OPERATOR AND MAINTENANCE MANUAL FOR 24VDC PRO-VERTER 5000-220 AGS

P/N 20-0104030

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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.

There are several sources for AC and DC power today, but 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 model that allows energy storage technologies to play a critical role in applications where the 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)
- Supporting generators during periods of overloading (Load Support)
- 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 Hybrid Power System (HPS) Architecture, and its flexible function and design allows the operator to use it with other technologies/capabilities that collectively meet the specific mission requirements for an application.

PRO-Verters are "Plug & Play" compatible with the Inter-Connect circuit, and can be used in concert with additional PRO-Verters when high-power or individual control over multiple loads/voltages are required.

AC and DC cables for the PRO-Verter are sold separately, as they must be correct for the voltage type and their current-carrying ability. Additionally, the optional Remote Monitoring Kit (RMK) allows the PRO-Verter to be tailored specifically to meet data collection and notification requirements.

Figure 1. A PRO-Verter in an HPS

Capabilities and Controls

The PRO-Verter provides specific capabilities for a System in which it is employed, but Systems vary in accordance with the application requirements, and not every feature in the PRO-Verter may be used for an application. The PRO-Verter is delivered pre-programmed at the factory for the customer's application, and only minor programming adjustments are occasionally needed in the field.

Most functions and modes are controlled by programming at the User Interface.

- "**Functions**" are related to specific circuits or hardware in the PRO-Verter
- "**Modes**" refer to the operational status of the PRO-Verter circuits.

This manual provides an overview of the core functions and operation modes of the PRO-Verter, along with a complete overview of the menu options, but there are many programming options and features that are not covered. These are "Tech Program Menus" that require specialized knowledge and circumstances to operate.

Programming menus can usually be manipulated by the operator for changing conditions, such as:

- System architecture is altered
- Operational environment changes (hot or cold climates)

Please consult the System Deployment Guide for information on how the PRO-Verter is programmed for its specific role in a particular system, Operator-Level programming changes and more. Always consult the Field Service Representative (FSR) for access and instructions on "Tech-Level" menu programming.

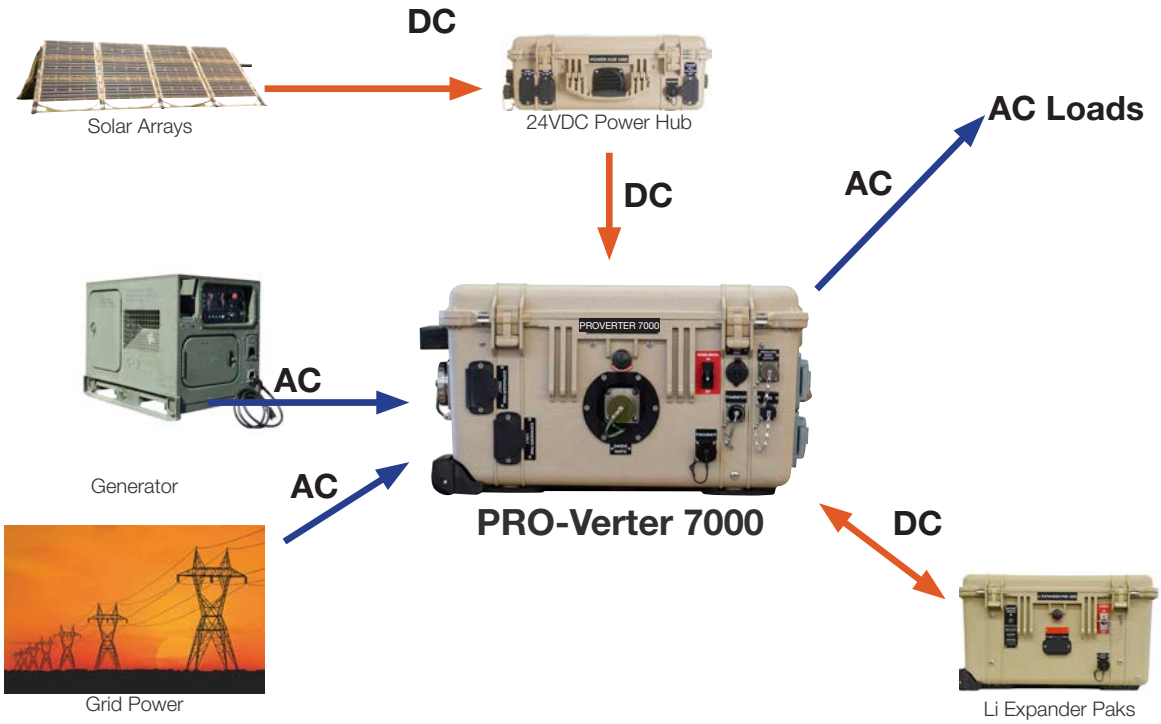


Figure 2. How power flows through a PRO-Verter in a System.

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 5000-220 AGS

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.

Fire Hazard

Fire Types

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

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

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

Recommended Fire Extinguisher

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

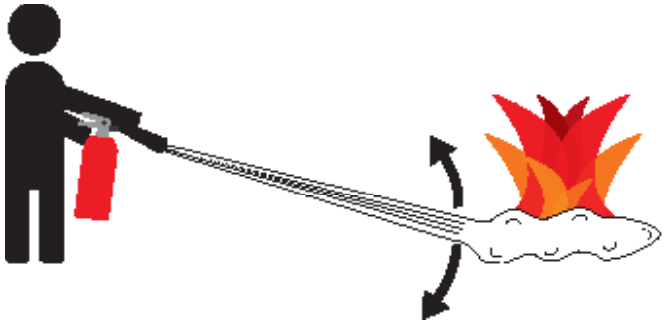
⚠ WARNING

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

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

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



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, photovoltaic (PV) 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

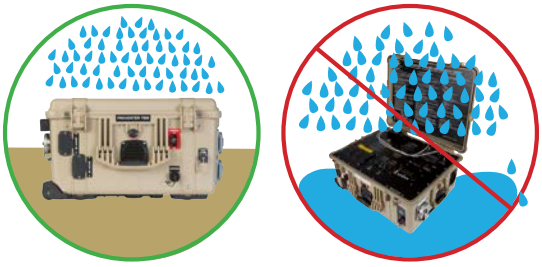
The 24VDC PRO-Verter 5000-220 AGS is NOT GFCI protected.

Environmental and Handling Precautions

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

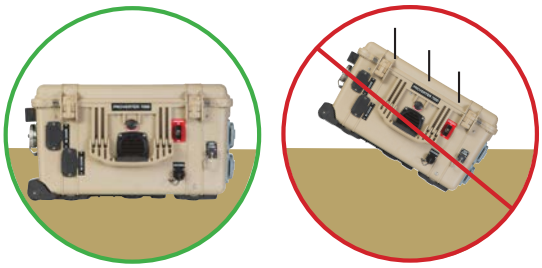
Water

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



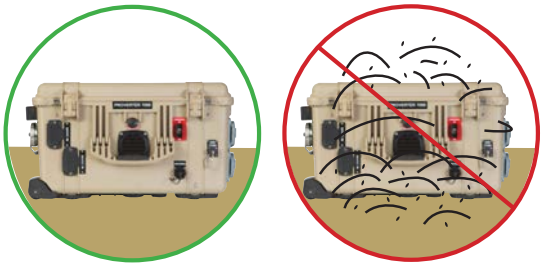
Impact

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



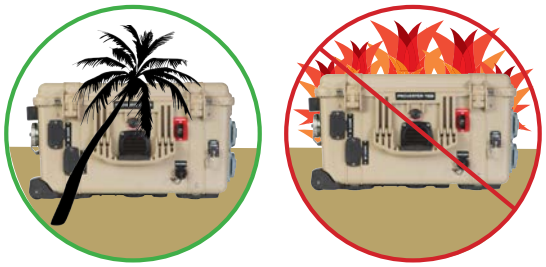
Dust/Foreign Object Intrusion

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



Heat

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



Theory of Operation

Models of Operation

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

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.

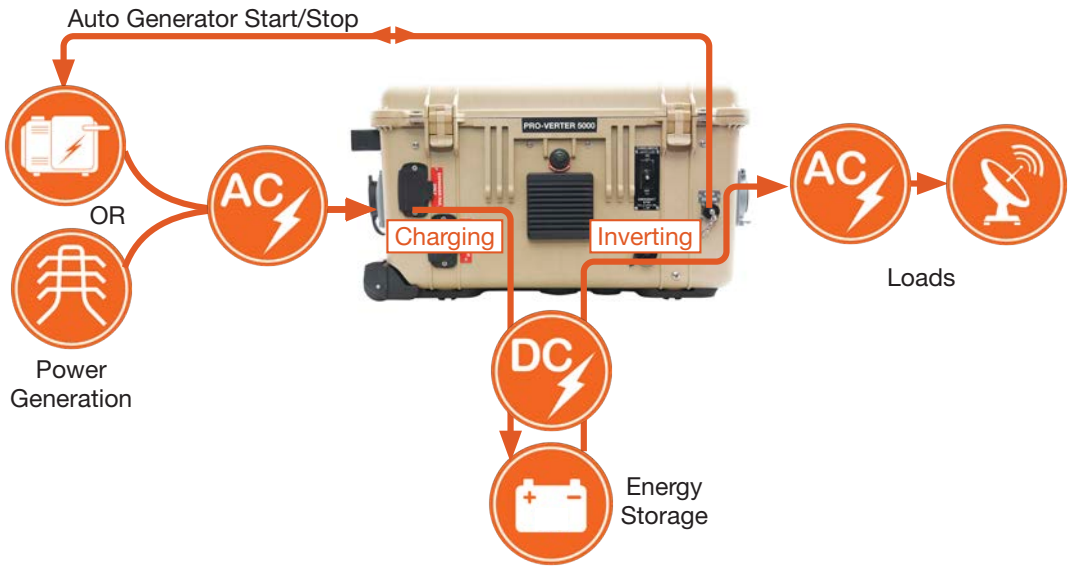


Figure 4. PRO-Verter primary circuits

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.

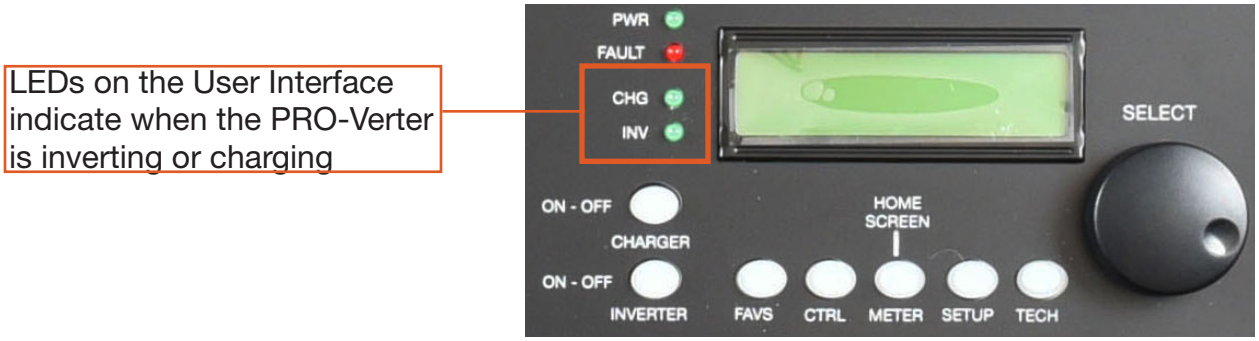


Figure 5. Invert and charge mode LEDs on User Interface

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 LED indicators located on the faceplate (Figure 6) 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

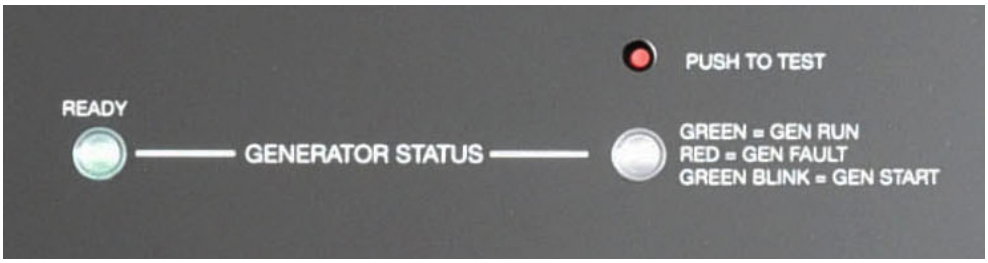


Figure 6. AGS Status LEDs

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

Color-coded Connections

The ends of each cable type are wrapped with colored heat shrink that matches the color of the placard next to the port to which it connects to enable proper connection without technical training.

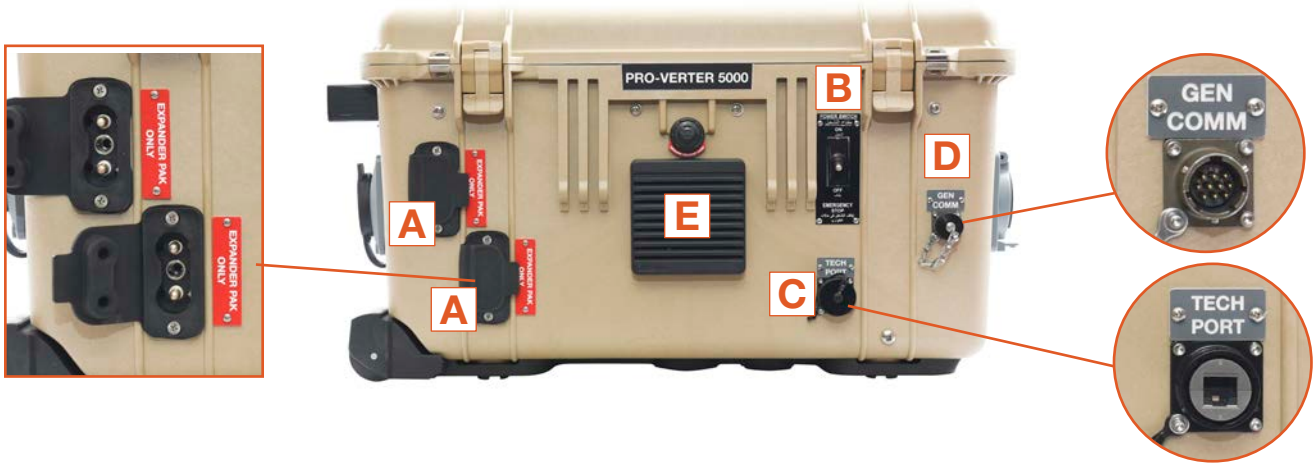
Each of the cables (Figure 8) has a port on the PRO-Verter. Simply match the color of the heat shrink with the color of the placard and the proper connection will be made. Moreover, each of the connectors is keyed or polarized so improper connections cannot be made.

Cable Color	PRO-Verter Ports
Red: 24 VDC Circuit Connection 	
Blue: AC Input Connection 	
Gray: AGS Communication Connection 	
Green: AC Output Connection 	

Figure 8. System connection color coding

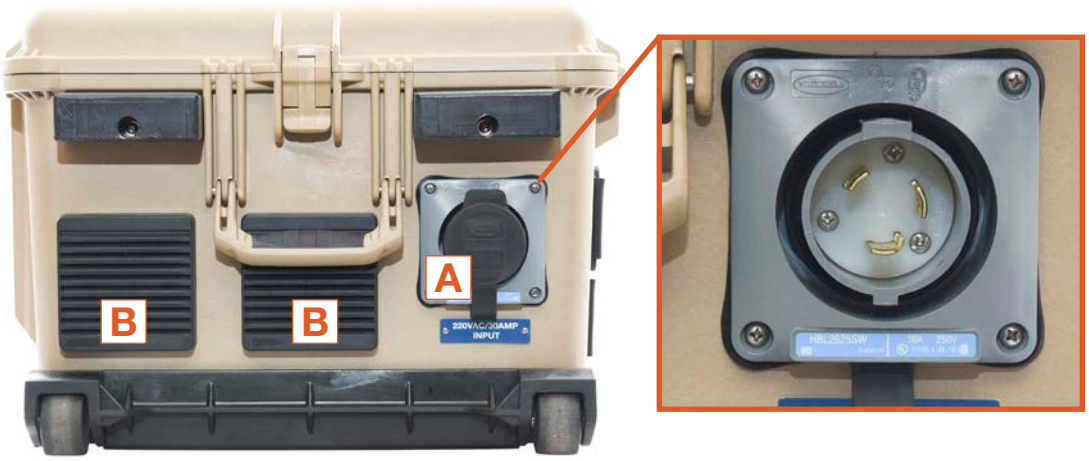
Features

Note: Ports vary among PRO-Verters according to customer requirements. The ports in the pictures below are only examples.



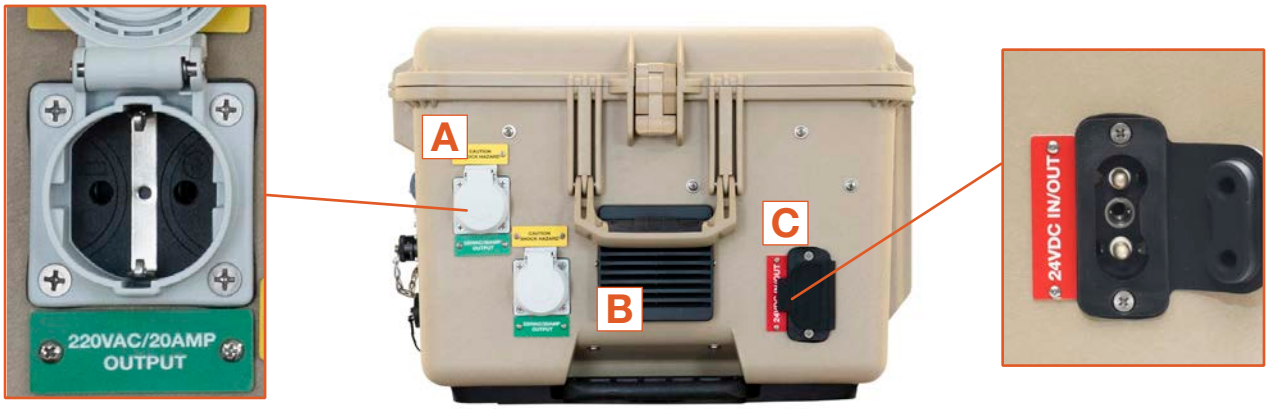
	Description	Connector	Voltage	Amps
A	Battery Connection (metered port)	Inter-Connect Port	24 VDC	100 A
B	Power Switch	-	-	-
C	Modem	Ethernet - RJF21B	-	-
D	Gen Comm Port	Amphenol HA100001-02-36	-	5 A
E	Air Intake	-	-	-

Figure 9. PRO-Verter 5000-220 AGS front exterior



	Description	Connector	Voltage	Amps
A	Input Connection (customer – per application)	HBL2625SW	220 VAC	30 A
B	Air Exhaust	-	-	-

Figure 10. PRO-Verter 5000-220 AGS left exterior



	Description	Connector	Voltage	Amps
A	220 VAC Output (custom – per application)		220 VAC	20 A
B	Air Intake	-	-	-
C	Battery/Power Hub Connection (standard; non-metered)	Inter-Connect Port	24 VDC	100 A

Figure 11. PRO-Verter 5000-220 AGS right exterior

The I-Plate

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

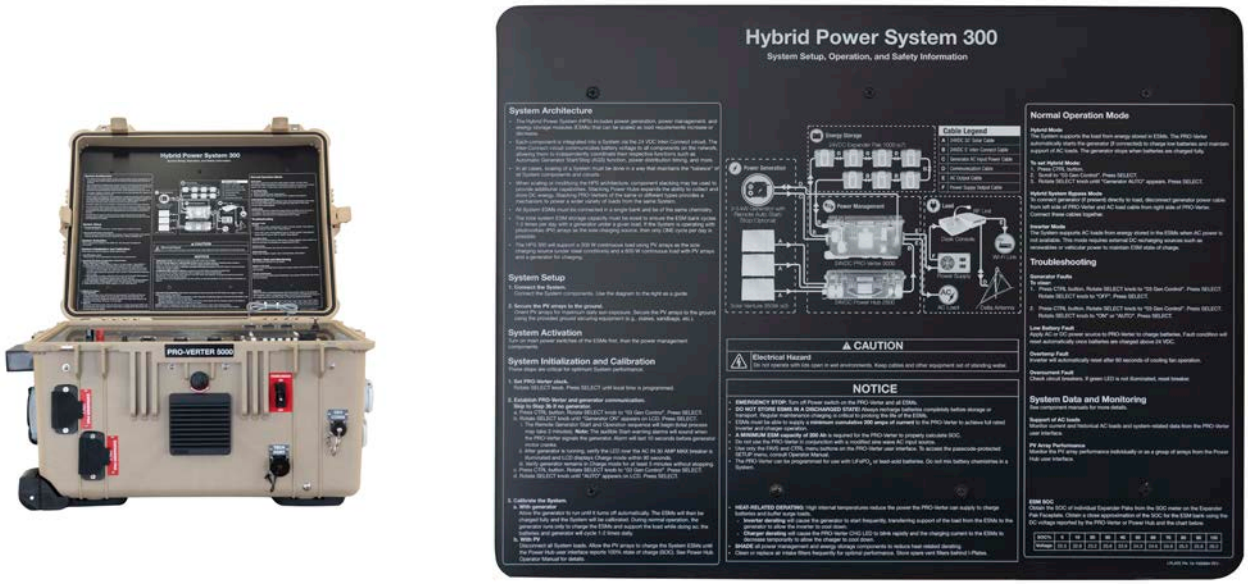


Figure 12. PRO-Verter I-Plate

Faceplate Features and Descriptions

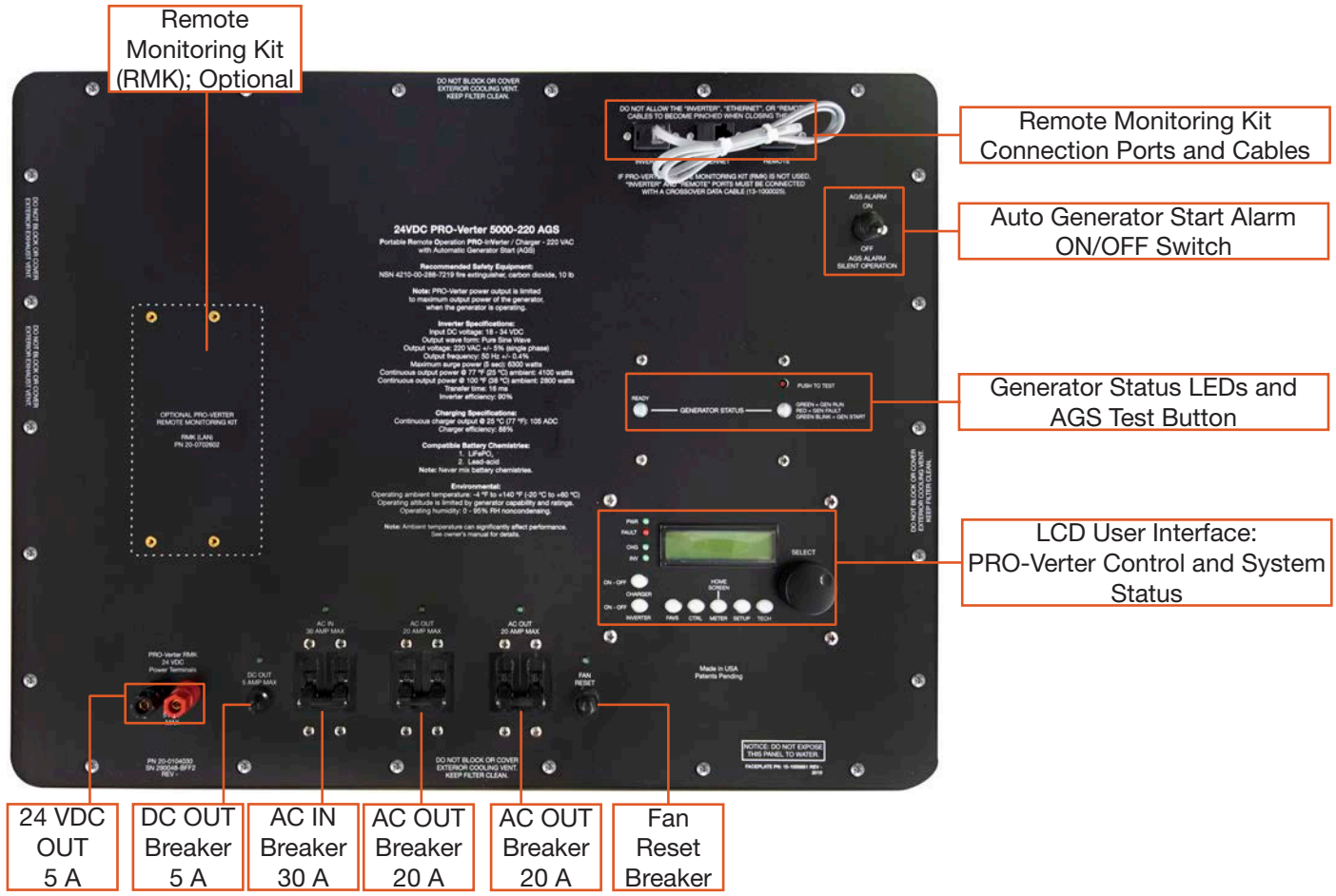


Figure 13. PRO-Verter faceplate

LCD User Interface – The User Interface is used to program, control and monitor a System. The PRO-Verter is programmed to meet the specifications of a specific application.

Generator Status LEDs – The LED on the left will be blinking green during generator start, and steady-on green when the AGS circuit is functional and when the generator is running. The LED will be red if there is a generator fault.

Auto Generator Start (AGS) Alarm ON/OFF Switch – In the ON position, an alarm will sound as warning that the generator has initiated the autostart 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.

Fan Reset Breaker – Push to reset the breaker if the fans are not operating while the PRO-Verter is turned on. The fans do not operate if the PRO-Verter is off. **Keeping the fans running and the air filters clean is critical for maintaining the optimal performance of the PRO-Verter.**

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.

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

Remote Monitoring Kit (RMK) – This optional (sold separately) device reports, records, and stores twenty-eight (28) PRO-Verter and System metrics. See Remote Monitoring Kit section.

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

PRO-Verter LCD User Interface

Overview

The LCD, LEDs, and key pad provide easy System and/or specific function control, PRO-Verter programming, and performance data to the operator. Invert and charge functions can be controlled independently. Other programming menus can be accessed here to allow tailoring of the PRO-Verter's native settings, or tweaks to existing programming when adapting to changes in application or function are necessary. PRO-Verters with I-Plates come programmed for a specific application.

Figure 14. LCD and User Interface

LED Indicators

There are four (4) LED indicators, which provide the operating status of the PRO-Verter's functions:

- PWR (Green)—Indicates the presence of 24 VDC power at the PRO-Verter
- FAULT (Red)—Indicates a fault condition exists in the System
- CHG (Green)—Indicates when the Charge function is operating
- INV (Green)—Indicates when the Invert function is operating

Table 1. LED System Status Indicator Guide

LED	Status	Meaning
PWR (GREEN)	OFF	(1) Inverter is disabled; (2) User interface is in Power Save function—press any button to activate LEDs; (3) No power to User Interface (check User Interface 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 inverter's 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 function—press any button to activate LEDs; or (2) Charger is off—no utility or AC generator present.
	ON	Bulk, Absorb, Float, or CC/CV charge mode (see the LCD screen to determine charge status).
	BLINKING, display says "Charger Standby"	The charger is in Charger Standby function even though AC is present. This occurs when the Charger ON/OFF button is pressed to disable the charger.
	BLINKING, display says "Full Charge" or "Silent"	The charger is in Battery Save function. This function monitors the battery voltage level and only charges if the battery voltage decreases to a low level. Silent function will automatically start charging when the ReBulk volts setting is reached.
	BLINKING, display shows a charging status (I.e., Bulk, Absorb, Float)	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 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.)

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. The green "INV" LED turns on and off with the button.
- **CHARGER ON/OFF:** This button toggles the charge function on and off whenever the charger is actively charging. The green "CHG" LED turns on and off with this button.

Understanding the User Interface Menus

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.

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

Each one of these options will introduce several sub-menus and programming based on the following criteria:

FAVS
The FAVS menu is used for most configuration management, operation settings, and troubleshooting. The operator can configure up to five (5) menu options to be accessed in the FAVS, and 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 information on 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 passcode. This menu should only be accessed when primary PRO-Verter functions require fine-tuning based on application demands. Contact Tech Support or your FSR if changes need to be made on a protected menu.

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

Rotary SELECT Knob

Turn the knob clockwise and counterclockwise to view the different menu items and available PRO-Verter settings. Push the SELECT knob to enter a menu item or to save a setting once 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)...

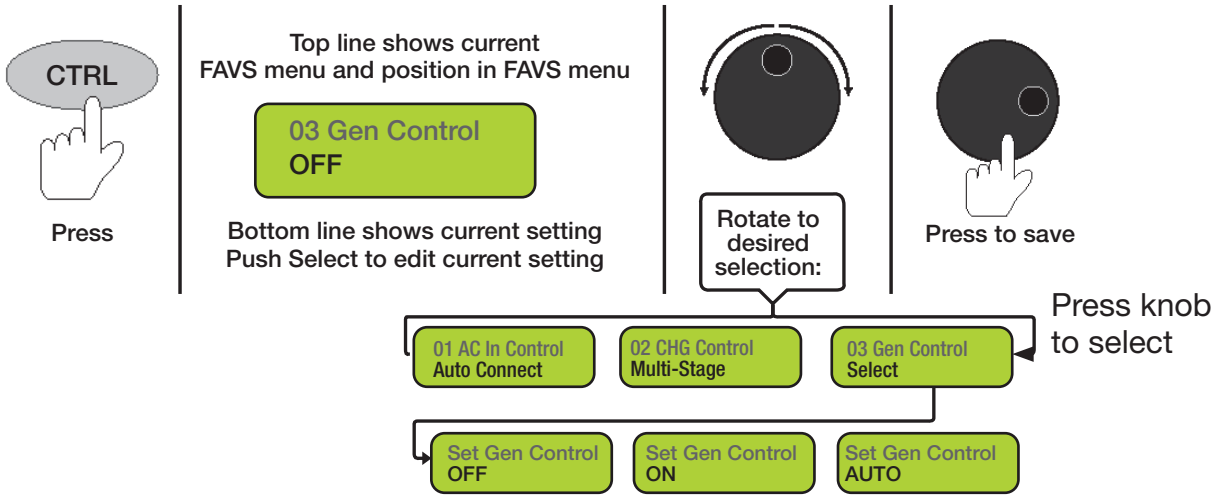


Figure 15. How to start/stop a generator manually

Overview of the Menu Windows

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

Figure 16. 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

PRO-Verter Programming Menu Map

The PRO-Verter has been programmed at the factory to operate with lead-acid batteries and reflect factory settings for PRO-Verters within the HPS 300 or 500. The programming map on the following pages illustrates how to navigate the information in the PRO-Verter User Interface. The color coding key below provides information that makes understanding the programming map easier.

Menu Map Color Coding Key

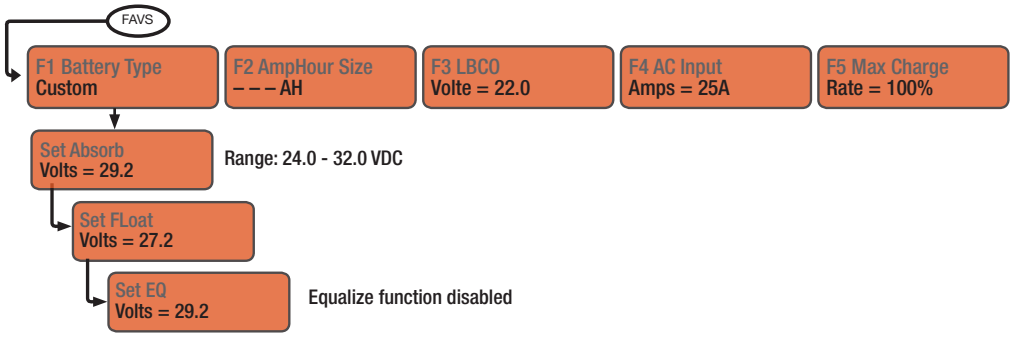
Green menu items represent factory default settings, read-only settings, or options that exist within a specific menu item.

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

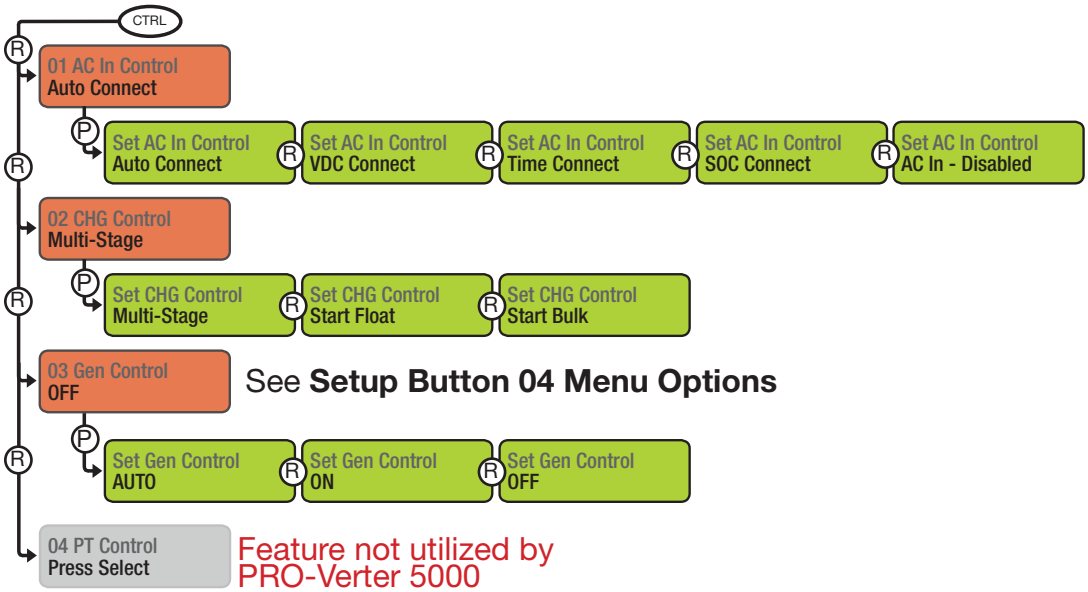
Orange menu items indicate values that are set at the factory for a specific application. These values (with the exception of setting the clock to local time) should not be changed by the user.

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

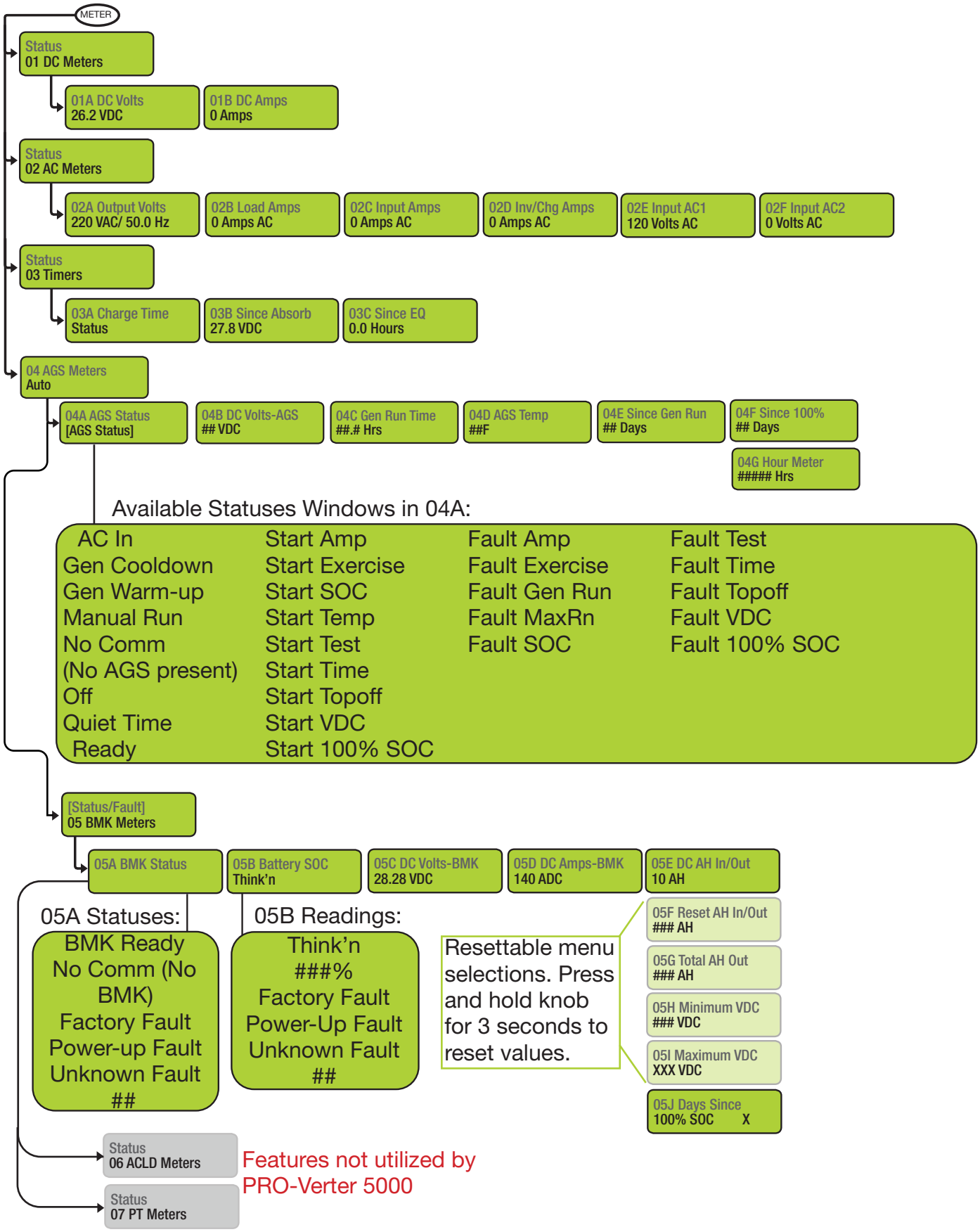
FAVS Button Menus



CTRL Button Menus

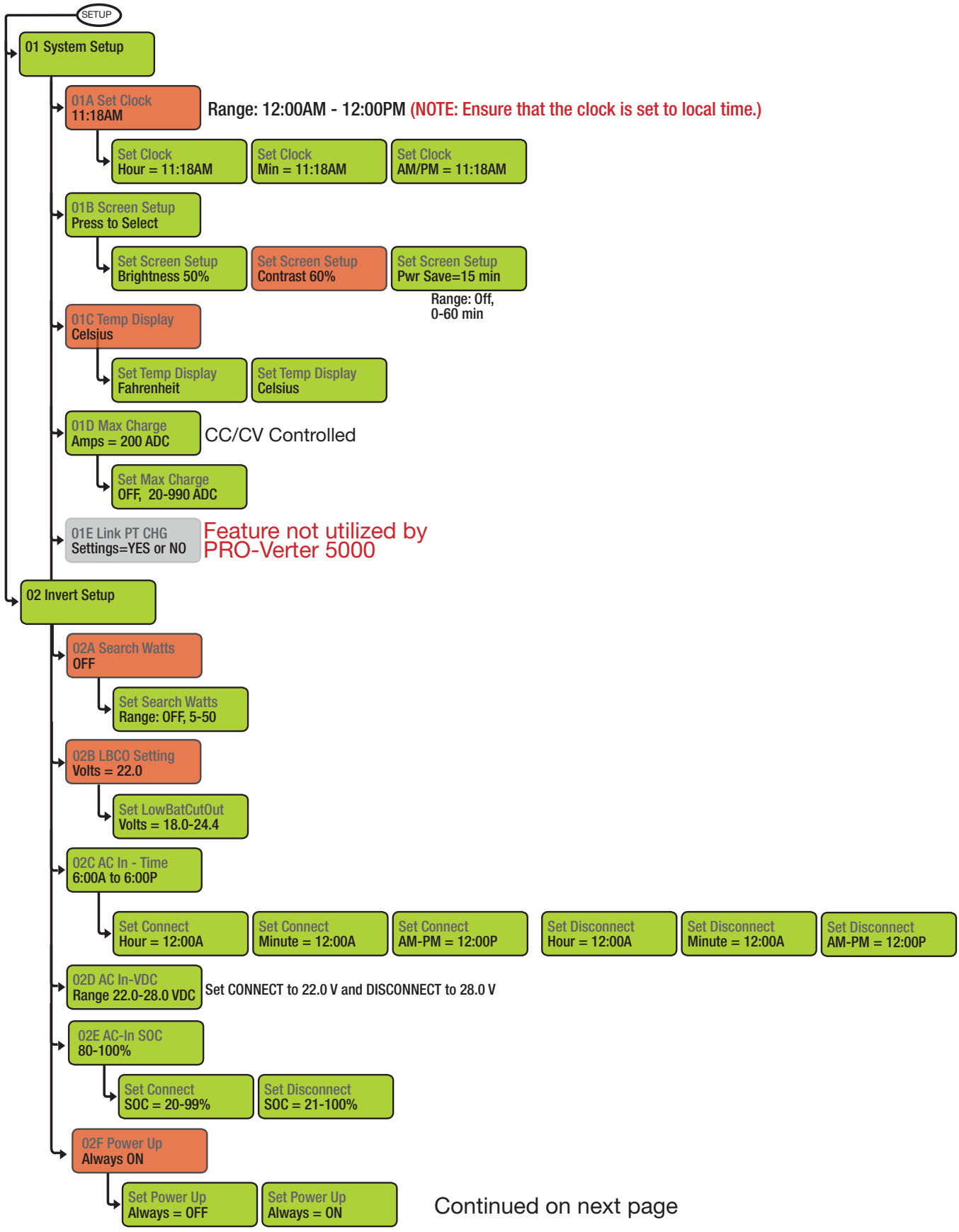


METER Button Menus: Read-only Displays



SETUP Button Menus

Setup: 01 System & 02 Inverter Setup



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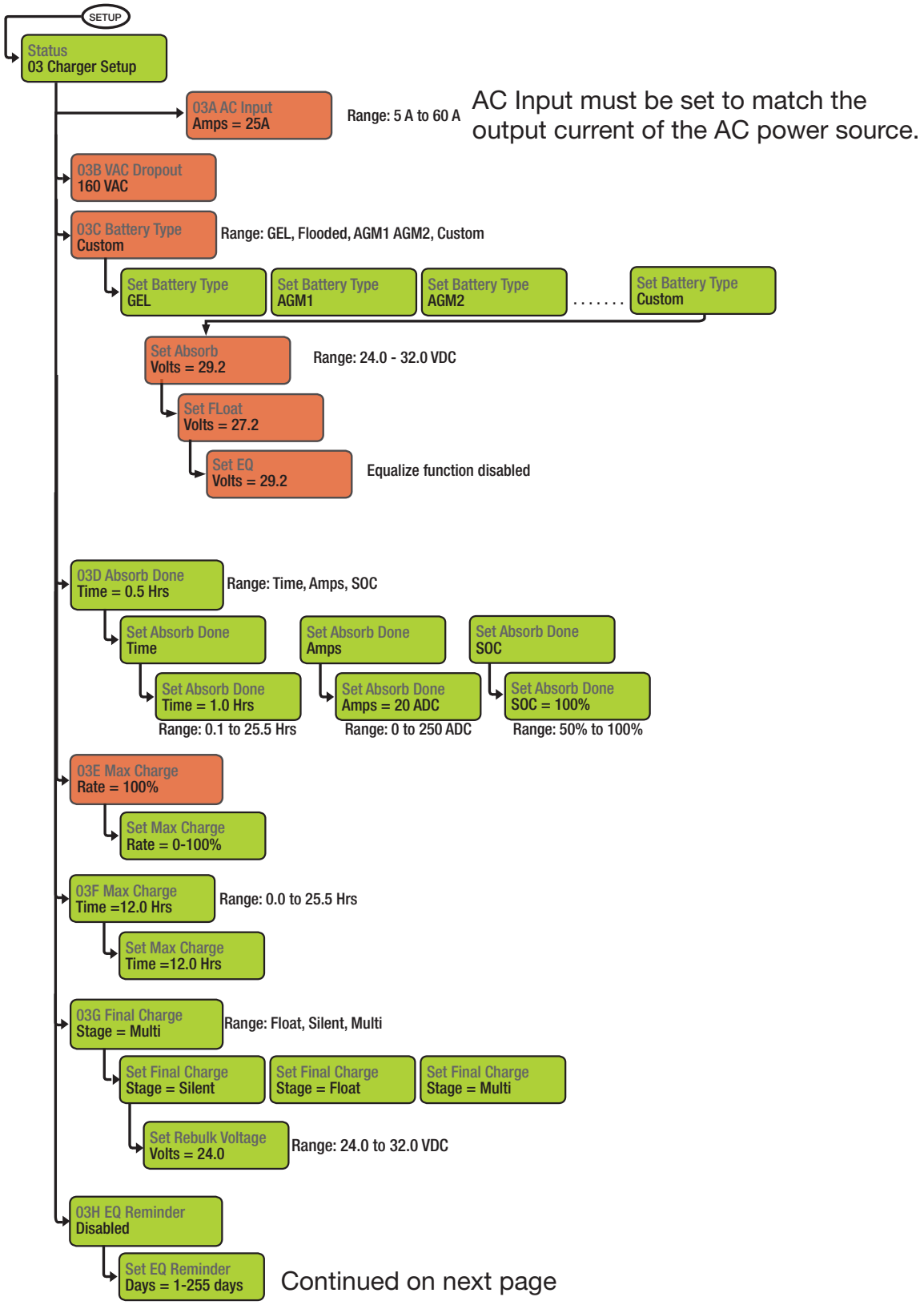
SETUP Button Menus continued

Setup: 03 Charger



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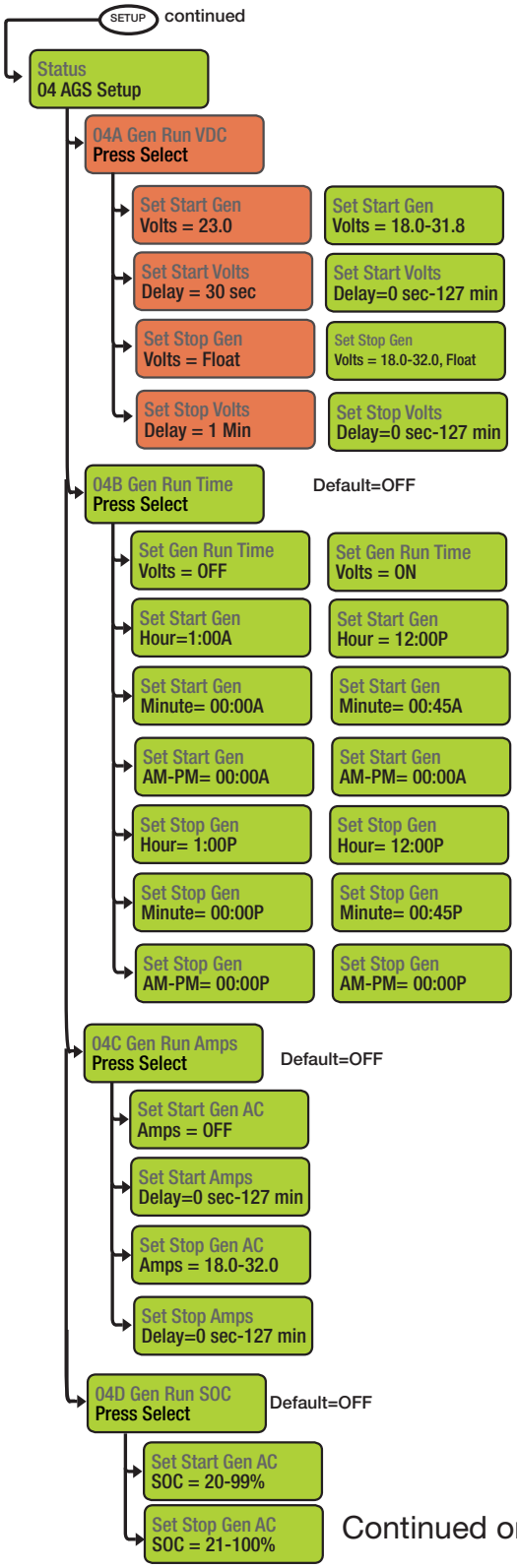
SETUP Button Menus continued

Setup: 04 AGS Setup



AGS Function Notes

- After 30 seconds at or below 23.0 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 21.0 V (LBCO), the AC Out (Inverter) turns off. This is the LBCO voltage in the menu tree.

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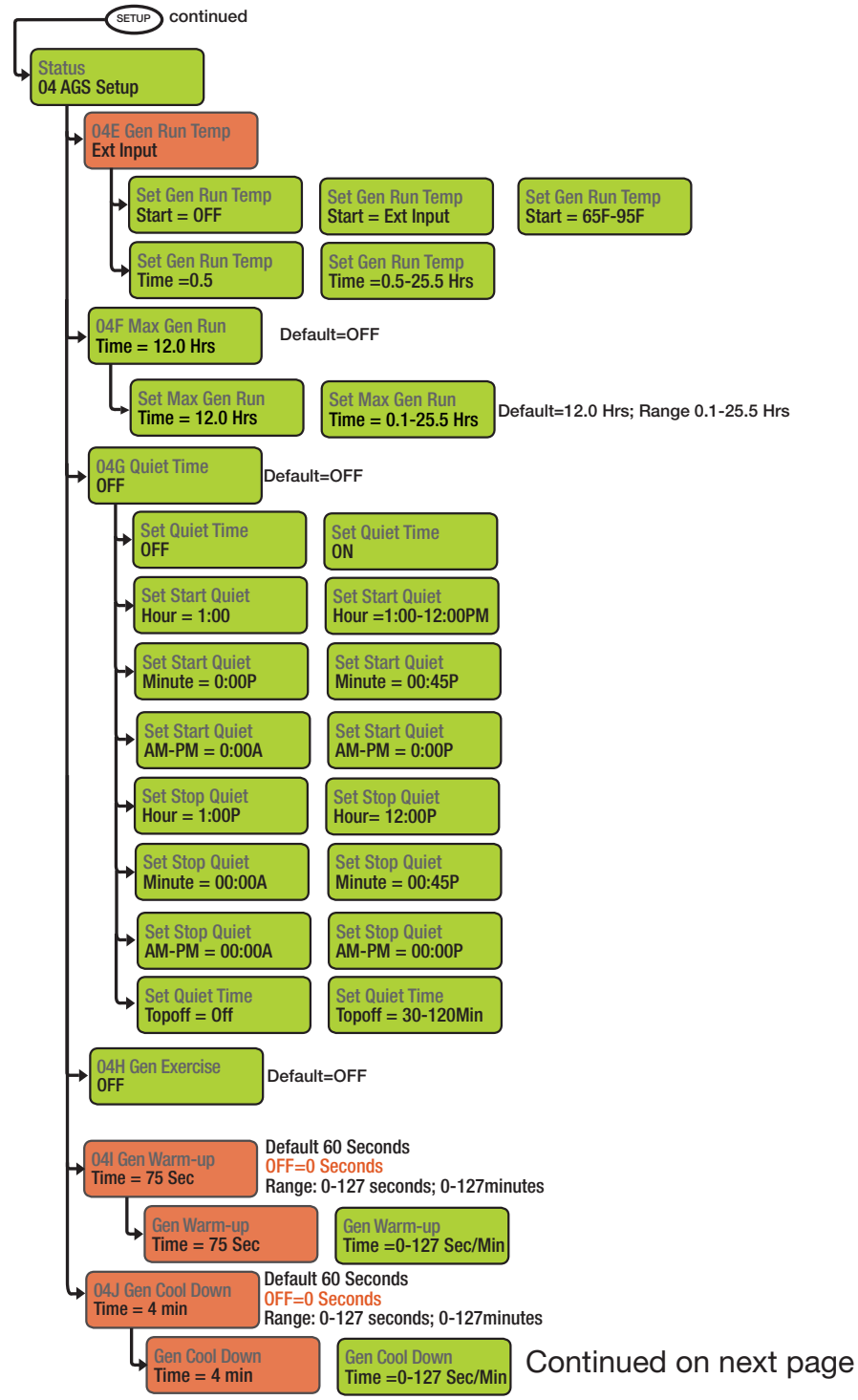
SETUP Button Menus continued

Setup: 04 AGS Setup



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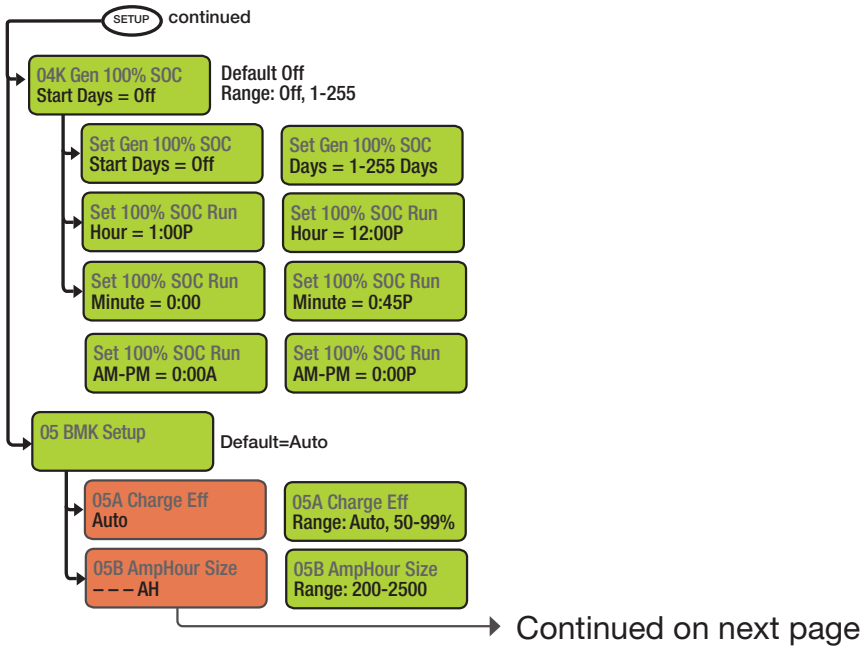
SETUP Button Menus continued

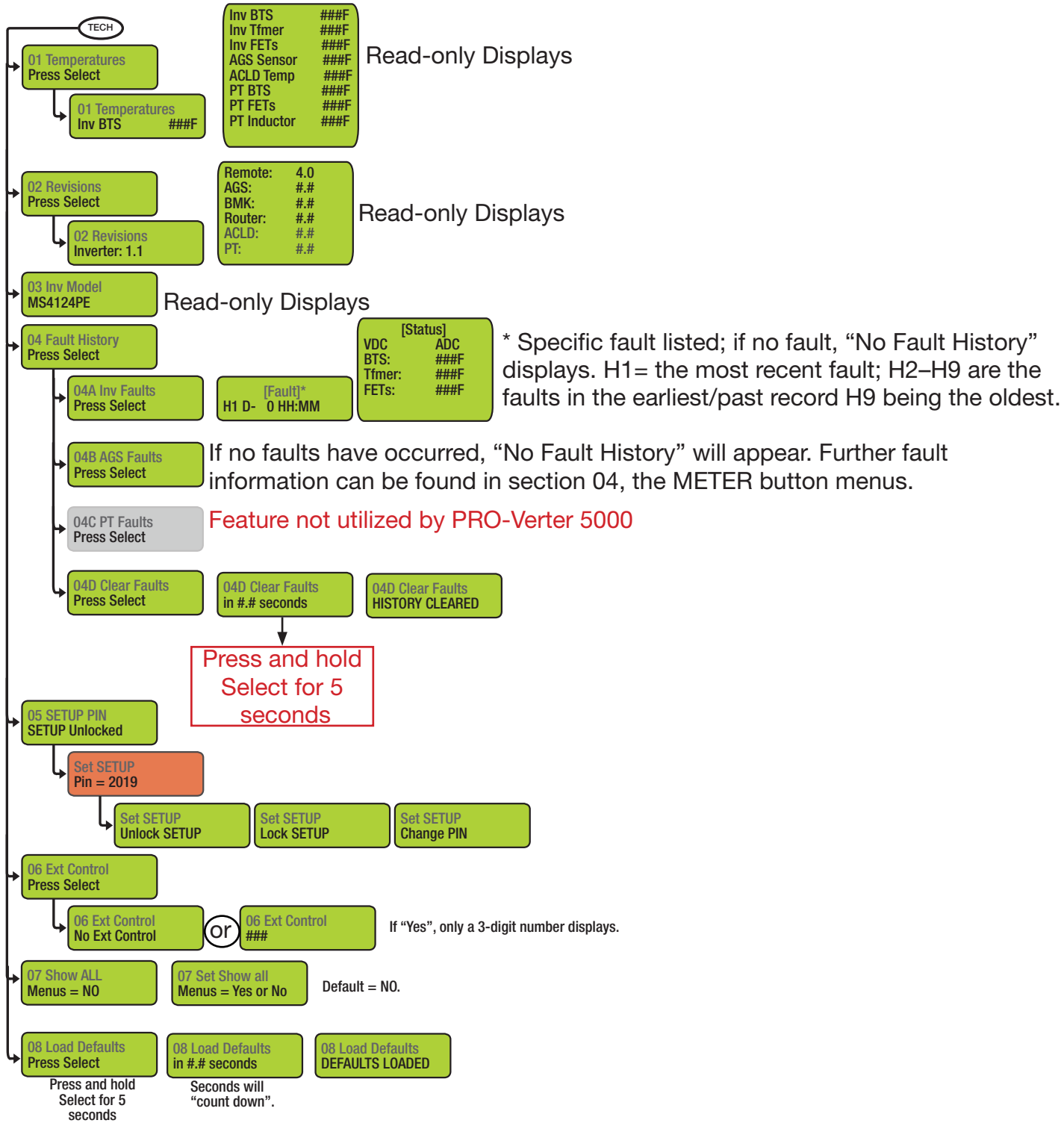
Setup: 04 AGS Setup, 05 BMK Setup



Note:

- The AmpHour Size value should be set according to the total capacity of the battery bank. For example, one (1) 24VDC Expander Pak 1000 is 40 Ah. The minimum setting allowed is 200 Ah.
- The SOC reported by the 24VDC PRO-Verter 5000-220 will be accurate only if the total battery bank size is at least 200 Ah.

TECH Button Menus



OPERATOR INSTRUCTIONS

Powering Up the PRO-Verter

The PRO-Verter must be connected to a 24 VDC power source (such as 24VDC Expander Paks) to operate. When the PRO-Verter is connected to an active DC circuit and is powered on, the master control board that commands the various internal circuits performs an internal diagnostic check to ensure the functions can be safely used. While this is occurring, the LCD at the keypad will flash individual revision information for all of the control boards that are installed.

Figure 17. Powering up the PRO-Verter

Setting the Clock

The LCD screen will automatically display the “Set Clock” screen after it has been turned on. The series of pictures in Figure 18 shows what the operator will see at each stage of the process. Follow the steps in order.

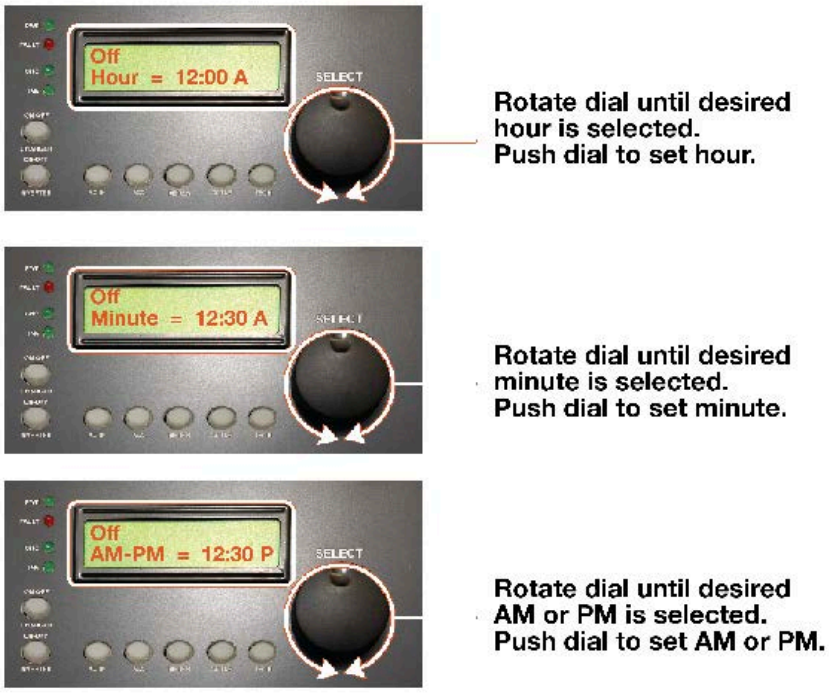


Figure 18. Setting the PRO-Verter clock

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.

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 correct.
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.

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. Contact FSR 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 User Interface; ensure (1) it is connected to the User Interface and (2) the correct communications cable is used. (A four-conductor telephone cable may be substituted to determine if the cable is good).
	PRO-Verter is not connected to the batteries.	Ensure the inverter batteries are connected and the inverter is operating correctly without any AC power connected (can invert and power AC loads from batteries).
	No crossover cable present or incorrect RMK cable configuration installed.	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 LCD User Interface cable from inverter for 5 seconds and then reconnect. (2) Check RJ11 cable connection on back of LCD board. Ensure the RJ11 connector is pushed into the correct port. You should feel/hear 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.

MAINTENANCE INSTRUCTIONS
Preventive Care and Maintenance

Note: The function and efficiency of all electronic equipment is related to and dependent upon the temperature at which it is operating. It performs optimally within a narrow temperature range and less so as the temperature falls outside of that range. **Heat will cause the PRO-Verter to derate**.

Please use the following measures to mitigate against heat and other environmental effects:

- Shade the PRO-Verter from direct sun exposure and shelter it from the elements as much as possible.
- Keep case lid and Inter-Connect covers closed to prevent water/dust intrusion.
- Check the integrity of electrical connectors on a monthly basis.
- Turn off electrical appliances when they are not in use. This will save power and allow more power to be available when it is needed.
- Clean the air filters of the PRO-Verter air intake vents monthly. Wash them with water, dry them thoroughly, and place them back in the intake vents (see below). The filters must be cleaned more frequently when high winds are frequent and particulate levels are high.

Cleaning the Air Filters

a. Squeeze the sides and pull away to remove the louvered vent cover..

Figure 19. Louvered vent cover

b. The foam air filter sits on top of the filter assembly.

Figure 20. Air filter

c. Remove the foam filter. Clean with water or compressed air.

Figure 21. Cover and filter removed

d. Reinstall the louvered cover in the proper orientation—leading edge of the baffles facing toward the ground.

Note: Only air intake vents have air filters. The exhaust vents do not. See Figure 9 through Figure 11 for vent type locations.

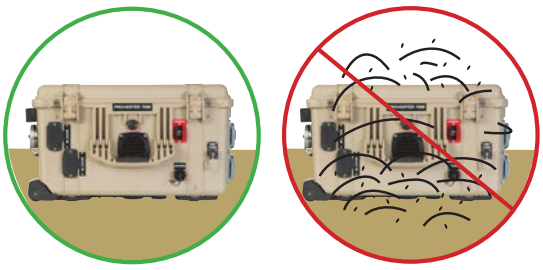


Figure 22. PRO-Verter air intake vent

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.

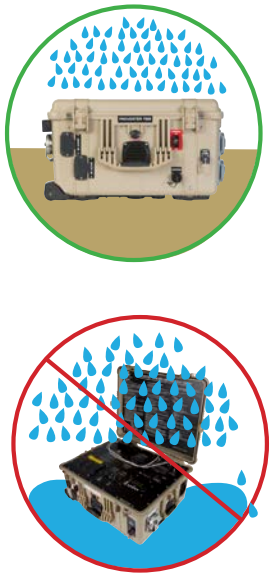


Figure 23. Location of drain plug screws in the PRO-Verter 5000

PRO-Verter/Inverter Reset

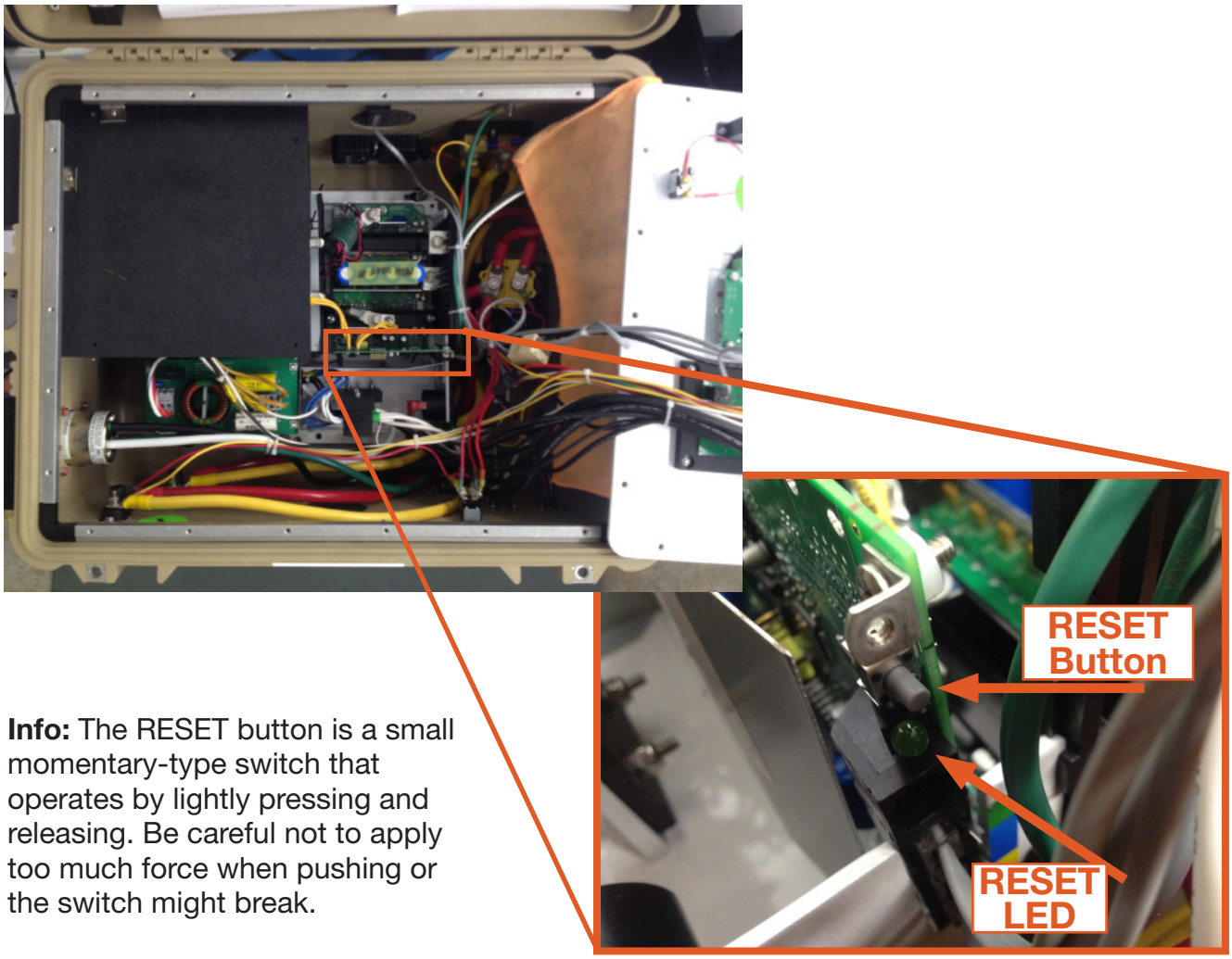
To perform an inverter reset:

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. If the fault does not clear after this procedure, contact the FSR.



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.

SUPPORTING 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	220 VAC, Single Phase
AC Output Voltage Tolerance	±5%
Rated Current	30 A
Output Frequency and Accuracy	50±0.4 Hz
Continuous Output Power	4100 VA
Inverter Efficiency	90%
Transfer Time	About 20 ms
Waveform	Pure Sine Wave
5-second Surge Power	6300 W
30-second Surge Power	5300 W
5-minute Surge Power	4750 W
30-minute Surge Power	4600 W

DC Charger Specifications (@ 25 ºC/77 ºF)

Charging Stages	Bulk, Absorb, Float, CC/CV, Gen Exercise, and Battery Saver
Continuous Output Current	105 ADC
Charging Efficiency	88%

Connections

Input(s)	(1) AC Input up to 30 A (see Custom Port Types)
Output(s)	(1) AC Output up to 30 A (see Custom Port Types), (1) General Gen Comm, (1) 24 VDC dual binding post
Input/Output(s)	(3) 24 VDC Inter-connect port(s) (1) Tech Port (RJ45)

Safety

Breaker(s)	(1) AC Input 30 A (1) AC Output 30 A (1) DC Output 5 A (1) Fan 1 A (Breakers may vary with Custom Port Types)
Fuse(s)	(2) 3 A internal

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
Standards	MIL-STD-810G tested

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	100 lb (46.3 kg)
Dimensions	26.0 x 19.75 x 13.90 in (66 x 50 x 35.3 cm)

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)

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. 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.