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BMS16

Battery Management System

For 12-16 cell lithium battery packs

v1.2

Introduction

The ZEVA BMS16 is an integrated battery management system for lithium battery packs containing 12-16 cells in series and 10-1000 Ah capacity. It is suitable for both electric vehicle and battery storage applications. The BMS16 includes an internal power supply to allow it to run directly from the battery pack, internal shunt resistors for automatic pack balancing, dual solid state relay outputs for directly switching power contactors to protect charging and discharging of batteries, and a CAN bus port for optional colour touchscreen interface, current shunt adapter, or inverter integration.

The BMS16 Monitor provides information such as voltage, current, power, battery state of charge, and all individual cell voltages. It can also be used for configuring the operating parameters of the BMS16. It may be installed up to 50m from the BMS16 (if correct shielded twisted pair cable is used).

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

Safety Warning

Although 16-cell lithium battery packs do not involve lethal voltages, they frequently involve dangerous amounts of current and power. Proper precautions and electrical safety procedures should always be observed. Please read this manual carefully to ensure correct installation and operation. If you are unsure of anything, please contact us before proceeding.

We have endeavoured to make a safe and reliable product which performs as described, however since ZEVA has no control over the integration of its products into a battery system, we can assume no responsibility for the final safety or functionality of the completed installation. It is up to the end user to determine the suitability of the products for the purpose employed, and the end user assumes all risks associated. Products should only be installed by suitably qualified and experienced persons, and should always be used in a safe and lawful manner.

Specifications

- Number of cells: 12-16
- Battery types: LiFePO4, LiCo, LiMn, etc
- Accuracy: Within 0.01V per cell
- Battery capacity: 10-1000Ah
- Current measurement: 0-1000A (depending on shunt used)
- Dimensions: 170x90x20mm
- Outputs: Dual solid state relays, 60V 1.3A max, internally fused

Installation

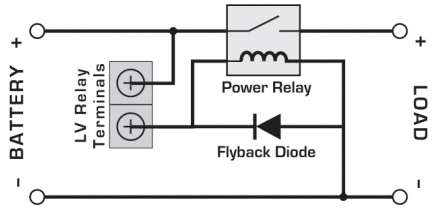
The BMS16 should be mounted securely using screws through the four holes on the case flanges. Install the BMS16 in a location protected from direct sun and water and close to the cells if possible to minimise cell wiring lengths (under 1m recommended).

The BMS16 has 17 spade connectors for cell connections, with the most negative point of the battery pack connected to **C00**, and successive positive terminals connected to **C01-C16**. Wire gauge around AWG20-26 is recommended for sufficient mechanical strength and suitable current rating. A suitable crimping tool (such as Altronics part T1548) should be used to attach wires to the supplied female spade crimp lugs. A light tug on the lug after crimping is recommended to verify a tight connection.

Cell connections should be wired up starting from most negative (C00) and working up to most positive (C16)! If you need to disconnect the BMS16 from the cells, be sure to disconnect cell wires in the reverse order, unplugging most positive first and working down. (It is expected that once wired up the BMS will remain on at all times, but if you need to temporarily power down the BMS16, temporarily disconnect the wire at C16 and wait for the unit to power down. To power up again, reconnect C16 then press the power button.)

Ensure that all wiring is secured so it will not become damaged from vibration or abrasion. Optionally small fuses (~1A) may be used to protect wiring, best installed close to each cell terminal. Power is always taken from the most positive input C16. If using the module with fewer than 16 cells, simply add a short jumper wire from your most positive cell terminal to C16. It is a good idea to verify all voltages at the terminals before switching the module on.

When used to switch power relays or contactors, the two output relays are typically wired as below. (Discharge circuit shown. For charge protection, use the HV Relay terminals and connect charger instead of load.) Relay outputs are floating / isolated, and have a maximum rating of 60V and 1.3A continuous. Be sure to include a flyback diode (if not built in to the relay/contactor) to suppress inductive voltage spikes from switching the relay coil.



In installations with a single “battery enable” relay, the LV and HV relays may be wired in series such that either an over-voltage or under-voltage condition will open the relay to isolate the battery pack.

Once your wiring is complete, use a small screwdriver to press the power button on the top left of the case, and the status LED should come on. A green light indicates all cells are within correct voltage range, and both relay outputs will be closed circuit. A steady red light indicates one or more cells are over-voltage, and the HV Relay outputs will be open circuit. A blinking red light indicates one or more cells are under-voltage, and the LV Relay outputs will be open circuit. Green/red flashing indicates an over-temperature shutdown.

Current Shunt

The BMS16 may be supplied with either a 100A, 200A or 500A rated shunt. These are continuous current ratings, but the BMS can measure up to twice the rated current intermittently. Note that the current shunt may get very hot with sustained current above its continuous rating.

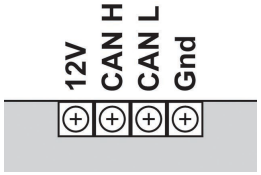
The shunt is connected via two wires to the shunt terminals on the BMS16. For best performance, twisted pair wire is recommended. The sample wire from the anode / positive side of the shunt (closest to the +ve of the battery) should be connected to the terminal nearest the edge of the BMS. When used with a monitor, the current displayed is discharge amps – i.e charge amps will be negative values.

Temperature Sensing

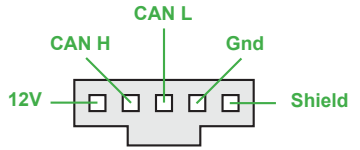
The BMS16 is supplied with a 10Kohm NTC thermistor for temperature sensing. It is connected to the two Temp screw terminals at the rear of the case, and is non-polarised. It is recommended that the temperature sensor be installed somewhere near the middle of the pack, since this is typically the warmest location (wires on the sensor may be extended as long as necessary). The default temperature limit of 80˚C suits most lithium battery types.

CAN Bus Wiring

There are four screw terminals for connecting the BMS16 to a CAN bus, and a Molex C-Grid SL plug on the optional BMS Monitor, with the following pin identifications:



CAN pin assignments on BMS16 housing (viewed from above)



CAN pin assignments on Monitor (as viewed on Monitor housing)

The 12V terminal is an output for optionally providing power to external devices, such as a monitor (200mA max, fuse protected). The CAN bus is galvanically isolated from the battery pack so can be safely connected to share the inverter’s ground reference or an external ground.

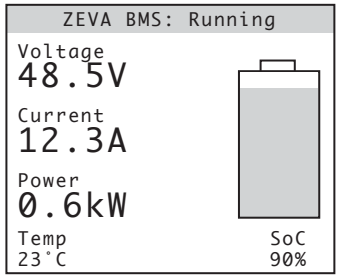
Often if the BMS16 is communicating with an inverter over CAN bus, the inverter will respond to BMS errors (such as under- or over-voltage conditions) and the relay outputs on the BMS16 will not be required.

CAN buses work best when wired as a single daisy chain of devices, with 120Ω termination resistors at each end to prevent signal reflection. At least one termination resistor is required for the CAN bus (and BMS16) to function. The BMS16 and Monitor both have built-in termination resistors which can be bypassed by removing the small black jumper next to the CAN port *if the device is not at one end of the CAN bus*.

For best performance, shielded twisted pair (STP) cable is recommended. Very short connections are usually OK with untwisted and/or unshielded cable.

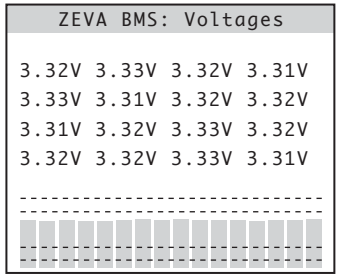
BMS16 Monitor

The BMS16 Monitor is an optional colour touchscreen which may be used to remotely interact with the BMS16. The Monitor displays various pages of information:



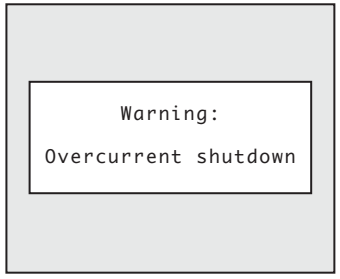
The standard display when the system is running, showing pack voltage, current, power, temperature, battery state of charge.

Touching the panel briefly will toggle between this and the voltages page below.

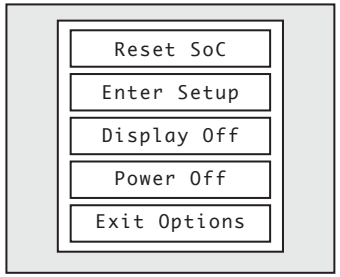


This page shows all individual cell voltages, plus a bar graph below. Dotted lines on the graph show HV and LV thresholds plus hysteresis.

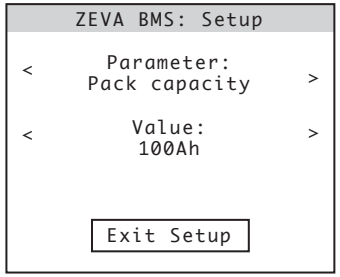
Graph bars will be green when a cell is in range, blue for under-voltage, red for over-voltage, and orange if a cell is currently being shunt balanced.



If the BMS detects an error, this warning page will be displayed. In most cases, the error can be acknowledged/reset by tapping the screen.



You can bring up the options menu by touching and holding for 1 second. From here you can do a manual reset of the State of Charge (back to 100%), enter the Setup mode, switch the display off, or command the BMS16 to turn off. (When the display is off, touch and hold anywhere for 1 second to turn it back on. Display will automatically wake if there is a new warning to display.)



If you choose Enter Setup, the Monitor can be used to reconfigure settings for the BMS16. The top row selects the parameter, and the bottom row adjusts the value, in both cases by touching the left or right arrows on each side. Once finished, touch Exit Setup and the new parameters will be transmitted to the BMS16.

List of Settings

The following table describes the parameters available in the Settings page.

Name	Range	Description
Number of cells	12-16	The number of cells the BMS16 expects to see connected.
Pack capacity	10-1000Ah	The rated capacity of your traction battery pack, in Amp-Hours.
SoC warning	0-100%	The BMS16 can raise a warning when the traction battery's SoC reaches a predetermined level. (Use 0% to disable.)
Full voltage	1-100V	The BMS uses a "full voltage" threshold (combined with low charge current) to detect charge completion and automatically re-synchronize the SoC to 100% when pack voltage is within 1V of this value. Typically set value to your peak charge voltage.
Warn current	0-1000A	The BMS16 will provide a warning if the current in or out of the battery exceeds this threshold. Set to 0A to disable (will display as "off").

Trip current	0-1000A	The BMS16 will automatically shut down the battery pack if current exceeds this threshold (for over 1 second continuously). Note: This should not replace a physical fuse, but can be used as a “first line of defence”. This is considered a serious error which will require the device to be power cycled to reset.
Thermal limit	0-100C	The BMS can automatically shut down the battery pack (both charge and load output relays) if the measured temperature exceeds this programmed threshold. This error will automatically reset once temperature drops by at least 10 degrees below threshold.
Min voltage	1.00-5.00V	The minimum voltage any single cell should be allowed to reach. If any cell goes below this threshold (minus any hysteresis), the LV output relay will go open circuit.
Max voltage	1.00-5.00V	The maximum voltage any single cell should be allowed to reach. If any cell goes above this threshold (plus hysteresis), the HV output relay will go open circuit.
BMS hysteresis	0-1.00V	This settings provides some hysteresis on voltage thresholds, such that charge and load relays are not switched on and off too rapidly. For example, with a 0.2V hysteresis, the LV relay will be disabled when a cell goes 0.2V below the Min Voltage threshold, and re-enabled once the cell recovers to 0.2V above Min Voltage.
Shunt voltage	1.00-5.00V	The voltage threshold where shunt balancing will occur. Balancing should only be performed on cells which are higher than average, so typically set this to the average maximum charge voltage of each cell (i.e max charge voltage divided by number of cells).
Shunt size	100A / 200A / 500A	This selects the size of current shunt attached to the BMS16 (for 75mV shunts). Note that if using an external CAN bus shunt interface, this setting is ignored as the external device is separately programmed with its shunt size.

BMS Power Consumption Protection

An inherent problem with any BMS which powers itself from the cells it is monitoring is that the BMS can slowly discharge the cells, which can eventually flatten cells – particularly if powering contactors or monitors, and no charging source is present for an extended period. To prevent possible damage, the BMS16 is able to switch of its own power supply if any cells get critically low (under 2.0V). If your BMS has turned off due to a critically low cell, simply attach a charging source to the batteries then press the power button to re-enable the BMS.

Inverter CAN Integration

The BMS16 includes plug-and-play integration over CAN bus with some inverters such as SMA Sunny Island products. Only three wires are required between devices: CAN H, CAN L and Ground. Use the BMS’ Full Voltage setting to tell the inverter what voltage to charge the battery to, and be sure that this not high enough to cause any cells to exceed the high voltage threshold, or the BMS may cause an inverter shutdown for protection.

Note that we cannot guarantee compatibility with every inverter, as CAN protocols may vary. Please contact us prior to ordering to discuss if you plan to use CAN integration.

Tech Support and Warranty Information

All ZEVA products are covered by a 12 month warranty against manufacturing faults or failures under normal operating conditions. The warranty does not cover misuse of the product, including but not limited to: excessive voltage or reversed polarity on terminals, short circuits on outputs, opening of housings and/or modification of internal electronics, severe impact damage (e.g due to vehicle crashes), submersion in water.

We have taken great care to design a safe and reliable product, but faults can happen. If you believe your product has a fault, please contact us via our website to discuss. If it is determined that a hardware fault is the likely cause, we will provide an RMA number and return address to proceed with repairs.

If you have any questions not covered by this manual, please contact us via our website:

http://www.zeva.com.au