10W MPPT Solar Meshtastic / APRS node T1

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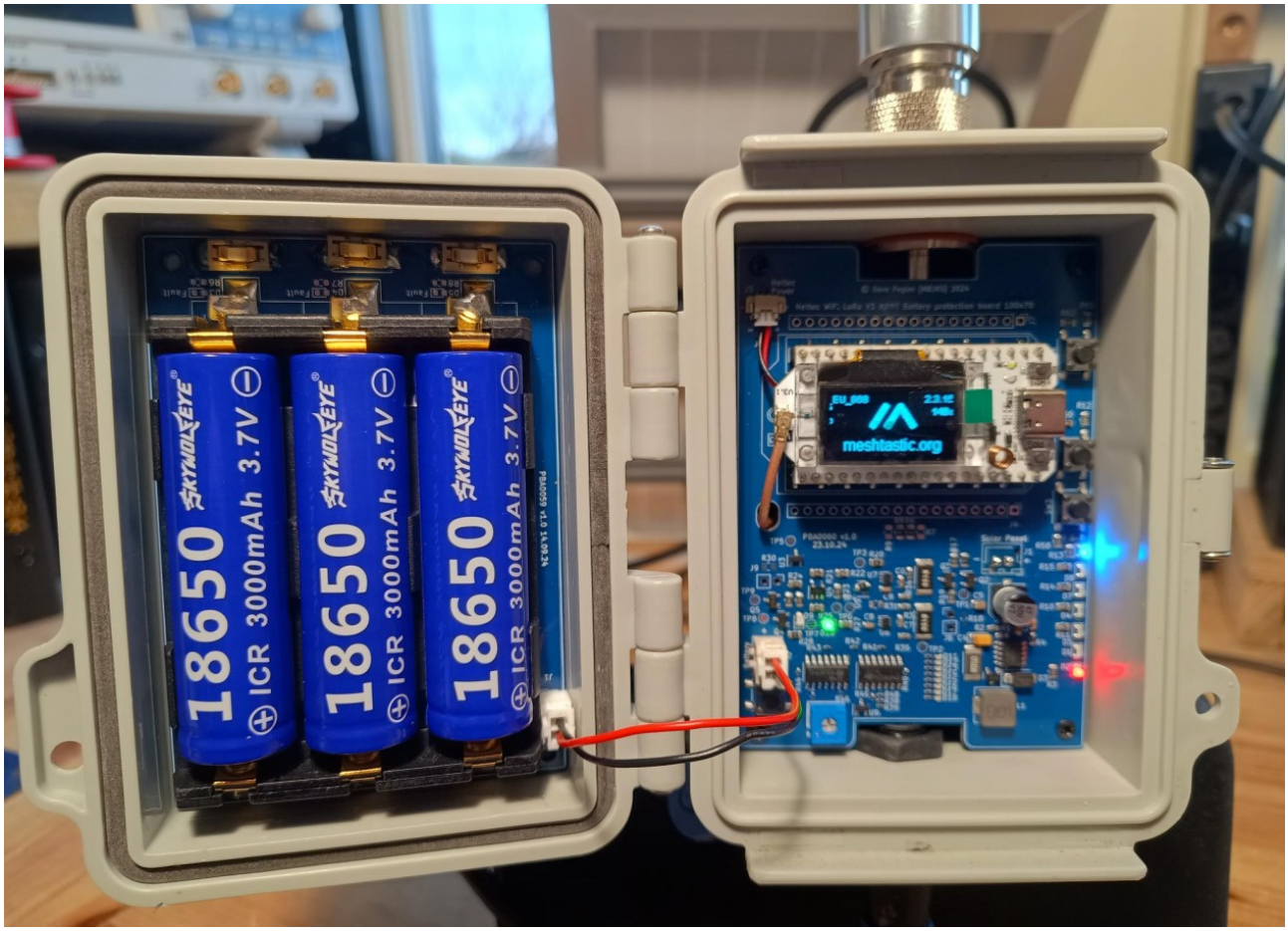
Thank you for purchasing the 10W Solar Meshtastic node. Below is a short user guide to help you get the maximum performance from it. To get the latest version, please lease scan the the QR code in the top left corner using your phone's camera:

The 10W MPPT Solar Meshtastic node uses a LoRa WiFi 32(V3) Single Board Computer (SBC) from Heltec Automation (EU868 version). At the heart of the WiFi LoRa 32(V3) SBC is a 32bit ESP32 microprocessor with integrated Bluetooth and WiFi; and a Semtech SX1262 LoRa modem.

To learn more about the WiFi LoRa 32(V3) SBC from Heltec, please scan the the QR code above using your phone's camera.
Like all PCBs, the LoRaWiFi 32(V3) SBC computer PCB is not designed for outdoor use (i.e. it's not waterproof) and so in order for it to operate in remote or harsh conditions it is housed in a IP67 outdoor case with three 18650 Li-Ion batteries (not supplied) mounted neatly in the door. To charge the 18650 batteries, a 10W Photovoltaic (PV) Solar Panel is also provided along with a MPPT charger PCB, which the LoRa WiFi 32(V3) SBC plugs into via a dual 18 way (2.54mm pitch) pin header connector as show below:

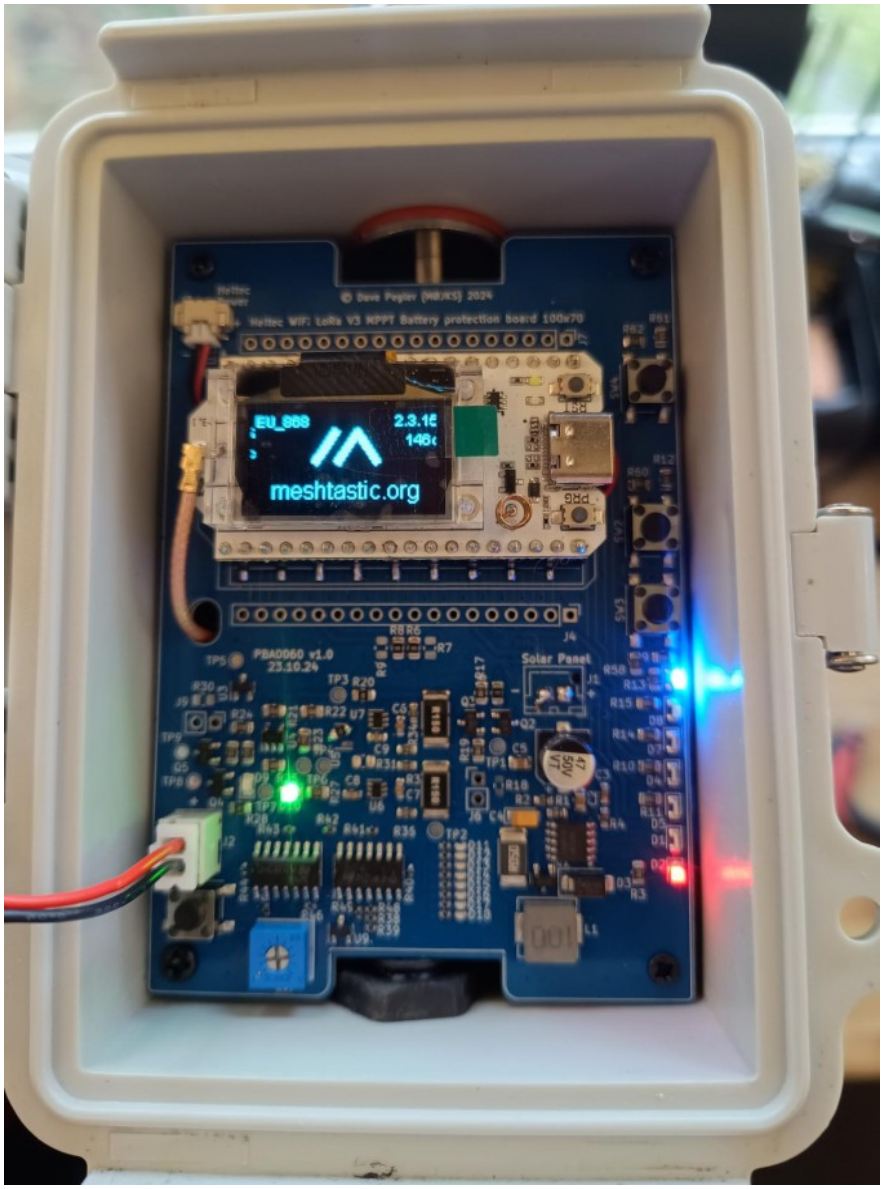


One of the challenges with powering electronics from Solar, especially in northern hemisphere countries like the U.K, is that during the winter months there are long periods of dull, cloudy, overcast days, which is not ideal for using Solar Panels to charge Li-Ion batteries. In the U.K the longest day (aka Summer Solstice) occurs on 21st June where there is sixteen hours of daylight, however on the shortest day (aka Winster Solstice), which occurs on the 21st December, there is just under eight hours of daylight.

To cope with periods of short, cloudy, overcast days, MPPT or Maximum Power Point Tracking is a technique that has been developed to adjusts the load seen by Solar Panels (i.e. input impedance) to maximize the amount of power transferred – irrespective of the amount of solar radiation and ambient temperature. MPPT controllers are particularly useful in low-light conditions, such as cloudy or overcast days, because (unlike traditional PWM controllers) they can still extract some energy from a Solar Panel. They also perform well in cold weather, where they can boost module output more than in warm weather. MPPT controllers are more complex and expensive than PWM controllers because of the additional circuitry they contain. However, the benefits of improved energy production and faster return on investment can often outweigh the initial cost.

For this reason your 10W Meshtastic Solar node contains a MPPT controller PCB which attempts to charge the three 18650 Li-Ion batteries whatever the weather can throw at it.

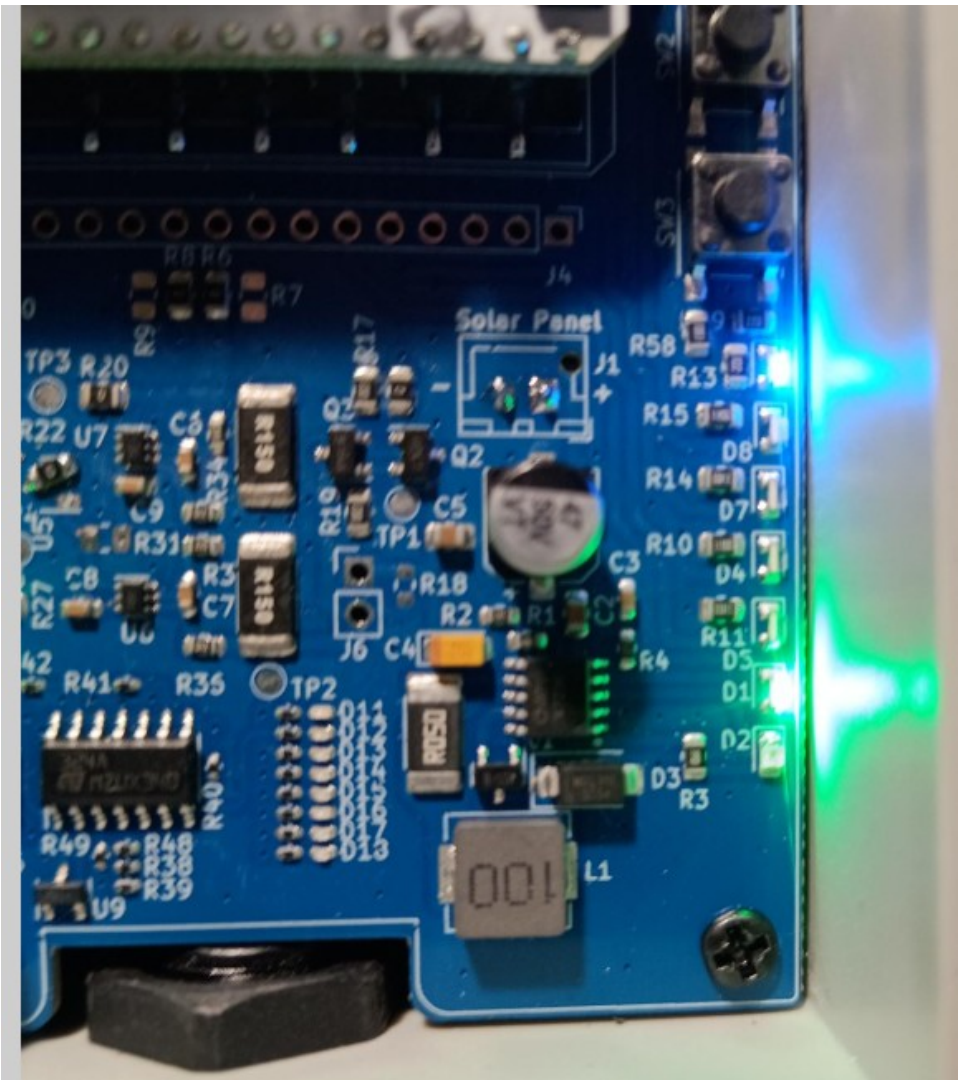
Below is a photograph of the MPPT controller PCB in your Meshtastic node, with a short description of what the various LEDs indicate. It is important to understand what the LEDs show as the most important job of the PCB is to prevent the 18650 Li-Ion batteries from becoming over discharged if there is insufficient sunlight for the MPPT charger to keep them topped up. If Li-Ion batteries are allowed to discharge below 3.1V, they become permanently damaged which will cause capacity degradation.



On the MPPT controller PCB (shown above) the Blue LED (middle right) indicates that the Heltec LoRa 32(V3) SDC is receiving power from the batteries, and the onboard LDO regulator is supplying power to itself and to the MPPT controller PCB.

The Red LED (bottom right) indicates that the MPPT controller is extracting some power from the Solar Panel and it is charging the Li-Ion batteries. The brightness of this LED indicates how much

power it is extracting from the Solar Panel. On a dull day it will be quit dim, on a bright sunny day it will be very bright.
Above the Red LED is a Green LED (not illuminated in the picture overleaf, but shown in the picture below), which the MPPT controller illuminates when the 18650 Li-Ion batteries have reached their maximum charge voltage (approx 4.2v); and it has decided to stop charging them (to prevent overcharging). It is very unlikely you will see this illuminated much unless the solar panel is seeing a lot of sunlight for a long period of time.

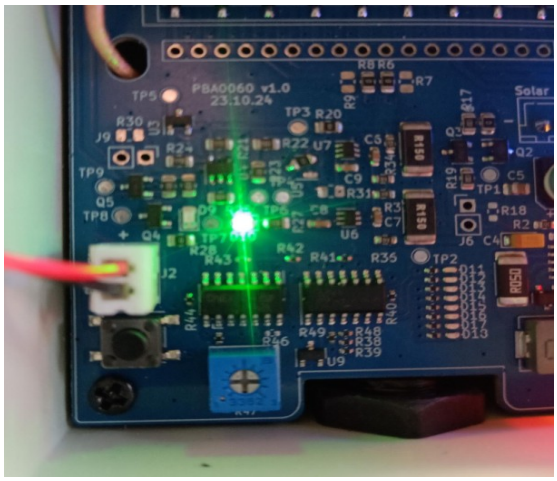


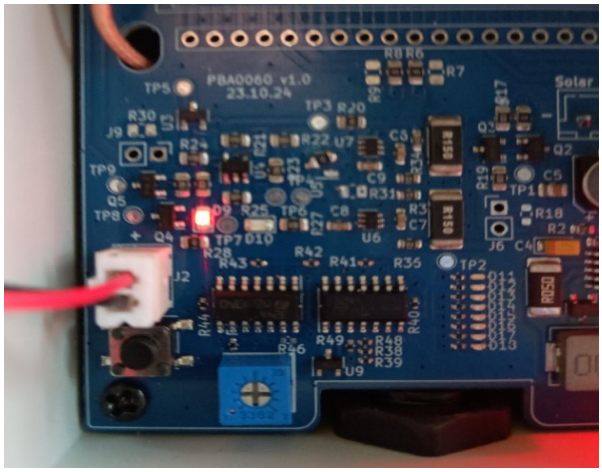
It is important to remember there is only so much a MPPT controller can do to keep Li-Ion batteries charged if the sun just doesn't shine enough This is especially true if the Software running on the Heltec LoRa 32(V3) board is very busy handling lots of LoRa packets, which can happen with Meshtastic if the node is not at the edge of the network and is routing Meshtastic packets for other Meshtastic nodes. As outlined above, in this scenario the most important thing is to prevent the Li-Ion batteries from being discharged too much, as this will effect the life span of the batteries.

Overdischarge will have catastrophic consequences for a Li-ion battery, especially large current overdischarge or repeated discharge, as this will damage the batteries permanently. To prevent this the MPPT charger PCB in you Meshtastic node comes with a Li-Ion overdischarge protection circuit which prevents the Li-Ion batteries from being discharged below 3.15V. If during a long period of dull or overcast weather (i.e. a period of no direct sunlight), the Solar Panel and MPPT

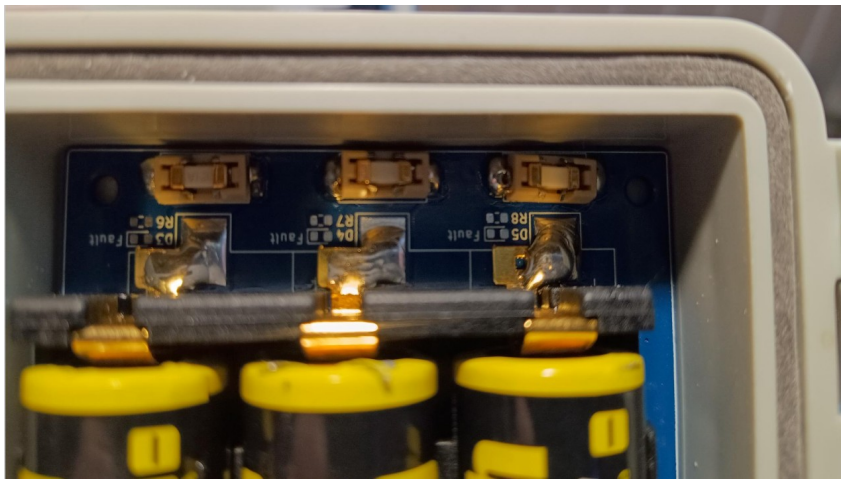
controller cannot keep the batteries top up (so the battery voltage drops to 3.15v), the overdischarge protection circuit will automatically kick in and turn off power to the Heltec LoRa 32(V3) board (to prevent further discharge and damage). When this occurs, the overdischarge protection circuit will then work in conjunction with the MPPT controller to charge the LI-ion batteries back up as quickly as possible, and, crucially, will only turn the Heltec LoRa 32(V3) back on when the Li-ion cells reaches 3.7v. This hysteresis is deliberate to allow the Li-Ion cells to recover and be charged back up to a level which will allow your Meshtastic node to come back up and stay up.

In order to indicate what the discharge protection circuit is doing, the MPPT controller PCB has two additional LEDs – Green and Red – positioned to the right of the JST 2.54mm XH battery connector labelled J2. When the Green LED is illuminated (as shown in the picture below left), this indicates that the battery voltage is currently above 3.15v and all is well:





When the Red LED is illuminated (as shown in the picture above right), this indicates that the Li-ion battery voltage (of the three combined 18650 cells) is currently below 3.15v and all is NOT well. If you insert 18650 Li-ion batteries in you Meshtastic node which have not been charged up (and balanced – so they are the same voltage) it is possible nothing will happen if the discharge protection circuit detects that the combined voltage of all three 18650 batteries (as they are all in parallel) are below 3.15v. My advice is to use new 18650 Li-ion batteries, from a known manufacturer, that have been purchased at the same time; and make sure they are externally charged to the maximum (4.2v) before installing them in your Meshtastic node.

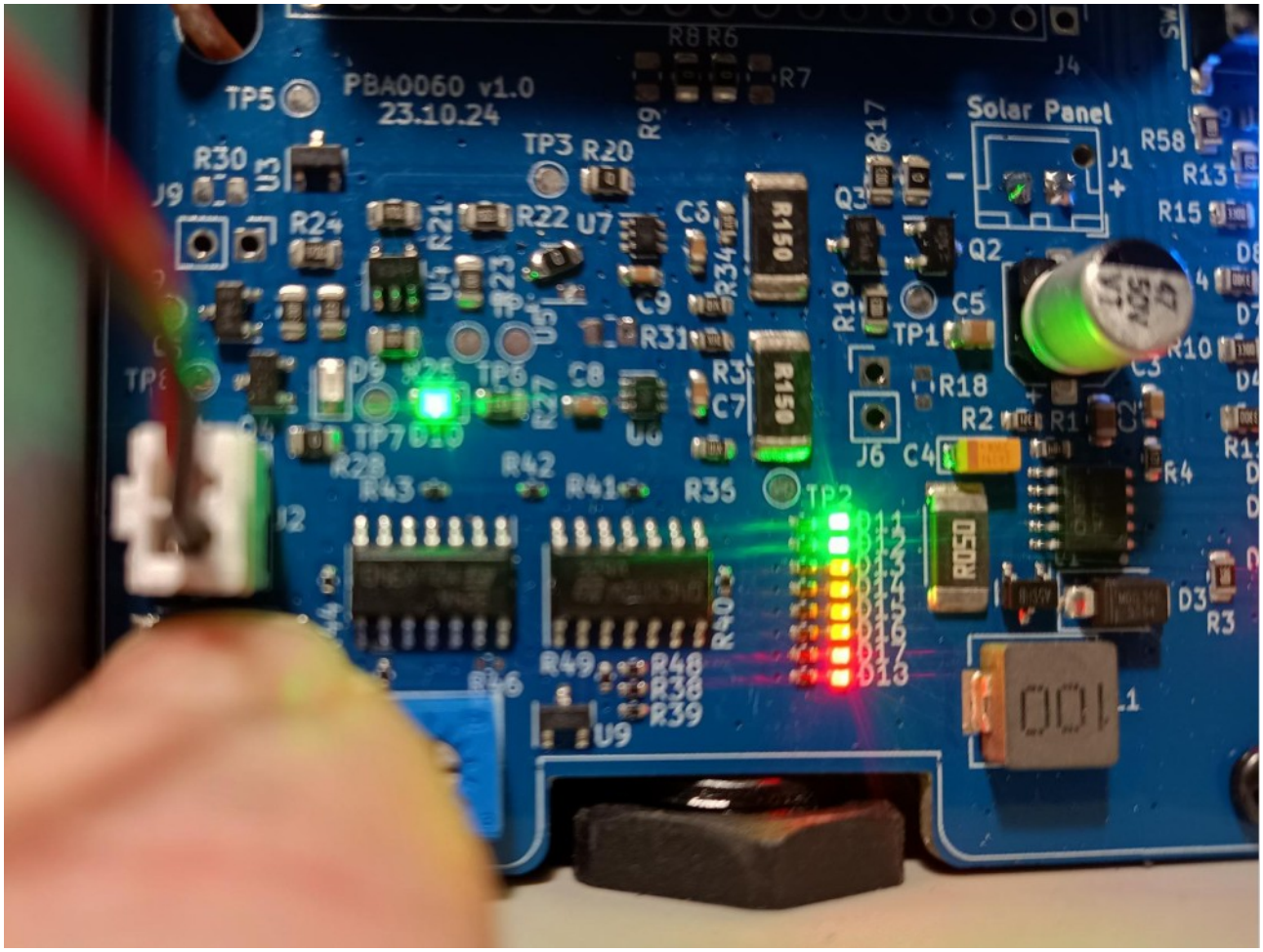


In addition to the overdischarge protection circuit, the battery PCB in your Meshtastic node (located in the door of the IP67 case) has three 1808 1A protection fuses. These fuses are provided in case you accidentally insert the 18650 batteries the wrong way around, or if one of the 18650 cells

decides to go short-circuit. The three 18650 cells in you Meshtsatic node are wired in parallel, so if one of the cells you fails and goes short circuit, this could shorten-out the other two cells causing a large current to flow. This could cause overheating or a fire so the 1A 1808 protection fuses are provided to blow should this ever happen.

Note that the 18650 Li-ion cells need to be inserted as show with the negative closest to the fuses. Be careful here, as on some nodes the battery PCB is the other way around. I shall therefore reiterate that the negative of the 18650 batteries needs to be closet to the 1808 fuses. If you accidentally blow the 1808A fuses, then don't fret, they are there to protect the electronics. You can easily obtain new ones from Amazon, eBay or Aliexpress. They are very cheap Just search for "1808 1A Fuses".

Finally, in order to easily and quickly gauge the 18650 Li-ion battery charge level, at the bottom of the MPPT controller PCB is simple battery tester which can be initiated by pressing the switch which is situated below the JST 2.54mm XH power connector (labelled J2).



The battery tester consists of a bar graph of eight coloured LEDs (two RED, four YELLOW and two GREEN) which are used to indicate what the battery charge level is. If the batteries are fully charged all eight LEDS will come one when the switch below J2 is pressed (as shown). This indicates that the battery voltage is over 4.1V. If LED 1-7 come on (so just one GREEN LED – D11 is off), this indicates that the battery level is approximately 3.7V. If no GREEN LEDs come on, then this indicates the battery voltage is around 3.5V and if only the RED LEDs come on, then this indicates that the battery voltage is probably below the over-discharge voltage of protection threshold of 3.15V.

73 Dave (M0JKS)