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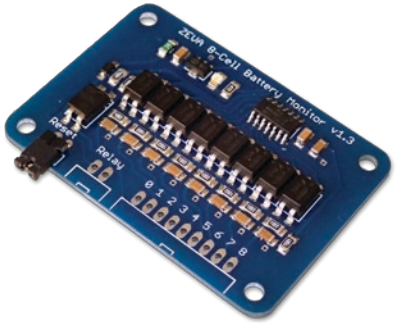


8-cell Battery Monitor Module v1.3

Simple, reliable and economical protection for your LiFePO4 battery pack.

Please read these instructions carefully for proper installation and use of this product.

SPECIFICATIONS

- Monitor 2–8 cells per module
- Automatic cell count detection
- Over-voltage threshold: 3.7V
- Under-voltage threshold: 2.0V
- Sampling rate: 10Hz
- Dimensions: 68x52x15mm
- Solid State Relay (SSR) output, 500mA max.
- Status LEDs for visual feedback
- Power consumption:
  6.5mA when SSR on, 3.5mA when SSR off

PROTECTING YOUR LITHIUM BATTERIES

Lithium batteries have been a revolution in energy storage and a major enabling factor in the resurgence of electric vehicles. However lithium batteries can be damaged if their voltage goes out of safe operating range – either too high (overcharging) or too low (over-discharging).

Battery packs are commonly built from a large number of individual cells in series to achieve higher voltages. Due to manufacturing tolerances, cells always have some variation in capacity, so there will always be some cells in a pack which get full or go flat before others.

In battery packs made up of many cells in series, the overall voltage gives little indication of the voltage of individual cells in the chain. As such it is important to have a system which monitors the voltages of each cell and take action if any individual cell goes out of range.

ZEVA's 8-Cell Battery Monitoring Modules (BMMs) offer a simple and economical way to monitor the voltage of your Lithium Iron Phosphate (LiFePO4) cells, and signal external systems to protect the battery pack if a cell goes out of range. A single module can monitor 2–8 cells, or multiple modules can be cascaded for larger packs.

The BMM is microcontroller based and uses a Solid State Relay (SSR) output to signal over-voltage or under-voltage conditions. There is also a blue LED which provides visual feedback on module status.

Battery management or monitoring systems are the last line of defence for your battery pack. In normal circumstances it should not interfere with the vehicle operation, only intervening when something goes wrong and protection is required.

WHY NO BALANCING?

As well as cell voltage monitoring, most Battery Management Systems (BMSs) include a mechanism for balancing cells, typically by shunting some power off high cells. Balanced cells are all at the same state of charge, which maximises the usable capacity of the pack.

Cells should be manually balanced when first installed by individually charging them to 3.65V (known as *top balancing*). Thereafter the only reason they get out of balance are variations in self-discharge, or variations in quiescent current draw by BMS modules themselves. Self-discharge in lithium cells is very low – typically around 1% per month. Variations in self discharge between cells due to manufacturing tolerances are typically an order of magnitude lower again. So if they start balanced, they may need no further balancing for the life of the pack. (But occasional "health checks" of your battery pack are still a good idea.)

Over the years we have seen dozens of instances where shunt balancing caused more trouble than its worth. Shunt systems may fail from manufacturing faults, damage during installation or component ageing. If they fail to come on, the cell ends up higher than the others. If they get stuck on (a common failure mode in transistors), the cell will be continually discharged.

For these reasons, we decided to develop a battery protection system without active balancing.

MODULE VARIANTS

Modules are available either with momentary outputs or latching outputs:

- **Momentary outputs:** In packs with more than 8 cells, multiple BMMs will be needed to monitor all the cells, and a supervisor module is used to monitor outputs from BMMs and take actions. Output relays are closed only while all cells monitored by the BMM are in range.

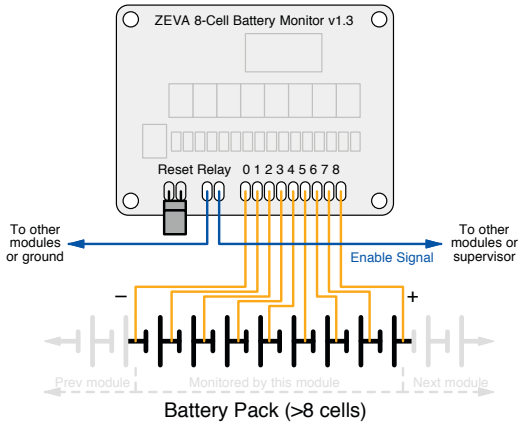
- **Latching outputs:** For packs with 4-8 cells, one BMM can monitor the whole pack. Output relays are closed when all cells are within range, but will open and remain open if a cell goes out of range. This can be used to shut down your charger (using the overvoltage output) or drive system (using the undervoltage output) to protect the cells. Resetting the module is achieved by momentary power cycling (via onboard pin jumper, or added remote switch). Latching modules are indicated by a **green sticker on the microcontroller**.

Modules may also be ordered with or without **sockets and locking plugs**. Without plugs/sockets, wires are soldered directly to the PCB. This is suitable for installations when the BMM will never be disconnected from the battery. Plugs & sockets are recommended in installations where boards may periodically disconnected from batteries. It can also make installation safer as wiring can be completed before the BMM is plugged in.

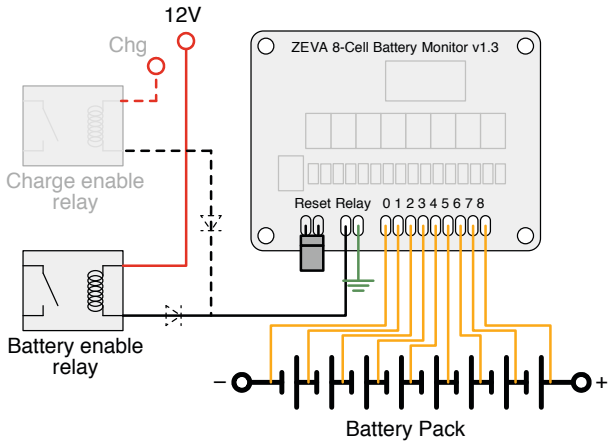
EXAMPLE WIRING DIAGRAMS

The following diagrams show example wiring for the two types of module available, latching or momentary.

Momentary variant (multiple modules + supervisor):



Latching variant (single module):



In installations with separate charge enable and drive enable relays, they may both be connected to the BMM relay output with diodes as indicated by the dashed lines in the diagram above.

INSTALLATION

Before you commence installation, remove the jumper across the two pins labelled RESET. This will keep the module powered down and offer some protection from temporary wiring faults during installation.

The board has a 3mm hole in each corner which should be used to securely mount the module. If mounting to metal surfaces, use standoffs or an insulating layer between to ensure the circuit board does not contact the metal. Modules should be installed in a location protected from water and debris – typically inside your sealed battery enclosure is ideal.

Once mounted, connect voltage sampler wires between the module and the cells. If using modules without plugs, take care to avoid short circuits by attaching wires to the board first, and inspect for any "bridged" connections (where adjacent connections are touching) before attaching to the cells.

Small inline fuses may be used to protect wiring, best installed near the cell. If fuses are not used, small gauge wire is recommended (approx AWG26-28), such that the wire's conductor will quickly burn out in the event of a wiring or insulation fault.

Ensure that wiring is secured so it will not become damaged from vibration or abrasion.

Power is always taken from input #8. If using the module with fewer than 8 cells, simply add a wire jumper from your top-most cell to input #8. (For example, if monitoring 4 cells add a small wire between input #4 and #8.)

Please consult the manual for your supervisor module or BMS Master Unit for instructions on integrating modules with the rest of your battery protection system.

OPERATION AND USE

Modules will automatically detect the number of cells connected when first powered up, and will flash the LED according to the number of cells detected for visual confirmation. If the LED is blinking continuously (approx 1Hz), it means zero cells have been detected.

The threshold for over-voltage is 3.7V, and under-voltage is 2.0V. The LED indicates the status of the cells/module according to the following key:

LED on	All cells within safe voltage range
LED flashing (approx 2 flashes per second)	Cell(s) above 3.7V
LED blinking (brief flash every second)	Cell(s) below 2.0V
LED off	Module is off (check reset plug and wiring)

LiFePO4s are typically charged to 3.65V per cell, so if your pack is in a good state of balance the BMMs should not interfere with a normal charge cycle. Once a cell is full, voltage rises quickly and damage may occur above 4.2V, so it is important that your supervisor system can respond by disabling the charger within a few seconds.

When discharging, cells will not suffer damage unless they are driven negative – that is, if a cell goes completely flat (0V) but the voltage from other cells continues the flow of current through it. For the low voltage threshold, 2.0V was chosen because it allows for a significant amount of voltage sag under load (so the BMM will not give false positives during acceleration), but still allowing sufficient notice of a low cell before damage will occur.

POWER CONSUMPTION WARNING

An inherent problem with any BMS which powers itself from the cells it is monitoring is that the BMS itself slowly discharges the cells. In normal operation this effect is insignificant, but if the vehicle is to be left unused for extended periods of time (months or years), it is recommended that either the cells are left fully charged, or the BMMs are powered down (by removing the Reset plug) to ensure they can't flatten any cells.

TECHNICAL SUPPORT

If you have any queries not covered by this manual, feel free to contact us via our website: **www.zeva.com.au**

Products are covered against manufacturing faults for a period of 12 months from date of purchase. If you believe your module may be faulty, please contact us for RMA information.

ZEVA is a 100% carbon neutral business. All products proudly designed and manufactured in Australia.