SOLAR STIK®

OPERATOR AND MAINTENANCE MANUAL FOR 24VDC POWER HUB 2400

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Interactive

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Revision History

Section	Page(s)	Description	Date
Troubleshooting	30	Added Heat, Overheating, and Derating topic	01 Feb 2018
ALL	ALL	Major Update	20 April 2018
ALL	ALL	Major Update	24 Dec 2019

GENERAL INFORMATION, THEORY OF OPERATION, AND EQUIPMENT DESCRIPTION

Power Hub Introduction

The primary function of the DC Power Hub is to serve as a singular collection, management and distribution tool for DC power in a Hybrid Power System (HPS).

The Hub is designed specifically for operation between energy-storage batteries and DC generation sources, including photovoltaic (PV) arrays, wind generators, fuel cells, small hydro generation, vehicular power, and more. It regulates the incoming power, making it compatible for a connected battery, loads, or distribution devices such as inverters.

Power Hubs play a critical role in applications where any combination of the following is necessary:

- Renewable power generation is required to support a battery
- Reducing generator run-time in a hybrid system is critical
- Less reliance on grid-utility power is desirable
- DC power management and distribution is required for a battery platform

It is a modular component of the HPS architecture, and its flexible design allows use with other technologies that collectively meet specific mission requirements.

All Power Hubs are “Plug & Play”-compatible with the Inter-Connect circuit and are modular and scalable. Their design allows multiple Power Hubs to be used in a single application where power management requirements exceed the ability of a single Hub, or when multiple DC loads are required to meet the demand.

The Power Hub includes one DC Inter-Connect Cable for connection to an HPS.

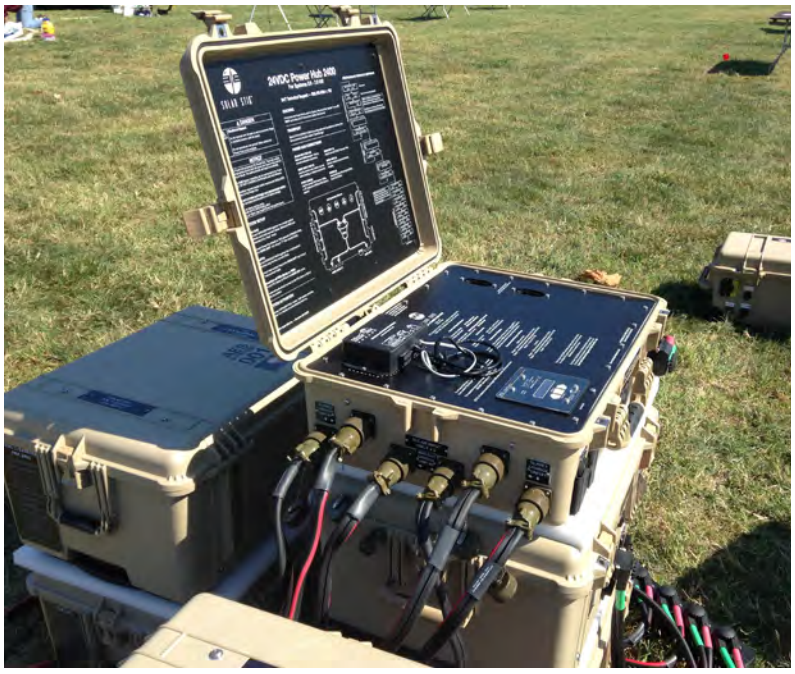


Figure 1. A Power Hub in a Hybrid Power System

Use of the Power Hub in a System

The Power Hub provides a portal to integrate multiple DC power sources into a hybrid power network, from both unregulated (PV) and regulated power sources. (Figure 2). It funnels all incoming power to the batteries, PRO-Verters, or loads automatically, using basic programming in the User Interface to direct the flow.

Programming and connection of the Hub in a System will vary according to the specific functions the system in which it is employed, but systems vary in accordance with the operator's requirements. Consequently, not every feature in the Power Hub may be used for an application.

The Power Hub can support operation with either lead-acid or lithium battery types. This manual provides an overview of the core features and capabilities of the Power Hub along with a guide for the User Interface menu windows. Other changes in programming may improve performance in extreme environmental operating conditions. Contact Solar Stik or your field service representative (FSR) for assistance in altering operation configurations or programming.

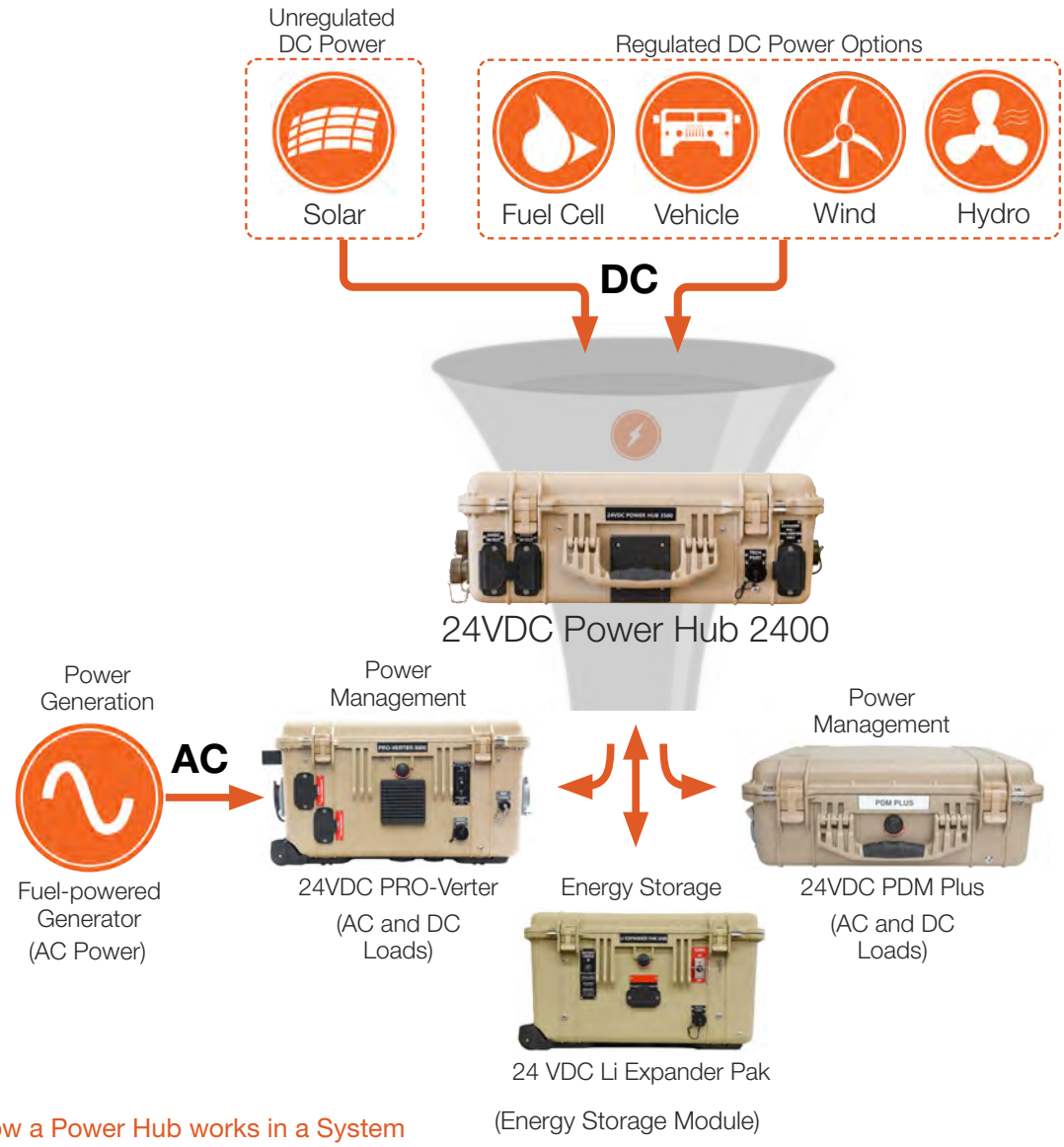


Figure 2. How a Power Hub works in a System

Modes of Operation

Depending on the application, there are several operational modes that can be configured using a Power Hub:

Hybrid
DC loads, DC generation and batteries are all connected to a Power Hub. It is the central power management device in the system. The Power Hub provides constant DC power to a load by alternating between power from batteries and power from a DC generator (such as a PV array). In the hybrid configuration, the batteries cycle regularly, which maximizes electrical efficiency throughout the circuit, minimizing dependency on any one DC source.

Direct DC Support
The Power Hub can be configured to provide DC into a system configuration where DC is used for any of the following:

- Peak Shaving
- Inverter operation
- Battery charging

Product Safety Information and Instructions

This manual contains important safety instructions that must be followed during the installation and operation of this product. Read all instructions and safety information contained in this manual before installing or using this product.

All electrical connections must be made using the proper polarized connectors.

While this product is designed for indoor/outdoor operation, the interior of the Power Hub 2400 must not be exposed to rain, snow, moisture, or liquids. Close and latch and/or lock the cases when the System is unattended.

The Power Hub is not field serviceable beyond simple preventive maintenance. Do not attempt to open or service the unit. If repair is needed, contact your FSR.

Exercise caution when handling or operating the Power Hub. Live power may be present at more than one point.

Figure 3. 24VDC Power Hub 2400

Safety Information Labels

Your safety and the safety of others is very important.

Always read and obey all safety messages.

This is the safety alert symbol. This symbol alerts you to potential hazards that can kill you or hurt you and others. All safety messages will follow the safety alert symbol and the word “DANGER”, “WARNING”, or “CAUTION”. These words are defined as:

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

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

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

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

Limitations on Liability

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

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

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

Fire Hazard

Fire Types

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

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

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

Recommended Fire Extinguisher

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

WARNING

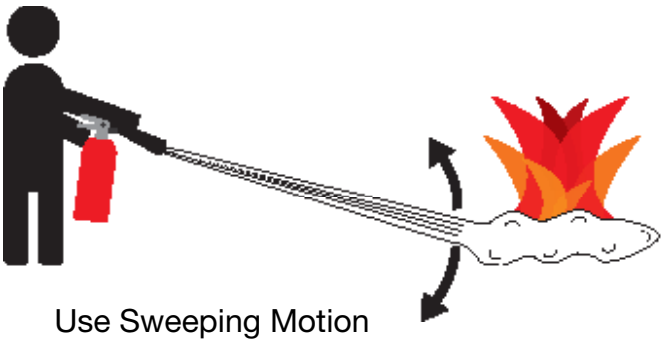
Only CO_2 (carbon dioxide) fire extinguishers should be used with equipment.

Using the Fire Extinguisher

When using the extinguisher on a fire, remember PASS:

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

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



Use Sweeping Motion

These additional cautionary steps will ensure your safety:

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

Electric Shock Hazard

⚠ WARNING

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

DON'T LET THIS BE YOU!

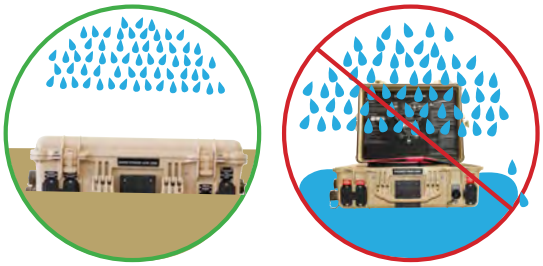
HIGH VOLTAGE: System components, PV arrays, and generators may have lethal line voltages. Extreme care should be taken to protect against electrocution. Always work with another person in case an emergency occurs. Disconnect power before performing maintenance. Wear safety glasses whenever working on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

Environmental and Handling Precautions

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

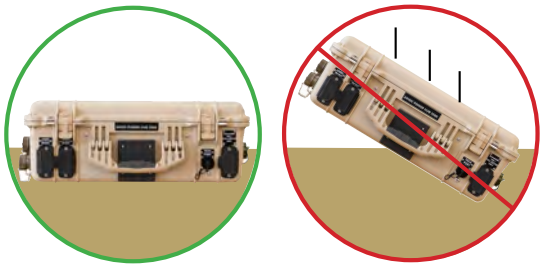
Water

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



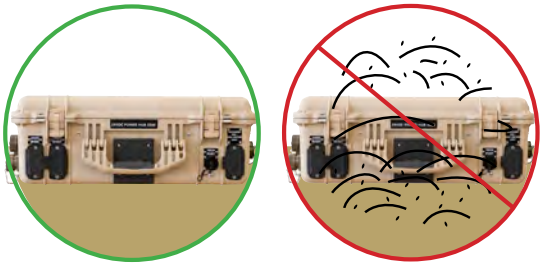
Impact

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



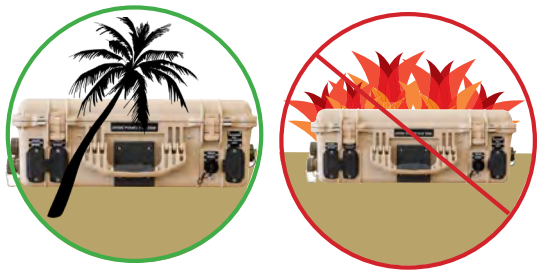
Dust/Foreign Object Intrusion

Air intake filters should be cleaned once per month, or more frequently when conditions warrant. 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, causes Power Hub derating, and shortens life expectancy. **Shade the Power Hub** to prevent the negative effects of heat.



THEORY OF OPERATION

Operation Overview

The Power Hub has multiple DC connections on its exterior, allowing for multiple configuration possibilities.

It requires connection to an active 24 V battery circuit in order for it to operate. A minimum of three (3) energy storage modules (i.e., Expander Paks; ESMs) must be present and functioning for the Power Hub to operate at its rated power, however, for lower power configurations, a single ESM or small bank of ESMs may be used.

The Hub has an internal DC bus that can support multiple **regulated** DC generation sources to include the following:

- Wind
- Fuel Cell
- Vehicular
- Hydro

It also has a dedicated circuit for managing **unregulated** power from PV arrays. The Hub has a sophisticated ultra-fast Maximum Power Point Tracking (MPPT) PV charge controller system that regulates PV power, and optimizes PV power production based on two factors:

1. Available PV power
2. Battery state of charge (SOC)

The MPPT process allows a PV array to operate at its rated/available voltage, converting the higher PV voltage into charging current (amps), which is then provided to the battery at the appropriate voltage, improving performance and life of the batteries.

Battery Charging

When the Power Hub is connected to an active battery bank, it will automatically calibrate its charge algorithm in accordance with the voltage of the connected battery.

The solar charger controllers can be programmed to charge using several algorithms, including multi-stage charging for lead-acid batteries as well as Constant Current / Constant Voltage (CC/CV) for lithium battery types. Selection of charge profiles should be based on battery chemistry, capacity and operating conditions.

Protection Circuits

The Power Hub serves as a DC junction within the Inter-Connect Circuit. When connected to an active 24 V DC Inter-Connect network, it allows DC to flow through its internal bus, with ONLY the PV circuit offering limit protections:

- The bayonet connector for the Solar Leash is keyed and unique to the PV circuit. It cannot be connected improperly, and no other System cable will fit.
- The PV charge controller is fully protected against voltage transients, over-temperature, over-current, reverse battery connections, and reverse PV connections. An automatic current limit feature allows use of its full rated capability without worrying about overload from excessive PV input current.

Other DC power sources and batteries that connect to the Hub have their own individual circuit protections, so the Hub does not need circuit breakers for individual loads or other connected equipment. If a short-circuit conditions occurs within the DC network, only affected batteries, loads, and power sources will engage their protections circuits, leaving non-problematic circuits active. (See Circuit Breaker Protections in the Inter-Connect section for more details.)

Metered Circuits

Information regarding the status of the batteries and the overall flow of power into and out of the system can be obtained from the Power Hub User Interface. Precise data is available in both real-time and historical models.

DC power values are tracked as it flows in through the PV Controller circuits, as well as power that flows out to a connected battery, PRO-Verter or additional Power Hub(s).

Only certain ports are metered on the Hub. Follow recommended connection diagrams on the I-Plate and the System manual for proper metering of DC values.

Maximum Power Point Tracking (MPPT) – Charge Controls

The Power Hub 2400 contains three (3) photovoltaic (PV) charge controllers. Each charge controller has two (2) input ports; both ports are parallel.

The Master Charge Unit is connected directly to the Power Hub User Interface, which reports System activity as well as activity unique to each of the three (3) charge controllers. Monitoring each charge controller and its solar input(s) independently facilitates system optimization and troubleshooting of the PV arrays.

Derating

Derating is a condition where the PV power management functions are diminished due to high temperatures.

Excessive heat in the Power Hub reduces its ability to supply to DC into the Inter-Connect circuit (i.e. to the batteries and other connected devices). It is usually caused by poor airflow over the internal charge controls or by solar loading in high-heat environments.

The first indication of heat-related derating may be the appearance that the PV arrays are “not producing any power” when they should be. If this is the case, check the temperatures. (**Note:** The Power Hub User Interface will also report 0 VDC charging current when the System batteries are fully charged.)

If the internal temperature of the Power Hub is greater than 104 ºF (40 ºC), the Power Hub performance will be degraded (See: Power Hub Internal Temperature Reading).

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

Equipment Description

The Inter-Connect System

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

- Energy storage
- Power management
- Power generation

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

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

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

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

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

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

The Standard Inter-Connect Plug

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

Figure 4. Inter-Connect Plug

Connection Port Details

Port placards assist in making the correct connections between components. Please review the information on all of these plates and labels, as they contain the basic information required to set up and operate the Hub.

Overview

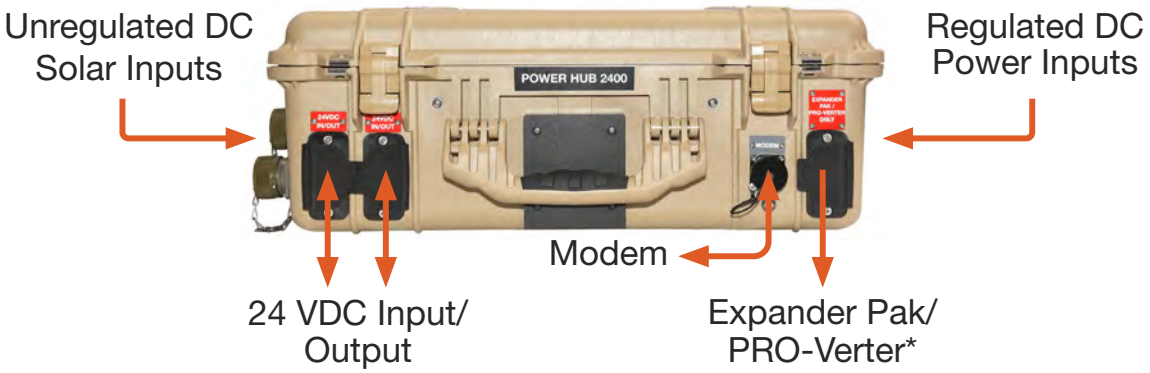


Figure 5. Overview of Power Hub Connections

	Description	Connector	Voltage
A	24VDC Load Port (unmetered)	Inter-Connect Port	24 VDC
B	Exhaust Vent	-	-
C	Modem Port	Ethernet - RJF21B	-
D	24VDC Battery/PRO-Verter Port (metered)	Inter-Connect Port	24 VDC

Figure 6. Front—DC Output and Communications

A. May be connected to Power Distribution Modules (PDMs) or 24 VDC loads.

C. For external modem connection to the remote monitoring kit (RMK) if present (optional).

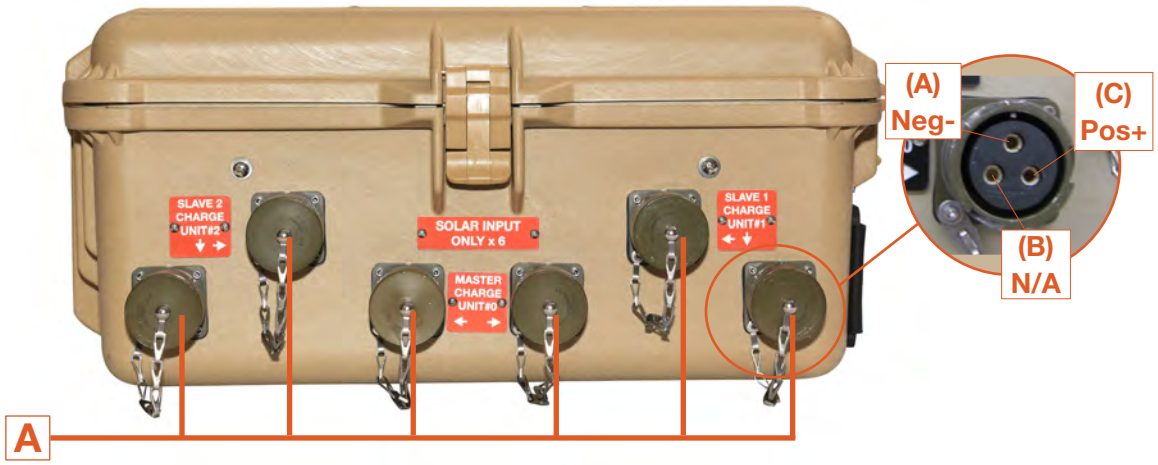
D. For connection to a 24VDC PRO-Verter or 24VDC Expander Paks.

	Description	Connector	Amps	Voltage
A	24 VDC NATO Slave (unmetered)	NATO Slave	100 A	24 VDC
B	Regulated 24 VDC Input Only (unmetered)	Inter-Connect Port	50 A each	24 VDC

A. For connection to a Tactical Vehicle or generator.

B. For connection to 24 VDC regulated power sources such as wind, vehicle, fuel cell, hydroelectric charging, or stacked 24 VDC components.

Figure 8. Right Side—Regulated 24 VDC Input and NATO Connector



	Description	Connector	Watts	Amps
A	Solar Input	Cannon Bayonet Receptacle CB2-22-2SC	420 W Max	7.5 A @ 57 VDC* 15 A @ 28.5 V*

A. Connections for Solar Panel Input

Figure 9. Left Side—Solar-only Ports

Internal Cooling

Figure 11. Back side—air intake vent

Thermostatically controlled, internal cooling fans turn on at 104 °F (40 °C) and turn off when the internal temperature drops to 90 °F (32 °C).

Information Plate (I-Plate)

The Power Hub I-Plate provides concise, abbreviated information for setting up and running a Power Hub as part of a System (Quick-start Guide and Operating Information). All System components should be connected as described on the I-Plate. Warnings and Notices are provided. Be familiar with their content before operating the Power Hub. An I-Plate is (usually) tailored to a customer's specific application.

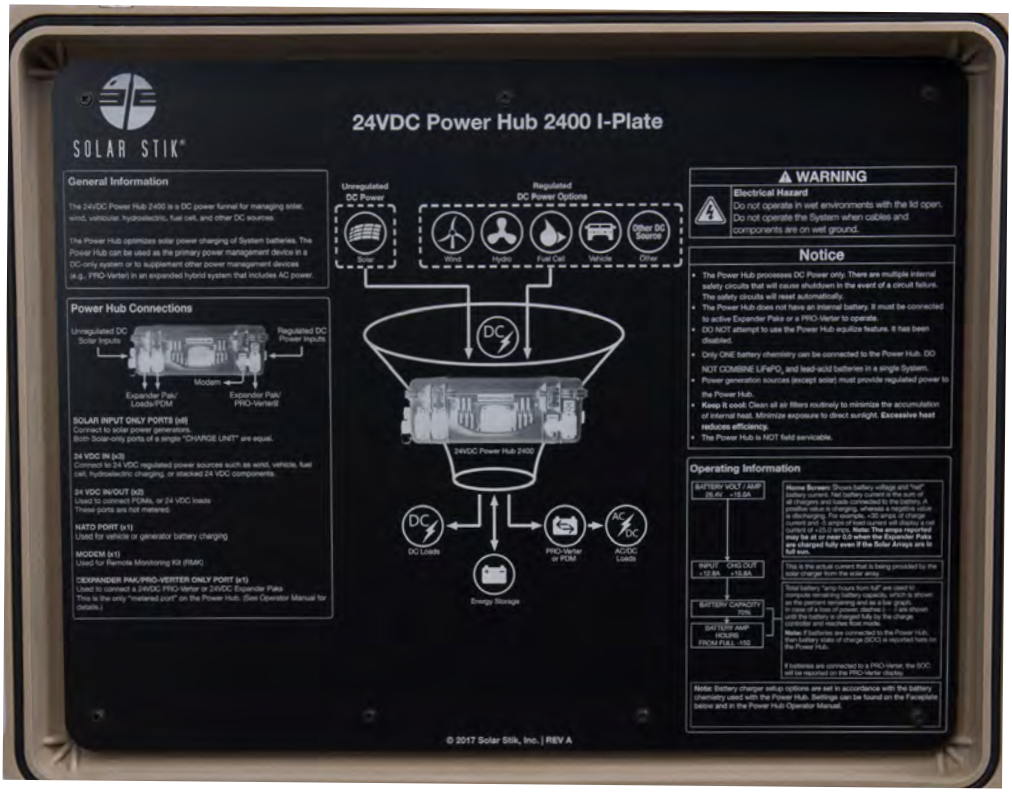


Figure 10. Power Hub I-Plate

The Power Hub 2400 Faceplate

The Faceplate provides Operator Access to the User Interface, PV charging Specifications and recommended charger settings. A Universal Communications Module or Remote Monitoring Kit (RMK) may be installed on the Faceplate at the location indicated below. The two (2) Inter-Connect ports are not electrically active; they are for Inter-Connect Cable storage.

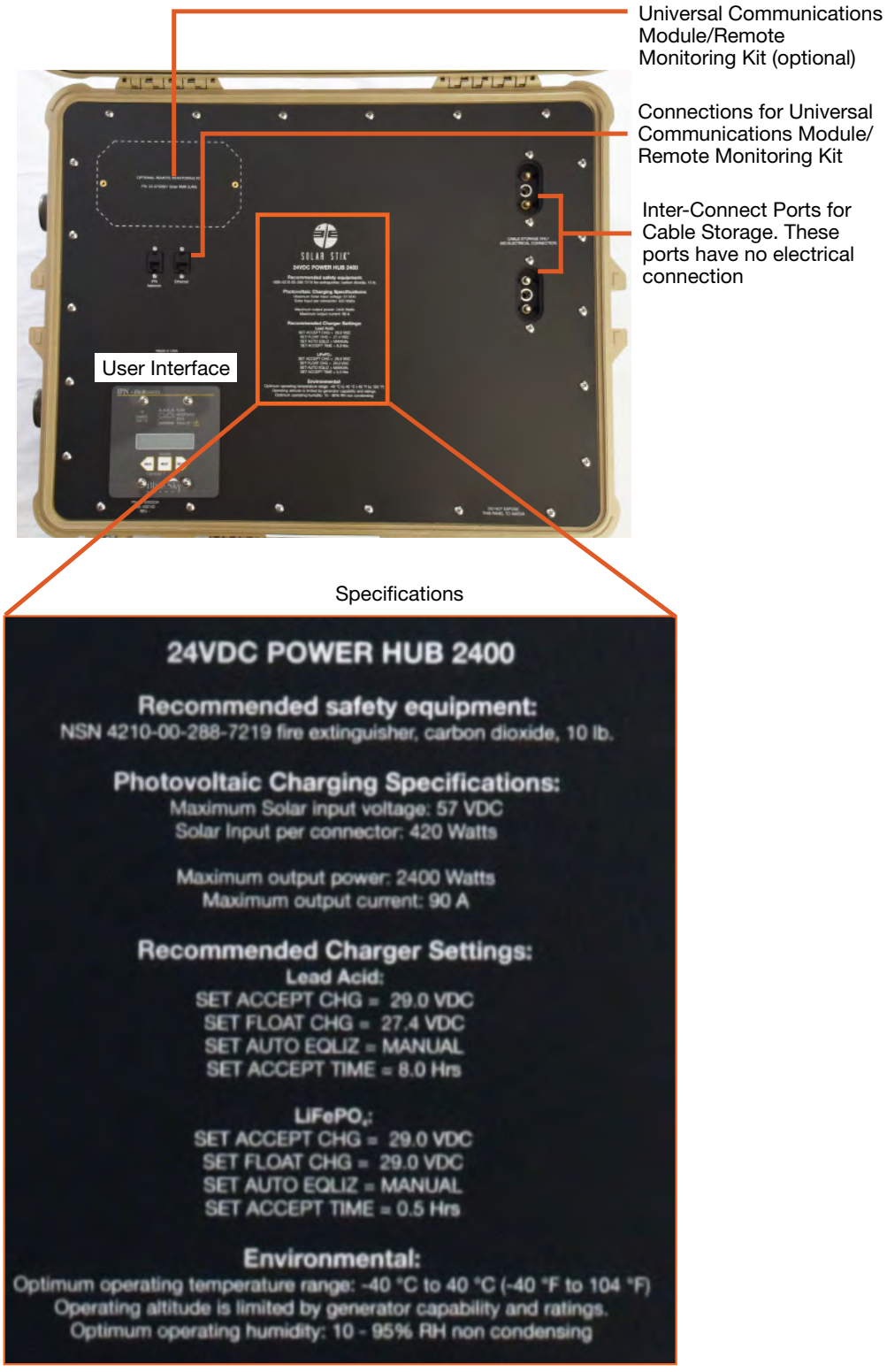


Figure 12. Power Hub Faceplate

OPERATOR INSTRUCTIONS

NOTICE

The Power Hub must be connected to a 24 VDC battery directly or indirectly via the PRO-Verter to operate. Connection only to solar power will not activate the Power Hub 2400.

Connections

Connecting PV Arrays

Up to six (6) PV arrays can be connected to the Power Hub Solar Input Only ports using solar cables. The Power Hub 2400 contains three (3) solar charge controllers. Each charge controller has two (2) input ports. When connecting three (3) arrays, choose one port from each of the three (3) charge controllers. After the first three (3) ports are connected to PV arrays, the remaining ports may be connected to additional PV arrays at random.

Each of the three (3) solar chargers safely accepts up to 800 watts of power from PV arrays or 400 watts max per input connector. Different types of PV arrays can be connected to the Power Hub simultaneously as long as their specifications meet the requirements shown on the Faceplate (Figure 12). The bayonet connector for the Solar Cable is keyed and unique within the System. It cannot be connected improperly, and no other Solar Stik cable in the kit will fit.

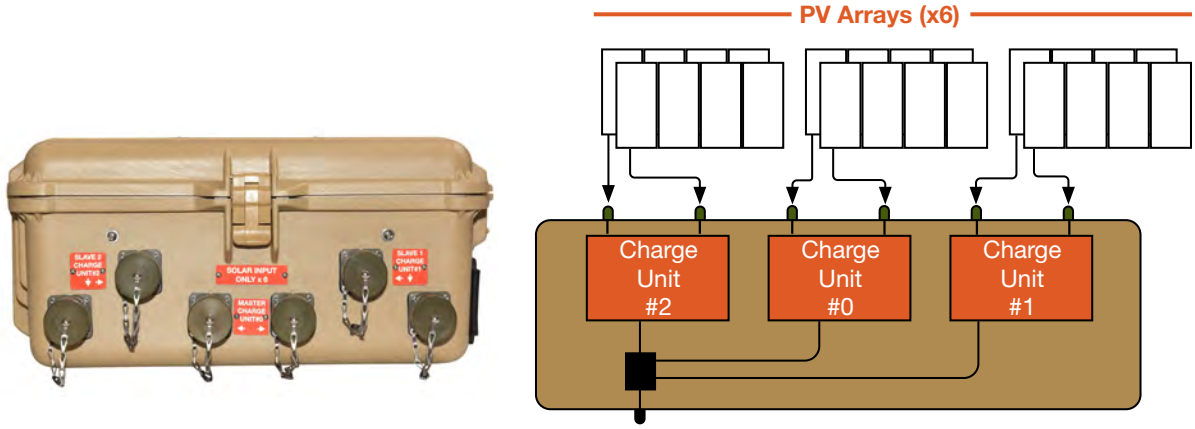


Figure 13. Power Hub Solar Input Only connectors

Connecting / Disconnecting the Power Hub From Service

Connect PV arrays last when assembling a Solar Stik System. DO NOT disconnect the Power Hub from the PRO-Verter (Inter-Connect connection) in a Hybrid Power System with active PV arrays connected to the Power Hub.

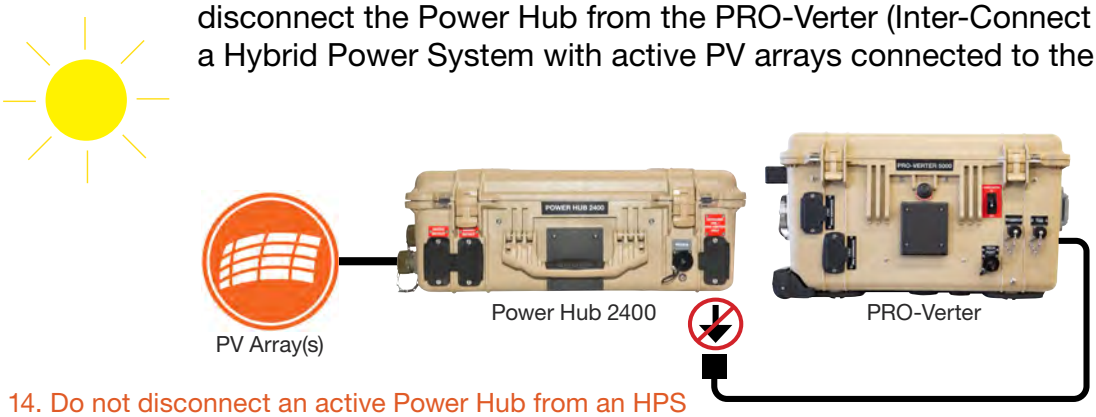


Figure 14. Do not disconnect an active Power Hub from an HPS

Connecting Regulated 24 VDC Power Sources

Figure 15. Power Hub regulated 24 VDC inputs

Connect regulated 24 VDC power sources such as wind generators and fuel cells to the three (3) Inter-Connect ports. Connect 24 VDC power from Military Vehicles (e.g., HMMWV) and TQGs to the NATO port.

Connecting a 24VDC PRO-Verter or 24 VDC Expander Paks

Figure 16. Power Hub PRO-Verter or Expander Pak connection

Connect the Power Hub to either a PRO-Verter or Expander Paks using the “EXPANDER PAK/PRO-VERTER ONLY” port on the right side of the Power Hub. Use Inter-Connect Cables to make these connections.

METERED PORT - Data for multiple DC values is collected at this port and is made available at the LCD User Interface.

Connecting Loads

Figure 17. Power Hub 24 VDC IN/OUT ports

Connect loads to the 24VDC IN/OUT ports on the front left of the Power Hub. Regulated 24 VDC power sources may also be connected here.

Connecting to Communications Network

Figure 18. Power Hub Tech port

Connect to the internet or a computer using the TECH PORT. This is an Ethernet connection to the User Interface and provides remote access to the data provided by it.

Powering up the Power Hub

User Interface

The User Interface will activate when the Power Hub Inter-Connect Circuit is active.

Power Hub 2400 User Interface

The 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. Using the menu navigation buttons is described in the next section.

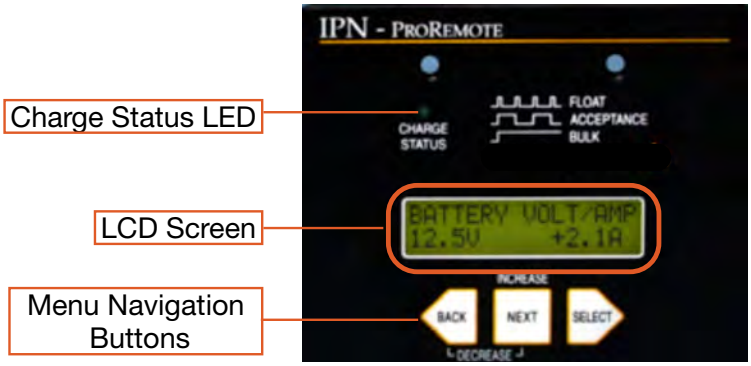


Figure 19. User Interface

How to Use the BACK, NEXT, SELECT Buttons to Navigate the Menus

- To move forward through screens in a menu, press NEXT.

  Note: It is only possible to move forward through the menu items.

- To move to the top of a menu, press BACK.

Note: 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.

See the menu structure in the Menus and Submenus section to assist in knowing when one menu ends and the next begins.

Figure 20. Back, Next, and Select buttons

- To change settings / parameters in the SETUP and BATTERY CHARGE PARAMETERS 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.

Monitoring the Charging Status LED

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

Blinking LED indicates charge control operation status

Figure 21. Power Hub User Interface

Bulk Charge: During Bulk mode, the charge controller can deliver full output to recharge the Expander Paks 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 Expander Pak 2400, the acceptance charge phase is not necessary.

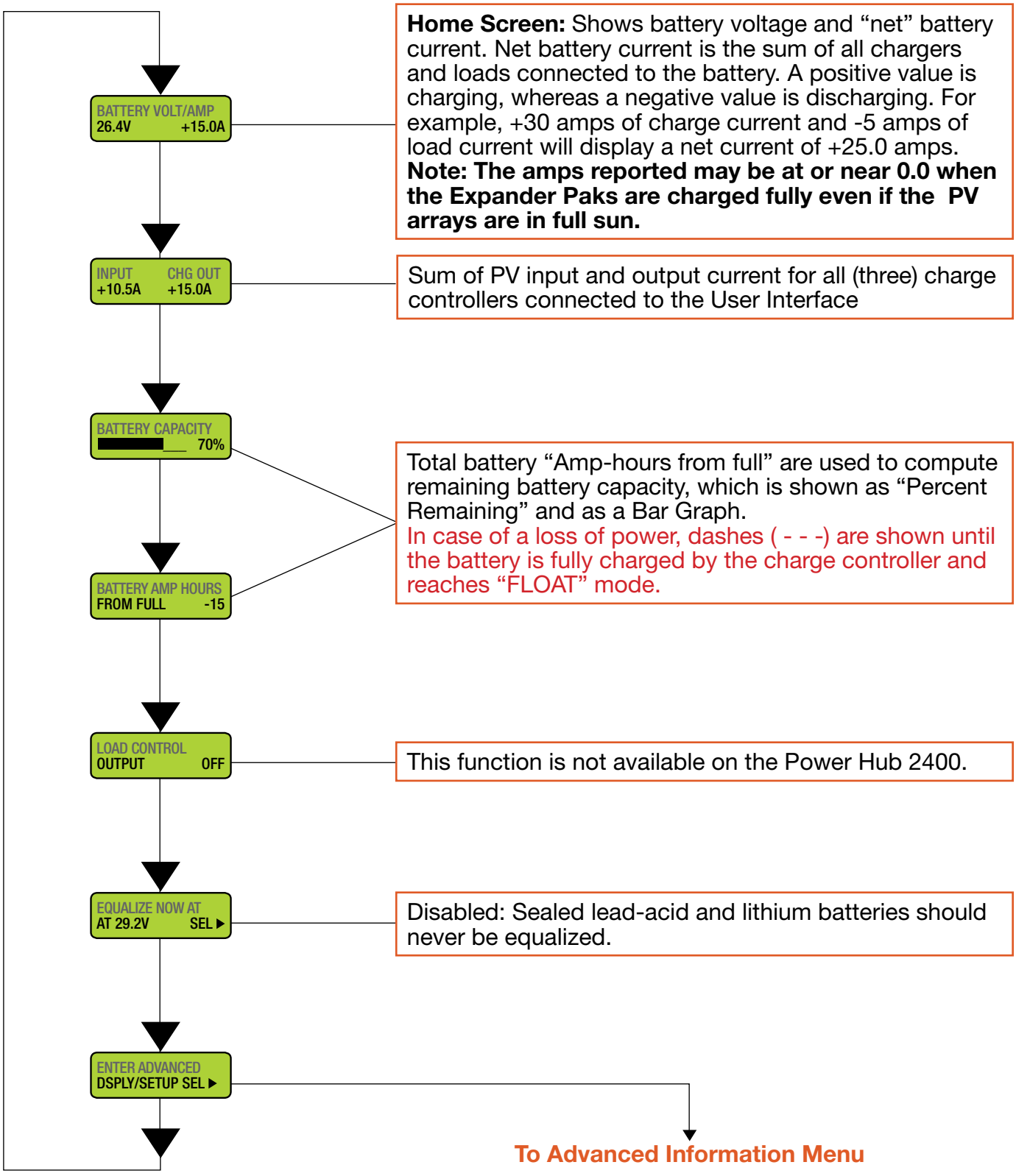
Float Charge: This final stage compensates for the battery's self-discharge and temperature.

Temperature and Power Output: The Power Hub charge controller 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.

The Menu Windows

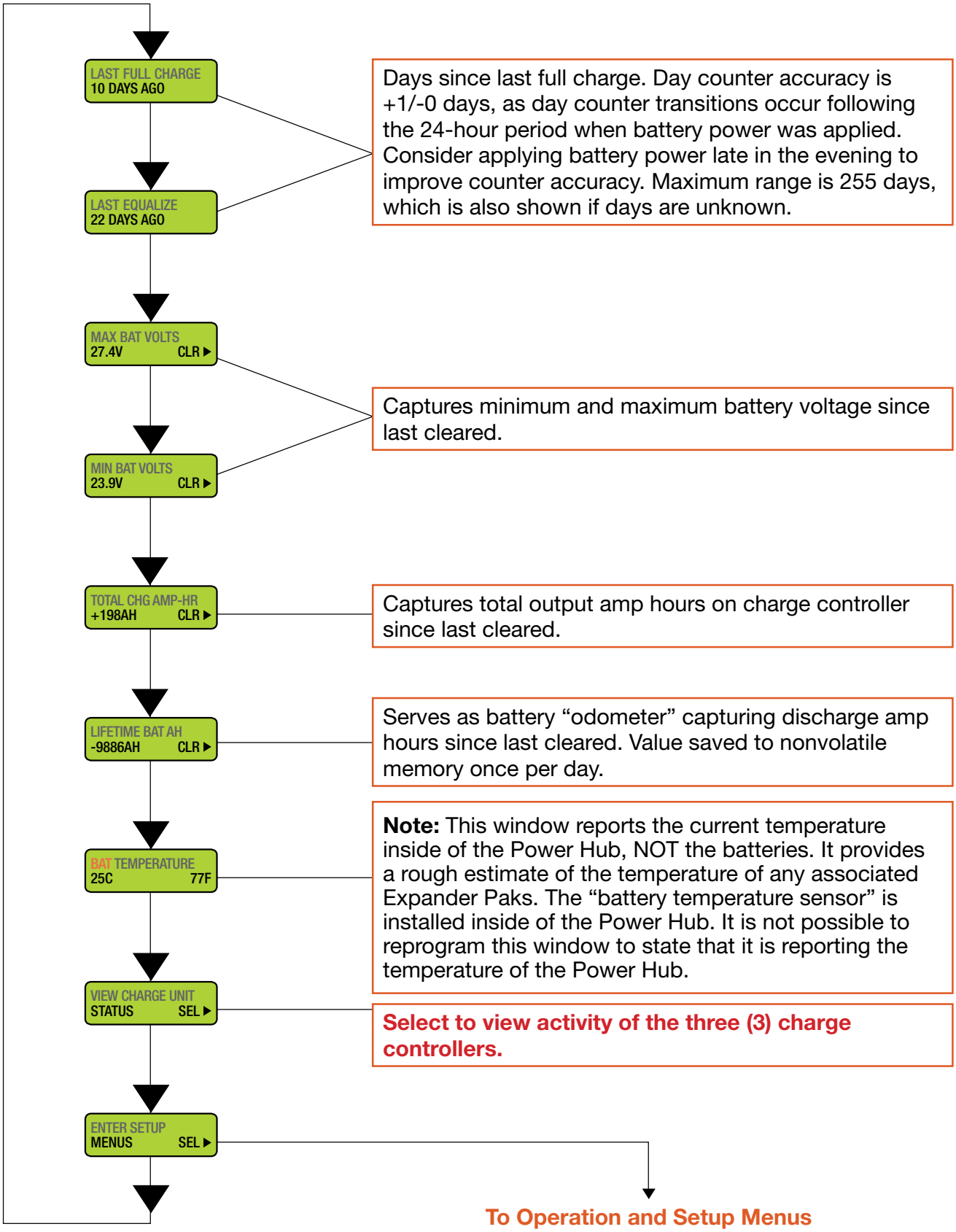
General Information Menu

Provides basic information including battery voltage, current in and out, net current, and remaining capacity.



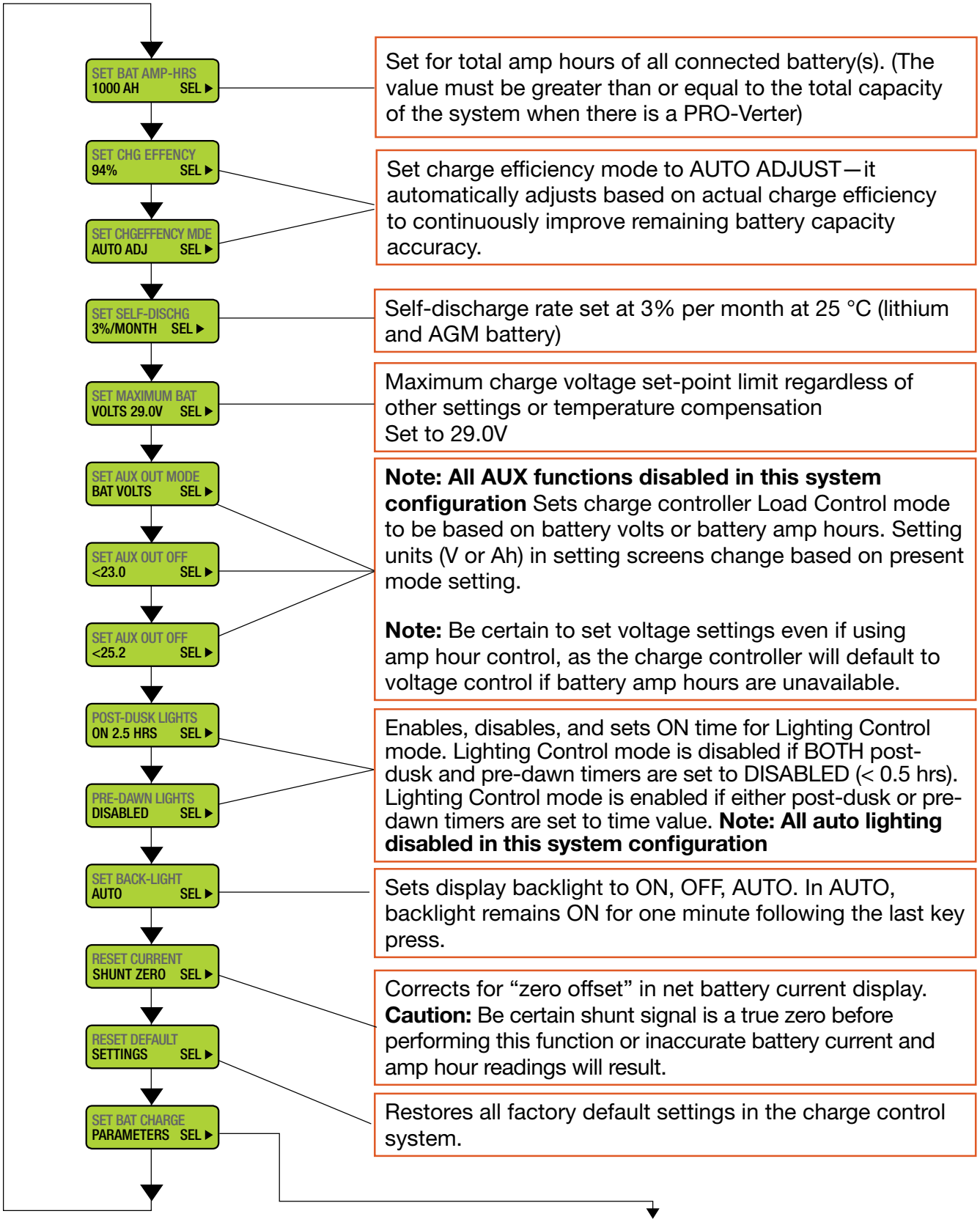
Advanced Information Menu

Provide detailed battery information including discharge cycles, temperature, battery-event tracking information, and more



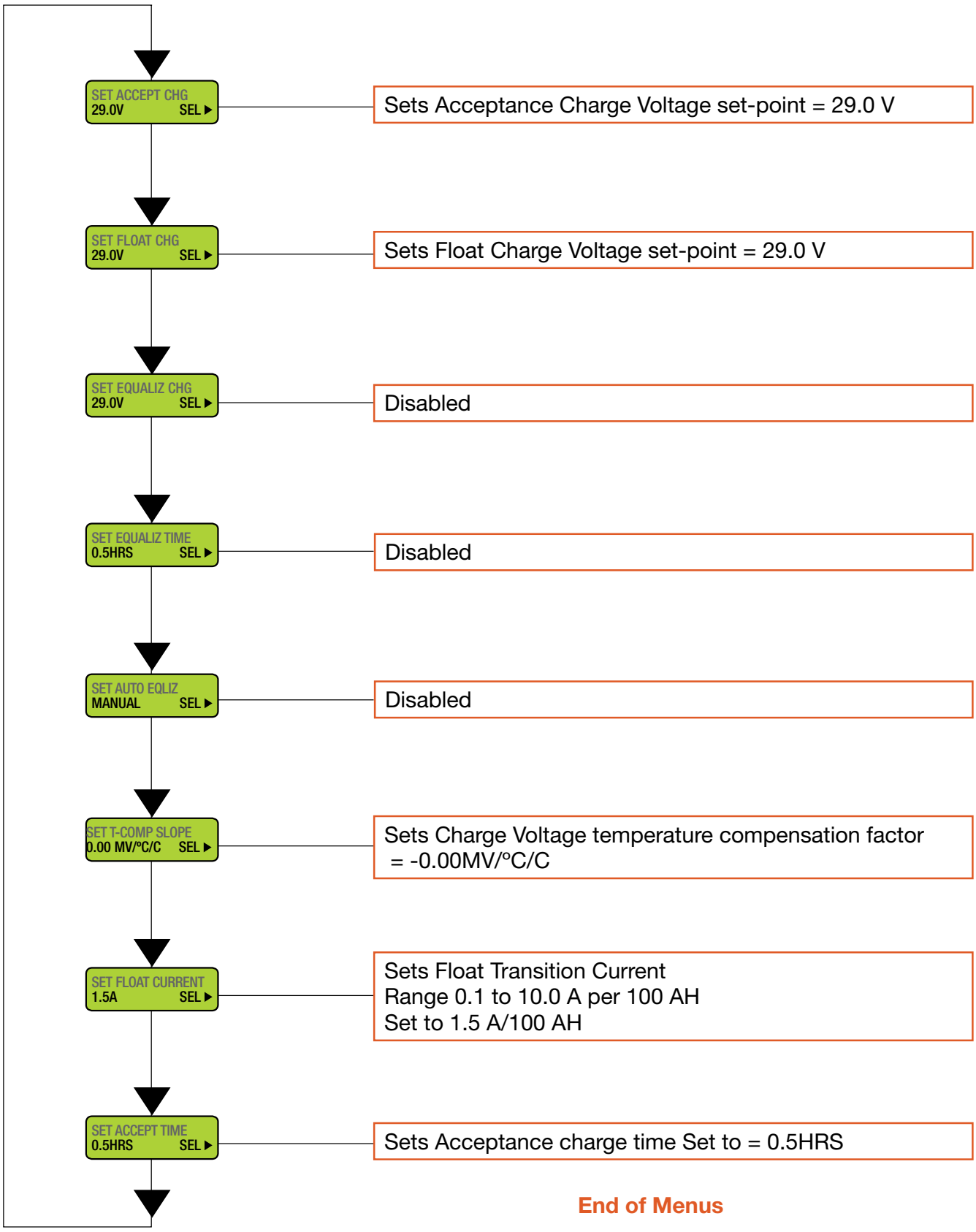
Operation and Setup Menu

Provides operational setup and auxiliary functions



Battery Charge Parameter Setup Menu

Provides access to battery charge parameters



Storing the Inter-Connect Cable

The 5’ Inter-Connect cable can be coiled and stored using the connectors on the Faceplate.

Note: These connectors are not electrically active.

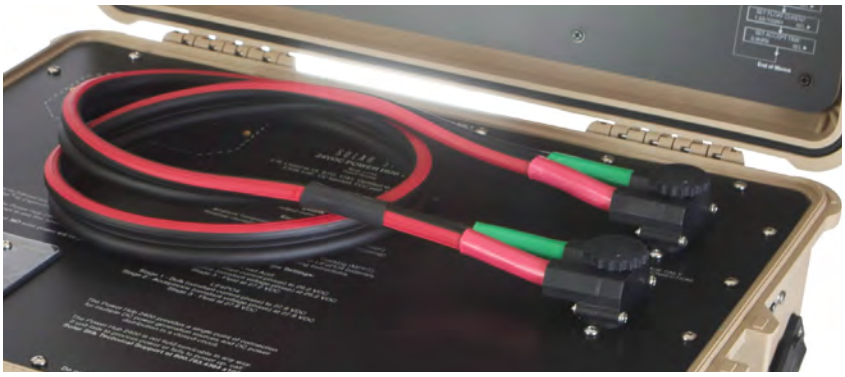


Figure 22. Inter-Connect Cable storage

Locking Component Cases to Prevent Tampering

The Power Hub 2400 can be secured with a padlock to deter tampering. Four (4) latches allow the case to be sealed to prevent damage to the internal components from environmental factors. Additionally, two (2) sets of steel-reinforced holes, one (1) in the lid and one (1) in the base of the case, flank the latches on the front of the case. A lock similar to the one shown in Figure 24 is recommended; not all locks are compatible.

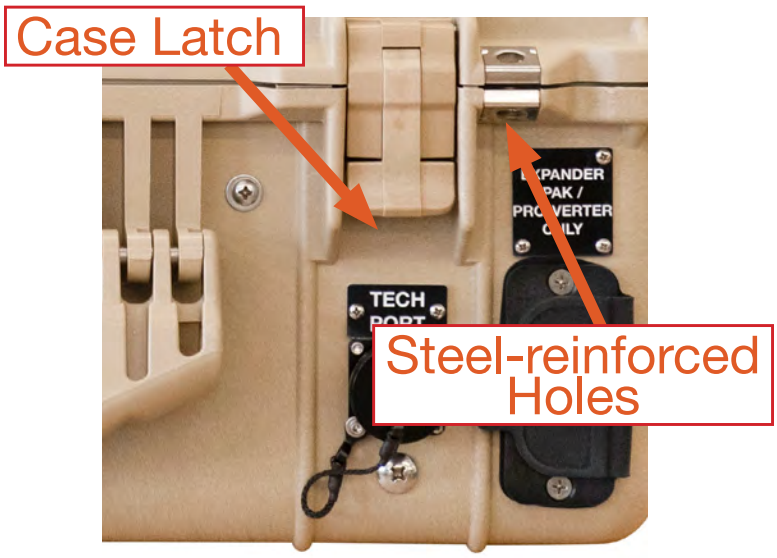


Figure 23. Steel-reinforced padlock holes

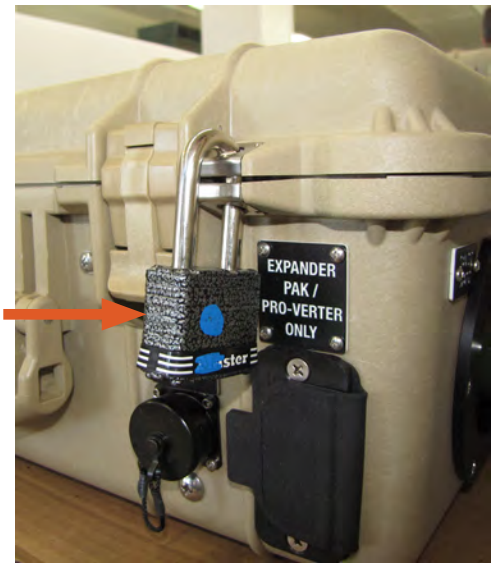


Figure 24. Lock securing Power Hub lid

Transporting the Power Hub

The Power Hub transports like a briefcase and is safe for all modes of transportation, including land, sea, and air. There are no transport restrictions.

Water Intrusion Remediation

If water intrusion is suspected, and the System is still functional, disconnect power sources entering the Power Hub 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 Power Hub from the System. Do not move or relocate what may be a flooded Power Hub.

Keep the Power Hub 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 Power Hub slowly until no more water drains from the hole. After the water has been drained, remove the Faceplate. Place the Power Hub in the most dry environment possible for a time long enough that any remaining moisture inside will dry. When it is dry, reintegrate the Power Hub to the System and test it to determine if it is still functional.

Figure 25. Drain plug screw located under the TECH PORT

TROUBLESHOOTING PROCEDURES

Power Hub Will Not Power Up

If the Power Hub 2400 is not powered up, it is probably not connected to an active 24 VDC circuit. **Solar power alone will not activate the Power Hub 2400**; it must be connected to a battery.

Other Issues

Table 2. Symptoms and Solutions for the Most Common Power Hub Issues

Symptom	Possible Cause(s)	Solution
Remaining Battery Capacity and Amp-Hours From Full show dashes (– – –)	Charge controller has not finished charging battery	Normal operation. Remaining Battery Capacity and Amp-Hours From Full displays show dashes until the battery is fully charged, **using solar power**, which initializes amp hour counting.
Remaining Battery Capacity or Amp-Hours From Full seems inaccurate	Battery not fully charged for an extended period	Since battery charge/discharge behavior is not ideal, error in the Amp-Hours From Full counter builds as the battery cycles without becoming full. Try to fully charge the battery often. The System configuration could also be at fault. Refer to the setup diagram to make sure that the System is correctly assembled.
Not registering charge current with panels operating in sun 	1. Power Hub overheated 2. Batteries fully charged (29.0 VDC or near to that)	1. Check internal temperature and “battery” temperature on User Interface. Derating begins at 104 ºF; no power as temp approaches 140 ºF. Check for dirty or blocked air vents. Shade the Power Hub to reduce solar loading. 2. Normal operation.
User Interface inoperative	1. No power to the Hub 2. The LCD screen is overheated/sunlight exposure	1. Check connections and make sure batteries are active. 2. Close lid and allow Power Hub to cool down.

Note: All battery-related readouts on the Power Hub 2400 User Interface are accurate ONLY if the batteries are connected directly to the Power Hub 2400. If the batteries are connected to the PRO-Verter (indirectly to the Power Hub 2400), then information about the battery SOC and other parameters should be obtained from the User Interface in the PRO-Verter or the optional RMK.

Recommended Operation Environment (Location)

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

Temperatures, Overheating, and Derating

The function and efficiency of all electronic equipment is related to and dependent upon the temperature at which it is operating. It performs optimally within a narrow temperature range and less so as the temperature falls outside of that range. PV panel power output drops off significantly in high heat as well.

The solar charge controllers within the Power Hub are rated to perform at full rated power until the internal temperature reaches 104 ºF (40 ºC). At this point, the charge controller will begin to "derate", or reduce its level of activity, to prevent the internal temperature from rising further. When the internal temperature of the charge controller reaches 160 ºF (71 ºC) it will "shut down" to prevent damage.

The Power Hub User Interface reports two (2) temperatures:

1. The "Battery Temperature" is reported by a temperature sensor located inside the Power Hub (NOTE: Depending on the battery type that is connected, it may or may not reflect the actual battery temperatures). This value is reported in the "BAT TEMPERATURE" window: See Advanced Information Menu Windows for directions to navigate to this window.

2. The "Internal Temperature" is measured by a thermister. This value is reported independently for each of the three (3) charge controllers inside the Power Hub. See the Method section of How to navigate the VIEW CHARGE UNIT STATUS submenus for instructions on how to navigate to these windows. If any of the temperatures reported from these sensors is greater than 104 ºF (40 ºC), the Power Hub performance will be degraded.

The first indication of overheating may be the appearance that the PV arrays are not producing charge current when connected to active PV arrays. If this is the case, check the temperature in the VIEW CHARGE UNIT STATUS windows.

Note: The Power Hub User Interface will also report "0 AMPS" charging current when the System batteries are fully charged.

Causes of Overheating

The two (2) most common reasons for the Power Hub to overheat are high ambient/internal temperatures and solar loading (heat accumulation due to the sun shining directly the Power Hub). These two factors work together to quickly elevate the internal operating temperature.
Power Hub Internal Cooling

Twin internal cooling fans are installed to maintain the internal temperatures within the optimal operating range. The fans are audible when operating. Clogged air intake filters can significantly

accelerate heat-related problems, so they should be cleaned as often as necessary to maintain maximum airflow. Clean or replace the air filter monthly, or more frequently if operating in very dusty environments.

Avoid operating the Power Hub in direct sunlight or directly on the ground. It should be placed in a shaded, well-ventilated location.

Power Hub Internal Cooling

Twin internal cooling fans are installed to maintain the internal temperatures within the optimal operating range. The fans are audible when operating. Clogged air intake filters can significantly accelerate heat-related problems, so they should be cleaned as often as necessary to maintain maximum airflow. Clean or replace the air filter monthly, or more frequently if operating in very dusty environments.

Avoid operating the Power Hub in direct sunlight or directly on the ground. It should be placed in a shaded, well-ventilated location.

Foreign Object Debris (FOD) and Water Intrusion

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

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

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

Clogged air filters reduce airflow, which in certain environments, can promote condensation inside the Hub. Condensation can cause tripped breakers/fuses and damage to the controller circuit boards over time. Clean or replace the air intake filters regularly.

MAINTENANCE INSTRUCTIONS

Preventive Maintenance, Checks and Service (PMCS)

Table 3. 24VDC Power Hub 2400 PMCS

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable
1	Visual inspection of 24VDC Power Hub 2400	M	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior, interior and connectors. 3. Close all unused port covers.	~If the case is broken or split or if connectors are damaged, do not place into service.
2	Air Intake Filters	M[1]	1. Remove the air intake vent covers to expose the filter material. 2. Wash with water and dry the filter. Reinstall. 3. If the filter is damaged or cannot be cleaned replace.	~If the filter cannot be cleaned, is too damaged to function properly and a replacement is not immediately available, the unit is partially mission capable. Replace the filter as soon as possible to restore the unit to fully mission capable.

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

Clean Power Hub Air Intake Vent Filter

The air intake vent and filter on the back of the Power Hub. The louvered vent cover is secured by two (2) cross tip screws, one on each side. A fine cross tip screwdriver or similar will be required to remove the screws (Figure 26A). After exposing the filter (Figure 26B), lift it from the vent and wash thoroughly with water, dry thoroughly and reinstall the filter and louvered vent cover. Ensure that the leading edge of the louvers are facing downward. The parts and tool required are shown in (Figure 26C).

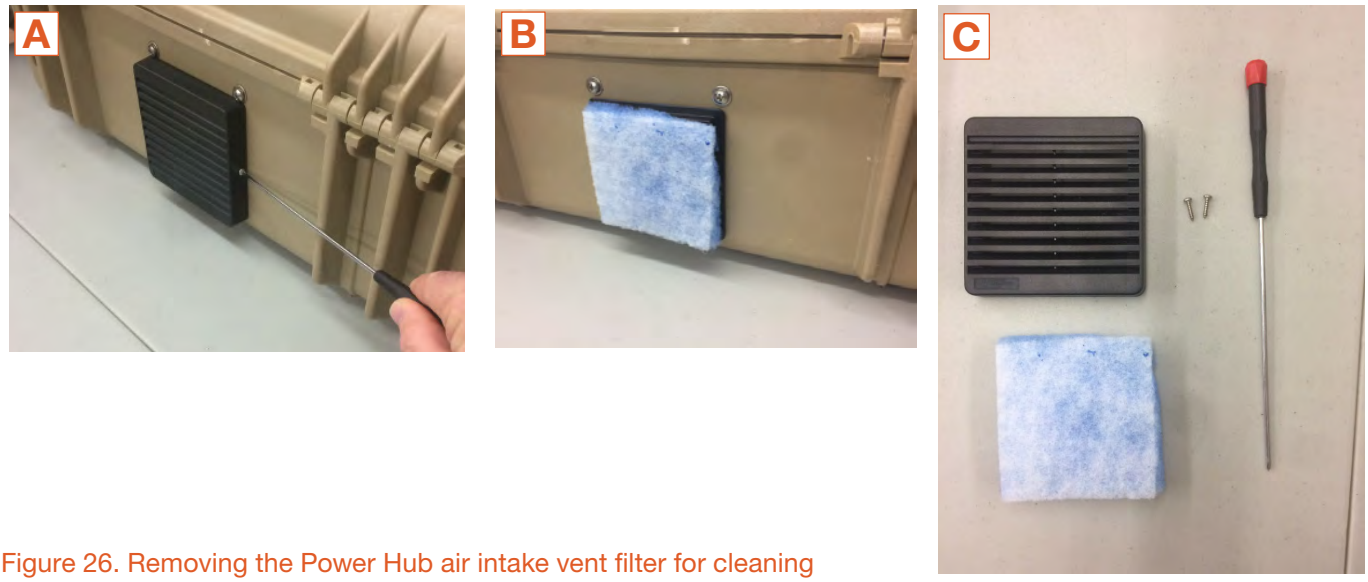


Figure 26. Removing the Power Hub air intake vent filter for cleaning

SUPPORTING INFORMATION

Power Hub Stacking

All Solar Stik Systems are scalable, and the method used for scaling Power Management components is “Stacking”. Multiple Power Hubs can be stacked when conditions warrant. Stacking can be used when a greater contribution from PV is desired, and the PV rating exceeds the ability of a single Power Hub to regulate. (Figure 27)

The combined maximum ***potential*** power output from two (2) Power Hub 2400s is 4800 W in a stacked configuration. At 24 VDC, that equals 200 A of current, equal to the 200 A max capacity of the Inter-Connect Cable. A maximum of six (6) 400 W PV arrays (~2400 W) may be connected to each of the two (2) Power Hubs to remain within the rated current capacity of a single Inter-Connect Cable in the configuration shown in Figure 27. Higher power configurations are possible with additional Inter-Connect cables and Strips.

Expansion of a system to include more solar than 4800 W of PV power is simple, but it must be done in a way that maintains the “balance” of all System components and circuits. Please contact Solar Stik Technical Support or your FSR for help with such an expansion.

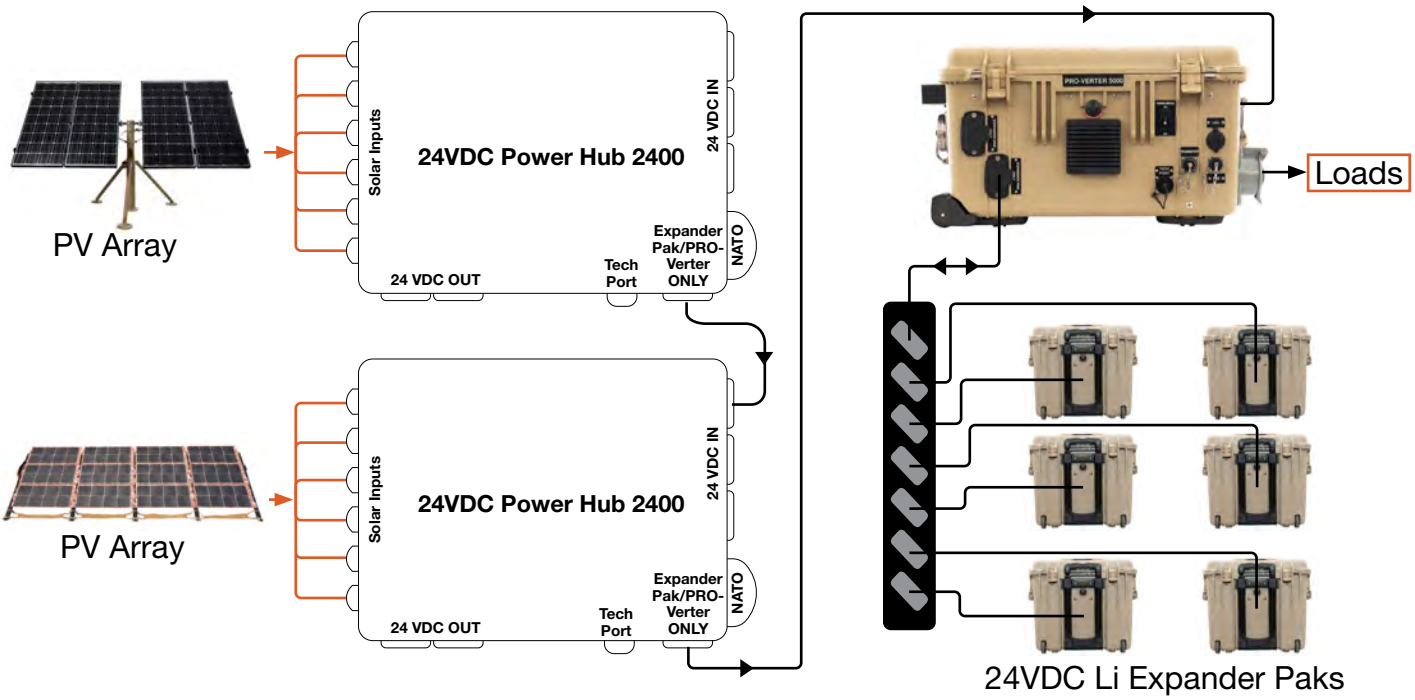


Figure 27. Stacking Power Hubs

Battery Monitor: Understanding Reported Values

The voltage and current flowing out of the Power Hub are accurate in any System configuration. The Batt Capacity % reported by the General Information Menus is accurate when both batteries and loads are connected directly to the Power Hub as shown in Figure 28.

The battery Batt Capacity % or state of charge (SOC) is calculated based on (a) the programmed amp hour (Ah) capacity of the system batteries and (b) measuring the amps that flow into and out of the battery over time (Ah counting). Measuring the battery SOC requires current to move in and out through a “metered” port: into the batteries from a charging source and out from the batteries to support loads.

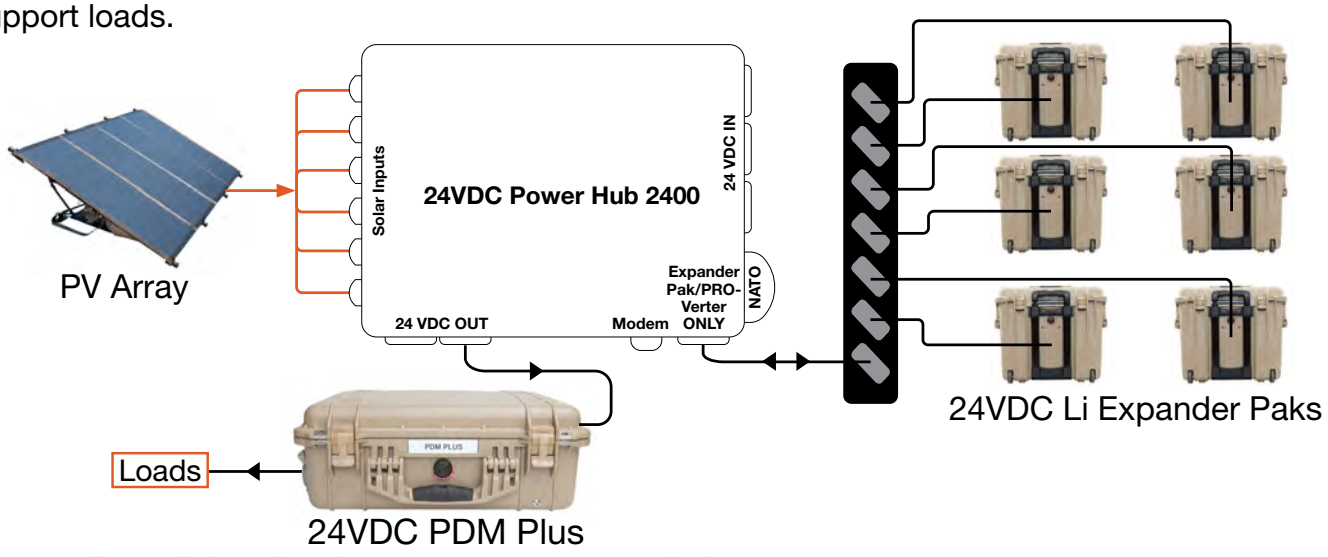


Figure 28. Power Hub as the primary power management device

If the Power Hub is connected to the system batteries indirectly, via another power management device such as a PRO-Verter the Power Hub is no longer then primary Power Management component. In this case, the SOC reported by the PRO-Verter supersedes the SOC reported by the Power Hub because the energy stored in the batteries flows to the load via the metered port of the PRO-Verter and not the metered port of the Power Hub. In this configuration, the SOC reported by the Power Hub will report 100% when the system batteries become charged fully; the Power Hub SOC will remain at or near 100% until the power is cycled.

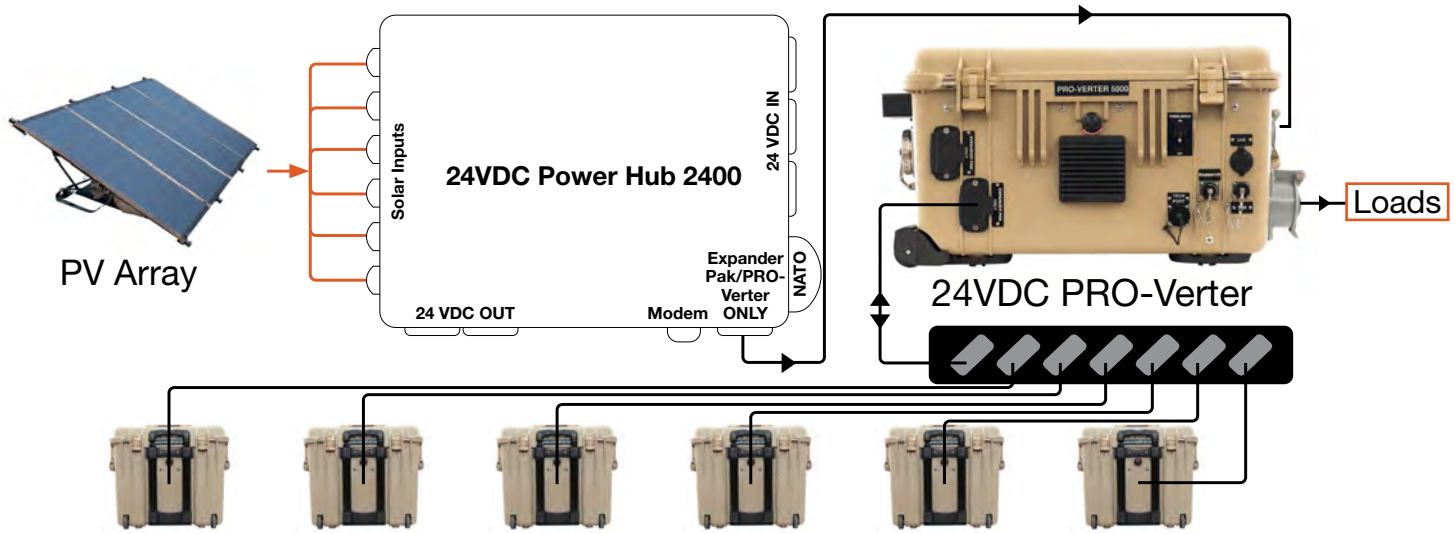


Figure 29. Power Hub as the secondary power management device

Assessing PV Array Performance

The amount of power that is produced by a PV panel depends primarily on two (2) operating conditions:

- Direct sunlight onto the PV cell
- Temperature

MPPT charge controllers optimize the power production based on two factors:

- Available PV (solar) power
- Battery state of charge (SOC)

PV array output fluctuates due to changing environmental conditions. PV power generation can degrade as the panel temperature rises, and the failure of an entire PV array may occur if a portion of a single panel is shaded or damaged. It is important to monitor the voltage and current of each charge control ("Charge Unit in the User Interface) in the Power Hub.

The DC readings should be approximately the same for every PV array across all charge controls.

Troubleshooting Individual PV Arrays Using the Power Hub User Interface

Failure of a PV panel or PV array may not be noticed during normal operation if monitoring only the total solar output current from multiple arrays in the main menu of the User Interface.

When using a single PV array in a system, the failure of a single panel may cause the entire PV array to appear failed when the solar panels are wired in series. The output from the entire PV array will be zero (0), and therefore the current of a single "charge unit" will be significantly lower.

If multiple PV arrays are connected and have equal exposure to sunlight, then the output current from each PV array should be approximately equal. The output of individual arrays can be monitored independently at the User Interface.

The diagram in (Figure 30) illustrates the connection between PV arrays and the charge controllers inside the Power Hub 2400

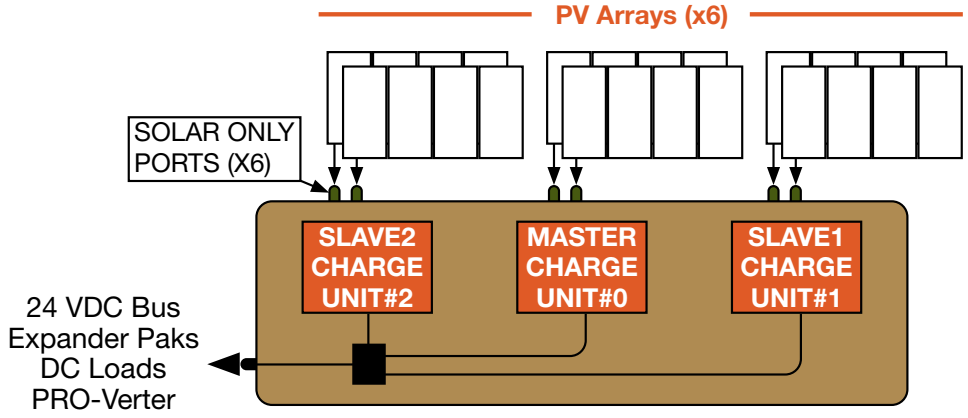


Figure 30. Power Hub 2400 SOLAR INPUT ONLY ports and their connection to charge controllers

Navigating the “Charge Unit Status” Submenus

The VIEW CHARGE UNIT STATUS menu option provides a way to monitor the output of PV arrays independently. Independent monitoring allows you to optimize the PV array performance and simplifies the identification and correction of problems with individual panels in a PV array should they arise.

Enter “Advanced Information Menu”. (See Menus and Submenus section.)

Advance to “VIEW CHARGE UNIT STATUS”.

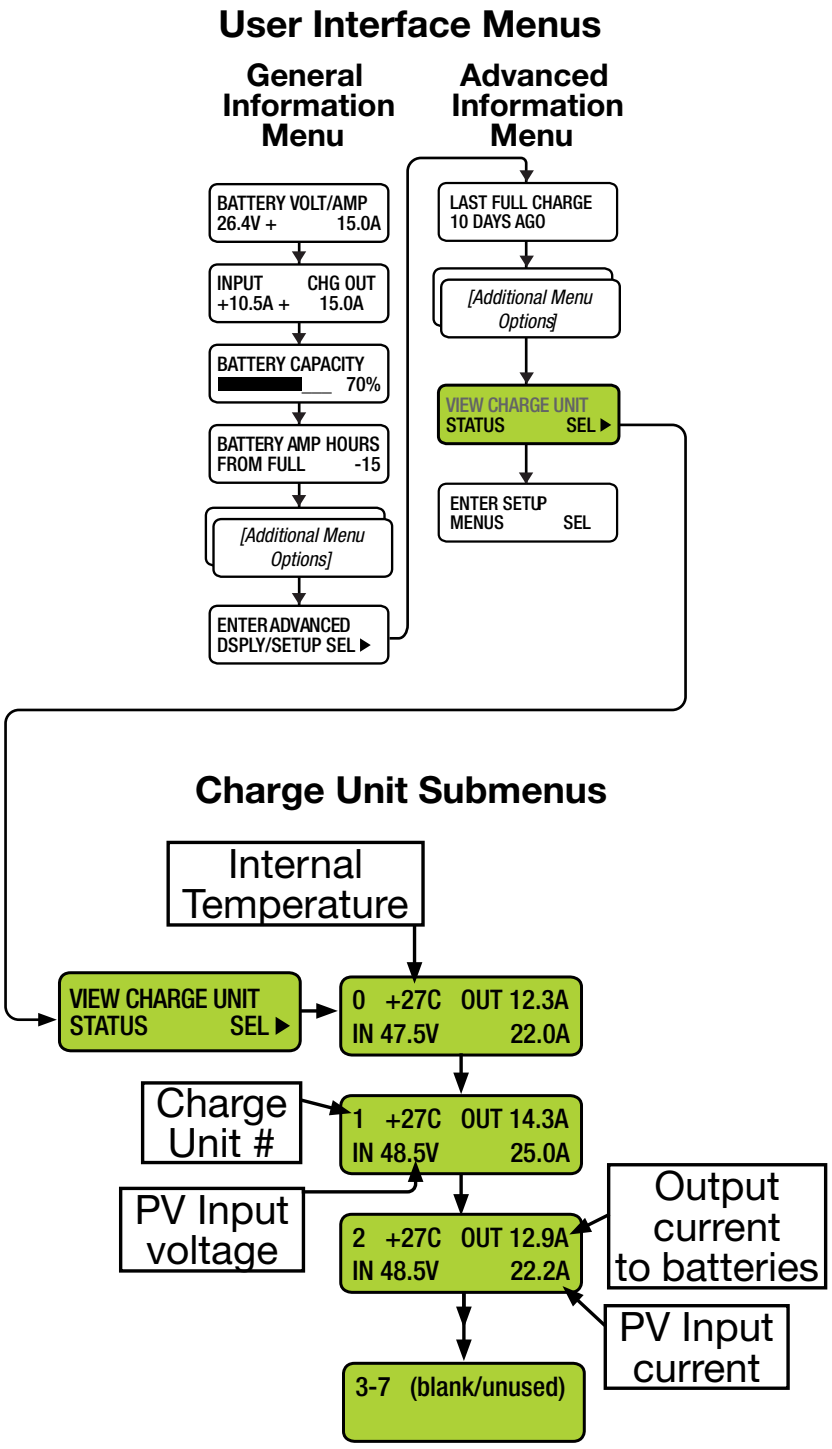
Press and hold SELECT for 4 seconds.
The number “0” displays in the upper left corner. This is the MASTER/ CHARGE UNIT #0. This window reports solar input voltage and current, output current to batteries, and the internal temperature for the pair of solar panels connected to the ports labeled MASTER/CHARGE UNIT #0.

Press NEXT.
The number “1” displays in the upper left corner. This is SLAVE1, CHARGE UNIT#1. This window reports same as the master but for the pair of solar panels connected to SLAVE1 input ports.

Press NEXT.
The number “2” displays in the upper left corner. This is SLAVE2, Charge Unit#2. This window reports same as the master but for the pair of solar panels connected to SLAVE2 input ports.

Press NEXT.
The number “3” displays in the left corner. The rest of the screen is blank because no charge controller occupies this channel.
Note: Menu windows for Charge Units 3-7 contain only the Unit # in the upper left hand corner

Press BACK to exit this submenu.



SUPPORTING INFORMATION

Specifications

General	
Solar Charge Controls	Maximum Power Point Tracking (MPPT)
Maximum Input Voltage	57 VDC
Battery (Output) Voltage	20–30 VDC Programmable
Maximum PV Input Current	100 A (@ 24 V nominal)
Maximum Total Bus Current	300 A
Cooling	(2) Internal fans and case brow venting
Circuit Protection	Automatic
Reverse Polarity Protection	Automatic
Temperature Protection	Automatic
Case	Pelican 1600
Warranty	1-year materials and workmanship

Weights and Dimensions (L x W x H)	
Weight	45 lb (20.4117 kg) Including Inter-Connect cable
Dimensions	24.39 x 19.36 x 8.79 in (62.0 x 49.2 x 22.3 cm)

Connections	
Solar Port	(6) 24 VDC Amphenol Bayonet (CB2-22-2SC)
DC Input Port (regulated DC)	(3) 24 VDC Inter-Connect*
NATO	(1) NATO 24 V Slave
24 VDC PRO-Verter/Battery	(1) Inter-Connect*
24 VDC Load/Bus	(2) Inter-Connect*

Environmental	
Operating Temperature	-50 °C to + 75 °C (-58 °F to +167 °F)

Includes
(1) 5-foot Inter-Connect Cable

Inter-Connect Port = Deltran 224-0061-BK

Accessories

Solar Remote Monitoring Kit (RMK) LAN
Item # 20-0702601

24VDC 5’ Inter-Connect Strip 7
P/N: 113-1000160

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

Warranty and Returns

Return Material Authorization

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

Warranty

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

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

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

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

ABOUT SOLAR STIK, INC.

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

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

Solar Stik Training and Education

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

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

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

Contact

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