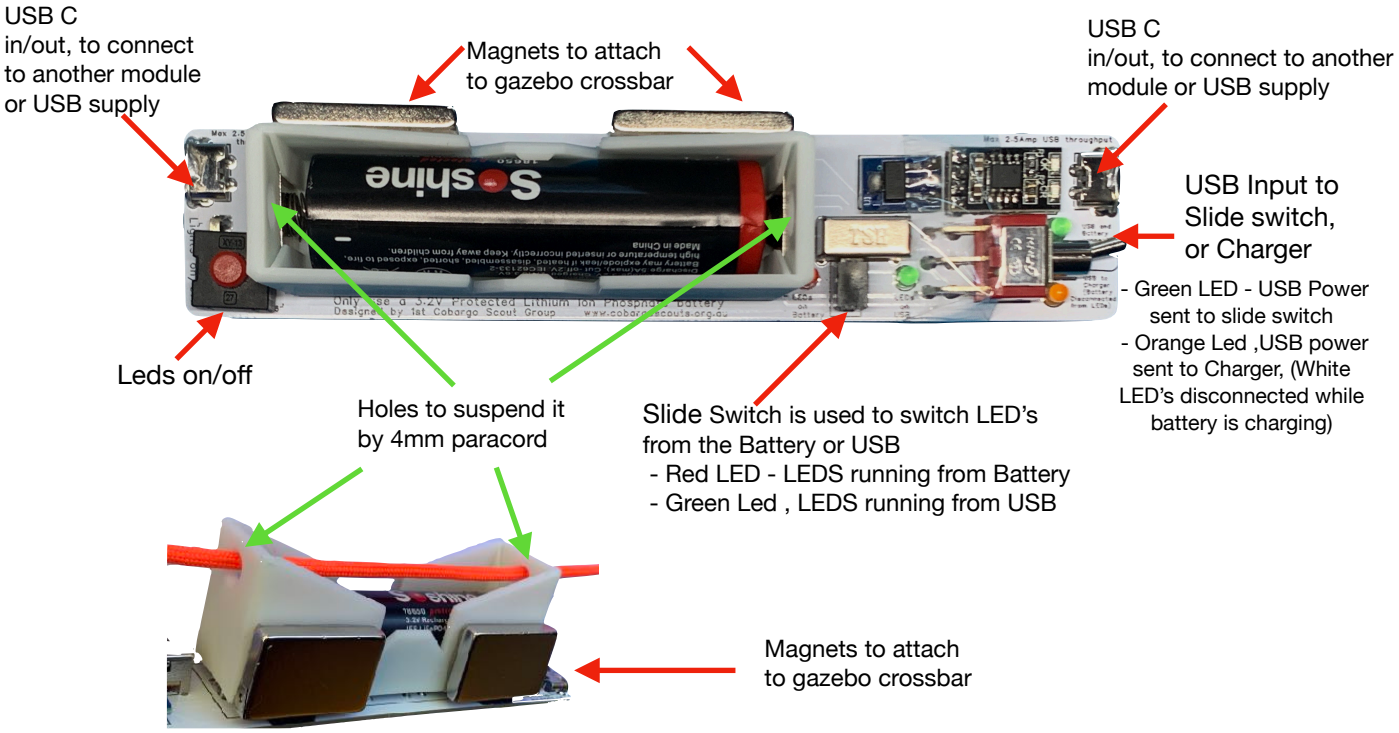
Let There Be light

The instructions for making this kit are not as extensive and clear as the other kits aimed at youth members assembling them.

These instructions assume that the assembler has quite an extensive knowledge of electronics and experience in building kits, and can work out the finer details.

Any questions then email me - Michael
michael.gross@nsw.scouts.com.au or venturers@cobargoscouts.org.au



What it is.

"Let There be light" is a Gazebo lighting system designed for Scout Camps
It can be run off the internal Lithium Ion Phosphate battery and will run for about 10 hours on a charged battery. It can also be run off a USB A connection, (or USB C with a PD adapter).

Each light has 2 USB C sockets. You can use these to Daisy Chain them together and connect them to a single USB A Power Source. This single power source can be used to run the LED's, or charge the batteries. (limits apply - see page 3)

Each module can be attached by Magnets to the Gazebo cross bar, or suspended by 4mm Paracord

********** Safety Notice **********

This circuit has been designed with a 3.2 V Protected Lithium Ion Phospate battery for safety reasons. Please do not redesign this circuity to use a standard lithium ion battery, lets keep it as safe as possible please.

Yes there are pros' and cons to using a lithium ion phosphate battery, but in my opinion the risks of using a standard lithium ion battery outweigh the benefits

Lithium Ion Phosphate is 3.2V, Standard Lithium Ion is 3.7V. The Lithium Ion phosphate also have less that half the amount of usable power (up to 2000mah, compared to 3500mah or greater), But the Lithium ION Phosphate battery has much better chemical and thermal stability which prevents thermal runaway, thereby preventing them from exploding or catching fire. Also the battery I have chosen has an inbuilt protection circuit against overcharging, and over discharge.

NOTE: THE LIPO Charger will get quite warm - do not charge it unattended, this is the same for charging any Lithium ION product.

Call me over protective, but I am a firm believer in Safety 1st, so please only use the protected lithium ion phosphate battery i have recommended. Also the battery holder has been specifically designed to accomodate the length of this protected battery.

Powering it from USB A or C

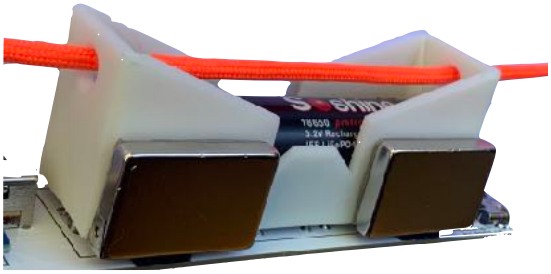
Note: You will need to use a USB A to C Cable on the 1st module to connect to a power source as there is no USB PD Module on the boards, so they will not activate a USB C power source.

If you want to connect to a USB C power source, you will need a USB A to C adapter with a built in PD module. See the parts list for a suggested cable to use.

To Daisy chain the modules together you need a USB C to USB C Cable

Mounting options

Each module has magnets on the side of the battery holder, these can be used to attach either to the crossbar on a gazebo, or other Ferris materials. The battery holder also has a hole at each end that you can use to thread 4mm paracord through if you need to hang the lights individually or in a long line..



Daisy Chain

The Maximum recommended Cable length is about 12M is due to voltage drop issues
The number of modules that can be daisy chained together depend on 3 factors

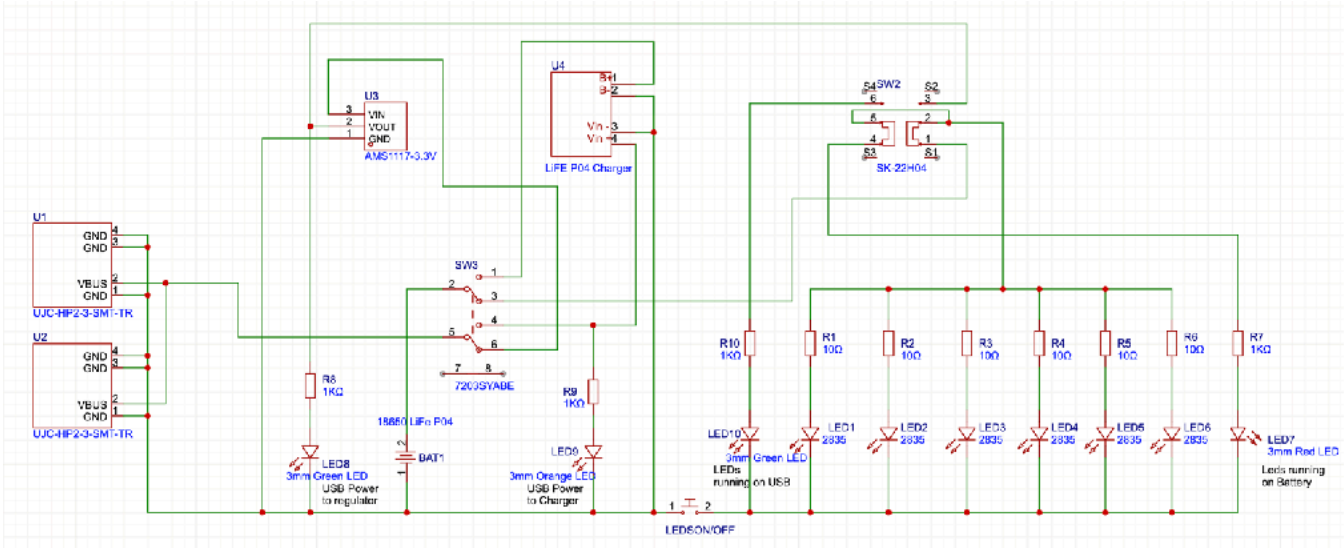
1) Total Cable length (from USB A source to last Module)
2) Whether all modules are running the LEDS from USB (Approx 200- 240ma max per device)
3) Whether you are charging the batteries (Approx 500 MA per device - need to strap this on the module). Note: LED's are disconnected on modules that are charging the battery.
4) With 4 modules (powering the LEDS) with 3M cables between them, and 3M cable from the 1st module to the USB A connection, they will all work ok, the last one will be a little dimmer, but still quite usable. Any more than this and you will notice a distinct drop in brightness.

Voltage drop issues
It is important that the last module on the daisy chain has a minimum voltage on it of at least 4.3V for the AMS1117 3.3v regulator to still supply 3.3V. If unsure, measure the voltage at the pins on the back of the USB socket of the last module in the chain. If the Voltage is lower than 4.3V on the USB C socket on any modules, then the LEDS on that module will be dimmer as the AMS1117 regulator can not provide the required 3.3V output. It will still work, it will just be dimmer.

5) When charging the batteries in a chain, with 3M cables, 2 modules works ok.

Current limits
The tracks between the USB C sockets on the board are rated at 2.5A, please keep well below this limit. You can use a USB charge tester to measure current drain if necessary.

Circuit Diagram



Component specifications, assembly and notes

Charger

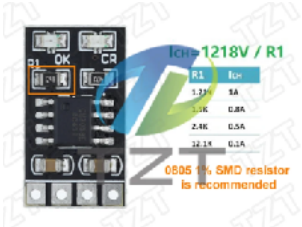
The battery Charger is based on a CN3058, this IC is specifically designed to only charge 3.2v lithium Ion Phosphate batteries
See the following for specifications on the IC.
https://www.mikrocontroller.net/attachment/519010/DSE-CN3058E.pdf

Link to Charger board on Aliexpress

https://www.aliexpress.com/item/1005006297281091.html?spm=a2g0o.order_list.order_list_main.118.f3181802qWhrKE

Note: The charger is capable of delivering up to 1A. Please strap this as follows to limit it to 500ma max, so you do not exceed the ratings of the USB C socket if you daisy chain the modules to charge the batteries. The USB C sockets have a max current limit throughput of 3A, but its best to derate it and keep the max current through the USB port to below 2.5A

Replace R1 with a 2.4K 0805 1% SMD resistor, this will limit it to 500ma charge current.



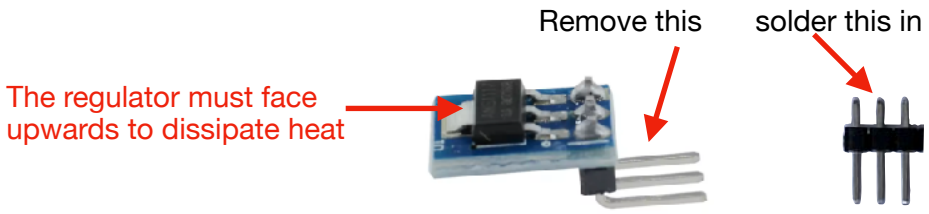
You will also need to solder a straight 4 pin 2.54mm pin header onto the board so it sits flat onto the PCB

The IC must face upwards to dissipate heat

Voltage regulator

The 5V to 3.3 V Voltage regulator module is a low dropout linear voltage regulator, based on an AMS1117 and can handle a max current of 800ma

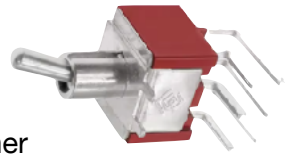
This board must sit flat on the PCB, so you will need to desolder the right angle pin header and solder in a straight pin header.



Switches

There are 3 switches in this project

1) Toggle switch, this is a 3A DPDT right angle switch. The Max current that will be put through it is the charger current of 500ma. Its part number is MTS-202C3 (7mm length shaft)



In one position (towards the USB C socket) This Switch is used to feed the USB input to the 3.3V regulator, so that its available to run the LEDS. In the other position, it disconnect the LEDS and feeds the USB power to the battery charger

2) Slide switch.

This is used to switch power to the LEDS, between either the battery or the 3.3V regulator from USB. Its part number is SK-22H04. it has a shank height of 8mm.

This is a DPDT switch capable of handling 300ma at 30V. The Max current will be about 240ma at 3.3 v from the LEDS

NOTE: This is a Non-Shorting switch, also know as a “Break before Make” switch. When you move this switch, it disconnects the 1st set of contacts before connecting the 2nd set. This is important so that you are not potentially shorting the battery to the regulator, even for a fraction of a second. So if you substitute this with with another brand, you must ensure that it can handle the current and be a non-shorting switch.

3) Push Button switch
This is used to turn the LED's on and off. it is rated at 1A at 30V

Tape required for the push button Switch

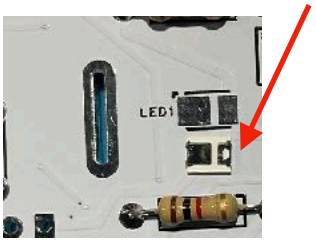
These switches only have pins on one side, so if they get knocked they may lift up.
Ideally a piece of 3M VHB tape under them will help prevent this. Note 3M VHB tapes can take up to 72 hours to achieve full bonding strength, so the initial bond will be quite weak.

- Use 0.8mm tape, part number - 3M VHB 5608 tape (0.8mm thick) 10-12mm wide
- See the parts list for a link to purchase this.

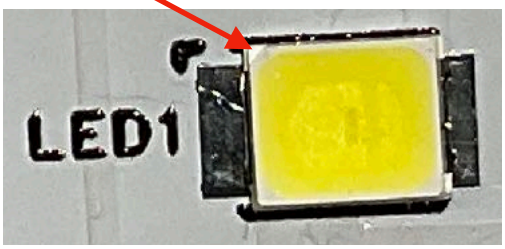
LEDS

The LEDS are 3v 120 degree, 60ma 2835 LEDS. They can handle 60ma, but the current is limited with a 10ohm resistor to approximately 40ma each, to derate them and ensure longevity.
I have increased the solder pad size to make it easier to solder them in.

Note the LED Orientation before you solder them in



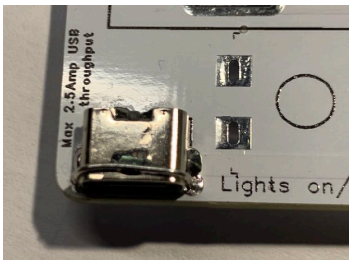
There is a slight notch on one corner, that should go to the top left

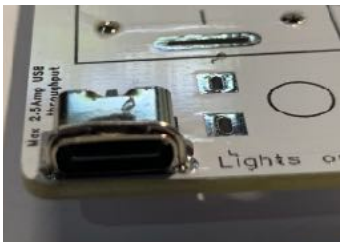


USB C socket and tracks

The USB Socket is rated at 3A at 5V, for safety purposes, i recommend that you do not exceed 2.5A. You will rarely get to this current anyway, as the lengths of cable you use will have a high voltage drop that will make putting too many devices on one link impractical anyway.
The sides of the USB socket is soldered to the board, to try and stop it from being broken off the board.

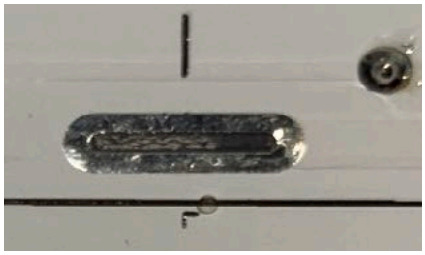
NOTE: There is an extra 2 holes at the front of the board, one each side of the usb socket. It is important to solder a length of solid wire (leftover from a resistor will do), over the USB socket and into the 2 holes. Pull it tight before soldering it in and put a drop of solder on the top of the USB to keep the wire in place. This will add considerable strength to the USB C socket and make it quite hard to pull off the board.





Magnets

The Magnets are 30mm*20mm*4mm. I have placed 2 orders from different suppliers and the actual thickness varies from 3.1mm on one order to 4.1 on another. The board has a slot for the battery holder contact to be adjusted before soldering in to accomodate the different magnet thicknesses, so that the magnets do not hang too far over the edge of the board.



Cover the entire surface of one side of the magnets with the 0.8mm 3M VHB tape (see parts list).
Note: the initial bond strength is very weak, and you need to pull the backing cover off slowly as the tape may come away from the magnet.
This tape takes up to 72 hours to fully cure, at which point its very hard to remove. It is used in construction to replace screws and nails in some situations. So let it cure before putting it to the test.
NOTE: Try not to touch the side of the magnet, or battery holder you are putting the tape on, as the oils from your fingers will weaken the tape bond strength.

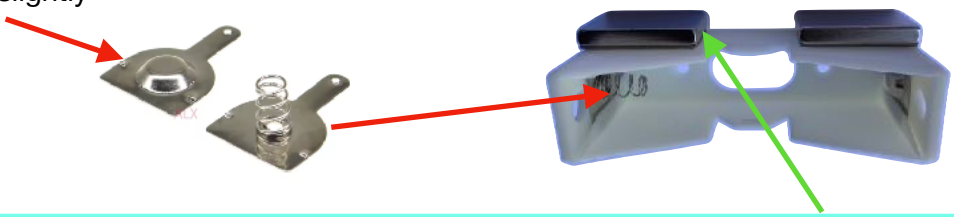
The Magnets need to be stuck onto the side of the battery holder as follows, do this before putting the battery holder into the board, as you have to align the magnets to be just over the edge of the board.

Battery holder, clips and tape
The battery holder is 3D printed. I ordered these from JLCPCB https://jlcpcb.com/

Ordering the battery holder
I chose the following parameters. The JLC Temp Resin, has a heat deflection temperature of 101 degrees, others have much lower temperature, it can get hot in mid summer under a Gazebo, hence the reason i chose this resin.

Flattening the pins and putting them in
Flatten the 4 locking pins just a little bit, with a pair of pliers just a little to make it easier to get them into the battery holder, and then put them into the battery holder. The Spring end is the negative contact.

Flatten slightly



NOTE: The Location of the battery pins relative to the Magnets. With the Magnets on the Top, the Battery pin with the Spring must go on the left , so that the battery holder goes in the board the right way and the magnets hang over the correct side of the board.

Put 2 strips of 2mm thick double sided foam tape on the bottom of the battery holder. (See parts list for the tape)

Battery holder installation instructions continued on next page.

Installing the battery holder - the right way round

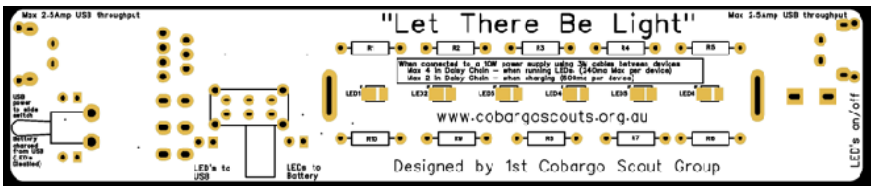
Take the red cover off the tape on the bottom of the battery holder, put the pins through the board and align the magnets, so that they are just hanging over the edge of the board by about 1mm, before sticking the battery holder to the board and soldering it in.

Note: The overhang is important so that the magnets will sit flush with whatever they are attached to.

NOTE: The magnet must be on the same side of the board, as the “Let There Be Light” title on the front of the board, and hang over the edge of the board by about 1mm. (So ensure you put the battery contacts in the right end)

Ordering the board

NOTE: When you order the board, order it in a **white colour,** this will help to reflect the LED Light and provide more illumination



Turn over the page for the Insulation instructions

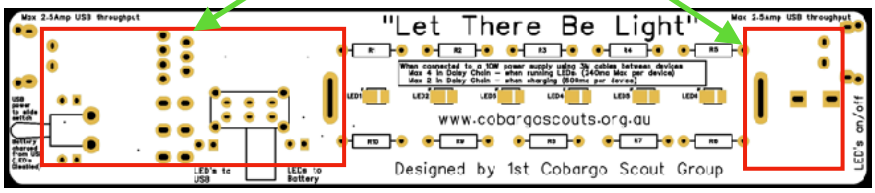
Insulate, Insulate, Insulate - Yes its important, don't miss this step !!!!

A shorted battery can supply a lot of current that translates to heat and issues !!!
So you must insulate the modules as below.

STEP 1 - Front of the board

You need to cover 2 sections on the front of the board with Foam tape
I used 25mm Purlin tape (get it at any hardware), but you will find similar 3m thick foam tapes online that are suitable.

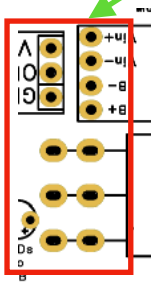
Cover the following 2 areas



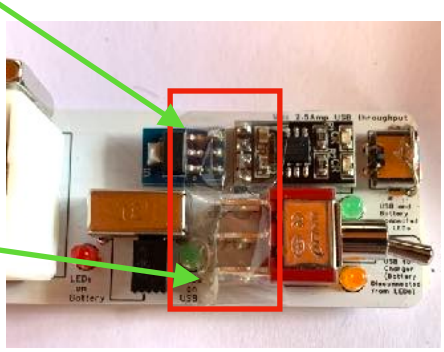
STEP 2 - Back of the board

You need to cover the pins of the Toggle Switch, as well as the contacts on the regulator and charger. To do this use a piece of 15mm Kapton Tape or other suitable Antistatic, non conductive, high temperature tape.

Cover all these pins, as well as the pins on the bottom of the AMS1117 regulator.



Just push the tape down between the green LED and the toggle switch so that the LED is not covered



The Pin Header pins and the pins at the bottom of the AMS1117 must both be covered by tape.

Assembly procedure checklist

1. 6 - Leds - check orientation
2. Resistors 1-6 , 10 ohm
3. Resistors 7-10, 1K ohm
4. USB C Connectors, Solder in
   - 2 power pins
   - 2 Side case pIns
   - Add wire loop over the top, and solder to the case and board
5. Push button on/off switch
   - Add 0.8mm VHB tape to the bottom
6. Slide switch
7. Toggle switch
   - Remember to solder in the front 2 locking pins
8. Coloured Led's
   - Refer to the picture on page 1 for locations and colours.
9. LIPO charger
   - Strap to 500ma - replace R1with a 2.4K 0805 1% SMD
   - Solder in a straight pin header, ensuring that the IC is upwards
10. Regulator (AMS1117 module)
    - Remove the right angle pin header and solder in a straight pin header, keeping the regulator on top to allow it to dissipate heat.
11. Battery holder
    - Cover the magnets with the 0.8mm VHB tape.
    - Stick the magnets to the Battery holder
    - Flatten the Battery socket locking pins a little.
    - Put the pins into the correct end - see page 8
    - Put two strips of the 2mm VHB tape onto the bottom of the battery holder
    - Remove the cover of the VHB tape and put the battery holder into the board with the Magnets hanging 1mm over the edge. Ensure that its round the right way - see page 9.
12. Put 2 pieces of Purlin tape over the front of the board - see page 10.
13. Put a piece of Kapton tape over the back of the board - see page 10.
14. Power it up and test

Test sequence - Battery running LEDS

1. Put in a battery
2. Move the Toggle switch to the Green Led (USB socket Side). (The White LEDS are enabled in this position)
3. Move the slide Switch to the left (near red led)
4. Press the pushbutton on and off , the LEDs should go on and off and the red LED to the left of the slide switch will illuminate when the LEDS are on.
5. Check Current drain with a multimeter, it should be 200-240ma approx.

Test sequence - USB C Running LEDS

1. Move the Toggle switch to the Green Led (USB socket Side). (The White LEDS are enabled in this position)
2. Connect a USB C cable to the Module, and plug the other end (USB A), into a USB Power pack. Green LED, by the toggle switch should come on to indicate that there is 5V in via the USB. The RED LED under the 3.3V regulator should also illuminate.
3. Move the slide to the right (Green LED)
4. Press the pushbutton on and off , the LEDS should go on and off and the Green LED, to the right of the slide switch will illuminate, when the LEDS are on.
5. Plug the USB C cable into the USB C socket on the other end of the module. Repeat the test above, this tests whether the other socket also works.
6. Check Current drain with a USB inline USB meter, it should be 200-240ma approx. There is quite a variance in current drain between individual LEDS.

Test sequence - USB C Charging the battery

1. Connect a USB C cable to the Module, and plug the other end (USB A), into a USB Power pack.
2. Move the Toggle Switch to the position near the Orange LED. The Orange LED will illuminate. (Note the White LEDs will not work in this position).
3. The “CR” LED on the LIPO Charger will illuminate when charging.
   NOTE: THE LIPO Charger will get quite warm - do not charge it unattended,
4. When the battery is charged the CR LED will go out and the “OK” LED will illuminate.
5. If there is no battery installed, then the “OK” LED will also illuminate.
6. Check Current drain with a USB inline meter, it should be 500ma approx, when the battery is flat but will taper off and eventually down to 0ma when the battery is charged. It may take 4 or so hours to fully charge a flat 2000ma LIPO Battery.