GENASUN

Installation and Operating Notes for Genasun Lithium Batteries
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Introduction

Congratulations on the purchase of your Genasun Lithium Battery System. This manual will describe the typical installation procedures and outline the differences between our batteries and lead-acid batteries, with which you are probably already familiar.

Aside from the phenomenal savings in weight and gains in efficiency over lead-acid batteries, there are two other important differences to keep in mind when switching to lithium batteries. First, the battery voltage limits and ranges are somewhat different. Second, the battery system contains circuitry to protect and isolate the batteries in the case of abnormal conditions. These functions are totally transparent under normal operation, but should be kept in mind when planning the system.

Safety and Protection

Our battery systems contain advanced electronics to ensure safe operation. Our system provides the following:

- Protection against over-charge
- Protection against over-discharge
- Protection against over-temperature
- Protection against short-circuit
- Audible fault alarms

Warnings and Cautions

Your battery system MUST be used with the included battery management system (BMS) as detailed in this manual. Direct connections to the battery other than through the BMS will invalidate the warranty, and may create a risk of battery damage or fire. The aluminum battery racks provide compression to the battery cells, and must not be removed. While all of the electronics in the battery system have been conformally coated to resist humidity, the system is NOT WATERPROOF, and measures must be taken to prevent exposure to water. Water damage is the responsibility of the customer, and will not be covered under warranty. Chargers (i.e., shore power, solar charge controllers, fuel cells, alternator regulators, etc.) must be set for 14.2V or less for 12V nominal systems, or 28.4V or less for 24V nominal systems.

Mechanical Installation

Your Genasun lithium battery system should be mounted in a location free from exposure to liquid water and protected from mechanical damage. If there is no suitable battery compartment available, the use of conventional plastic battery boxes is recommended. The batteries must be securely mounted to prevent movement, especially in the event of a capsize. Aluminum handles have been provided on each end of the battery for lashings or straps. Do not place straps or other point loads on the clear plastic battery cover.

The Battery Management System (BMS) should be mounted close enough to the batteries to make connection with the data cables. The BMS should be mounted in a dry location and protected from drips caused by condensation, splashes, or leaks. Usually, a nearby bulkhead will provide a satisfactory location. The BMS can be mounted from inside the enclosure using the 4 included mounting screws. The BMS contains a buzzer which gives audible notification of fault conditions, so the ideal location will not be too far removed from the sailing crew or other operator.

Electrical Installation

Stud/Ring Terminal Size:	**8mm or 0.313" (5/16") nominal**
Battery Stud Torque:	**15 ft-lbs**

CAUTION: Batteries are always live. Exercise extreme caution while making connections in order to avoid short circuits, fire, and other damage. Insulate the handles of all metal tools with tape or heat-shrink tubing. Tape off any exposed cable ends during assembly; rubber-coated or taped tools are recommended.

The diagram at the end of this manual shows a sample installation of a Genasun lithium battery system. Chargers and loads are connected separately through the "CHARGE" and "DISCHARGE" relays of the Battery Management System (BMS). Providing separate connections for chargers and loads allows the system to function gracefully during an over-charge or over-discharge situation, and prevents system damage by preventing a situation where chargers and loads are connected together while the battery is disconnected.

Each Genasun lithium system is divided into two redundant banks of equal capacity. Smaller systems will be packaged as two batteries, but larger systems may be comprised of several battery modules connected in series. In the latter case, battery modules will be shipped marked with a letter, "A", or "B". All of the A modules should be connected in series to form one bank, and all the B modules should be connected in series to form the second bank, as each set has been balanced together.

Alternators/Regulators

Alternator fields **MUST** be connected as shown in the diagram in order to prevent damage to the alternator rectifier diodes should the CHARGE relay open while the alternator is charging. This is a special protection feature unique to the Genasun battery Management System. Note: if dual alternator regulators are used (to drive dual alternators), then run each field wire to one BMS per regulator. In this case the field wiring to each alternator will be separate circuits rather than joined as shown in the diagram.

Powering the Relays

When wiring the power to the charge & discharge relays, note that the + supply to the relays is provided by the main circuit to the relay buss. You will see both + and – terminals on the BMS but run only the – from the BMS terminals to the relays.

Connecting to the batteries

Depending on configuration, Genasun batteries may be supplied with cable-clamp connections for 8 to 1/0 AWG cable, or configured for use with 8mm or 5/16" ring terminals. For cable clamp connections, insert cables and tighten the clamp securely with a ¼" Allen wrench. For ring terminal connections, the ring terminal should be placed over any bus bars that may be present, and the stud nut carefully tightened to **15 ft-lbs**. using a torque wrench and a fresh lock washer. If the ring terminal will be touching the battery terminal directly, the use of an anti-corrosive zinc paste for aluminum connections such as Penetrox or Noalox is highly recommended.

In some cases, a BMS circuit board (typically green) will be covering the desired connection point. In this instance, the nut and washer should be removed, and the stud unscrewed from the battery terminal. The ring terminal should then be inserted under the BMS circuit board, and the stud screwed in through the BMS circuit board and ring terminal.

To avoid stripping the aluminum battery terminals, the stud must be screwed in fully. Dial calipers may be used to check that the stud insertion depth matches the original insertion depth. Place a flat washer, then a fresh lock washer onto the stud over the BMS PCB, then tighten on a nut to **15 ft-lbs**. using a torque wrench. **The use of a torque wrench is essential to avoid stripping the delicate aluminum battery terminals.**

System Configuration

After installation, your Genasun battery system requires no additional configuration, however, the systems used to charge and monitor the battery must be set appropriately. All chargers should be set for a simple **float voltage of 14.2V (28.4V for 24V nominal systems), with no temperature compensation.** This type of charging is variously called Constant-Current/Constant-Voltage, CC/CV, and Forced Float, among others.

Charging Sources and Monitors

For solar charging, Genasun manufactures a range of high-performance MPPT solar charge controllers that can be configured to charge appropriately.

For shore-power (AC) chargers, temperature compensation should be disabled by removing the external temperature sensor or taking other configuration steps specific to the charger. The charge voltage should be set to 14.2V/28.4V. If multi-stage charging cannot be disabled, all voltages should be set to 14.2V/28.4V. Failing that, the charge curve must be adjusted such that the maximum voltage reached (variously called "Bulk", "Boost", or "Absorption") is 14.2V/28.4V or less.

For alternator charging, Genasun manufactures an appropriate alternator regulator that is compatible with most externally regulated alternators with an isolated or P-type field.

Battery monitors vary, however, a good starting point would be to set the Peukert exponent to 1, and the Charging Efficiency Factor (CEF) to 100%.

Battery Operation

To start the battery, hold the associated switch in the momentary "**START**" position briefly, then allow it to return to the center "**RUN**" position. The relays should click on, and power should now be present at both the "**CHARGE**" and "**DISCHARGE**" connections. The BMS may beep briefly on startup. If another battery is already powered on, or power is present from a charger, the battery will start up as soon as the switch is set to the "**RUN**" position. To turn the system off, turn the switch to the "**OFF**" position, which is the non-momentary, off-center switch position. When the boat will be left unattended, the batteries should be switched off, unless a solar panel or other charging source is present and active.

Maintenance

The M8 nuts on each battery cell should occasionally be re-torqued 15 ft-lbs., taking care to avoid stripping the aluminum battery terminals. Occasionally inspect the battery racks for loose hardware. **ONLY** if loose, the ¼-20 battery rack hardware should be torqued to **5 ft-lbs.** To avoid stripping the aluminum threads, **DO NOT** make any adjustments without a torque wrench. For longest life, bring the batteries to 50-70% state of charge before storage.

Troubleshooting

The BMS includes an audible alarm which will sound if any cell is outside any protection limit or there is an internal or communication fault. Beeping may continue for a short time after faults are corrected due to the buzzer buffer. The beep codes are listed in the table below. A "." represents a short beep, while a "_" represents a long beep. Due to the work load of the BMS microcontroller, beeps may be somewhat irregular.

Cell Undervoltage:	..
Cell Overvoltage:	...
Cell Overtemperature:	....
Cell Undertemperature:	_._.
Communication Error:	_ _..

During the first charge, or after the battery has been stored during the off-season, the cells within a battery bank may become unbalanced. When the batteries near full charge, the BMS may begin beeping Cell Overvoltage, and the CHARGE relay will cycle on and off. The BMS will correct the imbalance, but in extreme cases this may take several days. If possible, the batteries should be charged with a small current (such as a part of a solar array) until the batteries have reached 14.2V/28.4V, and beeping has ceased. Balancing progress may be monitored by examining the serial data output of the BMS.

Viewing System Data

The Battery Management System for each battery bank has a standard RS-232 serial output that gives human-readable information about system status, including battery cell voltages in mV and temperatures in tenths of a degree Celsius. Some larger systems may include additional dummy cell modules that always read 3600mV.

If you have questions about the operation of your system, please log some serial data and email it to Genasun so we can provide you the best and most efficient service.

To monitor serial data, you will need a computer with a serial (RS-232) port. This can be either built in, or a USB to Serial adapter (available at most computer stores). You can use a terminal program, such as HyperTerminal, which is included with Microsoft Windows 2000 and XP. Instructions for HyperTerminal under Windows XP follow.

To start HyperTerminal, Select:
Start Menu -> Programs -> Accessories -> Communications -> HyperTerminal
The path may vary slightly depending on your Windows menu settings.

Once HyperTerminal is started, A "New Connection" box will pop up. Type any name and click "OK".

The "Connect To" Dialog will pop up. in the "Connect using:" field, select your serial port and click "OK". The serial port is often COM1 or COM2 if the serial port is built in, or COM3 - COM9 if you are using a USB-Serial adapter. Trial and error is a good technique here, since things like modems and IR links often show up as serial ports.

This should get you to a "COM* Properties" Dialog. Choose the following Settings:

Bits per Second:	**9600**
Data Bits:	**8**
Parity:	**None**
Stop Bits:	**1**
Flow Control:	**None**

Click "OK".

You should now be receiving data. If not, make sure "Connected" with a time appears in the lower left hand corner of the HyperTerminal window. If not, try clicking "Call" from the "Call" drop-down menu.

If still no data, or the data is garbled, check your settings and connections.

Genasun products should be connected to computers using ordinary "straight-through" DB-9 serial cables, not null-modem serial cables.

For troubleshooting, it will be very useful to capture some log files, which can then be emailed to Genasun. To begin logging once data is being received, select "Capture Text..." from the "Transfer" drop-down menu, type a convenient descriptive file name and pick a convenient location
(i.e. C:\Documents and Settings\user\Desktop\log20090819GenasunLithum.txt). Click "Start". When logging is done, select Transfer -> Capture Text-> Stop.

If you begin logging again without selecting a new file, HyperTerminal will append the logs to the existing file.

Warranty and Service

Your Genasun battery system is warranted against defects in materials and workmanship for a period of two years from the date of purchase. This warranty does not cover normal decrease in battery capacity resulting from use, or mechanical or water damage. This warranty does not cover damage due to incorrect connections, operation outside of the rated conditions, or other abuse. In no event will Genasun LLC be held liable for incidental or consequential damages resulting from product failure.

To obtain technical support, repairs, or other service, please contact us at:

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Genasun Lithium Iron Phosphate Battery System

Typical Installation