SOLAR STIK®

OPERATOR MANUAL FOR 24VDC PRO-VERTER 5000-120 AGS

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GENERAL INFORMATION, THEORY OF OPERATION, AND EQUIPMENT DESCRIPTION

PRO-Verter Introduction

The primary function of a Portable Remote Operation – Inverter/Charger (PRO-Verter) is to serve as the central power management device in a circuit where both alternating current (AC) and direct current (DC) are present and being used.

A PRO-Verter is designed specifically for operation between energy-storage batteries (DC) and a fuel-driven generator or utility-grid (AC) power. When being used with a portable fuel-driven generator and a bank of batteries, it creates a “hybrid” power system (HPS) that allows energy storage technologies to play a critical role in applications where any combination of the following is necessary:

- Backup power for critical loads when the primary power source fails
- Reducing generator burdens (fuel consumption, wet-stacking, maintenance, or logistic support)
- Durations of “silent” operation are critical
- Use of renewable power generation is desirable
- Less reliance on grid-utility power is desirable (peak shaving)
- Temporary replacement of inadequate grid or generator power during periods of peak power demand (peak power delivery)

A PRO-Verter is a modular, portable component of the HPS architecture, and its flexible function and design allows the operator to use it with technologies that collectively meet the specific mission requirements in an application.

All PRO-Verters are “Plug & Play”-compatible with the Inter-Connect circuit and can be used with additional PRO-Verters (PRO-Verter “stacking”) when high-power or multiple load voltages are required.

AC and DC cables for a PRO-Verter are sold separately, as they must be correct for the voltage type and their current-carrying ability.

Figure 1. A PRO-Verter with an HPS

Use of the PRO-Verter in a System

The PRO-Verter provides specific capabilities for the system in which it is employed, but systems vary in accordance with the operator's requirements; consequently, not every feature in the PRO-Verter may be used for an application.

The PRO-Verter is delivered fully programmed at the factory for the customer's system and application, and only minor programming adjustments are usually needed in the field.

Most of the features/functions are controlled by programming at the user interface. This manual provides an overview of the core feature/functions and capabilities of the PRO-Verter along with a complete overview of the menu options, but there are many functional properties within the programming menus that are not covered.

The PRO-Verter programming can be easily adjusted for changing conditions. If the system architecture is altered (changes to system functions) or if the operational environment changes (climate), programming can be manipulated accordingly.

Please consult the specific System Operator Manual for information on how the PRO-Verter is programmed for its specific role in a particular system.

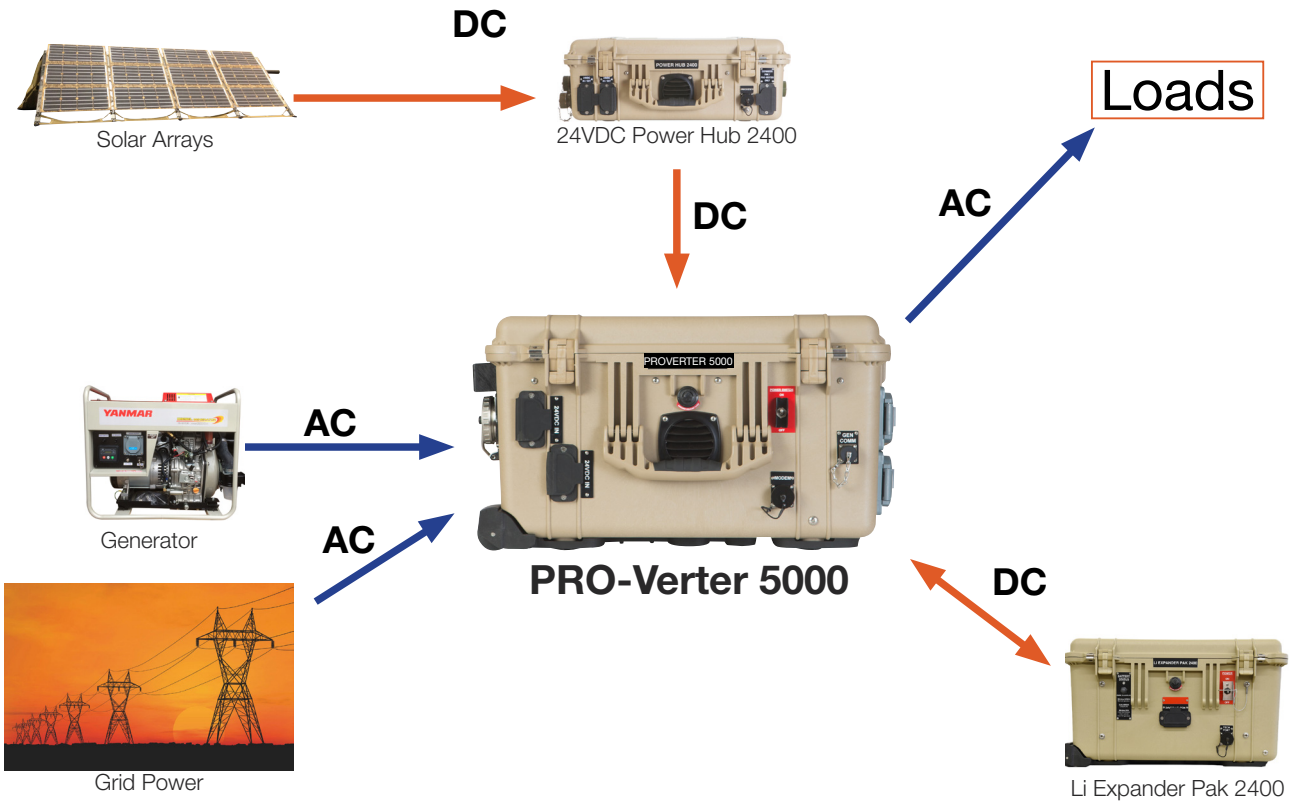


Figure 2. How a PRO-Verter works in a System

Important Product Safety Information and Instructions

This manual contains important safety instructions that must be followed during the installation and operation of the 24VDC PRO-Verter 5000-220 AGS. Read all instructions and safety information contained in this manual.

While the PRO-Verter is 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 equipment is unattended.

The PRO-Verter is not field serviceable. If repair is needed, contact your field service representative (FSR) for assistance in diagnosis and identification of the proper repair and parts.

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

Figure 3. 24VDC PRO-Verter 5000-120 AGS

Shown with AMMPS Auto Generator Start and Remote Monitoring Kit (Item # 20-0702604)

Safety Information Labels

Your safety and the safety of others is very important.

Always read and obey all safety messages.

This is the safety alert symbol. This symbol alerts you to potential hazards that can kill you or hurt you and others. 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 tell you what the potential hazard is, tell you how to reduce the chance of injury, and tell you what can happen if the instructions are not followed.

Limitations on Liability

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

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

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

Fire Hazard

Fire Types

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

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

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

Recommended Fire Extinguisher

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

⚠ WARNING

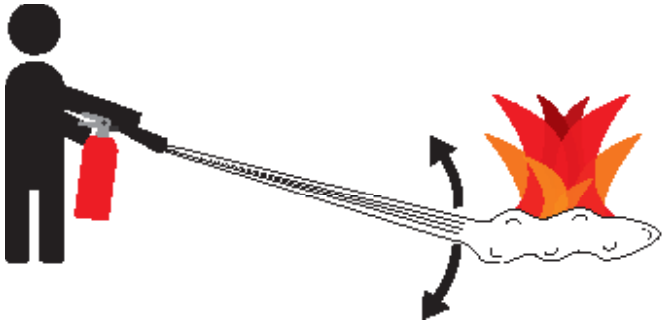
Only CO_2 (carbon dioxide) fire extinguishers should be used with Solar Stik equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

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

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



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

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

Electric Shock Hazard

⚠ WARNING

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

DON'T LET THIS BE YOU!

HIGH VOLTAGE: System components, solar arrays, and generators may have 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

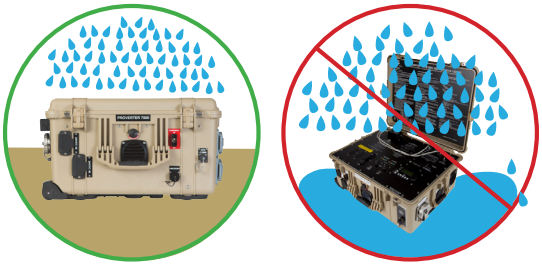
The 24VDC PRO-Verter 5000-120 AGS is NOT GFCI protected.

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 product.

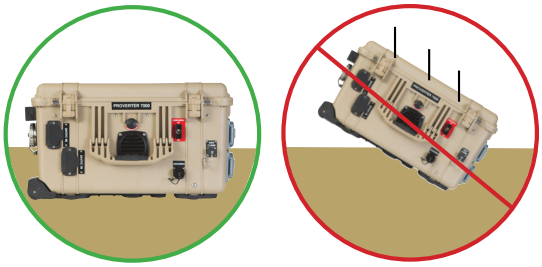
Water

If outdoor operation is necessary, the lids of all components should be closed and latched whenever possible. **Lids should only be open to access operator controls and closed at all other times.**



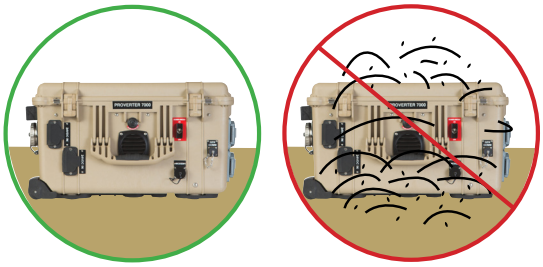
Impact

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



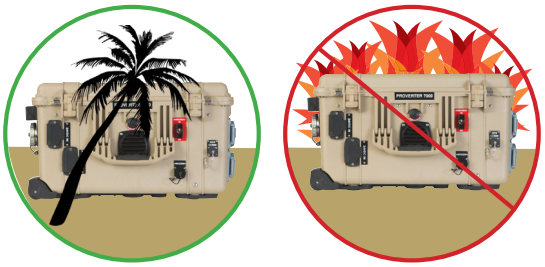
Dust/Foreign Object Intrusion

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 reduce efficiency and life expectancy. Shade products (except PV arrays) to prevent the negative effects of extreme heat.



Theory of Operation

Models of Operation

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

DC-only/Inverter (automatic functions)

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

Hybrid (automatic functions)

Operating conditions – The "Continuous Load" AC power requirement is LESS than the individual Inverter or Generator/Grid AC power output ratings.

In the Hybrid model, the PRO-Verter serves as the primary power management device in a System, using either Inverter AC power or Generator/Grid AC power to maintain the load. In the Hybrid model, the batteries will cycle regularly to mitigate generator run-time 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.

In the Load Support model, 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 only be supported 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 usually pre-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 for HYBRID, LOAD SUPPORT, PEAK POWER DELIVERY or UPS models when changes to operating conditions and system architecture are necessary. Consult the System Deployment Guide for details.

Selecting a Generator/Grid AC Source

PRO-Verters can be used with grid-utility or generator AC power sources, and can be easily programmed to work with the amperage limits of both the AC source circuits and the AC load circuits. Once programmed, the PRO-Verter effectively calculates and then regulates how much power is delegated between these circuits, to prevent overload conditions while maintaining (prioritizing) the load.

Acceptable generators/grid AC sources for use with a single PRO-Verter should provide power between 1 kW to 10 kW, and ALL source AC power must provide consistent, pure sine-wave AC output. The PRO-Verter will not accept modified sine wave AC, or “dirty” power. Fluctuations in voltage or frequency during operation may have an adverse affect on PRO-Verter functions. (See Troubleshooting AC Problems)

Many factors should be considered when selecting a specific generator for use with a PRO-Verter, including:

- Auto-start/stop capability
- Physical size
- Weight
- Fuel consumption
- AC output rating

If a particular generator is desired based on the application, then one of the following power models will likely be used:

The Hybrid Model

- The peak AC load should not exceed the maximum continuous AC output of both the PRO-Verter and AC power source (i.e., **Peak Load AC ≤ AC Source and PRO-Verter AC**)

The Load Support Model

- The peak AC load should not exceed the PRO-Verter maximum continuous AC power output (i.e., **Peak Load AC** ≤ **PRO-Verter AC**).
- The peak AC load can exceed the AC source maximum continuous AC output up to 130% (i.e., **Peak Load AC** ≥ **Source AC**).

The Peak Power Delivery Model

- The peak AC load exceeds the PRO-Verter continuous AC output up to 150% (i.e., **Peak Load AC** ≥ **PRO-Verter AC**)

Note: Several programmable settings may affect the ability of the PRO-Verter to operate with a particular generator or grid AC power source. Surges and/or overloads can occur at the AC source when the transfer switch engages, causing it to shut down or overload. Consult Solar Stik Technical Support when configuring the PRO-Verter programming for a particular AC source.

Energy Storage Requirements for Operation

PRO-Verters require connection to an active 24 V battery circuit in order for it to operate. They CANNOT be used directly between an AC source and an AC load without a battery connected to it. PRO-Verters are compatible with both lead-acid and lithium battery chemistries.

A minimum of four (4) energy storage modules (i.e. Expander Paks or Power Paks) must be present and functioning for the PRO-Verter to be able to operate at its rated power.

DC Voltage

The PRO-Verter has an intelligent brain that uses one primary data point for most of its critical operating decisions – battery (bus) DC voltage.

The Inter-Connect Circuit communicates VOLTAGE! Voltage is the one value that triggers all of the events in the PRO-Verter. If it can't read the battery voltage, it can't perform its critical role. Make sure all system configuration diagrams are followed and that setup is complete before attempting to operate the PRO-Verter.

DC Voltage is the safest and most reliable "trigger" mechanism for controlled functions such as external generator start/stop, charging rates and inverter modes, and load prioritization/sharing.

Battery Voltage can also be universally used to accurately determine SOC, at both fully "charged" and "discharged" thresholds for ALL battery chemistries. This allows the operator to choose from multiple chemistry options when configuring energy storage that is compatible with mission requirements, logistics, and cost.

Voltage is also used to determine battery health, correct system sizing, configuration management and troubleshooting, and also affects both historical and real-time performance data.

PRO-Verter Circuits and Functions

A PRO-Verter is the central power management device (i.e. the “brain”) for a Hybrid or High-Efficiency Electrical System. At its core, the PRO-Verter has a combination inverter/charger, which operates in concert with its supporting circuits to provide the operator with a multifaceted solution and seamless power for an application:

Primary Circuits
- INVERTER – Transforms DC from a battery to AC for use by a load
- CHARGER – Converts AC from generator or grid to DC for charging batteries

Support Circuits
- BMK – “Battery Monitor” circuit
- AGS – “Automatic Generator Start/Stop” circuit

Recovery Circuit
- AC-powered System Recovery (overdischarged batteries)

NATO Circuit –
- DC Load or Battery Charging circuit

Both the primary and the support circuit functions of the inverter/charger are managed by native programming, which can be easily adjusted through settings made at the User Interface.

If the PRO-Verter is connected to an over-discharged battery, the recovery circuit enables the PRO-Verter to restore the battery to service using a 240 VAC power source such as a generator or grid utility. This circuit is not programmable and is an Optional Feature.

The NATO port allows connection of a NATO 24V DC circuit to the Hybrid System’s 24V bus. This can be in support a 24V DC load or to allow charging from an external 24V DC source.

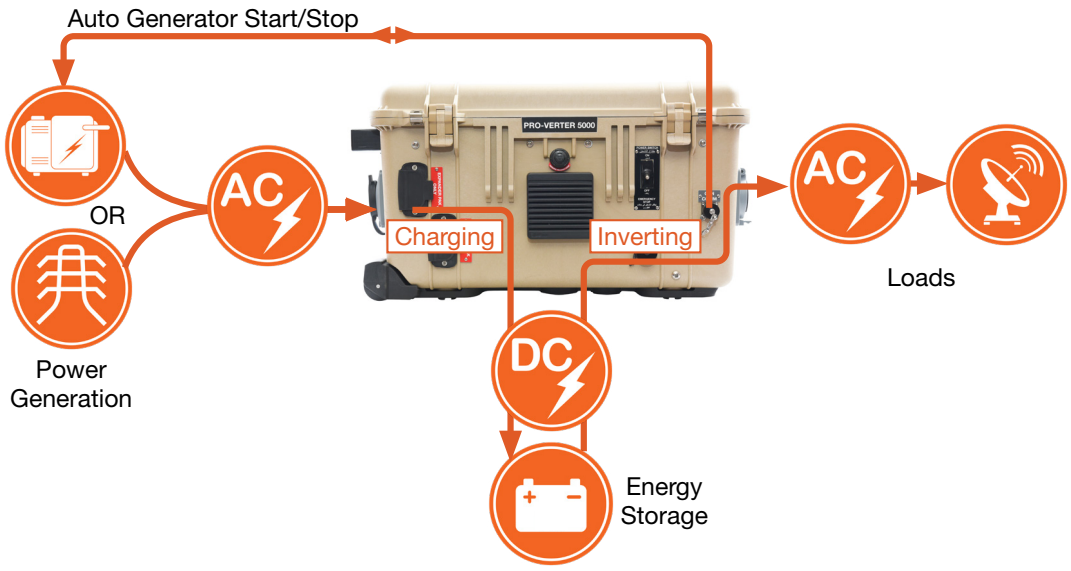


Figure 4. PRO-Verter primary circuits

Load Prioritization

The PRO-Verter has a “one-track mind” when it comes to managing power – In every operation mode it is entirely focused on maintaining constant power to the load. This function is key to understanding how the PRO-Verter behaves. It makes decisions and executes actions based on a real-time operating conditions, which include:

- Total amount of power available to the PRO-Verter
- total power needed to support the load
- Battery state of charge (SOC)
- Temperature
- User programming for special conditions

PRO-Verters can be used with grid-utility or generator AC power, and can be easily adjusted to work with the amperage limits of both the AC load circuit and the external AC power source. Limitations can be programmed into the PRO-Verter, and once done, it effectively calculates and then regulates how much power is delegated between the circuits, preventing “overload” conditions, while maintaining (prioritizing) the load.

If there are dynamic changes in the load, the PRO-Verter can instantly increase or decrease current flow to both the load and batteries simultaneously while maintaining a 100% load at the generator (AC INPUT).

If a PRO-Verter is being used with other external DC power sources (i.e. Photovoltaic, Wind, vehicular, fuel cells, etc), all incoming power will be directed (prioritized) to the load, reducing DC flowing from the batteries, prolonging battery-operation time and the reducing need for AC from a grid-utility or generator source.

If a PRO-Verter is being used with a fuel-driven generator, the AGS circuit can be used to control the generator when the battery SOC is low. Once the battery SOC reaches a determined point, the PRO-Verter AGS circuit will start the generator, ensuring (prioritizing) power to the load. In effect, the PRO-Verter uses a connected generator as the last line of defense against mission failure.

With Load Prioritization, the load will always be the first to receive AC, with balance of electrical output from a grid-utility or generator converted to “potential energy” which is stored in the batteries, to be used during periods where the grid source is unavailable or the generator is off.

Real-time Load Management

When connected to an active AC power 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 power source from exceeding the value of the AC INPUT setting while still maintaining a 100% load at the external AC power 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 power output rating of the source. For example, if the generator is rated for 3000 Watts continuous output, then the AC INPUT should be set for 25 Amps for @ 120 VAC or 13.6 A @ 220 VAC (=3000 Watts).

"Pass-through" Power and the Internal AC Transfer Switch

The PRO-Verter employs a high-speed transfer switch that enables it to toggle between incoming AC power when it is available (i.e. when the generator is on or it is connected to grid-utility power) and Inverter power when necessary (using energy from the batteries).

When AC power is available at the PRO-Verter's AC input, it is first "qualified" by the PRO-Verter to make sure it is acceptable (i.e. within the programmed limits of quality) to pass on to a connected load, and once it has been qualified (approximately 15 seconds in duration), the switch engages and incoming AC power is transferred directly to the load. The PRO-Verter is designed to ensure that the load is always supported FIRST before it does anything else with the incoming power (Load Prioritization).

The primary benefit of using a transfer switch is simple: it maximizes the efficiency of the system while keeping constant power to the load:

- If the PRO-Verter is controlling a generator, the transfer switch allows it to maximize the load on the generator (for optimal engine operation), and it also ensures that the all of the fuel (i.e. "energy") consumed in the generator engine is utilized - for direct load support and/or to charge a connected battery bank (storing energy for later use).
- If the PRO-Verter is being used with grid-utility power, the transfer switch allows the PRO-Verter to control multiple conditions under which power is harvested, including time-of-day, peak-shaving, or other condition based on application requirements.

The transfer switch is directly controlled by the inverter function, but it ONLY reacts to the presence of incoming AC power from a generator or grid-utility. The switch ensures that the AC output of the PRO-Verter is always active, whether the PRO-Verter is inverting or passing power through from an external source (generator or grid).

If inverter function is engaged, the transfer switch is also engaged. The transfer switch is disabled if the Inverter function is off.

Transfer time between incoming AC and Inverter mode is ~16ms when using 60Hz, which is usually fast enough to support computers, servers, and other critical loads, however, the "effective" transfer switch time may be prolonged if the frequency is lower (i.e., 50Hz) and/or if the VAC DROPOUT (Charger Setup menu) is set too low for the loads to be sustained (the voltage drops below a load's minimum voltage requirement AND the transfer switch causes an interruption in AC to the load.

When using the PRO-Verter with critical loads, the VAC DROPOUT should be set to UPS MODE. The disadvantage of a higher VAC Dropout setting is that smaller generators (or large generators with an unstable output) may nuisance transfer. This happens commonly when powering loads that are larger than the generator can handle—causing the generator's output voltage to constantly fall below the inverter's input VAC dropout threshold.

Note: When switching from Inverter mode to Standby mode, the PRO-Verter waits approximately 15 seconds as it qualifies the incoming AC, ensuring the AC source is clean and stable before transferring the load.

Qualifying AC Input Power

The PRO-Verter must only be used with AC sources that generate or provide pure sinusoidal waveforms with voltage and frequency that meet minimum standards.

When an active AC source is connected to the PRO-Verter, it will “qualify” the power before passing it through to the load and initiating the battery charging sequence. If the PRO-Verter detects poor quality AC power, then the PRO-Verter may reject it and remain in invert mode.

Once AC has been accepted, it will not automatically reject the AC input power if it falters or morphs during operation. It can, however, be programmed to reject the power of it falls below certain thresholds, such as the VAC DROPOUT setting.

If the AC waveform itself distorts during operation, it may cause certain PRO-Verter functions to retard (de-rate) or cease. For example, if the Field Effect Transistors (FETS) and the EMI filter are pushed beyond their design limits by poor AC power, it may result in a FET OVERLOAD or FET OVERTEMP faults, which will cause either retardation of charging functions or a failure to provide AC power to the load.

Charge Function

Whenever an AC source is connected to the AC INPUT, the PRO-Verter automatically begins monitoring for acceptable AC voltage and power quality. During this qualification phase, the CHARGER (“CHG”) LED will blink rapidly. Once the AC voltage is accepted, the AC transfer relay closes passing AC power to the load, and then CHARGE function begins, indicated by a steady-on “CHG” LED at the User Interface, and the LCD will show “CHARGING”.

The PRO-Verter is equipped with a logic-controlled, multi-stage battery charger. It actively monitors battery voltage and SOC, using this information to control the amount of power used to charge the batteries in real-time. Voltage and current are independently controlled so that maximum charge current is always applied to the batteries, reducing charging times. This maximizes the real power available from the AC power source (grid-utility or generator), which translates into less power wasted and less dependence on external power sources.

The automatic, multi-stage charger in the PRO-Verter provides Bulk, Absorb, Float, and “Full Charge” stages, ensuring complete recharging and monitoring of the batteries without damage due to over/under charging. There is also a “Constant Current / Constant Voltage” (CC/CV) option for use with certain types of lithium batteries.

When entering CHARGE mode, the PRO-Verter uses battery voltage to determine the charging stage. If the battery voltage is low, the charger begins Bulk charging. If the voltage is high enough, the charger will skip the Bulk and Absorb charge stages and go directly to Float charging.

If the PRO-Verter is being operated in high-heat environments, it can “throttle-back” its charging amperage rate to prevent overheating of the internal transformer or FET board. The “CHG” LED will blink when this protection is engaged.

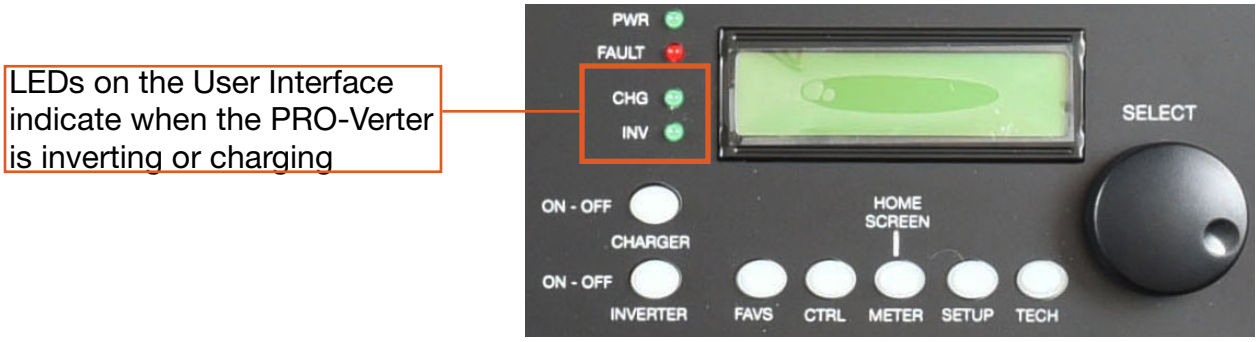


Figure 5. Invert and charge mode LEDs on User Interface

Invert Function

The PRO-Verter's Invert function transforms DC from a connected battery into pure sine-wave AC power for an AC load. When 24 volts DC is available from a connected battery, the PRO-Verter automatically engages its inverter circuit functions, and AC power is immediately available for the load. The inverter ("INV") LED indicator at the User Interface will be steady-on when AC power is available, while inverting, or in standby.

When AC power is available from a grid-utility or generator source, the PRO-Verter is programmed to defer the load (via the transfer switch) onto the external source, which will cause the inverter circuit to go into "standby" mode (green INV LED remains on). In standby mode, the inverter circuit is not actively providing power from the batteries to the loads, rather, the loads connected to the inverter are powered directly using the external AC power (pass-through power). However, if power from the external AC source is interrupted, the inverter senses these conditions and immediately starts inverting to maintain AC output to the loads.

Only a manual deactivation of the inverter function will cause the LED to turn off. If the inverter function is not engaged, then AC power will only be available when the PRO-Verter is connected to an active AC source, and it is passing power through to the AC load. **It is recommended that this function always remain on**.

The inverter circuit has extensive protection circuitry to shut down the inverter under certain fault conditions. The red FAULT LED will be steady-on and the associated error message will be shown on the LCD.

Automatic Generator Start/Stop (AGS) Function

The AGS circuit is used to start/stop an external generator, controlling it based on AGS programming that is made for the application in which the PRO-Verter is being used.

Generator function can be triggered by singular or multiple conditions, including:

- Battery state-of-charge (SOC)
- Time of day
- Peak shaving
- Quiet time

When the AGS is active during hybrid operation, it might only start/stop a generator as a last line of defense to ensure continuity of power is available to the load when the batteries are at low SOC.

The GENERATOR STATUS LEDs located on the faceplate provide the following information to the operator:

- The Ready LED indicates when the AGS has power and is ready for normal operation.
- The Status LED indicates when the AGS system is initiating a generator start sequence. This happens when the Test button (on the AGS) has been pressed and released, or a programmed condition has triggered the AGS to autostart the generator.
  - ✳ Blinking green LED indicates that the generator start sequence has begun.
  - ● Steady-on green LED Indicates the generator has started successfully and is providing the Gen Run sense signal/voltage to the AGS module.
  - ● Steady-on RED LED Indicates a fault condition in which the generator either has not started, or has not provided the correct run gen sense signal/voltage to the AGS module – after four (4) start attempts
- See also Table 1.

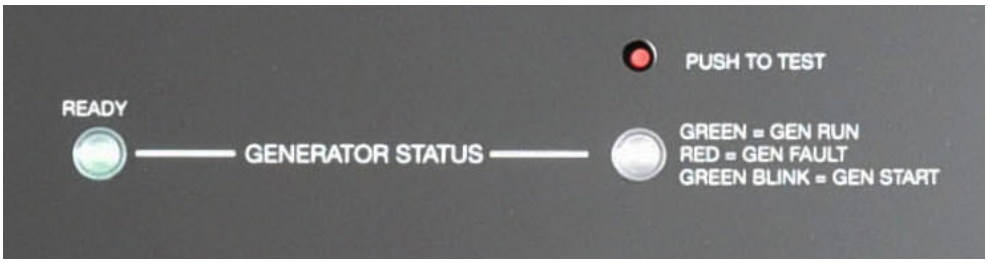


Figure 6. AGS Status LEDs

Testing the AGS Function

There is a red AGS TEST button at the AGS interface that can be used to confirm that 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 blink green indicating the AGS has initiated an automatic generator start/stop sequence.

Once the generator starts, view the STATUS LED and ensure it turns solid green (indicating 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.

AGS Audible Alarm

The PRO-Verter has an audible warning that signals the generator has initiated the autostart protocol and is about to start. This provides operators standing or working on or around the generator with an opportunity to take precautions before it auto-starts. This function can be disabled for silent operations.

Cooling Fan Operation

The PRO-Verter contains two (2) variable-speed internal cooling fans that are controlled automatically. The speed of these fans is determined either by the PRO-Verter internal temperature or by the load on the transformer.

- Fans run at full speed if the FETs or the power transformer reaches 80 °C (176 °F), or the inverter is running at 100% of its rated load.
- Fans run at medium speed if the FETs or the power transformer reaches 60 °C (140 °F), or the inverter is running at 50% of its rated load.
- Fans run at low speed when the inverter is running at 25% of its rated load.

The fans shut down when none of the above conditions are met, or if the battery voltage drops below 20 V.

Protection Circuits

The PRO-Verter is protected against fault conditions using both internal protection circuits and external circuit protections in the form of magnetic/thermal circuit breakers. During normal usage, it will be rare to see any faults; however, if a condition occurs that is outside the normal operating parameters, it will shut down and attempt to protect itself, the battery bank, and the AC loads. If there is a condition that causes the inverter to shut down, it will be reflected as a FAULT with the indicator LED in a steady-on state. The LCD will display an error message with the fault code/reason. (Refer to the Troubleshooting Procedures section to help diagnose and clear the fault condition).

Note: Circuit breakers will vary among PRO-Verters according to customer requirements and connection ratings.

EMI Circuit Protection

The AC power output of the PRO-Verter is filtered using a high performance 2-stage EMI filter inside the PRO-Verter to reduce high-frequency interference.

Circuit Limitations

When the PRO-Verter is selected for duty in an application, it must be configured to work properly and safely between the load and any AC power source that is connected to it (generator or grid-utility). The PRO-Verter manages and distributes AC power IN and OUT through a network of cables and connections. A series of circuit breakers protect the PRO-Verter, as well as the connected loads or generator, from overloading.

If circuit breakers on the AC INPUT or AC OUTPUT are tripping, it is likely that the load has exceeded the available current of the PRO-Verter and/or the generator.

Derating

Derating is a condition where the power ratings for both inverter and charger functions are diminished. This occurs when the internal components of the PRO-Verter operate in extremely high temperatures, usually caused by poor airflow over the transformer or MOSFETS or solar loading in high-heat environments.

If the system is not operating at rated power, be sure to check the air filters on the case of the PRO-Verter and/or shade the case from direct sunlight if operating outdoors.

- Inverter derating will cause the generator to start frequently, transferring support of the load to the generator to allow the inverter to cool down. “Overtemp Fault” may appear on the LCD User Interface.
- Charger derating will cause the PRO-Verter CHG LED to blink red and the charging current to the ESMs to decrease temporarily to allow the charger to cool down.

See additional information

Meter Circuits

The PRO-Verter accurately tracks and provides data in both real-time and historical format. It has dedicated menus in the METERS programming for both the AC and DC circuits, which will aid in troubleshooting issues or verifying system performance.

The “Battery Monitor” (“BMK”) meters employs a highly accurate shunt within the PRO-Verter to provide detailed information about current flow through the DC Inter-Connect network. It is important that the battery bank is connected at the ports marked “EXPANDER PAK ONLY” for proper metering to occur.

AC Meters provide detailed information about AC as it flows through both the INPUT and the OUTPUT connections. Voltage, Frequency and Amperage are all tracked.

Historical Data and Fault Tracking

In the TECH menus, historical data on Inverter faults, Generator (AGS) faults, temperatures, and other PRO-Verter functions are tracked. This information is available to the operator and aids in troubleshooting.

Equipment Description

The Inter-Connect System

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

- Energy storage
- Power management
- Power generation

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

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

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

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

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

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

The Inter-Connect Plug

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

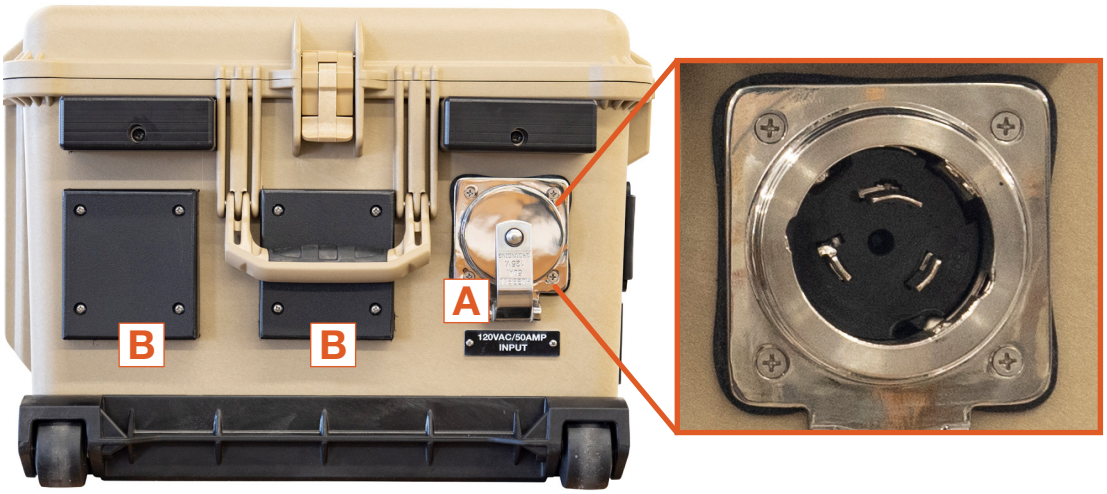
Figure 7. Inter-Connect Plug

Connections and Cooling

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

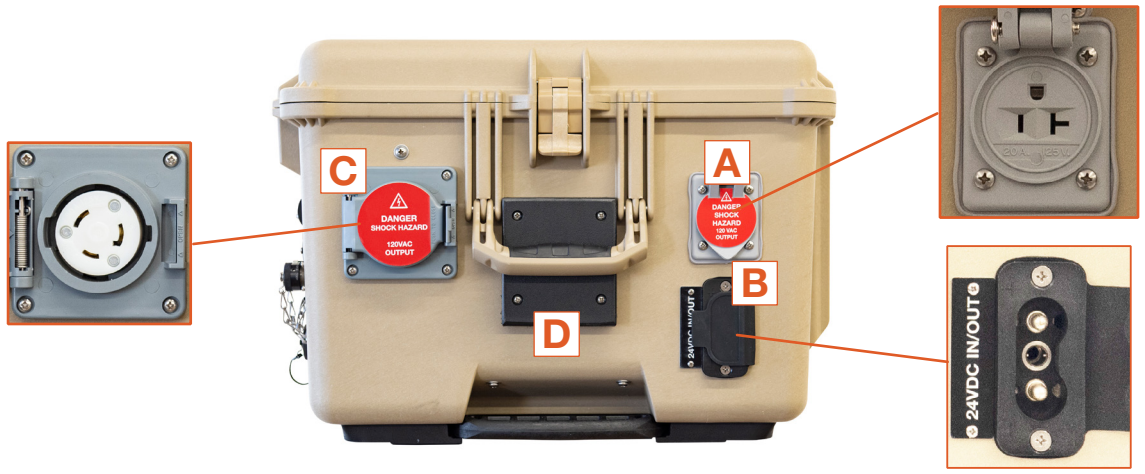
	Description	Connector	Voltage	Amps
A	Battery Connection (metered port)	Inter-Connect Port	24 VDC	200
B	Power Switch	-	-	-
C	USB Ports for device charging; no data.	USB	5 VDC	2.1
D	AMMPS Comm Port	MS3452W14S-28	-	-
E	TQG Comm Port	Amphenol HA100001-02-36	-	-
F	Tech Port	Ethernet - RJF21B	-	-
G	Air Intake	-	-	-

Figure 8. 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 9. PRO-Verter 5000-120 AGS left exterior



	Description	Connector	Voltage	Amps
A	120 VAC Output	HBL61CM65	125 VAC	20
B	DC load /Power Hub Connection	Inter-Connect Port	24 VDC	200
C				
D	Air Intake	-	-	-

Figure 10. PRO-Verter 5000-120 AGS right exterior

The 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 11. PRO-Verter I-Plate

Faceplate Features and Descriptions

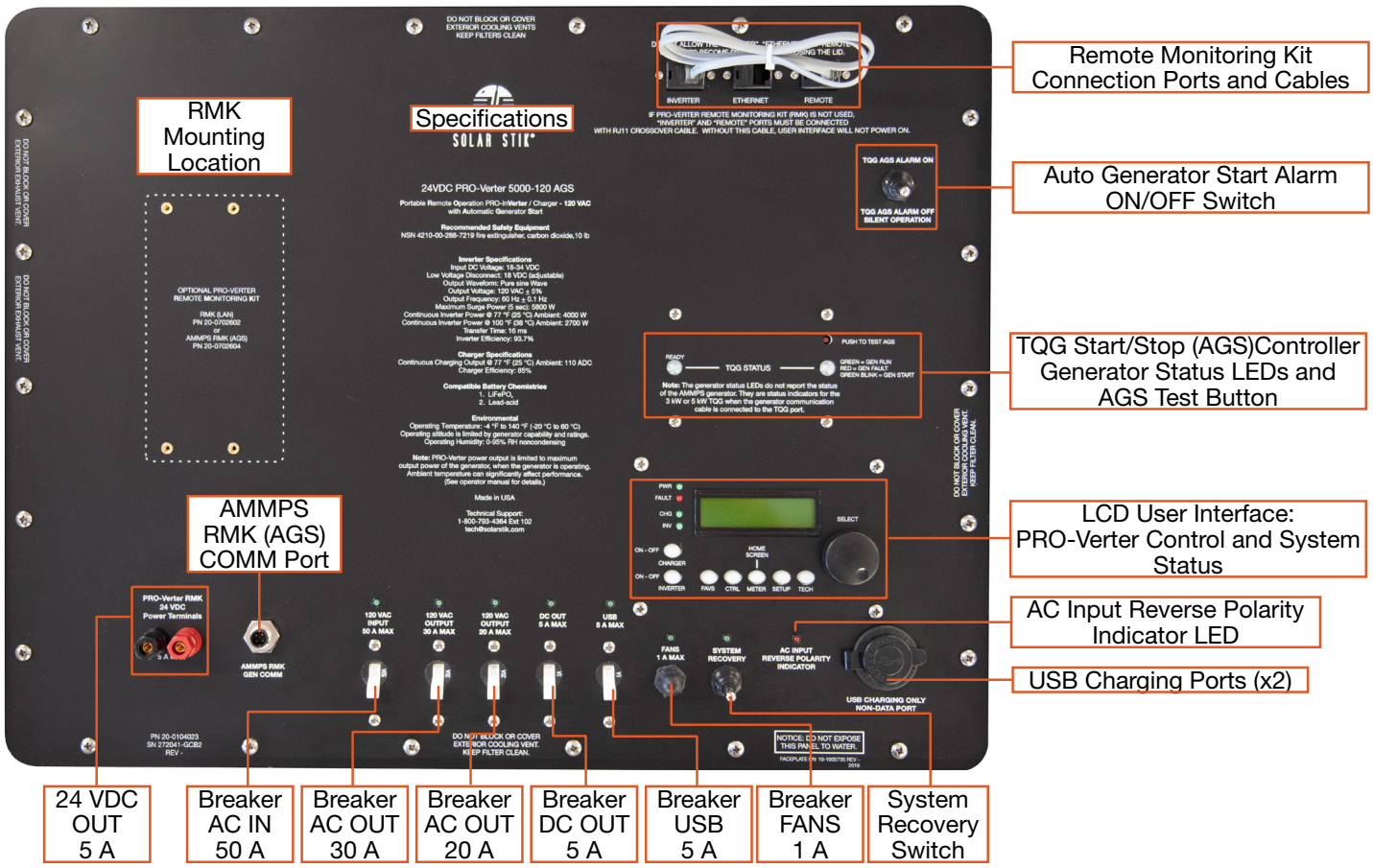


Figure 12. PRO-Verter Faceplate

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 can be accessed if reprogramming is required 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. See Remote Monitoring Kit section.

RMK Connections Ports and Cables – These provide communication connections between the RMK, the PRO-Verter and remote access monitoring equipment (via the Tech Port). See Remote Monitoring Kit section.

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 Restart a System with 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.

Understanding the User Interface

The PRO-Verter menu options and programming features in the user interface were developed over 10 years using real data and feedback from users around the world. They allow PRO-Verter functions to be configured in exact accordance with mission requirements, and support operation in a flexible "open" architecture that includes a myriad of disparate technologies commonly found in the field (i.e. PV panels, batteries, etc.).

PRO-Verters are usually shipped pre-programmed based on the application and system configuration prescribed by the customer, but if operating conditions warrant changes to the system architecture, the PRO-Verter programming can be adjusted accordingly.

When configuring or making changes to a PRO-Verter programming, it is important to understand the individual settings found in the menus, and how each one can affect overall system operation or individual functions within the PRO-Verter itself.

Consult with Solar Stik Technical Support if changes are necessary.

Figure 13. LCD user interface

ON/OFF Buttons

The ON/OFF buttons allow the PRO-Verter inverter and charger to be independently and quickly enabled or disabled.

- **INVERTER ON/OFF:** This button toggles the Invert function on and off (standby mode). The green "INV" LED turns on and off with the button.
- **CHARGER ON/OFF:** This button toggles the Charge function on and off (standby mode) whenever the charger is actively charging. The green "CHG" LED turns on and off with this button.

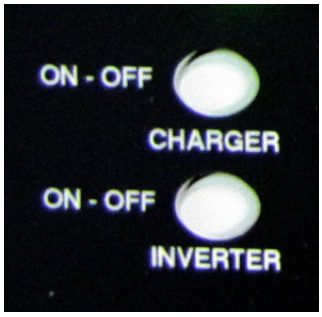


Figure 14. Inverter/Charger ON / OFF Buttons

Status LEDs

Four (4) status indicator LEDs for power, faults, charging and Inverting. Table 1 below lists the meaning for each state of the four (4) LEDs.

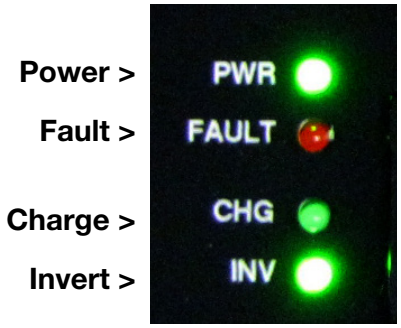


Figure 15. PRO-Verter / System Status LEDs

Table 1. LED System Status Indicator Guide

LED	Status	Meaning
PWR (GREEN)	OFF	(1) PRO-Verter is disabled; (2) User interface is in Power Save mode—press any button to activate LEDs; (3) No power to user interface (check cable or the power to the inverter); or (4) No AC power at the inverter's AC output terminals.
	ON	AC power is available from the inverter, utility, or generator at the PRO-Verter AC output terminals.
Fault	OFF	Normal operation
	ON	A fault condition has been detected. Check the LCD screen to find and correct the cause.
CHG (GREEN)	OFF	(1) User interface is in Power Save mode—press any button to activate LEDs; or (2) Charger is off—no utility or AC generator present.
	ON	Charger steady on. See the LCD screen to determine charge status.
	BLINKING, display says "Charger Standby"	The charger is in Charger Standby mode. This occurs when the Charger ON/OFF button is pressed to disable the charger.
	BLINKING, display shows a charging status	The charger current is automatically decreased because (1) Charger Back-off—the inverter's internal temperature is getting hot, and the current is decreased to reduce/maintain temperature; or (2) Low AC Input Voltage—the input AC voltage is low, and the charger is disabled to help stabilize incoming AC voltage to prevent AC disconnect.
	BLINKING, display does not show any charge status	The inverter is detecting and qualifying AC voltage (from utility or an AC generator) on the inverter's AC input terminals.
INV (GREEN)	OFF	(1) Inverter is disabled; or (2) The User Interface is in Power Save mode—press any button to activate the LEDs.
	ON	Inverter is enabled. (1) Inverter supplies AC power on the output; or (2) In Inverter Standby (if both INV and CHG LEDs are on), the inverter will automatically supply AC power to the loads if utility or generator power is lost.
	BLINKING	Inverter is in Search mode. (The AC load is below the SETUP: 02A Search Watts setting.)

Menus Overview

There are five (5) menu trees commonly accessed at the PRO-Verter's user interface:

- **FAVS** ("Favorites")
- **CTRL** ("Control")
- **METER** ("Home")
- **SETUP**
- **TECH**

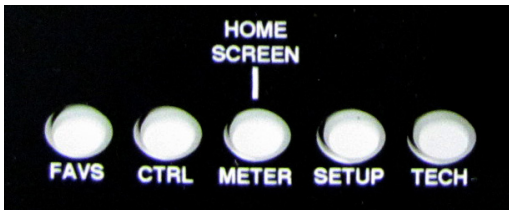


Figure 16. User Interface Menu Buttons

Each one of these buttons/options will open up several sub-menus and programming options:

FAVS
The FAVS menu is used for most configuration management, operation settings, and troubleshooting. The operator can configure up to five (5) menu options as FAVS. They should be programmed based on the application in which the PRO-Verter is to be used. Most FAVS menus are programmed in accordance with the I-Plate. A conference call with the customer to discuss the application will usually provide enough information for any PRO-Verter to be properly programmed for use immediately upon delivery. If the customer does not have a specific application for which the PRO-Verter will be used, the "default" FAVS programming provides the operator with basic architecture and operation programming commonly needed in the field.

CTRL
The CTRL menu provides quick access to AC-related controls.

METERS
The METERS menu is mostly a "read-only" medium and can provide both live and historical data for the PRO-Verter functions. It can provide real-time data as well as performance indicators for troubleshooting.

SETUP
The SETUP menu contains the prime programming for PRO-Verter operation. Nearly every function the PRO-Verter manages can be accessed and controlled from within the SETUP menus. The menus are configured at the factory in accordance with application information provided by the customer, and the programming is usually protected from unauthorized access by a pass code. This menu should only be accessed when primary PRO-Verter functions require fine-tuning based on application demands.

TECH
The TECH menus allow for observation of key metrics including software revisions, temperatures, fault and data tracking, and reset protocols.

Rotary SELECT Knob
Rotate the knob clockwise and counterclockwise to view the different menu items and available PRO-Verter settings. Press down the SELECT knob to enter a menu item or to save a setting after it is displayed on the LCD screen.

The LCD screen can be refreshed by holding down the SELECT knob for 10 seconds.

Example: How to Navigate the User Interface Menus

To change or check a setting, first press a menu button, then use the SELECT knob to navigate to the desired menu item. The diagram below illustrates how to use the menu buttons and the SELECT knob to move between and within various menus. The diagram below illustrates how to change the generator control. The options OFF, ON, and AUTO are in CTRL (03 Gen Control)...

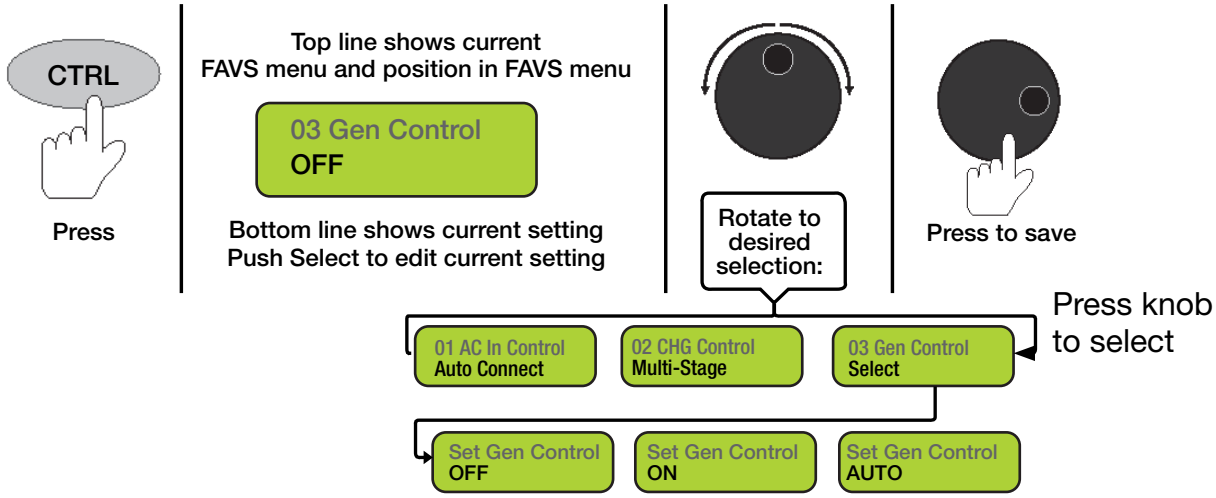


Figure 17. How to start/stop a generator manually

OPERATOR INSTRUCTIONS

Power Up PRO-Verter

For normal, sustained operation, the PRO-Verter must be connected to a 24 VDC power source (such as 24VDC Li Expander Paks) to power up. When the PRO-Verter powers up, the master control board that commands the various internal circuits performs an internal diagnostic check to ensure their functions can be safely used. While this is occurring, the LCD at the keypad will flash revision information for all of the control boards that are installed.

Figure 18. Powering up the PRO-Verter

Set Clock

The LCD screen will automatically display the “Set Clock” screen after it has been turned on. The series of pictures in Figure 19 shows what the operator will see at each stage of the process. Follow the steps in order.

Rotate the dial until desired hour appears. Press down SELECT knob to set hour.

Rotate the dial until desired minute appears. Press down SELECT knob to set minute.

Rotate the dial until desired AM or PM appears. Press down SELECT knob to set AM or PM.

Figure 19. Setting the PRO-Verter clock

The AC INPUT Setting

The AC INPUT setting can control several aspects of the PRO-Verter's AC-related functions:

- AC Power Management
- Generator/Grid
- Charge Amperage Rates
- Load Support Engagement (if installed)
-

Setting the AC Input for "Nominal-load" Conditions

The AC INPUT setting (FAVS-03) controls the total amount of continuous power (AC and DC) the PRO-Verter can process under normal operating conditions.

The "continuous load(s)" should not exceed either of the following two conditions:

- The PRO-Verter's continuous AC power when inverting
- The connected AC source's (generator or grid-utility) continuous AC power when active

Note: Load support can be used for brief intervals when the load may exceed the power available from a connected AC source (i.e. generator or grid-utility). See section on "Overloading".

When a PRO-Verter and external AC source (generator or grid-utility) are selected for an application, it is imperative that the AC source be capable of meeting the full demand that the PRO-Verter's AC INPUT setting allows:

- **The total AC load must be rated for continuous power that is "less" than the total power the AC INPUT setting allows.**
- **The total DC loads must be rated for continuous power that is "less" than the maximum DC AMPS that are available when in CHARGE mode.**

Proper Loading and Power Distribution

The PRO-Verter can serve as a power distribution point for a generator or other AC power source (grid-utility). This allows the external AC power source to support only a "single" load. Even though there is only one AC connection between the AC source and the PRO-Verter, multiple AC and DC loads can be supported by the PRO-Verter.

The operator must ensure that the cumulative total for all of the loads is less than the AC INPUT (FAV-03) setting. This ensures that the sum total of all of the continuous loads handled by the PRO-Verter does not exceed the continuous output limit of the connected AC source (generator or grid-utility), and that when the AC source is available, there is enough power available for battery charging to occur.

Note: The AC METERS can assist in determining when the maximum continuous load limit on the PRO-Verter has been reached.

“Overload” Conditions

Over-loading of the PRO-Verter can occur under the following conditions:

- Load AC power demand is greater than the inverter’s rated power output
- Load AC power demand is greater than the rated output of the connected AC power 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

In each of these scenarios, the solution only requires a reduction in the Load AC power demand. Use the AC METERS to confirm the load is reduced to prescribed levels and proceed with normal operation.

Load Support Function

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

1. Load Support Model
2. Peak Power Model

It 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 exceeds the AC source’s or the PRO-Verter’s rated AC power output.

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

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

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

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

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

Lag Times and Surge Rates

The PRO-Verter’s inverter function can provide up to 130% of its rated power output for brief surges demanded 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.

System-level Troubleshooting Procedures

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. This manual provides troubleshooting information that relates primarily to the PRO-Verter. System-level troubleshooting information is documented in System Operator Manual even though many of the issues encountered will be reported by and corrected using the PRO-Verter.

There is a simple 6-step process for solving technical issues:

1. Verify all of the programming in the PRO-Verter is correct.
2. Verify the System configuration is correctly.
3. Verify all external causes of FAULTS are mitigated.
    a. Generator has fuel/oil.
    b. Circuit breakers are not tripped.
    c. Cables are all connected properly and in working condition.
4. Verify heat issues are mitigated.
5. Use the PRO-Verter Meter and Tech menus to determine where a fault condition exists.
6. Contact your FSR.

The most common PRO-Verter performance problems are due to temperature issues. The PRO-Verter, batteries, power generation, and even the loads are all adversely affected by heat, so mitigating the affects of heat will only improve system performance. Clean air filters regularly and shade power management and batteries when possible.

Overview to the User Interface Menu Windows

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

Figure 20. 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

The PRO-Verter has been programmed at the factory to operate with $LiFePO_4$ batteries. The programming map on the following pages is a representation of how to navigate the information in the PRO-Verter user interface. The color coding key below provides information to make understanding the programming map easier.

Menu Map Color Coding Key

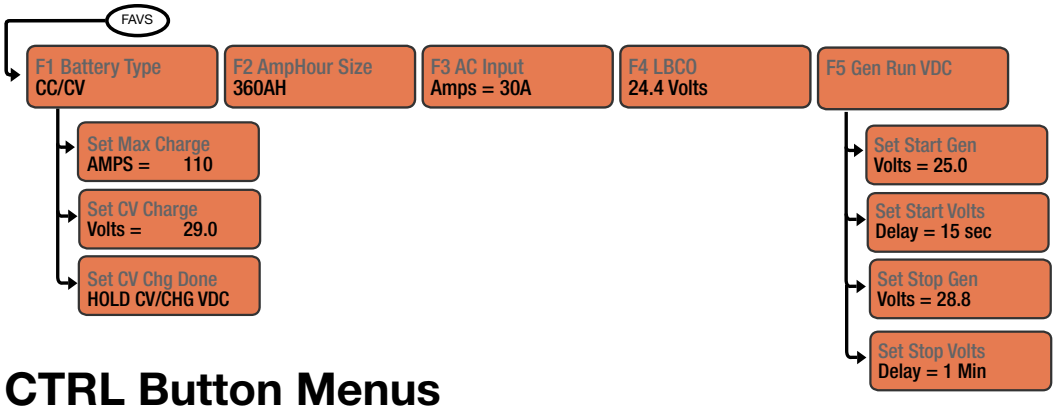
Green menu items represent factory default settings, read-only settings, or options that exist within a specific menu item.

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

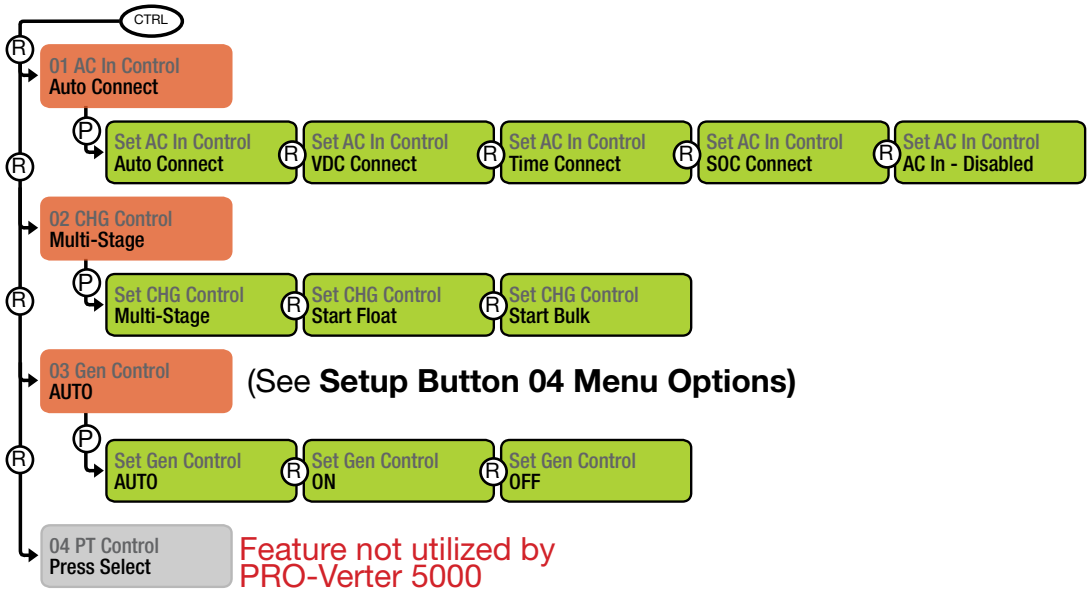
Orange menu items indicate values set by Solar Stik for a specific application. These values (with the exception of setting the clock to local time) should not be changed by the user without consulting tech@solarstik.com.

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

FAVS Button Menus



CTRL Button Menus



(See **Setup Button 04 Menu Options**)

Feature not utilized by PRO-Verter 5000

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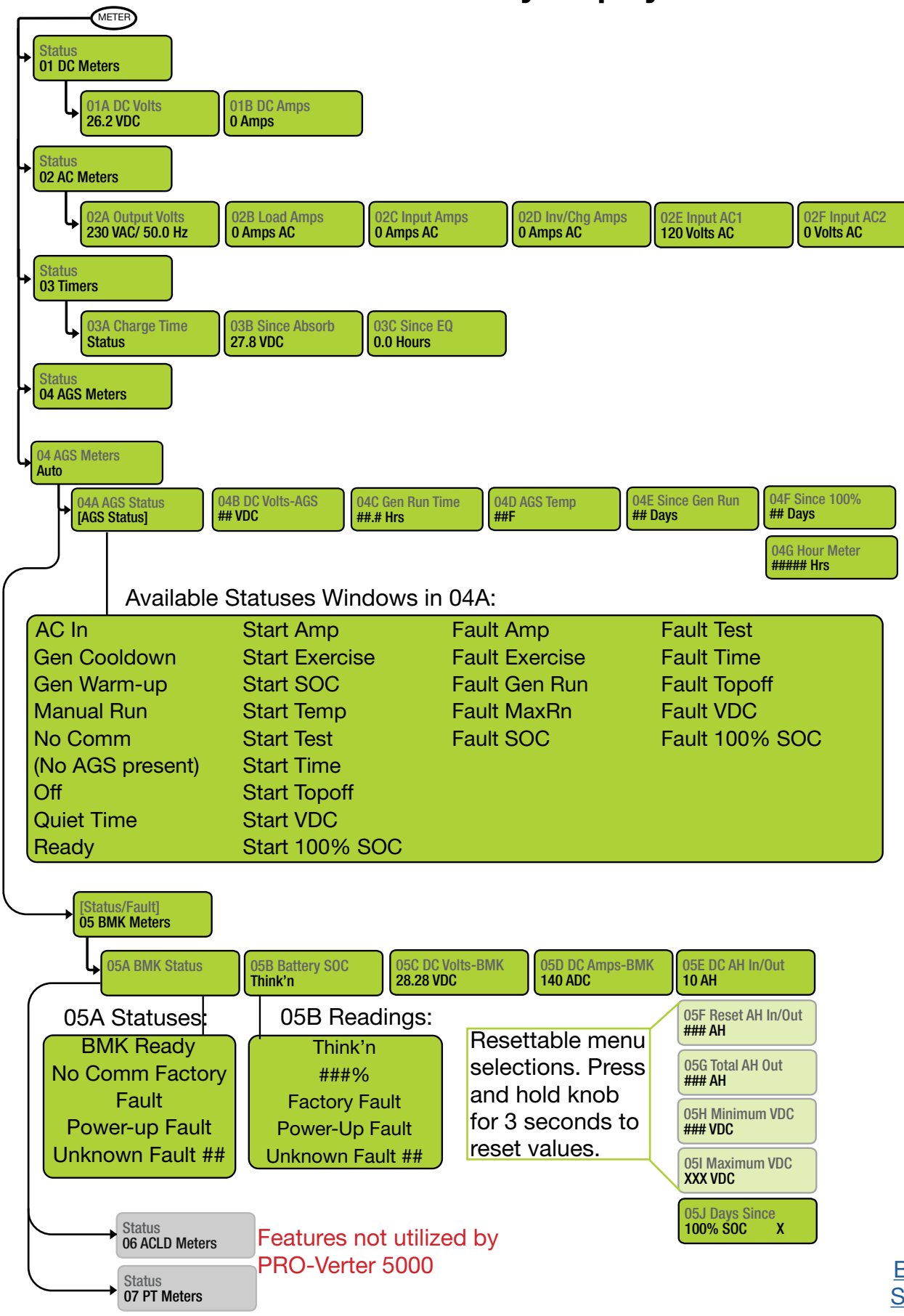
METER Button Menus: Read-only Displays



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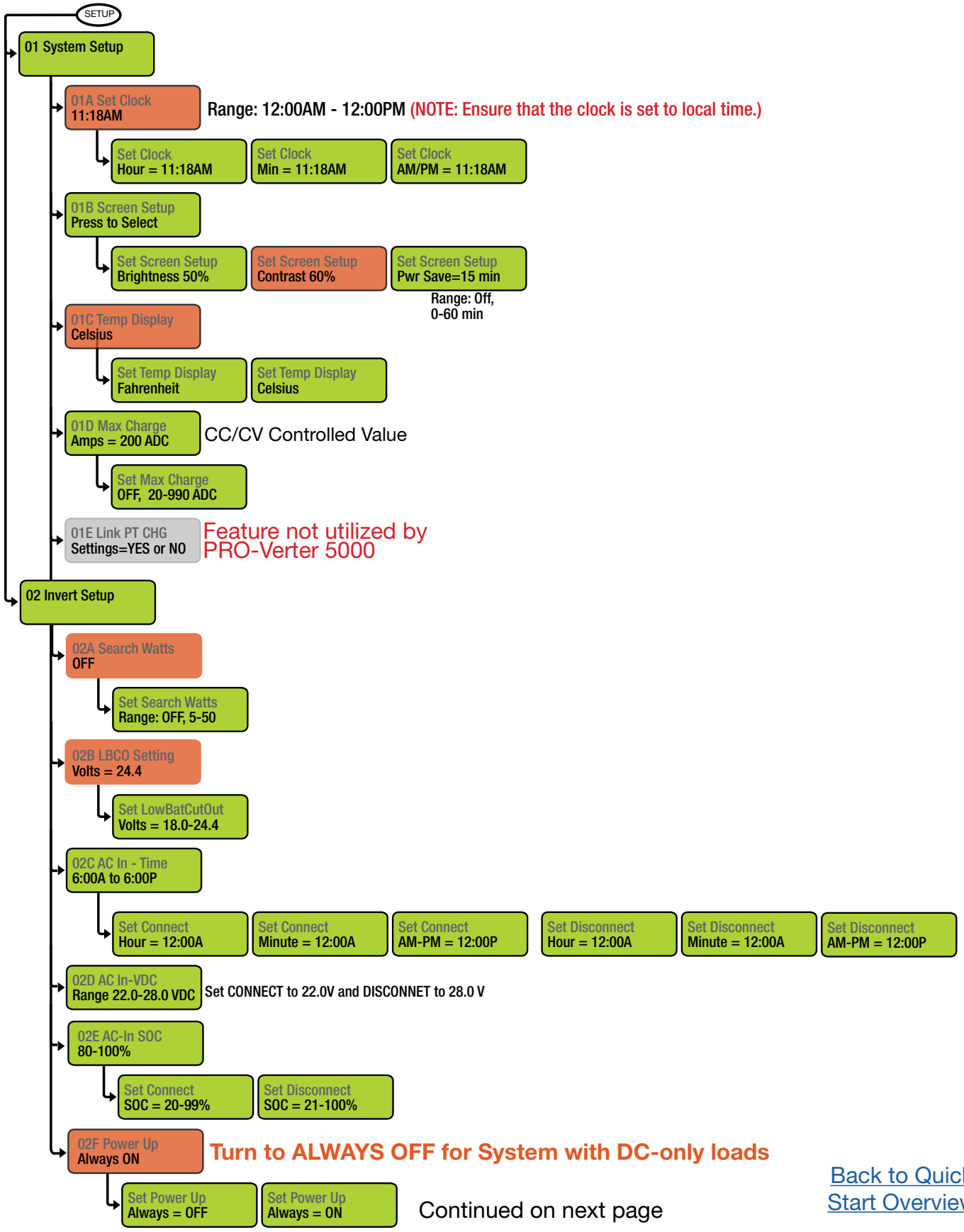
SETUP Button Menus

Setup: 01 System & 02 Inverter Setup



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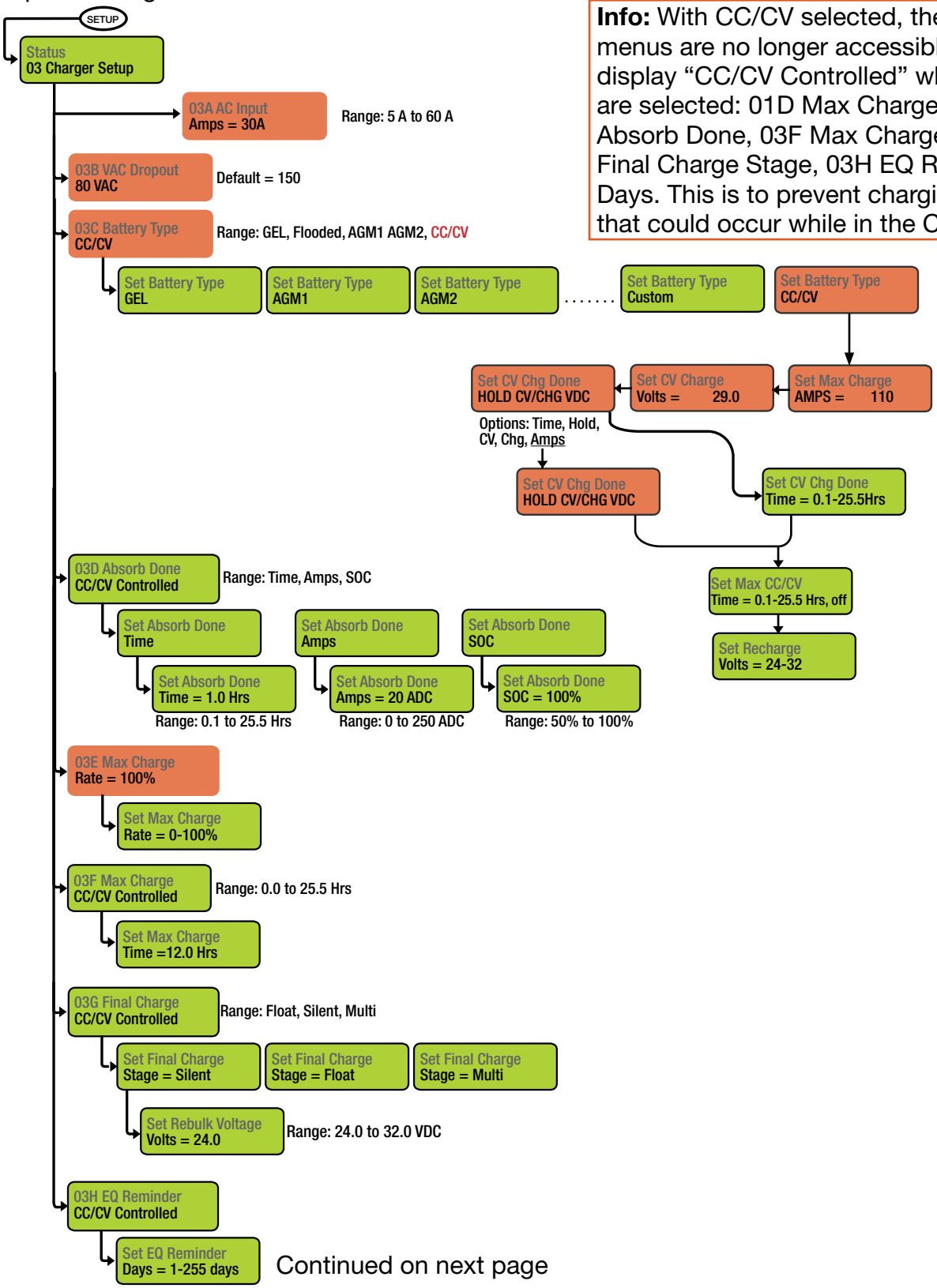
SETUP Button Menus continued

Setup: 03 Charger



Info: With CC/CV selected, the following menus are no longer accessible and will display “CC/CV Controlled” when they are selected: 01D Max Charge Amps, 03D Absorb Done, 03F Max Charge Time, 03G Final Charge Stage, 03H EQ Reminder Days. This is to prevent charging conflicts that could occur while in the CC/CV profile.

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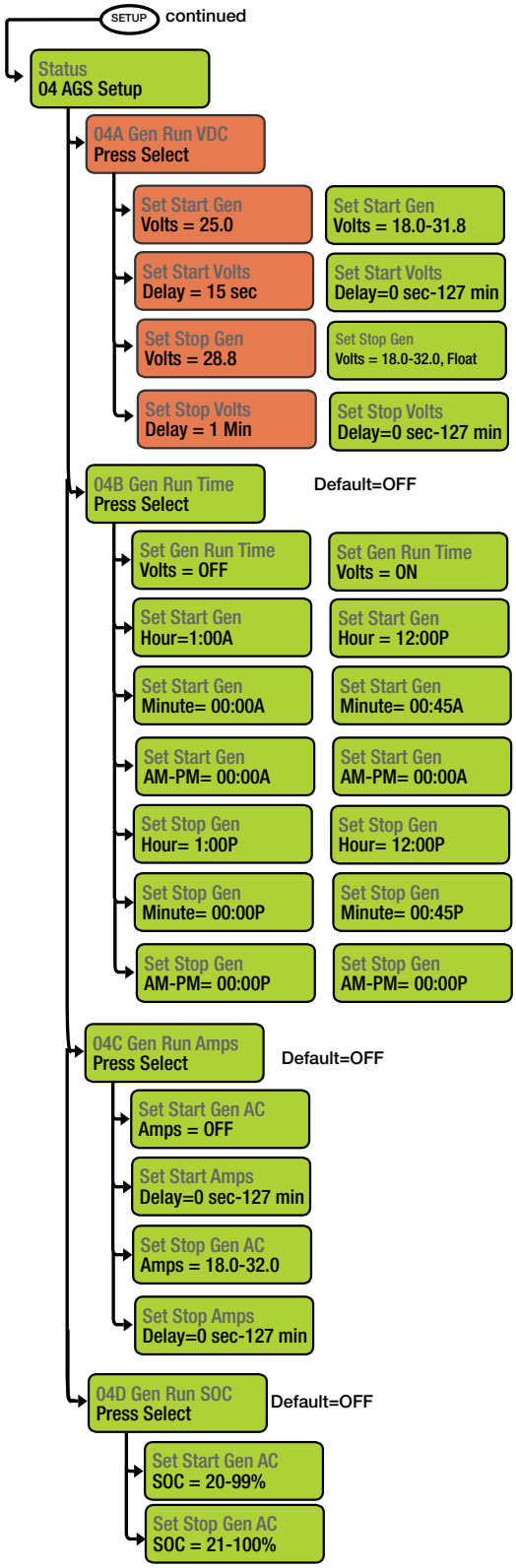
SETUP Button Menus continued

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 Float, the PRO-Verter turns off the Generator.
- If the Generator does not start and the battery voltage gets down to 24.4 V (LBCO), the AC Out (Inverter) turns off. This is the LBCO voltage in the menu tree.

Continued on next page

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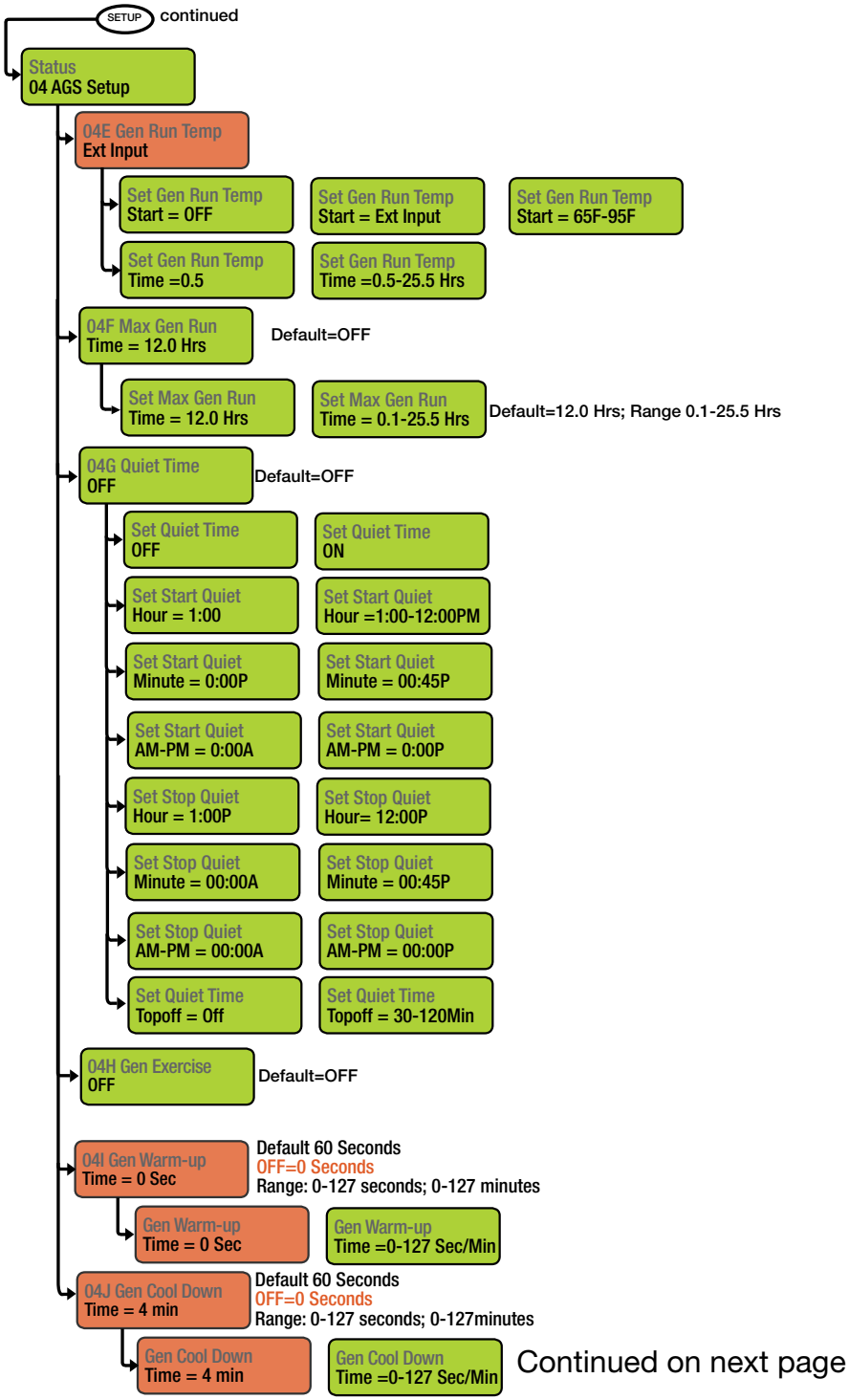
SETUP Button Menus continued

Setup: 04 AGS Setup



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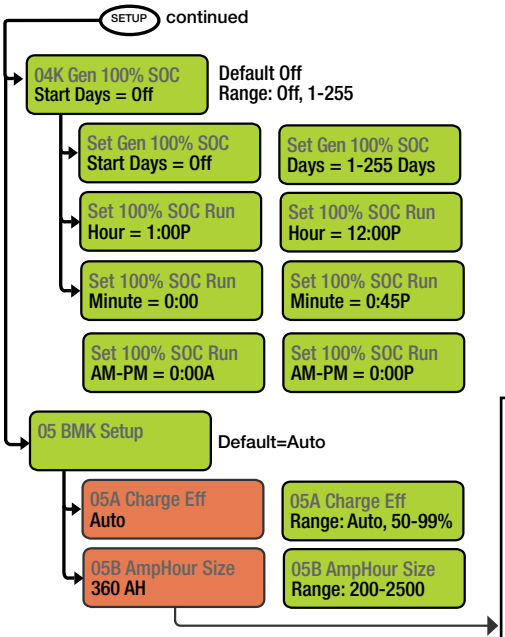
Continued on next page

SETUP Button Menus continued

Setup: 04 AGS Setup, 05 BMK Setup



BMK Setup Notes

The AmpHour Size value should be set according to the total capacity of the battery bank minus 10%. For example, one 24VDC Li Expander Pak 2400 is 100 Ah. The minimum setting allowed on the PRO-Verter is 200 Ah.

The state of charge reported by the 24VDC PRO-Verter 5000 will be accurate only if the total battery bank size is at least 200 Ah.

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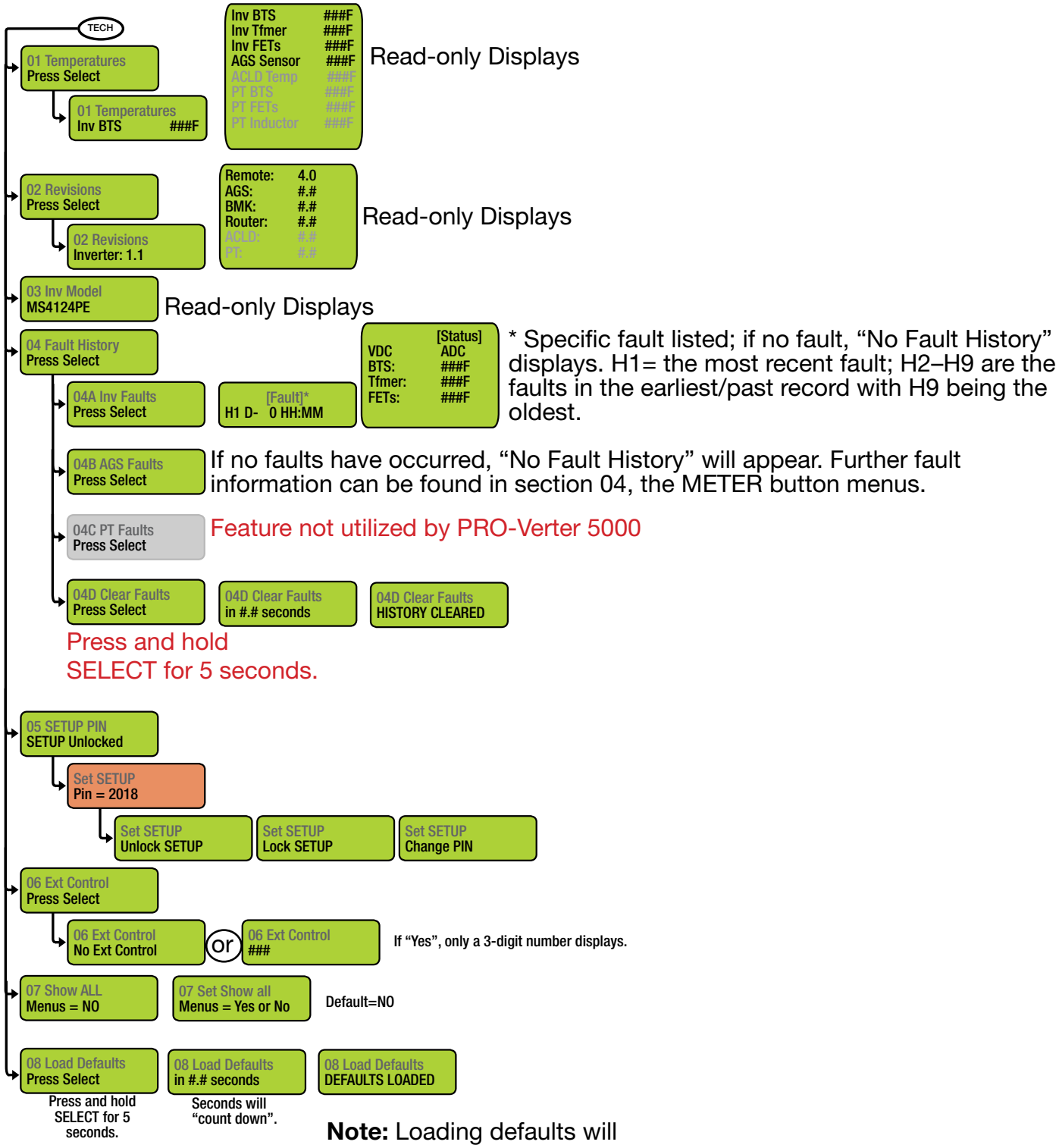
TECH Button Menus



Note: Loading defaults will overwrite settings programmed by Solar Stik that are specific for this system. Please contact Solar Stik Technical Support prior to loading defaults.

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

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

Quick Links to PRO-Verter Status Messages

Quick Links to Problems: Solutions and Explanations

PRO-Verter LCD Screen Troubleshooting Table

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

Table 2. Troubleshooting the LCD Screen

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

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PRO-Verter Charge Mode Status Messages

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

The PRO-Verter is programmed for constant current/constant voltage (CC/CV), two-stage charging. The charging voltage and current profiles are show in Figure 21. This setting consolidates all the battery charge settings required for a two-stage charging cycle.

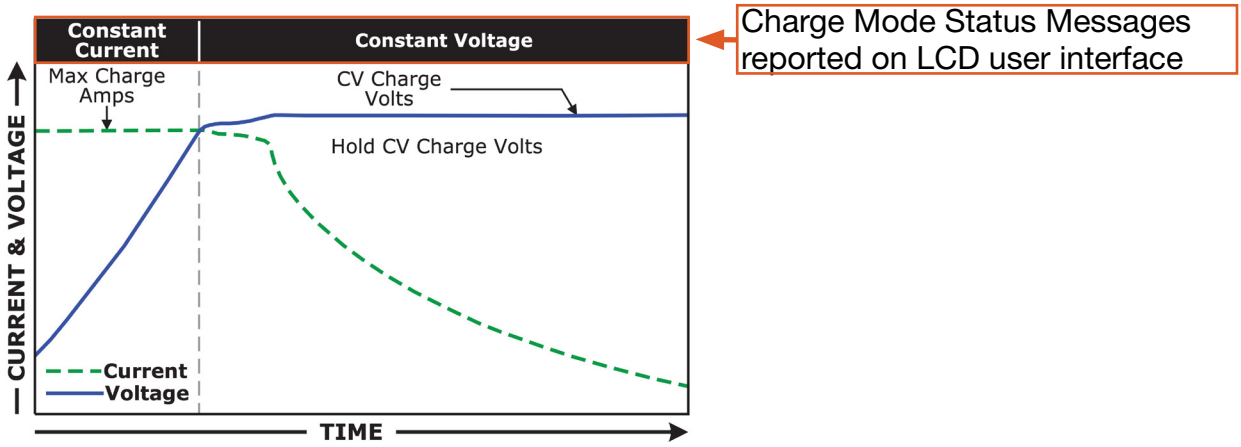

Figure 21. CC/CV, HOLD CV / CHG VDC charging profile

Constant Current
This is the period when the maximum programmed charge current (110 A) is applied to the System batteries. The battery voltage increases rapidly toward the maximum programmed charge voltage (29.0 VDC). The lower the battery voltage, the higher the current.

Constant Voltage
This is the period when the battery voltage approaches its programmed maximum voltage value. The charging current declines as the battery approaches its full-charge capacity. The generator is programmed to automatically stop the fuel-driven generator when the battery voltage reaches 28.8 VDC and automatically start the generator when the battery voltage falls to 25.0 VDC.

The LCD screen will display constant current most of the time during charging. Constant voltage may be seen as the System batteries approach full charge.

> **Note:** Whenever the CC/CV battery type is selected, some other settings will be automatically changed to values optimized for the CC/CV charge protocol. If a different “battery type” (Setup 03C) is selected, all charge settings must be reviewed to ensure they are correct for the new battery-type selection.

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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 Charge mode has been enabled, the unit waits and displays “Charging” to determine the charge routine.

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= 28.8) 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 = 1 Minute and cooldown (Setup: 04J) time is met.

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

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PRO-Verter Charger Problems: Solutions and Explanations

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

Solution: Is the charge (CHG) LED on the user interface blinking? If not, the charger does not recognize the incoming AC as being within acceptable limits. Disconnect the AC input cable from the PRO-Verter. Measure the voltage at the cable terminals—it should be 120 VAC +/- 20 VAC). 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.

Charger not charging even though Charger LED is on steady

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 28.8 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.

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 80 VAC. Also, check the 03A AC Input Amps and SETUP 03E Max Charge Rate settings to determine if the current is being limited.

Charger output voltage is different than expected

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

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PRO-Verter Inverter Problems: Solutions and Explanations

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

Clearing Faults

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

AC Overload

Inverter has faulted and stopped providing power to the load.

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

Solution

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

Breaker Tripped

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

Solution

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

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Dead Batt Charge
This fault indicates that the PRO-Verter is connected to a 120 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 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. Restart the System using the System Recovery Button/Function. See Restart a System with Overdischarged Batteries for instructions.

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. Clean the air filters if they are dirty. If this fault does not clear after doing the power reset, the inverter will require service contact Solar Stik Technical Support.

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

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Solution: This fault may occurs when an external DC charging source is charging the inverter's battery bank. Turn off any other additional charging source to allow the DC voltage level to drop. Check the Power Hub to ensure that it is functioning properly. Refer to the Power Hub Operator Manual.

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 (> 150 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 120 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 LBCO Setting (FAVS F4) value for more than one minute. This fault may occur when **(1)** the generator failed to start or **(2)** Other charging sources are offline or inadequate. 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 or test switch. 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 and Remote-start Enabling Kit Operator Manuals.

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

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

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

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

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

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

Solution
The AC pass-through relay is most likely stuck. A relay usually sticks because of damage to the contacts from trying to handle higher currents than that for which they are rated. This is usually caused by not protecting the relay from handling high continuous currents, or by switching high current inductive loads. The internal relay contacts are rated to handle 60 amps AC continuously. If connected to an AC source (grid or generator) and running large inductive loads (i.e., pumps, motors, etc.) on the PRO-Verter AC output, turn those particular loads off prior to removing the AC input source. This fault requires an inverter or power reset to clear.

Tfmr Overtemp
This fault message displays when the transformer causes the inverter to shut down to protect the internal power transformer from damage. Once the transformer cools down, the inverter automatically restarts and resumes operation.

> **Note:** A temperature sensor on the transformer will auto-start a connected generator, if the GEN CTRL is in AUTO mode, thereby transferring support of the load to the generator to maintain continuity of operations.

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Solution
Allow the inverter to cool down, then press the INVERTER ON/OFF button (manual restart) to resume operation. If the fault returns shortly after restart, reducing the charge rate (FAVS F1> Set Max Charge AMPS) may alleviate the problem.

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.

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PRO-Verter Internal Fault Messages

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

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

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

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

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

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

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PRO-Verter AGS Functional Tests

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

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

> **Note:** The AGS Test Button (Figure 12) is a momentary switch that allows the AGS system to be tested for correct wiring and generator start/stop operation.

PRO-Verter to Generator Communication Test

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

Determining AGS Status
Use the LCD user interface to determine the AGS's status:
1. Press the METER button until the bottom line displays "01 DC Meters".
2. Rotate the SELECT knob to the 04 AGS Meters menu, and then press the SELECT knob. The top line shows 04A AGS Status and the bottom line displays the current status of the AGS.

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

Starting the Generator from the PRO-Verter User Interface
To confirm that the generator will turn on and run from the PRO-Verter, first ensure the GENERATOR STATUS LED is Off or Ready. Then:
1. Press the CTRL button, and then rotate the SELECT knob to the 03 Gen Control menu.
2. Press the SELECT knob, and then rotate it to the ON setting.
3. Press the SELECT knob to activate the generator test. The selection arrow appears to the right of the screen. The generator should start.

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

If the AGS/generator system started, and if the GENERATOR STATUS LED turns solid green after two (2) minutes, then the wiring from the PRO-Verter to the generator is correct. The PRO-Verter Autostart/stop may now be enabled by setting CTRL 03 Gen Control setting to "AUTO".

AGS Start Statuses Table (Meter 04)

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

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

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

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

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

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

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

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

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

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

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

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AGS Operational Statuses (Meter 04)

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

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

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

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

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

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

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

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

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

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Resolving AGS Operational Statuses

No Comm
The “No Comm” status suggests that some wiring connections may be incorrect.

Solution
1. Ensure the GENERATOR STATUS READY LED is GREEN is on to indicate that the PRO-Verter Generator autostart controller is getting power.
2. Ensure the correct communications cables are connected.
3. Call Solar Stik Technical Support.

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Resolving AGS Faults Using the LCD User Interface

If an AGS fault occurs, use the PRO-Verter 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 this section in orange are the only ones that could appear in a PRO-Verter programmed to work in a Solar Stik HPS.**

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 AC output is off or has stopped.

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

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 adjust the AC INPUT (FAVS F3) to prevent the fault from recurring

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

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

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

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

Solution

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

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

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

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

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

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

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Fault MaxRn

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

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

Solution

Load

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

Expander Pak

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

Solar Loading

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

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

How to Clear AGS Fault History

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

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PRO-Verter Battery Monitoring Kit (BMK) Statuses

PRO-Verter BMK Operational Status Messages

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

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

No Comm
The BMK is not communicating with the inverter/user interface.

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

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

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

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Resolving BMK Faults Using the LCD User Interface

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

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

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

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

Solution: Call Solar Stik Technical Support.

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

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

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Fault History (Tech 04)

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

The following is an example describing how to access AGS Faults. The procedure for inverter and AGS Faults is the same:

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

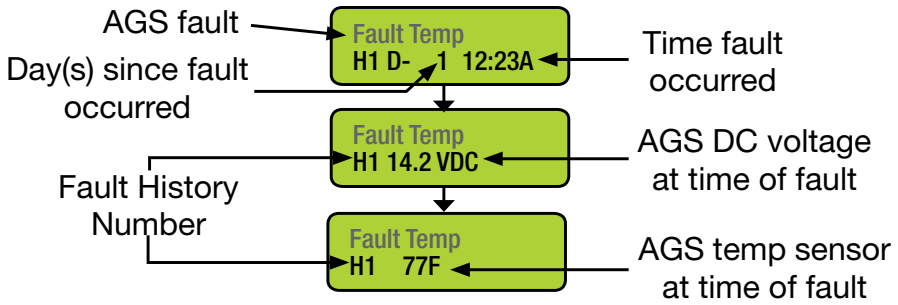
04B AGS Faults
This menu displays a history of the last nine AGS faults. Information for each fault displays from the most recent fault (H1) to the earliest/past recorded faults (H2 up to H9).

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

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

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

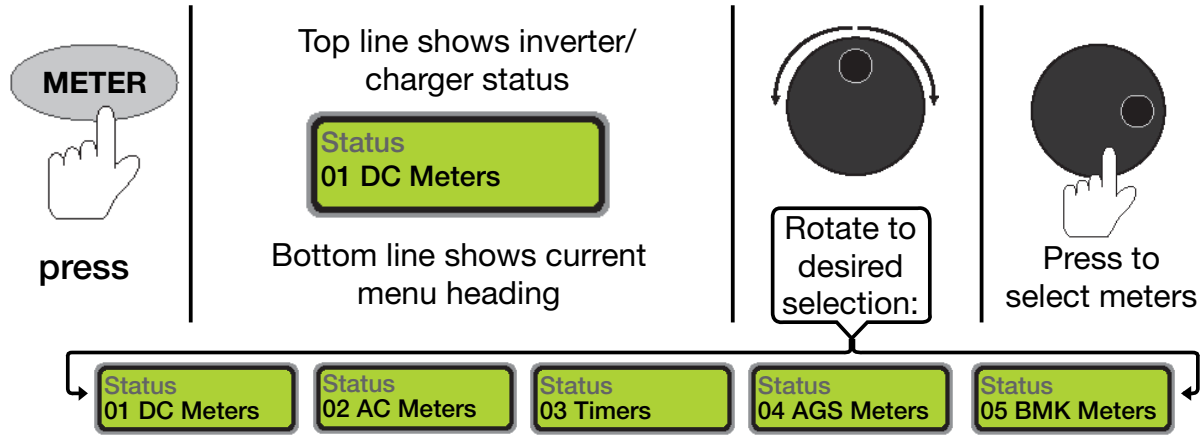
TECH: 04 Fault History
Press the SELECT knob, rotate the knob until the 04B AGS Faults menu displays, and then press the SELECT knob.



PRO-Verter: Historical Data Collection

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

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



Auto Generator Start/Stop (AGS) Data

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

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

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

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

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

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

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Battery Monitor (BMK) Data (Meter 05)

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

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

Battery SOC
This read-only menu either displays the calculated battery SOC for the connected battery bank—"Think'n" (to indicate the SOC is being calculated), or identifies a fault condition. The range is 0–100%, where 100% is a fully charged battery and 0% is completely discharged. When the PRO-Verter is first turned on, 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 Amps-BMK
This meter displays the real-time charge current (amps into battery) or discharge current (amps out of the battery) as measured through the BMK shunt. Charging is shown as a positive (+) number and discharging is shown as a negative (–) number. The range is from ±0.1 to 999 amps (±1.0%).

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

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

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

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

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

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

Back to METER Buttons Menu

PRO-Verter MAINTENANCE

Preventive Maintenance Checks and Services

Failure to follow these instructions may result in permanent equipment failure and/or personal injury.

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] M+[2]	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]Monthly (M)—every month
[2]Monthly Plus (M+) — more frequently than monthly as conditions require

Spare / Replacement Air Intake Filter

Part Number	Description	Filter Image
07-1000627	Replacement Air Vent Foam Filter for PRO-Verters and Power Hubs (pack of 100)	

Filter Removal and Cleaning or Replacement

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

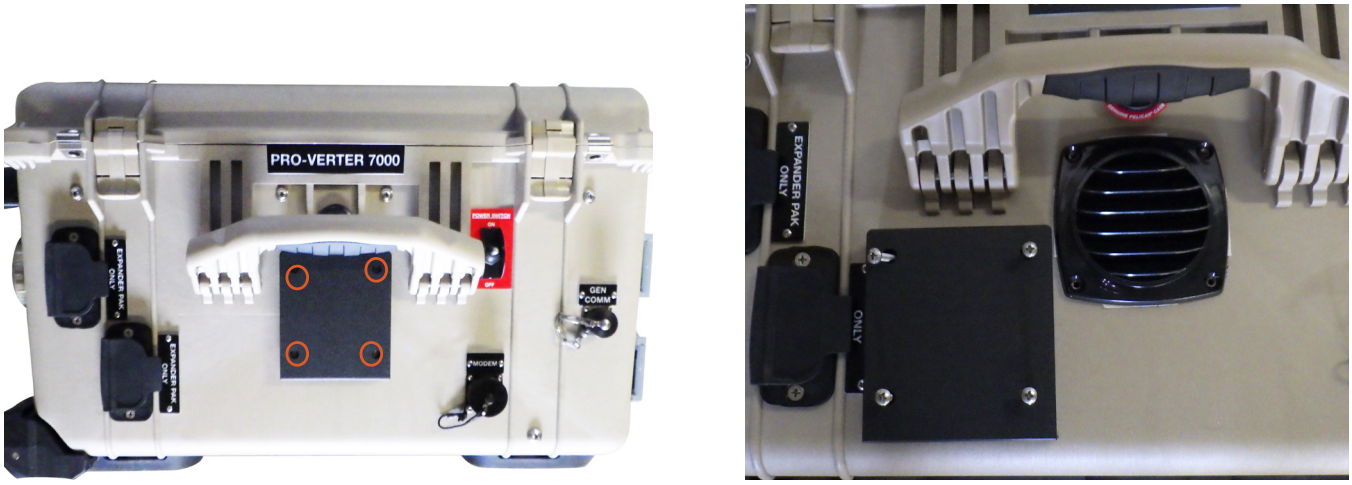


Figure 22. Removed vent shroud to access the louvered vent cover

2. Remove and inspect the filter. Replace the filter if it is damaged (arrows in Figure 23). 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 23.

Figure 23. Replacing PRO-Verter filter (left); cleaning a PRO-Verter filter (right)

3. Reinstall the clean, dry filter or install the new filter (replacements may be stored behind PRO-Verter I-Plate). Secure the louvered vent cover and vent shroud with the four (4) fasteners.

Water Intrusion—Prevention and Remediation

⚠ WARNING

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

- The lid on the PRO-Verter should be closed whenever possible while the System is operating to prevent water and dust from entering the System.
- If water intrusion is suspected, and the System is still functional, disconnect power sources entering that component from the most distant location possible, power down the System (turn off the power switches on all of the System components) and then disconnect the component from the System. Do not to try to remove what may be a flooded component while it is still powered up.
- Remove the screw from the drain hole at the bottom edge of the component case. If water flows out of the drain hole after removal of the plug, let it flow until it stops. Then slightly and slowly tilt the case toward the drain hole to remove any remaining water. Continue to increase the angle of the component slowly until no more water drains from the hole. After the water has been drained, move the component to a safe dry location and remove the Faceplate. Place the component in the most dry environment possible for a time long enough that any remaining moisture inside will dry. When it is dry, reintegrate the component to the System and test it to determine if it is still functional.

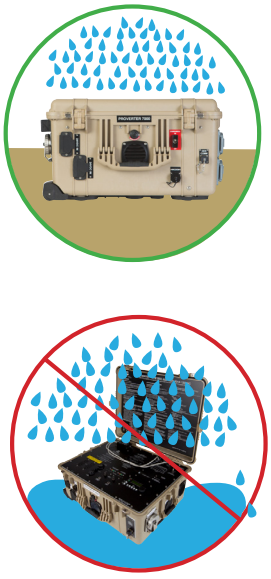


Figure 24. Location of drain plug screws in the PRO-Verter 5000

SUPPORTING INFORMATION

Restart a System with Overdischarged Batteries

Overdischarged System batteries should not occur in a System that is setup and maintained properly.

Restart with the PRO-Verter System Recovery Button

1. Turn off the AC Output Breakers on the PRO-Verter Faceplate.
2. Connect a 120 VAC power source to the PRO-Verter.
3. Ensure that the AC input breaker on the PRO-Verter Faceplate is turned on.
4. Press the HOME button on the PRO-Verter User Interface. A battery fault will appear on screen.
5. Push the SETUP button and scroll to 03 Charger Setup. Press SELECT knob.
6. Scroll to 03E, MAX Charge Rate. Reduce to 30%. Press SELECT knob. Press HOME button.
7. Press and HOLD the SYSTEM RECOVERY switch until the red FAULT LED turns off and the CHG LED is constant green, no longer blinking.
8. Return 03E Charge Rate to 100% AFTER at least four (4) batteries have a green battery status LED.
9. Charge all batteries fully.
10. Turn on AC output breakers on the PRO-Verter Faceplate to support loads.

The amount of time required for the CHG LED to become solid green (Step 7 above) will vary depending on the degree to which the System batteries are overdischarged; it may require several minutes of constantly pressing the SYSTEM RECOVERY button.

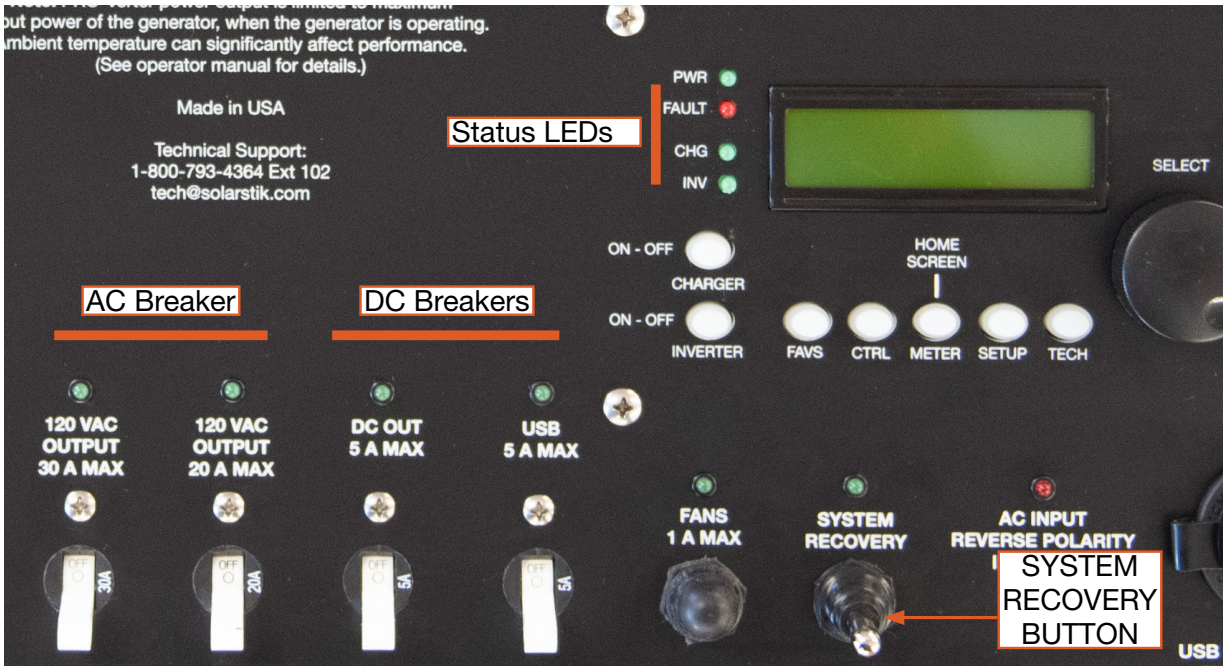


Figure 25. PRO-Verter Faceplate

Note: Solar Arrays, when connected via a Power Hub 3500, will wake up the System and charge the batteries when the solar output voltage is 5 VDC greater than the battery voltage. Solar power can continue to charge the batteries as long as the input voltage is at least 1 VDC greater than the battery voltage.

PRO-Verter/Inverter Reset

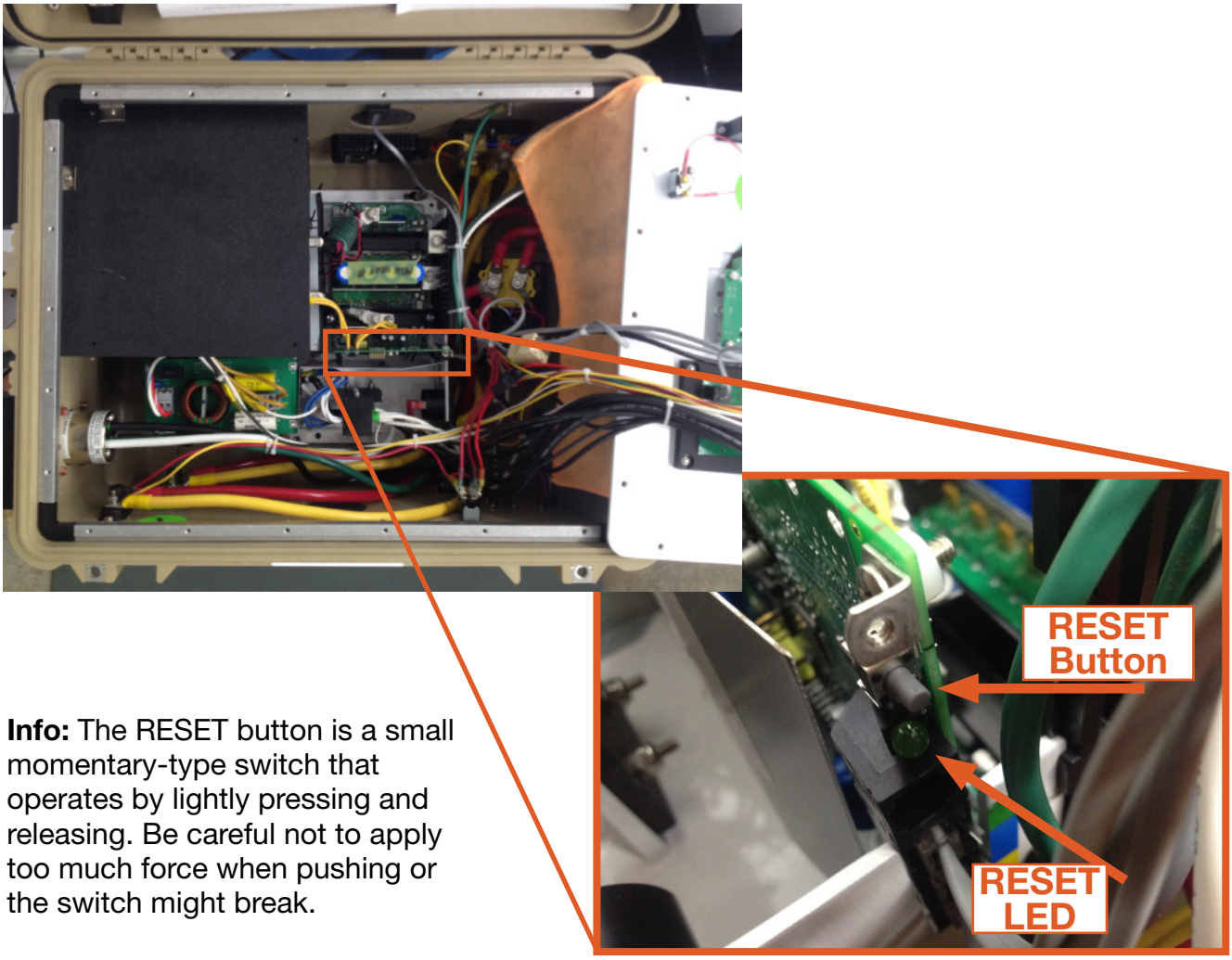
To perform an inverter reset:

1. Ensure all AC power (i.e., shore power or generator) is removed from the PRO-Verter.

2. Remove the PRO-Verter Faceplate. The control board on which the RESET button and RESET LED are mounted is in the center of the PRO-Verter (see below). Locate the RESET button on the right side of the control board.

3. Press and hold the RESET button for approximately ten (10) seconds until the RESET LED comes on and flashes rapidly.

4. Once the rapid flashing has begun, release the RESET button. The RESET LED will go off after the RESET button is released.



Info: The RESET button is a small momentary-type switch that operates by lightly pressing and releasing. Be careful not to apply too much force when pushing or the switch might break.

Accessories

PRO-Verter Remote Monitoring Kit (RMK) LAN
Item # 20-0702602

24VDC 5’ Inter-Connect Strip 7
P/N: 13-1000160

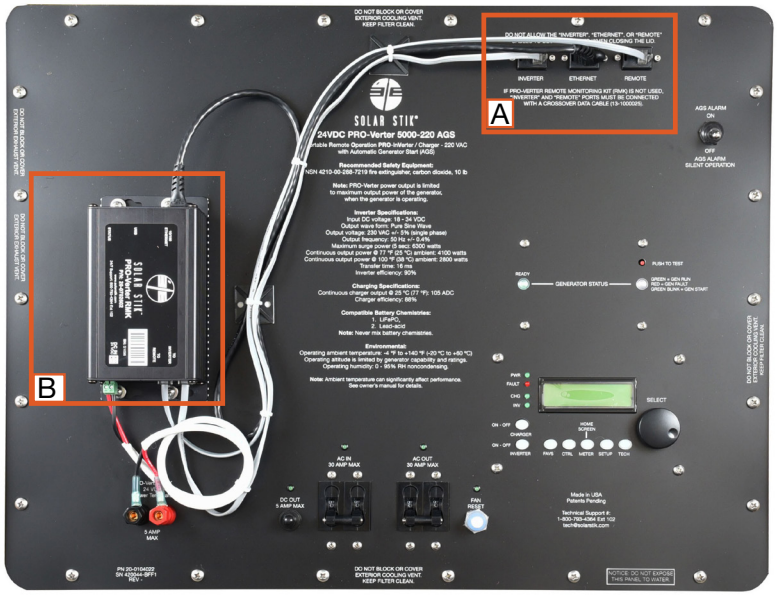
24VDC 5’ Inter-Connect Cable
P/N: 13-0000032
(Available in custom lengths)

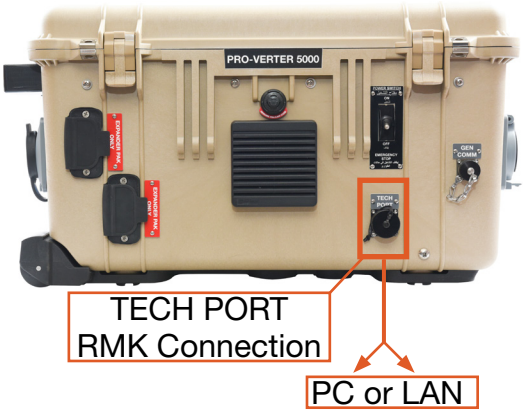
PRO-Verter Remote Monitoring Kit (RMK) AMMPS AGS
Item # 20-0702604

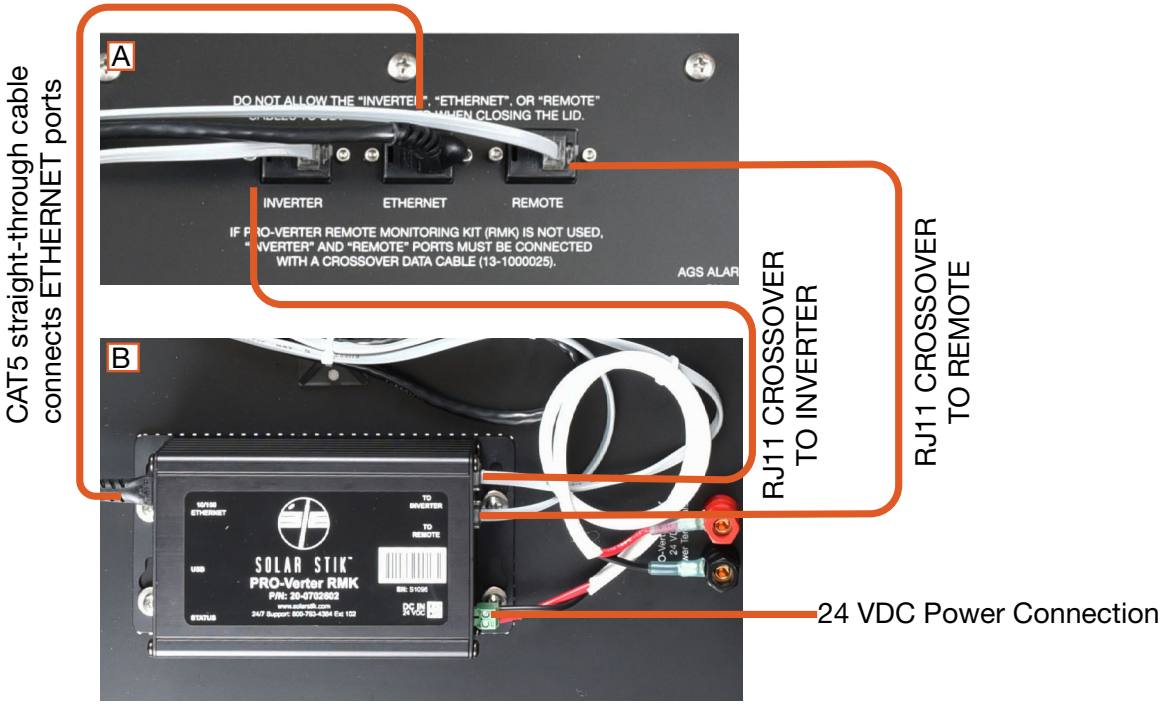
Remote Monitoring Kit (RMK; optional)

The RMK provides remote access to vital operating data of the PRO-Verter via the User Interface on the Faceplate. RMK data can be accessed via the TECH (ethernet) port on the front of the PRO-Verter. The RMK also records and stores all of the data from the PRO-Verter and provides tabular and graphical reports of these data in a user-friendly, browser-based User Interface.

If an RMK is installed, ensure that the connections are as shown below. See the Operator and Maintenance Manual for the RMK for detailed information.







Technical Specifications

General

Nominal Operating Voltage	24 VDC
Input Battery Voltage Range	18 to 34 VDC
Internal cooling	(3) Passive intakes (2) 120 cfm variable speed drive, 92 mm brushless DC fans (2) 80 mm exhaust fans
User Interface	LCD screen, LED indicators, ON/OFF push buttons, menu buttons, rotary SELECT knob, power switch
Case	Pelican 1620
Warranty	1-year materials and workmanship

Inverter Specifications (@ 25 ºC/77 ºF)

Nominal AC Output Voltage	120 VAC, Single Phase
AC Output Voltage Tolerance	±3%
Input Current	60 AAC
Output Frequency and Accuracy	60±0.5 Hz
Continuous Output Power	4000 VA
Inverter Efficiency	93.7%
Transfer Time	About 16 ms
Waveform	Pure Sine Wave
5-second Surge Power	5800 W
30-second Surge Power	5400 W
5-minute Surge Power	4900 W
30-minute Surge Power	4500 W

DC Charger Specifications (@ 25 ºC/77 ºF)

Charging Stages Available	*CC/CV, Bulk, Absorb, Float, Gen Exercise, and Battery Saver*
Continuous Output Current	*110 ADC*
Charging Efficiency	*87%*

Connections

Input(s)	(1) AC Input 120 VAC, 50 A (see Custom Port Types)
Output(s)	(1) AC Output 120 VAC, 50 A (1) AC Output 120 VAC, 20 A (2) General Gen Comm, (1) 24 VDC dual binding post (2) USB 5 VDC, 2.1 A
Input/Output(s)	(3) 24 VDC Inter-connect port(s) (1) Tech Port (RJ45)

Environmental

Operating Temperature	-4 °F to 140 °F (-20 °C to +60 °C)
Storage Temperature	-40 °F to 158 °F (-40 °C to +70 °C)
Operating Humidity	0 to 95% RH noncondensing

Custom Port Type Examples* (AC In/Out)

Port Type		Amps	Voltage
	5-15P 5-15R	15 A	125 VAC
	L5-30P L5-30R	30 A	125 VAC
	L5-50P L5-50R	50 A	125 VAC
	L15-20P L15-20R	20 A	250 VAC
	L14-30P L14-30R	30 A	125/250 VAC

*Connectors with specifications appropriate for any world region are available. For more information about other port types and their capabilities, please contact us.

Weights and Dimensions (L x W x H)

Weight	105 lb (46.3 kg)
Dimensions	27.5 x 19.75 x 13.90 in (69.9 x 50 x 35.3 cm)

Safety

Breaker(s)	(1) AC Input 60 A (1) AC Output 60 A (1) AC Output 20 A (1) DC Output 5 A (1) USB 5 A (Breakers may vary with Custom Port Types)
Fuse(s)	(2) 3 A internal

ABOUT SOLAR STIK, INC.

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

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

Solar Stik Training and Education

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

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

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

Contact

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