BlockMon – Block Monitor
LongMon – Long Monitor
LeafMon – Leaf Monitor

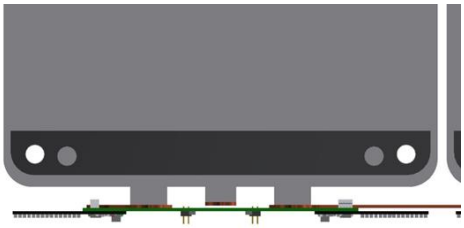
- **Bypass range 2.2V to 5.0V.**
- **Bypass current 0A to 2A (typically 1A).**
- **Over-voltage protection up to ±20V.**
- **Noise immune opto-isolated.**
- **Cell temperature and bypass load temperature measurements.**
- **Monitoring of live individual cell parameters and remote cell diagnostics.**
- **Covered in black thermally conductive epoxy (robust).**
- **Red and green LEDs for diagnostics and status.**
- **Parameters fully remotely programmable and software is upgradeable.**

BlockMon (Block Monitor)		**For "block" prism type cells. M8 and M14 bolt sizes.**
LongMon (Long Monitor)		**For long cylindrical or pouch type cells.**
LeafMon (Leaf cell monitor)		**For Leaf Cells (2s) (contains 2 GenMon cell monitors)**

*Note: BlockMon, LongMon and LeafMons are referred to collectively as "**CellMon**"*

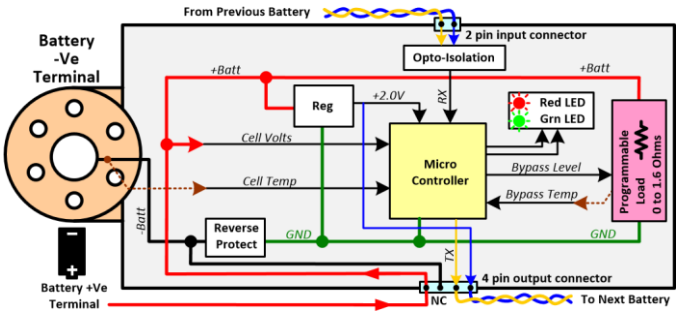
BlockMon, LongMon and LeafMons are intelligent battery monitor systems used to maintain high power lithium cell batteries at peak performance and optimum parameter range. They provide live cell status with programmable over-charge voltage limiting, shunting power up to 2A (7W with fan cooling) or typically 1A of bypass without cooling with 3.65V limit.

BlockMon is attached to the negative battery terminal with positive battery power via a cable. LongMon is used for cylindrical type batteries and is small enough to be placed between adjacent cells. LeafMon attach to the front of the Leaf Cell.



Power is obtained with a separate positive and negative cable. All units use the same circuit and connectors. They are fully interchangeable except for the addition of the extra negative wire on the 4 pin connector (for LongMon). The terminology "CellMon" is used when referring to either BlockMon or LongMon or GenMon on each end of the LeafMon.

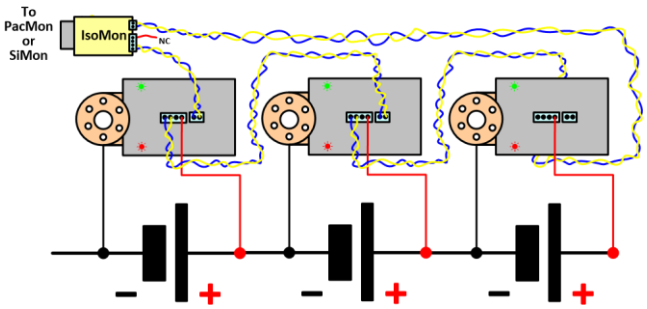
The primary function is to limit cell over-voltage by applying a variable bypass current across each cell.



CellMons are used for our Distributed Supervisors which includes WatchMon or PacMon supervising. PacMon was superceded by WatchMon1 in 2014 and WatchMon4 in 2018. CellMons autonomously interrogates the cells allowing it to send live data to the PC and control the charger. CellMons monitor cell voltage, battery temperature and the bypass (PCB) temperature. These are normally retransmitted to the display screen.

CellMons are effectively a programmable voltage limit (shunt regulator). The typical voltage limit is programmed at 3.65V, allowing each cell to balance (equalize) before end-of-charge condition. The battery input terminal pins are voltage tolerant up to ±20V (including reverse polarity protection).

Each CellMon is connected with a daisy chain, twisted pair, opto-isolated cable sequence to ensure the highest level of interference (noise) and fault tolerance.

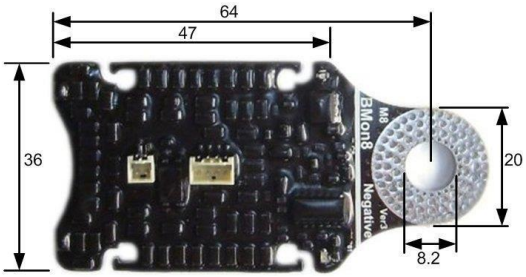


Absolute Maximum Conditions

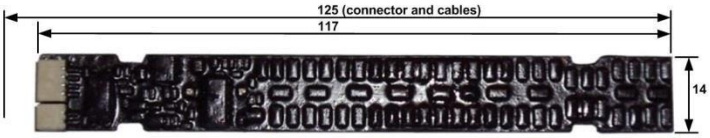
Note: Exceeding these limits will damage the CellMon electronics and may be hazardous.

Parameter	Min	Max	Unit	Notes
Terminal voltage	-20	+20	V	Over-voltage and reverse-voltage protection.
Shunt power with air temperature at 25ºC		3.5	W	Bypass heating above 75ºC will reduce bypass current and will allow cell over-voltage. Keep well below these limits.
Shunt power with fan-forced cooling at 25ºC		7	W	Prolonged high temperature use may reduce the life expectancy of the PCB and adjacent devices (batteries, wires, etc).
Isolation voltage at daisy chain RX input (two pin connector)		+/- 1000	V	Extreme care must be taken at high voltages. Systems typically are less than 150V and it is recommended that multiple fault level protection measures be taken (double insulation, creepage and clearance requirements, moisture protection etc…). The 4 pin connector is not isolated.
PCB surface temperature		75	°C	Caused by heating under high bypass currents. Keep well below this value.
BlockMon negative terminal mechanical bend forces		0.2	Kg	This is effectively a vertical torque applied to BlockMon that flexes the PCB and may crack the electronics. Prevent excessive vibrations (e.g. additional double-sided tape). Do not push down on the PCB (flex).

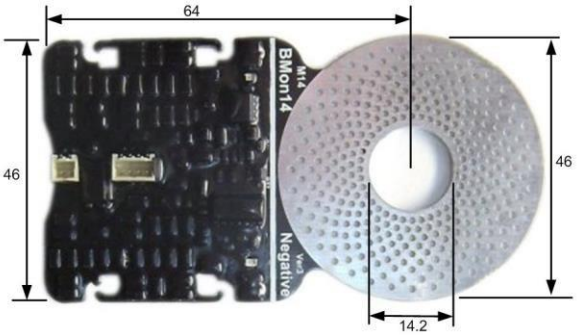
BlockMon, LongMon & LeafMon (CellMons)



BlockMon8 (M8)



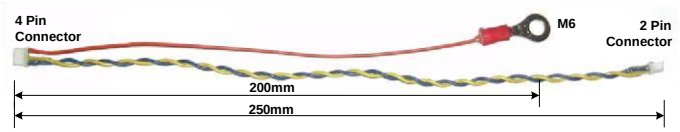
LongMon



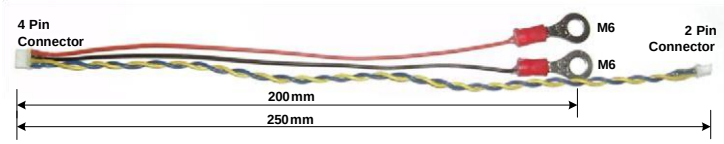
BlockMon14 (M14)

LongMon height (connector) = 6.5mm
BlockMon8
Height (connector and wire) = 12.6mm
PCB thickness = 2.0mm
BlockMon14
Height (connector and wire) = 13.0mm
PCB thickness = 2.0mm

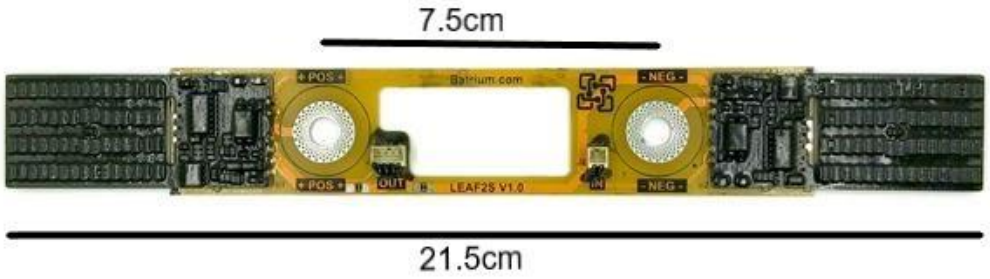
The slots in the sides are to tuck the cables through, holding the connectors tightly and cables neatly.



BlockMon Cable

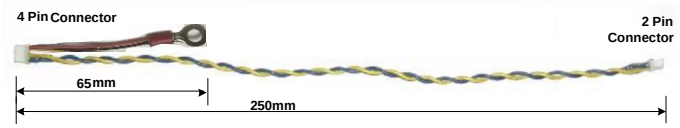


LongMon Cable



LeafMon

Length = 21.5cm
Height (connector and wire) = 13.0mm
PCB thickness = 2.0mm



LeafMon Cable

Detailed Specifications

Parameter	Min	Typical	Max	Unit	Notes
Bypass voltage range	2.2	-	5.0	V	Programmable.
Voltage monitoring range	2.2	-	5.4	V	System will accurately report battery voltage.
Self-protection battery voltage threshold		5.0		V	Above this value it continues to communicate, however the bypass function is disabled to selfprotect the circuit.
Under-voltage low power reset threshold	2.0	2.1	2.15	V	Minimum power consumption will occur until the voltage goes above this value. Below this voltage the device will stop communicating (reset).
Under-voltage leakage current			150	µA	Average current consumed for excessively low voltages.
Standby current for 2.1V to 5.4V		3	4	mA	Average current consumed when not in use, with no communication or no bypass shunt current.
Active current for 2.1V to 5.4V		4	6	mA	Average current consumed while communicating, no bypass shunt current.
Total PCB terminal shunt resistance	1.68	1.7	1.8	Ω	The connection power cable resistance is not included.
Maximum shunt current at 3.65V		2.0		A	Determined by the total terminal shunt resistance. It is also limited by the connecting cable impedance.
Recommended typical shunt (bypass) current at 3.65V		0.7		A	Depends upon thermal mounting (environment). LongMon may require a lower value without cooling.
Automatic shunt current range	0	Variable	2.0	A	Automatically adjusts to within approximately 1% resolution to limit the programmed battery terminal voltage.
Battery and PCB measurement temperature range	-40		+120	°C	Both sensors report temperature over this range.
Battery and PCB temperature accuracy at 25ºC	±5	±2	±5	°C	Errors increase at the extreme temperature ranges.
Bypass endpoint voltage accuracy	-0.05	0	+0.05	V	Cell terminal voltage variation from the set-point for 0A bypass current.
Bypass voltage accuracy including supplied cable (0 to 2.0A)	-0.05	0.1	+0.2	V	Including the standard cables provided.
Voltage measurement accuracy		±0.05	±0.1	V	For 2.2V to 5.4V readings. This voltage can be calibrated, please contact Batrium.
Bypass transient response time to within ±0.05V		0.1	1	sec	Stabilisation time from no bypass to 2.0A bypass (transient current) to reach ±0.05V regulation accuracy. Depends on battery parameters.
Number of addressable daisy chain cells	1		249	Cells	For very high-voltage systems it is recommended to break the pack into a number of shorter daisy chain paths.

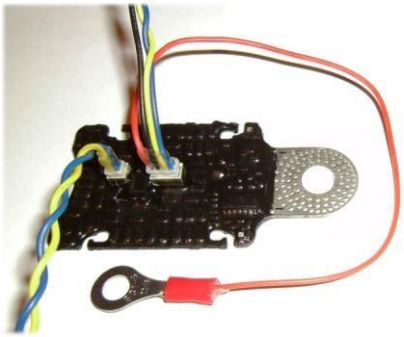
CellMon Operation Description

CellMons constantly monitor the cell voltage and temperature (at PCB). These values are sent to both supervisor and the monitoring PC. CellMons indicate over and under voltage conditions by flashing the red LED fast (0.1 sec).

CellMons are shunt regulators that continually maintain the cells below the bypass voltage setting by trimming the shunt load. Excess cell charge is dissipated as heat on the PCB. It discharges the cell until the desired voltage across the terminals is achieved. Bypass condition is indicated on a CellMon through the red LED being constantly on. The bypass and LED function is always operational even when the supervisor is off or not connected.

While charging, one cell eventually reaches the end-of-charge voltage and the charging controller (supervisor) sets a low bypass charge current. Low current is continually applied allowing all cells to equalise to end-of-charge state. Use a low bypass charger current setting to prevent overheating the CellMons. If the bypass currents are too high, the “shunt” heating will continue to increase, until the CellMon PCB temperature limit is reached (75°C). At this point, a CellMon will “self-protect” and stop bypassing. The supervisor will command a controlled charger to throttle back or shut down (if unsuccessful).

With the charger off, eventually the cell will be discharged by the CellMon to normal operating voltages. In some cases, a small residual CellMon bypass current may continue for a long time until the desired voltage is attained.



The CellMon voltage and temperature control loops run in parallel. Both loops control the load “shunt” current. The controlled bypass current function is a smooth variable (0 to 100%). The temperature loop controls the maximum PCB heat through reducing the overload “shunt” current value. CellMons indicate over temperature conditions to the operator by flashing the red LED slowly (at 0.5sec). The supervising device normally throttles back the charger.

Terminal Voltage and Limits

Each CellMon will operate over a voltage range of +2.2V to +5.0V for normal voltage monitoring and bypass conditions. However, the terminal voltage can withstand +20V without damage. The CellMon will self-protect by not bypassing above +5.0V. Above this voltage it will continue to communicate and read the cell voltage up to 5.4V.

CellMons will shut down in an under voltage condition (<2.1V). Normal CellMon function will automatically recover once the battery terminal voltage is re-established.

CellMons are also self-protected against accidental reverse terminal voltage. They will consume negligible current up to -20V applied across the terminals. The device will be irreparably damaged for any applied voltage beyond ±20V.

It is easy to achieve terminal voltages above ±20V while installing. Always connect the power 4 pin connector last, and unplug this connector first when removing a CellMon.

Voltage Thresholds

The programmable bypass voltage limit is fundamental to the operation of CellMon (discussed above). However there are two other programmable voltage limits. These are normally set automatically in the software commissioning stage as the “Over Cell Alert” and the “Under Cell Alert”. When the cell voltage goes beyond these values the red LED will flash fast (100ms) for an alert state that requires immediate action.

Self-Powered CellMon

Each CellMon is self-powered from the cell it is connected to. This ensures that all cells are self-discharged with a small current and also equally across each battery in the whole pack. CellMons consume a small current that is normally

below the cells own self-discharge rate for large cells. As an example, for a 160Ah cell with the small 4mA discharge from the connected CellMon, it will take 40,000 hours (833 days) to discharge. Normal batteries are recommended to recharge more than once a year (from self-discharge). The CellMon should be disconnected if left for extremely long periods.

Should the cell voltage drop below the 2.1V threshold, the CellMons will consume negligible current as a secondary battery protection method.

Daisy Chain Connection and Communication

Each CellMon is connected with a daisy chain, twisted pair, opto-isolated cable. This ensures a high level of interference (noise) tolerance. Data flows into the two pin, it is updated and passed out again on the 4 Pin connector.

This cable is connected in a daisy chain (in and out) of each CellMon. It typically follows the busbar path, however this path is not essential. Each input (2 pin connector) is opto-isolated to beyond most normal battery pack voltages. Thus more convenient signal paths may be chosen.

The full data path loop must be maintained. Unplugging any connector will stop all communications. It will also stop if one cell goes below its minimum operating voltage.

The 4 pin output connector signals are referenced to the voltage at the cell potential. Thus it is necessary to prevent temporary short circuits or possible high voltage conditions on these wires. For high voltage systems, always add sufficient additional insulation (e.g heat shrink) over exposed blue and yellow twisted cables.

The cables may be extended beyond several metres with similar blue and yellow twisted pair wires. It is best practice to keep them clear of high electrical noise sources; however it has been found that this type of connection is highly noise-immune in most EV electrical installations. The system can address up to 249 batteries on a single network reliably.

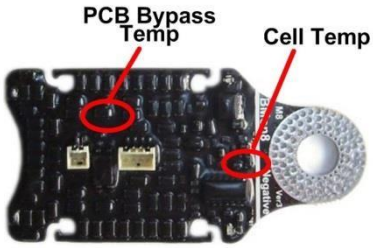
It is important to understand that the computer-based commissioning “auto node numbering” system starts at the first 2 pin input connector as cell #1 and continues incrementing through each cell. The cell number is stored permanently in CellMon, thus it is necessary to always recommission networks should a CellMon be replaced or rearranged. A number of diagnostic menus are provided for network node numbering diagnostics.

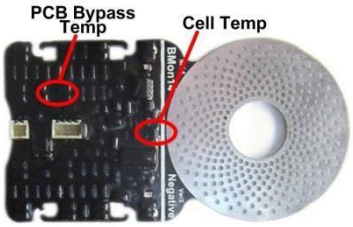
Individual cell details are monitored at a 40ms update rate by the supervisor. A second fast message at 1ms per cell is used to read and react at high speeds to critical cell limits allowing real time control. Also note that failure in any one cell does not jeopardise the rest of the battery pack over voltage bypass protection. Each CellMon autonomously monitors each battery.

Cell and Bypass Temperature

Cell temperature is an important parameter for lithium cell chemistry. Cell monitors measure the cell temperature and the bypass temperature. BlockMon and LeafMon measure the battery terminal temperature through the mounting screw. LongMon measures it under the connector-end cable tie. Inherently the LongMon temperature coupling cannot be as good as the BlockMon or LeafMon monitoring the terminal temperature.

LongMon Temperature Sensors





BlockMon Temperature Sensors

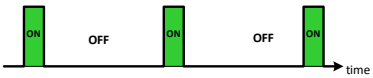
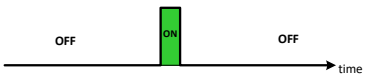
The charger control solution uses this cell temperature to prevent charging. Charging cells when they are at high temperatures (typically above 50-55°C) will cause irreparable chemical damage to the cells.

Exposed Metal on the CellMon PCBs

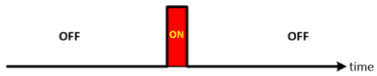
The CellMons are covered in a black thermally conductive epoxy. Although protecting the electronics, this does not provide adequate insulation for direct contact with metal (battery terminals or chassis). The circuits operate at battery potential. Do not allow any metal to come into contact with the bottom electronics surface of the CellMons. Insulate the bottom of the CellMons when exposed to metal to prevent high current damage. The top electronics should also be protected from all electrically conductive material (metal). The whole of the back of LongMon must be treated as exposed conductive metal (circuit). The area past the line on the back of BlockMon is exposed metal (circuit). The area of the GenMon past the LeafMon mounting board must be treated as exposed conductive metal (circuit).

LED Indicators

The red and green LEDs on the CellMon indicate the communication, bypass, and alarm states. When power is first applied, the green LED remains permanently “ON” (until the first message has been received). This allows initial confirmation of the correct power connection and network diagnostics. Once the first message has been received, the green LED will be OFF and then only indicates the message state with flashes. The green LED will flash in cell number sequence when being interrogated by the supervisor allowing diagnostics and status indication.

Green LED	State	Condition.
	Continually “ON”	Indicates that the power has been connected correctly (stays ON). It will turn OFF once the first message has been received. *It is also ON while parameters are being set by the Batrium software.*
	Repetitive flashes (0.5 sec rate)	Status messages are being processed from supervisor . This flash passes through each CellMon in sequential cell # order.
	Single flash	Flash when a valid configuration message has been interpreted.

The red LED indicates the bypass state and also shows three alarm states.

Red LED	State	Condition.
	Continually "ON" (or flash intermittently)	CellMon is bypassing current. Note: May flash intermittently when close to bypass threshold voltage.
	Slow flash (0.5 sec rate)	Over cell temperature or over bypass temperature.
	Fast flash (0.1 sec rate)	Over cell voltage or under cell voltage.
	Single flash	Bad/corrupt message is received.

Programmable Parameters

The following variables are programmable and are permanently stored in CellMon. These are set automatically through the Batrium software. However they can be manually set through the advanced menus. These parameters are local to CellMons (they do not affect system alarms) and are independent of the action parameters in the supervisor.

Parameter	Min	Typ	Max	Unit	Description
Bypass Threshold Voltage	2.1	3.65	5.0	V	If the cell voltage goes **above** this value, CellMon will begin to bypass. It will be indicated as a constant red LED ON. Note: The LED may flash intermittently when near this threshold.
Under Cell Alert	2.1	2.50	5.4	V	If the cell voltage goes **below** this value, CellMon will alert with fast flashing red LED (this is independent of the supervisor operation).
Over Cell Alert	2.1	3.75	5.4	V	If the cell voltage goes **above** this value, CellMon will alert with fast flashing red LED (this is independent of the supervisor operation).
Over Temp Alert	-40	55	120	ºC	If the cell temperature goes **above** this value, CellMon will alert with slow flashing red LED (this is independent of the supervisor operation).
Bypass Hi Temp Limit (fixed value)		75		ºC	If the CellMon PCB load goes **above** this temperature, it will self-protect the electronics from damage by lowering the bypass current. Keep well below this temperature because the battery voltage will be allowed to go above the bypass threshold voltage when this occurs. This will alarm with slow flashing red LED.