25W MPPT Solar MeshCORE, Meshtastic or APRS node

Dave Pegler G1JKS (M0JKS) – peglerd@gmail.com

Thank you for purchasing the 10/25W Solar MeshCORE, Meshtastic (EU868, or US915) or APRS (EU433) node. Below is a short user guide to help you get the maximum performance from it.

To get the latest version, please scan the the QR code in the top left corner using your phone's camera:

The 10W and 25W MPPT Solar MeshCORE, Meshtastic or APRS node uses a LoRa WiFi 32 (V3 or V4) Single Board Computer (SBC) from Heltec Automation; EU433/EU868/US915 (MeshCORE / Meshtastic) or EU433 (APRS). At the heart of the WiFi LoRa 32 (V3 or V4) SBC is a 32bit ESP32 microprocessor with integrated Bluetooth and WiFi; and a Semtech SX1262 LoRa modem.

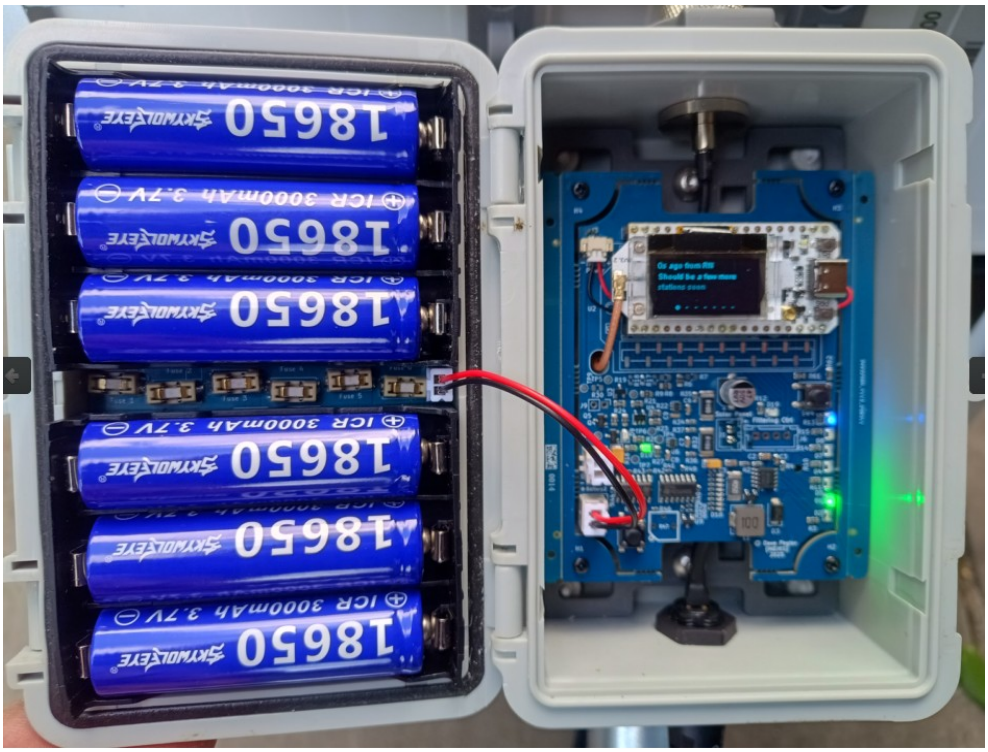
Heltec LoRa WiFi 32 (V3)

Heltec LoRa WiFi 32 (V4)

To learn more about the WiFi LoRa 32 (V3 or V4) SBC from Heltec, please scan the the QR code above using your phone's camera.

MPPT Solar Controller Overview

Like all PCBs, the Heltec LoRa WiFi 32 (V3 or V4) SBC computer PCB is not designed for outdoor use and so in order for it to operate in remote or harsh conditions it is housed in a IP67 outdoor case with six 18650 Li-Ion batteries (not supplied), all mounted neatly in the door. To charge the 18650 batteries, a 10W or 25W Photovoltaic (PV) Solar Panel is also supplied along with a MPPT charger PCB; which the Heltec LoRa WiFi 32 (V3 or V4) SBC plugs into via a dual 18 way (2.54mm pitch) pin header connector as show below.

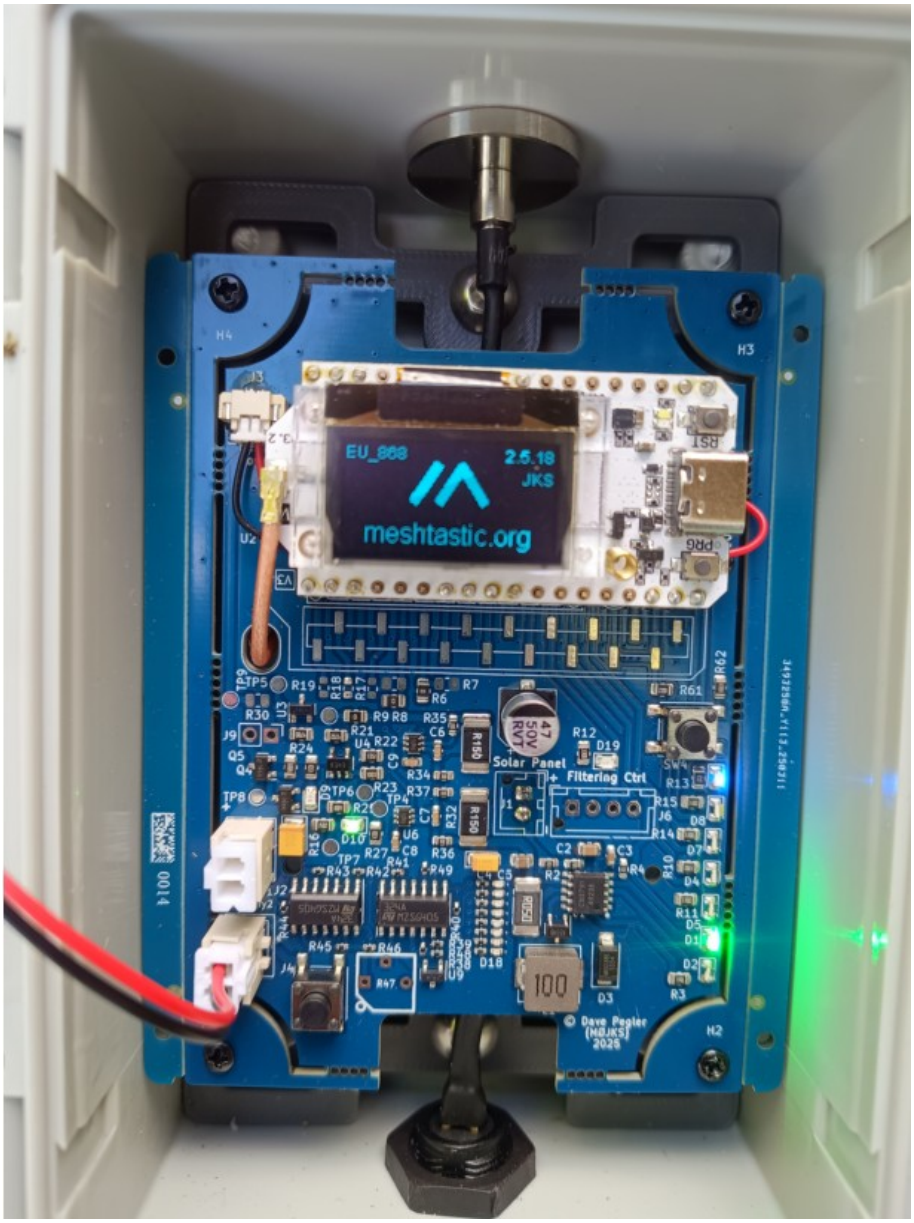


One of the challenges with powering electronics from Solar, especially in northern hemisphere countries, is that during the winter months there are long periods of dull, cloudy, overcast days, which is not ideal for using Solar Panels to charge Li-Ion batteries. In the northern hemisphere the longest 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 or 25W MeshCORE, Meshtastic or APRS Solar node contains a MPPT controller PCB which attempts to charge the six 18650 Li-Ion batteries whatever the weather can throw at it. Overleaf is a photograph of the MPPT controller PCB in your MeshCORE, Meshtastic or APRS 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 will become permanently damaged which will cause capacity degradation.

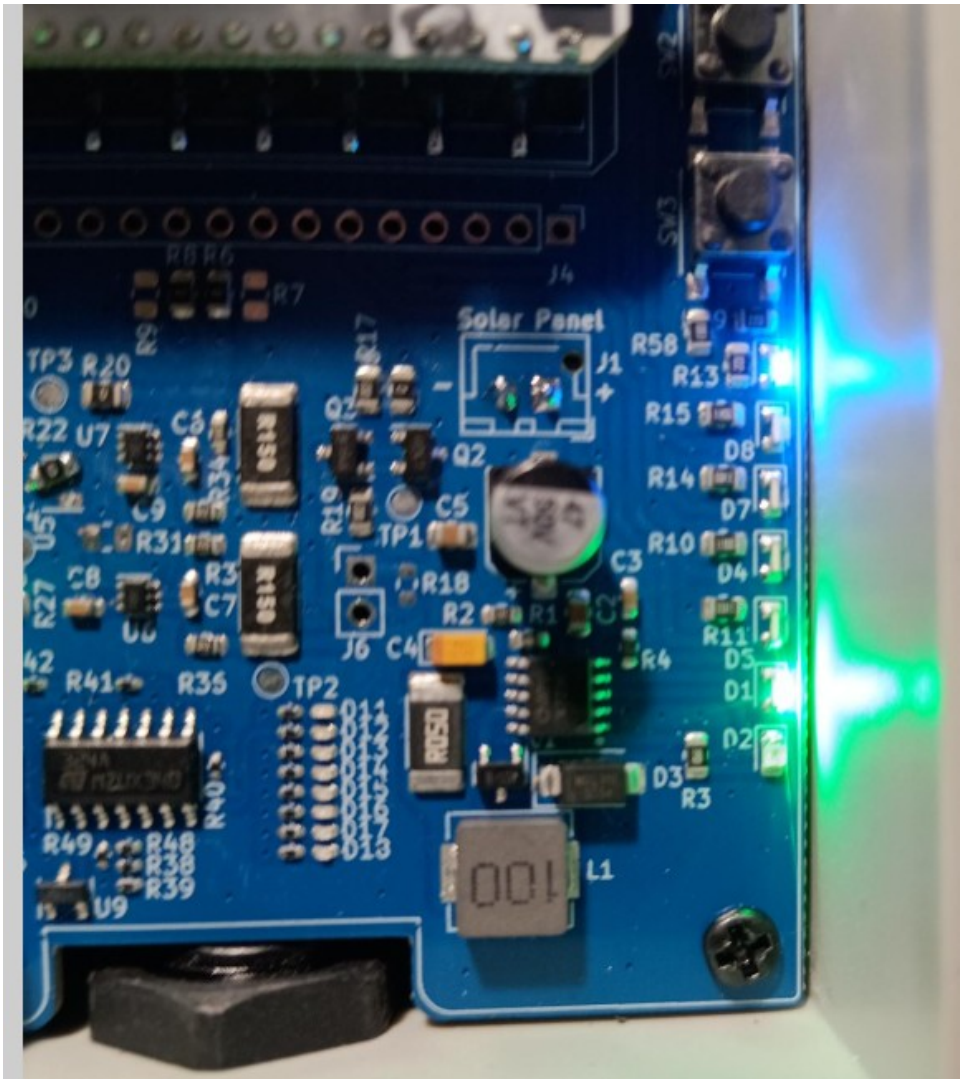


On the MPPT controller PCBs shown above the Blue LED (middle right, below the switch) indicates that the Heltec LoRa 32 (V3 or V4) SBC is receiving power from the batteries, and the onboard voltage regulator is supplying power to itself and to the MPPT controller PCB.

The Red LED (D2 bottom right, not illuminated in the above picture) 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 quite dim, on a bright sunny day it will be very bright.

Above the Red LED is a Green LED (D1) which the MPPT controller illuminates when the 18650 Li-Ion batteries have reached their maximum charge voltage (approx 4.2v); and it has stop charging them to prevent overcharging. It is very unlikely you will see this LED illuminated unless the solar panel is seeing a lot of sunlight for a extended period of time.

At times (particularly when the Solar panel is in bright sunlight) you may see both the Green (D1) and Red (D2) LEDs illuminated, but toggling on and off rapidly. This indicates that the Li-Ion batteries are almost at maximum charge (around 4.2v) and the MPPT charge controller is in constant current charging mode.

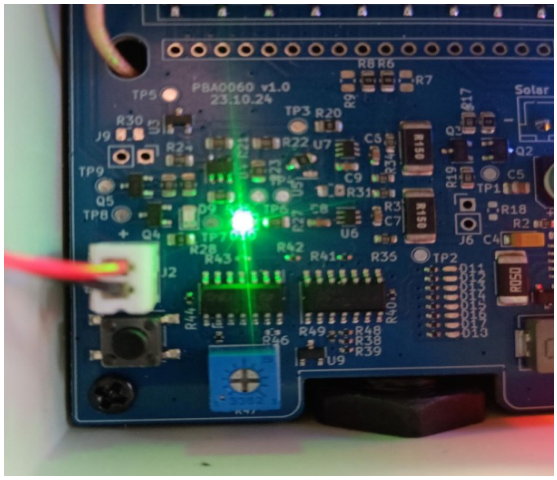


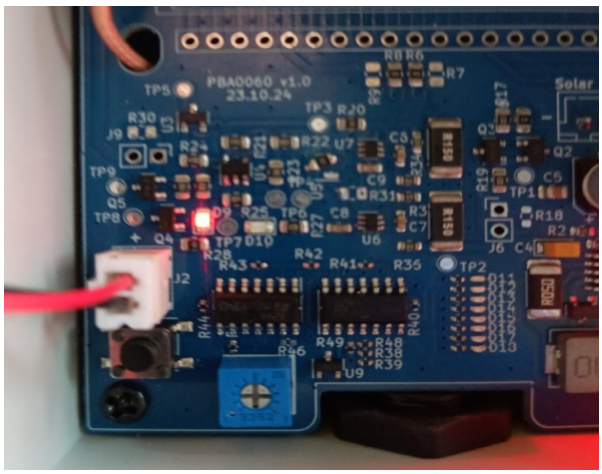
Over-discharge Protection Mechanism

It is important to remember there is only so much a MPPT controller can do to keep Li-Ion batteries charged if the just isn't enough light. This is especially true if the software running on the Heltec LoRa 32 (V3 or V4) board is very busy handling lots of LoRa packets; which can happen with MeshCORE, Meshtastic or APRS if the node is not at the edge of the network and is routing MeshCORE, Meshtastic or APRS packets for other MeshCORE, Meshtastic or APRS 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. Over-discharging will have catastrophic consequences for a Li-ion battery, especially large current over-discharge or repeated discharge, as this will damage the batteries permanently. To prevent this the MPPT charger PCB in you MeshCORE, Meshtastic or APRS node comes with a Li-Ion over-discharge protection circuit which prevents the Li-Ion batteries from dropping below 3.1V. 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 3.1V), the over-discharge protection circuit will automatically kick in and turn off power to the Heltec LoRa 32 (V3 or V4) board (to

prevent further discharge and damage). When this occurs, the over-discharge 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 or V4) 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 MeshCORE, Meshtastic or APRS 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 next to 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 six combined 18650 cells) is currently below 3.1v and all is NOT well. If you insert 18650 Li-ion batteries in you MeshCORE, Meshtastic or APRS 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 six 18650 batteries (as they are all in parallel) are below 3.1V. Therefore, always 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 MeshCORE, Meshtastic or APRS node.

18650 Li-Ion Batteries and Fuses

In addition to the over-discharge protection circuit, the battery PCB in your MeshCORE, Meshtastic or APRS node (located in the door of the IP67 case) has six 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 fails and goes short-circuit.

The six 18650 Li-Ion cells in you Meshtsatic, MeshCORE or APRS node are connected in parallel, so if one of the cells fails and goes short circuit, this could shorten out the other cells causing a large

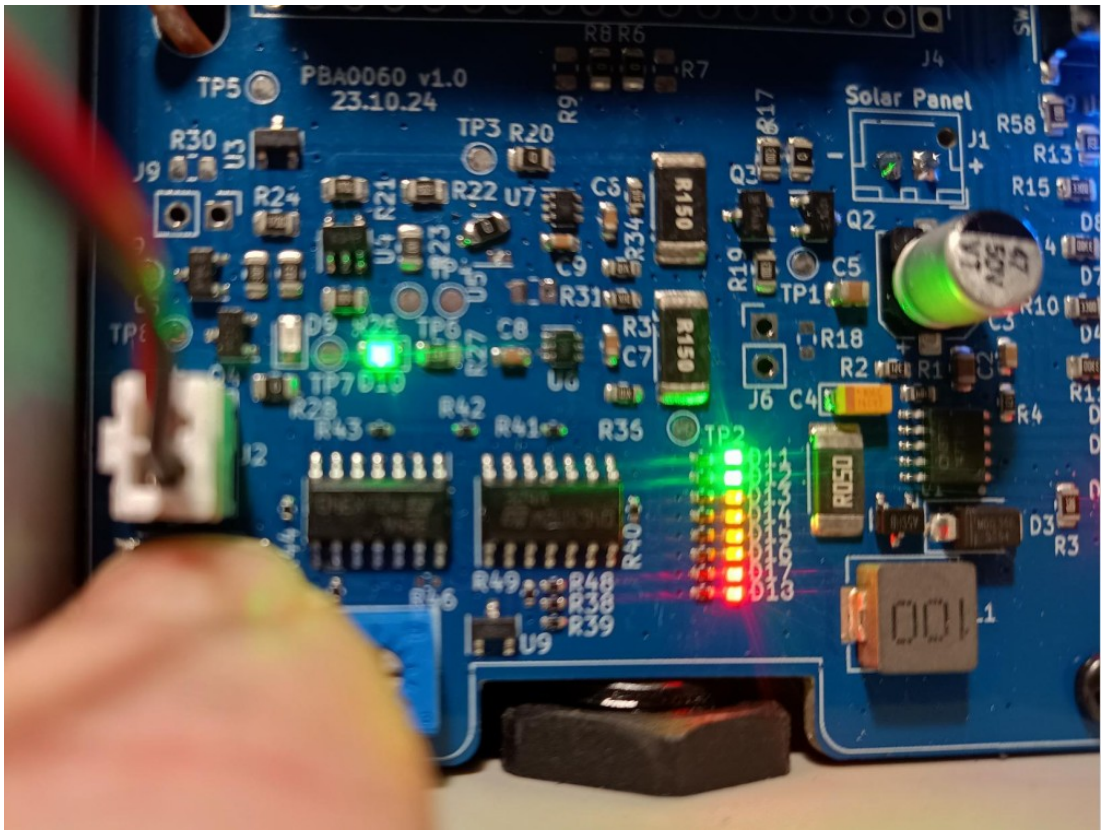
current to flow. This could cause overheating, so the 1A 1808 protection fuses are provided to blow should this ever occur.

Note that the 18650 Li-ion cells need to be inserted correctly, with the **negative** and **positive** terminals oriented so that positive is pointing towards the 2.54mm (red and black) power connector as show in the picture on the previous page. On some builds (MeshCORE) the MPPT PCB is mounted upside down so please make sure you insert the 18650 batteries as described above. To help you, there are + and – symbols marked on the 18650 battery holders.

If you accidentally blow the 1808A fuses (by connecting one of the batteries the wrong way around) then don't fret, they are there in case this happens. You can easily obtain new fuses from Amazon, eBay, Aliexpress or any good electronics retailer. They are very cheap, just search for "1808 1A Fuses".

18650 Li-Ion Battery Tester

To quickly check the 18650 Li-ion battery charge level, next to the 2.54mm XH power connector (J2) on the MPPT controller PCB is a simple battery tester, which can be initiated by pressing the switch situated next to it.



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 switch J2 is pressed (as shown). This indicates that the battery voltage is over 4.0V. If LEDs 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 protection threshold of 3.1V.

Installation Overview

With all things radio, height, the type of antenna, and minimising cable insertion loss are key to getting good range – both for transmit and receive. Although LoRa is great for Long Range, low power communications (it uses something called Chirp Spread Spectrum to achieve this), even it is useless if the antenna is poor, the equipment being used is at ground level (where there are lots of things like building in the way to attenuate the signal), or if a substantial proportion of the RF signal is lost between the equipment generating the signal (e.g. the Heltec LoRa board) and the antenna. This is particularly true at the UHF frequencies that Meshtastic, MeshCORE and APRS uses (866MHz and 433MHz respectively).

The best way to overcome these losses and hence maximise range, is to mount the electronics generating (and receiving) the RF signal as close to the antenna as possible (so that losses in any RF cables are as small as possible), use a antenna with some gain, and mount the complete assembly as heigh as possible. For this reason the 10/25W MeshCORE, Meshtrastic or APRS Solar node you have purchased has been designed so that the electronics generating (and receiving) the RF signal are co-located with a high gain antenna, all in the same IP67 enclosure. The electronics are contained inside the IP67 enclosure, and the antenna is mounted on the outside, with a short length of coaxial cable (10cm) between them. This way the RF feeder losses are kept to an absolute minimum, and the gain of the antenna extends the range. The complete unit (IP67 case, electronics and high gain antenna) can then be mounted in an elevated location using the external 1.5” (38mm) 3D printed mounting brackets – typically to a standard 38mm aluminium mast or satellite mounting bracket. The aluminium mast and brackets are not supplied with your 10/25W MeshCORE, Meshtastic or APRS node, but they are available from many online retailers. Just make sure the diameter of the pole that you want to mount your 12V Meshtastic/MeshCORE/APRS node is 38mm in diameter, such this one from CPC in the UK:

Blake SAT7 Elbow Mount 1.5"

Installing MeshCORE v1.9.0 (868MHz/915MHz)

The 868MHz (EU) and 915MHz (US) version (aka the “HF” version) of the Heltec Wi-Fi LoRa 32 (V3) board is supported by both MeshCORE (v1.9.0) and Meshtastic (v2.6.11). The Heltec Wi-Fi LoRa 32 (V4) board is also supported by MeshCORE (v.1.9.0), but is only supported as an alpha (pre-release) release for Meshtastic (v2.7.11). Thus, as of November 2025, the V3 boards (+21dBm) will be shipped with Meshtastic (v2.6.11), and the V4 boards (+28dBm) with MeshCORE (v1.9.0).

Obviously the above will change as new versions of MeshCORE and Meshtastic are released, so below is a quick guide on how to install MeshCORE on a V3 (or V4) board should you want to.

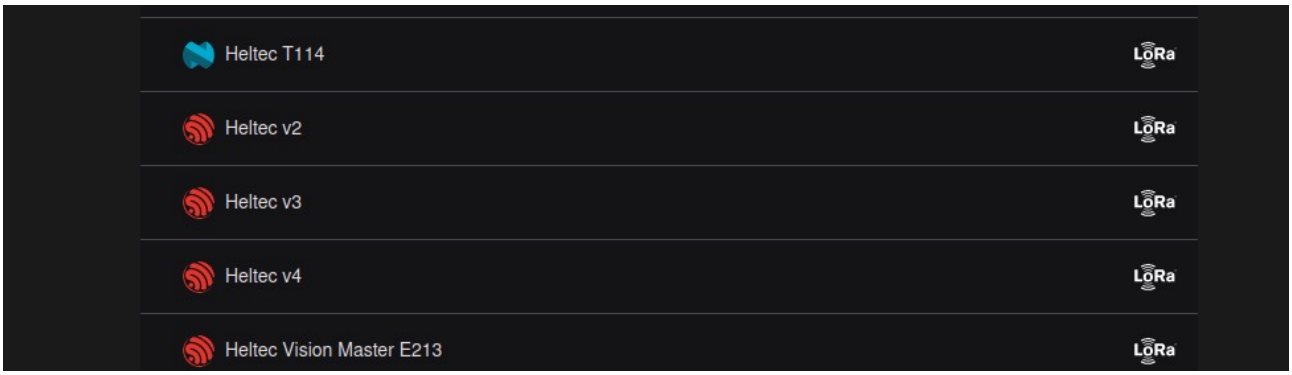
To begin, visit the MeshCORE web flash utility at the following link:

MeshCORE firmware web flasher

To flash MeshCORE on a Heltec LoRa WiFi (V3 or V4) board, you will need to plug it into a Windows or Linux PC using a USB-A to USB-C cable. There is a 90° USB-C adapter plugged into the Heltec LoRa WiFi (V3 or V4) so it does not need to be removed from the carrier PCB. However, **before** plugging anything into the 90° USB-C adapter, please make sure the battery board and Solar panel are disconnected.

To disconnect the battery board, remove the XH 2.54mm (red and black) power connector, and disconnect the solar panel by removing the SP13 (blue and black) connector.

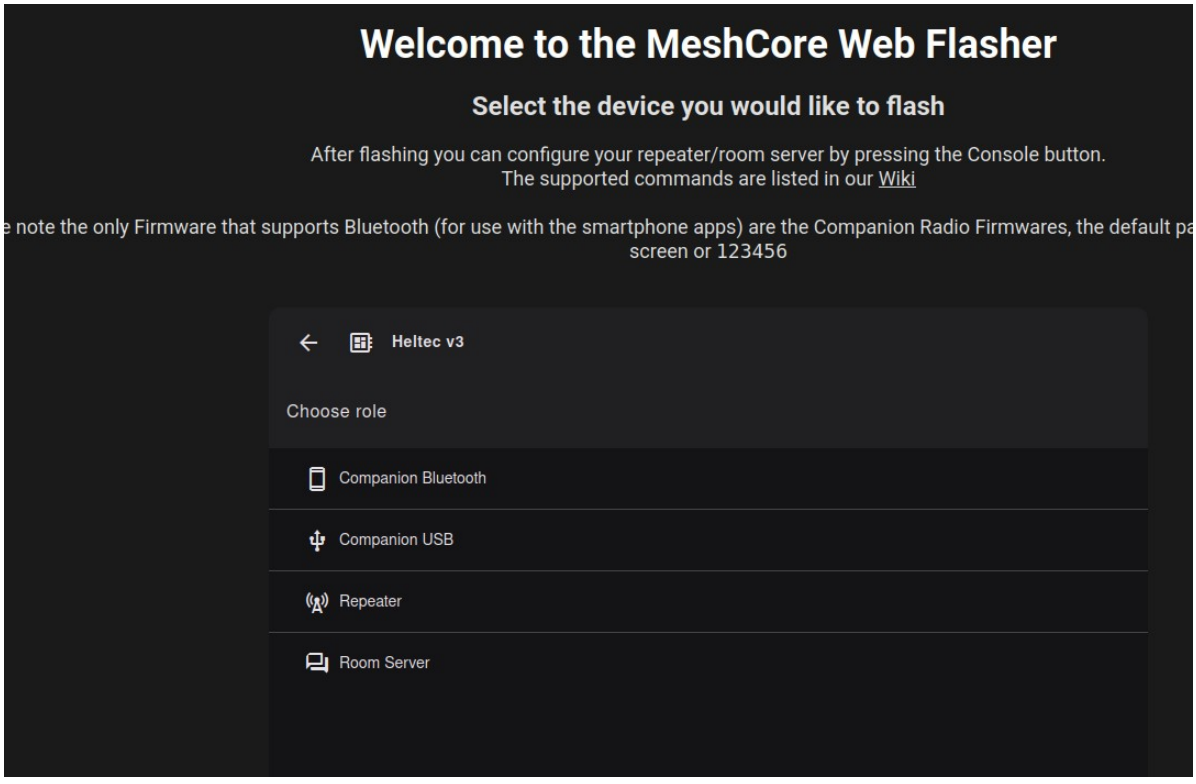
With the Heltec LoRa Wi-Fi (V3 or V4) board plugged in your Windows or Linux PC, it should power up. Next go to the MeshCORE firmware web flasher link above and select either “Heltec V3” or “Heltec V4” as shown below:



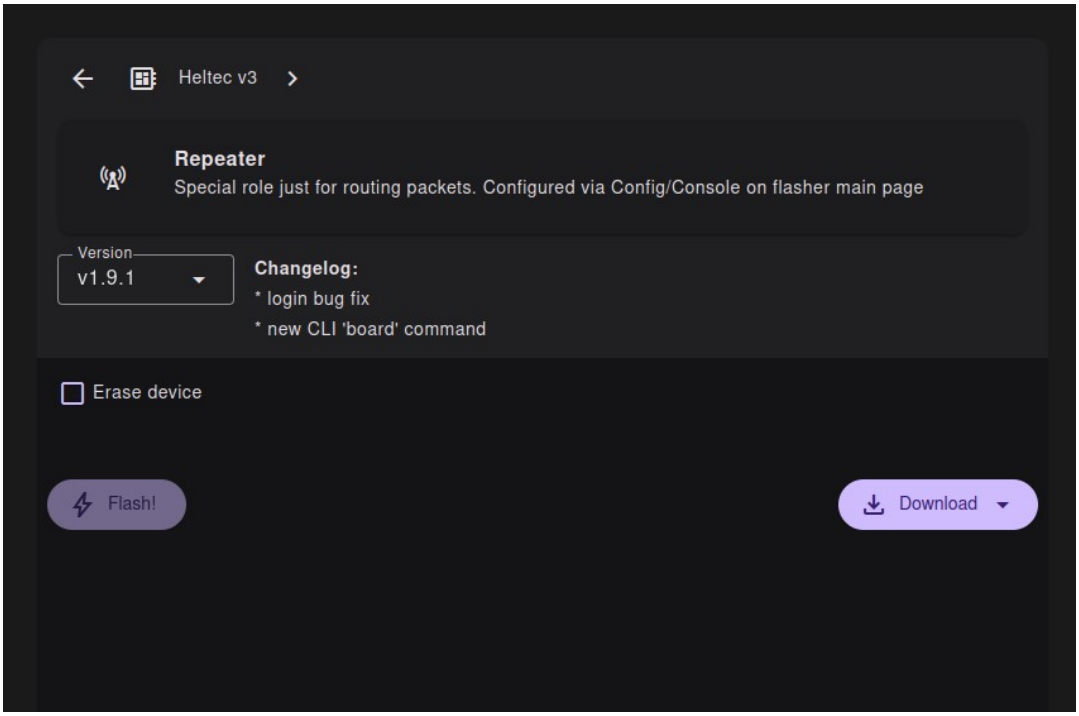
You next need to decide what “role” or mode you want your MeshCORE node to operate in. At this stage I recommend reading the MeshCORE documentation to understand what the various “roles” are.

https://github.com/meshcore-dev/MeshCore/wiki

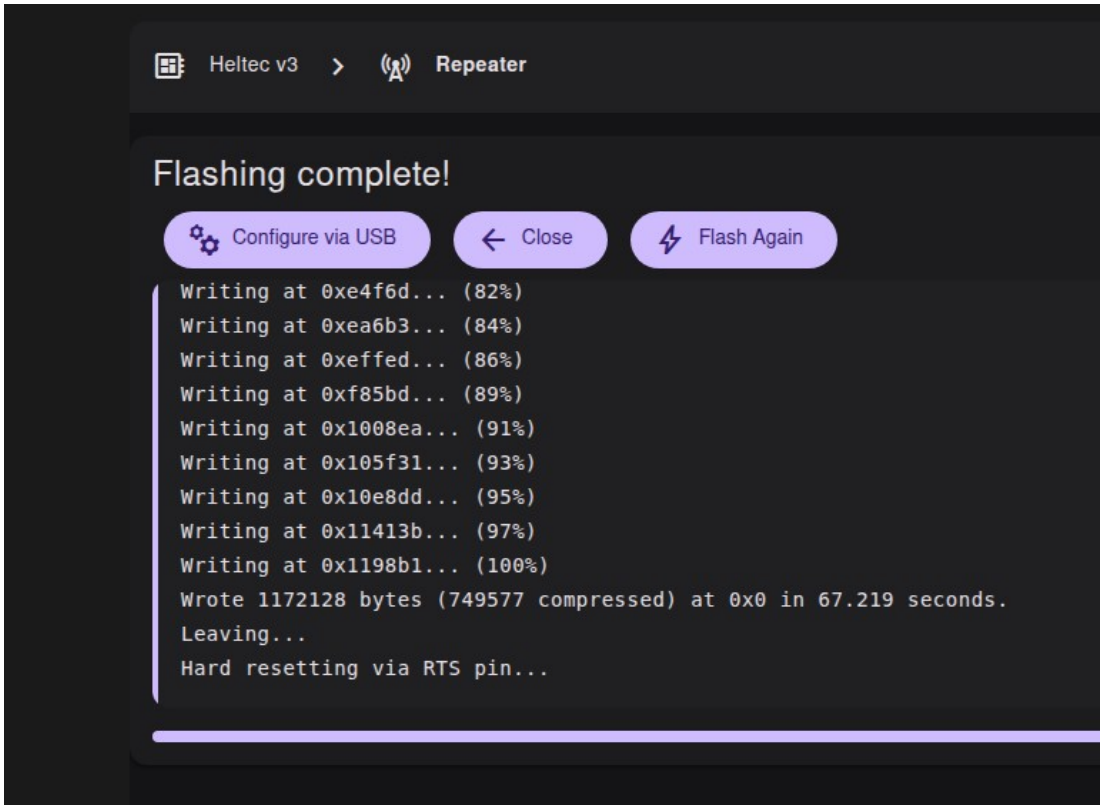
The modes are as show in the screenshot below; they are “Companion Bluetooth”, “Companion USB”, “Repeater” or “Room Server” :



Next you should be presented with a page which looks similar to the one overleaf. It will recommend the latest firmware (v1.9.0 – as of 05/11/25) and then invite you to “Flash!” the firmware. However, before you do this I recommend selecting “Erase device” to ensure that any existing software (e.g. Meshtastic) is erased completely before it attempts to install MeshCORE. If you don’t do this, “Loading …” will be display on the OLED forever.

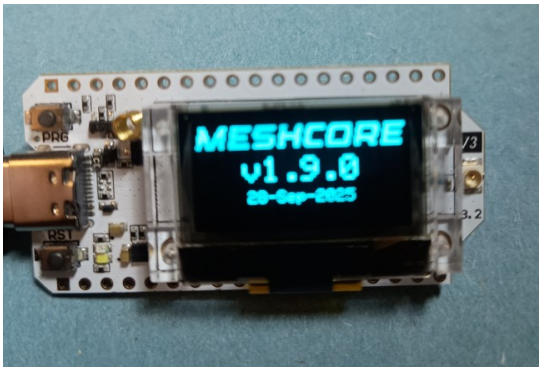


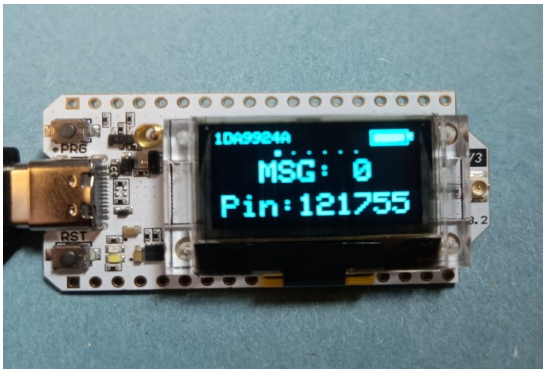
When you click “Flash!” (remember “Erase device” selected) the MeshCORE web flash utility will ask what “serial” port it should be using to communicate with the Heltec LoRa Wi-Fi (V3 or V4) board. Just select the one that has “CP2102 UART to USB bridge” written next to it, and then click “Connect”. It should then start flashing MeshCORE on to your Heltec LoRa Wi-Fi (V3 or V4) board like so:



You will know when the flashing process is complete, when you see “Hard resetting via RTS pin” displayed in the terminal window.

Depending on what “role” you selected, you will see information being displayed on the OLED display. For example, in the “Companion Bluetooth” or “Companion USB” roles, when the flashing process is complete you should see “MESHCORE v1.9.0” pop up on the OLED display, followed by a Pin number.





If you installed “Companion Bluetooth” mode, now is time to download the MeshCORE app from the following link :

MeshCORE Apple iOS and Android Apps

I recommend reading the instructions on the MeshCORE Wiki on how to use it properly before proceeding:

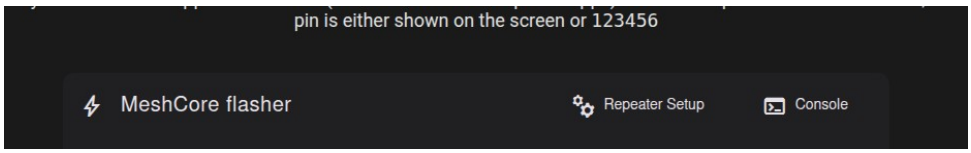
MeshCORE Wiki

Once you’ve read through the MeshCORE Wiki, you next need to tell the MeshCORE app how to communicate (over Bluetooth or USB) with the MeshCORE software now running on the Heltec LoRa Wi-Fi (V3 or V4) board. Next go into your phone settings, enable search for Bluetooth devices, and then select the MeshCORE device it discovers. You will then be promoted to enter the Pin (that is display on the OLED display of the Heltec LoRa Wi-Fi V3 or V4 board) when prompted to do so. You should now be able to use the MeshCORE app to manage your MeshCORE node.

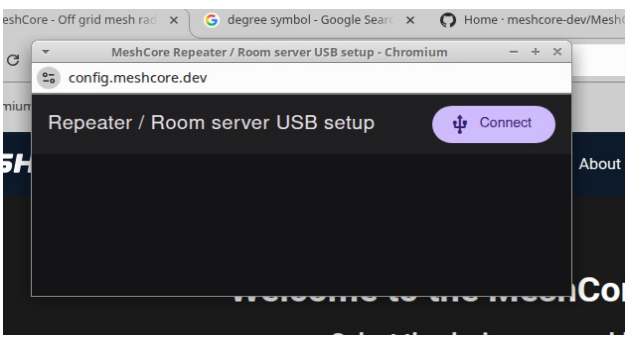
If you installed “Repeater” mode, the final stage is to configure your MeshCORE node to act as a repeater. To begin go to the MeshCORE firmware flash utility:

MeshCORE firmware web flasher

and at the top you will see a “Repeater Setup” button like so:



When you select this, the following window will pop up:

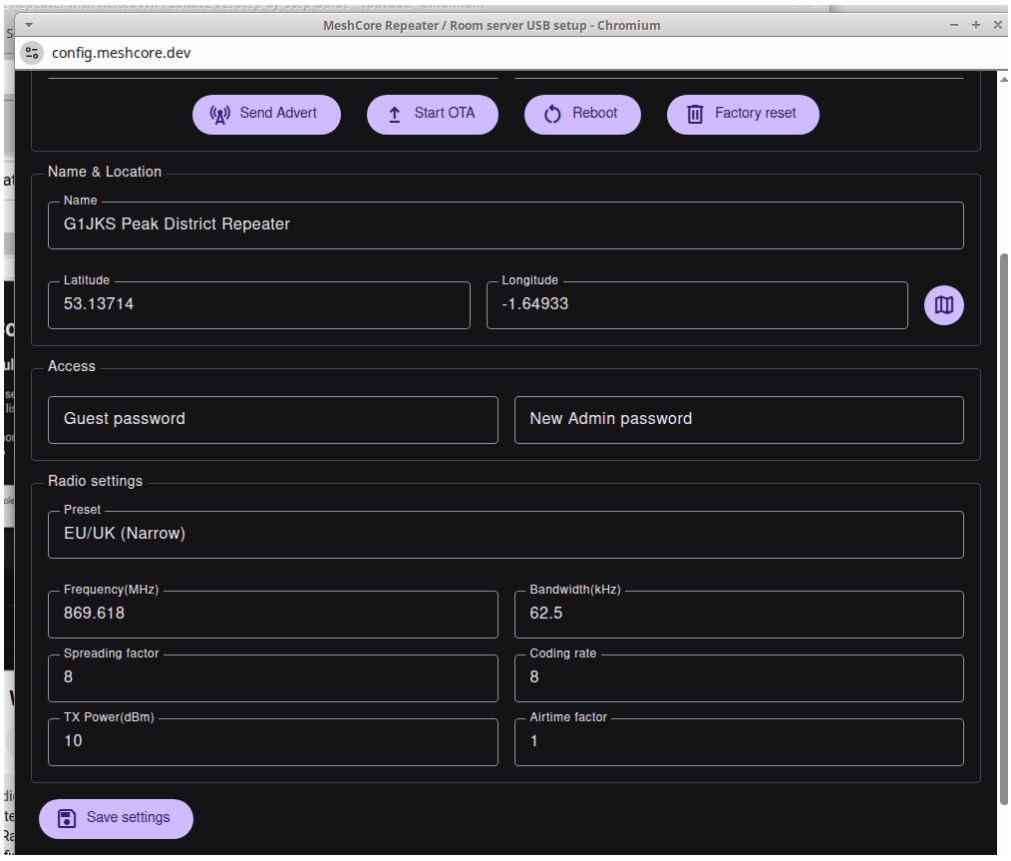


At this stage I recommend disconnecting the USB-C cable from the Heltec Wi-Fi LoRa (V3 or V4) board and then re-inserting it to force a complete reboot. The first time it boots it will display the message “Please wait …..” on the OLED display, as it generates a new public/private key pair.

Please be patient and wait for this to complete before proceeding.

When the “Please wait ….” message is replaced with “Heltec Repeater” as shown above, click the “Connect” button on the pop up browser Configuration window and you will then be ask what “serial” port it should be using to communicate with the Heltec LoRa Wi-Fi (V3 or V4) board. Just select the one that has “CP2102 UART to USB bridge” written next to it, and then click “Connect”.

You should then be presented with the “Repeater / Room server USB setup page” as shown below:



This is the utility that is used to configure your MeshCORE repeater. There’s lots to choose from here, but the main options to change are the “Name”, which is the name of your MeshCORE

repeater, the location (Latitude and Longitude) of your MeshCORE repeater and the Radio Settings; the latter being the most important. For the EU/UK the current recommend settings are EU/UK (Narrow) which configures the SX1262 LoRa modem inside your Heltec LoRa Wi-Fi V3 or V4 board to frequency 869.618MHz, 62.5MHz bandwidth, Spreading Factor (SF) 8, Coding Rate (CR) 8 and TX power level of +10dBm (10mW). For more information on what all this means, and in particular an explanation of the modulation scheme used by LoRa (called Chirp Spread Spectrum) I recommend reading the second paragraph on page 4 of the following document; written for the RSGB by yours truly:

https://github.com/G1JKS/GB1HAB/blob/main/RSGB_LoRA_ARPS_Balloon_Tracker_1.8.pdf

For the Heltec LoRa Wi-Fi (V3) board the TX Power level (in dBm) can be set to anything up to +21dBm (125mW); and for the Heltec LoRa Wi-Fi (V4) board anything up to +28dBm (630mW). However, I urge caution when setting the power level here, as you need to check what is legal for you country. For example, in Ofcom (the UK Spectrum regulator) document IR2030, the maximum output power in the License Exempt Short Range Device (SRDs) 868MHz band for the UK, is 500mW (EIRP). It may be different in your own country, please check.

EIRP (Effective Isotropic Radiated Power) is the combined output power of the transmitter, minus any cable insertion loss, plus the gain of the antenna. If you purchased the 10/25W Solar unit with the Heltec LoRa Wi-Fi V4 board inside, when setting the TX Power level in the MeshCORE configuration utility, it is important to include the +5.5dBi antenna gain in the calculation for the EIRP. If you set the power level to +28dBm, if one assumes the 10cm internal IPEX to N-Type cable has negligible insertion loss, the additional +5.5dBi gain of the antenna will result in an EIRP of +33.5dBm, which is approximately 2200mW (2.2W). This clearly exceeds what is allowed in the UK, Europe and probably in your country; so please check. For the UK I recommend setting the TX power level in the MeshCORE configuration utility to no more than +22dBm, as this, combined with the antenna gain of +5.5dBi results in a EIRP of +27dBm or 500mW! For more details on what is, and what is not permitted in the 868MHz band in the UK, please see the following link for more details.

https://tinyurl.com/bdfcwp7b

The spectrum regulator for your country will also have such a document, so please check it.

Finally, for more information on how to configure a MeshCORE repeater, please take a look at this video on Youtube:

https://www.youtube.com/watch?v=DhgY0K-iA60

Installing Meshtastic v2.6.11 (868MHz/915MHz)

If after doing all the above, you decide you really wanted Meshtastic after all, it also comes with a firmware web flasher utility similar to that used by MeshCORE. You can find it here:

Meshtastic firmware web flasher Utility

It uses the same “esptool.js” JavaScript tool to install firmware on the esp32 processor, so the instructions for Meshtastic are almost identical for those above for MeshCORE. The only difference is Meshtastic does not have different firmware for different “roles”. There is only one version of firmware and the role/mode (e.g. client, router) is configured from the Meshtastic app.

Installing APRS (433MHz)

If you purchased the 10W/25W Solar APRS (433MHz) node, it will come with latest version of APRS iGate software from Richard Gunzman (CA2RXU). This also has a firmware web flasher utility, which you can find here:

Richard Gunzman (CA2RXU) APRS iGate firmware web flasher utility

Best of luck, and any issue get in touch; my e-mail address is at the top of the page. However, before you do, please take the time to read the various online documentation which you can find here:

Meshtastic

MeshCORE

CA2RXU APRS iGate Firmware

73 Dave G1JKS (M0JKS)