Introduction to LiFePO4 Marine Batteries

LiFePO4 (lithium iron phosphate) is a lithium-ion battery technology that is safe, powerful and plug compatible with most lead acid battery charging systems. This battery technology offers **many advantages over lead acid technology including high capacity storage, delivery of consistently high power, longer cycle life, less weight, longer shelf life and rapid charging**.

LiFePO4 batteries are the safest type of lithium batteries as they will not overheat, and even if punctured they will not catch fire. The cathode material in LiFePO4 batteries is not hazardous, and thus poses no negative health hazards or environmental hazards. **Our LiFePO4 batteries are plug compatible with lead acid batteries and will accept a charge from most lead acid configured chargers. The charge voltage and amperage should be within the range specified for the LiFePO4 batteries.**

A CMP (Custom Marine Products) LiFePO4 battery has two primary components, the **LiFePO cells** and the **Battery Management System (BMS)**. Both are housed in a sealed battery case. The quality of each component is key to the longevity and performance of the battery. LiFePO cells are wired in parallel to form a module producing 3.2 volts. Four of these units are connected in series to form a rated 12.8 volt LiFePO4 battery. The temperature, charge and discharge of each cell is monitored and managed by the BMS, a computer of sorts built into each battery. In addition to cell monitoring and management, the BMS will prevent over discharging of cells by disconnecting the load and will prevent cell over charging by reducing charge current or stopping the charge process. The BMS will also shut down the system if the battery temperature is out of range.

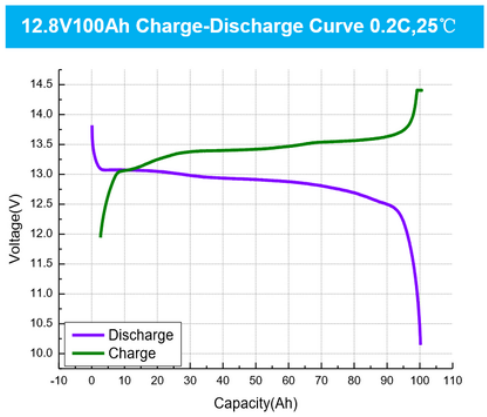
Our most popular CMP LiFePO4 battery is rated at 100 Amp hours and is roughly the size of a group 31 lead acid battery. LiFePO4 batteries are also rated as to their maximum discharge capacity; 100 Amps max discharge capacity is typical. CMP LifePO4 batteries have a discharge capacity of 100 or 150 Amps to robustly accommodate both house and start battery power requirements.

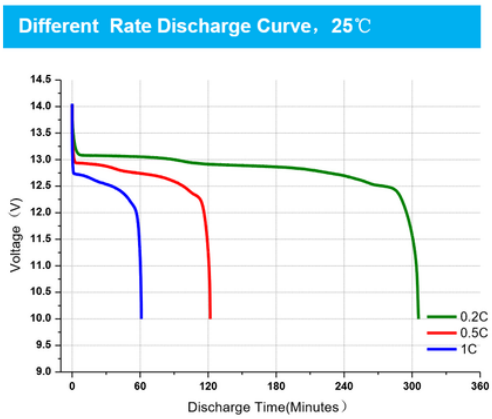
Advantages and Features of LiFePO4 Marine Batteries

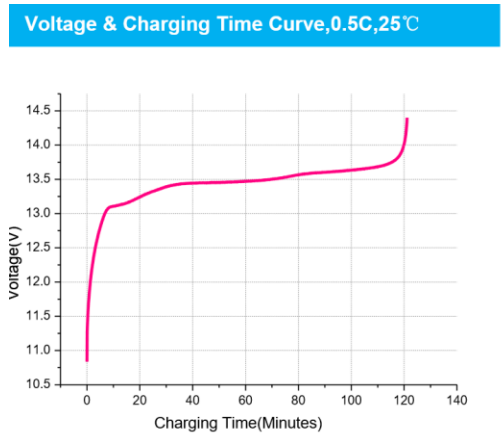
Charge/discharge cycles - LifePO4 batteries have an expected life of 2,000-5,000 charge/discharge cycles at a discharge to 90%. Lead acid batteries have an expected life of 300-700 charge/discharge cycles at a discharge to 50%.

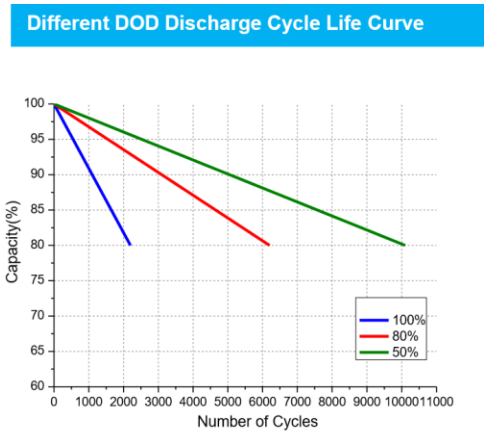
Discharge profile - LifePO4 batteries stay at a voltage of 13 to 13.4 volts during discharge of up to a 95+%. Voltage then drops off rapidly. A lead acid battery decreases in voltage from 13 to below 12 volts as more current is drawn. This means many appliances will operate more efficiently throughout the discharge cycle using LiFePO4 batteries.

Discharge rate - The BMS built into our batteries has a 100 amp or 150 amp continuous discharge capacity. This means the batteries can sustain a heavy continuous discharge without damage or degradation. Rapid charge is also a benefit of the high power BMS built into our batteries.

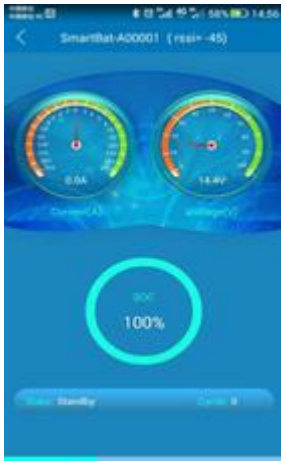








"C" is the rated Amp Hour BMS Discharge Capacity (150 Amps)



Battery Monitoring - Our LiFePO4 batteries are equipped with two methods of monitoring battery State of Charge (SOC). This is important because unlike lead acid batteries, LiFePO4 batteries maintain a nearly constant voltage between 13 and 13.4 volts so a volt meter is of limited value for measuring SOC. An LED meter is built into the top of each battery to indicate the SOC. A built in Bluetooth capability enables real time monitoring of each battery through an APP on an Android or IOS smartphone or tablet. The APP displays the state of charge (SOC) of the battery, the amp draw and voltage level, the temperature, the time to full charge and the number of charge/discharge cycles. This capability is nearly equivalent to having a built-in battery bank monitoring system like a Link 2000.

Compatibility - While the optimal charging parameters vary between LiFePO4 and lead acid battery technology, the BMS built into our LiFePO4 batteries compensates for this. Thus, our LiFePO4 batteries are compatible with most lead acid battery charging systems.

Weight/Power Ratio - A typical 100 Ah LiFePO4 battery weighs about 31 pounds. A comparable lead acid battery is over twice that. Because LiFePO4 batteries can be safely drawn down 90% vs 50%-60% for lead acid, fewer batteries are required to achieve the same power. Battery weight combined with useful power capacity means battery weight can be cut by more than half using LiFePO4 batteries. Also, LiFePo4 batteries will occupy up to 40% less space than equivalent lead acid batteries.

For example, 3 group 31 110 amp hour lead acid batteries weighing a total of 200 pounds can be replaced by 2 group 31 size 100 amp hour LiFePO4 batteries weighing a total of 62 pounds. Both configurations have roughly the same power capacity because the lead acid can be safely drawn down 50% (330 amps @50% = 165 amps) and the LiFePO4 can be safely drawn down 95% (200 amps @ 95% = 190 amps). Also, the lead acid will endure 400-600 cycles and the LiFePO4 over 2,000 cycles.

Example:	**Lead Acid**	**LiFePO4**
Battery Bank	3 Group 31 110 Ah	2 Group 31 size 100 Ah
Rated Capacity	330 Amps	200 Amps
Useable Capacity	165 Amps	190 Amps
Charge/discharge cycles	400-600	2,000-4,000
Weight	200 pounds	62 pounds

Safety – Lithium ion batteries have a reputation for catching fire. This is not so with LiFePO4 batteries, a very different technology. The built-in Battery Management System (BMS) monitors the state of charge of each cell group and manages the temperature, charge and discharge rates. The BMS will prevent over-charging and over-discharging by disconnecting from the source. There are no toxic chemicals or gases as in many types of lead acid batteries.

Efficiency – In off-grid applications such as solar and wind, energy efficiency can be of crucial importance. The round-trip energy efficiency (discharge from 100% to 0% and back to 100% charged) of the average lead-acid battery is 80%. The round-trip energy efficiency of a LiFePO4 battery is over 90%. The charge process of lead-acid batteries becomes particularly inefficient when the 80% state of charge has been reached, resulting in charging efficiencies of 50% or even less. In contrast, a LiFePO4 battery will still achieve 90% efficiency under shallow discharge conditions. This means more of the charging power is actually stored in the LiFePO4 battery.

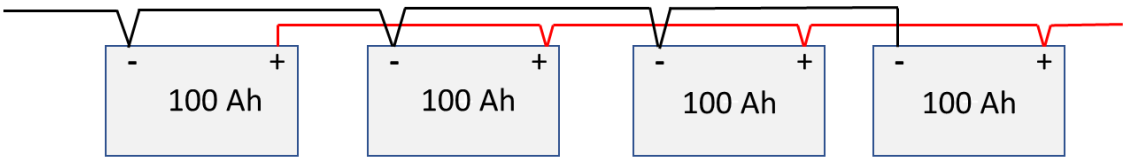
Bottom line - ***Our CMP LiFePO4 marine batteries are lighter, can be drawn down 90%, hold a steady voltage, are plug compatible with lead acid chargers, and charge more quickly than lead acid batteries. They are nontoxic and safe. They are more expensive than lead acid however their advantages often outweigh the additional expense.***

Installation and Operating Considerations

Mounting - The batteries can be positioned and secured in any direction; bottom or side. There is nothing to leak out. The area around the batteries should be ventilated for heat dissipation.

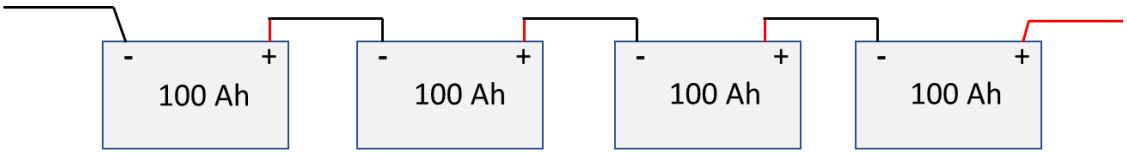
Wiring – Up to four batteries may be wired in series and up to ten batteries may be wired in parallel . See wiring diagrams below:

Parallel – Up to ten batteries may be connected in parallel to increase the current capacity of the battery bank. When batteries are connected in parallel, the voltage of the system does not change, but the current capacity of each battery is additive. For example, two 100 Amp batteries connected in parallel can deliver 200A continuously. All cables and connections MUST be able to accommodate the high currents that can be delivered by the battery bank. Appropriate fuses and circuit breakers are also highly recommended to protect downstream appliances.



Parallel - 12 V 400 A Draw Capacity 360 Ah Capacity at 90%

Series - Up to four batteries may be connected in series to increase the voltage of the battery bank up to a 48V system. When batteries are connected in series, current capacity remains the same, and the system voltage is additive. For example, three 100 Amp batteries connected in series can deliver 100 A continuously at a nominal 36V.



Series - 48 V 100 A Draw Capacity 360 Ah Capacity at 90%

It is important that all batteries be of equal charge greater than 70% before connecting them in series or parallel.

Important – The positive wires for charge and discharge should be connected to one end of the battery bank and the negative wires to the other end so current is drawn across the bank.

Operating and Storage Temperature Range - LiFePO4 batteries can be stored in temperatures of -10°F (-20°C) to 100°F (+38°C). It is recommended they not be charged and discharged at temperature below 0°F (-18°C) It is recommended that the negative terminals be disconnected for winter or long term storage so there is no chance of draining the batteries while in

storage. Complete discharge of LiFePO4 batteries for an extended period of time will likely damage the cells. LiFePO4 batteries should be recharged every 6 months.

Disposal - LiFePO4 batteries marked with the recycling symbol must be processed via a recognized recycling agency. Batteries must not be mixed with domestic or industrial waste.

Charging - For the Bulk/Absorption stage, the ideal voltage is 14.2V to 14.6V ± .5V. Our batteries do not require a float stage for charging, however, a float voltage of 13.4V to 13.8V can be used. Equalization is not recommended for our batteries. If equalization cannot be turned off, a maximum voltage of 14.6V is acceptable. The recommended charging amperage is 20A to 50A continuous (.2C to .5C).

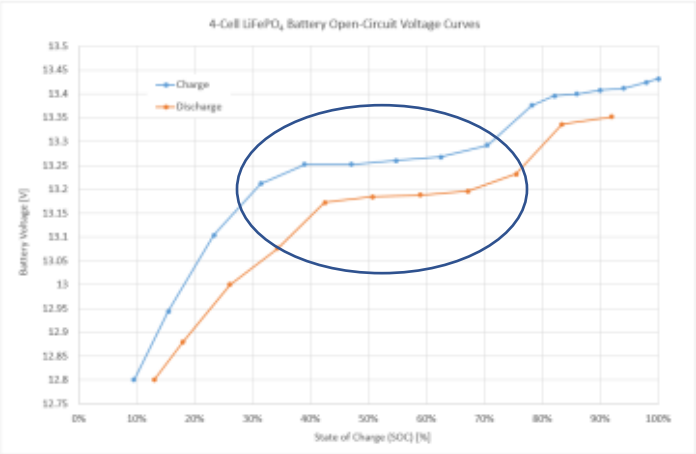
Temperature Compensation - Temperature compensation is not needed or recommended with our LiFEPO4 batteries.

Battery Monitoring Considerations

Programming a Battery Monitor – Battery monitors measure the power charging and discharging the battery bank. Most battery monitors are designed to operate with lead acid battery technology. Unless properly programmed, battery monitors can be inaccurate with LiFePO4 batteries. The key to improving the accuracy of a battery monitor is properly setting the Peukert coefficient. (This is F08 on the Xantrex Link series monitors.) **We have found the proper Peukert coefficient for LiFePO4 batteries is 1.04.** We have also found that increasing the rated battery capacity by 10% is helpful. For example, set a 200Ah battery bank to 220Ah. This is because the charging and discharging efficiency of LiFePo4 batteries is significantly higher than lead acid batteries.

Measuring State of Charge (SOC) –

Unlike lead acid batteries, LiFePO4 batteries maintain a near constant voltage until discharged up to 90%. This voltage ranges from 13 to 13.4 volts. Thus, a voltmeter provides only an approximation of the battery SOC. See table below:



Battery Voltage at Rest

13.3 V or higher	Over 80% full
13.2 V or higher	At least 70% full
13.15 V or less	Less than 40% full
13.0 V or less	Less than 25% full

To more accurately monitor battery SOC, CMP batteries are equipped with a built in meter on the top of the battery and are equipped with a Bluetooth capability so the battery SOC can be monitored from a Smartphone or tablet.

Fuel Gauge Battery Monitoring Meter - Many of our batteries include a built in "fuel gauge" meter. To activate the meter, press the button in the lower left of the meter display. This will activate the gauge to display the battery state of charge and the battery voltage.

Bluetooth Battery Monitoring System - The built in Bluetooth feature enables the monitoring of each battery State-of-Charge (SOC) via a Smartphone or tablet APP. We offer two APPS depending on the BMS used. The APP displays the Amps currently charging or discharging from the battery at a point in time, the voltage of the battery, SOC %, the temperature of the battery, the time to full charge, the time to full discharge and the number of charge/discharge cycles the battery has incurred.

See details for installing and using the Bluetooth APPs at the end of this manual.

Caution

Do not reverse polarity of the battery as this will damage both the battery and the devices being connected.

Do not submerge the battery.

Do not expose battery to excessive heat or fire.

Do not short circuit the battery.

Do not mishandle, drop, throw or apply excessive force to the battery.

Do not operate with loose terminal connections

Do not combine lead acid and LeFePO4 batteries in the same system. All batteries should be of the same make and model.

Be sure all batteries are at the same State-of-Charge before connecting in series or parallel.

Recharge batteries every 6 months at a minimum when in not in use. Remove all connections from the negative terminal when storing for long periods of time.

Warranty

Custom Marine Products warrants each branded battery to be free of defects for a period of 3 years from the date of sale as determined by either the customer's sale receipt, or other proof of purchase. Within the warranty period CMP will credit, replace or repair the product and/or parts of the product if determined to be defective in material or workmanship.

Specifications (100 amp draw battery)

Electrical Characteristics

Normal Voltage	12.8 V
Rated Capacity	100±3 Amp hrs. (.2C)
Energy	1280 Watt hrs.
Internal Resistance	≤40mOhms
Cycle Life	≥2,000 @ 0.2C (100% Depth of Discharge DOD)
	≥6,000 @ 0.2C (80% DOD)
	≥10,000 @ 0.2C (50%DOD)
Passive Protection	Over charge, over discharge, temperature protection

Standard Charge

Charge Voltage Range	14.2V to 14.6V
Full Charge Voltage	14.4 V
Continuous Charge Current	20 to 50 Amps (.2C to .5C)
Max. Charge Current	100 Amps (C)

Standard Discharge

Continuous Current	100 Amps (C)
Max. Continuous Current	≤100 Amps (C)
Discharge Cut-off Voltage	10.0 V

Environmental

Charge Temperature	32°F to 140°F	0°C to 60°C
Discharge Temperature	-4°F to 140°F	-20°C to 60°C
Storage Temperature	-10°F to 104°F	-25°C to 40°C
Shelf Life	6 months before recharging	

Mechanical

Material System	LiFePO4
Material Case	Plastic
Dimensions	13.6 in x 6.9 in x 8.5 in H
	345mm x 175mm x 215mm H
Weight	31 lb. 14.2 Kg
Terminal	M8
State of Charge	Bluetooth, LED/LCD

Bluetooth Battery Monitor APP for CMP LiFePO4 Batteries – Type 2 BMS

Download the APP

Android: Download from CMP website
Apple:

Press the green battery image to activate the list of available batteries to observe. Select the battery to be monitored from the list of batteries and Bluetooth appliances.

If the word NULL is displayed on the screen, the Bluetooth system is in sleep mode. Wake it up by putting a charge or discharge on the battery. Connect to the battery of choice by pressing on the green battery image. Once connected, the battery serial number will be displayed.

The State of Charge information will be displayed next to the image of the battery.

Swipe right to left to go to the next page.

Press the check button in the upper left area of the page to activate the battery health check process.

The four areas of health will be tested and the results will be displayed at the bottom of the page. If all four item appear with a red X, chances are the battery connection has been interrupted and the Bluetooth feature must be reactivated.

The bottom of the page shows the average minutes to full charge and to full discharge based on the current state of charge or discharge. The value of 65535 is displayed when there is no activity with the battery.

Swipe right to left to go to the next page.

The Main data page is used to monitor the current activity of the battery. The battery image displays the charge remaining in the battery.

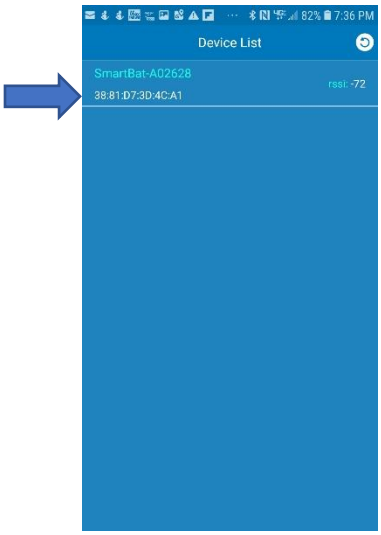
Note: LiFePO4 batteries consist of four sets of cells wired together in series. The Battery Management System (BMS) monitors each of the cell sets and displays the voltage of each set on this page.

The BMS also tracks the number of charge and discharge cycles. This battery should support at least 3,000 charge and discharge cycles.

Swipe right to left to go to the next page.

The last page displays battery status in detail. This page is used to troubleshoot issues with the battery should they occur. This page displays the min and max points for various operating aspects of the battery.

Bluetooth Battery Monitor APP for CMP LiFePO4 Batteries – Type 1 BMS



Download the APP	
Android:	Google Play – Smartec-BMS
Apple:	Apple Store – Smartec-BMS

Select the battery to be monitored from the list of batteries.

Refresh the list by pressing the round button in the upper right corner of the page.

Note: the rssi number to the right of each listed battery is a measure of the strength of the Bluetooth signal. The higher the number, the weaker the signal.

The battery monitor page shows the current being charged to or discharged from the battery, the voltage level of the battery and the State of Charge (SOC) of the battery.

Note: The Cycle number is the number of times the battery has been discharged to 80% and recharged.

The battery will withstand between 2,000 and 4,000 cycles if properly cared for.

Swipe right to left to go to the next page.

The graphic indicates the temperature of the battery and the amp hours remaining (RMC) at the current rate of discharge.

The rated capacity (DCAP) and the full charge capacity (FCC) is shown below the graphic. The FCC is computed based on the temperature of the battery and other factors.

The bottom of the page shows the average minutes to full charge and to full discharge based on the current state of charge or discharge. The value of 65535 is displayed when there is no activity with the battery.