SOLAR STIK®

Operator and Maintenance Manual for the 24VDC HyPR 3000

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GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

Introduction

A Hybrid Power Router (HyPR) is a power management device which processes and routes a variety of power inputs to both DC and AC power outputs.

The HyPR is a modular, portable component of the Solar Stik Architecture and its design and flexible function affords the operator a “multi-tool” for applications demanding a singular power solution to meet specific, and evolving, mission requirements.

Some features of the HyPR include:

- The ability to act as the primary power management device in a Hybrid Power System (HPS) or as a supplemental power manager in AC, DC, or AC/DC systems.
- The ability to work in concert with additional power management devices when high-power or individual control over multiple loads/voltages is required (eg. PRO-Verters).
- Support of simultaneous AC and DC outputs.
- Plug and play compatibility with the Solar Stik Inter-Connect circuit.
- Efficient management of available power to loads.

This manual provides operation and safety information for the HyPR 3000. The HyPR 3000 has been designed specifically to support Hybrid, UPS, Power Conditioning, and Scavenging requirements.

When operating the HyPR within a system, consult the I-Plate and the System Manual for specific operation guidelines.

Requirements for HyPR Operation

- Total power INPUT must exceed total power OUTPUT in any particular operation mode.
- The HyPR requires the presence of battery (DC bus) voltage to operate at its full rated power.
- Based on the application, the user must configure the system so there is “balanced” operation between the HyPR’s internal functions.

All HyPRs accept universal (85–264 VAC) single-phase AC input voltage, allowing connection to any generator or grid AC power source. It is ideally suited for use where available AC power quality is poor or AC line voltages vary. AC and DC cables for the HyPR are sold separately, as they must match voltage type and associated current-conducting ability.

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HyPR 3000 Capabilities and Controls

The HyPR features specific capabilities for the system in which it is employed and, while many of the circuits in the HyPR are fully automatic, outside user-established limits, not every HyPR feature may be used in every application.

Most functions and modes are controlled by programmable settings at the User Interface(s).
- “Functions” are related to specific circuits or hardware in the HyPR.
- “Modes” refer to the operational employment of the HyPR circuits.

User Control Functions

The faceplate is divided into two interfaces; the AC and the DC control panels:
- The HyPR AC INTERFACE panel provides complete AC circuit input and output control.
- The HyPR DC INTERFACE panel provides complete DC control, including complete circuit data and metering.

When the main power breaker switch is turned on:
- The HyPR DC INTERFACE will power up and report DC bus voltage and amperage data on the home screen.
- The inverter (DC>AC) will be active, but only operational once the HyPR AC OUTPUT breaker is engaged.
- The converter (AC>DC) will be active, but only operational once the HyPR AC INPUT breaker is engaged.
- The HyPR solar charge controller will be active, but only able to process PV power once the SOLAR INPUT breaker is engaged.
- The HyPR DC>DC converter (scavenger) will be active, but only able to process DC power once the 9-36 VDC INPUT breaker is engaged.

Data Management

- **The DC INTERFACE provides complete DC circuit data only when an active PV array is connected.**
- The HyPR DC Interface provides basic DC circuit data, including ESM/bus voltage and net current only when active ESMs are connected.
- If no ESMs are connected to the HyPR, then only the DC bus voltage is available from the HyPR DC INTERFACE.
- DC bus voltage is the only accurately-reported metric from the HyPR DC INTERFACE when ESMs are not connected.

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Theory of Operation

The HyPR 3000 coordinates the support of AC and DC loads using power supplied from AC and/or DC sources. Both AC and DC power sources energize the HyPR 3000 internal DC circuitry (DC bus), or the “Inter-Connect” circuit. The presence of DC bus voltage (battery voltage) enables the full function of the HyPR 3000 internal circuits. System voltage and net current can be monitored on the DC User Interface. However, it will report only a negative current value if no PV array is connected.

A schematized illustration of the DC bus and its relationship to internal components, inputs and outputs is shown below. The arrows indicate the flow of current in the circuits.

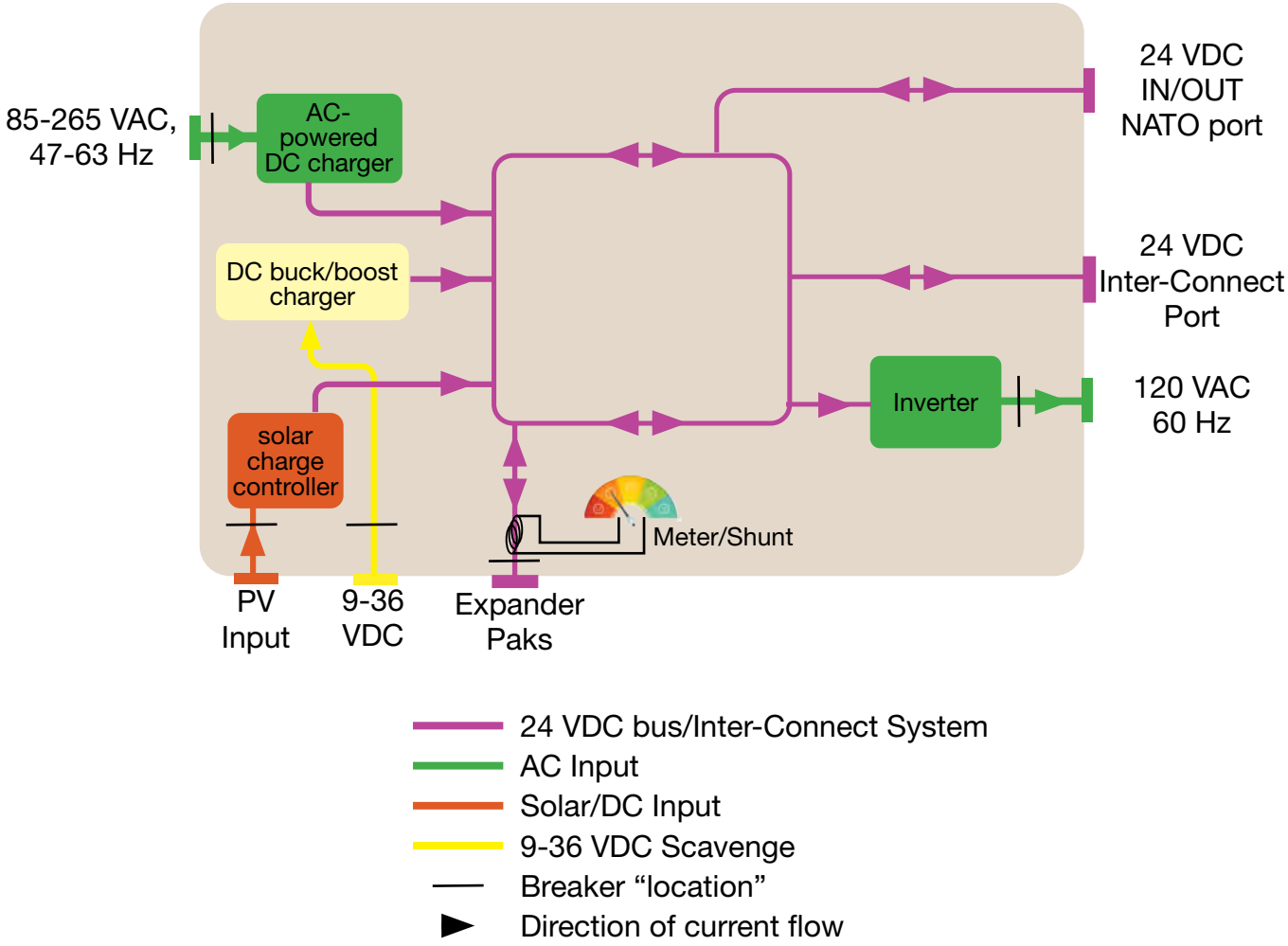

Figure 1. Schematized power flow from a top-down view of the interior of the HyPR 3000

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General Information

Circuit breakers on faceplate are only for IN/OUT circuit limit protections. They are NOT “function controls” or “function protections”.

The internal DC Bus is limited to 100 A total current flow. This may restrict some HyPR functionality in certain operating modes.

Current flow on the DC bus is controlled by voltage. Power will always be prioritized to the loads and will only cease when the voltage drops to low-voltage disconnects located within the inverter (AC loads), the ESMs and DC Interface (DC loads).

24 VDC IN/OUT NATO and 24VDC IN/OUT ports operate directly from the internal DC bus. Power in/out of these ports will only be reflected in the “net” current in/out of the ESMs when a PV array is connected.

System recovery from overdischarged batteries is possible using AC power or alternative 24 VDC power sources. System recovery using PV power is not an option.

Inverter “continuous AC power output” fluctuates based on conditions such as temperature (heat derating = efficiency loss).

AC Functions

The HyPR employs two (2) separate AC functions that operate on the DC bus:

Charging

AC>DC converter provides up to 100 A at 29 V DC to the DC bus (~3000 W).

Inverting

DC>AC inverter removes up to 84 A at 24 VDC from the internal DC bus (~2000 W).

When configuring the HyPR for use, it is important to understand how to establish balance between the power available from sources and the power required by the loads.

When using AC power sources in Hybrid or UPS models, the AC INPUT setting must be set for the following conditions:

- continuity of AC load operation
- battery charging
- not to exceed the power output of the AC source

When small expeditionary generators are used, the HyPR can be used for dynamic loads that would normally cause overloading of the generator.

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DC Functions

The DC bus is effectively the nervous system of the HyPR. All HyPR functions are regulated directly or indirectly by the DC bus voltage. The DC bus voltage is functionally equivalent to the System battery voltage. Direct connections to the DC bus can be made via the two (2) Inter-Connect ports and the NATO port. Ports for PV, the scavenger circuit, AC Input and AC output ports are indirect connections to the DC bus (See “Figure 1. Schematized power flow from a top-down view of the interior of the HyPR 3000” on page 7).

DC power will flow into or out of the HyPR via the direct connections (Inter-Connect and NATO ports).

The indirect connections allow power to flow to the bus after being altered from its original form, for example:

- 30-57 VDC power from PV arrays converted by the solar charge controller to 29.0 VDC
- 9-36 VDC scavenged power converted to 28.4 VDC
- AC power converted to 28.2 VDC
- Inverter converts energy stored in batteries to 120 VAC power output.

Utilization of power sources to charge batteries and support loads is prioritized by voltage. Prioritizing PV and scavenged DC power over AC power reduces reliance on fuel-powered generators.

Solar Power

The SOLAR INPUT port is the only port that may be used to connect PV power to the HyPR. Connecting a PV array to any other input port will damage to the HyPR.

Any PV array input must meet the following specifications: 400 W or less, voltage between 30 and 57 VDC, and a maximum current rating of 15 A at 24 VDC.

The HyPR converts incoming PV power to a 29.0 VDC charging current. When multiple power inputs are present, 29.0 VDC PV power is automatically prioritized for battery charging.

When a PV array is present, all features of the HyPR DC INTERFACE are available. If PV power is not an integral part of a HyPR 3000-based System, only the voltage and current metrics on the home screen are accurate while the System is operating.

Power Scavenging

Scavenged power is converted to 28.4 VDC charging voltage placing it second, after PV power, in the rank order of prioritization of power sources. Therefore if PV power is present, scavenged sources may not contribute to the charging current on the bus.

The scavenged power source must be able to provide at least 250 W of power. Total Internal power consumption of the HyPR is ~100 W. If passing power through to a load when in Scavenge mode, then only about 150 W will be available for use.

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Drawing power from a vehicle battery in scavenge mode has the potential to overdischarge the vehicle starter battery rapidly. Run the vehicle motor when scavenging power from a vehicle to avoid overdischarging the starter battery.

Beware of HyPR overheating when using the power scavenging function.

Power input is limited to 150 W. Power output is limited to 100 W. Custom cables may be required. If the load exceeds 100 W, the power supply will temporarily shut down and will not resume until the load is reduced. The 9-36 VDC switch on the Faceplate is unlikely to trip due to the fact that the Scavenger power supply and the inverter self protect.

Auto Generator Start / Stop

The HyPR Auto Generator Start/Stop (AGS) functions are controlled using the GENERATOR CONTROL switches on the Faceplate.

- The ON position turns on a connected generator regardless of the DC bus voltage.
- The AUTO setting automatically starts and stops a connected generator based on DC bus (battery) voltage.
- The OFF setting stops the generator(s) if it is running or prevents the generator from turning on.

Automatic Generator Start/Stop (AGS) voltages

The HyPR AGS is programmed to start and stop the generator(s) at voltages that allow the ESMs to charge and discharge over a safe and efficient voltage range.

- Generator start set point = 25.5 VDC
- Generator stop set point = 29.0 VDC

The generator start and stop voltage set points are programmable via a TECH PORT on the Faceplate. Contact Solar Stik Technical Support for assistance if reprogramming is required.

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Load Prioritization

In every operation mode, the HyPR will prioritize power to the load. It executes functions based on real-time operating conditions, which include:

- total power available at the INPUTS
- total power needed at the OUTPUTS
- battery SOC
- temperature
- user programming for special conditions

HyPRs can be used with grid-utility or generator AC power, and can easily be adjusted to operate within the current limits of both the AC load circuit and the external AC power source.

When operating a HyPR with multiple DC power sources connected (e.g., PV, Wind, vehicular, fuel cells, etc.), all incoming power will be prioritized to the load, reducing consumption of energy stored in the batteries, thereby extending battery-only runtime and the reducing need for AC power from a grid-utility or generator source.

When operating a HyPR with a fuel-driven generator(s), the AGS circuit can be used to start the generator(s) when the battery SOC is low. Once the battery SOC reaches a user-determined point, the HyPR AGS circuit will start the generator, ensuring power to the load. In effect, the HyPR 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 power. Any incoming power not consumed by the load is stored in the batteries. Stored energy is for use to support loads when these inputs are not available (e.g., grid failure, generator maintenance periods, etc.) and to reduce reliance on fuel-powered generators.

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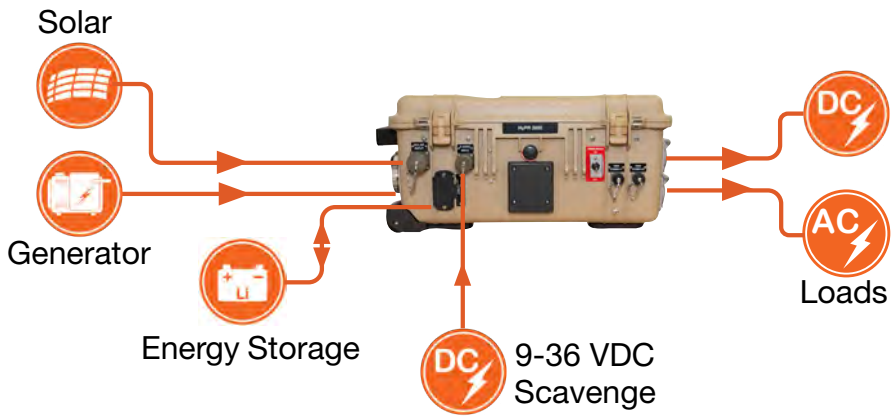
Modes of Operation

There are several operational modes in which the HyPR may be configured, depending on the application,

Hybrid Mode–The hybrid mode allows the use of a smaller generator based on average, continuous total loads over a 24-hour period, versus a larger generator that will support “peak” loads, which are usually momentary or short in duration:

- AC power generation source (Ranger/Defender, TQG) with ESMs
- DC power generation source (PV, scavenging) with ESMs
- AC and DC power generation sources (combinations of the above) with ESMs

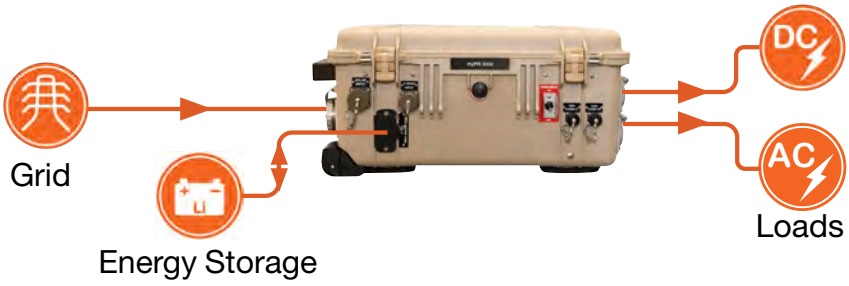


AC Power Limits
3000 W AC Input from source(s)
2000 W AC Output for loads

Figure 2. Using the HyPR 3000 in Hybrid Model

UPS Mode–The HyPR 3000 is capable of operating as an Uninterruptible Power Supply/Source, providing instantaneous emergency power to a load in the event that primary power source fails. In this mode, the HyPR 3000 will to provide power to the load until it can be turned off safely or until primary power is restored. In this mode, power duration is limited to that contained in the ESM’s connected to the HyPR 3000.

- AC utility / grid power sources with ESMs
- ESMs do not cycle



AC Power Limits
3000 W AC Input from source(s)
2000 W AC Output for loads

Figure 3. Using the HyPR 3000 in UPS Model

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Power Conditioning Mode–The HyPR 3000 has a power conditioning mode that stabilizes output voltage and frequency from dirty AC power sources. The HyPR will convert AC power with voltage ranging from 85-264 and frequencies between 47-63 Hz into clean, pure sine wave 120 VAC, 60 Hz power providing protection for sensitive loads:

- HyPR with ESMs between AC power sources and AC and DC loads - eliminates overloading of small expeditionary generators and increases the HyPR power output stability over longer periods of time.
- HyPR without ESMs between AC power sources and AC and DC loads - eliminates AC power source voltage and frequency fluctuations that can cause problems with sensitive electronic loads.

Figure 4. Using HyPR in Power Conditioning Model

DC Scavenging Mode–The HyPR 3000 provides an energy scavenging tool to harvest power from conventional and non-conventional 9 to 36-volt power sources not integral to the Solar Stik family of products, such as a random batteries or a 12 VDC vehicle accessory outlet. The HyPR scavenging circuit automatically converts any power source voltage between 9 and 36 VDC to 28.4 VDC which is appropriate for charging ESMs and/or to support small 120 VAC or 24 VDC loads. It is not necessary for a Solar Stik ESM to be connected to the HPS to take advantage of the Scavenging circuit. If ESM's are not connected, however, the HyPR can only support loads up to the amount of power provided through the Scavenging circuit (Figure 1).

- Scavenging with ESMs connected to HyPR allows ESMs to be charged using external batteries or vehicle DC systems.
- Scavenging without ESMs connected to HyPR allows small loads to be operated directly from a connection to a 12 VDC vehicle accessory outlet.

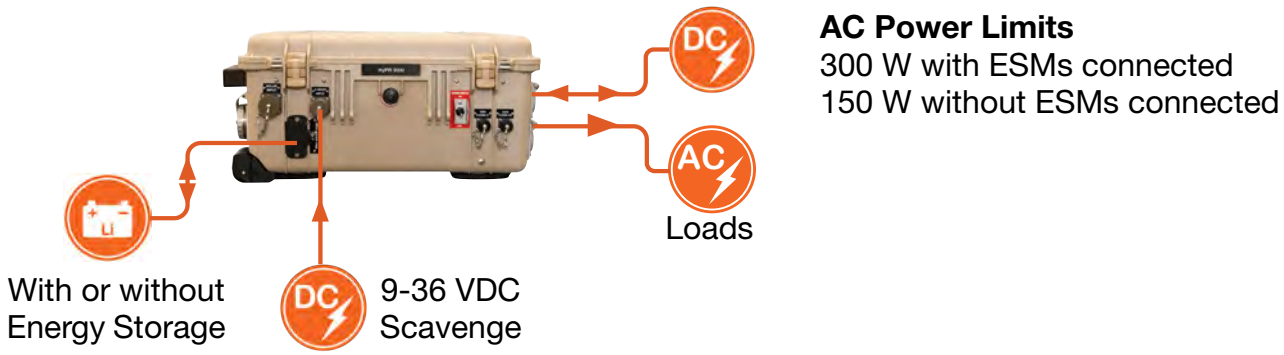

Figure 5. Using HyPR in Scavenge Model

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Inverter Mode – The HyPR 3000 may be used in inverter mode when no AC power generation sources are available. This allows the combined total input of DC sources (including ESMs) to be dedicated to AC loads. This mode may be used when:

- Renewable power generation is abundant and stable.
- Scavengable DC power resources are available.
- Connection to a vehicle NATO port is available.

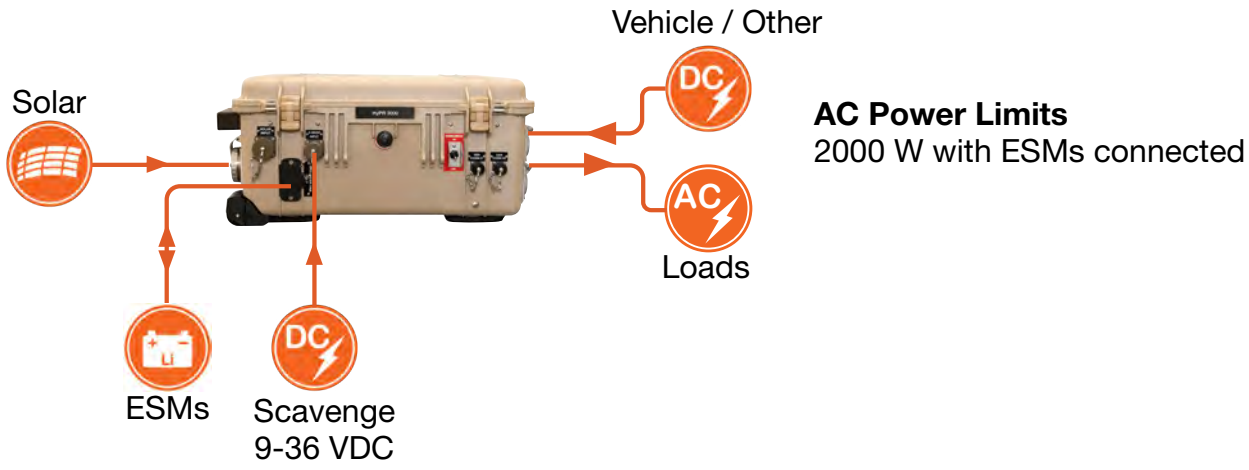

Figure 6. Using HyPR in Inverter Mode

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Selecting an AC Power Source

HyPRs can be used with grid-utility or generator AC power sources, and can easily be configured to work with the current limits of both the DC/AC power source circuits and the DC/AC load circuits. Once the input and output power limits are configured, the HyPR regulates how much power is delegated between these circuits, to prevent overload conditions.

Acceptable AC power sources for use with a single HyPR 3000 should provide the following:
- 1–3 kW of power
- Pure Sine Wave AC wave form output

When considering a fuel driven generator to pair with the HyPR, note that the maximum continuous AC load should not exceed the maximum continuous output of the AC power generator (i.e., maximum load AC power requirement ≤ generator AC power output). Moreover, to use the HyPR in hybrid mode, a fuel-powered generator must be compatible with Solar Stik auto generator start/stop capabilities.

Energy Storage Requirements for Operation

The HyPR requires connection to an active 24 VDC battery to operate. There is a minimum energy storage capacity requirement for operation of the HyPR at it's full rated power. Consult the I-Plate and subsequent sections of this Manual for specific information regarding minimum capacity necessary for a particular application.

The HyPR is compatible with lead-acid and lithium battery chemistries. However, battery chemistries should never be mixed within a System.

Battery Low-voltage Cut Off (LVCO)

AC loads
The HyPR inverter is programmed, via the DC INTERFACE AUX circuit, to cease support of AC loads (turn off the inverter) before the System battery voltage drops to a critical, overdischarged level.
- The HyPR will discontinue the support of AC loads when System battery voltage drops to 25.0 VDC.
- The HyPR will resume support of AC loads when System battery voltage is charged backup to 25.2 VDC.

The LVCO values are set in accordance with the battery's BMS specifications and will vary depending on the battery type and the total battery capacity in a System.

DC loads
The HyPR does NOT provide battery LVCO protections when supporting DC loads. DC loads connected to the HyPR may draw down battery voltage to the point that the battery BMS will disconnect the battery from service to protect it from overdischarge.

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Battery Current Requirements for HyPR AC Output

A bank of batteries with the capacity to provide ≥ 84 amps of current is required for the HyPR (inverter) to operate at its full rated capacity (2000 W). Battery banks with smaller current capacity are sufficient to power up the HyPR and support loads (AC and DC) that do not exceed the current capacity of the connected batteries.

Connecting ESMs with an insufficient current capacity to the HyPR may result in the batteries being charged or discharged too quickly causing the battery temperature to rise to a point that the battery management system (BMS) disconnects the batteries from the system.

Note: The total Ah capacity of all connected ESMs must be programmed, (a setting in the DC interface), for the HyPR DC interface to report accurately, the battery state of charge.

Temperature-dependent Power Processing

The performance of all electric and electronic equipment varies with temperature with the rated performance listed determined at standard testing conditions (77 ºF; 25 ºC). Generally performance declines or “derates” when the equipment is operating in ambient temperatures colder or hotter than STC; the hotter or colder the poorer the performance.

When the equipment itself generates heat, the temperature of the equipment will rise above ambient (and STC) in direct proportion to power being processed. This too results in derating. Internal thermostatic mechanisms are built into most equipment to reduce power processing in a heat-dependent manner to lower heat and prevent damage. Power processing vs heat curves vary widely.

They HyPR contains two (2) major subcomponents, a charger and inverter. Both of these derate at elevated temperatures but in a different manner. The inverter will provide full power up until a critical temperature and then turn off, dropping the AC load then resume support of the AC load after the inverter has cooled to a set point. The charger on the other hand, will reduce power processing at a critical, defined temperature but continue to charge the batteries at a lower rate.

Heat absorbed by the sun (solar loading) also increases the internal temperature contributing to temperature-dependent derating. Understanding how temperature-dependent derating affects HyPR power processing will enable the Operator to make adjustments to ensure continuity of operations in any environment.

Derating Specifications

The Inverter

- The inverter provides full power (2000 W) up to 86 ºF (30 ºC). It will decrease power output by 20% for each 18 ºF (10 ºC) increase over 86 ºF (30 ºC). The inverter will cease to process power at 176 ºF (80 ºC), to self-protect, and will resume providing AC power after it cools to operating temperature.
- Below 80 ºF (27 ºC), the HyPR can provide up to 2,000 W continuous while not charging.

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The Charger

- The HyPR charger provides full power (3000 W) up to ~158 ºF (30 ºC). At 158 ºF (70 ºC) it will reduce power ~30% of full-rated power until it cools and resumes normal, full-rated output.
- Below 80 ºF (27 ºC), the HyPR can process around 2000 W continuous for battery charging (with no loads connected).

How to Minimize Derating

- Do not overload the HyPR. Manage power processing demand by paying close attention to what is “plugged in. Prioritize critical loads.

- Shade the HyPR 3000 to reduce solar loading. Solar Stik data indicate that solar loading of a Pelican case can increase internal heat by ~40 ºF (~ 22 ºC) above ambient.

- Do not block airflow into or out of the HyPR; give is space to breathe.

- Clean or replace the air intake filters regularly.

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Important Safety Information and Instructions

This manual contains important instructions that must be followed during the setup and operation of a the HyPR 3000. Read all instructions and information contained in this manual.

DO NOT begin assembly or use of the HyPR 3000 without first reading and understanding this manual.

While the HyPR 3000 designed for indoor/outdoor operation, the user interfaces (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 HyPR 3000. 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.

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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 4210-00-548-7219 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.

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Electric Shock Hazard

⚠ WARNING

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

DON'T LET THIS BE YOU!

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

⚠ WARNING

The System is NOT GFCI protected.

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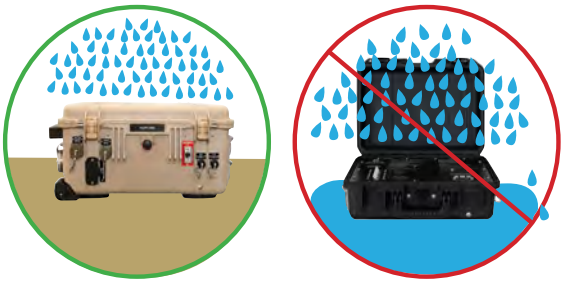
Environmental and Handling Precautions

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

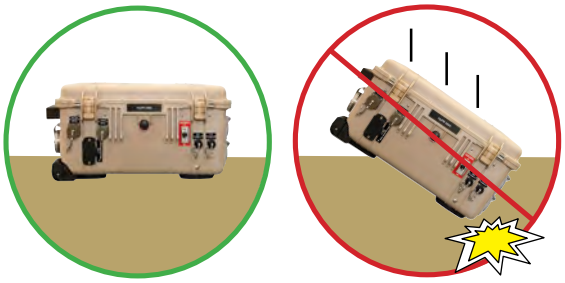
Water

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



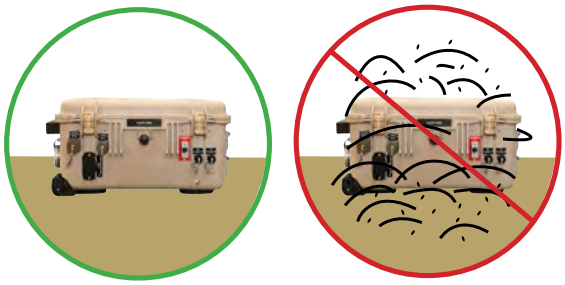
Impact

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



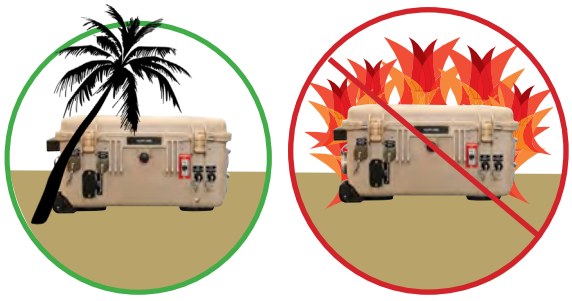
Dust/Foreign Object Intrusion

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



Heat

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



PRELIMINARY DRAFT

The Inter-Connect System

A Solar Stik 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 HyPR 3000s 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.

PRELIMINARY DRAFT

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 7).

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

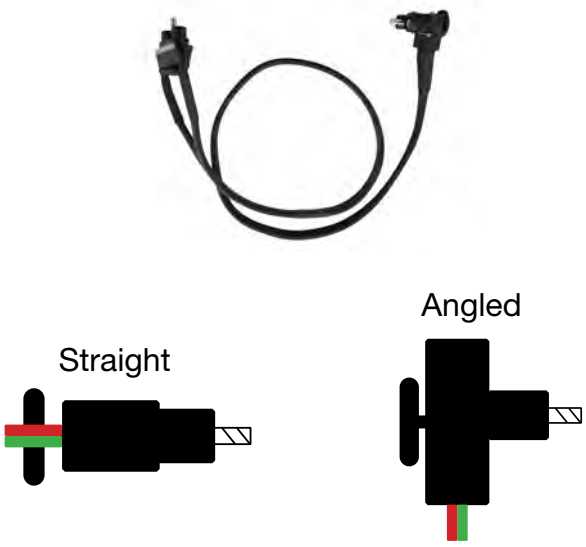


Figure 7. Linear Inter-Connect Plug

The Standard Inter-Connect Plug

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

Figure 8. Inter-Connect Plug

PRELIMINARY DRAFT

EQUIPMENT DESCRIPTION

Introduction

The HyPR 3000 manages power between power sources and loads. The HyPR 3000 provides both AC and DC mechanisms to charge ESMs while the system is operating or idle. The HyPR 3000 provides important battery status information and therefore increased security for continuity of operations.

The following diagram illustrates an overview or where to connect power sources, ESMs and loads to the HyPR 3000.

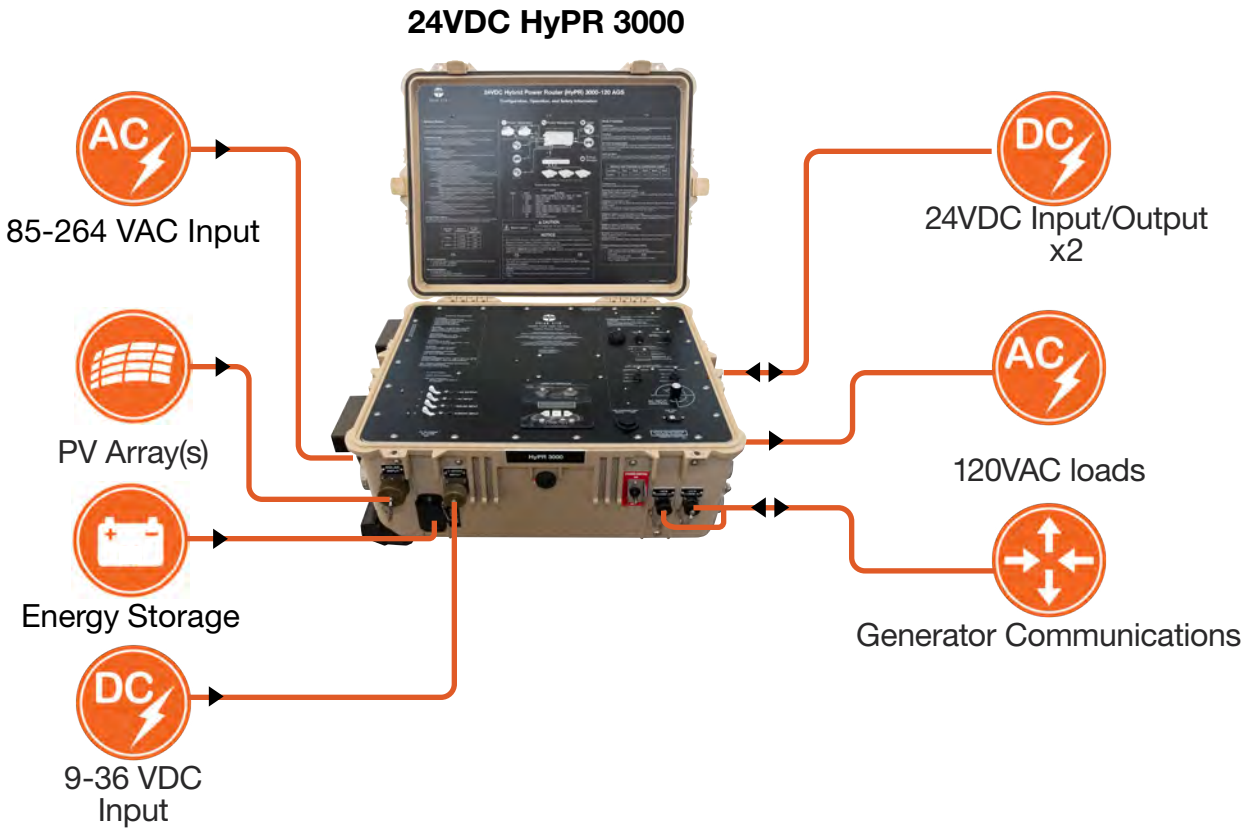


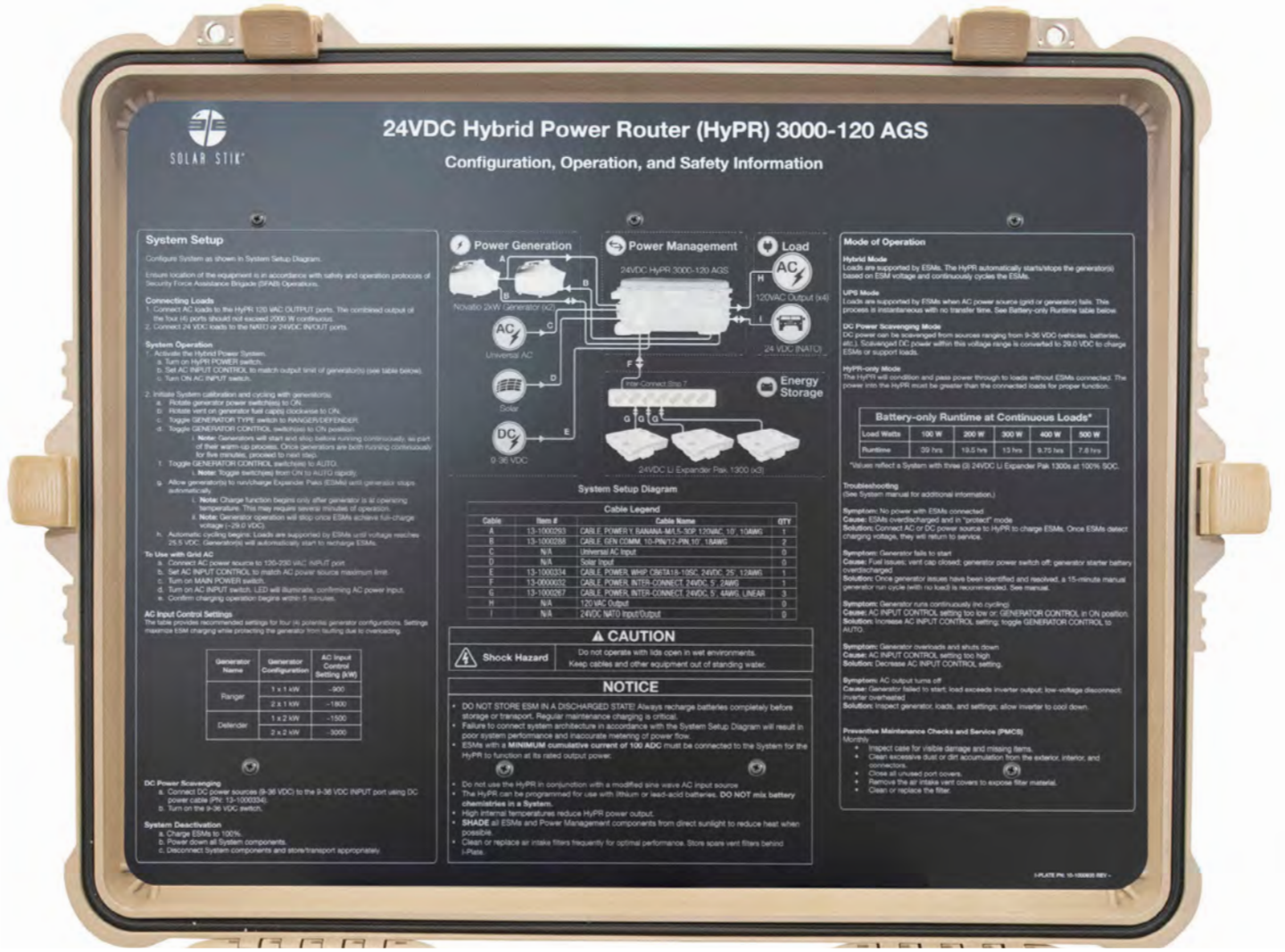
Figure 9. 24 VDC HyPR 3000 connections

PRELIMINARY DRAFT

Information Plate (I-Plate)

The I-Plate is an application-specific part of the HyPR. It provides condensed instructions for deploying and operating a System that includes a HyPR as manager of power within the System.

Detailed information about deployment of a specific System including a HyPR is found in System Setup and Operation Manuals.



The HyPR 3000 I-Plate

PRELIMINARY DRAFT

AC Power Input Port

Connect AC power sources to the 120-230VAC INPUT port. The HyPR 3000 accepts “universal” (85 - 264 V) power. Power via this connection charges batteries and supports DC loads connected the 24VDC IN/OUT and NATO ports.

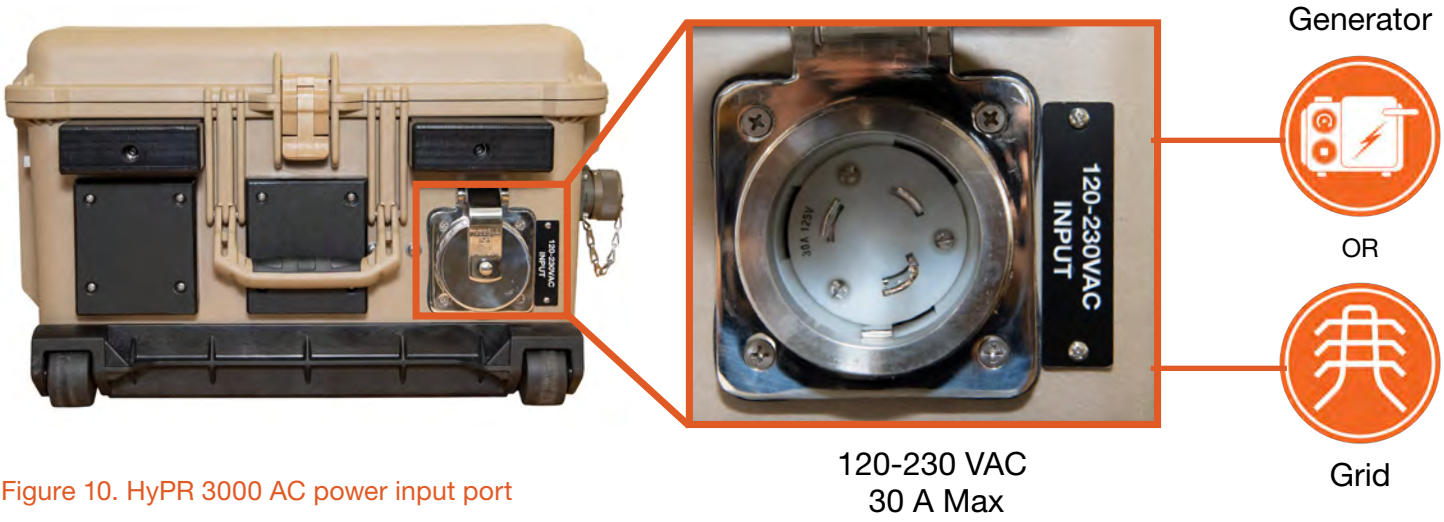


Figure 10. HyPR 3000 AC power input port

Solar Input Port

The HyPR accepts power from PV arrays to charge connected ESMs. Specifications for the solar charge controller and compatible PV arrays are on the HyPR 3000 Faceplate. **Functioning PV arrays must be connected for the DC INTERFACE to calculate and report ESM state of charge (SOC).** Pins A and C are the current conductors, pin B is unused.

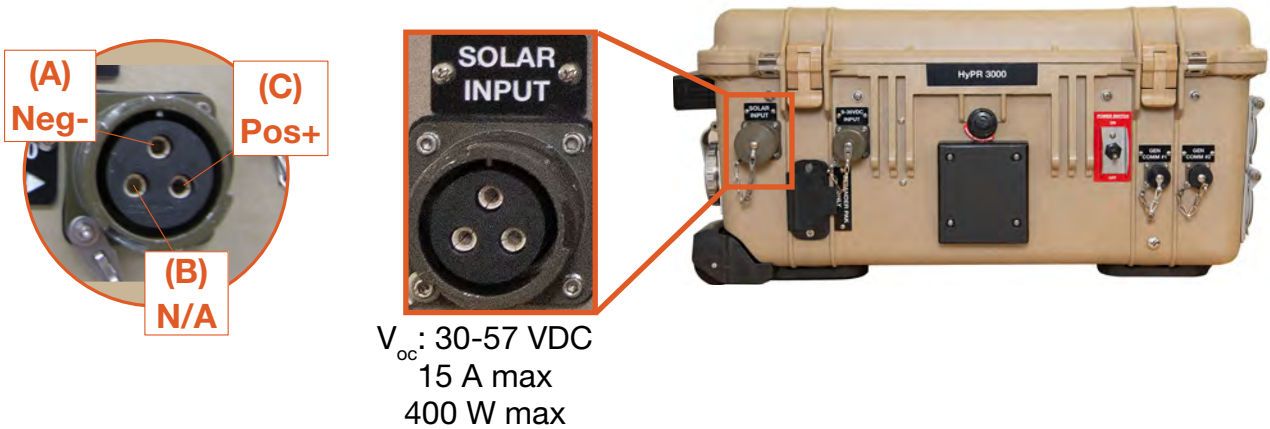


Figure 11. HyPR 3000 solar input port

PRELIMINARY DRAFT

Power Scavenging Port

Connect unregulated DC power ranging from 9 to 36 VDC to this 4-pin bayonet connector. Power between these voltages is converted to 28.3 VDC and applied to the DC bus to charge batteries or support small loads. Power input is limited to 150 W. Power output is limited to 100 W. Custom cables may be required. Pins A and C are the current conductors, pins B & D are unused.

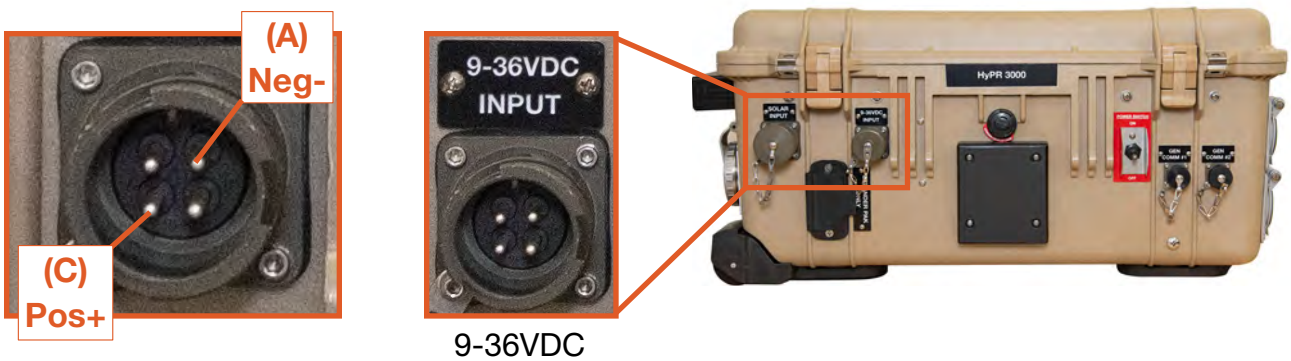


Figure 12. HyPR 3000 DC power scavenging port

PRELIMINARY DRAFT

Expander Pak Only Port

Connect Expander Paks (ESMs) to this metered Inter-Connect port.

Use Inter-Connect cables to connect multiple ESMs to an Inter-Connect Strip 7 and to the HyPR 3000 EXPANDER PAK ONLY port.

A single battery is enough to power up the HyPR 3000 internal circuits and user interface as well as to support small loads. However, additional batteries must be connected for the HyPR to operate at its full rated capacity (see Battery Requirements for Operation).

Note: The total Ah capacity of all connected ESMs must be programmed into the HyPR, using the DC interface, for the HyPR DC interface to report battery SOC accurately.

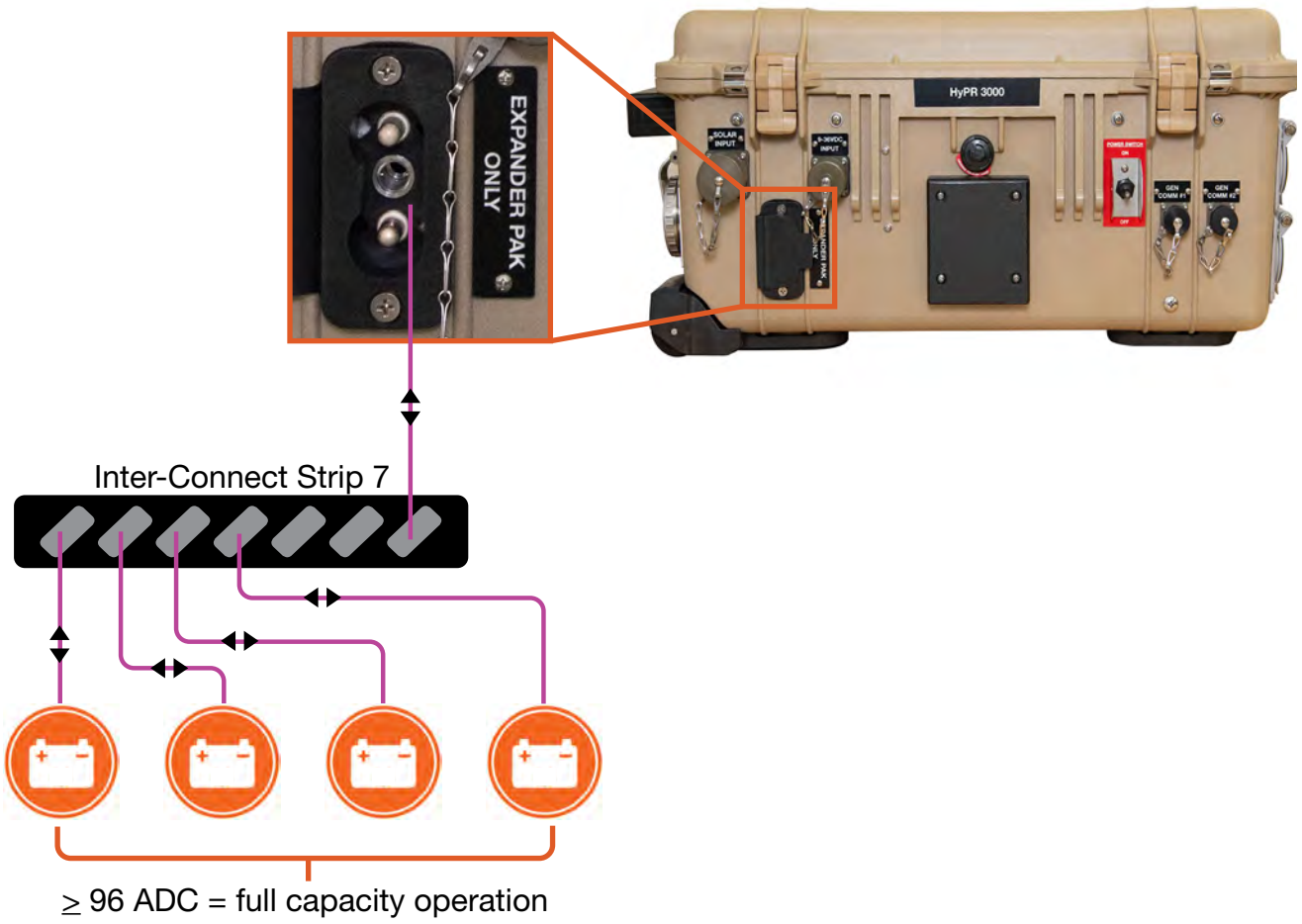


Figure 13. HyPR Expander Expander Pak / ESM connection port

PRELIMINARY DRAFT

24 VDC IN/OUT Ports

The Inter-Connect Port is a direct connection to the HyPR DC bus. This port is not metered; may be used to parallel HyPRs or to connect additional power management components.

The NATO port is a direct connection to the HyPR DC bus. This port is not metered and may conduct current into or out of the HyPR. This connection is common on military vehicles

Figure 14. HyPR 24 VDC input / output ports

120 VAC OUTPUT Ports

Connect AC loads to one or more of the four (4) 120 VAC output ports. Together, these four (4) ports can provide 2000 W (16.7 A) continuous power output. Brief surges of up to 4000 W are tolerated. These four (4) ports are cumulatively breaker limited to 20 A.

Figure 15. HyPR 120 VAC output ports

PRELIMINARY DRAFT

GEN COMM Ports

These connectors provide a communication link between the HyPR and auto start/stop-capable generators.

- GEN COMM #1 and GEN COMM #2 communicate with 1 kW and 2 kW generators.
- GEN COMM #1 communicates with TQGs.

Figure 17. Expander Pak generator communications ports

Vents

Exhaust vents have fans to remove move air from the case. Ambient air enters the case through the intake vents. The intake vents have air filters that must be cleaned on a regular basis, especially when operating in dusty environments.

Note: The HyPR 3000 REV - version has a single (1) exhaust vent. The REV A version has two (2) exhaust vents.

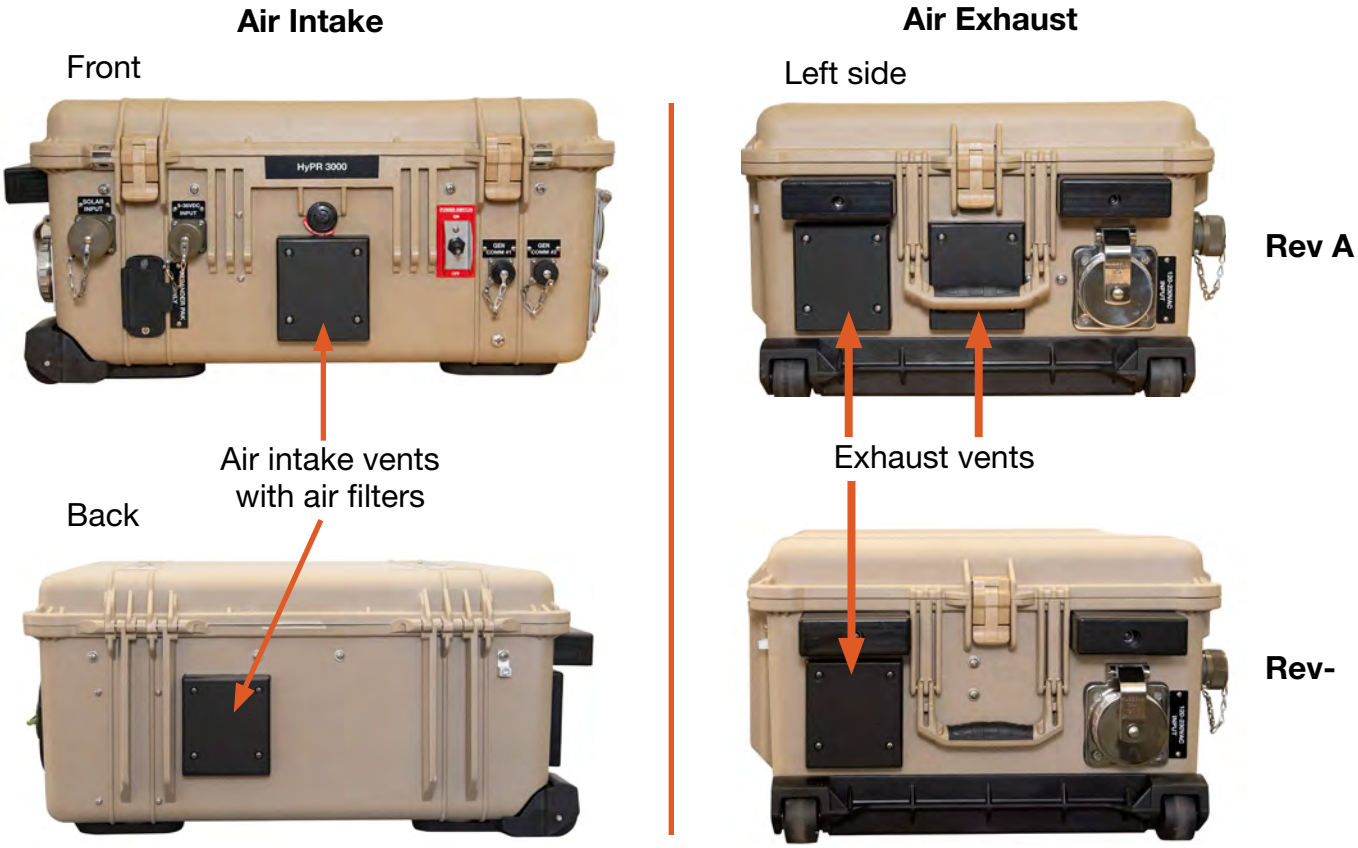


Figure 16. HyPR 3000 cooling vents

PRELIMINARY DRAFT

Faceplate

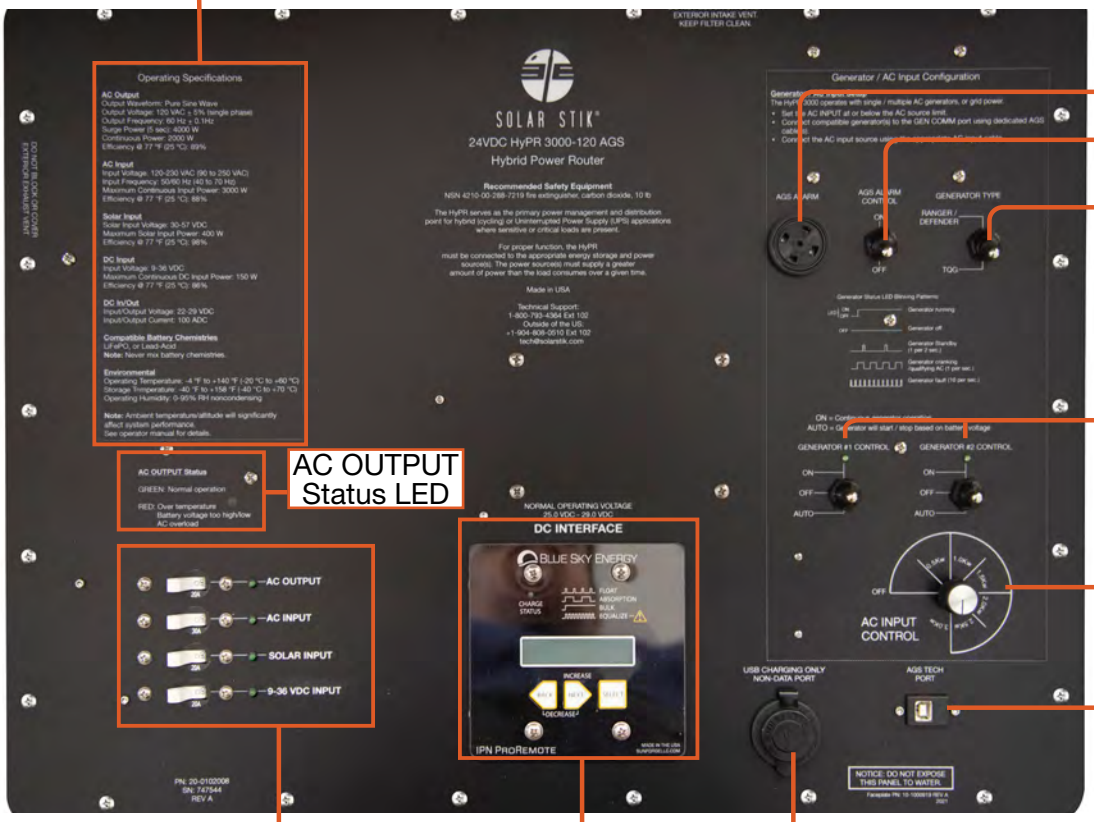


Figure 18. 24 VDC HyPR 3000 Faceplate

DC INTERFACE – When operated with a battery, the HyPR 3000 backlit LCD DC User Interface with three-key panel provides data and control for battery and PV-related functions, including battery state of charge (SOC), voltage, net (charge/discharge) current, inverter low-voltage disconnect, and more. It contains a microprocessor that allows it to learn the battery's behavior over time, increasing accuracy of reported metrics

GENERATOR TYPE selection switch – Choose "Ranger/Defender" if the HyPR is connected to Novatio 1 kW or 2 kW gensets. Choose "TQG" if connected to auto start/stop-equipped gensets (i.e., MEP-802A or MEP-831A).

GENERATOR CONTROL 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 the HyPR AGS communication with any connected genset.

Generator Status LEDs – Each displays the current status of a connected generator. A legend correlating the blinking pattern with a status is immediately above the LEDs.

PRELIMINARY DRAFT

AC INPUT CONTROL dial – Allows selection of AC input current limit. This must be adjusted to match the maximum recommended current output limit of the AC power source. Recommended settings are found on HyPR 3000 I-Plate.

AC OUTPUT Status LED – Green indicates the HyPR inverter is operating normally and AC power is available from the 120 VAC output ports. A red LED indicates an inverter fault.

AGS ALARM CONTROL Switch – The audible alarm indicates a connected generator is in the process of starting. This alarm may be defeated (toggle switch) when silent operation is required.

USB CHARGING Ports – The USB ports are for charging only; no data are transmitted via these ports.

Breakers/Switches – The breakers serve as switches to activate circuits and to deactivate 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 by each breaker will be lit if the circuit is active and the breaker is not tripped.

AGS TECH PORT – This port is used to program the Auto Generator Start/Stop module and to update firmware if/when necessary. Please contact Solar Stik Technical Support for further information.

Specifications – A list of performance metrics and limitations for the HyPR; provides guidance when configuring a System.

PRELIMINARY DRAFT

DC Interface

The DC Interface consists of an LED that reports the battery charging status (see Table 1 for a functional description), an LCD screen and three (3) menu navigation buttons. System voltage and net current are reported on the DC INTERFACE home screen.

There are some programmable settings that will be important to change or confirm, depending on System configuration. A description of these settings and their locations in the menu map are shown on subsequent pages. **Note:** the HyPR 3000 must be connected to an active PV array to access the full functionality of the DC INTERFACE. Without PV input only the voltage and current readings on the home screen are useful

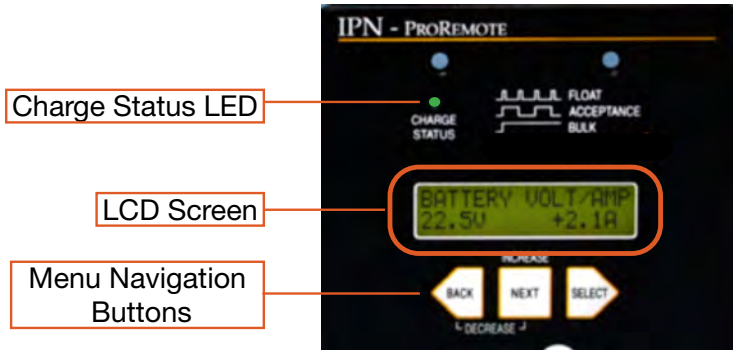


Figure 19. HyPR 3000 DC INTERFACE

Solar Charging Status LED

The user interface charging status LED reports charging only via solar power input. The LED will not illuminate when the HyPR 3000 is charging connected batteries using AC power. The information in this section is relevant only when photovoltaic panels are part of the system.

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

Acceptance Charge: In this stage, the charge current gradually decreases as the batteries obtain full charge. It is also known as the "constant voltage phase". With the Li ESM 1300, the acceptance charge phase is not necessary.

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

Temperature and Power Output: The HyPR 3000 charge controller can deliver full output in an ambient temperature of up to 40 °C (104 °F). If an overtemperature condition exists, the charge controller will cycle on/off, reducing average power delivery to within safe limits. During thermal shutdown, the charge status indicator will display an OFF condition.

Table 1. Charge Status Indicator—LED Status

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

PRELIMINARY DRAFT

AC Interface

AC Input Control Dial

This control may be thought of as the battery charging rate limit. Adjust this dial to match the maximum output of the AC power source connected to the HyPR. Properly setting this value will prevent overloading the AC power source.

The 3 kW setting is equivalent to 25 AAC at 120 VAC. Therefore, if the AC power source is from the grid or prime power, the current limit of the power output receptacle may be the limiting factor.

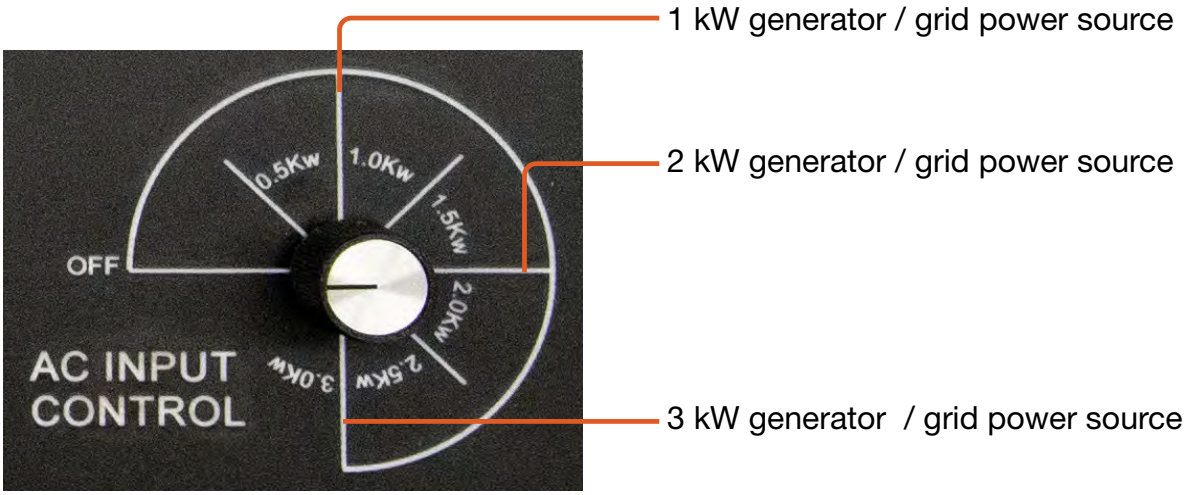


Figure 22. AC Input Control dial

Generator Control Switches

These switches provide manual and automatic control of connected generators. The AUTO setting allows Systems to operate autonomously; the generator(s) running only to recharge System batteries. A System Setup and Operation Manual will provide details their use.

Generator operating status is reported by the LEDs above the GENERATOR CONTROL switches (Figure 20; arrows). The blinking pattern of the LED is indicative of the generator status (Figure 21).

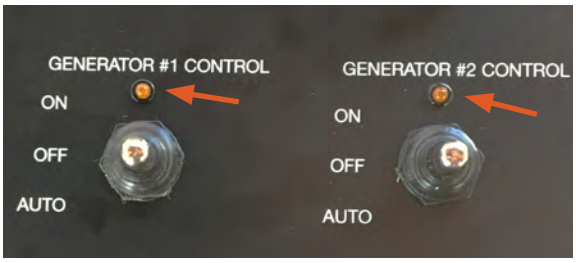


Figure 20. Generator mode control switches and LEDs

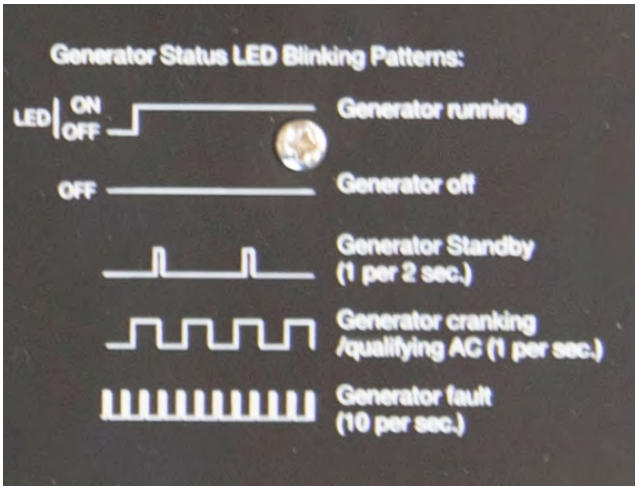


Figure 21. Generator Status LED blinking pattern

PRELIMINARY DRAFT

Breakers / Switches Panel

The HyPR can be configured into a System in many ways. Understanding the function of each breaker and its associated circuit is critical to proper operation. Circuit breaker panel is only for IN / OUT circuit limit protections.

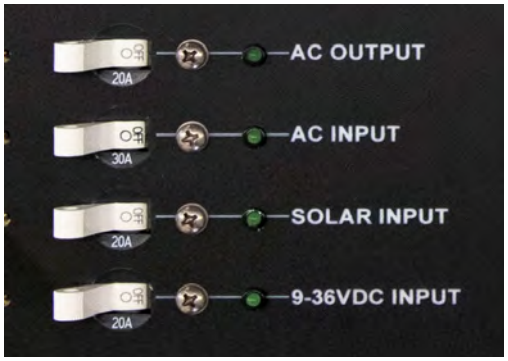


Figure 23. HyPR 3000 breakers

AC OUTPUT 20 A – Limits flow of power from the HyPR inverter to the four (4) AC output receptacles.
AC INPUT 30 A – Limits flow of power from AC power source into HyPR.
SOLAR INPUT 20 A – Limits flow of power from PV array(s) into HyPR.
9-36 VDC INPUT 20 A – Limits flow of power from "scavenged" DC power sources into the HyPR. As a practical matter, other internal protections and limits present in the scavenged-power circuit will be triggered prior to tripping this breaker. Therefore, this functions primarily as an ON/OFF switch for the circuit.
Power Switch 100 A – Limits flow to and from batteries to 100 ADC.

AC Output Status LED

The LED on the Faceplate under AC OUTPUT Status is green when the HyPR inverter is operating normally. A red LED indicates the inverter is in fault mode. The problem causing the fault must be corrected before inverter operation can return to normal.

Possible issues leading to inverter fault include loads exceeding the maximum power output of the inverter or overdischarged Expander Paks.

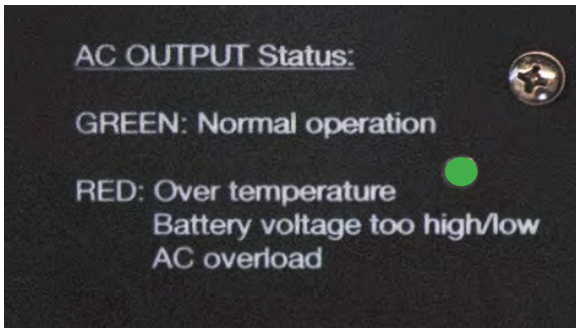


Figure 24. HyPR Inverter / AC OUTPUT status LED

PRELIMINARY DRAFT

Connecting Generators to HyPR

Connect generator power cables to the “AC INPUT” port on the left side of the HyPR.

Figure 26. Connecting generators to HyPR

Compatible Generator Options

The HyPR can remotely start/stop TQGs that have been modified with a Solar Stik Remote-start Enabling Kit (RsEK) and the 1 kW and 2 kW Man Portable Generators (MPGs; Figure 25).

Tactical Quiet Generators (TQG)

MEP-802A
5 kW TQG

MEP-831A
3 kW TQG

Man Portable Generators (MPG)

Ranger
2 kW MPG

May be paralleled

Defender
1 kW MPG

May be paralleled

Figure 25. Compatible generator options

Note: The TQGs above must have a Solar Stik RsEK installed to be compatible with the HyPR.

PRELIMINARY DRAFT

HyPR GEN COMM Port Specificity

The two (2) GEN COMM ports are not equivalent. Their specificity is as follows:

- **Defender or Ranger single operation** – Connect to Gen Comm #1 or #2 port.
- **Defender/Ranger MPG tandem operation** – Connect to Gen Comm #1 and #2 ports. (Use 120 VAC Parallel Power Cable.)
- **Tactical Quiet Generator (TQG)** – Connect ONLY to Gen Comm #1 port.

MEP-802A and MEP-831 TQG

Connect ONLY to Gen Comm #1 port on the front of the HyPR and the Auto Generator Control port on the TQG using a TQG Gen Comm Cable. A Solar Stik Remote-start Enabling Kit (RsEK) must be installed on a TQG to communicate with the HyPR.

Figure 27. MEP-831A and MEP-802A Gen Comm Cable connections

PRELIMINARY DRAFT

Defender 1 kW and Ranger 2 kW MPGs

Connect to Gen Comm ports #1 and/or #2 on the front of the HyPR to the DC OUT / AUTOSTART port on the generator using a Ranger/Defender Gen Comm Cable.

Figure 28. Defender 1 kW and Ranger 2 kW Gen Comm Cable connections

PRELIMINARY DRAFT

MPG Parallel Connections

The HyPR has the ability to receive power from two (2) MPGs simultaneously. The power output from each of two generators is merged into a single “Y” cable connected to a single power input port on the left side of the HyPR (Figure 12). The mode of each generator is controlled independently and each has its own communication cable to the HyPR. The LED over each Generator Control Switch (HyPR Faceplate) blinks slowly when functioning in Auto mode, more rapidly when manual On mode, and very rapidly when there is a generator fault. The LED does not blink when the switch is in the Off position.

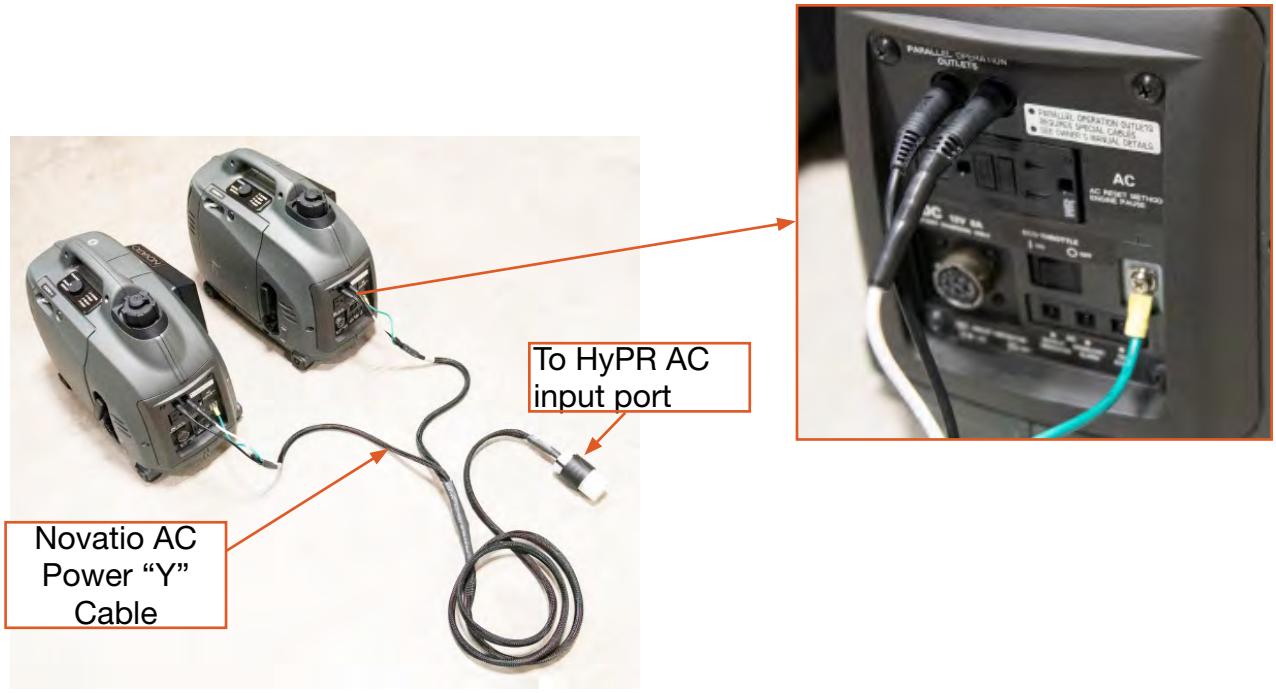


Figure 29. Connecting two 1 kW generators in parallel with the “Y” AC power cable.

PRELIMINARY DRAFT

Operator Instructions

Specific, detailed Operator Instructions depend on the System into which the HyPR 3000 is integrated. Each HyPR 3000 I-Plate is customized with an abbreviated version of the System-specific HyPR 3000 Operator instructions. A detailed set of System-specific Operator instructions is available in the System Setup and Operation Manual. For these reasons, the HyPR 3000 Operator instructions presented in this manual are brief and general in nature.

HyPR Setup and Operation

Before starting ensure that generators (if using) are serviced and in operating condition. The Operator must understand how to operate the generator connected to the System.

Turn off all breaker switches on the HyPR 3000 including the POWER SWITCH on the front exterior.

1. Connect the System according to the Connection Diagram on the HyPR 3000 I Plate.

2. Connect AC and / or DC loads to HyPR.
   - Ensure load power switches are OFF.
   - Load power requirements must not exceed rated output of their respective connections.

3. Toggle HyPR POWER SWITCH to ON.
   This switch, located on the front exterior of the HyPR, allows current to flow from connected batteries into the HyPR, energizing the internal DC bus (Figure 1 on page 7). At this point the DC Interface will power up.

4. Check/Confirm/Program total Ah capacity in HyPR DC User Interface (typically programmed at Solar Stik for the application illustrated on the HyPR 3000 I Plate.)

5. Set HyPR AC INPUT CONTROL to match output limit of generator(s) or shore power.

6. Toggle HyPR GENERATOR TYPE switch to choose generator type (if applicable).

7. Toggle HyPR AC INPUT breaker switch to ON.

8. Toggle HyPR GENERATOR CONTROL Switch(es) to ON position to start connected generator(s).
   - Allow generator(s) to warm up (~5 minutes).
   - Charge function begins only after generator is at operating temperature. This may require several minutes of operation.

9. Rapidly toggle HyPR GENERATOR CONTROL switch(es) to AUTO.
   - Allow generator(s) to run and charge ESMs until generator stops automatically.
   - Generator operation will stop when ESMs achieve full-charge voltage (~29.0 VDC).

10. Toggle breaker switch(es) for circuits in use to ON.

11. Turn on loads.

PRELIMINARY DRAFT

Navigating DC User Interface Menus

The user interface has four main menus:
1. General Information,
2. Advanced Information,
3. Operation Setup, and
4. Battery Charger Parameter Setup.

The Home screen is in the General Information menu.

To move forward through screens in a menu, press NEXT. It is only possible to move forward through the menu items.

To move to the top of a menu, press BACK. Pressing BACK does not move “back” one menu screen. Instead, it moves to the top of the current menu or to the top of the higher menus when BACK is pressed repeatedly.

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

To change settings/parameters in the Operation Setup and Battery Charger Parameter Setup menus, move forward through the menus (using the steps above) to the menu window that contains the desired parameter. Then do the following:

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

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

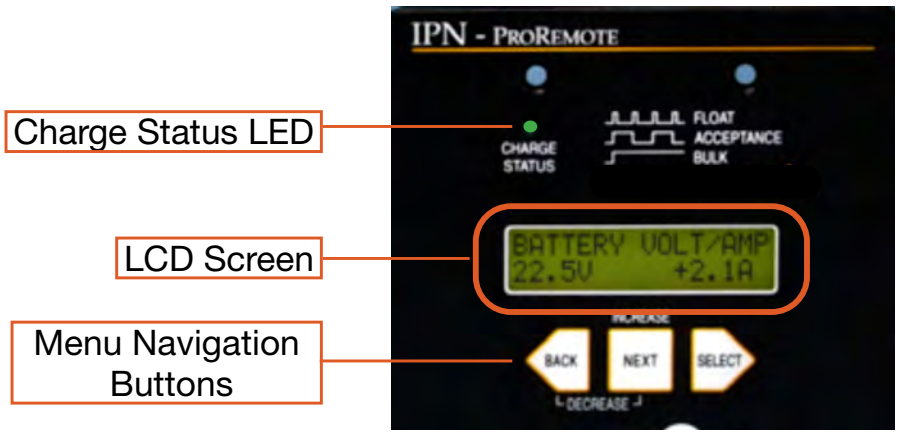


Figure 30. Navigating the DC Interface

PRELIMINARY DRAFT

Programmable Parameters

Parameters that may need to be set or confirmed are (orange outline windows):

S**ET BAT AMP-HRS** - The value in this window should be the cumulative Ah capacity of the battery bank connected to the HyPR.

SET AUX OUT OFF/ON - The “OFF” value is the battery low-voltage cut off (LVCO). These values are set to protect the battery from overdischarge. The “ON” value is the voltage at which the HyPR allows battery support of loads.

SET ACCEPT CHG and SET FLOAT CHG - These values will vary depending on the System battery type.

These settings are programmed by Solar Stik in accordance with the intended application. If changes to the intended application are required, please contact Solar Stik Technical Support for assistance with these settings.

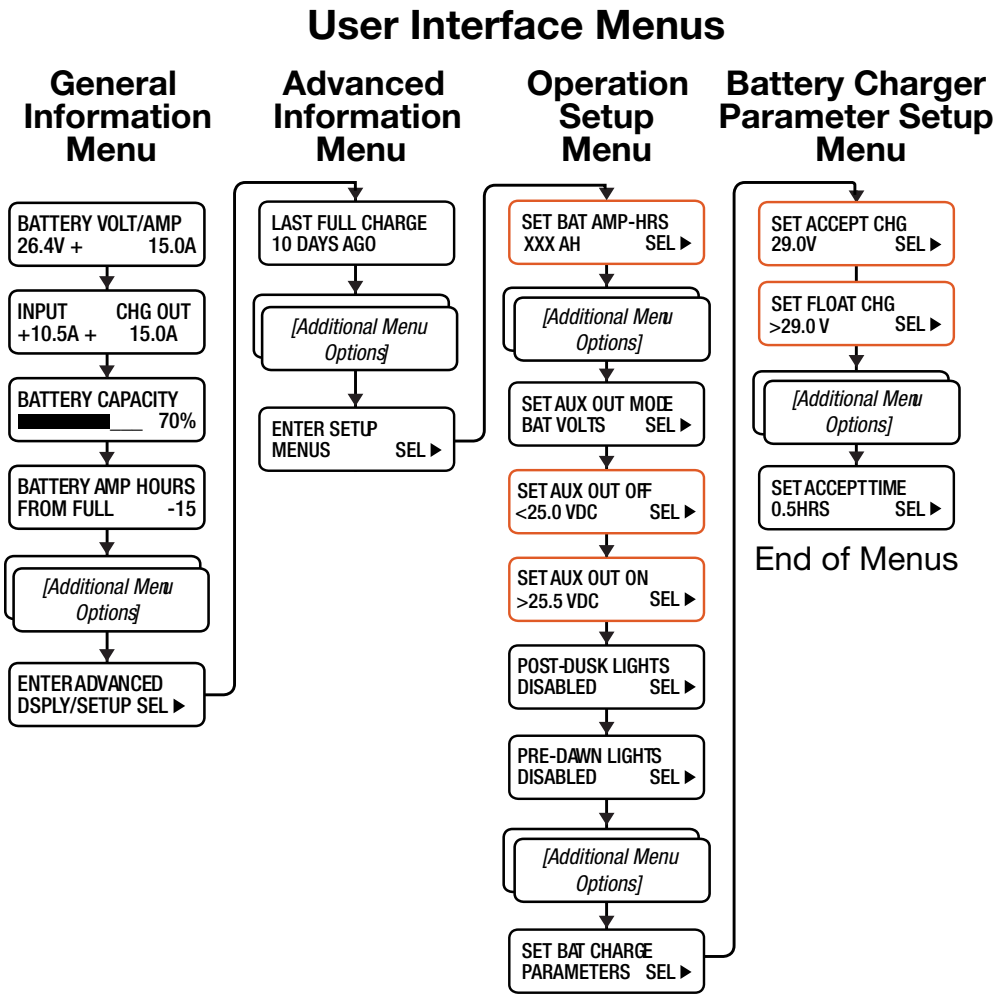


Figure 31. Abbreviated HyPR DC Interface Menu Map

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Maintenance

Preventive Maintenance Checks and Services (PMCS)

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of 24VDC HyPR 3000	M	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior, interior and all connectors. 3. Close all unused connector 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 two (2) air intake filters. 2. Wash with water and dry the filter. Reinstall. 3. If the filter is damaged or cannot be cleaned --replace it.	~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.

HyPR 3000 Air Intake Filter Cleaning

There are two (2) air intake filters on the HyPR, one (1) on the front and one (1) on the back.
Note: See also Figure 16 on page 30.

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. The four (4) fasteners hold both parts onto the case.

Front

Back

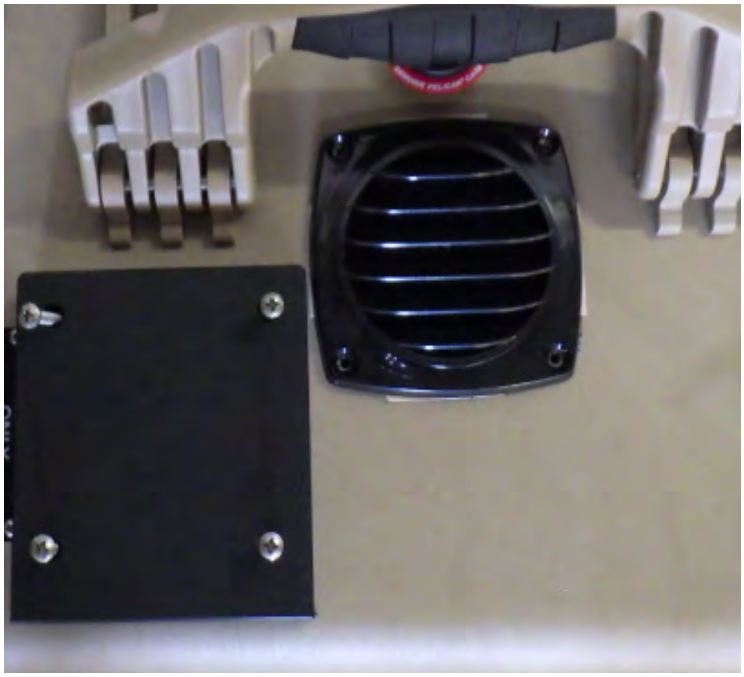

Figure 32. Fastener locations on vent shroud

PRELIMINARY DRAFT

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 then 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 HyPR I-Plate.

Figure 33. Replacing HyPR air intake filter (left); cleaning a HyPR air intake filter (right)

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

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Water Intrusion Remediation

If water intrusion is suspected, and the System is still functional, disconnect power sources entering the HyPR 3000 from the most distant location possible, power down the System (turn off the power switches on all of the System components) and then disconnect the HyPR 3000 from the System. Do not move or relocate what may be a flooded HyPR 3000.

Keep the HyPR 3000 as level as possible to prevent the water inside from accumulating at one end or the other and submerging the internal electronics. Remove the screw from the drain hole at the bottom edge of the case. If water flows out of the drain hole after removal of the plug, let it flow until it stops. Then slightly and slowly tilt the case toward the drain hole to remove any remaining water. Continue to increase the angle of the HyPR 3000 slowly until no more water drains from the hole. After the water has been drained, remove the Faceplate. Place the HyPR 3000 in the most dry environment possible for a time long enough that any remaining moisture inside will dry. When it is dry, reintegrate the HyPR 3000 to the System and test it to determine if it is still functional.

Figure 34. Drain plug screw located under the TECH PORT

Transporting the HyPR 3000

The HyPR 3000 is designated as a two-person lift. It also has an extendable tow handle and wheels for easy single-person transportation across appropriate surfaces.

Figure 35. HyPR human transportation.

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TECHNICAL SPECIFICATIONS

General	
Nominal Operating Voltage	24 VDC
Battery Chemistry	$LiPO_4$/Pb Compatible
Operational Voltage Range	25-29 VDC
Internal cooling	Convection
User Interface	IPN PRO remote manual control knobs/switches
Remote Monitoring	UCM
Case	Pelican 1610
Transportation	Any
Certification	None
Warranty	1-year materials and workmanship

Charge Controller Specifications (@ 77 °F/25 °C)	
Maximum PV Input Voltage	57 VDC
Maximum PV Input Current	12 A (@24 V Nominal)
Maximum PV Power	400 W
Efficiency	97% (typical)
Charging Stages	Bulk, Acceptance, Float
Charge Control Method	Maximum Power Point Tracking (MPPT)

DC Output	
Output Voltage	Up to 29 VDC
Output Power Rating	100 A

AC Output Specifications (@77 °F/25 °C)	
AC Output Frequency	60 Hz
AC Output Voltage	120+-2% VAC
Continuous Output Current	16.7 A (2000 W)
3 Second surge capacity	4000 W
Inverter Efficiency	87%
Transfer Time	None

AC Charger Specifications (@77 °F/25 °C)	
AC Input Frequency	47-63 Hz
AC Input Voltage	85-264 VAC
DC Output Voltage	25-29 VDC
Charging Stages	CC/CV
Continuous Output Current	~100 ADC
Charging Efficiency	87%
Transfer Time	None

Safety	
Breaker(s)	(1) 100A, (3) 20A, (1) 30 A
Fuse(s)	3 A
Certifications	Built and designed to MIL-STD-810G and IP65

Connections	
Inputs	(1) 120-230 VAC, 30 A (NEMA L5-30P) (1) Inter-Connect (Deltran 224-0061-BK) (1) Solar (CANNON CB2-22-2SC) (1) 9-36 VDC (CB2-18-10PC)
Outputs	(4) 120 VAC, 20 A (NEMA 5-15/20R)
Input(s)/Output(s)	(1) NATO (1) 24VDC Inter-Connect (Deltran 224-0061-BK) (2) Gen Comm

Environmental	
Operating Temperature*	-4 °F to 140 °F (-20 °C to 60 °C)
Storage Temperature**	-40 °F to 140 °F (-40 °C to 60 °C)
Relative Humidity	0 to 90%
Ingress Protection	IP54

**** Operating outside of range will accelerate the battery aging process*
*****Prolonged exposure to high temperatures in storage will reduce battery life*

Weights and Dimensions (L x W x H)	
Weight	75 lb (34 kg)
Dimensions	24.8 x 19.7 x 11.9 in (63 x 50 x 30.2 cm)

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ABOUT SOLAR STIK, INC.

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

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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