CHALLENGE BATTERIES WA

Technical Update

Lithium Battery Management Systems

The Battery Management System (BMS) in not a new idea however it is a critical element in a lithium based battery to ensure maximum safety and performance. The BMS is designed to keep a battery within safe operating parameters by monitoring voltage, current and temperature. If a battery or cell moves outside the programmed parameters, the BMS will isolate the battery to try and eliminate any potential risk. The BMS can then reactivate the battery once is it back within the normal range so it is able to function correctly.

There are now a large number of lithium based batteries for sale which are designed to be used in deep cycle and auxiliary power applications such as caravans, campers, 4WD's and recreational vehicles. Although these batteries all compete in the same market, they are not all the same.

The two key factors which directly affect overall battery performance and safety are the quality of the cell and the Battery Management System.

Cell Quality

More than anything else, the quality of the cells will determine how well a battery delivers power and how long the battery will last (i.e. cycle life).

Lithium Iron (LiFePO4) cells are probably the most common cell used in the applications listed above because this chemistry is inherently safe and is highly resistant to thermal runaway and fire. Even with this safe chemistry, it is critical that the cells are managed to ensure they are kept within their safe operating range.

Battery Management

The BMS manages and protects the battery in a number of ways:

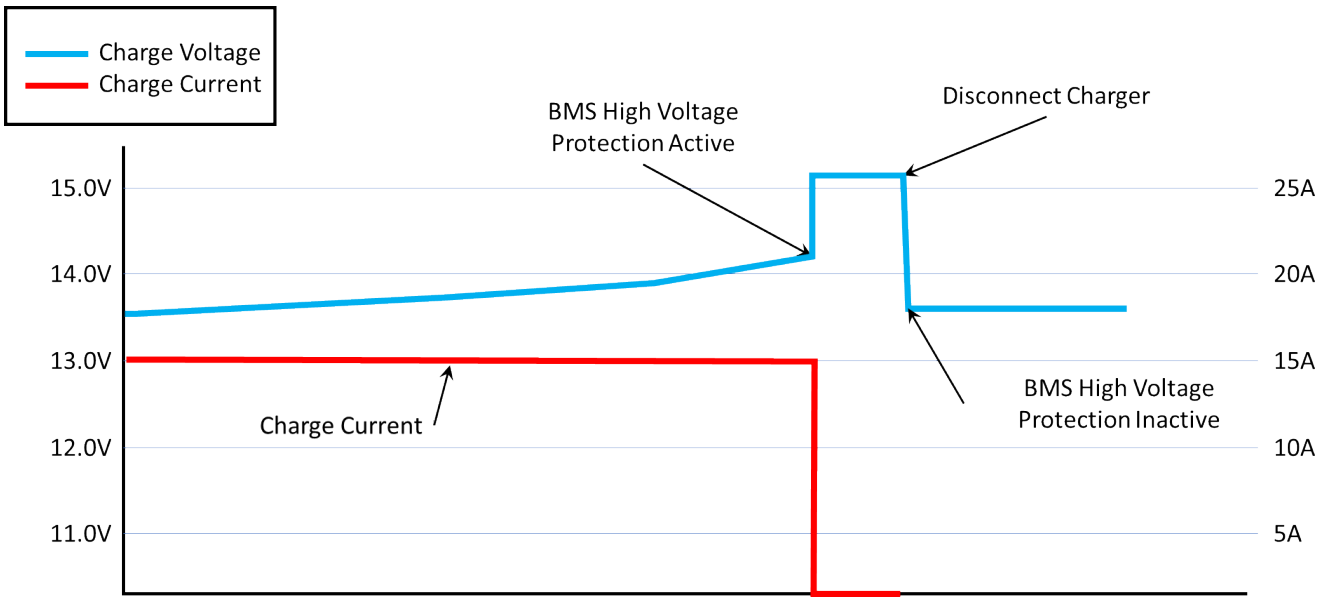
Cell Balance – When a battery is charging or discharging, it is important that the cells remain in balance (i.e. at the same voltage). A BMS is not able to increase the voltage of a low voltage cell however it can use a resistor to place a small load across a high voltage cell to reduce the voltage. By reducing the voltage of any high voltage cells, the BMS can ensure that all cells operate within the same voltage range.

This means that each cell can contribute equally to any loads experienced by the battery and are kept at the same SoC during the charging process.

Over Current – Lithium batteries are very good at delivering power and can be charged quickly however they have limits. If a battery is charged or discharged with a current which is higher than it is capable of supporting, it can generate excessive heat internally. A good BMS will accurately monitor the current flow in and out of the battery. If the current exceeds the limits of the battery, it will isolate the battery to protect it.

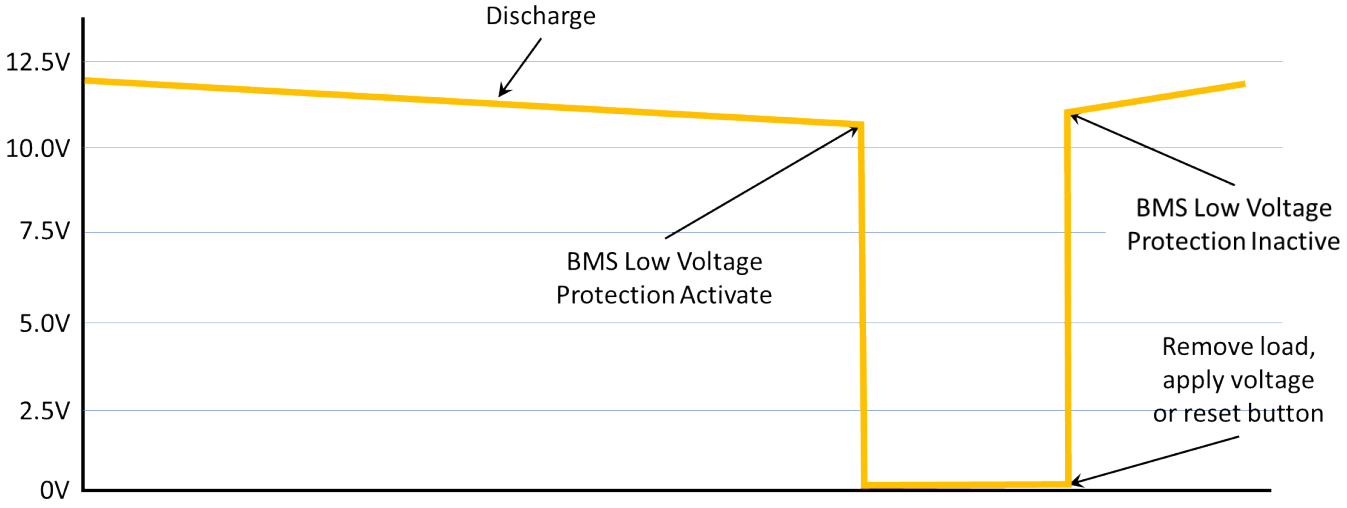
Temperature – Lithium batteries can only function within a limited temperature range. The BMS will isolate the battery if the cells become too cold or too hot to protect them from being used. Normally a lithium battery has a different temperature range for charging and discharging.

Over Voltage – if the battery voltage exceeds the maximum allowable voltage, the BMS will isolate the battery to protect it. High voltage will damage the cells and can cause them to generate heat. The chart below shows how a BMS can protect a battery being charged by placing a high resistance across the battery terminals. This stops current flowing into the battery and also causes the charge voltage to increase which will trigger the end of the charge process for a smart charger.



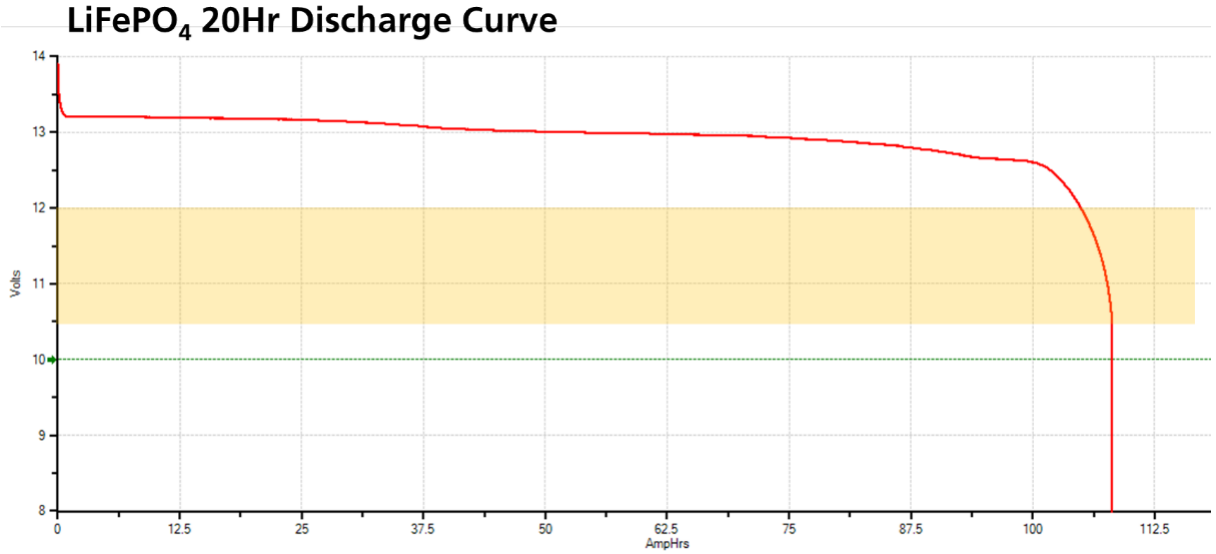
Under Voltage – if the cell voltage is allowed to drop below the minimum allowable voltage, a lithium cell will be damaged and will not recover. This is a key difference of rechargeable lithium batteries. The BMS will isolate the battery before it reaches the minimum voltage to protect the cells.

The curve below shows a typical voltage profile when the low voltage protection is activated by the BMS, and then reset.



The discharge curve below is a 20Hr test on a $LiFePO_4$ battery. You can see that less than 5% of the battery's overall capacity is delivered between 12.0V and the voltage cutoff.

The best Customer experience would be never having to worry about the battery's low voltage protection. Advising the Customer to set a cut-off voltage or to manually charge their battery when the voltage falls below 12V will ensure a Customer never needs to worry about triggering the low voltage protection of the battery.



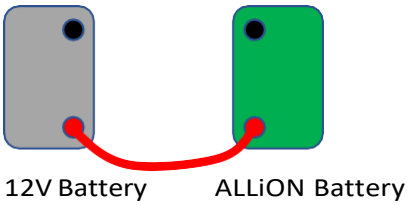
If the low voltage protection is activated, there are a number of different ways to reset the BMS, depending on the brand:

1. Some batteries including RELiON will automatically reset after the load has been removed (there is a delay before it resets).
2. ALLiON batteries will reset when the battery is placed on charge, or a voltage of between 12.0V and 14.6V is applied (see process below). Note that multistage smart chargers will not automatically detect the battery when it is in low voltage protection mode.
3. There are also some lithium batteries which have a reset button on the case which must be pushed to manually reset the low voltage protection.

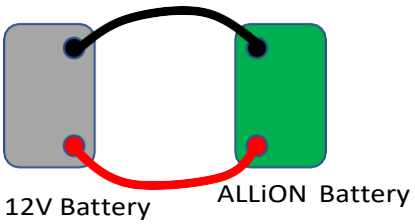
ALLiON Low Voltage Reset

This process is the same as jump starting a vehicle

1. Connect the positive lead to the positive terminal of each battery >>>>>



2. Connect the negative lead to the negative terminal of each battery >>>>>



3. Wait for 2 seconds and then disconnect in the reverse order.