invert mode to ensure that AC power to the load is maintained. If the load reduces to 1 A less than the programmed value of Grid Max Current/Gen Max Current for 5 sec, the PRO-Verter will switch back to Charge mode.
Input Recovery	0=Buffered	Option 0 = Under this option, the unit will initially start in “Inverting Mode”, synchronize with the AC input and then transfer to “Charging Mode” Option 1 = Direct: The PRO-Verter will start in Charge mode.

Input Low Limit Programmable Settings

Table 6. Parameters for Grid/Generator Input Low Voltage Level

GROUP 3: INPUT LOW LIMIT		
Parameter	**Setting Value**	**Description**
Reset Voltage	200.0 V	This is the reset voltage at which the PRO-Verter will revert to Charge mode after it has switched over to Invert mode due to input voltage falling to Cut Off Volt 1/Cut Off Volt 2/Cut Off Volt 3.
Cut Off Volt 1	190.0 V	If during Charge mode, the AC input voltage falls below Cut Off Volt 1 for period > Detect Time 1, the PRO-Verter will transfer to Invert mode from Charge mode.
Detect Time 1	250 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 1 is allowed.
Cut Off Volt 2	180.0 V	If during Charge mode the AC input voltage falls below Cut Off Volt 2 for period > Detect Time 2, the PRO-Verter will transfer to Invert mode.
Detect Time 2	50 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off 2 is allowed.
Cut Off Volt 3	1700.0 V	If during Charge mode, the AC input voltage falls below Cut Off Volt 3 for period > Detect Time 3, the PRO-Verter will transfer to Invert mode.
Detect Time 3	1 Cycle	This is the time limit in cycles up to which the low AC input voltage Cut Off 3 is allowed.

Input High Limit Programmable Settings

Table 7. Parameters for Grid/Generator Input High Voltage Level

GROUP 4: INPUT HIGH LIMIT		
Parameter	**Setting Value**	**Description**
Reset Voltage	250.0 V	This is the reset voltage at which the PRO-Verter will revert to Charge mode after it has switched over to Invert mode due to input voltage falling to Cut Off Volt 1/Cut Off Volt 2/Cut Off Volt 3.
Cut Off Volt 1	245.0 V	If during Charge mode the AC input voltage falls below Cut Off Volt 1 for period > Detect Time 1, the PRO-Verter will transfer to Invert mode from Charge mode.
Detect Time 1	50 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 1 is allowed.
Cut Off Volt 2	1255.0 V	If during Charge mode the AC input voltage falls below Cut Off Volt 2 for period > Detect Time 2, the PRO-Verter will transfer to Invert mode.
Detect Time 2	15 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 2 is allowed.
Cut Off Volt 3	265.0 V	If during Charge mode the AC input voltage falls below Cut Off Volt 3 for period > Detect Time 3, the PRO-Verter will transfer to Invert mode.
Detect Time 3	1 Cycle	This is the time limit in cycles up to which the low AC input voltage Cut Off Volt 3 is allowed.

Other Functions Programmable Settings

Table 8. Power Saving/Alarm/Remote Switch/Multi-function Relay/etc.

GROUP 5: OTHER FUNCTIONS		
Group	**Setting Value**	**Description**
Power Saving	0 = Disable	Enable or disable Power Saving mode when in Invert mode.
Enter Point	6 W	If the value of power drawn by AC load falls to the Enter Point value for 5 sec, the unit will enter Power Save mode.
Wake Up Point	7 W	If the unit is in Power Save mode and the value of the AC power of the load rises to Wake Up Point, the unit will quit Power Save mode and will start operating in full voltage Invert mode.
Remote Switch	0 = Button	This selection is used when On/Off control of PRO-Verter is desired through external 12 VDC signal. Contact Solar Stik Technical Support.
Relay Function	2 = Generator	Ties battery voltage-related settings to generator autostart/stop.
Comm ID (Id For User Interface)	1	Communication ID: This sets the ID number for the Comm port and user interface.
Buzzer	Off	Set the buzzer On/Off.
Discharge Beep	0 = No	To select the buzzer On/Off while in Invert mode.
Default Reset	0 = No	This is to reset all of the parameters to the factory values. The factory values are not the program values set by Solar Stik.
Data Log Time	2 = 10 sec	A real time clock inside the user interface records timing. The time interval between recordings is programmable. Events and Errors are recorded as soon as they are sensed.
Parameter Save	0 = No	Save all parameters/program settings to SD card.
Temp Unit	0 = deg C	Temperature display can be selected in °C or °F.
Password Disable	1 = Yes	The default password (8052). Password may be disabled.

PRO-Verter Clock Time Setting

Table 9. Local Time Clock Setting

GROUP 6: TIME SETTING		
Group	**Setting Value**	**Description**
Time Setting	Local Current Time	24-hour clock set to local time for accurate time stamps on logged events. Password not required.

Stop SD Card Command

Shown only when SD Card is inserted. To stop SD Card accessed and to remove the SD Card.

Table 10. Instructions to Remove SD Card from PRO-Verter User Interface

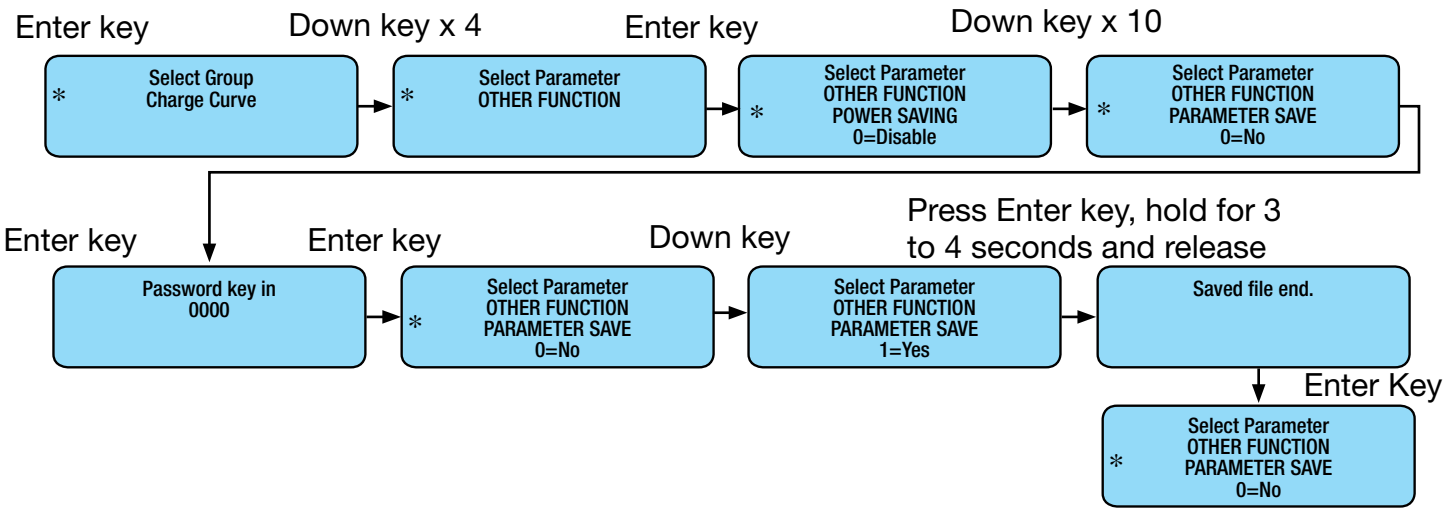
GROUP 7: STOP SD CARD		
Group	**Setting Value**	**Description**
Stop SD Card	1 = Yes to remove	Remove/eject SD card only after the operation of the card has been stopped.

Saving/Uploading Programmed Parameters

Saving Programmed PRO-Verter Parameters to SD Card

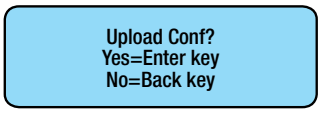
All the programmed parameters can be saved on an SD card (FAT 16/FAT 32 format, up to 16 GB capacity). The parameters will be saved in File named “xxxx_yyy.cfg”, where the first group of 4 digits xxxx is the model number of the inverter charger and the second group of 3 digits yyy is the Revision #. for that model, e.g., 074.

- For saving, first insert the SD card into the SD card slot.
- Then, go to “Parameter Save” screen . Steps are given below:



Uploading Saved PRO-Verter Parameters from SD Card

If there is an “xxxx_yyy.cfg” file in the SD card with stored programmed parameters, then upon inserting the card, the remote control will ask to upload the Config file. Press the Enter key to confirm or the Back key to cancel.



- Asks to confirm or cancel uploading of saved parameters.
- Choose Yes by pressing Enter key.

Configuration uploading.

PRO-Verter Data Logging

An SD card may be used to log operating information. When the SD card is inserted into the SD card slot, data logging is activated automatically (it will be disabled only if programmable setting has been changed to “0 = Disable”). Time interval between recordings (called “Data Log Time”) is programmable. A time stamp for each event is provided by the user interface’s internal, real-time clock.

Available options for Data Log Time are:

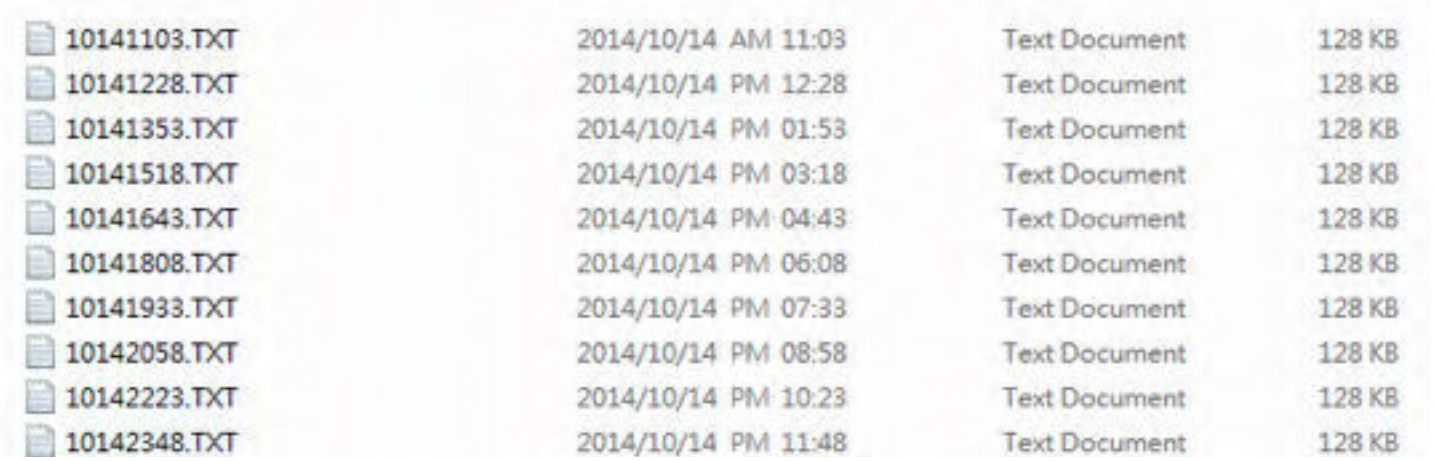
0 = Disable; 1 = 1 sec (default); 2 = 10 sec; 3 = 30 sec; 4 = 60 sec; 5 = 5 min; 6 = 10 min
“Events” and “Error Codes” are recorded as soon as they are sensed.

The following 25 data fields include System electrical parameters, events, and error codes:

Date	Time	Grid status	Grid freq	Input Amp 1	Input Amp 2	Input VA 1	Input VA 2	Input watt 1	Input watt 2	Output freq
External Amp	Battery Amp	Battery volt	Output watt 2	Output watt 1	Output VA 2	Output VA 1	Output Amp 2	Output Amp 1	Output volt	
Battery (c)	Transformer (c)	Heat sink 1(c)	Heat sink 2 (c)	Fan speed	Mode	Error code	Charge stage	CAN status	CAN watt	AVG watt	Event

Data Log Files: Viewing Data Log Files Using Excel

The Data Log files are written as text files (.txt) in the DATALOG folder on the SD card’s root directory. Below is an image of the DATALOG folder showing example of the Data Log Files. The file name format is month/day/hour/minute.txt (MMDDhhmm.txt). Each file has 512 rows of records. (Each row has multiple data fields.) Each file size is 128 KB.



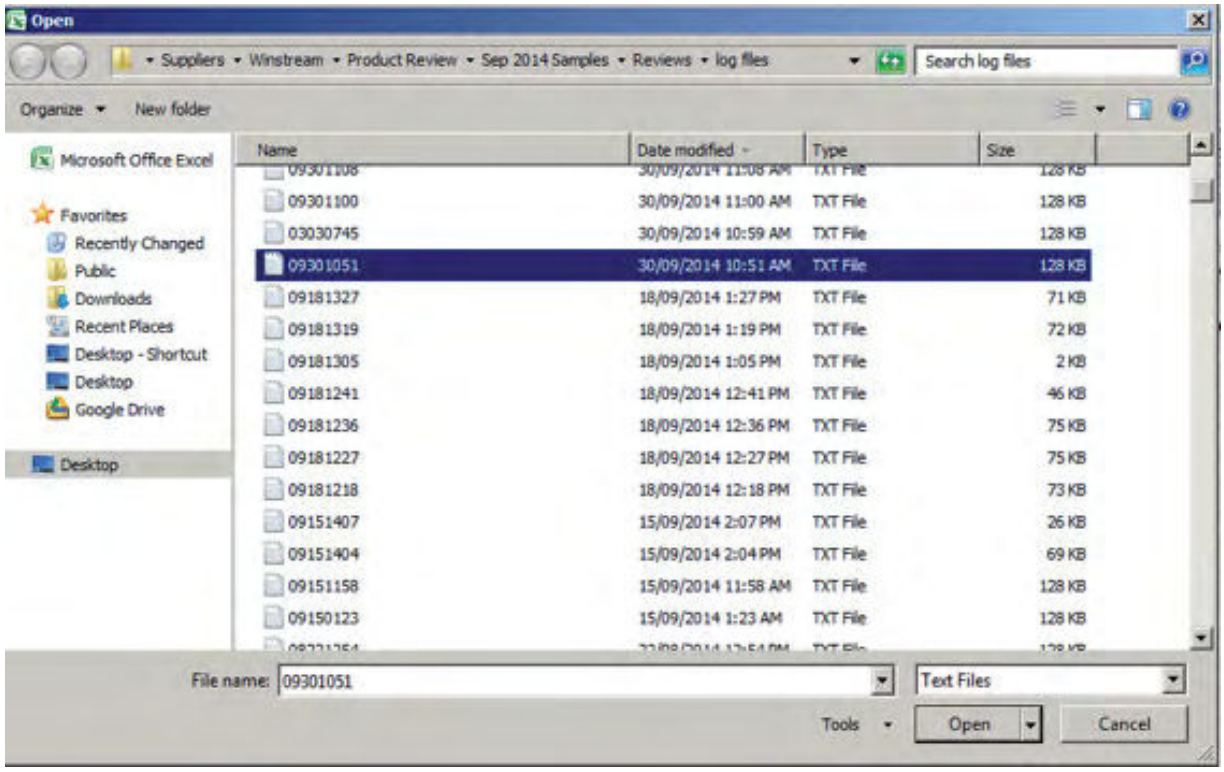
The figure below shows an example of one of the file's contents opened with a general purpose text reader. The second row shows data fields separated by semicolon (";"). The third row onwards shows the status of the data fields at time interval equal to the programmed value of Data Log Time.

Note: Event / Error Codes will be logged as soon as they occur.

```
Date;Time;Gen status;Gen freq;Gen volt;Grid status;Grid freq;Grid volt;Input current;Input VA;Input watt;Output freq;Output volt;Output current;Output VA;Output watt;Battery vo
2014/10/14;12:28:32;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:28:42;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:28:52;33340;000.00;000.62;33341;000.00;000.41;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:02;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:12;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:22;33340;000.00;000.62;33341;000.00;000.41;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.8;0027.1;0;0;00000;0;
```

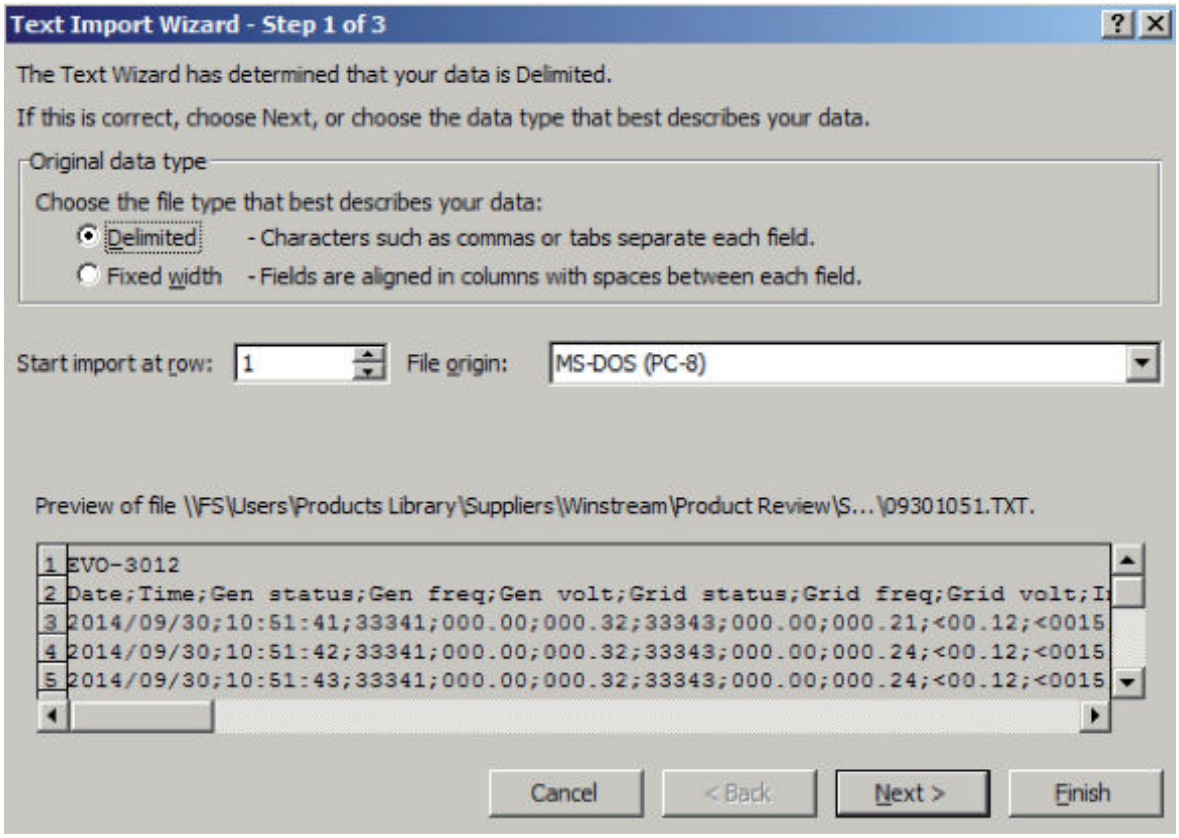
Follow procedure given below to open Data Log Files in Excel:

- Start Excel.
- Click File Microsoft Office Button on the top left hand corner.
- Click "Open" from the drop-down menu.
- Navigate to the directory where the Log files downloaded from the SD card are located.
- Click on "File Types" selection button at the bottom right corner (shows "All Excel Files" as default) and select text files from the drop-down menu.
- All text files (.txt) will be displayed.

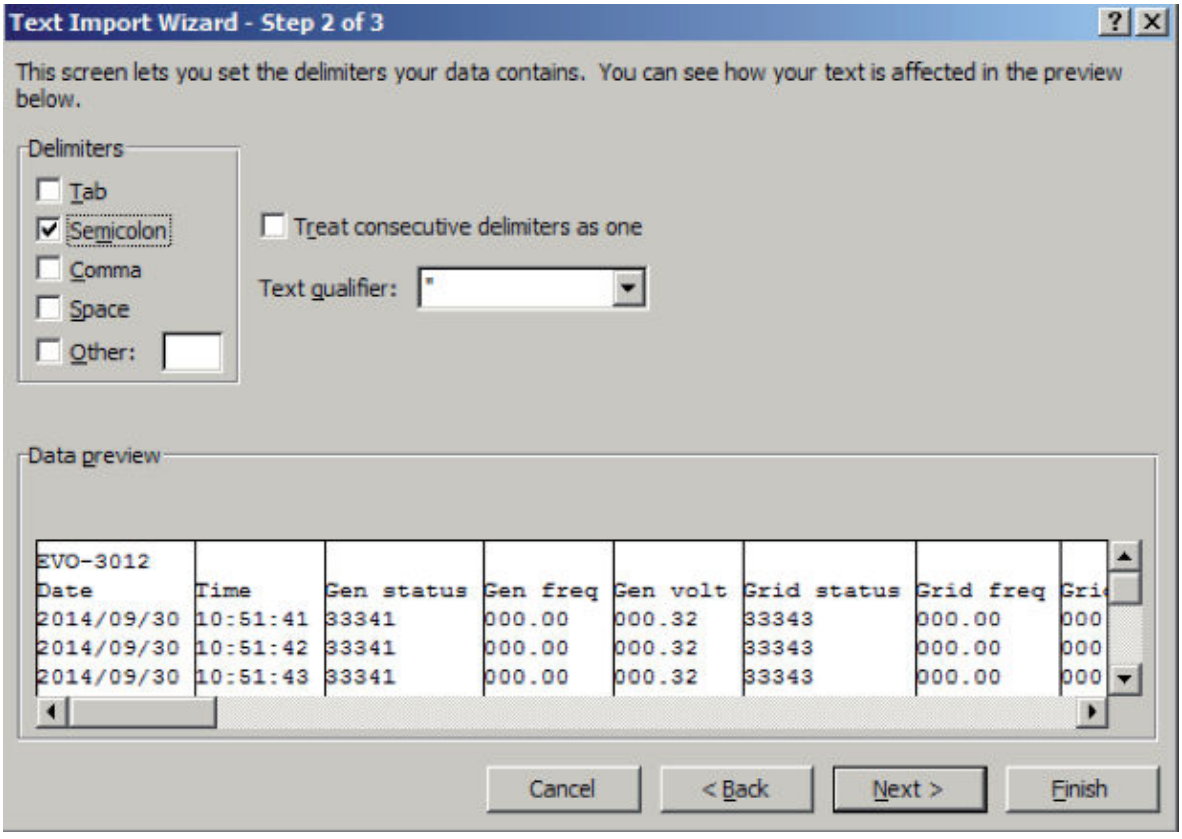


Click "Open" button

Text Import Wizard – Step 1 will be shown. Choose “Delimited” file type.



Text Import Wizard – Step 2 will appear. Choose “Semicolon” and click Finish button.



The Power Hub User Interface

The user interface consists of an LCD screen and buttons for navigating Pages, Menu, and submenu items. Using the buttons and navigating the contents is simple and highly intuitive.

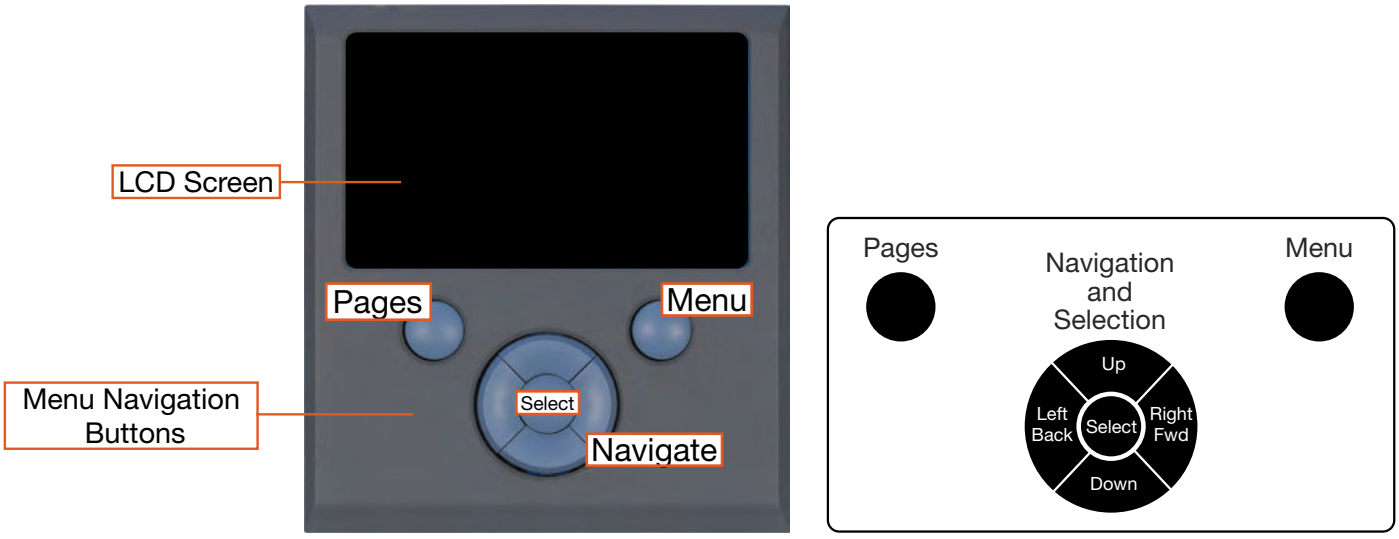


Figure 18. LCD user interface and navigation guide

Pages Button

At the basic level, the information available from the user interface is as follows:

- Power from the PV arrays
- System battery bank voltage
- Net current flowing to or from the System batteries.

Depending on how the System is configured, the LCD shows capabilities that may or may not be utilized by the Power Hub, so icons and windows are visible but may contain “--”, indicating no data Consult the System Manual for additional information about available data and configuring for an application.

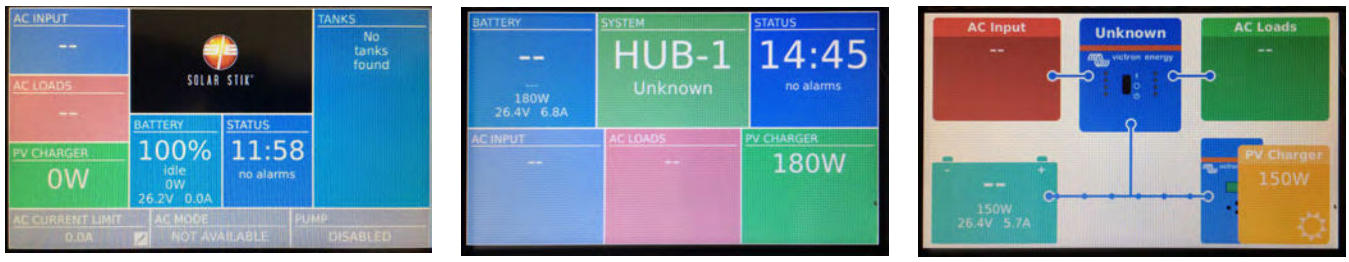


Figure 19. Data views displayed in “Pages”

PV Charger Icon: Reports the cumulative power from the PV arrays connected to the Power Hub. Specific information regarding the power being process by each of the two (2) solar charge controllers is reported in the device list displayed when pressing the Menu Button. Access to this information is described in the Monitoring PV Power: Current and Historical section.

Battery Icon: Reports battery SOC, voltage, and net current to/from the System battery. The SOC may be reported as "--" until the System batteries cycle enough to "learn" how to calculate accurately the SOC. Net battery current is the sum of all chargers and loads connected to the System batteries. A positive value is net charging; a negative value is net discharging. For example, +30 amps of charge current and -5 amps of load current will display a net current of +25.0 amps.

> **Note:** The net negative current will be observed when the Power Hub is the primary power management device in the System. If the Power Hub is not the primary power management device in the System, obtain the battery SOC from the primary power management device instead. Generally, the primary component is the one that is connected directly to the batteries and is responsible for charging the batteries and supporting the load.

Status Icon: Reports the time of day and "alarms". A list of the alarms/notifications that may occur, their meanings, and their solutions is provided in subsequent sections of the manual.

> **Note:** The charging current reported may be at or near 0.0 A when the batteries are charged fully, even if the PV arrays are in full sun.

Menu Button

The Menu button provides access to more detailed information from the solar charge controllers and notifications (information about alarms if they occur). Push the Menu button once and the device list appears. This is the starting point for the detailed information about the solar chargers, System batteries (DC bus), notifications, and System settings. Use the navigation buttons of the user interface to navigate submenus under the menu items on the device list.

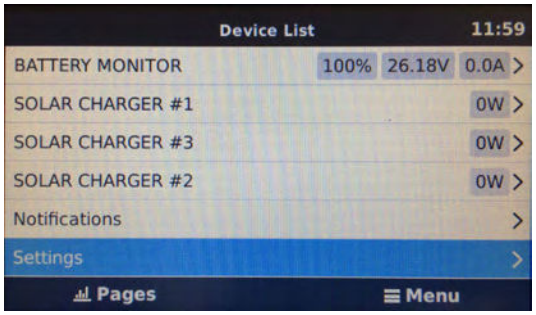


Figure 20. Device list on user interface

Device List: Power Hub Circuits

The Device List is populated automatically by detecting the internal components of the Power Hub and as such is a list of the major functional circuits of the Power Hub.

Battery Monitor Circuit

The battery monitor circuit reports the flow of power from the solar chargers, and other DC power sources onto the DC bus (batteries/ESMs) by measuring the DC bus current and voltage.

Solar Charger Circuits

The PV controls convert the higher voltage of the PV arrays so it is compatible with other 24-volt components including batteries and power management. This circuit also uses an MPPT algorithm to extract maximum available power from PV arrays regardless of environmental conditions.

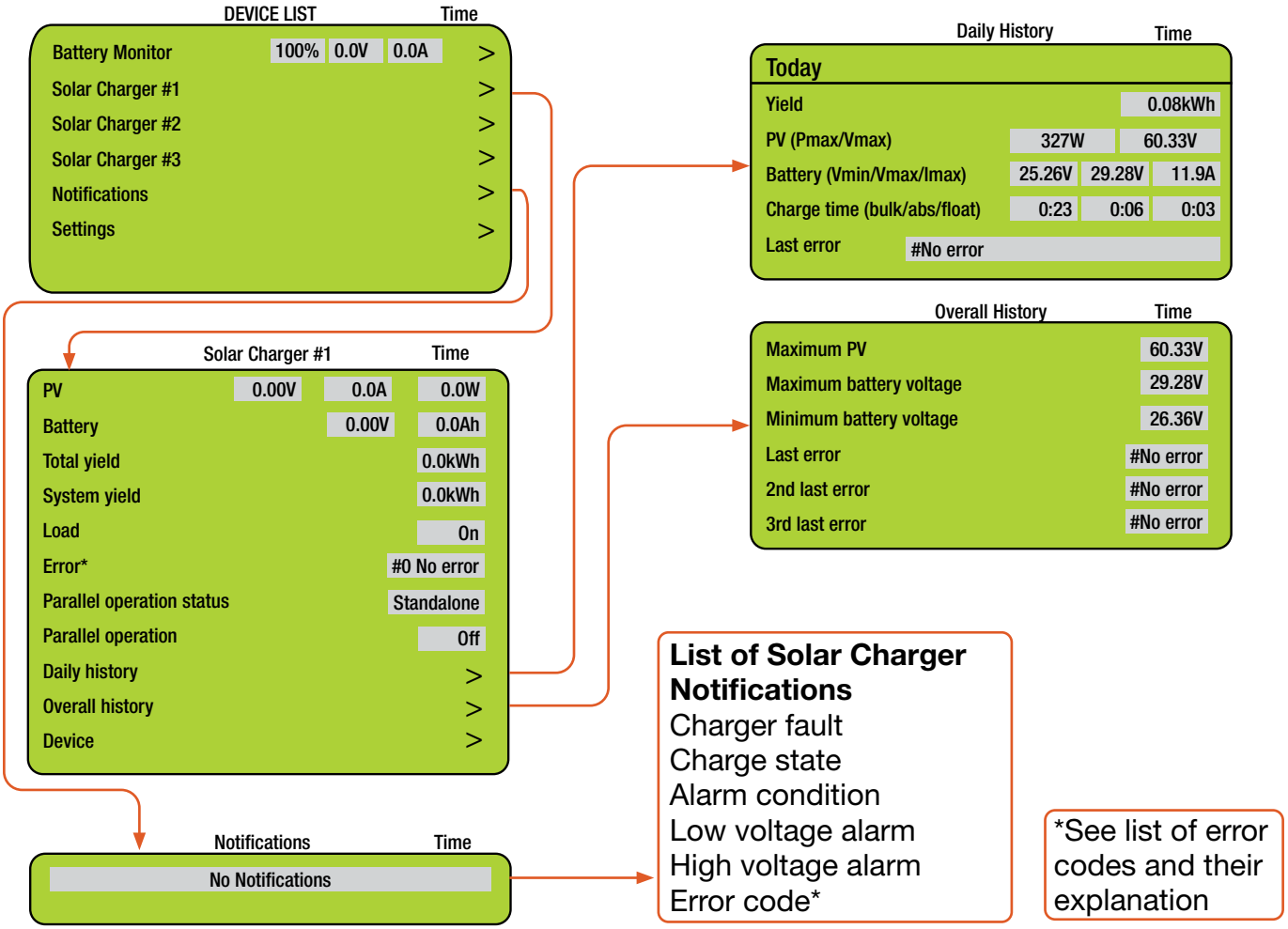
Power Hub Local Time and Date

Set the Power Hub to the local time and date prior to operating or collecting any data to ensure all events are associated with accurate time stamps. To find the time and date settings, press the Menu button to display the device list. Use the down button to highlight the settings line then press Select. Use the down button to scroll to the "Date and Time" (see User Interface Settings Menus) and press Select. Change the values in the submenu windows to reflect the correct local time and date.

Monitoring PV Power: Current and Historical

Press the Menu button one time to display the device list. The window that will appear is illustrated below. Solar Charger #1 and #2 will appear in lines 2–3. Use the Up/Down navigation buttons to highlight the any of the solar chargers. Press Right or Select to open the menu windows specific for that solar charger. The window that appears (Solar Charger #1 in the illustration below) provides an extensive report of the current status for that solar charger. Historical reports for Solar Charger #1 can be displayed by navigating down to the “Daily History” and “Overall History” lines then pressing Right or Select. Data reported in those windows are displayed in the illustration below. Notifications and errors related to solar chargers are found in the Notifications and History Menus.

Note: Values shown in all of the menu windows will vary.



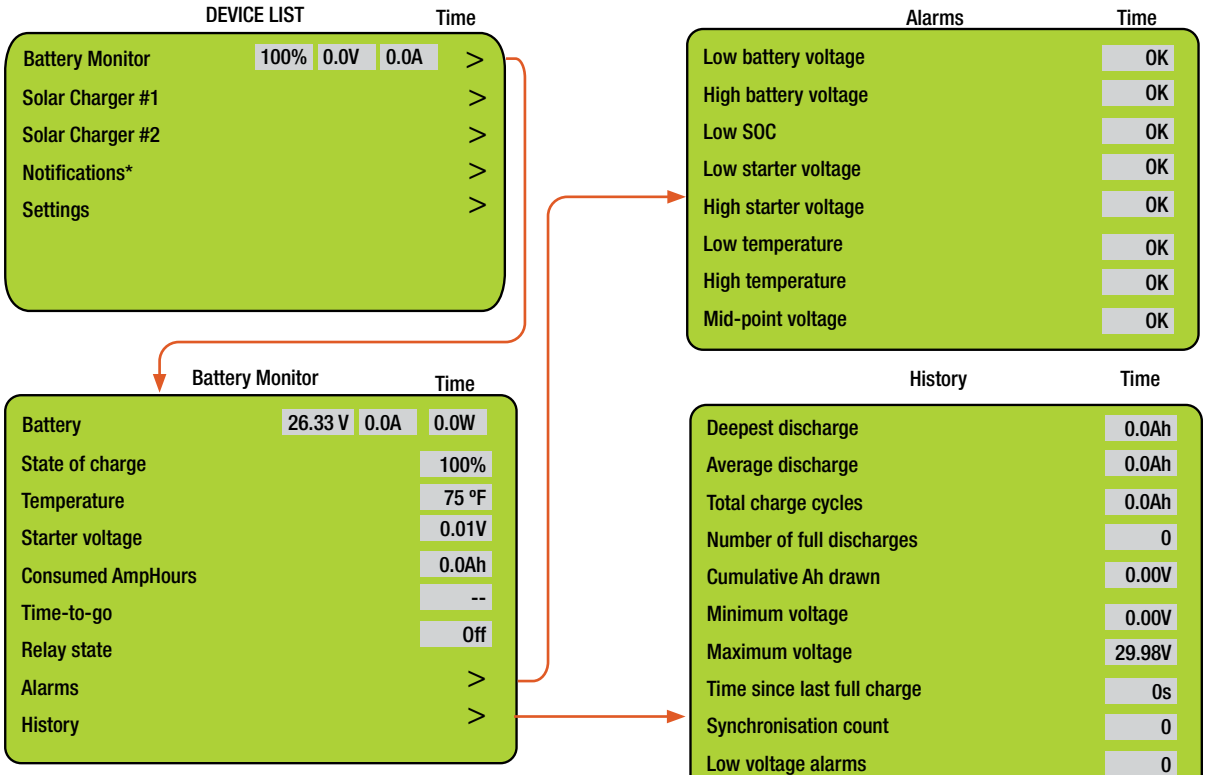
PV Power: Understanding Reported Values

The Power Hub solar charge controllers report the power they process to the user interface. Checking these readings often, over extended periods of time, will establish what is “normal” in the system and give the operator a greater ability to identify and correct deviations from “normal”.

Monitoring System Batteries: Current and Historical

Press the Menu button one time to display the device list. The window that will appear is illustrated below. The Battery Monitor will be the first device listed. Values for the current battery SOC, DC bus voltage, and current (amps) will appear in the fields on that line. Press the Select or Right button to open the Battery Monitor window to display current details about the batteries connected to the System. The temperature displayed here is the Power Hub internal temperature, not the temperature of the System batteries. Alarms and historical data related to the System batteries are found in the Alarms and History Menus.

As the System batteries approach a fully charged state, the charging current will approach zero (0) amps even if the sun is shining brightly and/or the generator is running. If this occurs, check the battery SOC to confirm that the batteries are nearing a full charge. If not approaching 100%, ensure the PV arrays are connected and functioning properly. Charging parameters can be changed if necessary. Please contact your FSR for assistance.



List of Battery Monitor Alarms

High voltage alarm
Low voltage alarm
High starter-voltage alarm
Low state-of-charge alarm
Low battery temperature alarm
High battery temperature alarm
Mid-voltage alarm
High charge current alarm
High discharge current alarm
Cell Imbalance alarm
Internal error alarm

Heat and Derating

The function and efficiency of all electronic equipment is related to and dependent upon the temperature at which it is operating. All equipment performs optimally within a narrow temperature range and less so as the temperature exceeds the upper end of that range. PV panel output drops off significantly in high heat as well. The Power Hub generates heat as a by-product of processing incoming PV power. Under normal circumstances, the amount of heat generated in this way will not exceed the rated temperature for the Power Hub to function at its rated capacity.

Causes of Overheating

The two (2) most common reasons for the Power Hub to overheat are high ambient temperature and solar loading (heat accumulation due to the sun shining directly the Power Hub). These two factors work together to elevate the internal operating temperature to the point where the solar chargers may automatically derate or even temporarily suspend output to prevent damage to their internal electronics. The solar chargers are rated to provide full power up to 104 ºF (40 ºC). Performance of the Power Hub will decline (charging current reduced) as the temperature increases or is sustained above this value.

> **Note:** The charging current reported by the Power Hub battery monitor will also approach zero (0) A as the batteries approach a fully-charged state.

Power Hub Internal Cooling

Thermostat-controlled, internal cooling fans turn on at ~104 ºF (40 ºC) to maintain the internal temperature within the optimal operating range. The fans are audible when operating. Clogged air intake filters can significantly exacerbate heat-related problems, so they should be cleaned as often as necessary to maintain maximum airflow. Clean or replace the air filter monthly, or more frequently if operating in very dusty environments. Do not operate the Power Hub in direct sunlight or directly on the ground. It should be placed in a shaded, well-ventilated location. Proper air filter maintenance and shading the Power Hub will help to ensure that the internal temperature does not reach critical levels.

Power Hub Internal Temperature Report

The Power Hub has a sensor that measures and reports the internal temperature. The internal temperature of the Power Hub (NOT the batteries) is reported in the Battery Monitor menu page. To access this and other battery-related data, press the Menu button to show the device list. Select/highlight “Battery Monitor” and either right-click or press the Select button to display.

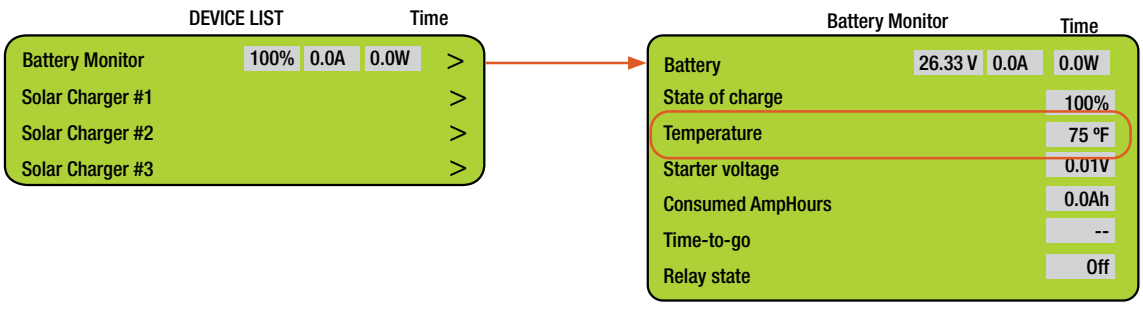
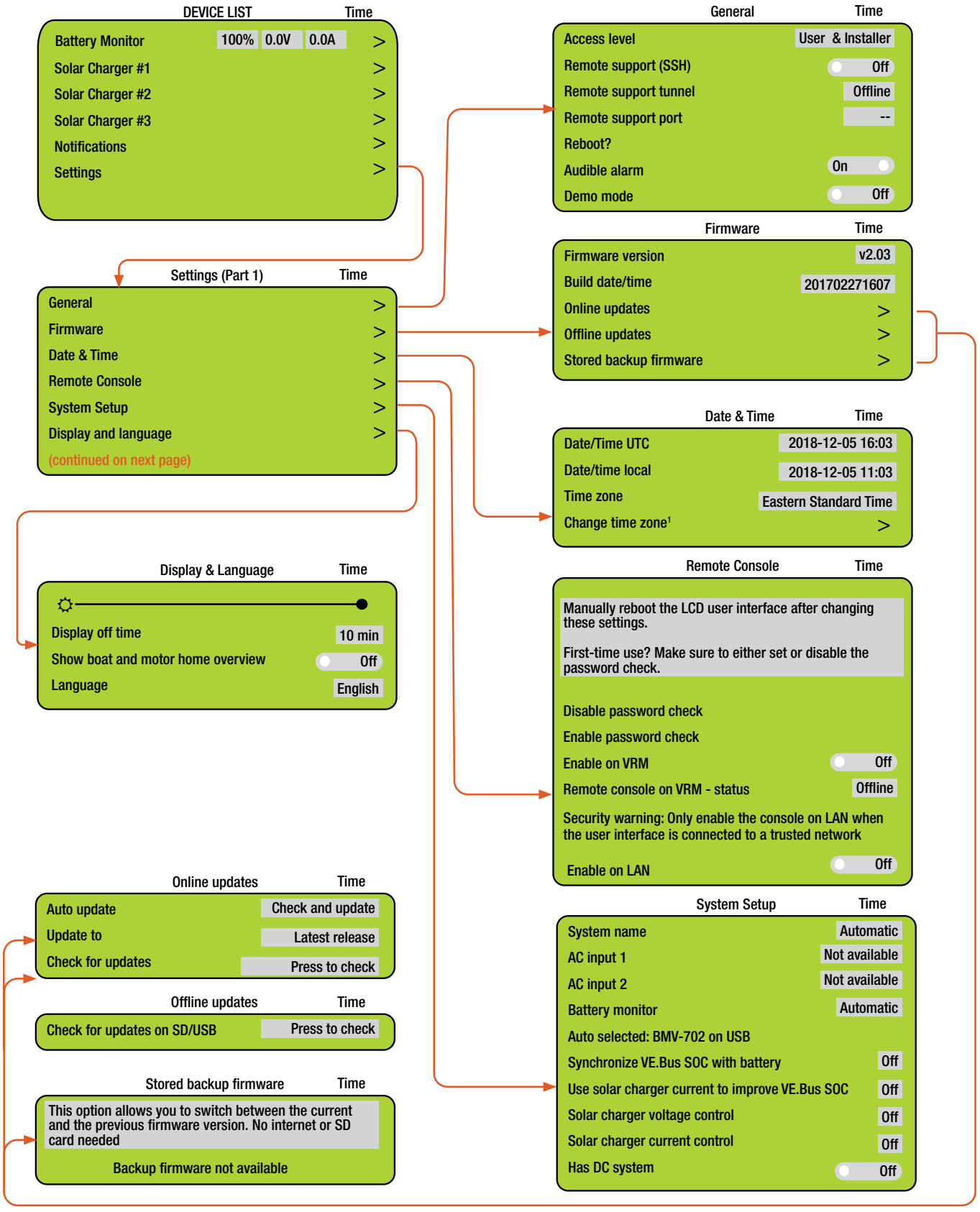
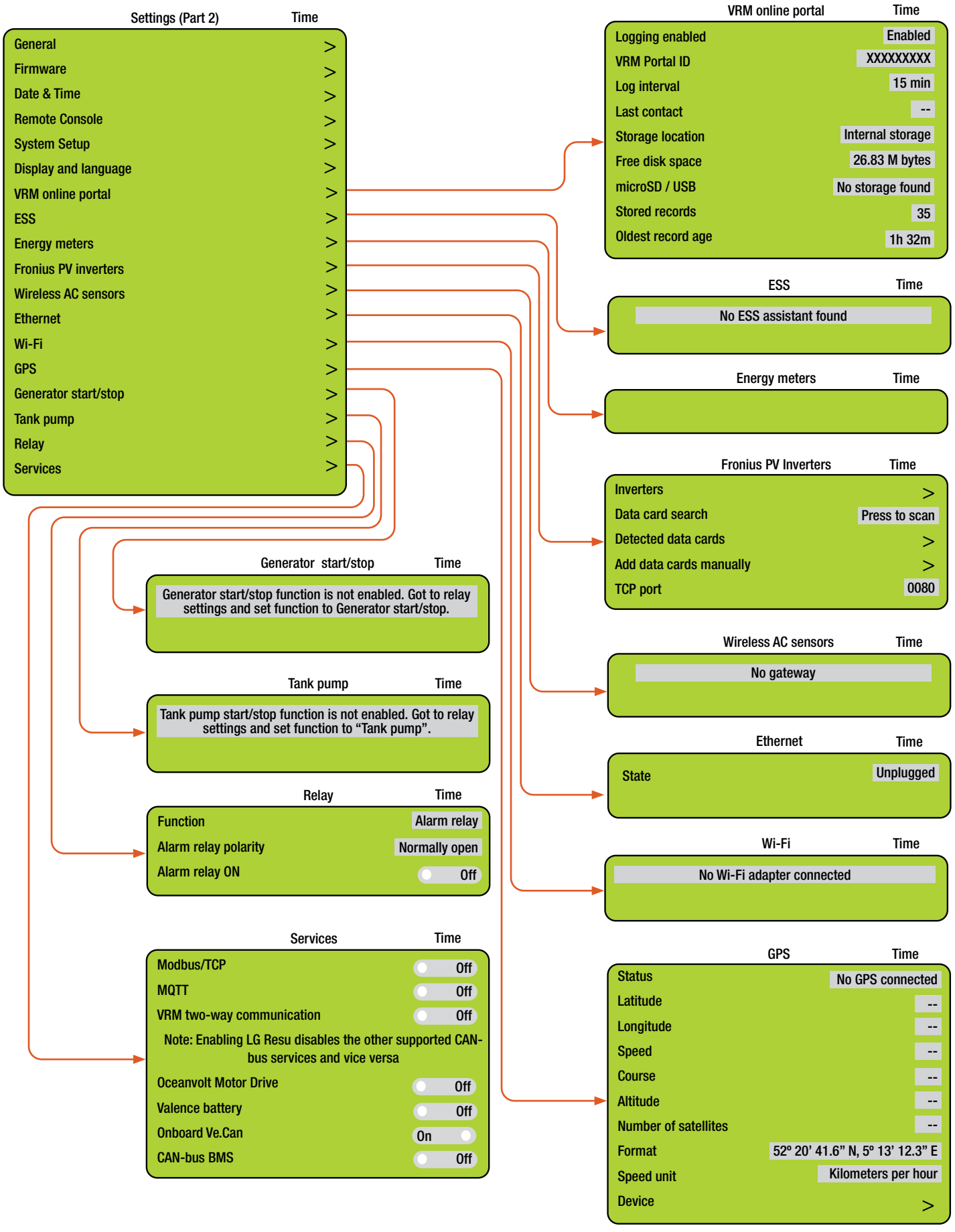


Figure 21. Power Hub internal temperature report on user interface

User Interface Settings Menus

Settings are accessed from the device list. The settings menus contain several parameters that may need to be changed during the course of normal operation. Many of the options are not relevant to the Power Hub.




Settings (Part 2) Time
General >
Firmware >
Date & Time >
Remote Console >
System Setup >
Display and language >
VRM online portal >
ESS >
Energy meters >
Fronius PV inverters >
Wireless AC sensors >
Ethernet >
Wi-Fi >
GPS >
Generator start/stop >
Tank pump >
Relay >
Services >
VRM online portal Time
Logging enabled Enabled
VRM Portal ID XXXXXXXXX
Log interval 15 min
Last contact --
Storage location Internal storage
Free disk space 26.83 M bytes
microSD / USB No storage found
Stored records 35
Oldest record age 1h 32m
ESS Time
No ESS assistant found
Energy meters Time
Fronius PV Inverters Time
Inverters >
Data card search Press to scan
Detected data cards >
Add data cards manually >
TCP port 0080
Generator start/stop Time
Generator start/stop function is not enabled. Got to relay settings and set function to Generator start/stop.
Wireless AC sensors Time
No gateway
Tank pump Time
Tank pump start/stop function is not enabled. Got to relay settings and set function to “Tank pump”.
Ethernet Time
State Unplugged
Relay Time
Function Alarm relay
Alarm relay polarity Normally open
Alarm relay ON Off
Wi-Fi Time
No Wi-Fi adapter connected
Services Time
Modbus/TCP Off
MQTT Off
VRM two-way communication Off
Note: Enabling LG Resu disables the other supported CAN-bus services and vice versa
Oceanvolt Motor Drive Off
Valence battery Off
Onboard Ve.Can On
CAN-bus BMS Off
GPS Time
Status No GPS connected
Latitude --
Longitude --
Speed --
Course --
Altitude --
Number of satellites --
Format 52º 20’ 41.6” N, 5º 13’ 12.3” E
Speed unit Kilometers per hour
Device >

ADDITIONAL TROUBLESHOOTING PROCEDURES

Power Hub Will Not Power Up

If the Power Hub 3500 is not powered up, it probably is not connected to an active 24 VDC battery and/or there is no PV input. The LCD user interface will power up and be navigable when connected to either of these power sources. Power from PV arrays will charge batteries once the voltage from the arrays is 5 volts greater than the battery voltage then continue charging as long as the voltage from the PV arrays is 1 volt higher than that of the batteries.

Performance Issues, Causes and Solutions

Table 11. Symptoms and Solutions for the Most Common Power Hub Issues

Symptom	Possible Cause(s)	Solution
Battery SOC displays "--".	Battery not fully charged for an extended period or has not been cycled enough times for the user interface to calculate SOC.	Try to charge the battery fully often. Refer to the setup diagram to make sure that the System is assembled correctly. Read SOC from individual Battery Status Monitors
Battery SOC seems inaccurate	Power Hub is not the primary power management device.	Normal operation. Read battery SOC individual batteries
Not registering charge current with panels operating in sun	1. Power Hub overheated	1. Check internal temperature and "battery" temperature on user interface. Derating begins at 104 ºF; diminishing power as temp approaches 140 ºF. Check for dirty, blocked air filters. Shade the Power Hub to reduce solar loading. Ensure that the internal cooling fans are operating (audible when operating).
	2. Batteries fully charged (29.0 VDC or near to that)	2. Normal operation.
LCD inoperative	1. No power to the Hub	1. Check connections and make sure batteries are active.
	2. The LCD screen is overheated/sunlight exposure	2. Close lid and allow Power Hub to cool down.

Note: The battery SOC and related readouts on the Power Hub 3500 LCD user interface are precise ONLY if the batteries are connected directly to the Power Hub 3500. If the batteries are connected to the PRO-Verter (indirectly to the Power Hub 3500), then information about the battery SOC and other parameters should be obtained from the individual Battery Status Screens.

Solar Charge Controller Error Codes

Detailed error codes can be read with a LCD user interface. The vast majority of these errors will not be encountered when the Power Hub is operating in concert with other HPS components. All possible error codes are included for reference purposes.

Err 2 - Battery voltage too high
This error will auto-reset after the battery voltage has dropped. This error can be due to other charging equipment connected to the battery or a fault in the solar charge controller. This error can also occur if the battery voltage is set to a lower voltage than the actual battery voltage (e.g., 12 VDC for a 24 VDC battery).

Err 3, Err 4 - Remote temperature sensor failure
Check if the T-sense connector is properly connected to a remote temperature sensor. Most likely cause: the remote T-sense connector is connected to the BAT+ or BAT- terminal. This error will auto-reset after proper connection.

Err 5 - Remote temperature sensor failure (connection lost)
Check if the T-sense connector is properly connected to a remote temperature sensor. This error will not auto-reset.

Err 6, Err 7 - Remote battery voltage sense failure
Check if the V-sense connector is properly connected to the battery terminals. Most likely cause: the remote V-sense connector is connected in reverse polarity to the BAT+ or BAT- terminals.

Err 8 - Remote battery voltage sense failure (connection lost)
Check if the V-sense connector is properly connected to the battery terminals.

Err 17 - Controller overheated despite reduced output current
This error will auto-reset after the solar charge controller has cooled down. Check the ambient temperature and check for obstructions in the ventilation filters. Shade the Power Hub.

Err 18 - Controller over-current
This error will auto-reset. If the error does not auto-reset disconnect the solar charge controller from all power-sources, wait 3 minutes, and power up again. If the error persists the solar charge controller is probably faulty. A cause for this error can be switching on a very large load on the battery side.

Err 20 - Maximum Bulk-time exceeded
This error can only occur when the maximum bulk-time protection is active. This error will not auto-reset. This error is generated when the battery-absorption-voltage is not reached after 10 hours of charging.

Note: This protection is default disabled in all solar charge controllers. Do not enable it.

Err 21 - Current sensor issue
This error will not auto-reset.
Disconnect all wires, and then reconnect all wires. Also, make sure the minus on the MPPT solar charge controller (PV minus/Battery minus) is not bypassing the solar charge controller.

If the error remains, please contact your FSR.

Err 26 - Terminal overheated
Power terminals overheated, check wiring, including the wiring type and type of strands, and/or fasten bolts if possible.

This error will auto-reset.

Err 28 - Power stage issue
This error will not auto-reset.

Disconnect all wires, and then reconnect all wires. If the error persists the solar charge controller is probably faulty. Contact FSR.

Err 33 - PV over-voltage
This error will auto-reset after PV-voltage has dropped to safe limit. This error is an indication that the PV-array configuration with regard to open-circuit voltage is critical. Check the PV panel spec, configuration, and if required, re-organise panels.

Err 34 - PV over-current
The current from the PV-panel array has exceeded 75A. This error could be generated due to an internal system fault. Disconnect the Power Hub from all power-sources, wait 3 minutes, and power-up again. If the error persists the controller is probably faulty, contact your FSR.

Err 38, Err 39 - PV Input shutdown
To protect the battery from over-charging the panel input is shorted.

Possible reasons for this error to occur:

- There is another device connected to the battery, which is configured to a higher voltage.
- The battery is disconnected using a manual switch. Ideally the charger should be switched off before disconnecting the battery, this avoids a voltage overshoot on the charger output. If necessary the voltage trip-level for the PV Short protection can be increased by raising the Equalization voltage set-point (note: equalization does not have to be enabled in this case).

Error recovery:

- Error 38: First disconnect the PV panels and disconnect the battery. Wait for 3 minutes, then reconnect the battery first and next the panels.
- Error 39: The Power Hub will automatically resume operation once the battery voltage drops below the max charge level for 1 minute.

If the error persists the one or more solar charge controller is probably faulty. Contact FSR.

Information 65 - Communication warning

Communication with one of the paralleled controllers in the Power Hub was lost. To clear the warning, cycle the power to the Power Hub.

Information 66 - Incompatible device

The controller is being paralleled to another controller that has different settings and/or a different charge algorithm.

Make sure all settings are the same and update firmware on all solar charge controllers in the Power Hub to the latest version

Err 67 - BMS Connection lost

The solar charge controller is configured to be controlled by a BMS, but it does not receive any control messages from a BMS. The charger stopped charging, as a safety precaution.

Check the connection between the charger and the BMS.

How to reset the solar charge controller to de-couple it from the BMS

When the charger needs to operate in stand-alone mode again, not controlled by a BMS, it needs to be reset:

- Solar chargers, go into the setup menu, and change setting ‘BMS’ from ‘Y’ to ‘N’ (setup item 31).
- Reset the solar charge controllers to factory defaults, and then reconfigure it.

  Note that solar chargers automatically configure themselves to be BMS-controlled when they are connected to one, either directly or via the LCD user interface. The Power Hub was programmed to work independently from a BMS.

Err 114 - CPU temperature too high

This error will reset after the CPU has cooled down. If the error persists, check the ambient temperature and check and or clean the air filters. Shade the Power Hub to reduce solar loading.

Err 116 - Calibration data lost

If the unit does not work and error 116 pops up as the active error the unit is faulty, contact your FSR.

If the error is only present in the history data and the unit operates normally this error can be ignored safely. Explanation: when the units power up for the very first, it does not have calibration data and an error 116 is logged.

Err 119 - Settings data lost

The Power Hub cannot read its configuration, and stopped.
This error will not auto-reset. To get it working again:

- First, restore it to factory defaults. Contact your FSR for the values.
- Disconnect the Power Hub from all power-sources, wait 3 minutes, and power up again.
- Reconfigure the Power Hub.

Clearing PRO-Verter Faults

If any fault occurs, the user interface will display the fault message and the red “Fault” LED will be lighted. Remove cause of the fault. The unit will remain in Fault mode until the fault is cleared. A short press (0.1 seconds) of the On/Off button will clear the fault message and the PRO-Verter will return to the operational status (if the reason for the fault condition has been corrected). Refer to the section on “Fault Messages”.

System Recovery with Overdischarged Batteries

If batteries are discharged to a “critical-low” level, the System may cease to function. There are two (2) methods to restore a System with overdischarged batteries:

1. Connect an active 230 VAC power source to the PRO-Verter “Generator Input” connector. Turn on the 230 VAC generator input breaker on the Faceplate. When the LED over the System Recovery switch illuminates, toggle the recovery switch while pressing the user interface On/Off button. After the user interface powers up, release the System Recovery switch and the user interface On/Off button. The System will begin charging the batteries within two (2) minutes

2. Connect an active PV array (exposed to sun) to the PRO-Verter (or Power Hub 3500). Turn on the PRO-Verter user interface. Charging will begin when the PV input voltage is 5.0 VDC higher than the battery voltage.

Tips to Keep the System Running Safely and Smoothly

General Requirements

- **Keep it cool**—Clean all component air filters frequently to minimize the accumulation of internal heat. Minimize exposure of all components, except the Solar Arrays, to direct sunlight. **Excessive heat reduces system efficiency** (less power available for loads, slower charging, etc.)

- **DO NOT STORE / TRANSPORT EXPANDER PAKS IN A DISCHARGED STATE!** Always recharge batteries completely before storing/transporting. Always follow prescribed in-storage maintenance charging procedures.

- The Solar Arrays should always be clean and pitched for maximum daily sun exposure.

- The state of charge reported by the PRO-Verter 5000 will be accurate only if the total battery bank size is at least 200 Ah and if there is only ONE PRO-Verter being used with the bank.

- EMERGENCY STOP: Turn OFF the PRO-Verter 5000 power switch and disconnect the ESM 2700s.

PV Array–related Troubleshooting

This section contains troubleshooting information for locating and correcting operating troubles that may develop in the PV array. Each malfunction is followed by a list of tests or inspections to help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, contact the Field Service Representative.

Equipment Condition Assumption Statement: The Power Hub is fully functional and operating normally.

No Power from the PV Array or Panel

Step 1. Verify the PV array is oriented for maximal sun exposure.
a. If the PV array is oriented for maximal sun exposure go to step 2.
b. If not, orient the PV array for maximal sun exposure.

Step 2. Check the Solar Cable connection at the Power Hub.
a. If the Solar Cable is properly connected to the Power Hub go to step 3.
b. If the Solar Cable is loose or not connected, tighten or connect properly.

Step 3. Check the connections between the Solar Cable and the PV array.
a. If connections between the Solar Cable and PV array are secure, go to step 4.
b. If connections are loose or disconnected, tighten or connect them properly.

Step 4. If the no-voltage problem persists, contact the Field Service Representative.

Lower Than Expected Voltage from the PV Array or Panel

Step 1. Verify the PV array is oriented for maximal sun exposure and is NOT shaded.
a. If the PV array is oriented for maximal sun exposure and NOT shaded, go to step 2.
b. Remove the shading obstruction or move the PV array to eliminate the shading.
c. Orient the PV array for maximal sun exposure.

Step 2. Measure PV array V_{oc} at pins A and C of the bayonet connector of the Solar Cable.
a. If the PV array V_{oc} at pins A and C of the bayonet connector of the Solar Cable is within acceptable limits, the PV array is operating normally.
b. If V_{oc} measured at pins A and C of the bayonet connector is low, go to step 3.

Step 3. Check the connections between the Solar Cable and the PV array output lead connectors.
a. If connections between the Solar Cable and PV array are connected properly, go to step 4.
b. If connections are loose or disconnected, tighten or connect them properly.

Step 4. Check the V_{oc} at the PV array output lead connectors.
a. If the V_{oc} is within acceptable limits, replace the Solar Cable.
b. If the V_{oc} at the PV array output lead connectors is not within acceptable limits*, replace the PV array.

Output values will vary depending on weather/environmental conditions (i.e., lower if overcast).

MAINTENANCE INSTRUCTIONS

HPS Preventive Care and Maintenance

Follow these procedures to maintain the System.

- **Shade the components (except the PV arrays) from direct sun exposure and shelter them from the elements.**
- Clean air filters of the PRO-Verter and Power Hub air intake vents once a month or more frequently as warranted to minimize the accumulation of internal heat. See the component manual for air filter cleaning instructions.
- Keep component case lids and Inter-Connect covers closed to prevent water/dust intrusion.
- Ensure the panels of the PV arrays are clean and positioned for maximum daily sunlight exposure.
- Ensure the Solar Cables are secured.
- Check the integrity of electrical connectors and communication contacts on a monthly basis.
- Turn off electrical appliances when they are not in use to save power and allow more power to be available when needed.

Water Intrusion—Prevention and Remediation

⚠ WARNING

Standing water around the electrical equipment or intrusion of water into the System components can increase the risk of electrical shock.

- Lids on the Power Hub 3500 and the PRO-Verter should be closed whenever possible while the System is operating to prevent water and dust from entering the System.

- If water intrusion is suspected, and the System is still functional, disconnect power sources entering that component from the most distant location possible, power down the System (turn off the power switches on all of the System components) and then disconnect the component from the System. Do not to try to remove what may be a flooded component while it is still powered up.

- Remove the screw from the drain hole at the bottom edge of the component case. If water flows out of the drain hole after removal of the plug, let it flow until it stops. Then slightly and slowly tilt the case toward the drain hole to remove any remaining water. Continue to increase the angle of the component slowly until no more water drains from the hole. After the water has been drained, move the component to a safe dry location and remove the Faceplate. Place the component in the most dry environment possible for a time long enough that any remaining moisture inside will dry. When it is dry, reintegrate the component to the System and test it to determine if it is still functional.

Inter-Connect Strips and Water Intrusion

The Inter-Connect Strip 7 is a DC bus for the entire System and should be placed in a protected and dry location to minimize the possibility of water intrusion. If water enters the Strip, power down the System and tilt the strip so that the drain hole (below; arrow) is a the lowest point.

Preventive Maintenance Checks and Services (PMCS)

The tables that follow describe PMCS at the field operator level.

24VDC ESM 2700 PMCS

Required Tools

Solar Stik PRO-Verter or $LiFePO_4$ battery maintenance charger.

Table 12. 24VDC Li ESM 2700 PCMS

Item #	Item to be Inspected	Interval at 91-140 °F (33-60 °C) Storage Temp	Interval at 77-90 °F (≤ 25-32 °C) Storage Temp	Procedures	Non-mission Capable
1	Visual inspection of 24VDC Li ESM 2700	M[1]	Q[2]	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior and ports. 3. Close all unused port covers.	~If the case is broken or split or if ports are damaged, contact Solar Stik Technical Support for advice on how to proceed.
2	In-storage maintenance charging	Q	S[3]	1. Charge Li ESMs for 24 hours at 29.0 V. Follow the instructions for the lithium battery charger used. 2. Charge until the Battery Status Meter reports ~100% SOC. 3. If the SOC remains low after 24 hours, continue charging for another 24 hours.	~If any Li ESM fails to charge after 48 hrs., contact Solar Stik Technical Support.

[1]Monthly (M)—every month [2]Quarterly (Q)—every three months [3]Semiannually (S) – every 6 months

24VDC PRO-Verter 5000-220 PMCS

Table 13. 24VDC PRO-Verter 5000-120 PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of 24VDC PRO-Verter 5000	M	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior, interior and connectors. 3. Close all unused port covers.	~If the case is broken or split or if connectors are damaged, do not place into service.
2	Air Intake Filters	M[1]	1. Remove the three (3) air intake vent covers to expose the filter material. (See PRO-Verter Manual for location of air intake filters.) 2. Wash with water and dry the filter. Reinstall. 3. If the filter is damaged or cannot be cleaned replace.	~If the filter cannot be cleaned, is too damaged to function properly and a replacement is not immediately available, the unit is partially mission capable. Replace the filter as soon as possible to restore the unit to fully mission capable.

[1]Clean or replace more frequently when the System is operating in dusty, windy environments

24VDC Power Hub 3500 PMCS

Table 14. 24VDC Power Hub 3500 PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of 24VDC Power Hub 3500	M	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior, interior and connectors. 3. Close all unused port covers.	~If the case is broken or split or if connectors are damaged, do not place into service.
2	Air Intake Filters	M[1]	1. Remove the air intake vent covers to expose the filter material. (See Power Hub Manual for location of air intake filters.) 2. Wash with water and dry the filter. Reinstall. 3. If the filter is damaged or cannot be cleaned replace.	~If the filter cannot be cleaned, is too damaged to function properly and a replacement is not immediately available, the unit is partially mission capable. Replace the filter as soon as possible to restore the unit to fully mission capable.

[1]Clean or replace more frequently when the System is operating in dusty, windy environments

PV Array PMCS

Table 15. PV Array PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of PV Arrays	M[1]	1. Inspect PV panels and support frame for visible damage 2. Clean excessive dust or dirt from the surface. 3. Inspect cables and connections. Ensure there is no damage and that cables are not in standing water.	~If the PV panels and/or the frame are damaged to the point of being non-functional, the PV array is NMC, replace.
2	Inspection of PV array ground securing	M	1. Check the integrity of the ground securing mesh panels. 2. Ensure ground securing sandbags are full and situated properly. 3. Ensure that none of the sandbags is positioned in a way that places stress on any part of the PV array.	~ If any aspect of the ground securing components is damaged or missing to the point the PV array cannot be secured to the ground, the PV array is NMC. Contact FSR to repair or replace the PV array. An unsecured PV array can become a wind-driven projectile posing risk of injury to personnel and damage to any connected equipment.
3	PV array output	Q[2]	1. Ensure each PV array is oriented for optimal sun exposure. 2. Independently check (on the Power Hub User Interface) the power output from each array.	~ If power output of an array is less than half the rated value, follow the instructions in this document to identify and solve the issue.

Terminal (End-of-Life) Battery Performance

When a $LiFePO_4$ battery has reached the end of its service life (SOH is less than 80%), it loses its ability to retain electrical energy in its cells, and the cycle performance will be severely degraded. Symptoms will include:

- Voltage will rise and fall in very short periods of time.
- Very short durations of inverter and generator run-times.
- Circuit breaker tripping.

NEVER STORE THE ESM IN A DISCHARGED STATE

Storing a discharged battery will cause it to “brick”

Discharging the ESM Battery to “EMPTY”

For longest service life, Expander Paks should only be discharged to 80% depth of discharge (DOD). This means that 80% of the power stored in the battery can be used to supply a load before recharging is recommended. The smaller the DOD%, the longer the battery will last.

ABOUT SOLAR STIK, INC.

Mission Statement
Saving lives across the globe through innovative power solutions

STIKopedia
STIKopedia is a compilation of everything you would ever want to know about portable Hybrid Power Systems, including the philosophy and mechanics of high-efficiency circuits, and the individual technologies used to create them.

Solar Stik Training and Education

- **Solar School (St. Augustine, FL)** provides an introduction to the design and support of small-scale, renewable-energy, power generation systems, with detailed explanation of system components. Advanced configuration options with hands-on deployment of actual systems will enhance student understanding.

- **Solar Stik New Equipment Training (on site)** teaches Hybrid System configuration options with hands-on deployment of actual systems to enhance student understanding.

Solar Stik Training Courses are tailored to the specific needs of the students. To schedule Solar Stik Training or to learn more about the curriculum, please contact us.

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