



## Xantrex Battery Management System (BMS)

881-0406-12  
881-0406-24  
881-0406-51

Compatible with 12V, 24V, and 51V Xantrex Lithium-ion Batteries.

### **DANGER**

#### HAZARD OF FIRE, ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

This Xantrex Battery Management System User Guide is in addition to, and incorporates by reference, the relevant product manuals for each product in the power system. After reviewing this guide you must read the relevant product manuals. Unless specified, information on safety, specifications, installation, and operation is as shown in the primary documentation received with the product. Ensure you are familiar with that information before proceeding.

**Failure to follow these instructions will result in death or serious injury.**

#### Exclusion for Documentation

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## 1

### Important Safety Information

#### READ AND SAVE THESE INSTRUCTIONS

Electrical equipment shall be installed, operated, serviced, and maintained only by qualified personnel. Certain configuration tasks shall only be performed by qualified personnel in consultation with your local utility and/or an authorized dealer. Servicing of batteries and the BMS shall only be performed or supervised by qualified personnel with knowledge of lithium-ion batteries and their required precautions. Qualified personnel have training, knowledge, and experience in:

- Installing electrical equipment
  - Applying applicable installation codes
  - Analyzing and reducing the hazards involved in performing electrical work
  - Installing and configuring lithium-ion batteries
  - Selecting and using Personal Protective Equipment (PPE)
- No responsibility is assumed by Xantrex LLC for any consequences arising out of the use of this material.



An example of an arc flash event could be a direct short circuit caused by a metallic object such as a tool bridging between the positive and negative of an energized circuit.

### **DANGER**

#### HAZARD OF FIRE, ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- Equipment must only be installed and serviced by qualified electrical personnel.
- Equipment may be energized from multiple sources. Never operate equipment energized with covers removed.
- In case of fire, use only a Class ABC type (dry chemical) fire extinguisher. Water can be a dangerous extinguishing medium for energized equipment because of the risk of electrical shock.
- Always use a properly rated voltage sensing device to confirm all circuits are de-energized.
- Do not short-circuit the battery.
- Do not expose the battery to flames.
- Do not attempt to open or dismantle the lithium-ion battery. If the battery is damaged, do not touch the corrosive electrolyte or powder. In case battery content comes in contact with skin or eyes, immediately flush the affected area with large amount of clean water and seek medical help.
- Upon disposal, do not crush, puncture, drop, disassemble, dispose of in fire, or similar actions.

**Failure to follow these instructions will result in death or serious injury.**

## 2

### **WARNING**

#### HAZARD OF FIRE, ELECTRIC SHOCK, EXPLOSION, BURN, OR PERSONAL INJURY

- Always use the Xantrex Battery with the Xantrex BMS. Never bypass the BMS. The BMS must always be connected to the lithium-ion battery and in the circuit for proper operation and safety.
- Do not connect other battery types to the system DC load or the system DC bus.
- Do not expose any of the equipment to rain, snow, or liquids of any type. Products are designed for indoor use only.
- Do not operate the battery or other equipment with damaged or substandard wiring.
- Do not replace the battery fuses or any other fuses in the system by yourself. Seek qualified assistance.
- Do not obstruct the air ventilation openings on the system devices. Do not install or operate any of the system devices in compartment containing flammable materials or in locations that require ignition-protected equipment.
- If the lithium-ion battery becomes damaged, it can release harmful gases. In such a case, ventilate the area whenever possible but evacuate the vicinity immediately.

**Failure to follow these instructions can result in death or serious injury.**

### **NOTICE**

#### RISK OF EQUIPMENT DAMAGE

- Do not physically modify the system devices, wiring harness, and accessories.
- Do not alter the factory settings on any of the system devices including the BMS.
- Do not disassemble the Xantrex Battery or the BMS. They contain non-serviceable parts.
- Only charge the Xantrex Battery with an approved charger. Contact Xantrex for details.
- Do not operate or store the battery outside of the specified environmental limits.
- Do not charge the battery in ambient temperature below freezing.
- Do not charge the battery above the recommended voltage.
- Do not allow the battery to be completely depleted.
- Do not disconnect the battery while it is being charged.
- Components which can be recycled must be recycled and those that cannot be recycled must be disposed of according to local, regional, and national environmental regulations.

**Failure to follow these instructions can result in damage to equipment and may void the warranty.**

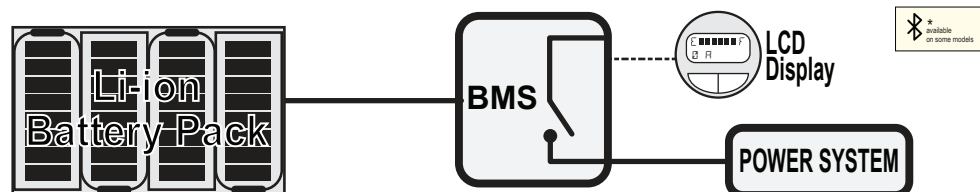
## 2

### Introduction

The Xantrex Battery Management System (BMS) primarily protects the Xantrex Battery by disconnecting it from the rest of the power system when it detects any potentially harmful conditions. It provides emergency energy reserve by saving some of the battery's energy capacity during normal use.

Additional functions of this advanced BMS are to collect data from the battery and send this data for analysis via a digital interface.

Information from the battery is displayed in real time through the battery monitor SoC LCD Display (sold separately).



\* On some devices, information from the battery is displayed in real time through Bluetooth wireless communication. The BMS transmits monitoring data over the integrated Bluetooth interface, allowing users to check the battery data on their mobile phones or tablets. You may download the Xantrex Battery app from Google Play or the App Store.

## 3

### Installation and Maintenance

This User Guide does not cover installation steps on how to install your Xantrex Battery and the Xantrex BMS. Please refer to the Xantrex Lithium-ion Battery Quickstart Guide (document number 975-1009-01-01) and Xantrex BMS Installation Guide (document number 975-1010-01-01), respectively. Contact a Xantrex representative for assistance with additional information resources.

Installation and maintenance shall only be performed by qualified personnel as defined in Important Safety Information above.

### **NOTICE**

#### RISK OF BATTERY DAMAGE

- Do not bypass the BMS by connecting DC loads directly with your Xantrex Battery.
- Always use the Xantrex Battery with the Xantrex BMS.

**Failure to follow these instructions can result in damage to battery and may void the warranty.**

## 4

### Definitions

#### RVC - Reserve Voltage Cutoff

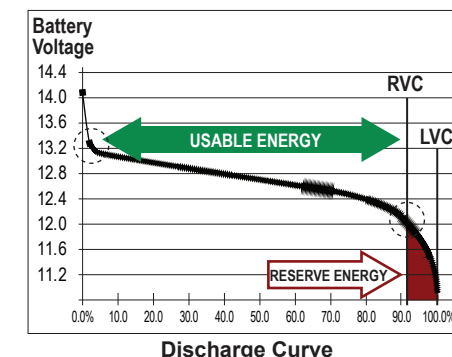
At this level, the BMS shuts off battery power allowing RESERVE ENERGY to be stored in the battery for an emergency, such as engine cranking.

#### LVC - Low Voltage Cutoff

At this voltage, the battery is almost fully discharged, so the BMS shuts off the battery to prevent damage due to over-discharging.

#### HVC - High Voltage Cutoff

At this voltage, the battery is not taking any more charge. So voltage rise becomes exponential and if left unchecked would cause permanent damage to the battery. The BMS shuts off the battery when it reaches this level, allowing voltage to rest down.



NOTE: The graph above illustrates a 12V battery discharge cycle.

## 5

### BMS Operation

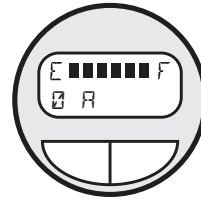
The BMS operates by monitoring the voltage and temperature data from each individual cell and battery pack as a whole. The BMS does not intervene if the battery is cycled normally. Turning the BMS on (or off) enables (or disables) power from the battery.

The following is a basic outline of the BMS operation:

1. Press the Power button to turn the BMS on. You will hear a click and the button will become illuminated.
2. During charging, the BMS will allow charging if a safe voltage limit (HVC) is not exceeded. The charger may pause for several minutes during charging, this is normal operation.
3. During discharging, the BMS will turn off when the RVC is reached. To use the 10% Reserve Capacity (reserve energy), press the Power button on the BMS to turn it on. If the battery has been depleted to below the safe voltage level it will not allow discharge. For more information, see the Low Battery Recovery section.
4. Press and hold the Power button for five seconds to turn the BMS off. You will hear a click and the button will no longer be illuminated.

## 6

### Monitor lithium-ion Battery Status



The SoC LCD Display (PN: 881-0401-12) on the system remote panel powers up whenever BMS is turned on. Its screen has two lines where battery information is displayed.

Press the Left (or Right) button to cycle through the following battery information displayed on the first (or second) line.

Example	Description
12.8V	Battery voltage (Volts)
77F t1	Battery temperature (t1 = battery one)
R0000100	Battery status code used for troubleshooting
D 225 0d	Remaining time until depletion (D) or full charge (C) in days (d) or hours (h)
T0000000	Total amount of amp-hours consumed from the battery since day of manufacture
600.0 Ah	Battery amp-hours (Ah) remaining
8040 Wh	Battery watt-hours (Wh) remaining
E ██████ F	Battery bar gauge (Empty-Full)
100% BAT	Remaining battery capacity before system shutdown
0A	Discharging current (Amps) no sign OR charging current (Amps) with "+" sign
0W	Load power consumption (Watts)

## 7

### LED Indicators

The Xantrex BMS has an LED indicator integrated into the Power button on the unit itself. In some cases, there are also optional remote LED indicators – one to indicate power (On/Off/Alarm) status and one to indicate low battery status. Please refer to your specific installation to check which LEDs, if any, you have available in your system.



**Power On/Off/Alarm** – This LED indicator is integrated into the Power button on the BMS unit or is installed remotely as an option.

- The LED is off when the BMS is turned off and battery power is disabled.
- The LED is on when the BMS is on and battery power is enabled.
- The LED flashes rapidly when BMS is in alarm state and battery power is disabled.



**Low Battery** – This optional LED indicator is typically installed at the vicinity of the control panel area in a vehicle. The goal is to show when the battery is getting low and therefore needs to be charged.

- The LED turns on when the battery goes below approximately 20% SoC.

## 8

### System Charging

When the battery's SoC is greater than 10% and while battery power is still engaged, you may charge the battery by engaging power from the charging source.

When SoC is less than 10% but greater than 3%, and the reserve shutdown event has occurred, press the Power button on the BMS. While battery power is engaged, start charging the battery from the charging source.

**NOTE:** When charging, avoid using heavy loads to prevent prolonged charging time. Also, avoid using heavy DC loads during charging to prevent the system from transitioning to thermal protection mode.

To stop charging, disengage the power from any and all charging sources. Do not turn off the BMS to disconnect the battery while the system is charging.

#### NOTICE

##### RISK OF EQUIPMENT DAMAGE

Do not disconnect battery while the system is charging.

**Failure to follow these instructions can result in damage to equipment.**

#### NOTICE

##### RISK OF BATTERY DAMAGE

- Do not charge the battery above the recommended voltage.
- To store, fully charge the battery and turn off the BMS when the system is not in use for less than a month. Observe proper storage instructions for long-term storage. For details, see *Xantrex Battery Storage and Maintenance Guide (document number 975-1005-01-01)*.

**Failure to follow these instructions can result in damage to battery.**

## 9

### Low Battery Recovery

#### NOTICE

##### RISK OF BATTERY DAMAGE

Turn off (or disconnect) all loads completely before performing a Low Battery Recovery procedure.

**Failure to follow these instructions can result in damage to battery.**

When SoC is less than 3% and the low voltage shutdown event has occurred, charge the battery immediately through an approved charging source. Follow the steps below.

1. Turn off (or disconnect) all DC and AC loads completely.
2. Start charging.

**NOTE:** If charging does not commence, then it is possible that the battery has been completely depleted. The battery including the entire power system has to be serviced by a qualified person such as an authorized technician. Contact your dealer for service.

#### NOTICE

##### RISK OF BATTERY DAMAGE

Do not perform the low battery recovery procedure repeatedly. Contact customer service so they can refer you to an authorized technician for service.

**Failure to follow these instructions can result in damage to battery.**

## 10

### Troubleshooting

PROBLEM	CAUSE	SOLUTION
Battery and LCD Display are turned off	Battery is low (reserve shutdown).	Follow the steps in "System Charging" and charge the battery immediately.
	Battery is critically low (low voltage shutdown).	Follow the steps in "Low Battery Recovery" and charge the battery immediately.
BMS will not turn on.	Battery temperature is outside normal range.	Apply proper ventilation and make sure ambient temperature is not too hot or too cold.
	Battery is critically low.	Follow the steps in "Low Battery Recovery" and charge the battery immediately.
	Battery fuse is blown due to overcurrent or short-circuit.	Call for service. Do not replace fuses in the system by yourself.
Battery information on LCD Display is inaccurate.	Battery is consistently left in a partially discharged state causing SoC reading to gradually drift.	Perform a full charge cycle to bring battery SoC to 100% to allow readings to recalibrate. Perform weekly to maintain accuracy. Check that the battery capacity is set correctly.

**NOTE:** Refer to your equipment's troubleshooting tips for specific information.

**Last recorded event code** When the BMS is first powered on, the LCD display shows the last recorded event code and the firmware version for five seconds before it switches to normal data display. You can power cycle the BMS again and to see both information again. Write down this information before contacting technical support.

# 11

## BMS Configuration

Xantrex ships every BMS unit pre-configured for the specific lithium-ion battery. However, in some cases a customer may need to make changes to those parameters suited to their system requirements.

The BMS configuration can be done using the two buttons on the SoC LCD Display (sold separately).

### Configuring BMS using the SoC LCD Display Unit

To enter the BMS Configuration Menu:

1. Long press for six seconds both buttons on the LCD Display. The BMS will enter Setup mode and will display the first configuration parameter and its current value.
2. Press the left button to scroll through the range of values.
3. Press the right button to lock the value and move to the next parameter screen.

**NOTE:** If no buttons are pressed within five minutes, the LCD will exit Setup Mode and switch to Display mode automatically.

The following list describes the setup screens and their variable descriptions.

**Pack Size** Settings are from 1 Ah to 3000 Ah. 0 – 50 Ah are in 1 Ah increments. 50 Battery pack Amp – 3000 Ah are in 10 Ah increments.  
Hour capacity

**Full Vlt**  
Full Voltage

Set this to the maximum per-cell voltage your battery reaches at the end-of-charge. This will be used to synchronize the SoC meter's 100% reading when the battery reaches this voltage level.

Typically, this value is 3.55 V per cell. So, a 12 V (4 cell) battery is 4 x 3.55 = 14.2 V. When the battery reaches this voltage at the end of a charge cycle, the SoC value will reset to 100%.

**NOTE:** If you notice that your SoC meter value never reaches 100% at the end of a charge cycle, you may need to slightly lower the Full Vlt value to what the voltage reading is on the LCD Display at the moment, when the charger turns off. This value must be higher than the resting voltage of the battery since the charger's end voltage is higher than its resting voltage.

**Min SoC**  
Minimal State-of-Charge

This percentage value sets the Empty Battery level, also known as Reserve Capacity, so the user can utilize the BAT Gauge reading and not completely deplete the battery thus, preserving its lifecycles. For example, if this value is set to 20%, then BAT Gauge will report 0% when SoC is still at 20%. If you desire to use your battery to its full capacity and/or want the BAT Gauge to reflect true SoC, then set this value to zero.

In addition, when RVC Mode is enabled, the BMS will turn off battery power when SoC reaches this preset level (assuming it comes before battery voltage reaches RVC level), typically 3.00VPC. This allows the Xantrex Reserve feature to act on both voltage trigger and SoC level trigger, whichever comes first.

**AGSR Lvl**  
Automatic  
Generator  
Start/Restart level

This percentage value determines the minimal Bat Gauge level at which the AGS/R circuit is triggered. AGS/R circuit triggers on voltage set to 3.05 V per cell, or the Low Bat level, whichever comes first, hence allowing flexible control of the generator starting point.

**Temp Unit**  
Temperature Units

Set this to Fahrenheit (°F) or Celsius (°C).

**Charge Eff**  
Charging Efficiency

This percentage value slows down the rate of SoC climb during the charge to compensate for battery losses during the discharge cycle. The recommended setting is 98%. In applications with high discharge rates, energy losses are more pronounced, so this value must be set lower to accurately report SoC and BAT Gauge values during partial charges. This setting must be tuned experimentally for best accuracy. Ideal setting will cause SoC to reach 100% at approximately the same time as the charger is finishing up the full charge.

**Dead Zone**

Due to thermal drift in Hall Effect sensors when temperature fluctuations are wide and fast, the BMS might report non-zero current reading when no current is present. The Dead Zone value allows ignoring small current readings when they are likely false (such as, when small reading fluctuates between zero and non-zero values). Default value of 0.3A is recommended for best zero-point stability.

**Idle Load**  
Shown as mA

This setting represents the constant idle load current powering the BMS system. This can be measured with a digital multi-meter in DC amperage mode in series with the BMS's negative reference wire. Allowed range is 0 – 200 mA. Since the idle current is usually too low to register by internal hall-effect sensor but still affects SoC reading over long time periods when the battery sits idle, setting this value allows for a better long-term accuracy of the SoC counter.

**Alarm**  
Alarm function

Turns ON or OFF an Alarm function, which drives the internal buzzer as well as the AUXOUT2 external relay circuit when the BMS is in Alarm state.

**RVC**  
Reserve voltage  
cutoff function

Default setting STD (Standard) would turn off the battery while leaving reserve charge, which can be accessed by pressing the Reset button. When set to EXT (Extended), the amount of reserve charge is increased on voltage-based triggers.

**Pre-charge Circuit**  
Applicable to the  
51V BMS model  
only (881-0406-51)

The feature reduces inrush current from a capacitive load such as an inverter or motor controller. The BMS limits the inrush current to a safe low level utilizing pre-charge timing and voltage thresholds that are configurable. A PRECHARGE\_ERROR status is reported by the BMS for troubleshooting when the pre-charge circuit encounters an error or a short circuit at the load side of the BMS.

**NOTE:** Disable the pre-charge circuit control feature when connecting to high power resistive loads such as electric heaters and heat lamps.

# A

## Power and Environmental Specifications

**NOTE:** Specifications are subject to change without prior notice.

<b>Electrical Overview</b>	<b>Nominal System DC Voltage</b>	12.8 – 51.2VDC	
	<b>Maximum Current</b>	300A continuous	
<b>12V Lithium-ion Battery Voltage versus SoC</b>	<b>Battery State</b>	<b>Battery Voltage</b>	<b>State-of-Charge (SoC)</b>
	Fully Charged	14.6V – 13.6V	100%
	Nominal Operation	14.6V – 12.2V	100% – 12%
	Float Charge	13.4V	100% – 80%
	Low Battery Warning	12.2V	12%
	Reserve Shutdown	12.0V	10%
<b>24V Lithium-ion Battery Voltage versus SoC</b>	<b>Battery State</b>	<b>Battery Voltage</b>	<b>State-of-Charge (SoC)</b>
	Fully Charged	29.2V – 27.2V	100%
	Nominal Operation	29.2V – 24.4V	100% – 12%
	Float Charge	26.8V	100% – 80%
	Low Battery Warning	24.4V	12%
Reserve Shutdown	24.0V	10%	
Low Battery Shutdown	23.2V	<3%	

<b>51V Lithium-ion Battery Voltage versus SoC</b>	<b>Battery State</b>	<b>Battery Voltage</b>	<b>State-of-Charge (SoC)</b>
	Fully Charged	58.4V – 54.4V	100%
	Nominal Operation	58.4V – 48.8V	100% – 12%
	Float Charge	53.6V	100% – 80%
	Low Battery Warning	48.8V	12%
	Reserve Shutdown	48.0V	10%
Low Battery Shutdown	46.4V	<3%	
<b>Humidity</b>	<b>Operating range</b>	5 – 95% RH, non-condensing	
	<b>Storage range</b>	45 – 75% RH, non-condensing	