

# 24 VDC Li Expander Pak 2400 Monitoring and Troubleshooting

## Background

### What would prompt suspicion that one or more of the Expander Pak 2400s in a bank is “bad” ?

- Resting battery bank voltage lower than expected after full charge.
- Battery bank magically dead/System unexpectedly shut down.
- Battery bank won't support load.
- Battery supports loads for less time that predicted/expected.
- Generator short cycling... running more frequently than predicted/expected.
- Generator won't turn off when set to “AUTO”.
- Battery bank voltage drops quickly as soon as generator turns off.

If any of these things is happening, it is possible that one or more Expander Pak 2400s is “bad”. All of these phenomena are indications of reduced battery bank capacity. A decrease in battery bank capacity could be due to a general decrease among all batteries in the bank (which is normal as batteries age) but also possible that one or more of the batteries in the bank has a fault. It is critical to determine if the decreased capacity is the fault of one, two, three or all of the Expander Pak 2400s.

Identifying batteries not contributing capacity to the bank should be done as early as possible. When one or more batteries drops out, the burden of supporting the load will be left to the batteries that remain meaning an increased likelihood that the remaining batteries will experience an overcurrent event.

A battery contributing zero capacity most likely has turned off the charge and/or discharge FETS... The FETS are switches that regulate current flow into or out of the battery. They get turned off when the battery experiences potentially unsafe or damaging conditions such as over/under voltage or current.

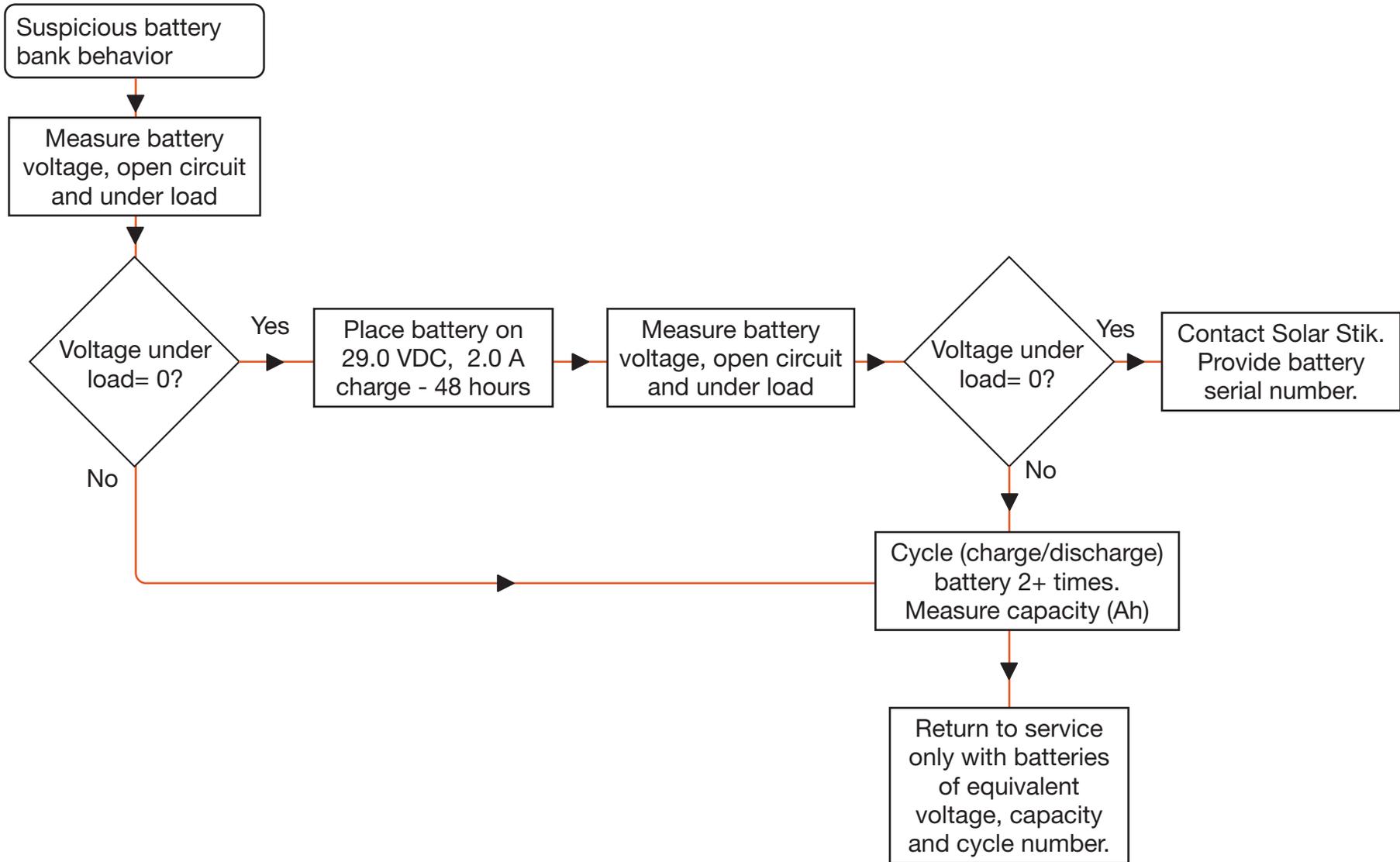
### What does a “Bad Battery” mean?

- Unacceptably low state of health (SOH).. won't hold a sufficient charge and can't support a normal load for very long.
- BMS permanently disconnects the cells from battery terminals (i.e., no current can flow in or out of the battery) resulting in a state called Permanent Fail (PF). There are several reasons why this can occur (over/under current or voltage most likely).
- Under these conditions, battery terminals may still show a voltage within normal operating range making the battery appear to be “ok”. We refer to these as phantom voltages. The phantom voltage may be the actual battery voltage but since the BMS/FETS have turned off the ability of the battery to allow current to flow, the battery is at that moment “dead”.

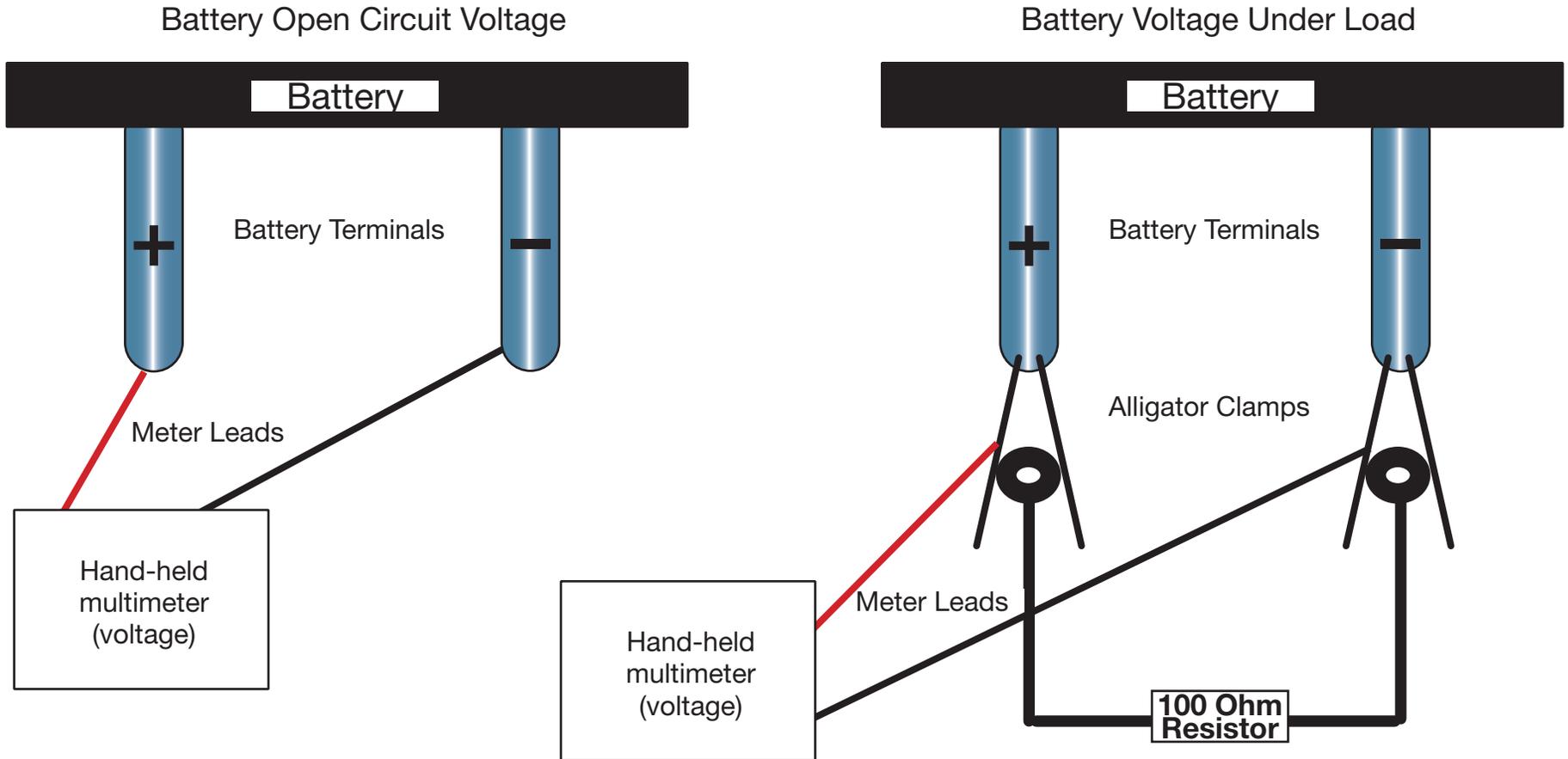
### What tests can you do to tell if a battery is “bad”?

1. Test battery open circuit voltage and voltage under a load using a resistive load tester
2. Measure battery capacity (Ah).

# Expander Pak 2400 Troubleshooting Guide



# Measuring Expander Pak 2400 Open Circuit Voltage and Voltage Under Load.



1. Measure and record voltage across the battery terminals (open circuit voltage).
2. Connect resistor to battery terminals.
3. Measure and record voltage across the battery terminals (voltage under load)
  - If voltage drops from "normal" to zero under load, FETS are turned off; faulted battery". Contact Solar Stik.
  - If voltage is maintained (drops less than 1 volt) under load, battery is OK.
  - **Do not leave the load tester connected to the battery for any longer than necessary (less than a minute!). It could generate significant heat.**

# Battery Recovery Attempt

If the battery load test results in a **FAIL**:

## What **NOT** to do

- Do not attempt to recover overdischarged Expander Pak 2400s with all breakers ON by connecting them to a single healthy, charged Expander Pak 2400s. High current may flow from the charged battery causing it to fault due to over current. Instead, first turn off all Expander Pak 2400 breakers, connect a charged Expander Pak 2400 to the bank and turn ON Expander Pak breakers one at a time. This will prevent large current bursts between batteries.

## Recovery-attempt Instructions

1. Charge at 29.0 VDC,  $\leq 2.0$  A for at least 48 hours  
The charger current reading may be 0.0 A at the beginning of the charge attempt even if the charger is set to deliver 2.0 A. This is an indication that the Expander Pak 2400 charge FETS have been turned off. Leave the battery connected to the charger even if there appears to be no current passing from the charger to the battery. It may “wake up” within 48 hours.
2. Measure resting open circuit battery voltage. Resting voltage of a fully-charged battery will be ~26.2-26.5 VDC.
3. Measure voltage under load at the terminals.
  - a. If battery voltage drops less than one (1) volt from resting voltage when tested under load, move on to the next step.
  - b. If battery voltage drops to zero (0), contact Solar Stik.
  - c. Even a drop of one (1) volt
4. Perform at least two (2) charge/discharge cycles to try to balance internal cell voltage. Hold at float voltage for 24 hours to balance cells. Measure battery capacity during these charge/discharge cycles.

# Instructions for measuring Expander Pak 2400 amp-hour capacity using a PRO-Verter 5000

## 1. Setup PRO-Verter to Charge and Discharge Expander Pak 2400

- a. Connect PRO-Verter to an AC power source.
- b. Connect an Expander Pak 2400 to one (1) of the two (2) metered Expander Pak ONLY ports PRO-Verter 5000 using Inter-Connect cable. Turn on the PRO-Verter Main Power Switch.
- c. Turn on PRO-Verter Main Power Switch. Set PRO-Verter charging voltage to 29.0 VDC. The charger menu location where this value resides may differ depending on how the PRO-Verter is programmed. It may also be a FAVs option.
- d. Set charging current to 25 A. Push SETUP, scroll to 03 Charger Setup, push select and scroll to 03E, MAX CHARGE RATE, press select, scroll to 22% and press select. Normal output of the charger is ~110 A so 22% is ~25 A charging current. (Confirm this value in DC meters while charging).
- e. Set low battery cut off (LBCO) to 24.0 VDC. This setting is likely one of the FAVS settings, if not it is SETUP 02B.

**2. Charge Expander Pak 2400** Connect Expander Pak to one (1) of the two (2) metered Expander Pak ONLY ports PRO-Verter 5000 using Inter-Connect cable. Charge until charging current drops to < 2A to ensure it is full. At this charging rate, it should take only 4-5 hours to completely charge a 100 Ah (when new) Expander Pak 2400. Leaving it overnight should ensure a complete, full charge.

## 3. Remove PRO-Verter charging source:

Toggle PRO-Verter 5000 AC INPUT breaker to OFF. Ensure there is no other charging source connected to PRO-Verter. The charged Expander Pak 2400 should continue to support PRO-Verter operation.

## 4. Reset AH counter to zero

- a. Press METER button and scroll to 05 BMK Meters, press rotary SELECT knob, scroll to METERS BMK 05F Reset AH In/Out.
- b. Press and hold the rotary SELECT knob for >5 seconds.

**Note:** The Ah leaving the battery during discharge is reported as a positive number in BMK Meters 05F.

**5. Connect an AC load** to PRO-Verter AC output. A 500-1000 W load, something like a light bulb is a good load. Ensure AC OUTPUT breaker is ON.

## 6. Discharge Expander Pak 2400 until LBCO

An LBCO setting of 24.0 will turn off the AC load at ~23.8-24.0 V. Once the AC load is off, voltage may raise back up to 24. 8-24.9 V.

## 7. Read and record AH out

BMK Meter> 05F Total AH In/Out. This value is the Expander Pak 2400 storage capacity. The Expander Pak 2400 rated capacity when new is 100 Ah. The math is easy. If the discharged Ah value is 80, the the battery SOH is 80%.

Note: you can only do this one Expander Pak 2400 at a time.

## How to Operate Expander Pak 2400s Safely

- Assemble a battery bank by connecting Expander Pak 2400s with similar SOH, SOC and voltage. These metrics should be known before connecting them.
- Do not include Expander Pak 2400s if voltage under load is zero (0) volts.
- Do not attempt to power up PRO-Verter 5000 (or any other power management component) with less than three (3) Expander Pak 2400.
- Do not mix Expander Pak 2400s with any other type of battery when building a battery bank.
- Do not exceed rated charging/discharging current, 50 A or charging voltage, 29.0 VDC.
- Do not connect Expander Pak 2400s with disparate ( $\Delta > 10\%$ ) states of health (SOH) into a battery bank. SOH is a measure of the existing battery energy storage capacity expressed as a percentage of the rated capacity when new. A Battery with a relatively low SOH will not “pull it’s weight” when connected to batteries with higher SOH value.
- Do not connect Expander Pak 2400s into a bank if they have different resting voltages ( $\geq 1.0$  VDC) after a full charge.

# PMCS

## In Operation

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable (NMC)
1	Voltage under load	Weekly	See procedure for testing Expander Pak 2400 voltage under load.	If voltage under load is zero (0) VDC the Expander Pak is NMC. Battery may be severely derated with a voltage drop of even 2 volts.
2	Balance Expander Pak cells	Monthly	Float-charge all Expander Pak 2400s in System for at least 12 hours to balance battery cells and batteries.	Resting VOC <24.0 VDC after full charge and 4-hour rest.*
3	Determine Expander Pak Ah capacity	Semi-annually (every 6 months)	See procedure for testing Expander Pak 2400 amp-hour capacity	Ah capacity ≤ 80 Ah**

\* VOC: open circuit voltage measured at battery terminals.

\*\*Industry standard marks 80% SOH as end of life (EOL). Using Expander Pak 2400s with lower SOH is possible if the bank is balanced and depending on application. The lower the SOH, the greater the possibility of erratic battery behavior.

## In Storage

Item #	Item to be Inspected	Interval	Procedures	Non-mission Capable (NMC)
1	SOC	91-140 °F (33-60 °C): every 3 months;  77-90 °F (≤ 25-32 °C): every 6 months	Charge Li Expander Paks fully using a PRO-Verter. If any other charging device is used, it must be rated for the Expander Pak storage capacity, voltage, and current limit.	If Expander Pak does not hold a charge higher than 25 VDC after 48 hours of charging, contact Solar Stik Technical Support