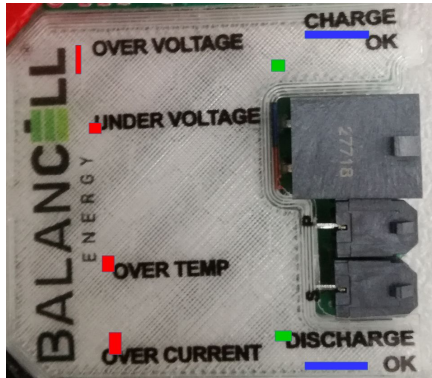
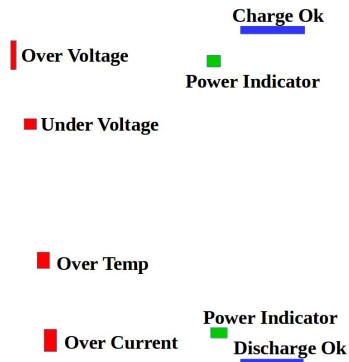


Battery Protector



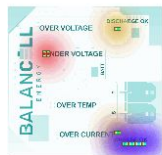
Indicator Light Guide Map



Over temperature – Protector over temp will **switch battery off** and prevent both CHARGE and DISCHARGE. It will **reset automatically** once temp is lower than 50°C.

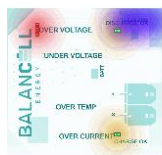
ON – If the on/off switch is turned on, and **both the blue lights come on** it means that both CHARGE and DISCHARGE are allowed, and the pack is ready for **normal operation**.

OFF – Protector has **two green lights on, but no blue lights**. This means battery is **ready to go but switch is off**.



Under voltage indicates that the battery pack is under-voltage, CHARGE is OK, but DISCHARGE has been disabled.

Protector off – There are **NO lights** on the protector. The BEM has disabled it due to either overvoltage, undervoltage or over temperature. The BEM will re-enable the protector every 30 sec and check if there is a load or charge present. If pack was undervoltage it will check that there is no load before it re-enables. If pack was overvoltage it will check that charger has been removed before switching on again.



Over voltage indicates that the battery pack has gone over-voltage. Hence DISCHARGE is possible, but CHARGE has been disabled, until pack voltage drops.

Pre-charge – The **over current will trip** when trying to start up into a **large capacitive load**. Provided there is no other excessive load, then each subsequent restart will charge the capacitor a bit more until it can turn on fully. This is the designed operation. Once the capacitors are fully charged the protector will stay on and normal operation can proceed.

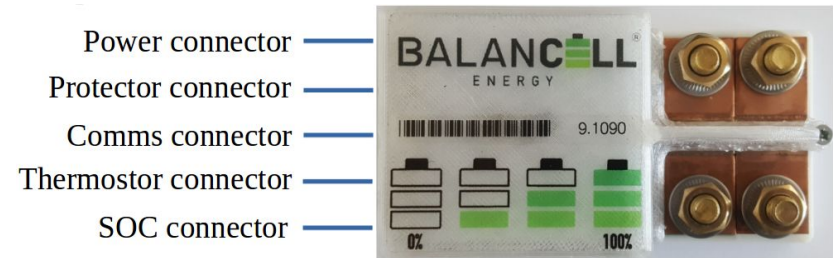


Over current occurs when the battery is Overloaded or if there is a Short circuit. If it trips, then the protector will try to restart automatically in ~50ms. It will do this repeatedly if the fault remains.

Balancell Battery Quick Reference Guide

BALANCELL
BATTERIES WITH BRAINS

Battery Energy Meter (BEM)



LED Colour	Light Pattern	Description
Red	Red light off	Normal operation
	300ms ON / 700ms OFF	Undervoltage condition is triggered
Blue	50ms ON / 950ms off	Normal operation
	50ms ON / 200ms OFF / 50ms ON / 700ms OFF	SD Card failure
	50ms ON / 200ms OFF / 50ms ON / 200ms OFF / 50ms ON / 450ms OFF	GSM modem failure
	150ms ON / 200ms OFF	SD Card and GSM modem failure
White	Strobe lamp OFF	Normal operation
	30ms ON / 970ms OFF	Undervoltage condition is triggered

Sound	Sound Pattern	Description
Buzzer	Buzzer OFF	Normal operation
	300ms ON / 2700ms OFF	Undervoltage condition is triggered

Energy Bar - Shows remaining energy in battery referred to as State of Energy (SOE) in %.

Green	Green	Green	Green	Green	Green	Green
0-14.2%	14.3-28.5%	28.6-42.8%	42.9-57%	57.1-71.3%	71.4-85.6%	85.7-100%

BATTERY LOW - when battery is less than **10% SOC** (State of Charge), the BEM will **flash its white STROBE** as well as **sound its BUZZER**. This is controlled by an absolute voltage trigger.

BATTERY EMPTY - LIMP MODE- When battery has reached its **minimum voltage** or is less than **1% SOC**, it will turn off and **machine will stop**. Approximately 2 or more minutes later it will turn itself back on again, giving a few more minutes of operation. This should allow machine to **drive slowly back to battery bay for charging**. This may happen two or three times depending on depth of discharge

Cell Management Module (CMM)

Over-voltage and Under-voltage limits can be set on CMM's. Over-temperature is set to 55°C on the CMM. Flashing patterns are provided in the tables below and adjacent. Cell temperature is based on CMM's estimate via its connection leads - the estimate is adjusted to compensate for any balancing heat generated by the CMM.

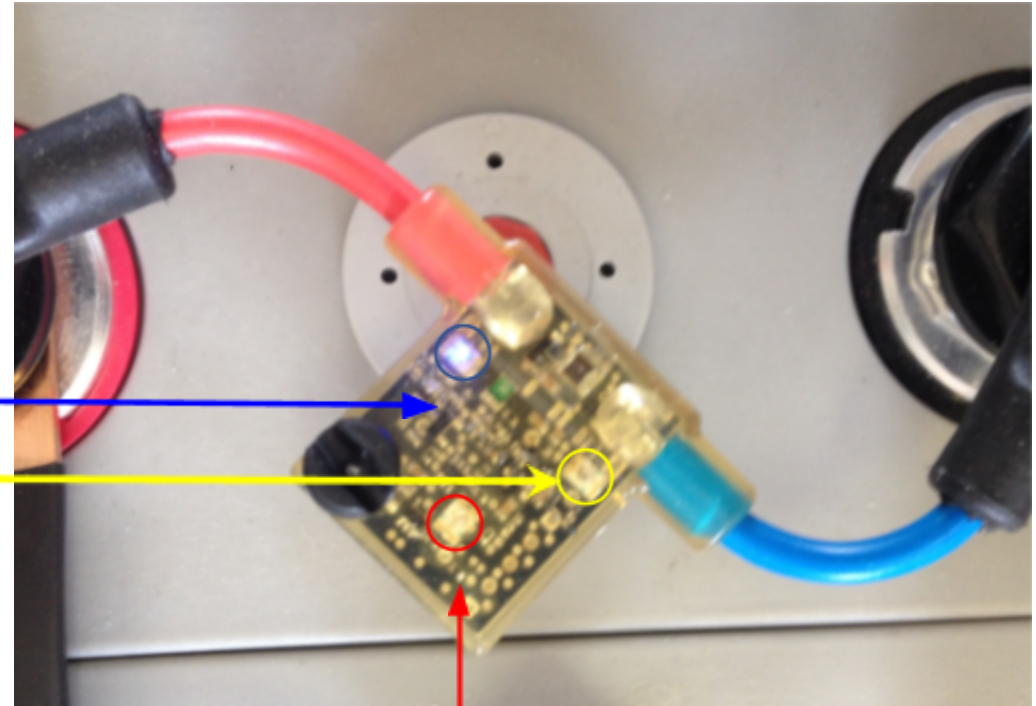
BLUE LED Light ON: Connection, Configuration and Communication.

BLUE	Flashing Pattern	Condition
	On power up, the BLUE LED will come on once only for 3 seconds . NOTE: This is used to show correct polarity connection. Its absence indicates that the device has been connected incorrectly.	Correct initial connection
	50ms on/ 200ms off/ 50ms on/ 200ms off/ 50ms on/3000ms off = three short pulses once every 3 seconds	Unconfigured
	50ms on/ 200ms off/ 50ms on/ 200ms off/ 50ms on/30000ms off = three short pulses once every 30 seconds	Lost communication
Whenever a message for itself is received correctly, the CMM will flash its BLUE LED = 50ms short pulse once every minute for normal operation.	Received message correctly / normal operation	

YELLOW LED Light ON: BALANCING

YELLOW	Flashing Pattern	Condition
	Always on, but brightness is proportional to the duty cycle of balancing resistor. Brighter indicates higher balancing current.	Balancing

Cell Management Module (CMM)



1 RED LED Light ON: Over-voltage, Under-voltage, Over-temperature.

RED	Flashing Pattern	Condition	Default
	50ms on / 450ms off = Short pulse twice a second	Over-temperature	50°C
	450ms on / 50ms off = Long pulse twice a second	Over-voltage	3.63V
	Fully on	Over-voltage and Over-temperature	3.63V 50°C
	50ms on / 3000ms off = Short pulse once every 3 seconds	Under-voltage	2.63V
	50ms on/ 200ms off/ 50ms on / 3000ms off = two short pulses once every 3 seconds	Under-voltage and Over-temperature	2.63V 50°C