SOLAR STIK®

SYSTEM SETUP AND OPERATION GUIDE FOR THE 1kW HYBRID POWER SYSTEM (HPS)

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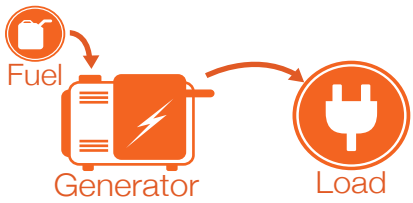
GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

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

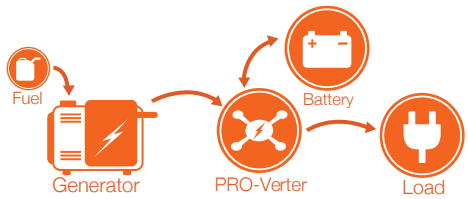
Introduction to Hybrid Power Systems

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

In the high-efficiency, Hybrid Power System (HPS), a battery bank supports the load. The power for the load is drawn from the batteries only as needed. Multiple sources of power generation can be used simultaneously to support the battery and ensure uninterrupted power to the loads. **The battery or energy storage module (ESM) becomes the foundation of the HPS and the architecture is opened to allow multiple technologies to operate in concert.**



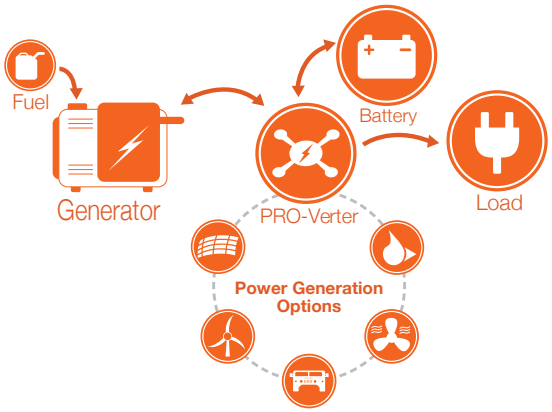
Low-efficiency
Traditional Power System



High-efficiency
HPS

The HPS Flexible Open Architecture

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



HPS with Open Architecture

Important Safety Information and Instructions

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

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

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

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

Safety Information Labels

Your safety and the safety of others is very important.

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

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

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

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

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

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

Fire Hazard

Fire Types

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

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

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

Recommended Fire Extinguisher

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

⚠ WARNING

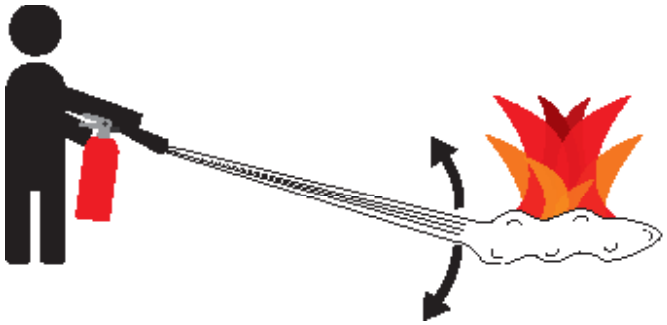
Only CO_2 (carbon dioxide) fire extinguishers should be used with this equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

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

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



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

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

Electric Shock Hazard

⚠ WARNING

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

DON'T LET THIS BE YOU!

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

⚠ WARNING

The System is NOT GFCI protected.

Grounding a PRO-Verter

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

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

Figure 1. PRO-Verter grounding lug

Environmental and Handling Precautions

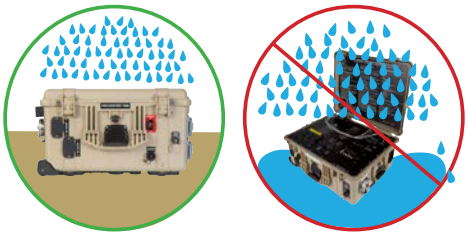
All Solar Stik components are ruggedized, yet there are a few things the operator can do to prevent failures and prolong the operational life of the Solar Stik System.

Wind

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

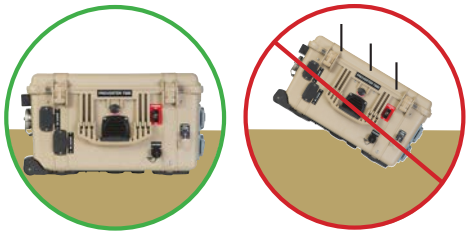
Water

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



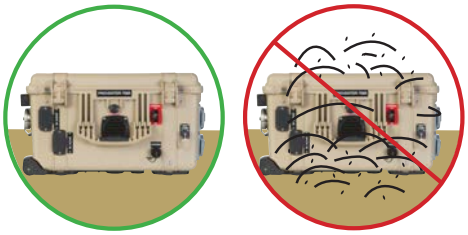
Impact

Equipment should not be dropped onto hard surfaces at a height greater than one (1) foot when transporting or during operation.



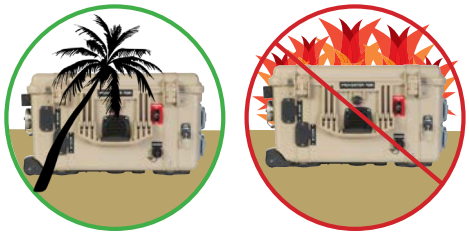
Dust/Foreign Object Intrusion

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 sources 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 provide supplemental, "surge" AC power (beyond what can be provided by a generator/grid AC source) during brief/ intermittent periods while allowing the "continuous" loads to be supported in the Hybrid model.

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.

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 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 power source maximum continuous AC output up to 150% for brief periods (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 battery circuit to operate. They CANNOT be used directly between an AC source and an AC load without a battery connected. PRO-Verters are compatible with both lead-acid and lithium battery chemistries.

The amount of energy storage required for a system depends on factors including but not limited to the load and charge/discharge current requirements

DC Voltage: Master Metric

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
- PHOTOVOLTAIC – Optimizes and regulates DC power from PV panels to charge batteries.

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

Recovery Circuits
- AC-powered System recovery (overdischarged batteries)
- PV-mediated System recovery (overdischarged batteries)

Both the primary and the support circuit functions of the PRO-Verter are managed by native programming, which can be adjusted via User Interfaces.

If the PRO-Verter is connected to an over-discharged batteries, the recovery circuit enables the PRO-Verter to restore the batteries to service using either a 120 VAC or PV power source. These circuits are not programmable. The AC-powered System recovery circuit an optional feature.

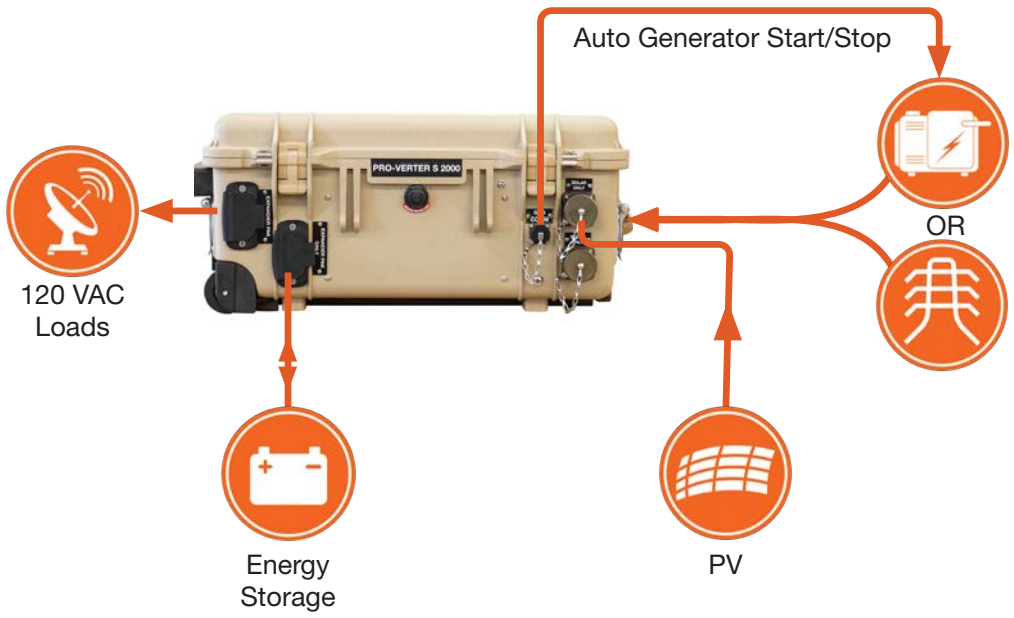


Figure 2. PRO-Verter S 2000 circuits

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 within 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 power, 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 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 1000 Watts continuous output, then the AC INPUT should be set for 8.3 Amps @ 120 VAC.

"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, 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, and <1ms from Inverter to the AC input source which is usually fast enough to support computers, servers, and other critical loads.

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 or goes over certain thresholds, such as those programmed in the INPUT LOW and INPUT HIGH SETTINGS.

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 Heat Sink Over Heat fault, which will cause either retardation of charging functions or a failure to provide AC power to the load.

Charge Function

Whenever an AC power source is connected to the AC INPUT, the PRO-Verter automatically begins monitoring for acceptable AC voltage and power quality. Once the AC voltage is accepted, the AC transfer relay closes passing AC power to the load, and then charge function begins.

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. The PRO-Verter can be programmed to charge with a “Constant Current / Constant Voltage” (CC/CV) protocol for use with certain types of lithium batteries.

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. .

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 VDC power 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 User Interface home screen will indicate that the PRO-Verter is inverting.

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. 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.

Transfer of Loads From Grid / Generator Input to Inverter (Batteries)

When the PRO-Verter is operating in “Charging Mode”, the phase and frequency of AC input power are tracked continuously. If AC input power fails or is disconnected, the load will be transferred, within 16 ms, to the inverter at the same phase and frequency as the AC input power that was disconnected.

Transfer of Loads From Inverter (Batteries) to Grid / Generator

When Grid / Generator becomes available, its voltage and frequency are checked to determine if they are within the programmed limits. If so, the output voltage of the Inverter is synchronized with Grid / Generator through “Phase Locked Loop” (PLL). This synchronization process takes few seconds. Once synchronization is completed, the load is transferred instantly (within 1 ms) to Grid / Generator at Zero Crossing of the voltage waveform, for seamless transfer and for better protection of Transfer Relay contacts.

PV Charging Management

Charging the System Expander Paks can be supplemented by connecting a PV array(s) to the PRO-Verter. The value of the PV current is displayed as “EXTERNAL”, the bottom line of the User Interface.

The PRO-Verter S 2000 can be programmed to manage PV power in either one of two ways:

1. Incoming PV power can “replace” or offset some generator power. For example, if “Bulk Current” is programmed to 20 A and the PV array is generating 15A, the PRO-Verter charger will reduce its current from 20 A to 5 A so the net charging current is equal to the programmed, maxiumum value of 20A

2. Incoming PV power can be “added” to generator power. For example, if the “Bulk Current” is programmed to 20 A and the PV array is generating 15A, the PRO-Verter charger will combine the currents 20 A and 15 A so the net charging current is 35 A, exceeding the programmed, maxiumum charging value of 20A.

Note: When managing PV power using method #2, do not exceed the maximum combined rated charging current of the batteries in the bank.

Automatic Generator Start/Stop (AGS) Function

The AGS circuit is used to start/stop an external generator, controlling it based on battery voltage.

When the AGS is active during hybrid operation, it should 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 real time generator function information to the operator.

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.

Soft Start

The PRO-Verter incorporates a “Soft Start” feature that provides advantages and protections. When the PRO-Verter powers up, it starts in Inverting Mode. The soft start allows the output voltage to ramp up gradually from around 48 VAC to 120 VAC in about 200 ms. This dampens the high inrush current, and concomitant voltage drop, of inductive loads like motors. This results in less mechanical stress, wear and tear and increased lifetime of the PRO-Verter and the loads.

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.

Two additional (2) PRO-Verter case exhaust fans come on when the PRO-Verter is powered up. They remove heat from the case interior.

Protection Circuits

The PRO-Verter is protected against fault conditions using protection circuits 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 on the LCD user interface.

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

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.

To protect against over temperature shut down when operating in higher ambient temperatures, the set value of “BULK CURRENT” is automatically reduced as follows based on temperature sensed at the Power Transformer and at the Heat Sink for the Power FET board.

- Power Transformer Temperature > 130°C: Reduce by 0.2% every 20 sec
- Heat Sink Temperature is > 90 °C: Reduce by 0.2% every 20 sec

If the system is not operating at rated power, be sure to check the PRO-Verter air filters 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 User Interface.
- Charger derating will temporarily reduce the charging current to the ESMs to allow the charger to cool down.

Dead-battery System Recovery Circuits

There are two (2) recovery circuits to revive a System if the System batteries become overdischarged to a “critical-low” level, to the point that the System may cease to function. The first option utilizes an AC power source and the second, PV power. See the I-Plate and this Manual for more information.

Historical Data and Fault Tracking

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

The PRO-Verter logs operating data and tracks faults on an SD card (optional) inserted into the User Interface. Information regarding these functions are found in the PRO-Verter S 2000 Data Logging section of this Manual. Data Log files may be viewed using Excel or similar program.

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.

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.

24VDC Standard Inter-Connect Plug

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

Figure 3. Inter-Connect Plug

24VDC Linear Inter-Connect Cable

Inter-Connect Cables for use with the Li Expander Pak 1300 have two types of plugs: straight and angled. The straight plug connects to the Expander Pak 1300 to facilitate stacking (Figure 4).

- 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

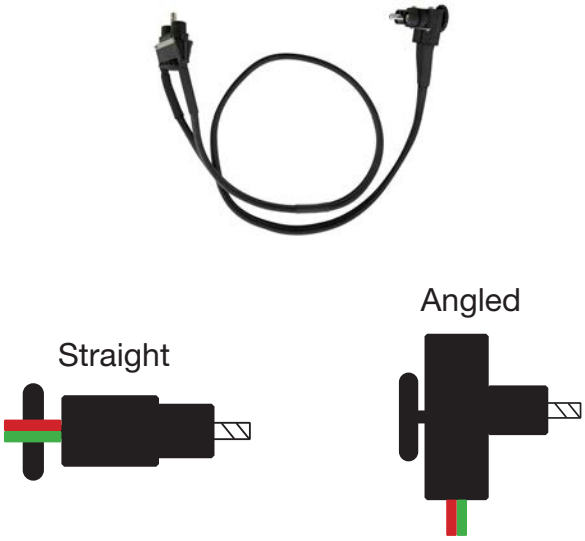


Figure 4. Linear Inter-Connect Plug

1kW HPS Kit

21-0202316
(2) 24VDC Li EXPANDER PAK 1300

19-1000012 (1) SOLAR VENTURE 300W KIT (INCLUDES CABLE & CASE)

20-0104025
(1) 24VDC PRO-VERTER S 2000-120 EAG1

01-1000100
(1) NOVATIO DEFENDER 1 KW WITH E-START MOD

13-1000288
(1) GENERATOR COMMUNICATION CABLE, 1KW & 2KW, 10’

13-1000277
(1) AC POWER CABLE, 10’, 5-15P TO 5-15R

13-1000032
(2) 24VDC INTERCONNECT CABLE, 5’ LINEAR

13-1000267
(2) 24VDC INTERCONNECT CABLE, 5’

13-1000130
(1) 24VDC Inter-Connect Strip 7

24VDC Li Expander Pak 1300 Description

External Features

- **Inter-Connect Port:** Point of connection with the system 24 VDC bus, Inter-Connect network
- **Stacking Locks**: Provide stability and alignment for stacked Expander Paks
- **Tech Port:** Contact Solar Stik Technical Support for information.

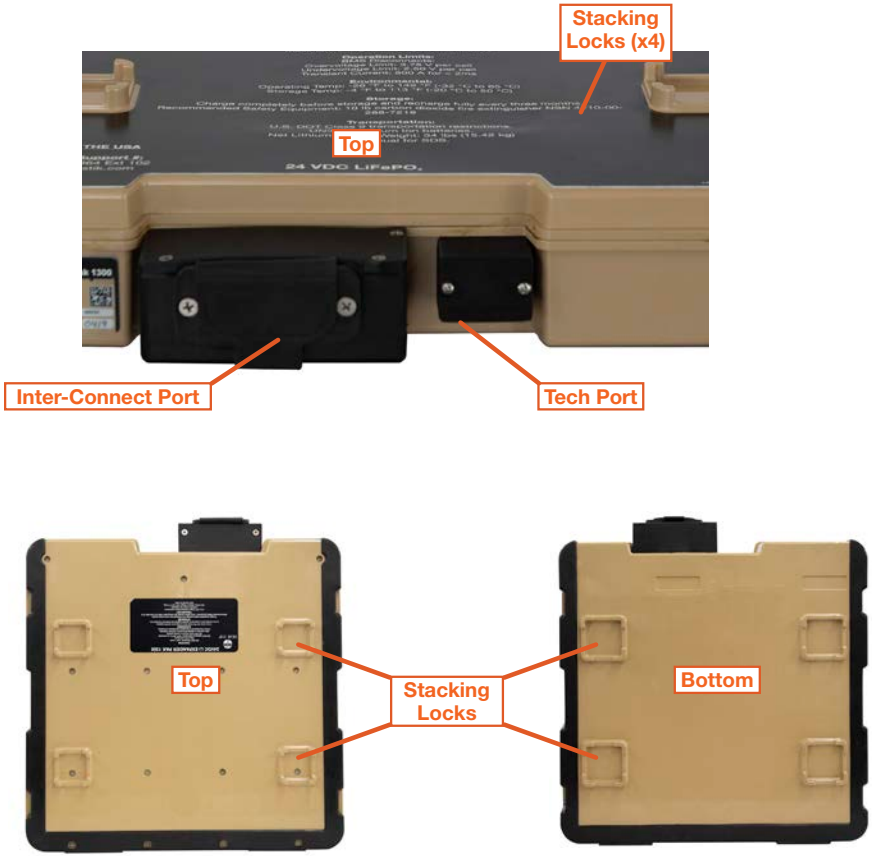


Figure 5. External features of the Expander Pak

24VDC Li Expander Pak 1300 Data Plate (D-Plate)

Figure 6. 24VDC Li Expander Pak 1300 D-Plate

Solar Venture 300W Kit Description

Kit Components

Solar Venture 300W PV Array	
1	Hard transport case
2	4-section foldable PV array
3	Ground-securing mesh (large and small)
4	Support frame
5	Sandbags (12 ea)
6	Solar Cable (Part #: 16-0800102)

Figure 7. Solar Venture 300W PV Array components in transport case (top) and unpacked (bottom)

PRO-Verter S 2000 AGS Description

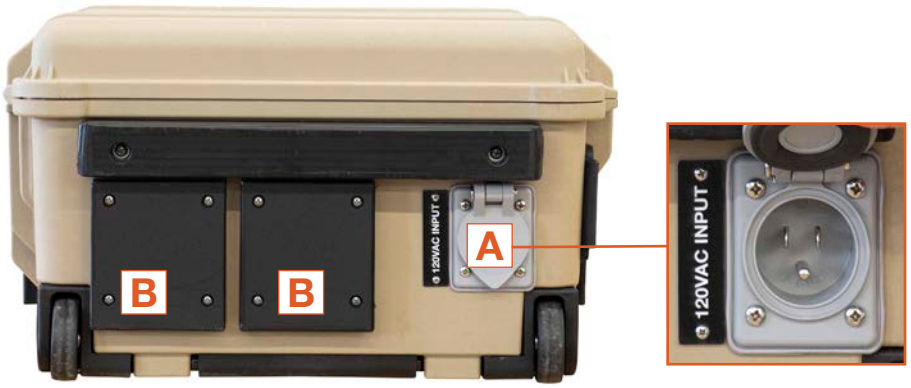
PRO-Verter Connection Ports and Vents

	Description	Connector	Voltage	Amps
A	24 VDC Expander Pak Only	Inter-Connect Port Deltran 224-0061-BK	24 VDC	200
B	GEN COMM Port	Amphenol HA100001-02-36	-	-
C	SOLAR ONLY Port	Cannon Bayonet Receptacle CB2-22-2SC	30–100 VDC each charger	4.4–14.6 each charger

Figure 8. PRO-Verter front side

	Description	Connector	Voltage	Amps
A	Exhaust Vent	-	-	-

Figure 9. PRO-Verter rear side



	Description	Connector	Voltage	Amps
A	120 VAC GRID Input	NEMA 5-15P	125	15
B	Air Intake Vent Cover	-	-	-

Figure 10. PRO-Verter left side

	Description	Connector	Voltage	Amps
A	120 VAC Output	NEMA 5-20R	125 VAC	20
B	Air Exhaust	-	-	-

Figure 11. PRO-Verter right side

PRO-Verter Faceplate

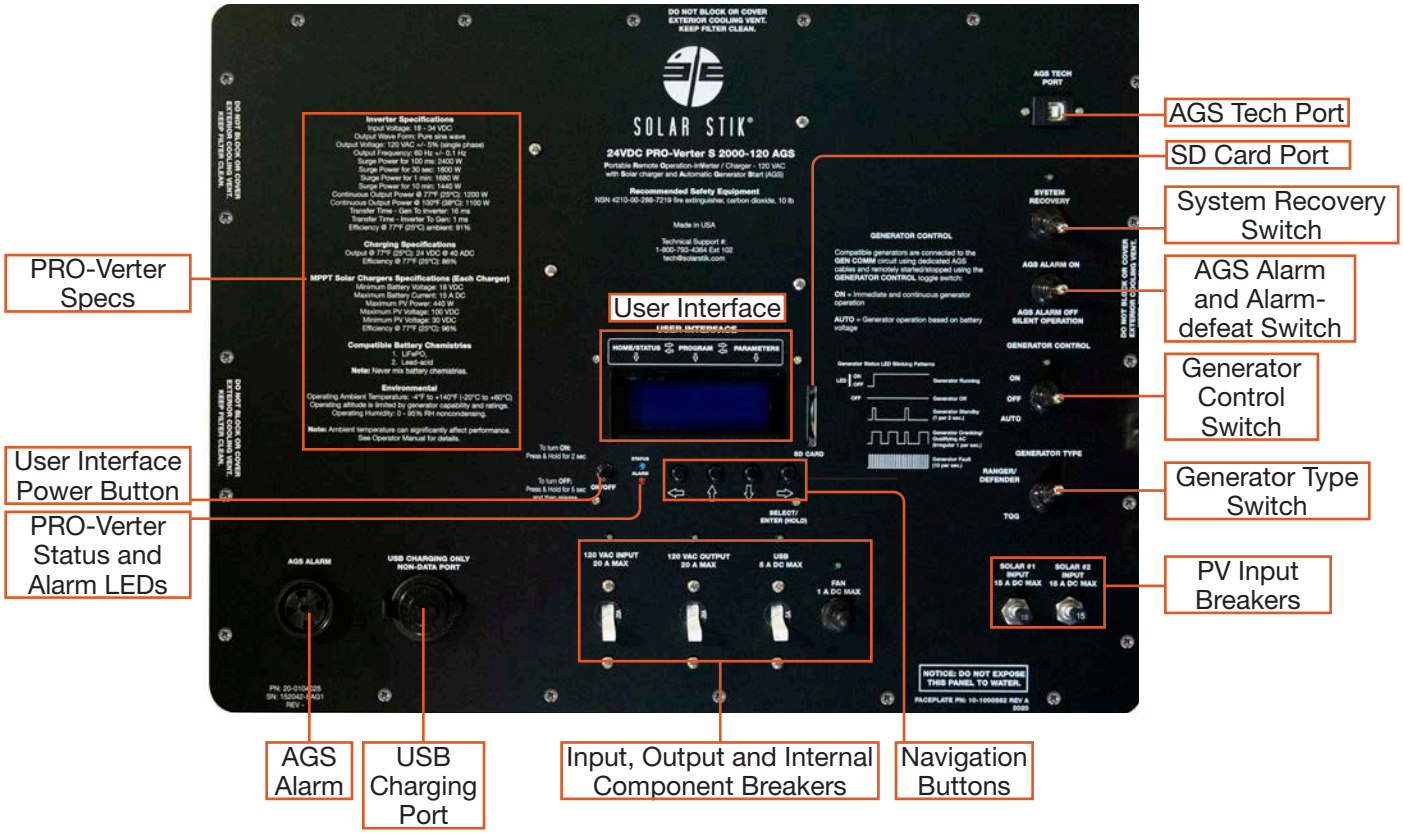


Figure 12. PRO-Verter Faceplate features

User Interface – The user interface is used to program and control the PRO-Verter and to monitor System status. The PRO-Verter is programmed at Solar Stik to meet the specifications of a specific application. Programming mode can be accessed if reprogramming is required. Contact Solar Stik Technical Support for more information.

System Recovery Switch – Provides a method to start the PRO-Verter when the System batteries have been overdischarged. Connect the PRO-Verter to a 120 VAC power source. Press and hold the System Recovery button. Turn on the PRO-verter user interface. Continue pressing the System Recovery button until the user interface reports “Charging”.

Generator Type Selection Switch – Choose “RANGER/DEFENDER” if the PRO-Verter is connected to either of these gensets. Choose “OTHER” if connected to other gensets (e.g., MEP-802A or MEP-831A) that have been equipped with auto start/stop functionality.

Auto Generator Start/Stop (AGS) Switches – The “ON” position manually turns on a generator; the “AUTO” position automatically starts and stops the connected generator based on programmed, battery voltage values. The “OFF” position defeats AGS communication with any connected genset.

AGS Alarm and Defeat Switch – Audible indication that a connected generator is in the process of starting. Alarm may be defeated (toggle switch) when silent operation is required.

USB Charging Ports and 5 A Breaker – For charging only. No data are transmitted via these ports. Push to reset the breaker if either of the USB ports is not operating.

IN/OUT Breakers/Switches – The breakers serve as switches to activate circuits and to turn off circuits not in use. 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 green LED over each breaker will be lit if the circuit is active and the breaker is not tripped. The 15 A PV input breakers are push/pull. The circuit for each will be active when the breaker is pushed down.

Cooling Fan 1A Breaker – The internal cooling fans are audible when functioning. Push to reset the breaker if the AC Input or AC Output port is not operating while the PRO-Verter is turned on.

AGS Tech Port – Used to program the Auto Generator Start/Stop module. Please contact Solar Stik Technical Support for further information.

SD Card Port – An SD card must be installed for PRO-Verter to log data. This is an optional function. A dummy SD card is installed prior to shipment from Solar Stik.

PRO-Verter I-Plate

The I-Plate is a custom part of the PRO-Verter S 2000 and contains essential HPS setup, operation, and safety information for the System that the PRO-Verter is integrated into. Figure 13 provides an example for such a System.

Solar Stik System Architecture: Balanced, Open, and Flexible

The I-Plate System Connection Diagram (Figure 13) illustrates how to connect components to build an HPS. The open-architecture design of the Solar Stik HPS allows power management components (PRO-Verters and Power Hubs) to integrate with ESMs (batteries) and renewable power generation sources (e.g., PV arrays) from providers other than Solar Stik. Custom cables may be required (and can be provided by Solar Stik) to establish connections with non–Solar Stik components.

The balance of ALL System components that comprise an HPS must be maintained when substituting non–Solar Stik components into a System. Specification requirements for connected components are listed on Solar Stik component Faceplates.

Figure 13. 24VDC PRO-Verter S 2000 I-Plate

OPERATOR INSTRUCTIONS

1. Minimize Potential for Water and Dust Intrusion

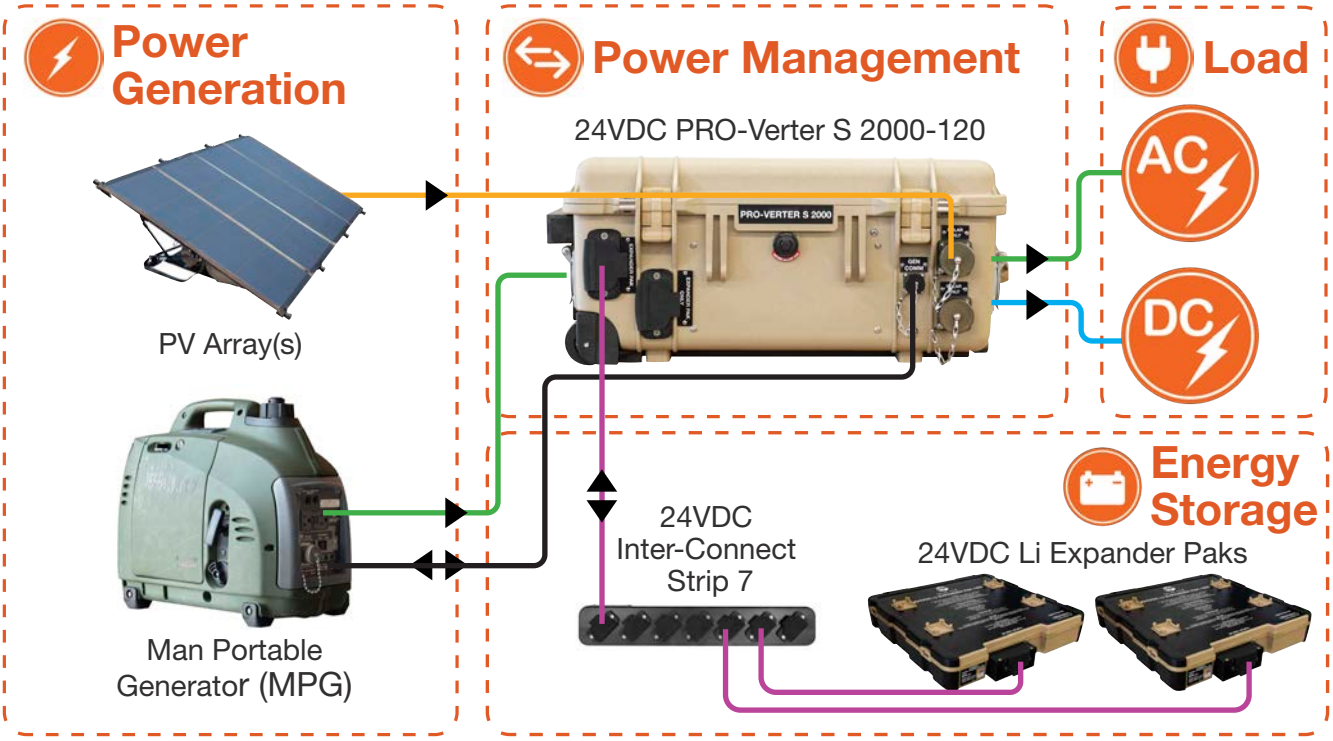
ALL Solar Stik equipment is designed for operation in adverse conditions, however, certain rules apply:

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

2. If operating in dusty environments, ensure good airflow by keeping air filters clean and placing unit in a location that minimizes exposure to particulates.

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

2. System Connection Diagram and Parts List



Item #	Nomenclature	QTY
21-0202316	24VDC Li EXPANDER PAK 1300	2
13-1000267	24VDC INTERCONNECT CABLE, 5’ LINEAR	2
13-1000032	24VDC INTERCONNECT CABLE, 5’	1
13-1000160	24VDC INTERCONNECT STRIP 7	1
20-0104025	24VDC PRO-VERTER S 2000-120 EAG1	1
01-1000100	NOVATIO DEFENDER 1kW with E-START MOD	1
13-1000288	GENERATOR COMMUNICATIONS CABLE, 1kW and 2kW, 10'	1
13-1000277	AC POWER CABLE, 10', 5-15P to 5-15R	1
19-1000012	SOLAR VENTURE 300W Kit (Includes Cable and Case)	1

Figure 14. 1 kW HPS diagram connection map

a. Connect PRO-Verter to Energy Storage Modules

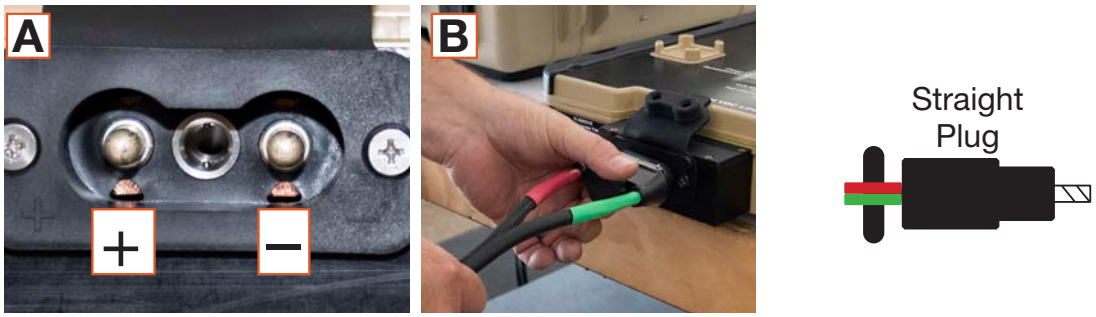
Note: A variety of energy storage modules (ESMs) may be connected to the PRO-Verter. Never mix battery chemistries in a System.

The 24VDC Expander Pak 1300 normal operating voltage ranges from 21.0 VDC to 29.0 VDC. Prior to operating the Expander Pak for the first time, charge it fully. Recharge it with connection to a PRO-Verter, Power Hub, or an external charging source, such as a battery charger, until the battery reaches 100% SOC.

1. Connect the (4 AWG) Linear Inter-Connect Cable straight-plug to the Expander Pak. The plug and socket are polarized (Figure 15A) and can be connected only in the proper orientation.

2. After inserting the plug into the socket (Figure 15B), twist the knob to lock the connection.

   Note: The red wire cover denotes the positive (+) terminal, and green (or black) denotes the negative (-) terminal.



3. Connect the “angled” Inter-Connect plug to the Inter-Connect Strip 7. Use a standard Inter-Connect cable with two (2) angled ends to connect the Inter-Connect Strip to the PRO-Verter Expander Pak only Inter-Connect port.

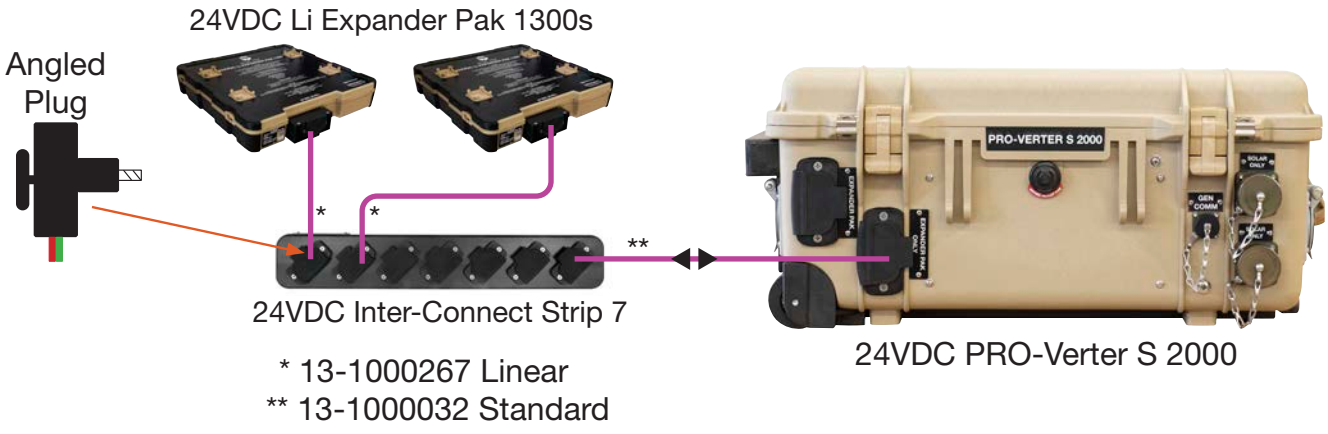


Figure 15. PRO-Verter to ESM connection

b. Connect PRO-Verter to AC Power Source

- **AC Input Power Cable:** Connect AC power output port on the generator to the “AC Input” port on the left-hand side of the PRO-Verter S 2000.
- **Grid Power Cable:** Connect AC power from the grid to the “AC Input” port on the left-hand side of the PRO-Verter S 2000. A custom cable may be required, depending on the grid power outlet.

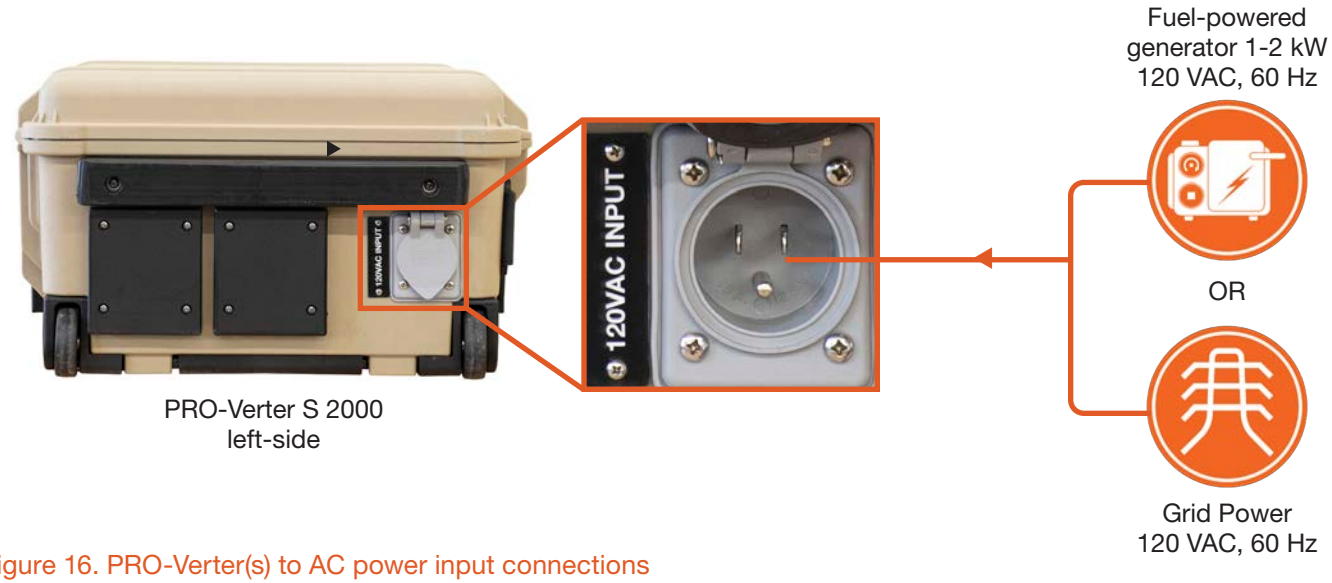


Figure 16. PRO-Verter(s) to AC power input connections

Compatible Generator Options

The PRO-Verter S 2000 can remotely start/stop the 1 kW and 2 kW man-portable generators (MPGs) (Figure 17).

Figure 17. Compatible generator options

c. Connect PRO-Verter to a Generator

Defender 1 kW and Ranger 2 kW MPGs

Use a Generator Communication Cable, 1kW and 2kW, 10’ to connect the Gen Comm port on the front of the PRO-Verter to the communication port on the generator.

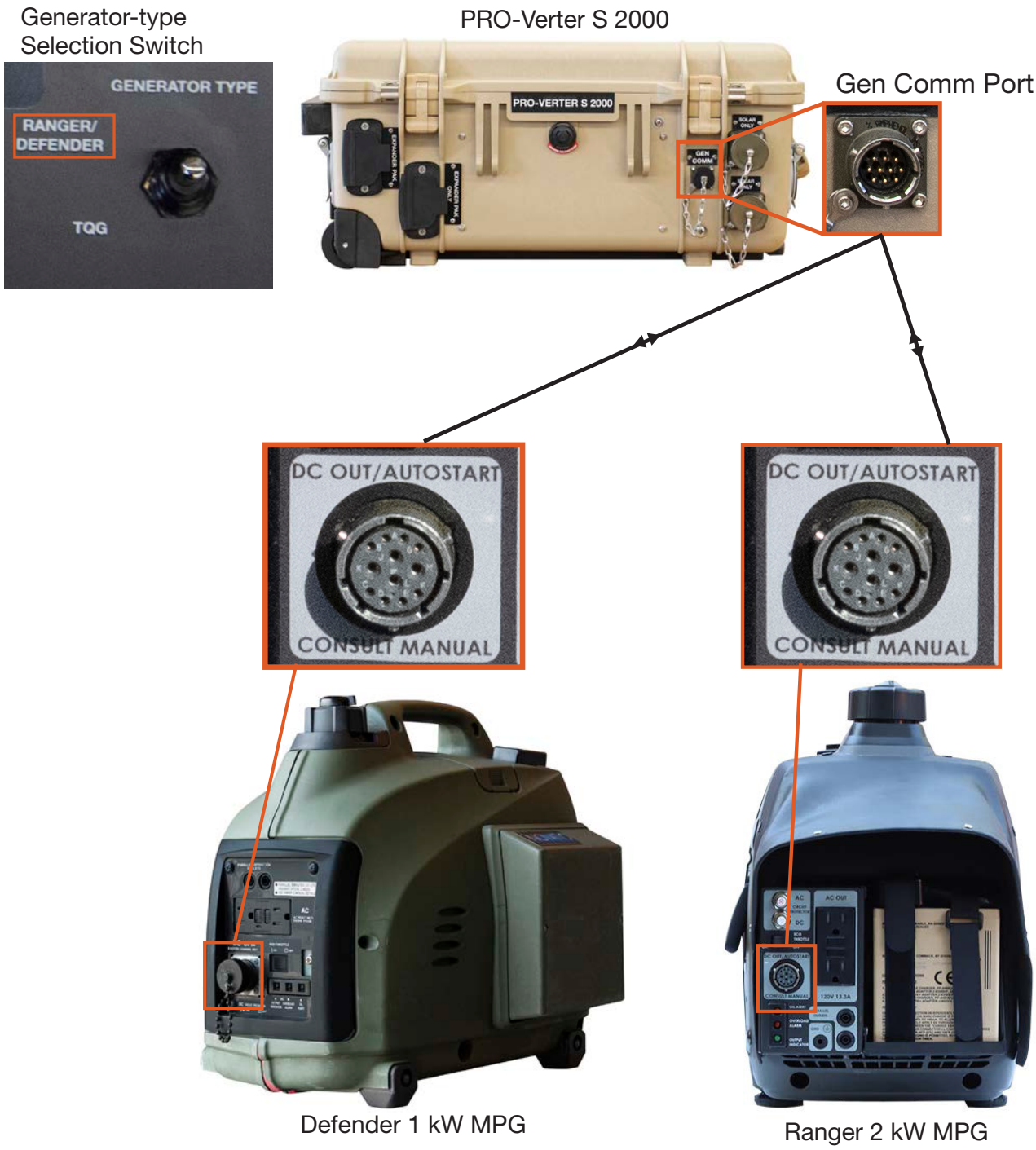
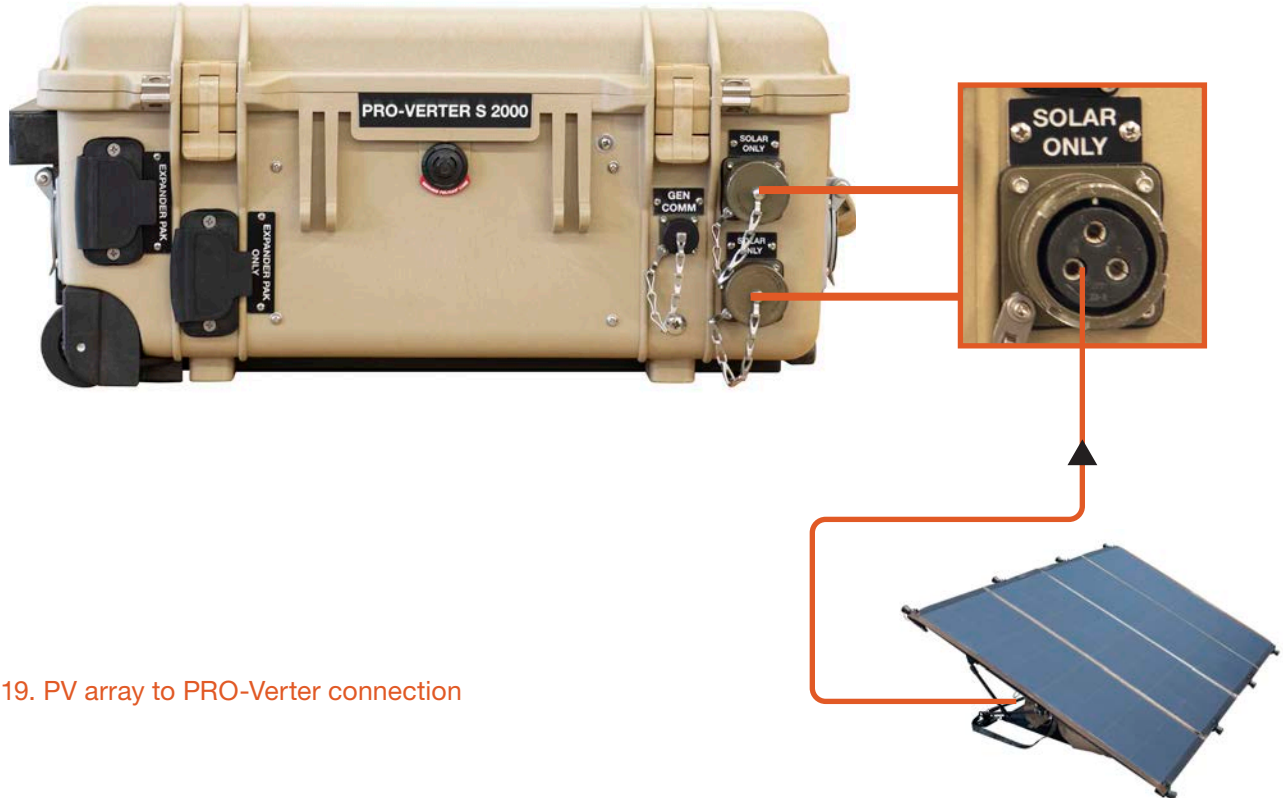


Figure 18. Defender 1 kW and Ranger 2 kW Gen Comm Cable connections

d. Connect PV Array(s) to PRO-Verter

Connect the PV array(s)/Solar Cable to the PRO-Verter Solar Only port(s) on the front of the PRO-Verter. For a detailed description of assembling the Array, see the Operator Manual For The Solar Venture 300W Photovoltaic Array.

Note: Up to 880 W of PV can be connected to the PRO-Verter*.



Solar Venture 300W
one (1) or Two (2)

Figure 19. PV array to PRO-Verter connection

***System PV arrays: General Rules and Requirements**

PV arrays, other than the ones provided in the kit, can be connected to the PRO-Verter as long as the power specifications for the arrays do not exceed the specifications listed on the Faceplate.

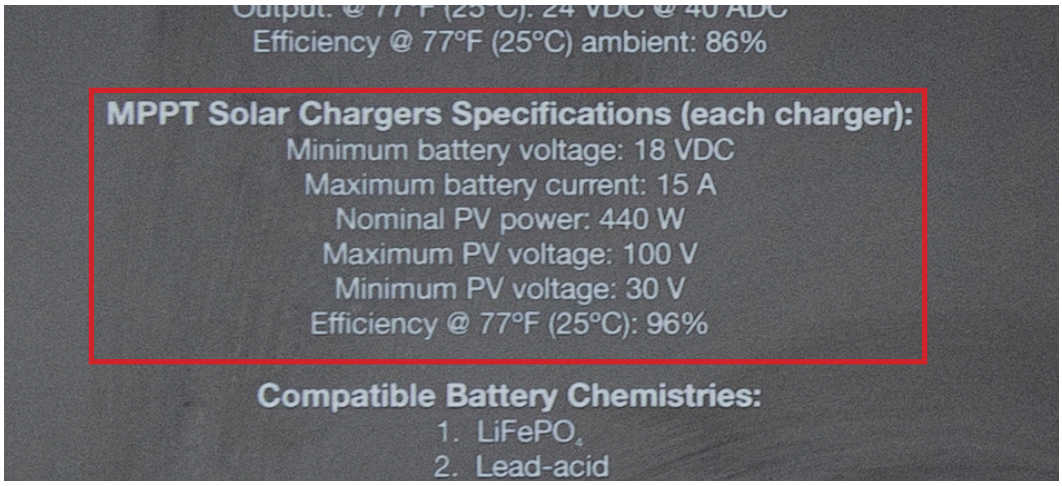


Figure 20. PRO-Verter power specifications for PV arrays

e. Secure the Array to the Ground

⚠ WARNING

Failure to properly secure the PV array(s) to the surface with sandbags could result in PV array damage, injury, or death in high winds. Wind damage can render arrays nonfunctional or significantly reduce their functional life expectancy. PV arrays must be properly secured to the ground even in low-wind environments.

The PV array must be secured with three (3) to six (6) sandbags (Figure 21) to reduce the potential for damage in high winds.

Sandbags should weigh a minimum of 50 pounds (23 kg) each. Place sandbags on the large ground-securing mesh under the PV panel and on the small ground-securing mesh behind the panel as shown below (Figure 21).

⚠ CAUTION

DO NOT DAMAGE THE ARRAY SUPPORT FRAME.
DO NOT DROP SANDBAGS ONTO THE PV ARRAY SUPPORT FRAME.

Figure 21. Ground-securing sandbag placement

Note: Before the arrays are secured to the ground, be observant and take care to ensure the support frame is not twisted. If the support frame is twisted, the array will be exposed to torsional strain, which can cause damage to the cells of the array panel(s).

f. Connect PRO-Verter to 120 VAC Loads

Connect 120 VAC loads to the PRO-Verter AC output on the left side of the PRO-Verter. Connect loads of no more than 20 A. Turn off load power switches to prevent power draw during System setup.

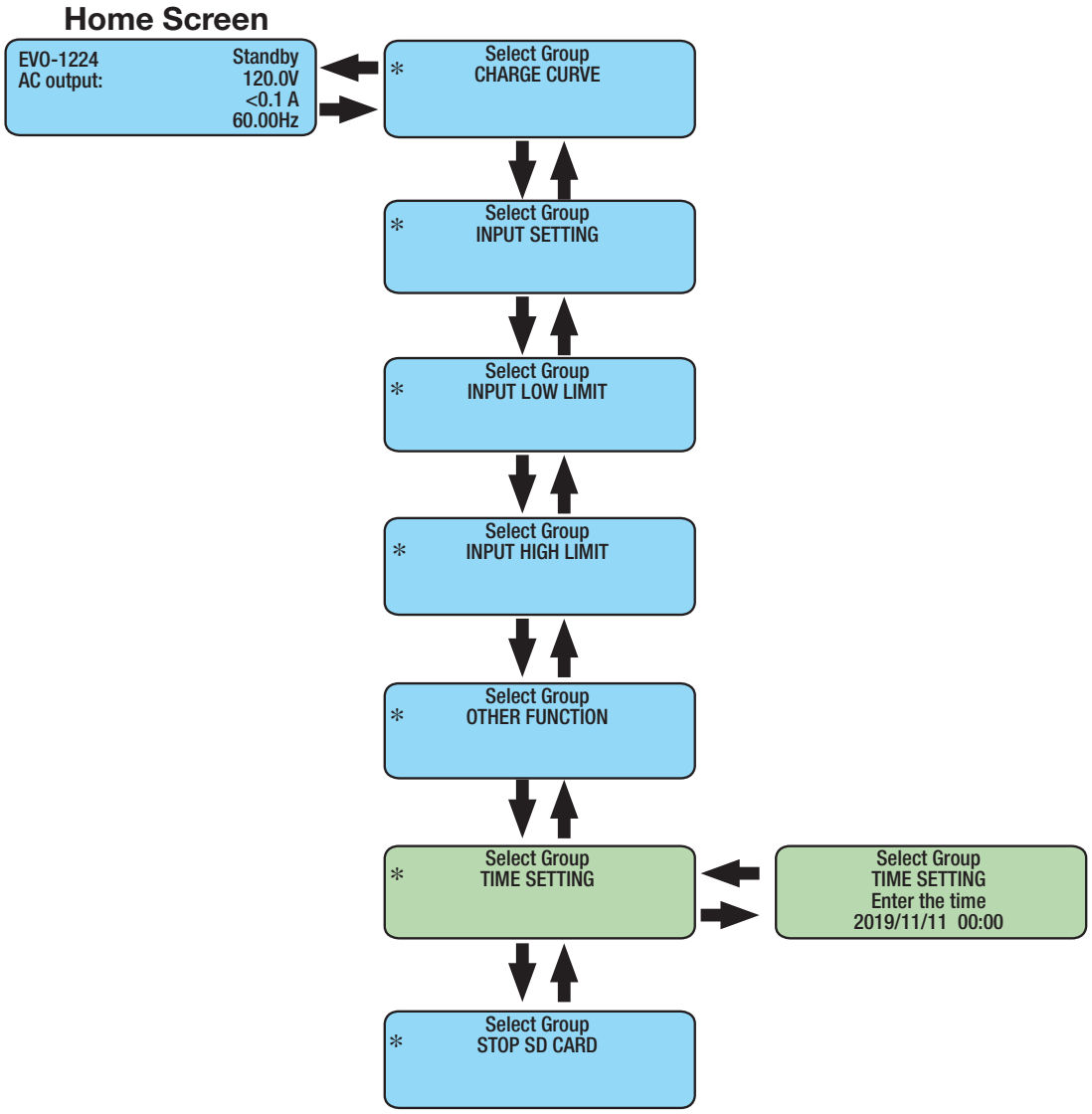
Figure 22. PRO-Verter AC power output port

g. Set PRO-Verter 24-hour clock (TIME SETTING).

The date and time format is Year/Month/Day Hour:Minute (24-hour clock).

Note: Password is not required for setting this parameter.

1. Press ENTER button.
2. Press DOWN button to arrive at TIME SETTING; press ENTER.
3. Use UP or DOWN buttons to change value of the digit.
4. Press ENTER when the value is correct to move to next digit.
5. When correct value is entered, press and hold ENTER to save.



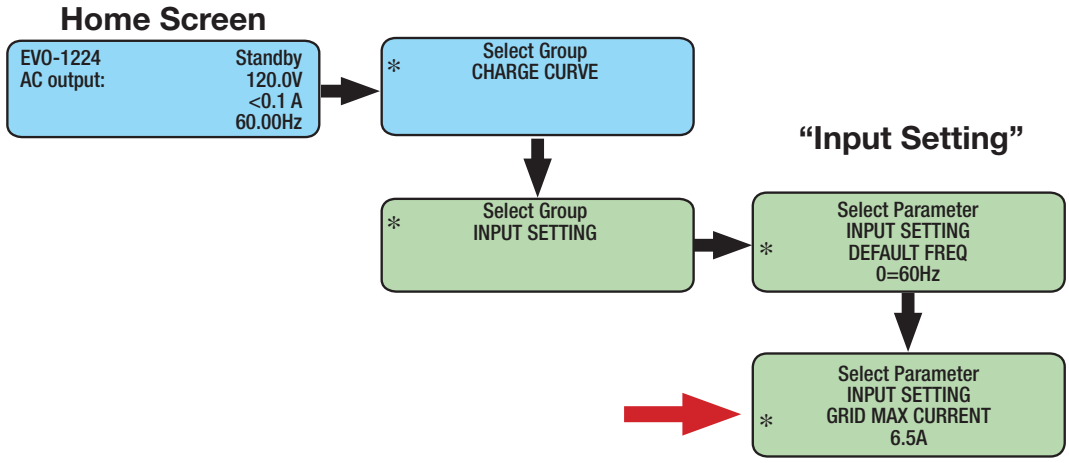
h. How to Set GRID MAX CURRENT equal to connected generator or grid output current.

Set the “Grid Max Current” setting to the same value (up to 20 A; max setting) as the maximum continuous output current of the AC power source (grid or generator) connected to the PRO-Verter. This setting is required to optimize generator/PRO-Verter interactions and System performance. If the PRO-Verter current setting is greater than the power source, the source will be overloaded and fault. If the PRO-Verter current setting is lower than the power source, System performance will be reduced or not be able to support loads that fall within the rated performance of the PRO-Verter.

Consult table on the PRO-Verter S 2000 I-Plate for recommendations on setting the AC INPUT when connected to a Ranger/Defender MPG.

Set GRID MAX CURRENT equal to connected generator or grid output current.

1. Press ENTER button.
2. Press DOWN button to arrive at INPUT SETTING.
3. Press ENTER button.
4. Press DOWN button to arrive at GRID MAX CURRENT.
5. Press ENTER button and hold until number flashes.
6. Press UP or DOWN button to change number.
7. Press ENTER to move to next digit.
8. When correct value is entered, press and hold ENTER to save.



i. Starting the MPG with PRO-Verter

1. Prior to generator operation, check the following items:
   a. Fuel and oil levels
   b. Engine switch ON
   c. Eco throttle switch OFF
   d. Fuel tank vent cap lever ON
   e. Choke lever OPEN
2. Toggle Generator Type switch to required position.
3. Toggle Generator Control switch to ON. Alarm sounds (10 s).
4. Generator cranks (2 min max). Five (5) attempts before fault.
5. Generator starts.
6. AC INPUT LED illuminates (~ 2 min after start).
7. PRO-Verter qualifies generator power.
8. Charging begins (see PRO-Verter user interface).
9. Rapidly toggle Generator Control switch to AUTO to begin normal hybrid operation.

Note:

- Do not connect a running generator to the PRO-Verter while the System is operating.
- Do not pull-start the generator if it is controlled by the PRO-Verter.

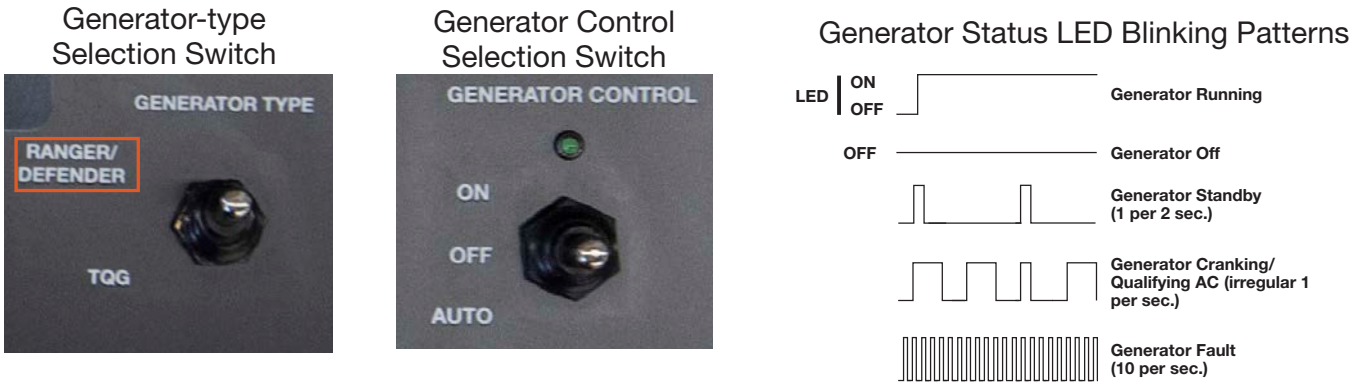


Figure 23. Generator type and control switches; Generator Status LED blinking pattern

Figure 24. Location of items to check before starting MPG

Operating the PRO-Verter User Interface

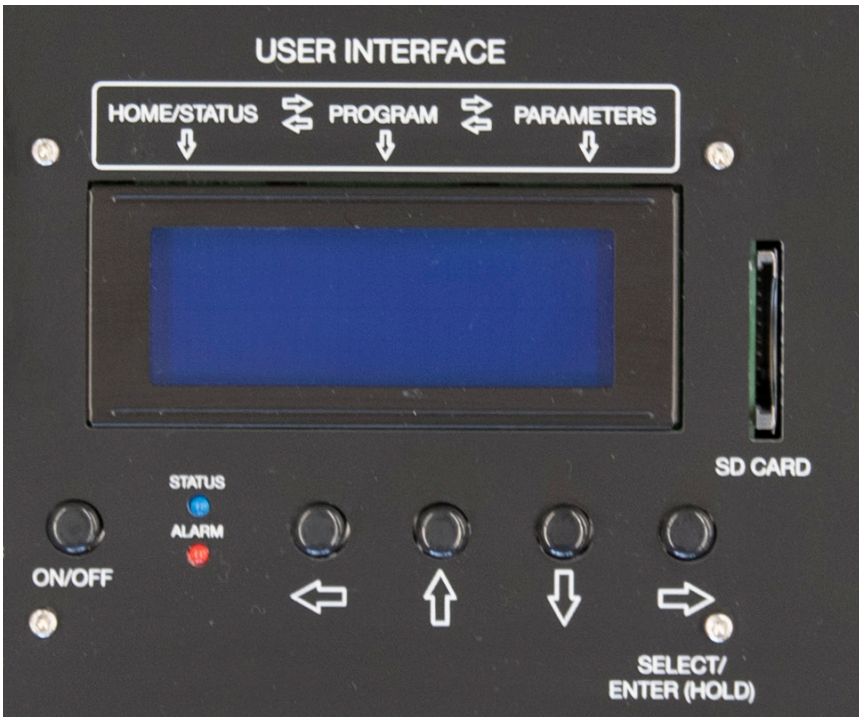


Figure 25. PRO-Verter user interface power and navigation buttons

- **On/Off Key**—The On/Off Key is used for switching on/off the PRO-Verter and also to enter/exit Standby mode.
- **Navigation Keys**—These four keys allow simple access to menu items that assist in configuring, monitoring, and troubleshooting the PRO-Verter.

  Navigation Key Functions

  - **Back** (left arrow)—Return to previous selection
  - **Up**—Move from lower to upper menu screen in various menu maps
  - **Down**—Move from upper to lower menu screen in various menu maps
  - **Enter** (right arrow)—Select/write a particular value or option. Access programmable settings.
- **Status LED**—Blue LED indicator for indicating operating status
- **Fault LED**—Red LED indicator for indicating fault conditions
- **SD Card Slot**—This slot supports an SD memory card (up to 16GB, FAT16/32). The SD card is used for data logging of PRO-Verter operational statistics and events and saving and uploading of programmed parameters. A dummy SD card is installed at the factory prior to shipment.

PRO-Verter Status and Alarm LEDs

The Status LED indicates the operating status of the PRO-Verter; the Alarm LED indicates a fault has occurred; specific information about the fault is reported on the user interface LCD screen. To clear faults see Clearing PRO-Verter Faults. The table below explains the meaning tied to each state for both LEDs.

Figure 26. PRO-Verter S 2000 user interface

Table 1. User Interface LED Indicators

LED INDICATIONS		
Status	**STATUS LED**	**ALARM LED**
Seen during power-on sequence Indicates completion of power-on sequence after power On/Off button is pressed for 2 sec	Flash 3 times	Off
Seen during power-off sequence Indicates completion of power-off sequence after power On/Off button is pressed for 5 sec	On	On
Normal charging	Flash 1 time/sec	Off
Equalization charging	Flash 2 times/sec	Off
Inverting (discharging) – alarm beep/3 sec (default off)	On	Off
Low battery alarm – alarm beep/1 sec	On	Flash 1/sec
Power saving	Flash 1 time/3 sec	Off
Standby	Flash 1 time/5 sec	Off
Fault	Off	On

PRO-Verter Operating Modes

When the PRO-Verter is operating normally, the user interface will display the name of the operating mode and values of operating parameters. Because all the operating parameters associated with a particular operating mode cannot be displayed in one screen, multiple screens are available that can be accessed using the UP and DOWN keys. Table 2 provides names and descriptions of the operating modes.

The user interface will automatically display the current PRO-Verter Operating Mode. Use the UP and DOWN buttons to view the values of parameters associated with the current mode.

The operating modes windows and subwindows are READ ONLY.

Table 2. Operating Modes: Descriptions

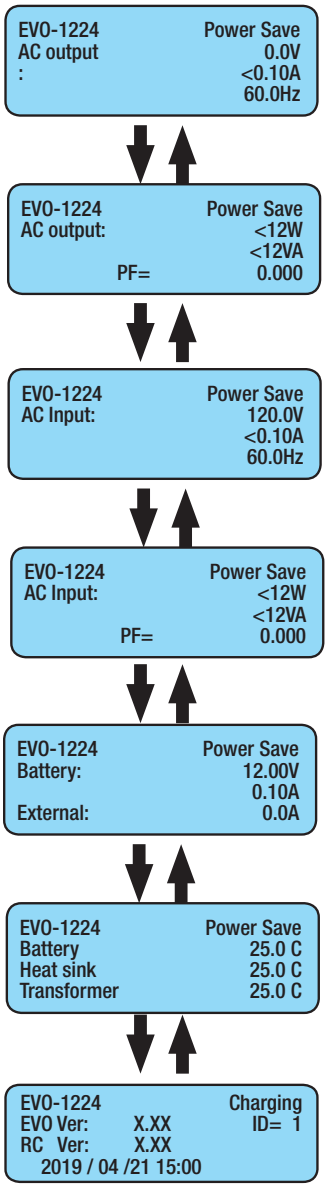
Operating Mode Display	Description
Standby	In **Standby mode** there is no output, no AC bypass, and no charging.
Inverting	In **Inverting mode**, the PRO-Verter is supporting the load by converting energy stored in the batteries into AC power. The batteries are not being charged when the PRO-Verter is in Inverter mode.
Charging	In **Charging mode**, the PRO-Verter is charging the batteries and supporting the AC load. The degree to which the batteries are charged will depend on the demand of the AC load; supporting the load is prioritized over charging the batteries.
Power Save	**Power Save Mode** is when the power drawn by AC load falls to (6 W) the “ENTER POINT” programmed value for 5 s, the PRO-Verter will enter “Power Save Mode”. If in “Power Save Mode” and the AC load rises to (7 W) “WAKE UP POINT”, the PRO-Verter will quit “Power Save Mode” and will start operating in Inverting Mode.
Online	This option is also called “On-Line UPS Mode”. In this mode, the Inverter is the primary source of power to an AC load, drawing energy stored in the batteries. The AC power input source is the back up power source to support AC loads.
Chrg Only [1]	Under “ONLINE MODE” only (Option 2=Charger Only). Provides charging and pass-through when the AC input is available. The PRO-Verter inverter is inactive when AC input is not available.

[1] It is not recommended to put the PRO-Verter into charge-only mode when the PRO-Verter is part of a functioning HPS with both AC and DC loads. AC loads connected to the PRO-Verter will not be supported if the AC power source connected to the PRO-Verter fails. Charge-only mode may be used in an HPS with DC-only loads.

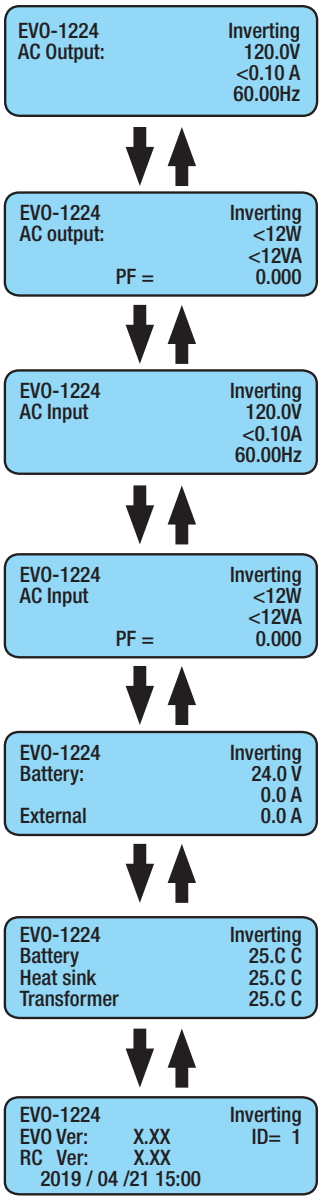
Operation Mode Screens

The read-only parameters available for viewing when the PRO-Verter is in Power Save, Inverting or Charging Mode are shown. These are the most frequently encountered modes for a PRO-Verter operating in this System.

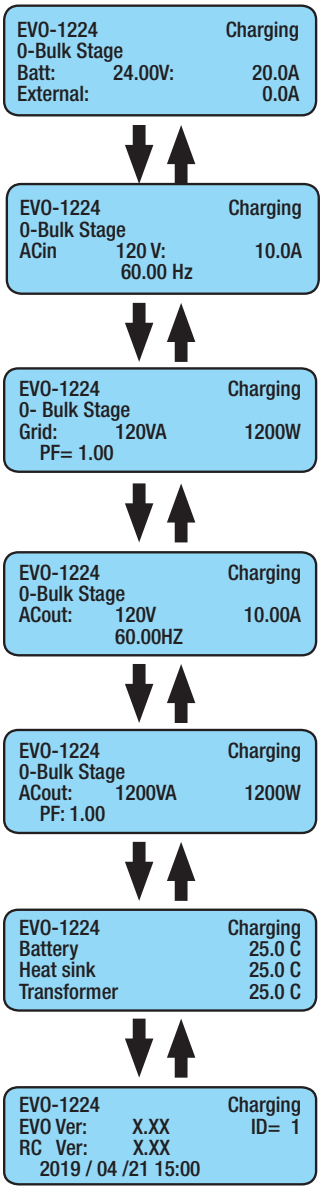
Power Save



Inverting



Charging



PRO-Verter Programmable Settings

Navigating "Select Group" and "Select Parameter" Menu Maps

The ENTER key is used to enter "Select Group" menu map from any operating mode screen.

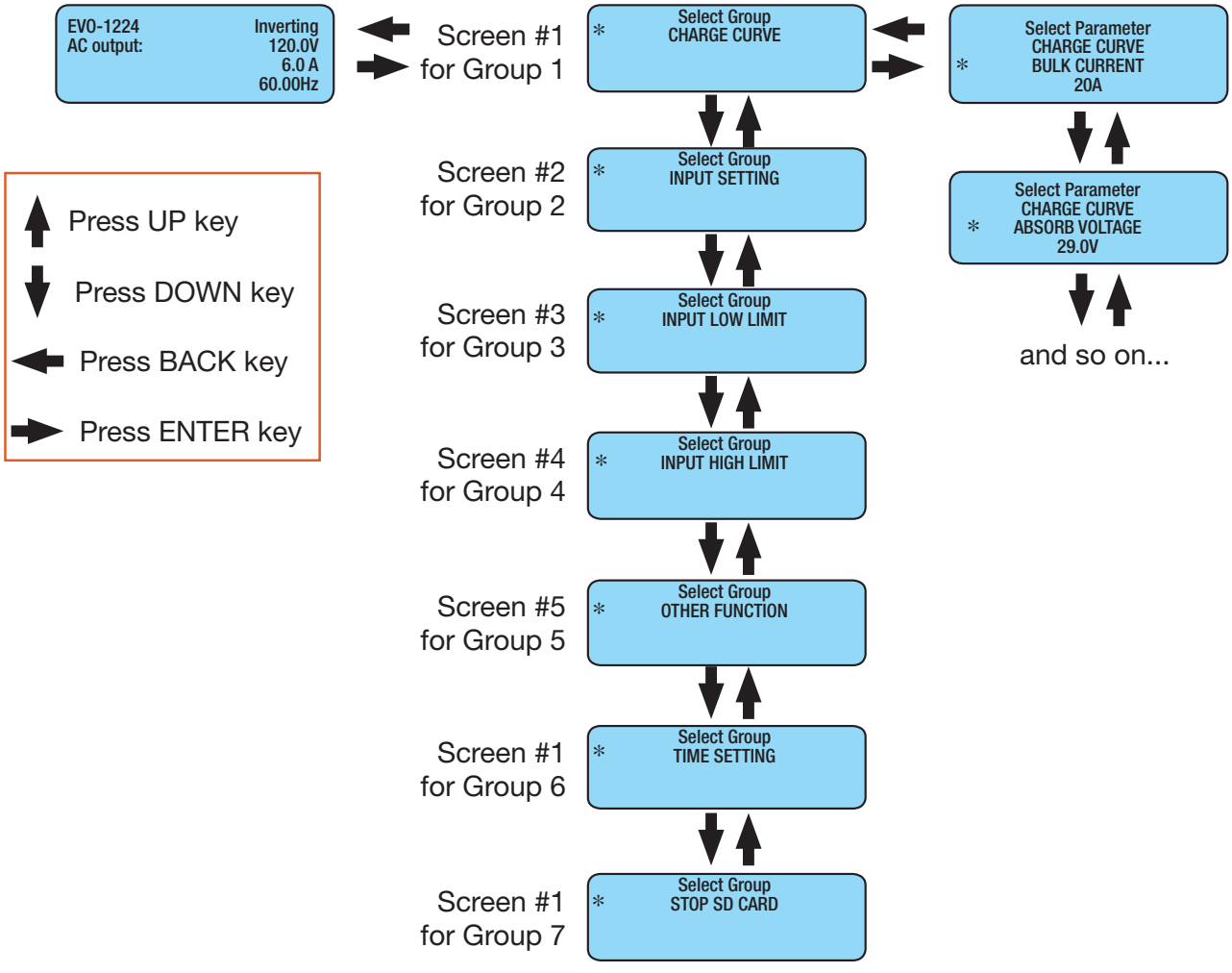
After the ENTER key is pressed, the UP/DOWN keys are used to navigate to one of the seven (7) "Select Group" screens.

When the group for the desired setting is displayed on the LCD, the ENTER key is used again to select this group. The UP and DOWN keys are used to move to the individual screens within the group.

The third line shows the name of the name of the parameter that can be varied with an asterisk sign "*" next to it. The asterisk sign * indicates this parameter will be selected when the ENTER key is pressed and the associated value can be changed.

Pressing the BACK key will exit to the previous level.

There is a 30-second time-out for setting parameters; after 30 seconds, the setting mode will be cancelled and the display will revert to the operating mode screen associated with current operation.



Parameter Groups: PRO-Verter Programmable Settings

“Parameter Groups” are the top-level categories of PRO-Verter programming.

Table 3. Programmable Parameter Groups: Descriptions

List of Parameter Groups 1 to 7		
Parameter	**Group Name**	**Description**
Group 1	CHARGE CURVE	Parameters for battery charging/battery protection.
Group 2	INPUT SETTING	Parameters for grid/generator input current level, frequency range.
Group 3	INPUT LOW LIMIT	Parameters for grid/generator input low voltage level.
Group 4	INPUT HIGH LIMIT	Parameters for grid/generator input high voltage level.
Group 5	OTHER FUNCTION	Power Saving/Alarm/Remote Switch/Multi-function Relay/etc.
Group 6	TIME SETTING	Local time clock setting.
Group 7	STOP SD CARD	Shown only when SD card is inserted. To stop SD card and to remove the SD card.

Please contact Solar Stik Technical Support before changing settings other than the clock or the AC Input settings. These settings are highlighted orange in the tables that follow.

Charge Curve Programmable Settings

Parameters in this group define System battery charging protocols.

Table 4. Parameters for Battery Charging/Battery Protection

GROUP 1: CHARGE CURVE		
Parameter	**Parameter Value**	**Description**
BULK CURRENT	20 A	Sets the maximum charging current during the Bulk Charging Stage.
ABSORP VOLTAGE	29.0 V	Sets the charging voltage in the Constant Voltage Absorption Stage.
EQUALIZE VOLTAGE	29.0 V	Not applicable when using $LiFePO_4$ batteries.
FLOAT VOLTAGE	29.0 V	Sets the charging voltage in the Constant Voltage Float Stage.
COMPENSATE	-3mV /°C/Cell	Sets the temperature compensation for the battery.
BATT OVER VOLT (Shut Down)	32.0 V	Sets the upper battery voltage threshold at which inverting/charging operations are switched off to protect the PRO-Verter.
RESET VOLTAGE (Low Voltage Reset)	29.0 V	The PRO-Verter inverter will restart when the battery voltage rises to this set value or above after “Battery low voltage!” shutdown occurs.
LOW VOLT ALARM	25.6 V	Battery voltage at which the “Alarm” triggers AGS to start generator.
BATT LOW VOLTAGE	24 V	Sets the battery low voltage threshold at which the PRO-Verter inverter will shut down to protect the battery from overdischarge.
LV DETECT TIME	60 sec	This is the timer for shutting off the inverter. Battery voltage must be at the low voltage set point for this period of time before the inverter shuts off.
LV CUT OFF TIME	3600 sec	This timer shuts off everything including the charger. (The load on the inverter will already be cut off during this time.)
EQUALIZE-4STAGES	0=NO	Equalize disabled with $LiFePO_4$ batteries.
ONLINE MODE	0 = Option 1 (Default) Offline	0 = Normal…AC input priority (Off-Line) 1 = On-Line…Inverter priority 2 = Charger Only…Charging & AC bypass - only, no inverting
RESET TO BULK	25.6 V	Sets battery voltage at which the charger will terminate current charging stage of the selected Charging Profile and restart charging from the beginning.
GS DETECT TIME	60 sec	A timer that sets the duration the battery voltage has to remain at threshold of Low Volt Alarm or lower before generator auto start/stop.
GEN ON TIME	30 minutes	N/A as programmed
GEN OFF DELAY	1 minute	Must be in the generator-stop condition for 1 minute before opening the relay
ABSORP TIME	10 min	
ABSORP EXIT AMPS	6 A	Set to ~1-% of battery bank capacity.) Value not in play with 2 Stage Type 1 charging
CHARGING PROFILE	3 = 2 Stage Type 1	(mimics CC/CV-type charging)

Continued on following page.

GROUP 1: CHARGE CURVE (Continued from previous page)		
Parameter	**Parameter Value**	**Description**
BATTERY TYPE	1 = lithium iron phosphate	N/A. A CC/CV charging profile appropriate for $LiFePO_4$ batteries has been programmed. Do not change.
SAFE CHARGING	0 Min	This timer, if set, will protect a depleted battery from being exposed to potentially heavy load if AC input is intermittent when first reacquired.
EXTERNAL CHARGER	1 = NOT AFFECT	"EXTERNAL" charger = PV. 0 = AFFECT = current generator will be reduced by current from PV to maintain 20 A max bulk current level. 1 = NOT AFFECT = Current from PV will ADD to bulk current from generator; bulk current may exceed 20 A max setting to a maximum of 50 A (solar charge controller = 15 A max x2)

Input Setting Programmable Settings

Table 5. Parameters for Grid/Generator Input Current Level, Frequency Range

GROUP 2: INPUT SETTING		
Parameter	**Setting Value**	**Description**
DEFAULT FREQ	60 Hz	Default frequency sets the Inverter frequency, which is also the standard frequency for AC input.
GRID/GEN MAX CURRENT	Range: 0-20 A Programmed: 6.5A	Value set to rated output current of grid power source (or to 20 amps, the maximum allowable input current, if connected to a TQG).
HIGH CUT OFF	65 Hz	If the AC input frequency is over the value of High Cut Off when in Charging mode, the PRO-Verter will transfer to Inverting mode.
HIGH RESET	64 Hz	This is the reset frequency at which the unit will revert to Charging mode after it has switched over to Inverting mode due to input frequency rising above High Cut Off.
LOW CUT OFF	55 Hz	If the AC input frequency is below Low Cut Off value when in Charging mode, the PRO-Verter will transfer to Inverting mode.
LOW RESET	56 Hz	This is the reset frequency at which the unit will revert to Charging mode after it has switched over to Inverting mode due to input frequency falling below Low Cut Off.
SYNC GRID	0 = Fine	Sets "syncing" algorithm for AC input 0 = Stable AC Input; 1 = not Stable AC input
SYNC GEN	0 = Fine	Sets "syncing" algorithm for AC input 0 = Stable AC Input; 1 = not Stable AC Input
INPUT OC PROTECT	0 = INVMODE	If the AC input current is 1 A more than the programmed value of Grid Max Current/Gen Max Current for more than 5 sec, the PRO-Verter will switch over to Inverting mode to ensure that AC power to the load is maintained. If the load reduces to 1 A less than the programmed value of Grid Max Current/Gen Max Current for 5 sec, the PRO-Verter will switch back to Charging mode.
INPUT RECOVERY	DIRECT	Option 1 = Direct: The PRO-Verter will start in Charging mode.

Input Low Limit Programmable Settings

Table 6. Parameters for Grid/Generator Input Low Voltage Level

GROUP 3: INPUT LOW LIMIT		
Parameter	**Setting Value**	**Description**
RESET VOLTAGE	105.0 V	This is the reset voltage at which the PRO-Verter will revert to Charging mode after it has switched over to Inverting mode due to input voltage falling to Cut Off Volt 1/Cut Off Volt 2/Cut Off Volt 3.
CUT OFF VOLT 1	100.0 V	If during Charging mode, the AC input voltage falls below Cut Off Volt 1 for period > Detect Time 1, the PRO-Verter will transfer to Inverting mode from Charging mode.
DETECT TIME 1	300 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 1 is allowed.
CUT OFF VOLT 2	95.0 V	If during Charging mode the AC input voltage falls below Cut Off Volt 2 for period > Detect Time 2, the PRO-Verter will transfer to Inverting mode.
DETECT TIME 2	60 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off 2 is allowed.
CUT OFF VOLT 3	90.0 V	If during Charging mode, the AC input voltage falls below Cut Off Volt 3 for period > Detect Time 3, the PRO-Verter will transfer to Inverting mode.
DETECT TIME 3	1 Cycle	This is the time limit in cycles up to which the low AC input voltage Cut Off 3 is allowed.

Input High Limit Programmable Settings

Table 7. Parameters for Grid/Generator Input High Voltage Level

GROUP 4: INPUT HIGH LIMIT		
Parameter	**Setting Value**	**Description**
RESET VOLTAGE	125.0 V	This is the reset voltage at which the PRO-Verter will revert to Charging mode after it has switched over to Inverting mode due to input voltage falling to Cut Off Volt 1/Cut Off Volt 2/Cut Off Volt 3.
CUT OFF VOLT 1	135.0 V	If during Charging mode the AC input voltage falls below Cut Off Volt 1 for period > Detect Time 1, the PRO-Verter will transfer to Inverting mode from Charging mode.
DETECT TIME 1	60 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 1 is allowed.
CUT OFF VOLT 2	140.0 V	If during Charging mode the AC input voltage falls below Cut Off Volt 2 for period > Detect Time 2, the PRO-Verter will transfer to Inverting mode.
DETECT TIME 2	15 Cycles	This is the time limit in cycles up to which low AC input voltage Cut Off Volt 2 is allowed.
CUT OFF VOLT 3	145.0 V	If during Charging mode the AC input voltage falls below Cut Off Volt 3 for period > Detect Time 3, the PRO-Verter will transfer to Inverting mode.
DETECT TIME 3	1 Cycle	This is the time limit in cycles up to which the low AC input voltage Cut Off Volt 3 is allowed.

Other Functions Programmable Settings

Table 8. Power Saving/Alarm/Remote Switch/Multi-function Relay/etc.

GROUP 5: OTHER FUNCTIONS		
Group	**Setting Value**	**Description**
POWER SAVING	0 = Disable	Enable or disable Power Saving mode when in Inverting mode.
ENTER POINT	6 W	If the value of power drawn by AC load falls to the Enter Point value for 5 sec, the unit will enter Power Save mode.
WAKE UP POINT	7 W	If the unit is in Power Save mode and the value of the AC power of the load rises to Wake Up Point, the unit will quit Power Save mode and will start operating in full voltage Inverting mode.
REMOTE SWITCH	0 = Button	This selection is used when On/Off control of PRO-Verter is desired through external 12 VDC signal. Contact Solar Stik Technical Support.
RELAY FUNCTION	2 = Generator	Ties battery voltage-related settings to generator autostart/stop.
COMM ID (ID for user interface)	1	Communication ID: This sets the ID number for the Comm port and user interface.
BUZZER	OFF	Set the buzzer On/Off.
DISCHARGE BEEP	0 = NO	To select the buzzer On/Off while in Inverting mode.
DEFAULT RESET	0 = NO	This is to reset all of the parameters to the factory values. The factory values are not the program values set by Solar Stik.
DATA LOG TIME	2 = 10 sec	A real time clock inside the user interface records timing. The time interval between recordings is programmable. Events and Errors are recorded as soon as they are sensed.
PARAMETER SAVE	0 = NO	Save all parameters/program settings to SD card.
TEMP UNIT	1 = deg F	Temperature display can be selected in °C or °F.
PASSWORD DISABLE	1 = Yes	The default password (8052). Password may be disabled.

PRO-Verter Clock Time Setting

Table 9. Local Time Clock Setting

GROUP 6: TIME SETTING		
Group	**Setting Value**	**Description**
TIME SETTING	Local Current Time	24-hour clock set to local time for accurate time stamps on logged events. Password not required.

Stop SD Card Command

Shown only when SD Card is inserted. To stop SD Card and to remove the SD Card.

Table 10. Instructions to Remove SD Card from PRO-Verter User Interface

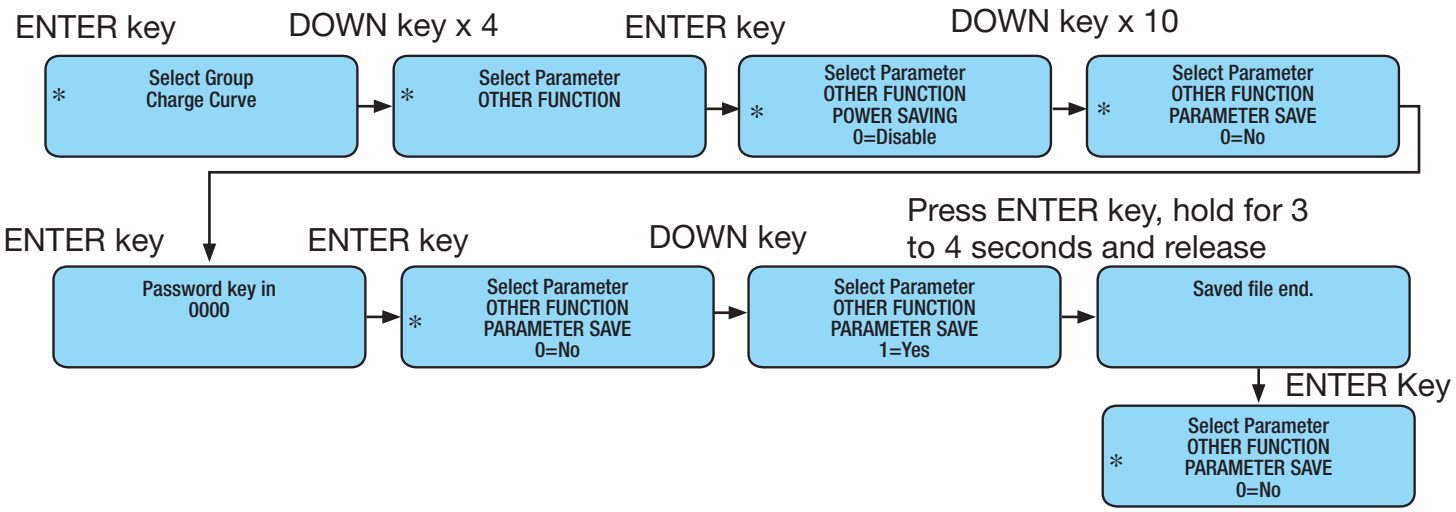
GROUP 7: STOP SD CARD		
Group	**Setting Value**	**Description**
STOP SD CARD	1 = YES to remove	Remove/eject SD card only after the operation of the card has been stopped.

Saving/Uploading Programmed Parameters

Saving Programmed PRO-Verter Parameters to SD Card

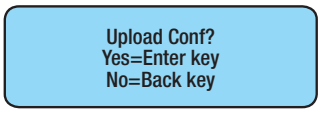
All the programmed parameters can be saved on an SD card (FAT 16/FAT 32 format, up to 16 GB capacity). The parameters will be saved in File named “xxxx_yyy.cfg”, where the first group of 4 digits xxxx is the model number of the inverter charger and the second group of 3 digits yyy is the Revision #. for that model, e.g., 074.

- For saving, first insert the SD card into the SD card slot.
- Then, go to “Parameter Save” screen . Steps are given below:



Uploading Saved PRO-Verter Parameters from SD Card

If there is an “xxxx_yyy.cfg” file in the SD card with stored programmed parameters, then upon inserting the card, the remote control will ask to upload the Config file. Press the ENTER key to confirm or the BACK key to cancel.



- Asks to confirm or cancel uploading of saved parameters.
- Choose Yes by pressing ENTER key.

Configuration uploading.

PRO-Verter S 2000 Data Logging

An SD card may be used to log operating information. When the SD card is inserted into the SD card slot, data logging is activated automatically (it will be disabled only if programmable setting has been changed to “0 = Disable”). Time interval between recordings (called “Data Log Time”) is programmable. A time stamp for each event is provided by the user interface’s internal, real-time clock.

Available options for Data Log Time are:

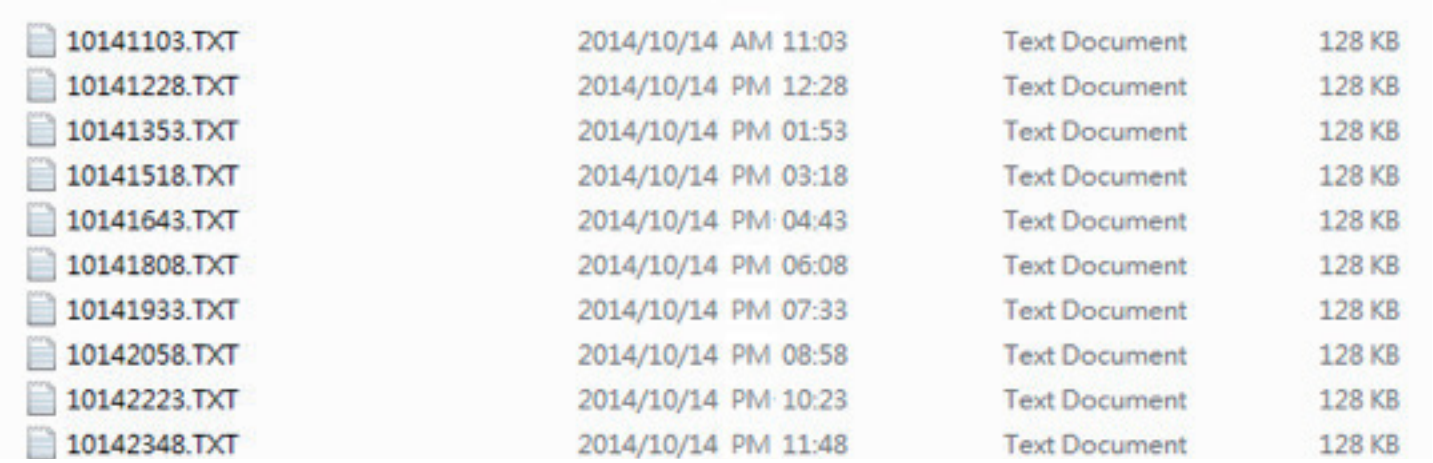
0 = Disable; 1 = 1 sec (default); 2 = 10 sec; 3 = 30 sec; 4 = 60 sec; 5 = 5 min; 6 = 10 min
“Events” and “Error Codes” are recorded as soon as they are sensed.

The following 25 data fields include System electrical parameters, events, and error codes:

Date	Time	Grid status	Grid freq	Grid volt	Input current	Input VA	Inputt watt	Output freq	Output Volt	Output current
Output VA	Output watt	Battery volt	Battery current	External current	Battery temperature (C)	Transformer temperature (C)				
Hear sink temperature 1 (C)	Hear sink temperature 2 (C)	Fan speed	Mode	Error code	Charge stage	Event				

Data Log Files: Viewing Data Log Files Using Excel

The Data Log files are written as text files (.txt) in the DATALOG folder on the SD card’s root directory. Below is an image of the DATALOG folder showing example of the Data Log Files. The file name format is month/day/hour/minute.txt (MMDDhhmm.txt). Each file has 512 rows of records. (Each row has multiple data fields.) Each file size is 128 KB.



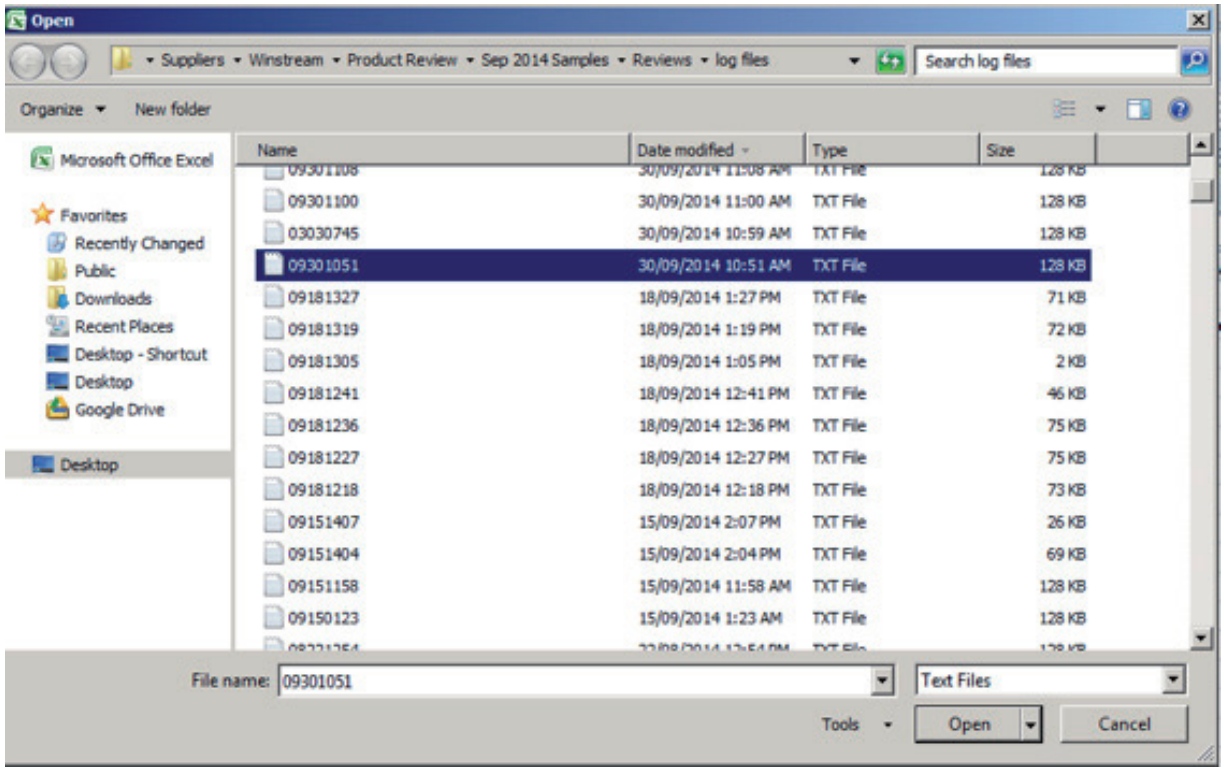
The figure below shows an example of one of the file's contents opened with a general purpose text reader. The second row shows data fields separated by semicolon (";"). The third row onwards shows the status of the data fields at time interval equal to the programmed value of Data Log Time.

Note: Event / Error Codes will be logged as soon as they occur.

```
Date;Time;Gen status;Gen freq;Gen volt;Grid status;Grid freq;Grid volt;Input current;Input VA;Input watt;Output freq;Output volt;Output current;Output VA;Output watt;Battery vo
2014/10/14;12:28:32;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:28:42;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:28:52;33340;000.00;000.62;33341;000.00;000.41;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:02;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:12;33340;000.00;000.62;33341;000.00;000.42;<00.10;<0012;<0012;060.00;000.43;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.7;0027.1;0;0;00000;0;
2014/10/14;12:29:22;33340;000.00;000.62;33341;000.00;000.41;<00.10;<0012;<0012;060.00;000.42;<00.10;<0012;<0012;25.002;0000.0;0000.0;0025.0;0026.0;0026.8;0027.1;0;0;00000;0;
```

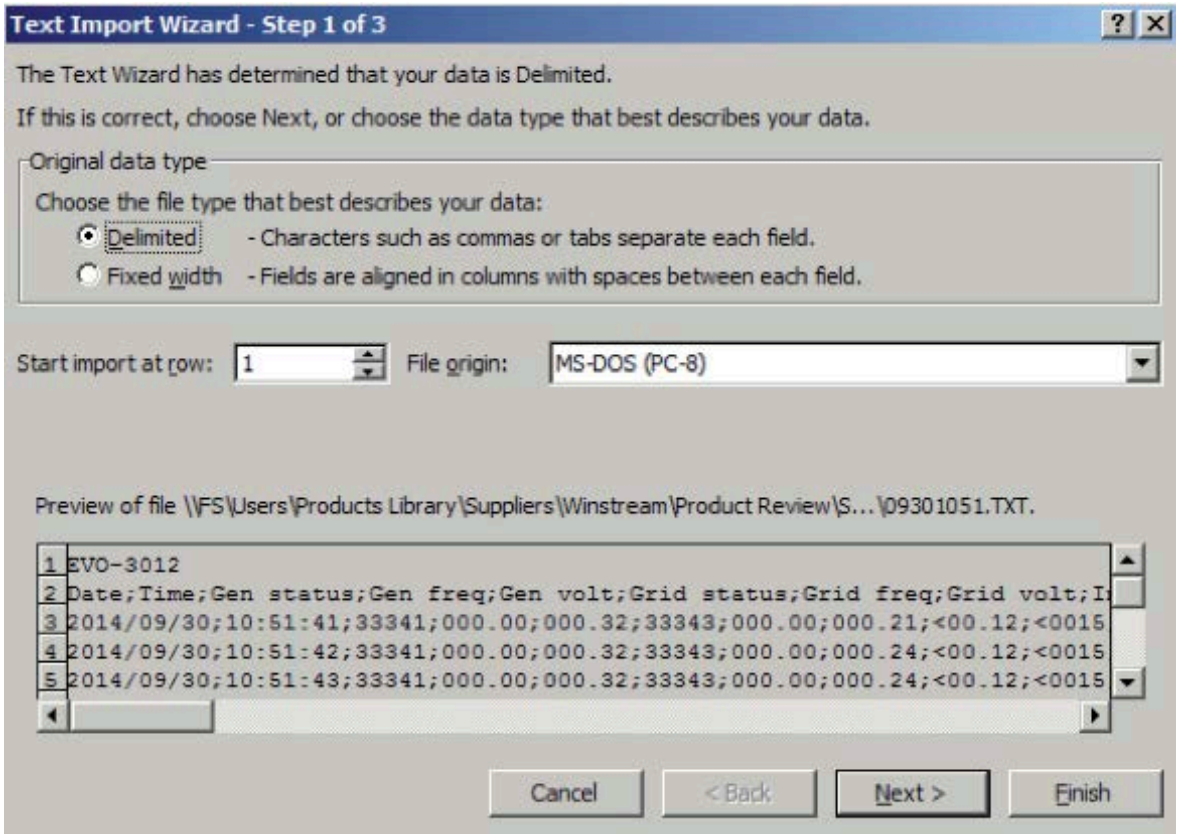
Follow procedure given below to open Data Log Files in Excel:

- Start Excel.
- Click File Microsoft Office Button on the top left hand corner.
- Click "Open" from the drop-down menu.
- Navigate to the directory where the Log files downloaded from the SD card are located.
- Click on "File Types" selection button at the bottom right corner (shows "All Excel Files" as default) and select text files from the drop-down menu.
- All text files (.txt) will be displayed.

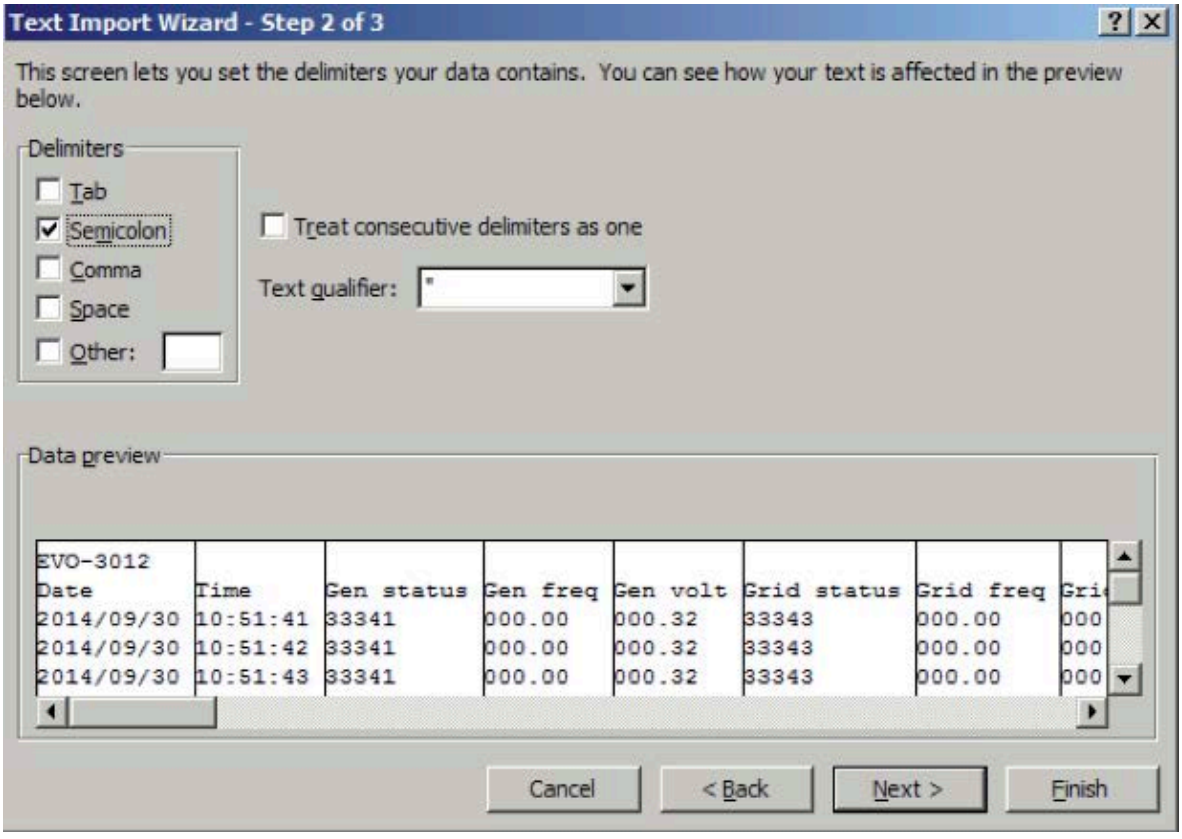


Click "Open" button

Text Import Wizard – Step 1 will be shown. Choose “Delimited” file type.



Text Import Wizard – Step 2 will appear. Choose “Semicolon” and click Finish button.



System Runtime Scenarios

The System has 2600 Wh of storage and two (2) power sources, a 1 kW AC generator and 300 W PV array. **For the System to function properly, the amount of power that is produced must be equal to or greater than the amount of power that is consumed by the load.** The power produced will be a balance between what is supplied by the sun (PV) and the generator. The rate of energy consumption may also vary.

The graphs below provide idealized, theoretical estimates of how the System will perform under various scenarios at different loads. These graphs should not be viewed as an indication of exact System performance.

Generator only

The first case demonstrates the 1 kW generator duty cycle in the HPS as a function of a series of continuous loads. This case assumes no PV contribution.

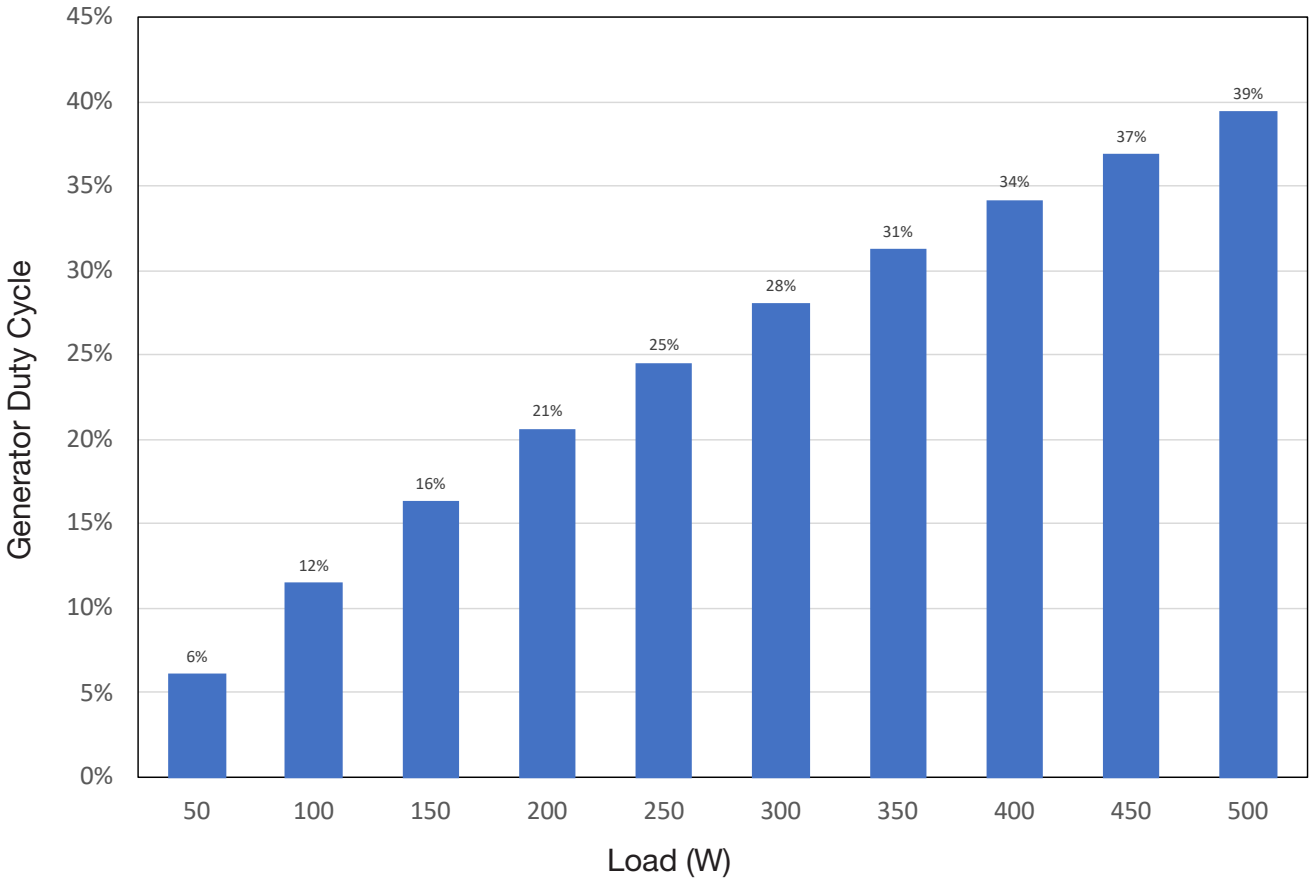


Figure 27. 1 kW generator duty cycle as a function of continuous loads.

PV only

This scenario demonstrates System performance at various continuous loads having only the 300 W PV array as a power source and assuming five (5) hours of sun daily. In this scenario, the System will run indefinitely (∞) when supporting loads loads of less than ~63 W.

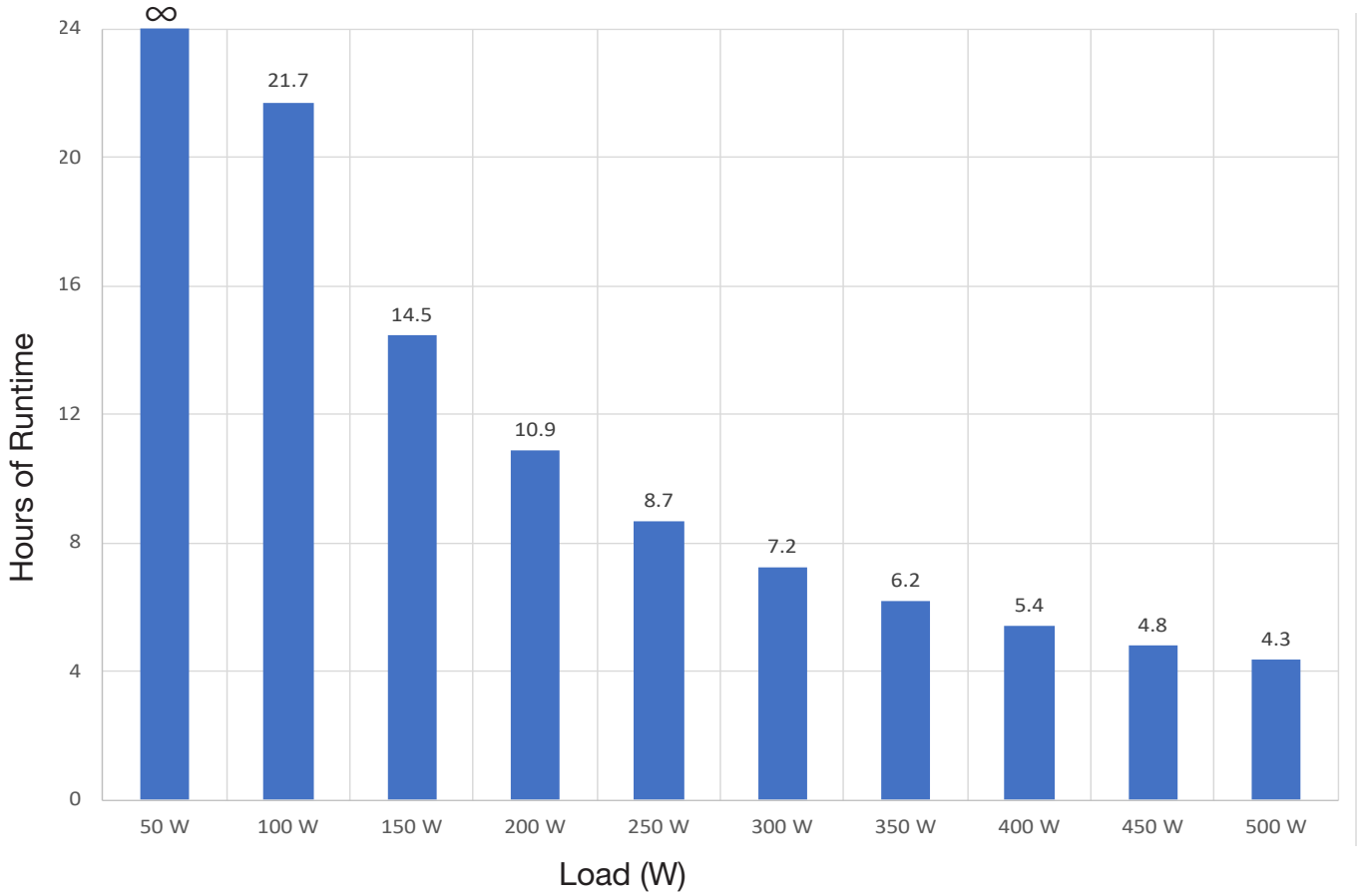


Figure 28. System runtime at various loads with PV power only

Generator and PV Input

The 1 kW HPS is configured to operate with the 1 kW MPG and the 300 W PV array as power sources. The “PV-only” scenerio assumes five (5) hours of sun daily. However, weather/sun varies daily and length of daylight varies seasonally so the amount of power supplied by the PV array will vary likewise. The graph below illustrates how generator duty cycle decreases, at various continuous loads, as the power from PV increases.

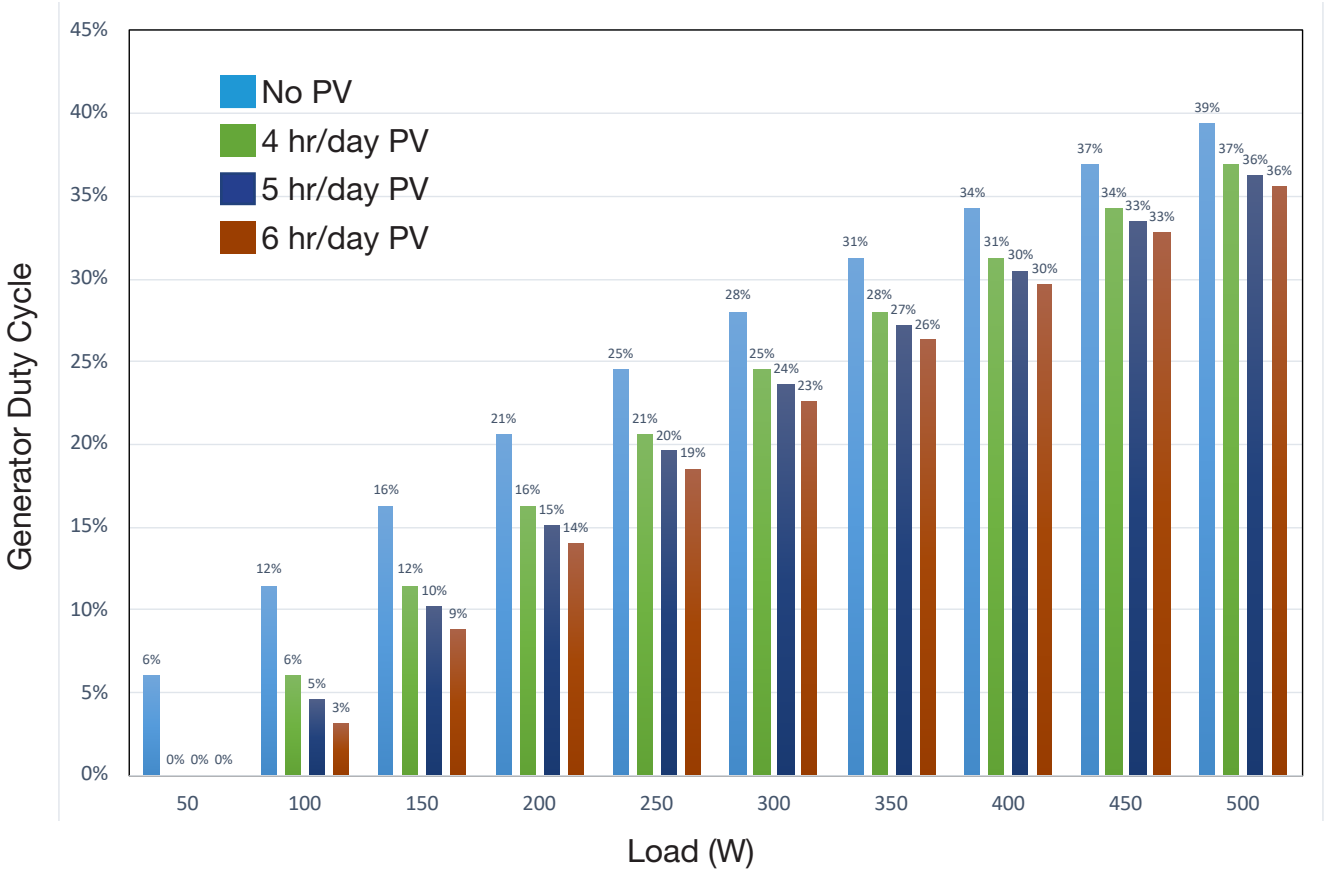


Figure 29. Increaseing PV power input reduces generator duty cycle.

TROUBLESHOOTING PROCEDURES

Clearing PRO-Verter Faults

If any fault occurs, the user interface will display the Fault Message and the Red “Fault” LED will be lighted. Remove cause of the fault. The unit will remain in Fault Mode until the fault is cleared. A short press (0.1 seconds) of the On/Off key will clear the Fault Message and the PRO-Verter will return to the operational status (if the reason for the fault condition has been corrected). Refer to the section on Fault Messages.

Recovery of System with Overdischarged Batteries

If batteries are discharged to a “critical-low” level, the system may cease to function. There are two (2) methods to restore a System with overdischarged batteries:

1. Connect an active generator/grid 120 VAC power source to PRO-Verter 120 VAC Input. Toggle and hold SYSTEM RECOVERY momentary switch for two (2) minutes to activate recovery circuit. Continue holding System Recovery switch while pressing user interface ON/OFF button. Once user interface powers up, release System Recovery switch and user interface ON/OFF button. The System will begin charging batteries within two (2) minutes.

2. Connect an active PV array (exposed to sun) to PRO-Verter. Turn on PRO-Verter user interface. Use either an active generator/grid 120 VAC source or continuous PV to charge the batteries.

Clearing Generator Faults Faults

A generator fault is indicated on the PRO-Verter Faceplate by rapid blinking of the Generator Status LED. To clear the fault and resum normal operation, complete the following steps.

1. Toggle Generator Control switch from ON (or AUTO) to OFF.
2. Correct condition that caused fault (Likely causes are listed).
   a. Fuel and oil levels
   b. Engine switch ON
   c. Eco throttle switch OFF
   d. Fuel tank vent cap lever ON
   e. Choke lever OPEN

- Do not connect a running generator to the PRO-Verter while the System is operating.
- Do not pull-start the generator if it is controlled by the PRO-Verter.

To restart generator:

1. Toggle Generator Type switch to required position (Ranger/Defender).
2. Toggle Generator Control switch to ON. Alarm sounds (10 s).
3. Generator cranks (2 min max). Five (5) attempts before fault.
4. Generator starts.
5. AC INPUT LED illuminates (~ 2 min after start).
6. PRO-Verter qualifies generator power.
7. Charging begins (see PRO-Verter user interface).
8. Rapidly toggle Generator Control switch to AUTO to begin normal hybrid operation.

Measuring PV Array Voltages

Voltage "open circuit" (V_{oc}) is unregulated PV array voltage and measured directly from the leads of an array when not connected to a "load" such as a charge controller. The rated V_{oc} of the Solar Venture 300W PV Array is approximately 65 V under standard test conditions (STC).

When the array is connected to the PRO-Verter S 2000 (i.e., the array is connected to a "load"), it is more likely the Operator will see voltages around 45–53 V_{mp}.

The V_{oc} and V_{mp} should be measured for each PV array in "ideal" conditions if possible. This means the arrays should be oriented directly at the sun and unshaded on a clear day to identify the maximum V_{mp} and V_{oc}

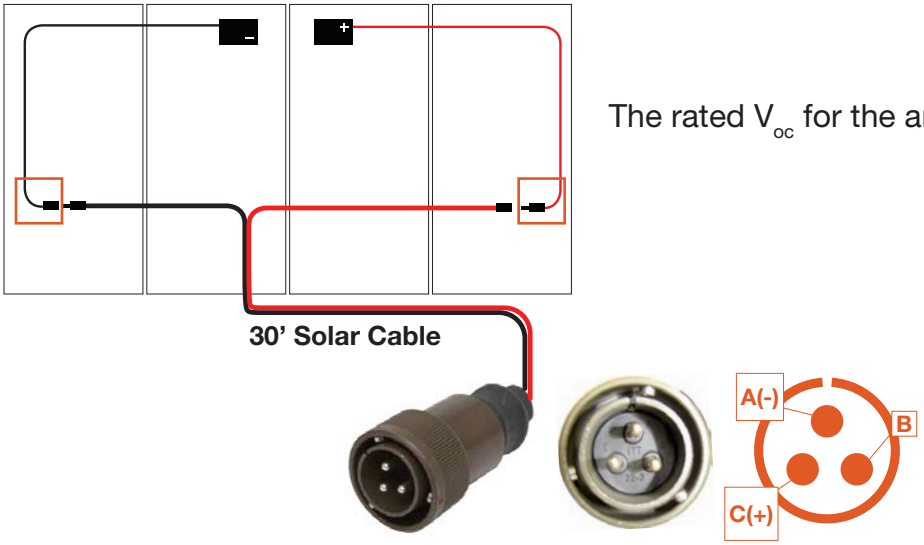
Procedure to Measure PV Array V_{oc} with a Multimeter

- Carefully place the leads of the voltmeter on pins A and C in the bayonet connector (Figure 30) at the end of the Solar Cable. Pin B is unused.

- Alternatively, disconnect the Solar Cable from the array leads and place the meter probes into the array lead connectors (orange boxes in Table 2).

Under ideal conditions, the reading should be 55 V or more. If a normal voltage reading cannot be measured at pins A and B of the Solar Cable but CAN be measured at the PV array lead connectors, replace the Solar Cable.

Contact the FSR if a PV array voltage measurement indicates that a PV array is either not functioning or is performing very poorly.



The rated V_{oc} for the array is 65 V

Figure 30. Measuring PV array open circuit voltage V_{oc}

PRO-Verter Fault Messages and Troubleshooting Guides

Table 11. Fault Messages Symptoms and Troubleshooting

Fault Messages and Troubleshooting Guide	
Fault Message	**Symptoms and Troubleshooting**
Battery low voltage!	PRO-Verter is in Fault mode because the battery voltage has dropped to the set lower threshold of Batt Low Voltage. • When the battery voltage drops to the set lower threshold of Batt Low Voltage, activation of this fault protection is initiated. The red Fault LED will flash once per second and the alarm in PRO-Verter will beep once per second. The inverter will continue to operate normally and the blue Status LED will continue to be on steady. (**Note:** Fault message "Battery low voltage!" will not be displayed during this time.) • If the battery voltage stays at or below the threshold setting for a duration equal to the set LV Detect Time, only the inverter will be switched off and fault message "Battery low voltage!" will be displayed. The red Fault LED will now change to steady on, the blue Status LED will switch off and the alarm in PRO-Verter will now beep steady. If the "Battery low voltage!" fault condition is not reset within the LV Cut Off Time, the PRO-Verter will shut down completely after the LV Cut Off Time (LCD screen/LED/Alarm will be off) has expired. • If the batteries are being charged by the PV array and the battery voltage recovers to the set Reset Voltage before LV Cut Off Time time expires while in "Battery low voltage!" fault condition, the inverter will restart and "Battery low voltage!" fault condition will be cleared. • While in "Battery low voltage!" fault condition, if AC input is made available before the expiration of LV Cut Off Time, the "Battery low voltage!" fault condition will be cleared. The PRO-Verter will restart in Inverting mode, synchronize with the AC input, and then transfer to the AC input at zero crossing. It will now operate in Charging mode.
Battery ultra low voltage!	The PRO-Verter is in Fault mode because the battery voltage has dropped to 18 V or lower. **(Note: A voltage this low will not be encountered when using $LiFePO_4$ batteries because the battery's own BMS will disconnect the output terminals before the voltage drops that low.)**

Continued on next page

Fault Messages and Troubleshooting Guide	
Fault Message	**Symptoms and Troubleshooting**
Battery over voltage!	The PRO-Verter is in FAULT MODE because the battery voltage has risen to the programmed upper threshold of “BATT OVER VOLTAGE”. **(a) AC input is not available and PRO-Verter is operating in Inverting Mode:** • There will be no AC output because the Inverter will be switched OFF. The Blue “Status” LED will be switched OFF and the Red “Fault LED” will be steady ON. The alarm will beep steady. • The fault will be cleared automatically when the battery voltage drops to 0.5V below the set upper threshold of “BATT OVER VOLT”. **(b) AC input is available and PRO-Verter is operating in Charging Mode:** • There will be no AC output or charging. • The fault will be cleared automatically when the battery voltage drops to 0.5V below to the set upper threshold of “BATT OVER VOLT”. The PRO-Verter will restart in Inverting Mode, synchronize with the AC input and then, the Transfer Relay will be energized to transfer to AC input at zero crossing. The PRO-Verter will, thus, resume operation in “Charging Mode”,
Input over current!	The PRO-Verter is in FAULT MODE because the input current being drawn from the AC input source (Input current = Charging Current + Pass Through Current to the load) is 1A more than the set threshold of “ GRID MAX CURRENT” / “GEN MAX CURRENT” for 5 seconds (current is sampled every 33.3 µs). • There will be no AC output because the Transfer Relay will be de-energized, charging will be stopped and PWM drive to the Inverter Section will be switched OFF. The Blue LED marked “Status” will be switched OFF and the Red LED marked “Fault” will be steady ON. The alarm in PRO-Verter will beep steady. • PRO-Verter will be turned off and will require manual reset by turning OFF the main breaker, waiting for 1 minute and then turning ON the main breaker. • The set threshold of “ GRID MAX CURRENT” / “GEN MAX CURRENT” should match the breaker capacity of the AC input source / AC input Branch Circuit. If AC input current capacity cannot be increased, reduce the AC load / “BULK CURRENT” accordingly.
Output over current!	The PRO-Verter is in FAULT MODE because the instantaneous output current being drawn from the PRO-Verter inverter by the AC load is 330% of the rated value of the PRO-Verter for 2 samples (current is sampled every 33.3 µs). • There will be no AC output because the PRO-Verter inverter will be switched OFF. The Blue LED marked “Status” will be switched OFF and the Red LED marked “Fault” will be steady ON. The alarm will beep steady. • PRO-Verter will be OFF and will require manual reset by powering OFF, waiting for 1 minute and then powering ON again. • Ensure that the maximum, instantaneous surge current of the load is NOT more than 300% (30 A) of the rated current (10 A) of the inverter for more than 1 millisecond.

Continued on next page

Fault Messages and Troubleshooting Guide	
Fault Message	**Symptoms and Troubleshooting**
Output over load!	The PRO-Verter is in Fault mode because of overload to the inverter: • There will be no AC output because the Inverter will be switched off. The blue Status LED will be switched off and the red Fault LED will be steady on. The alarm in PRO-Verter will beep steady. • PRO-Verter will shut down and will require manual reset by turning off the main power switch, waiting for 1 minute, and then turning on the main power switch. Output voltage is less than 96 V_{rms} for 300 cycles (5 seconds at 60 Hz).
Output over load 1!	Output power demand is over the rated output by 110% for 30 min.
Output over load 2!	Output power demand is 120% of rated output for 10 min.
Output over load 3!	Output power demand is 140% of rated output for 1 min.
Output over load 4!	Output power demand is 150% of rated output for 30 sec.
Output short circuit!	The PRO-Verter is in Fault mode because there is a short circuit on the output side in Inverting mode. Short circuit protection is activated when: Output voltage < 15 V_{rms} for 6 cycles and output current is more than the rated output current of 10.00 A_{rms}. • There is no AC output because the inverter has been switched off. The blue Status LED will be switched off and the red Fault LED will be steady on. The alarm will beep steady. • The PRO-Verter will be turned off and will require manual reset by powering off, waiting for 1 minute, and then powering on again. **Note:** If there is short circuit condition in Charging mode, i.e., when AC input is available, short circuit condition on the output side will trip the AC input breaker. The load will be transferred to the inverter and the inverter will then see short circuit condition and will shut down as described above.
Output failure!	The PRO-Verter is in Fault mode because AC input from grid/generator has been connected to the AC output terminals by mistake. 10 VAC or above detected at the AC output terminals when the PRO-Verter boots up will activate this protection. • The blue Status LED will be switched off and the red Fault LED will be steady on. The alarm in will beep steady. • The PRO-Verter will be turned off and will require manual reset by powering off, waiting for 1 minute, and then powering on again. Check the connection. If there is 10 VAC or over at the output terminal, remove the connection and connect to the input terminals.
Transformer over heat!	The PRO-Verter is in Fault mode because the bidirectional transformer in the PRO-Verter has overheated to 150°C. • The blue Status LED will be switched off and the red Fault LED will be steady on. The alarm will beep steady. • If in Inverting mode, inverter will be switched off. If in Charging mode, the transfer relay will be de-energized and the inverter will be switched off. • Ensure the fans are working properly, there is no blockage of air flow, there is adequate airflow, and the ambient temperature is within the limits. Reduce the load/Bulk Current. • The fault will clear when the transformer has cooled down to 80°C.

Continued on next page

Fault Messages and Troubleshooting Guide	
Fault Message	**Symptoms and Troubleshooting**
Heat sink over heat!	The PRO-Verter is in Fault mode because the internal heat sink for the MOSFETS in the PRO-Verter has overheated to 70°C. • The blue Status LED will be switched off and the red Fault LED will be steady on. The alarm will beep steady. • If in Inverting mode, the inverter will be switched off. If in Charging mode, the transfer relay will be de-energized and the inverter will be switched off. • Check that the fans are working properly, there is no blockage of air suction and discharge vents, adequate cool replacement air is available, and the ambient temperature is within the limits. Reduce the load and Bulk Current. • The fault will be cleared when the heat sink has cooled down to 40°C.
SD card unusable!	• Data logging will not start. • Check that the format is FAT16/FAT32. • Check that the capacity is less than 16 GB. • Reformat the card.
SD card read error!	• Data logging stops. • Remove and reinsert the card.
SD card write error!	• Data logging stops. • Remove and reinsert the card.
SD card full!	• Data logging stops. • Move or delete files or reformat the card.
WRITE FAILURE!	The entered value of programmable parameter could not be written.
OUT OF RANGE!	The entered value of programmable parameter is out of the programmable range. Change parameter value to within the specified range.

MAINTENANCE, SECURITY, AND TRANSPORT

24VDC PRO-Verter S 2000 PMCS

Table 12. 24VDC PRO-Verter S 2000-120 PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of 24VDC PRO-Verter S 2000	M	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior, interior and connectors. 3. Close all unused port covers.	~If the case is broken or split or if connectors are damaged, do not place into service.
2	Air Intake Filters	M[1]	1. Remove the three (3) air intake vent covers to expose the filter material. (See PRO-Verter Manual for location of air intake filters.) 2. Wash with water and dry the filter. Reinstall. 3. If the filter is damaged or cannot be cleaned replace.	~If the filter cannot be cleaned, is too damaged to function properly and a replacement is not immediately available, the unit is partially mission capable. Replace the filter as soon as possible to restore the unit to fully mission capable.

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

PRO-Verter 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 31. Fastener locations on vent shroud (upgraded/new version)

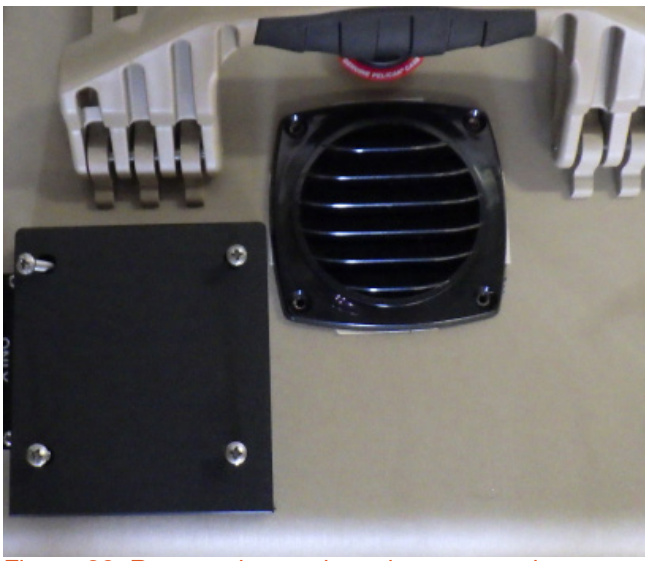


Figure 32. Removed vent shroud to access the louvered vent cover

2. Remove and inspect the filter. Replace the filter if it is damaged (arrows in Figure 33). If the filter is in good shape, clean it by rinsing it with water to remove the particulate matter and dry it. Replace the filter if it is crushed, rotted, or cracked as illustrated in the left column of Figure 33. Spare filters may be stored behind the PRO-Verter I-Plate.

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

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

Preventive Maintenance Checks and Services (PMCS)

In-storage PMCS for 24VDC Li Expander Pak 1300

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

Required Tools
Solar Stik PRO-Verter or LiFePO4 battery maintenance charger.

Table 13. In-storage Preventive Maintenance Checks and Services

Item #	Item to be Inspected	Interval* at 91-140 ºF (33-60 ºC) Storage Temp	Interval* at 77-90 ºF (≤ 25-32 ºC) Storage Temp	Procedures	Non-mission Capable
1	Visual inspection of 24VDC Li Expander Pak 1300	M[1]	Q[2]	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior and ports. 3. Close all unused port covers.	~If the case is broken or split or if the port is damaged, contact Solar Stik Technical Support.
2	In-storage maintenance charging	Q	S[3]	Charge Li Expander Paks for 24 hours using a PRO-Verter. If any other charging device is used, it must be rated for the Expander Pak storage capacity, voltage, and current limit.	If an Li Expander Pak has does not hold a charge after 48 hours of charging, contact Solar Stik Technical Support.

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

Solar Venture 300W PV Array PMCS

Table 14. PV Array PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of PV Arrays	M[1]	1. Inspect PV panels and support frame for visible damage 2. Clean excessive dust or dirt from the surface. 3. Inspect cables and connections. Ensure there is no damage and that cables are not in standing water.	~If the PV panels and/or the frame are damaged to the point of being non-functional, the PV array is NMC, replace.
2	Inspection of PV array ground securing	M	1. Check the integrity of the ground securing mesh panels. 2. Ensure ground securing sandbags are full and situated properly. 3. Ensure that none of the sandbags is positioned in a way that places stress on any part of the PV array.	~ If any aspect of the ground securing components is damaged or missing to the point the PV array cannot be secured to the ground, the PV array is NMC. Contact Solar Stik to repair or replace the PV array. An unsecured PV array can become a wind-driven projectile posing risk of injury to personnel and damage to any connected equipment.
3	PV array output	Q[2]	1. Ensure each PV array is oriented for optimal sun exposure. 2. Independently check the voltage of each array.	~ If output of an array is less than half the rated value, follow the instructions in the Solar Venture 300W Manual to identify and solve the issue.

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

Locking Component Cases to Prevent Tampering

Solar Stik Component can be secured with a padlock to deter tampering. Four (4) latches allow the case to be sealed to prevent damage to the internal components from environmental factors. Additionally, two (2) sets of steel-reinforced holes, one (1) in the lid and one (1) in the base of the case, flank the latches on the front of the case. A lock similar to the one shown in Figure 35is recommended; not all locks are compatible.

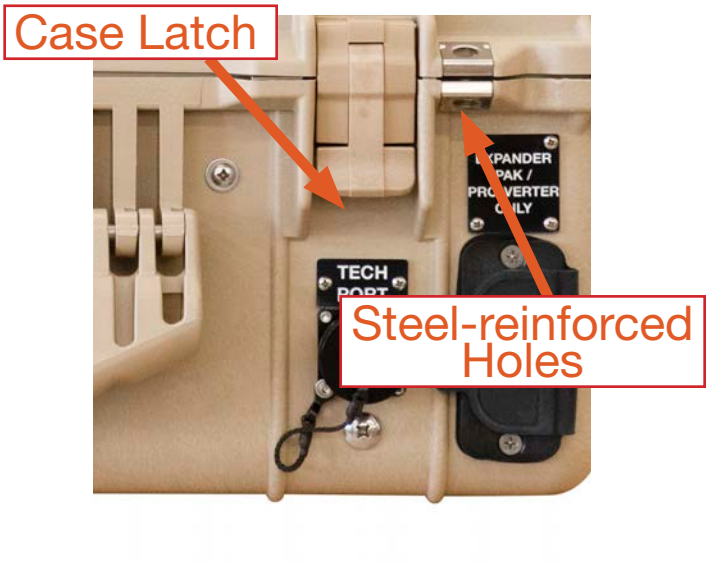


Figure 34. Steel-reinforced padlock holes

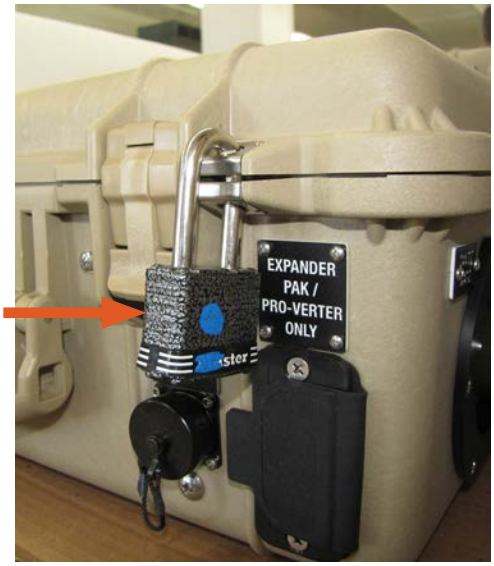


Figure 35. Lock securing Case

Human Transport of Components

There are no transport restrictions for these components, which are safe for all modes of transportation, including land, sea, and air. See individual component Manuals for details. The PRO-Verter has wheels and a tow handle at the opposite end enabling it to roll easily on appropriate surfaces.

Figure 36. Human component transportation – PRO-Verter S 2000

The Solar Venture transport case has wheels and handles to facilitate rolling transport and one (1) or two (2) person carry. The transport is weight 45.6 lb (20.7 kg) or 53.1 lb (24.1 kg) with 30 ft Solar Cable.

Figure 37. Human component transportation – Solar Venture 300

The 24VDC Li Expander Pak 1300 weighs 34 lb (15.42 kg) and can be carried by a single person. Please see the Operator and Maintenance Manual for the 24VDC Li Expander Pak 1300 for information regarding transport of the Expander Pak via air and ground.

Figure 38. Human component transportation – 24VDC Li Expander Pak 1300

The 1 kW MPG has a dry weight of 39.1 lbs (17.7 kg), has a handle on top and can be carried by a single person.

Figure 39. Human component transportation – 1 kW MPG

Warranty and Returns

Return Material Authorization

If Customer believes a Product is defective, a Return Material Authorization (RMA) number must be obtained from Solar Stik prior to shipment of such Product back to Solar Stik. The RMA number must appear on all packages returned to Solar Stik and be referred to in all related correspondence. Return shipment of the Product for which damages are claimed shall be at Customer's expense, and such Products shall not be returned, repaired, or discarded without Solar Stik's written consent. Returned Products will be subject to inspection and final determination as to whether or not any adjustment is due. If the inspection shows the warranty for the Product is breached, the provision of WARRANTY (below) will apply. Solar Stik advises that Customer order recommended spares and maintenance parts, especially for critical OCONUS operations. Otherwise Customer may experience system downtime during the return and inspection of nonworking components.

Warranty

1. Solar Stik warrants, unless otherwise agreed to between buyer and seller (Solar Stik, Inc.), for a period of one (1) year from Solar Stik's delivery of such Products, the Products shall be free from defects in materials and workmanship and shall conform to the contractual specifications or to specification sheet of the Product. This warranty does not cover defects or failure caused by improper handling, storage, maintenance, or repair or by any modification, misconnection, abuse, abnormal use of such Products (inter alia, overloading or overcharging) or use not complying with Solar Stik's user manual provisions if any.

2. Warranty claims must be made to Solar Stik immediately after discovering the defect and within the warranty period or are forever waived.

3. The foregoing warranty is exclusive of any other warranties, express, implied or statutory. In particular, this warranty shall not apply to failure arising from defect in design when the design has been completed in part by the Customer or a third party. Unless otherwise agreed, the warranty shall not apply to the compliance of Products to Customer's needs. Should the Products warranty be breached, Customer's exclusive remedy against Solar Stik, and Solar Stik's sole obligation, shall be limited to, at Solar Stik's option, repairing or replacing the defective Products.

4. The Product shall be considered defective if the failure may be duplicated by Solar Stik, it being understood nonconformity shall be determined by reference to the contractual specifications applicable to the allegedly defective Products.

ABOUT SOLAR STIK, INC.

SOLAR STIK®

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

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

Solar Stik Training and Education

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

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

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

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