SOLAR STIK®

OPERATOR AND MAINTENANCE MANUAL FOR THE 24VDC Li ESM 2000

P/N 21-0202317

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

Initial Release

Updated: 20240304

IMPORTANT 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.

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

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.

General

- Do not short (+) and (-) terminals.
- Do not submit to excessive mechanical stress.
- Do not directly heat, do not solder or throw into fire. Such unsuitable use can cause leakage or spout vaporized electrolyte fumes and may cause fire or explosion.
- Immediately disconnect the batteries if, during operation, they emit an unusual smell, feel hot, change shape, or appear abnormal in any other way.
- Do not open ESM 2000 case unless specifically trained and authorized to do so.
- Do not mix Li-ion batteries and lead-acid or most other types of Li-ion batteries because their operational parameters and capacities are likely to differ. Mixing battery types can lead to dangerous outcomes such as charging at too high voltage resulting in off gassing and possible thermal runaway.

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 Solar Stik 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.

Large fires: use large quantities of water for the surrounding fire and to prevent propagation. If water is used on batteries in operation, caution should be taken to avoid the electrical hazard that may be present.

SPECIAL FIRE FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus. Use approved / certified vapor respirator to avoid breathing toxic fumes. Wear protective clothing and equipment to prevent potential body contact with electrolyte solution. It is permissible to use any class of extinguishing medium, specified above, on these batteries or their packing material. Cool exterior of batteries if exposed to fire to prevent rupture.

PARTICULAR HAZARDS RESULTING FROM EXPOSURE TO THE SUBSTANCE/PREPARATION, TO COMBUSTION AND GAS PRODUCTS: The cell can spout vaporized or decomposed electrolyte fumes with fire when being heated over +100°C (+212°F) or disposed in fire. Solvents within the electrolyte are flammable liquids and must be kept away from any kind of ignition source.

Risk of irritation occurs only if the cell is mechanically, thermally or electrically abused to the point of compromising the integrity of the enclosure. If this occurs, irritation to the skin, eyes and respiratory tract may occur.

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!

First Aid Measures

EYE CONTACT: Immediately flush eyes with copious amounts of water for at least 15 minutes. Seek immediate medical attention.

SKIN CONTACT: Remove contaminated clothing and flush affected areas with plenty of water for at least 15 minutes. Wash skin with soap and water. If skin irritation persists, call for medical attention.

INHALATION: Remove to fresh air and seek immediate medical attention. Obtain medical advice.

I**NGESTION:** Rinse mouth with water and afterwards drink plenty of water. Do not induce vomiting. Seek immediate medical attention.

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 in 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.

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Revision History

Section	Page(s)	Description	Date
All	All	Overall editing	2023/05/27
	17,19,25	Editing to reflect updated firmware in the BMI	2024/03/04

GENERAL INFORMATION

Scope

This Operator and Maintenance Technical Manual (TM) contains instructions for operating and maintaining the 24VDC Li Energy Storage Module (ESM) 2000. The 24VDC Li ESM 2000 is a $LiFePO_4$ ESM from Solar Stik that uses Saft's Xcelion 6T-Energy (X6TE) battery as the primary energy storage building block.

Preparation for Storage or Shipment

Instructions including in-storage monitoring, charging are found in Maintenance Instructions page 27.

Transportation

All transportation of Li-ion cells and batteries in the public domain is controlled by federal law regulating shipment of hazardous materials. The general regulations are stated in 49 CFR 172.101 and 173.185. For instructions regarding land and air transport of the 24VDC Li ESM 2000. (see Li ESM Transport page 15)

Warranty

1-year materials and workmanship. See detailed Warranty Terms page 30.

List of Abbreviations/Acronyms

BMS - Battery Management System
CAN bus - Controller Area Network. CAN is a multi-master serial bus standard for connecting electronic control units (ECUs) also known as nodes.
DRMO - Defense Reutilization and Marketing Office
EOL - End of Life
ESM - Energy Storage Module/Battery
HPS - Hybrid Power System
HWSA - Hazardous Waste Storage Area
IPxx - Ingress Protection Code
$LiFePO_4$ - Lithium Iron Phosphate
Pb - Lead (as in lead-acid battery)
SOC - State of Charge
SOH - State of Health
PBIT - Power on Built in Test

Electrical Units
A - amps
Ah - amp hours
AC - Alternating current
DC - Direct current
V - volts
W - watts
Wh - watt hours

EQUIPMENT DESCRIPTION AND DATA

Equipment Characteristics, Capabilities, and Features

- Maximum capacity, simple form factor, minimum weight
- Communication of battery state of charge, temperature, and other key parameters via J1939 CAN bus
- Networkable battery monitoring (J1939 CAN bus)
- Fast charging under varying conditions
- 5-stage State of Charge Indicator
- Built-in self-balancing
- Built-in test at start-up and during operation
- Cell heating allows full battery capability over operating temperature
- Self-shutdown in unsafe conditions
- Battery has internal protection for overcharge, over-discharge, overload and short-circuit
- Impact resistant case with molded-in stacking ribs
- Scalable and hot-swappable
- Plug & Play with polarized, twist-lock connection

Specifications, Environmental Control and Handling Requirements

General	
Battery	(1) Saft X6T-E $LiFePO_4$ Battery
Nominal Voltage	26.4 VDC
Nominal Capacity	2.1 KWh (82 Ah)
Energy Density	72.2 Wh/kg
Max Charge Rate	100 A continuous
Max Discharge Rate	100 A continuous
Cycle Life	• >1000 cycles to 30% capacity for loss at 38 ºC • >500 cycles to 30% capacity loss at 50 ºC
Battery Voltage Range	20.0-30.4 VDC
SOC Indicator	ePaper display with push button refresh
Case	Pelican AL1212-0605FM Single Lid Case
Warranty	1-year materials and workmanship

Connections	
Output(s)	(1) Data Port (PT02SE12-10SW)
Input(s)/Output(s)	(1) Power Port (AIB2-32-5SC)

Environmental	
Operating Temperature	-40 °F to 140 °F (-40 °C to 60 °C)
Charge Temperature	-40 °F to 140 °F (-40 °C to 60 °C)
Storage Temperature	-50.8 °F to 159.8 °F (-46 °C to 71 °C)
Ingress Protection	Designed to IP67

Weights and Dimensions (L x W x H)	
Weight	64.1 lb (29.1 kg)
Dimensions	15 x 15 x 12 in (38.1 x 38.1 x 30.48 cm)

Safety	
Battery and User	Multiple battery internal SW / HW protection
Breaker(s)	100 A, 150 VDC, 1 Pole, UL Recognized, 5000 A SCCR
Reverse Polarity	Polarized Connectors
Case Pressure Relief Valve	0.5 PSI
Inadvertent Activation	Cotter Pin with Guard on ON/OFF Switch
Certifications	• UN 38.3 • Designed to MIL-STD-810H • Compatible with MIL-STD-1275E

Location and Description of Major Components

ESM 2000 Front

Detailed information provided in Figure 2 on page 11

Figure 1. ESM 2000 front

ESM 2000 Front – Detail

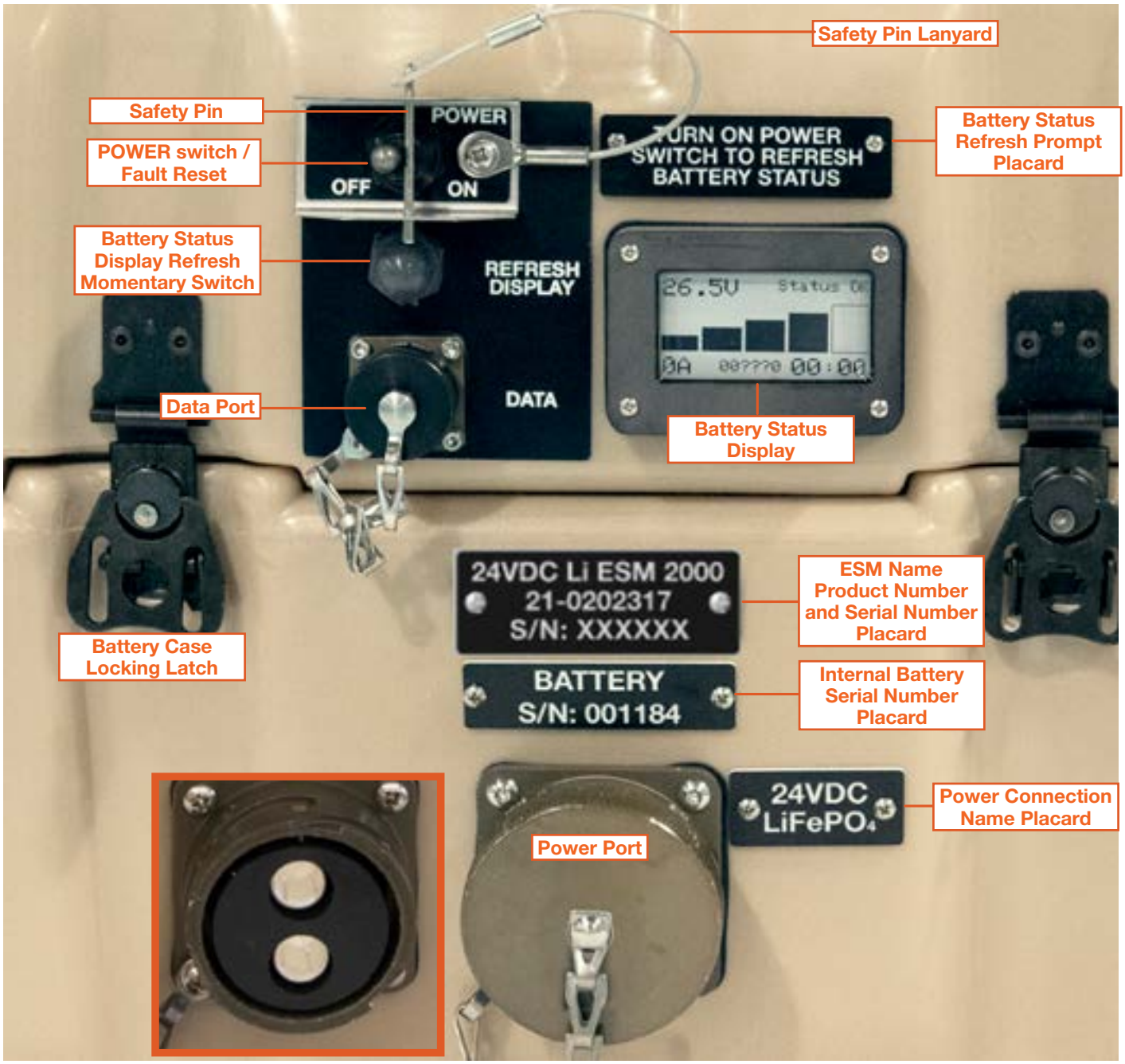
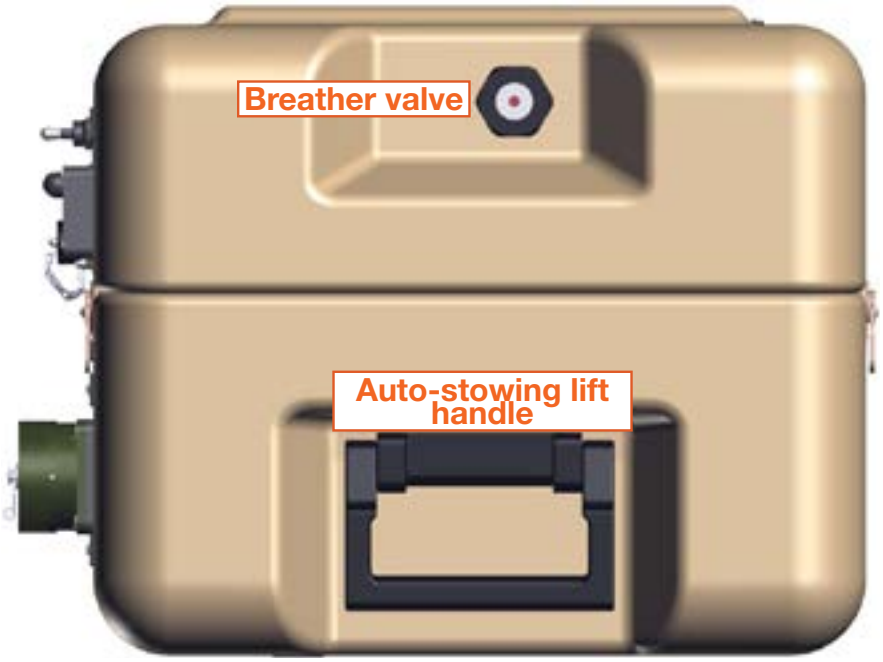


Figure 2. ESM 2000 front details

- **POWER Switch:** ON-activates battery. Toggle ON>OFF>ON to clear most faults.
- **Power Port:** Provides interface for charging the internal battery and for sending power to a load.
- **Battery Status Indicator**: Reports voltage, current, date and time stamp of last auto-refresh, SOC, fault details, state of health.
- **Data Port:** Provides access to the communications interface of the internal battery. The connector format and pinouts match the ones on the battery and provide CAN communications, configuration and other necessary signals to and from the BMS.
- **Refresh Display**: Momentary switch – push to update battery status display. In case of fault push once to display current status then push a second time for fault details.
- **Locking Latches:** Secures the top section of the case to the bottom section.

ESM 2000 Right Side



- **Breather valve:** Prevents pressure differentials between interior and exterior of case.
- **Auto-stowing handle**: Handles, one on each side of case, return automatically to stowed position after use.

Figure 3. ESM 2000 right side

ESM 2000 Left Side

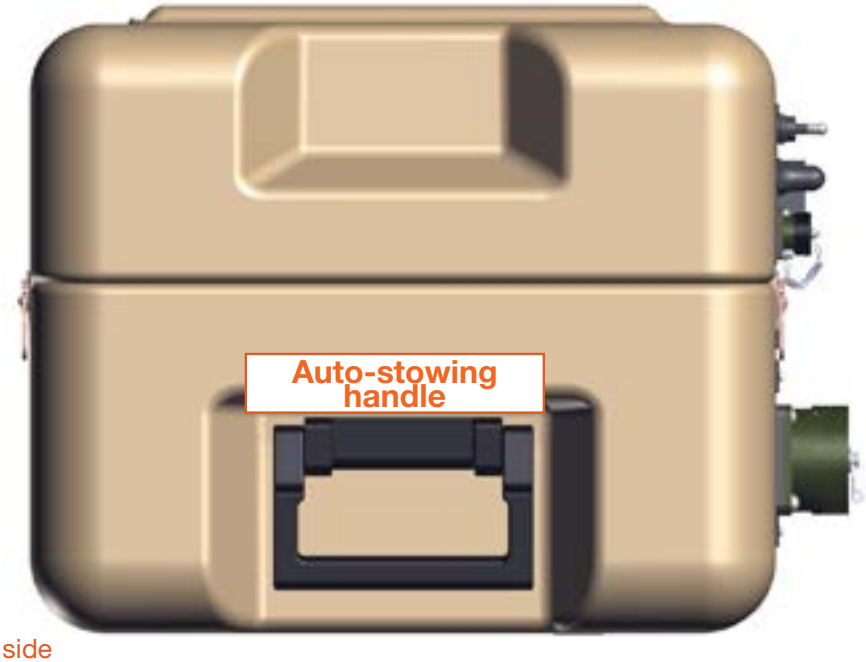


Figure 4. ESM 2000 left side

ESM 2000 Bottom

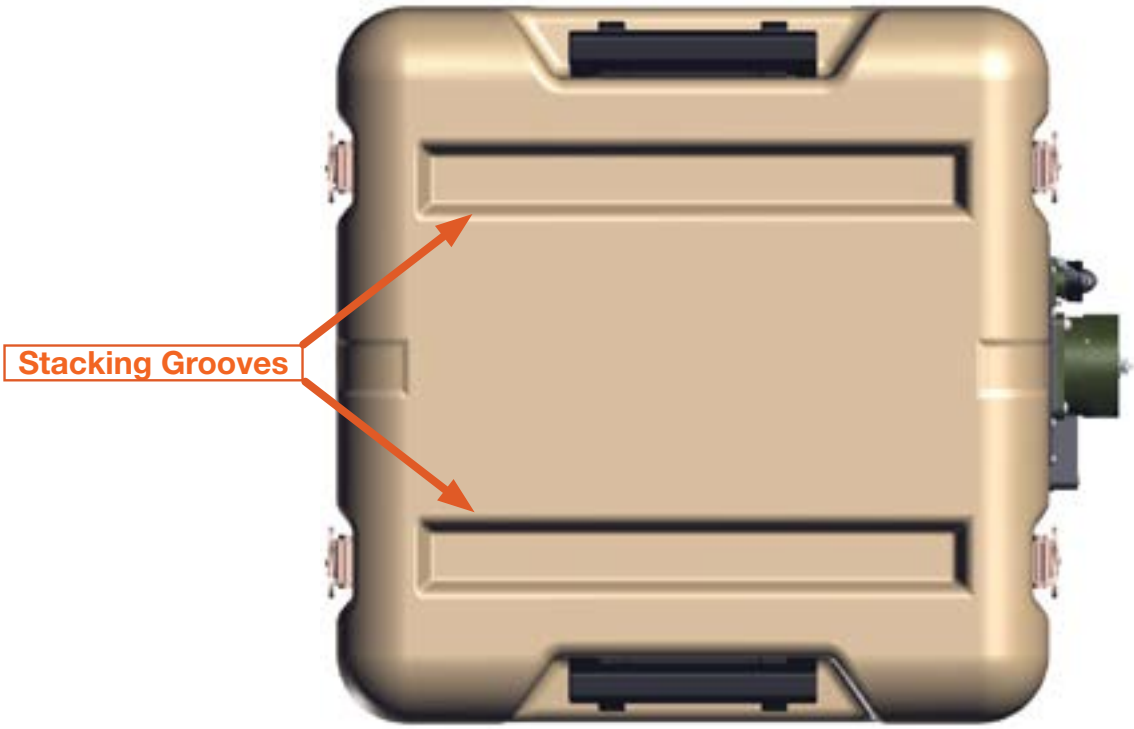


Figure 5. ESM 2000 bottom

ESM 2000 Top

Detailed information provided in Figure 7 on page 14.

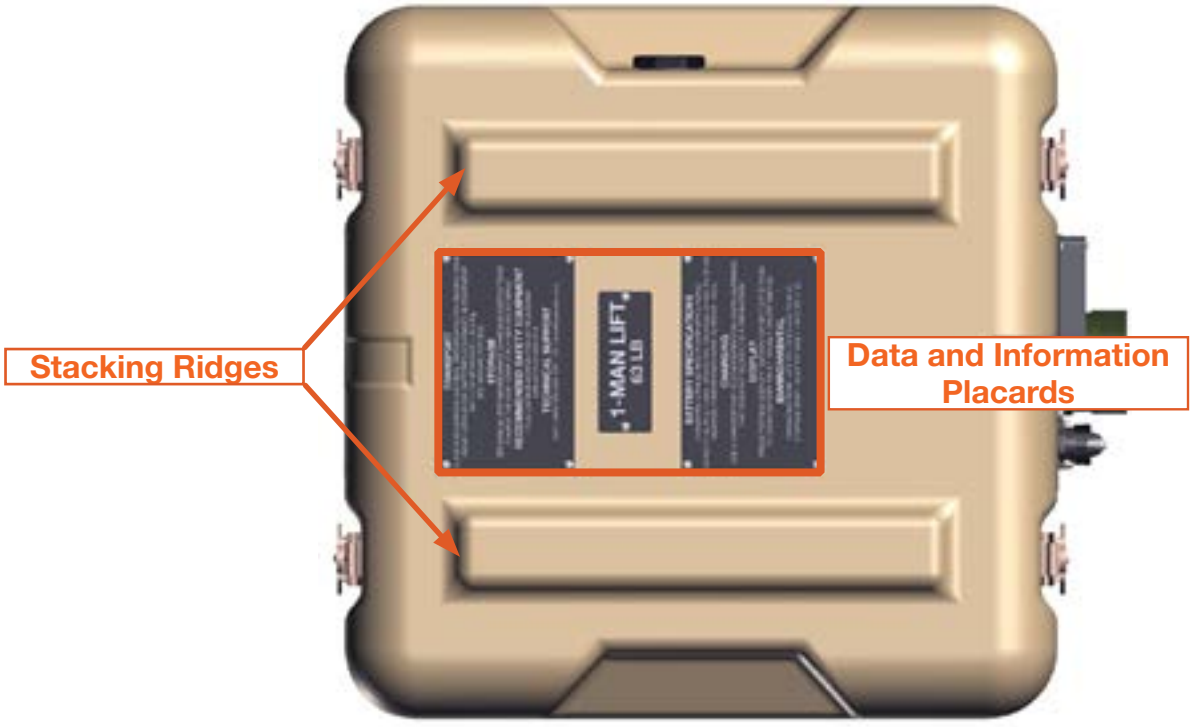


Figure 6. ESM 2000 top

ESM 2000 Top – Data and Information Placards

ESM 2000 Top

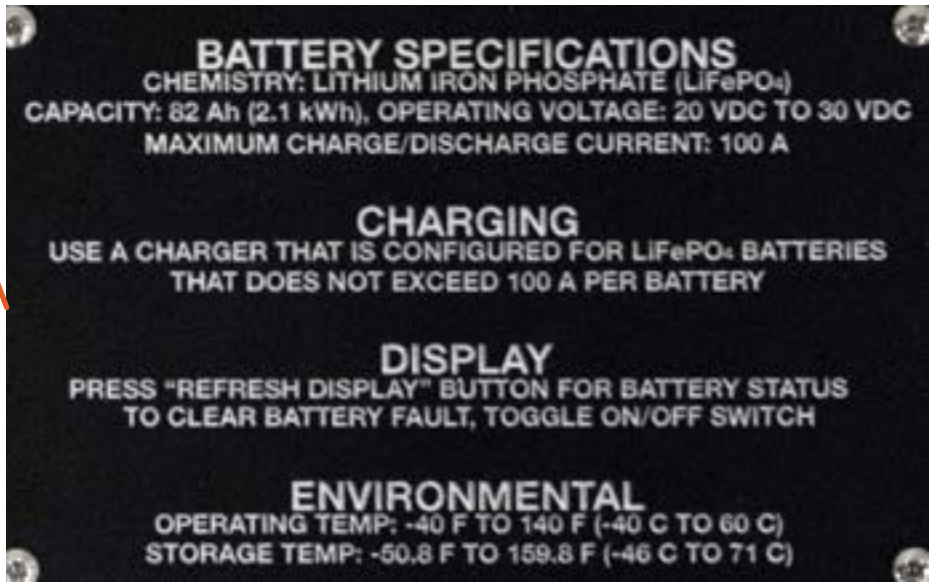


Figure 7. ESM 2000 data and information placards

Li ESM 2000 Air and Ground Transport

The following information is a summary of the conditions that apply to the 24VDC Li ESM 2000 for air and ground transport:

- **Dangerous Goods Training.** The international and U.S. transportation regulations require personnel involved in shipping the 24VDC Li ESM 2000 to complete the appropriate level of HAZMAT training.
- **Classification.** The 24VDC Li ESM 2000 is classified as Class 9 hazardous material.
- **Testing.** The $LiFePO_4$ cells of the Li ESM 2000 and the battery itself have passed UN 38.3 T1 – T8 tests.
- **Short Circuit Protection**. The 24VDC Li ESM 2000 is protected against short circuit and unintended movement.
- **Accidental Activation.** The 24VDC Li ESM 2000 is protected against accidental activation.
- **Net Weight Limit.** The net weight of the lithium batteries in the 24VDC Li ESM 2000 is 20.7 kg and is below the maximum of 35 kg net weight limit.
- **Marking and Labeling.** The 24VDC Li ESM 2000 shipping container must bear the following labels: Class 9 hazard and Cargo Aircraft Only labels. Packages must also be marked with Proper Shipping Name (UN3481 Lithium Ion Batteries Contained in Equipment) and Shipper and Consignee addresses.
- **Shipper's Declaration for Dangerous Goods.** A Shipper's Declaration for Dangerous Goods must be filled out and accompany the 24VDC Li ESM 2000 for air transport. The certifying official must have the requisite training.
- **Master Air Waybill.** The Master Air Waybill or Bill of Lading (BOL) is the document that travels with and describes the shipment.

Disposal – $LiFePO_4$ Battery

The battery should not be opened. The battery should not be destroyed or incinerated since the battery may cause fire or the ingredients contained in the cells could be harmful if exposed.

As a general rule, lithium-ion batteries are managed as universal waste under the Resource Conservation and Recovery Act. However, battery disposal regulations vary on national, state/provincial, and installation levels. Disposal must be conducted in accordance with all applicable regulations. ANY breached or leaking battery is managed as hazardous waste.

Before initiating the disposal process for the Li ESM, it must be fully discharged. Consult your local Hazardous Waste Storage Area (HWSA), Defense Reutilization and Marketing Office (DRMO), or other local authorities for the standard operating procedure for packaging, quantity, labeling, shipping, and tracking requirements. If an HWSA or DRMO is not available or does not accept the Li ESM, contact your servicing environmental compliance organization. Solar Stik is also able to handle disposal of the Li ESM at a cost to the customer. Solar Stik may be contacted at 800-793-4364.

The Li ESM contains recyclable materials, and recycling is encouraged over disposal if a lithium battery recycling facility is available.

The box in which the replacement battery was shipped is UN rated and should be used to ship the defective battery to the appropriate disposal location. See also SUPPLEMENTAL INFORMATION, page 32.

THEORY OF OPERATION
Energy Storage Modules - An Introduction

Energy Storage Modules (ESMs or “batteries”) serve as the foundation for every Hybrid Power System (HPS). When ESMs are employed in a power system, they can serve many different functions:

- Backup power for critical loads when the primary power source fails
- Power when periods of “silent” operation are critical
- Use of renewable power generation is desirable
- Decreased reliance on grid-utility power is desirable (peak shaving)

ESMs are also critical to the operation of the Inter-Connect network. They open the system architecture to allow multiple technologies to operate in concert. When functioning ESMs are connected within the Inter-Connect Circuit, their collective voltage is what allows other components within the network to perform their functions.

While ESM roles may vary widely, their function is quite simple: ESMs charge and discharge (storing and dispensing power) repeatedly, over time. This is called “cycling”. Batteries have an inherent, finite cycle-life and several factors determine how many cycles a battery can endure before it is depleted. These include, but are not limited to:

- Operational environments and conditions
- Charging and discharging rates
- Storage conditions (even though it may not be actively cycling, the chemical reaction in a battery never stops.)

All batteries have a finite lifespan and as such it must be understood that batteries are “consumable” parts of the HPS.

Keys to ESM Performance

- Multiple ESMs should be connected in parallel into a single bank.
- All ESMs in a bank should be similar in health (age, cycles, capacity) when possible.
- Do not mix Li-ion batteries and lead-acid or most other types of Li-ion batteries because their operational parameters and capacities are likely to differ.
- ESMs are charged most effectively using Solar Stik HPS power management components. Any other charging device must be rated for the ESM’s storage capacity, voltage, and current limit.
- Charge ESMs fully before placing into storage.
- Turn ESM 2000 POWER switch to OFF when ESMs are connected to an HPS that is idle / not in use to prevent overdischarge due to unchecked self-discharge.
- Do not submit to excessive mechanical stress.

Battery Management System (BMS)

The 24VDC Li ESM 2000 consists of $LiFePO_4$ cells and an advanced BMS that performs, in very general terms, two vital functions:

1. The BMS manages all battery functions and promotes healthy cycling at the individual cell level.
2. BMS protection circuits protect the battery and the operator from dangerous conditions related to cell voltages, temperatures, and current flowing in or out of the battery.

When all operating conditions are satisfactory, current can flow in/out of the battery cells (cycling). If temperature, voltage, or current is outside of programmed limits, the BMS protection circuits engage and remove the cells from service, disabling the battery at its terminals until proper operating conditions are restored.

Information from the BMS such as State of Charge, State of Health and Faults are reported on the Battery Status Indicator. In ESM 2000's with S/N 462481 the Battery Status Indicator will display a message stating "Unbalanced" on the main screen when the batteries are not at the same state of charge. The second Battery Status Indicator Screen will also display a message stating "Cells Are Balancing" when the batteries are attempting to actively reestablish the same state of charge.

ESM State of Charge (SOC)

The BMS State of Charge (SOC) algorithm is based on a combination of open-circuit cell voltages, coulomb counting, and other cell-level telemetry. The algorithm computes and reports SOC for the entire battery on the Battery Status Indicator in five (5) segments or bars that fill / empty as the ESM charges / discharges respectively. The SOC reported in Figure 8 is somewhere between 61% and 80%. When the battery is charged to 81%, the fifth bar will fill completely. A numerical SOC report can be found on the diagnostic screen (see Figure 18 on page 24).

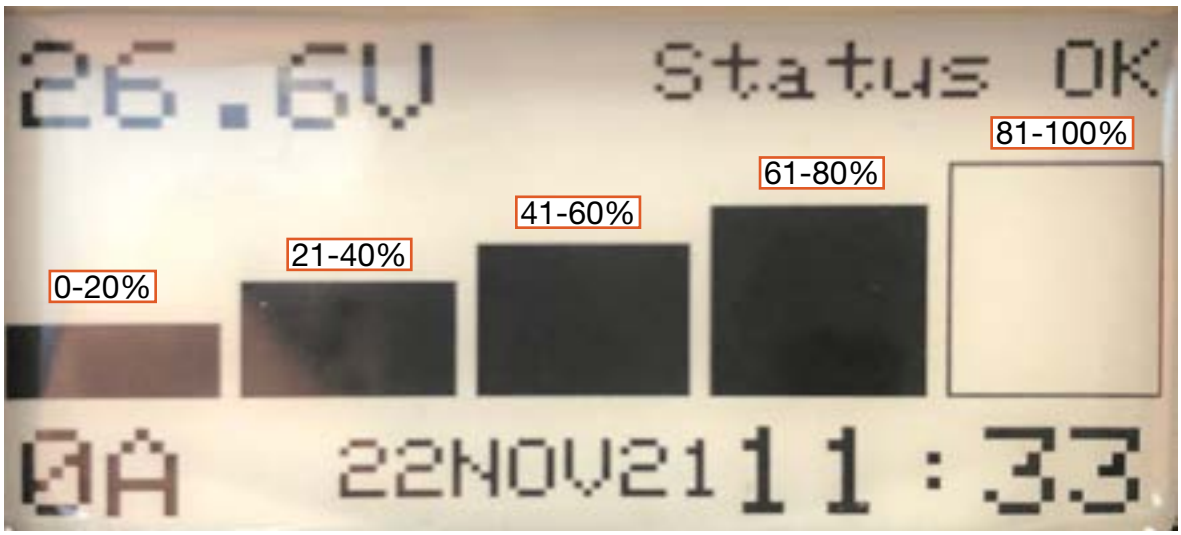


Figure 8. Battery Status Indicator SOC 5-segment report

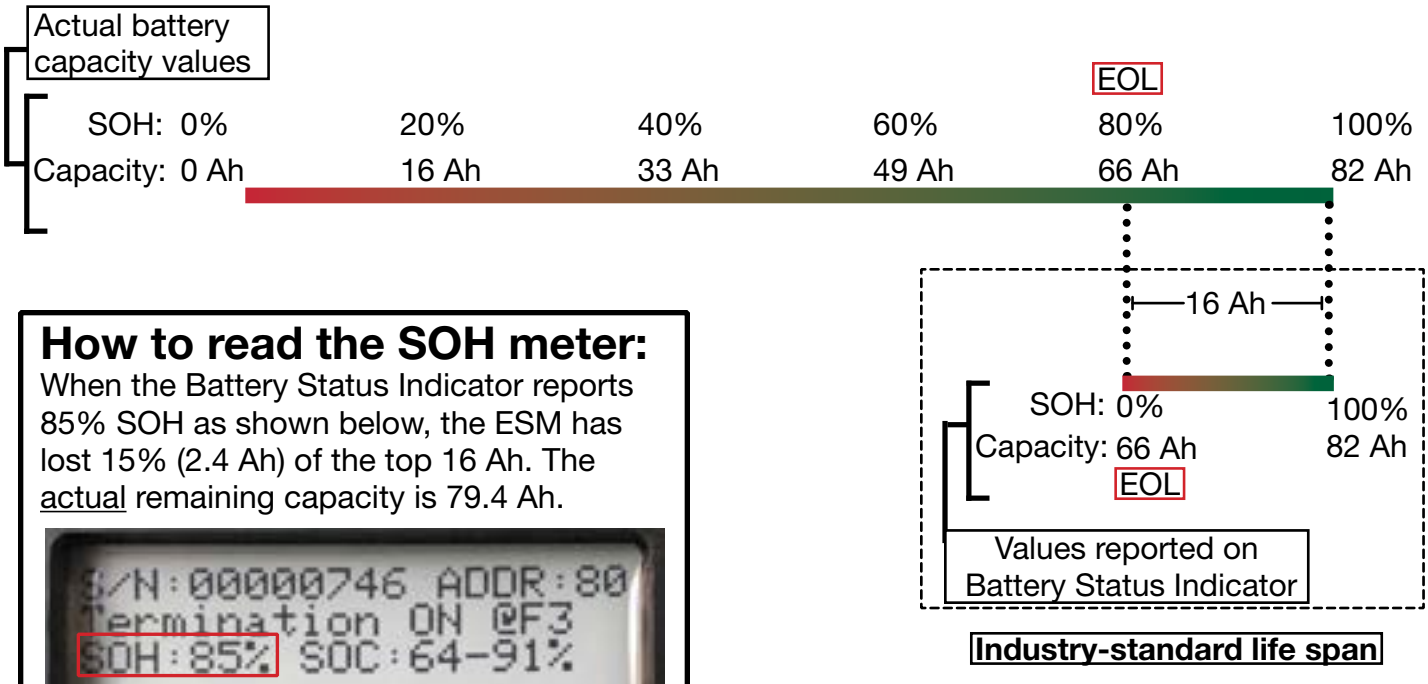
ESM State of Health (SOH)

The battery implements a State of Health algorithm that predictively estimates the useful lifetime of the battery cells. As shipped at beginning of life, the ESM 2000 is configured to deliver a nameplate capacity of 82 Ah. As the battery is charged/discharged, heated/cooled, and calendar time elapses, the cells will age and their useful capacity will decrease. The SOH algorithm keeps track of many battery parameters and uses them along with characteristics from the cells themselves to estimate the battery's life.

Batteries such as the ESM 2000 are consumable components of a Hybrid Power System. Monitoring and understanding HPS performance with respect to the battery SOH will assist in knowing when to replace the batteries. Generally speaking, as the SOH decreases, generator runtime will increase, fuel consumption will increase and the ability to support surge loads may be compromised. If the ESMs are being used for an uninterruptible power supply (UPS), the length of time they can maintain the load in the absence of prime power will decrease as SOH decreases. Proper planning is required to ensure the usable battery capacity is sufficient to support the application or mission.

ESM 2000 End of Life (EOL)

A new, unused ESM 2000 has a rated useful capacity of 82 Ah. The "industry standard" states a battery is at EOL when the battery SOH drops to 80%. As such, EOL for this 82 Ah battery is actually a battery with 66 Ah remaining capacity (see Figure 9 below) even though the Battery Status Indicator reports 0% SOH. The battery can certainly be used beyond an SOH reading of 0% and may indeed contain more capacity than expected. This is a predictive algorithm so it's important to remember that it is only an estimated useful lifetime.



How to read the SOH meter:

When the Battery Status Indicator reports 85% SOH as shown below, the ESM has lost 15% (2.4 Ah) of the top 16 Ah. The actual remaining capacity is 79.4 Ah.

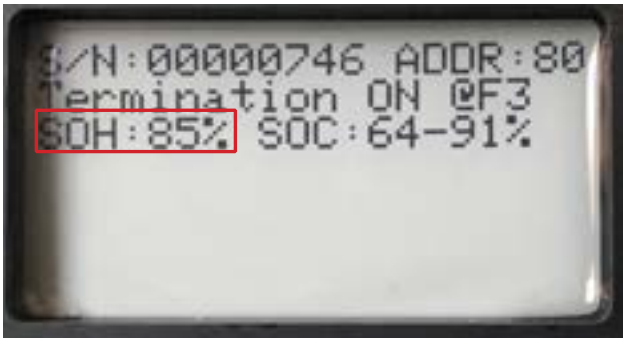


Figure 9. SOH value reported by ESM 2000 and End of Life

Internal Battery Heater

Lithium-Ion batteries allow maximum charge and discharge at warmer temperatures. To maintain optimal internal temperatures, the ESM 2000 internal battery is equipped with heaters that automatically keep the internal battery temperature at 20°C when the ESM is operating in cold temperatures. The heaters themselves consume ~640 W when operating. The heater is either on at full power or off, drawing no power. The power required by the heaters may be supplied by the ESM internal battery and / or a charging source such as a PRO-Verter. The battery will stop heating when the cells are warm enough to support maximum loads, or if the BMS determines that the heaters alone are discharging the battery to the point of being overdischarged. In such a case, the BMS will turn off the heaters to prevent critical overdischarge.

There is a five-(5) second delay after the Main POWER switch is turned on to prevent the heaters from turning on unintentionally during start-up. During this time, the Battery Status Indicator will report zero (0) A current. The only exception to this is if there is a charge current greater than 50 A. This exception prevents damage to the cells by charging at too high of a rate in very cold temperatures.

If the ESM Battery Status Indicator reports a negative current value (~20 A) with no other load drawing current from the ESM, this is an indication that the heater is operating. On ESM 2000's with Serial numbers greater than: S/N 462481 the Battery Status Indicator will read "Heater ON" when the Internal Battery Heater is operating.

ESM Modes

Storage Mode

When the ESM POWER switch is toggled to OFF, the BMS software disconnects the ESM 2000 power terminals from the battery cells and enters a low-power state. While the ESM is in Storage Mode, the BMS does not communicate with the Battery Status Indicator because the circuitry is powered down to extend battery shelf life. (Note: The ESM may also enter Storage Mode, without toggling the POWER switch to OFF, after 60 minutes in Protected Mode. See Protected Mode below)

Operational Mode

When the ESM POWER switch is toggled to ON the BMS software performs a series of self-tests referred to as Power-up Built-In-Test (PBIT). If the PBIT is passed, the BMS enables charging and discharging of the ESM and transfer of information from the BMS to the Battery Status Indicator. The ESM will remain in Operational Mode as long as the POWER switch is toggled to ON UNLESS a fault occurs.

Protected Mode

If a critical fault or other potentially unsafe condition within the ESM is detected, the BMS will disconnect the ESM power terminals from the internal battery cells (Protected Mode) even with the ESM POWER switch in the ON position. The BMS will continue to communicate with the Battery Status Indicator for up to 60 minutes while the ESM is in Protected Mode allowing the Operator to diagnose and correct the fault. The ESM internal battery will enter Storage mode after 60 minutes (even with the ESM POWER switch in the ON position) so that the battery does not discharge itself to the point of irreversible cell damage. If the fault condition that caused the ESM to enter Protected Mode clears on it's own, the ESM will automatically return to Operational Mode.

Battery Faults and Troubleshooting

The Battery Status Indicator will report the word "FAULT" on the Home Screen. Details of the fault are reported on the second screen (Diagnostic Screen) of the Battery Status Indicator. Information on how to identify and correct faults is found on page 24 and subsequent sections.

OPERATOR INSTRUCTIONS

Prior to operating the ESM in an HPS for the first time, charge it fully with a PRO-Verter, Power Hub, or other charging source, such as a battery charger, until the battery reaches 100% SOC.

Connect Inter-Connect Cable to ESM Power Port

Connect the Inter-Connect Cable to ESM. After inserting the plug (**A**) into the socket (**B**) , twist/tighten the connector collar (**C**) to lock connection. The connection is "keyed" making it impossible to connect with reverse polarity.

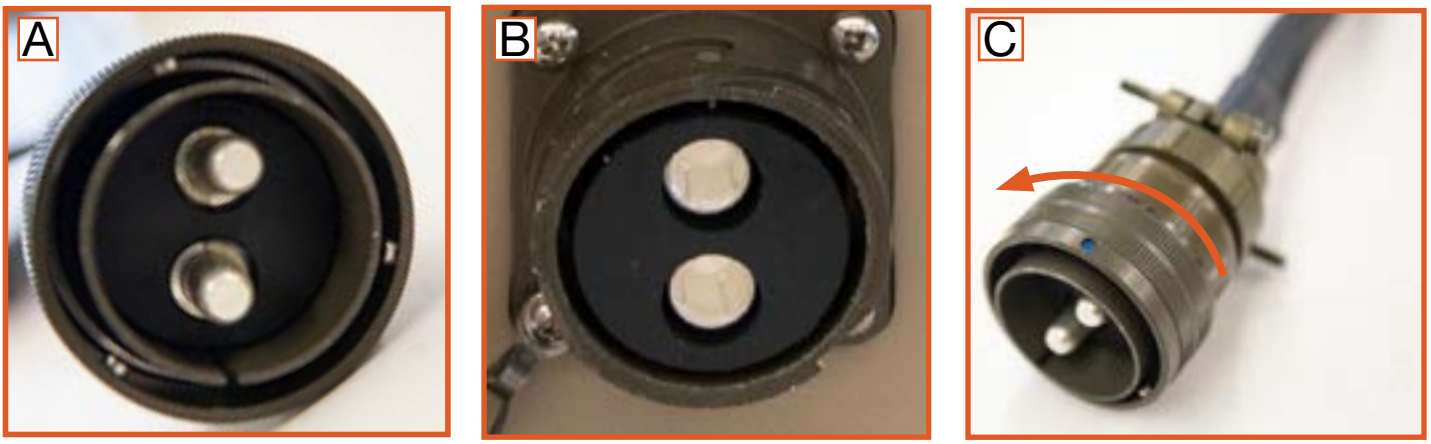


Figure 10. ESM Power Connector

Connect Inter-Connect Cable(s) to Inter-Connect Strip

Connect the opposite end of the Inter-Connect Cable to the Inter-Connect Strip or, directly to the power management component if only one (1) or two (2) ESMS are to be used. Lock connection by twisting the locking wheel.

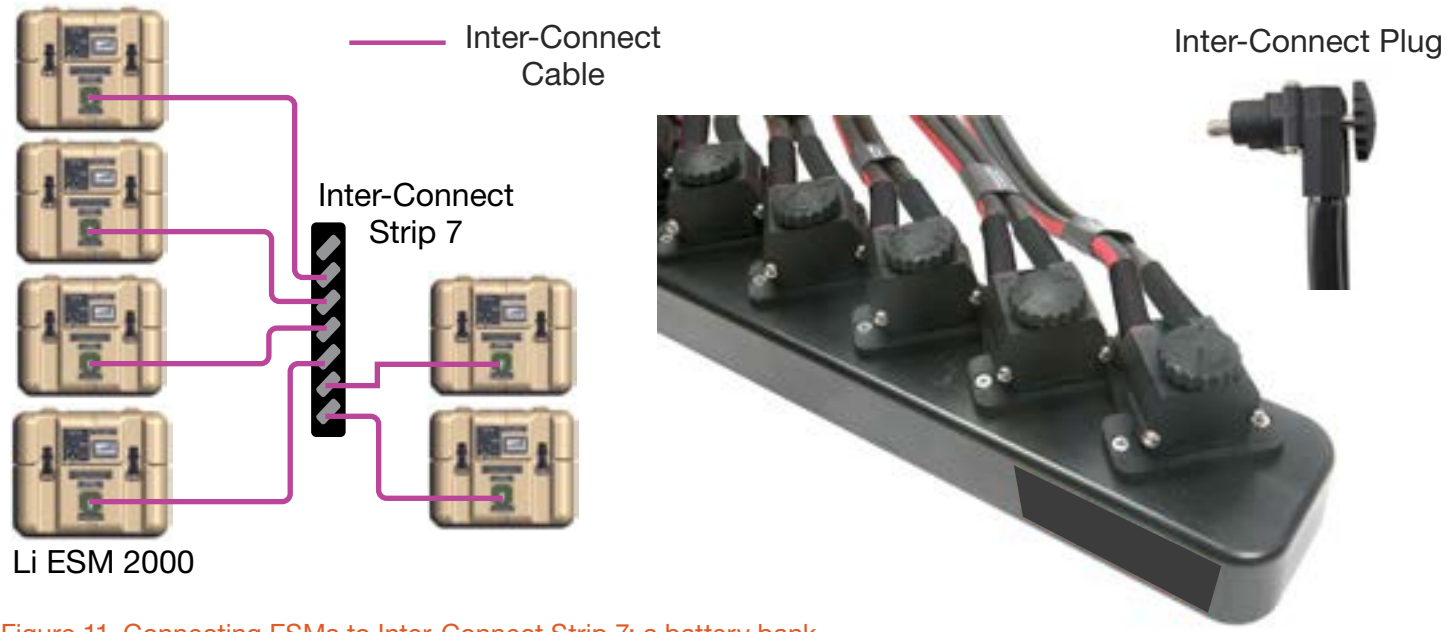


Figure 11. Connecting ESMs to Inter-Connect Strip 7: a battery bank

Connect ESM Bank to Power Management

ESM–specific ports on Solar Stik power management components are labeled “ESM ONLY” or “EXPANDER PAK ONLY”. The examples below read “EXPANDER PAK ONLY” and may be treated as the functional equivalent to “ESM ONLY”. Individual ESMs or a bank of ESMs can be connected to these ports. ESM–specific ports are metered and measure the energy flowing into and out of the ESMs.

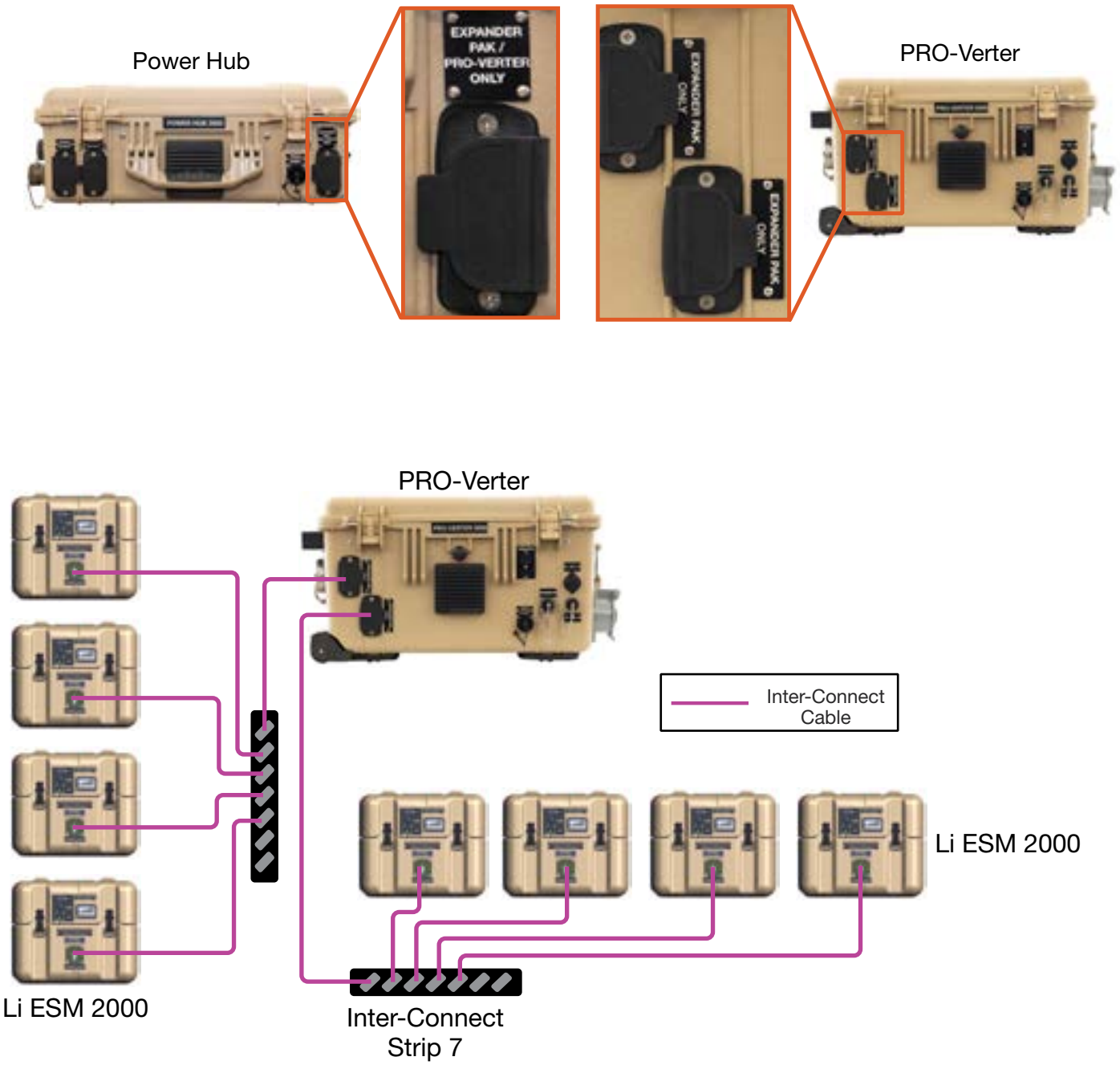


Figure 12. Connecting ESMs to Solar Stik power management – examples

Activate ESM(s): Operational Mode

Remove safety/cotter pin and toggle POWER switch to ON. Over the course of ~ one (1) min. several startup tests (PBIT) results will be displayed (Figure 14) before the Status Indicator displays the Operational-Mode screen (Figure 13). Check the voltage and SOC. Ensure that each battery is in normal operating condition.

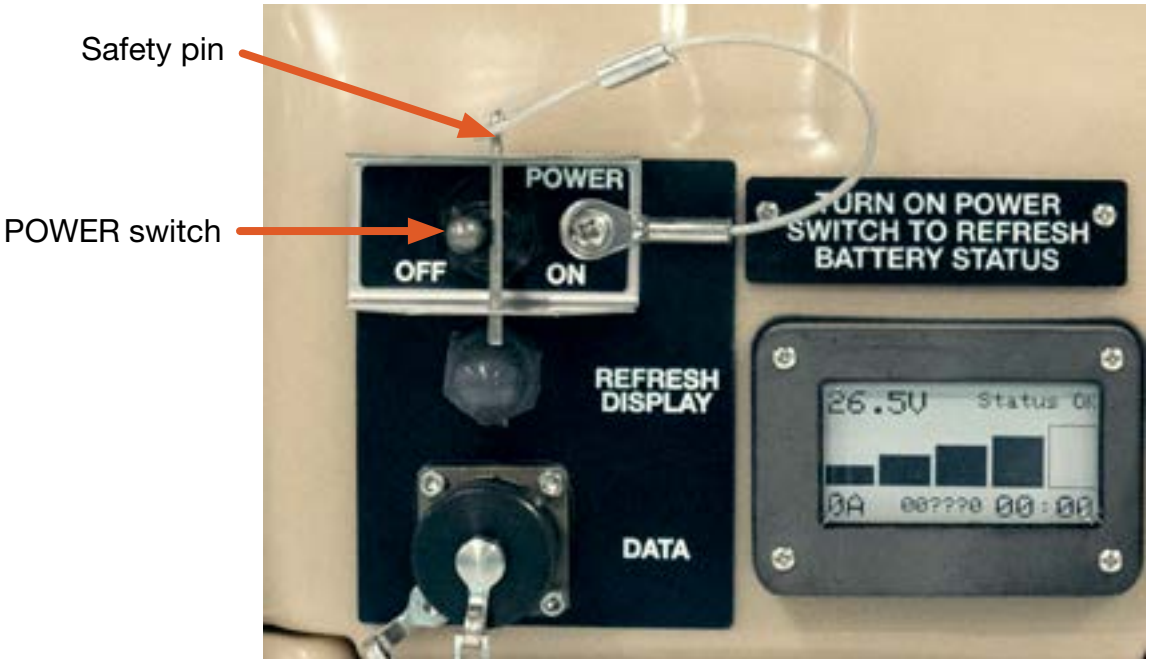


Figure 13. Activate ESM 2000

Battery Status Indicator Startup Screens

Screen 1

Screen 2

These two screens will scroll by automatically before the final status screen is populated (e.g., Figure 14). This is the location where the firmware version is documented. For more information on the firmware, contact Solar Stik Technical Support.

1. Firmware version and date
2. CAN bus auto-termination status
3. CAN bus communication operational
4. Connecting to battery comms
5. Battery serial number

Figure 14. Battery Status Indicator Startup Screens

Monitoring Battery Status

Battery Status Indicator

Home Screen

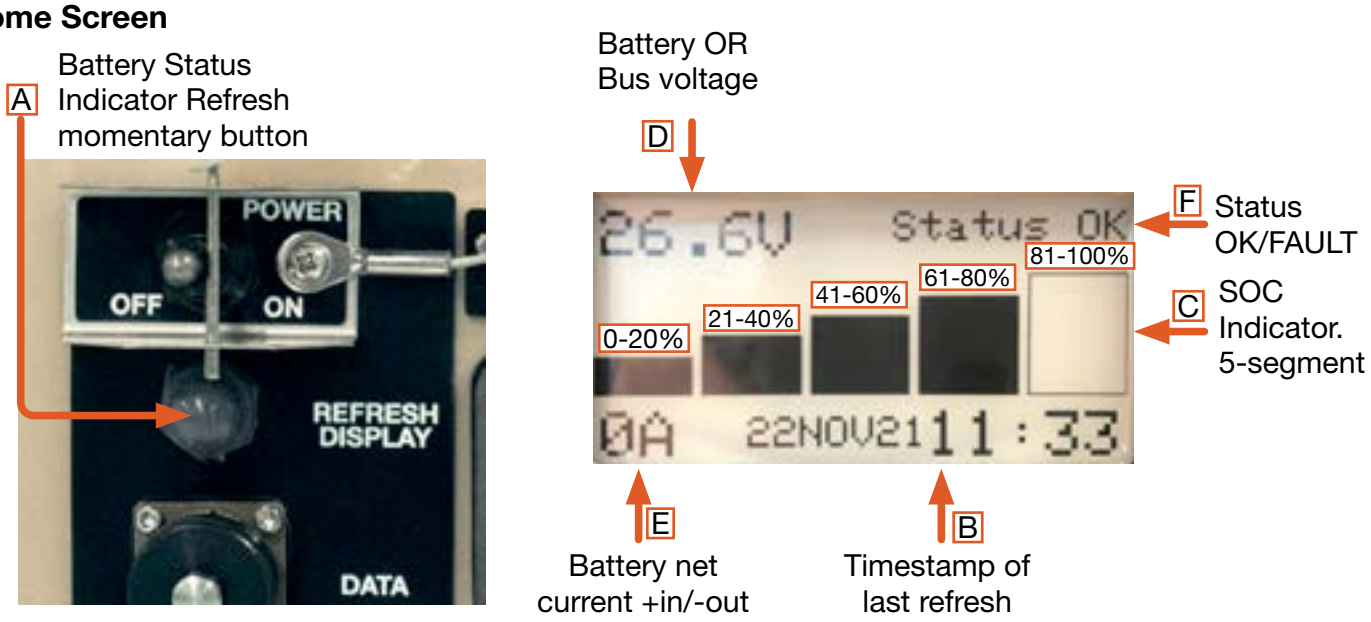


Figure 15. Battery Status Indicator – Home Page, normal operation

A. During normal operation, the display is updated automatically at intervals of three (3) minutes. The "REFRESH DISPLAY" momentary button can be pressed and held to update the display during normal operation. The REFRESH DISPLAY button must be pushed and held until the home page is completely repopulated. If the button is released too soon, the display will not populate. If this happens, wait five (5) seconds, press and hold button until home page is repopulated.

B. A timestamp for the last "refresh" is updated and displayed, whether it occurred automatically or by pushing the refresh button.

C. The SOC is reported visually by a five-segment "fuel gauge". Each segment represents 20% increments up to 100%. Each segment fills completely when the SOC reaches the lowest percentage for that segment. For example, the segment on the right will fill completely when the SOC reaches 81%.

D. Under normal operating conditions, if the ESM 2000 is connected to a battery bank, the voltage reported (**D**) is bus voltage. If the battery is not connected to any other equipment, the value reported here is battery voltage. Nominal voltage = 26.4 VDC; voltage @ 100% SOC ≈ 30.4 VDC; voltage @ 0% SOC ≈ 20.0 VDC.

E. The net current (A) with respect to the battery. It is positive when the ESM is charging and negative when the ESM is discharging.

F. If/when a battery fault occurs, the word "FAULT" appears in the upper right corner of the display. If the fault is unattended for three (3) minutes, "FAULT" appears in large font, filling the screen (Figure 17). If the fault is not corrected within 60 minutes, the ESM will enter storage mode even with the POWER switch in the ON position.

Additional information about the fault can be found on the second "page" (Diagnostic Screen) of the Battery Status Indicator, accessed by pressing the Refresh Display button twice.

In-service Battery Status Information

Figure 16. Battery Status Indicator home page “dead battery”

Figure 17. Battery Status Indicator - home page unattended fault warning

The Battery Status Indicator automatically refreshes at three (3)-minute intervals when it the ESM is operating normally. The “REFRESH DISPLAY” momentary button can be pressed to update the display at any time while the ESM 2000 is operating.

See Figure 15 for a detailed description of the Battery Status Indicator information fields.

An exclamation mark (“!”) will appear in the left-most bar when SOC drops to 0% (Figure 16).

If/when a battery fault occurs, the word “FAULT” appears in the upper right corner of the display. If the fault is unattended for three (3) minutes, “FAULT” appears in large font, filling the screen (Figure 17). If the fault is not cleared within 60 minutes, the ESM will enter storage mode even with the POWER switch in the ON position.

Additional information about the fault(s) can be found on the second page of the Battery Status Indicator.

Diagnostic Screen

To access the diagnostic screen, push the refresh button once to refresh display then a second time for the diagnostic screen.

Figure 18 is an example of the information on the diagnostic screen that is present when the ESM 2000 is operating normally. The SOC value range will narrow as the battery cycles.

Table 1 on page 26 lists the faults that may appear and procedures to clear them.

A. Battery serial number
B. CAN address for Battery Status Indicator
C. CAN bus termination status of battery
D. CAN address of battery
E. State of Health
F. State of Charge

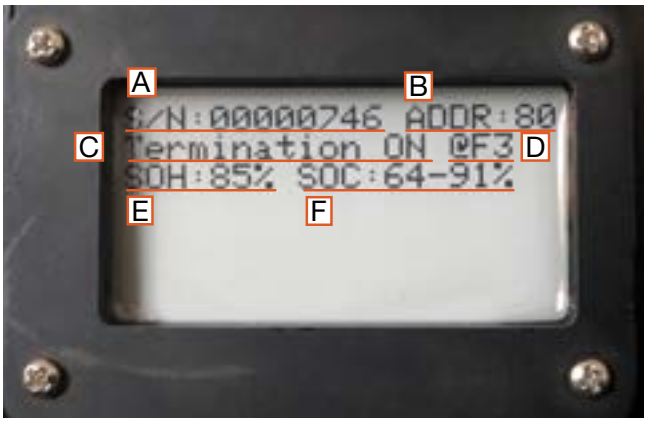


Figure 18. Battery Status Indicator diagnostic screen

Battery Status Monitor Firmware 1.2

Applies to ESM 2000s with serial numbers greater than: SN X-462481

ESM 2000 modules with serial numbers SN X-462481 and above will have additional information displayed on the Battery Status Indictor. The firmware update to these units features an indicator that states “Heater ON” which specifies if the battery’s internal heater is active (Figure 19).

An additional feauture included allows the Battery Status Indicator to read “Unbalanced” (Figure 20) in the upper right corner of the display indicating when the battery cells are unbalanced. A further warning will occur on the second screen when the battery cells are balancing and will read “CELLS ARE BALANCING”(Figure 21).

Main Screen

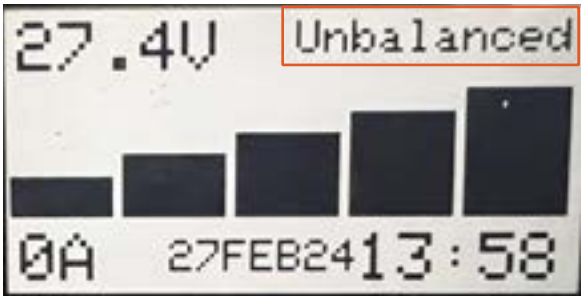


Figure 19. Battery Status Indicator - home screen Unbalanced indicator

Diagnostic Screen

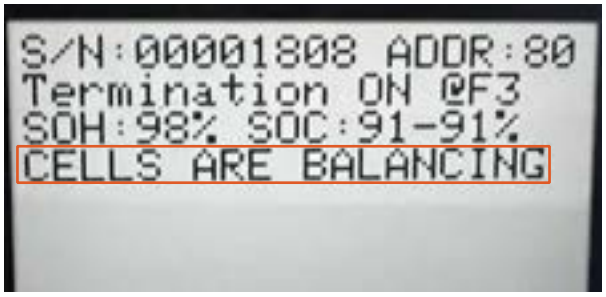


Figure 21. Battery Status Indicator - diagnostic screen CELLS ARE BALANCING

Figure 20. Battery Status Indicator - home page Heater ON indicator

Contact Solar Stik for information on how to update ESM firmware. This update requires access to a Windows laptop, a USB Type A to USB Type mini B cable, AVRDUDESS programmming software and the current Solar Stik firmware.

ESM 2000 TROUBLESHOOTING

Frequent visual monitoring of ESM 2000 Battery Status Indicator for all batteries in a bank is the best method to ensure each battery is operating normally. The SOC should be approximately the same for each battery. The voltage reported in the upper left corner is bus voltage when the ESM 2000 is connected to an active system and battery voltage when it is disconnected from all other equipment. If a NOTIFICATION or FAULT is displayed on the screen take the prescribed corrective action to clear the fault.

Notifications and Faults

Notifications and faults are found on the diagnostic screen. To access the diagnostic screen, push the refresh button once to refresh the display then a second time for the diagnostic screen.

Notifications:

Battery Offline – This notification indicates that the Battery Status Indicator lost communication with the battery. It may have taken itself offline to protect from overdischarge. Toggle the POWER switch to clear notification. If this doesn't clear the fault, apply a charging source with the POWER switch turned ON for at least two (2) minutes. If this fails to clear the fault, contact Solar Stik.

Battery Voltage Low – "Battery voltage low" fault occurs when the ESM battery voltage falls below 20 VDC. It is only a notification. It does not cause the battery to shut off. This notification automatically clears after charging brings voltage to >20 VDC.

Faults:

The battery may report one or more faults at a time on the diagnostic screen. If a condition other than the ones shown below appears, contact Solar Stik for assistance. Faults place the ESM 2000 into Protected Mode until the fault is corrected and the ESM returns to Operational Mode **or**, if the fault is not cleared in 60 minutes, the ESM 2000 will enter Storage mode even if the POWER switch remains in the ON position.

Table 1. Faults reported on diagnostic screen: and solutions

Fault Name	Value Exceeded	Clear Value
Critical Cell Overvoltage for 2 minutes	Max Cell V ≥ 4.2000 V	Max Cell V < 3.8000 V
Critical Cell Undervoltage	Cell Voltage ≤ 2.00 V @ ≤ 120 A discharge (battery voltage ≤ 16.0 VDC)	Automatically clears fault one time after 2-minute delay. If fault occurs again without charging battery for 2 minutes, must clear by charging for 2 minutes or toggling the POWER switch ON>OFF>ON.
Critical Cell Temp High	Max Cell Temp ≥ 76 ºC	Reduce Cell Temp to ≤ 65 ºC
Critical Board Temp High	Max Elec Temp 1 or 2 ≥ 120 ºC	Reduce Max Elec Temp to ≤ 90 ºC
Hardware Overload	Current ≥ 3000 A	2-minute cool down, followed by toggling the POWER switch ON>OFF>ON
Fast Software Overload	Current ≥ 1500A 30 ms	2-minute cool down, followed by toggling the POWER switch ON>OFF>ON
Software Overload	Max Elec Temp 3 ≥ 135 ºC	2-minute cool down, followed by reducing Elec Temp 3 to ≤ 90 ºC

MAINTENANCE CHARGING INSTRUCTIONS

In-storage ESM status information

The Battery Status Indicator will display the last status acquired before the POWER switch was turned OFF. However, battery voltage will decrease during storage due to self-discharge. Toggle ON the POWER switch to update in-storage battery status.

Never store an ESM in a discharged state! Charge ESM fully before placing in storage.

Never store an EMS 2000 with the POWER switch in the ON position.

Temperature-dependent self-discharge

The self-discharge rate increases as storage temperature increases. See In-storage Preventive Maintenance Checks and Services for charging instructions. If the ESM is stored at temperatures above 90 ºF (32 ºC), then intervals between maintenance checks and / or charges should be reduced to three (3) months.

In-storage Battery Status Refresh: Voltage, SOC and SOH

When the ESM 2000 POWER switch is toggled OFF, the Battery Status Indicator will continue to report the last-recorded battery status; it does not refresh automatically during storage. The Battery Status indicator must be refreshed to report the current status while in storage.

1. Remove safety/cotter pin and toggle POWER switch to ON.
2. The Battery Status Indicator Screen will populate with up-to-date information. This will take ~ one (1) min. with the several startup tests/results displayed before the Status Indicator is populated.
3. Check the voltage and SOC on the Home Screen
4. Press REFRESH DISPLAY button to move to the Diagnostic Screen to check SOH.

Maintenance Charging

The 24VDC ESM 2000 has a high current capacity. For this reason, a constant voltage-type maintenance charger should be used with the voltage fixed at the optimum charging voltage (29.5 – 30.5 VDC) for the ESM 2000. Any non-Solar Stik charger will need a custom cable to connect to the Power port of the ESM 2000.

A Solar Stik PRO-Verter 5000 or HyPR 6000 are ideal maintenance chargers. Both are programmable battery chargers with the capacity to charge one, or bank of ESM 2000s. Furthermore, these Solar Stik charging components are easily connected to ESM 2000s using Inter-Connect cables and Inter-Connect Strips.

If charging at any temperature lower than 68 ºF (20 ºC), use a charger with a current capability >25 A. The internal battery may need to heat to charge optimally (power to heat takes precedent over charging). The internal heater alone requires 20-25 A to operate. To charge and heat simultaneously, the charger must supply >25 A. If the charging source provides less than 25 A, the battery will use its stored energy to heat itself. This will drain the battery instead of charging. This situation will be apparent if the Battery Status Indicator reports a negative current value during charging and when there is no other load connected to the ESM.

1. Connect a constant voltage charging source to the ESM 2000 with the voltage set between 27.5 and 30.5. A voltage of at least 29.5 is needed to charge to 100% SOC.

   NOTE – if the ESM battery was previously **over-discharged**, it will need to be connected to the charge source for at least 2 minutes, or power-cycled (toggling POWER switch ON>OFF>ON) before charge current will begin to flow

2. Enable the charging source and allow the ESM 2000 to charge. Remember, the battery may heat itself before charging if the ESM internal battery is colder than 68 ºF (20 ºC).

3. The ESM 2000 should continue to charge, balance, and taper until it reaches the voltage setpoint at less than 0.5 A. At this point the ESM 2000 can be considered to be fully charged.

Internal cell balancing

Over time a voltage difference may accumulate between the eight (8) super cells of the ESM internal battery, resulting in an apparent capacity loss. To re-balance the ESM internal cells, charge the ESM between 27.5 and 30.5 V until the maximum difference between cells is 5 mV or less. Individual cell voltages can be read over the CAN Bus Data port (Contact Solar Stik Technical Support for more information).

If connection to the CAN Bus Data port is not an immediate option, leaving the ESMs in charging mode for an additional 24 hours after they have reached 100% SOC will balance the internal battery super cells. The Battery Status Indicator may provide a range of values for SOC. If so, another indicator of a full charge is when the voltage reported by the ESMs is at the charging voltage set point and the current value is < 0.5 A.

In-storage Preventive Maintenance Checks and Services

The ESM 2000 is designed to be capable of not less than two (2) years of warehouse storage, without any maintenance during storage at a temperature of 72 ±5 °F (22 ±5 °C). However, storage temperature can vary widely from this relatively mild temperature. Rates of self discharge increase as temperature increases. If storage temperature is higher than 72 °F (22 °C), maintenance charging intervals must be shortened to less than two (2) years.

Even under ideal conditions (22 °C) we recommend quarterly SOC checks and charging when necessary.

Item #	Item to be Inspected	Interval* at 91-140 °F (33-60 °C) Storage Temp	Interval* at ≤ 90 °F (≤ 32 °C) Storage Temp	Procedures	Non-mission Capable (NMC)
1	Visual inspection of 24VDC Li ESM 2000	Q[1]	S[2]	1. Inspect case for visible damage and missing items. 2. Clean excessive dust or dirt accumulation from the exterior and ports. 3. Close all unused port covers.	If case is broken or split or if port is damaged, contact Solar Stik Technical Support.
2	In-storage SOC Check	Q[1]	S[2]	1. Toggle POWER switch to refresh Battery Status Monitor Indicator. 2. If SOC less than or equal to 50%, charge to 100% SOC. See Maintenance Charging	The Li ESM does not hold a charge after 48 hours of charging.
3	In-storage SOH Check	Q[1]	S[2]	Check SOH prior to deployment to ensure remaining capacity is sufficient to support mission.	Determining end of life based on SOH for ESM 2000 will be application specific.

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

Warranty Terms

Solar Stik warrants, unless otherwise agreed to between buyer and seller (Solar Stik Inc), for a period of one 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, mis-connection, abuse, abnormal use of such Products (inter alia overloading or overcharging) or use not complying with Solar Stik's user manual provisions if any.

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

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.

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
Saving lives across the globe through innovative power solutions

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

Solar Stik Training and Education

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

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

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

Contact

Technical Support:
1-800-793-4364 Ext 102
Outside of the US:
+1-904-808-0510 Ext 102
tech@solarstik.com
(24 hours a day, 365 days a year)

Address
Solar Stik, Inc.
13 N Leonardi Street
Saint Augustine, Florida 32084

Website
www.solarstik.com

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SUPPLEMENTAL INFORMATION

Replacement Battery SDS

SAFT

Safety Data Sheet

Rechargeable lithium-ion cells, modules, and battery systems

Saft rechargeable Li-ion cells, modules and battery systems are manufactured articles which contain hazardous chemicals. Saft batteries are manufactured to specific shapes and designs and have end use functions that are dependent in whole or in part upon those shapes and designs. Under normal conditions of use, Saft batteries do not release hazardous chemicals and do normally not pose a physical hazard or health risk to the end user.

Under situations involving neglect, misuse, abuse, and/or improper handling and storage, exposure to hazardous chemicals normally contained inside the batteries can result.

1. IDENTIFICATION

1.1 Product

Lithium-ion rechargeable cells and modules or battery systems composed of these cells

1.2 Supplier

Headquarters	**Saft S.A.S.**
Address	26 Quai Charles Pasqua, 92300 LEVALLOIS-PERRET – France
Phone/Fax	Phone/Fax: +33 (0)1 58 63 16 00 /+33 (0)1 58 63 16 50
Factory	**Saft Bordeaux**
Address	111-113, boulevard Alfred Daney, 33074 BORDEAUX - France
Phone/Fax	+33 (0)5 57 10 64 00 /+33 (0)5 57 10 68 77
Factory	**Saft Jacksonville**
Address	13575, Waterworks street, JACKSONVILLE, FL 32221 - USA
Phone/Fax	+1 904 861 1501/+1 904 772 1463
Factory	**Saft Nersac**
Address	Zone Industrielle, 16440 NERSAC - France
Phone/Fax	+33 (0)5 45 90 50 26 /+33 (0)5 45 90 50 71
Factory	**Saft Raskovice**
Address	Raskovice 247, 73904 PRAZMO - Czech Republic
Phone/Fax	+420 558 426 257/+420 558 692 226
Factory	**Saft Poitiers**
Address	Rue Georges Leclanché – BP n°1039, 86060 POITIERS Cedex 9 - France
Phone/Fax	+33 (0)5 49 55 48 48 /+33 (0)5 49 55 48 50
Factory	**Saft Cockeysville**
Address	107 Beaver Court, COCKEYSVILLE, MD 21030 - USA
Phone/Fax	+1 410 771 3200/+1 410 771 1144
Factory	**Saft Valdese**
Address	313 Crescent Street, VALDESE, NC 28690 - USA
Phone/Fax	+1 828 874 4111/+1 828 874 2431
Factory	**Friemann & Wolf Batterietechnik GmbH (a company of the Saft Group)**
Address	Industriestrasse 22, 63654 BÜDINGEN - Germany
Phone/Fax	+49 (0)6042 954 150 / +49 (0)6042 954 490
Factory	**Saft Urja**
Address	Plot No. 10/1 A, 1B & 1C, Abbanakuppe, Bidadi Industria Area, Bangalore 562109 Karnataka – India
Phone/Fax	+91 80 2728 7947/+91 80 2728 7716

SAFT

1.3 Emergency contact

Chemtrec US Service within USA-Canada: +800 424 93 00/outside: +1-703-527-3887
In case of an incident and/or accident involving the battery, this telephone number is available 24 hours a day and is monitored at all times by a person who has comprehensive emergency response and accident mitigation information for the battery or can immediately call upon a person who possesses such knowledge and information.
If needed, the fire brigade may also be called in case of an incident/accident involving the battery.

2. HAZARD IDENTIFICATION

2.1 Electrolyte contained in individual cells

Electrolyte Globally Harmonized Sysytem (GHS) classification:

Flammable liquids (category 3), acute toxicity -oral (category 4), eye damage (category 1), skin sensitization (category 1), specific target organ toxicity –repeated exposure (category 1)

Electrolyte GHS label elements:

- **Pictograms:**

- **Signal word: Danger**
- **Electrolyte hazard statements:** Flammable liquid and vapour. Harmful if swallowed. May cause an allergic skin reaction. Causes serious eye damage. Causes damage to organs through prolonged or repeated exposure
- **Electrolyte physical hazard:** thermal decomposition generates corrosive vapours
- **Electrolyte ecological hazard:** harmful to aquatic life with long lasting effects

2.2 At cell level

Not chemically dangerous during normal use in accordance with Saft recommendations as stated in the user manuals or other similar documentation. In particular, the battery should not be opened or burned. Exposure to the ingredients contained inside the cells or combustion products could be harmful.

EYE CONTACT: contents of an opened cell inside a battery can cause eye irritation. Dust may cause inflammation of eyelids

SKIN CONTACT: Electrolyte solution contained inside cells can cause skin irritation. Contact with positive active material may in addition cause allergic dermatitis or irritation to skin.

INHALATION: Contents of an opened cell can cause respiratory tract and mucus membrane irritation. Overexposure to lithiated nickel compounds may cause an allergic response. If gas is generated during battery disassembly, throat irritation may occur.

2.3 At module and battery system level

HIGH VOLTAGE: Always use the large battery systems in a restricted access area. Only authorized people aware of high voltage hazards and trained to work on such systems are allowed to enter in the battery area.

TEMPERATURE: Do not place the batteries on or near fires or other high-temperature locations (> 70°C for VL and VES cells, and > 85°C for extended temperature range MP cells with "xtd" extension). Doing so may cause the batteries to overheat or ignite. Using the batteries in this manner may also result in a loss of performance and a shortened battery life.

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3. COMPOSITION, INFORMATION, OR INGREDIENTS

3.1 At cell level

Component	CAS Number	EINECS/ELINCS	Content * (wt%)
Positive Active Materials: among			25-35
$LiNiCoAlO_2$ (NCA)	177997-13-6	700-042-6	
$LiNiCoMnO_2$ (NMC)	182442-95-1	480-390-0	
$LiFePO_4$ (LFP)	15365-14-7	476-700-9	
LiCoO2 (LCO)	12190-79-3	235-362-0	
Conductor: Carbon black	1333-86-4	215-609-9	0.5-4
Negative Active Materials: among			15-30
Graphite	7782-42-5	231-955-3	
$Li_4Ti_5O_{12}$ (LTO)	12031-95-7	619-916-2	
Organic Electrolyte: among			15-25
$LiPF_6$	21324-40-3	244-334-7	
PC	108-32-7	203-572-1	
EC	96-49-1	202-510-0	
DMC	616-38-6	210-478-4	
EMC	623-53-0	433-480-9	
VC	872-36-6	212-825-5	
Separator	NA	NA	2-8
Aluminium	7429-90-5	231-072-3	5-20
Copper	7440-50-8	231-159-6	1-20
Others: inert material, mechanical parts	NA	NA	Remainder

** Quantities may vary a little with cell model*

In the course of battery production, active substances detailed in the previous table are embedded in a mechanical substrate to form electrodes. These electrodes are then further assembled with the other battery components such as separator, electrolyte, connectors, and casing to obtain a finished battery. This battery is defined in OSHA and REACH regulations as "an article with no intended release" meaning that, **under normal and reasonably foreseeable conditions of use, no end-user of this battery will be exposed to any chemical substances** (summarized as [illegible] in the rest of the document).

3.2 At module and battery system level

Depending on the type of battery system, the battery may contain either a glycol ethylene-based coolant or a refrigerated coolant.

4. FIRST AID MEASURES [illegible]

EYE CONTACT: Immediately flush eyes with copious amount of water for at least 15 minutes. Seek immediate medical attention.
SKIN CONTACT: Remove contaminated clothing and flush affected areas with plenty of water for at least 15 minutes. Wash skin with soap and water. If skin irritation persists, call for a medical attention.
INHALATION: Remove to fresh air and seek immediate medical attention. Obtain medical advice.
INGESTION: Clear mouth with water and afterwards drink plenty of water. Do not induce vomiting. Seek immediate medical attention.

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5. FIRE FIGHTING MEASURES (not anticipated under normal use)

ESTINGUISHING MEDIA:

- Small fires: use B or C type fire extinguisher, inert gas (for instance blend of argon and nitrogen), CO_2, dry chemical powder, or foam extinguishers
- Large fires: use large quantities of water for the surrounding fire and to prevent propagation. If water is used on batteries, caution should be taken to avoid the electrical hazard that may be present.
- In all cases, the fire extinguisher must be compatible with the level of voltage.

SPECIAL FIRE FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus.
Use approved / certified vapour respirator to avoid breathing toxic fumes. Wear protective clothing and equipment to prevent potential body contact with electrolyte solution.

PARTICULAR HAZARDS RESULTING FROM EXPOSURE TO THE SUBSTANCE/PREPARATION, TO COMBUSTION AND GAS PRODUCTS: The cell or battery can spout vaporized or decomposed electrolyte fumes with fire when being heated over +100°C (+212°F) or disposed in fire. Solvents within the electrolyte are flammable liquids and must be kept away from any kind of ignition source.

6. ACCIDENTAL RELEASE MEASURES (not anticipated under normal use)

INDIVIDUAL PRECAUTIONS: Evacuate the employees from the contaminated area until fumes dispersal. In case of electrolyte leakage from a cell or battery, do not inhale the gas as possible. In case of skin or eye contact, inhalation or ingestion, follow the measures described in section 4.

ENVIRONMENTAL PRECAUTION: Avoid sewage, surface water and underground water contamination. Avoid ground and atmosphere contamination.

CLEANING PROCEDURE: Use protective glasses and gloves, use absorbent material (sand, earth or vermiculite) to absorb any exuded material. Seal leaking battery (unless hot) and contaminated absorbent material in plastic bag and dispose of as Special waste in accordance with local regulations.

7. HANDLING AND STORAGE

IMPORTANT NOTICE: The battery should not be opened without Saft approval. The battery should not be destroyed or incinerated since the battery may cause fire or the ingredients contained in the cells could be harmful if exposed.

STORAGE: Store in a cool, dry and ventilated area. Elevated temperatures can shorten battery life. Since short circuit can cause burn hazard, leakage or venting hazard, keep batteries in original packaging until use and do not jumble them.

HANDLING:

- Do not short (+) and (-) terminal with conductors.
- Do not short (-) terminal and the can of aluminium can cells with conductors
- Do not short (+) terminal and the can of stainless steel can cells with conductors
- Do not reverse the polarity
- Do not mix different type batteries or mix new and old ones together.
- Do not open the battery system or modules
- Do not use the unit without its electronic management system.
- Do not submit to excessive mechanical stress.

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10. STABILITY AND REACTIVITY – the battery system is stable when handled and stored according to section 7

MATERIALS TO AVOID: Oxidizing agents, acids, bases and reducing agents.

CONDITIONS TO AVOID: Avoid exposing battery to fire or high temperature. Do not disassemble, crush or short or install with incorrect polarity. Avoid mechanical or electrical abuse. Do not repair or maintain when not authorized.
HAZARDOUS DECOMPOSITION PRODUCTS: Lithium hexafluorophosphate may react with water in the atmosphere and produce some traces of hydrogen fluoride, which do not worsen the gas toxicity. Thermal decomposition of the cell may release electrolyte liquid and vapour, harmful materials, and dusts.

11. TOXICOLOGICAL INFORMATION

Risk of irritation occurs only if the cell is mechanically, thermally, or electrically abused to the point of compromising the integrity of the enclosure. If this occurs, irritation to the skin, eyes and respiratory tract may occur.

12. ECOLOGICAL INFORMATION

None known if used/disposed of properly.

13. DISPOSAL CONSIDERATIONS

Battery recycling is recommended and may be mandatory in some jurisdictions. Recycle or dispose in accordance with local laws and regulations.

Batteries should be fully discharged prior to sending for recycling or disposal and terminals should be protected.

The recycling of batteries must only be conducted by fully trained personnel of licensed recyclers. Attempting to dismantle batteries or modules into individual cells may lead to serious injuries or death due to high electrical voltage and/or energy.

Store material being held for recycling or disposal as indicated in Section 7.

Do not dispose in fire. Do not dump into any sewers, on the ground or into any body of water.

See the section on "Environmental Responsibility" on https://www.saftbatteries.com/about-us/environmental-responsibility

14. TRANSPORTATION INFORMATION

The regulations that govern the transport of rechargeable lithium-ion batteries include US Department of Transportation (DOT) CFR 49 Part 171 – 180 of the US Hazardous Materials Regulations (HMR), the International Civil Aviation Organization (ICAO) Technical Instructions, the International Air Transport Association (IATA) Dangerous Goods Regulations and the International Maritime Dangerous Goods (IMDG) Code. Persons engaged in the transport of dangerous goods are required to be trained in the contents of dangerous goods requirements commensurate with their responsibilities (see 49 CFR 171.8 and Chapter 1.3, UN Recommendations on the Transport of Dangerous Goods Model Regulations).

14.1. UN Proper Shipping Name, Class, and Number

Shipment of new and used Lithium-ion cells and batteries are classified as Dangerous Goods[1] under the UN model regulation.

Proper shipping Name	Class	UN N°
LITHIUM-ION BATTERIES	9	3480
LITHIUM-ION BATTERIES CONTAINED IN EQUIPMENT	9	3481
LITHIUM-ION BATTERIES PACKED WITH EQUIPMENT	9	3481
BATTERY-POWERED VEHICLE OR BATTERY-POWERED EQUIPMENT	9	3171

NB: When Li-ion batteries are installed in cargo transport unit, the UN number is UN 3536.

14.2. International Regulations

Persons offering Lithium cells or batteries for transport need to properly determine the applicable provisions and instructions. More information is available in the official documentation for this purpose (http://www.unece.org/trans/danger/danger.html).

By Air International: IATA/ICAO Technical Instructions
By Sea International: IMDG Code
European road transportation: ADR
European rail transportation: RID

14.3 UN Tests Summary Report

Except cases of prototype stage or short production run, Saft cells or batteries have been tested for transport according to the UN Recommendations On the Transport of Dangerous Goods, Manual of Tests and Criteria, Part III. subsection 38.3. To access to the UN38.3 Tests Summary report please perform the below two steps.

1. Go on-line to https://customerportal.saftbatteries.com/tsr or scan the QR Code:
2. Enter the cell or battery part number from the transport documents (Waybill or Packing Slip) and click "Search" to receive a PDF copy of the relevant UN 38.3 Test Summary Report for the product being shipped.

15. REGULATORY INFORMATION

Marking Consideration
European Union: According to directive 2006/66/EC, the batteries must be marked with the crossed-out wheel bin symbol. Lithium-ion batteries, which contain electronic modules (e.g., PCM) and which are subject to the EMC directive 93/97/EEC, must be approved and must be marked with the CE marking.
Depending on the application, lithium-ion batteries may be subject to CE marking according to European Regulation N°765/2008 or E marking according to UNECE Regulations N° R10/R100

[1] Dangerous Goods Regulations – 62nd Edition Effective 1 January 2021 (or any further last applicable edition): International Air Transport Association (IATA)

16. OTHER INFORMATION

This information has been compiled from sources considered to be dependable and is, to the best of our knowledge, accurate and reliable as of the date compiled. However, neither complete exhaustiveness nor perfect reliability can be granted. The communication of this information does not constitute an implicit or specific warranty.

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Saft does not accept liability for any loss or damage that may occur, whether direct, indirect, incidental, or consequential, from the use of this battery information sheet provided as a service to our customers. Saft does not offer warranty against patent infringement.

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