SOLAR STIK®

SYSTEM SETUP AND OPERATION GUIDE FOR THE SOLAR STIK USAF G-BOSS MEDIUM AND HEAVY HYBRID POWER SYSTEMS

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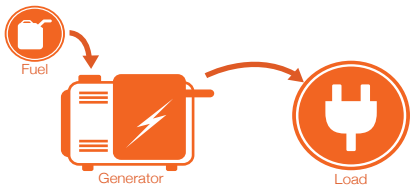
GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

The introductory parts of this manual describe Hybrid Power Systems (HPSs) composed of Solar Stik components. However, the Solar Stik architecture is modular and open, allowing Operators to integrate non-Solar Stik components as part of an HPS solution. Please contact Solar Stik Technical Support for assistance in optimizing the integration of other components into a Solar Stik HPS.

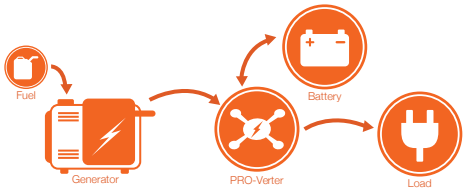
Introduction to Hybrid Power Systems

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 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.**



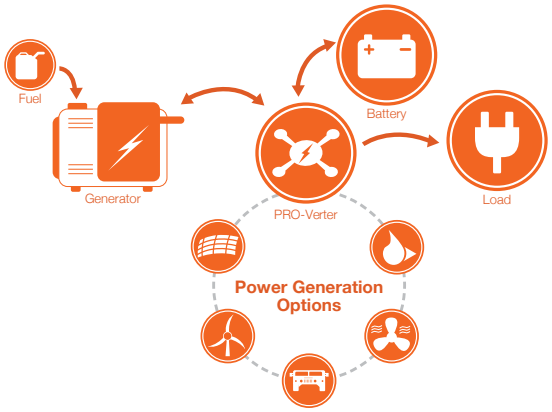
Low-efficiency
Traditional Power System



High-efficiency
HPS

The Hybrid Power System Flexible Open Architecture

The HPS is comprised of modular components that integrate into a flexible architecture 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

Important Safety Information and Instructions

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

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

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

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

Safety Information Labels

Your safety and the safety of others is very important.

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

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

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

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

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

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

Fire Hazard

Fire Types

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

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

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

Recommended Fire Extinguisher

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

⚠ WARNING

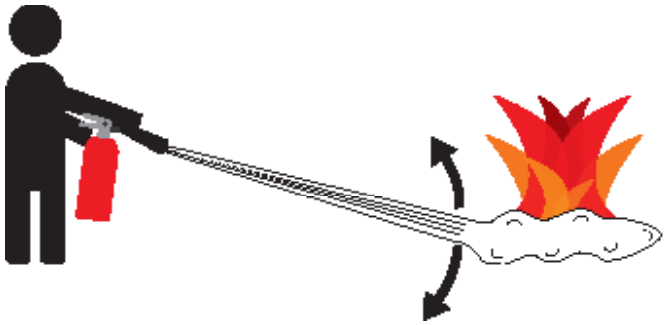
Only CO_2 (carbon dioxide) fire extinguishers should be used with this equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

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

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



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

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

Electric Shock Hazard

⚠ WARNING

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

DON'T LET THIS BE YOU!

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

⚠ WARNING

The System is NOT GFCI protected.

Grounding the System

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

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

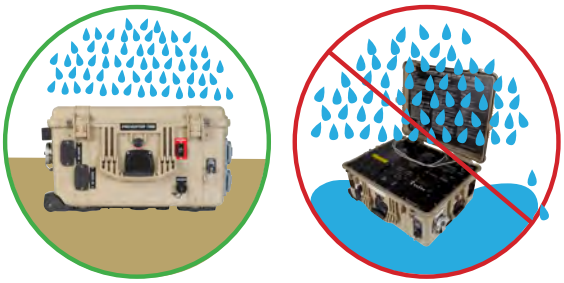
Figure 1. PRO-Verter grounding lug

Environmental and Handling Precautions

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

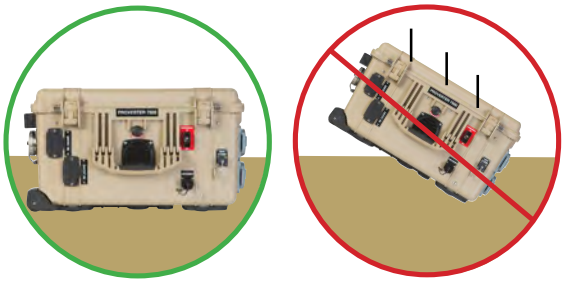
Water

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.



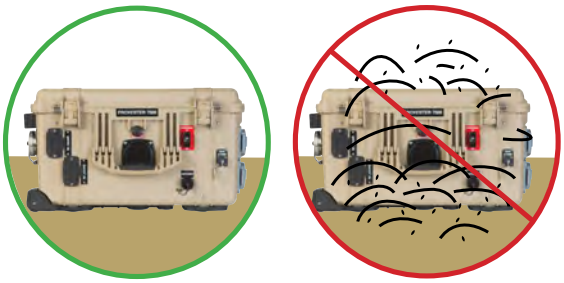
Impact

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



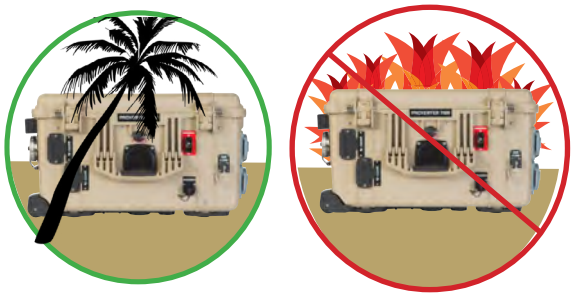
Dust/Foreign Object Intrusion

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. 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/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/grid AC source during brief/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/grid AC power with inverter AC power to support "peak" AC for brief periods. This mode can be supported only for limited durations and is directly dependent on the total battery capacity and their 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 provide uninterrupted pure sine-wave AC and DC power to the loads. It 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 generation and 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 in the Energy Storage Modules—Supplemental Information section.

Minimum Battery Capacity Required for Optimal System Operation

An 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, PRO-Verters 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. Ensure the battery bank connected to the System is sufficient 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 ONLY begin to charge once the DC generation exceeds the demand from the load.

During periods of peak renewable DC generation, 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 (SOC), the PRO-Verter can be programmed to auto-start the generator to keep AC flowing to the load, only charging the connected batteries once 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 section.

"Overload" Conditions

Overloading 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 only requires 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/grid AC source with the inverter's AC output to briefly support high AC loads that exceed 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 be used only 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.

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 until to shut down entirely.

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

Figure 2. 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 to handle.

Scaling

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

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

Stacking

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

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

> **Note:** Scaling or modifying the HPS architecture should be done with all components in the HPS completely inactive and OFF. The Initialization and Calibration setup step must be repeated once 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.

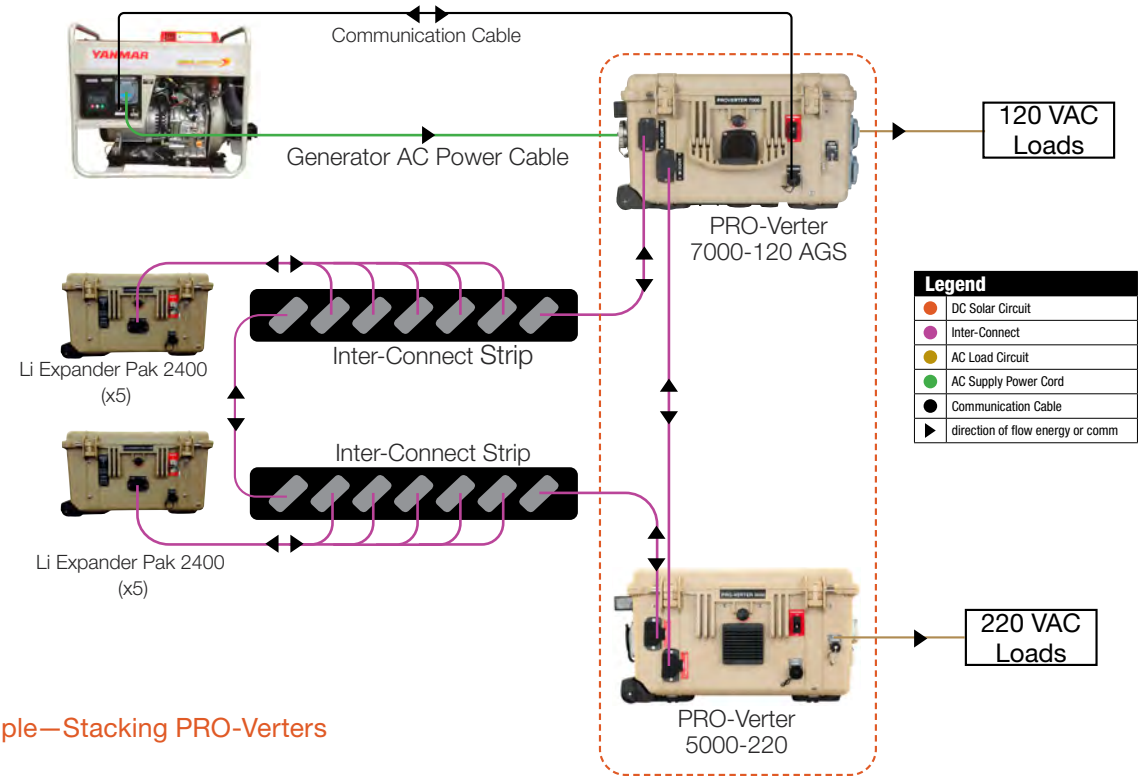


Figure 3. Example—Stacking PRO-Verters

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.

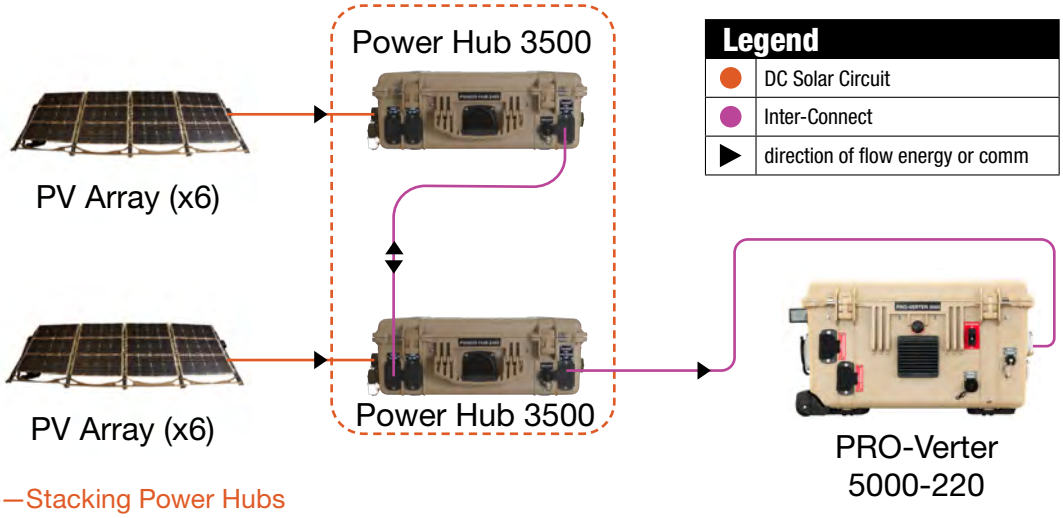


Figure 4. Example—Stacking Power Hubs

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 5). **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, then Li Expander Paks can be removed from service in accordance with reductions in runtime requirements.

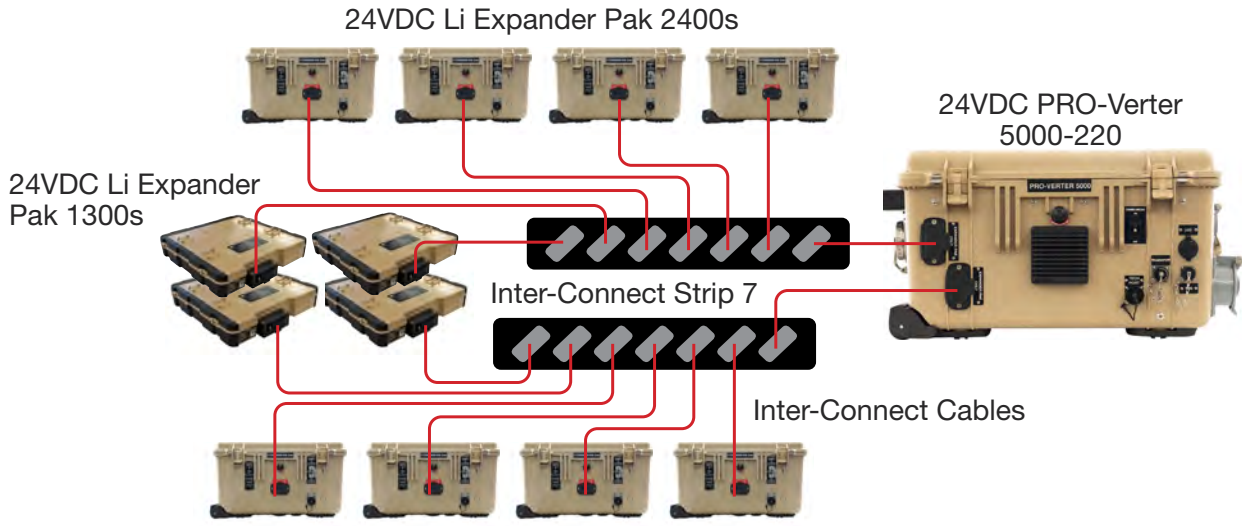


Figure 5. Connecting Li Expander Paks using Inter-Connect Strips and Inter-Connect Cables

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 dial clockwise to lock, counterclockwise t
- Can be repaired or modified in the field

Figure 6. Inter-Connect plug

24VDC Power Distribution (PDM) 3000 Description

The PDM 3000 draws power from the HPS 24 VDC bus and converts it to stable, regulated 28 VDC output. The PDM protects equipment sensitive to voltage fluctuations.

PDM 3000 Connections

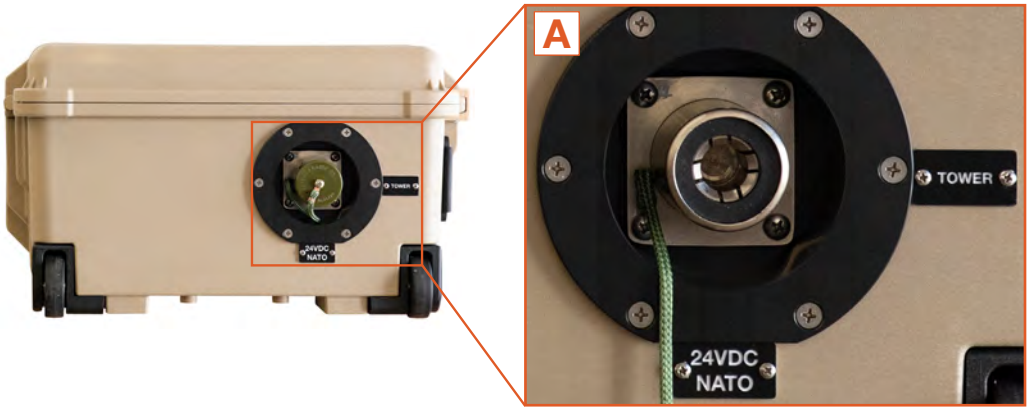
The Inter-Connect port connects the PDM 3000 to the HPS DC bus.

24VDC Inter-Connect

Figure 7. PDM 3000 front side

	Description	Connector	Voltage	Amps
A	Battery Connection (metered port)	Inter-Connect Port	24 VDC	100

The NATO Port provides 24VDC Power to the G-BOSS tower.



24VDC NATO

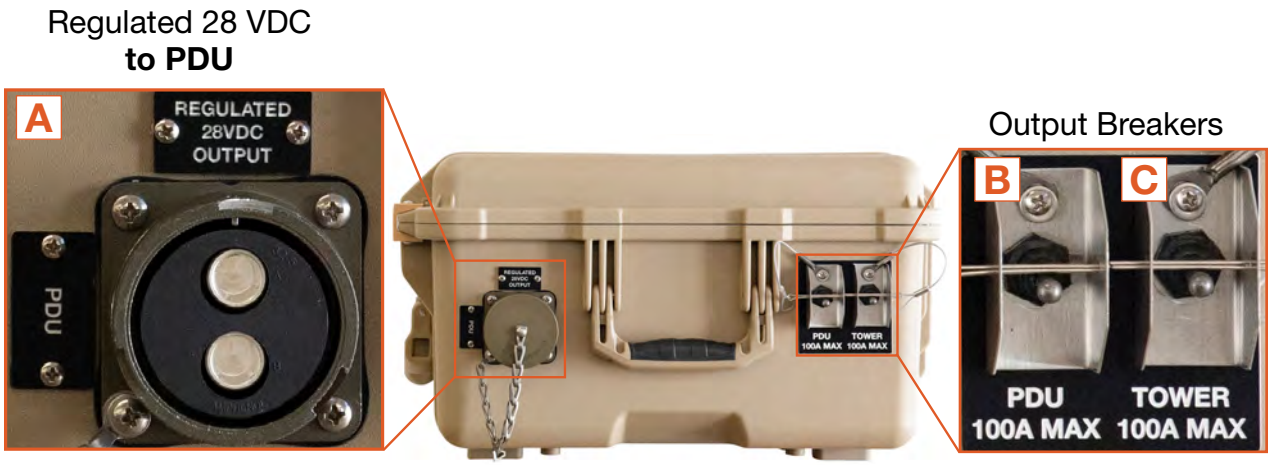
Figure 8. PDM 3000 left side

	Description	Connector	Voltage	Amps
A	24 VDC NATO Slave (unmetered)	NATO Slave	24 VDC	100

The 2-pin connector in the right side of the PDM 3000 provides regulated 28.0 VDC power to the G-BOSS Power Distribution Unit (PDU). The 100 A breakers on the right side also serve as power switches for engaging and disengaging power circuits to the tower and the PDU.

⚠ CAUTION

Do NOT connect a battery directly to the regulated 28VDC output port as this will damage the PDM 3000.



	Description	Connector	Voltage	Amps
A	28.0 VDC regulated output	Amphenol?	28.0 VDC	100
B	Regulated 28 VDC Output to PDU	N/A	N/A	100
C	24 VDC Output to Tower	N/A	N/A	100

Figure 9. PDM 3000 right side

The bottom of the PDM 3000 case is cut away and sealed to facilitate passive heat dissipation from the internal components.

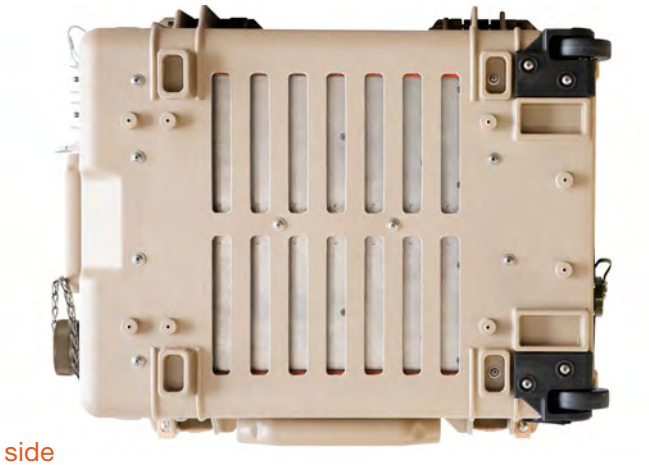


Figure 10. PDM 3000 bottom side

PDM 3000 I-Plate

Figure 11. PDM 3000 top, Faceplate, specs, and cautions

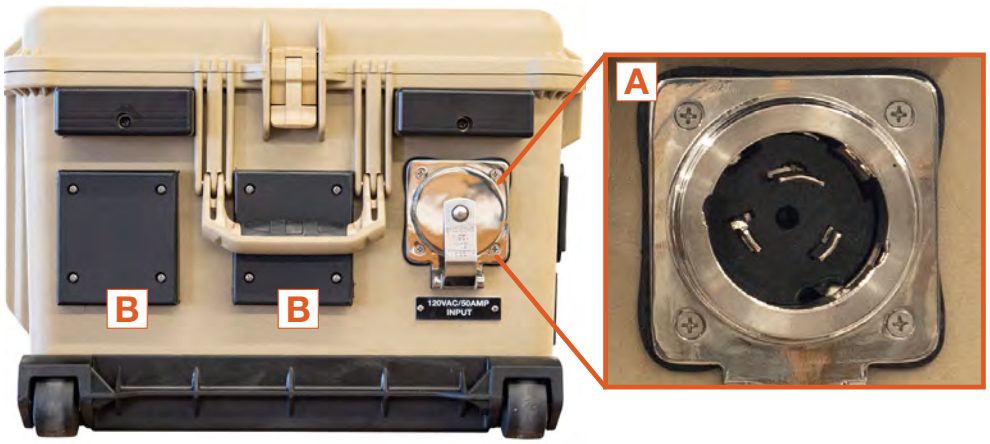
24VDC PRO-Verter 5000-120 AGS Description

PRO-Verter 5000 Exterior Features

Note: Ports vary among PRO-Verters according to model selected.

	Description	Connector	Voltage	Amps
A	Battery Connection (metered port)	Inter-Connect Port	24 VDC	200
B	Power Switch	-	-	-
C	AMMPS Comm Port	MS3452W14S-28	-	-
D	TQG Comm Port	Amphenol HA100001-02-36	-	-
E	Tech Port	Ethernet - RJF21B	-	-
F	Air Intake	-	-	-

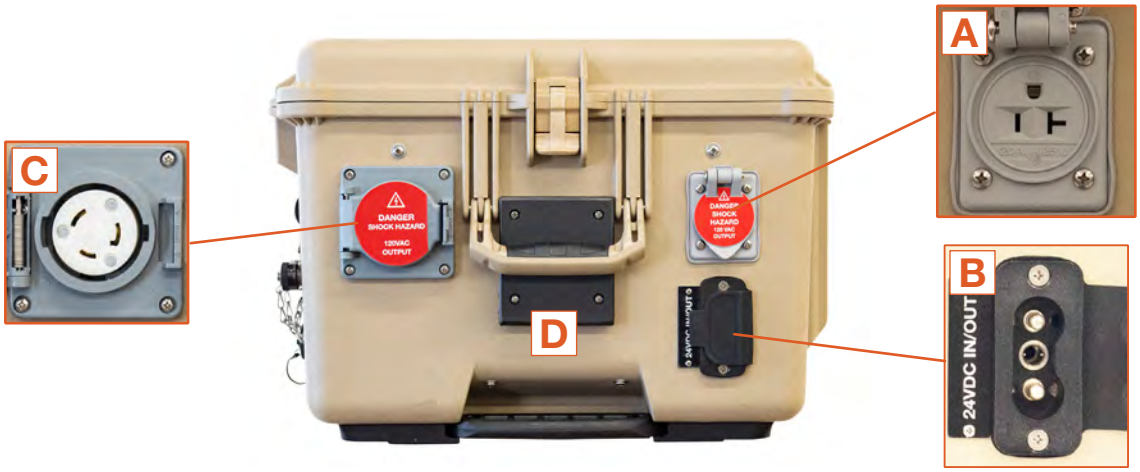
Figure 12. PRO-Verter 5000-120 AGS front exterior



	Description	Connector	Voltage	Amps
A	Input Connection (customer – per application)	HBL503SS	125 VAC	50
B	Air Exhaust	-	-	-

Figure 13. PRO-Verter 5000-120 AGS left exterior

PRO-Verter 5000 Exterior Features



	Description	Connector	Voltage	Amps
A	120 VAC Output	HBL61CM65	120 VAC	20
B	DC load /Power Hub Connection	Inter-Connect Port	24 VDC	200
C	120 VAC Output	HBL2610 SW	120 VAC	30
D	Air Intake	-	-	-

Figure 14. PRO-Verter 5000-120 AGS right exterior

	Description	Connector	Voltage	Amps
A	Air Intake	-	-	-

Figure 15. PRO-Verter 5000-120 AGS back exterior

PRO-Verter 5000 Information Plate

The Information Plate (I-Plate) provides concise but abbreviated information for setting up and running a System. All System components should be connected as shown in the diagram on the I-Plate. The diagram illustrates component connections but not the actual physical arrangement of the components for a specific application.

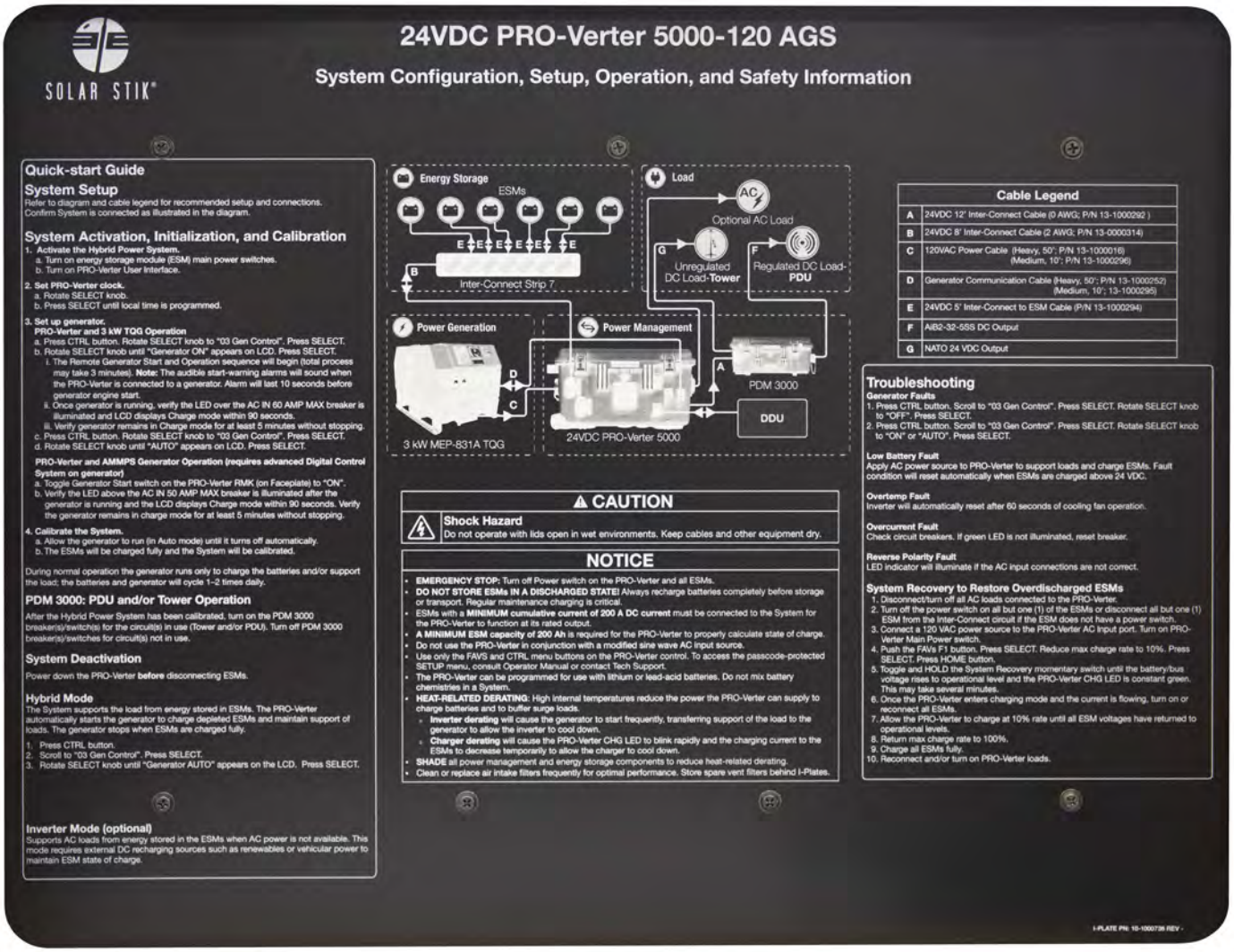


Figure 16. PRO-Verter I-Plate

PRO-Verter 5000-120 Faceplate

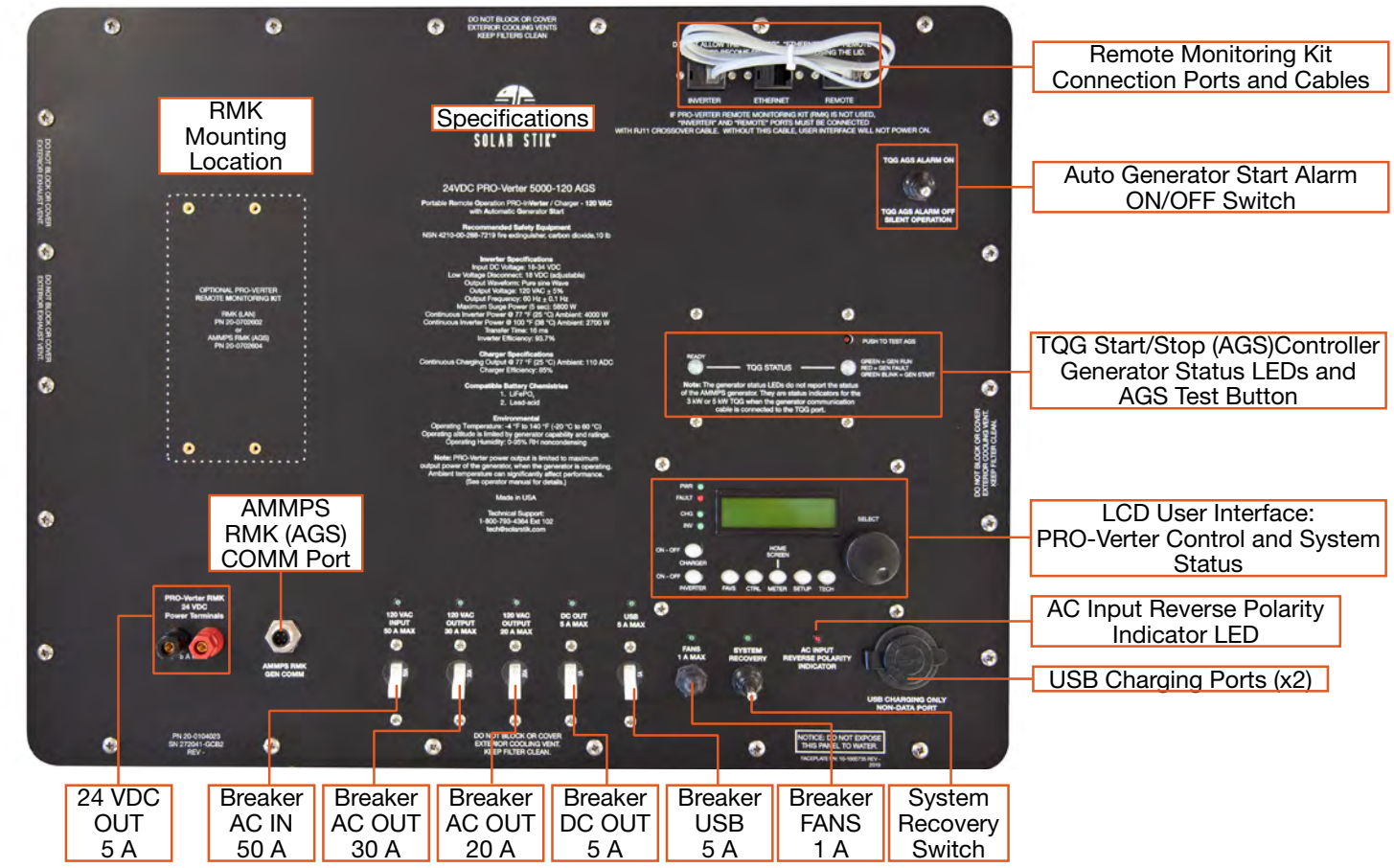


Figure 17. PRO-Verter Faceplate

LCD User Interface—The LCD screen and the associated buttons and LEDs are used to program and control the PRO-Verter and to control and monitor the status of the System. The PRO-Verter is programmed at Solar Stik to meet the specifications of a specific application. Programming mode is blocked and password protected, but if reprogramming is required it can be accessed by contacting Solar Stik Technical Support (800-793-4364 Ext. 102; 24 hours a day, 365 days a year).

Generator (TQG) Status LEDs—The LED on the left blinks green during generator start; it is steady-on green when the AGS circuit is functional and when the generator is running. The LED on the right is red if there is a generator fault, solid green when the generator is running, and blinking green when the generator is starting. (For an AMMPS generator, these LEDs are active but do not report the status of the generator.)

Auto Generator Start (AGS) Alarm ON/OFF Switch—In the ON position, an alarm will sound as warning that the generator has initiated the auto-start protocol and is about to start. The OFF position disables the alarm for silent operations.

Auto Generator Start (AGS) Test Button—The Test Button is a push-button momentary switch that allows the AGS system to be tested for correct wiring and generator start/stop operation.

USB 5 A Breaker—Push to reset the breaker if the USB port is not operating while the PRO-Verter is turned on.

AC IN and AC OUT Breakers—Circuit breakers protect against overcurrent conditions in dedicated circuits. If too much amperage flows due to short-circuit, inadequate or improper loading, or component failure, these will protect the System and Operator. The LED associated with the breaker is green when there is power to the breaker from an AC power source. The LED will be illuminated even when the breaker is in the OFF position.

24 VDC 5 A Output and Breaker—These terminal posts supply power to the RMK if present. The LED associated with the breaker is green when the circuit is operating normally.

Remote Monitoring Kit (RMK)—This optional (sold separately) device reports, records, and stores 28 PRO-Verter and System metrics.

RMK Connection Ports and Cables—These port and cables provide communication connections between the RMK, the PRO-Verter, and remote access monitoring equipment (via the Tech Port).

System Recovery Switch—This switch provides a way to restart a System using 120 VAC power if the System batteries are overdischarged/there is no 24 VDC power source available. See System Recovery to Restore Overdischarged Batteries section.

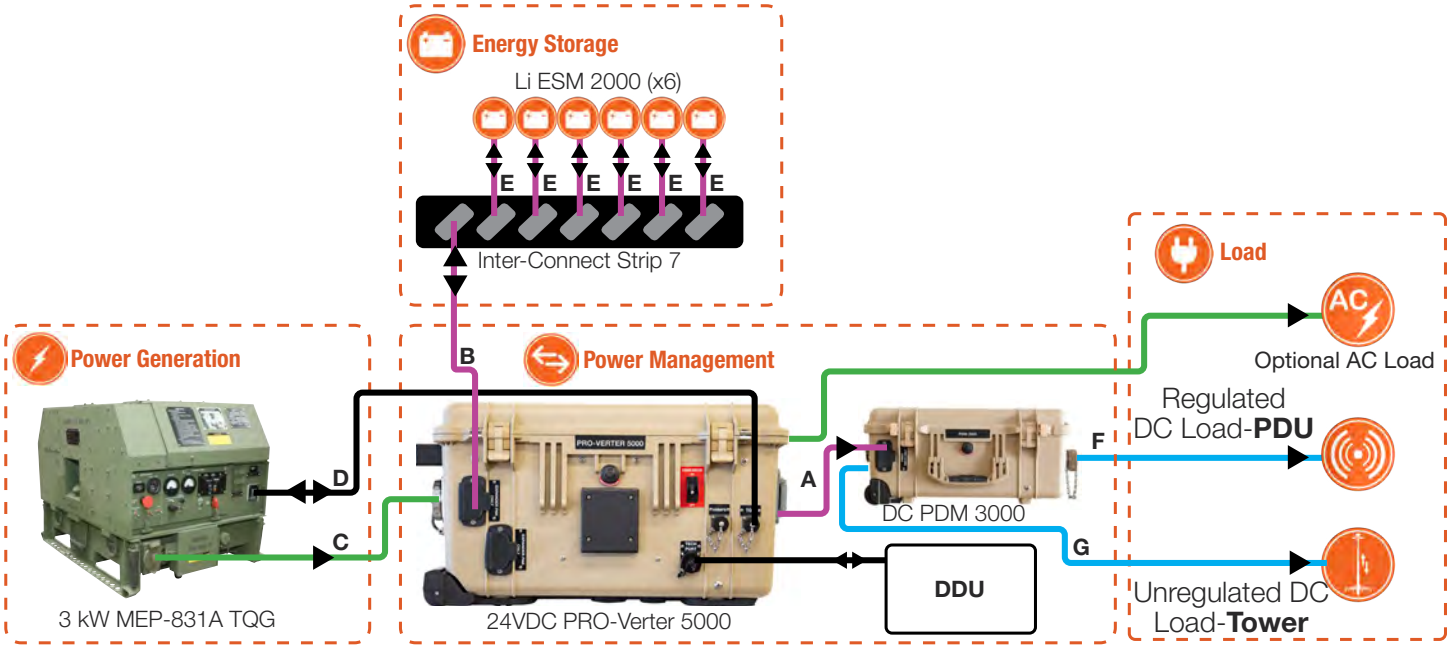
AC Input Reverse Polarity Indicator LED—LED will light red when reverse polarity is sensed on the AC input.

USB Charging Ports (x2)—Provides 5 VDC / 2.1 A. Charging only. No data.

OPERATOR INSTRUCTIONS

1. Connect System Components

The connection diagram below illustrates the HEAVY and MEDIUM configurations of G-BOSS USAF.



G-BOSS Heavy and Medium Kit Inventory

The difference between the Heavy and Medium kits is the length of cables A-D.

Table 1. USAF G-BOSS Heavy Inventory

Cable	Item #	Cable Name	QTY
A	13-1000292	24VDC **12'** INTERCONNECT CABLE (0 AWG)	1
B	13-0000032	24VDC **8'** INTERCONNECT CABLE (2AWG)	1
C	13-1000016	**50'** AC CABLE MEP-831A	1
D	13-1000187	**50'** GENERATOR COMMUNICATION CABLE	1
E	13-1000294	24VDC 5' INTERCONNECT CABLE	6
F		AIB2-32-5SS	
G		NATO Cable	
	13-1000160	24VDC INTERCONNECT STRIP 7	1
Component	**Item #**	**Component**	
	20-0104023	24VDC PRO-VERTER 5000-120 GCB2	1
	20-0002510	DC POWER DISTRIBUTION MODULE 3000 28V-REG	1

Table 2. USAF G-BOSS Medium Inventory

Cable	Item #	Cable Name	QTY
A	13-1000292	24VDC **12'** INTERCONNECT CABLE (0 AWG)	1
B	13-0000032	24VDC **8'** INTERCONNECT CABLE (2AWG)	1
C	13-1000016	**10'** POWER CABLE, 125V/30A	1
D	13-1000187	**10'** GENERATOR COMMUNICATION CABLE	1
E	13-1000294	24VDC 5' INTERCONNECT CABLE	6
F		AIB2-32-5SS	
G		NATO Cable	
	13-1000160	24VDC INTERCONNECT STRIP 7	1
Component	**Item #**	**Component**	
	20-0104023	24VDC PRO-VERTER 5000-120 GCB2	1
	20-0002510	DC POWER DISTRIBUTION MODULE 3000 28V-REG	1

a. Connect PRO-Verter to Energy Storage Modules

Use 5’ Inter-Connect cables (E) to connect the System batteries to PRO-Verter as shown in Figure 18. Connect the PRO-Verter to the Inter-Connect Strip

Note: A variety of Energy Storage Modules (ESMs) may be connected to the PRO-Verter. Never mix battery chemistries in a System.

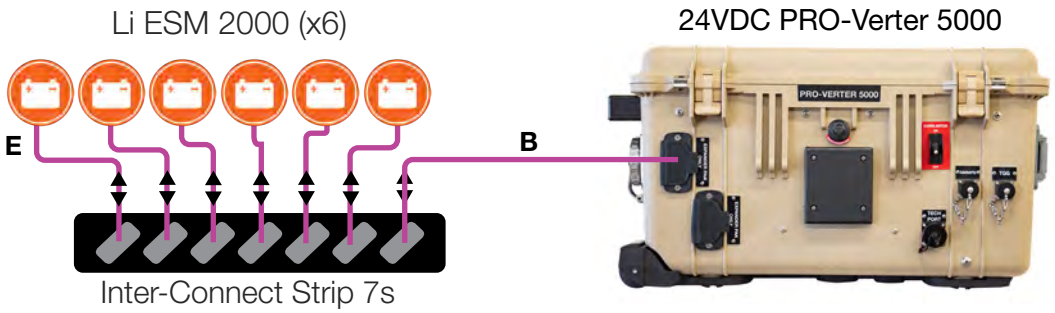


Figure 18. PRO-Verter to ESM connections

b. Connect PRO-Verter 5000 to AC Power Source

Use the Generator AC Power Cable (Heavy, 50’; Medium, 10’) to connect the generator to the “120VAC/50A INPUT” port on the left side of the PRO-Verter 5000. A custom cable or adaptor may be required to connect grid power to the PRO-Verter 5000.

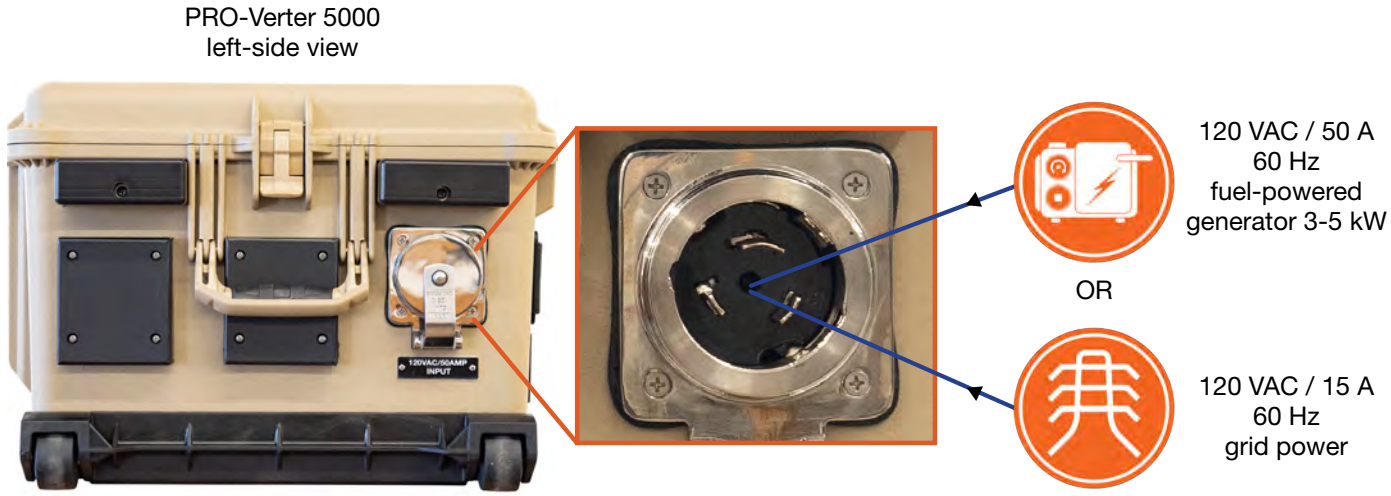


Figure 19. Connecting AC power sources to PRO-Verter

Note: The TQGs must be equipped with a Solar Stik Remote-start Enabling Kit (RsEK) installed to be compatible with the PRO-Verters 5000. The PRO-Verter 5000 must be equipped with a Solar Stik RMK AGS to communicate with and control the AMMPS series of generators. Currently, the PRO-Verter 5000 is not capable of interfacing with the 1–2 kW Man Portable Generators (Ranger/ Defender).

c. Connect PRO-Verter -Generator Comms Cables

i. MEP-831 TQG and (optional) MEP-802A

Connect TQG port on the front of the PRO-Verter and the AUTO GENERATOR CONTROL port on the TQG using the TQG GEN COMM Cable (Heavy, 50'; Medium, 10').

Figure 20. MEP-831A and MEP-802A Generator Communication Cable connections

ii. MEP-1030 AMMPS 5 kW Generator (optional)

Connect to “AMMPS” Gen Comm Port on the front of the PRO-Verter and the “NETWORK” port on the AMMPS using the AMMPS GEN COMM Cable (Contact Solar Stik for information on this cable).

Figure 21. MEP-1030 AMMPS 5 kW Generator Communication Cable connections

d. Connect PRO-Verter 5000 to PDM 3000

Use a 24VDC Inter-Connect cable (Heavy & Medium 12'; 0 AWG) to connect the 24VDC PDM 3000 the PRO-Verter. There is a single Inter-Connect port on the PDM 3000 labeled 24 VDC "INPUT ONLY"

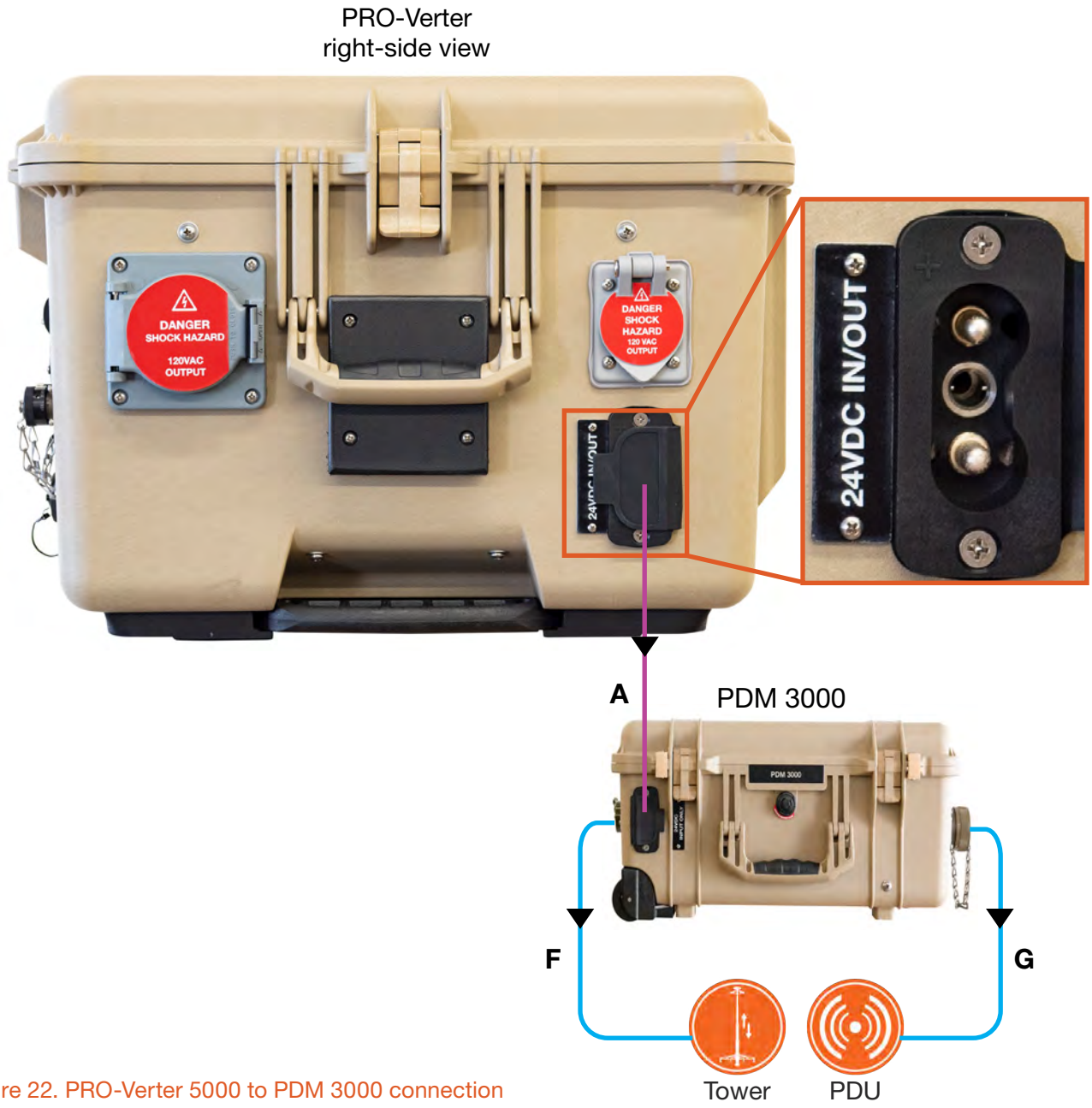


Figure 22. PRO-Verter 5000 to PDM 3000 connection

e. Connect PRO-Verter 5000 to Data Distribution Unit (Optional)

Use an Ethernet cable to connect the PRO-Verter to the Data Distribution Unit (DDU). The TECH PORT provides access to System-level operation data. The PRO-Verter must be equipped with a Remote Monitoring Kit for data to be retrievable from the TECH PORT.

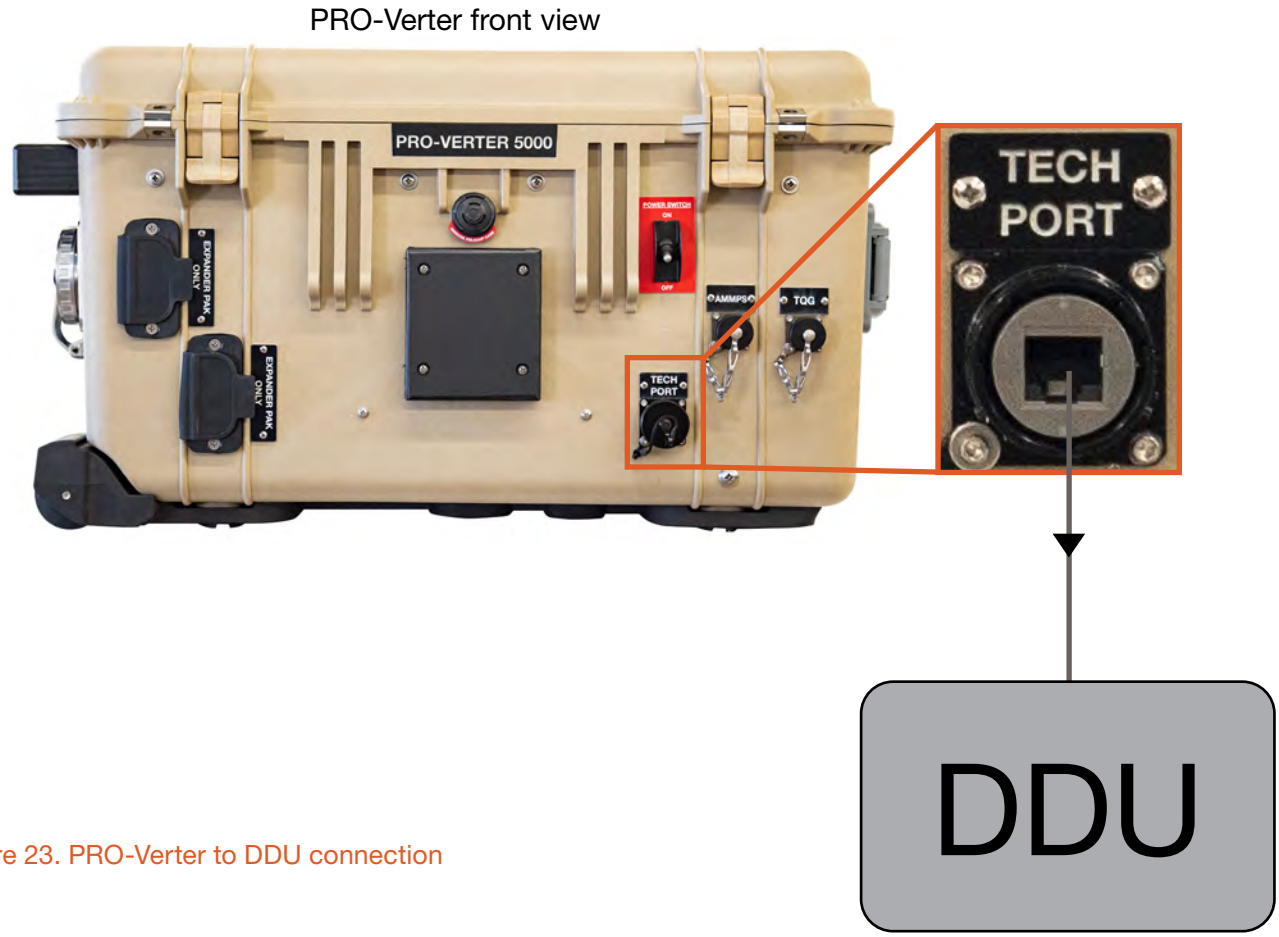


Figure 23. PRO-Verter to DDU connection

f. Connect PRO-Verter 5000 to 120 VAC Loads (Optional)

Connect 120 VAC loads to the PRO-Verter AC outputs on the right side of the PRO-Verter. Connect loads of no more than 20 amps for one (1) outlet and no more than 25 amps total between the two (2) outlets. Turn off load power switches to prevent power draw during System setup.

> **Note:** The PRO-Verter inverter may be "turned off" during programming at Solar Stik (per customer request). The PRO-Verter will not support AC loads when the inverter is turned off.

The inverter may be turned on following the instructions below:

1. Push the SETUP button on the PRO-Verter user interface.
2. Scroll to 02 Inverter Setup and press the rotary dial.
3. Scroll to 02F Power Up Always OFF and press the rotary dial.
4. Scroll to change 02F Power Up Always ON and press the rotary dial.

Figure 24. PRO-Verter 5000 AC power output ports

2. System Activation and Initialization

a. Activate the Hybrid Power System.

1. Turn on the System battery main power switches.
2. Turn on PRO-Verter User Interface.

b. Set PRO-Verter clock.

1. Rotate SELECT dial.
2. Press SELECT until local time is programmed.

c. Set Ah Capacity (FAVS 2).

This value should be equal to the total capacity of the batteries connected to the System.

d. Set AC Input Amps (FAVS 3).

This value should be equal to the current provided by the AC power source.

e. Set up generator.

PRO-Verter and TQG Operation

1. Press CTRL button. Rotate SELECT dial to “03 Gen Control“. Press SELECT.

2. Rotate SELECT dial until “Generator ON“ appears. Press SELECT.

i. The Remote Generator Start and Operation sequence will begin (total process may take 3 minutes). **Note:** The audible start-warning alarms will sound when the PRO-Verter is connected to a generator. Alarm will last 10 seconds before generator engine start.

ii. Once generator is running, verify the LED over the AC IN 50 AMP MAX breaker is illuminated and User Interface displays Charge mode within 90 seconds.

iii. Verify generator remains in Charge mode for at least 5 minutes without stopping.

3. Press CTRL button. Rotate SELECT dial to “03 Gen Control“. Press SELECT.

4. Rotate SELECT dial until “AUTO“ appears on LCD. Press SELECT.

PRO-Verter and AMMPS Generator Operation (optional)

(Optional; requires advanced Digital Control System on generator)

1. Toggle Generator Start switch on the PRO-Verter RMK (on Faceplate) to “ON“.

2. Verify the LED above the AC IN 50 AMP MAX breaker is illuminated after the generator is running and the LCD displays Charge mode within 90 seconds. Verify the generator remains in charge mode for at least 5 minutes without stopping.

f. Calibrate the System.

1. Allow the generator to run (in AUTO MODE) until it turns off automatically.

2. The ESMs will be charged fully and the System will be calibrated. During normal operation the generator runs only to charge the batteries and/or support the load; the batteries and generator will cycle 1–2 times daily.

3. PDM 3000: PDU and/or Tower Operation

After the Hybrid Power System has been calibrated, turn on the PDM 3000 breaker(s)/switch(s) for the circuit(s) in use (Tower and/or PDU). Turn off PDM 3000 breaker(s)/switches for circuit(s) not in use.

4. System Deactivation

Power down the PRO-Verter before disconnecting ESMs.

Modes of Operation

Hybrid Mode
The System supports the load from energy stored in ESMs. The PRO-Verter automatically starts the generator to charge depleted ESMs and maintain support of loads. The generator stops when ESMs are charged fully.

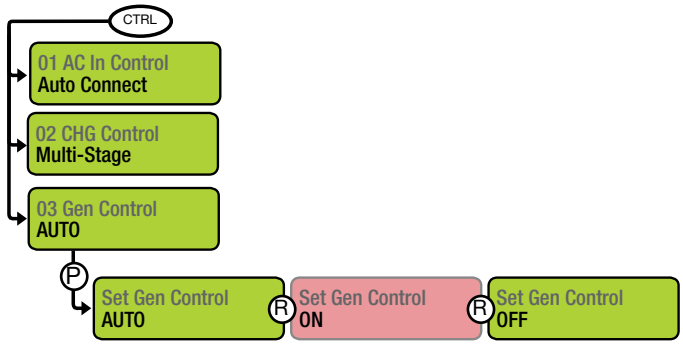
1. Press CTRL button.
2. Scroll to “03 Gen Control”. Press SELECT.
3. Rotate SELECT dial until ”Generator AUTO” appears on the LCD. Press SELECT.

Invert Mode (optional)
Supports AC loads from energy stored in the ESMs when AC power is not available. This mode requires external DC recharging sources such as renewables or vehicular power to maintain ESM state of charge.

System Breakdown and Storage

Prior to System breakdown, charge the System batteries 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 System batteries state of charge prior to charging.

Overview to the PRO-Verter User Interface Menu Windows

The columns below provide a condensed version of the menu windows that constitute the menu tree of each button.

Figure 25. Menu buttons on the LCD user interface

FAVS Button
- F1 Battery Type
- F2 AmpHour Size
- F3 AC Input
- F4 LBCO
- F5 Gen Run VDC

CTRL Button
- 01 AC In Control
- 02 CHG Control
- 03 Gen Control
- 04 PT Control

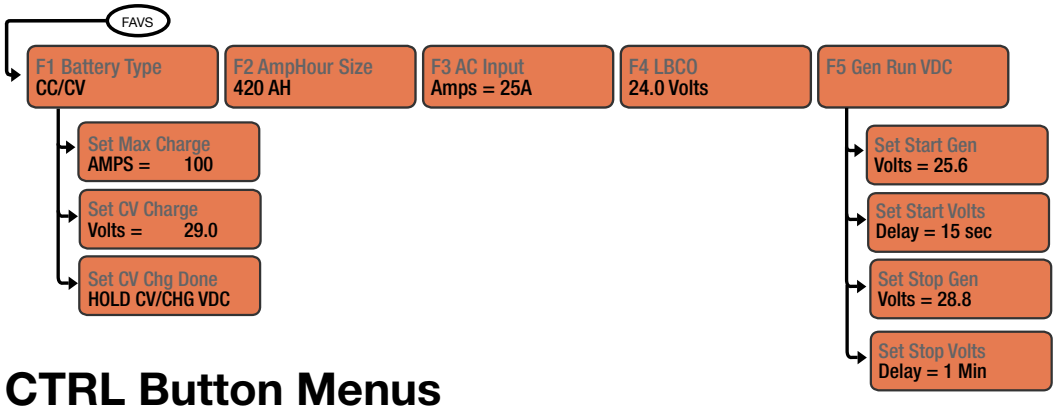
METER Button
(Read Only)
- 01 DC Meters
  - 01A DC Volts
  - 01B DC Amps
- 02 AC Meters
  - 02A Output Volts
  - 02B Load Amps
  - 02C Input Amps
  - 02D Inv/Chg Amps
  - 02E Input AC1
  - 02F Input AC2
- 03 Timers
  - 03A Charge Time
  - 03B Since Absorb
  - 03C Since EQ
- 04 AGS Meters
  - 04A AGS Status
  - 04B DC Volts-AGS
  - 04C Gen Run Time
  - 04D AGS Temp
  - 04E Since Gen Run
  - 04F Since 100%
  - 04G Hour Meter
- 05 BMK Meters
  - 05A BMK Status
  - 05B Battery SOC
  - 05C DC Volts-BMK
  - 05D DC Amps-BMK
  - 05E DC AH In/Out
  - 05F Reset AH In/Out
  - 05G Total AH Out
  - 05H Minimum VDC
  - 05I Maximum VDC
  - 05J Days Since
- 06 ACLD Meters
- 07 PT Meters

SETUP Button
- 01 System Setup
  - 01A Set Clock
  - 01B Screen Setup
  - 01C Temp Display
  - 01D Max Charge
- 02 Inverter Setup
  - 02A Search Watts
  - 02B LBCO Setting
  - 02C AC In-Time
  - 02D AC In-VDC
  - 02E AC In-SOC
  - 02F Power Up
- 03 Charger Setup
  - 03A AC Input
  - 03B VAC Dropout
  - 03C Battery Type
  - 03D Absorb Done
  - 03E Max Charge Rate
  - 03F Max Charge Time
  - 03G Final Charge
  - 03H EQ Reminder
- 04 AGS Setup
  - 04A Gen Run VDC
  - 04B Gen Run Time
  - 04C Gen Run Amps
  - 04D Gen Run SOC
  - 04E Gen Run Temp
  - 04F Max Gen Run
  - 04G Quiet Time
  - 04H Gen Exercise
  - 04I Gen Warm-up
  - 04J Gen Cool Down
  - 04K Gen 100% SOC
- 05 BMK Setup
  - 05A Charge Eff
  - 05B Amp Hour Size

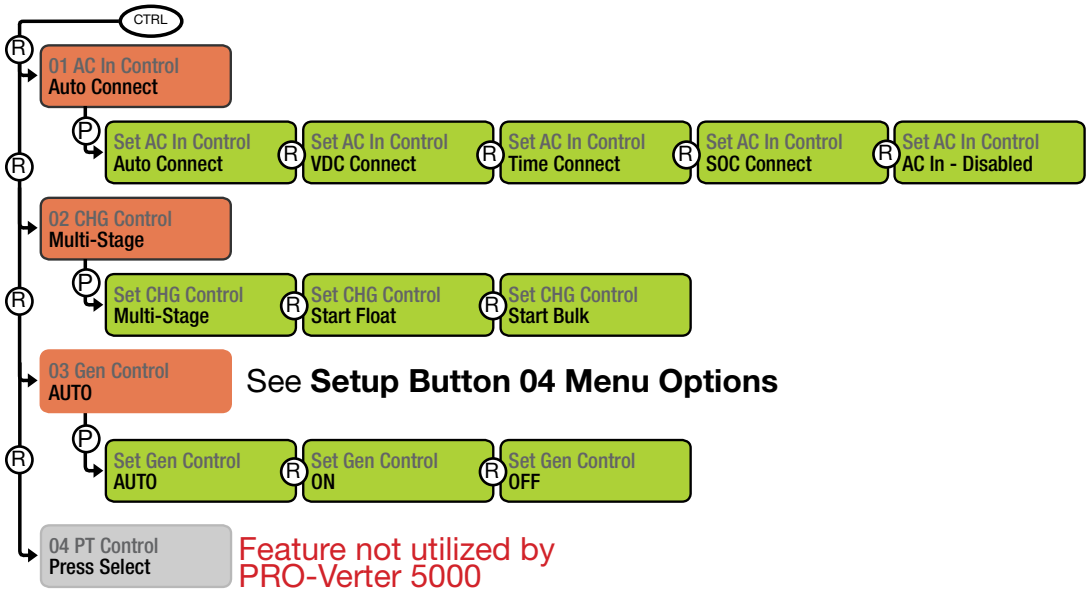
TECH Button
- 01 Temperatures
- 02 Revisions
- 03 Inv Model
- 04 Fault History
  - 04A Inv Faults
  - 04B AGS Faults
  - 04C PT Faults
  - 04D Clear Faults
- 05 Setup PIN
- 06 Ext Control
- 07 Show All Menus
- 08 Load Defaults

Programming Menu Map

FAVS Button Menus



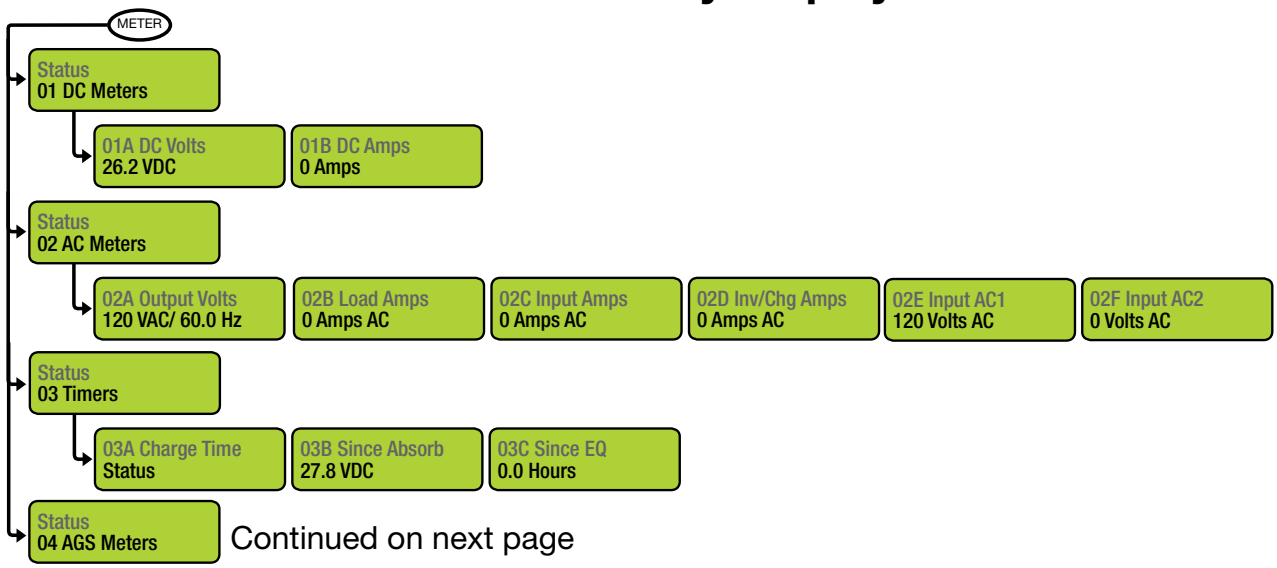
CTRL Button Menus



See **Setup Button 04 Menu Options**

Feature not utilized by PRO-Verter 5000

METER Button Menus: Read-only Displays



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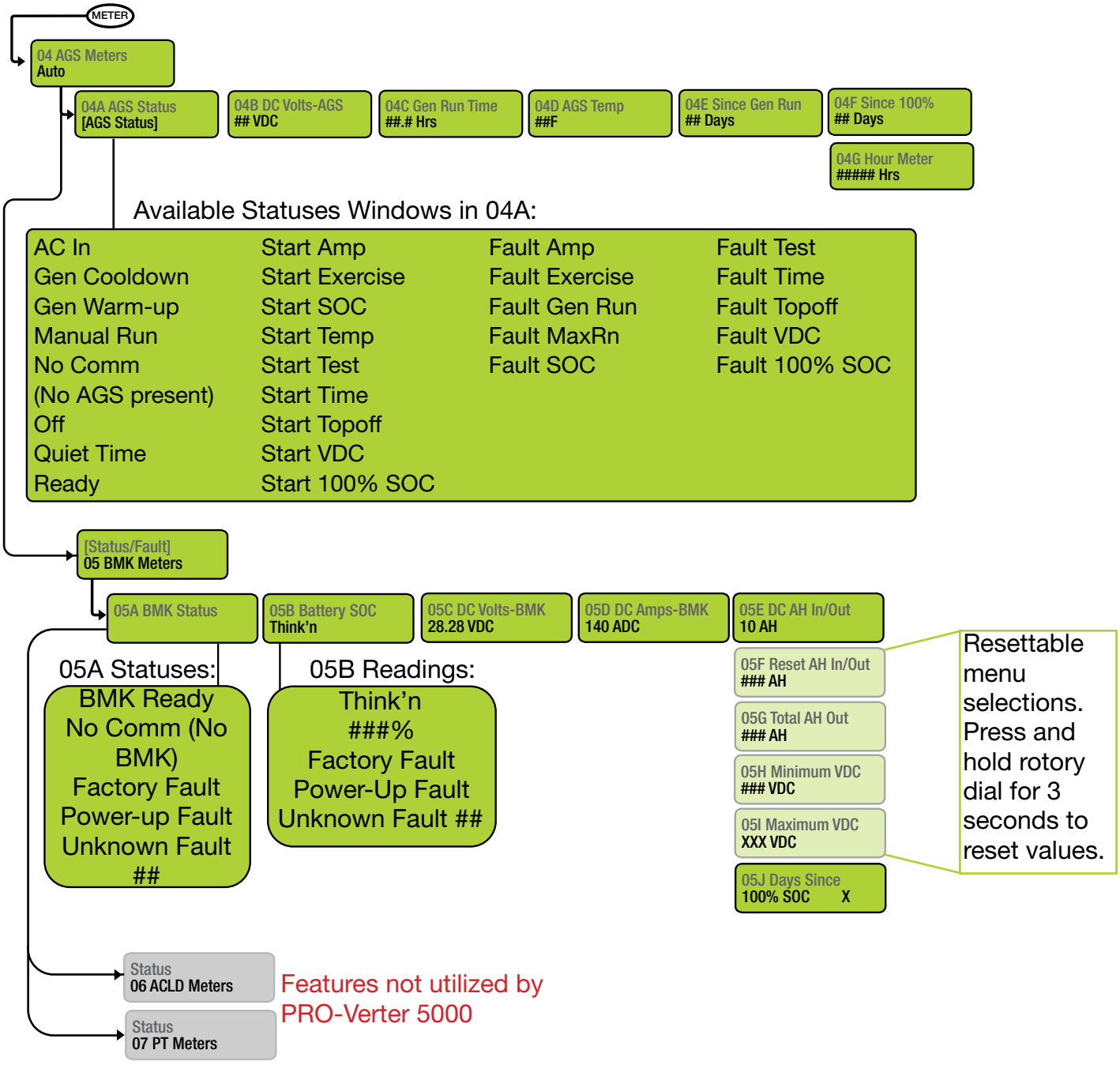
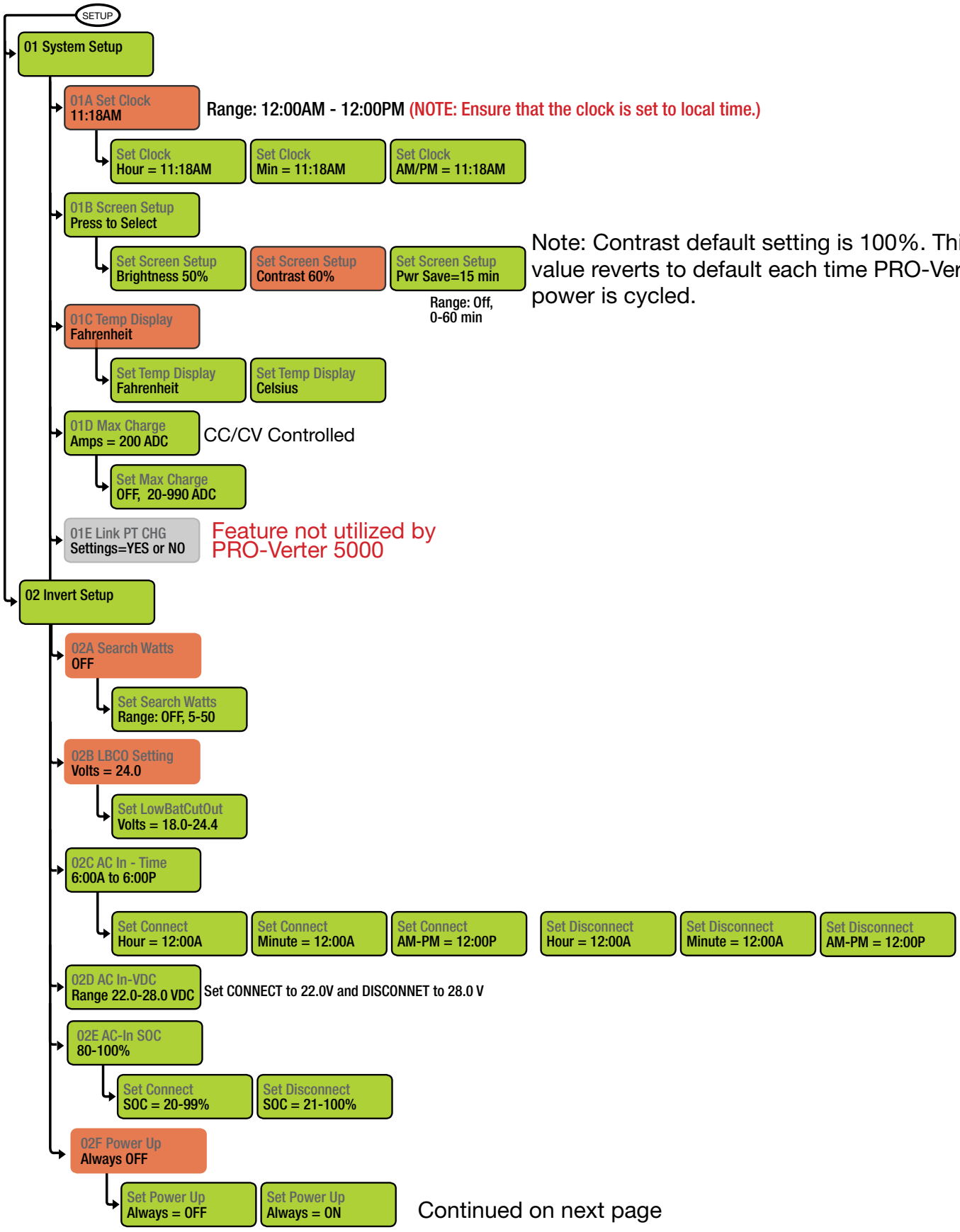
METER Button Menus continued



SETUP Button Menus

Setup: 01 System & 02 Inverter Setup



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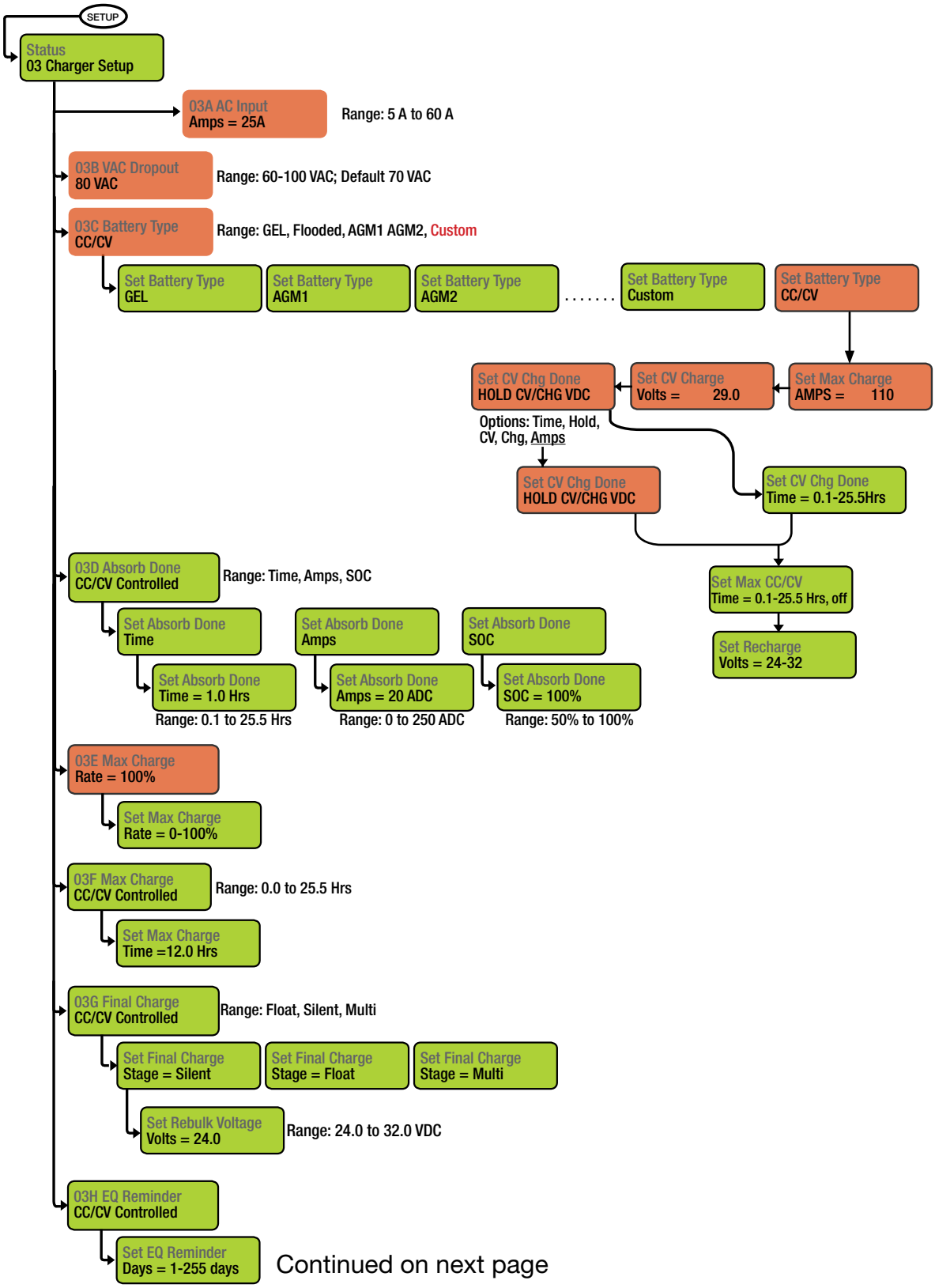
SETUP Button Menus continued

Setup: 03 Charger



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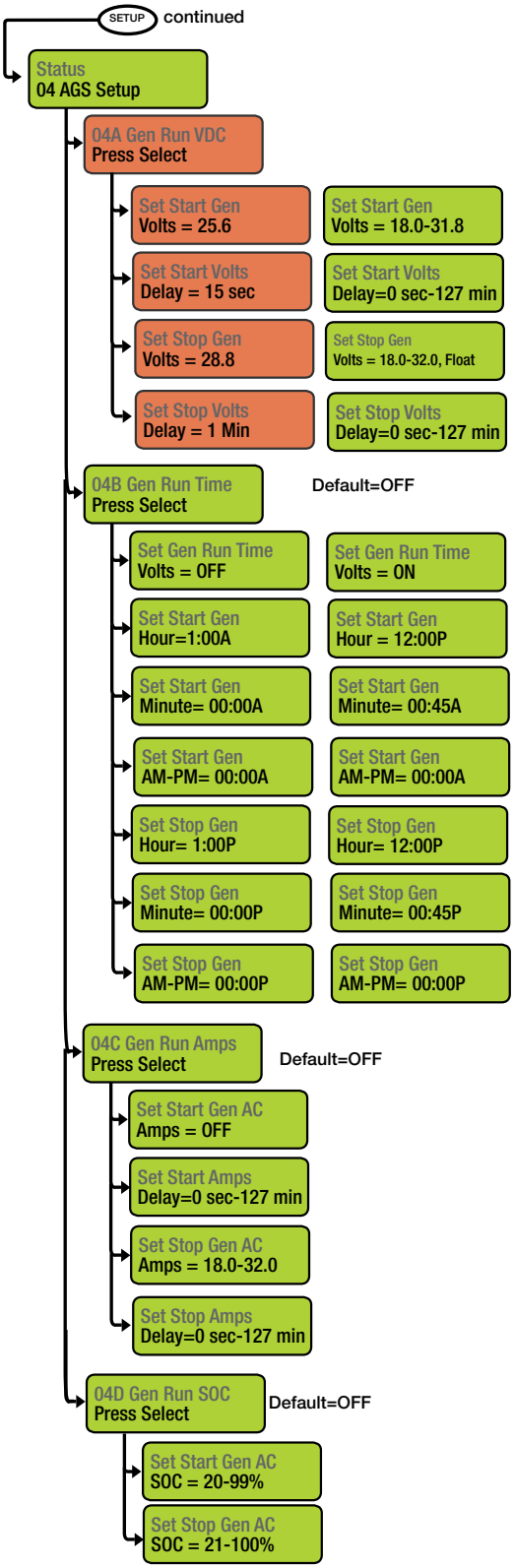
SETUP Button Menus continued

Setup: 04 AGS Setup



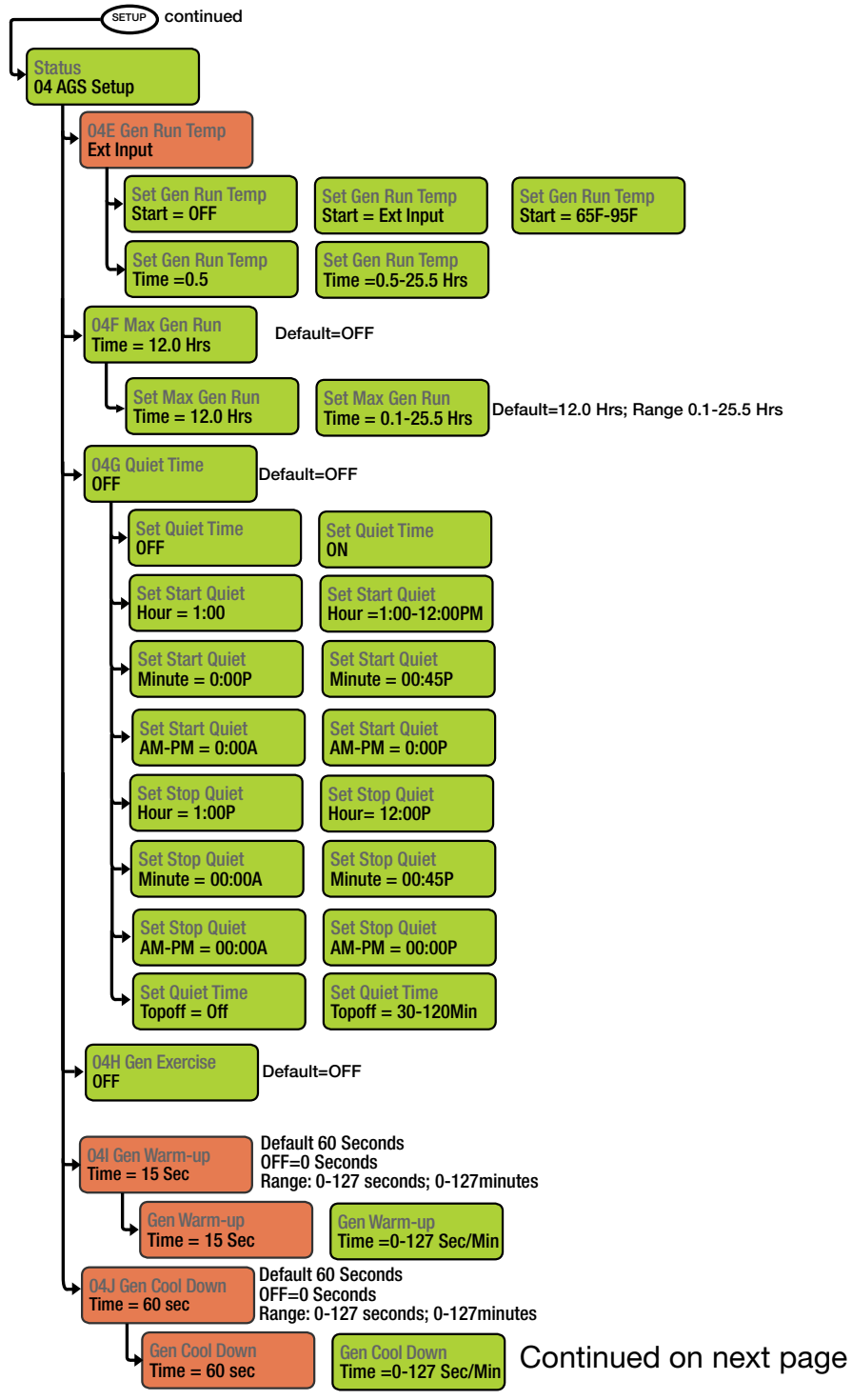
AGS Function Notes

- 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 24.4V (LBCO), the AC Out (Inverter) turns off. This is the LBCO voltage in the menu tree.

Continued on next page

SETUP Button Menus continued

Setup: 04 AGS Setup



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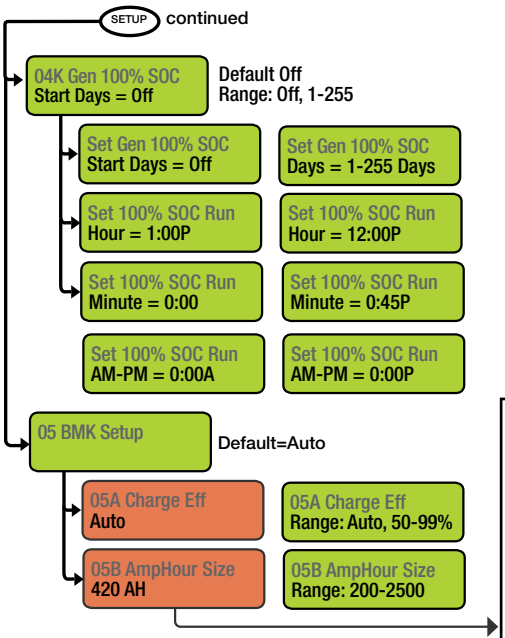
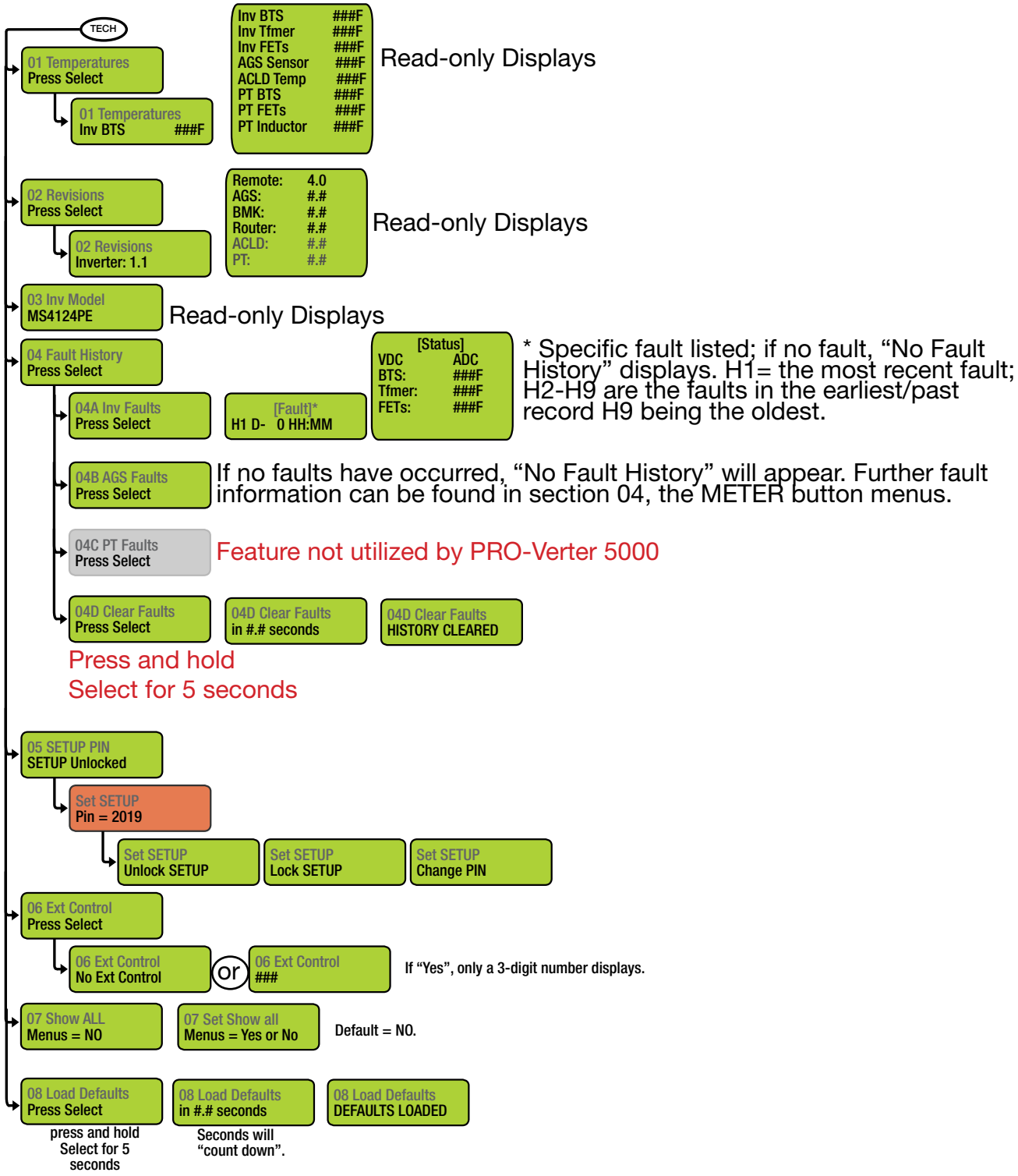
SETUP Button Menus continued

Setup: 04 AGS Setup, 05 BMK Setup



NOTE: The AmpHour Size value should be set according to the total capacity of the battery bank. For example, one 24VDC Li Expander Pak is 100 Ah. The minimum setting allowed is 200Ah. NOTE: The state of charge reported by the 24VDC PRO-Verter 5000-120 will be accurate only if the total battery bank size is at least 200 Ah.

TECH Button Menus



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 4 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 4. List of Faults and Source(s) of Problem

Fault	Excessive Load	Generator	Batteries	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

Generator Faults

1. Press CTRL button. Scroll to "03 Gen Control". Press SELECT. Rotate SELECT dial to "OFF". Press SELECT.
2. Press CTRL button. Scroll to "03 Gen Control". Press SELECT. Rotate SELECT dial to "ON" or "AUTO". Press SELECT.

Low Battery Fault

Apply AC power source to PRO-Verter to support loads and charge ESMs. Fault condition will reset automatically when ESMs are charged above 24 VDC.

Overtemp Fault

Inverter will automatically reset after 60 seconds of cooling fan operation.

Overcurrent Fault

Check circuit breakers. If green LED is not illuminated, reset breaker.

Reverse Polarity Fault

LED indicator will illuminate if the AC input connections are not correct

PRO-Verter Troubleshooting

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.

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BMK Faults

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Inverter/Charger Faults

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Quick Links to PRO-Verter Status Messages

Charger Mode Status Messages
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Quick Links to Problems: Solutions and Explanations

Charger Problems: Solutions and Explanations
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Quick Links to Other Troubleshooting Guides

PRO-Verter LCD Screen Troubleshooting Table

PRO-Verter LCD Screen Troubleshooting Table

If the display is not functioning correctly, use Table 5 to help find a solution.

Table 5. Troubleshooting the LCD Screen

Symptom	Possible Cause(s)	Solution
LCD Screen on but not responsive when buttons are pressed	Dust/dirt buildup inside of the LCD User Interface.	Remove the LCD User Interface and clean with compressed air. Please call Solar Stik Technical Support for assistance.
LCD is nonfunctional (no lights, or text on LCD screen, and no response when pressing any button).	Communications cable is bad or not connected correctly to the LCD port on the inverter.	Check communications cable from inverter to LCD; ensure (1) it is connected to the remote port and (2) the correct communications cable is used. (A four-conductor telephone cable may be substituted to determine if the cable is good).
	PRO-Verter is not connected to the batteries.	Ensure the inverter batteries are connected and the inverter is operating correctly without any AC power connected (can invert and power AC loads from batteries).
	No crossover cable or incorrect cable installed between the two ports on the RMK.	See PRO-Verter Remote Monitoring Kit (RMK) LAN Operator Manual.
Display shows unrecognized letters or symbols.	Static electricity may have been discharged into the LCD screen.	Refresh display: Press and hold the SELECT dial 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.

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).

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.

Back to Quick Links page

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.

PRO-Verter Charger Troubleshooting

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.

PRO-Verter Inverter Troubleshooting

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.

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.

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.

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.

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.

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.

PRO-Verter AGS Troubleshooting

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 dial to the 04 AGS Meters menu, and then press the SELECT dial. 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 dial to the 03 Gen Control menu.
2. Press the SELECT dial, and then rotate it to the ON setting.
3. Press the SELECT dial 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 Setup Instructions 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.

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.

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.

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 G-BOSS 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.

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.

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 Paks are operating normally (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.

How to Clear AGS Fault History

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

> **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.

PRO-Verter Battery Monitoring Kit (BMK) Troubleshooting

PRO-Verter 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.

PRO-Verter 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 dial, rotate the dial until the 04B AGS Faults menu displays, and then press the SELECT dial.

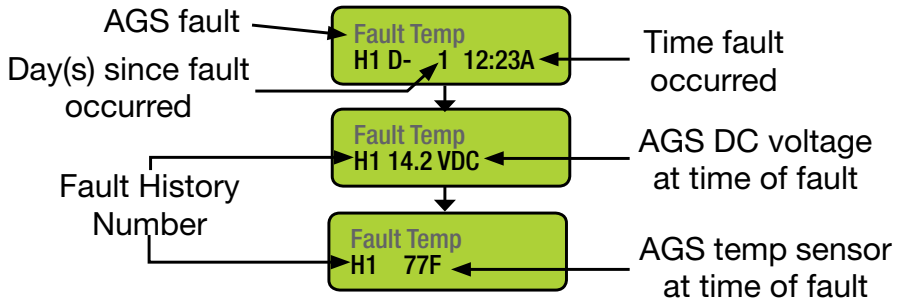
04B AGS Faults
This menu displays a history of the last nine AGS faults. Information for each fault displays from the most recent fault (H1) to the earliest/past recorded faults (H2 up to H9).

> **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 dial 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 dial 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 dial, rotate the dial until the 04B AGS Faults menu displays, and then press the SELECT dial.



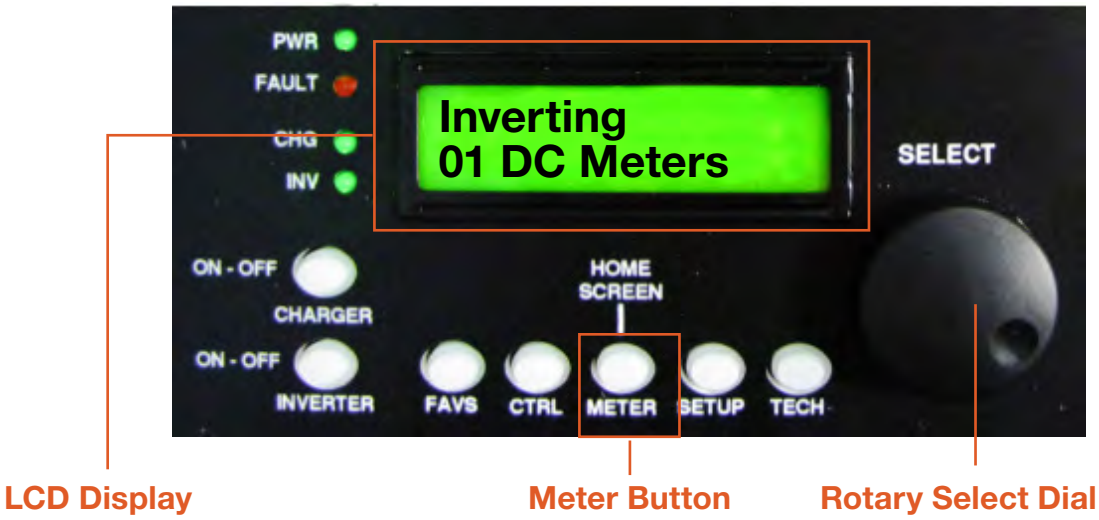
PRO-Verter: Historical Data Collection

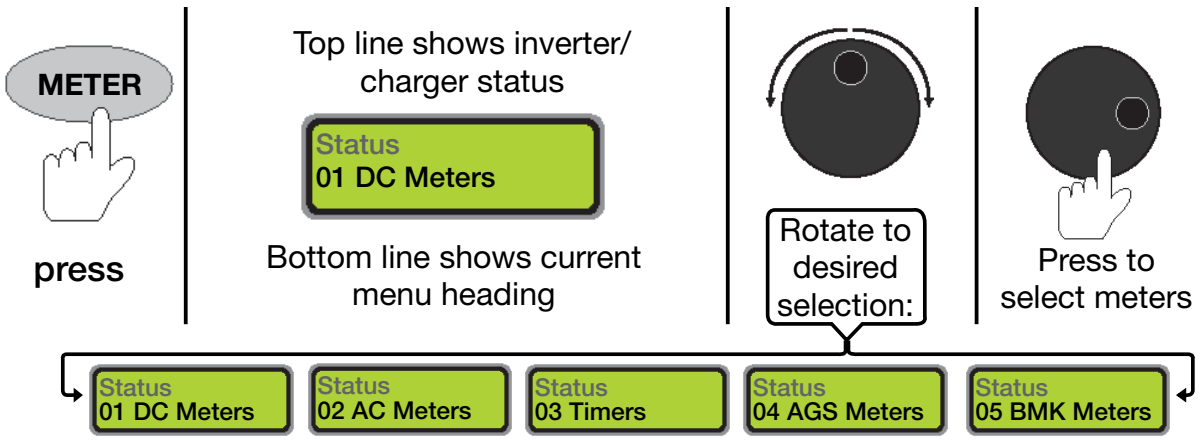
The PRO-Verters can provide some historical data for generator and battery operation.

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.

Meter button options

See the METER button menu maps for a complete listing of information provided in each submenu.





Auto Generator Start/Stop (AGS) 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) Circuit Operational 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 dial 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.

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 dial 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 dial 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.

Generator Troubleshooting

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

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

Generator Starts, Shuts Down When Load Transferred

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

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

Generator Short-cycles

Causes

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

Solution

1. Verify the Inter-Connect Circuit is in accordance with the schematic on the PRO-Verter I-Plate.
2. The Gen Run VDC should be set to 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 section.

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 too high—not enough power available from generator to support both charging and load 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 F3) setting is too low.
5. Charge Rate (SETUP 03E) setting is too low.
6. Battery capacity (FAVS F2) is too large.
7. Charger programming is not compatible with the battery type.
8. Battery Temp sensor is reading high temp. (Clean air filters.)

SOC Disparity Among System Batteries

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.

Battery SOC disparities may cause erratic System behavior including:

- Premature termination of the AGS functions, or generator "short-cycling" (frequent start / stop)
- Battery 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 Battery 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.

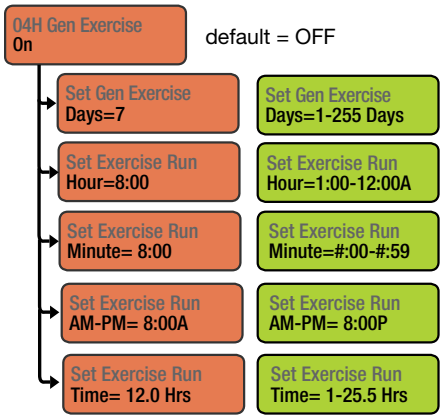
Maintaining SOC Parity

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

Method to Maintain Battery 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.



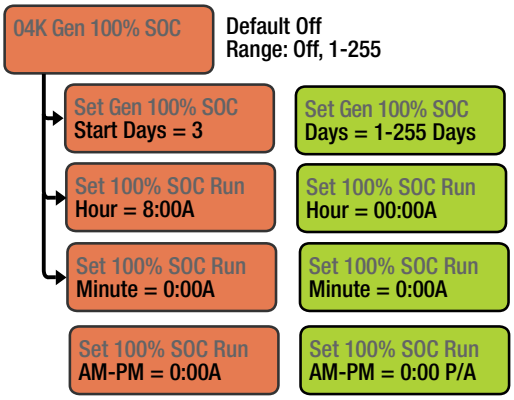
1. Press the SETUP Button on the PRO-Verter user interface (password may be required).
2. Navigate to 04H Gen Exercise. Press SELECT to enter this menu.
3. Enter and save the values best suited for your application into each of the fields. Start with the frequency (e.g., every seven days) and duration (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 Battery SOC Parity using Gen 100% SOC

The feature “Gen 100% SOC” is designed specifically for the purpose of equalizing the SOC of all batteries in a bank 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 battery 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 batteries 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%. .

Notes

- 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.

System Recovery to Restore Overdischarged Batteries

1. Disconnect/turn off all AC loads (if present) connected to the PRO-Verter.
2. Turn off the power switch on all but one (1) of the batteries or disconnect all but one (1) battery from the Inter-Connect circuit if the battery does not have a power switch.
3. Connect a 120 VAC power source to the PRO-Verter AC Input port. Turn on PRO-Verter Main Power switch.
4. Push the FAVs F1 button. Press SELECT. Reduce max charge rate to 10%. Press SELECT. Press HOME button.
5. Toggle and HOLD the System Recovery momentary switch until the battery/bus voltage rises to operational level and the PRO-Verter CHG LED is constant green. This may take several minutes.
6. Once the PRO-Verter enters charging mode and the current is flowing, turn on or reconnect all batteries.
7. Allow the PRO-Verter to charge at 10% rate until all ESM voltages have returned to operational levels.
8. Return max charge rate to 100%.
9. Charge all batteries fully.
10. Reconnect and/or turn on PRO-Verter loads.

Note: The recovery feature works even if the inverter has been turned off in the program settings.

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 G-BOSS 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 Battery to "FULL".

Expander Paks should be charged until in "FLOAT" stage 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

MAINTENANCE INSTRUCTIONS

HPS Preventive Care and Maintenance

Follow these procedures to maintain the System. See PMCS tables for details.

- **Shade the components (except the PV arrays) from direct sun exposure and shelter them from the elements.**
- Clean air filters of the PRO-Verter and Power Hub (if using) air intake vents once a month or more frequently as warranted to minimize the accumulation of internal heat.
- Follow the generator maintenance procedures listed in the generator operator and maintenance manual.
- Keep component case lids and unused Inter-Connect port 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.

24VDC PRO-Verter 5000-120 PMCS

Table 6. 24VDC PRO-Verter 5000-120 PMCS

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

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

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 26) and remove the louvered vent cover to access the filter.

Figure 26. Fastener locations on vent shroud (upgraded/new version)

Figure 27. 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 28). 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 28.

Figure 28. 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.

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 29. Lock securing the lid of the Power Hub 2400

ABOUT SOLAR STIK, INC.

SOLAR STIK®

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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