SOLAR STIK®

Operator and Maintenance Manual for the 24VDC HyPR 3000

P/N 20-0102020

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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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.

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.

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

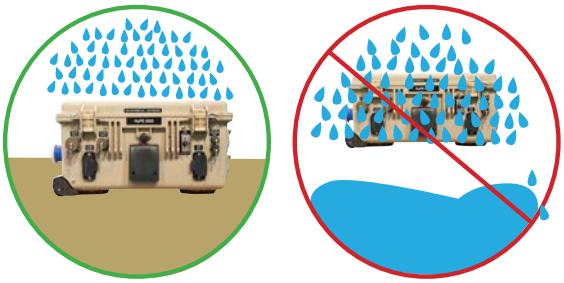
The System is NOT GFCI protected.

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.

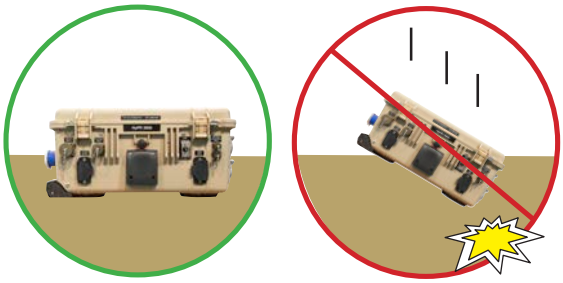
Water

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.



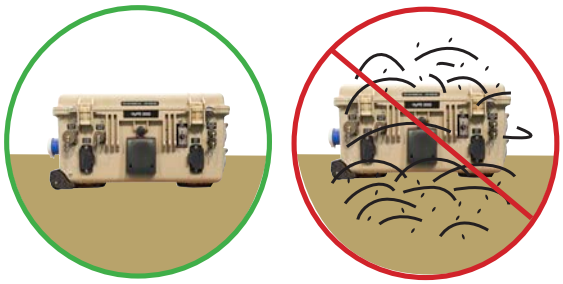
Impact

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



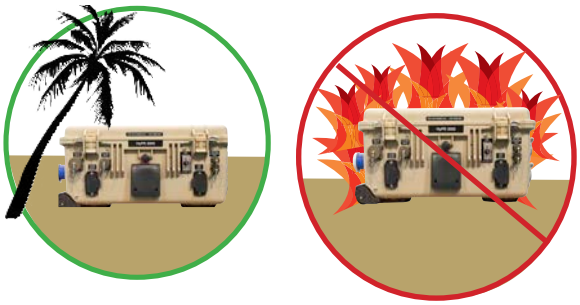
Dust/Foreign Object Intrusion

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.



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Revision History

Section	Page(s)	Description	Date
		First released as a PRELIMINARY DRAFT	30 March 2021
		Edited to update to HyPR 3000 Rev A	20 March 2024

GENERAL INFORMATION

Scope

This Operator and Maintenance Technical Manual (TM) contains general instructions for operating and conducting operator/field maintenance on the HyPR 3000. When operating the HyPR within a system, consult the I-Plate and the System Manual for specific operation guidelines.

Transportation

The HyPR 3000 can be transported via all modes of transport without restrictions.

Warranty

Solar Stik warrants the HyPR 3000 for a period of one (1) year from Solar Stik's delivery of the products. Solar Stik warrants that the delivered HyPR 3000 shall be free from defects in materials and workmanships and shall conform to the contractual specifications and the HyPR 3000 specification sheet. This warranty does not cover defects or failure caused by improper handling, storage, maintenance, or repair or by any modification, misconnection, abuse, abnormal use or use not complying with Solar Stik's Operation and Maintenance Technical Manual for the HyPR 3000.

Warranty claims must be made to Solar Stik immediately after discovering the defect and within the 1-year warranty period or are forever waived. Solar Stik will provide a Return Merchandize Authorization (RMA) if the defective kit or individual components are required to be returned to the Solar Stik facility.The end-user will pay to ship the product to Solar Stik. If the product is covered under warranty, then Solar Stik will pay the return shipping of the repaired or replacement item. If the product is not covered by warranty, then the end-user will be quoted for the repair or replacement and return shipping.

Solar Stik retains sole obligation to deem the HyPR 3000 under warranty. The HyPR and any individual component shall be considered defective if the failure may be duplicated by Solar Stik, it being understood nonconformity shall be determined by reference to the applicable contractual or technical specifications.

Provisions and limitations of this warranty applies to all items delivered as HyPR 3000 and any spares or replacement items. These provisions and limitations applies to all delivered products regardless of whether the end-user is within the Continental United States (CONUS) or Outside the Continental United States (OCONUS).

List of Abbreviations/Acronyms

A- Amps
AC- Alternating Current
ADC - Amps Direct Current
Ah - Amp hours
Aux - Auxiliary
BMS - Battery Management System
CC/CV - constant charge /constant voltage
VDC- Voltage Direct Current
CHG - Charge
CONUS - Continental United States
DC - Direct Current
ESM - Energy Storage Modules
HyPR - Hybrid Power Router
kW - kilo Watts
LCD - Liquid Crystal Display
LED- Light enitting diode
LVCO - Low Voltage Cut Off
NATO - North Atlantic Treaty Organization
OCONUS - Outside the Continental United States
P/N - Part Number
PV- Photovoltaic
RMA - Return Merchandise Authorization
SOC- State of Charge
STC - Standard Testing Conditions
TM - Technical Manual
UPS - Uninterupptible Power Supply
USB A - Universal Serial Bus port A
USB C - Universal Serial Bus port C
VAC - Volts AC
W- Watts

EQUIPMENT DESCRIPTION and DATA

Equipment Characteristics, Capabilities, and Features

A Hybrid Power Router (HyPR) (Solar Stik P/N: 20-0102020) is a power management device which contains an internal DC bus that is activated by the presence of voltage. DC Bus voltage can be utilized from both DC and AC power outputs simultaneaously or independently.

The HyPR is designed to be 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.

All HyPRs accept universal (85–264 VAC) single-phase AC input voltage, allowing connection to any generator or grid AC power source, including those with poor quality such as those with varying line voltages or inconsistent sine waves. Acceptable AC power sources for use with a single HyPR 3000 should provide 1–3 kW of power.

AC and DC cables for the HyPR are sold separately as they must match voltage type and associated current-conducting ability.

The HyPR is compatible with lead-acid and lithium battery chemistries. However, battery chemistries should never be mixed within a System. Battery capacity should also be the same for all connected batteries.

- 120-230 VAC Input
- 9-36 VDC Input
- Solar Charge Controller 45 VDC Input, 12 A and 400 W input
- AC charger 25-29 VDC Output voltage with ~100 ADC
- 24 VDC Output @ 100 A
- 120 VAC Output, 20 A and 2000 W continuous
- 2 BB-2590 Chargers
- 4 USB C/A Output ports
- NATO Input/Output receptacle
- Plug & Play with polarized, twist lock connecetion
- Inter-Connect for energy expansion with Energy Storage Modules(ESM)s
- 24 VDC Inter-Connect port for use with Inter-Connect strip
- 80lbs

Requirements for HyPR Operation

- Total INPUT POWER must exceed total OUTPUT POWER in any particular operation mode.
- The HyPR requires the presence DC bus voltage to operate.

HyPR 3000 Specifications, Environmental Control and Handling Requirements

General

Nominal Operating Voltage	24 VDC
Battery Low Voltage Cut-Off	User programmable; factory default to 24.4 VDC
Internal Cooling	Convection
User Interface	IPN ProRemote
Case	Pelican 1610
Warranty	1-year materials and workmanship

Solar Charge Controller (@ 77 ºF / 25 ºC)

Maximum PV Input Voltage	45 VDC
Maximum PV Input Current	12 A
Maximum PV Input Power	400 W
Efficiency	97%
Charge Control Method	Maximum Power Point Tracking (MPPT)

DC Output

Inter-Connect Power Rating	24 VDC nominal @ 100 A
BB-2590 Charger Power Rating	16 VDC @ 3 A (x4)

AC Output Specifications (@77 °F/25 °C)

Frequency	60 Hz
Voltage	120 VAC +/- 2%
Current	16.7 A
Power Rating	2000 W continuous
Surge capacity	4000 W for 3 seconds
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	84%

Safety

Breaker(s)	(1) 100 A (2) 20 A (1) 30 A (4) 5A (1) 25A
Certifications	Built and designed to MIL-STD-810H

Connections

Inputs	(1) 120-230 VAC, (IEC) (1) Solar (CANNON CB2-22-2SC) (1) 9-36 VDC (CB2-18-10PC)
Outputs	(4) 120 VAC, 20 A (NEMA 5-15/20R) (2) BB-2590 Charger (MS3470W10-6S) (4) USBs (USB Type C/A) (Faceplate)
Input(s)/Output(s)	(1) NATO (1) Inter-Connect (Deltran 224-0061-BK) (ESM) (1) 24VDC Inter-Connect (Deltran 224-0061-BK)

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)
Ingress Protection	IP54

** Operating outisde of STP and this range < > will accelerate the battery aging process and increase likelihood of premature failure

***Prolonged exposure to high temperatures in storage will reduce battery life

Weights and Dimensions (L x W x H)

Weight	80 lb (36.3 kg)
Dimensions	26.0 x 20.1 x 12.0 in (66.04 x 51.05 x 30.48 cm)

Recommended Components and Accessories

120W Foldable Panel
Item # 11-1000076

24VDC Inter-Connect Strip 7
Item # 13-1000160

Location and Description of Major Components

Introduction

The HyPR 3000 utilizes a DC BUS to connect a variety of AC and DC power sources to power both AC and DC loads. The HyPR 3000 provides both AC and DC mechanisms, including solar inputs, VAC universal power inputs, 9-36 VDC inputs, 24 VDC input/output, NATO input/output and ESM input/output to charge ESMs or other connected DC loads while the system is operating or idle. The HyPR 3000 provides important battery status information and therefore increased security for continuity of operations.

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.
- Power conditioning capabilities.
- Power scavenging capabilities.
- Can be used with small expeditionary generators and dynamic loads that would normally cause overloading of the generator.

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

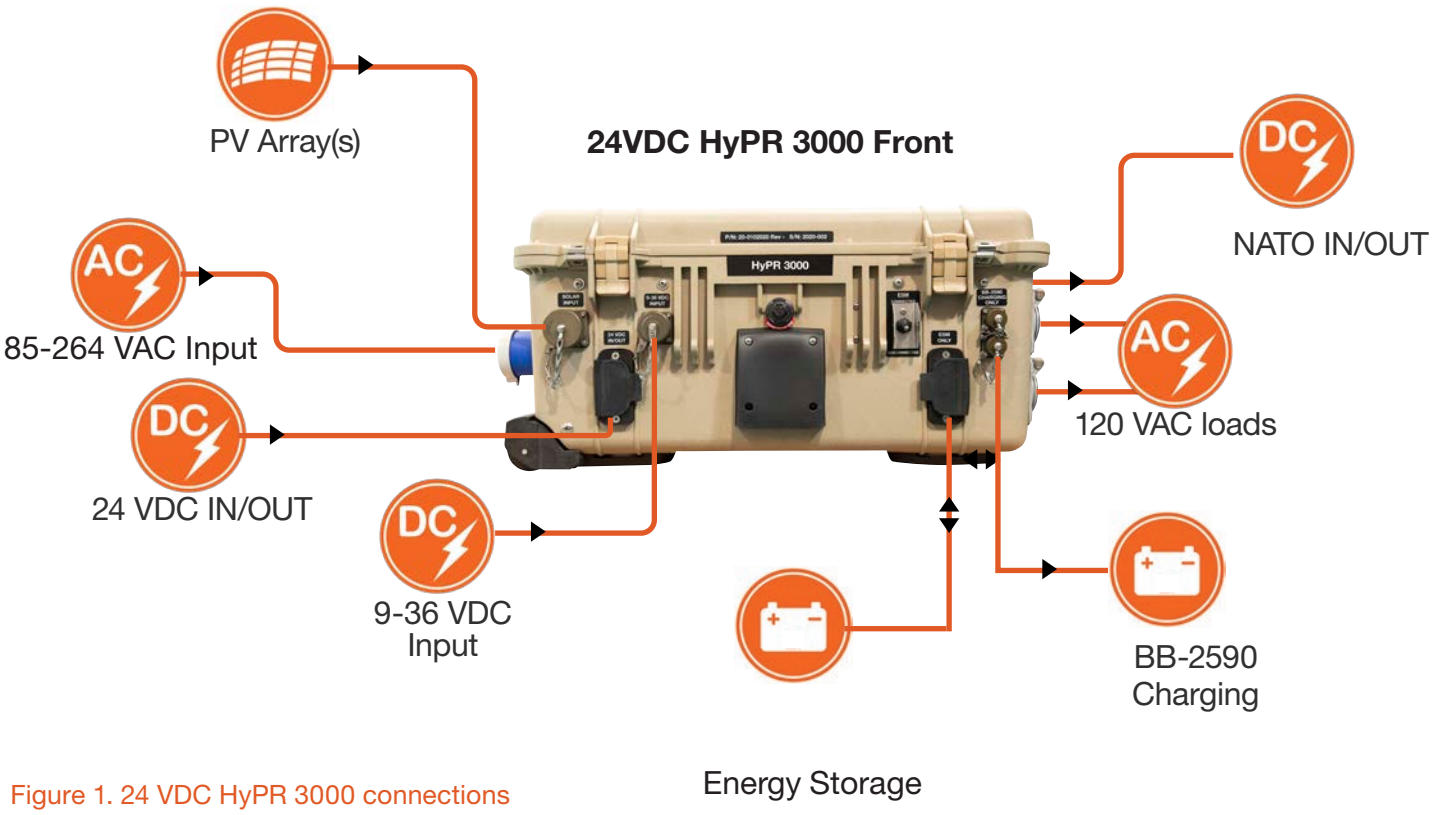


Figure 1. 24 VDC HyPR 3000 connections

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.

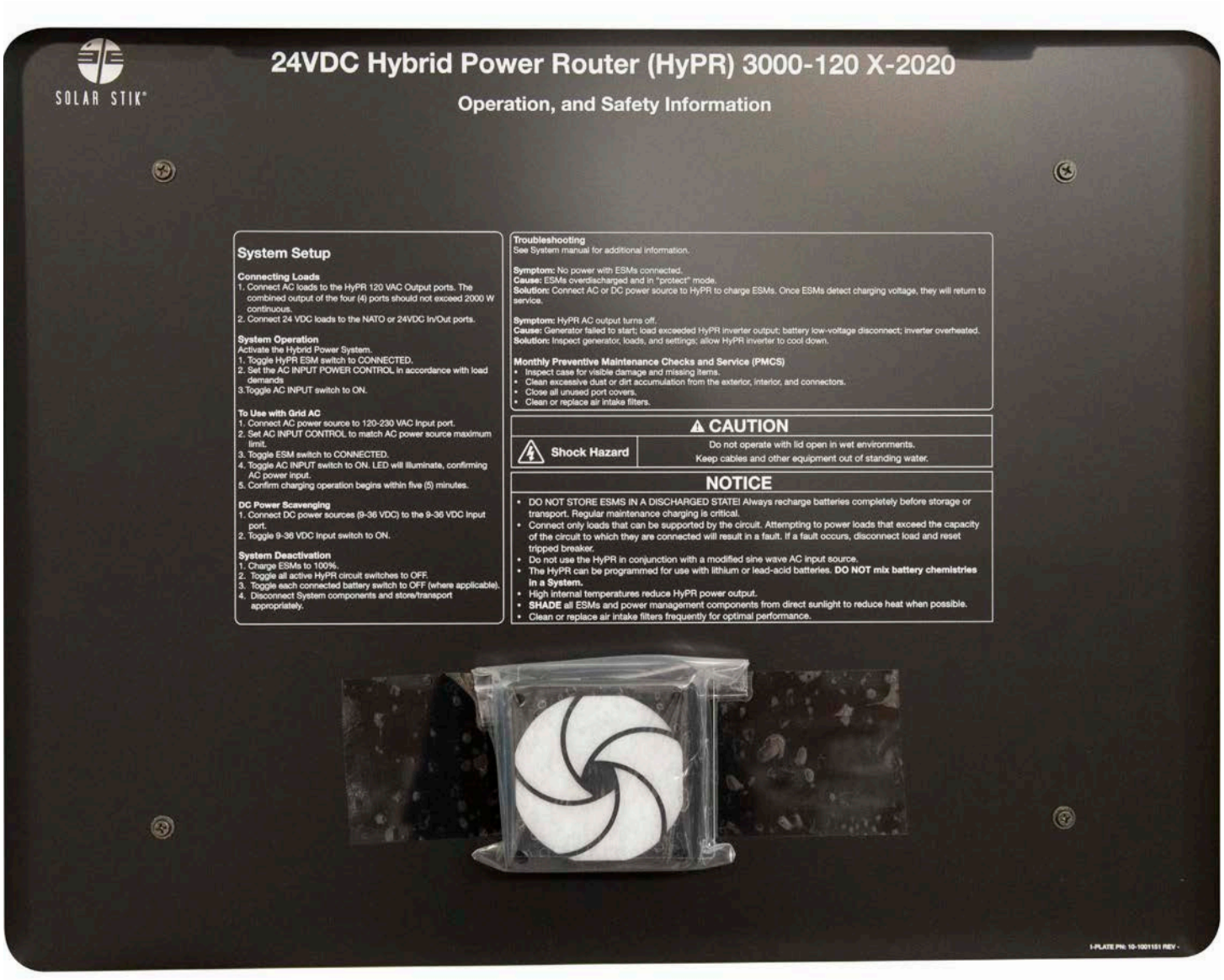


Figure 2. The HyPR 3000 I-Plate

Faceplate

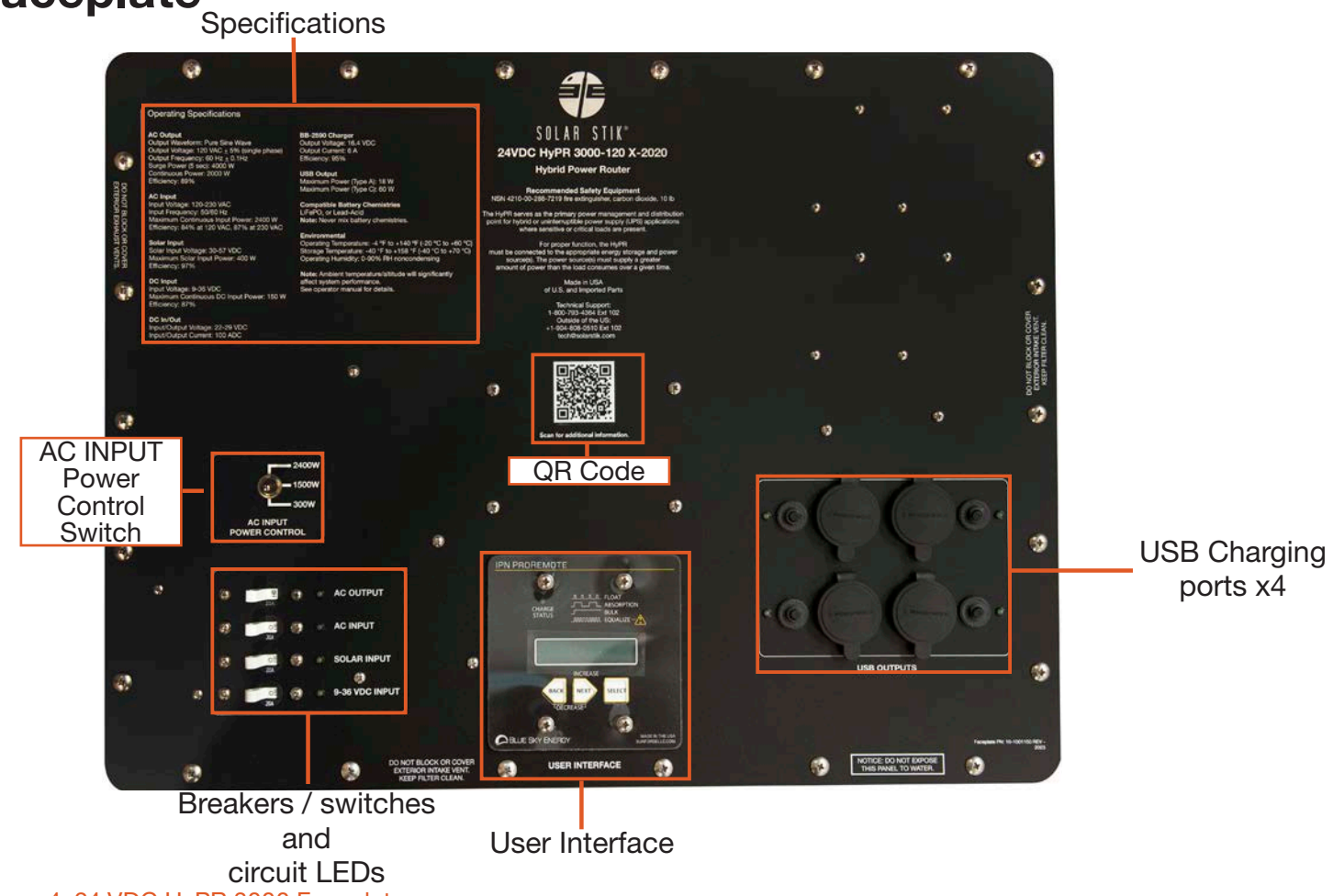


Figure 4. 24 VDC HyPR 3000 Faceplate

USER 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), DC bus 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.

AC INPUT Power Control Switch – Allows selection of AC input current limit. This must be adjusted to match the maximum recommended power output limit of the AC power source. For example, choose 1500 W setting when a 2000 W generator (nominal) is connected. Recommended settings are found on HyPR 3000 I-Plate.

Breaker switches and Circuit LEDs – The breakers serve as switches to activate circuits and to deactivate circuits Circuit breakers also protect against overcurrent conditions. 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 illuminated if the circuit is active and the breaker is not tripped. A red LED indicates a fault.

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

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

QR Code – Provides access to HyPR Operator Technical Manual.

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.

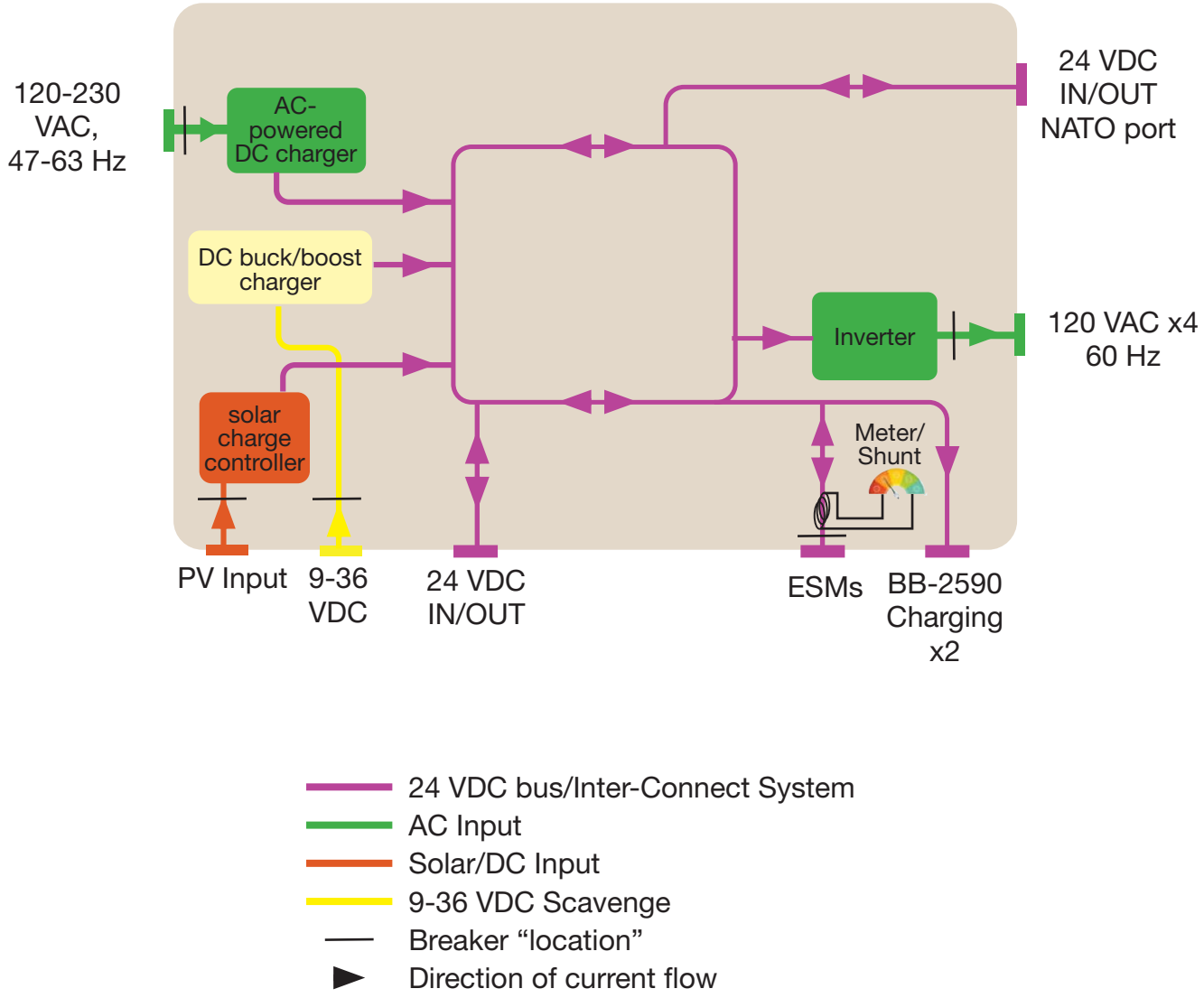


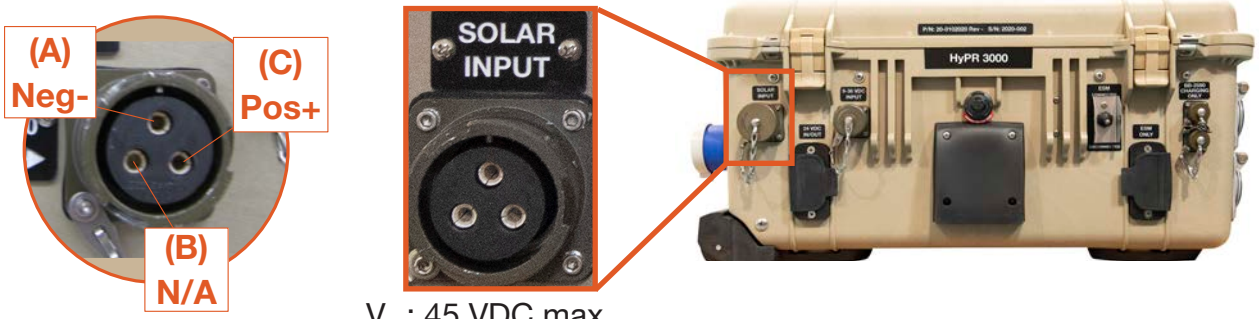
Figure 5. Schematized power flow from a top-down view of the interior of the HyPR 3000

HyPR 3000 Front

Figure 6. HyPR 3000 front side

Solar Power 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.



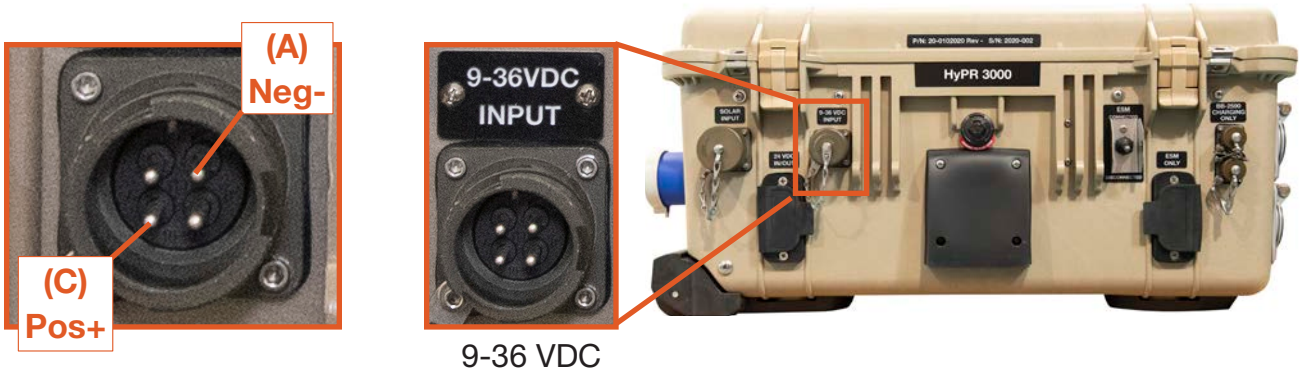
V_{oc}: 45 VDC max
9-12 A
400 W max

Description	Connector	Voltage	Amps
Solar Input	P/N 07-1000314 Amphenol Bayonet Connector	33.3 VAC	9-12 A

Figure 7. HyPR 3000 solar input port located on front side

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.



9-36 VDC

Description	Connector	Voltage	Amps
Input Connection	P/N 07-1001659 SZ18, Bayonet, 4 POS, PIN, OD	9-36 VAC	20 A

Figure 8. HyPR 3000 9-36 VDC power scavenging port located on front side

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. This port can also be used to connect additional battery storage. When connecting batteries to this port and the ESM port simultaneously, ensure the battery chemistries and capacities are the same.

Description	Connector	Voltage	Amps
24 VDC IN/OUT	P/N 07-1000009 24 VDC Marine Receptacle w/cover	24-29 VAC	100 A

Figure 9. HyPR 3000 24 VDC input/output ports located on front side

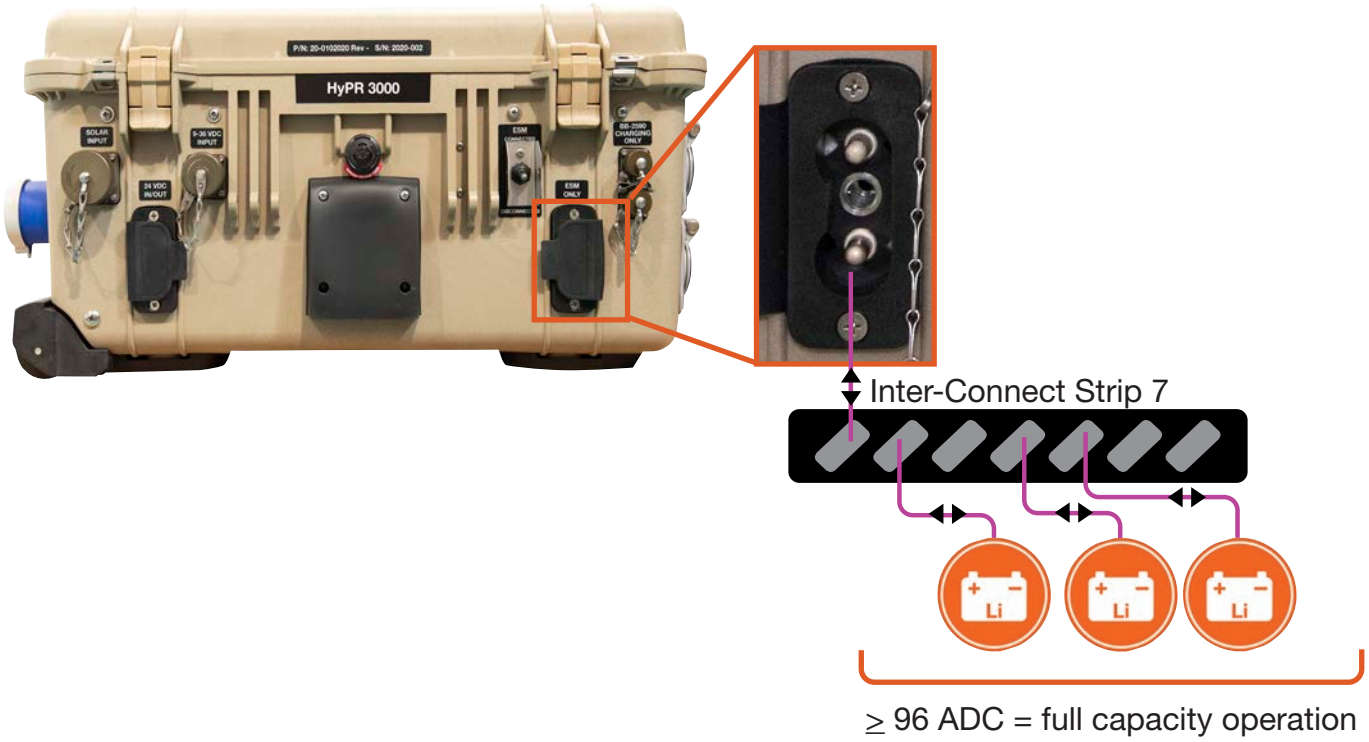
ESM Only Port

Connect Energy Storage Module (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 ESM 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.

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



Description	Connector	Voltage	Amps
24 VDC IN/OUT	P/N 07-1000009 24 VDC Marine Receptacle w/cover	24-29 VAC	100 A

Figure 10. HyPR ESM connection port located on front side

BB-2590 Charging Ports

These connectors provide a DC charging port for BB-2590 Batteries.

Description	Connector	Voltage	Amps
BB-2590 Charging Port	P/N 07-1002119 SZ10, Bayonet, 6POS, Socket	16.4 VAC	6 A

Figure 12. BB-2590 Charging Only ports

24 VDC NATO Input/Output Port

The NATO port is a direct connection to the HyPR DC bus. This port may conduct current into or out of the HyPR. This connection is common on military vehicles.

Description	Connector	Voltage	Amps
NATO Receptacle 24 VDC	P/N 07-1000032 NATO Receptacle 24 VDC	24-29 VAC	100 A

Figure 11. HyPR 24 VDC NATO Input/output port

AC Power Input Port

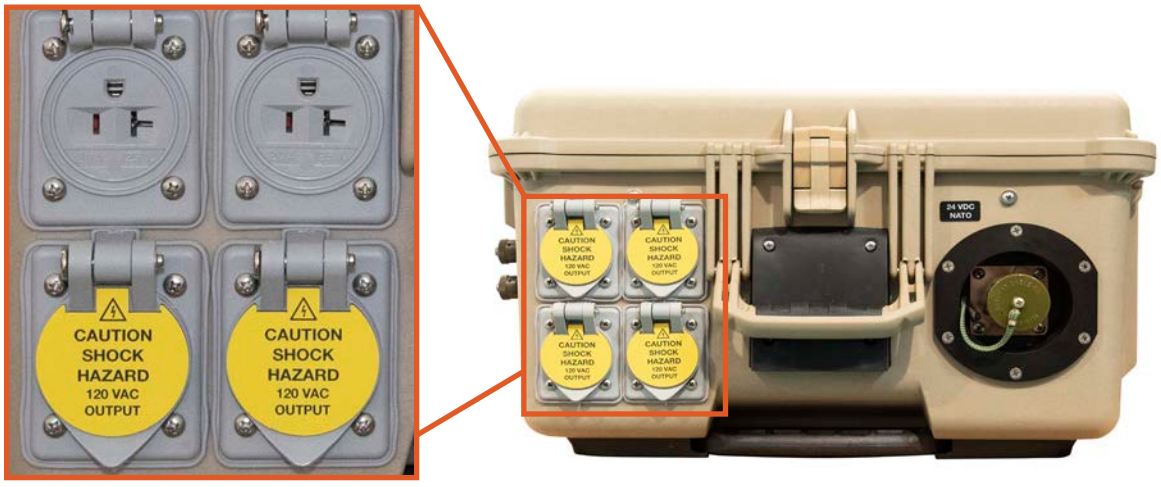
Connect AC power sources to the 120-230 VAC INPUT port. Power via this connection is capable of charging batteries and can support DC loads connected the 24VDC IN/OUT and NATO ports.

Figure 13. HyPR 3000 120-230 VAC Input located on right side

Description	Connector	Voltage	Amps
120 -230 VAC INPUT	P/N 07-1001787 Connector, IEC 60309, 6H, 3 PIN, BLUE	120-230 VAC	30 A

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 25 A.

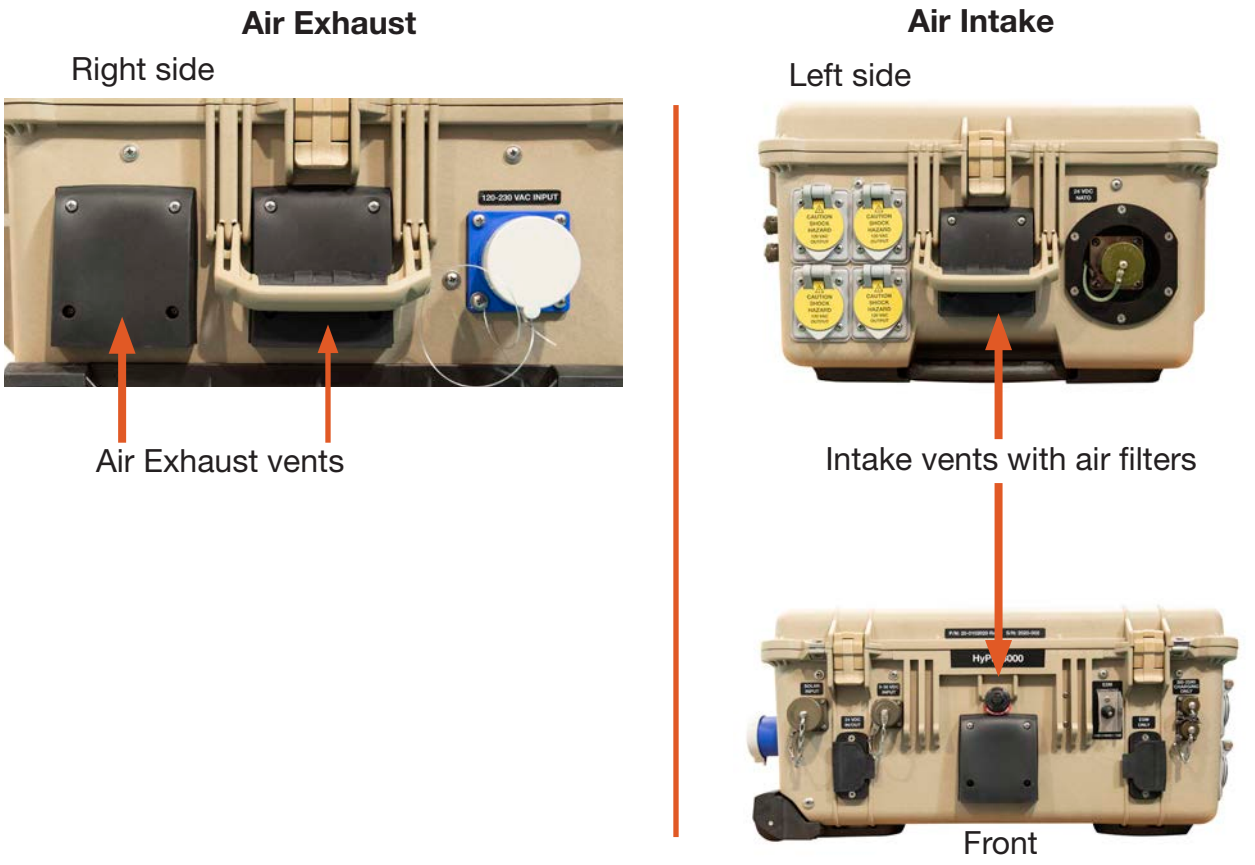


Description	Connector	Voltage	Amps
120 VAC OUTPUTS	P/N 07-1000023 20 A, 125V Receptacle (Outlet)	24-29 VAC	100 A

Figure 14. HyPR 3000 120 VAC power output ports located on right side

Vents

Exhaust vents have fans to remove air from the case. Ambient air enters the case through the intake vents and also have fans to force air into the case. **The air filters must be cleaned or replaced on a regular basis, especially when operating in dusty environments.**



Description	Connector	Voltage	Amps
Vent Shroud	P/N 10-1001060 Vent Shroud, 80 MM Fan	NA	NA

Figure 15. HyPR 3000 cooling vents

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 24 VDC 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 to DC converter provides up to 100 A at 24 VDC to the DC bus (~3000 W).

Inverting

DC to 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.

HyPR 3000 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 INPUT POWER CONTROL toggle switch and AC INPUT and OUTPUT breakers provide complete AC circuit input and output control.
- The HyPR DC INTERFACE panel provides complete DC control, including complete circuit data and metering.

When the HyPR circuit switches are turned on:

- The HyPR DC INTERFACE will power up and report DC bus voltage and amperage data on the home screen.
- The inverter (DC to AC) will be active, but only operational once the HyPR AC OUTPUT breaker is engaged.
- The charger (AC to 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 to DC converter (scavenger) will be active, but only able to process DC power once the 9-36 VDC INPUT breaker is engaged.

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 15).

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:

- 45 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

Any PV array input must meet the following specifications: 400 W or less, voltage of 33-45 VDC, and a maximum current rating of 9 A at 45 VDC.
The HyPR converts incoming PV power to 29.0 VDC which goes directly to the DC BUS. 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.

BB-2590 connections

The HyPR BB-2950 connections are controlled using the ports on the front of the HyPR. Once connected, the BB-2590 will automatically start charging.
The HyPR is designed to provide 16 VDC at voltages that allow the BB-2590s to charge and discharge over a safe and efficient voltage range.

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.

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.

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.

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.

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

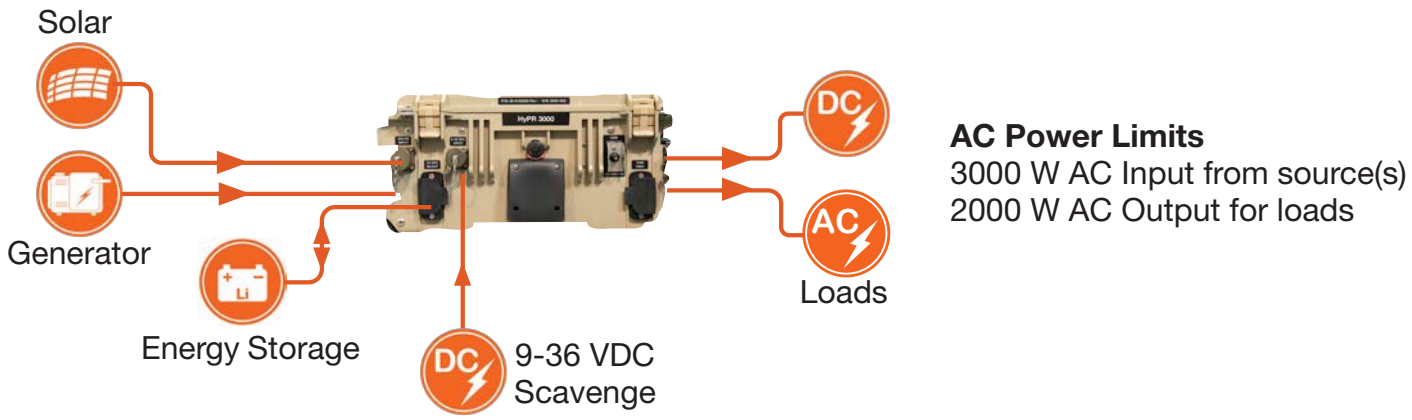


Figure 16. Using the HyPR 3000 in Hybrid Model

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.

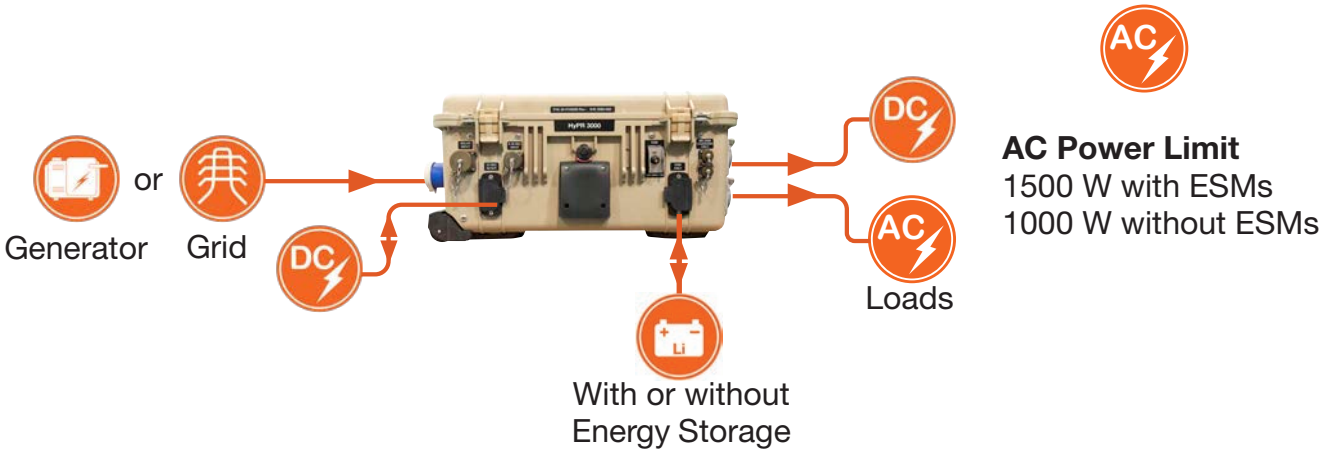
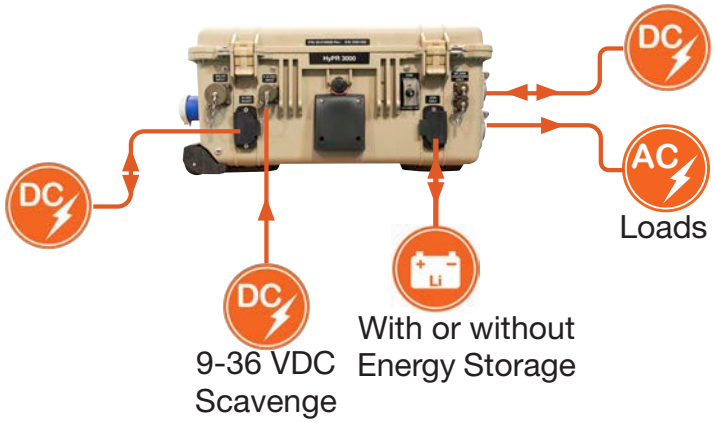


Figure 17. Using HyPR in Power Conditioning Model

DC Scavenging Function–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.



AC Power Limits
300 W with ESMs connected
150 W without ESMs connected

Figure 18. Using HyPR in Scavenge Model

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.

DC User Interface

The DC User 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 User INTERFACE. Without PV input only the voltage and current readings on the home screen are accurate.

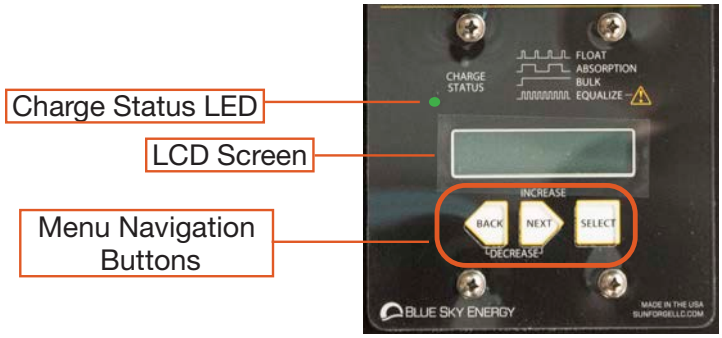


Figure 19. HyPR 3000 DC Interface

- **The DC USER 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.

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 solar 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 2000, 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

Battery Low-voltage Cut Off (LVCO)

AC loads

The HyPR is programmed, via the DC INTERFACE AUX circuit, to cease support of AC loads 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.

AC Interface

AC Input Power Control Switch

This control may be thought of as the battery charging rate limiter. Toggle this switch 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 2.4 kW setting is equivalent to 20 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.

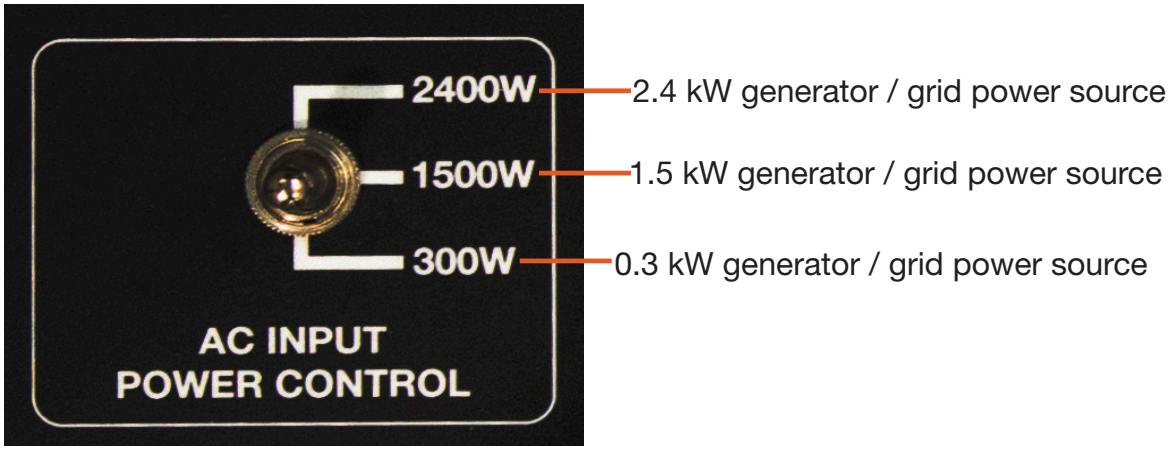


Figure 21. AC Input Power Control switch

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.

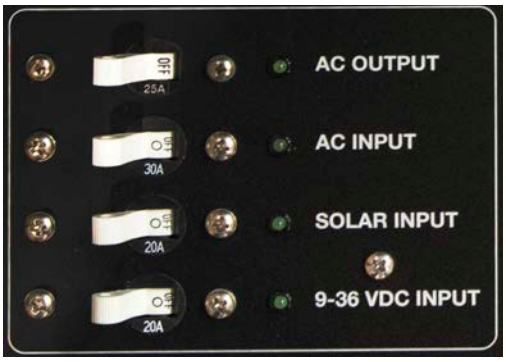


Figure 20. HyPR 3000 breakers

AC OUTPUT 25 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.
ESM CONNECTED/DISCONNECTED 100 A – Limits flow to and from batteries to 100 ADC.

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

9. Turn on loads.

Navigating DC User Interface Menus

The user interface has four main menus:
1. General Information
2. Advanced Information
3. Operation Setup
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

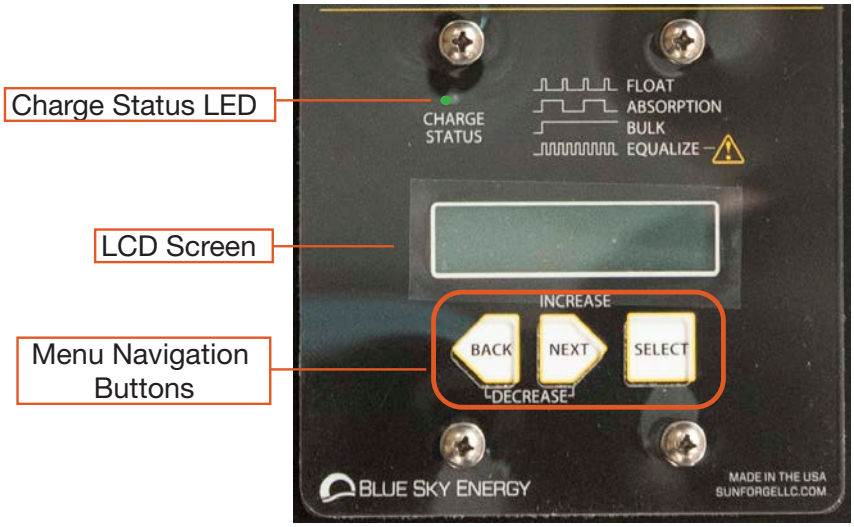


Figure 22. Navigating the DC Interface

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.

Read-only Parameters

The first screen under General Information Menu is the Home Screen. It displays the DC bus voltage (battery voltage in the absence of a charging source or load) and the net current.

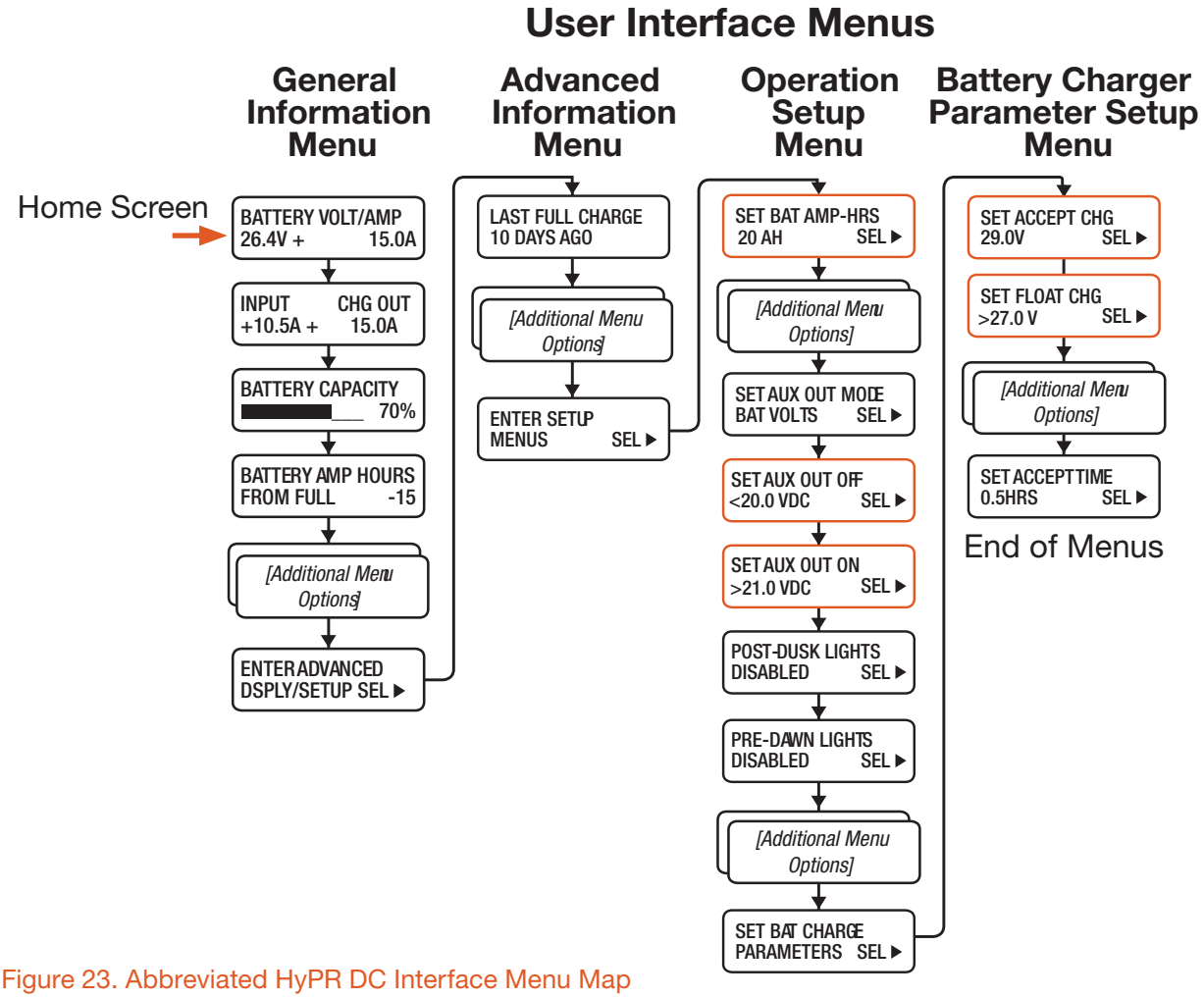


Figure 23. Abbreviated HyPR DC Interface Menu Map

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 Maintenance*

There are two (2) air intake filters on the left and front sides of the HyPR 3000 (the vents on the right side of the HyPR are exhaust fans and have no vent filter). Use a #2 cross tip screw driver to remove four (4) fasteners from the vent cover. Removing these fasteners will remove the vent cover. The plastic casing housing the filter snaps in and out of the case. Carefully remove and clean or replace the filter then reinstall the vent assembly.

Correct Filter Orientation

Incorrect Filter Orientation

Figure 24. Cleaning/replacing HyPR 3000 air intake vent filter

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 2000 W continuous while not charging.

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 to ~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 it space to breathe.

- Clean or replace the air intake filters regularly.

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 25. Drain plug screw located under the Solar Input 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 26. HyPR human transportation.

ABOUT SOLAR STIK, INC.

Mission Statement
Saving lives across the globe through innovative power solutions

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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