SOLAR STIK®

SYSTEM SETUP AND OPERATION MANUAL FOR ATSC MS3 L1/L2

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Version 1.0
Updated:20220303

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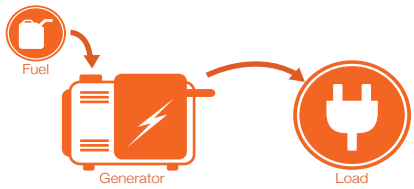
Section	Page(s)	Description	Date
		First Published	21 May 2018
		Update PRO-Verter Programming Values	29 July 2021

GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

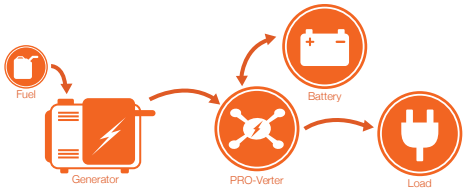
Introduction to Hybrid Power Systems

When a portable fuel-driven power generator is the primary source of power for an application, it must operate continuously to provide electricity to the load, even if the power requirements of connected loads are minimal or intermittent. Fuel energy is wasted in the production of electricity because neither the generator nor the load(s) can fully use the fuel's potential energy. This traditional power model is a low-efficiency system.

In the high-efficiency, Solar Stik Hybrid Power System (HPS), a battery bank supports the load. The power for the load is drawn from the batteries only as needed. Multiple sources of power generation can be used simultaneously to support the battery and ensure uninterrupted power to the loads. **The battery becomes the foundation of the HPS.**



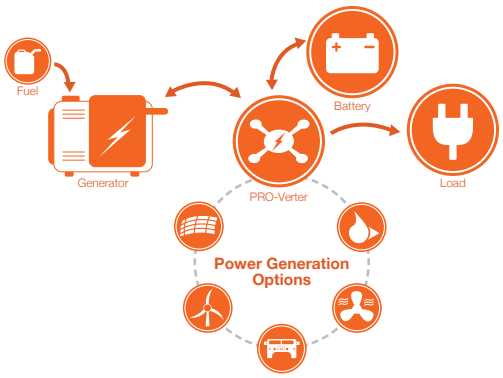
Low-efficiency
Traditional Power System



High-efficiency
Solar Stik HPS

The Solar Stik MS3 HPS

The MS3 Platform operates using a Solar Stik HPS to reduce logistical burdens (i.e., generator support) and provide maximum autonomy when operating in remote, austere locations. The System is comprised of modular components that integrate into a flexible architecture that meet this application's specific mission requirements.



HPS with Open Architecture

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.

Limitations on Liability

Since the use of this manual and the conditions or methods of operation, use, and maintenance of the System are beyond the control of Solar Stik, Inc. this company does not assume responsibility and expressly disclaims liability for loss, damage or expense, whether direct, indirect, consequential or incidental, arising out of or anyway connected with such operation, use, or maintenance.

Due to continuous improvements and product updates, the images shown in this manual may not exactly match the unit purchased.

This System **CAN BE USED FOR CONNECTION WITH LIFE SUPPORT SYSTEMS OR OTHER MEDICAL EQUIPMENT** or devices; however, without limiting the generality of the foregoing, Solar Stik, Inc. makes no representations or warranties regarding the use of the System in connection with life support systems or other medical equipment devices.

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

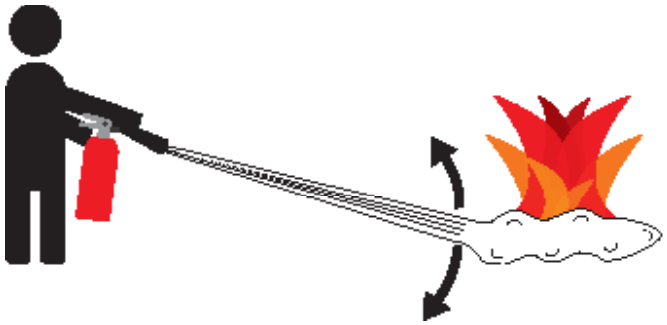
Only CO_2 (carbon dioxide) fire extinguishers should be used with Solar Stik equipment.

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!

⚠ WARNING

The System is NOT GFCI protected.

HIGH VOLTAGE: System components, solar 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.

Environmental and Handling Precautions

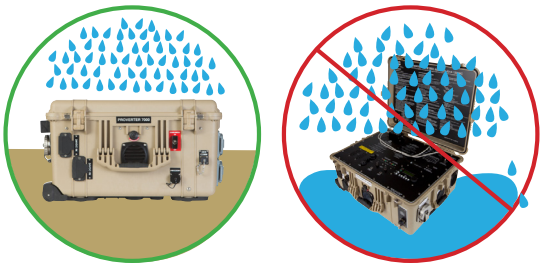
All Solar Stik components are ruggedized, yet there are a few things the operator can do to prevent failures and prolong the operational life of the Solar Stik System.

Wind

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

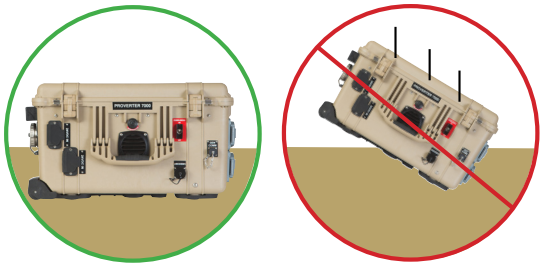
Water

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.



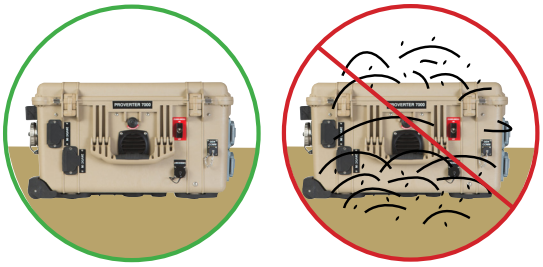
Impact

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



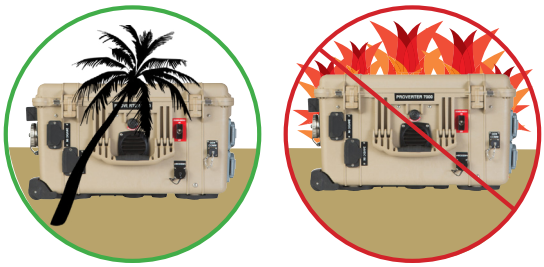
Dust/Foreign Object Intrusion

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

Modes of Operation

Hybrid Mode
- Reducing generator burdens (fuel consumption, wet-stacking, maintenance, or logistic support)
- Use of renewable power generation is desirable
- Durations of “silent” operation are critical

Peak Power Delivery Mode
- Temporary replacement of inadequate grid or generator power during periods of peak power demand (peak power delivery)
- Supporting generators during periods of overloading (load support)

UPS Mode
- Less reliance on grid-utility power is desirable
- Back-up power for critical loads when the primary power source fails

L1/L2 Solar Stik HPS

The Solar Stik HPS on the L1/L2 provides the operator with a high efficiency electrical circuit that accomplishes the following:

1. Reduces generator burdens and failures, including inefficient fuel burn, wet-stacking, fuel requirements, maintenance, logistics support, etc.

2. Opens the power system architecture to include renewable photovoltaic (PV) power generators.

The 13 kw diesel-fuel generator included in the HPS is rated for higher output than the peak AC power requirement of the loads.

Peak Power Loads Defined

1. Mast raising/lowering—The deployment of the L1/L2 mast requires up to 10 kW (43 A at 230 VAC) at peak load.

2. Environmental control units (ECUs)—The ECUs require up to 8050 W each (35 A @ 230 VAC) at peak load.

ECU Soft-starts

The ECUs on the L1/L2 have been configured with soft-start kits to reduce the surge loads of the compressor, preventing AC Overload faults during normal hybrid functions. When the PRO-Verter transfer switch engages, there is a 16 ms interruption in the AC provided to the ECU. The soft-start will sense the interruption and disengage the compressor. After the pressure has equalized, the compressor will restart (~5 minutes).

Sequential Deployment

When deploying the L1/L2 platform, **raising the mast must be an isolated step**, because it requires 100% of the PRO-Verter's capability when it is inverting (using the System's batteries). **The generator must not be running when raising or lowering the mast.**

After the mast is fully deployed, the remaining L1/L2 Systems and loads can be activated, and the System can be returned to normal hybrid mode with the generator engaged as necessary to support normal operations.

Hybrid Function and Operation

The Solar Stik HPS provides pure sine-wave AC power to the L1/L2 platforms using a 24 kWh battery bank, diesel-fuel generator, and solar array to meet the daily power requirements.

The power produced must be greater than or equal to the power consumed.

- The generator operates when the PRO-Verter commands it to charge the batteries or power the load. If the generator is powering the load, excess power charges the batteries.

- The solar array generates power when exposed to sunlight.

Batteries in a hybrid system are designed to cycle. A cycle is defined as one complete discharge and recharge over a specific period of time.

The PRO-Verter is the primary power management device in the Solar Stik HPS. All incoming PV power is immediately directed (prioritized) to the load, reducing DC flowing from the batteries, prolonging battery-operation time, and reducing need for AC from a grid-utility or generator source. When the batteries reach a programmed state of charge (SOC), the PRO-Verter starts the generator to provide power for both the load and for recharging the batteries.

A properly balanced L1/L2 HPS will cycle the generator and battery 1–2 times (average) per day.

Using Multiple PRO-Verters in an HPS

Solar Stik Systems (energy storage, power management, and power generation) can be scaled using a variety of methods that meet mission or load requirements. For hybrid systems that have a single battery bank and generator, multiple PRO-Verters can be used in concert.

Using multiple PRO-Verters in a System accommodates the following conditions:

1. Total load of the application exceeds the ability of one PRO-Verter.
2. Individual control over multiple loads/voltages is required.

PRO-Verters are designed to support loads in specific power ranges (voltage and current), so the generator and the battery bank must be able to meet the maximum power requirements if multiple PRO-Verters are used.

When using multiple PRO-Verters, they must be programmed to operate with one another. If being used with a single generator, then only **one (1)** PRO-Verter should be used to control it. The PRO-Verter connected to the generator becomes the Master (PRO-Verter #1), and the other PRO-Verter in the L1/L2 System is a Slave (PRO-Verter #2).

The generator in this configuration must be rated for the maximum amount of power the collective PRO-Verters require for proper operation. The L1/L2 uses a 13 kW diesel generator, providing up to 13 kW continuous power output for the Master (PRO-Verter #1) and Slave (PRO-Verter #2).

The Remote Monitoring Kit

The Remote Monitoring Kit (RMK) transmits HPS information in real time from the PRO-Verter over any LAN or internet gateway. It can be configured to provide warnings when fault conditions occur, and it also provides real-time and historical data tracking.

Programming, Metering and Data

The Master (PRO-Verter #1) and Slave (PRO-Verter #2) are programmed at the factory for use with the L1/L2 platform. It is possible to alter the programmed settings for special conditions or changes in System conditions or application. Contact Solar Stik Technical Support for assistance.

When the L1/L2 HPS is properly configured, all System performance data is collected at the Master (PRO-Verter #1) and can be viewed in real time and in historical perspective through both the RMK and the user interface.

> **Note:** Alteration of the System configuration will affect how data is collected. Please ensure all connections within the System are configured correctly.
>
> Additionally, when using multiple PRO-Verters, some of the system performance data collected in the battery monitoring circuit will not reflect actual System-level values. This is a consequence of each PRO-Verter metering only voltage and current (amperage) values that flow through its own monitoring circuits. The battery-related meter readings likely will be different among PRO-Verters because voltage and current will not flow at equal rates through multiple PRO-Verters.

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 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 1. Inter-Connect Plug

Trailer Inventory

☐ Two (2)
24VDC PRO-Verter 5000-220s

☐ One (1)
24VDC Power Hub 2400

☐ Six (6)
420W Expedition Solar Array-Cs
in transport cases

☐ Ten (10)
24VDC Li Expander Pak 2400s

☐ Two (2)
Inter-Connect Strip 7s

☐ One (1)
Cable Transport Case

☐ Two (2)
AC Input Power Cables
15’ 220 V 50 Hz
Blue

☐ One (1)
AGS Cable 15’

☐ Two (2)
AC Output Power
Cables 15’ 220 V 50 Hz
Green

☐ Two (2)
24VDC 10’
Inter-Connect Cables

☐ Twelve (12)
24VDC 5’
Inter-Connect Cables

☐ One (1)
24VDC 20’
Inter-Connect Cable

☐ One (1)
13.0 kW Generator

Color-coded Connections

Cables and ports are color-coded based on their function.

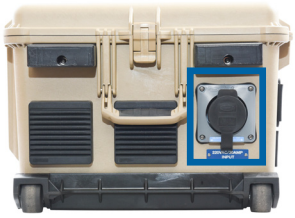
Cable Color	Example Ports
Orange: Solar Circuit Connection 	
Red: DC Circuit Connection 	
Blue: AC Input Connection 	
Gray: AGS Communication Connection 	
Green: AC Output Connection 	

Figure 2. System connection color coding

The Information Plate (I-Plate)

The I-Plate in The PRO-Verter provides critical setup and safety information for the operator including a System connection diagram, shown in detail below.

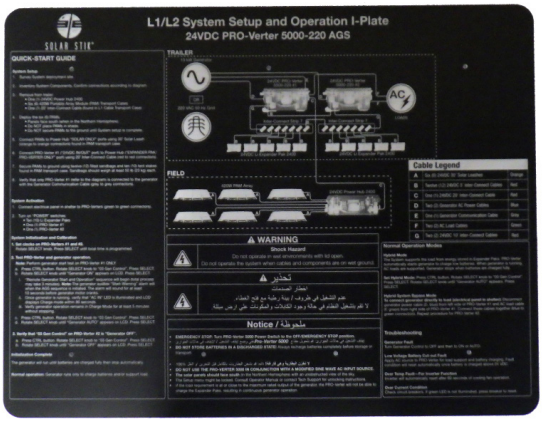


Figure 3. System Setup Guide on the PRO-Verter I-Plate

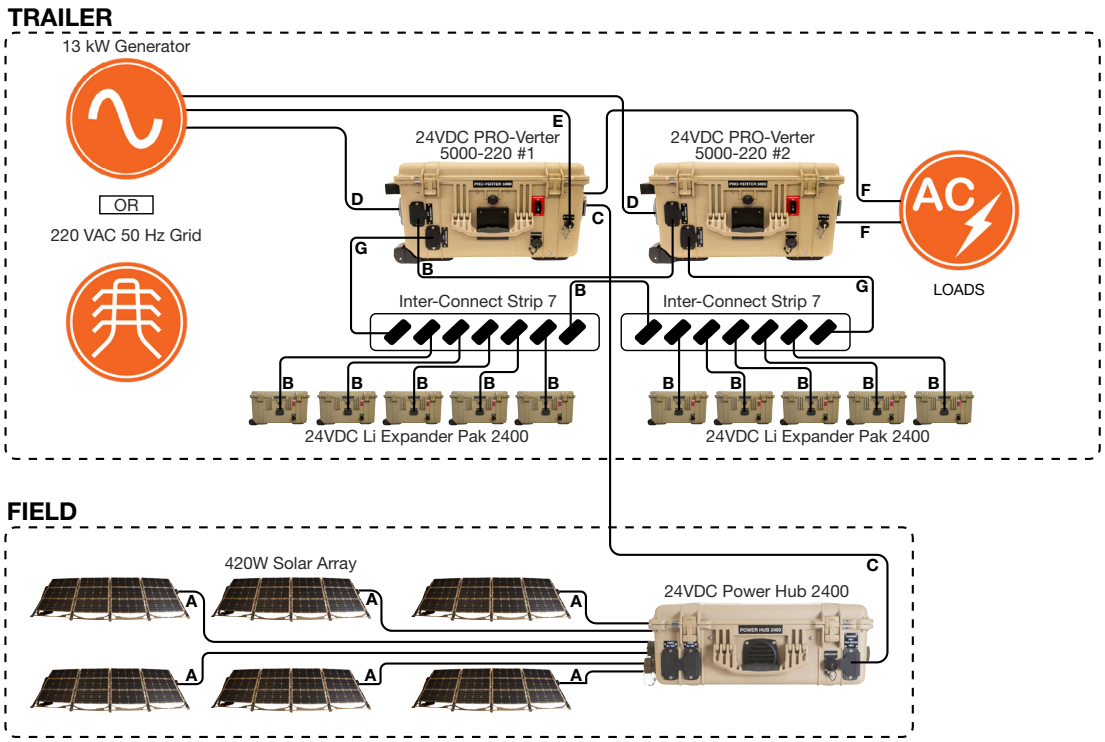


Figure 4. System connection diagram

Cables	
A	24VDC 30’ Solar Leash
B	24VDC 5’ Inter-Connect Cable
C	24VDC 20’ Inter-Connect Cable
D	AC Input Power Cable
E	AGS Cable
F	AC Output Power Cable
G	24VDC 10’ Inter-Connect Cable

OPERATOR INSTRUCTIONS

System Setup

1. Identify locations for System components.

Survey the site where the System will be deployed. The Solar Arrays should be located in a non-shaded area. The Power Hub should be located in a shaded area with appropriate distance allowed for cable connection to all components.

2. Remove Solar Arrays, Power Hub, and 20’ Inter-Connect Cable from trailer.

Locate and remove the following components from the trailer:

- One (1) 24VDC Power Hub 2400
- Six (6) 420W Expedition Solar Array-C transport cases
- One (1) 20’ Inter-Connect Cable, located inside of the cable transport case

Solar Array Transport Case Contents

Inventory the contents of each of the six (6) Solar Array transport cases prior to their deployment.

420W Expedition Solar Array-C Kit Inventory	
☐	Four (4) 105 W Photovoltaic (PV) Panels 1
☐	One (1) Transport Case 2
☐	One (1) Rollable Stand 3
☐	Twelve (12) Sandbags 4
☐	Ten (10) Stakes 5
☐	One (1) 30’ Solar Leash 6

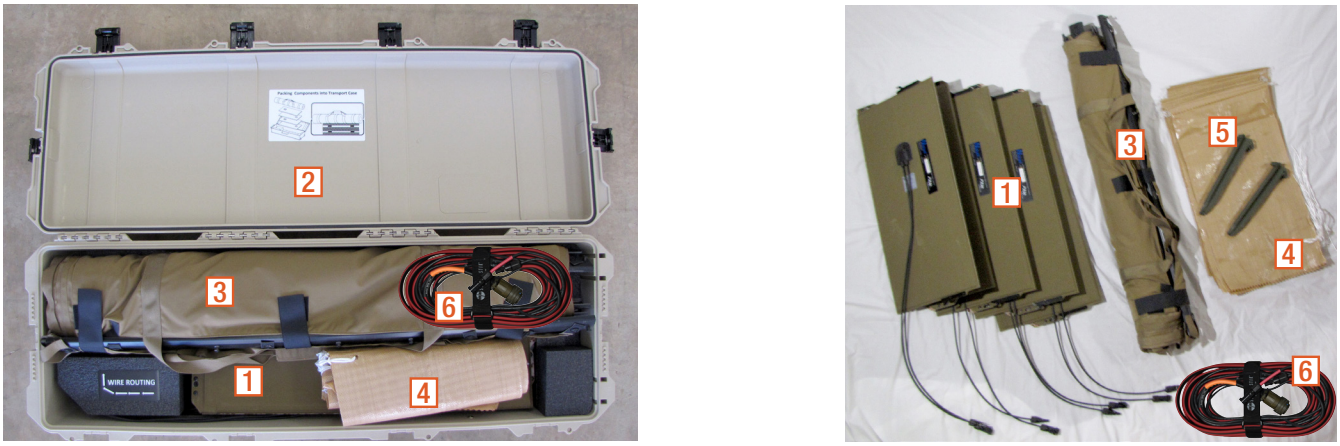


Figure 5. Solar Array transport case contents packed (left) and unpacked (right)

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.

Cable lengths determine the maximum working radius of the System; the Solar Arrays could be up to ~50’ from the PRO-Verter/trailer.

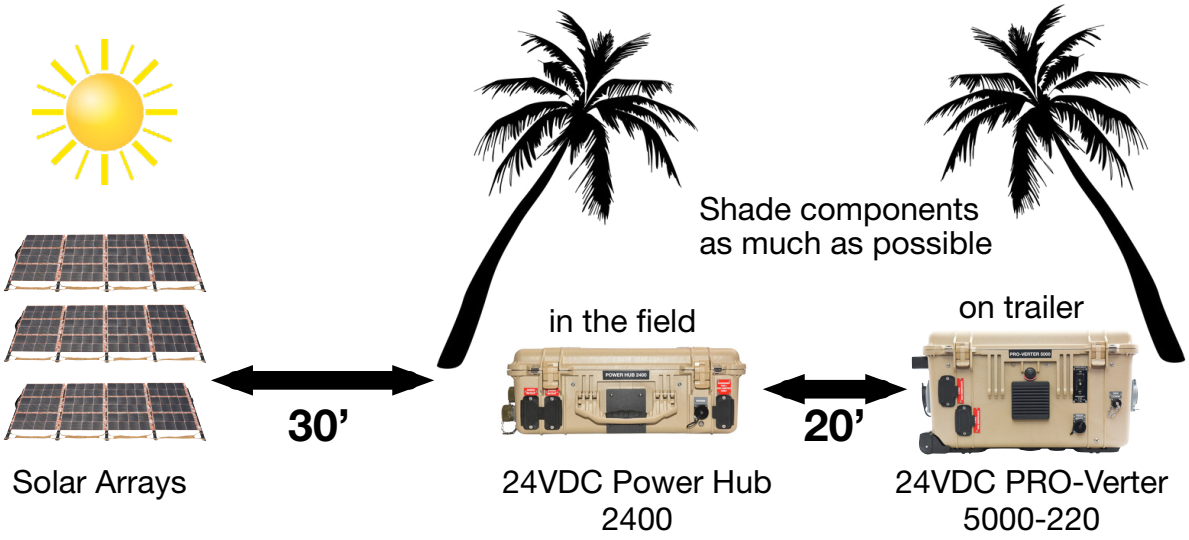


Figure 6. Working-space distance for the Solar Arrays, Power Hub, and the trailer

3. Inventory and connect System components on the trailer.

Inventory the System components using the list in the Trailer Inventory section.

Make connections between the System components that are to remain on the trailer according to the diagram on the PRO-Verter I-Plate and in this manual. The lines connecting the components indicate the colors of the connections to be made.

Connect PRO-Verter to Expander Paks.

Connect ten (10) Expander Paks to two (2) Inter-Connect Strip 7s. Connect the Inter-Connect Strips to the PRO-Verters using two (2) 10’ Inter-Connect Cables as shown in Table 2. This will require twelve (12) 5’ Inter-Connect Cables and two (2) 10’ Inter-Connect Cables. All of these are red-to-red connections.

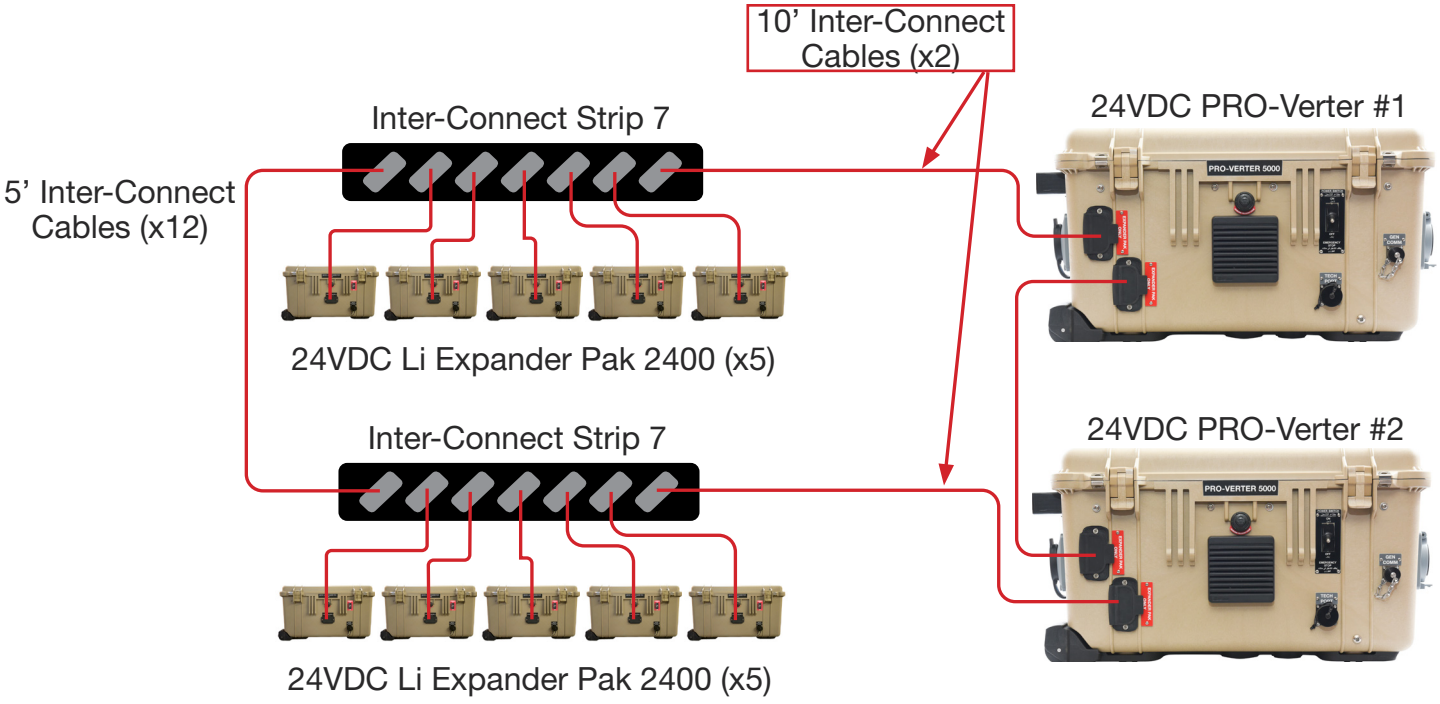


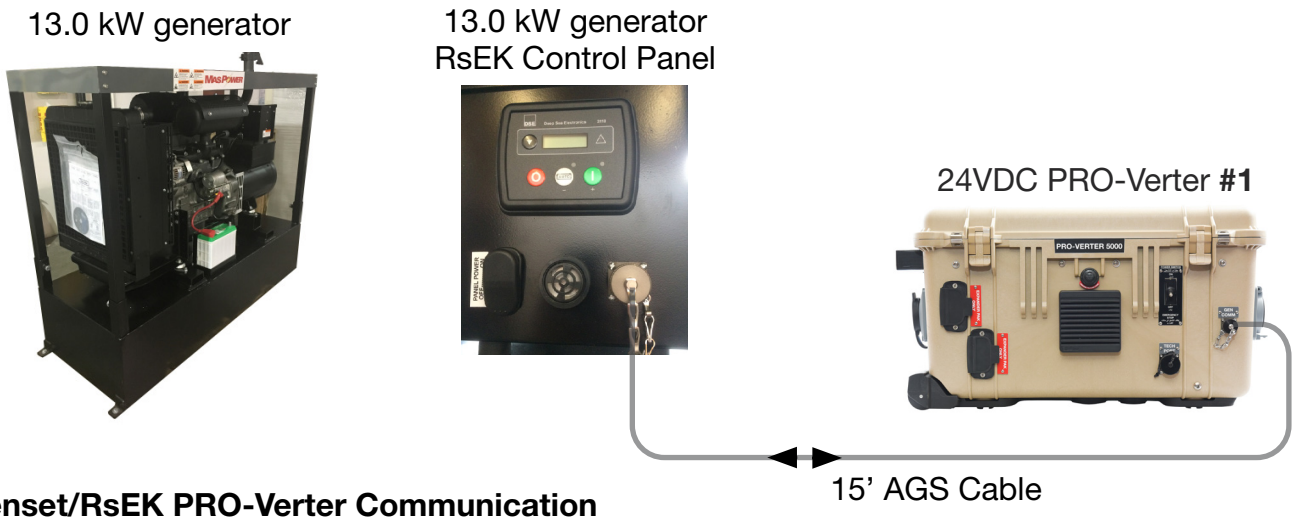
Figure 7. PRO-Verter to Expander Pak connections

Connect PRO-Verter to generator.

> **Note**: PRO-Verter #1 communicates with and controls the genset. The GenControl Setting is "AUTO". PRO-Verter #2 does NOT communicate with or control the genset. There is no Gen Comms cable from PRO-Verter #2 to the genset. PRO-Verter #2 GenControl Setting is "OFF".

Make power and communications connections between the generator and PRO-Verter:

- **AGS Cable:** "GEM COMM" port on the 24VDC PRO-Verter 5000 and "GEN COMM" port on the generator using gray-to-gray connection
- **AC In Power Cable:** AC power out on the generator to the "120 VAC INPUT" port on the left-hand side of the PRO-Verter 5000 using blue-to-blue connection



Genset/RsEK PRO-Verter Communication

Genset to PRO-Verter Power

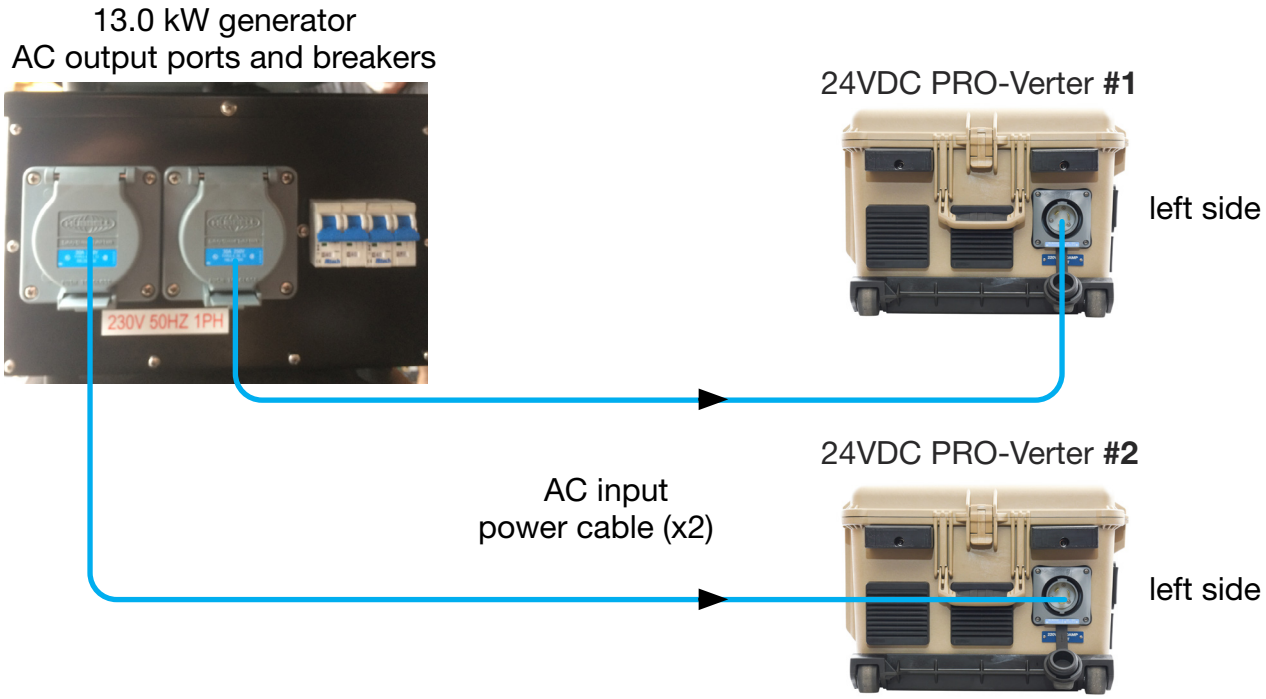


Figure 8. PRO-Verter to generator connections

Connect PRO-Verter to the shelter service panel.

Connect the PRO-Verter (“220 VAC/30 AMP OUTPUT” port) to the shelter service panel using a green-to-green connection.

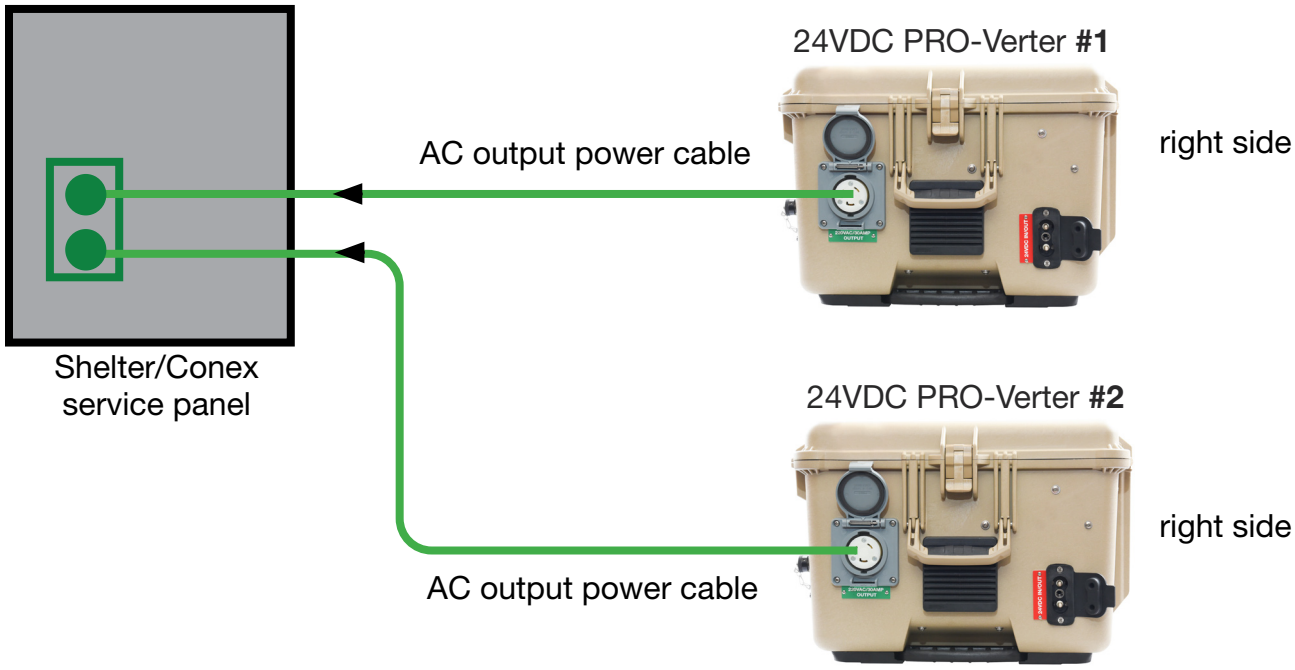


Figure 9. PRO-Verter to shelter service panel connection

Grounding the System

Grounding the PRO-Verter at the grounding lug is a safety measure. The PRO-Verter and the generator should be bonded to the trailer equipment grounding conductor, which should be connected to the 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 automatically are bonded internally at the PRO-Verter.

There should be no other neutral to ground bonds on the trailer.

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.

Figure 10. PRO-Verter grounding lug

4. Deploy the Solar Arrays.

For detailed setup instructions, see the 420W Expedition Solar Array-C Operator Manual. The panels should be positioned for maximum daily exposure. **DO NOT secure the Solar Arrays to the ground until the entire System is setup.**

Connect the four (4) PV panels on a single rack “in series” using the wiring diagram below. There will be one (1) “free” connector at each end of the rack of panels*. Connect these two (2) free ends to the MC4 connectors of the 30’ Solar Leash.

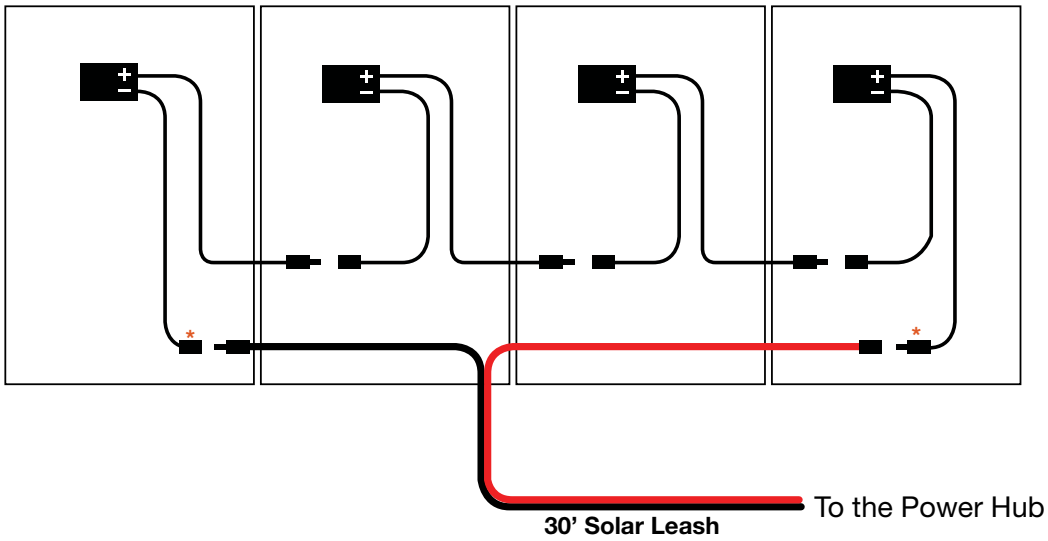


Figure 11. Connect negative and positive ends of the cables as shown

5. Connect the Solar Arrays to the Power Hub.

Connect the Solar Leash to the SOLAR ONLY ports These are orange-to-orange connections.

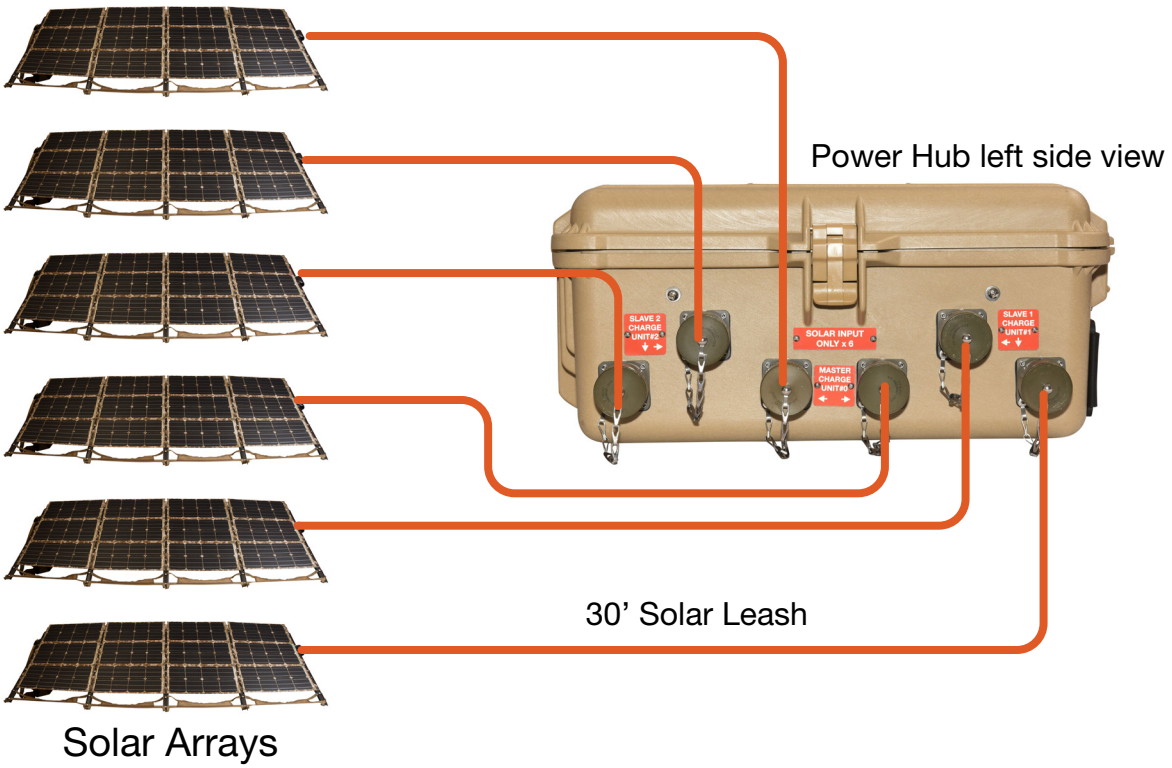


Figure 12. Solar Array to Power Hub connections

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.

Figure 13. Power Hub air intake port and vent filter

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

6. Connect PRO-Verter #1 to the Power Hub.

Connect PRO-Verter #1 (“24VDC IN/OUT” port) to the Power Hub (“EXPANDER PAK/PRO-VERTER ONLY” port) using a 20’ Inter-Connect Cable. This is a red-to-red connection.

Figure 14. PRO-Verter to Power Hub connection

7. Secure the Solar Arrays to the ground.

⚠ WARNING

Failure to properly secure the Solar Arrays to the surface with sandbags could result in PV panel damage, injury, or death in high winds. Tent stakes should be used in addition to sandbags when possible. Wind damage can render panels nonfunctional or significantly reduce their functional life expectancy.

Solar Arrays must be properly secured to the ground even in low-wind environments. The methods used for ground securing are determined by two (2) factors:

1. The type of surface upon which the Solar Arrays are to be deployed—“hard” surface (such as pavement) or “soft” surface (such as dirt or sand)

2. The environmental conditions—wind conditions that the Solar Arrays might encounter

Detailed instructions for securing the Solar Arrays are found in the 420W Expedition Solar Array-C operator manual. Read and follow these instructions.

System Activation

Figure 15. Generator control panel

1. Connect loads to the PRO-Verters (If not already connected).
2. Verify the generator has fuel and oil and that the generator starter battery cables are connected.
3. Turn on the generator main switch by toggling it up (arrow in Figure 15).

Note: The generator control panel is programmed for the L1/L2 application and set to AUTO MODE. DO NOT use the buttons on the generator control panel to control the generator.

4. Turn on the main power switches on all Expander Paks and the PRO-Verter.
   ~The Power Hub turns on automatically when connected to the battery bank via the DC bus (Inter-Connect network).
5. Verify the Inverter function engages. The LED next to “INV” will be illuminated when the inverter is operating.

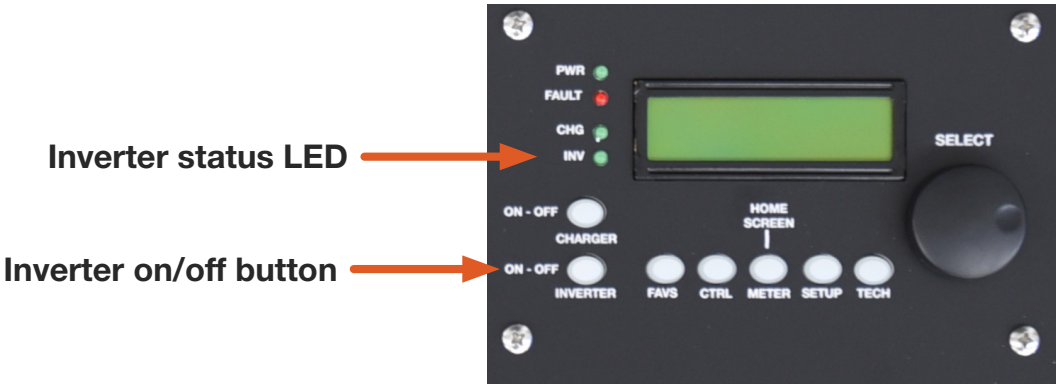


Figure 16. PRO-Verter control panel

System Initialization and Calibration

1. **Set the PRO-Verter clock.** Rotate the SELECT knob. Press SELECT until local time is programmed.

2. **Test the PRO-Verter and generator operation.**
   The Generator Status LED (Figure 17, left side) will be illuminated green.
   a. Press the CTRL button (Figure 16). Rotate the SELECT knob to “03 Gen Control”. Press SELECT.
   b. Rotate the SELECT knob until “Generator ON” appears on the LCD. Press SELECT.
      i. The “Remote Generator Start and Operation” sequence will begin (total process may take 3 minutes).
      Note: The audible “Start-Warning” alarm will sound when the PRO-Verter is attempting to start a generator. The alarm will last for 10 seconds before the motor cranks. During this time, the Generator Status LED on the right will blink green indicating that the AGS function is initiating the generator start sequence.
      ii. Once the generator is operating, verify the “AC IN” LED illuminates and the LCD displays CHARGE MODE within 90 seconds. At this point, the Generator Status LED on the right will be solid green*.
      iii. Verify the generator stays operating for 5 minutes uninterrupted while the CHARGE mode is operating (Charger status LED will be illuminated).
   c. Press the CTRL button. Rotate the SELECT knob to “03 Gen Control”. Press SELECT.
   d. Rotate the SELECT knob until “Generator AUTO” appears on the LCD. Press SELECT.

* If the Generator Status LED on the right is solid red, it Indicates a fault condition in which the generator either has not started, or has not provided the correct Gen Run sense signal/voltage to the AGS module – after four start attempts.

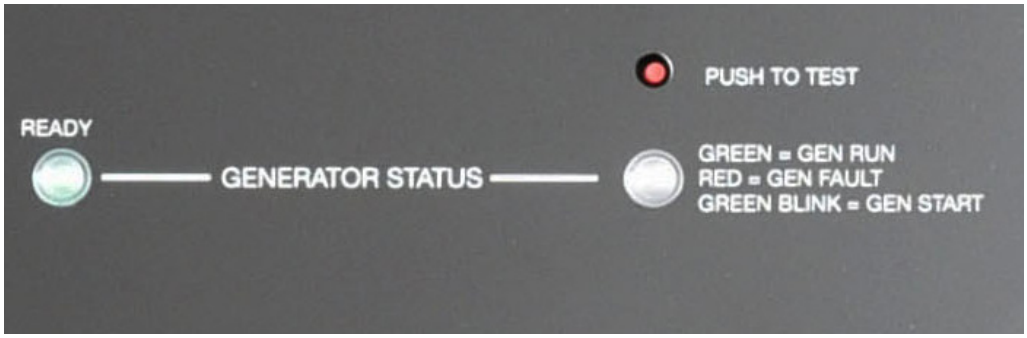


Figure 17. Generator Status LEDs

Initialization Complete

The generator will run until the batteries achieve full charge and then auto-stop. Normal cycling will begin with the generator operating only as necessary for continuity of operation (keeping the batteries charged and the load functioning).

Note: AGS function can be tested by pressing the red “PUSH TO TEST” button above the status light on the right. This may be useful for troubleshooting if communication with the generator cannot be established using the programmed method.

Order of Operations

L1/L2 Activation Sequence

1. Turn off generator.
2. Raise mast.
3. Activate shelter systems.

L1/L2 Deactivation Sequence

1. Turn off generator.
2. Deactivate all shelter systems.
3. Lower mast.

Note: Do NOT operate any shelter systems while raising or lowering the mast.

If the load does not power up when connected to the PRO-Verter 5000, check the following:

- Are all System connections correct and secure?
- Are all power switches and breakers switched to the ON position?
- Is the appliance or load connected to the PRO-Verter properly and is it turned on?
- Are the 24VDC Expander Paks charged sufficiently to support the load?
- Is the inverter function engaged?
- Is there a fault condition reported by the PRO-Verter user interface?

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.

- If the combined load for both PRO-Verters is at or close to the maximum rated output of the generator, the PRO-Verters will not be able to charge the Expander Paks, resulting in continuous generator operation.

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

- The PRO-Verter setup menu might be locked. Consult the PRO-Verter 5000 Operator Manual or contact Technical Support for access.

- EMERGENCY STOP: Turn OFF the PRO-Verter 5000 power switch and disconnect the Expander Pak 2400s.

L1/L2 PRO-Verter Programming Menu Map

The PRO-Verters have been programmed at the factory with identical program values to operate with the MS3 L1/L2 System. The programming map on the following pages is a representation of how to navigate the information in the PRO-Verter user interface. The color coding key below provides information that makes understanding the programming map easier.

Menu Map Color Coding Key

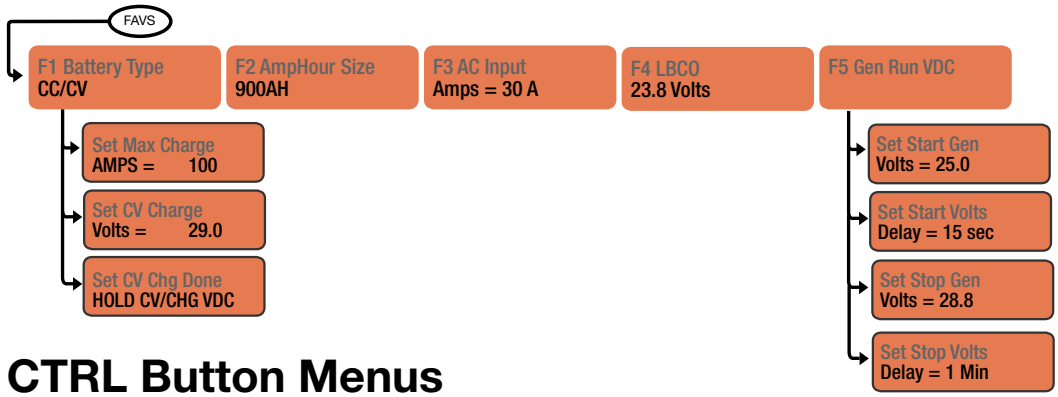
Green menu items represent factory default settings, read-only settings, or options that exist within a specific menu item.

Light green menu items represent resettable menu selections. Press and hold the knob for 3 seconds to reset values.

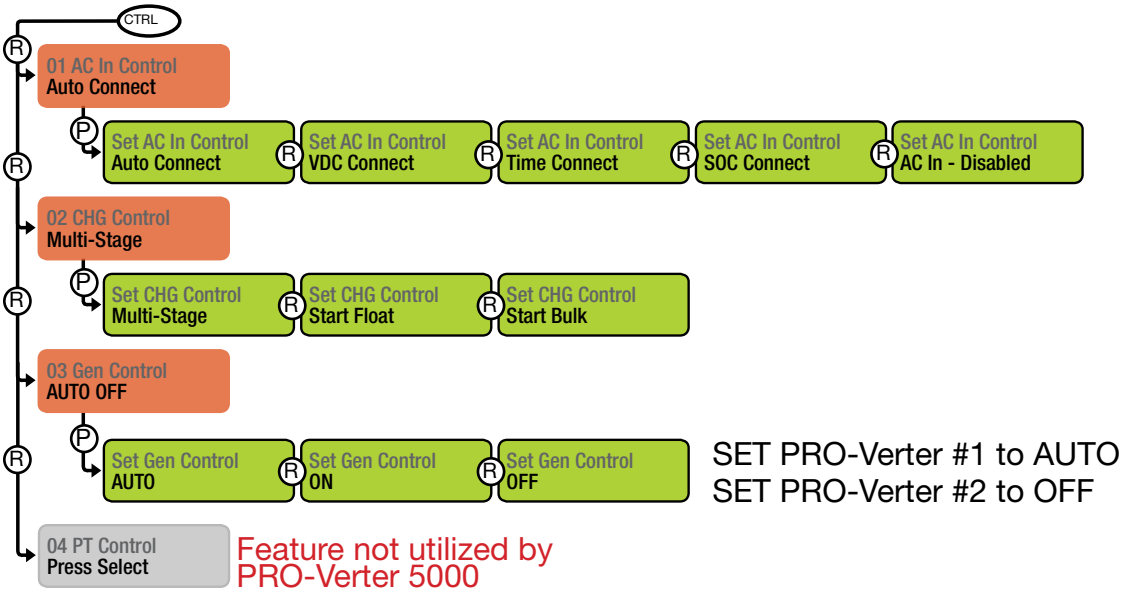
Orange menu items indicate values that are set by Solar Stik for a specific application. These values (with the exception of setting the clock to local time) should not be changed by the user without consulting tech@solarstik.com.

Gray menu items highlight features that are NOT currently used in the PRO-Verter 5000. If TECH: 07 Show All Menus = “No”, then items in a gray window will not be visible to the user.

FAVS Button Menus



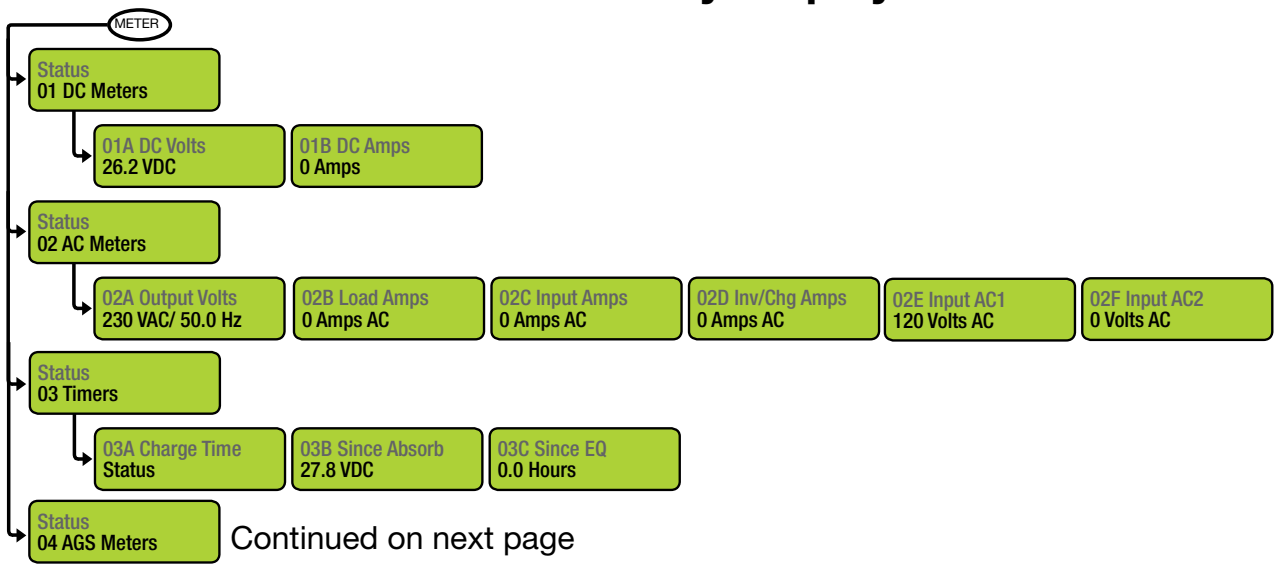
CTRL Button Menus



SET PRO-Verter #1 to AUTO
SET PRO-Verter #2 to OFF

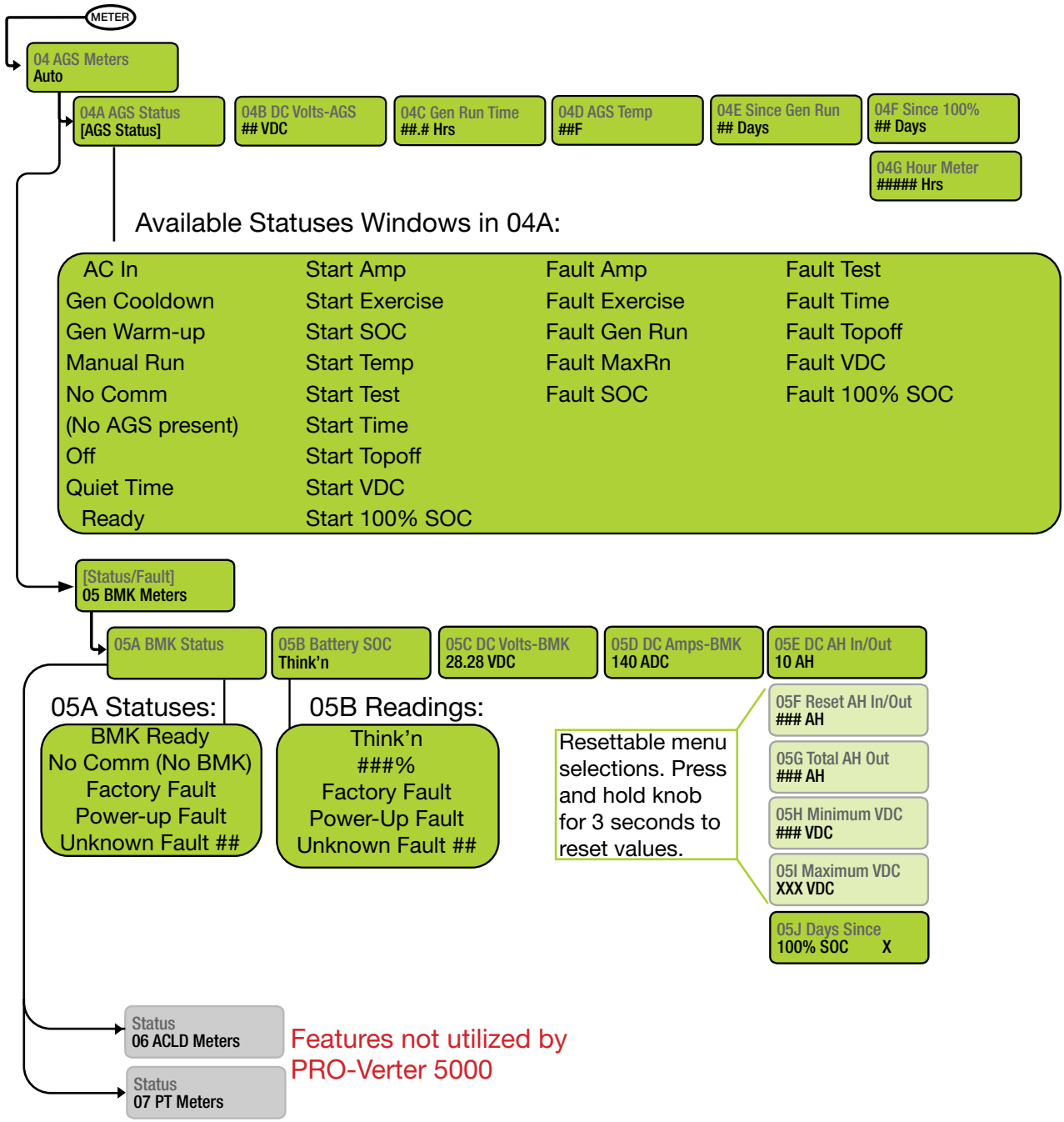
Feature not utilized by PRO-Verter 5000

METER Button Menus: Read-only Displays



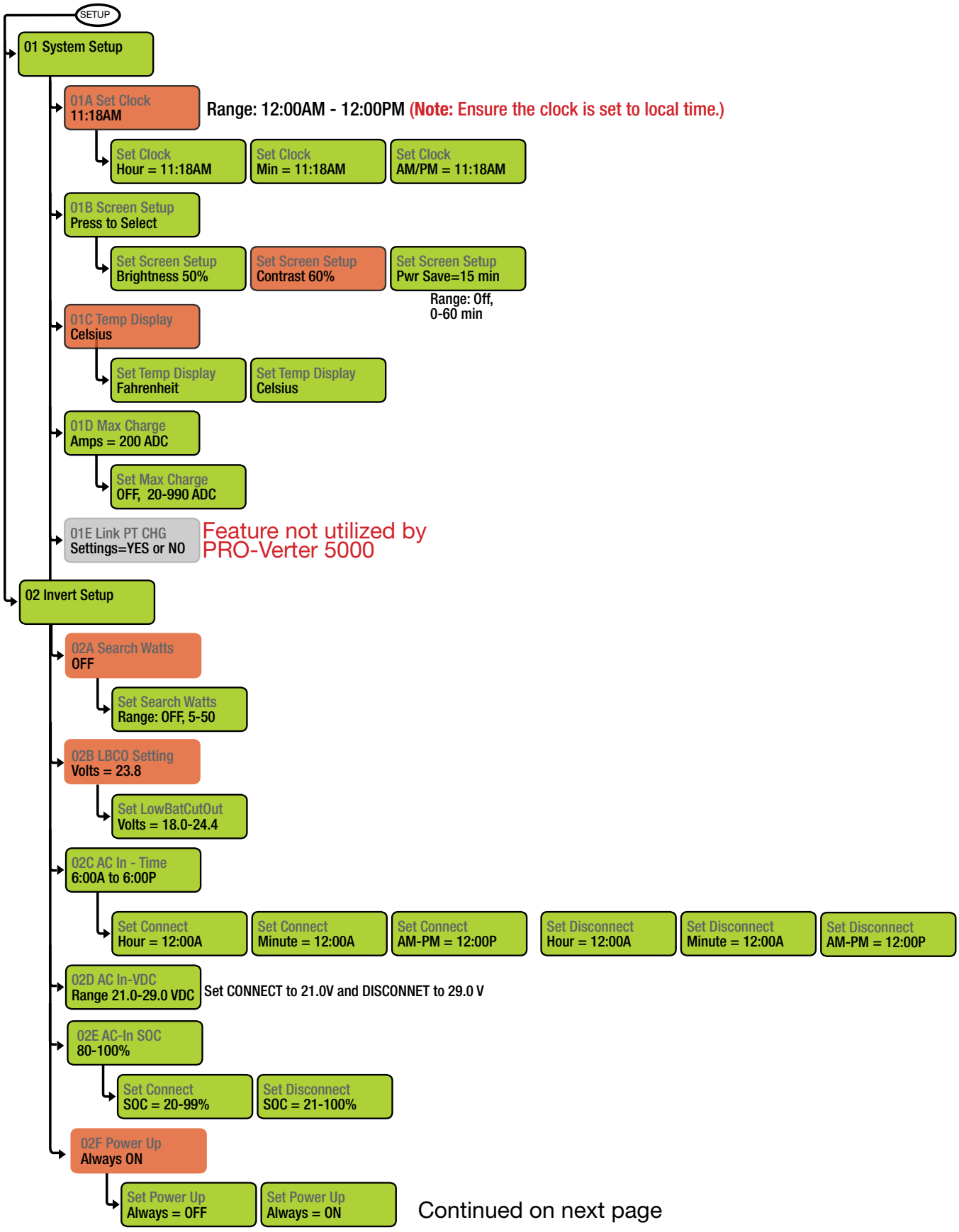
Continued on next page

METER Button Menus continued



SETUP Button Menus

Setup: 01 System & 02 Inverter Setup



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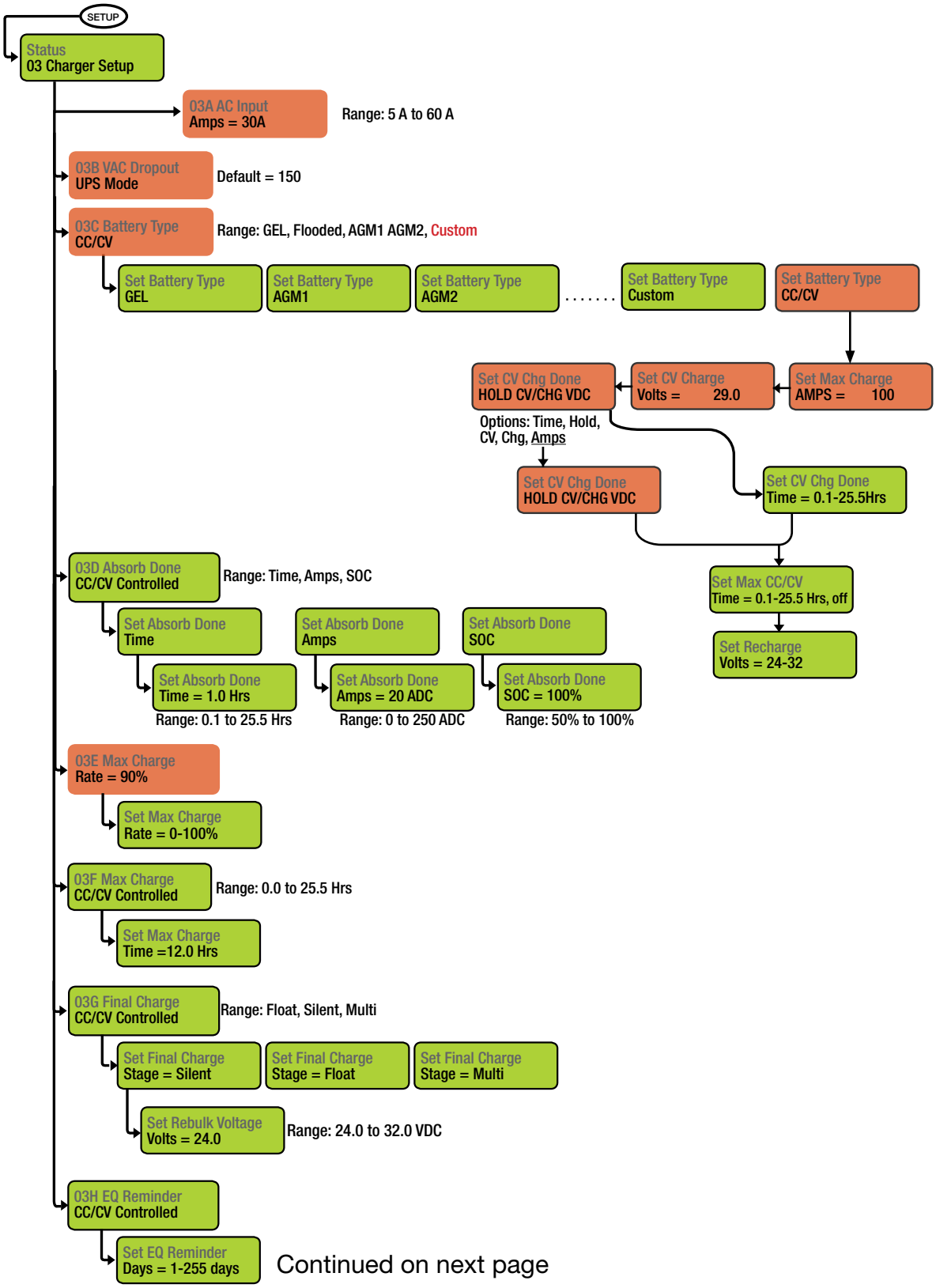
SETUP Button Menus continued

Setup: 03 Charger



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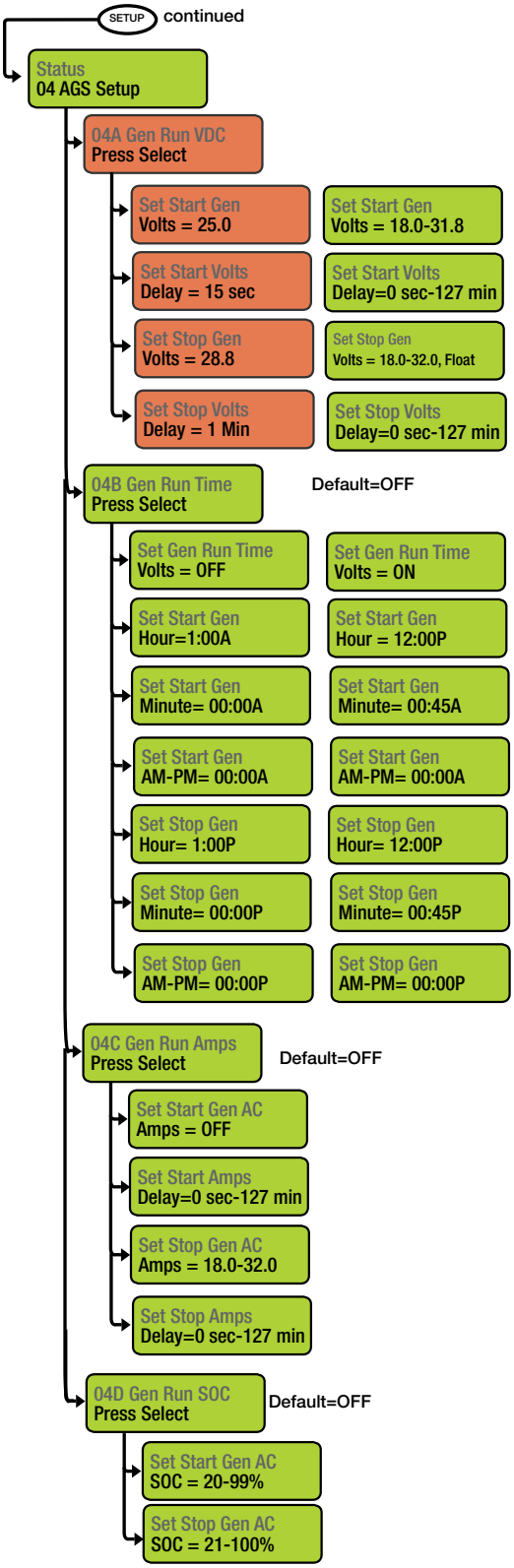
SETUP Button Menus continued

Setup: 04 AGS Setup



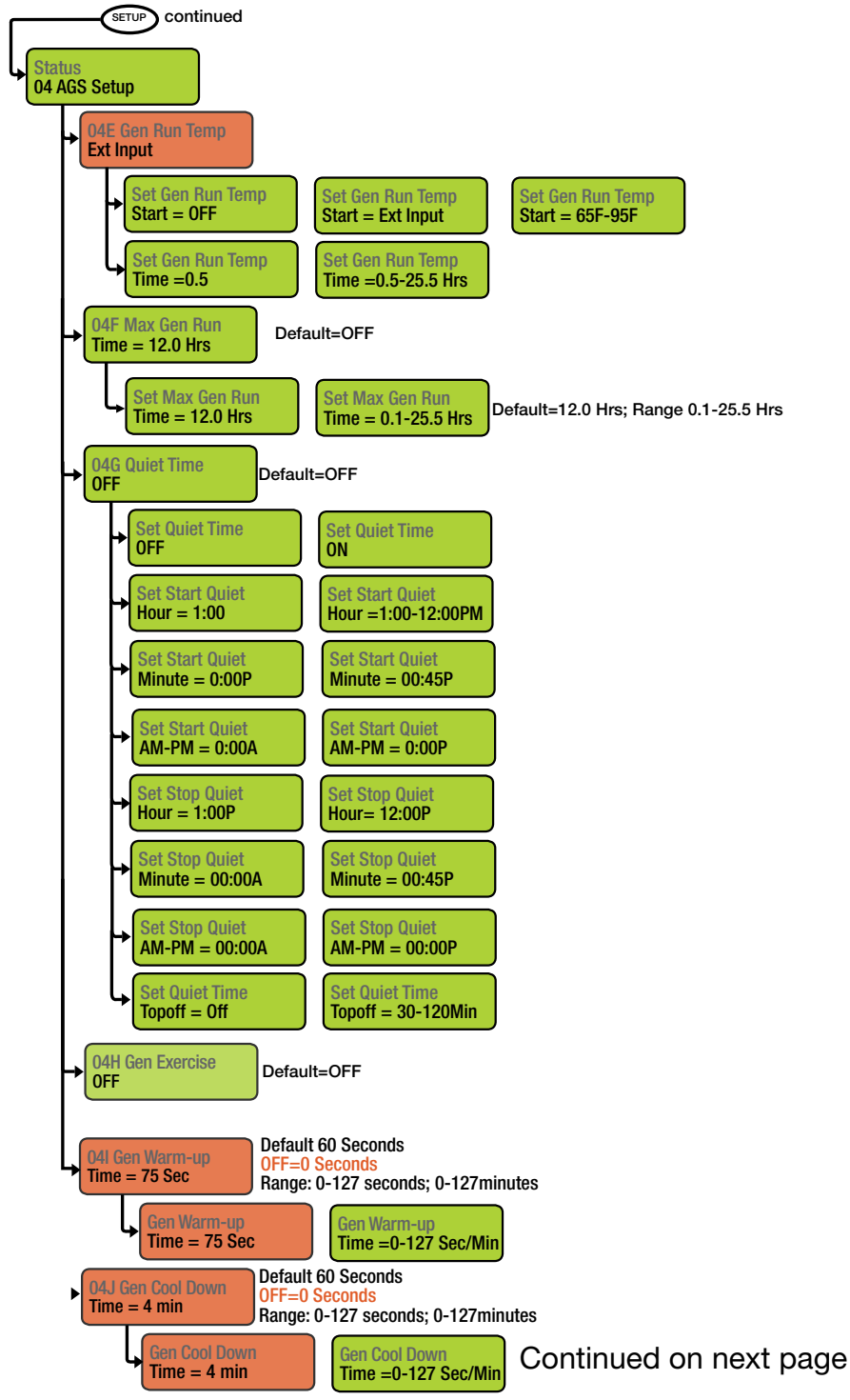
AGS Function Notes

- After 15 seconds at or below 25.0 V, the PRO-Verter #1 sends the start signal to the Generator. AGS is OFF in PRO-Verter #2.
- After 1 minute at or above 28.8 VDC, PRO-Verter#1 turns off the Generator.
- If the Generator does not start and the battery voltage drops to 23.8 V (LBCO), the AC Out (inverter) turns off. This is the LBCO voltage in the menu tree. This is true for both PRO-Verters.

Continued on next page

SETUP Button Menus continued

Setup: 04 AGS Setup



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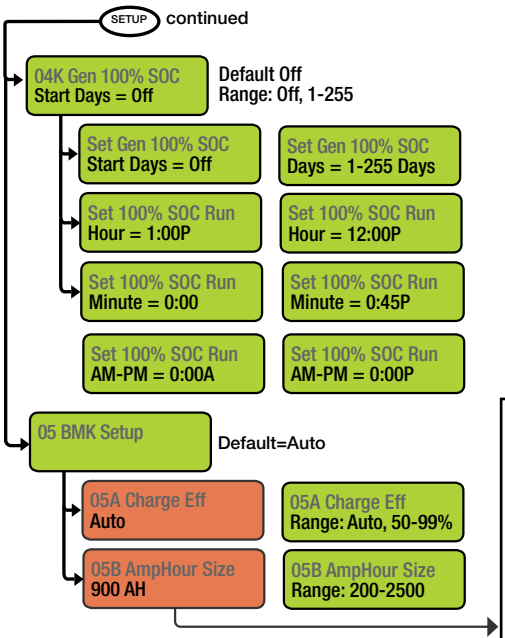
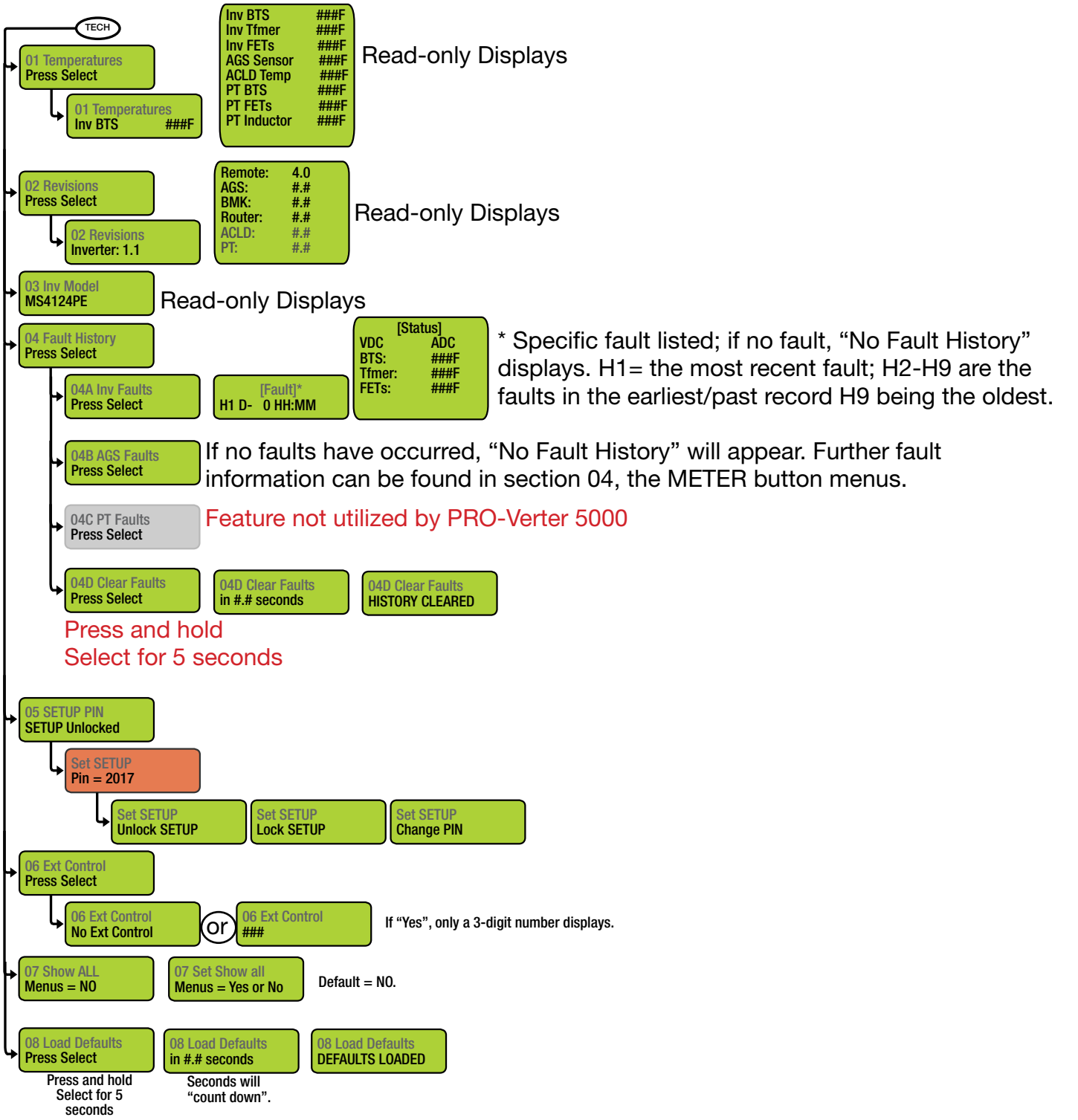
SETUP Button Menus continued

Setup: 04 AGS Setup, 05 BMK Setup



Note: The AmpHour Size value should be set according to the total capacity of the battery bank minus 10%. For example, one 24VDC Li Expander Pak is 100 Ah; ten Expander Paks equals 1000 Ah, minus 10% equals 900 Ah. **Note:** The state of charge reported by the 24VDC PRO-Verter 5000-220 will be accurate only if the total battery bank size is at least 200 Ah.

TECH Button Menus



Locking Component Cases to Prevent Tampering

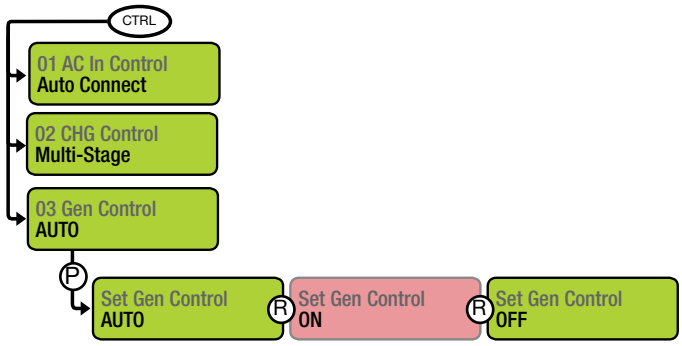
Each component of the System is either sealed (e.g., the Li Expander Paks) or can be secured with a padlock to deter tampering. Two or more latches allow the cases to be sealed to prevent damage to the internal components from environmental factors. Additionally, two sets of steel-reinforced holes flank the latches on the front of the case. A lock similar to the one shown below is recommended. Not all locks are compatible.

Figure 18. Lock Securing the Lid of the Power Hub 2400

System Breakdown and Storage

Prior to System breakdown, charge the Expander Paks fully.

- Start the generator manually. CTRL>03 Gen Control>ON. Allow the generator to run until the charging amps drop to 3–4 A, as reported by the LCD user interface home screen.



- The amount of time required for the charging amps to decrease to this level will be a function of the Expander Paks state of charge prior to charging.

- Refer to the 24VDC Li Expander Pak Operator Manual in-storage maintenance charging instructions.

Procedure

1. Turn off the power switches on all components. All circuits must be powered down before proceeding.

2. Disconnect and clean all cables and stow them in the Cable Transport Case. Stow the Solar Leashes in the Solar Array Transport Case.

3. Disassemble and clean the Solar Arrays. Repacking the Solar Arrays requires careful placement of the parts in the transport case. Refer to the Operator Manual for the Expedition-C Solar Array for details.

4. Secure the lids of the PRO-Verter and the Power Hub by fastening the latches.

5. Stow all components securely prior to transport.

⚠ WARNING

Solar Arrays produce power when in the sun. Use caution when disconnecting the Solar Leashes and the panels.

SYSTEM TROUBLESHOOTING

The PRO-Verter is the central management device in most Systems and as such will be the primary device to report and correct issues both within the PRO-Verter and the System.

Most faults and System failures can be caused by two factors: (1) incorrect programming values in the PRO-Verter (and possibly the Power Hub) or (2) incorrect setup. Ensure the PRO-Verter and Power Hub programming values are set according to the Program Requirements.

Table 1 provides the faults most commonly encountered when a System is running in Hybrid mode. The source(s) of the problems that generates these faults is indicated by an “X” in the appropriate column. This information will streamline the troubleshooting process by telling the operator what to check first. Click the fault name to link to a detailed explanation of the reason(s) why the fault occurred and solutions to correct the fault. The full list of all faults and statuses is on the following page. Refer to the component manuals if faults are not System-related.

Table 1. List of Faults and Source(s) of Problem

Fault	Excessive Load	Generator	Expander Paks	Power Hub	AGS Cable	AC Cable	Heat/ Derating
AC Overload	X						
Fault Gen Run	X	X			X	X	
Fault MaxRn	X	X	X				X
Fault VDC		X			X	X	
FET Overload	X						X
High Battery				X			
Low Battery	X	X	X				
Tfmr Overtemp	X						X

Quick Links to Statuses, Faults, and Resolutions Reported by the PRO-Verter

This guide is interactive if used on a computer or handheld device. Each of the faults in the lists below is touch-linked to an explanation of the fault and a solution to resolve the fault.

AGS Faults

Fault Gen Run
Fault MaxRn
Fault VDC

PRO-Verter Internal Fault Messages

Internal Bridge
Internal Charger
Internal NTC
Internal Relay

AGS Statuses

AC In
Gen Cooldown
Gen Warm-up
Manual Run
No Comm
Off
Quiet Time
Ready
Start VDC

BMK Faults

Factory Fault
Power-up Fault
Unknown Fault ##

BMK Statuses

###%
BMK Not Present
BMK Ready
No Comm
Think'n

Inverter/Charger Faults

AC Overload
Breaker Tripped
Dead Batt Charge
FET Overload
High Battery
High Volts AC
Low Battery
Overcurrent
Overtemp
Stuck Relay
Tfmr Overtemp
Unknown Fault ##

Quick Links to PRO-Verter Status Messages

Charger Mode Status Messages
Inverter Mode Status Messages
Secondary Scrolling Status Messages

Quick Links to Problems: Solutions and Explanations

Charger Problems: Solutions and Explanations
Inverter Problems: Solutions and Explanations

Quick Links to Other Troubleshooting Guides

PRO-Verter LCD Screen Troubleshooting Table
24VDC Li Expander Pak 2400 Troubleshooting
24VDC Power Hub 2400 Troubleshooting
Solar Array Troubleshooting

PRO-Verter LCD Screen Troubleshooting Table

If the display is not functioning correctly, use Table 2 to help find a solution.

Table 2. Troubleshooting the LCD Screen

Symptom	Possible Cause(s)	Solution
LCD Screen on but not responsive when buttons are pressed	Dust/dirt buildup inside of the LCD user interface.	Remove the LCD user interface and clean with compressed air. Please call Solar Stik Technical Support for assistance.
LCD is nonfunctional (no lights, or text on LCD screen, and no response when pressing any button).	Communications cable is bad or not connected correctly to the LCD port on the inverter.	Check communications cable from inverter to LCD; ensure (1) it is connected to the remote port and (2) the correct communications cable is used. (A four-conductor telephone cable may be substituted to determine if the cable is good).
	PRO-Verter is not connected to the batteries.	Ensure the inverter batteries are connected and the inverter is operating correctly without any AC power connected (can invert and power AC loads from batteries).
	No crossover cable or incorrect cable installed between the two ports on the RMK.	See PRO-Verter Remote Monitoring Kit (RMK) LAN Operator Manual.
Display shows unrecognized letters or symbols.	Static electricity may have been discharged into the LCD screen.	Refresh display: Press and hold the SELECT knob for 10 seconds.
LCD text is locked up; pushing any button has no response.	Connections on communication cable are not making a good connection.	Reset LCD: (1) Disconnect remote cable from inverter for 5 seconds and then reconnect. (2) Check RJ11 cable connection on back of remote. Ensure the RJ11 connector is pushed into the correct port. A “click” is felt/heard when the connection is made.
	LCD is not getting sufficient power from inverter.	Ensure batteries are connected and the inverter is operating correctly; the inverter should be able to invert and power AC loads from batteries. Ensure no AC power is connected to the inverter AC outputs.
LEDs and backlight are off.	LCD may be in Power Save mode.	Press any button to reactivate the LCD, or turn off Power Save mode.

PRO-Verter Inverter Mode Status Messages

View the top line of the LCD screen and the corresponding message in this section to identify and understand the particular Inverter mode.

Inverting
The inverter is transforming battery DC into AC for the PRO-Verter Output.

Inverter Standby
The PRO-Verter is receiving AC power from an external source (utility or generator) and is passing it through to the load. The inverter function is active, but the transfer switch has it in Standby until the external source is disconnected.

No Inverter Comm
The LCD user interface is not receiving any communication data via the PRO-Verter's Internal Circuit Network.

Solution
The inverter may need to be serviced. Contact Solar Stik Technical Support.

Off
There is no AC available on the inverter's AC output. The inverter function is OFF, and there is no utility or generator AC power sensed on its input.

Unknown Mode ##
This status message displays when the inverter/charger has sent an operational status code that is unrecognized.

Solution
Call Technical Support at Solar Stik for assistance in identifying and understanding the actual fault status.

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PRO-Verter Charger Mode Status Messages

When AC power (utility or generator) is connected to the PRO-Verter, it automatically begins to monitor the AC input for acceptable voltage. Once the AC input is accepted, the AC transfer relay (inside the PRO-Verter) closes and Charger mode begins.

View the top line of the LCD screen and the corresponding message in this section to identify and understand the particular Charger mode.

Absorb Charging
The Absorb charge state is the constant voltage stage and begins when the absorb voltage is reached (determined by the SETUP: 03C Battery Type setting) while Bulk charging. During this stage, the DC charging current decreases in order to maintain the absorb voltage setting. This charge stage continues until the 03D Absorb Done (Time, Amps, or SOC) or the 03F Max Charge Time setting is reached.

Bulk Charging
The battery charger is delivering maximum current (determined by the SETUP: 03E Max Charge Rate setting) to the batteries. The charger remains in Bulk charge until the absorb voltage (determined by the SETUP: 03C Battery Type setting) or the 03F Max Charge Time setting is reached.

Float Charging
At the end of the absorb charge time, the charger reduces the charge voltage and maintains the batteries at the float charge voltage setting (programmed at 29.0 VDC, SETUP: 03C Battery Type setting).

Charger Standby
This indicates the charger has been disabled to prevent further charging, but the AC power (from utility or generator) to the AC input is still available on the AC output. This display is shown when the CHARGER ON/OFF button is pressed while the AC power is passing through the inverter/charger.

> **Note**: Press the CHARGER ON/OFF button to enable charging again. When enabled, the charger continues in the previous charge mode and the CHG (green) LED comes on.

Charging
Once Charger mode has been enabled, the unit waits and displays “Charging” to determine the charge routine. If the DC voltage is low (≤ 25.6 VDC), the charger initiates Bulk charging. If the DC voltage is high (≥ 25.7), the charger skips the Bulk and Absorb charging stages and go directly to the final charge stage (Float or Silent).

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Full Charge
This status indicates Battery Saver mode is activated. This mode maintains the batteries without overcharging. After four (4) hours of float charging, the charger turns off and “Full Charge” displays (charger is now in Battery Saver mode). If the battery voltage drops to ≤ 25.2, the charger automatically initiates another four (4) hours of float charging. This cycle helps to ensure the batteries are maintained and continues as long as AC power is continuously connected to the AC input. “Full Charge” only displays if Multi-Stage is selected from the SETUP: 03G Final Charge Stage menu.

Silent
This displays at the end of the Absorption stage if Silent is selected from the SETUP: 03G Final Charge Stage menu. In Silent mode, the charger is not actively charging but does monitor the battery voltage. When the battery voltage reaches the Set Rebulk Voltage setting (from 03G Final Charge Stage menu), the charger will restart a Bulk and Absorb charge cycle and then transition back into Silent mode at the end of the Absorb cycle.

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Secondary Scrolling Status Messages

These displays alternate with the inverter/charger status to indicate other pertinent messages.

Gen Warm-up
The AGS unit has commanded the generator to run, but the PRO-Verter will not connect to the generator’s AC output until the generator warm-up time is complete.

Gen Cool Down
The autostop setting (FAVS F5: Gen Run VDC > Set Stop Gen V= 28.0) has been met and the generator has been disconnected from the PRO-Verter. However, the generator still runs until the FAVS F5: Gen Run VDC > Set Stop Gen = 30 Minutes and cooldown (Setup: 04J) time is met.

Note: Most faults (inverter, AGS, and BMK) also alternate with the inverter/charger status.

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PRO-Verter Charger Problems: Solutions and Explanations

Unit won't transfer to Charge mode when connected to generator or grid AC

Solution: Is the charge (CHG) LED on the user interface blinking? If not, the charger does not recognize the incoming AC as being within acceptable limits. Disconnect the AC input cable from the PRO-Verter. Measure the voltage at the cable terminals—it should be 230 VAC +/- 20 VAC). Also, check that the SETUP 03B VAC Dropout setting on the user interface is "UPS Mode". If the CHG LED is blinking, the transfer relay should close within 20 seconds and begin charging. If the LED is on solid, the relay should be closed and the charger should begin charging.

Transfer relay closes, then opens and continues to cycle

Solution: Input voltage is too low or has transients that drop the voltage momentarily. Change the SETUP 03B VAC Dropout setting to 180 VAC and check for improvements. If the cycling continues, back off the charge rate from 100% to 10% (or "OFF", if available). This cycling may also be caused if the AC output of the inverter is connected to the inverter's AC input. Check for proper input and output AC wiring.

Charger not charging even though Charge LED is on steady and the unit says "Charging"

Solution: Full charge rates are not obtained in Charging mode. Full charge rates will occur only after this mode changes to Bulk charging, Absorb charging, or Float charging modes.

Charger not charging even though Charge LED is on steady and the unit says "Bulk Charging" (or "Absorb Charging")

Solution: Check the METER 01A DC Volts and METER 01B DC Amps meter values on the LCD screen. It should be close to the maximum rated (or programmed) charge current if the battery voltage is under 28.0 VDC on 24-volt models. Check the Meter SETUP 03A AC Input Amps setting and ensure that it is set in accordance with system requirements.

Charger says "Float Charging" not "Bulk Charging" when the AC is first plugged in

Solution: Check the METER 01A DC Volts meter on the LCD screen. If the battery is > 26.0 VDC then the battery was already charged and the charger automatically goes to Float charging to keep from overcharging the batteries.

Charge amps are lower than expected, or is 0 amps DC

Solution: The charge rate may have been reduced to keep the input voltage above 150 VAC. Measure input voltage and increase it if the input voltage is under 150 VAC. Also, check the 03A AC Input Amps and SETUP 03E Max Charge Rate settings to determine if the current is being limited.

Charger output voltage is different than expected

Solution: Check the Battery Temperature Sensor (BTS) temperature. The charge voltage settings will increase if the temperature around the BTS is below 77 °F (25 °C) or decrease if the temperature around the BTS is higher than 77 °F (25 °C). The BTS is located inside of the PRO-Verter.

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PRO-Verter Inverter Problems: Solutions and Explanations

Most faults (inverter, AGS, and BMK) also alternate with the inverter/charger status. The FAULT LED comes on and a fault status is displayed by the LCD user interface when an abnormal condition is detected. Use the information in this section to identify and correct the issue.

Clearing Faults

Many fault statuses clear automatically after the active fault condition is corrected. When some faults are cleared from the fault history, the Gen Run relay may open temporarily which shuts down the generator. To resume normal operation ensure that the PRO-Verter is set to autostart the generator (CTRL>03E), then press and release, the INVERTER ON/OFF button on the user interface. Finally, if the fault will not clear, a PRO-Verter reset or power reset may be required.

AC Overload

Inverter has faulted and stopped providing power to the load.

This fault message displays when the AC load on the PRO-Verter output has exceeded the inverter's AC current protection limits. This fault may occur because the connected AC loads are larger than the inverter's output capacity due to unauthorized equipment being used on the platform, surge loads are present, there is a wiring short on the output, or the output wires are incorrectly installed.

Solution

If the overload condition lasts for less than 10 seconds, the fault automatically clears, and the unit restarts and resumes operation. However, if the overload occurs for more than 10 seconds, the unit shuts down and the fault will require a manual restart. After the AC loads are reduced, the inverter can be restarted after a manual restart (press the INVERTER button to restore inverter function).

Breaker Tripped

The AC input breaker on the PRO-Verter has opened due to excess current flow through the inverter to the AC loads. While in Charge mode, the inverter's AC input breaker could nuisance trip if the loads on the inverter's output exceeds the current rating of the inverter's input circuit breaker.

Solution

After reducing the AC loads, push in the inverter's AC input circuit breaker to reset and resume operation.

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Dead Batt Charge
This fault indicates that the PRO-Verter is connected to a 230 VAC source and is attempting to close its internal relay and begin charging, but it has detected less than 18 volts on the battery bank or determined that no battery is present.

When the Li Expander Pak is discharged below 20 V, the internal Battery Management System (BMS) will disconnect the internal cells from the battery terminals in order to protect them from further discharge. When this occurs, BATTERY STATUS LED will also be blinking red (or be off) on all of the Li Expander Pak 2400s.

It is possible that the terminals will still reflect voltage ranging from 2 V to 12 V. This is known as “bleed voltage” and is the result of the BMS not being able to fully disconnect from the internal battery cell strings. As a result, there may be enough voltage present for the PRO-Verter LCD user interface to register the “DEAD BATT CHARGE” fault; however, there will be insufficient charge remaining in the Li Expander Pak 2400s to allow the PRO-Verter to function properly or to autostart the generator.

Solution
1. Check the DC voltage at any of the PRO-Verter’s DC terminals (Inter-Connect ports) and compare it with the DC voltage at the battery bank. These two voltages should be very close (< 0.5 VDC difference). If not, ensure all connections are tight and the power switch on each Expander Pak is turned on.

2. Jump-start the Li Expander Paks 2400s.

This fault automatically clears once current flows into the battery from the PRO-Verter / battery charger—this may take anywhere from a few minutes to a few hours, depending on the condition of the batteries. This fault can also be cleared if the AC input is removed.

FET Overload
This fault message indicates the PRO-Verter was running normally, but the temperature of the field effect transistors (FETs) started rising abnormally fast.

Solution
Allow the inverter to cool down, then press the INVERTER ON/OFF button (manual restart) to resume operation.

To resume normal operation, reduce the load to within normal operating parameters. Shade the PRO-Verter to reduce solar loading. If this fault does not clear after doing the power reset, the inverter will require service contact Solar Stik Technical Support.

High Battery
The inverter has turned off because the battery voltage is at a very high level. This fault message displays and the FAULT (red) LED turns on when the battery voltage is above the High Battery Cut-Out (HBCO) value. This fault automatically clears and the inverter resumes operation when the battery voltage drops 0.6 VDC below the HBCO value. This fault can occur whether the inverter is “inverting”, “searching”, or “off”.

Solution: Check the Power Hub to ensure that it is functioning properly. Refer to the Power Hub Operator Manual.

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High Batt Temp
This fault message indicates the PRO-Verter has shut down because the battery temperature sensor (BTS) inside of the PRO-Verter has reached a temperature greater than 129 °F (54 °C).

Solution
Once the BTS has cooled down to less than 120 °F (49 °C), it automatically restarts and continues operation.

High Volts AC
This fault causes the AC input to be disabled because a very high voltage (> 300 VAC) has been detected on the AC input.

Solution
Remove all AC power from the PRO-Verter AC input for at least 15 minutes to clear this fault. Ensure only 230 VAC power is connected to the PRO-Verter.

Low Battery (LBCO)
No power to the loads.

The inverter has turned off to prevent the batteries from being overdischarged. The fault message displays and the FAULT (red) LED illuminates when the battery voltage drops below the SETUP: 02B LBCO Setting value for more than one minute. This fault may occur when **(1)** the generator failed to start or **(2)** the battery capacity is reduced (one or more Expander Paks is offline). The fault will clear and the inverter will automatically restart and resume operation when the battery voltage rises to 24.6 VDC.

Solution
Generator
Disconnect the Generator from the System and start it using the generator native controls. If the generator does not start, check the generator for fault codes, adequate fuel and refer to the generator Operator and Maintenance Manual. If the generator starts, reconnect it to the System and attempt to start it manually (“ON”) using the PRO-Verter control (CTRL 03). If the generator does not start using the PRO-Verter controls, ensure proper electrical connections between the PRO-Verter and the generator and refer to the PRO-Verter Operator Manual.

Power Hub
Ensure proper electrical connections between the Power Hub and the PRO-Verter and refer to the Power Hub Operator Manual.

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Overcurrent
This fault may be the result of an excessive AC load and causes the inverter to shut down to protect internal power components. If the overload condition lasts for less than 10 seconds, the unit automatically restarts and resumes operation. However, if the overcurrent condition occurs for more than 10 seconds, the unit shuts down and requires a manual restart.

Solution
This fault usually occurs because the connected AC loads are larger than the inverter's output capacity, there is a wiring short on the AC output, or the output wires are incorrectly wired. Once the AC loads are reduced or the output wiring is corrected, manually restart the inverter to resume operation. If this fault condition continues, perform an inverter reset.

Overtemp
This fault message indicates the PRO-Verter has shut down because the internal power components (FETs and/or transformer) have exceeded their safe temperature operating range. Once the PRO-Verter cools down, the fault automatically clears and the unit restarts and continues operation.

Solution
If the fault occurs while inverting, reduce the load on the inverter. If it occurs while charging, turn down the charge rate. If this fault happens often, ensure the inverter is not in a hot area, has proper ventilation, and the PRO-Verter cooling fans are working and that the air filters are clean. Shade the PRO-Verter from exposure to direct sunlight. Solar loading is a major source of heat buildup inside the PRO-Verter.

Stuck Relay
This fault message displays when the inverter is "inverting", but the internal AC pass-through relay that should be open while inverting is closed.

Solution
The AC pass-through relay is most likely stuck. A relay usually sticks because of damage to the contacts from trying to handle higher currents than that for which they are rated. This is usually caused by not protecting the relay from handling high continuous currents, or by switching high current inductive loads. The internal relay contacts are rated to handle 30 amps AC continuously and should be protected with a breaker sized no larger than 30 amps. If connected to an AC source (grid or generator) and running large inductive loads (i.e., pumps, motors, etc.) on the inverter output, turn those particular loads off prior to removing the AC input source. This fault requires an inverter or power reset to clear.

Tfmr Overtemp
This fault message displays when the transformer causes the inverter to shut down to protect the internal power transformer from damage. Once the transformer cools down, the inverter automatically restarts and resumes operation. A temperature sensor on the transformer will auto-start a connected generator, if the GEN CTRL is in AUTO mode, thereby transferring support of the load to the generator to maintain continuity of operations.

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Solution
Allow the inverter to cool down, then press the INVERTER ON/OFF button (manual restart) to resume operation.

To resume normal operation, reduce the load to within normal operating parameters. Shade the PRO-Verter to reduce solar loading.

If this fault does not clear after doing the power reset, the inverter will require service contact Solar Stik Technical Support.

Unknown Fault ##
This fault message displays when the inverter/charger has sent a fault code that cannot be identified by the user interface.

Solution
Contact Technical Support at Solar Stik for more information or assistance in identifying the actual fault status.

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PRO-Verter Internal Fault Messages

The inverter continually monitors several internal components. If a condition inside the inverter occurs that does not allow proper operation, one of the following internal fault messages displays and the inverter shuts down to prevent damage. The solution to all of these faults follows.

Internal Bridge
This fault message displays when the FET bridge shuts down after the inverter has been inverting—the inverter output circuit can no longer detect any AC output voltage or current.

Internal Charger
This fault message displays when the FET bridge shuts down because the charger circuit is trying to provide maximum current, but is not detecting a current or voltage rise to the battery bank.

Internal NTC
This fault message displays when the internal negative temperature coefficient (NTC) temperature sensor suddenly causes a very large but unexpected temperature change.

Internal Relay
This fault message displays when the internal AC transfer relay is not closed while charging.

Solution
If one of these internal faults occurs, the inverter will require an inverter or power reset to clear the fault. After resetting the inverter, press the INVERTER ON/OFF button on the user interface to turn the inverter on and then verify that the fault has cleared (i.e., manual restart). If the internal fault remains or returns, the inverter may require repair at a Solar Stik. Call Solar Stik Technical Support: 800-793-4364, Ext 102.

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PRO-Verter AGS Functional Tests

When the autostart/autostop settings have been established and programmed, perform the following tests to verify that the AGS system is functioning correctly and there is communication between the remote/inverter and the AGS.

> **Note:** The AGS Test Button is a momentary switch that allows the AGS system to be tested for correct wiring and generator start/stop operation.

PRO-Verter to Generator Communication Test

This section describes using the LCD user interface to start the generator and to determine the AGS status.

Determining AGS Status

Use the LCD user interface to determine the AGS's status:

1. Press the METER button until the bottom line displays "01 DC Meters".
2. Rotate the SELECT knob to the 04 AGS Meters menu, and then press the SELECT knob. The top line shows 04A AGS Status and the bottom line displays the current status of the AGS.

An AGS status of Off or Ready indicates the user interface and the inverter is communicating with the AGS. If the AGS status is not Off or Ready, then refer to section **Resolving AGS Operational Statuses** or section **Resolving AGS Faults Using the LCD User Interface** for assistance before continuing.

Starting the Generator from the PRO-Verter User Interface

To confirm that the generator will turn on and run from the PRO-Verter, first ensure the AGS status is Off or Ready. Then:

1. Press the CTRL button, and then rotate the SELECT knob to the 03 Gen Control menu.
2. Press the SELECT knob, and then rotate it to the ON setting.
3. Press the SELECT knob to activate the generator test. The selection arrow appears to the right of the screen. The generator should start.

> **Note:** Once the generator starts, it should run until 03 Gen Control is changed to OFF.

If the AGS/generator system started, and if the STATUS LED on the AGS turns solid green after two (2) minutes, then the wiring from the AGS to the generator is correct. The AGS may now be enabled by setting the remote's 03 Gen Control setting to "AUTO".

If the LCD user interface displays a generator fault, or if the AGS's STATUS LED continues to blink or shows a fault condition (solid red LED indication), refer to the AGS owner's manual for assistance.

AGS Start Statuses Table (Meter 04)

The following “Start” statuses identify the condition that autostarted the generator. The list below includes all possible statuses. If the autostart condition occurred sooner than expected, or it was not the intended autostart condition, refer to step 2 of System Initialization and Calibration to change (or disable) the autostart setting.

> **Note:** The PRO-Verter for this system has been set at the factory to start the generator based on the DC bus (Li Expander Pak) voltage. For this reason, “Start VDC” will be the only status reported by the PRO-Verter in this System. The Statuses in the gray box would appear only if the PRO-Verter were programmed differently. They are shown only as a reference.

Start VDC – Generator has autostarted based on the SETUP: 04A Gen Run VDC setting.

Start Amp – Generator has autostarted based on the SETUP: 04C Gen Run Amps setting.

Start Exercise – Generator has autostarted based on the SETUP: 04H Gen Exercise setting.

Start SOC – Generator has autostarted based on the SETUP: 04D Gen Run SOC setting.

Start Temp –The AGS is in Test mode. Test mode may be started from the TEST button located on the AGS.

Start Test – The AGS is in Test mode. Test mode may be started from the TEST button located on the AGS.

Start Time - Generator has autostarted based on the SETUP: 04G Quiet Time Topoff setting

Start Topoff – Generator has autostarted based on the SETUP: 04G Quiet Time Topoff setting.

Start 100% SOC – Generator has autostarted based on the SETUP: 04K Gen 100% SOC Start Days setting.

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AGS Operational Statuses (Meter 04)

AC In
The inverter/charger is connected to another source, such as a grid or an alternate generator, and is not controlled by the AGS. When AC In displays, the AGS is prevented or locked out from all autostarting conditions, except for when the generator needs to exercise—if enabled.

Gen Cooldown
The autostop setting has been met in one of the generator autostart/autostop menus and the generator has been disconnected from the PRO-Verter. However, the generator still runs until the cooldown time is met (as per the SETUP: 04J Gen Cooldown Time setting).

Gen Warm-up
The AGS is attempting to start the generator and a time period has been set from the SETUP: 04I Gen Warm-up Time menu. Once the AGS status indicates “Warm-up”, the PRO-Verter’s AC input ignores any incoming AC power. This prevents the PRO-Verter from loading the generator during warm-up. Once the AGS has determined that the generator is running, the warm-up time setting must be met before the generator can connect to the PRO-Verter.

Manual Run
Generator started manually from a start/stop switch directly connected to the generator, or from the CTRL: 03 Gen Control menu.

No Comm
The AGS is not communicating with the inverter or the LCD user interface.

Off
The CTRL: 03 Gen Control menu is set to OFF. This setting will not allow the AGS to autostart the generator.

Quiet Time
The AGS has entered Quiet Time per the SETUP: 04G Quiet Time setting. This setting is generally not programmed in Solar Stik PRO-Verters.

> **Note:** The generator will not autostart during Quiet Time.

Ready
The CTRL: 03 Gen Control menu is set to AUTO, and the AGS is ready to autostart the generator based on the active autostart settings under the SETUP: 04 AGS Setup menus.

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Resolving AGS Operational Statuses

No Comm
The “No Comm” status suggests that the PRO-Verter internal circuits have failed to communicate.

Solution
1. Ensure the GREEN READY indicator on the AGS controller is on (blinking or solid) to indicate that the AGS controller is getting power.
2. Ensure the correct communications cables are connected.
3. Call Solar Stik Technical Support.

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Resolving AGS Faults Using the LCD User Interface

If an AGS fault occurs, use the LCD user interface and the information in this section to resolve the issue.

> **Note:** PRO-Verters in a Solar Stik Hybrid Power System are programmed to start and stop generators based on DC voltage. **The faults highlighted in orange are the only ones that could appear in a PRO-Verter programmed to work with the L1/L2 System.**

Fault Gen Run
Symptoms: Generator is overloading and shutting down; the generator successfully started and ran for more than two (2) minutes, but the generator unexpectedly stopped before the active AGS autostop condition was finished.

This fault occurs when the generator is overloading as a result of (1) unauthorized equipment being used on the platform and/or (2) surge loads are present.

> **Note:** The AGS controller determines the generator is running by monitoring the Gen Run sense voltage/signal. When this Gen Run sense voltage/signal is no longer available, the AGS thinks the generator is off or has stopped.

> **Note:** Fault Gen Run detection is not active if the generator is manually started.

Solution
Ensure proper electrical connections between the PRO-Verter and the generator.

Disconnect the generator from the System and start it using the generator native controls.
If the generator starts, reconnect it to the System. Reduce the load and/or the charging rate (%) to prevent the fault from recurring

If the generator does not start, check the generator for fault codes, adequate fuel and refer to the generator Operator and Maintenance Manual.

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For these AGS faults, refer to the Solution immediately following.

Fault Test

The generator failed to autostart and run after the red TEST button is pressed on the AGS controller.

> **Note**: The LCD user interface can be set to manually turn the generator on and off, which can be used to test the generator wiring to the AGS.

Fault VDC

The generator failed to autostart and run per the FAVS: F5 Gen Run VDC menu's start parameters (24.6 VDC).

Solution

Disconnect the generator from the System and start it using the generator native controls.

If the generator does not start, check the generator for fault codes, adequate fuel and refer to the generator Operator and Maintenance Manual.

If the generator starts, reconnect it to the System and attempt to start it manually ("ON") using the PRO-Verter control (CTRL 03).

If the generator does not start using the PRO-Verter controls, ensure proper electrical connections between the PRO-Verter and the generator and refer to the PRO-Verter Operator Manual.

> **Note:** One of the fault messages above may display on the LCD user interface when:

- The AGS attempts to start the generator four (4) times, but the generator failed to start and run per the specific autostart parameters; or
- The generator started, but did not provide the correct Gen Run sense signal to the AGS controller.

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Fault MaxRn

Generator turned off because the SETUP: 04F Max Gen Run Time setting had been met. This fault can occur when the autostop condition (FAVS F5: Gen Run VDC) exceeded the Max Gen Run Time setting.

> **Note**: The Max Gen Run Time menu uses the SETUP: 04B Gen Run Time display to determine the generator's runtime. Cooldown and warm-up times are not included in the Gen Run Time display.

Solution

Load
Reduce the load to increase the power available to charge the Expander Paks. This will reduce the time required to charge the Expander Paks to within the programmed Max Gen Run Time limit of 12 hours.

Expander Pak
Ensure all Expander Pak are in normal operation (green-flash LED) and that all Inter-Connect Cables are properly connected and in good condition.

Solar Loading
High heat inside the PRO-Verter reduces the charging voltage and current resulting in the inability to charge the Expander Paks to the voltage required to stop the generator. Shade the PRO-Verter to reduce solar loading and keep the air intake filters clean to promote more efficient cooling.

> **Note**: After the fault clears and the reason for the fault is determined, be sure to enable the AGS to autostart. Go to the CTRL: 03 Gen Control menu and select AUTO. Once the fault is cleared and the reason for the fault is determined, enable the AGS again to see if the fault returns, or test the AGS/generator system by performing the AGS functional test.

How to Clear AGS Fault History
Go to the TECH: 04 Fault History menu, press the SELECT knob, and then turn the knob until the 04D Clear Faults screen appears. At the 04D Clear Faults screen, press and hold the SELECT knob until the "5.0 to 0.0 second" screen countdown is finished and the screen displays "HISTORY CLEARED".

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PRO-Verter Battery Monitoring Circuit (BMK) Statuses

PRO-Verter BMK Operational Status Messages

A BMK status message may be an operational or fault message. Access the METER: 05A BMK Status menu to view the BMK's current operating status. The status is important when determining if the BMK is working correctly or for troubleshooting a BMK installation.

BMK Ready
The BMK is correctly communicating with the inverter/charger.

No Comm
The BMK is not communicating with the inverter/remote. This is a normal status if there is no BMK connected in the system.

BMK Not Present
View the BMK sense module's LED.

a. If the LED is green, disconnect the terminal block for 5 seconds, and then reconnect it to ensure the terminal block is correctly seated into the sense module.

b. If the LED is blinking red, there is no communication or there is an unrecognizable communication on the network. Check the communication cable—ensure it is connected correctly. If the ME-BMK communication cable is missing, a standard two-conductor telephone cable may be temporarily substituted.

The following "SOC" statuses indicate the battery's current state of charge (SOC). Access the METER: 05B Battery SOC menu to view the BMK's current SOC status.

Think'n
When the BMK sense module is first connected, the batteries need to be fully charged (i.e., SOC = 100%) to establish a SOC reference point. The BMK sense module is disconnected from power and the batteries require a full charge before the remote display begins providing SOC percentage information.

###%
The batteries are fully charged; the display has changed from "Think'n" to "100%" and is ready to provide accurate SOC percentage values.

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Resolving BMK Faults Using the LCD User Interface

For the three BMK faults that follow, refer to their respective solutions.

Factory Fault
The BMK has lost its factory-set internal calibration reference.

Solution: Reset the battery monitor by removing all power from the BMK. If the fault remains or returns after resetting, the BMK may require repair. Contact Solar Stik Technical Service.

Unknown Fault ##
This fault message displays when the BMK has sent a fault code that is not recognized by the remote.

Solution: Call Solar Stik Technical Support.

Power-up Fault
The BMK's power-up sequence failed.

Solution:
(1) Ensure the current sense wires are connected into pins 1 (blue wire) and 2 (orange wire), and the voltage wires are connected to pins 3 (black/negative) and 4 (red/positive).
(2) Unplug the four-port terminal block from the sense module, and then check for the correct DC voltage on pins 3 (-) and 4 (+). The voltage must be 7–70 volts DC, depending on the nominal voltage of the inverter.

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Fault History (Tech 04)

Tech 04 in the LCD user interface provide provides the fault history for the inverter (04A) and the AGS (04B). The following is an example of how to read and understand the fault history in 04B AGS Faults

Press the SELECT knob, rotate the knob until the 04B AGS Faults menu displays, and then press the SELECT knob.

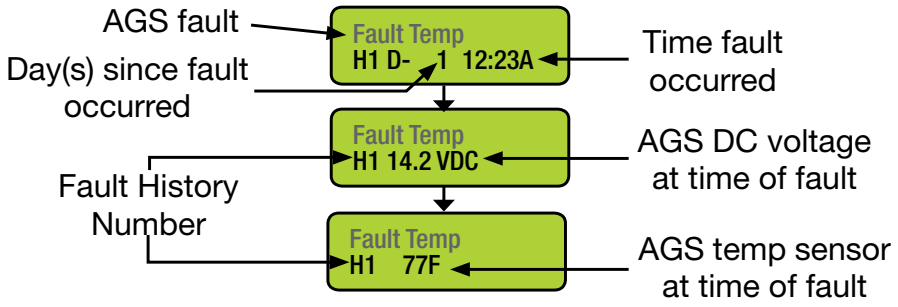
04B AGS Faults
This menu displays a history of the last nine AGS faults. Information for each fault displays from the most recent fault (H1) to the earliest/past recorded faults (H2 up to H9).

> **Note**: The 04D Clear Faults menu allows all recorded fault history information—for any inverter and/or AGS, ACLD, or PT controller that is network connected—to be cleared/erased. Refer also to the TECH: 04 Fault History/04D Clear Faults menu.

See the diagram below. Rotate the SELECT knob to display the second and third screens for the particular fault shown on the first screen. After viewing all screens for the fault, continue to rotate the SELECT knob to display earlier faults (as applicable).

- **First screen**—The top line displays the AGS fault mode. The bottom line displays the fault history number, day(s) since this fault occurred, and the time this fault occurred.
- **Second screen**—The DC voltage on the AGS at the time of this fault.
- **Third screen** – The temperature of the AGS temp sensor at the time of this fault.

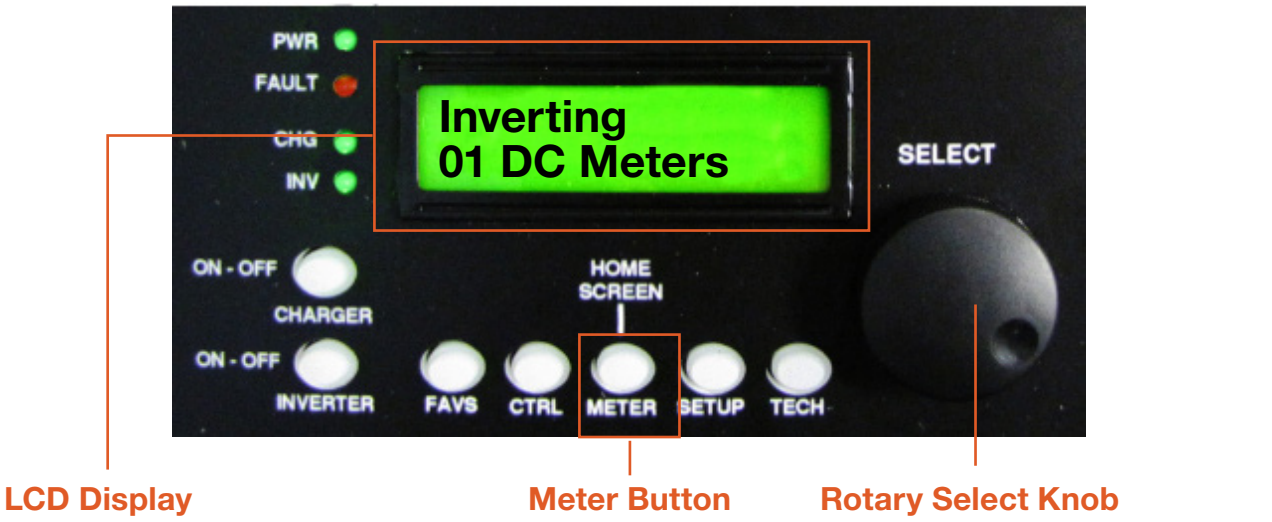
TECH: 04 Fault History
Press the SELECT knob, rotate the knob until the 04B AGS Faults menu displays, and then press the SELECT knob.

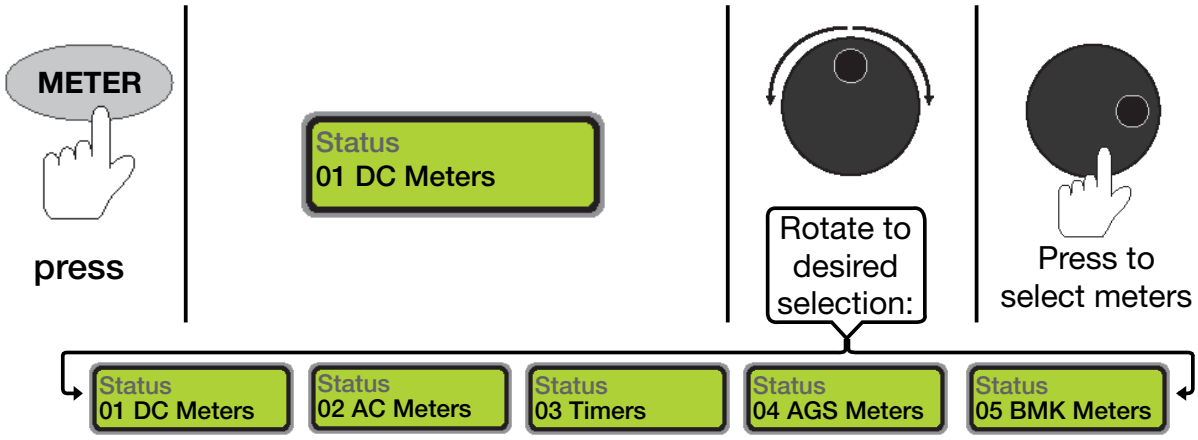


PRO-Verter: Historical Data Collection

The PRO-Verters can provide some historical data for generator and battery operation.

Press the METER button on the PRO-Verter Controller to access both the BMK and AGS functions. Scroll through 01 DC Meters, 02 AC Meters, 03 Timers until 04 AGS Meters or 05 BMK Meters is displayed. AGS and BMK Meters represent the only data sets for the generator or the battery system that is cumulative. The DC and AC meters indicate current status information only.





Auto Generator Start/Stop (AGS) Data (Meter 04)

Gen Run Time
This menu displays the time the generator has been running since the AGS circuit auto started the generator. This menu does not display run time when the generator has been manually started.

This hour meter resets each time the generator is stopped. This meter is useful when trying to determine how long the generator has been running in the auto mode. This meter does not replace the hour meter for total hours the generator has run.

AGS Temp
This feature is not enabled in the PRO-Verter 5000.

Days Since Gen Run
This menu displays the number of days since the generator has last run. This menu is useful in determining if the AGS start and stop settings are set up correctly.

> **Note:** This meter resets whenever the generator is either auto started, exercised, or manually started. The meter reads the B+ signal provided by the generator to the AGS module for this meter.

Days Since 100% SOC
This read-only menu displays the number of days since the battery was at 100% SOC, and is calculated in the remote.

Battery Monitor (BMK) Data (Meter 05)

This section describes what battery bank information is available from the battery monitor when using the LCD user interface.

BMK Status
This menu selection offers read only displays that give the current operating status of the battery monitor. This selection also provides information to determine if there is a power-up fault condition. Also see the section PRO-Verter Battery Monitoring Kit (BMK) Statuses.

Battery SOC
This read-only menu either displays the calculated battery SOC for the connected battery bank—"Think'n" (to indicate the SOC is being calculated), or identifies a fault condition. The range is 0–100%, where 100% is a fully charged battery and 0% is completely discharged. When the BMK sense module is first connected, the display will show "Think'n", to indicate that the SOC reference point is being calculated. After the batteries are fully charged, the display changes from "Think'n" to "100%" and begins to provide accurate SOC% values.

> **Note:** If the sense module is disconnected from power, this display resets to "Think'n" and the batteries require another full charge before SOC percentage information is displayed.

DC Volts-BMK
This meter displays the DC volts at the BMK input. The range is from 07.00 to 70.00 volts (±0.02).

DC Amps-BMK
This meter displays the real-time charge current (amps into battery) or discharge current (amps out of the battery) as measured through the BMK shunt. Charging is shown as a positive (+) number and discharging is shown as a negative (–) number. The range is from ±0.1 to 999 amps (±1.0%).

AH In/Out
This meter displays the Ah returned to or removed from the battery. When this value is positive, it represents Ah returned to the battery during any subsequent charging. A negative value represents Ah removed from a full battery. The range is ±32,768 Ah. When using the charge efficiency's Auto setting, the AH In/Out value is recalculated after the battery has been fully charged (100% SOC) and ≥ 0.5% of the battery capacity has been discharged. If the sense module is disconnected from power, the AH In/Out value resets to zero.

Reset AH In/Out
This meter displays the total amp hours removed from the battery since it was last reset. This display can be used as a battery load indicator to help determine and monitor the battery load consumption. Its range is 0 to 65,535.0 amp hours (0.1 amp hour resolution). **To reset the Ah value to zero**, press and hold the SELECT knob for three (3) seconds when the Reset AH Out display is shown. After this display has been reset, it will begin calculating and displaying new Reset AH Out values. This display automatically resets to zero if the sense module is disconnected from power.

Total AH Out
This meter displays the total amp hours removed from the battery since the PRO-Verter was first connected. This display can be used as a battery service life indicator. The value is displayed in 0.1 k [or 100 amp hours ("k" equals 1000)] resolution up to a maximum of 6553.5 k amp hours (6,553,500 amp hours). The displayed number resets to 0.0 k when the PRO-Verter is disconnected from power.

Minimum VDC
This menu displays the lowest battery voltage since the last reset. The voltage shown on the display is averaged each second, and is helpful when troubleshooting or detecting an overdischarge condition. **To reset this display**, press and hold the SELECT knob for three (3) seconds while the Minimum VDC display is shown. After this value has been reset, the display will begin monitoring and showing new minimum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

Maximum VDC
This menu displays the highest battery voltage since the last reset. The voltage shown on the display is averaged each second, and this allows the charging system (battery charger, charge controller, etc.) to be checked to ensure the charging voltage has been attained. This display is also helpful when troubleshooting or detecting if an overcharge condition has occurred. **To reset this display**, press and hold the SELECT knob for three (3) seconds while the Maximum VDC display is shown. After this value has been reset, the display begins monitoring and showing new maximum DC input values. If the battery monitor is not connected or not communicating, the display shows "0.0".

Days Since 100% SOC
This read-only menu displays the number of days since the battery was at 100% SOC, and is calculated in the remote.

Li Expander Pak–related Troubleshooting

It is most important to maintain Li Expander Paks in such a way that they will never end up in a red-flash state.

Battery Status LED

Problem
Red-flash or no-light Battery Status LED

Solution
With the Power switch in the ON CHARGING/OPERATION position, push the momentary switch to check the Battery Status LED (see Table 3). Consult the Expander Pak Operator Manual to resolve the issue.

Figure 19. 24VDC Li Expander Pak 2400

Table 3. Battery Status LED Color and Corresponding Condition

Color	Frequency	Condition
Green	Flashing	**Normal operation**
Red	Flashing	**Protection circuits engaged** 1. Cell overvoltage 2. Cell undervoltage 3. Overcurrent (charge or discharge) 4. Overtemperature (> 160 °F/71 °C) 5. An internal battery fault (such as a broken wire, etc.)
None	N/A	**Battery inoperative**

Power Hub–related Troubleshooting

Common Issues

Table 4. Symptoms and Solutions for the Most Common Power Hub Issues

Symptom	Possible Cause(s)	Solution
Remaining Battery Capacity and Amp-Hours From Full show dashes (– – –)	Charge controller has not finished charging battery	Normal operation. Remaining Battery Capacity and Amp-Hours From Full displays show dashes until the battery is fully charged, **using solar power**, which initializes amp hour counting.
Remaining Battery Capacity or Amp-Hours From Full seems inaccurate	Battery not fully charged for an extended period	Since battery charge/discharge behavior is not ideal, error in the Amp-Hours From Full counter builds as the battery cycles without becoming full. Try to fully charge the battery often. The System configuration could also be at fault. Refer to the setup diagram to make sure that the System is correctly assembled.
User interface reports 0.0 charging amps in full sun.  **Home Screen**	1. Power Hub overheated 2. Batteries fully charged (29.0 VDC or near to that)	1. Check internal temperature and “battery” temperature on user interface. Derating begins at 104 ºF; no power as temp approaches 140 ºF. Check for dirty or blocked air vents. Shade the Power Hub to reduce solar loading. 2. Normal operation.
LCD inoperative	1. No power to the Hub 2. The LCD screen is overheated/sunlight exposure	1. Check connections and make sure batteries are active. 2. Close lid and allow Power Hub to cool down.

Power Issues

Power Hub Will Not Power Up

If the Power Hub 2400 is not powered up, it is likely that it is not connected to batteries. **Solar power alone will not activate the Power Hub 2400**; it must be connected to batteries either directly or indirectly via a PRO-Verter.

> **Note:** All battery-related readouts on the Power Hub 2400 LCD user interface are accurate ONLY if the batteries are connected directly to the Power Hub 2400. In this System, the batteries are connected to the PRO-Verter (indirectly to the Power Hub 2400), so information about the battery SOC and other parameters should be obtained from the PRO-Verter user interface.

Power Hub Overheating and Derating

The function and efficiency of all electronic equipment is related to and dependent upon the temperature at which it is operating. It performs optimally within a narrow temperature range and less so as the temperature falls outside of that range. The solar charge controllers within the Power Hub are rated to perform at full capacity until the internal temperature reaches 104 ºF (40 ºC). At this point, the charge controller will “derate”, or reduce its level of activity, to prevent the internal temperature from rising further. When the internal temperature of the charge controller reaches 160 ºF (71 ºC) it will “shut down” to prevent damage. If this uncommon situation occurs, it is most likely to happen during the hottest, sunniest part of the day when power from the solar arrays should be producing power, but the report on the LCD user interface may say that they are producing no power at all.

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 quickly elevate the internal operating temperature. Clogged air filters can exacerbate the problem significantly so they should be cleaned as often as necessary to maintain maximum airflow.

How To Know If the Power Hub Is Overheated

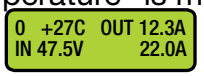
The first indication of overheating may be the appearance that the solar arrays are “not producing any power” when they should be. If this is the case, check the temperature.

> **Note:** The Power Hub User Interface will also report 0 VDC charging current when the System batteries are fully charged.

The Power Hub LCD user interface reports two (2) temperatures:

1. The “Internal Temperature” is measured by a thermister directly on the charge controller. This value is reported in the BAT TEMPERATURE window: 

   See Advanced Information Menu Windows in the Power Hub Operator Manual for directions to navigate to this window.

2. The “Battery Temperature” is measured by a Battery Temperature Sensor that is located inside the Power Hub. 

   Note: THIS IS NOT REPORTING THE TEMPERATURE OF THE BATTERIES but rather the temperature inside the Power Hub case. This value is reported independently for each of the three (3) charge controllers inside the Power Hub.
   See the Power Hub Manual for instructions on how to navigate the View Charge Status submenus for instructions on how to navigate to these windows.

If either of the temperatures reported from these two sensors is greater than 104 ºF (40 ºC), the Power Hub performance will be degraded.

How To Keep It Cool

- Keep the air filters clean.
- Shade the Power Hub to reduce solar loading.

Solar Array–related Troubleshooting

Assessing PV Array and Panel Performance Using the Power Hub

Failure of a single solar panel or Solar Array may not be noticed during normal operation if monitoring only the total solar output current from multiple arrays in the main menu of the LCD user interface.

Solar Array output fluctuates due to changing environmental conditions. PV generation can degrade as the panel temperature rises, and the failure of an entire solar array may occur if a portion of a single panel is shaded. It is important to occasionally monitor the current of each charge unit independently using the charge unit status submenus of the LCD user interface.

If using a single array, the failure of a single (1) solar panel may cause the entire solar array to appear failed when the solar panels are wired in series. The output from the entire solar array will be zero (0), and therefore the current of a single (1) charge unit will be significantly lower.

If multiple Solar Arrays are connected and have equal exposure to sunlight, then the output current from each array should be approximately the same. The output of three (3) pairs of Solar Arrays can be monitored independently in the charge unit status submenus: Charge Unit 0, Charge Unit 1, and Charge Unit 2. The current readings should be approximately the same in all three (3) units and reflect the output of the two (2) solar arrays connected to each charge unit. If the current is significantly lower (approximately half or less) in one (1) of the charge units, it suggests that one (1) or more panels in one (1) or both (2) of the Solar Arrays that enter this charge unit is defective.

To identify which of the two (2) Solar Arrays is responsible for the decrease in current in that charge unit, CAREFULLY disconnect one (1) of the two (2) Solar Leashes from the Power Hub 2400 while viewing the current reading for that charge unit on the LCD user interface. If there is no decrease in the current when the Solar Leash is disconnected, the defective Solar Array has been identified. If there is a decrease, then reconnect that Solar Leash to the Power Hub 2400 and disconnect the other Solar Leash from the Power Hub 2400. There should be no change in the current reading when one (1) of the two (2) leashes is disconnected from this channel. The Solar Array connected to this Solar Leash may have one or more faulty solar panels.

To confirm the output from a particular solar array, CAREFULLY measure the open circuit voltage (Voc) across pins A and C in the bayonet connector at the end of the Solar Leash. The B pin is unused. There should be no (or low) output from a faulty Solar Array. If a Solar Array is functioning properly, the voltage measured should be near to the rated Voc value for the array.

Refer to the Solar Array Operator Manual for additional methods to troubleshoot the PV arrays and individual panels.

Generator-related Troubleshooting

Generator Having Difficulty Starting

Causes
- Generator starter battery voltage too low
- Low fuel
- Fuel / Air filters clogged

Solution
1. Charge the generator starter battery.
2. Add fuel.
3. Check air and fuel filters; replace if necessary.

Generator Will Not Start

Causes
- Out of gas (diesel fuel) (“OG”)
- Auto Gen Start (AGS) control module on generator in “fault” mode
- Gen Control (CTRL 03) function set to OFF
- Dead generator starter battery

Solution
1. Fill fuel tank and prime the lines.
2. Reset the AGS module by toggling the PRO-Verter power switch OFF, then ON.
3. Set the Gen Control to ON or AUTO.
4. Charge or replace generator starter battery.

Generator Starts, Then Shuts Down When Load Is Transferred

Cause
The diesel motor in the generator cannot sustain a significant load until the diesel engine is fully warmed up.

Solution
Gen warm-up and cooldown phases are critical for repetitive start/stop function. Make sure the Gen Warm-up setting is at least 75 seconds in duration.

Generator Short-cycles

Causes
- Incorrect setup of the Inter-Connect Circuit
- Incorrect voltage setting in the Gen Run VDC menu
- Expander Pak(s) not turned on
- High heat causing AGS to trigger (normal)

Solution
1. Verify the Inter-Connect Circuit is in accordance with the schematic on the PRO-Verter I-Plate.
2. The Gen Run VDC should be set to “25.0 to 28.8”.
3. Verify all Expander Pak switches are in the ON position.
4. If the internal transformer is in danger of overheating, the AGS will automatically start the generator to ensure continuity of operations. The AGS will stop the generator after temperatures have cooled.

Generator Fails to Shut Down

Causes
- Charge function in standby mode
- AC circuits running at the generator’s full-rated output (batteries not being charged)
- Gen Run VDC value altered from factory setting

Solution
1. Verify CHARGER LED is illuminated (not blinking).
2. Reduce AC loads on the station.
3. Ensure the Gen Run VDC is set to “25.0 to 28.8”.

Station-related Troubleshooting

No Power in Station, PRO-Verter Inverting and/or Generator Operating

Cause
The EMERGENCY STOP relay / switch in the station is in the “open” position.

Solution
Inside the station, push in the red EMERGENCY POWER OFF switch and then rotate clockwise to pull it back out. Then push and hold the green MAIN POWER ON button for 2 seconds and release. Power inside the station should be restored.

> **Note:** If certain circuits remain off, check the individual circuit breakers or circuit switches at their dedicated panel.

Expander Pak Circuit Breakers Tripping

Cause
The batteries had varying states of charge (i.e., the initialization and calibration step was missed).

Solution
Charge the hybrid system’s bank of batteries fully (to equalize the states of charge among the Expander Paks) before the mast is raised.

RMK-related Troubleshooting

RMK Status Indicator Light Not Illuminated When PRO-Verter Powers Up

Cause
Power failure or RMK malfunction or failure

Solution
1. With the PRO-Verter on, measure voltage at green power connector at RMK screw terminals.

    a. If voltage is not similar to the battery bank voltage, measure voltage at the binding posts of the PRO-Verter. If the voltage is not similar to the battery bank voltage, the problem is with the PRO-Verter.

    b. If the voltage is similar to the battery bank voltage, continue with the next step.

2. Disconnect the RMK power connector and remove the RMK circuit board from its enclosure.

    Caution: The RMK circuit board could be damaged by electrostatic discharge. Perform this operation in an electrostatic-safe environment.

3. Remove and reinsert the coin cell battery. Re-connect the RMK power connector. If the malfunction is not cleared, continue with the next step.

Cannot Communicate with RMK

Possible Causes
A. RMK does not have green light
B. RMK has not been at green light status for at least 5 minutes
C. Computer has more than one network interface set up (e.g., Wi-Fi and Ethernet)
D. Incorrect network settings in RMK interfaces file
E. No gateway set up in interfaces file on RMK or no gateway set up on DHCP server

Solution A
See solution for RMK Status Indicator Light Not Illuminated When PRO-Verter Powers Up.

Solution B
Wait for RMK to be green light for at least 5 minutes and retry.

Solution C
Disable all network interfaces except the one being used to communicate with the RMK.

Solution D
1. Verify interfaces file is in folder matching serial number.
2. Verify interfaces file does not have ASCII 10 and ASCII 13 characters at the end of any lines.
3. Verify that interfaces.bak file is being created on the USB drive after the copy process.
4. Verify that the correct sequence of steps is being executed to install the file.

Solution E

1. If not using DHCP, add this line under the netmask (where [host name] is the DNS name or IP address of the gateway):
   gateway [host name]

2. If using DHCP, consult the documentation for the DHCP server.

Status Light Stays Orange after Inserting USB Drive

Cause

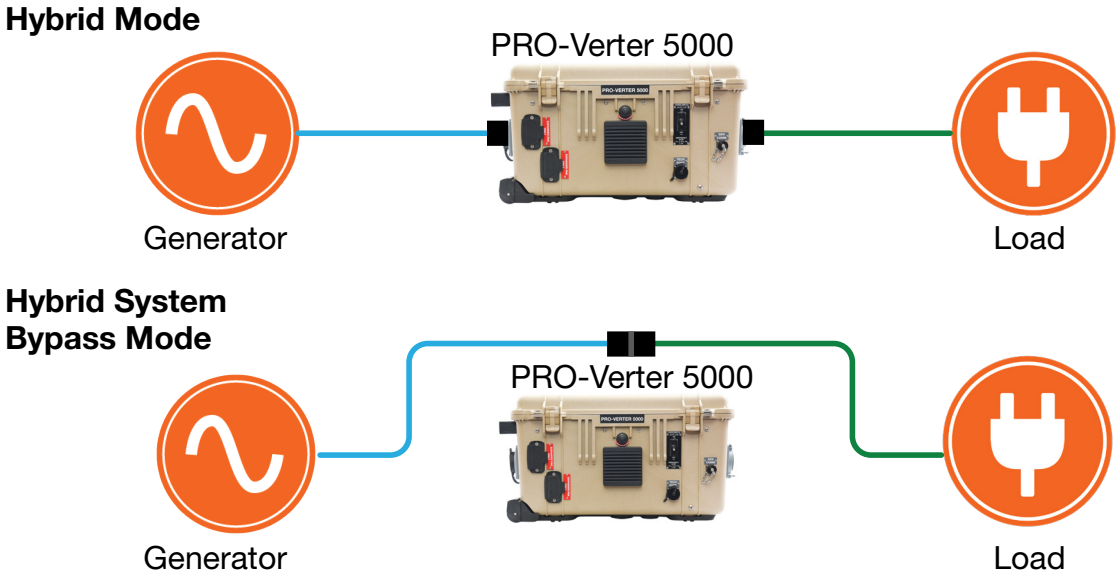
RMK automatically copying large number of log files to USB drive

Solution

If the data are required, wait. Otherwise, purge the log files. Contact Solar Stik Technical Support for assistance with purging log files.

Hybrid System Bypass Mode

Bypass the HPS only if the PRO-Verter fails.



Disconnect the AC Power Cables (input–blue; output–green) from the PRO-Verter then connect and twist lock these two cables together. The connectors have markings to indicate locking status (bottom).

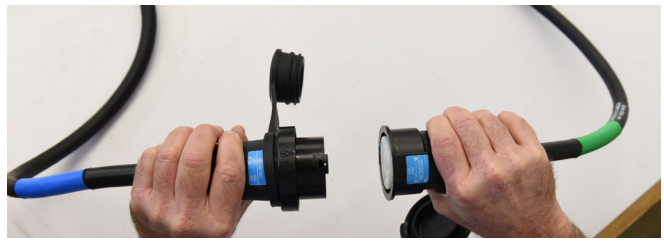


Figure 20. Hybrid Power System bypass connection

Observed Fault Situations

High-heat Generator (AGS) Auto-starting

The generator starts and stops without the programmed settings controlling it.

Cause
The PRO-Verter uses an internal transformer to create current for inverting or battery charging. When inverting at high rates, the transformer can generate excessive heat, which can cause an Overtemp fault. Since the inverter function can only respond to the load requirement, it cannot tailor back the rate at which it inverts if external factors (e.g., high heat) are causing it to derate. The PRO-Verter's internal cooling system must manage the transformer temperature. If it cannot maintain the temperature within acceptable limits, it will trigger the AGS to start the generator so it can assume the load, allowing the transformer to cool down. This feature ensures the load always has uninterrupted power, even when PRO-Verter operating conditions (high heat, dirty filters, etc.) are not optimal.

Artificial Voltages

DC voltage rises and falls very quickly, triggering short generator cycles.

Cause
When both PRO-Verters are operating at greater than 75% of their rated abilities, it is likely to create artificial drops or rises in bus or battery voltage. This is primarily due to due to high rates of current flowing in/out of the PRO-Verters and through the Inter-Connect Circuit (and by extension, the battery bank). Since the AGS is set to trigger the generator start/stop functions based on battery voltage, it is possible the generator will start and stop in rapid succession. If this occurs, please contact Solar Stik Technical Support for instructions on altering the AGS settings.

Dead Generator Battery

Frequent VDC faults appear on the PRO-Verter LCD. (The generator is not starting when the PRO-Verter AGS signals it to do so.)

Cause
The generator's battery is likely dead. The Auto Generator Start/Stop (AGS) module installed on the generator requires power from the generator battery for function. When the AGS module is in the ON position, power from the generator starter battery is drawn, so there is a risk it could drain the battery over time (i.e., it is a quiescent load). The generator must run at regular intervals, keeping its internal starter battery charged. If it remains idle for extended periods, it should be turned off. There is a GEN EXERCISE feature in the PRO-Verter programming that can be used for situations where the generator does not run regularly. This feature is not engaged in the factory programming, but it can be set easily if conditions warrant. Please contact Solar Stik Technical Support for instructions on setting the GEN EXERCISE function.

Water Intrusion—Prevention and Remediation

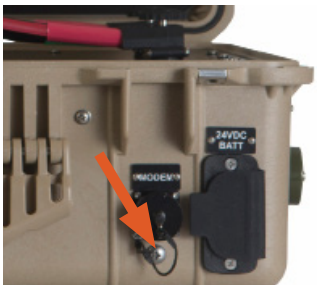
⚠ WARNING

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 2400 and the PRO-Verter should be closed whenever possible while the system is operating to prevent water and dust from entering the system. The lids of the Li Expander Pak 2400s are sealed.

- 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.

- After the component is separated from the system, move it to a safe dry location. Keep the component as level as possible to prevent the water inside from accumulating at one end or the other and submerging the internal electronics. 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, 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.

MAINTENANCE INSTRUCTIONS

HPS Preventive Care and Maintenance

Follow these procedures to maintain the HPS.

- Shade the components (except the Solar Arrays) from direct sun exposure and shelter them from the elements.
- Follow the Expander Pak preventive maintenance checks and services listed in the Expander Pak Operator Manual.
- Clean air filters of the PRO-Verters 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.
- Follow the generator maintenance procedures listed in the generator operator and maintenance manual.
- Keep component case lids and Inter-Connect covers closed to prevent water/dust intrusion.
- Ensure the panels of the Solar Arrays are clean and positioned for maximum daily sunlight exposure.
- Ensure the Solar Leashes are secured with Velcro straps and provide strain relief at locations where the leashes are stressed.
- Check the integrity of electrical connectors 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.

ABOUT SOLAR STIK, INC.

Mission Statement
Using American-made components and constant innovation, Solar Stik creates portable power solutions that enable self-sufficiency for the soldier, the sailor, and beyond. In doing so, we save lives, change lives, and help revive American manufacturing.

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.

Contact

Technical Support Line
800-793-4364 Ext. 102
(24 hours a day, 365 days a year)

Address
Solar Stik, Inc.
226 West King Street
Saint Augustine, Florida 32084

Website
www.solarstik.com

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