

BATTERY MANAGEMENT SYSTEM 7-R



Features:

- robust and small design
- 4 – 14 series cell configuration
- single cell voltage measurement (0.5 – 5.0 V, resolution 1 mV)
- single cell - under/over voltage protection
- cell internal resistance measurement
- over temperature protection (up to 8 temperature sensors)
- under temperature charging protection
- passive cell balancing up to 1.3 A per cell with LED indication
- current measurement (-350 A – 350 A, resolution 0.15 A – optional accessory)
- 2 galvanically isolated user defined multi-purpose inputs/outputs
- programmable integrated disconnection relay
- programmable integrated transistor for driving external relay
- stand-by current consumption 3 mA
- galvanically isolated RS-485 communication protocol
- emergency main relay enable button
- error LED indicator and buzzer
- fuse on every cell
- PC user interface for changing the settings and data-logging (optional accessory)
- enable switch
- two-year warranty

General description

Battery management system (BMS) is a device that monitors and controls each cell in the battery pack by measuring its parameters. The capacity of the battery pack differs from one battery cell to another and this increases with number of charging/discharging cycles. The Li ion or Li-poly batteries are fully charged at typical cell voltage 4.18 - 4.20 V. Due to the different capacity this voltage is not reached at the same time for all cells in the stack. The lower the capacity the sooner this voltage is reached. When charging series connected batteries with single charger, the voltage on some cells might be higher than maximum allowed charging voltage at the end of charging. Overcharging the cell additionally lowers its capacity and number of charging cycles. The BMS equalizes cells' voltage by diverting some of the charging current from higher voltage cells – passive balancing. The device temperature is measured to protect the circuit from over-heating due to the passive balancing. Battery pack temperature is monitored by Dallas DS18B20 digital temperature sensor/s. Maximum 8 sensors may be used. The BMS parameters are listed in table below.

Parameter table:

parameter	value	unit
balance start voltage	3.9	V
balance end voltage	4.18	V
maximum diverted current per cell	up to 1.3	A
cell over voltage switch-off	4.2	V
cell over voltage switch-off hysteresis per cell	0.02	V
Victron charger end of charge switch-off cell / pack	4.18 / 54.35	V
Victron charger end of charge switch-off hysteresis	1.3	V
cell under voltage protection switch-off	3.24	V
under voltage protection switch-off hysteresis per cell	0.035	V
BMS under voltage sleep mode	39	V
BMS over temperature switch-off	60	°C
BMS over temperature switch-off hysteresis	5	°C
over temperature switch-off	60	°C
under temperature charging disable	-10	°C
aux relay drive transistor - drive voltage	Battery pack voltage	
aux relay drive transistor - max drive current	2	A
aux relay switch-off	54.08	V
aux relay switch-off hysteresis	1.3	V
max. current (optocoupler)	50	mA
max. voltage (optocoupler)	300	V
max. AC current (relay)	2	A _{AC}
max. AC voltage (relay)	250	V _{AC}
max. DC current (relay)	1.5	A _{DC}
max. DC voltage (relay)	55	V _{DC}
operating temperature	-15 to 70	°C
BMS stand-by current supply	2.5	mA
BMS disable current supply	<0.05	mA
cell balance fuse rating	2	A
internal transistor fuse	2	A
internal relay fuse	2	A
dimensions (w × l × h)	190 x 114 x 39	mm
weight	0.650	kg

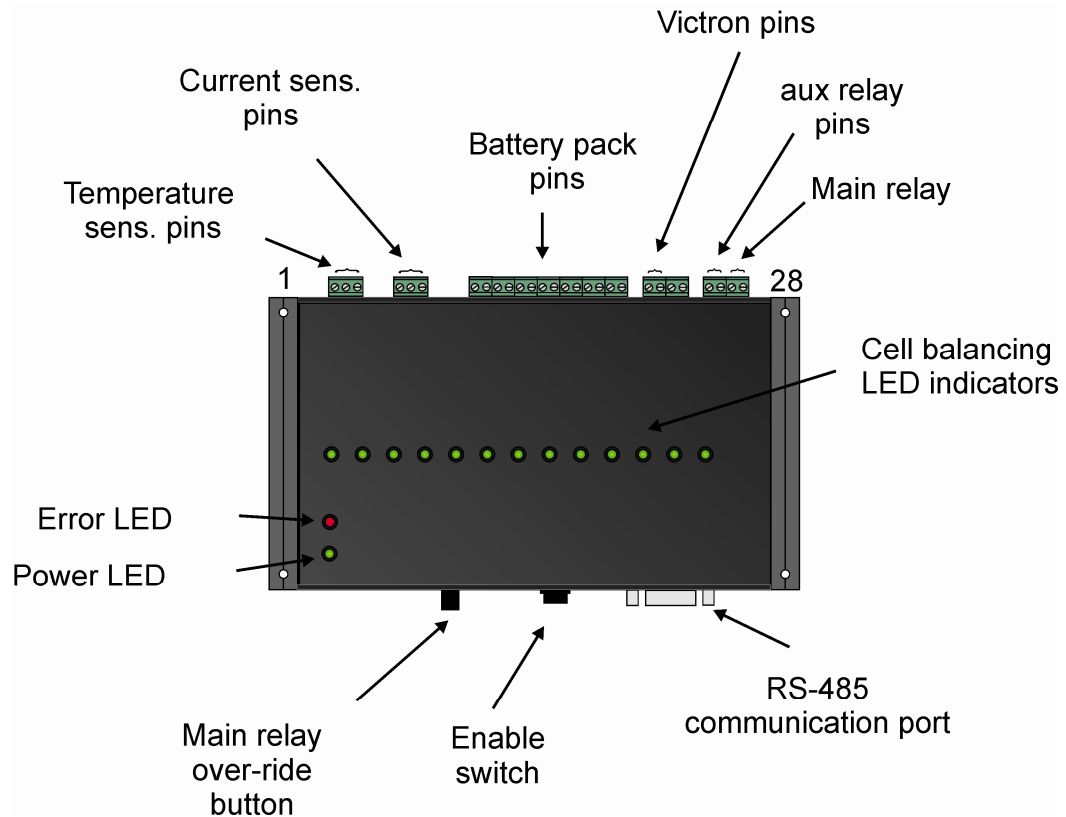


Figure 1: BMS function overview.

Connection table:

connection	description	
1	DALLAS 18B20 temp. sensor pins	GND
2	DALLAS 18B20 temp. sensor pins	1-wire digital signal
3	DALLAS 18B20 temp. sensor pins	+5 V
4	Current sensor pins	+5 V
5	Current sensor pins	GND
6	Current sensor pins	Analog signal
7	Cell 1 ground	Analog signal
8	Cell 1 positive	Analog signal
9	Cell 2 positive	Analog signal
10	Cell 3 positive	Analog signal
11	Cell 4 positive	Analog signal
12	Cell 5 positive	Analog signal
13	Cell 6 positive	Analog signal
14	Cell 7 positive	Analog signal
15	Cell 8 positive	Analog signal
16	Cell 9 positive	Analog signal
17	Cell 10 positive	Analog signal
18	Cell 11 positive	Analog signal
19	Cell 12 positive	Analog signal
20	Cell 13 positive	Analog signal

21	Victron communication +	Optocoupler collector
22	Victron communication -	Optocoupler emitter + anti-reverse schottky diode
23	Aux LED alarm pin + (not connected)	+5 V
24	Aux LED alarm pin - (not connected)	GND
25	Internal transistor switch (aux relay) +	Battery pack voltage
26	Internal transistor switch (aux relay) -	Transistor collector
27	Internal relay	N.O.
28	Internal relay	N.O.

BMS Connection Instructions

Connect the BMS to the system by the following order described in Fig. 2. It is important to disable all the BMS functions by turning enable switch OFF before plugging any connectors. **All cells should be connected last and simultaneously.** When all the system components are plugged in, the enable switch can be turned ON and the BMS starts the test procedure.

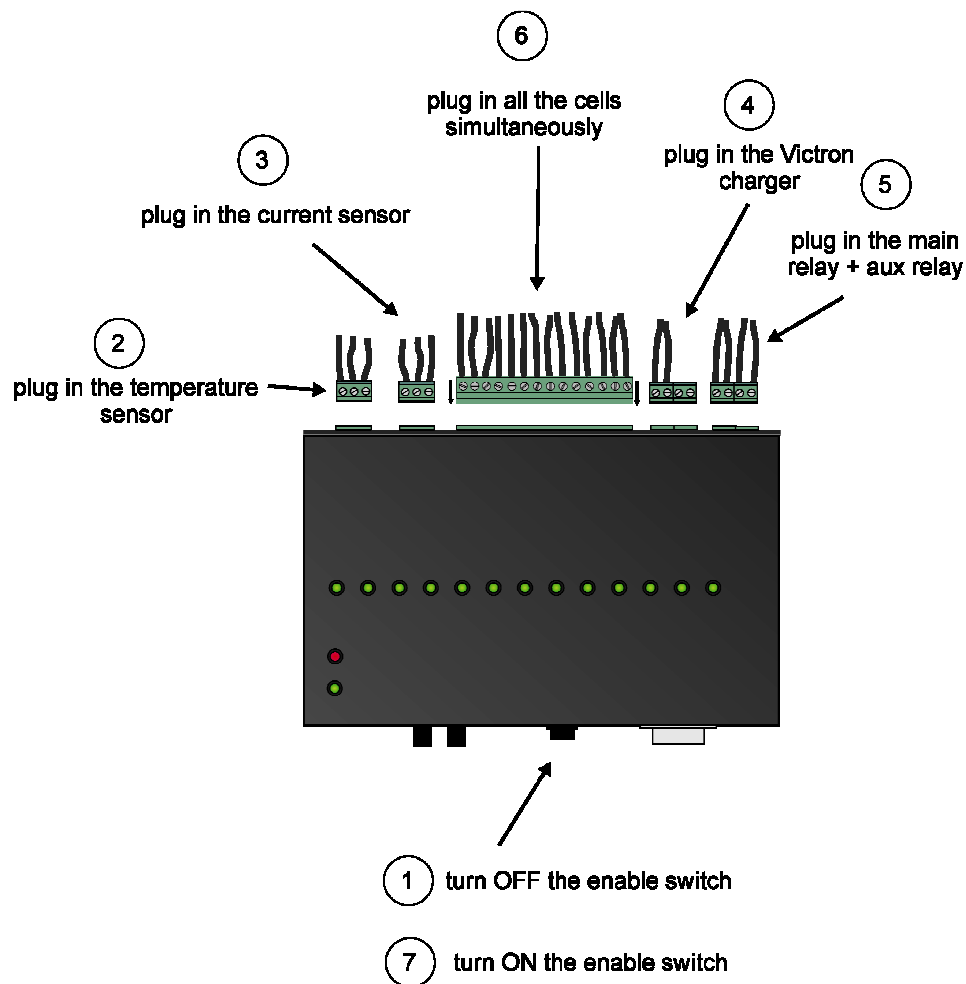


Figure 2: BMS connection order.

When disconnecting the BMS from the battery pack, the procedure should be followed in reverse order.

Test procedure

When the BMS is turned ON by the enable switch it commences the test procedure. Red error LED turns on to signal the system's test procedure. The procedure starts by testing BMS balancing switches and then turns on all outputs sequentially for 2 seconds with 2 seconds dead time between the outputs. The test completes in 34 seconds, red LED turns off and BMS starts working in normal mode.

System Error Indication

System errors are indicated with **red** error LED by the number of ON blinks, followed by a longer OFF state. Red LED switch-off indicator turns on in case of:

Number of ON blinks	ERROR	BMS	OWNER
1	Single or multiple cell voltage is too high (cell over voltage switch-off).	BMS will try to balance down the problematic cell/cells to safe voltage level (10 s error hysteresis + 15 mV single cell voltage hysteresis is applied). Main relay and solar relay are disconnected, Victron charger is disabled.	<ul style="list-style-type: none">• Wait until the BMS does its job or• press and hold main relay over-drive button to connect the main relay and try to discharge the battery until the error stops.
2	Single or multiple cell voltage is too low (cell under voltage protection switch-off).	If the Current sensor is attached and battery pack voltage is above 41 V, BMS will try to connect the battery back to the system if charging current is supplied. If the current sensor is not attached, the BMS only signals error (10 s error hysteresis + 35 mV single cell voltage hysteresis is applied). Main relay and solar relay are disconnected, Victron charger is enabled.	<ul style="list-style-type: none">• Press and hold main relay over-drive button to connect the main relay and try to charge the battery by connecting to the mains (start Victron charger) or start the generator until the error stops.
3	Cell voltages differs more than allowed (cells differ more than 75 mV).	BMS will try to balance the cells (10 s error hysteresis + 20 mV voltage difference hysteresis). Main relay and solar relay are connected, Victron charger is enabled.	<ul style="list-style-type: none">• Wait until the BMS does its job. If the BMS is not able to balance the difference in a few hours, contact the servis crew.
4	Cell temperature is too high (over temperature switch-off).	Cells temperature or cell inter-connecting cable temperature in the battery pack is/are too high. Main relay and solar relay are disconnected, Victron charger is disabled.	<ul style="list-style-type: none">• Contact the service. To reset this error the service crew should examine the battery pack and reset the BMS with PC software.

5	BMS temperature is too high(BMS over temperature switch-off)..	Due to extensive cell balancing the BMS temperature rose over upper limit (10 s error hysteresis + 5 °C temperature hysteresis).	<ul style="list-style-type: none"> • Wait until the BMS cools down.
6	Number of cells is not set properly.	<p>Number of cells at the back of the BMS was changed from the default manufacturer settings.</p> <p>Main relay and solar relay are disconnected, Victron charger is disabled.</p>	<ul style="list-style-type: none"> • Contact the service to set the proper number of cells.
7	The temperature is too low for charging (under temperature charging disable).	<p>If cells are charged/discharged at temperatures lower than operating temperature range, cells are aging much faster than they normally would, so usage is disabled. (10 s error hysteresis + 2 °C temperature hysteresis).</p> <p>Main relay and solar relay are disconnected, Victron charger is disabled.</p>	<ul style="list-style-type: none"> • Wait until the battery's temperature rises to usable range.
8	Temperature sensor error.	<p>Temperature sensor is unplugged or not working properly.</p> <p>Main relay, solar relay are disconnected, Victron charger is disabled.</p>	<ul style="list-style-type: none"> • Turn-off the BMS by enable switch and try to replug the temperature sensor connector. Turn BMS back ON. If the BMS still signals error 8, contact the service. The temperature sensors should be replaced.
9	Communication error.	-	<ul style="list-style-type: none"> • Contact the service crew.
10	Cell in short circuit or BMS measurement error.	<p>Single or multiple cell voltage is close to zero or out of range, indicating short circuit or measuring failure.</p> <p>Main relay and solar relay are disconnected, Victron charger is disabled.</p>	<ul style="list-style-type: none"> • Restart the BMS by turning-off and then back ON the BMS's enable switch. If the same error starts to signal again contact the service.
11	Tyco main relay is in short circuit (if current sensor is connected).	<p>If the main relay should be opened and current is not zero the BMS signals error 11. When the error is detected, the BMS tries to un-shorten the main relay by turning it on an off for three times.</p> <p>Main relay and solar relay are disconnected, Victron charger is disabled.</p>	<ul style="list-style-type: none"> • Restart the BMS by turning-off and then back ON the BMS's enable switch. If the same error starts to signal again contact the service.

- **Victron Charger**

Victron charger is controlled by pulling down the disable pin in the charger's control circuit by turning on the BMS's integrated optocoupler. The anti-reversed diode is added to protect the circuit from reverse connection. Victron charger is turned on until all the cells reach the end of charging voltage. If system error 1, 4, 6 - 12 occur the Victron charger switches off. When the error 2 occurs Victron charger stays turned on. Enable charging of the battery pack by turning on the main relay with an over-ride button.

Enable switch

The enable switch is positioned at the back of the BMS unit (see Fig. 1). When switched OFF the BMS power is turned off and all the integrated functions are disabled. The enable switch is integrated into BMS to turn OFF the system if it would be unattended for a long time.

Before switching OFF the enable switch for a long time charge / discharge the battery pack to its nominal value (3.7 V/cell or 48 V/battery pack)!

Optional accessories

- **BMS Control Software + RS-485 cable**

BMS Control Software enables to monitor and log all the parameters of the battery pack and change the original settings.

- **Hall Current Sensor (± 350 A)**

Single Current sensor can be connected to the BMS. Input of the BMS is plug-in ready. The current measurement resolution is 0.15 A.