SOLAR STIK®

# SYSTEM SETUP AND OPERATION MANUAL FOR ATSC MS3 L0

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# Revision History

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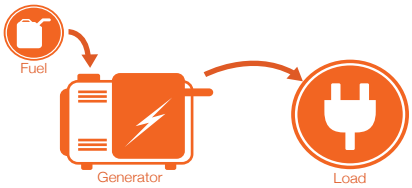
# GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

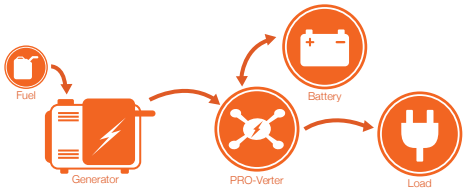
## Introduction to Hybrid Power Systems

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, 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 and the architecture is opened to allow multiple technologies to operate in concert.**



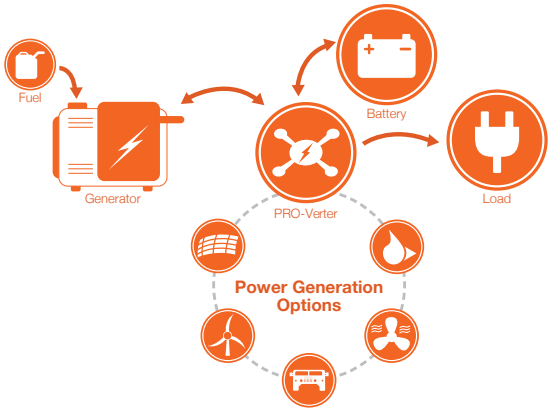

Low-efficiency
Traditional Power System




High-efficiency
HPS

## The Hybrid Power System Flexible Open Architecture

The System is comprised of modular components that integrate into a flexible architecture that is configured for an application's specific mission requirements. If the application changes, the modular System architecture can be modified or scaled to meet the new requirements.




HPS with Open Architecture

Figure 1. MS3 L0 HPS

# The L0 Hybrid Power System

The Solar Stik Hybrid System (HPS) integrated into the L0 platform is configured for operation with compact Yanmar YDG5500 diesel-fuel generator. The generator is rated for lower output than the peak AC power requirement. Only the PRO-Verter's inverter function can meet the peak-power delivery requirement of the AC loads.

## Peak-Power Loads Defined

1. Mast and Payload Raising/Lowering—The deployment of the L0 mast requires up to 10 kW (43 A at 230 VAC) at peak load.
2. Environmental Control Units (ECUs)—The ECUs on the L0 requires up to 8050 W (35 A @ 230 VAC) at peak load.

## ECU Soft-starts

The ECUs on the L0 have been configured with soft-start kits, which reduce the surge loads of the compressor, allowing them to operate within the limits of the generator during normal hybrid functions.

## Sequential Deployment

Raising the mast with payload requires 100% of the PRO-Verter's capability, and since the PRO-Verter is the only AC source capable of raising the L0 mast with its payload, it should be used exclusively when performing this step. The generator should not be used.

Once the mast and payload are fully deployed, the remaining L0 systems and payloads can be activated, and the system can be returned to normal hybrid mode with the generator engaged as necessary to support normal L0 operations.

## L0 Hybrid Power Function Overview

The Solar Stik Hybrid System is designed to provide constant, quality sine-wave AC power to the L0 platform, using a 12 kWh battery bank, a Yanmar diesel-fuel generator, and a photovoltaic (PV) array to meet the daily power requirements of the L0. Both power generation sources (Yanmar and PV) must produce enough power on a daily basis to be used by the loads, although they will both provide power under different conditions:

- The Yanmar generator only operates when the PRO-Verter commands it to, based on programming.

- The PV array only generates power when exposed to sunlight.

The PRO-Verter is programmed at the factory for use in the L0 application. 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.

The Remote Monitoring Kit (RMK) transmits Hybrid Power System information in real time from the PRO-Verter over any LAN or internet gateway.

# Important Safety Information and Instructions

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

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

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

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

## Safety Information Labels

Your safety and the safety of others is very important.

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

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

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

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

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

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

# Fire Hazard

## Fire Types

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

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

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

# Recommended Fire Extinguisher

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

**⚠ WARNING**

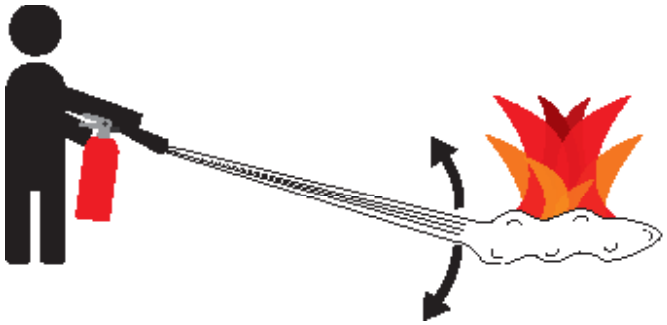
Only $CO_2$ (carbon dioxide) fire extinguishers should be used with this equipment.


## Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

**P**ull the pin.
**A**im the nozzle or hose at the base of the fire from a safe distance.
**S**queeze the operating lever to discharge the fire extinguishing agent.
**S**weep the nozzle or hose from side to side until the fire is out. Move forward or around the fire as the fire diminishes.

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



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

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

## Electric Shock Hazard

**⚠ WARNING**

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

DON'T LET THIS BE YOU!

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

**⚠ WARNING**

The System is NOT GFCI protected.

## Grounding the System

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

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

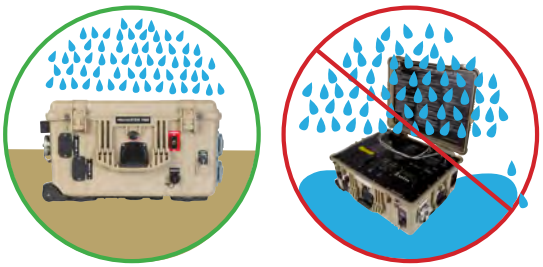

Figure 2. PRO-Verter grounding lug

# Environmental and Handling Precautions

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

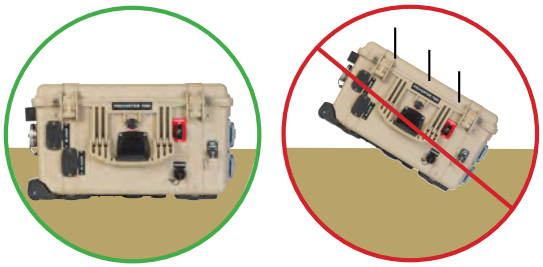
## Water

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.



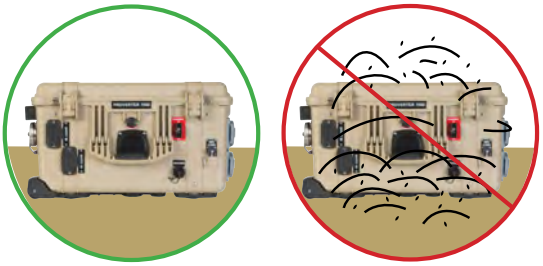
## Impact

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



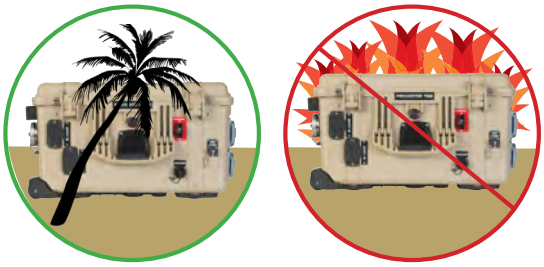
## Dust/Foreign Object Intrusion

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

## Models of Operation

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

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

### DC-only/Inverter (Automatic Functions)

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

### Hybrid (Automatic Functions)

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

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

### Load Support (Automatic Functions)

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

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

### Peak Power Delivery (manual functions)

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

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

### UPS (Automatic Functions)

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

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

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

## The HPS Architecture, Function, and Operation

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

- Energy storage
- Power management
- Power generation

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

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

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

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

## Energy Storage—The Foundation of the HPS

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

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

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

See additional information about the Expander Paks: Energy Storage Modules – Supplemental Information.

## Minimum Battery Capacity Required for Optimal System Operation

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

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

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

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

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

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

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

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

## System Cycling

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

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

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

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

## Load Prioritization

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

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

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

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

## Real-time Load Management

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

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

It is incumbent on the Operator to ensure the sum of all loads does not exceed the limit of the AC source (generator or grid utility) or the connections or circuit protections in the network. The AC INPUT (FAVS 03) setting should be set to the same value of the maximum AC output rating of the source. For example, if the generator is rated for 3000 W continuous output, then the AC INPUT should be set for 25 A* (25 A @ 120 VAC = 3000 W)

*See Lag Times and Surge Rates

# “Overload” Conditions

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

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

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

# Load Support (If Equipped)

**Load Support function is used to support two models of operation:**

1. Load Support Model
2. Peak Power Model

Load Support is an automatic function of the PRO-Verter that combines power from a generator or grid AC source with the inverter’s AC output to briefly support high AC loads that exceeds the AC source’s or the PRO-Verter’s rated AC power output.

It is typically used in operations where the PRO-Verter is connected to a generator or Grid AC power source that is rated for LESS AC output than the inverter output power rating of the PRO-Verter.

It automatically engages once the load exceeds the AC INPUT setting (FAVS 03), and because it requires power from the batteries, it should only be used if the excessive loads are brief in duration and intermittent in scope.

For Load Support to function, the PRO-Verter must be connected to an active AC power source. It cannot engage if there is no active external AC power source.

The PRO-Verter can also be configured to perform Load Support as a manual intervention method when conditions warrant. This is also referred to as the Peak Power Model.

Consult the PRO-Verter I-Plate to determine if the PRO-Verter is equipped with the Load Support feature and for specific instructions on manual engagement of Load Support for a particular application.

How Power demand surges can crash the system.



# Managing Lag Time and Surge Rates

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

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

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

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

Figure 3. Hybrid Power System in Operation

# Scaling and Modifying the HPS

When expanding or modifying the HPS architecture, scaling and stacking may be used to provide additional capabilities that may exceed the ability of any one component.

**Scaling**

- Power generation and energy storage can be modified in accordance with changes in load requirements. Additional generation sources should be selected based on availability of resources, logistics and the local environment (fuel-driven generator, wind, fuel cell, etc.).

- Additional energy storage modules can be of a different form factor but must be of the same chemistry and voltage, have compatible charge and discharge current capabilities etc.

**Stacking**

- Capabilities can be added (or removed), including advanced power distribution and management modules, stacking of generators with PRO-Verters, Power Hubs and more.

Consult the individual product manuals for additional information about scaling and stacking.

> **Note:** When scaling or modifying the HPS architecture, all components in the HPS should be completely inactive and OFF. The Initialization and Calibration step must be repeated after the modifications have been made.

# PRO-Verter Stacking Example

Stacking PRO-Verters, of the same or different types provides a mechanism to power a wide variety of AC loads from the same System. The dashed-line box surrounds the stacked PRO-Verters.

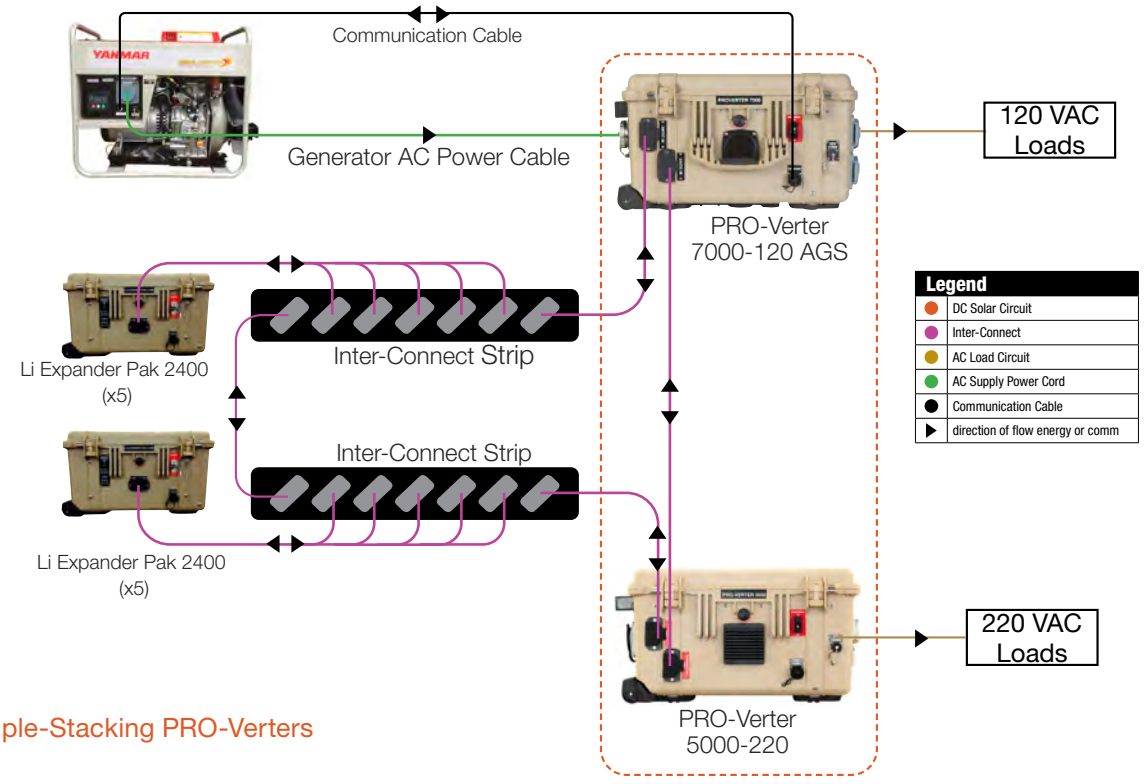



Figure 4. Example-Stacking PRO-Verters

# Power Hub Stacking Example

Stacking Power Hubs, of the same or different types, provides a mechanism to add DC power sources to a System. The dashed-line box surrounds the stacked Power Hubs.

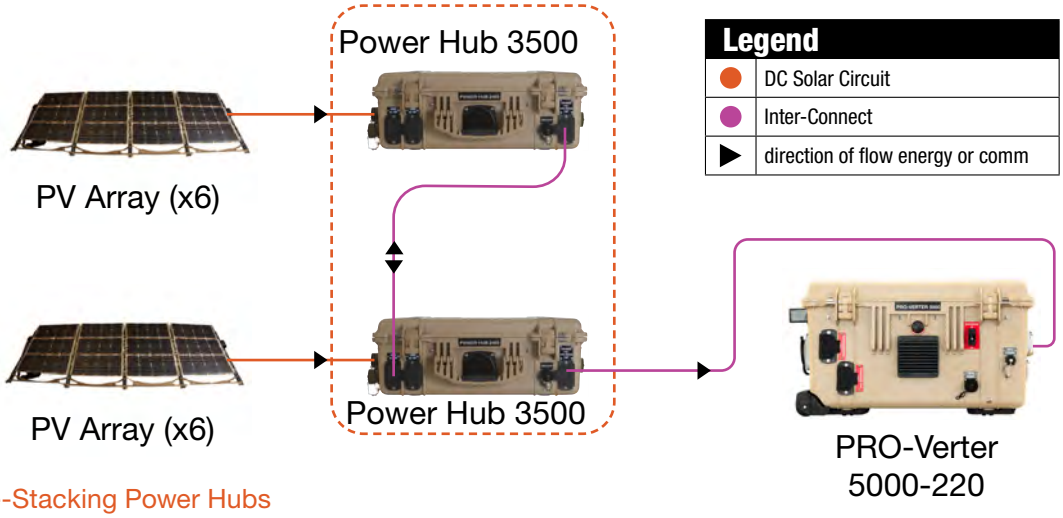



Figure 5. Example-Stacking Power Hubs

# Scaling Energy Storage Capacity Example

Plug & Play architecture allows expansion or contraction of battery capacity when conditions warrant.

Use Inter-Connect Strips and Inter-Connect Cables to create a “bank” of Li Expander Paks (Figure 6). **Note:** Do not mix battery chemistries in a System battery bank.

If a System needs to be downsized, due either to reductions in the load or simply to reallocate energy storage resources to other locations, Li Expander Paks can be removed from service in accordance with reductions in runtime requirements.

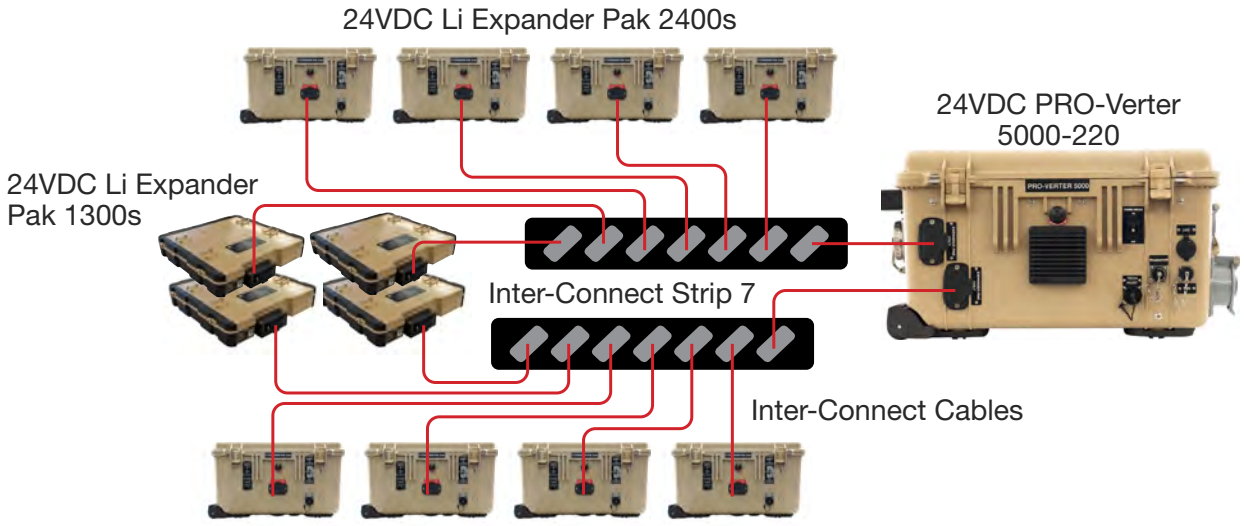



Figure 6. Connecting Li Expander Paks using Inter-Connect Strips and Inter-Connect Cables

# Equipment Description

## The Inter-Connect System

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

- Energy storage
- Power management
- Power generation

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

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

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

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

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

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

# The Standard Inter-Connect Plug

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

Figure 7. Inter-Connect Plug

# 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 8. System connection color coding

# Trailer Inventory

| QTY |
|---|
| 1 |
| 1 |
| 1 |
| 5 |
| 1 |
| 3 |
| 1 |
| 1 |
| 3 |
| 5 |
| 1 |
| 1 |
| 2 |
| 2 |
| 1 |


☐ One (1)
24VDC PRO-Verter 5000-220


☐ One (1)
24VDC Power Hub 2400
(includes one 5’ Inter-Connect Cable)

☐ Three (3)
420W Expedition Solar Array-Cs
in transport cases


☐ Five (5)
24VDC Li Expander Pak 2400s


☐ One (1)
Remote
Monitoring Kit

☐ One (1)
Inter-Connect
Strip 7


☐ One (1)
Cable Transport Case

☐ One (1)
AC Input Power Cable
15’ 220 V 50 Hz
Blue

☐ One (1)
Gen Comms Cable 15’

☐ One (1)
AC Output Power
Cable 15’ 220 V 50 Hz
Green

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

☐ Five (5)
24VDC 5’
Inter-Connect Cables

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


☐ One (1)
5.5 kW Yanmar YDG 5500 and
Fuel Tank

# 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.

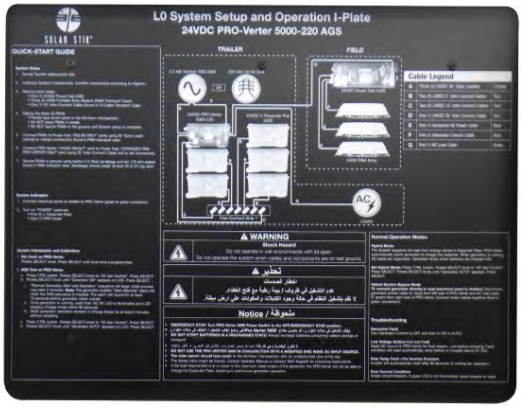



Figure 9. System Setup Guide on the PRO-Verter I-Plate

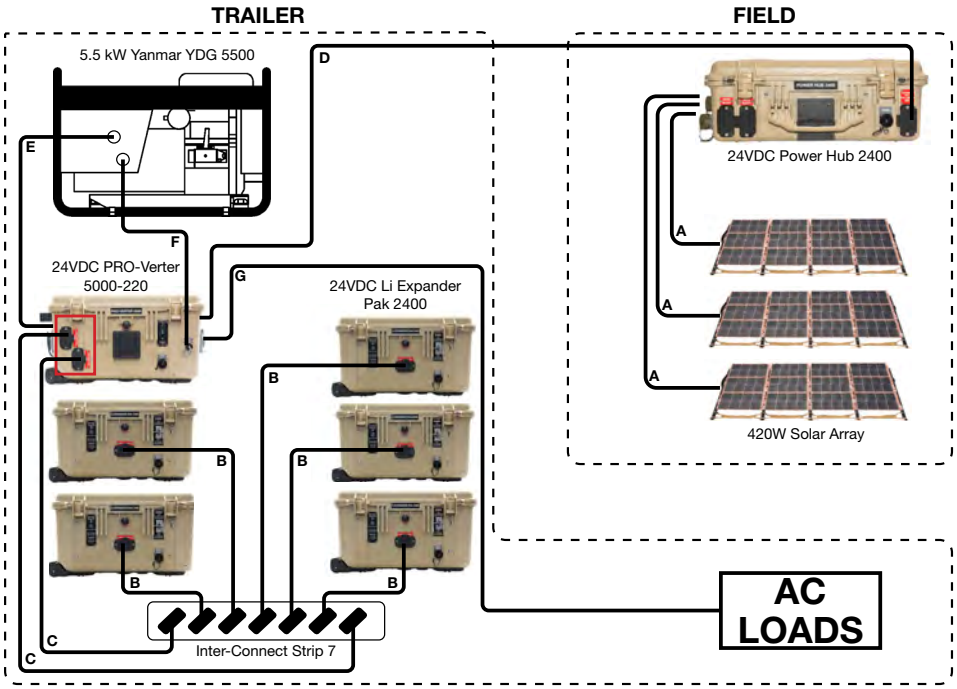



Figure 10. System connection diagram

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

# OPERATOR INSTRUCTIONS

## A. System Setup

### 1. Inventory System components.

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

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

Remove the following components from the trailer:

- One (1) 24VDC Power Hub 2400
- Three (3) 420W Expedition Solar Array-C transport cases
- One (1) 20’ Inter-Connect Cable, located inside of the L0 Cable Transport Case

### 3. Inventory 420W Expedition Solar Array-C kit.

Inventory the contents of each of the three (3) 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 |

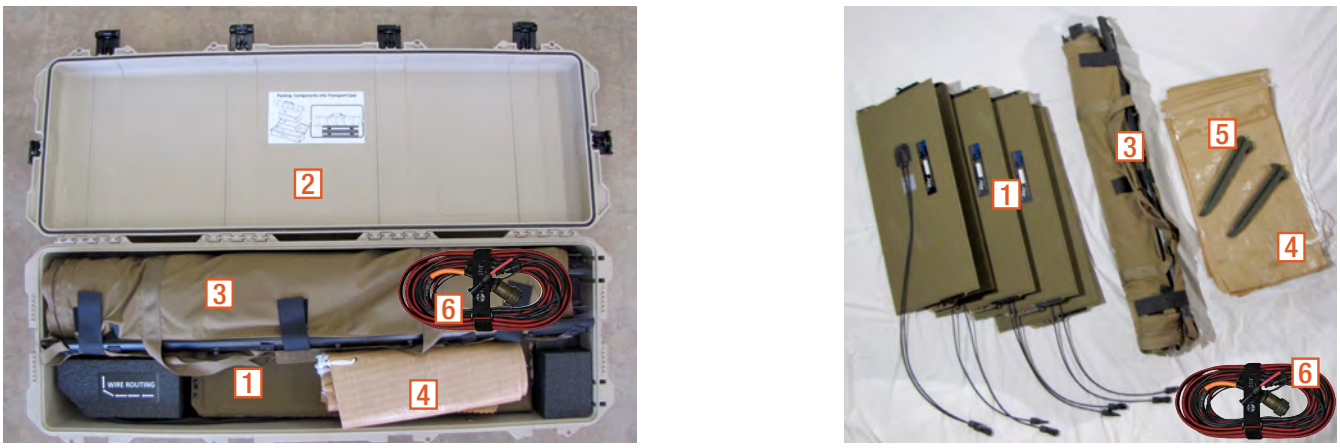



Figure 11. Solar Array transport case contents packed (left) and unpacked (right)

# 4. Identify locations for System components.

### a. 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.

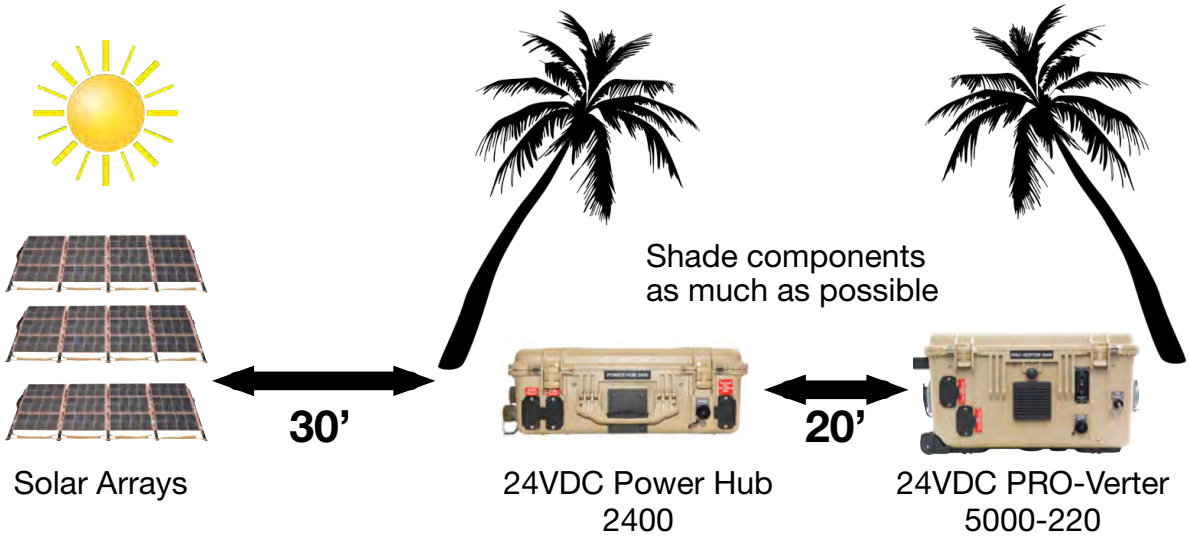



Figure 12. Working-space distance for the Solar Arrays, Power Hub, and the trailer

### b. Minimize Potential for Water and Dust Intrusion

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

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

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

Direct ground placement of any power management or energy storage component is generally not recommended, but possible if no other option is available. If it is necessary, preventive measures for water and dust should be taken. Consult the PMCS section of this manual for additional details.

# 5. Connect System components.

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.

## a. Connect PRO-Verter to Expander Paks.

Connect five (5) Expander Paks to the Inter-Connect Strip 7 with five (5) 5’ Inter-Connect Cables. Connect the Inter-Connect Strip to the PRO-Verter with two (2) 10’ Inter-Connect Cables. All of these are red-to-red connections.

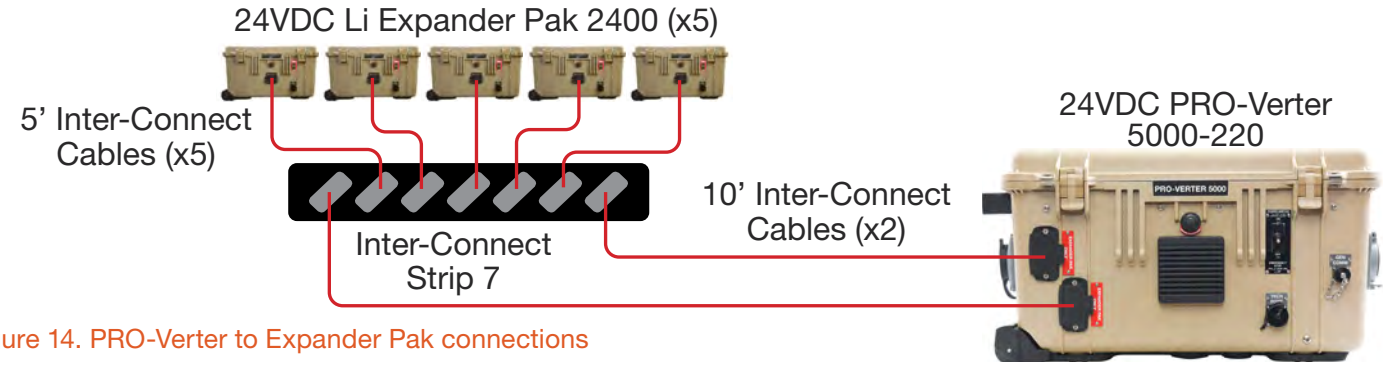



Figure 14. PRO-Verter to Expander Pak connections

## b. Connect PRO-Verter to generator.

Make power and communications connections between the generator and PRO-Verter according to Figure 13:

**Gen Comm Cable:** “GEN COMM” port on the 24VDC PRO-Verter 5000 and “GEN COMM” port on the generator using gray-to-gray connection

**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

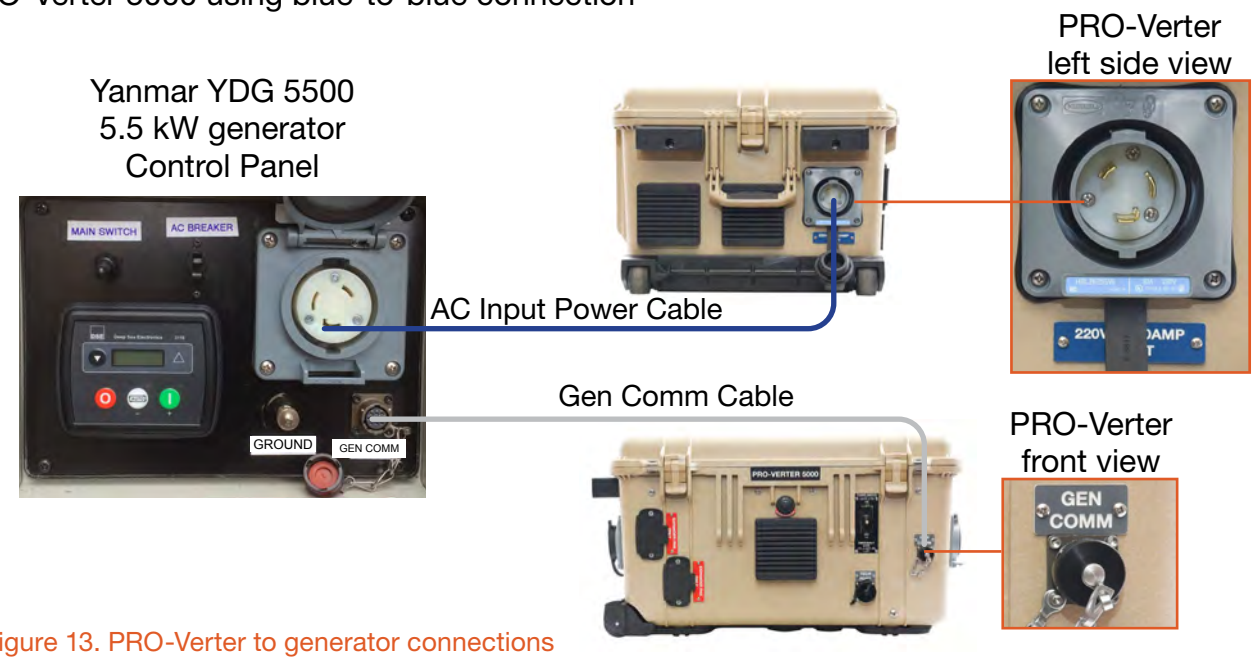



Figure 13. PRO-Verter to generator connections

## c. Connect PRO-Verter to shelter service panel.

Connect the PRO-Verter (“220 AC OUT” port) to the shelter service panel using a green-to-green connection.

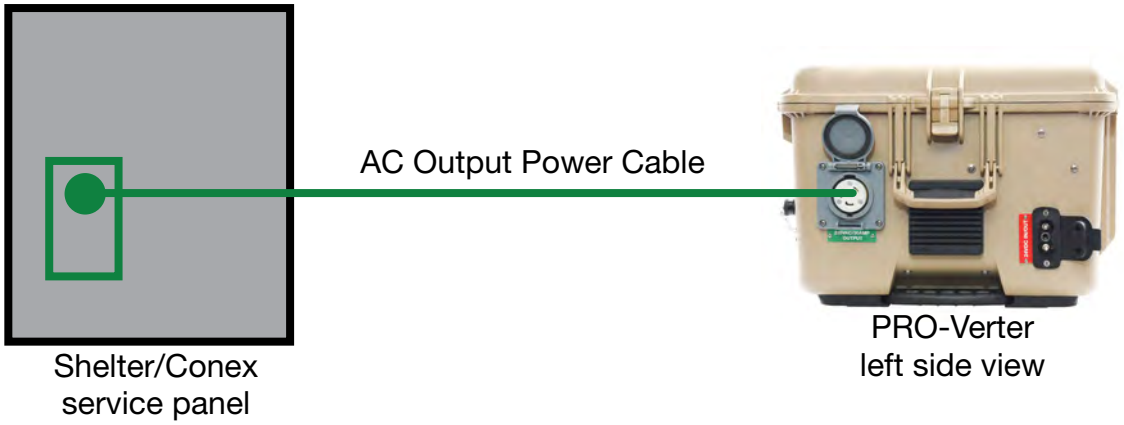



Figure 15. PRO-Verter to shelter service panel connection

## d. Connect / Assemble Solar Arrays.

For detailed setup instructions, see the 420W Expedition Solar Array-C Operator Manual. The panels should be positioned for maximum daily sun 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 (* in figure below). Connect these two (2) free ends to the appropriate connectors of the 30’ Solar Leash.

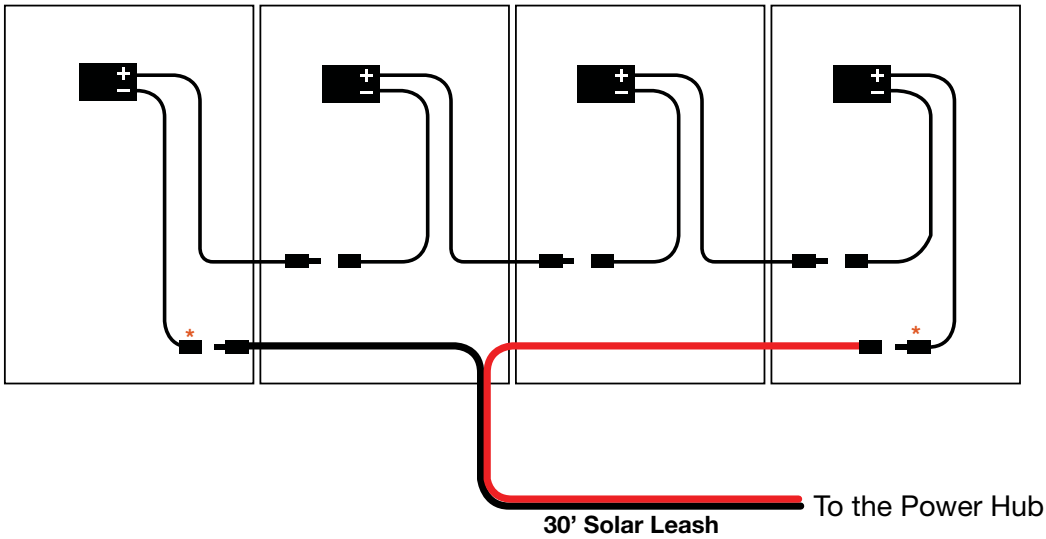



Figure 16. Connect negative and positive ends of the cables as shown

### e. Connect PV Arrays to Power Hub.

Connect one (1) Solar Leash to one (1) SOLAR ONLY port from each pair of ports (CHARGE UNIT#0, CHARGE UNIT#1, CHARGE UNIT#2). These are orange-to-orange connections.

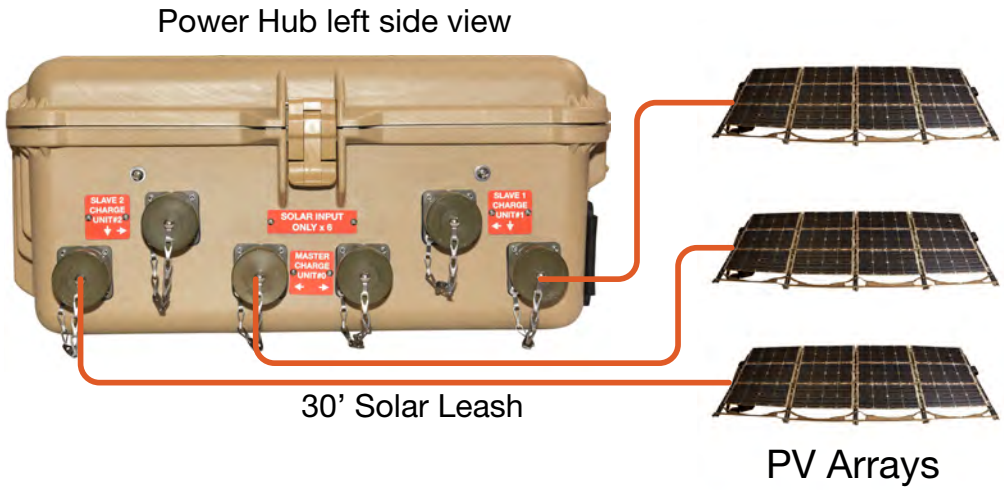



Figure 17. Solar Array to Power Hub connections

**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 18. 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.

### f. Connect PRO-Verter to Power Hub.

Connect the PRO-Verter (“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 19. PRO-Verter to Power Hub connection

### g. Connect Remote Monitoring Kit to PC or LAN (RMK; optional)

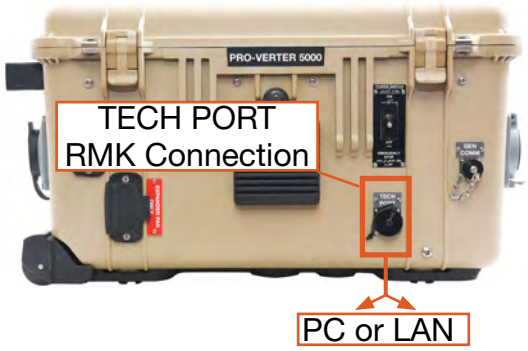



Figure 20. RMK external communication

The RMK provides remote access to vital operating data of the PRO-Verter via the User Interface on the Faceplate. RMK data can be accessed via the TECH (ethernet) PORT on the front of the PRO-Verter. If an RMK is installed, ensure that the connections are as shown below. See the Operator and Maintenance Manual for the RMK for detailed information.

## 6. Grounding the System


Figure 21. PRO-Verter grounding lug

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.

## 7. Secure Solar Arrays to 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.

The 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.**

# B. System Activation


Figure 22. Generator control panel

1. Connect loads to the PRO-Verter (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 and AC BREAKER switch by toggling it up (Figure 22, arrows).

   **Note:** The generator control panel is programmed for the L0 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.

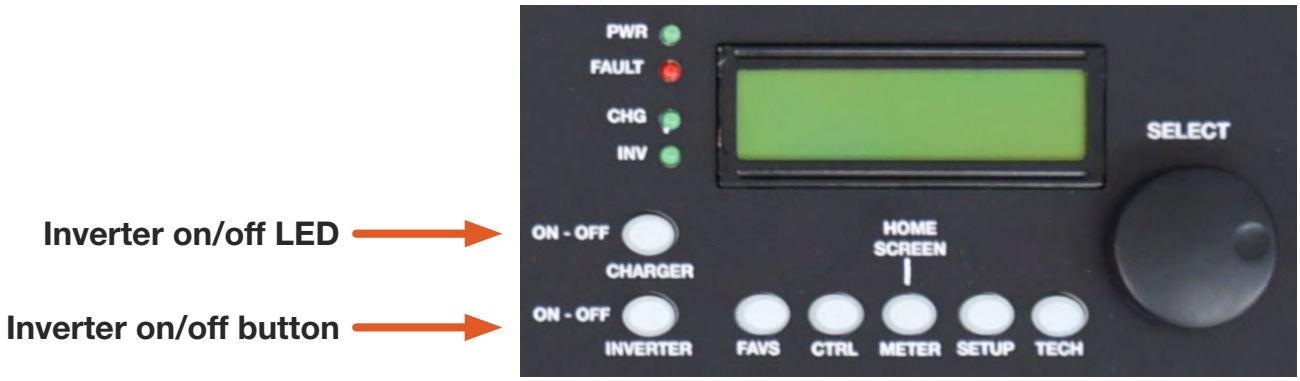



Figure 23. PRO-Verter LCD control panel

# C. System Start Up 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 16, left side) will be illuminated green.
   a. Press the CTRL button (Figure 23). 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 connected to 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 (LED next to CHG 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 24. 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 if communication with the generator cannot be accomplished using the normal, programmed method.

# D. Order of Operations: Activation and Deactivation of the System

**L0 Isolation of Operations:**
When *deploying* the L0, it is recommended that the ECUs not be engaged. The sensors can be powered up before raising the tower, but the ECUs must remain off. Failure to follow this recommendation may result in overloading of the HPS.

**L0-architecture Deactivation Sequence**
When *terminating operations* on the L0 platform, all of the L0 systems must be shut down before the HPS can be turned off. Before decommissioning the HPS, all individual components must be deactivated and the inter connect circuit de-energized.

**Steps to power down the HPS:**
1. Power down the PRO-Verter
2. Turn off all Expander Pak power switches.
3. Disengage the Power Hub and Solar Arrays

# E. 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 load requirement is at or close to the maximum rated output of the generator, the PRO-Verter 5000 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.

- Expander Paks must be configured to provide a MINIMUM cumulative 200 A DC to the System for the PRO-Verter to function at its rated power.

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

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

# F. L0 PRO-Verter Programming Menu Map

The PRO-Verter has been programmed at the factory to operate with the MS3 L0 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

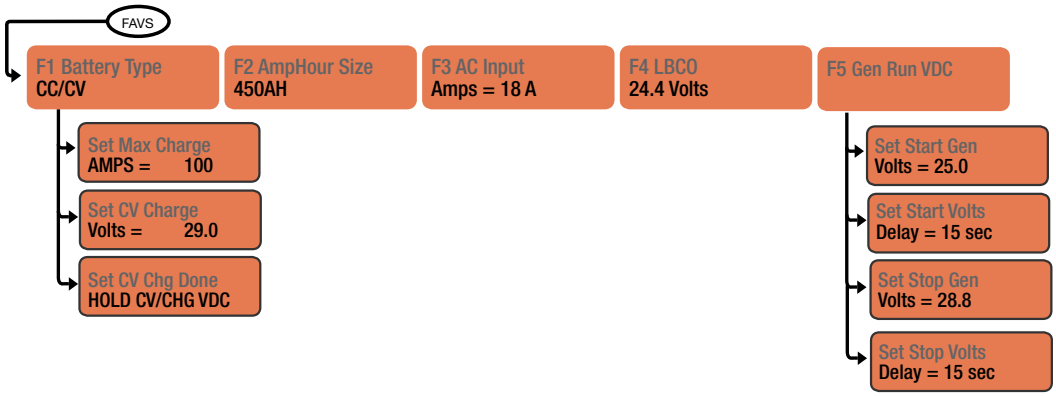
Green menu items represent factory default settings, read-only settings, or options that exist within a specific menu item.

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

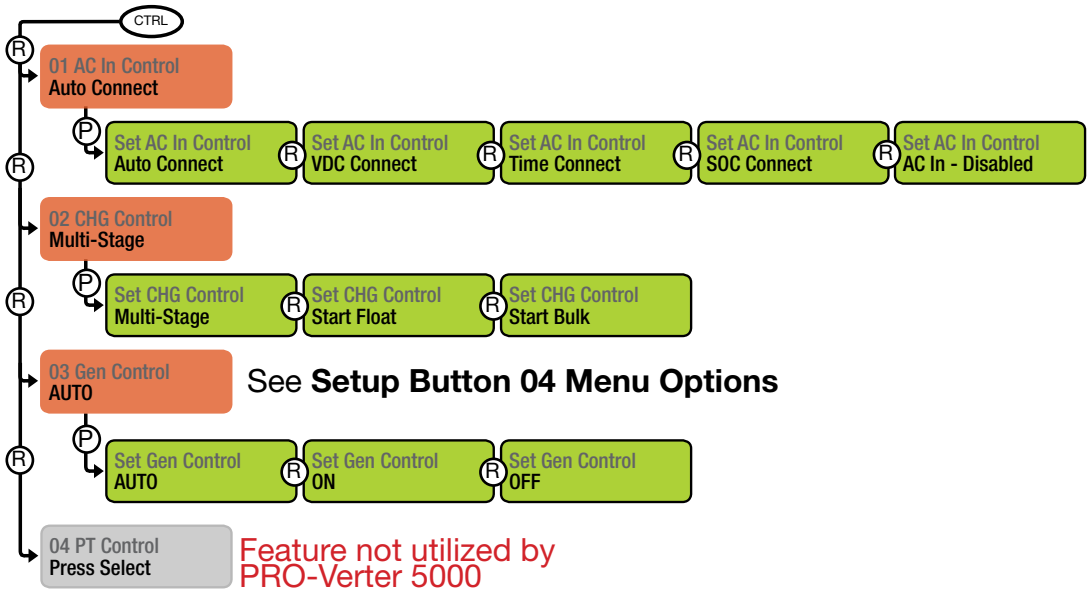
Orange menu items indicate values that are set by Solar Stik for a specific application. These values (with the exception of setting the clock to local time) should not be changed by the user without consulting tech@solarstik.com.

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



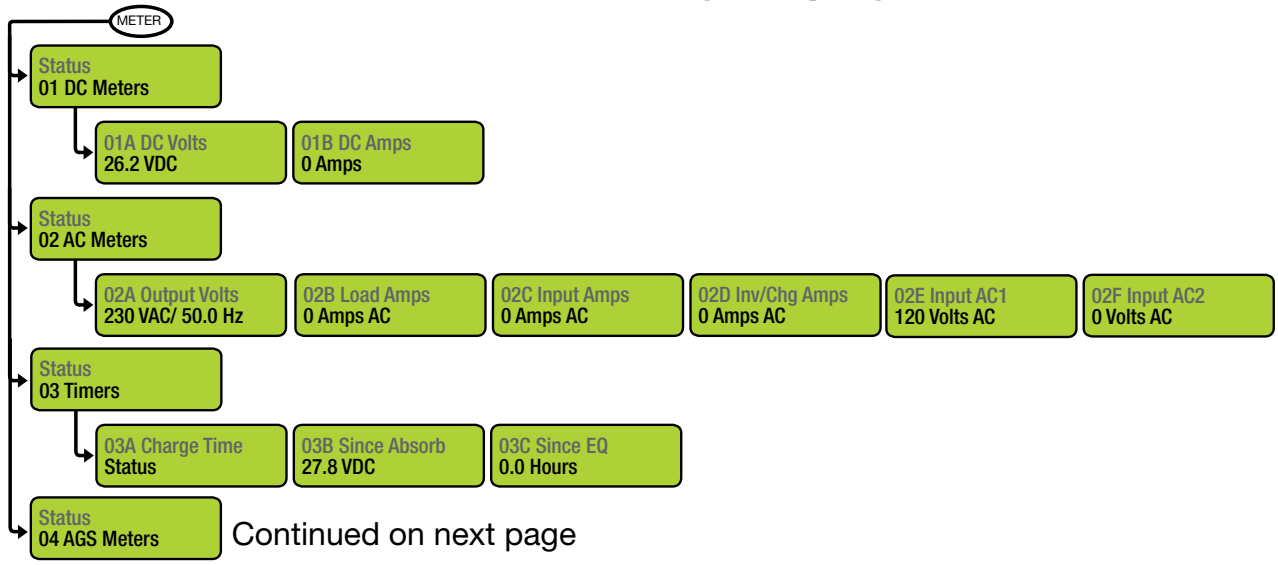
# CTRL Button Menus




See **Setup Button 04 Menu Options**

Feature not utilized by PRO-Verter 5000

# METER Button Menus: Read-only Displays

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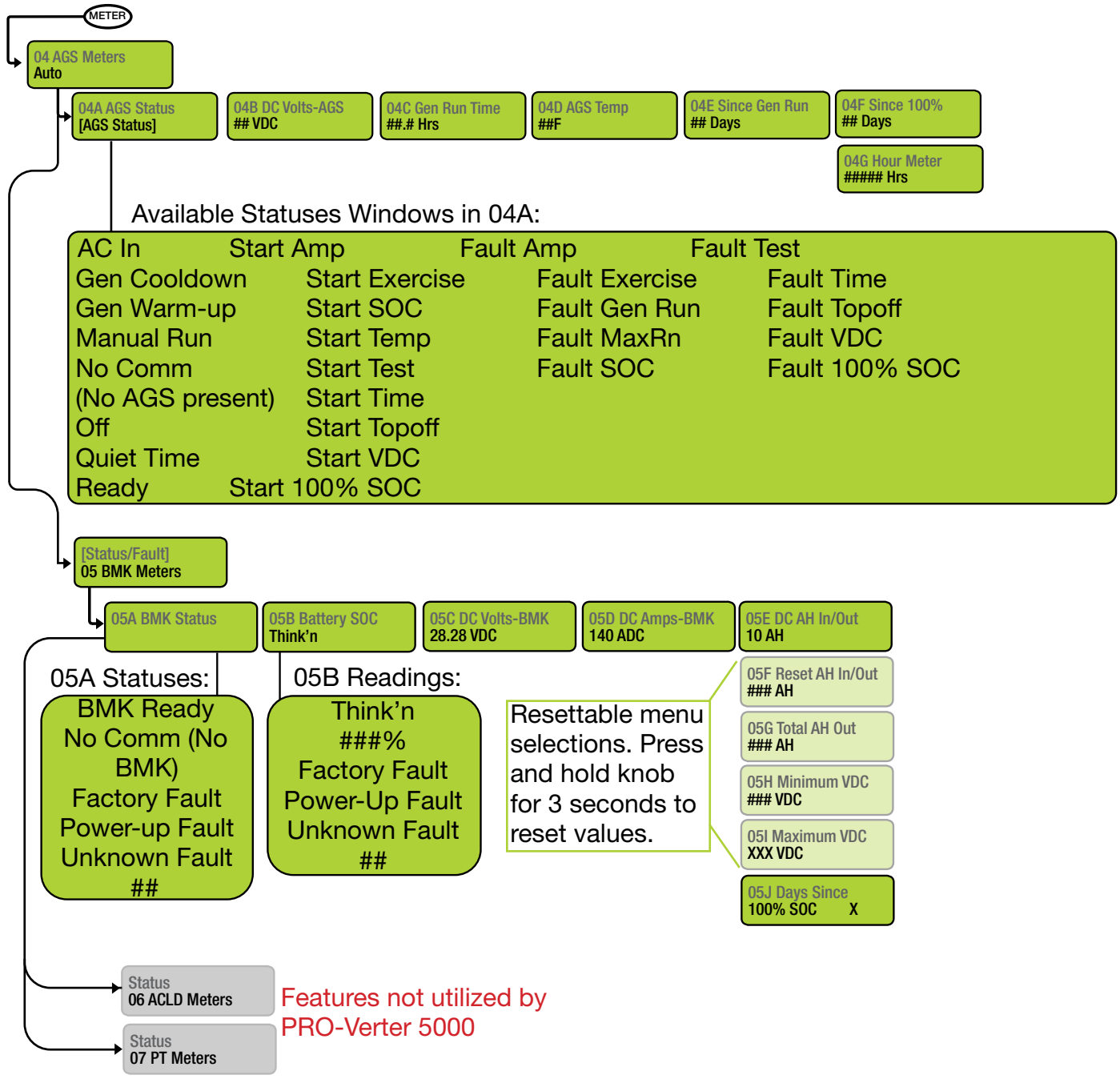
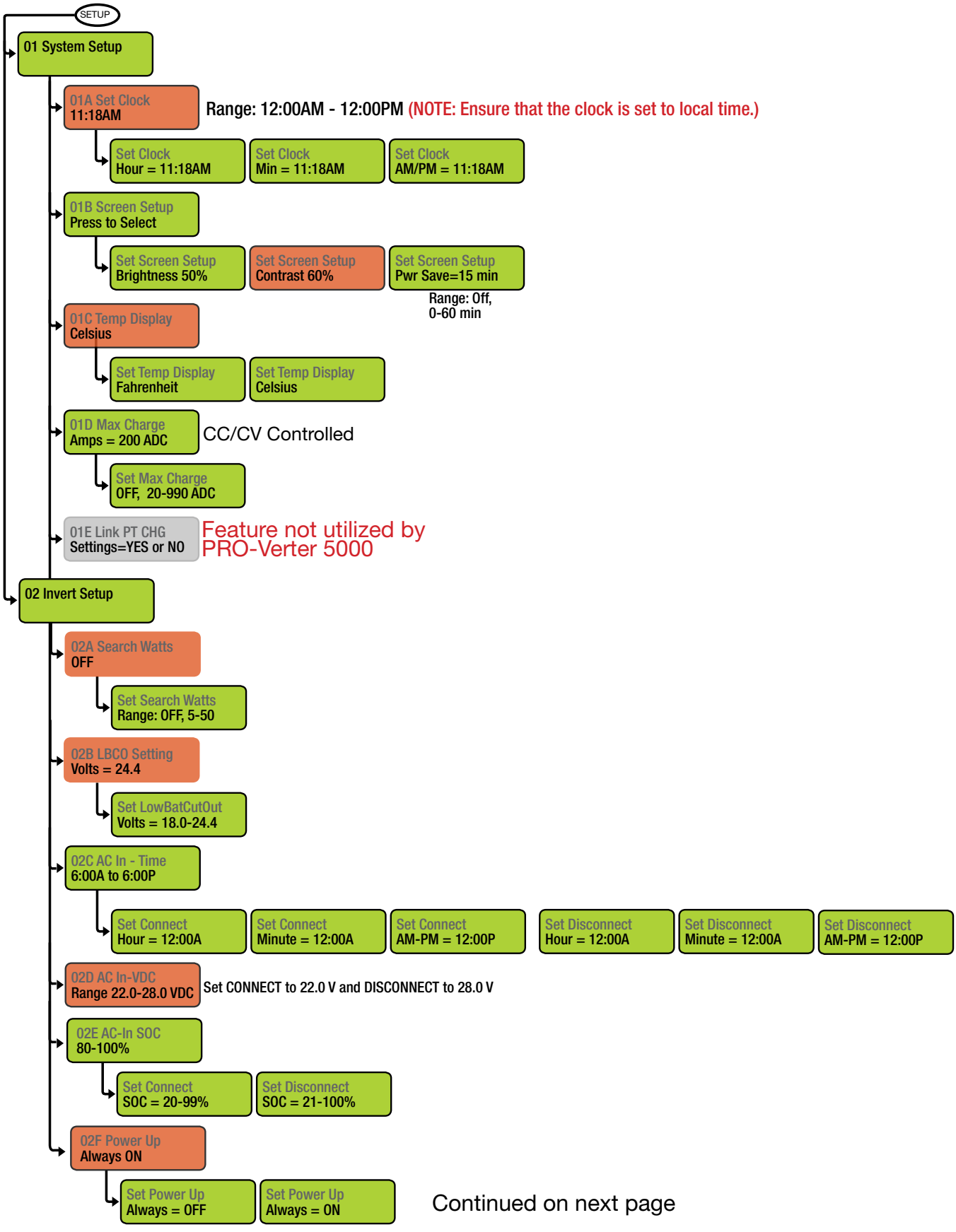
# METER Button Menus continued



# SETUP Button Menus

## Setup: 01 System & 02 Inverter Setup

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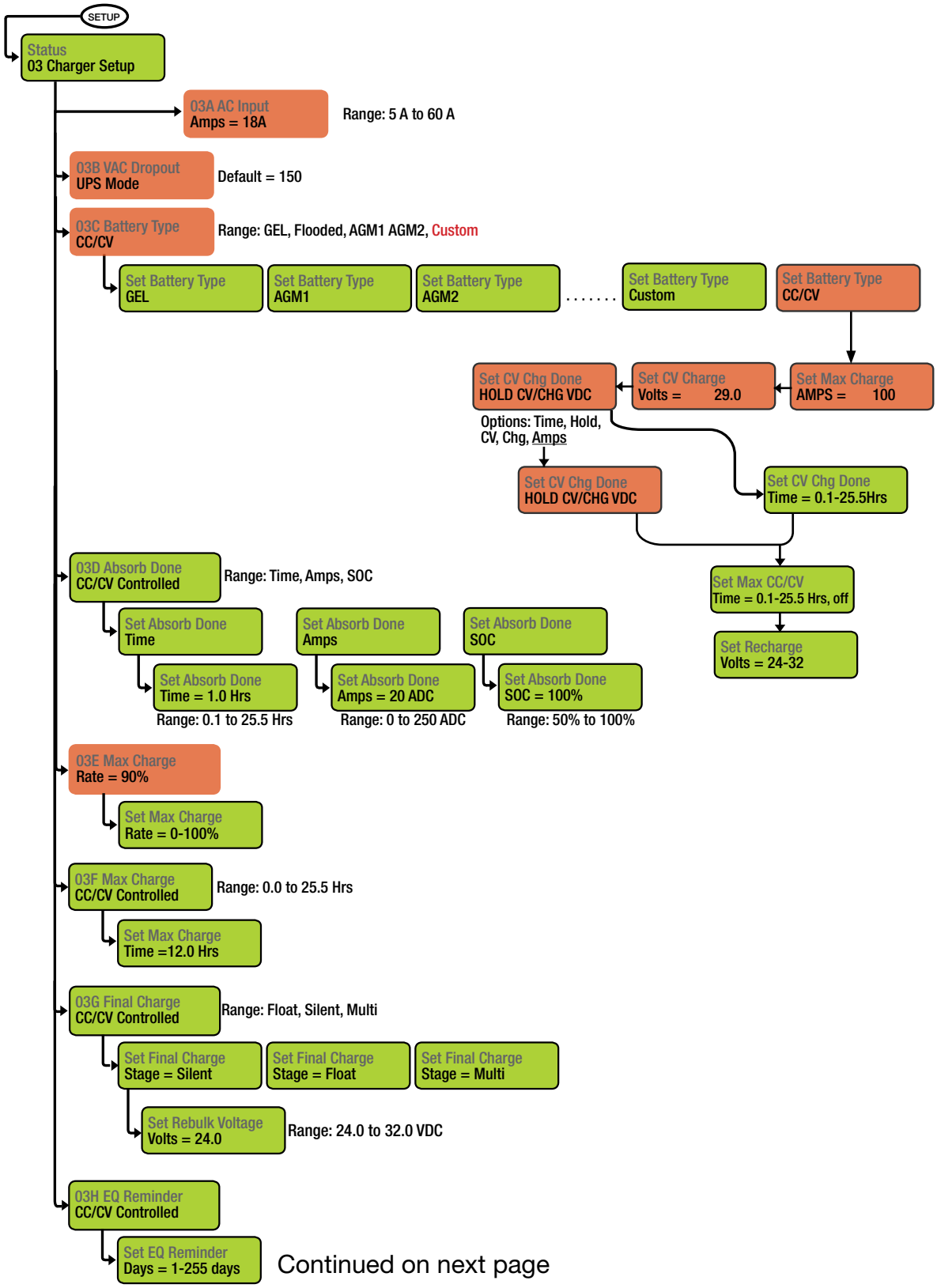
# SETUP Button Menus continued

## Setup: 03 Charger

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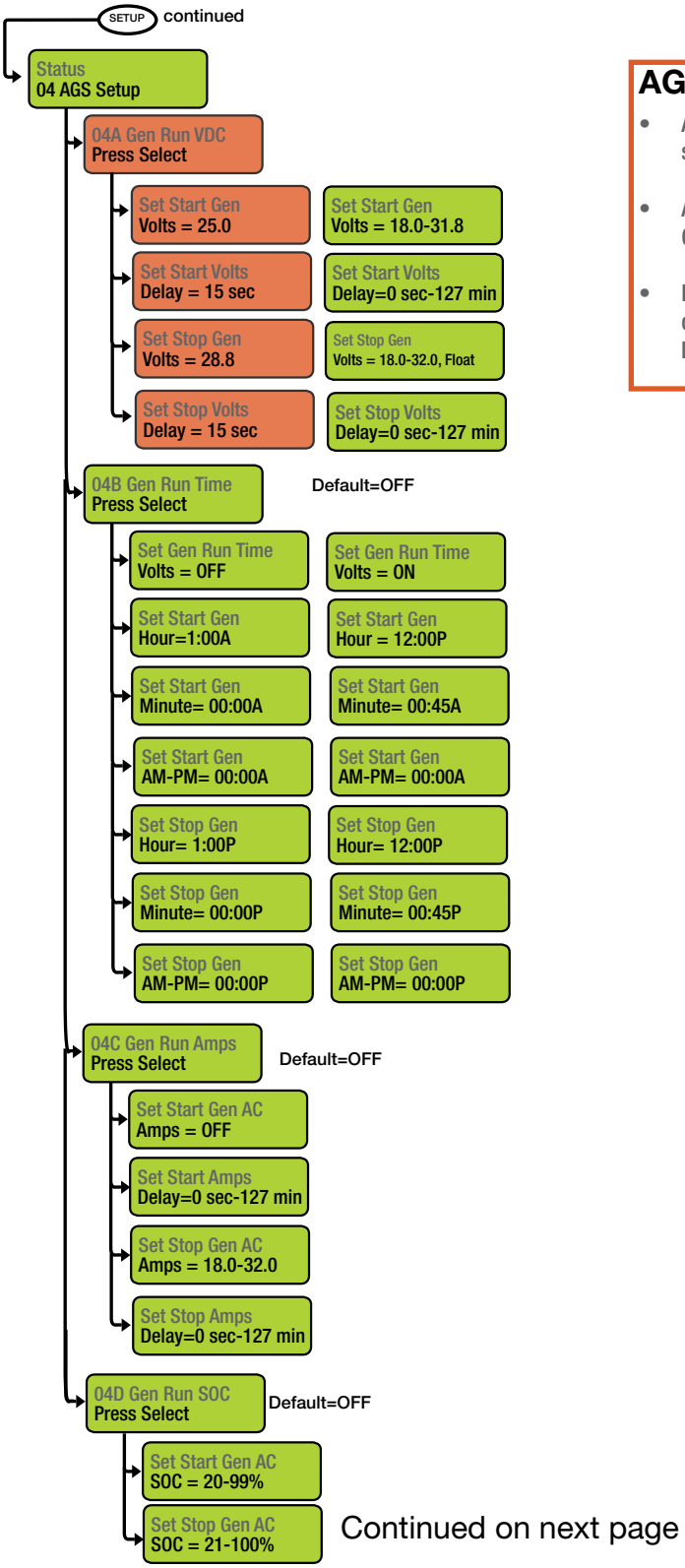
# SETUP Button Menus continued

## Setup: 04 AGS Setup

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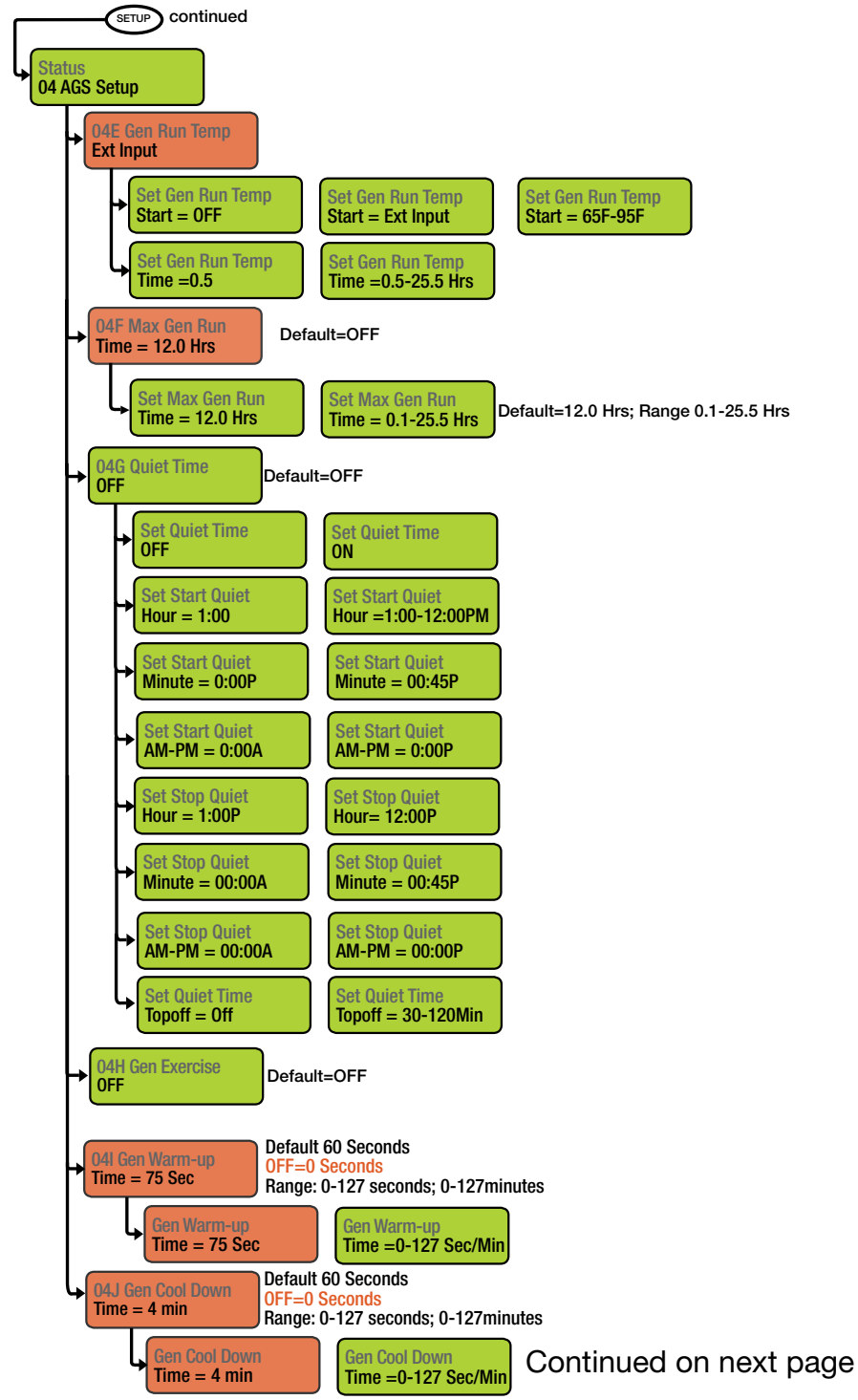
## AGS Function Notes

- After 15 seconds at or below 25.0 V, the PRO-Verter sends the start signal to the Generator.
- After 1 minute at or above 28.8, the PRO-Verter turns off the Generator.
- If the Generator does not start and the battery voltage gets down to 23.8 V (LBCO), the AC Out (Inverter) turns off. This is the LBCO voltage in the menu tree.

# SETUP Button Menus continued

## Setup: 04 AGS Setup

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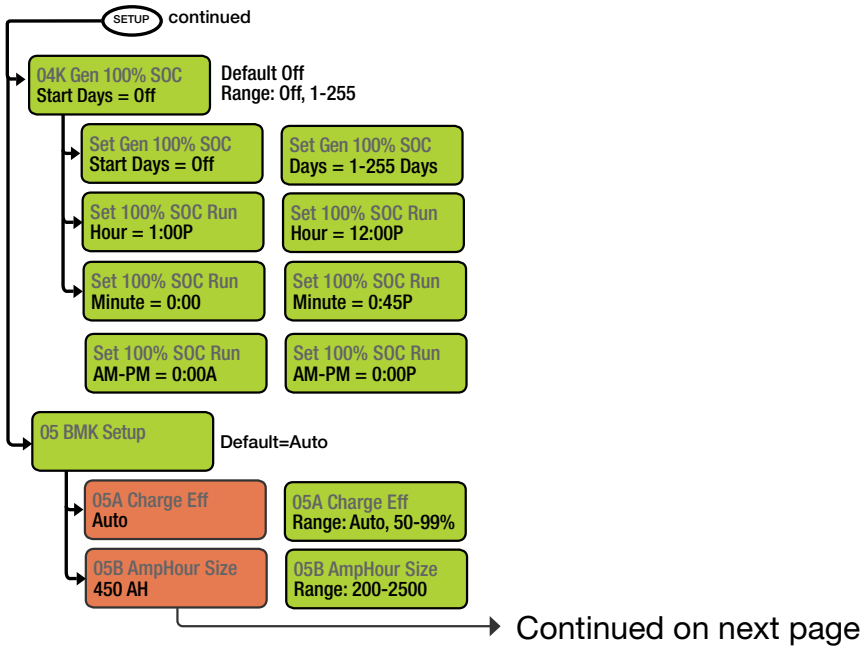
# SETUP Button Menus continued

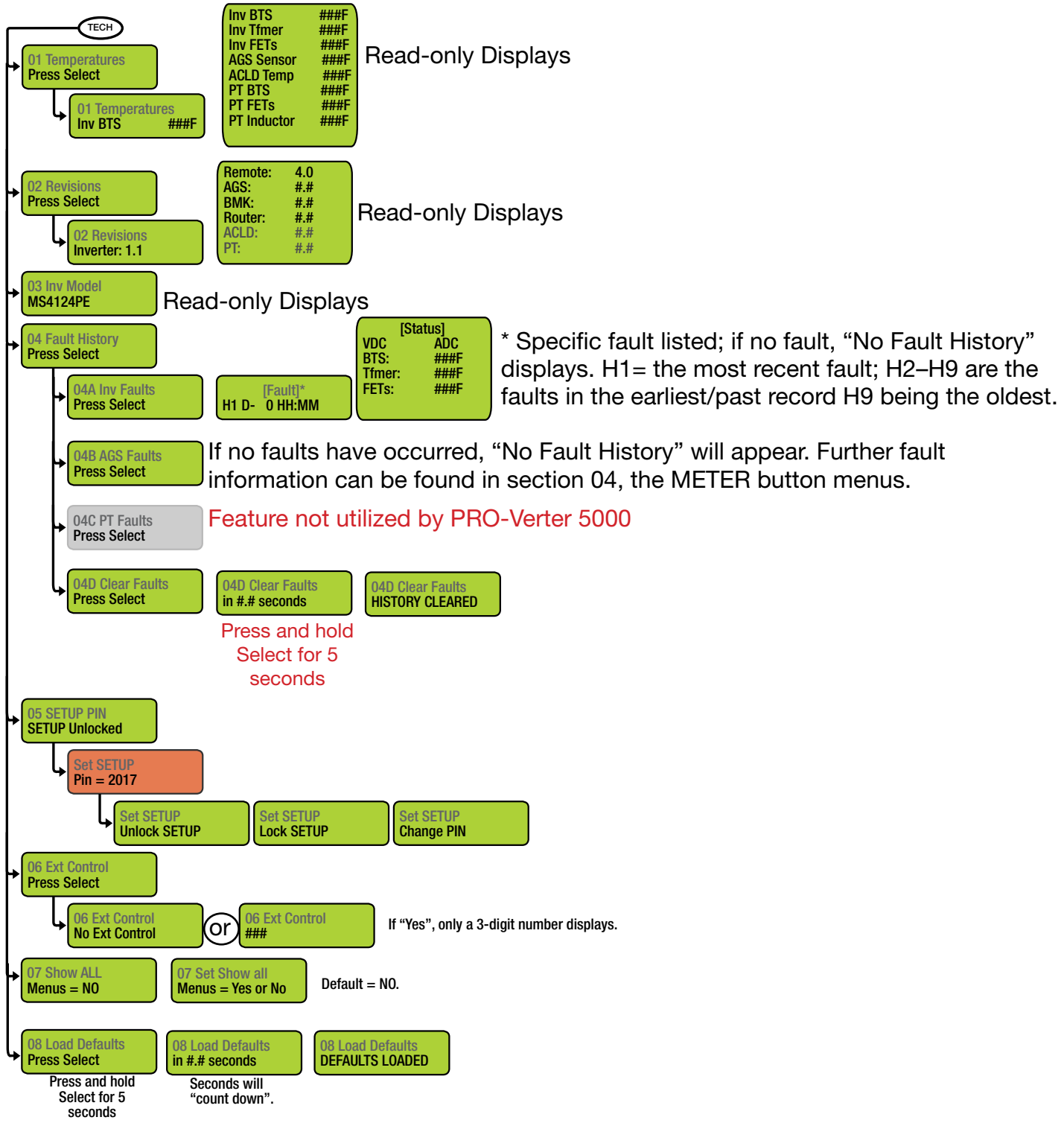
Setup: 04 AGS Setup, 05 BMK Setup




**Note:** The AmpHour Size value should be set according to the total capacity of the battery bank. For example, one 24VDC Li Expander Pak is 100 Ah. The minimum setting allowed is 200 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



# G. Power Hub User Interface Menu Operation

### How to Use the BACK, NEXT, SELECT Buttons to Navigate the Menus

- To move forward through screens in a menu, press NEXT.

  **Note:** It is only possible to move forward through the menu items.

- To move to the top of a menu, press BACK.

**Note:** Pressing BACK does not move “back” one menu screen. Instead, it moves to the top of the current menu OR to the top of the higher menus when BACK is pressed repeatedly.

- To move to the “next” menu, press and hold SELECT for 4 seconds.

See the menu structure in the Menus and Submenus section to assist in knowing when one menu ends and the next begins.

Figure 25. Back, Next, and Select buttons

- To change settings / parameters in the SETUP and BATTERY CHARGE PARAMETERS menus, move forward through the menus (using the steps above) to the menu window that contains the desired parameter. Then do the following:

  Press and hold SELECT for 4 seconds. “SETTING” blinks.
  Change the value.
  - To **increase** a value, press NEXT. (The word “Increase” is above the NEXT button on the interface.)
  - To **decrease** a value, press and hold NEXT, then press and tap or hold BACK. (The word “Decrease” is below the NEXT and BACK buttons on the interface.)

- To exit the selected menu screen, press and hold SELECT for 4 seconds.

# H. Monitoring the Charging Status on Power Hub

Table 1. Charge Status Indicator—LED Status

| Charge status LED | Charge Mode |
|---|---|
| Off | Charge Off |
| Continuously On | Bulk |
| Blinking – 1 second On / 1 second Off | Acceptance |
| Blinking – 0.2 second On / 1 second Off | Float |

**Blinking LED indicates charge control operation status**


Figure 26. Power Hub User Interface

**Bulk Charge:** During Bulk mode, the charge controller can deliver full output to recharge the Expander Paks rapidly and drive voltage up to the acceptance charge voltage setpoint. This stage typically takes the battery to about three-quarters of full charge and at a rate that usually does not exceed 25% of the battery's amp hour capacity. This is also known as the "constant current phase".

**Acceptance Charge**: In this stage, the charge current gradually decreases as the batteries obtain full charge. It is also known as the "constant voltage phase". With the Li Expander Pak 2400, the acceptance charge phase is not necessary.

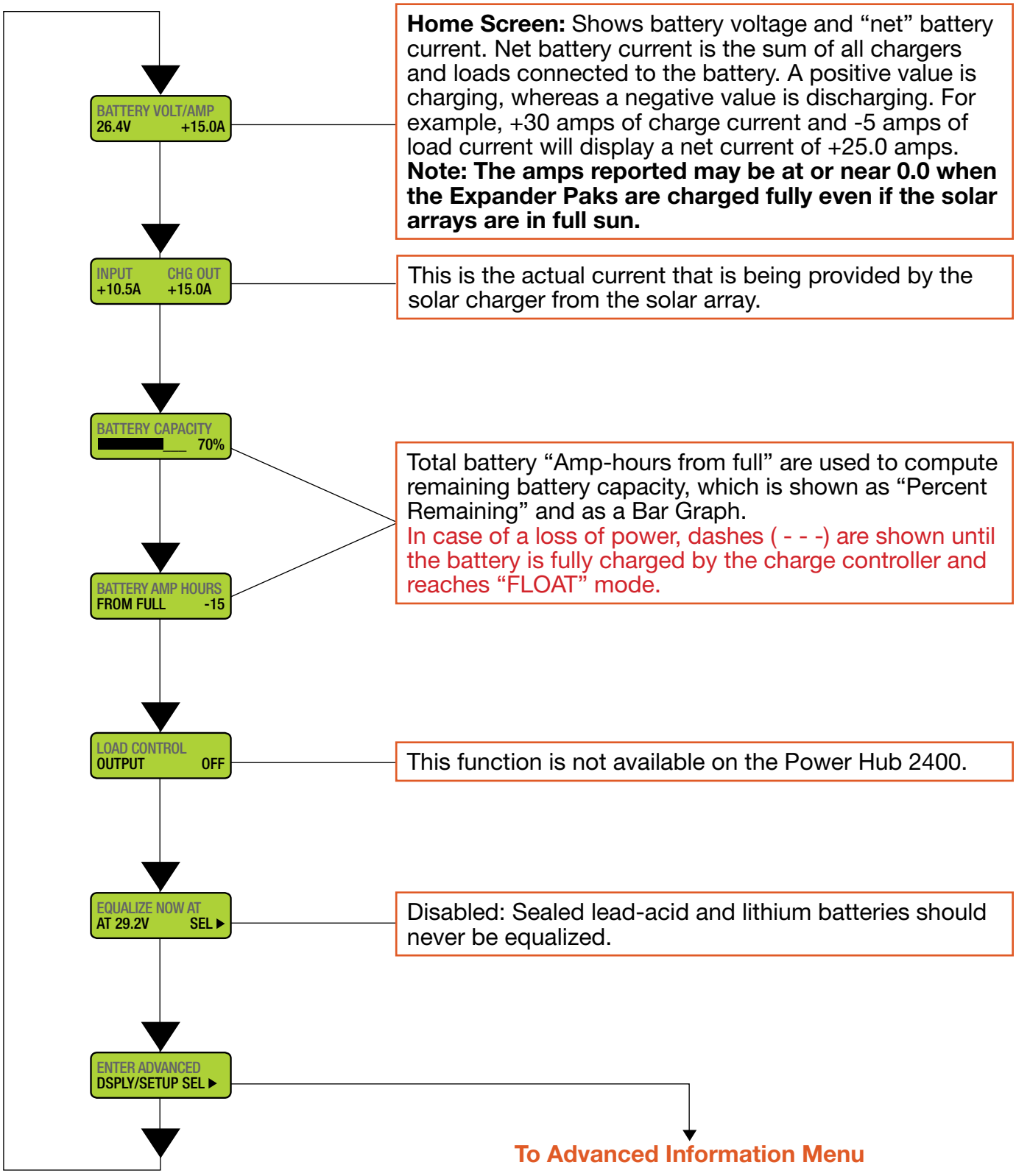
**Float Charge**: This final stage compensates for the battery's self-discharge and temperature.

**Temperature and Power Output:** The Power Hub charge controller charge controller can deliver full output in an ambient temperature of up to 40 °C (104 °F). If an overtemperature condition exists, the charge controller will cycle on/off, reducing average power delivery to within safe limits. During thermal shutdown, the charge status indicator will display an OFF condition.

# I. Power Hub User Interface Menu Windows

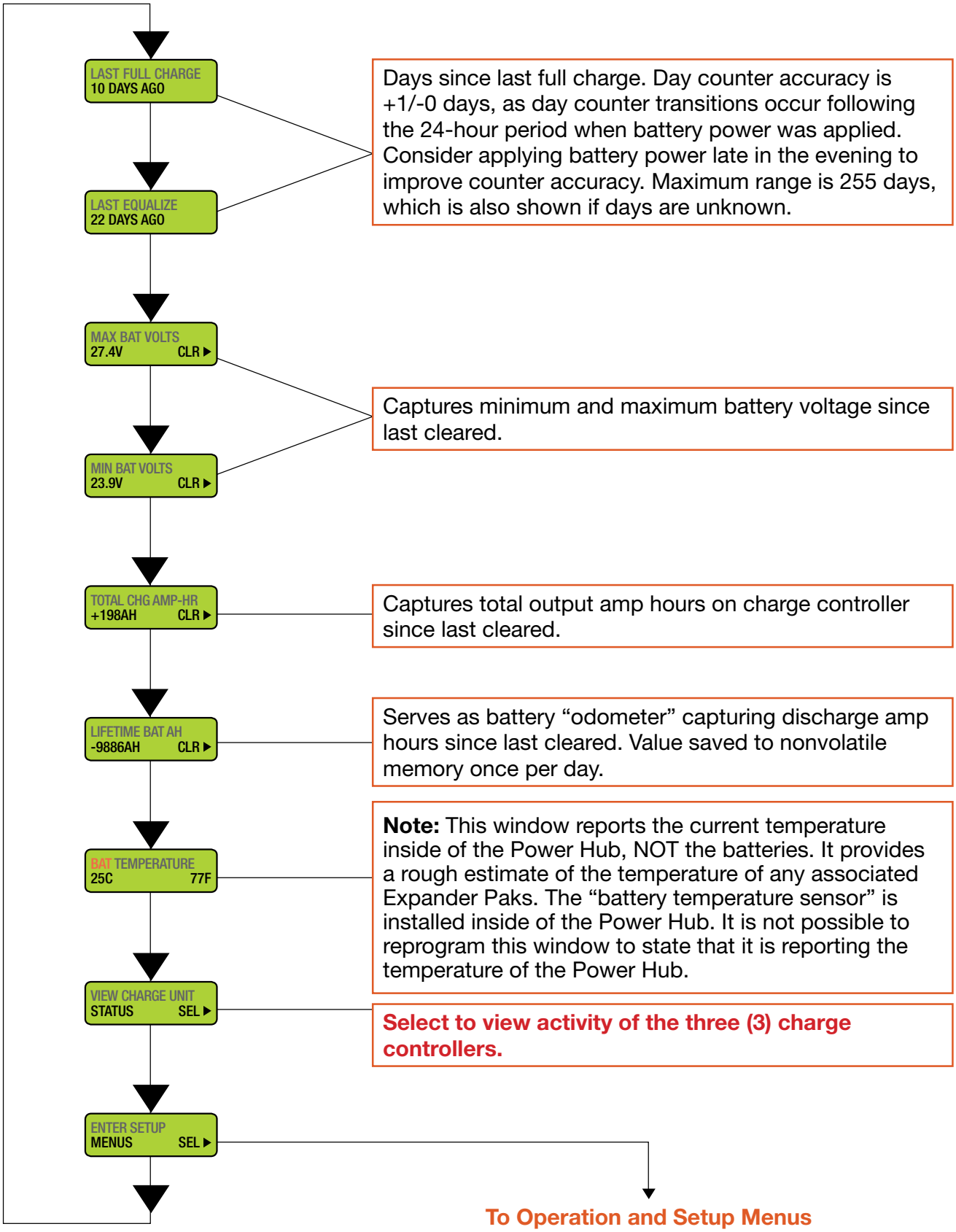
## General Information Menu

Provides basic information including battery voltage, current in and out, net current, and remaining capacity



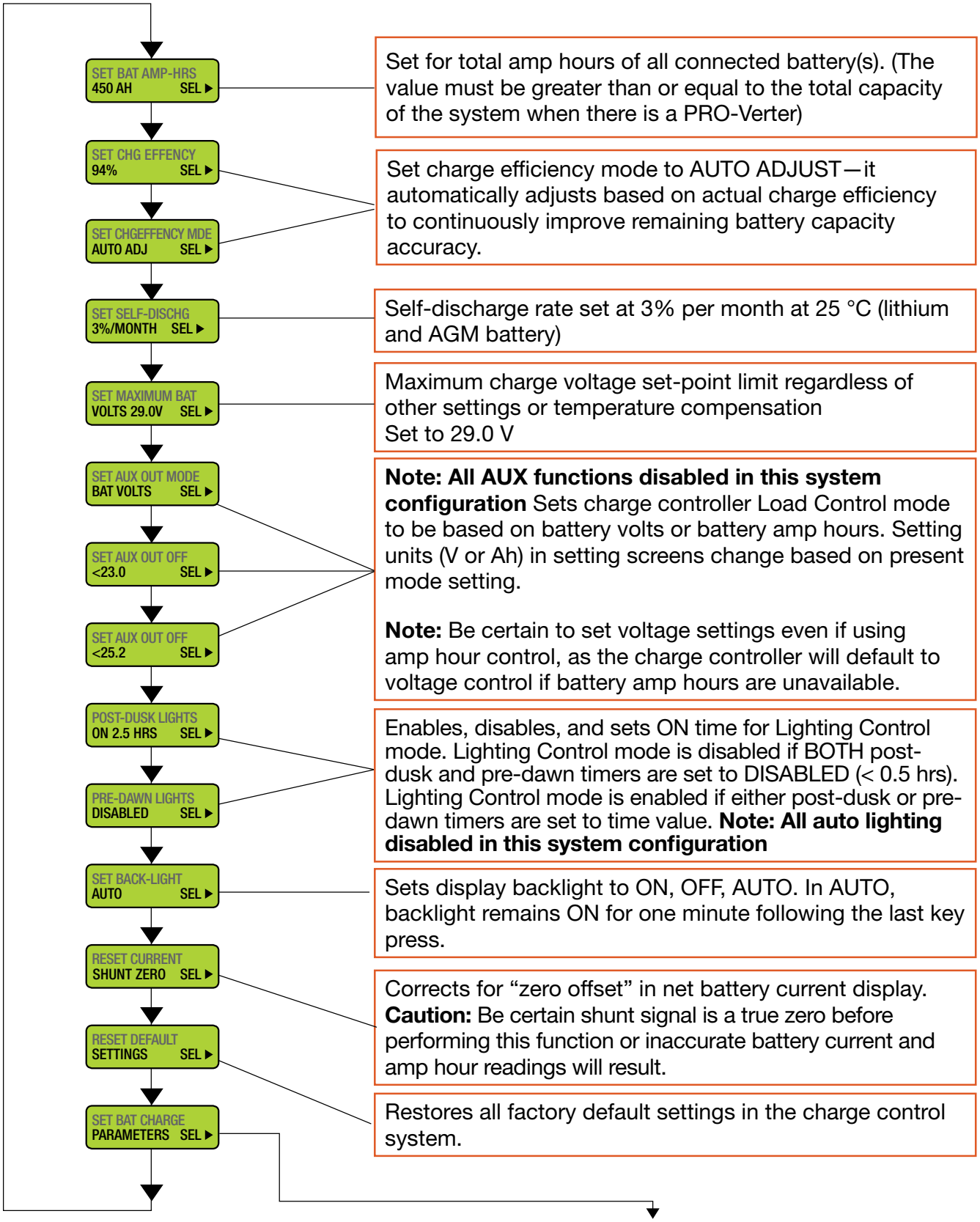
# Advanced Information Menu

Provide detailed battery information including discharge cycles, temperature, battery-event tracking information, and more



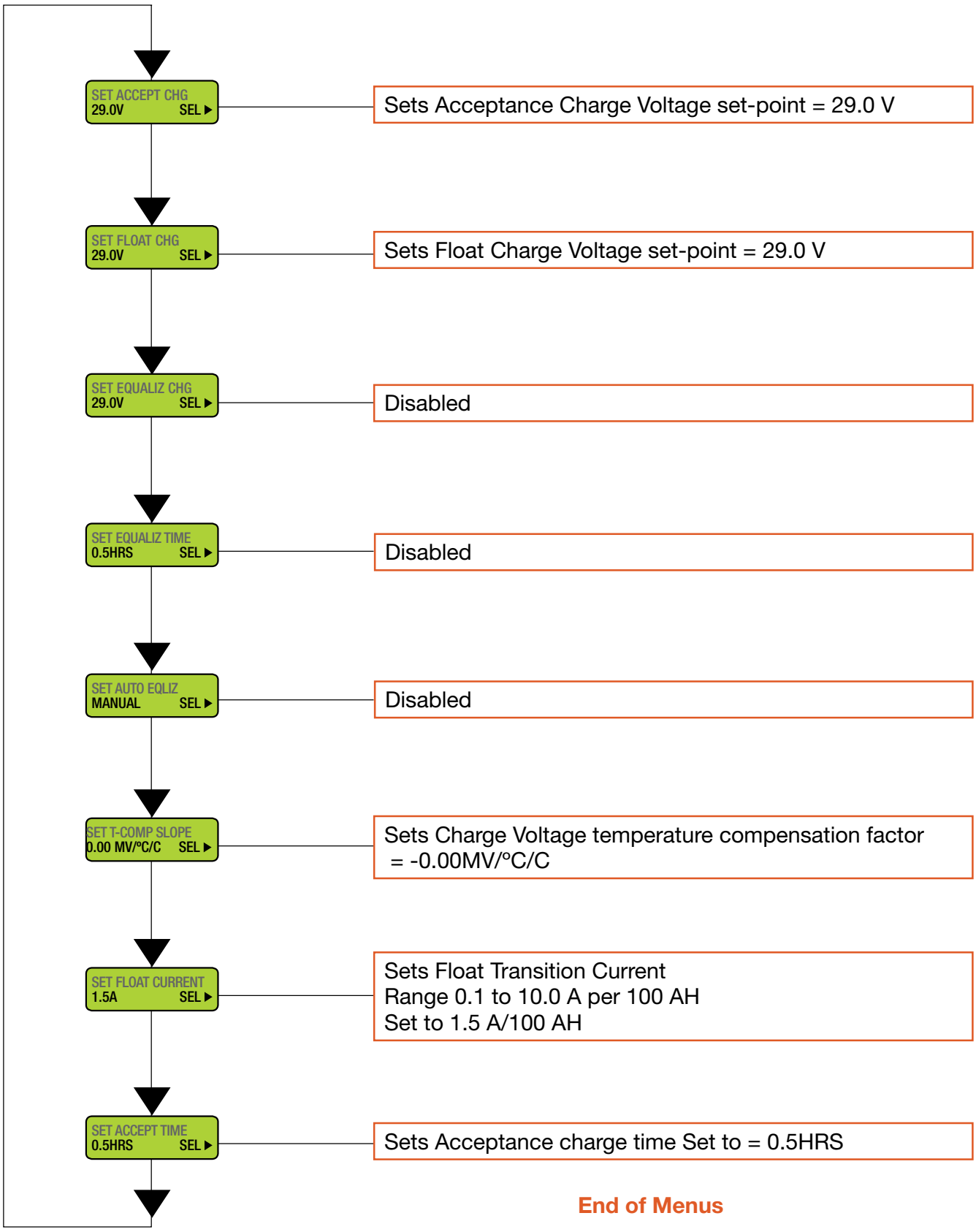
# Operation and Setup Menu

Provides operational setup and auxiliary functions



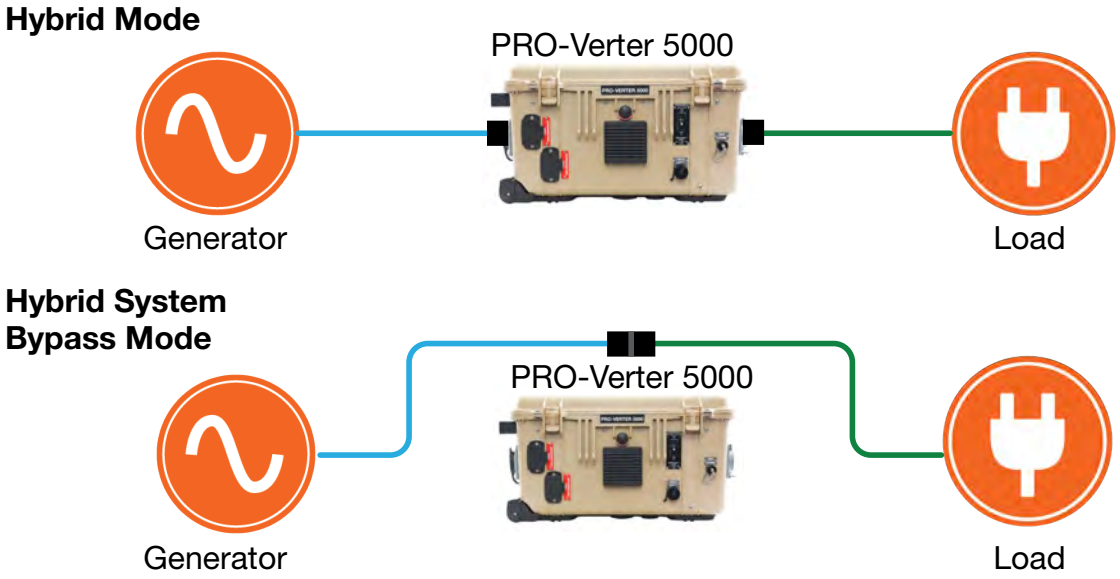
# Battery Charge Parameter Setup Menu

Provides access to battery charge parameters



# J. Hybrid System Bypass Mode

Bypassing the Hybrid Power System may be helpful if the HPS is temporarily inoperable.



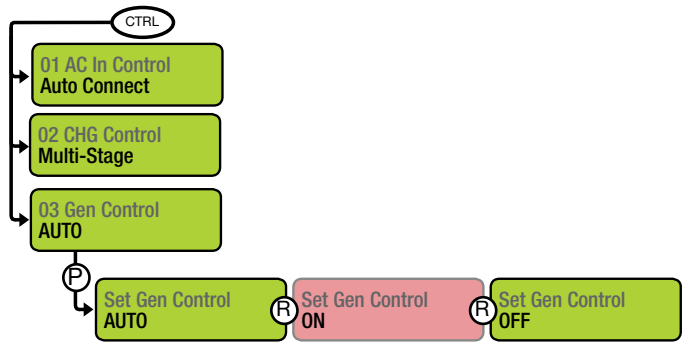

Disconnect the AC Power Cables (input–blue; output–green) from the PRO-Verter then connect and lock these two cables together.


Figure 27. Hybrid Power System bypass connection

# K. 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 completely de-energized before disconnecting components from the Inter-Connect DC or the AC circuits.

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.

# 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 2 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 2. 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 | X | | | |
| Low Battery | X | X | X | | | | |
| Tfmr Overtemp | X | | | | | | X |

# Troubleshooting

## PRO-Verter: Quick Links to Statuses, Faults, and Resolutions

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 Ready
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
PV Array Troubleshooting

# PRO-Verter Troubleshooting

## The User Interface LCD Screen

Table 3. Troubleshooting the User Interface 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. There will be a “click” 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**
This message tells indicates that 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.

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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 that the PRO-Verter is in Battery Saver mode. 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 220 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 Expander Paks.

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.

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.

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**High Battery**
The inverter has turned off because the DC bus voltage has exceeded 34 volts. 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 programmed and functioning properly. Refer to the Power Hub Operator Manual. Verify that connected batteries are all "in service" (flashing green BATTERY STATUS LED). If the batteries are all offline, perform a full System reset (see Dead Batt Charge Section above).

**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.If the fault persists after the resets are performed, it may be necessary to erase the memory as the fault may have cached into the programming. Clear the Fault History and reload the default menu programming. Consult the menu tree to reprogram the values for a particular application.

**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.

Note: 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

These tests are applicable when the PRO-Verter is connected to a fuel driven generator that has been modified with a Remote-start Enabling Kit (RsEK).

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 some wiring connections may be incorrect or compromised.

**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 L0 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.

> **Note**: see "Gen Fails to Stop" section for additional information on causes of "Max Run Fault"

## Solution

### Max Gen Run Setting

This should be set to the maximum "run time" that a can be achieved from the fuel reservoir before it is rendered "empty". For example, if a generator consumes 0.5 gallons per hour of fuel under full load, and the fuel reservoir maximum capacity is four (4) Gallons, then the MAX GEN RUN time should be set to eight (8) hours or less.

### 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, 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 (BMK) Circuit Operational Statuses

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

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

**The following "SOC" statuses indicate the battery's current state of charge (SOC). Access the METER: 05B Battery SOC menu to view the Battery Monitor'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 batteries are fully charged; the display has changed from "Think'n" to "100%" and is ready to provide accurate SOC percentage values.

# Resolving BMK Faults Using the LCD User Interface

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

**Factory Fault**
The Battery Monitor has lost its factory-set internal calibration reference.

**Solution:** Reset the Battery Monitor by removing all power from the PRO-Verter. If the fault remains or returns after resetting, the unit may require repair. Contact your Field Service Representative.

**Unknown Fault ##**
This fault message displays when the Battery Monitor has sent a fault code that is not recognized by the user interface.

**Solution:** Contact your Field Service Representative

**Power-up Fault**
The Battery Monitor power-up sequence failed.

**Solution:** Restart the PRO-Verter.

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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.

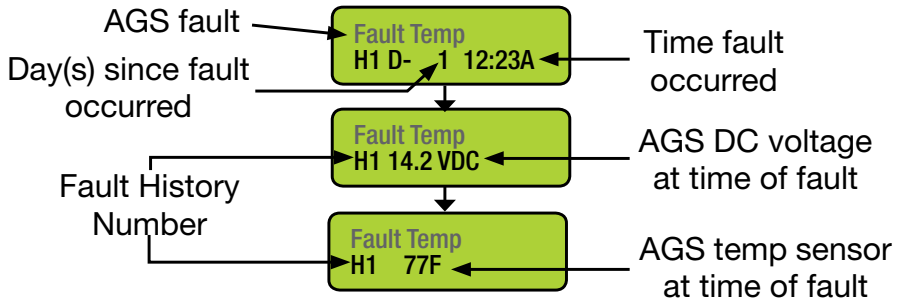
**04B AGS Faults**
This menu displays a history of the last nine AGS faults. Information for each fault displays from the most recent fault (H1) to the earliest/past recorded faults (H2 up to H9).

> **Note**: The 04D Clear Faults menu allows all recorded fault history information 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.

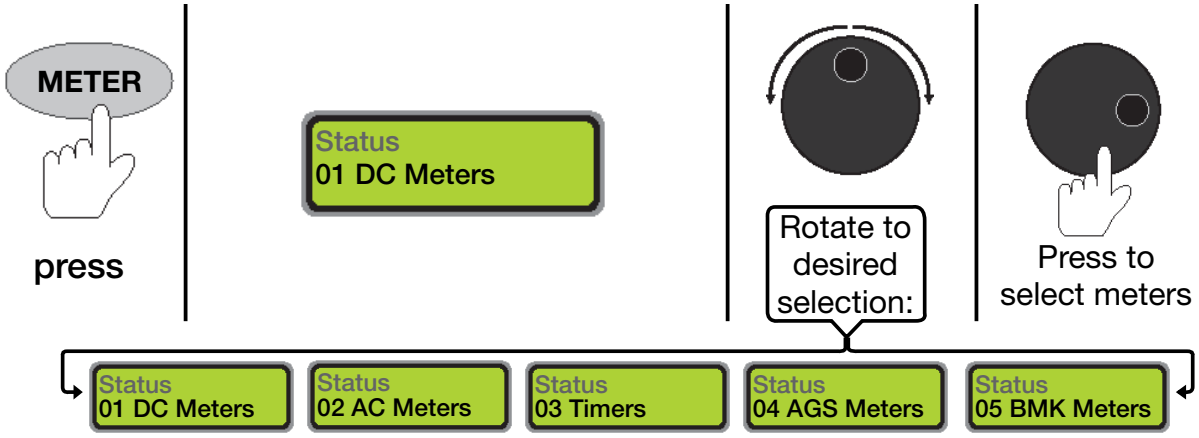
TECH: 04 Fault History
Press the SELECT knob, rotate the knob until the 04B AGS Faults menu displays, and then press the SELECT knob.



# 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; Meter 04) Data

**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.

**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.

# 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 PRO-Verter 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 PRO-Verter 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 Inter-Connect bus. 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 PRO-Verter. 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 PRO-Verter is disconnected from power, the AH In/Out value resets to zero.

**Reset AH 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 PRO-Verter is disconnected from power.

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**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 a check of the charging system (battery charger, charge controller, etc.) 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.

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# Power Hub–related Troubleshooting

## Power Hub Will Not Power Up

If the Power Hub 2400 is not powered up, it probably is not connected to an active 24 VDC battery and/or there is no PV input. The LCD user interface will power up and be navigable when connected to either of these power sources. Power from PV arrays will charge batteries once the voltage from the arrays is 5 volts greater than the battery voltage then continue charging as long as the voltage from the PV arrays is one (1) volt higher than that of the batteries.

## Performance Issues, Causes and Solutions

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

| Symptom | Possible Cause(s) | Solution |
|---|---|---|
| Battery SOC displays “--”. | Battery not fully charged for an extended period or has not been cycled enough times for the user interface to calculate SOC. | Try to charge the battery fully often. Refer to the setup diagram to make sure that the System is assembled correctly. |
| Battery SOC seems inaccurate | Power Hub is not the primary power management device. | Normal operation. Read battery SOC from primary management device (e.g., PRO-Verter) or 24VDC Expander Pak 1000s |
| Not registering charge current with panels operating in sun | 1. Power Hub overheated<br><br>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 °F; diminishing power as temp increases. Check for dirty, blocked air filters. Shade the Power Hub to reduce solar loading. Ensure that the internal cooling fans are operating (audible when operating)<br><br>2. Normal operation. |
| LCD inoperative | 1. No power to the Hub<br><br>2. The LCD screen is overheated/sunlight exposure | 1. Check connections and make sure batteries are active.<br><br>2. Close lid and allow Power Hub to cool down. |

**Note:** The battery SOC and related readouts on the Power Hub 2400 LCD user interface are precise ONLY if the batteries are connected directly to the Power Hub 2400. If the batteries are connected to the PRO-Verter (indirectly to the Power Hub 2500), then information about the battery SOC and other parameters should be obtained from the PRO-Verter user interface or the optional RMK.

# PV Array–related Troubleshooting

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

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

## No Power from the PV Array

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

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

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

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

## Lower Than Expected Voltage from the PV Array

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

**Step 2.** Measure PV array $V_{oc}$ at pins A and C of the bayonet connector of the Solar Cable.
a. If the PV array $V_{oc}$ at pins A and C of the bayonet connector of the Solar Cable is within acceptable limits, the PV array is operating normally. See PAM 420W Array PMCS for details. Contact the Field Service Representative for further assistance.
b. If $V_{oc}$ measured at pins A and C of the bayonet connector is below ~30 V*, go to step 3.

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

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

***This value will vary depending on weather/environmental conditions (i.e., lower if overcast).**

# Li Expander Pak–related Troubleshooting

**It is most important to maintain Li Expander Paks in such a way that they will never reach 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. Consult the Expander Pak Operator Manual to resolve the issue.


Figure 28. 24VDC Li Expander Pak 2400

Table 5. Battery Status LED Color and Corresponding Condition

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

## Expander Pak Circuit Breakers Tripping

**Cause**
The batteries have varying states of charge possibly because the initialization and calibration steps were omitted or battery SOC parity was lost due to improper cycling.

**Solution**
Charge the hybrid system's bank of batteries fully to equalize the states of charge among the Expander Paks (see: SOC Disparity Among Expander Paks).

# Generator-related Troubleshooting

**Please consult OEM Generator Technical Manuals for in depth genset troubleshooting information**

## Testing the AGS Function

Push the red AGS Test button at the AGS interface to confirm all wiring from the generator to the AGS module is correct and the AGS circuit is configured correctly for a particular generator. When pressed, the Status LED on the AGS module will begin to blink green and the generator should start (a blinking green Status LED means the AGS has initiated an automatic generator start/stop sequence).

Once the generator starts, view the Status LED and ensure it turns solid green (a solid green Status LED means the generator has started successfully and is providing the Gen Run sense signal to the AGS module). It should run for approximately 30–60 seconds before automatically turning off.

## 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
- Fuel line valve turned off

**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
5. Turn on fuel line valve (should be vertical for ON)

# Generator Starts, Then Shuts Down When Load Is Transferred

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

**Solution**
Gen warm-up and cool down 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 frequent start/stop

**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 values appropriate for the System.
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 Stop

See also: Max Gen Run fault

**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
- AC load is too high - not enough power available from generator to support both charging and load support functions.

**Solution**
1. Verify CHARGER LED is illuminated (not blinking)
2. Reduce AC loads
3. Ensure the Gen Run VDC is set properly (SETUP: 04A)
4. AC INPUT (FAVS 4) setting too low
5. CHARGE RATE (FAVS 5) setting too low
6. Battery capacity (FAVS 2) too large
7. Charger programming not compatible with the battery type
8. Battery Temp sensor reading high temp (clean air filters)

# RMK-related Troubleshooting

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

**Cause**
Power failure or RMK malfunction

**Solution**
1. With the PRO-Verter on, measure voltage at the RMK power source (see PRO-Verter 5000 Operator Manual) and at an Inter-Connect port on the PRO-Verter.

    a. 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 from the PRO-Verter and remove the RMK circuit board from its enclosure. **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. Reconnect the RMK to the PRO-Verter.

## Cannot Communicate with RMK

**Conditions Observed or Possible Causes or Inability to 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 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 your Field Service Representative for assistance with purging log files.

# Heat and System 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 exceeds the upper end of that range. Solar panel output drops off significantly in high heat as well. The Power Hub, PRO-Verter and Expander Paks generate heat as a by-product of their normal function. Under normal circumstances, the amount of heat generated in this way will not exceed the rated temperature of these components to function at their rated capacity.

## Causes of Overheating

The two (2) most common reasons for overheating are **high ambient temperature** and **solar loading** (heat accumulation due to the sun shining directly the a component). These two factors work together to elevate the internal operating temperature to the point where the internal subcomponents of the PRO-Verter, Power Hub and Expander Paks may automatically derate or even temporarily suspend operation to prevent damage to their internal electronics. The solar chargers in the Power Hub are rated to operate normally up to 104 ºF (40 ºC), the PRO-Verter up to 140 ºF (60 ºC) and the Expander Pak up to 149 ºF (65 ºC)  Performance of the each of these components will decline as the temperature increases or is sustained above this value.

## Keep the System Cool

Thermostat-controlled, internal, cooling fans in the Power Hub and PRO-Verter turn on to maintain the internal temperature within the optimal operating range. The fans are audible when operating. Clogged air intake filters can significantly exacerbate heat-related problems, so they should be cleaned as often as necessary to maintain maximum airflow. Clean or replace the air filter monthly, or more frequently if operating in very dusty environments. Do not operate the Power Hub in direct sunlight or directly on the ground. It should be placed in a shaded, well-ventilated location. Proper air filter maintenance and shading the Power Hub will help to ensure the internal temperature does not reach critical levels. Expander Paks do not have cooling fans and vents making it even more important to keep them shaded to reduce solar loading.

## 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.

# Power Hub Temperature Reports

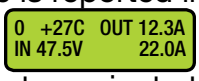
The first indication of overheating may be the appearance that the solar arrays are “not producing any power” when they should be. If this is the case, check the temperature.

**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.**

# PRO-Verter Temperature Reports

The PRO-Verter user interface reports a range of temperatures in the first submenu after pushing the TECH button. Like the Power Hub, the battery temperature sensor (BTS) is inside the PRO-Verter case and not in the batteries.

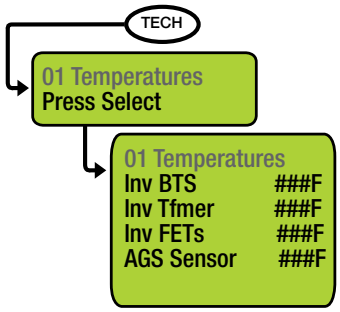


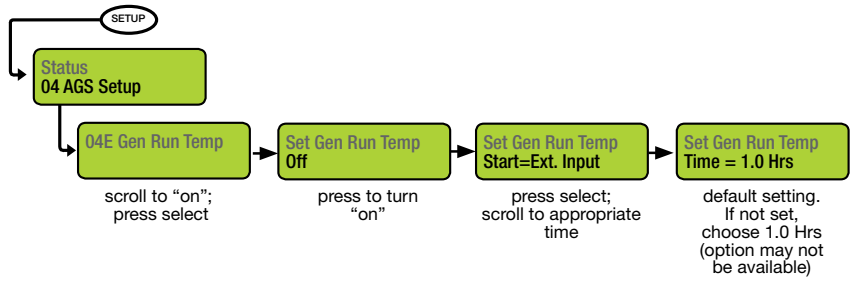

Figure 29. PRO-Verter temperature reports from the user interface

# PRO-Verter High-temp Generator Auto-Start

When a heavy load (≥100% rated output) is placed on the PRO-Verter while inverting, the internal transformer temperature will rise in accordance with the amount of power it is processing. If the internal “Transformer Temperature” reaches or exceeds 221 ºF (105 ºC) the PRO-Verter will automatically start a connected generator to assume the load. This protects the PRO-Verter from damage and/or going into FAULT mode and provides continuity of operations during peak demand.

This feature has been programmed at the factory and requires no programming by the operator other than the duration of the generator run time (based on the generator fuel tank volume), if the time needed is different than what is pre-programmed.

Should the PRO-Verter go into fault mode (Overtemp or TmfrOvertemp) during peak demand, ensure that the AGS is set to Auto (FAVS 5 Menu) and that Set Gen Run Temp is set to “1.0 Hrs” (If this option is available) by following the Menu Map below:




**Note**: Do not change Max Gen Run Time in section 04F of the Menu. This should remain at 12 hours.

# Charger Mode: PRO-Verter High-temp Protection

The PRO-Verter is equipped with a function that will temporarily reduce the amount of current that passes to the batteries should the internal “Transformer Temperature” reach or exceed a preset value during the charging process. When this is occurring, the LED charge light will blink while charging continues at a decreased rate. After the transformer cools to a temperature below the preset value, the LED will stop blinking and remain on constantly and full-capacity charging will resume.

# MAINTENANCE INSTRUCTIONS

## HPS Preventive Care and Maintenance

Follow these procedures to maintain the System.

- **Shade the components (except the PV arrays) from direct sun exposure and shelter them from the elements.**
- Follow the Expander Pak preventive maintenance checks and services listed in the Expander Pak Operator Manual.
- Clean air filters of the PRO-Verter and Power Hub air intake vents once a month or more frequently as warranted to minimize the accumulation of internal heat. See the component manual for air filter cleaning instructions.
- 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 PV arrays are clean and positioned for maximum daily sunlight exposure.
- Ensure the Solar Cables are secured.
- Check the integrity of electrical connectors and communication contacts on a monthly basis.
- Turn off electrical appliances when they are not in use to save power and allow more power to be available when needed.

# Water Intrusion—Prevention and Remediation

**⚠ WARNING**

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

- Lids on the Power Hub 2500 and the PRO-Verter should be closed whenever possible while the System is operating to prevent water and dust from entering the System.

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

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



### Inter-Connect Strips and Water Intrusion

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

# 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 30. Lock Securing the Lid of the Power Hub 2400

# SOC Disparity Among Expander Paks

When cycling multiple batteries in a bank, it is possible to see the states of charge (SOC) lose parity between them due to the following reasons:

- **High-cycling** – fast charge and discharge rates with an inadequate battery bank (more than 2 cycles per day) will cause some batteries to work harder than others, creating disparity in their individual SOCs.
- **Short-cycling** – the PRO-Verter's AGS is set to control the generator by either TIMED or MANUAL programming rather than the AUTO (Volts or SOC) mode. If the operator or the TIME/MANUAL AGS function turns the generator off before 100% SOC is reached, then it is likely that not all of the batteries on the bus achieved the same SOC. Repetitive cycles in this manner will cause the batteries' SOC to drift apart over time.
- **Solar loading** – Expander Paks exposed to direct sun will be hotter and will discharge more rapidly than Expander Paks that are shaded and cooler.

Expander Pak SOC disparities may cause erratic System behavior including:

- Premature termination of the AGS functions, or generator "short-cycling" (frequent start / stop)
- Expander Pak Circuit breaker tripping
- System crashes

Expander Paks will maintain parity close to 100% SOC on a regular basis if the PRO-Verter AGS is in AUTO mode using VOLTS to start/stop the generator.

## Restoring SOC Parity

The only method of restoring parity between multiple batteries on a DC bus with varying SOCs is to manually perform a dedicated charge cycle using a reduced charge rate and the highest allowable charging voltage applied over a period of time. Once the batteries have all reached their peak voltage, the charging amperage should taper off to single digits, and the operator can have confidence that the batteries are actually all at 100% SOC. Normal cycling can then commence.

**Method to Restore Expander Pak SOC Parity**

1. Press SETUP on the PRO-Verter user interface (pass code may be required).
2. Scroll to 03 Charger Setup, press SELECT,
3. Scroll to 03E MAX Charge, press SELECT,
4. Reduce the charge rate to 40%, press SELECT.
5. Press CTRL and scroll to 03 Gen Control, press SELECT.
6. Scroll to Set Gen Control ON, press SELECT.
7. The "Remote Generator Start and Operation" sequence will begin (total process may take 3 minutes).
8. Charge the Expander Paks until the PRO-Verter user interface home screen reports 29.0 V and the charging current has decreased to and stabilized at 5 to 10 A.
9. Set Gen Control to AUTO.

This slow charge protocol will equalize Expander Pak SOCs, eliminate the erratic System behavior and restore normal cycling of the HPS.

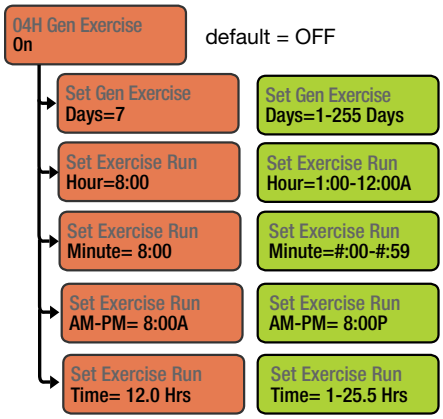
# Maintaining SOC Parity

The PRO-Verter has two programmable “maintenance” functions in the AGS menus that can be used to maintain battery SOC parity correct: Gen Exercise and Gen 100% SOC

## Method to Maintain Expander Pak SOC Parity using Gen Exercise

The Gen Exercise function will periodically start and run the generator to maintain the generator starter battery and lubricate internal parts of the generator on a regular basis. If run regularly and for long enough, Gen Exercise can also maintain an equivalent SOC among batteries in a bank.

Gen Exercise is in the Setup Menus. The example below shows the programming values for running the exercise once a week starting at 8:00 AM for 12 hours.



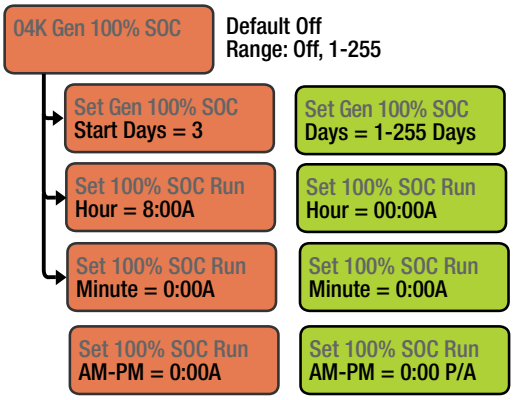

1. Press the SETUP Button on the PRO-Verter user interface (password may be required).
2. Navigate to 04H Gen Exercise. Press SELECT to enter this menu.
3. Enter and save the values best suited for your application into each of the fields. Start with the frequency (e.g., every seven days) and duration (e.g., 12 hours) as shown.
4. Confirm that the SOC of the System battery bank reported in METER 05B is 100%.
5. If the Expander Paks do not reach 100% SOC during the 12 hour period, increase the Gen Exercise the time until they do.

**Note:**

- Ensure that the System clock is set to local time.
- Ensure that the Max Gen Run Time (SETUP 04F) is greater than or equal to the duration of the Gen Exercise.

### Method to Maintain Expander Pak SOC Parity using Gen 100% SOC

The feature “Gen 100% SOC” is designed specifically for the purpose of equalizing the SOC of all Expander Paks in an HPS to 100%. After the SOC of the bank has been below 100% for a programmable number of days (three in the example below), the PRO-Verter will start and run the generator until the bank is at 100% SOC. The time of day for this protocol to begin must also be set (see below). The length of time require to restore the bank to 100% will depend on the degree to which the bank of Expander Paks are discharged and the magnitude of the SOC difference when Gen 100% SOC starts.




1. Press the SETUP Button on the PRO-Verter user interface (password may be required).
2. Navigate to 04K Gen 100% SOC. Press SELECT to enter this menu.
3. Enter and save the values best suited for your application into each of the fields. Start with the frequency (e.g., every 3 days) as shown and at an appropriate time of day.
4. Confirm that the SOC of the System battery bank reported in METER 05B is 100%. .

**Note:**

- Ensure that the System clock is set to local time.
- Turn OFF Max Gen Run Time (SETUP 04F) to avoid generator shutdown before 100% SOC is achieved.
- The *Gen 100% SOC Start Days* setting uses information from the BMK’s *METER 05J Days Since 100% SOC* to determine how many days have passed since the battery bank has not been charged to 100% SOC.
- A valid SOC number must display in *METER 05B Battery SOC* for the BMK’s *METER 05J Days Since 100% SOC* menu to accumulate and display days (Think’n, No Comm, Internal Fault, Power-up Fault, or Unknown Fault ## are not valid SOC numbers).
- Once the BMK’s *METER: 05B Battery SOC* displays 100%, the AGS stops the generator and the BMK’s *METER: 05J Days Since 100% SOC* display resets to “0 days”.
- If the generator does not start at the scheduled time (i.e., AGS fault, generator runs out of fuel, etc.,), one more day must pass before another attempt is made to charge to 100% SOC.

# Recovering a System with Overdischarged Expander Paks

Adding a fully charged Expander Pak into the battery bank will also bring the System back online. If solar is not available and the System is to be charged using an AC source, the addition of a functional battery will allow the PRO-Verter to power up and charge the Expander Paks.

# Energy Storage Modules – Supplemental Information

Batteries in high-efficiency hybrid power systems will cycle as they work. The total amount of battery cycles that can be expected is called the cycle-life of the battery, and this is usually associated with the chemistry and the type of cycling that occurs (light or heavy duty). The L0 HPS uses $LiFePO_4$ batteries as its primary energy storage mechanism.

One of the most important factors in maximizing battery cycle-life is to make sure that it is sized properly for a load. Since batteries store energy, they have ratings that correspond to the total amount of energy they can hold. This is known as battery capacity.

In any high-efficiency (hybrid) power system, it is critical to have the proper amount of battery capacity, as it will directly affect the overall performance of the system.

A properly sized battery should meet the following criteria:

- It should be able to provide the total power required by a load at any given point during operation.
- It should be able to fully recharge from the selected power generation sources at regular intervals.
- It will ensure there is enough energy to power the intended load between charges.

The best measure of a properly sized battery in a cycling application is that it will cycle 1-2 times during a 24-hour period. Improper sizing of a battery bank will cause improper cycling, which leads to shortened battery life and poor use of other resources such as fuel (if a generator is used to recharge the batteries).

When assembling multiple batteries or ESMs into a bank for a particular application, the following need to be considered:
- Consistency of chemistry
- Consistency of operating voltage
- Commonality of cycles (similar age, cycle exposures)
- A single battery bank (connected together and not disparately)

The HPS battery bank is sized directly for the 300W continuous load that may be placed on it when in support of the mission. If the load requirements change, then the size of the battery should also be reconsidered.

# Life Expectancy of a Battery

The battery is the “consumable” part of any hybrid system... It is sacrificial. The chemical reaction in a battery never stops, but it can be controlled in ways that affect the life expectancy and the cycle-life it will provide.

**Primary factors that determine the life expectancy of a battery:**

1. Cycles
    - Chemistry
    - Application (operating conditions, C-rates, etc.)
2. Abuse
    - Storing in a discharged state
    - Improper cycling

# Terminal (End-of-Life) Battery Performance

When a $LiFePO_4$ battery has reached the end of its service life (“health” is less than 50%), it loses its ability to retain electrical energy in its cells, and the cycle performance will be severely degraded. Symptoms will include:

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

**There is one major rule to remember when using a Expander Pak:**

**NEVER STORE THE EXPANDER PAK IN A DISCHARGED STATE**

Storing a discharged battery will cause it to “brick” (See 24VDC Expander Pak 2400 Manual)

**Discharging the Expander Pak Battery to “EMPTY”**

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

**Charging the Expander Pak fully.**

Expander Paks should be charged fully at least once every 15 cycles.

**Scaling Expander Paks in the System**

“Expanding” the size of a battery bank accomplishes three things:

1. It decreases the burden of repeated deep discharges on the Expander Pak battery during periods of heavy cycling, thereby extending battery life

2. It reduces generator cycling (on/off) frequency

3. It provides the operator with additional appliance “run-time” capability when the generator is not a desired option due to noise or generator failure

# Preventive Maintenance Checks and Services (PMCS)

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

## 24VDC Expander Pak 2400 PMCS

### Required Tools

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

Table 6. 24VDC Li Expander Pak 2400 PCMS

| Item # | Item to be Inspected | Interval at 91-140 °F (33-60 °C) Storage Temp | Interval at 77-90 °F (≤ 25-32 °C) Storage Temp | Procedures | Non-mission Capable |
|---|---|---|---|---|---|
| 1 | Visual inspection of 24VDC Li Expander Pak 2400 | M[1] | Q[2] | 1. Inspect case for visible damage and missing items.<br>2. Clean excessive dust or dirt accumulation from the exterior and ports.<br>3. Close all unused port covers. | ~If the case is broken or split or if ports are damaged, contact Solar Stik Technical Support for advice on how to proceed. |
| 2 | Battery Status LED color | M | Q | 1. Push and hold the Battery Status LED button.<br>2. Record the color of the Battery Status LED in the maintenance/service log<br>3. If the Battery Status LED is flashing red on any Li Expander Pak, proceed to Item #3. | ~If the Battery Status LED emits no light, contact Solar Stik Technical Support. |
| 3 | In-storage maintenance charging | Q | S[3] | 1. Charge Li Expander Paks for 24 hours at 29.0 V. Follow the instructions for the lithium battery charger used.<br>2. Charge until the Battery Status LED on all Li Expander Paks is flashing green (if flashing red to begin with).<br>3. If the Battery Status LED flashes red on any Li Expander Pak after 24 hours, continue charging all Li Expander Paks for another 24 hours. | ~If any Li Expander Pak has a red-flash Battery Status LED after 48 hours of charging OR if the LED emits no light after charging, contact Solar Stik Technical Support. |

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

# 24VDC PRO-Verter 5000-220 PMCS

Table 7. 24VDC PRO-Verter 5000-120 PMCS

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

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

### PRO-Verter Air Intake Filter Removal and Cleaning or Replacement

1. Use a #2 cross-tip screwdriver to remove the four (4) fasteners from the vent shroud (Figure 31) and remove the louvered vent cover to access the filter.


Figure 31. Fastener locations on vent shroud (upgraded/new version)

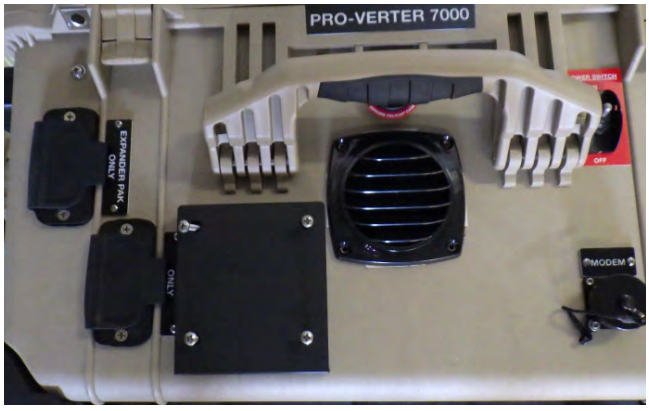



Figure 32. Removed vent shroud to access the louvered vent cover

2. Remove and inspect the filter. Replace the filter if it is damaged (arrows in Figure 33). If the filter is in good shape, clean it by rinsing it with water to remove the particulate matter and dry it. Replace the filter if it is crushed, rotted, or cracked as illustrated in the left column of Figure 33.


Figure 33. Replacing PRO-Verter filter (left); cleaning a PRO-Verter filter (right)

3. Reinstall the clean, dry filter or install the new filter. Secure the vent shroud with the four (4) fasteners.

# 24VDC Power Hub 2400 PMCS

Table 8. 24VDC Power Hub 2400 PMCS

| Item # | Item to be Inspected | Interval | Procedures | Non-mission Capable |
|---|---|---|---|---|
| 1 | Visual inspection of 24VDC Power Hub 2400 | M | 1. Inspect case for visible damage and missing items.<br>2. Clean excessive dust or dirt accumulation from the exterior, interior and connectors.<br>3. Close all unused port covers. | ~If the case is broken or split or if connectors are damaged, do not place into service. |
| 2 | Air Intake Filters | M[1] | 1. Remove the air intake vent covers to expose the filter material. (See Power Hub Manual for location of air intake filters.)<br>2. Wash with water and dry the filter. Reinstall.<br>3. If the filter is damaged or cannot be cleaned replace. | ~If the filter cannot be cleaned, is too damaged to function properly and a replacement is not immediately available, the unit is partially mission capable. Replace the filter as soon as possible to restore the unit to fully mission capable. |

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

# Clean Power Hub Air Intake Vent Filter

The air intake vent and filter on the back of the Power Hub. The louvered vent cover is secured by two (2) cross tip screws, one on each side. A fine cross tip screwdriver or similar will be required to remove the screws. After exposing the filter, lift it from the vent and wash thoroughly with water, dry thoroughly and reinstall the filter and louvered vent cover. Ensure that the leading edge of the louvers are facing downward. The parts and tool required are shown in (Figure 34).

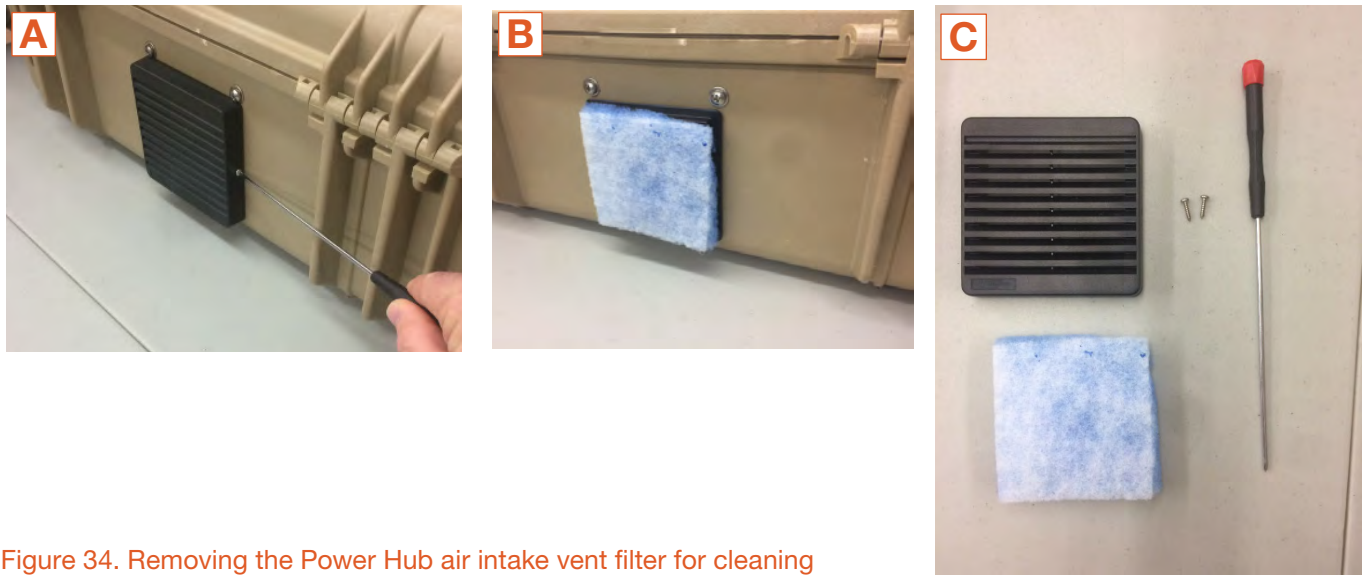



Figure 34. Removing the Power Hub air intake vent filter for cleaning

# PAM 420W PV Array PMCS and Troubleshooting

Table 9. PV Array PMCS

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

[1]Monthly (M)—every month [2]Quarterly (Q)—every three months

This section contains procedures that should be used for monitoring and maintaining the performance of the PAM 420W photovoltaic (PV) array. The information herein may be used to troubleshoot performance issues that may develop with a PV array or one of the quarter panels.

The measurement and interpretation of two (2) performance metrics, voltage open circuit ($V_{oc}$) and voltage maximum power ($V_{mp}$) are described. Use these metrics to ascertain PV array and PV quarter panel performance.

The following tests/inspections and corrective actions should be prioritized in the order listed. This document cannot list all issues that may occur, nor all tests or inspections and corrective actions. If an issue cannot be corrected by following these procedures, contact Solar Stik Tech Support.

**⚠ CAUTION**

- **Photovoltaic panels produce electricity when exposed to light.**
- **Live power may be present at multiple points.**
- **Never route the cables through standing water.**
- **All cables and connections should remain dry.**

**Required Tools and Equipment**

- Functional Power Hub 2400 connected to a 24 VDC power source such as a functional 24VDC Expander Pak/battery. Solar Power alone will not power up a 24VDC Power Hub 2400
- Digital Multimeter

## Maximum Power (Vmp) and Open Circuit Voltages (Voc)

Voltage "**m**aximum **p**ower" ($V_{mp}$) is the voltage at which the maximum power of a panel or array is produced when connected to a charge controller, or when the panel is considered "under load" such as a charge controller (Power Hub or Power Pak).

Voltage "**o**pen **c**ircuit" ($V_{oc}$) is unregulated panel voltage and measured directly from the leads of a panel or an array when **not** connected to a "load" such as a charge controller (Power Hub or Power Pak).

The $V_{oc}$ of a single PAM quarter panel is approximately 15.72 V under standard test conditions (STC). In a PAM, four (4) panels are connected in series; therefore, the $V_{oc}$ for the four (4) panels could theoretically be as high as 62.88 V. Once the panels are connected to the Power Hub (i.e., the panels are connected to a "load"), it is more likely that the operator will see voltages around 50 $V_{mp}$ reported on the User Interface.

The $V_{oc}$ and $V_{mp}$ should be measured under "ideal solar conditions" if possible. This means that the panels should be oriented directly at the sun and unshaded on a clear day to identify the maximum $V_{mp}$ and $V_{oc}$.

# Procedure to Measure PV Array $V_{mp}$ with a Power Hub 2400

1. Disconnect one (1) PV array from each of the three (3) charge controllers.

2. Read and record the performance metrics for each PV array as reported by the User Interface in charge units 0, 1 and 2. The values for the three (3) arrays should be about the same. Use the instructions in Figure 1 to navigate to the “VIEW CHARGE UNIT STATUS” submenus.

   **Note:** the Power Hub User Interface will report very low to no charging current, even in full sun, if the connected batteries are fully charged.

3. Disconnect two (2) of the three (3) PV arrays from the Power Hub. Leave one (1) connected as a reference standard for comparing the remaining PV arrays.

4. Connect each of the remaining PV arrays and compare the performance values to the reference standard connected to the other solar charge controller.

5. If no voltage is reported by an array, measure the $V_{oc}$ at the array lead connectors. If a voltage cannot be measured at the lead connectors, replace the Solar Cable.

6. If a PV array appears to be under performing, measure the $V_{oc}$ of the array. Follow the directions for measuring PV array $V_{oc}$, Figure 36.

# Navigating the User Interface Menus “View Charge Unit Status” Submenus

Enter “Advanced Information Menu”. Advance to “VIEW CHARGE UNIT STATUS”.

Press and hold SELECT for 4 seconds.
The number “0” displays in the upper left corner. This is the MASTER/ CHARGE UNIT #0. This window reports solar input voltage and current, output current to batteries, and the internal temperature for the pair of solar panels connected to the ports labeled MASTER/CHARGE UNIT #0.

Press NEXT.
The number “1” displays in the upper left corner. This is SLAVE1, CHARGE UNIT#1. This window reports same as the master but for the pair of solar panels connected to SLAVE1 input ports.

Press NEXT.
The number “2” displays in the upper left corner. This is SLAVE2, Charge Unit#2. This window reports same as the master but for the pair of solar panels connected to SLAVE2 input ports.

Press NEXT.
The number “3” displays in the left corner. The rest of the screen is blank because no charge controller occupies this channel.
Note: Menu windows for Charge Units 3-7 contain only the Unit # in the upper left hand corner

Press BACK to exit this submenu.

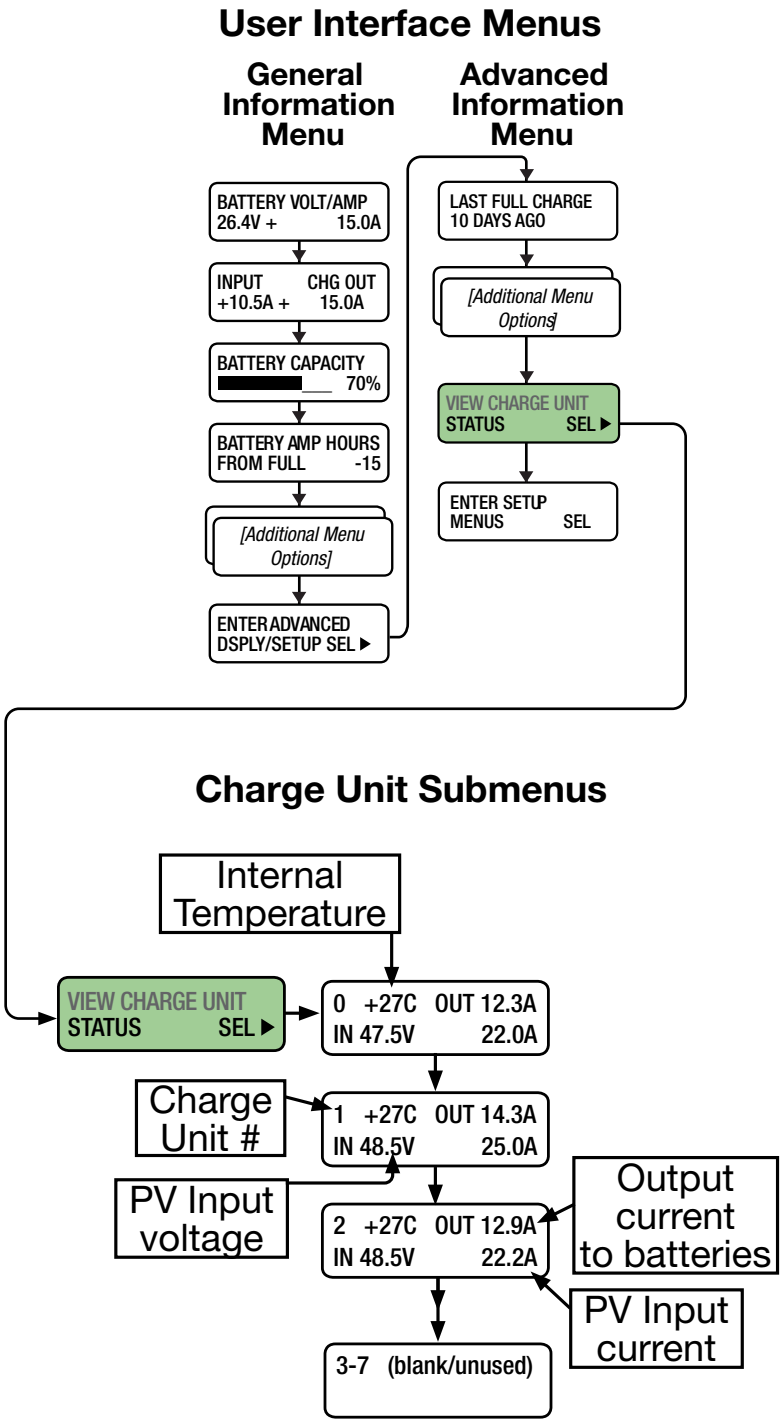



Figure 35. View Charge Unit Status submenu navigation

# Procedure to Measure PAM $V_{oc}$

To measure $V_{oc}$ from a single PAM, **carefully** place the leads of the voltmeter on pins A and C in the bayonet connector at the end of the Solar Leash (DO NOT SHORT THESE PINS). Pin B is unused. The rated $V_{oc}$ for the four-panel PAM is ~ 63; however, the voltage may vary. Under ideal-sun conditions, the reading should be 50 V or more.

- If the $V_{oc}$ is significantly below (less than half) 50 V under ideal-sun conditions, measure the $V_{oc}$ of the individual quarter panels as described in the next section (and Figure 3).

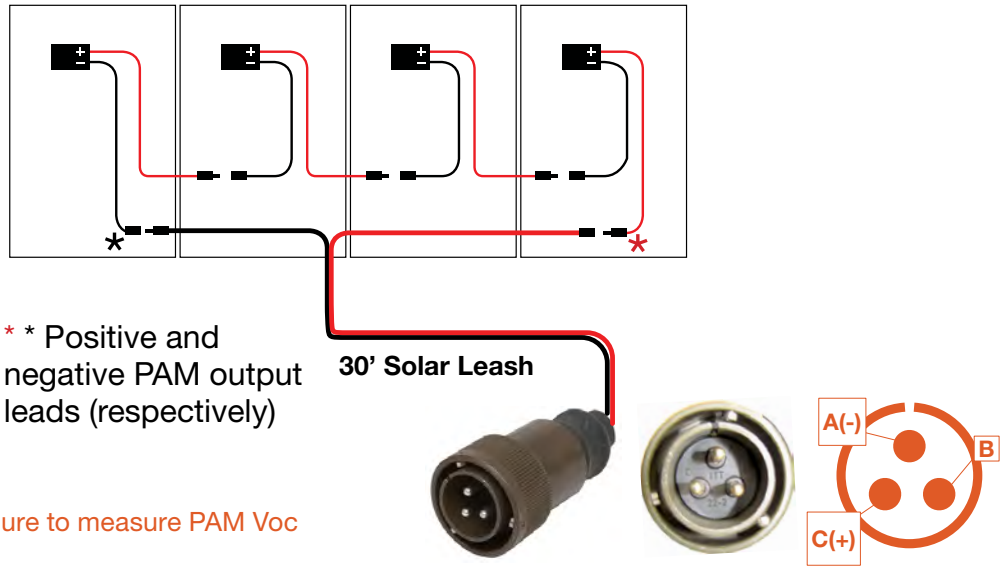



Figure 36. Procedure to measure PAM Voc

# Procedure to Measure $V_{oc}$ of a Single PAM Quarter Panel

To measure the $V_{oc}$ of a PAM quarter panel, **carefully** place the leads of the voltmeter in/on the quarter panel positive and negative connector terminals of the (DO NOT SHORT THESE TERMINALS). The voltage measurement across the terminals of these leads is the $V_{oc}$ of the quarter panel and should be ~15 V under ideal-sun conditions.

- If all of the quarter panels are performing up to specs, replace the Solar Cable and retest.
- If the $V_{oc}$ of a quarter panel is significantly below (less than half) 15 V under ideal-sun conditions, replace the quarter panel.
- If a replacement quarter panel is not available, connect the remaining quarter panels to assemble a partial PAM.

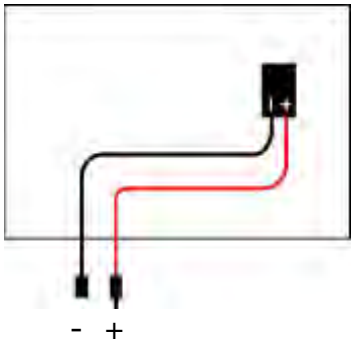



Figure 37. Procedure to measure PAM quarter panel Voc

# Yanmar 5500 Genset PMCS

**Please consult OEM Generator Technical Manuals for in depth genset PMCS information**

# 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.

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