SOLAR STIK®

LO System Training 01/29/2023

Overall Schedule

Training Schedule: 29 January, 2023 – 02 February

- 0700 – 0900 Training
- 0900 – 1000 Breakfast
- 1000 – 1300 Training
- 1300 – 1400 Lunch
- 1400 – Until completion for the day

Overall Schedule

Training Schedule: 29 January, 2023

- 0700 – 0900 History and Introduction
- 0900 – 1000 Breakfast
- 1000 – 1300 Environmental, Handling, Safety, System Overview and Components
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

Overall Schedule

Training Schedule: 30 January, 2023

- 0700 – 0900 System Sizing
- 0900 – 1000 Breakfast
- 1000 – 1300 System Set Up and Start Up
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

Overall Schedule

Training Schedule: 31 January, 2023

- 0700 – 0900 System Monitoring and Control
- 0900 – 1000 Breakfast
- 1000 – 1300 System Operation
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

Overall Schedule

Training Schedule: 01 February, 2023

- 0700 – 0900 PMCS and Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 System Hands On Setup
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

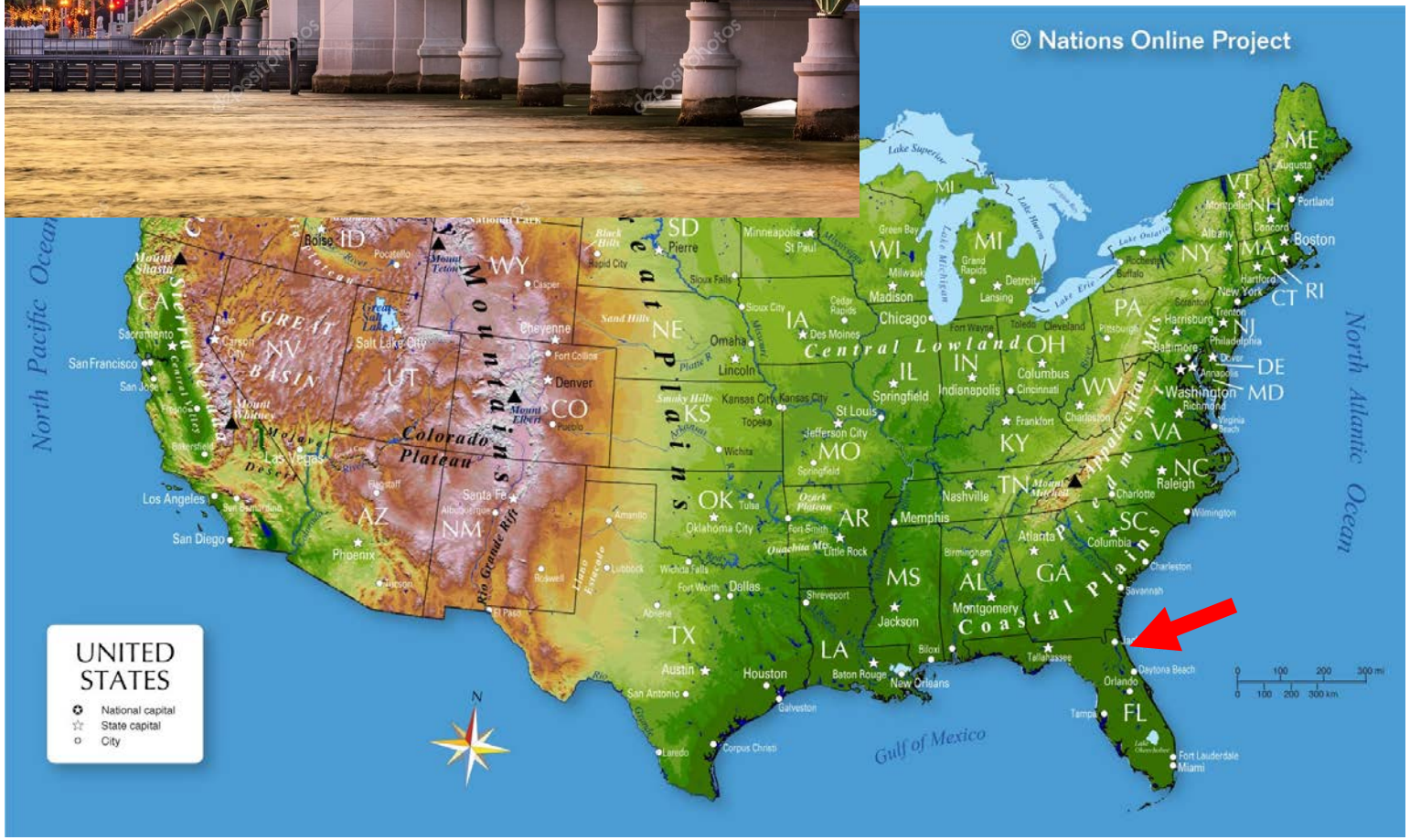
Overall Schedule

Training Schedule: 02 February, 2023

- 0700 – 0900 Live Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 Hands on Breakdown and Q/A
- 1300 – 1400 Lunch
- 1400 – TBD Quiz and Certificate Presentation

History and Introduction

SOLAR STIK®



Saint Augustine, Florida
America's "oldest city" – 1565

Presentation Outline

- Who We Are
- What We Do
  - Our Mission
- Power Basics
- Solar Stik History
- Solar Stik Today
  - Why Hybrid?
  - Hybrid Power Spectrum
- Solar Stik Hybrid Systems
  - Design Principles
  - Leading Edge vs Cutting Edge
  - Intuitive Setup and Operation
- Customer Support
- Product Categories
  - Hybrid System Examples
- Our Focus

Solar Stik, Inc.

- Founded in 2006
- Based in St. Augustine, FL, the oldest city in North America
- Woman Owned Small Business
- SBA certified HUB Zone
- 60+ Team Members
- Made in the USA with American-made components
- Innovators
- Family

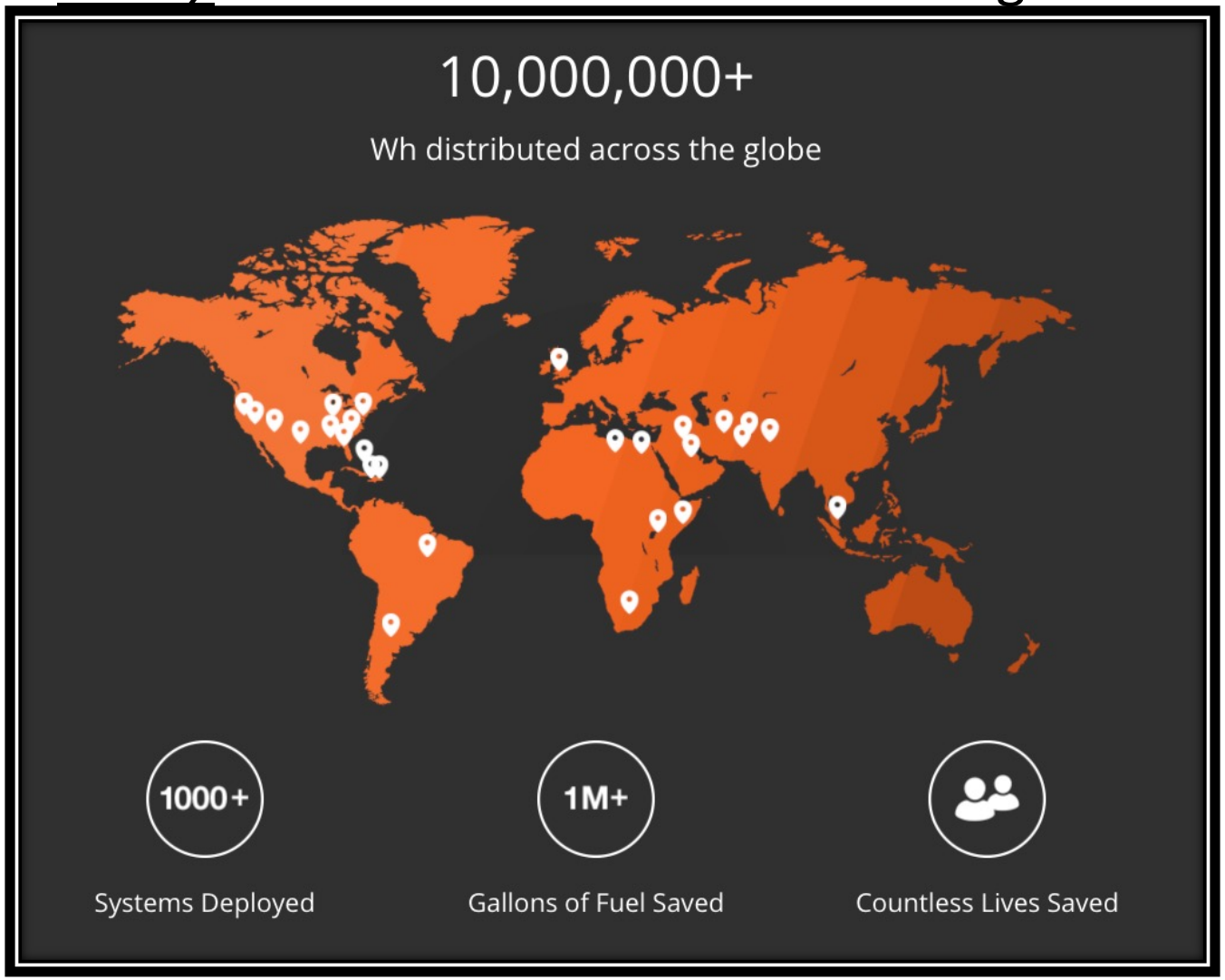
Our Mission

SAVING LIVES ACROSS THE GLOBE THROUGH INNOVATIVE POWER SOLUTIONS

SOLAR STIK®

Powering the Impossible!

Solar Stik autonomous energy solutions provide *power surety* to sustain missions across the globe.



Deployed Worldwide

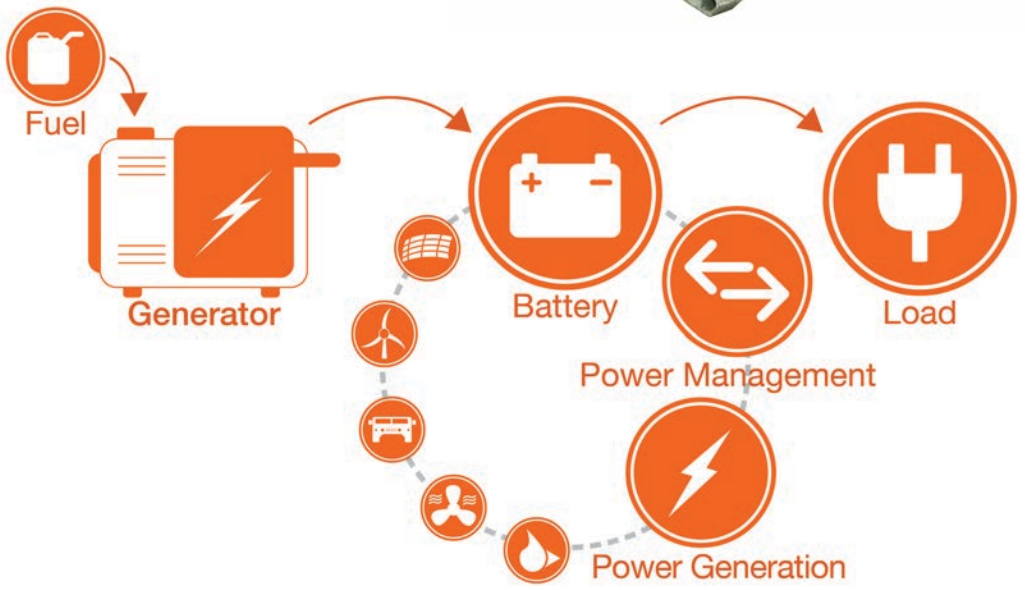
- Qty 100 + Alternative Energy System (AES) to power the United States Army Persistent Surveillance System – Ground (PSS-G)
- Qty 15 Hybrid Power System for United States Army Ground-Based Operational Surveillance System (G-BOSS E)
- Qty 30 Hybrid Power System for United States Air Force Ground-Based Operational Surveillance System (G-BOSS AF)
- Qty 45 Hybrid Power System for United States Army Security Force Assistance Brigades (SFAB)
- Qty TBD Hybrid Power System for United States Marine Corps Mobile Electric Hybrid Power Systems (MEHPS, partnered with Cummins)
- Qty 5 Hybrid Power System for United States Judicial Security Division and Administrative Office of the United States Courts
- Qty 51 Hybrid Power System for Foriegn Military Sale via ATSC MS3 and ATSC MBSS
- Qty 1 Solar Power System for Dutch Ministry of Defense (MOD)
- Qty 100 + Solar Power System for the Northrop Grumman Outdoor Node of the Rocket, Artillery, Mortar (RAM) Warning System RAM
- Qty 6 Solar Power System for J6 Contingency IT's mission to support Global Response Force – Rapid Deployment Teams (GRF-RDT)
- Qty 11 Solar Power System for Oak Ridge National Lab (ORNL)
- Qty 11 Solar Power Systems for Emergency Fire Alarm System Naval Facilities Engineering Systems Command (NAVFAC)
- Qty 14 Power Systems for United Nations Office for Project Services (UNOPS)

Creating Global Hybrid Power Systems

Designs → Manufactures → Deploys → Supports

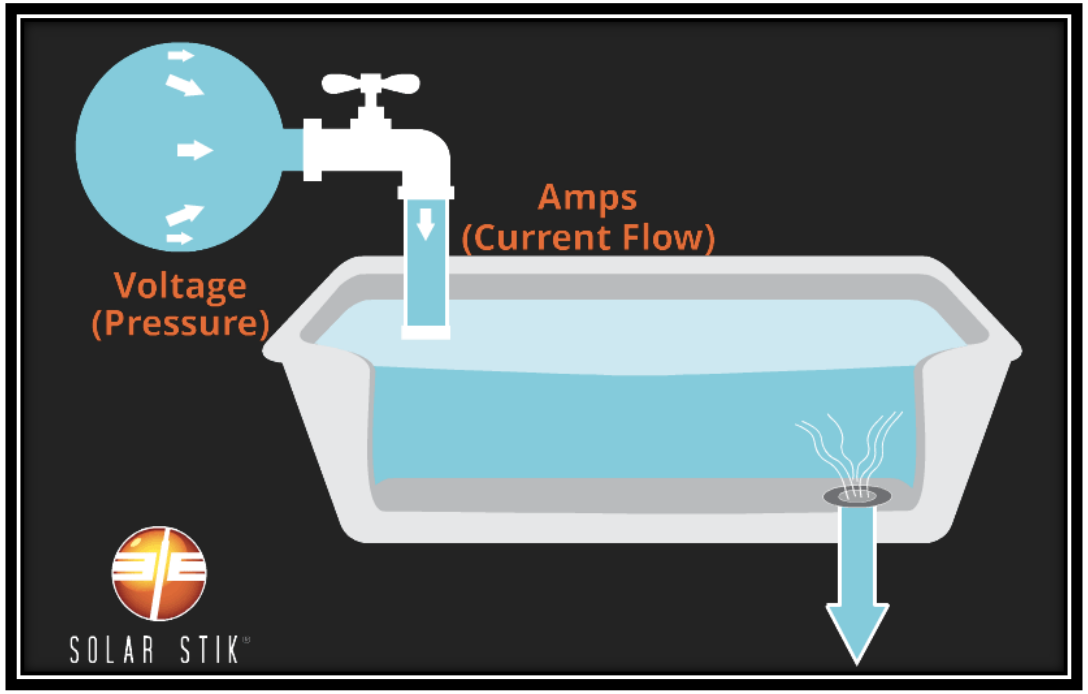
Power Basics:
The Road to Hybrid Power

- Power vs Energy
- Dynamic Nature of Electric Loads
- Power in the Field
- Traditional Power and Hybrid Power

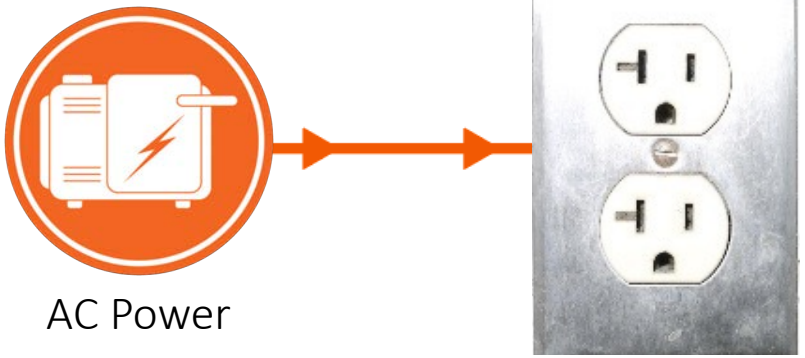


Power Basics:
Formula 101

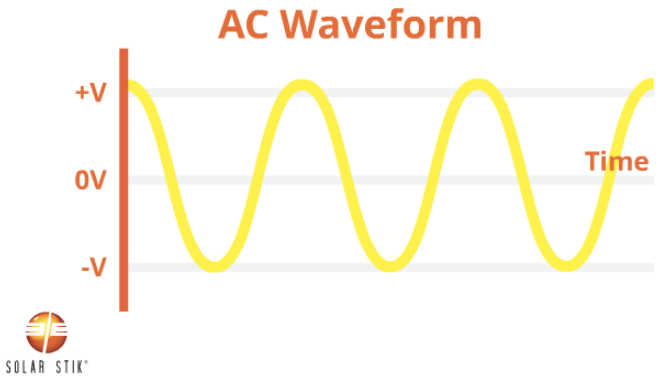
- Amperage = Current
- Voltage = Pressure
- Amperage x Voltage = Watts
- Watts = Power
- Power (watts) x time (hours) = Energy (Wh or kWh)



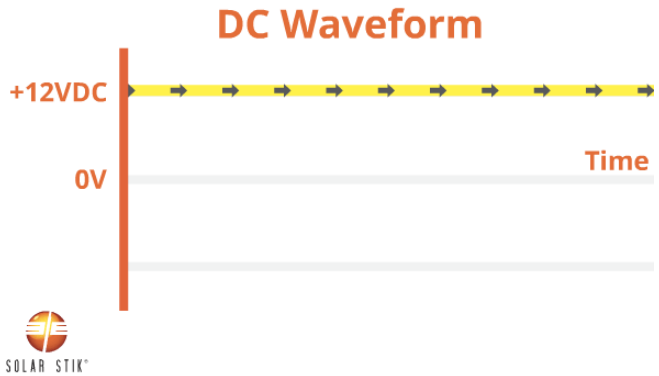
Power Basics:
AC vs DC



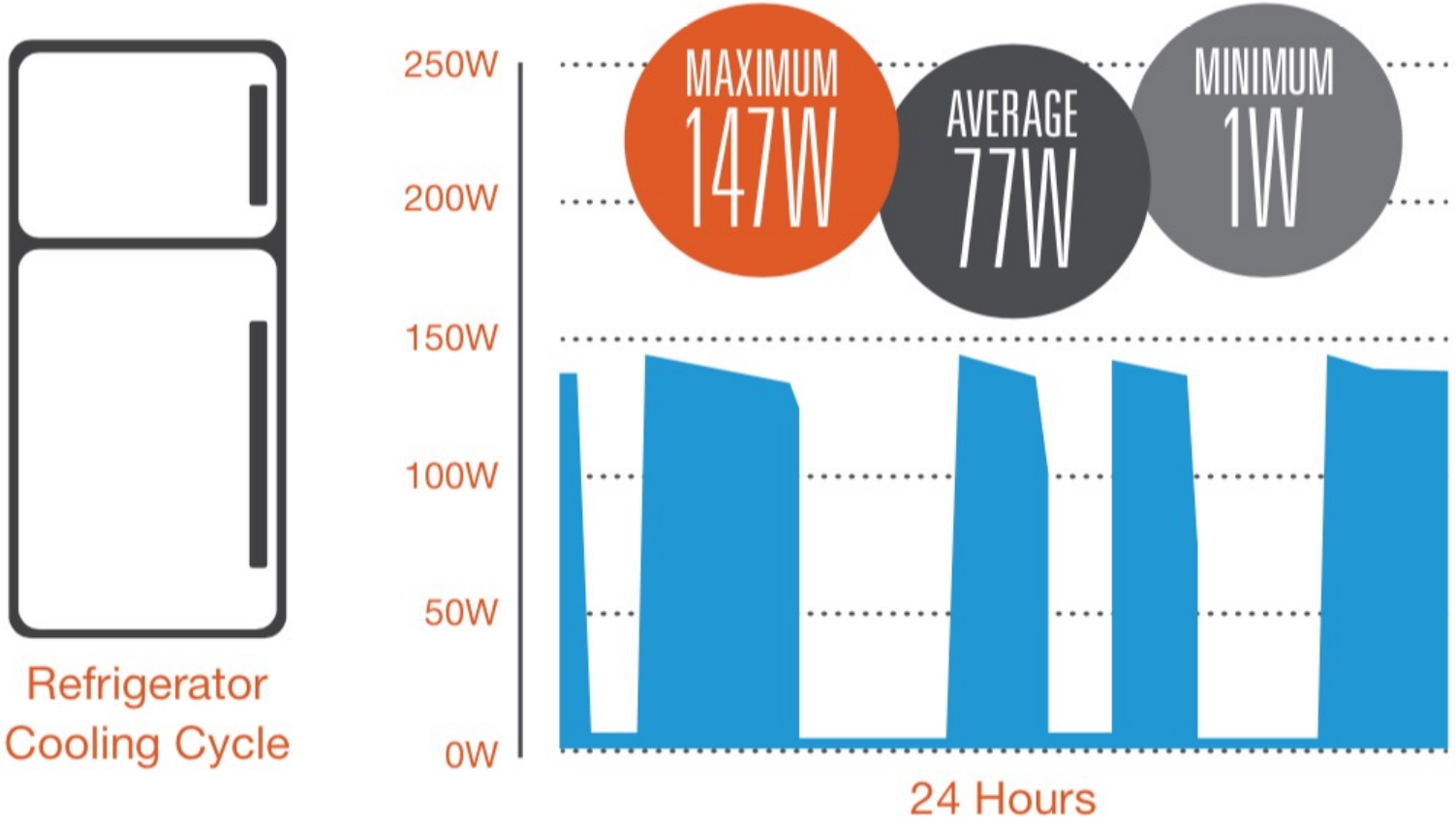
AC Power



DC Power



Power Basics:
Dynamic Nature of Electric Loads



Traditional Power

Sized for peak or surge loads

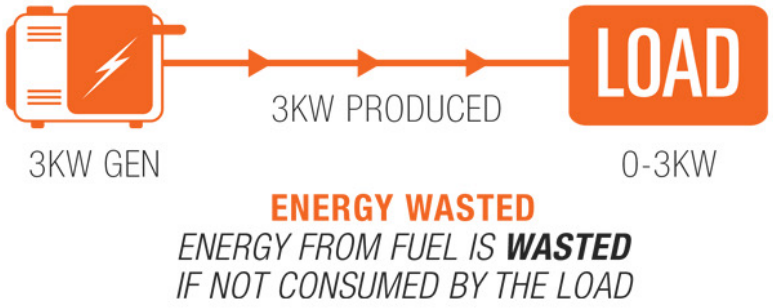
Relies on generator power only

Produces more power than consumed

Requires maximum maintenance and logistics support

Traditional Power

Low Efficiency, Closed Architecture, Strained Generator



Traditional Tactical Power in the Field

Hybrid Power

Sized for continuous loads

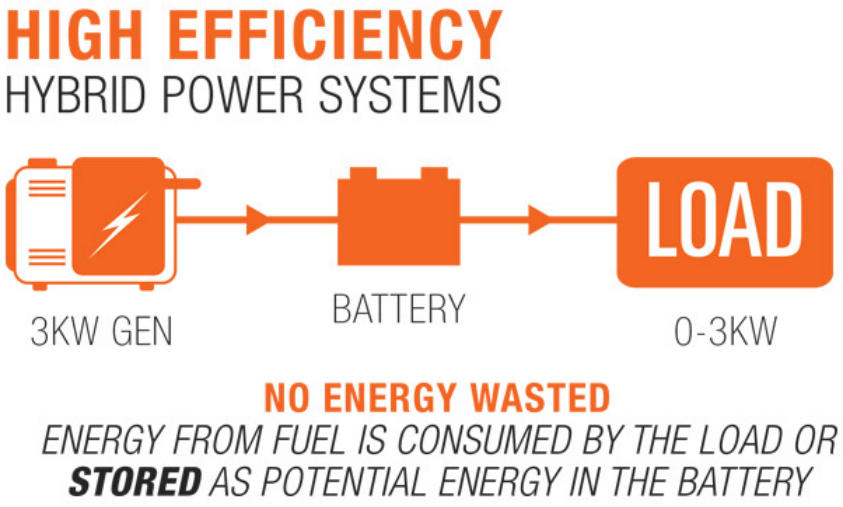
Can supplement with renewable power sources

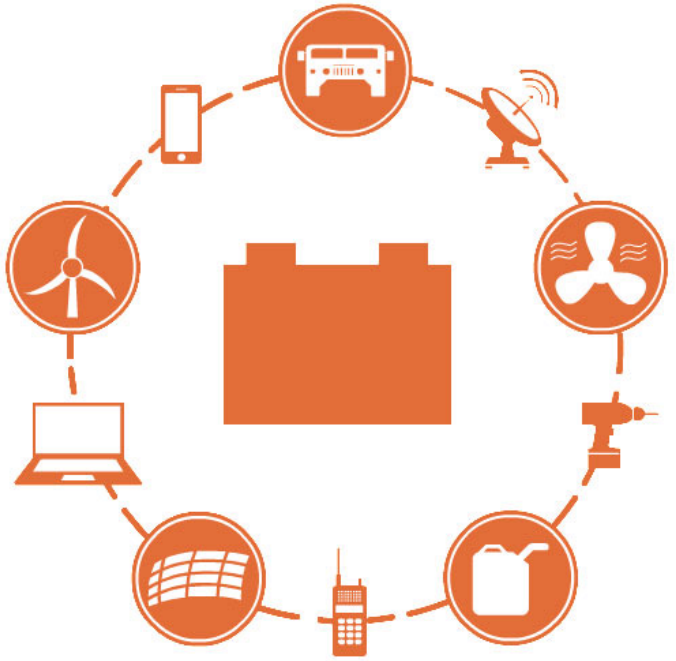
Consumes or stores all power generated

Requires minimum maintenance and logistics support

Solar Stik = Hybrid Power

High Efficiency, Open Architecture, Protected Generator





Hybrid Power in the Field

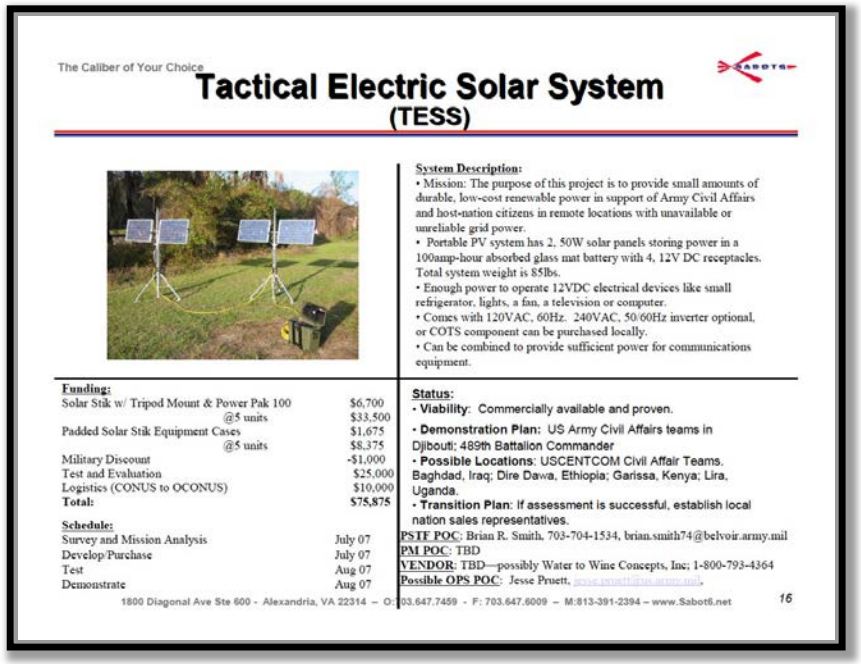
Solar Stik's History with Hybrid Power

1998 – 2003

Parallel Worlds – Sailing and Portable Power

2004 – 2006

Development of the System



The Caliber of Your Choice

Tactical Electric Solar System (TESS)

System Description:

- Mission: The purpose of this project is to provide small amounts of durable, low-cost renewable power in support of Army Civil Affairs and host-nation citizens in remote locations with unavailable or unreliable grid power.
- Portable PV system has 2, 50W solar panels storing power in a 100amp-hour absorbed glass mat battery with 4, 12V DC receptacles. Total system weight is 85lbs.
- Enough power to operate 12VDC electrical devices like small refrigerator, lights, a fan, a television or computer.
- Comes with 120VAC, 60Hz. 240VAC, 50/60Hz inverter optional, or COTS component can be purchased locally.
- Can be combined to provide sufficient power for communications equipment.

Funding:

Solar Stik w/ Tripod Mount & Power Pak 100	$6,700
@5 units	$33,500
Padded Solar Stik Equipment Cases	$1,675
@5 units	$8,375
Military Discount	-$1,000
Test and Evaluation	$25,000
Logistics (CONUS to OCONUS)	$10,000
Total:	**$75,875**

Schedule:

Survey and Mission Analysis	July 07
Develop/Purchase	July 07
Test	Aug 07
Demonstrate	Aug 07

Status:

- **Viability**: Commercially available and proven.
- **Demonstration Plan**: US Army Civil Affairs teams in Djibouti; 489th Battalion Commander
- **Possible Locations**: USCENTCOM Civil Affair Teams. Baghdad, Iraq; Dire Dawa, Ethiopia; Garissa, Kenya; Lira, Uganda.
- **Transition Plan**: If assessment is successful, establish local nation sales representatives.

PSTF POC: Brian R. Smith, 703-704-1534, brian.smith74@belvoir.army.mil
PM POC: TBD
VENDOR: TBD—possibly Water to Wine Concepts, Inc; 1-800-793-4364
Possible OPS POC: Jesse Pruett, jesse.pruett@us.army.mil,

1800 Diagonal Ave Ste 600 - Alexandria, VA 22314 – O: 703.647.7459 - F: 703.647.6009 – M:813-391-2394 – www.Sabot6.net

16

2007 – 2008

First DoD Acquisitions and Fieldings

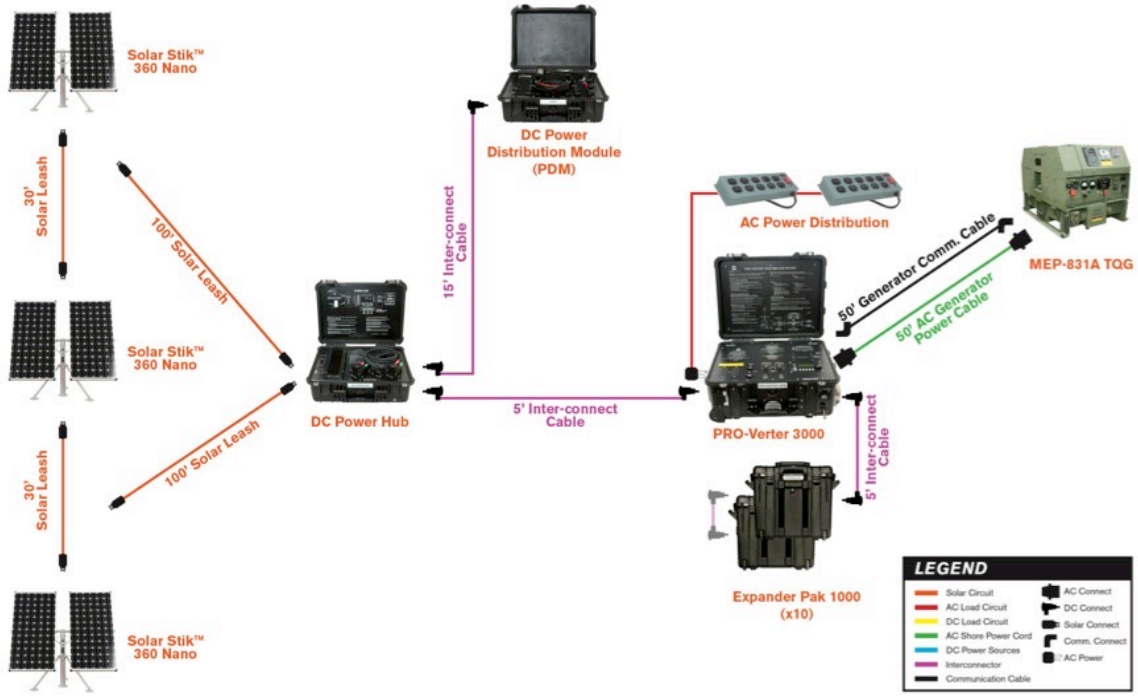
2009

GREEN CP: JUICE

The **objective** is to develop a comprehensive, user-friendly technical solution that enables a conventional fuel-powered **US Army tactical generator set to operate** seamlessly **with a connected renewable energy** (solar and wind) powered generator(s) in **a *seamless, automated* fashion** for the purposes of ***reducing fuel consumption*** **and** ***run time*** **of the conventional generator**.

2010

CRADA w/PM-MEP



2011

REF Deploys 3kW TQG Hybrid Systems

Force Protection

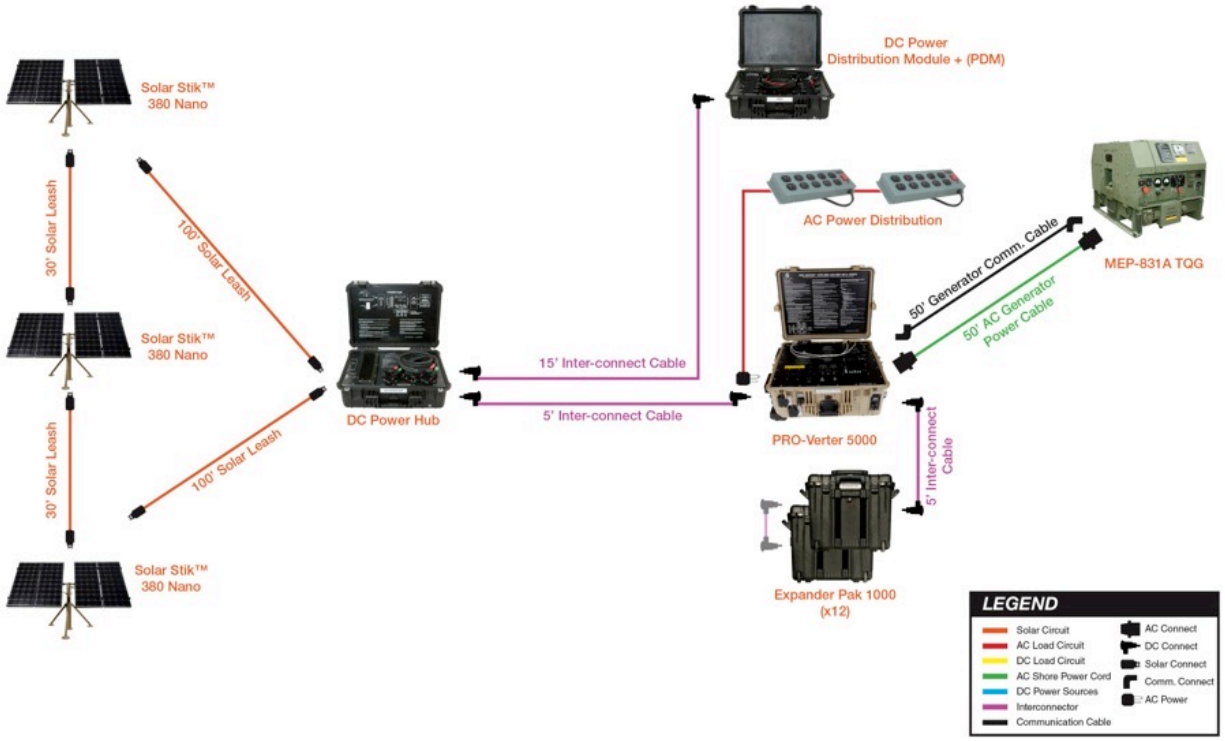
AEWE & NIE Exercises

C4ISR

Intelligence

2012

Deployment and Field Testing



2013

REF 2nd Deployment of Hybrid Systems

Aerostats

TALS for UAV

2013

Expanded Utilization in Theater

2013 – 2014

ExFOB and Follow-on Testing

2014

Selected for PSS-G AES

2014

RAM Warn 3.0 becomes POR

“Life is a Journey…
Relationships are adventures along the way!”

2015-2016

FSRs support Solar Stik Systems in theater

2017

Selected to support ATSC MS3

2018

Solar Stik sets sites on new House of Stik

2019

Continued growth, one year at a time

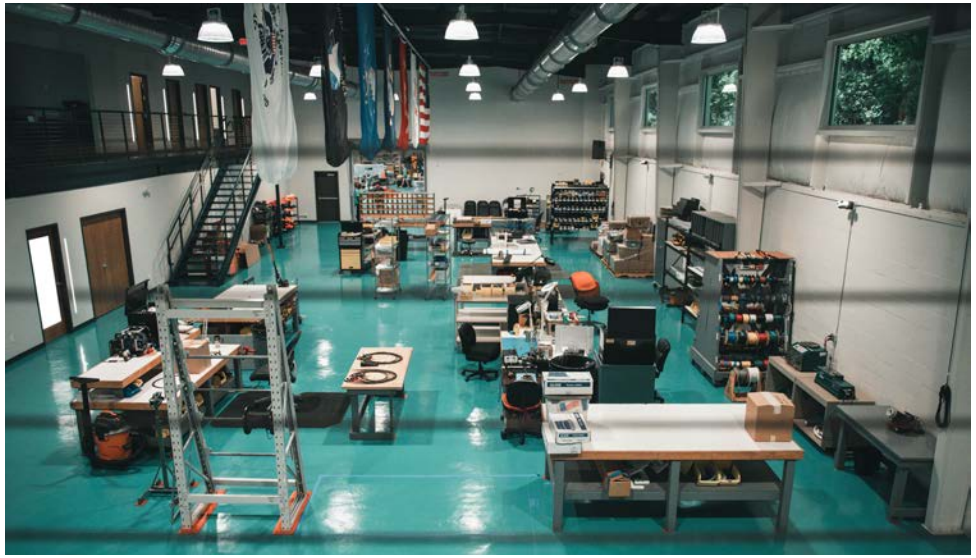
2020

Groundbreaking on House of Stik

2021

Solar Stik selected for MEHPS

Solar Stik Today



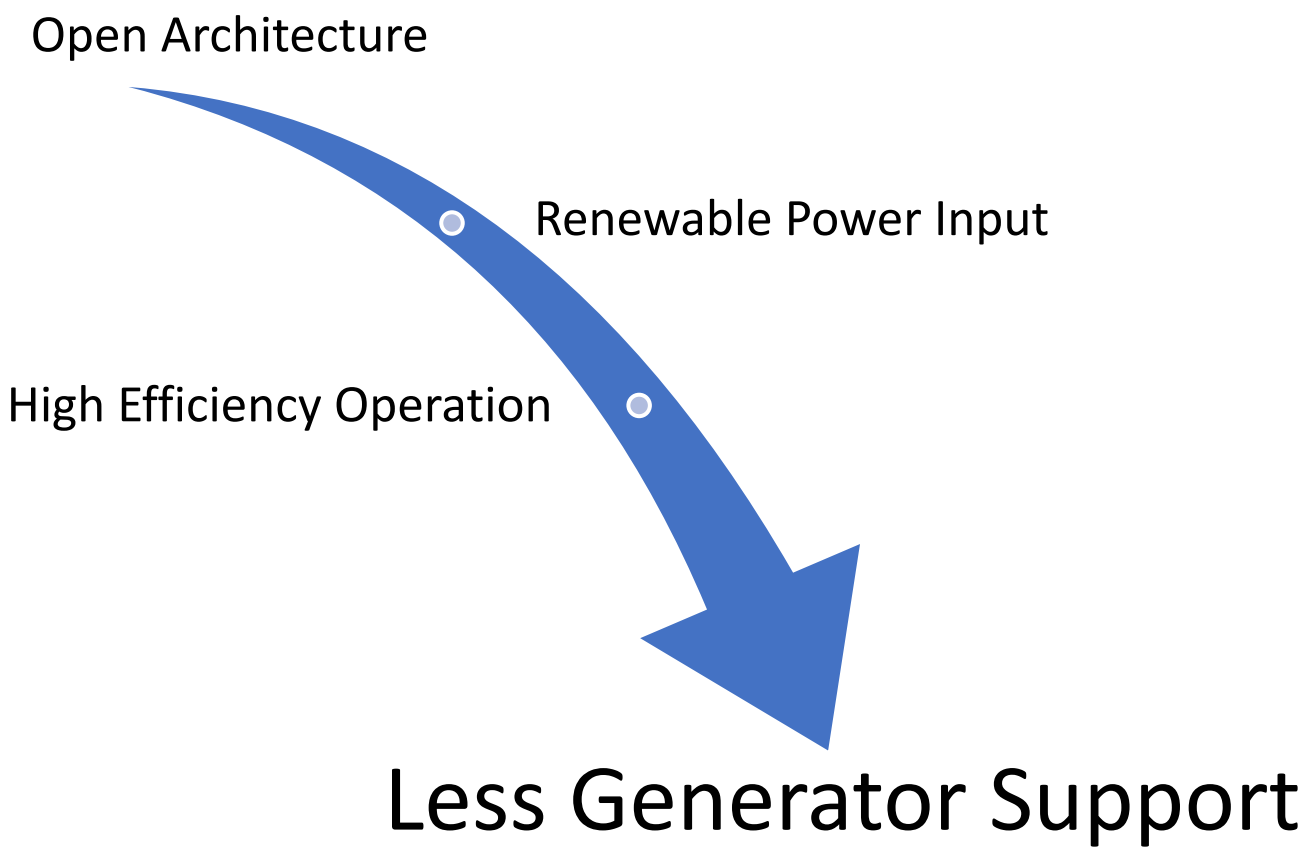
Superior

Technology

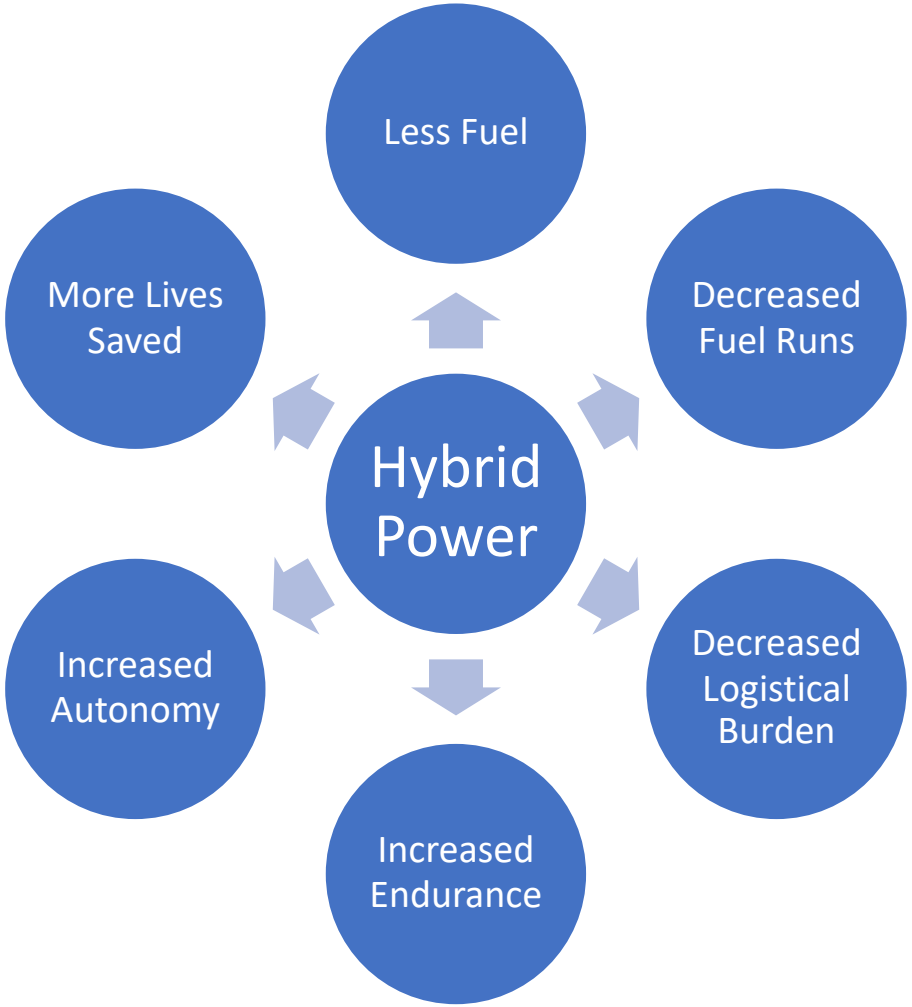
Integration

Knowledge

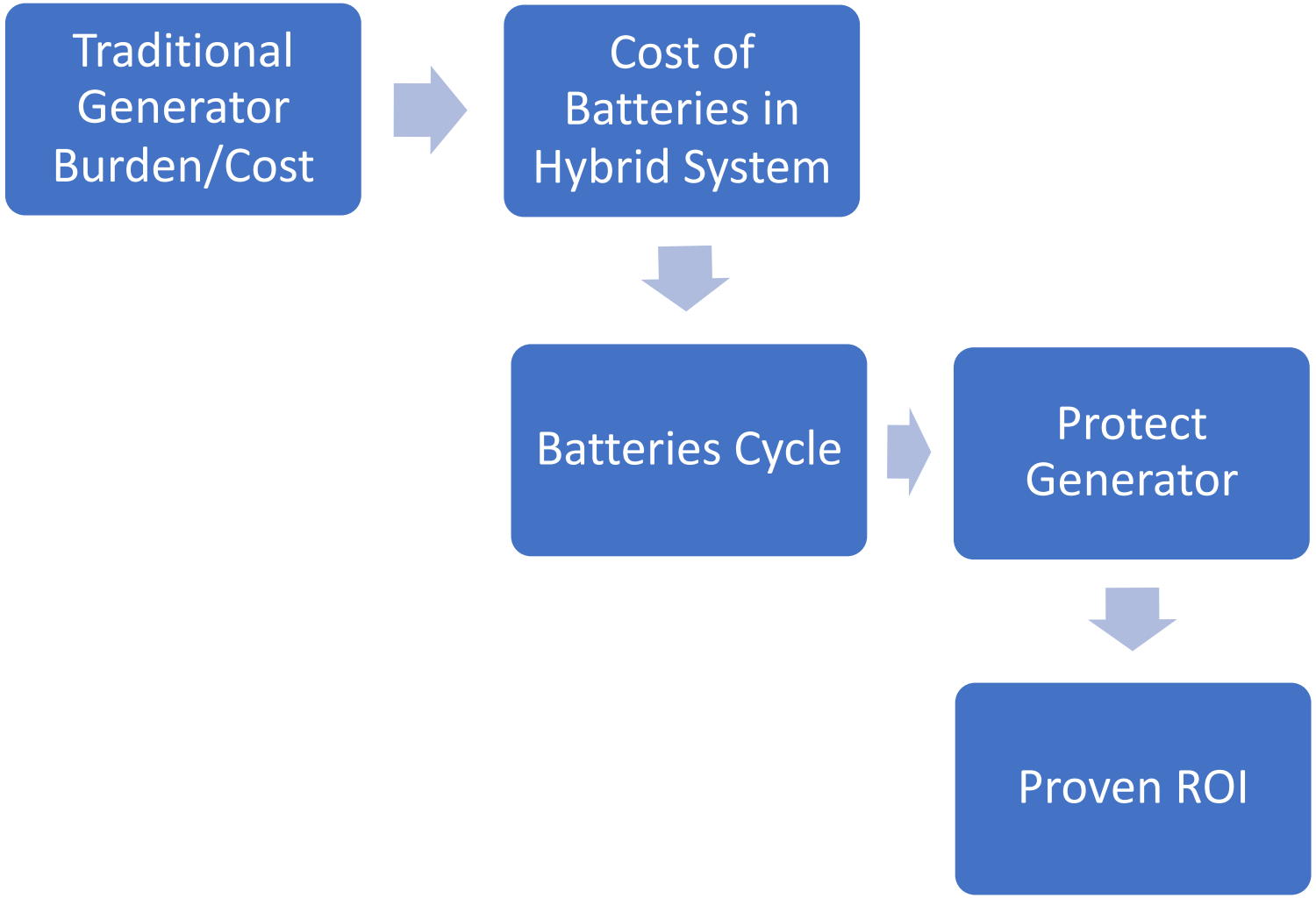
Hybrid Power = Less Generator Support



Hybrid Power = Mitigated Risk



Hybrid Power Paradigm Shift



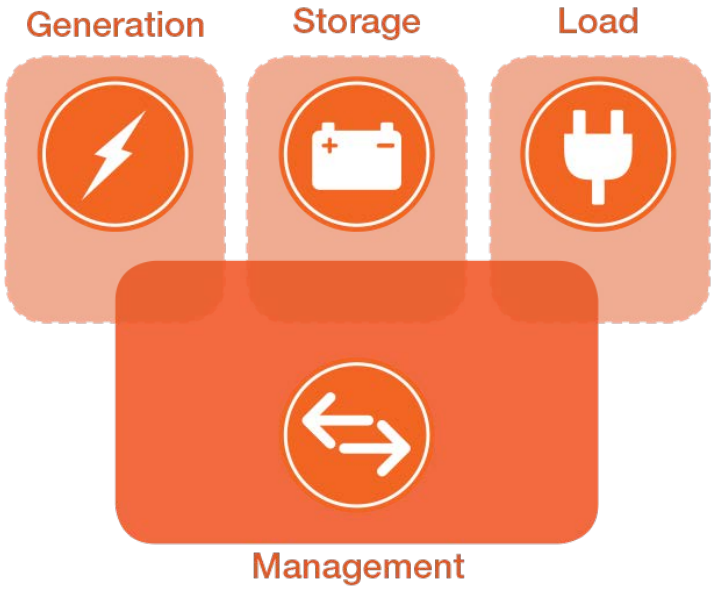
Hybrid Power
Operating Spectrum

1kW

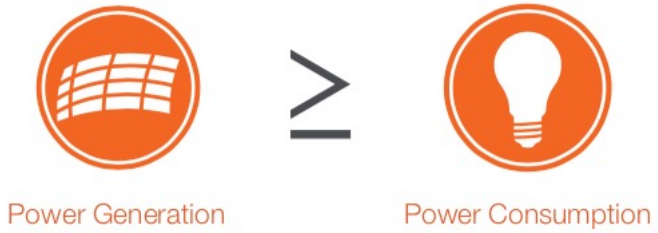
15kW

High-Efficiency Hybrid Circuits

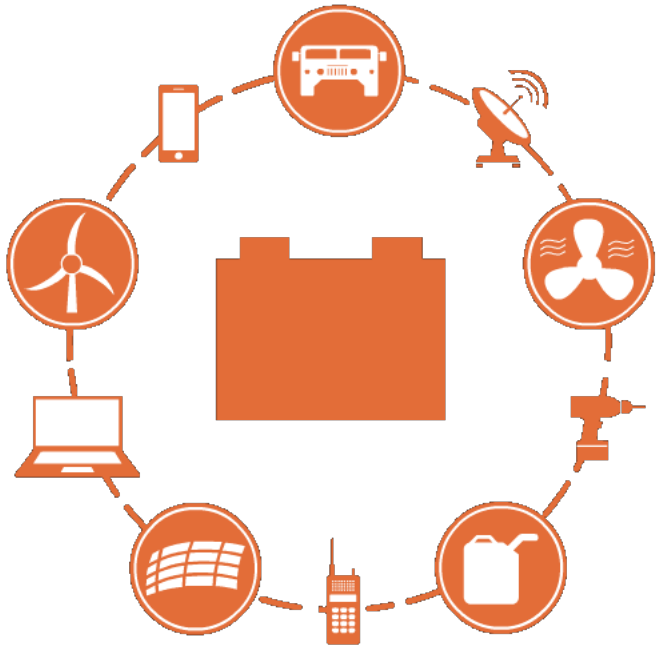
Hybrid Power Systems have 4 main categories of equipment



Power Generated must be ≥ Power Consumed by the Load



Energy Storage:
The “Heart” of Solar Stik Hybrid Power



Solar Stik Hybrid Systems Principles of Design

Portable/Mobile

- All components easily transportable

Adaptable

- Open/modular architecture

Scalable

- Expanded or contracted based on load requirements

Durable

- Mil-spec, rugged
- Low failure rate, reliable

Autonomous

- Focus on Power Management and Efficiency

Solar Stik Hybrid Systems
Integrating Leading Edge vs. Cutting Edge Technologies

Cutting Edge Technology

- Rare or experimental technologies
- High production cost
- Minimal safety & training available
- Unpredictable performance
- Unstable financial backing
- Limited support structure
- High failure rates

Leading Edge Technology

- Vetted technologies
- Manufacturable
- Stable availability of components
- Field-proven & supported
- Safety & training programs in place
- Established customer base
- Established ROI and Value Statements

Solar Stik Hybrid Systems: Intuitive Setup

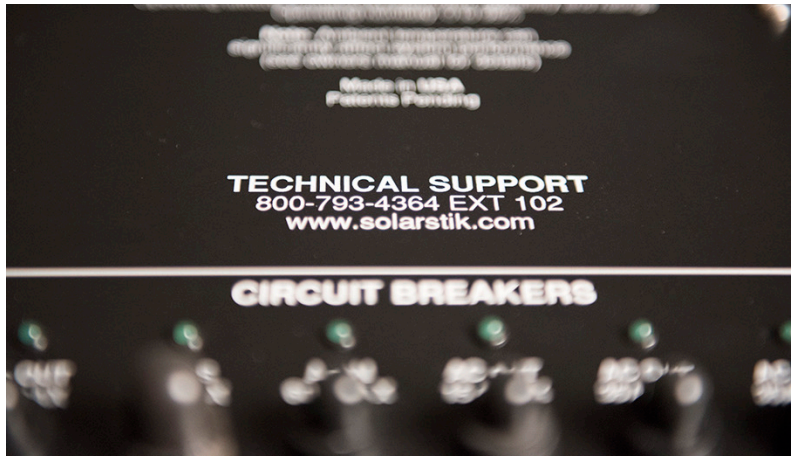
- Plug & Play
- System Safety

Solar Stik Hybrid Systems:
Simplicity of Operation

I-Plates are installed on major power management components, eliminating the need for complex manuals.

Extreme Customer Service and Tech Support

Technical Support information is on every piece of equipment we make



Education and Training

Product Categories: Power Generation

- Agnostic about power sources
- Practical selections

Product Categories: Energy Storage

- Energy Storage platforms include:
  - Power management
  - Scalable energy storage
- Plug & Play Inter-Connect System
- 12 VDC / 24 VDC versions
- Custom configurations
- Multiple battery chemistries available

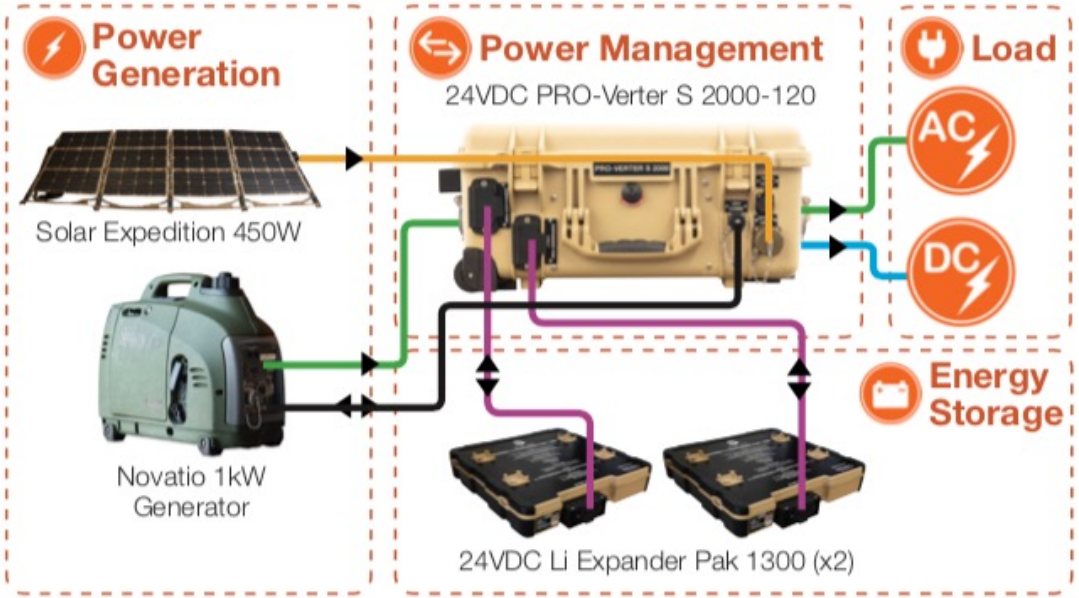
Li ESM

Lead-Acid Power Paks

Product Categories: Power Management

- Acts as the “brain” for a Micro-Grid or Hybrid System
- Integrates AC and DC power into a single uninterrupted power circuit
- Auto-Start/Stop military TQGs and some commercial generators

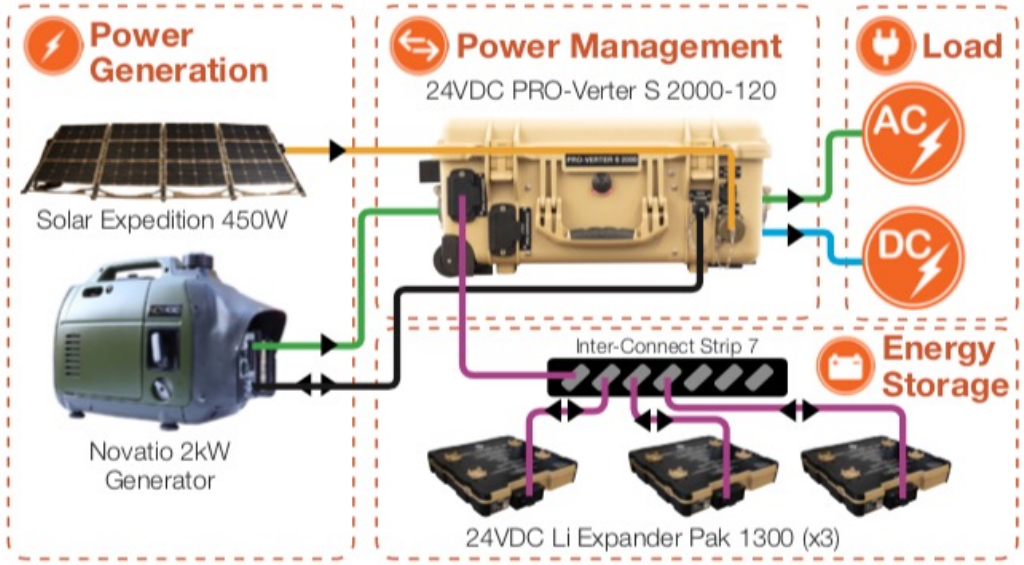
System Examples:
1kW Hybrid Power System



Features

- 1.8–2.7 kWh daily power generation from 450 W solar array (assuming 4–6 hours of solar irradiance)
- 2.6 kWh of $LiFePO_4$ energy storage (3000 cycle life)
- Auto Generator Start capability for 1kW or 2kW Novatio Generator
- 24 VDC and 120 VAC 60 Hz configuration
- Ability to process and accept solar, grid, and generator power
- Transportable by land, sea, and air cargo
- Built and designed to MIL-STD-810G
- Scalable and modular system architecture (allc components two person portable)
- Customizable inputs and outputs (NATO, CLA, USB, NEMA, etc.)

System Examples:
2kW Hybrid Power System

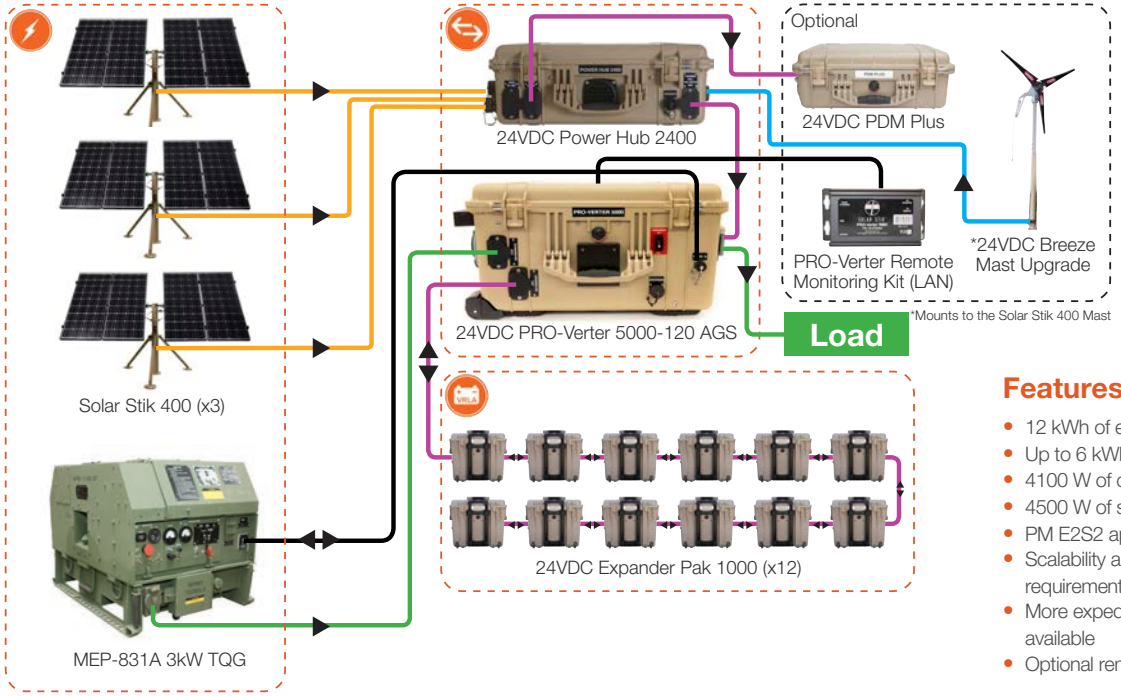


Features

- 1.8–2.7 kWh daily power generation from 450 W solar array (assuming 4–6 hours of solar irradiance)
- 3.9 kWh of $LiFePO_4$ energy storage (3000 cycle life)
- Auto Generator Start capability for 1kW or 2kW Novatio Generator
- 24 VDC and 120 VAC 60 Hz configuration
- Ability to process and accept solar, grid, and generator power
- Transportable by land, sea, and air cargo
- Built and designed to MIL-STD-810G
- Scalable and modular system architecture (allc components two person portable)
- Customizable inputs and outputs (NATO, CLA, USB, NEMA, etc.)

SOLAR STIK®

3kW TQG HPS 5000-120
Rapid Equipping Force (REF)
System Diagram
Baseline Config



Legend			
	DC Solar Circuit	▶	Direction of flow
	Wind Circuit	----	Component types
	AC Circuit	- - -	Optional
	Data Circuit		

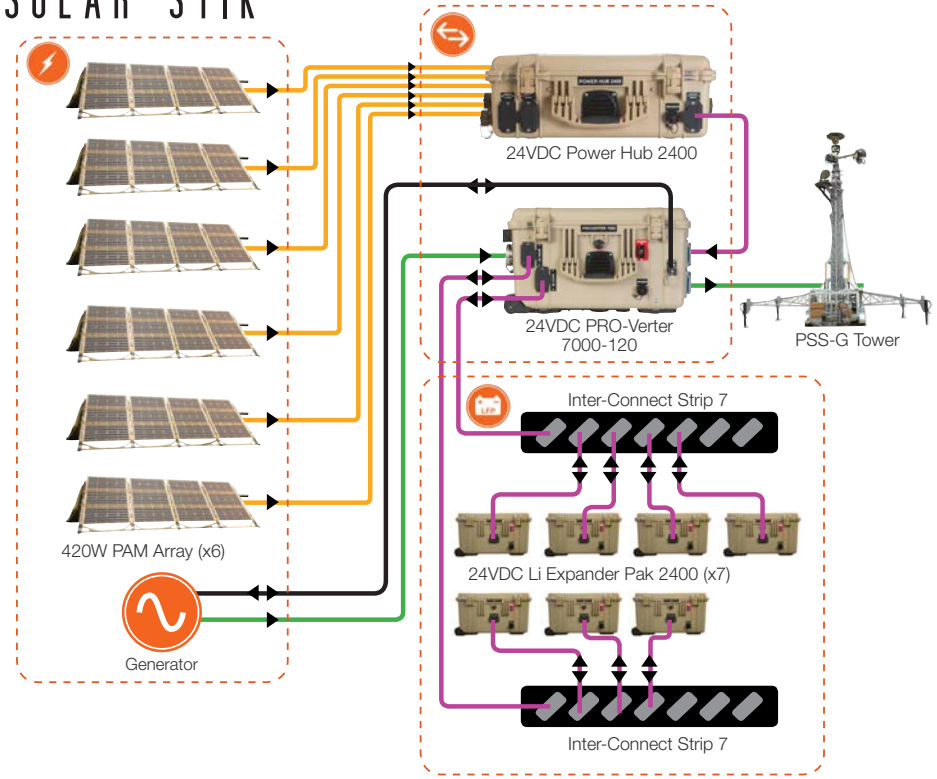
Features

- 12 kWh of energy storage
- Up to 6 kWh of daily solar power generation
- 4100 W of continuous power
- 4500 W of surge power
- PM E2S2 approved Remote-start Enabling Kit
- Scalability and modularity of system architecture allow for tailoring to requirements
- More expeditionary power generating and energy storage modules available
- Optional remote monitoring of system status available

SOLAR STIK®

Alternative Energy System (AES)
Product Manager Electro-optic/Infrared (PdM EO/IR)
System Diagram

Baseline Config



Legend	
	DC Solar Circuit
	Inter-Connect Circuit
	AC Circuit
	Data Circuit
▶	Direction of flow

Features

- 16.8 kWh of LiFePO4 energy storage
- 2520 watts of total solar array
- Up to 12.6 kWh of daily solar power generation
- Scalability of system architecture allows for addition & subtraction of energy storage & power generation
- Modularity of system architecture allows for integration of other power generating components
- 4000 W continuous output power; up to 5800 W surge; up to 6800 W in load support
- MIL-STD-810G tested and government approved components
- PM E2S2 approved Remote-start Enabling Kit for the MEP-802A
- Remote monitoring of system status

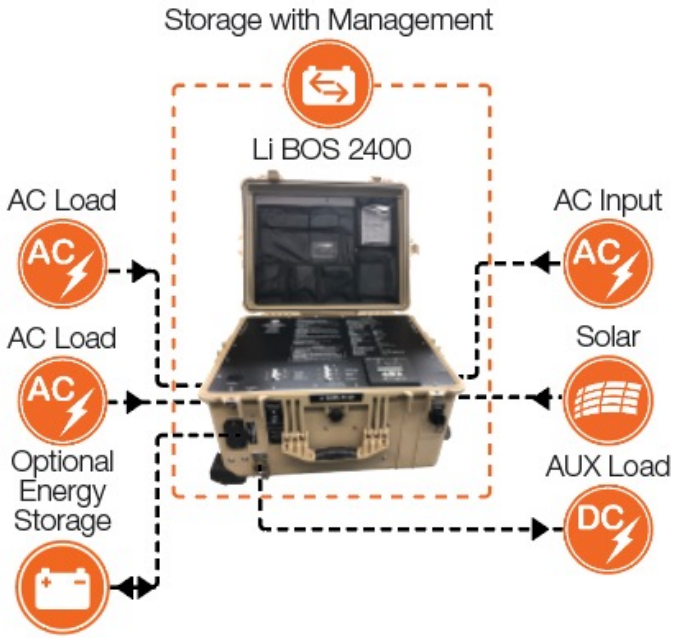
Category: Storage with Management

24VDC Li BOS 2400-120

Item # 20-0205201

Features

- 2.4 kWh (100 Ah) of storage
  - Capable of over 3000 charge/discharge cycles
  - 100% discharged = inert ($LiFePO_4$ chemistry)
- Compatible with 1.0–2.0 kW generators
  - Auto Generator Start/Stop
- Transportable by land, sea, and cargo aircraft
- Solar input port
- Ruggedized for extreme conditions
- Open architecture



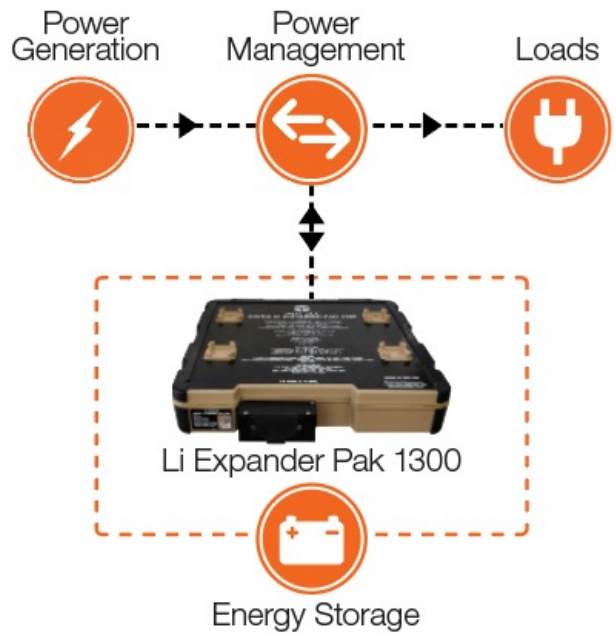
Category: Energy Storage

Li Expander Pak 1300

24VDC Item # 21-0202316

Features

- 1.3 kWh of storage
- Integrated vertical stacking
  - One-person lift
  - 19-inch rack compatible
- $LiFePO_4$ chemistry
  - 100% discharged = inert
  - Transportable by land, sea, and air cargo



OUR FOCUS…

…IS YOUR MISSION.

- U.S. Federal Agencies
- U.S. Foreign Armed Forces
- State Local Governments
- Foreign Government Agencies
- U.S. Defense Contractors
- Commercial Enterprises
- U.S. Space Force

NORTHROP GRUMMAN

LOCKHEED MARTIN

BAE SYSTEMS

HARRIS®

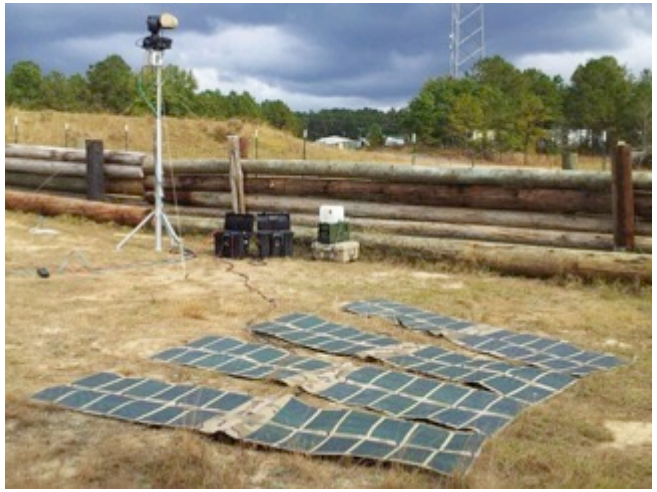
STAR-TIDES

SERT

Custom Solutions

Solar Stik, Inc

- Authorities in our field…
  …but students of application
- Pushing the technology curve forward…
  …paving the way for a young industry
- Redefining the culture of how people use power
- Defining the point of singularity between technology and our customers' needs



Overall Schedule

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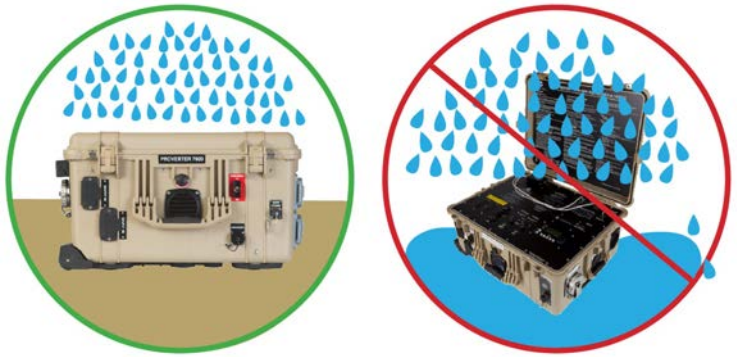
- 0900 – 1000 Breakfast
- 1000 – 1300 Environmental, Handling, Safety, System Overview and Components
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

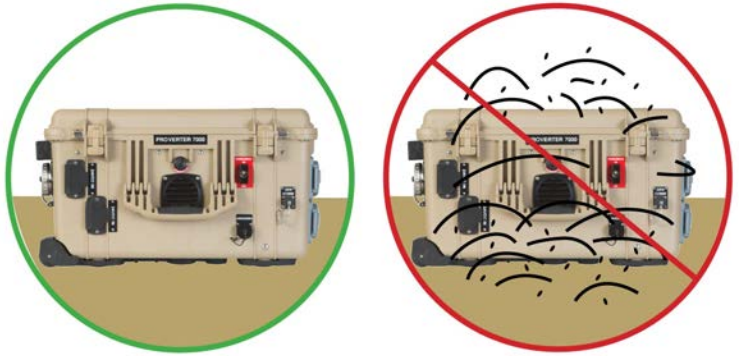
Environmental and Handling Precautions

Environmental and Handling Precautions

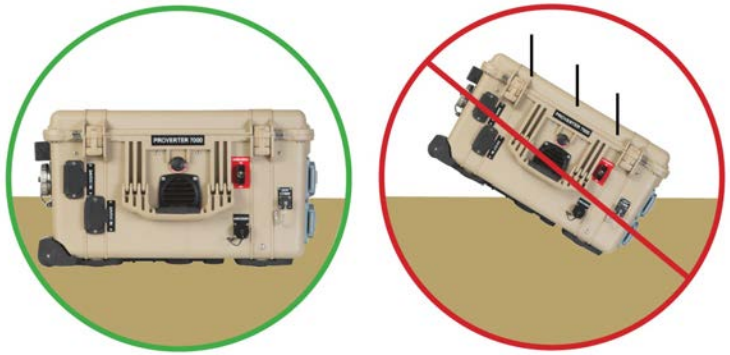
All Solar Stik components are ruggedized, yet there are a few things the operator can do to improve the performance, prevent failures, and prolong the operational life of the HPS.



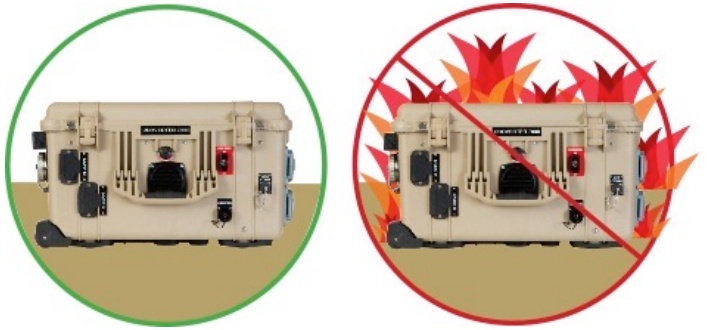
Water



Dust



Impact



Heat

Environmental and Handling Precautions

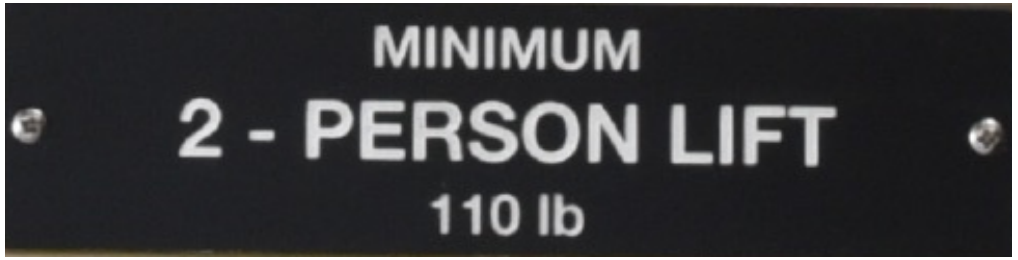
How to Reduce Environmental Impacts

- **Solar Loading/Heat** – Shade the components.
- **Heat** – Clean the air intake filters and shade the components.
- **Dust/Particulates** – Keep the component lids closed, clean the air intake filters and keep components off the ground.
- **Water** – Keep the component lids closed, components off the ground avoid having cables in standing water.
- **Impact** – Protect the components during transport and deployment.

Safety

Safety

Placards, I-Plates, and Stickers



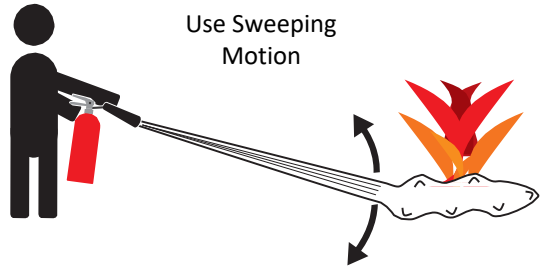
Safety

Fire and Electric Shock Hazards

Fire Hazard

WARNING

CO_2 (carbon dioxide) fire extinguishers are the best option for electric fires.



Electric Shock Hazard

DANGER

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

Safety

Circuit Breakers

Circuit breakers are designed to prevent overheating of electrical conductors and connections in an electrical circuit as well as protect equipment and operators.

Safety

Safe Operation

- Ensure System is grounded properly.
- Operation in wet conditions requires extra attention.
- Power OFF all components before connecting.
- Solar panels make electricity when they are in the sun!
- BE **VERY CAREFUL** WHEN WORKING WITH ELECTRICITY!

Safety

Technical Documentation

Each Technical Manual in the online library contains safety information specific for the equipment covered in the Manual.

All Technical Manuals for ATSC Systems are available for download via Web Link

https://solarstik.com/atsc-oman-l0/

- 24VDC PRO-Verter 5000-220
- 24VDC Power Hub 2400
- 24VDC Li Expander Pak 2400
- 24VDC Li Expander Pak 1300
- 7 kW Generator
- 3 kW Generator
- Solar Expedition 450W
- Solar Expedition 560W
- Remote-start Enabling Kits

Overall Schedule

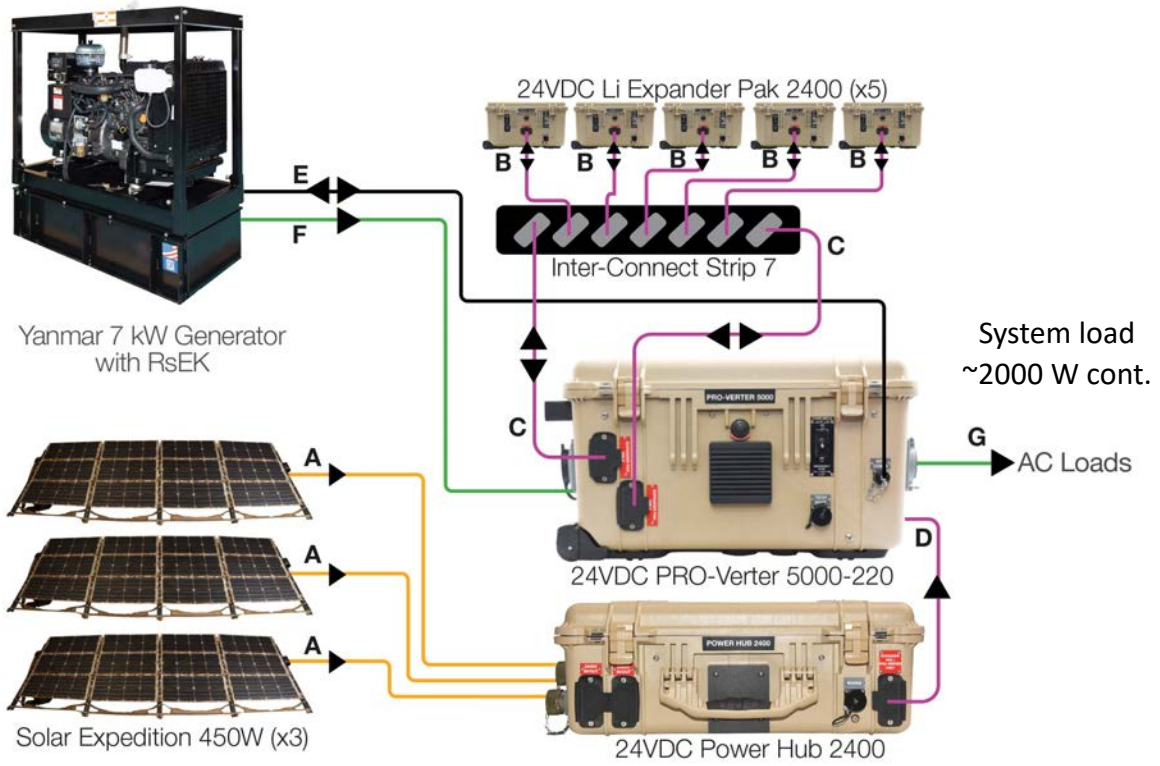
Training Schedule: 29 January, 2023

- 0700 – 0900 History and Introduction
- 0900 – 1000 Breakfast
- 1000 – 1300 Environmental, Handling, Safety, System Overview and Components
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

System Overview
System Components

The L0 System

Components and Inventory

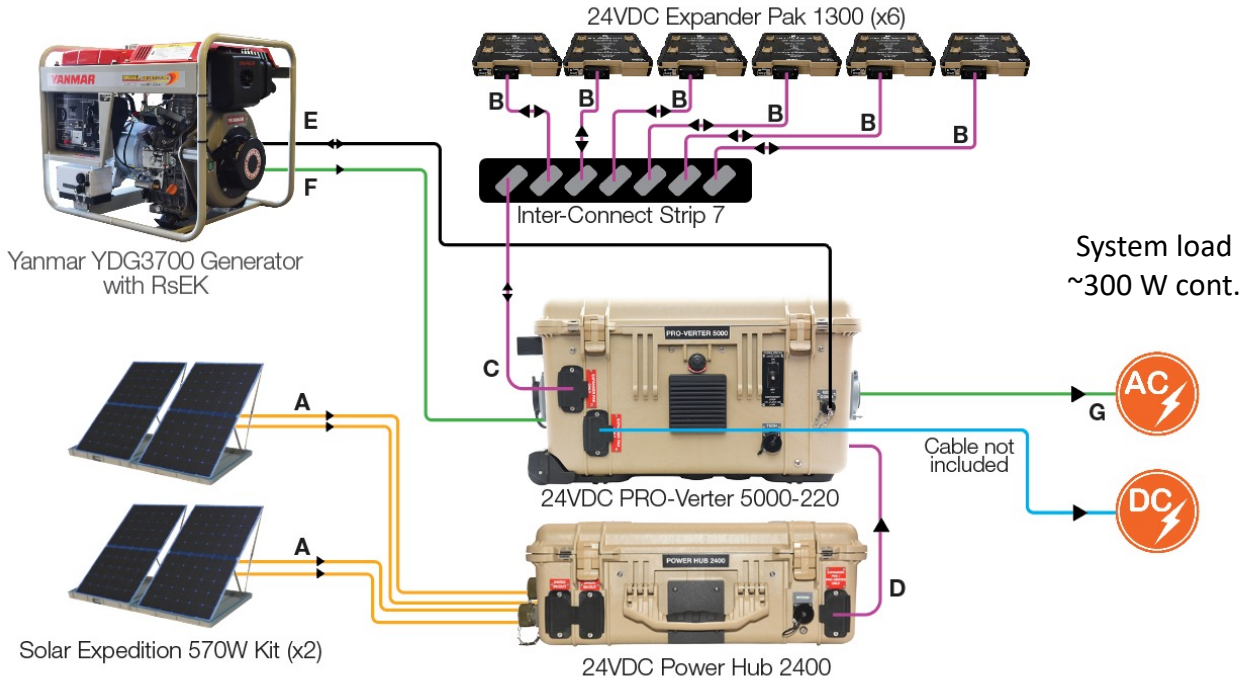


Inventory List

Cable	Item #	Nomenclature	QTY
N/A	20-0104022	24VDC PRO-Verter 5000-220 AGS BFF1	1
N/A	20-0702602	PRO-Verter RMK (LAN)	1
N/A	20-0302204	24VDC POWER HUB 2400	1
N/A	21-0202303	24VDC Li Expander Pak 2400	5
N/A	19-0401006	YANMAR 7 kW GENERATOR WITH RsEK	1
N/A	11-1000020	SOLAR EXPEDITION 450W	3
A	16-0800102	24VDC PAM Solar Leash 30'	3
N/A	14-1000027	L0 CABLE TRANSPORT CASE	1
N/A	13-1000160	24VDC INTERCONNECT STRIP 7	1
B	13-0000032	24VDC 5' INTERCONNECT CABLE (2AWG)	4
C	13-0000047	24VDC 10' INTERCONNECT CABLE (2AWG)	2
D	13-1000246	24VDC 20FT PRO-VERTER TO POWER HUB INTERCONNECT CABLE (2AWG)	1
E	13-1000155	15' GENERATOR COMMS CABLE	1
F	13-1000248	AC POWER CABLE, 15FT 230V 50Hz HBL2621SW TO HBL2623SW (INPUT)	1
G	13-1000248	AC POWER CABLE, 15FT 230V 50Hz HBL2621SW TO HBL2623SW (OUTPUT)	1

The MRSC System

Components and Inventory



Inventory

Item #	Nomenclature	QTY
20-0104022	24VDC PRO-VERTER 5000-220 AGS BFF1	1
20-0702602	PRO-VERTER RMK (LAN)	1
20-0302204	24VDC POWER HUB 2400	1
21-0202316	24VDC Li EXPANDER PAK 1300	6
19-0401002	YANMAR YDG3700 GENERATOR WITH RsEK	1
01-1000055	35 GALLON EXTERNAL FUEL TANK	1
19-0302020	EXPEDITION 570 W KIT	2
14-1000027	LO CABLE TRANSPORT CASE	1
13-1000160	24VDC INTER-CONNECT STRIP 7	1

Cable	Item #	Nomenclature	QTY
A	13-0000002	30' SOLAR LEASH	4
B	13-1000267	5' LINEAR INTER-CONNECT CABLE,	6
C	13-0000047	10' INTER-CONNECT CABLE	1
D	13-1000246	20' PRO-Verter TO POWER HUB INTER-CONNECT CABLE	1
E	13-1000155	15' GENERATOR COMMUNICATION LEASH	1
F	13-1000248	15' AC POWER CABLE	1
G	13-1000316	15' AC POWER CABLE,	1

System Components

Component Categories

Power Generation

450 W Solar Arrays

7.0 kW Generator

Power Management

24VDC PRO-Verter 5000-220

24VDC Power Hub 2400

Energy Storage

24VDC Li Expander Pak 2400

Loads

L0
ECUs
Payloads
Tower
Server

System Components

7 kW Genset (x1)

24VDC PRO-Verter 5000 AGS (x1)

24VDC Power Hub 2400 (x1)

24 VDC Li Expander Pak 2400 (x5)

System Components

Inventory L0

PAM Transport Case (x3)

Solar Array (x3)

Metal Stake (x10/array)

Sandbag (x12/array)

30’ Solar Leash (x3)

15’ MEP-802A Generator Communications Cable (x1)

15’ AC Power Cable 220 V 50 Hz (x1)

15’ AC Power Cable 220 V 50 Hz (x1)

24VDC 5’ Inter-Connect Cable (x5)

20’ 24VDC Inter-Connect Cable (x1)

10’ 24VDC Inter-Connect Cable (x2)

24VDC Inter-Connect Strip 7 (x2)

Cable Transport Case (x1)

System Components

7 kW Generator

General

AC Power Generation	7.2 kW peak, 6.9 kW continuous
AC Operating Voltage	230 VAC, 50 Hz
Rated Current	30 A
Max Operating Temperature	131 °F (55 °C) (ambient)

Fuel

Capacity	51 U.S. gal
Fuel Type	Diesel
Consumption	0.25 gal/hr @ 50% load
	0.50 gal/hr @ 100% load

232 liter capacity

1.14 L/hr 50% load
2.28 L/hr 100% load

Safety Circuits

Engine	Oil pressure shutdown
Engine	Coolant temperature shutdown
Emergency Stop	Push Button
AC Breaker	Generator main switch AC circuit breaker, 40 A DPST

System Components

Solar Expedition 450

Panel Specs (@25^{0}C)

Max Power (Pmax)	112 W
Rated Voltage (Vmp)	12.9 V
Open Circuit Voltage (Voc)	15.9 V
Rated Current (Imp)	8.81 A
Short Circuit Current (Isc)	9.0 A
Cell Type	Monocrystalline silicon passivated emitter rear contact
Cell Efficiency (%)	> 18%

Array (4-panels) Specs (@25^{0}C)

Array Voltage	52 V
Array Current	8.81 A
Array Power	458 W
Number of Solar Panels	4

System Components

24VDC Power Hub 2400

Charge Controller Specifications (@77 °F/25 °C)	
Maximum PV Input Voltage	57 VDC
Maximum PV Input Current	100 A (@ 24 V nominal)
Maximum PV Power	800 W per charge controller, 2400 W total
Efficiency	97% (typical)
Charging Stages	Bulk, absorb, float and equalize
Charge Control Method	Maximum Power Point Tracking (MPPT)

Environmental	
Operating Temperature	-58 °F to 104 °F (-50 °C to 40 °C), derated operation up to 167 °F (75 °C)
Operating Humidity	10% to 90% RH noncondensing

Three (3) solar charge controllers inside

System Components

24VDC PRO-Verter 5000

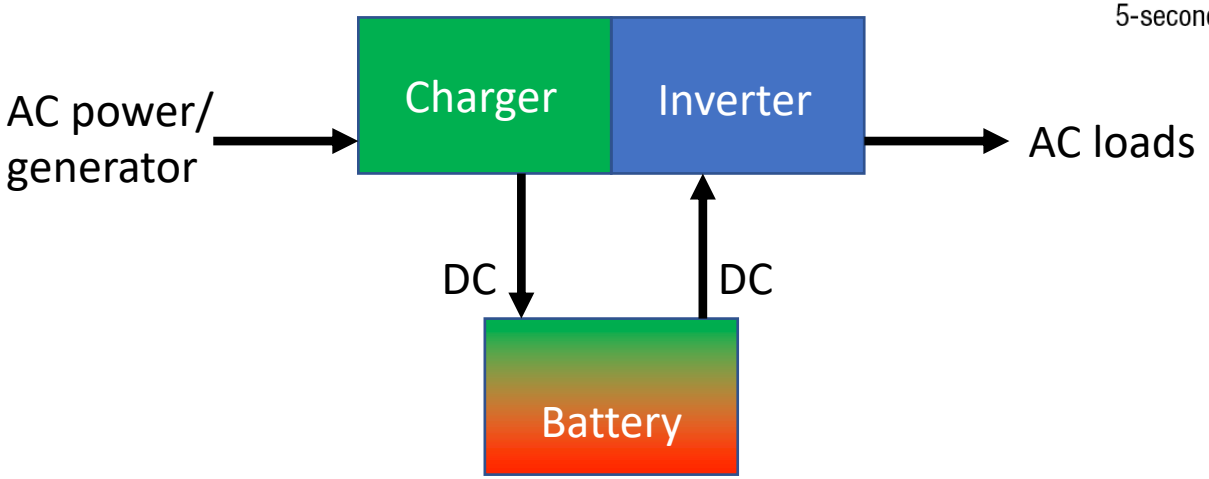
DC Power/Battery Charging

DC Charger Specifications (@ 77 °F/25 °C)	
Charging Stages	Bulk, Absorb, Float, CC/CV, Gen Exercise, and Battery Saver
Continuous Output Current	105 ADC
Charging Efficiency	88%

Environmental	
Operating Temperature	-4 °F to 140 °F (-20 °C to +60 °C)
Storage Temperature	-40 °F to 158 °F (-40 °C to +70 °C)
Operating Humidity	0 to 95% RH noncondensing
Standards	MIL-STD-810G tested
EMI (EMI Approvals)	High-performance EMI filter on AC output

AC Power Output

Inverter Specifications (@ 77 °F/25 °C)	
Nominal AC Output Voltage	230 VAC, Single Phase
AC Output Voltage Tolerance	±5%
Rated Current	30 A
Output Frequency and Accuracy	50±0.4 Hz
Continuous Output Power	4100 VA
Inverter Efficiency	90%
Transfer Time	About 20 ms
Waveform	Pure Sine Wave
5-second Surge Power	6300 W



System Components

Li Expander Pak 2400

Battery Chemistry – Lithium Iron Phosphate ($LiFePO_4$)

Battery Capacity

- 2400 watt hours (Wh)
- 100 amp hours (Ah)

Voltage

- 24 volts (nominal)
- 25.6 volts (actual)

Current

- 50 amps (circuit breaker protected)

24VDC Li EXPANDER PAK 2400

Battery Life Span

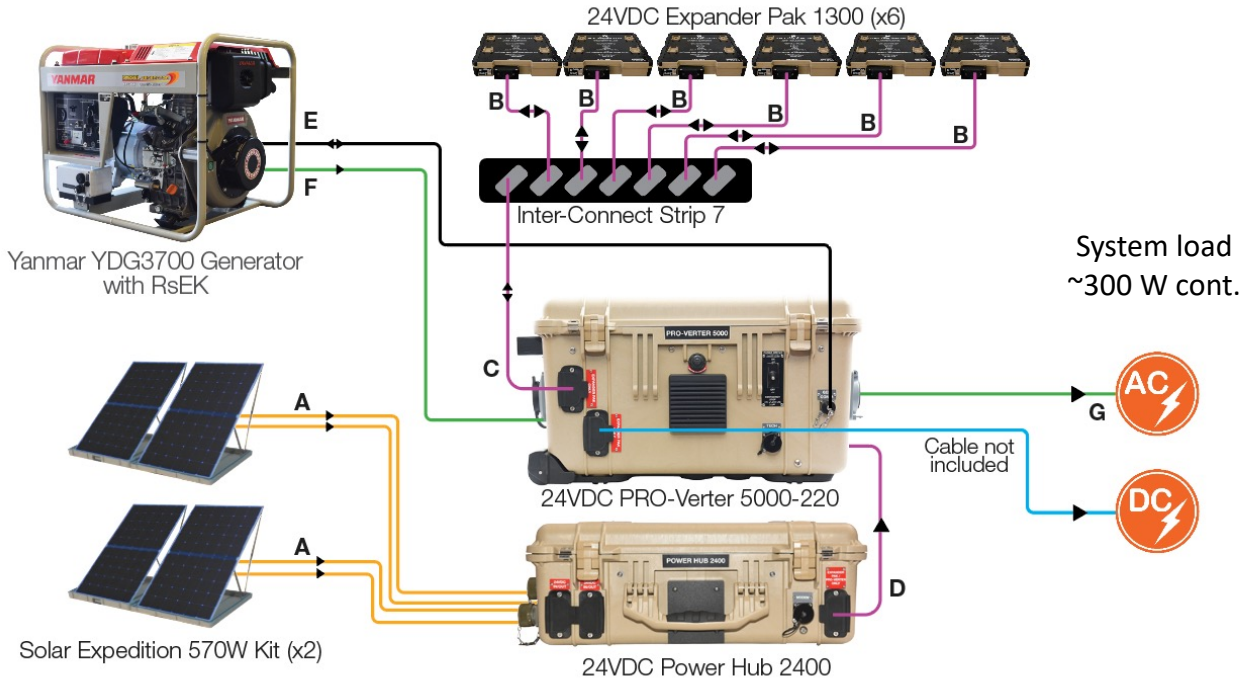
Batteries are a **consumable** part of the HPS.
They do not last forever and must be replaced.

Primary factors that determine the life span of a battery:

- **Number of Cycles**
- **Abuse/Conditions of use**
    - Storing in a discharged state (self discharge>overdischarge)
    - Operating/storing in high heat
    - Improper cycling

The MRSC System

Components and Inventory



Inventory

Item #	Nomenclature	QTY
20-0104022	24VDC PRO-VERTER 5000-220 AGS BFF1	1
20-0702602	PRO-VERTER RMK (LAN)	1
20-0302204	24VDC POWER HUB 2400	1
21-0202316	24VDC Li EXPANDER PAK 1300	6
19-0401002	YANMAR YDG3700 GENERATOR WITH RsEK	1
01-1000055	35 GALLON EXTERNAL FUEL TANK	1
19-0302020	EXPEDITION 570 W KIT	2
14-1000027	LO CABLE TRANSPORT CASE	1
13-1000160	24VDC INTER-CONNECT STRIP 7	1

Cable	Item #	Nomenclature	QTY
A	13-0000002	30' SOLAR LEASH	4
B	13-1000267	5' LINEAR INTER-CONNECT CABLE,	6
C	13-0000047	10' INTER-CONNECT CABLE	1
D	13-1000246	20' PRO-Verter TO POWER HUB INTER-CONNECT CABLE	1
E	13-1000155	15' GENERATOR COMMUNICATION LEASH	1
F	13-1000248	15' AC POWER CABLE	1
G	13-1000316	15' AC POWER CABLE,	1

System Components

Solar Expedition 570

QTY 4 Solar Panels @ 77 ºF (25 ºC)	
Rated Power	570 W
Rated Voltage (V_{MP})*	65.5 VDC
Open Circuit Voltage (V_{OC})	79.6 VDC
Rated Current (I_{MP})*	8.7 A
Short Circuit Current (I_{SC})	9.0 A
Maximum System Voltage	600 VDC

System Components

Li Expander Pak 1300

Battery Chemistry – Lithium Iron Phosphate ($LiFePO_4$)

Battery Capacity

- 1300 watt hours (Wh)
- 54 amp hours (Ah)

Voltage

- 24 volts (nominal)
- 25.6 volts (actual)

Current Maximum

- ~20 amps

System Components

Information Plates (I-Plates), Faceplates, and Placards

I-Plates, Faceplates, and placards provide setup and operation information

Please review all of the information on the I-Plates, Faceplates, and placards before setting up the HPS.

System Components

Color-coded Connections

Cable Color

Orange: Solar Circuit Connection

Red: DC Circuit Connection

Example Ports

System Components

Color-coded Connections

AC Power Cable
15’ 230 V 50 Hz

Blue: AC Power Circuit Connection (from Power Generation to Power Management).

5’ Generator
Communications Leash

Gray: Communications Circuit Connection

AC Power Cable
15’ 230 V 50 Hz

Green: AC Power Circuit Connection (from Power Management to Load)

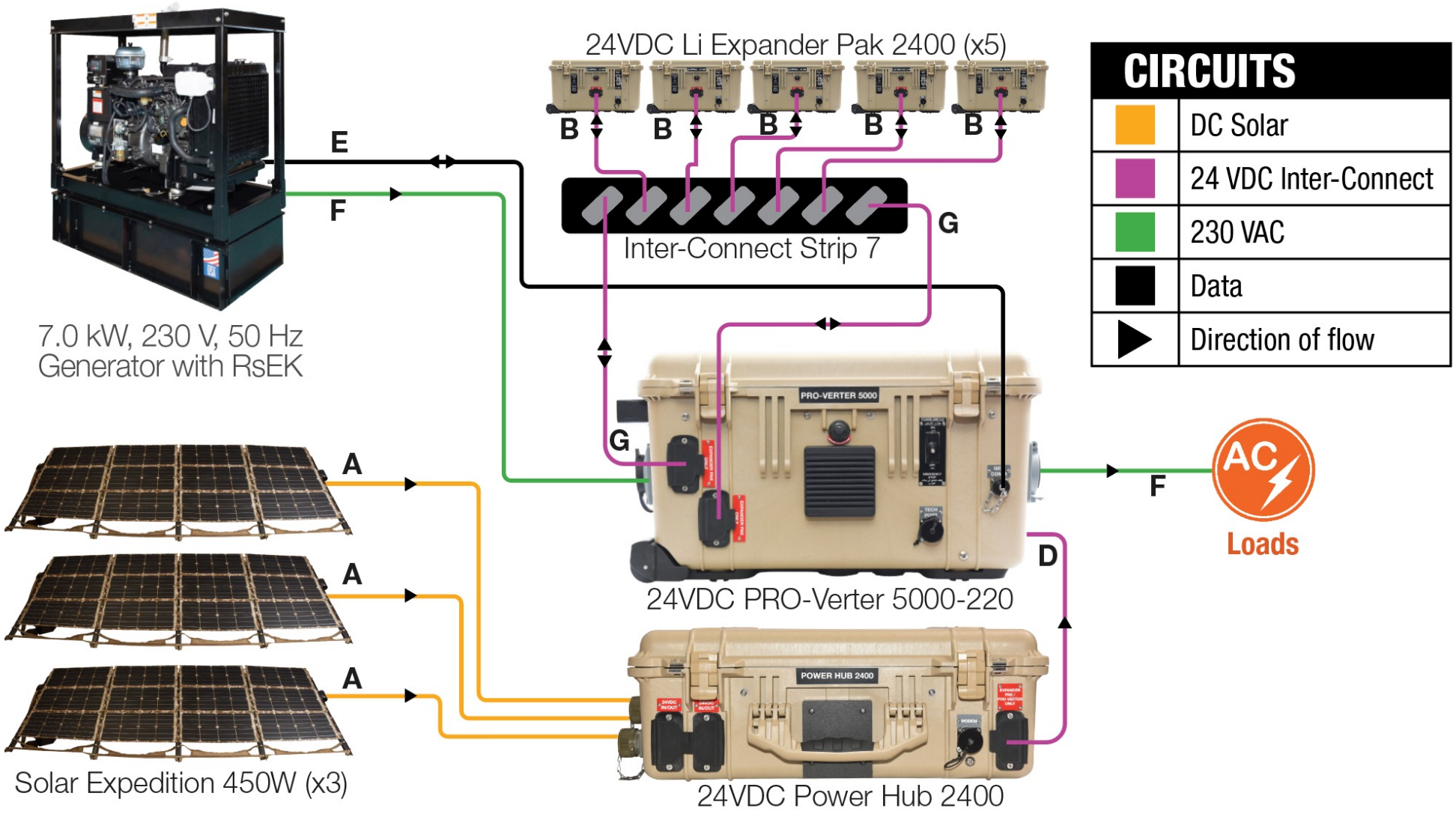
Overall Schedule

Training Schedule: 30 January, 2023

- 0700 – 0900 System Sizing
- 0900 – 1000 Breakfast
- 1000 – 1300 System Set Up and Start Up
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

System Sizing

Why 5 batteries and 3 solar arrays and a 7 kW generator?



General System Sizing

Load: L0 2,300 W continuous, 5,400 W surge
MRCS: 220 W continuous, 3,000 W surge

Battery sizing: Load x 6-12 hours (1-2 cycles daily)
Power Management Sizing: Must handle peak and continous
Generator Sizing: Must power load an charge batteries
Solar Sizing: Must offset generator runtime

Questions:
Battery only runtime, runtime with solar, runtime off tank of fuel, etc

More on Whiteboard!

Overall Schedule

Training Schedule: 30 January, 2023

- 0700 – 0900 System Sizing
- 0900 – 1000 Breakfast
- 1000 – 1300 System Set Up and Start Up
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

System Setup

Step-by-step

1. Inventory all System components before leaving depot.
2. Identify locations for System components.
3. Remove Solar Arrays, Power Hub, and 20’ Inter-Connect cable from trailer.
4. Connect the Expander Paks to the PRO-Verter.
5. Connect the PRO-Verter to generator.
6. Connect the PRO-Verter to the load/service panel.
7. Ground the System*.
8. Deploy the Solar Arrays.
9. Connect the Solar Arrays to the Power Hub.
10. Connect the PRO-Verter to the Power Hub.
11. Orient and secure the Solar Arrays to the ground.
12. Activate the System.
13. Initialize and calibrate the System

System Setup

Inventory and connect System components

Inventory the System components before you go to the field to deploy.

Item #	Nomenclature	QTY
20-0104022	24VDC PRO-Verter 5000-220 AGS BFF1	1
20-0702602	PRO-Verter RMK (LAN)	1
20-0302204	24VDC POWER HUB 2400	1
21-0202303	24VDC Li Expander Pak 2400	5
19-0401006	YANMAR 7 kW GENERATOR WITH RsEK	1
11-1000020	SOLAR EXPEDITION 450W	3
16-0800102	24VDC PAM Solar Leash 30'	3
14-1000027	L0 CABLE TRANSPORT CASE	1
13-1000160	24VDC INTERCONNECT STRIP 7	1
13-0000032	24VDC 5' INTERCONNECT CABLE (2AWG)	4
13-0000047	24VDC 10' INTERCONNECT CABLE (2AWG)	2
13-1000246	24VDC 20FT PRO-VERTER TO POWER HUB INTERCONNECT CABLE (2AWG)	1
13-1000155	15' GENERATOR COMMS CABLE	1
13-1000248	AC POWER CABLE, 15FT 230V 50Hz HBL2621SW TO HBL2623SW (INPUT)	1
13-1000248	AC POWER CABLE, 15FT 230V 50Hz HBL2621SW TO HBL2623SW (OUTPUT)	1

System Setup

Ensure Expander Pak 2400s are operationally ready before leaving depot

1. Remove safety pin
2. Toggle POWER switch to ON
3. Press Battery Status Display button. <u>LED must be green to deploy</u>.
4. Turn off Power switch and replace safety pin.

Battery Status Indicator

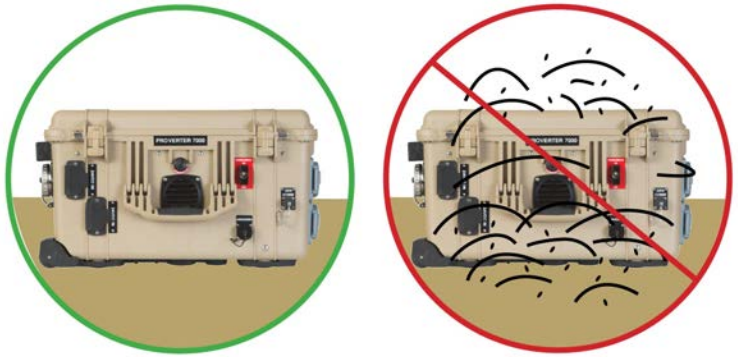
Display Refresh Button

Does a green LED mean the battery is charged fully?

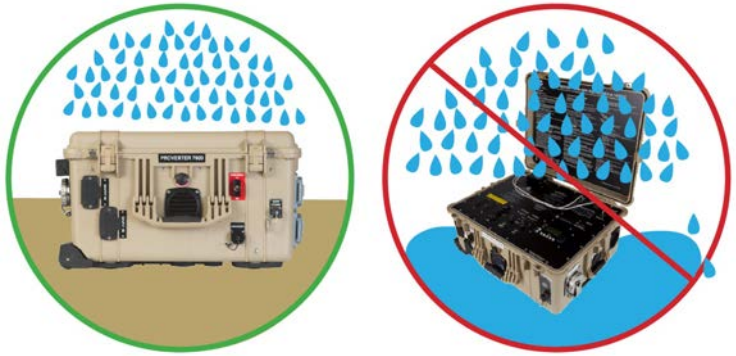
System Setup

Considerations Prior to System Setup

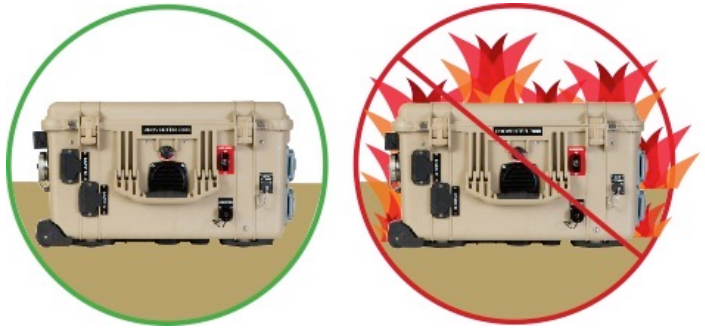
Minimize potential for exposure to dust, debris, sun/heat and water.



Dust



Water



Heat

Turn OFF Switches/Breakers on all System Components

System Setup

Instructions for System Setup and Operation are on I-Plate

System Setup

Connectors: Unique and Polarized

Difficult to connect System in an unsafe way

Gen Comm

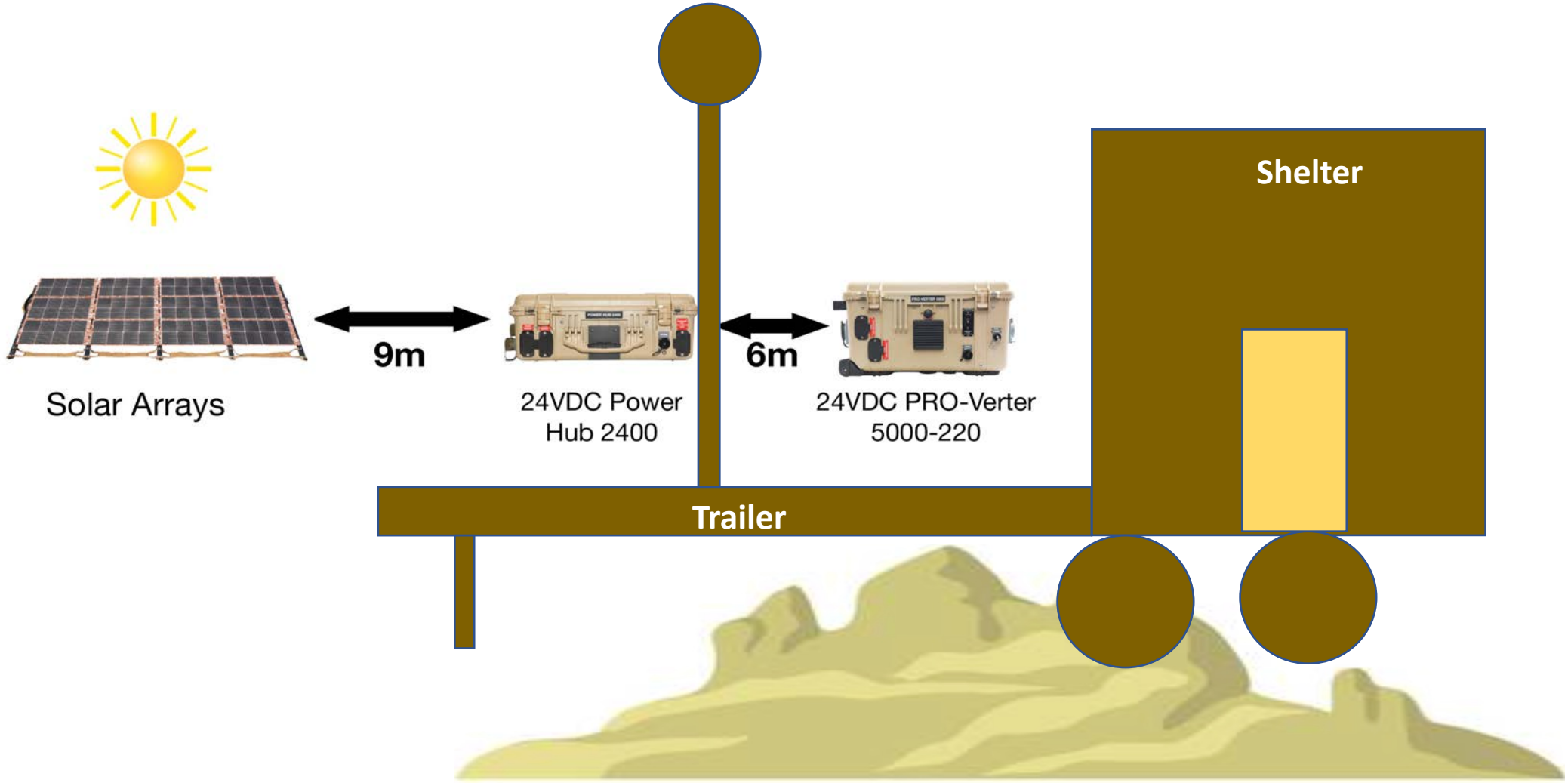
Inter-Connect

Solar

AC power in/out

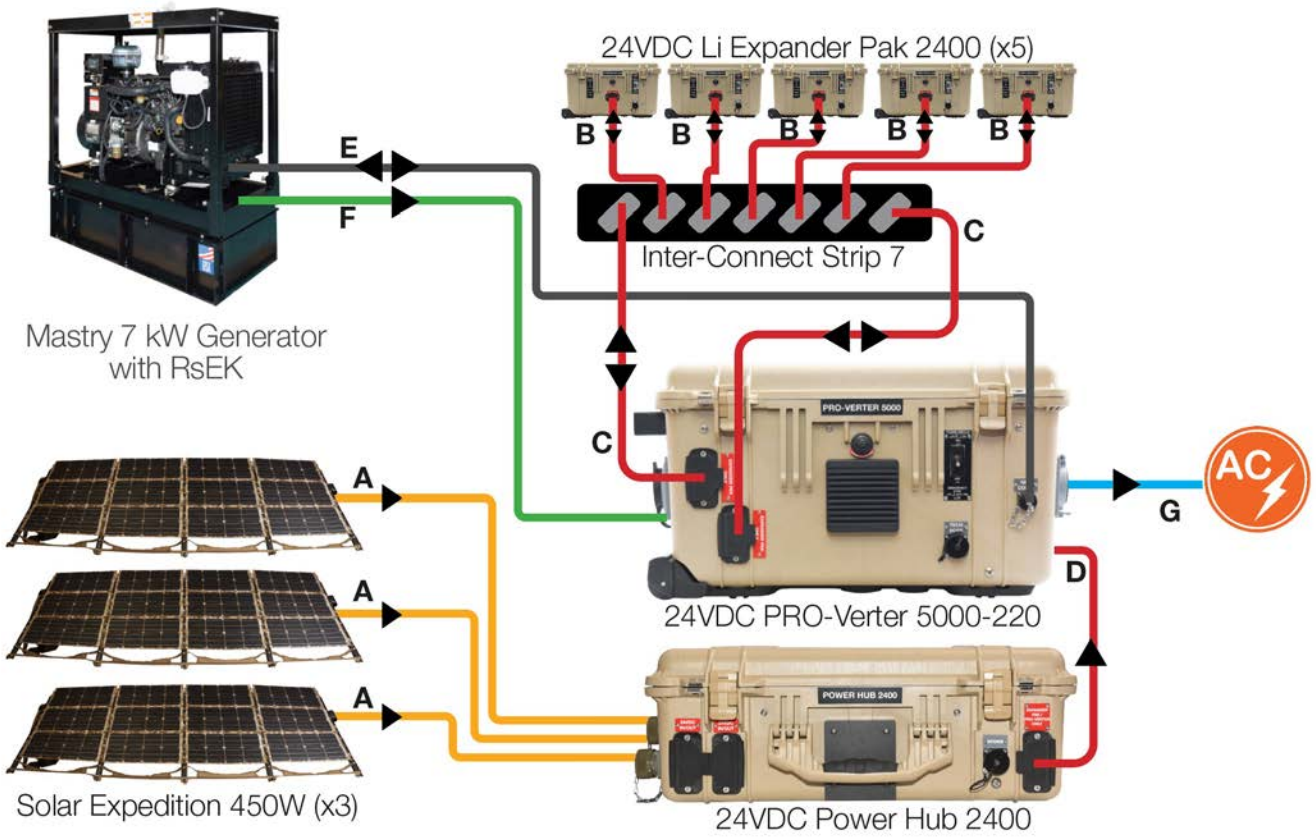
System Setup

Identify locations for System components: High point



System Setup

Connect System Components

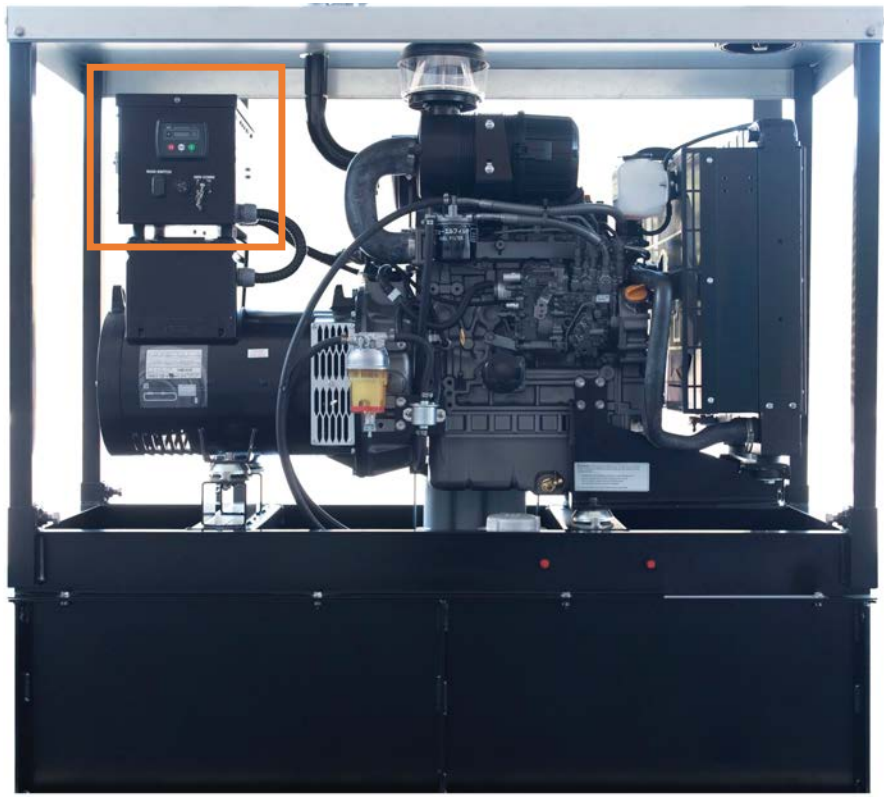


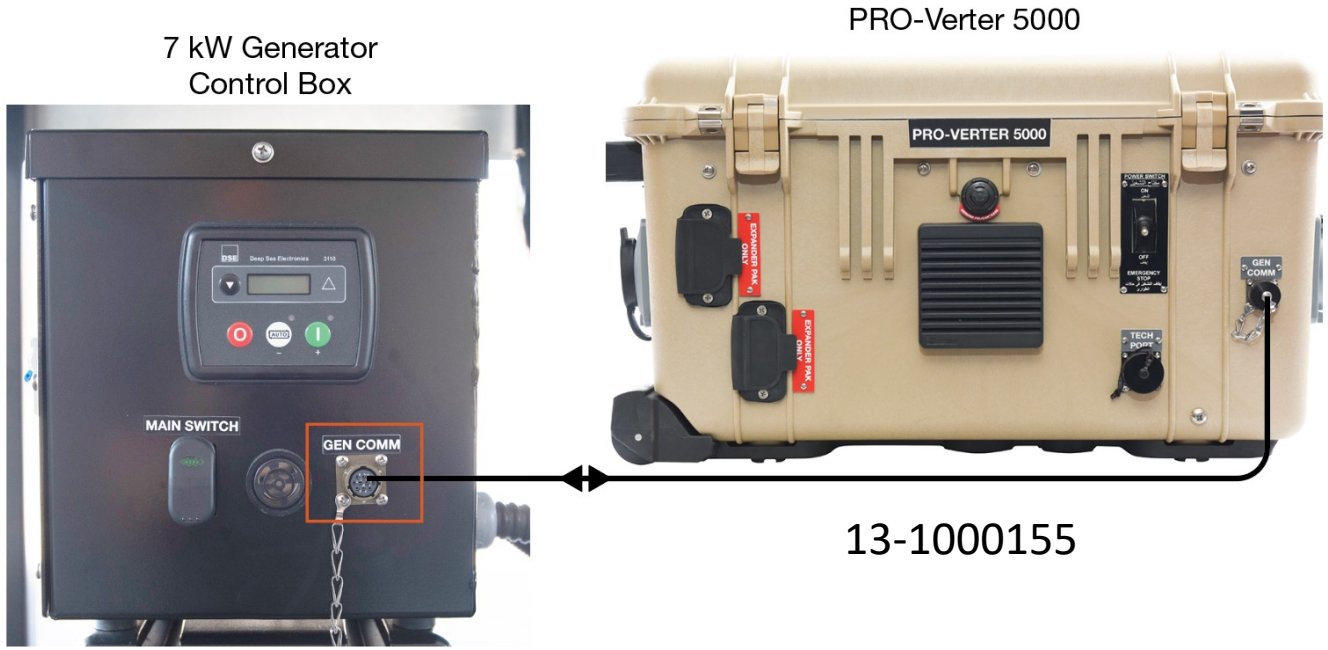
Use cable color and Item # to assist

	Item #	Cable Name	Color
A	16-0800102	24VDC 30' Solar Leash, 30'	Orange
B	13-0000032	24VDC Inter-Connect Cable, 5'	Red
C	13-0000047	24VDC Inter-Connect Cable, 10'	Red
D	13-1000246	24VDC Inter-Connect Cable, 20'	Red
E	13-1000155	Gen Comms Cable 15'	Gray/Black
F	13-1000248	AC Input Power Cable 15'	Green
G	13-1000248	AC Output Power Cable, 15'	Blue

System Setup

PRO-Verter to Generator Comms Connections





System Setup

PRO-Verter to Generator Power Connection

7 kW Generator
Control Box

7 kW 230 VAC, 50 Hz
output

13-1000248

PRO-Verter 5000

System Setup

PRO-Verter to Shelter Service Panel Power Connection

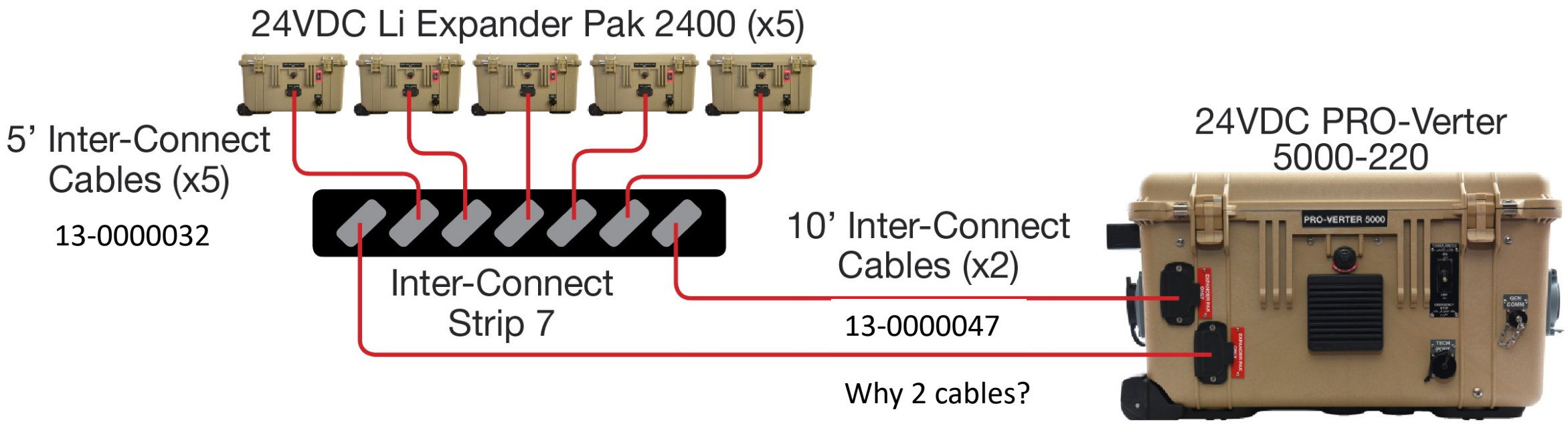
AC power cable
15’ 220 V 50 Hz

13-1000248

PRO-Verter
right-side view

System Setup

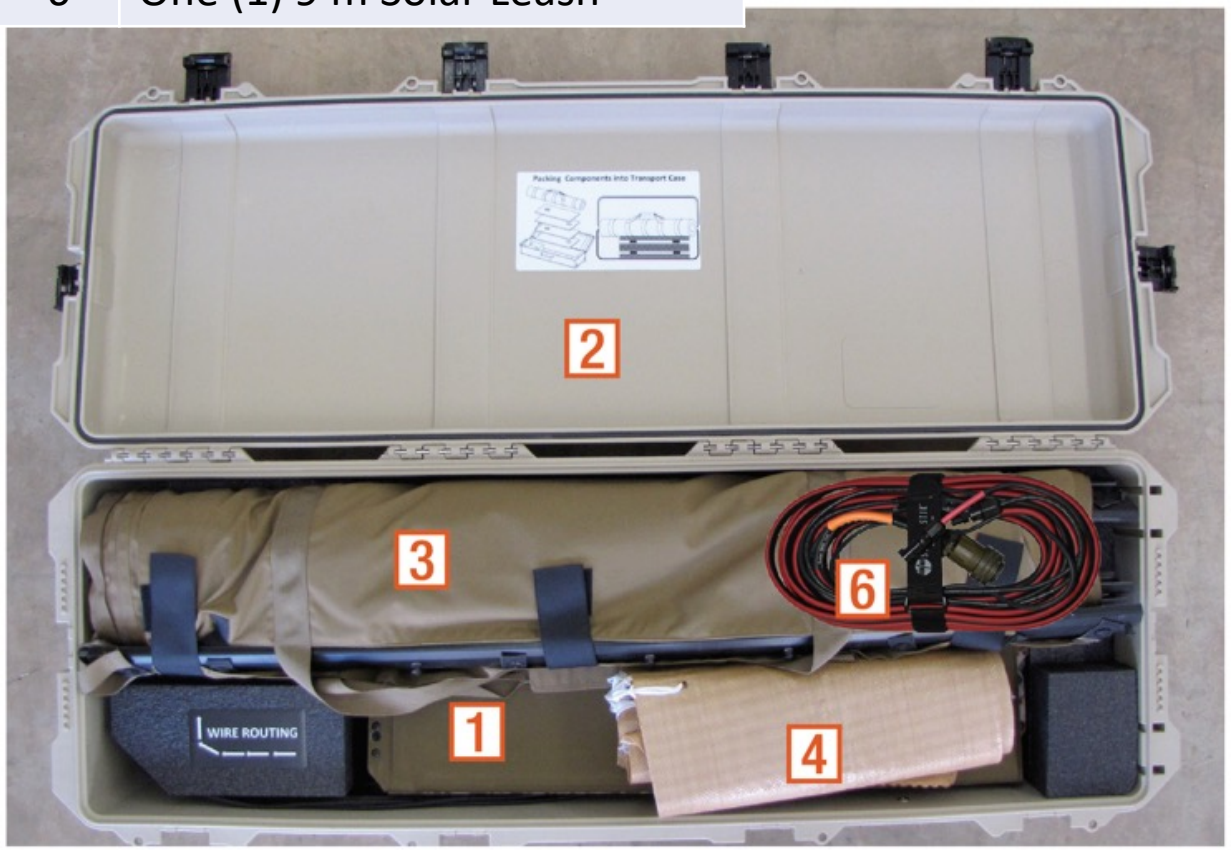
PRO-Verter to Expander Pak Connections



System Setup

Inventory Solar Arrays

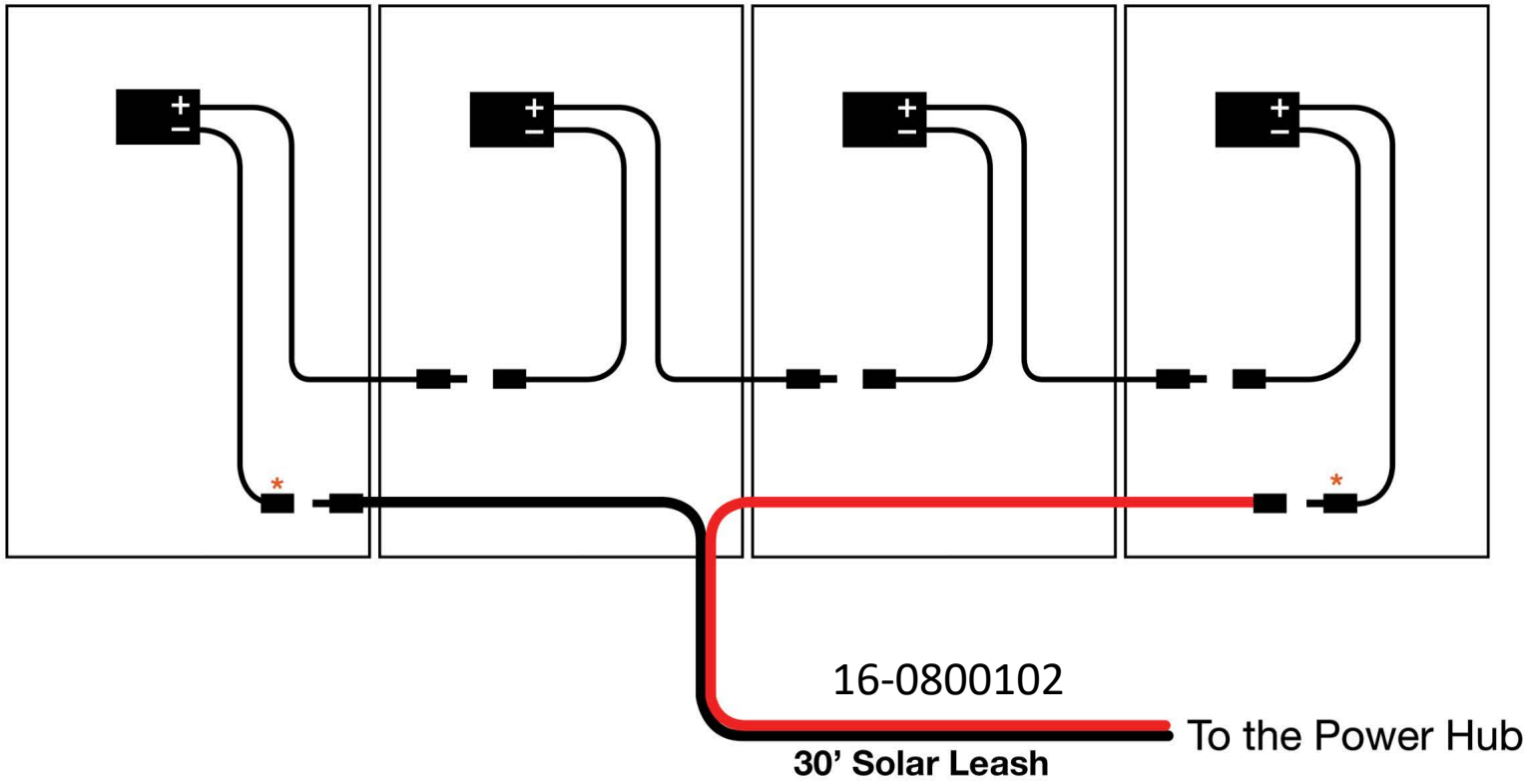
#	Array Components
1	Four (4) 112 W Solar Panels
2	One (1) Transport Case
3	One (1) Rollable stand
4	Twelve (12) Sandbags
5	Ten (10) Stakes
6	One (1) 9 m Solar Leash



System Setup

Deploy the Solar Arrays.

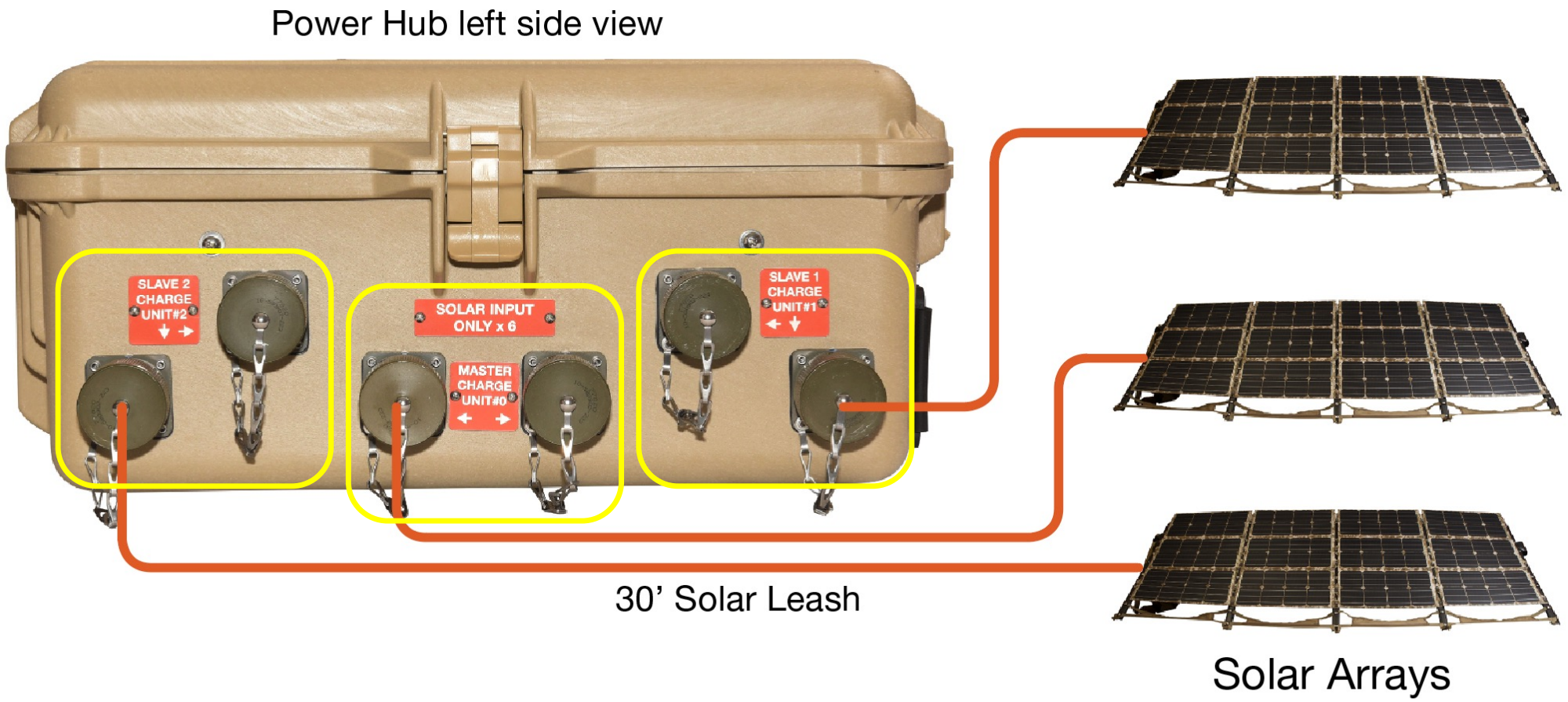
Connect the four (4) PV panels on a single rack in series using the wiring diagram below.



DO NOT secure the Arrays to the ground until the entire System is set up.

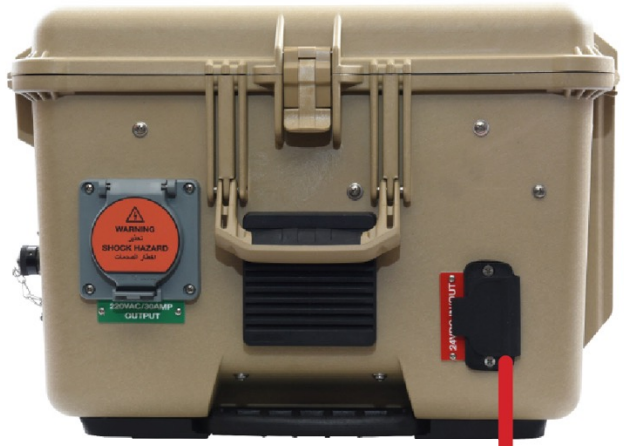
System Setup

Connect the Solar Arrays to the Power Hub.



System Setup

Connect the PRO-Verter to the Power Hub.



PRO-Verter
right side view

24VDC Power Hub 2400
front view

20’ Inter-Connect Cable

13-1000246

Systme Setup

Lastly: Secure the Solar Arrays to the ground.

Aim them to the south

⚠ WARNING

Failure to properly secure the Solar Arrays to the ground surface could result in solar panel damage, injury, or death in high winds. Tent stakes and/or sandbags should be used. Wind damage to panels can render them nonfunctional or significantly reduce their functional life expectancy.

System Setup

Ground the System

PRO-Verter, Power Hub and generator are bonded to trailer equipment grounding conductor, which should be connected to earth grounding rod.

System Startup

System Startup Quickstart Guide

System Startup

1. Prepare generator for operation
2. Toggle ON Generator MAIN SWITCH and Generator output breakers
3. Press the Generator RsEK AUTO button
4. Toggle ON all Expander Pak 2400 Power Switches
5. Power Hub will power up automatically
6. Toggle ON PRO-Verter Power Switch
7. Set PRO-Verter clock to local time.
8. Toggle ON PRO-Verter AC INPUT breaker
9. Toggle PRO-Verter GENERATOR CONTROL switch to ON – Generator will start (CTRL > 03 Gen Control/ON).
10. Allow generator to run for a few minutes and toggle GENERATOR CONTROL switch to AUTO (CTRL > 03 Gen Control/AUTO).
11. Allow batteries to charge fully. Generator will turn off automatically when batteries are charged fully.

To support connected loads

Toggle ON PRO-Verter AC OUTPUT breaker

System Startup

Prepare generator for operation

BEFORE OPERATING Generator

1. Check fuel levels / fill fuel tank
2. Check for fuel leaks.
3. Check to make sure the fuel filter / water separator fuel cock is in the ON position.
4. Check oil levels
5. Check for engine oil leaks,
6. Check for engine coolant / top off if needed.
7. Check for any coolant leaks.
8. Check hoses for cracks, abrasions, and damaged, lose or corroded / compromised connectors.
9. Check for damaged or missing parts.
10. Check for loose, missing or damaged fasteners.
11. Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors.
12. Check for floating neutral = No conductivity between neutral output post and generator frame (ground terminal if present).
13. Check battery terminal for corrosion.
14. Check battery connections are secured.

Generator RsEK Operation

RsEK User Interface

The Power Switch must be ON to power the RsEK

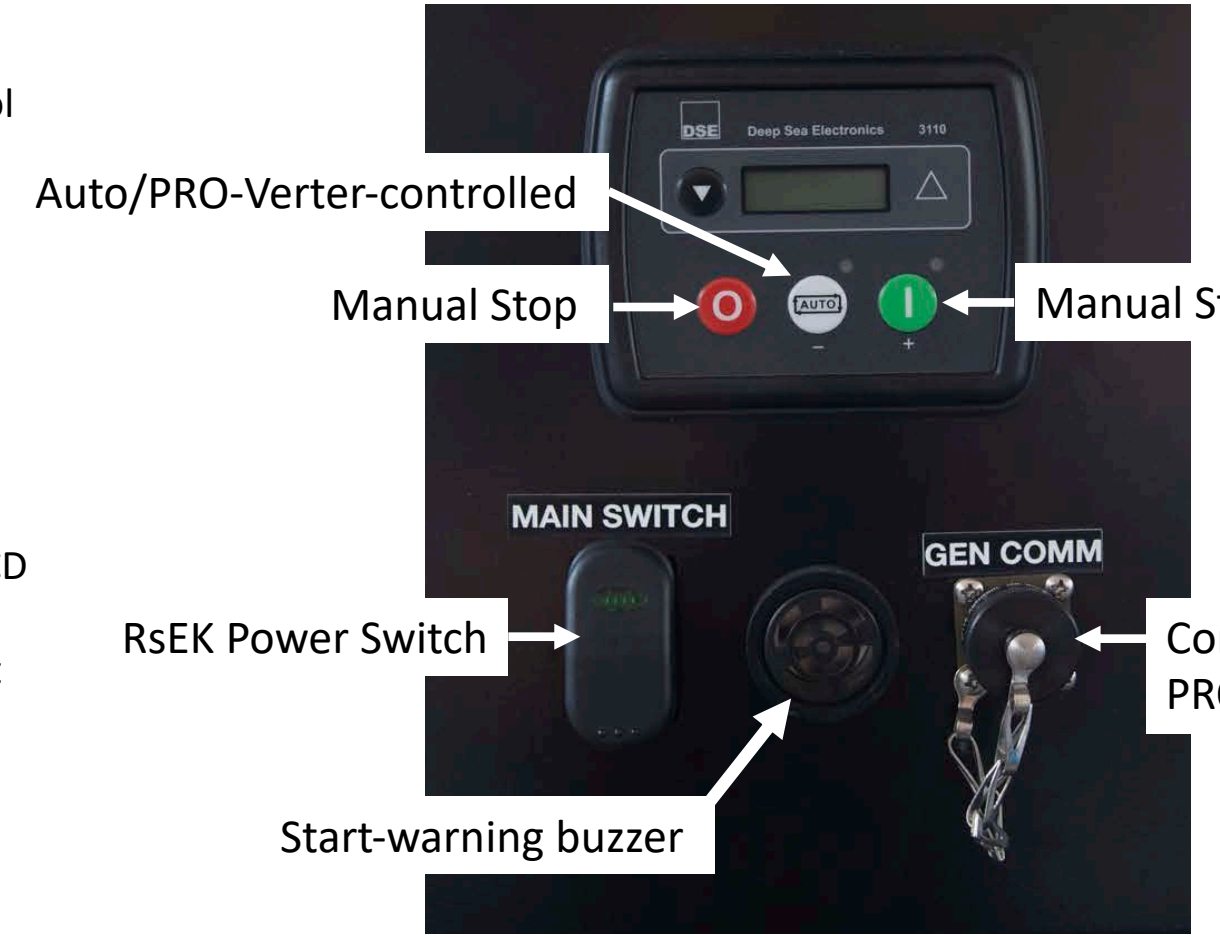
AUTO mode allows the PRO-Verter to remotely control the generator bases on battery/DC bus voltage.

The generator may be started and stopped manually using the green and red buttons.

The RsEK must be connected to a PRO-Verter for remote control of generator.

Monitor output voltage and frequency reported on LCD screen. If either of these values fall out of range, the System will become unstable. Methods to tune/adjust voltage and frequency can be found in using the PRO-Verter QR code link.

RsEK User Interface



System Startup

Power up Expander Pak 2400s

1. Remove safety pin
2. Toggle POWER switch to ON
3. Press Battery Status Display button. <u>LED must be green to deploy</u>.

Battery Status Indicator

Display Refresh Button

System Startup

Prepare Generator for Auto start/stop

1. Toggle ON the MAIN SWITCH to power up RsEK.
2. Toggle on AC BREAKER switches to ON.
3. Press the AUTO button

7 kW Generator Control Panel

System Startup

Toggle ON PRO-Verter Power Switch

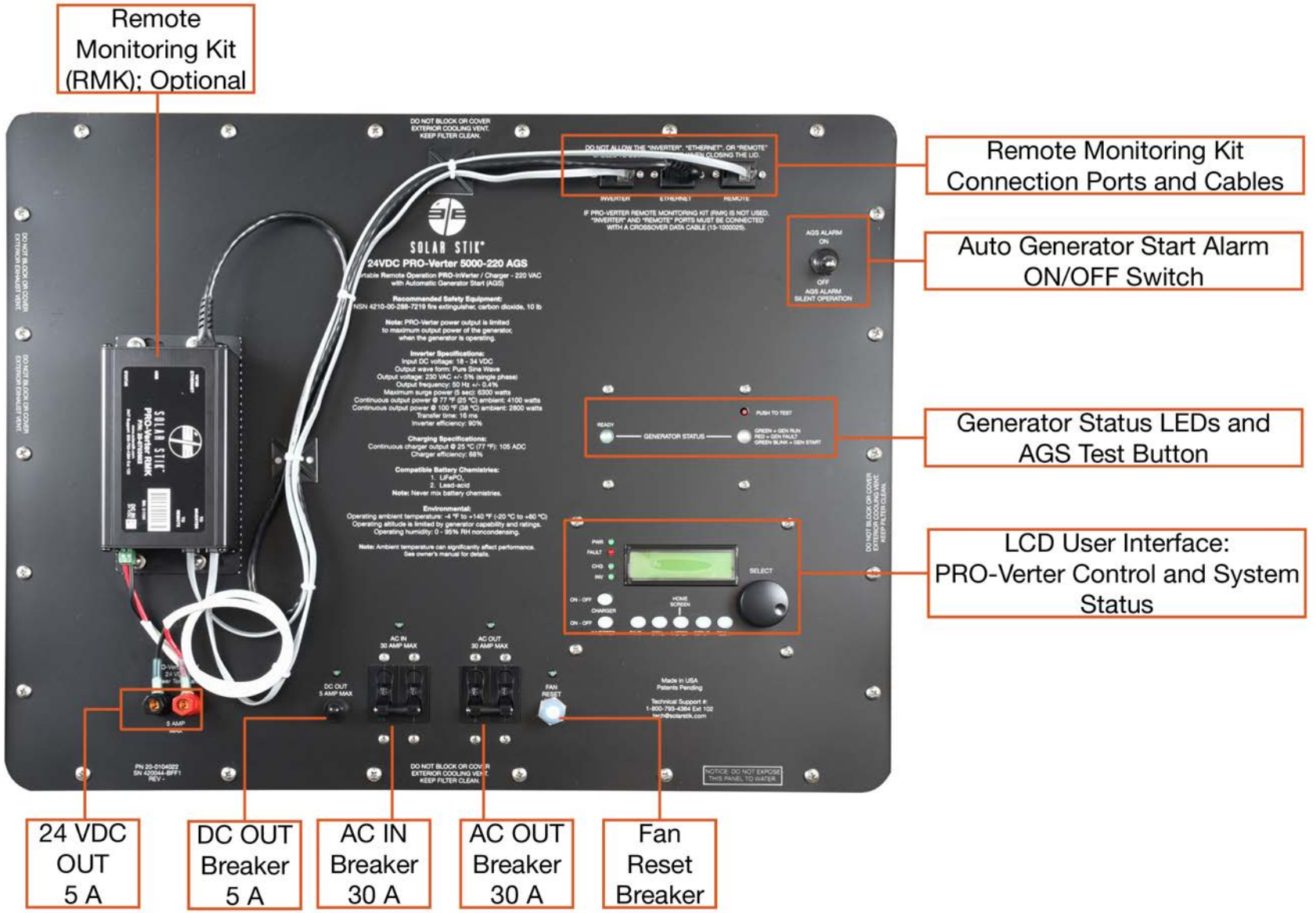
System Startup
Ensure Power Hub is ON

There is no “power switch” on the Power Hub. It powers up automatically when the batteries are turned ON.

System Startup

PRO-Verter 5000-220 Faceplate

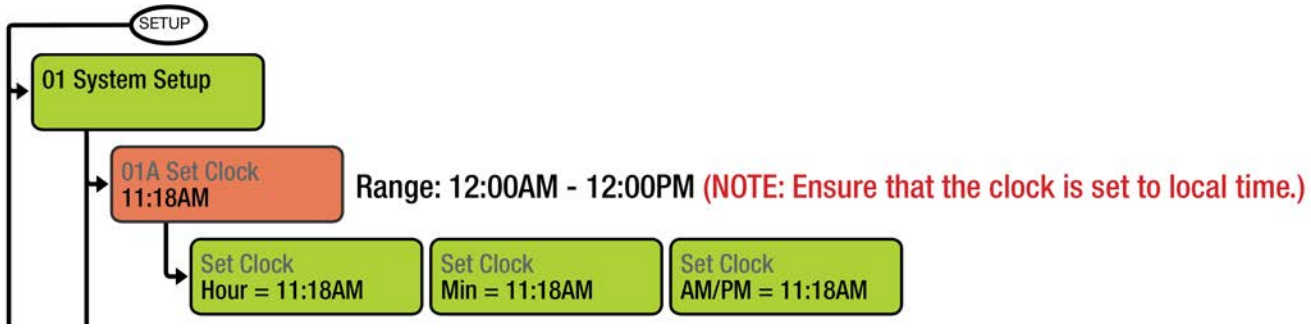
- User Interface monitoring and control
- Input and output breakers/switches
- Generator control
- Remote monitoring



System Startup

Set PRO-Verter Clock to Local Time

The Set Clock screen appears when PRO-Verter is powered up.
To reset clock while PRO-Verter is operating, go to SETUP>01A.

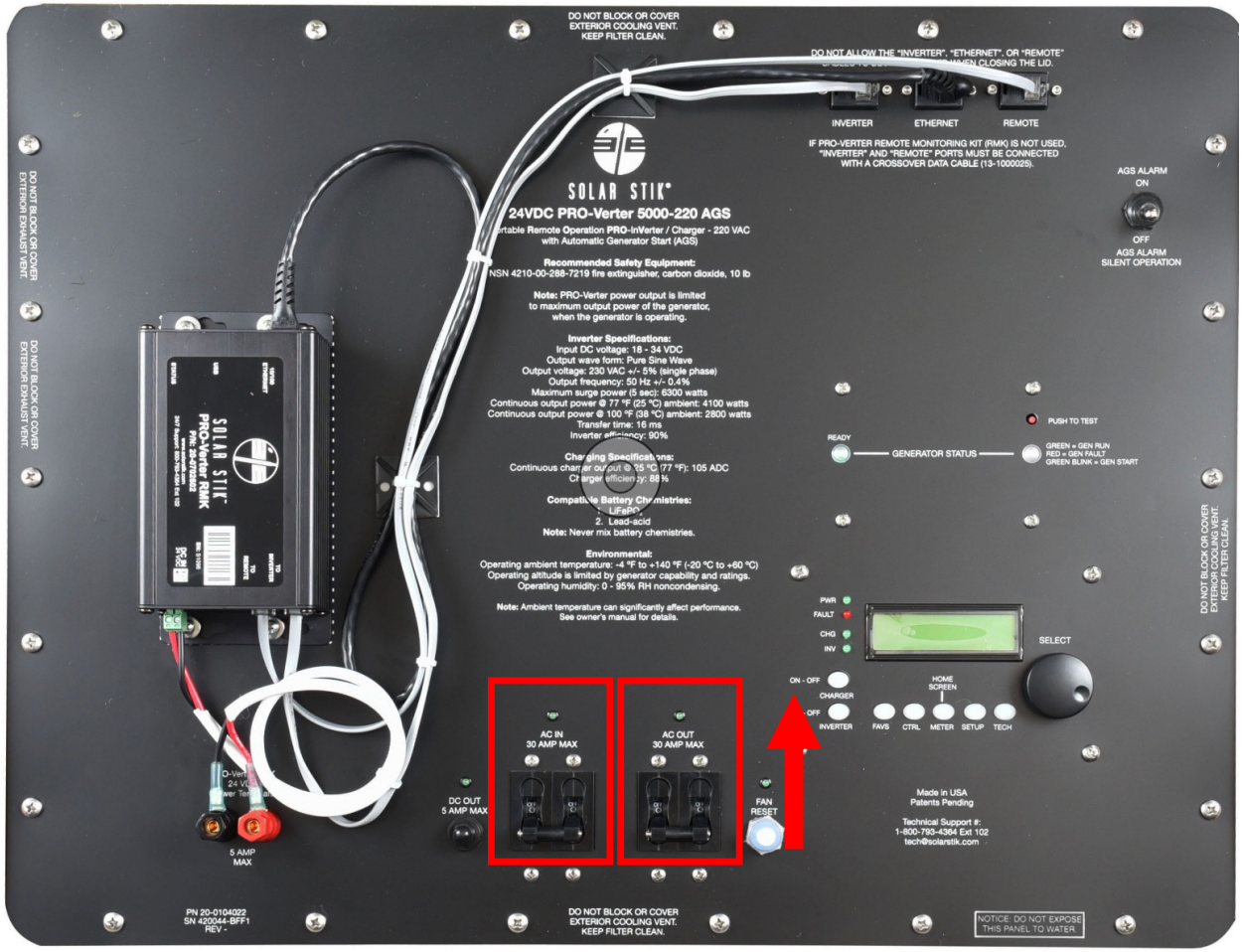


Why set the clock to local time?

Troubleshooting is easier. Faults will have an accurate time stamp.

System Startup

Toggle ON AC INPUT and OUTPUT breakers

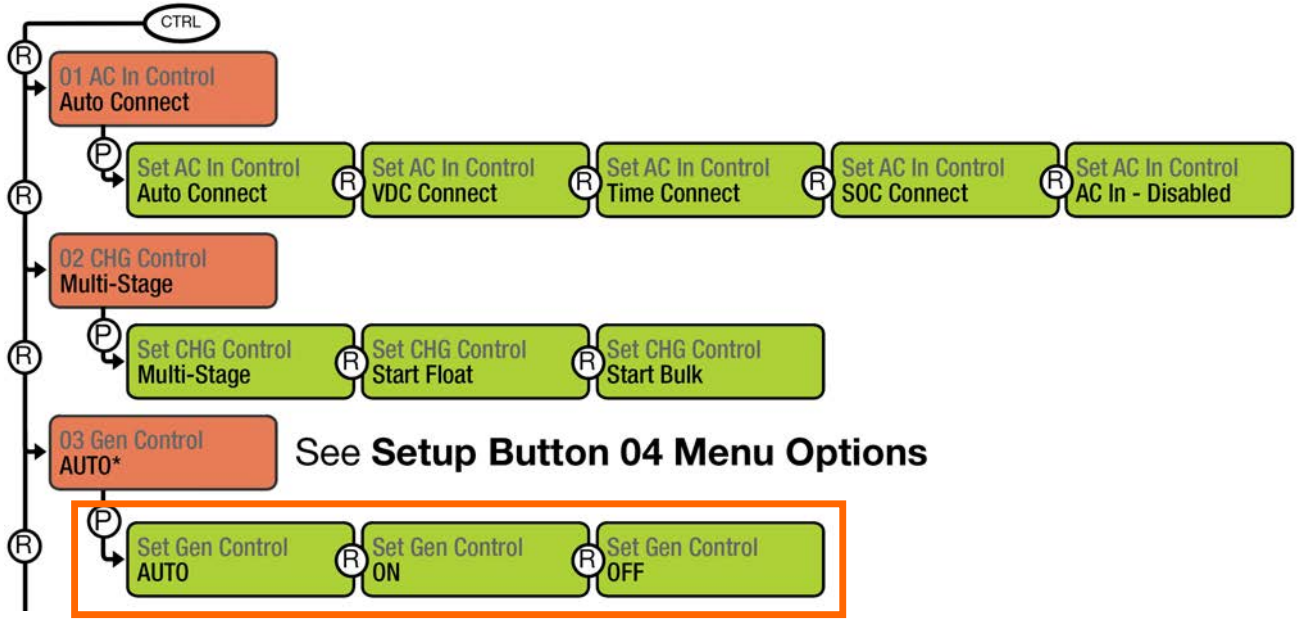


LED above breaker will illuminate when circuit is active/AC power is available.

System Startup

Start Generator from PRO-Verter

CTRL > 03 GEN CONTROL > ON/OFF/AUTO



First, choose “ON”.
Run for 5 min.
Change to ”AUTO”.

Overall Schedule

Training Schedule: 31 January, 2023

- 0700 – 0900 System Monitoring and Control
- 0900 – 1000 Breakfast
- 1000 – 1300 System Operation
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

System Monitoring

System Monitoring

Main sources of System information:

- Expander Pak 2400 Battery Status LED
- PRO-Verter User Interface
- Power Hub User Interface
- Remote Monitoring Kit/Monitor in Shelter

24 Hour Data			
Data Supplied By Battery Monitor (ME-BMK)			
	Minimum	**Maximum**	**Average**
Battery State of Charge:	*Was Disconnected...*		
Battery Volts:	26.13	26.14	26.14
Battery Amps:	-1.7	-1.6	-1.6
Battery Watts:	-45	-42	-43
Renewable Watts:	-45	-42	-43
Data Supplied By Inverter (MSH4024)			
	Minimum	**Maximum**	**Average**
AC volts Out: (when volts > 80)	119	119	119
AC amps Out: (when not charging)	0	0	0
AC amps In:	0.00	0.00	0.00
AC Frequency: (Hz)	60.0	60.1	60.0
Battery Temperature:	25°C / 77°F	25°C / 77°F	25°C / 77°F
Transformer Temperature:	26°C / 79°F	26°C / 79°F	26°C / 79°F
FET Temperature:	22°C / 72°F	22°C / 72°F	22°C / 72°F
AGS			
	Minimum	**Maximum**	**Average**
AGS Temperature:	*Was Disconnected...*		
AGS Voltage: (volts DC)	26.00	26.00	26.00

System Monitoring

Expander Pak 2400 Battery Status

Battery Status Indicator

Display Refresh Button

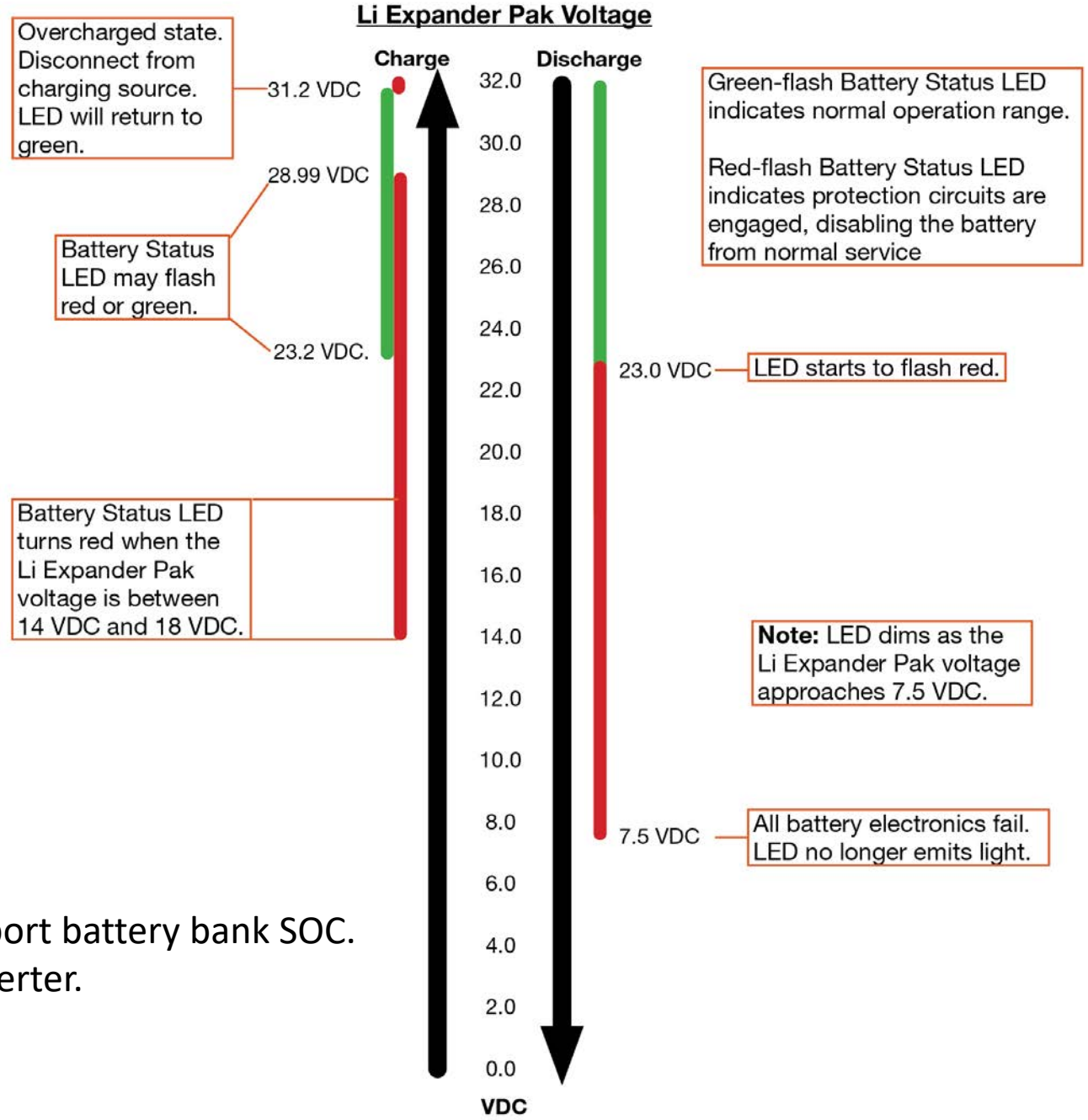
Color	Frequency	Condition
Green	Flashing	**Normal operation**
Red	Flashing	**Protection circuits engaged** 1. Cell overvoltage 2. Cell undervoltage 3. Overcurrent (charge or discharge) 4. Overtemperature (> 160 °F/71 °C) 5. An internal battery fault (such as a broken wire, dead cell, internal short circuit, etc.)
None	N/A	**Battery inoperative**

- Expander Pak Power Switch must be ON for light to work.
- If RED, turn OFF, disconnect from battery bank.
- If LED is green, does that mean it is charged fully?

System Monitoring
Expander Pak 2400 Voltage and LED color

Battery Status Indicator:

DISPLAY REFRESH BUTTON



- If the System has been cycling normally, the RMK will report battery bank SOC.
- The SOH of each battery can be measured using a PRO-Verter.

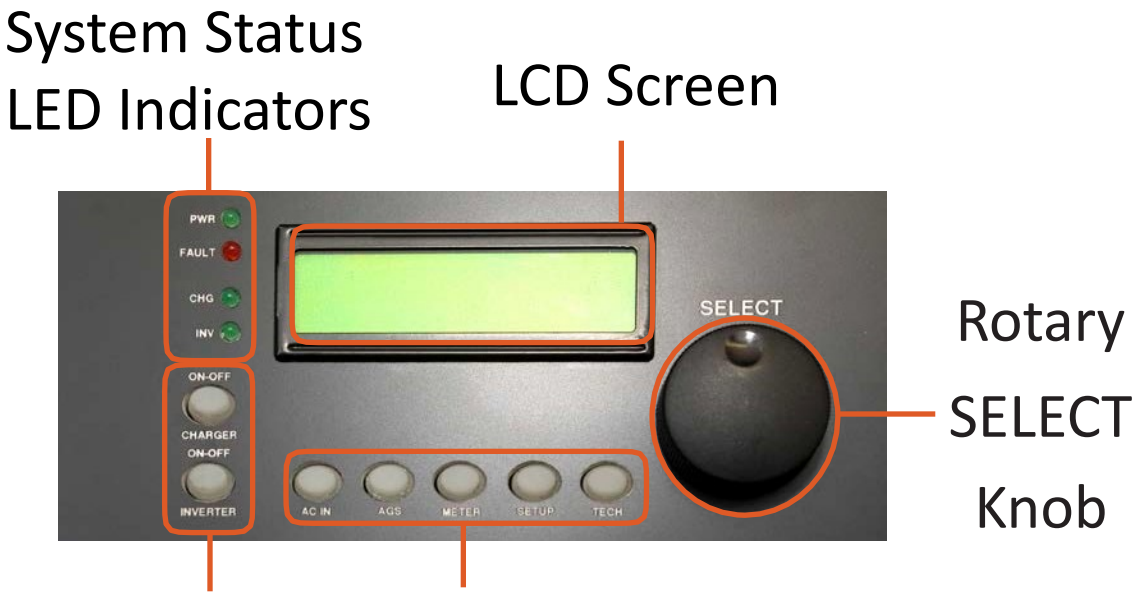
System Monitoring

Expander Pak 2400 Battery Status

Breaker status:
The Power Switch is also a 50 A breaker which may switch to OFF when overcurrent event happens. It is not always obvious and should be checked regularly. If one trips more are likely to trip.

System Monitoring

PRO-Verter LCD, Buttons, and Menu Items



System Monitoring

LED Indicator Guide and Charger, Inverter Buttons

Power Status LED (illuminates when powered)

Fault Status LED (illuminates when there is a fault)

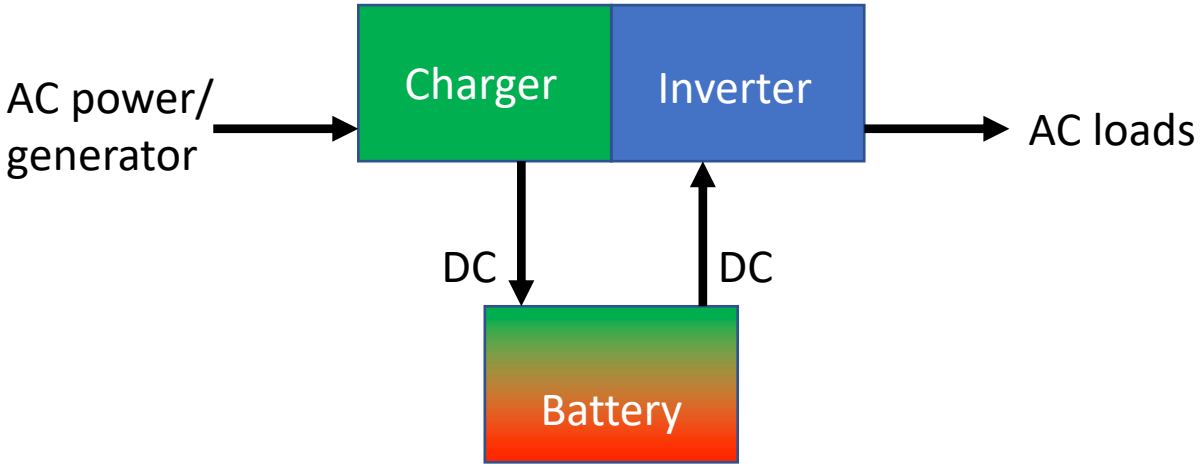
Charger Status LED (illuminates when charging)

Inverter Status LED (illuminates when inverting)

When the System is supporting loads during normal operation, the PRO-Verter will be either INVERTING or CHARGING.

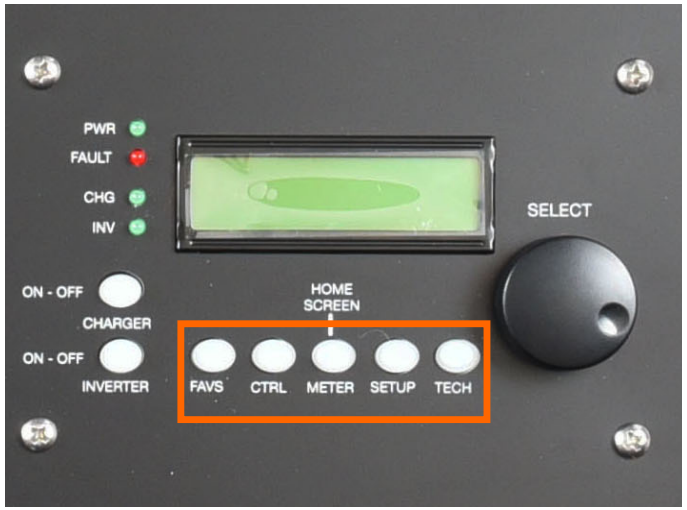
Charger Power Button

Inverter Power Button



System Monitoring

PRO-Verter Menu Buttons



FAVS

Stores the most commonly used settings, which aids in troubleshooting.

CTRL

Contains the menus for “AC In Control”, “CHG Control”, and “Gen Control”. Gives quick control of the main functions of the inverter/charger.

METER/HOME

Provides metering information on the PRO-Verter such as the AC, DC, or AGS meters. Brings the LCD back to the default HOME screen from any other menu.

SETUP

Allows the PRO-Verter to be configured to specific system preferences or to change the functions and capabilities. (Passcode may be required.)

TECH

Allows access to menu selections that can help service personnel with troubleshooting, historical data, revisions, and more.

System Monitoring
Menu Windows

FAVS Button
F1 Battery Type
F2 AmpHour Size
F3 AC Input
F4 LBCO
F5 Gen Run VDC

CTRL Button
01 AC In Control
02 CHG Control
03 Gen Control
04 PT Control

METER Button
(Read Only)
01 DC Meters
- 01A DC Volts
- 01B DC Amps

02 AC Meters
- 02A Output Volts
- 02B Load Amps
- 02C Input Amps
- 02D Inv/Chg Amps
- 02E Input AC1
- 02F Input AC2

03 Timers
- 03A Charge Time
- 03B Since Absorb
- 03C Since EQ

04 AGS Meters
- 04A AGS Status
- 04B DC Volts-AGS
- 04C Gen Run Time
- 04D AGS Temp
- 04E Since Gen Run
- 04F Since 100%
- 04G Hour Meter

05 BMK Meters
- 05A BMK Status
- 05B Battery SOC
- 05C DC Volts-BMK
- 05D DC Amps-BMK
- 05E DC AH In/Out
- 05F Reset AH In/Out
- 05G Total AH Out
- 05H Minimum VDC
- 05I Maximum VDC
- 05J Days Since

06 ACLD Meters
07 PT Meters

SETUP Button
01 System Setup
- 01A Set Clock
- 01B Screen Setup
- 01C Temp Display
- 01D Max Charge

02 Inverter Setup
- 02A Search Watts
- 02B LBCO Setting
- 02C AC In-Time
- 02D AC In-VDC
- 02E AC In-SOC
- 02F Power Up

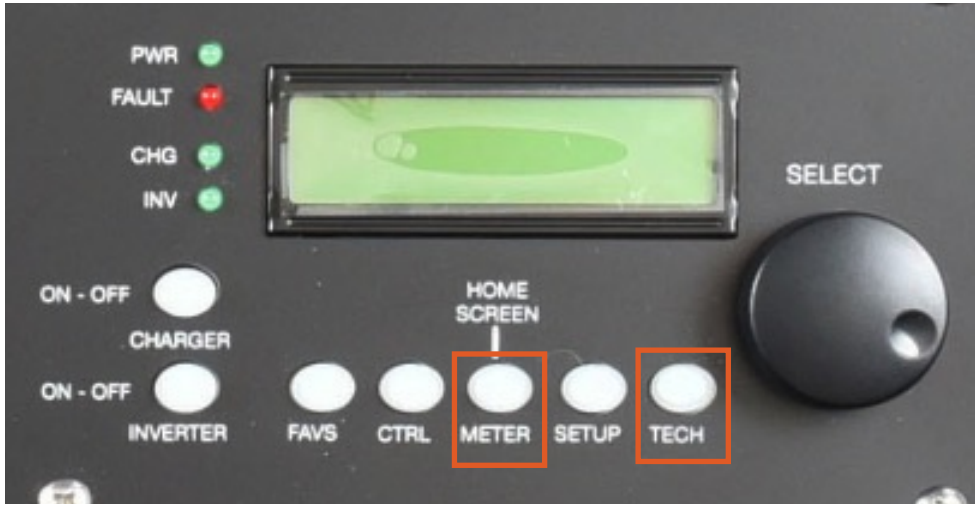
03 Charger Setup
- 03A AC Input
- 03B VAC Dropout
- 03C Battery Type
- 03D Absorb Done
- 03E Max Charge Rate
- 03F Max Charge Time
- 03G Final Charge
- 03H EQ Reminder

04 AGS Setup
- 04A Gen Run VDC
- 04B Gen Run Time
- 04C Gen Run Amps
- 04D Gen Run SOC
- 04E Gen Run Temp
- 04F Max Gen Run
- 04G Quiet Time
- 04H Gen Exercise
- 04I Gen Warm-up
- 04J Gen Cool Down
- 04K Gen 100% SOC

05 BMK Setup
- 05A Charge Eff
- 05B Amp Hour Size

TECH Button
01 Temperatures
02 Revisions
03 Inv Model
04 Fault History
- 04A Inv Faults
- 04B AGS Faults
- 04C PT Faults
- 04D Clear Faults

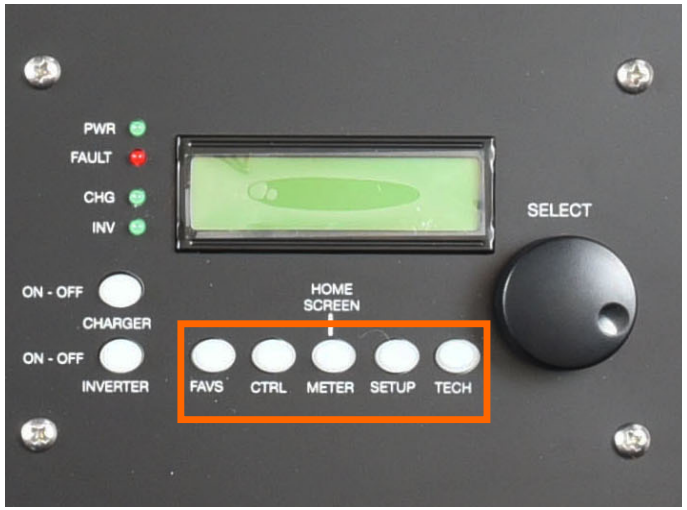
05 Setup PIN
06 Ext Control
07 Show All Menus
08 Load Defaults

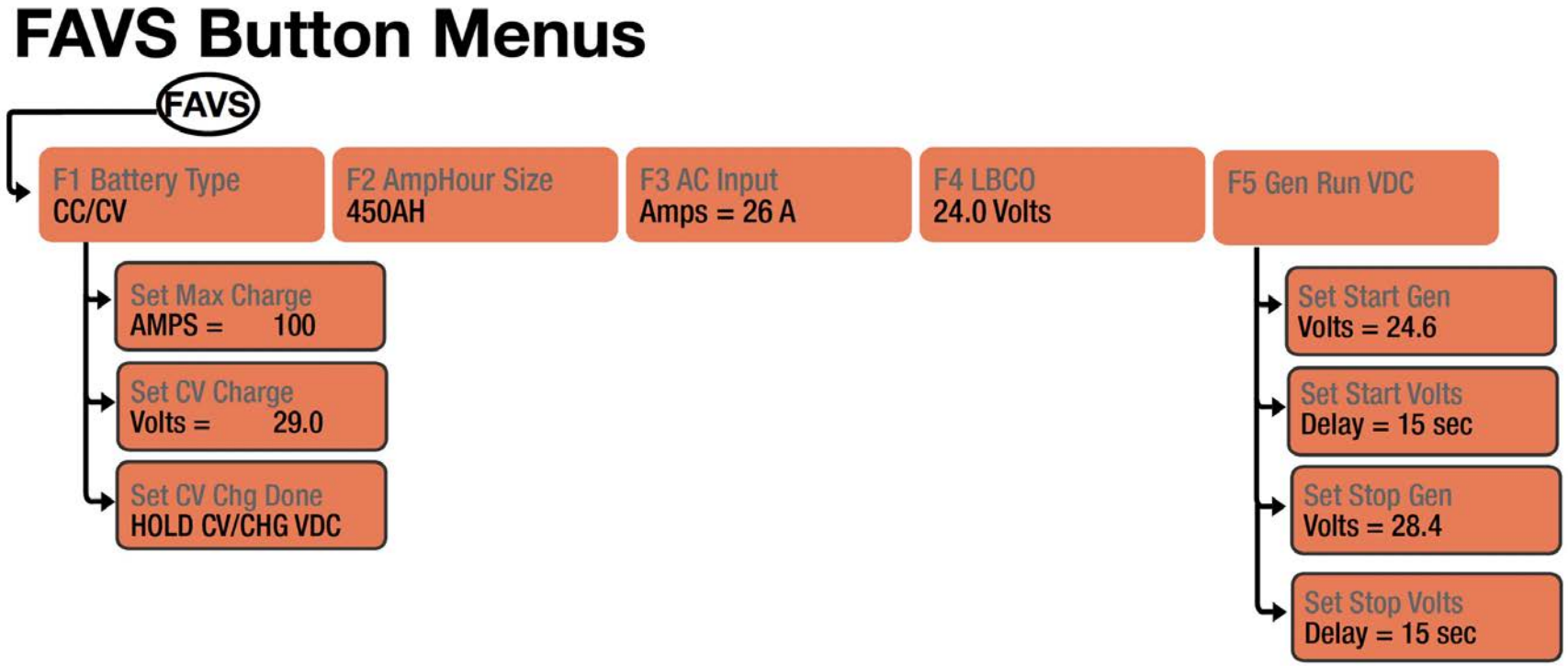


System Control and Monitoring

PRO-Verter Menu Buttons

FAVS

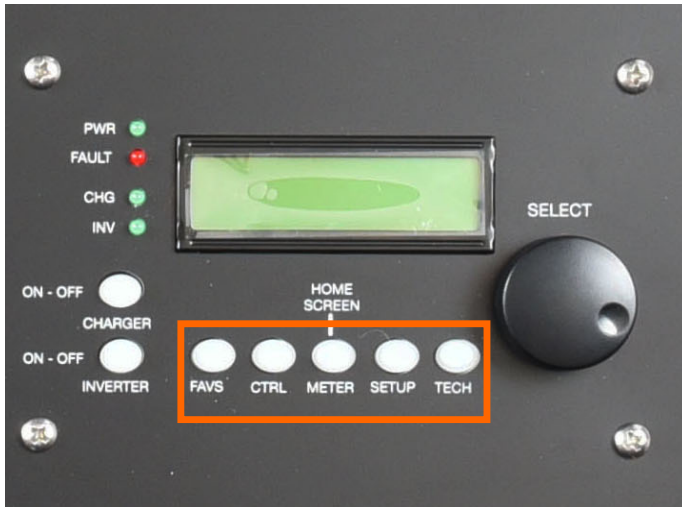


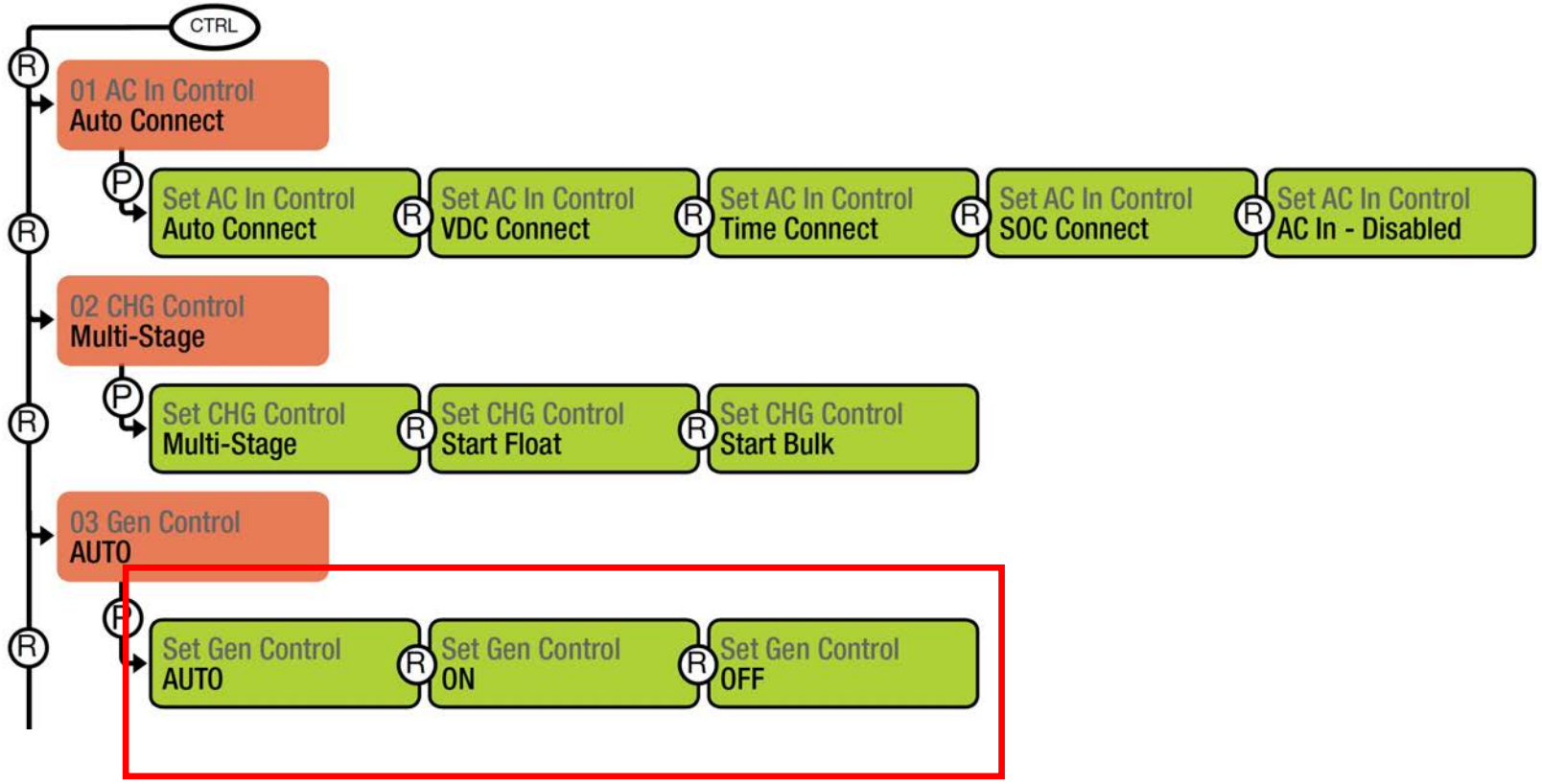


System Control

PRO-Verter Menu Buttons

CTRL (Control)

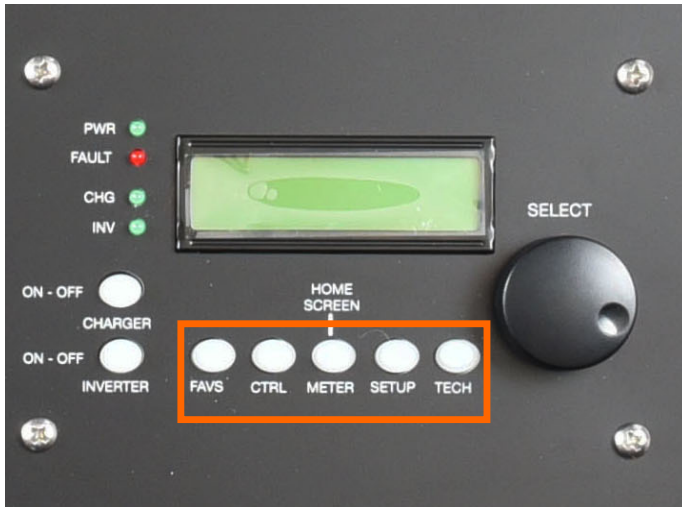


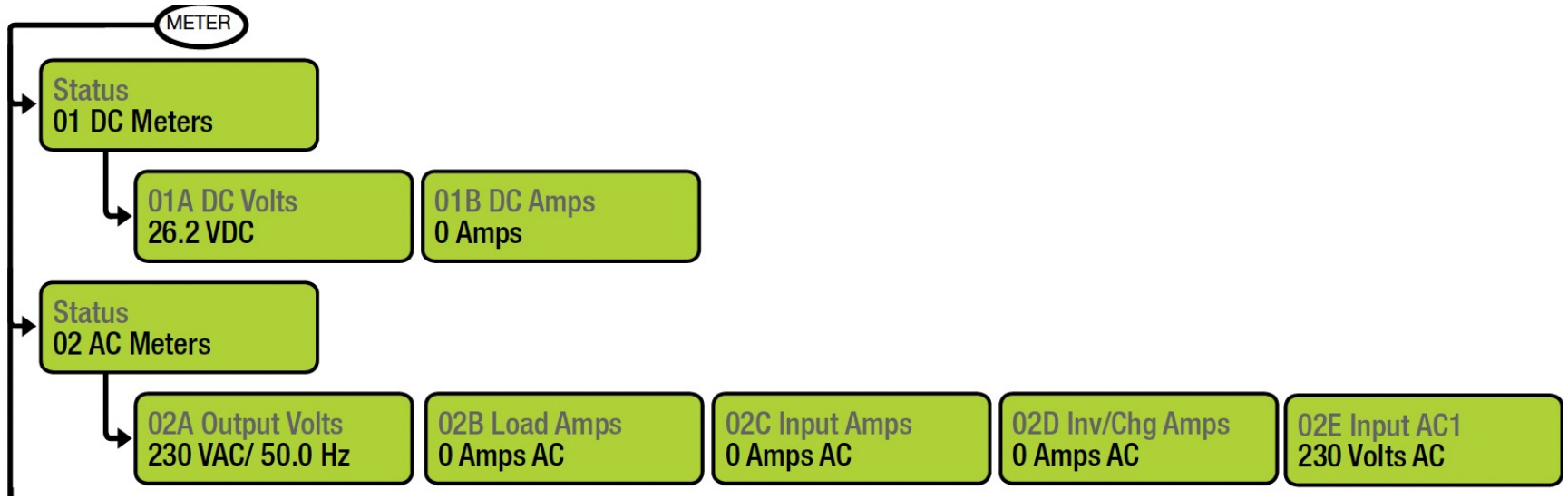


System Monitoring

PRO-Verter Menu Buttons

METER

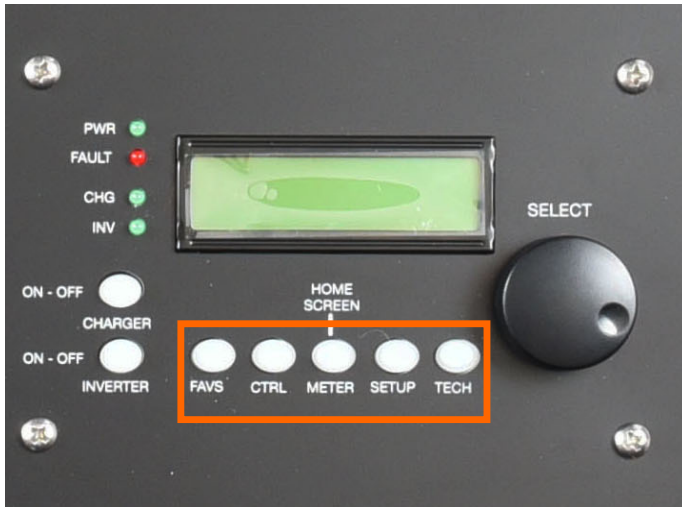




System Monitoring and Control

PRO-Verter Menu Buttons

SETUP



01 System Setup (clock time is here)
02 Invert Setup
03 Charger Setup
04 AGS Setup

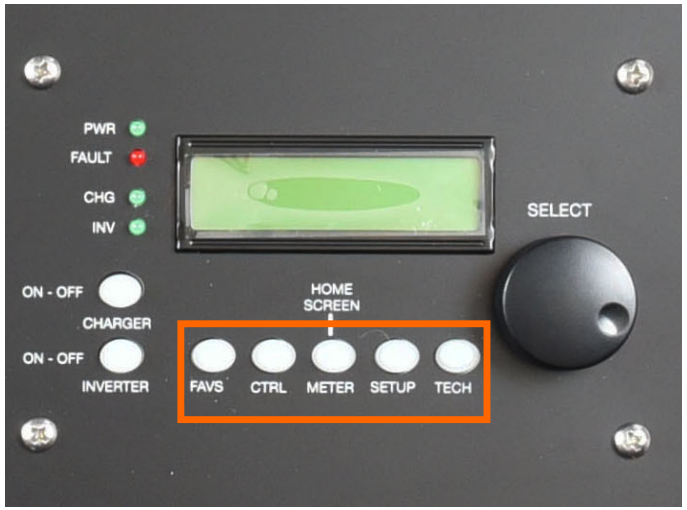
Generally, the settings in these menus should not be changed unless you have a lot of experience.

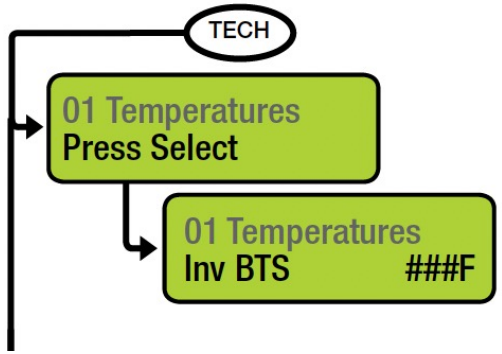
System Monitoring

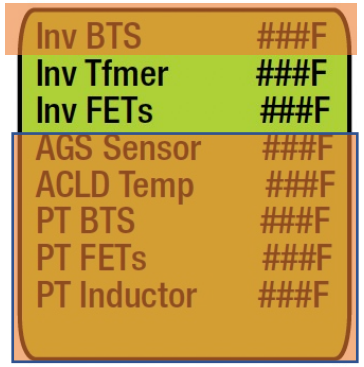
PRO-Verter Menu Buttons

Tech

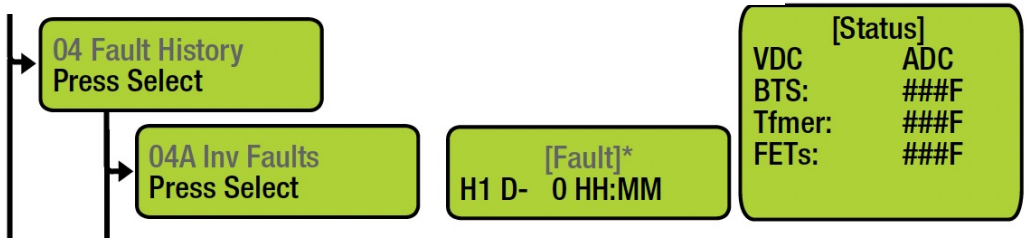
(INTERNAL Temperatures and Fault History)







Read-only Displays



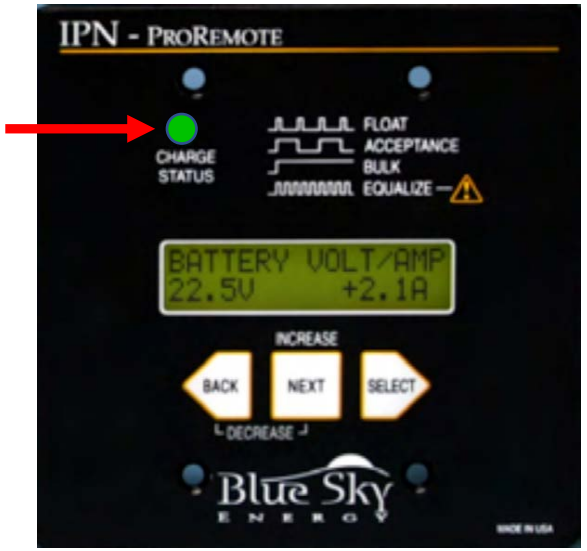
* Specific fault listed; if no fault, “No Fault History” displays. H1= the most recent fault; H2–H9 are the faults in the earliest/past record H9 being the oldest.

System Monitoring

Power Hub Control Interface

Monitoring the Solar Charging Status

Charge Status Indicator - LED Status	
Charge status indicator 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

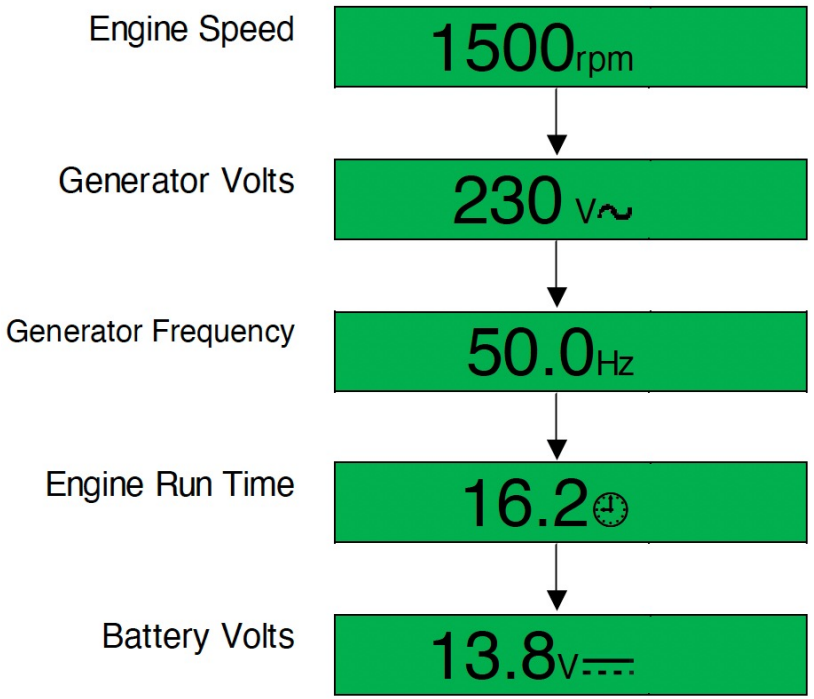


PV Charge Status LED

NOTICE
The Equalize function in the Charge Controller has been disabled in the Power Hub 2400.

System Monitoring
7 kW Generator DSE 3110

Order of information on screen



After generator is running and stable, voltage and frequency should be 230 VAC and 50 Hz.

System Monitoring

RMK Data in Shelter

Now	
Data Date (UTC):	2015-01-07 16:41:46 Report received 5 seconds ago
Data Supplied By Battery Monitor (ME-BMK)	
Real Time Battery Volts:	26.14 VDC
Real Time Battery Amps:	-1.6 amps
Real Time Battery Watts:	-43 watts
Real Time Renewable Watts: (Approximate Value +/- 50W)	-43 watts
Battery State of Charge: (10 minute averages over past 24 hours) Gray Bars Indicate Thinking	Thinking...
Battery Watts In/Out: (10 minute averages over past 24 hours)	
Battery Amp Hours In / Out: (10 minute averages over past 24 hours)	-1 amp hours
Renewable Watts: (10 minute averages over past 24 hours)	
Data Supplied By Inverter (MSH4024)	
Status:	Inverting
Battery Temperature:	25°C / 77°F
Transformer Temperature:	26°C / 79°F
FET Temperature:	22°C / 72°F
AC Out Volts:	Approximately 119 volts
AC Out Amps:	Approximately 0.00 amps
AC Out Watts:	Approximately 0 watts
AC In Volts:	Inactive.
AC Frequency: (Hz)	60.0
DC volts / amps: (Values are approximate)	26.2 VDC @ 0 amps (0 watts)
AGS / Generator	
Status:	Off
AGS Temperature:	< 1°C / 33°F
AGS Voltage:	26.00 VDC
Generator Runtime: (Current Cycle)	0.0 hours
Days Since Last Run:	0 days
Total Generator Runtime: (Since AGS Boot)	0 hours

24 Hour Data			
Data Supplied By Battery Monitor (ME-BMK)			
	Minimum	Maximum	Average
Battery State of Charge:	*Was Disconnected...*		
Battery Volts:	26.13	26.14	26.14
Battery Amps:	-1.7	-1.6	-1.6
Battery Watts:	-45	-42	-43
Renewable Watts:	-45	-42	-43
Data Supplied By Inverter (MSH4024)			
	Minimum	Maximum	Average
AC volts Out: (when volts > 80)	119	119	119
AC amps Out: (when not charging)	0	0	0
AC amps In:	0.00	0.00	0.00
AC Frequency: (Hz)	60.0	60.1	60.0
Battery Temperature:	25°C / 77°F	25°C / 77°F	25°C / 77°F
Transformer Temperature:	26°C / 79°F	26°C / 79°F	26°C / 79°F
FET Temperature:	22°C / 72°F	22°C / 72°F	22°C / 72°F
AGS			
	Minimum	Maximum	Average
AGS Temperature:	*Was Disconnected...*		
AGS Voltage: (volts DC)	26.00	26.00	26.00

Memory
click to show/hide

System Memory	
Total Space:	3,997 MB
Free Space: Percent:	3,960 MB 99%
Used Space: Percent:	21 MB 1%
Days Left: approximate	1,999

Alarm Controls
click to show/hide

Silenced: false

- Silence Alarm
- Unsilence Alarm
- Dismiss
- Test Alarm

Overall Schedule

Training Schedule: 31 January, 2023

- 0700 – 0900 System Monitoring and Control
- 0900 – 1000 Breakfast
- 1000 – 1300 System Operation
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

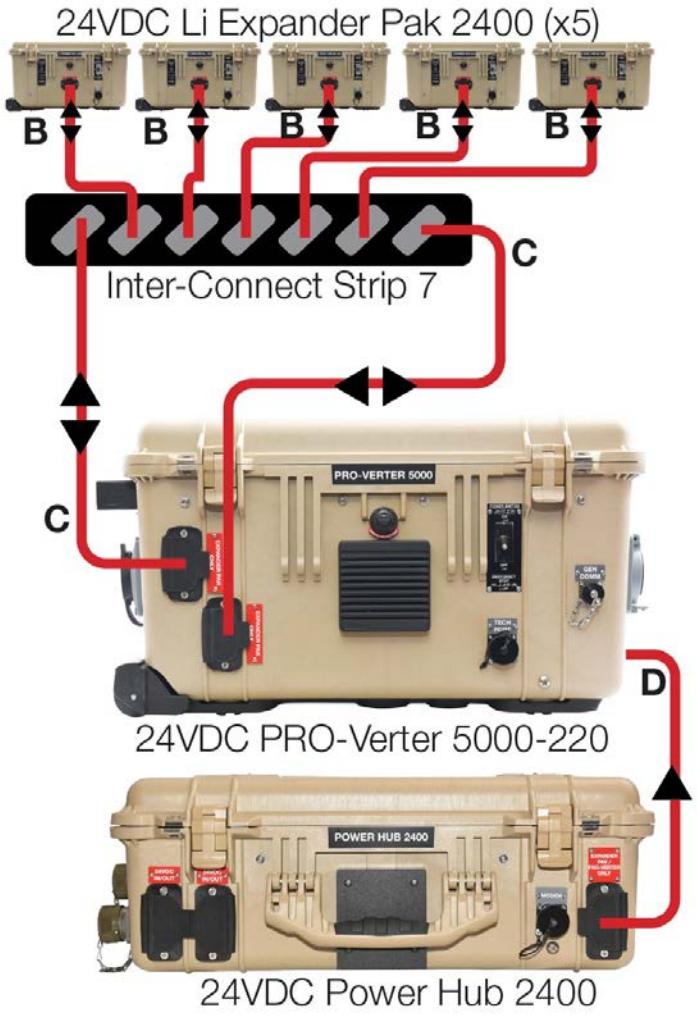
System Operation Overview

- Inter-Connect Network
- Power Flow through the System

System Operation

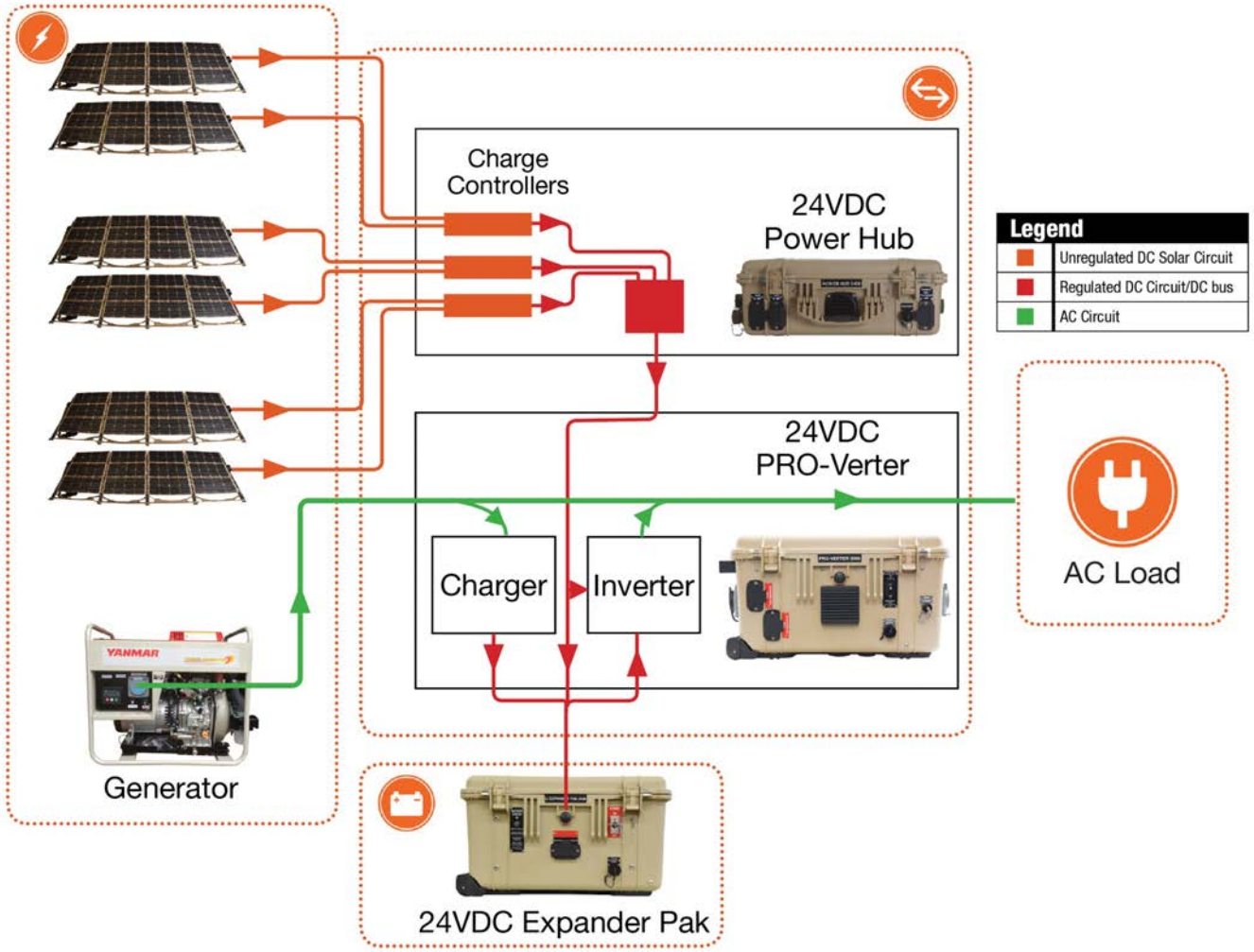
Inter-Connect Network: The DC bus

- Enables “communication” (voltage) between components
- Provides the common DC circuit (bus) to which all HPS components are connected
- Enhances setup and safety through polarized connections
- Automatic Generator START/STOP is controlled by DC bus voltage.



System Operation

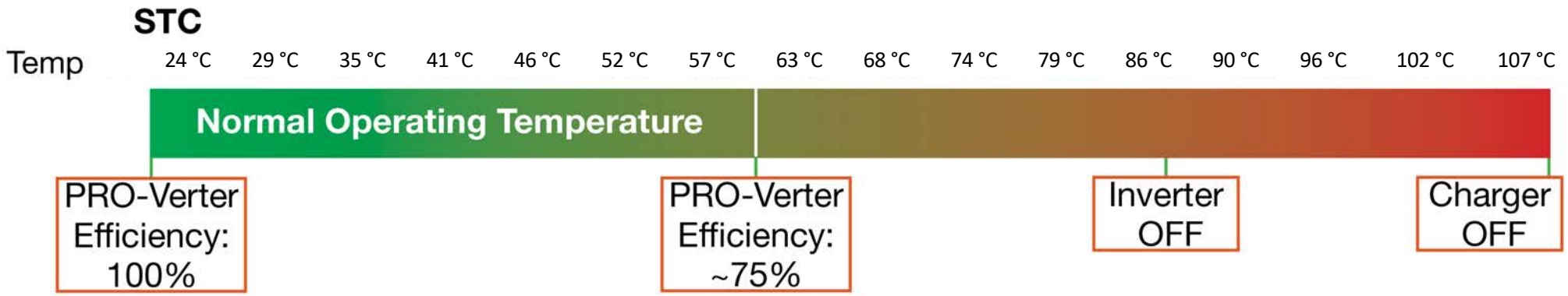
Power Flow through the System



System Operation

PRO-Verter heat-related derating

The temperatures are inside of PRO-Verter not ambient temperature



Overall Schedule

Training Schedule: 01 February, 2023

- 0700 – 0900 PMCS and Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 System Hands On Setup
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

PMCS

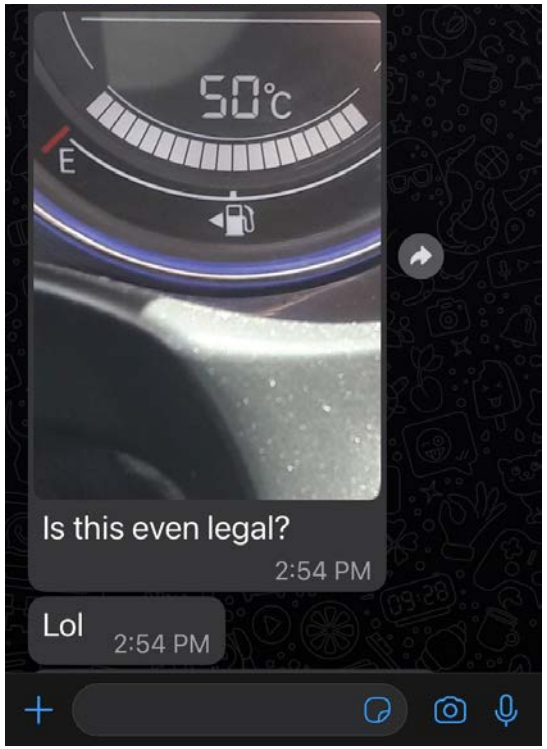
- **Maintain health of each Expander Pak in the battery bank.**
- Cover and shade equipment (except for Solar Arrays) as much as possible.
- Follow all generator maintenance procedures and intervals.
- Keep lids closed on PRO-Verters and Power Hubs to prevent precipitation or particulates from damaging internal components.
- Keep unused port/connector covers closed.
- Check air filters monthly; keep them clean.
- Check electrical connectors and cables monthly.
- Ensure Solar Arrays are clean and oriented for maximum daily sun exposure.

PMCS

Avoid using and storing Expander Paks in HOT places. Shade them when in use.

- **<u>Heat shortens battery lifespan.</u>**
- The electrochemical reaction that discharges a battery continues even when the battery is turned OFF.
- Heat increases the electrochemical reaction.
- When stored in hot places, INCREASE frequency of maintenance charging.

Oman- May 2022



PMCS

The battery bank is only as healthy as the weakest battery.

All Expander Paks in a battery bank should have the same:

- State of Health (SOH; remaining storage capacity)
- State of Charge (SOC)
- Cycle Number
- Age

Expander Pak SOC and SOH disparities may cause erratic System behavior including:

- Premature termination of the AGS functions, or generator “short-cycling” (frequent start / stop)
- Expander Pak Circuit breaker tripping
- System crashes

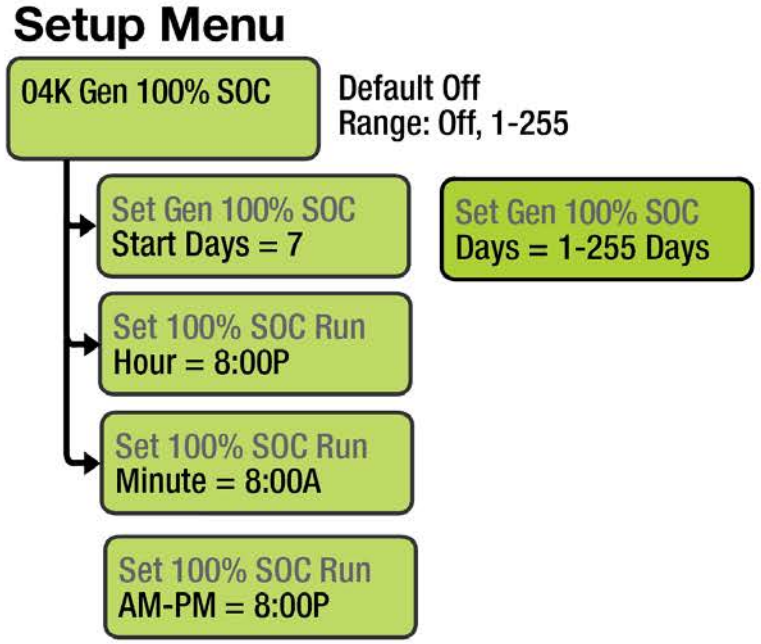
Cell phone battery example

PMCS

How to maintain a healthy battery bank:

Manually: Charge batteries to 100% SOC weekly. CTRL>03 Gen Control> ON for 8 hours or until charging current is reduced to 5 A or less (METER>01B DC Amps) with minimum / no AC load on PRO-Verter.

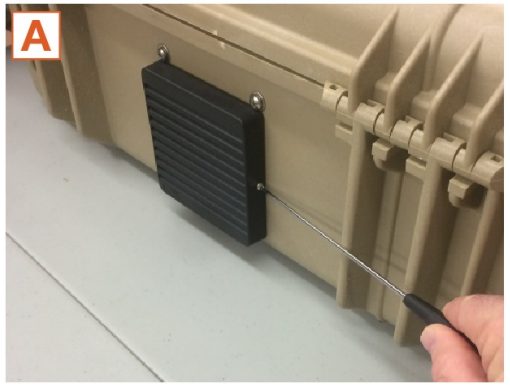
Automatically: PRO-Verter will allow generator to run until battery bank is at 100% SOC after 7 days of NOT being up to 100% SOC. The process will begin at 8:00 PM or 20:00 Hrs.



1. Press the SETUP Button on the PRO-Verter user interface (password may be required).
2. Navigate to SETUP 04K Gen 100% SOC. Press SELECT to enter this menu.
3. Enter and save the values best suited for your application into each of the fields. Start with the frequency (e.g., every 7 days) as shown and at an appropriate time of day.
4. Confirm that the SOC of the System battery bank reported in METER 05B is 100%. .

PMCS

Cleaning the Power Hub Air Filters



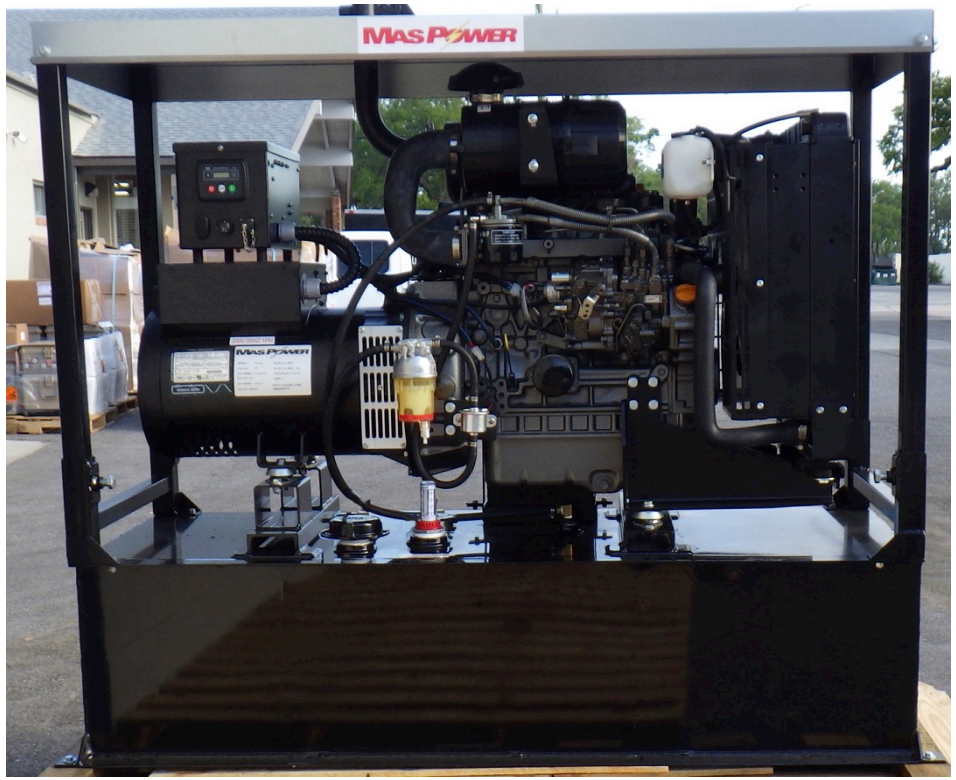
PMCS

Cleaning the Solar Panels

Clean panels = more free power

PMCS
7 kW Generator Maintenance

Engine Model: 4TNV88



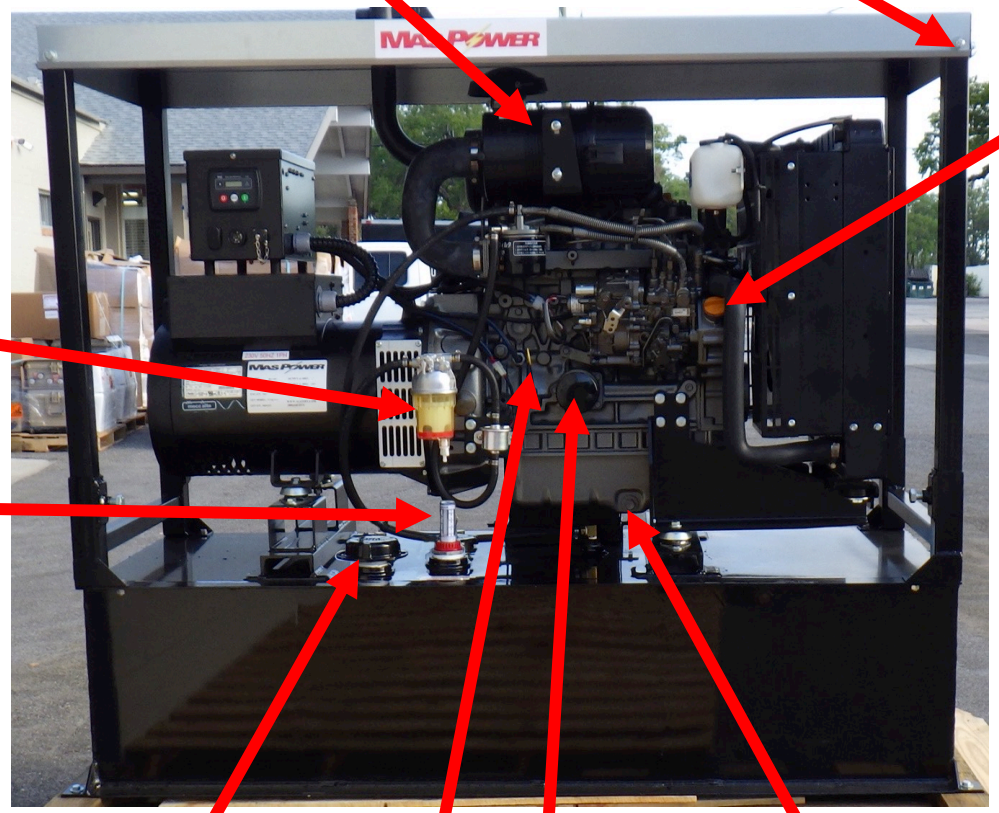
Details in Generator Operator and Maintenance Manual

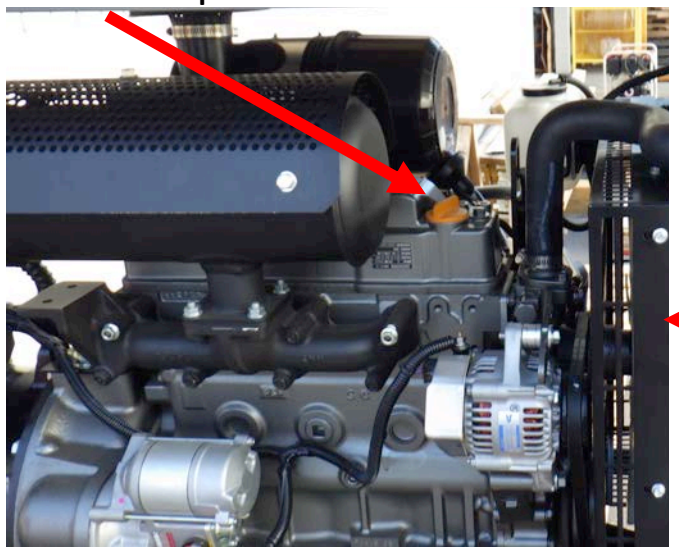
Periodic Maintenance Schedule in generator OEM Manual

○: Check ◇: Replace ●: Contact your authorized Yanmar industrial engine dealer or distributor

System	Check Item	Daily	Periodic Maintenance Interval: Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 1500 hours	Every 2000 hours
Cooling System	Check and Refill Engine Coolant	○						
	Check and Clean Radiator Fins		○					
	Check and Adjust Cooling Fan V-belt		○ 1st time	○ 2nd and after				
	Drain, Flush and Refill Cooling System With New Coolant					◇ or every 1 year which-ever comes first		
Cylinder Head	Adjust Intake / Exhaust Valve Clearance					●		
	Lap Intake / Exhaust Valve Seats. If necessary							●
Electrical Equipment	Check Indicators	○						
	Check Battery		○					
Engine Oil	Check Engine Oil Level	○						
	Drain and Fill Engine Oil		◇ 1st time	◇ 2nd and after				
	Replace Engine Oil Filter							
Engine Speed Control	Check and Adjust Governor Lever and Engine Speed Control	○		○				
Emission Control Warranty	Inspect, Clean And Test Fuel Injectors						●	
	DI ENGINE Inspect Turbocharger (Blower Wash as Necessary) 3TNV84T, 4TNV84T, 4TNV98T, 4TNV106T, 3TNV84T-B, 4TNV84T-Z, 4TNV98T-Z						●	
	DI ENGINE Inspect, Clean and Test EGR Valve 4TNV84T, 4TNV98T						●	
	DI ENGINE Clean EGR Lead Valve 4TNV84T, 4TNV98T						●	
	DI ENGINE Clean EGR Cooler (Clean to Blow Water/Air Passages) 4TNV84T, 4TNV98T						●	
	Inspect Crankcase Breather System						●	
Fuel	Check and Refill Fuel Tank Level	○						
	Drain Fuel Tank			○				
	Drain Fuel Filter / Water Separator	○						
	Check Fuel Filter / Water Separator	○						
	Clean Fuel Filter / Water Separator				○			
	Replace Fuel Filter				◇			
Hoses	Replace Fuel System and Cooling System Hoses							◇ or every 2 yrs.

PMCS
7 kW Generator Maintenance



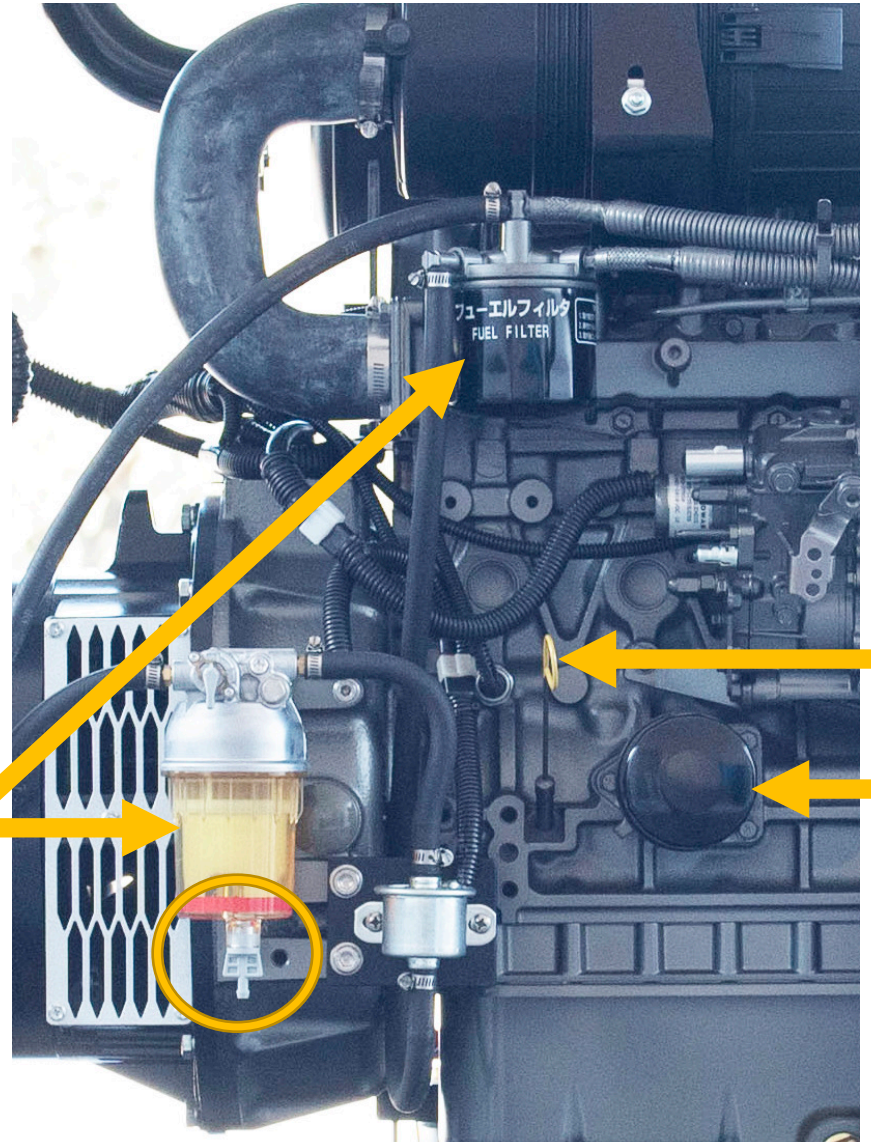


PMCS

7 kW Generator Air Filter Cleaning

PMCS

7 kW Generator Oil and Fuel Filters

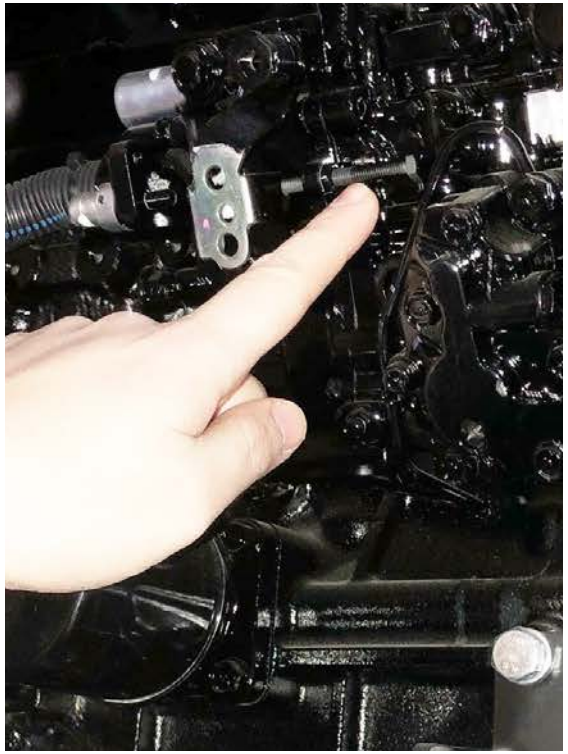


PMCS

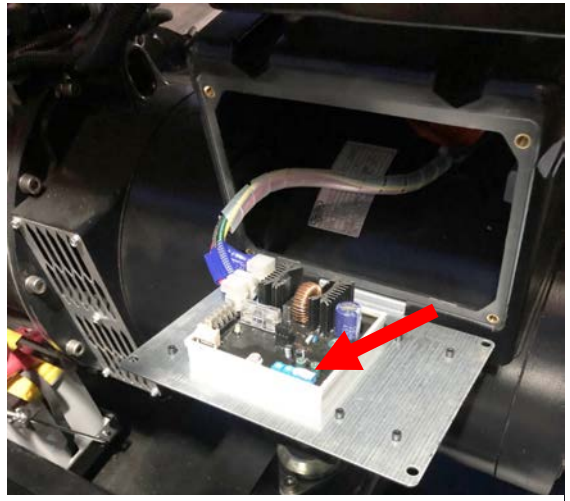
7 kW Generator Maintenance/Tuning

Generator output should be 230 VAC and 50 Hz. These values can be monitored on the Generator Control Panel (DSE 3110) and on the PRO-Verter 5000.

Adjust throttle linkage to change Output frequency



Gently adjust potentiometer to change voltage



See MECC ALTE DSR VR.pdf

PMCS

Water Intrusion Remediation

It can get rainy in Oman (cyclone Shaheen)!

Location of Drain Plugs PRO-Verter 5000 (left), and Power Hub (right)

There is a drain hole on the side, at the end of the strip (arrow).

Troubleshooting

Troubleshooting

https://solarstik.com/atsc-oman-l0/

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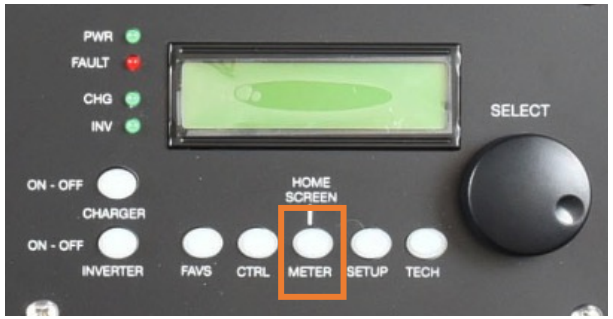
Generator Control Module DSE 3110 QUICK GUIDE	Download
Generator Control Module DSE 3110 MANUAL	Download
7 kW Electric Generator MECC ALTE MANUAL	Download

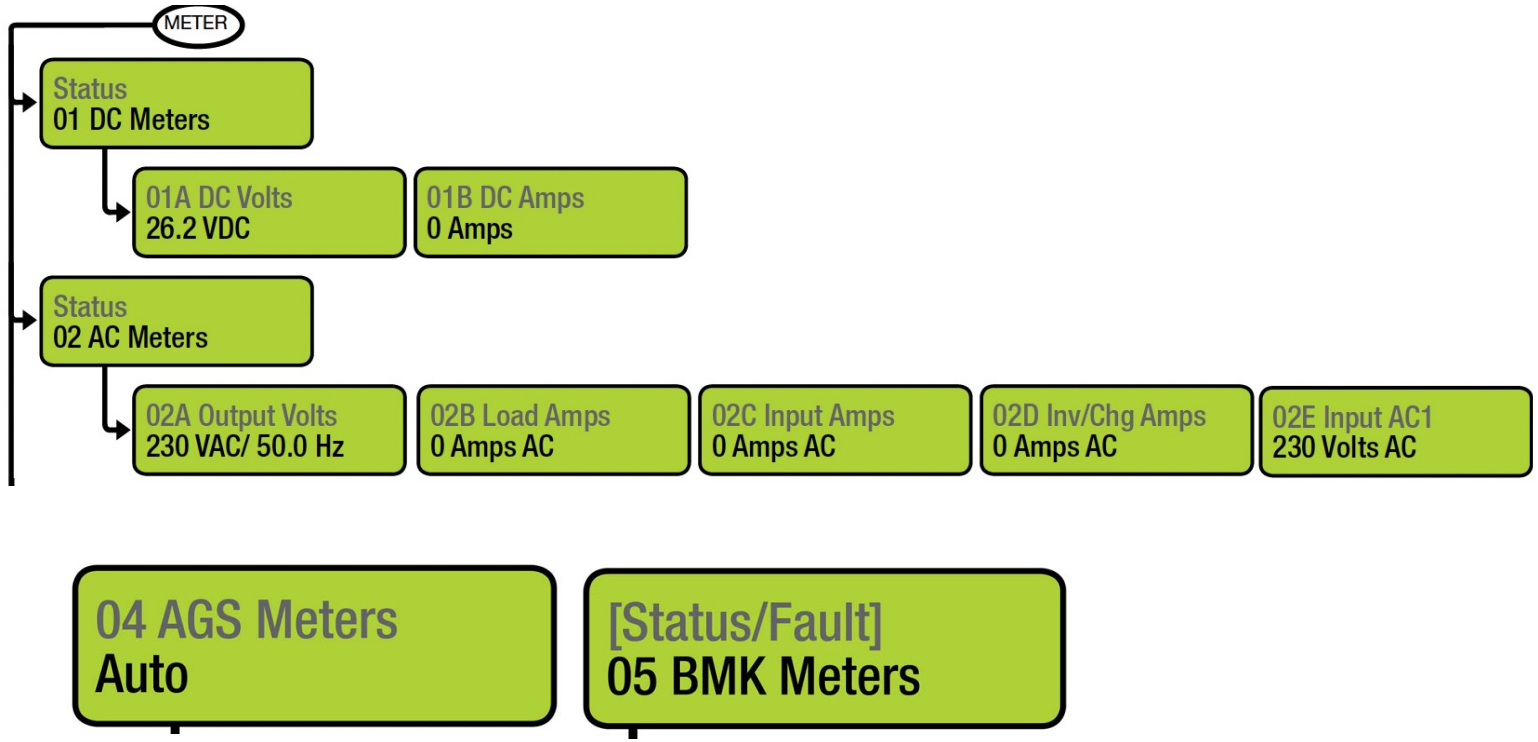
Show 25 per page 11 documents

Open Troubleshooting Guide PDF and Walk through all sections

Troubleshooting

Information in METERs is very helpful for troubleshooting





Troubleshooting

PRO-Verter: Quick Links to Statuses, Faults, and Resolutions

This guide is interactive if used on a computer or handheld device. Each of the faults in the lists below is touch-linked to an explanation of the fault and a solution to resolve the fault.

Troubleshooting

PRO-Verter Fault Messages and Troubleshooting Guides

Table 1. Fault Messages Symptoms and Troubleshooting

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

Continued on next page

TROUBLESHOOTING PROCEDURES

Power Hub Will Not Power Up

If the Power Hub 3500 is not powered up, it probably is not connected to an active 24 VDC battery and/or there is no PV input. The LCD user interface will power up and be navigable when connected to either of these power sources. Power from PV arrays will charge batteries once the voltage from the arrays is 5 volts greater than the battery voltage then continue charging as long as the voltage from the PV arrays is 1 volt higher than that of the batteries.

Performance Issues, Causes and Solutions

Table 1. Symptoms and Solutions for the Most Common Power Hub Issues

Symptom	Possible Cause(s)	Solution
Battery SOC displays "--".	Battery not fully charged for an extended period or has not been cycled enough times for the user interface to calculate SOC.	Try to charge the battery fully often. Refer to the setup diagram to make sure that the System is assembled correctly.
Battery SOC seems inaccurate	Power Hub is not the primary power management device.	Normal operation. Read battery SOC from primary management device (e.g., PRO-Verter)
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 °F; diminishing power as temp approaches 140 °F. Check for dirty, blocked air filters. Shade the Power Hub to reduce solar loading. Ensure that the internal cooling fans are operating (audible when operating). 2. Normal operation.
LCD 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.

Overall Schedule

Training Schedule: 01 February, 2023

- 0700 – 0900 PMCS and Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 System Hands On Setup
- 1300 – 1400 Lunch
- 1400 – TBD (If Needed)

System Hands on Setup

Overall Schedule

Training Schedule: 02 February, 2023

- 0700 – 0900 Live Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 Hands on Breakdown and Q/A
- 1300 – 1400 Lunch
- 1400 – TBD Quiz and Certificate Presentation

Live Troubleshooting

Overall Schedule

Training Schedule: 02 February, 2023

- 0700 – 0900 Live Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 Hands on Breakdown and Q/A
- 1300 – 1400 Lunch
- 1400 – TBD Quiz and Certificate Presentation

Hands on Breakdown

Overall Schedule

Training Schedule: 02 February, 2023

- 0700 – 0900 Live Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 Hands on Breakdown and Q/A
- 1300 – 1400 Lunch
- 1400 – TBD Quiz and Certificate Presentation

Questions and Answers

Questions and Discussion

Where can ALL information on the system be found?

What fire extinguisher type is best to use with the L0 System?

What must be turned off before making any electrical connections to the L0 System?

True/False – The PRO-Verter must be turned off before connecting it to the load.
Information about connecting the system is found on the I-Plate of which component?

What are the four categories of components in an L0 System?

Why is it important to take inventory of the components?

What is the purpose of placards on the Inter-Connect ports of L0 System components?

Questions and Discussion

When should the lids of the components be closed?

What fire extinguisher type is best to use with the L0 System?

Under what conditions is extra attention required when operating the L0 System?

What must be turned off before making any electrical connections to the L0 System?

What environmental conditions have the greatest impact on the operation of the L0 System?

Which components should be shaded? Why?

How often should the air intake filters of the PRO-Verters and Power Hubs be cleaned?

Questions and Discussion

What component is the foundation of the L0 Systems?

Which components should be shaded? Why?

What is the battery chemistry of the ESM 2000?

True/False – $LiFePO_4$ batteries can be stored and transported in a discharged state.

Provide at least two conditions under which the battery BMS disconnects the cells from service.

Which components should be shaded? Why?

True/False The generator should be running when the mast is raised or lowered.

Why is it important to secure Solar Arrays?

Questions and Discussion

True/False – The Power Hub regulates AC power from generator and grid sources.

How should the Solar Arrays be aimed when deployed?

Which device(s) offers critical system operation information?

What is the connection framework of the L0 System DC power network?

What component is considered the most important part of the L0 System ?

True/False – The L0 System is protected by circuit breakers.

What two factors are the source of most faults and System failures?

Overall Schedule

Training Schedule: 02 February, 2023

- 0700 – 0900 Live Troubleshooting
- 0900 – 1000 Breakfast
- 1000 – 1300 Hands on Breakdown and Q/A
- 1300 – 1400 Lunch
- 1400 – TBD Quiz and Certificate Presentation