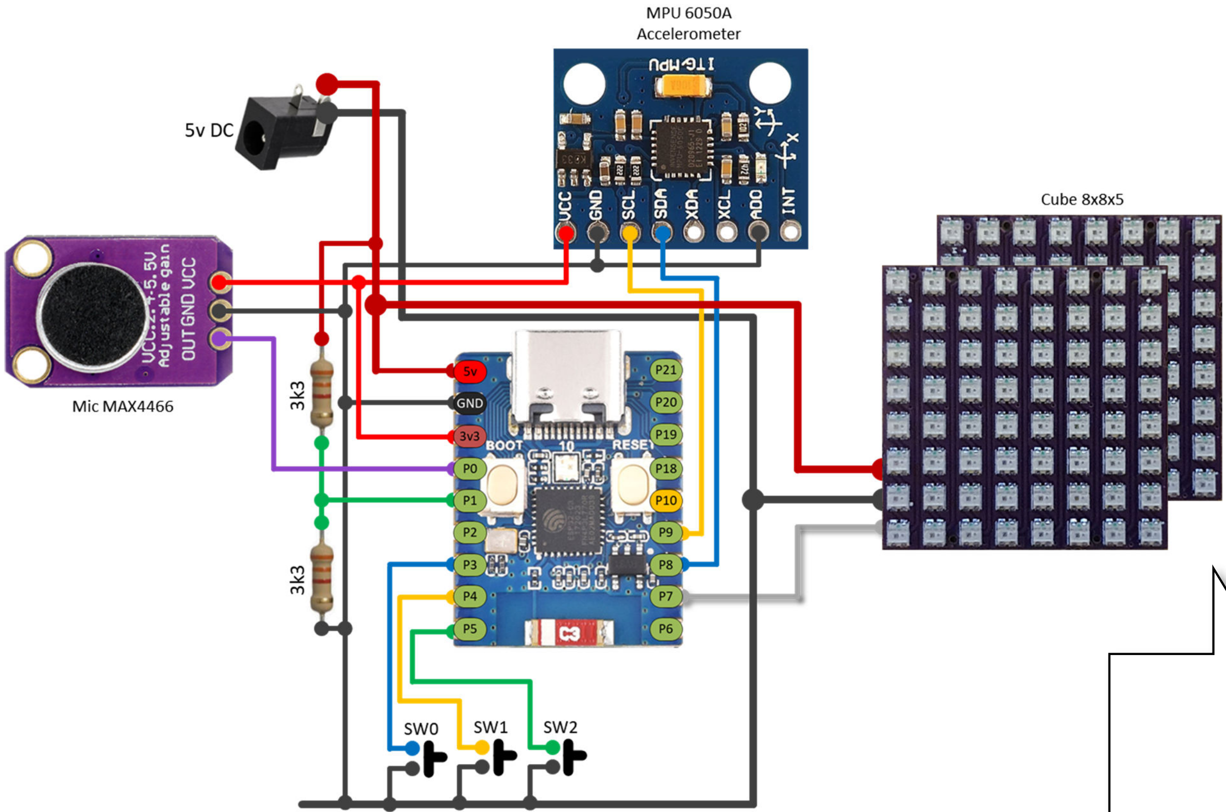
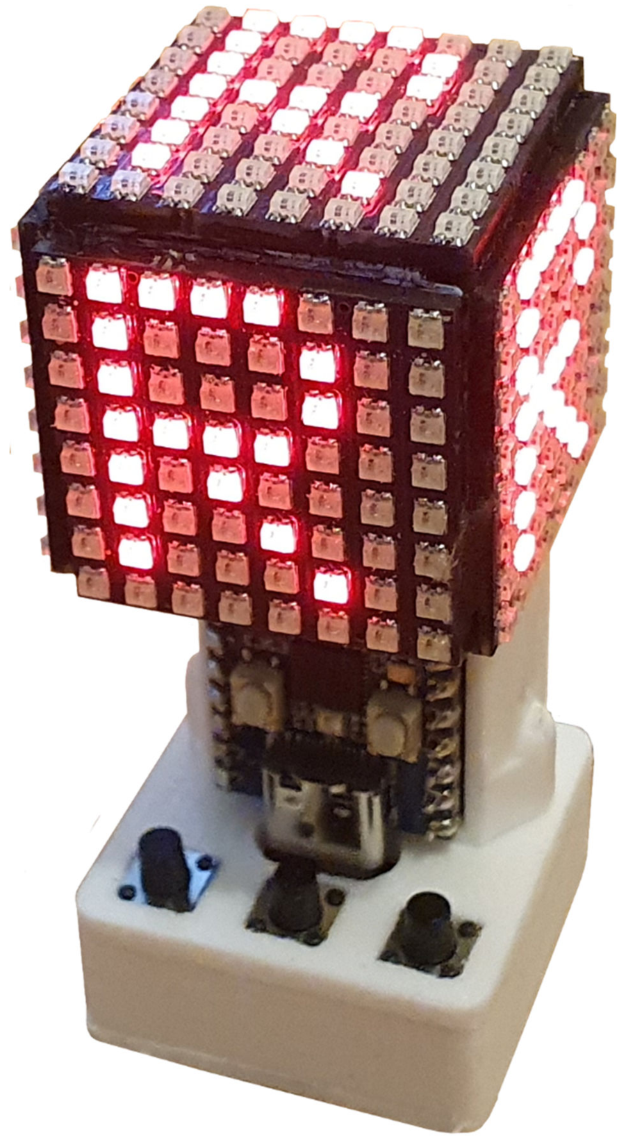
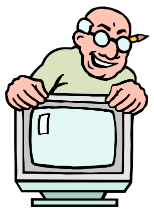
Cube 8x8x5 HD

Circuits & Wiring







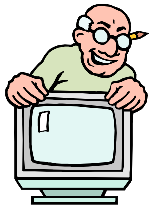
Read through this documentation completely <u>before</u> attempting this project.
The construction in parts is quite tricky, to say the least.

Issue: 1.2 Released: 29/01/2025 TechKnowTone

Hand Tools:

Recommended:

- Fine nosed pliers
- Side cutters
- 1.5 mm Drill
- 2.0 mm Drill
- 4.0 mm Drill
- Needle files
- Screwdrivers
- Craft knife

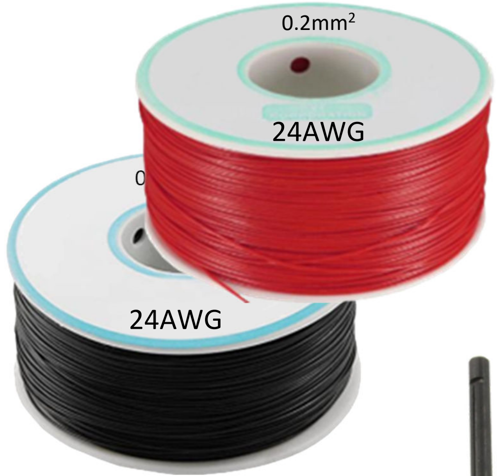


Note: Not all items needed are shown here.

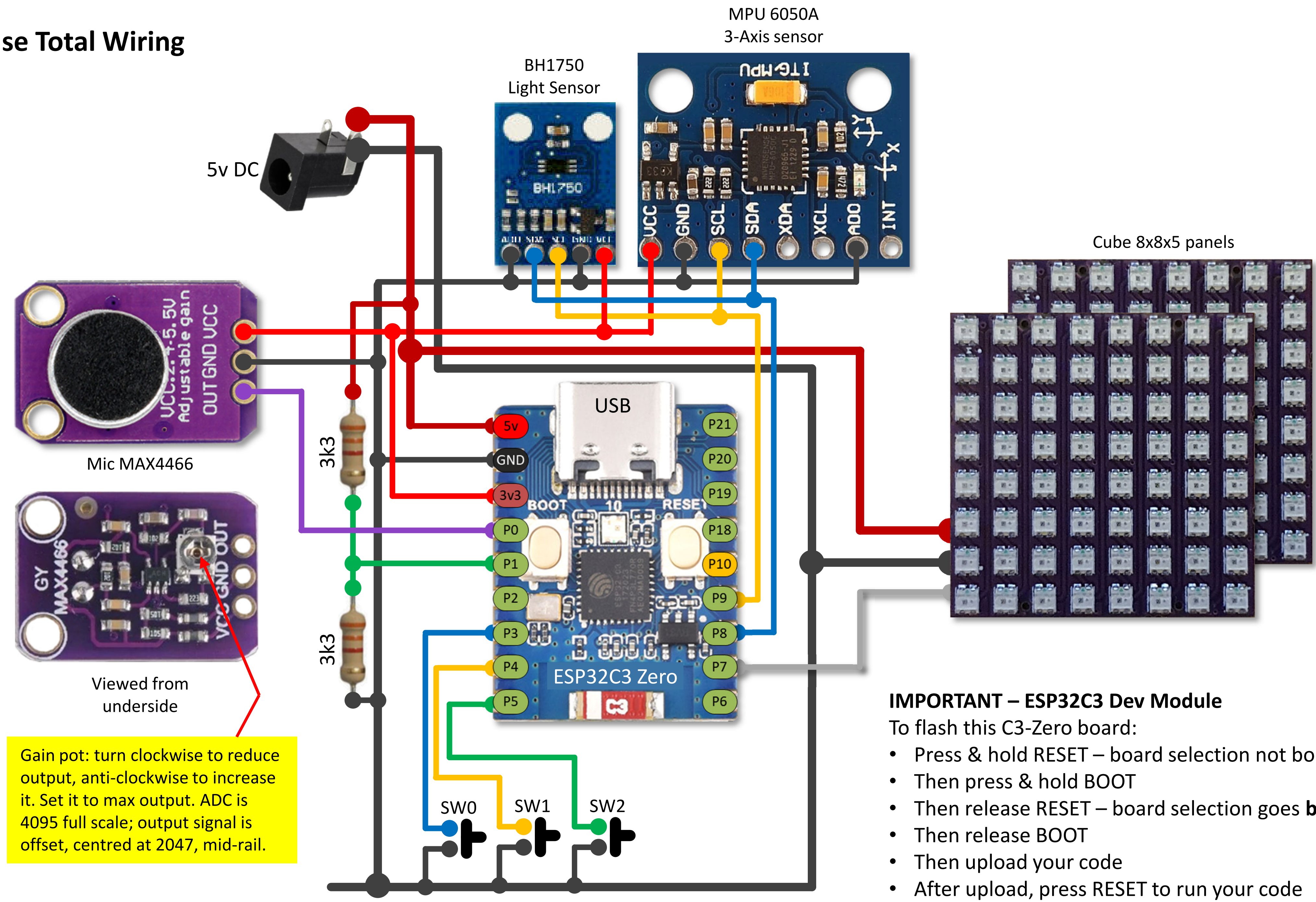
Some printed components act as aids and gauges. Use them.

Tools & Materials:

60W Temperature controlled iron
Solder flux resin
Resin cored solder
Hot melt glue gun {optional)
2-part epoxy resin glue
Screw drivers
Wire wrapping tool
Wire wrapping wire 30 AWG
24 AWG stranded wire (red & black)
Multimeter



Base Total Wiring



Gain pot: turn clockwise to reduce output, anti-clockwise to increase it. Set it to max output. ADC is 4095 full scale; output signal is offset, centred at 2047, mid-rail.

IMPORTANT – ESP32C3 Dev Module

To flash this C3-Zero board:

- Press & hold RESET – board selection not bold
- Then press & hold BOOT
- Then release RESET – board selection goes **bold**
- Then release BOOT
- Then upload your code
- After upload, press RESET to run your code

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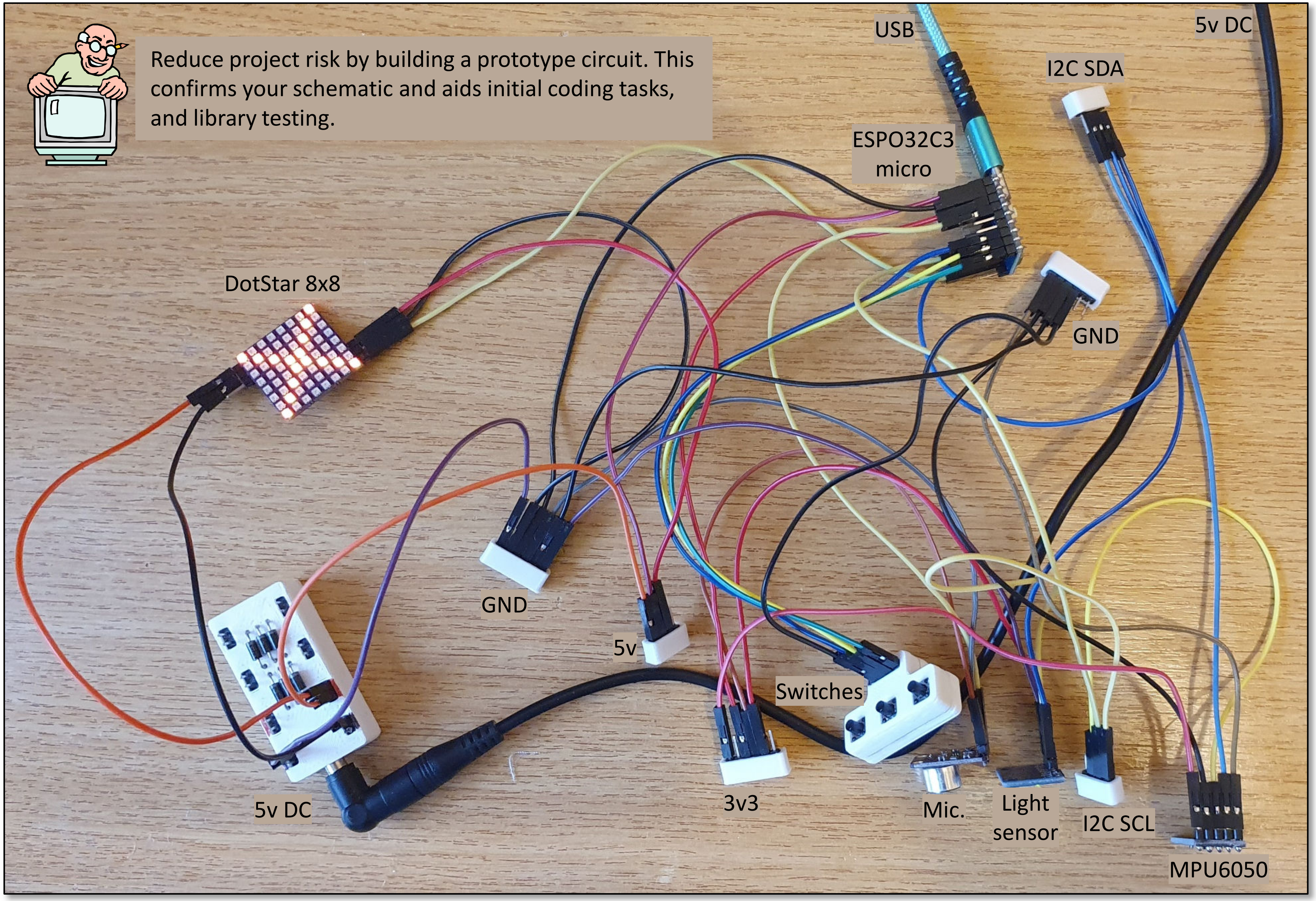
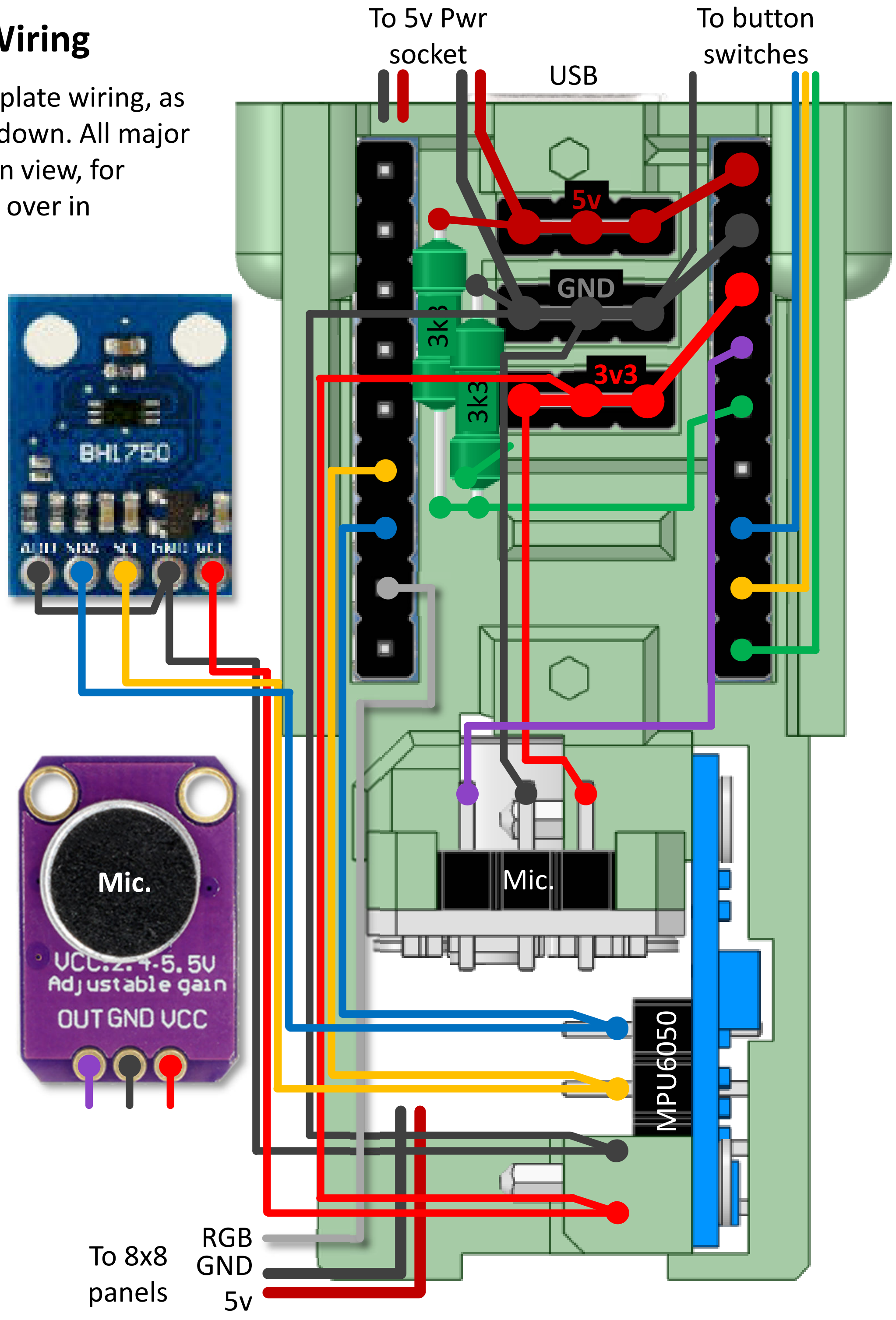
Design Prototyping

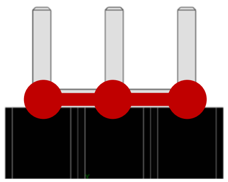


Front Plate Column Wiring

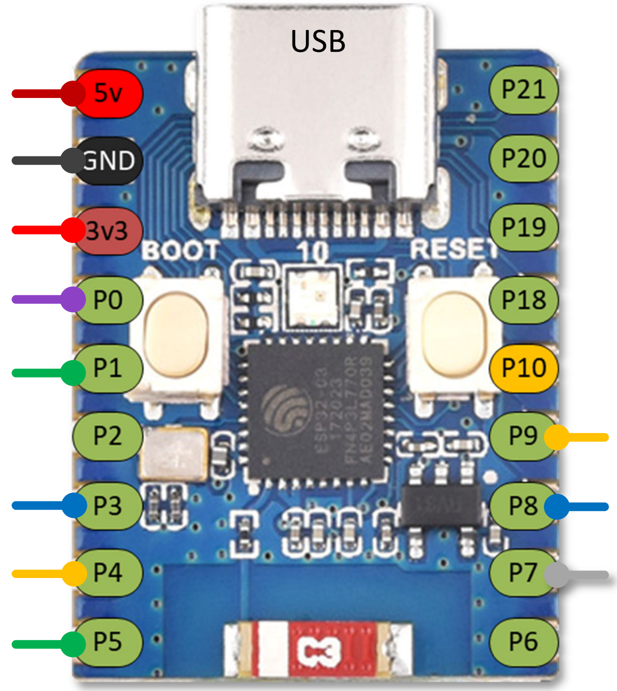
This diagram shows the front plate wiring, as viewed from the rear, upside down. All major components are shown in plan view, for reference, but may be flipped over in practise.



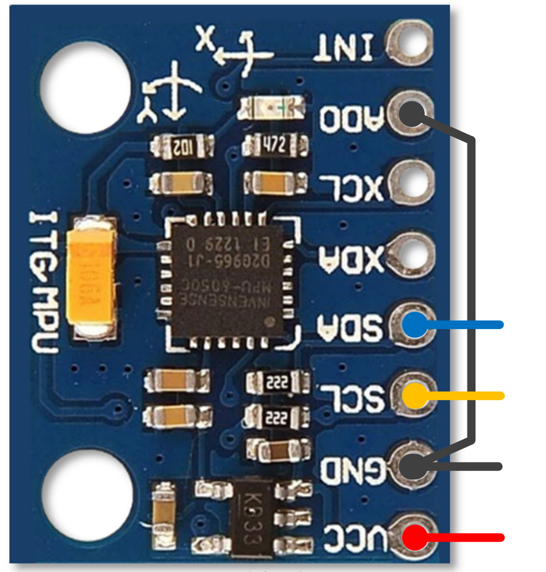
The three common connection points, 5v, GND and 3v3 are made from pin strips. The pins are pushed through the base, so that they are flush with the plastic body, then soldered together with wire, and cropped to size, once mounted.



Note: keep pins as short as possible. There is very limited space in this design. Always crop them back once wiring and soldering are complete.



ESP32C3

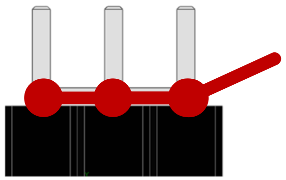


MPU6050

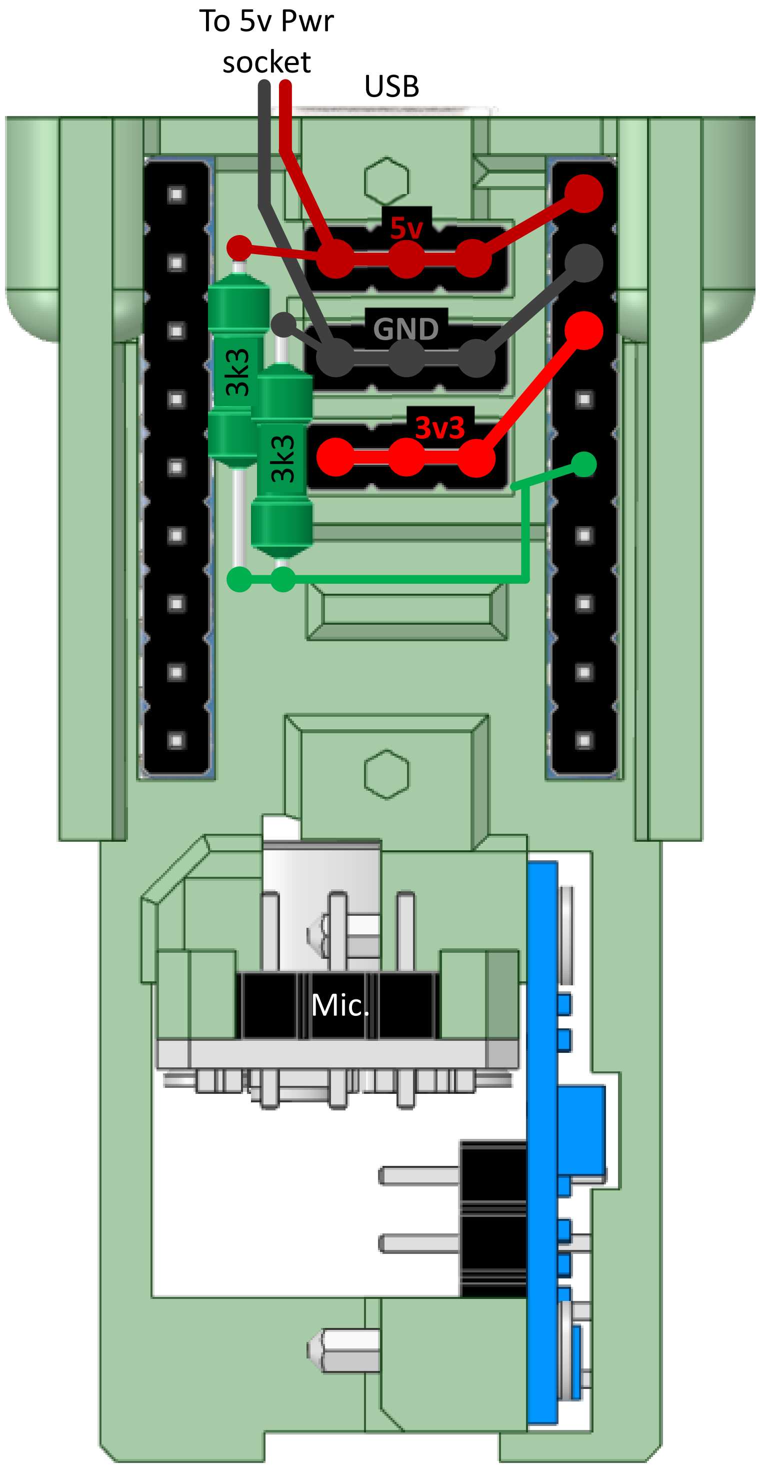
Front Plate Wiring – Step 1

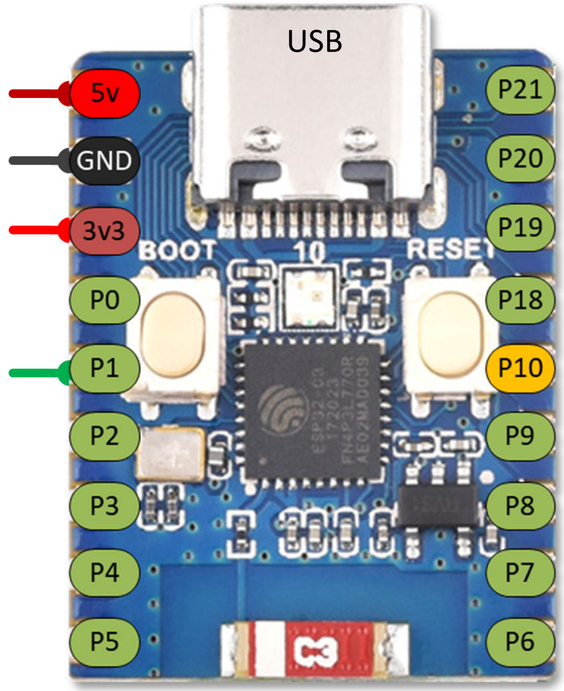
With the ESP32C3 Zero micro glued into position, along with the mount for the microphone sensor, and the two 3k3 resistors, wire up the three common supply lines and the resistors as shown.

The three common connection points, 5v, GND and 3v3 are made from pin strips. The pins a re pushed through the plastic bases, so that they are flush with them. Then the pins are soldered together with wire, from the micro, and cropped to size.



Wires are attached to the 5v and GND points, with sufficient length to feed through into the base, and connect to the power socket.





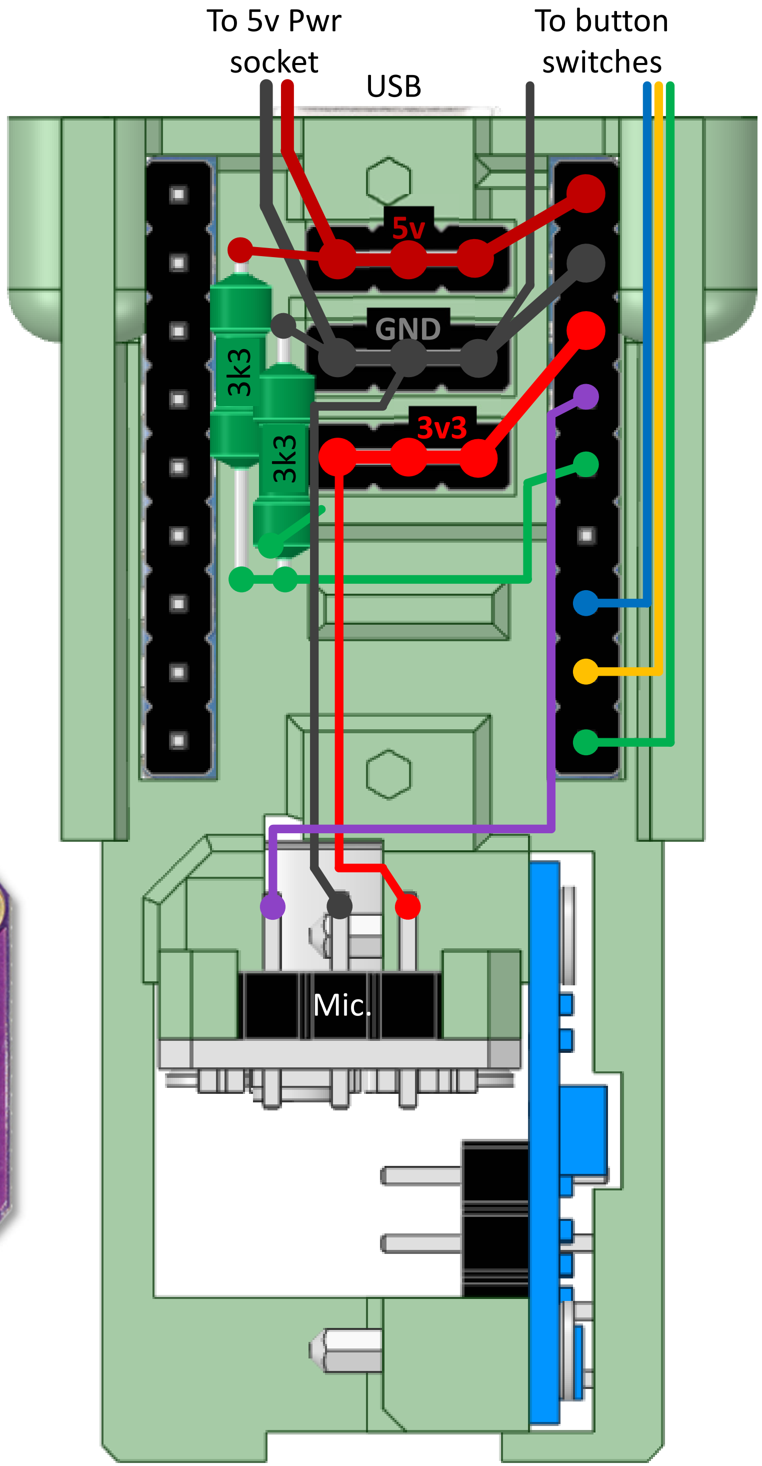
ESP32C3

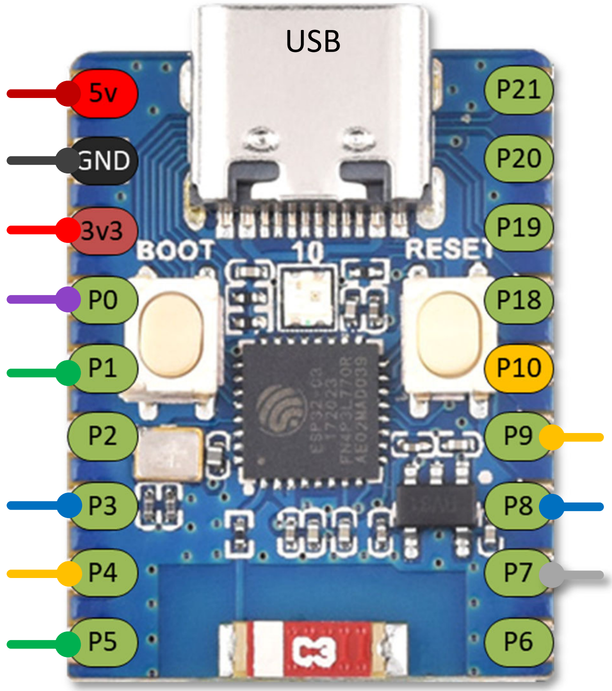
Front Plate Wiring – Step 2

Next attach wires to the GND and the three switch input connection points, with sufficient length to reach the switches in the base; to be connected later.

Then wire up three the microphone connections, using wire-wrap wire. Then solder the joints, <u>before</u> attaching it to its mount with two screws. And then complete the wiring to the micro and common power points, GND and 3v3.

Ensure the wires are long enough <u>before</u> soldering onto the mic pcb.





ESP32C3

Front Plate Wiring – Step 3

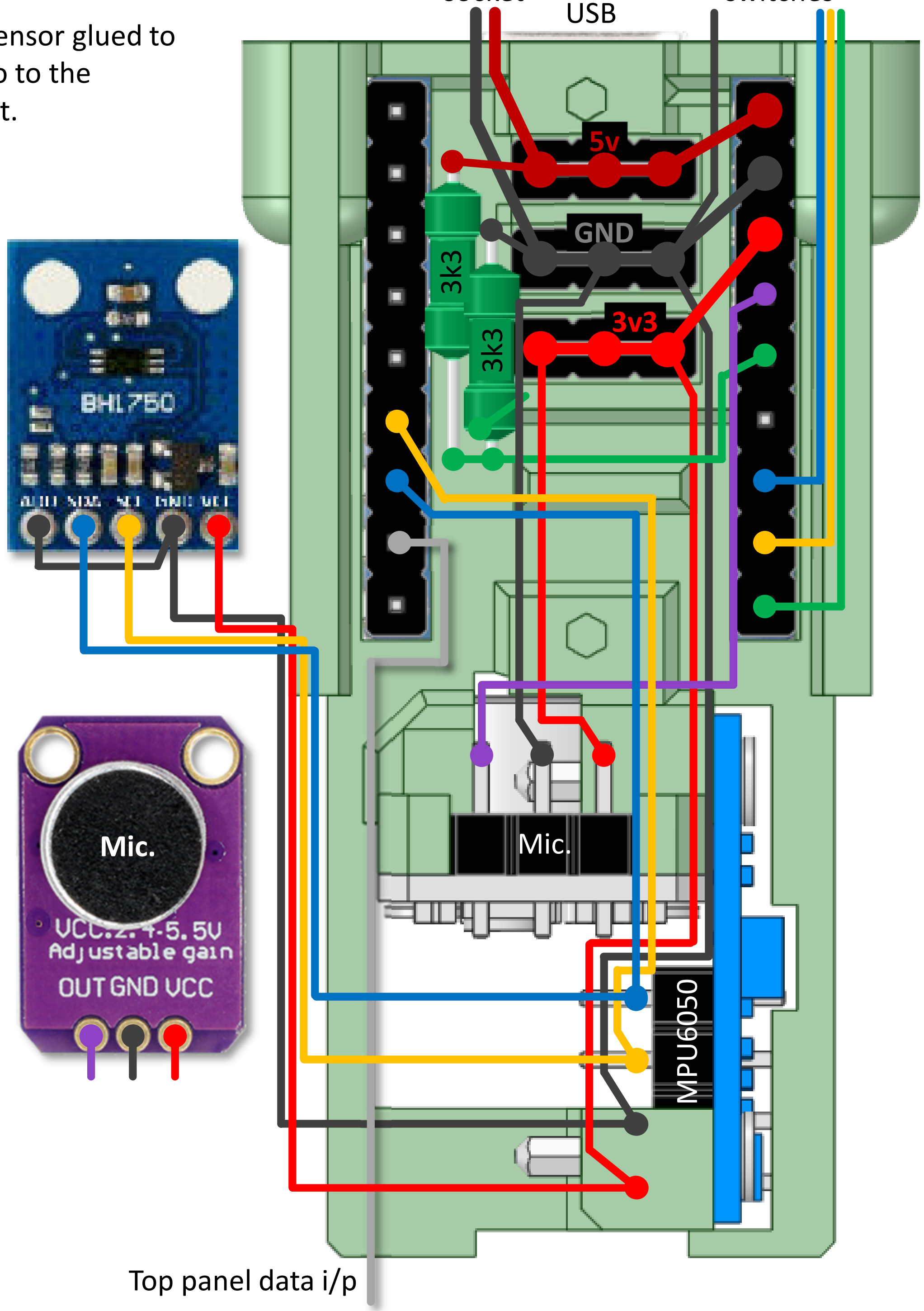
Next, with the BH1750 light sensor glued to the back plate. Wire the micro to the MPU6050 motions sensor first.

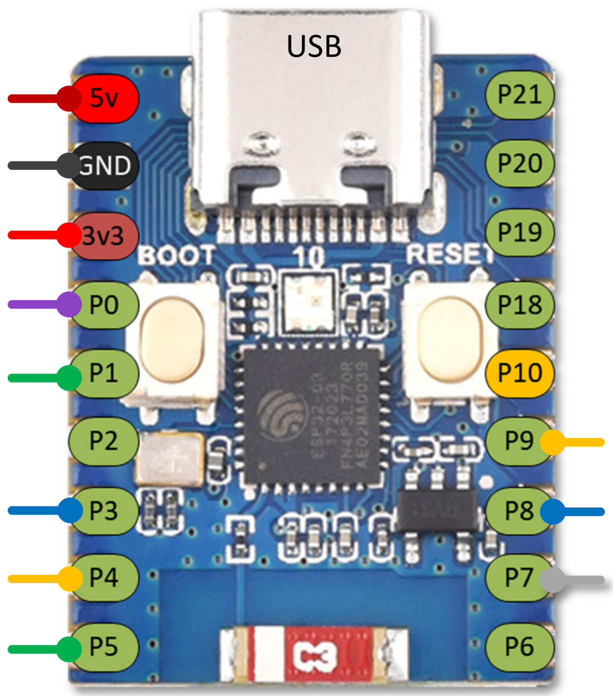
Then attach wires to the BH1750 light sensor, including the address line.

Note: you will need to crop the pins on the light sensor and the common connection points, as they are too long, and will prevent the back cover from being in place.

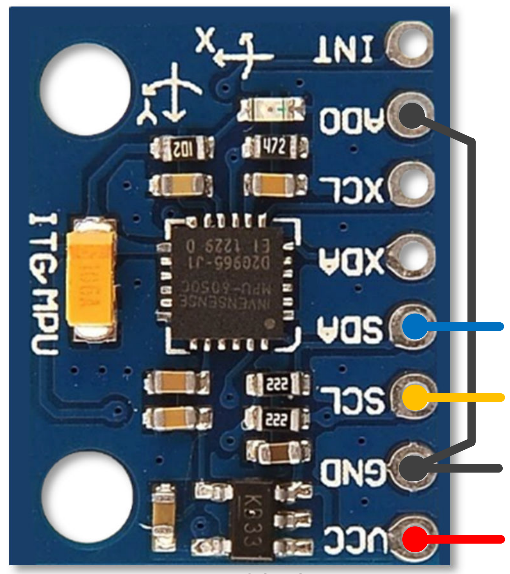
Ensure that there is clearance between the common connection pins and the light sensor pcb. So that they do not touch the pcb when the case is closed.

This completes the column wiring. The wiring of the base switches is next.





ESP32C3



MPU6050

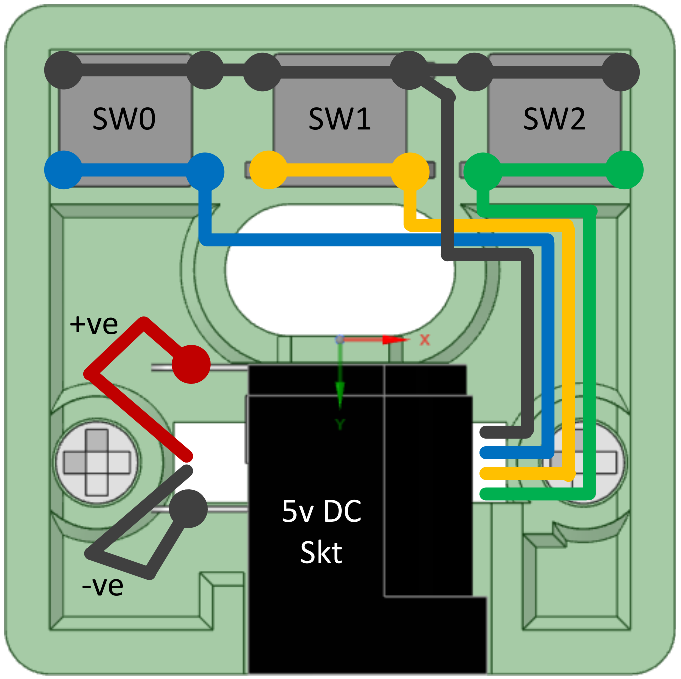
Issue: 1.2 Released: 29/01/2025 TechKnowTone

Base Wiring – Part 1

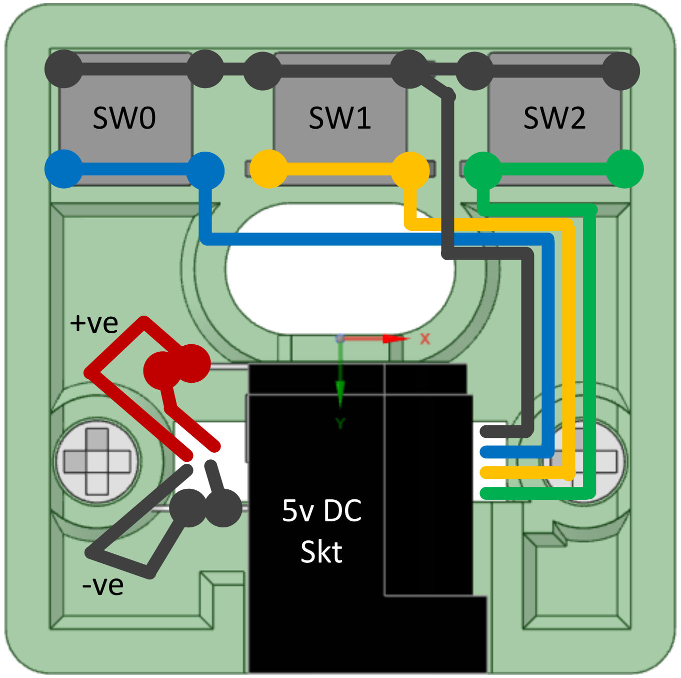
The base button switches are wired as shown. Note that there are two pins for each of the switch contacts. They are like staples inside the swich body, and pushing the switch shorts them together.

For clarity the wiring here obscures the USB entry point, but in practise the wires are held out of the way, above the switches.

The 5v positive and GND connections are wired from the internal pin strips to the external socket, once the base is fastened to the body column.



Then once the cube panels are attached to the body column, the GND and 5v feed from the cube are also wired to the external sockets once the assembly is complete.

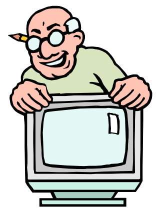


8x8 Panel Wiring

RGB strip code tests, run on a panel, show that the LEDs will work at 3v3 to 5v, driven via an ESP32C3, running FastLED. Whilst the ESP32C3 works at 3v3, there does not appear to be any need for a level-shifting LED, as with the previous WS2812B panels, so one is not used in this project. This affects the LED mapping for the LED matrix, resulting in a code change.

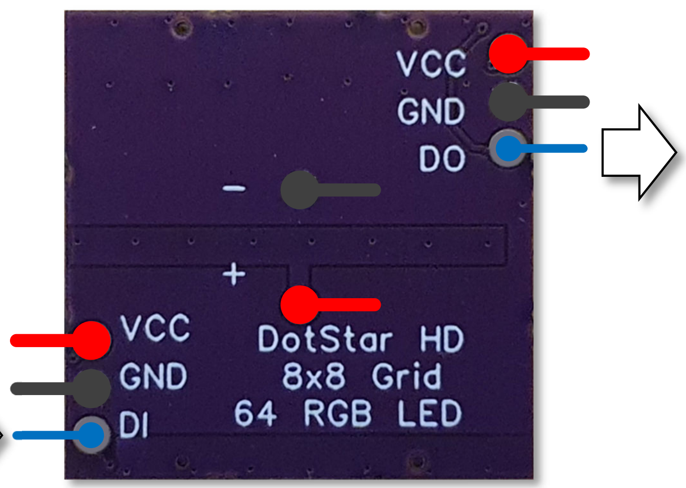
When viewed from the front, with data input fed from the bottom right, the bottom right LED ‘0’ is the first in the chain of LEDs. The next LED ‘1’ is above that, and so on, making the top right LED ‘7’. The LED chain then restarts at the bottom ‘8’, and follows the same sequence up the panel. Such that finally, the top left LED is number ‘63’ in the daisy chain.

This is different to the previous projects WS2812B 8x8 panels, which also started bottom right, but ran horizontally left across the panel, rather than up it. Thankfully, the revised GFX code functions, I’ve written, takes all of this LED mapping into account; which means that the animations used in the previous project will work with this one too.

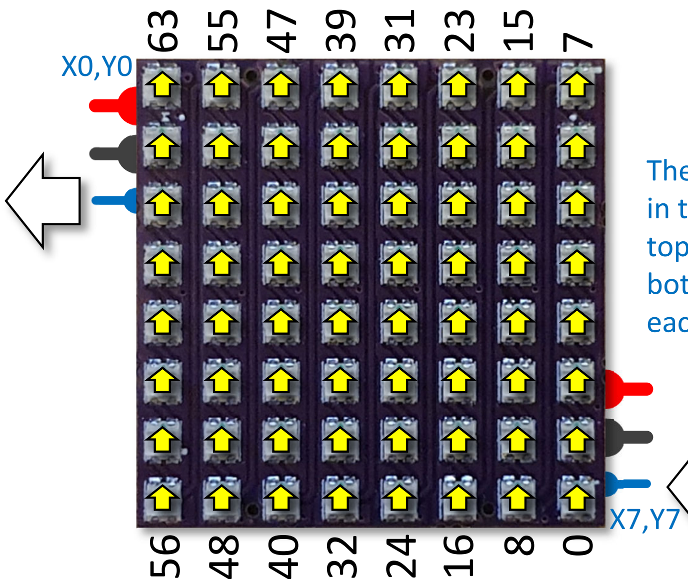


LED map

Data in



Data out



The GFX co-ordinate system, in the code, defines X0,Y0 as top left corner, and X7,Y7 as bottom right corner, for each panel.

Data in

Viewed from the rear

Viewed from the front

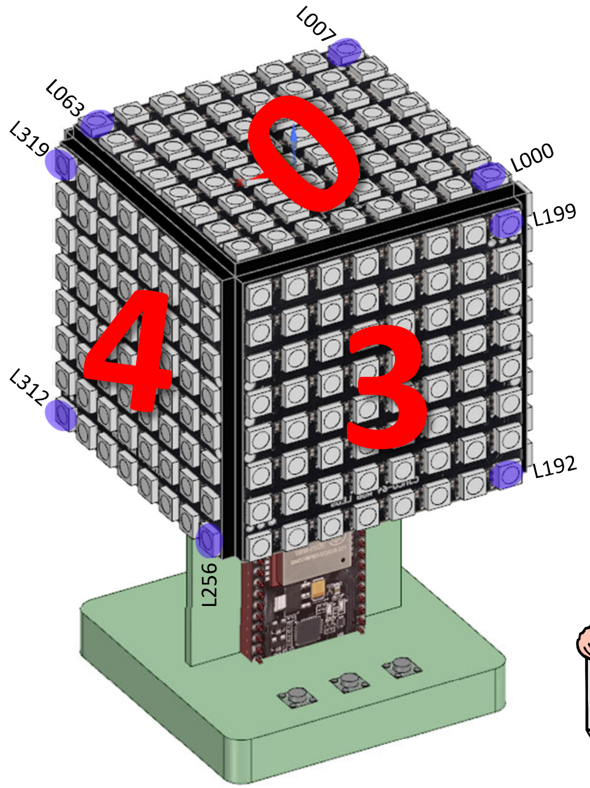
8x8 LED Matrix Mapping

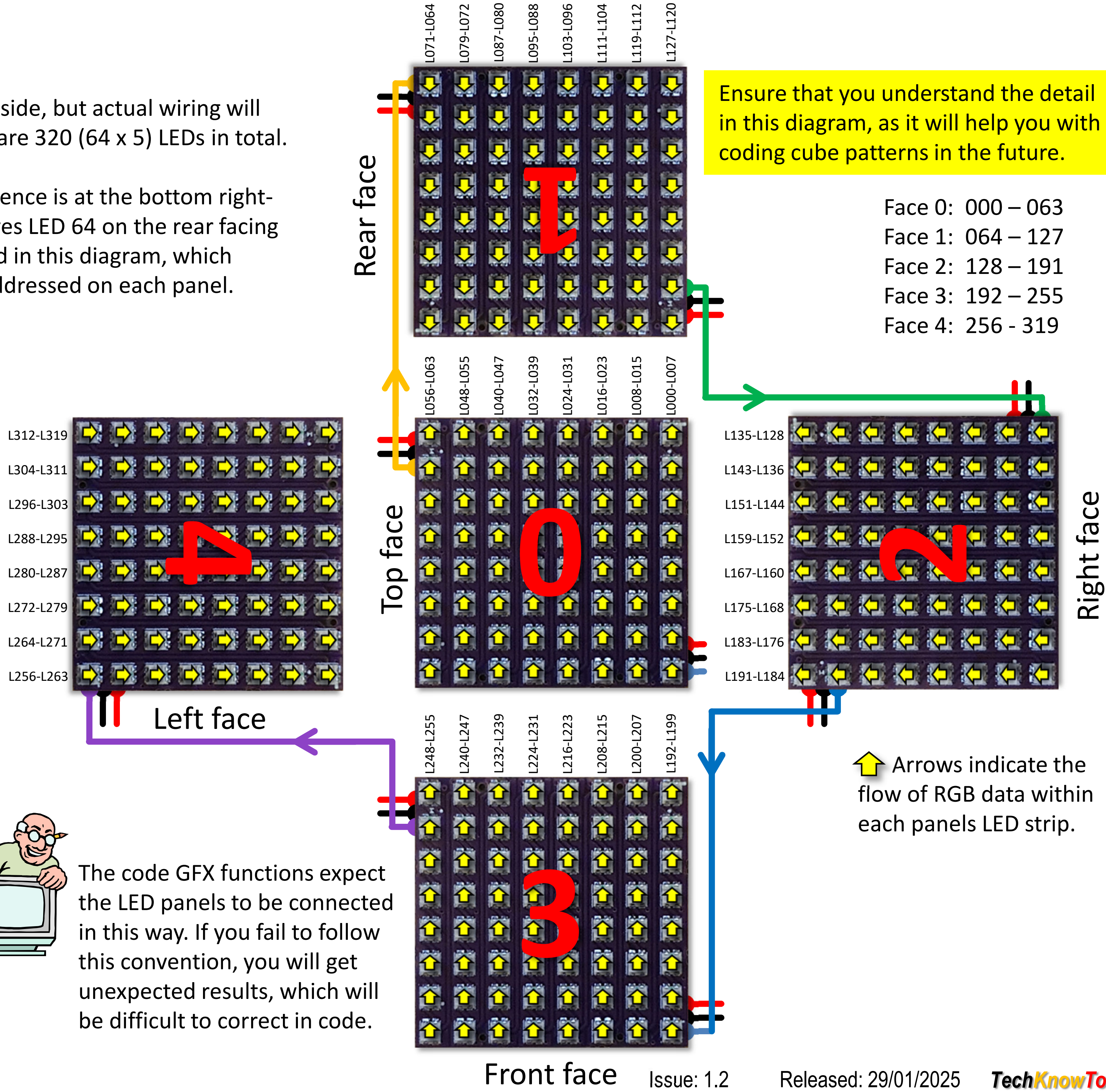
Data connections are shown from the outside, but actual wiring will need to be mirrored on the inside. There are 320 (64 x 5) LEDs in total.

On the Top Plate, the first LED in the sequence is at the bottom right-hand corner. The top LED matrix then drives LED 64 on the rear facing plate, bottom right, and so on as indicated in this diagram, which shows how LEDs in the overall strip are addressed on each panel.

Ensure that you understand the detail in this diagram, as it will help you with coding cube patterns in the future.

Face 0: 000 – 063
Face 1: 064 – 127
Face 2: 128 – 191
Face 3: 192 – 255
Face 4: 256 - 319





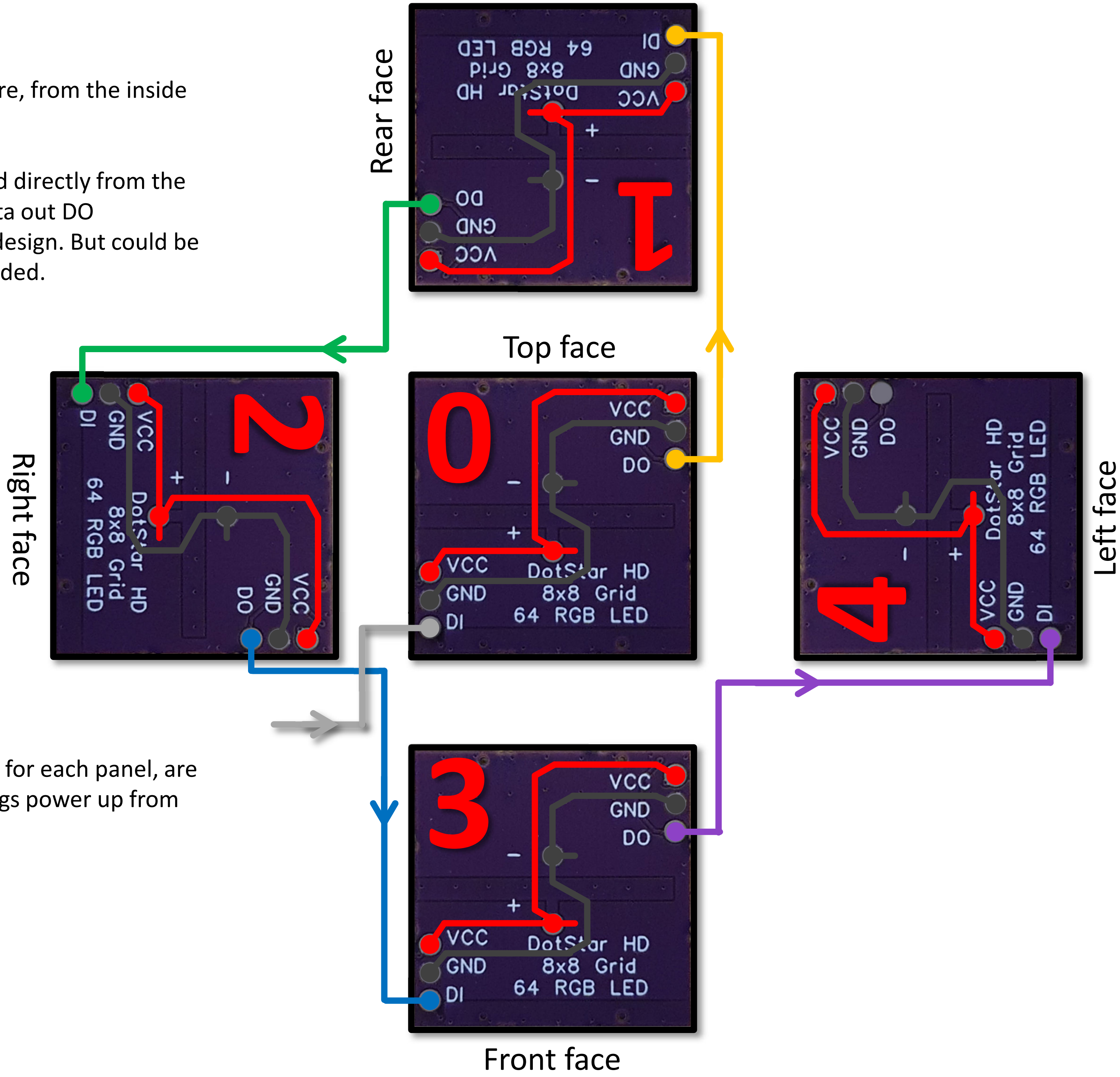
Arrows indicate the flow of RGB data within each panels LED strip.

The code GFX functions expect the LED panels to be connected in this way. If you fail to follow this convention, you will get unexpected results, which will be difficult to correct in code.

8x8x5 LED Matrix Wiring

Data and power connections are shown here, from the inside of the cube.

The data in DI connection, on panel 0, is fed directly from the ESP32C3 micros, GPIO7 output pin. The data out DO connection, on panel 4, is not used in this design. But could be used to extend the LED array further, if needed.



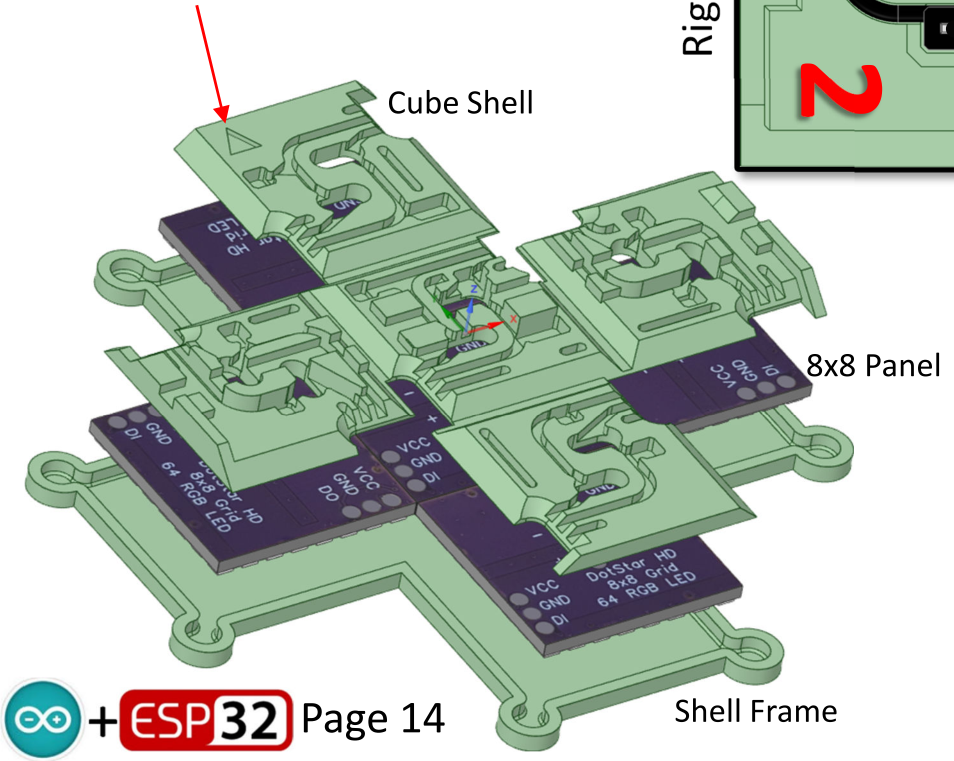
The panel VCC (+5v) and GND connections, for each panel, are wired together. Then one pair of wires brings power up from the cubes base socket.

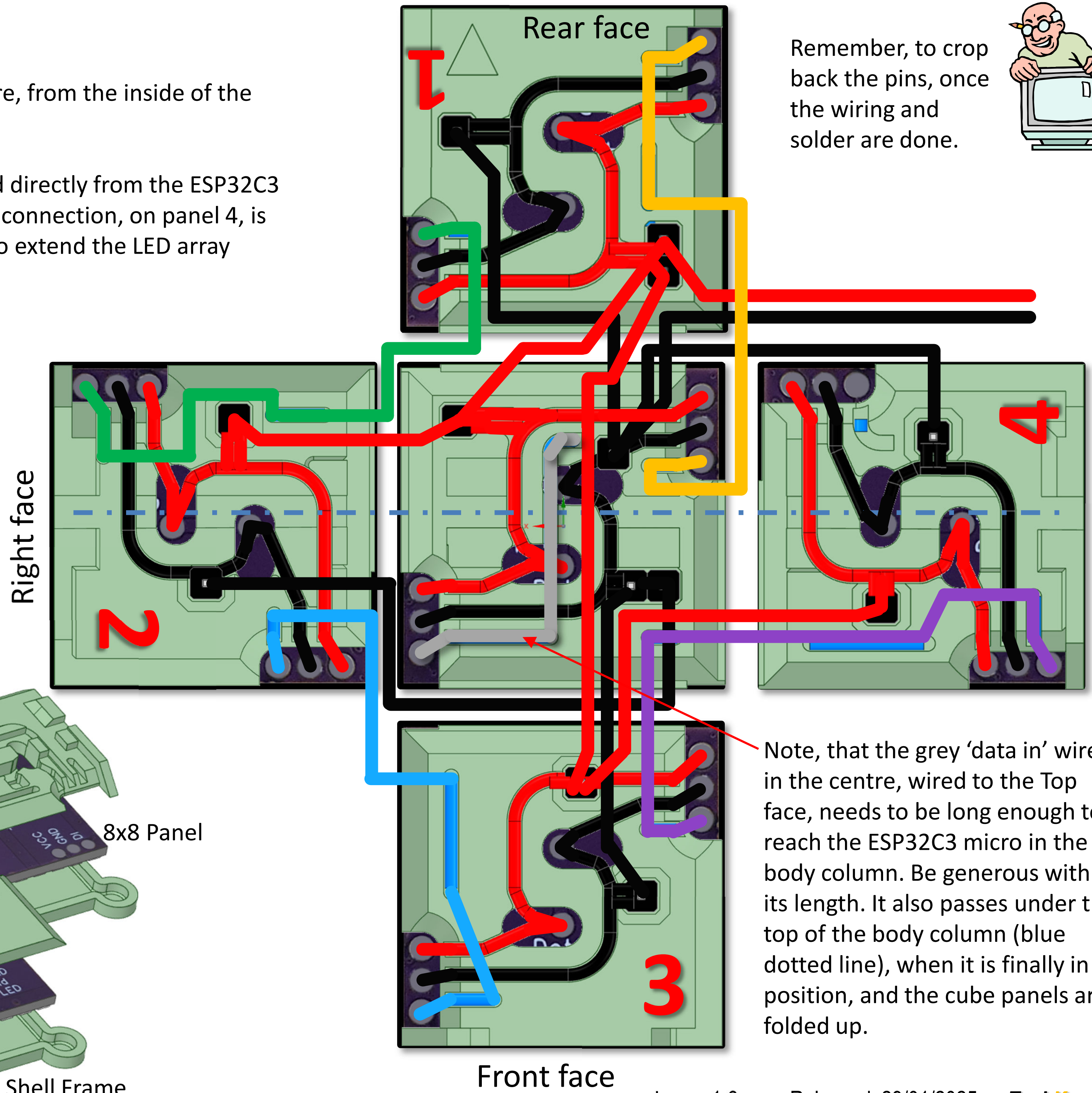
8x8x5 LED Matrix Wiring

Data and power connections are shown here, from the inside of the cube.

The data in DI connection, on panel 0, is fed directly from the ESP32C3 micros, GPIO7 output pin. The data out DO connection, on panel 4, is not used in this design. But could be used to extend the LED array further, if needed.

The 8x8 DotStar panels are placed in the Shell Frame, in the correct orientation for wiring. Then the Cube Shell is glued into position on top.

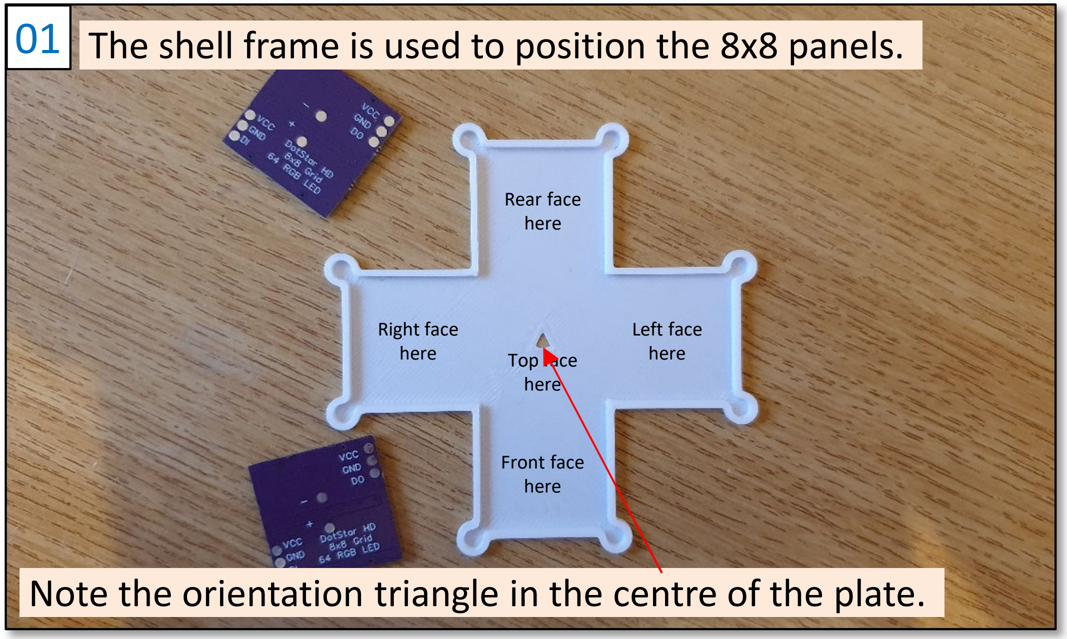




Remember, to crop back the pins, once the wiring and solder are done.

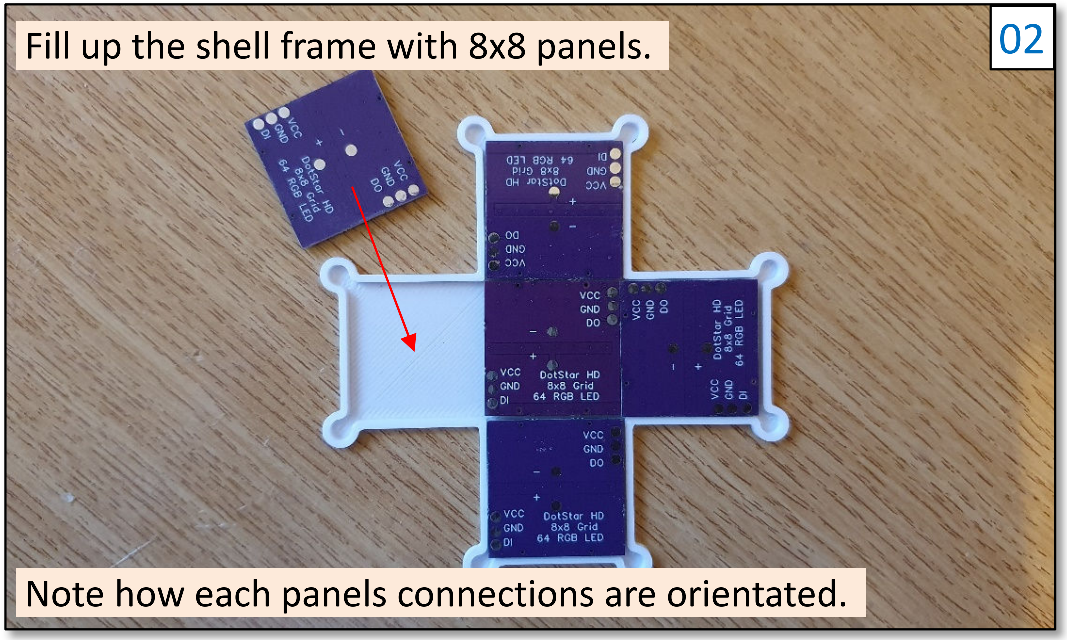
Note, that the grey 'data in' wire in the centre, wired to the Top face, needs to be long enough to reach the ESP32C3 micro in the body column. Be generous with its length. It also passes under the top of the body column (blue dotted line), when it is finally in position, and the cube panels are folded up.

Recorded Build Sequence



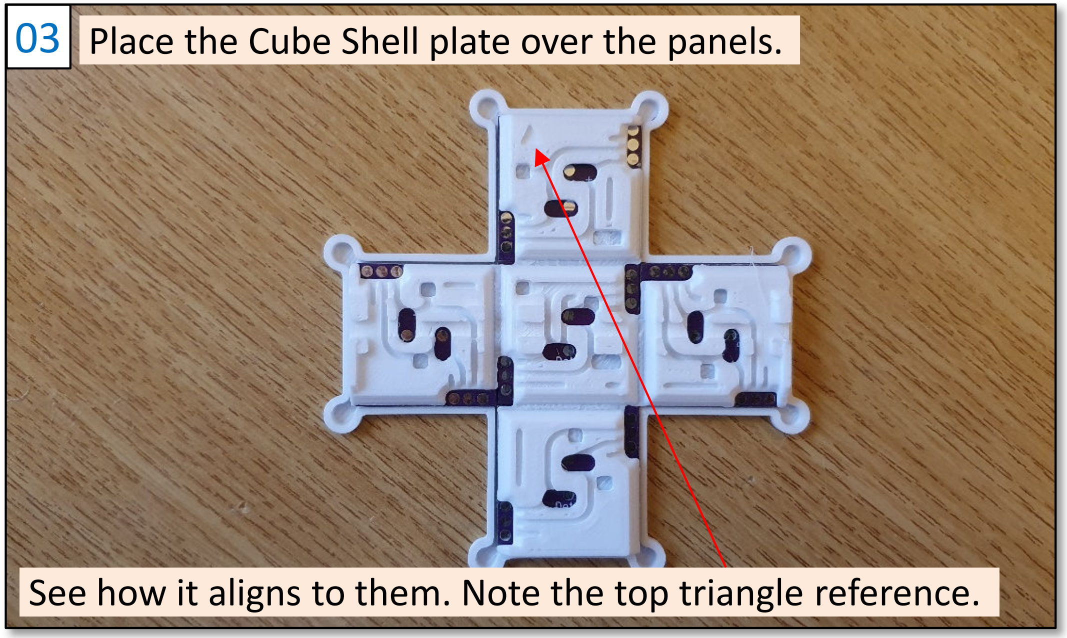
01 The shell frame is used to position the 8x8 panels.

Note the orientation triangle in the centre of the plate.



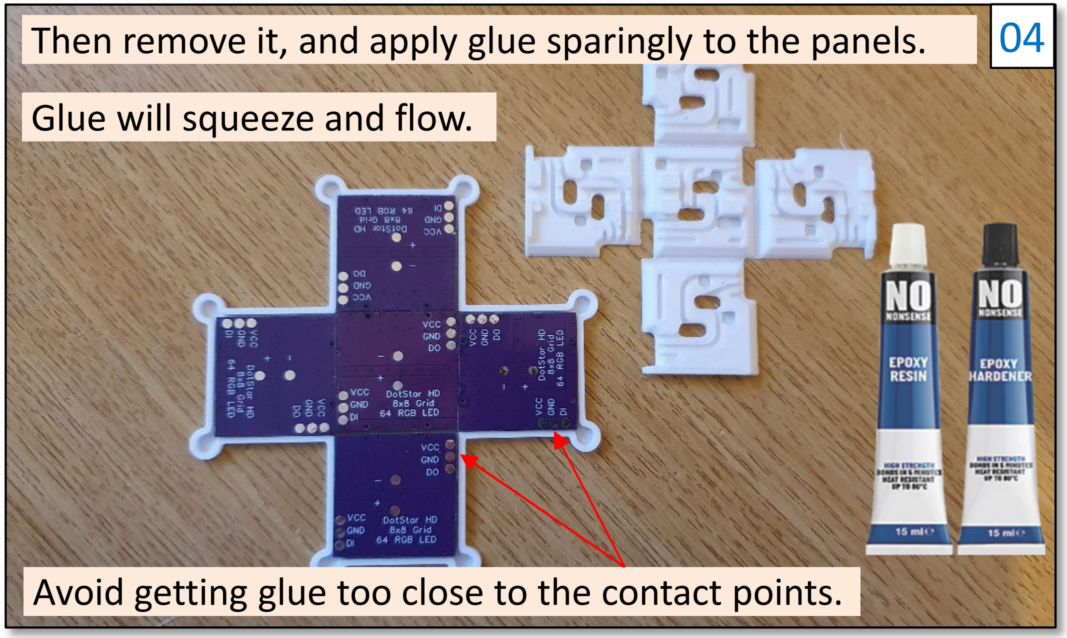
02 Fill up the shell frame with 8x8 panels.

Note how each panels connections are orientated.



03 Place the Cube Shell plate over the panels.

See how it aligns to them. Note the top triangle reference.

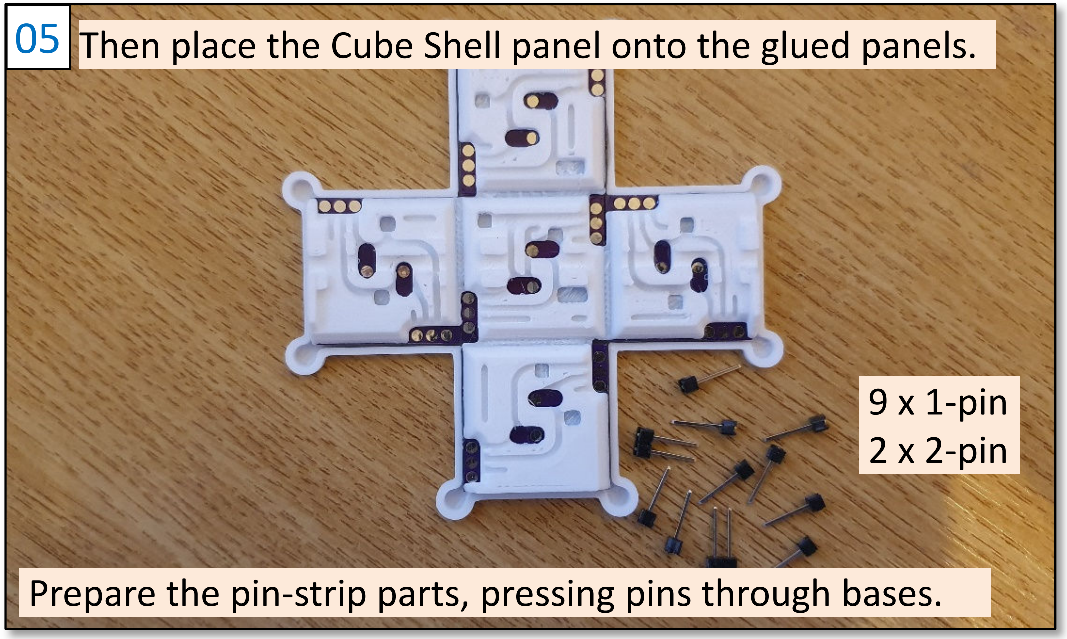


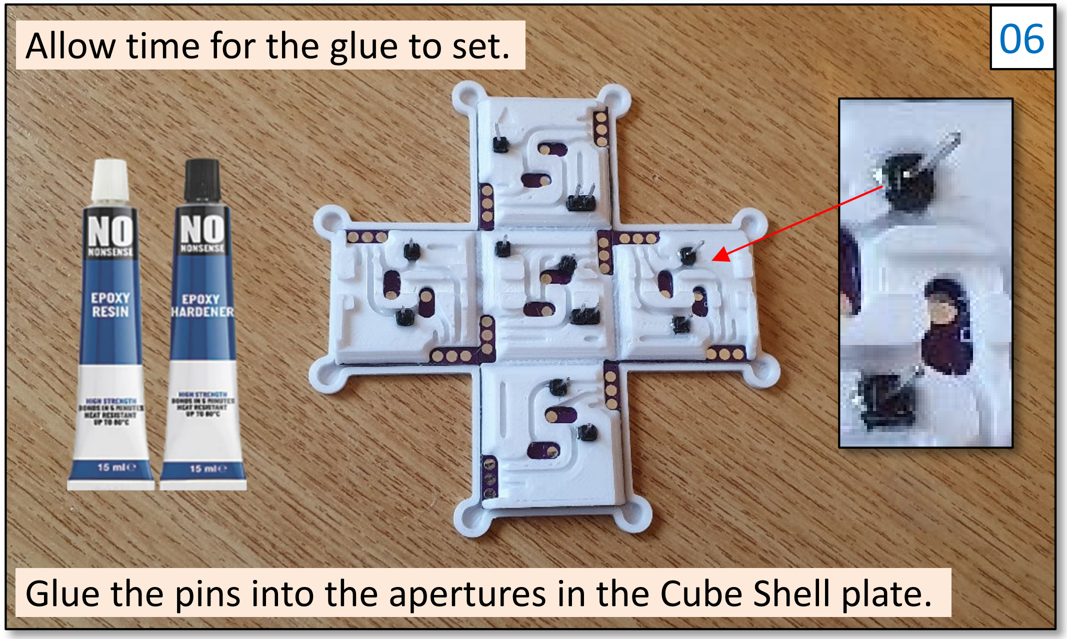
04 Then remove it, and apply glue sparingly to the panels.

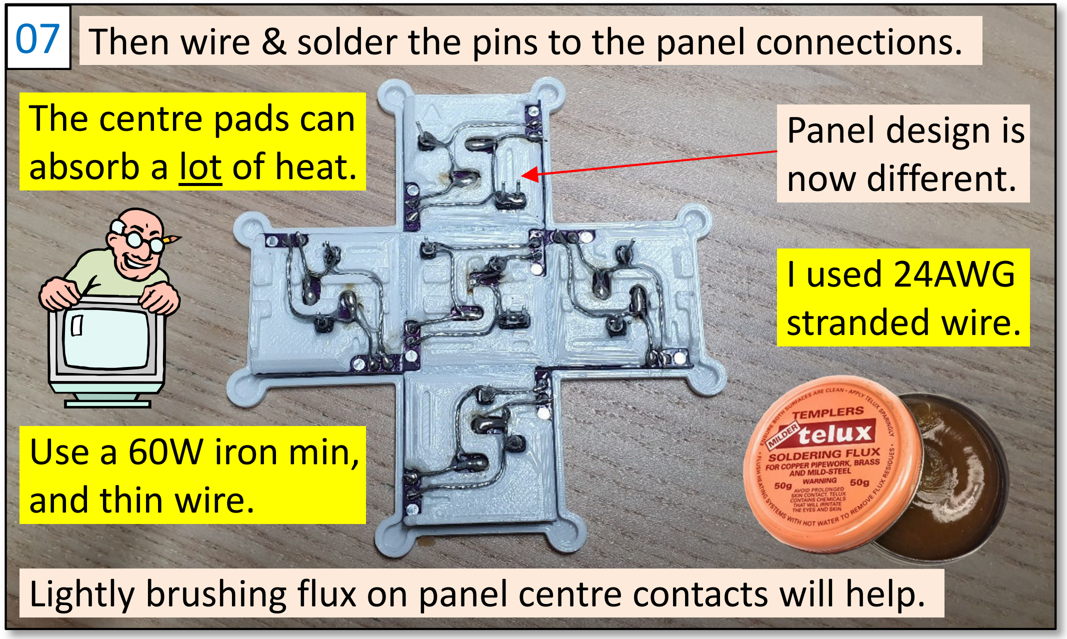
Glue will squeeze and flow.

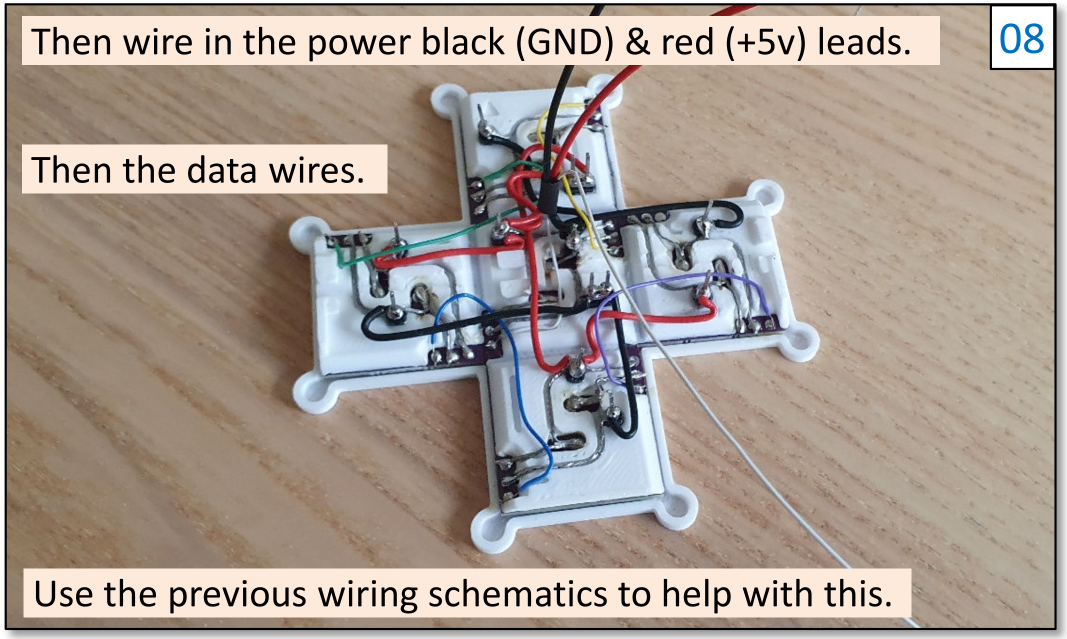
Avoid getting glue too close to the contact points.

Recorded Build Sequence



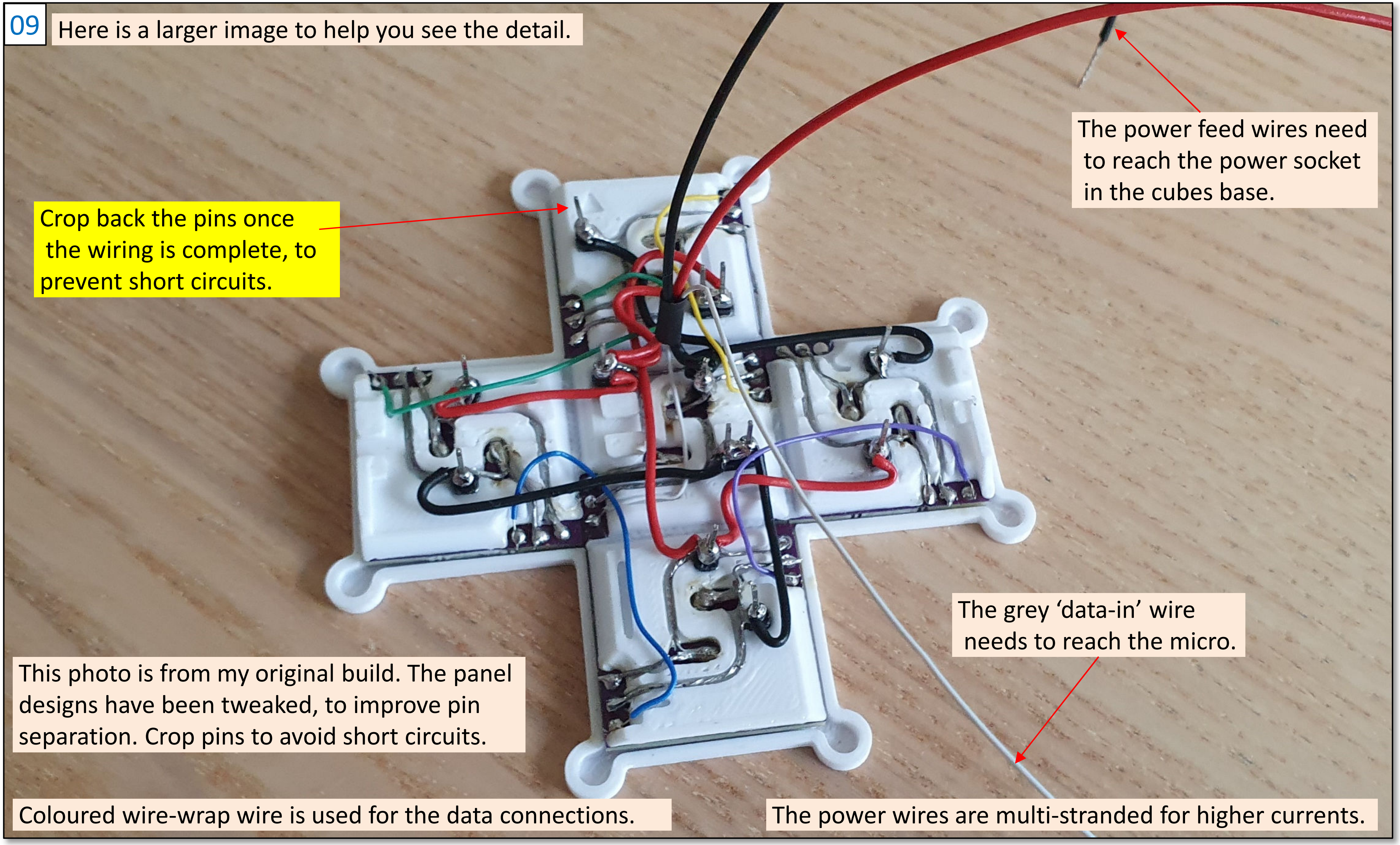




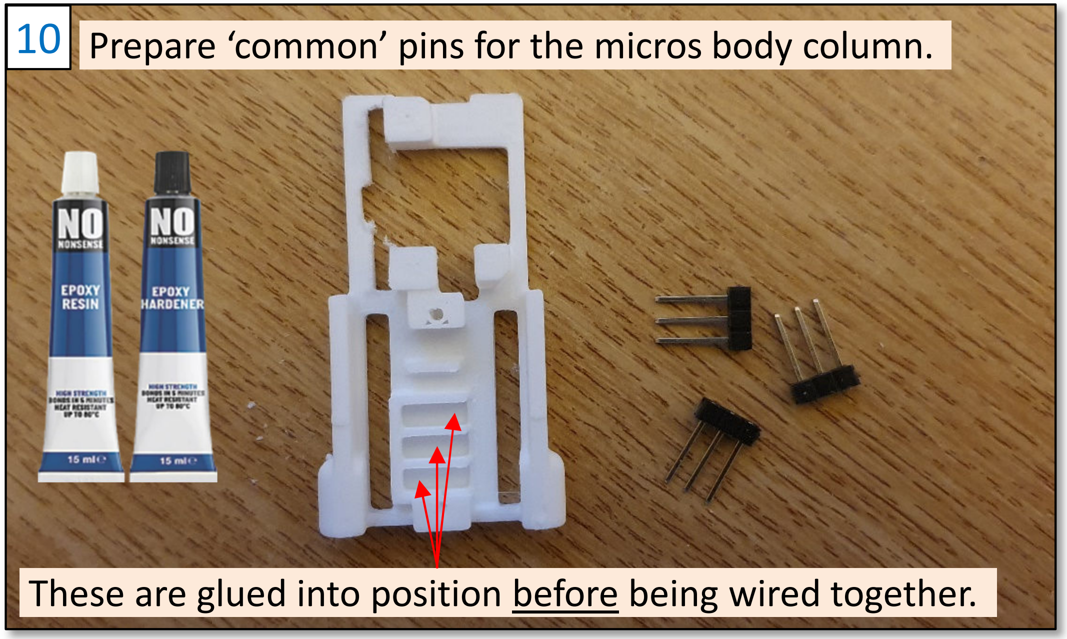


Recorded Build Sequence

09

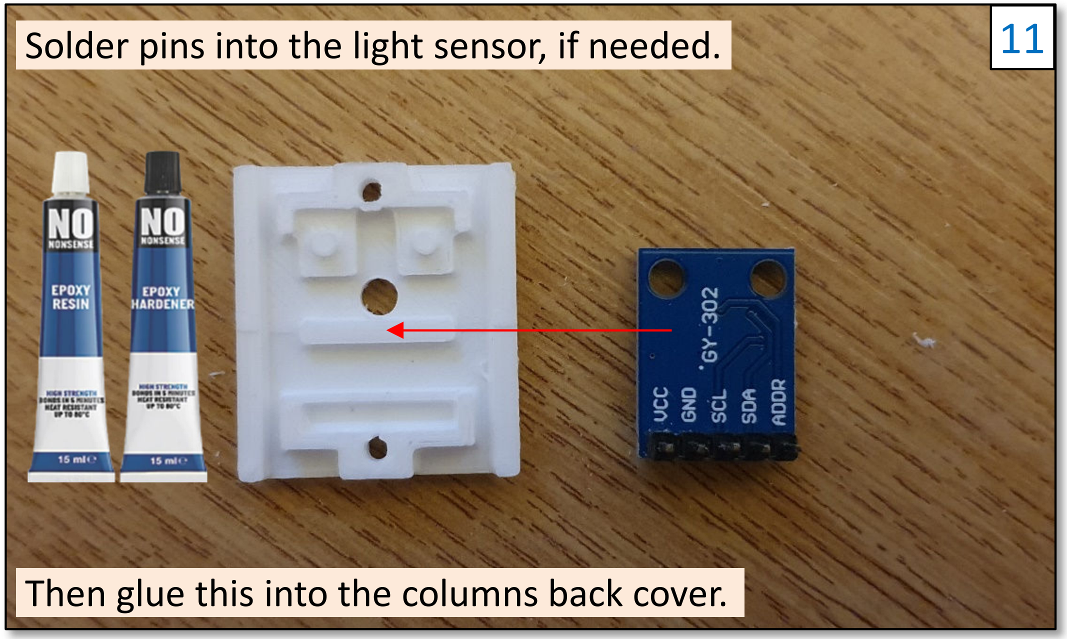


Recorded Build Sequence



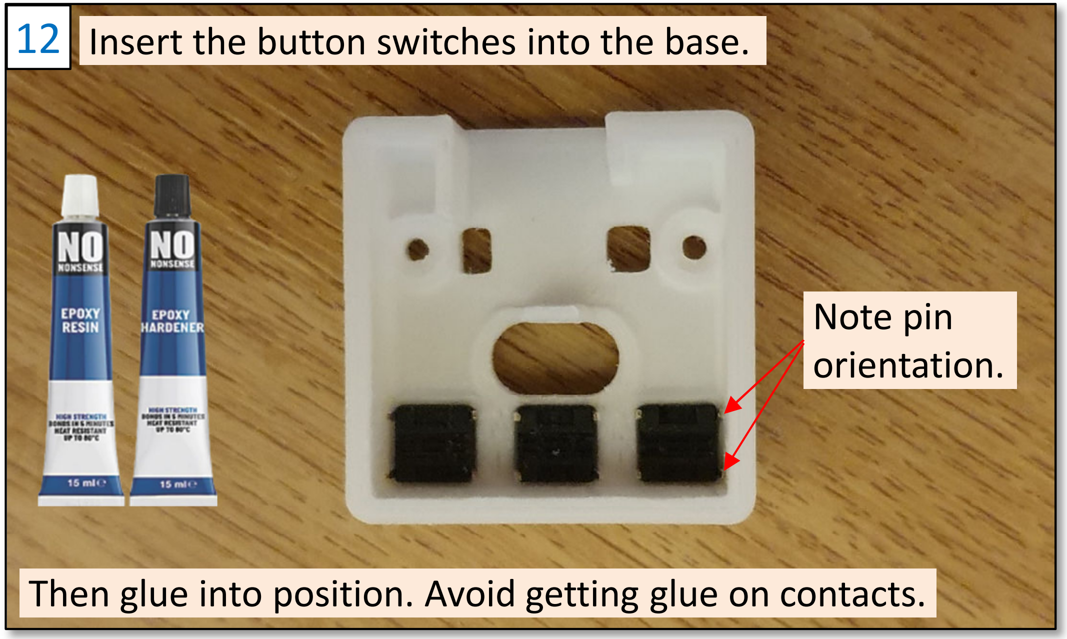
10 Prepare 'common' pins for the micros body column.

These are glued into position before being wired together.



11 Solder pins into the light sensor, if needed.

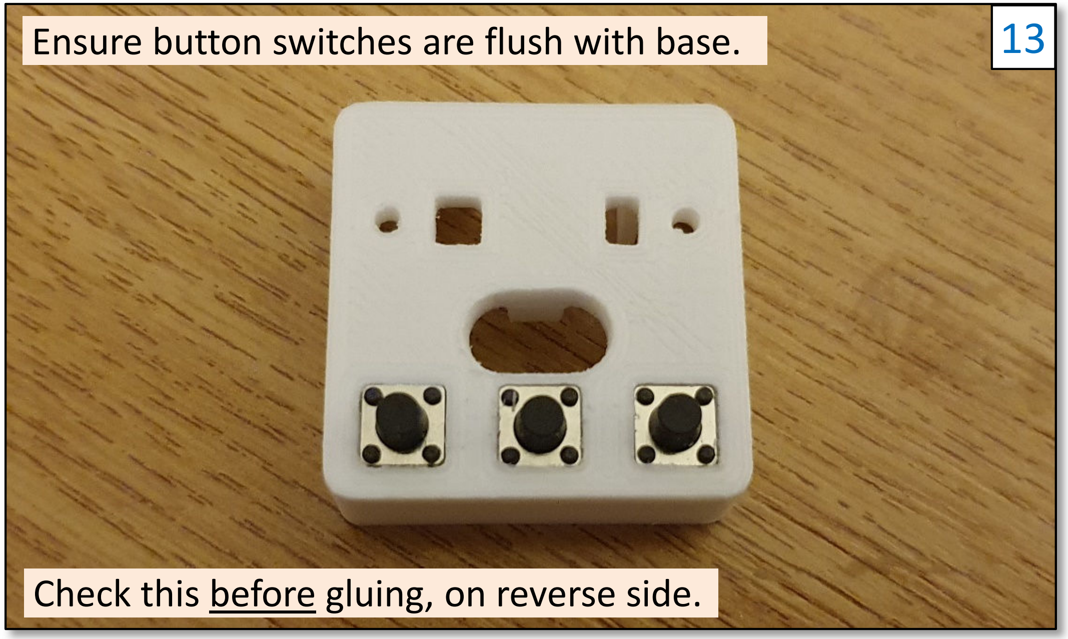
Then glue this into the columns back cover.



12 Insert the button switches into the base.

Note pin orientation.

Then glue into position. Avoid getting glue on contacts.

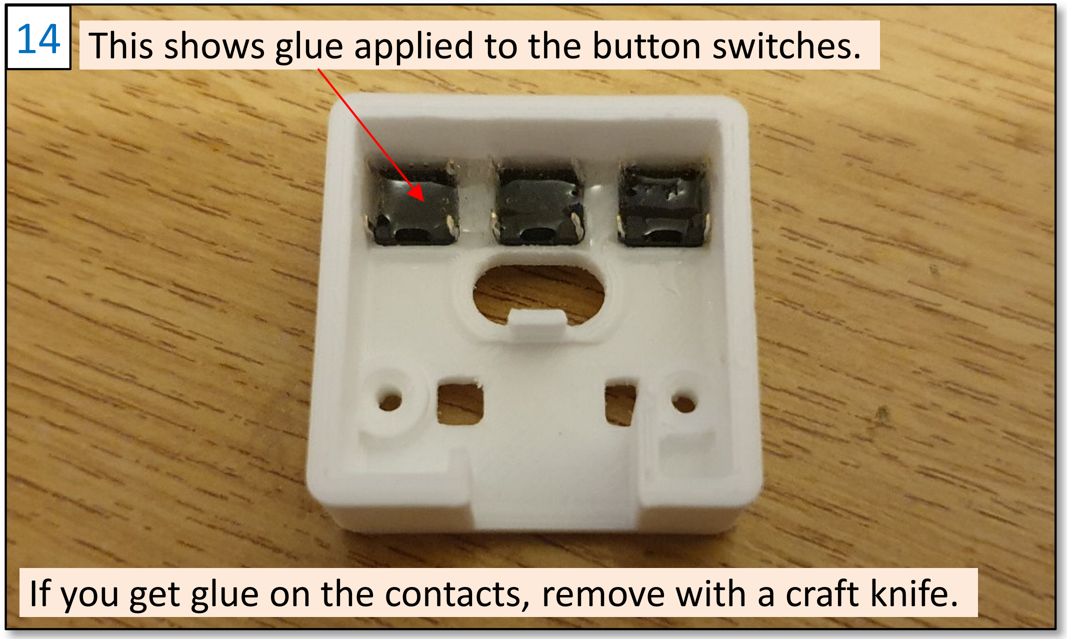


13 Ensure button switches are flush with base.

Check this before gluing, on reverse side.

Recorded Build Sequence

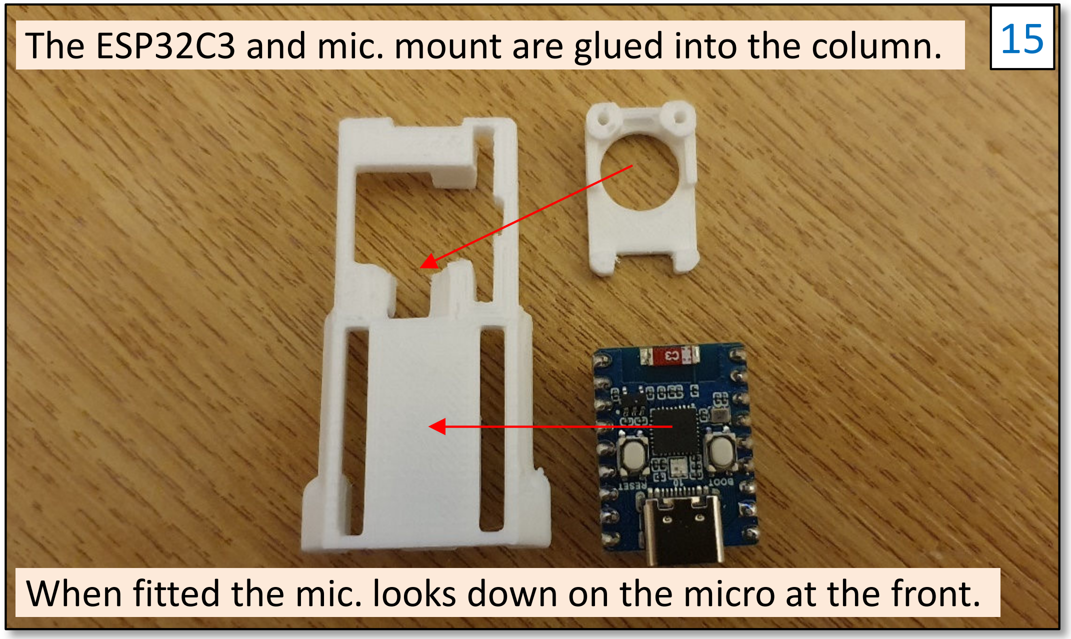
14



This shows glue applied to the button switches.

If you get glue on the contacts, remove with a craft knife.

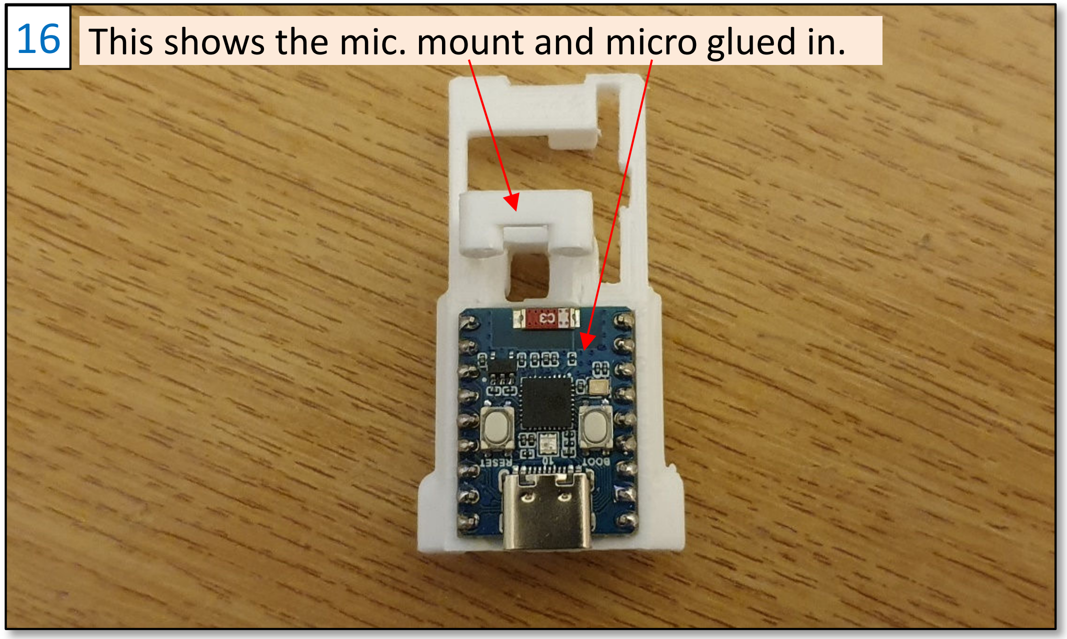
15



The ESP32C3 and mic. mount are glued into the column.

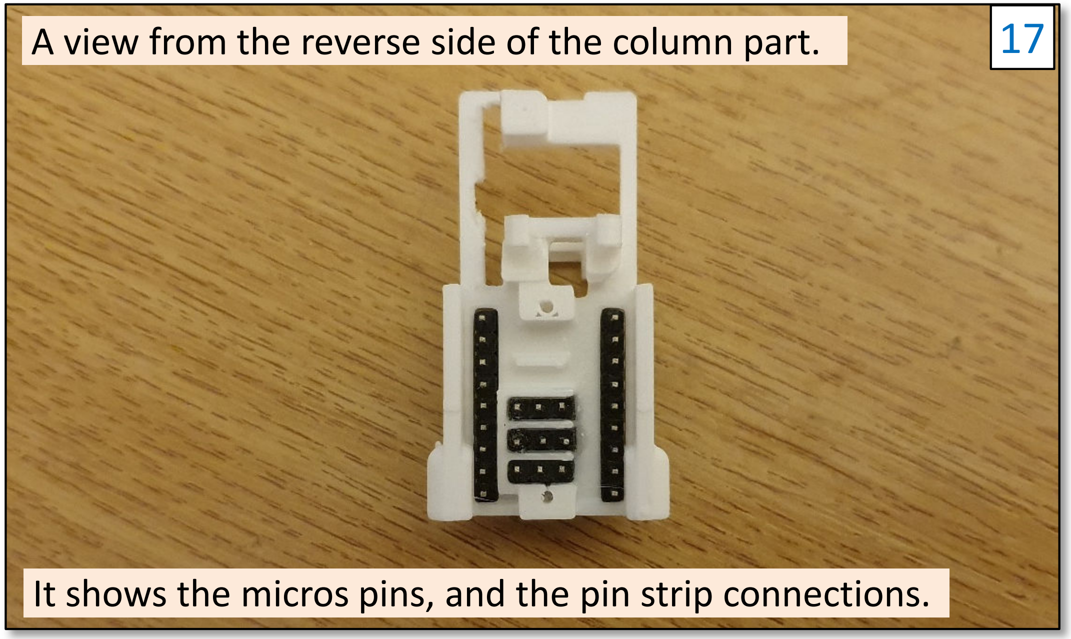
When fitted the mic. looks down on the micro at the front.

16



This shows the mic. mount and micro glued in.

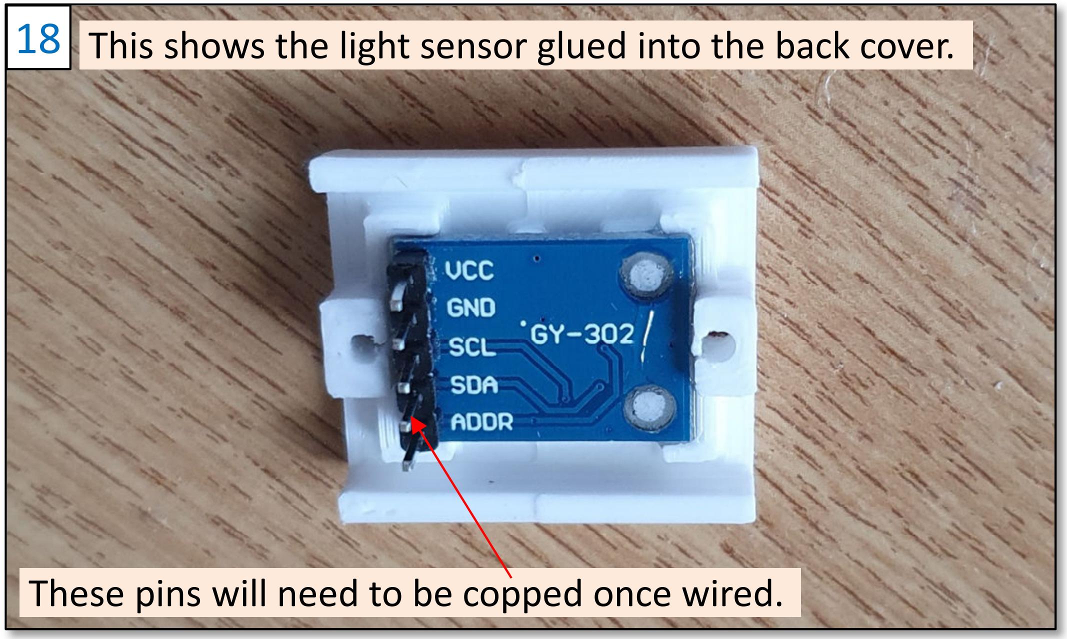
17



A view from the reverse side of the column part.

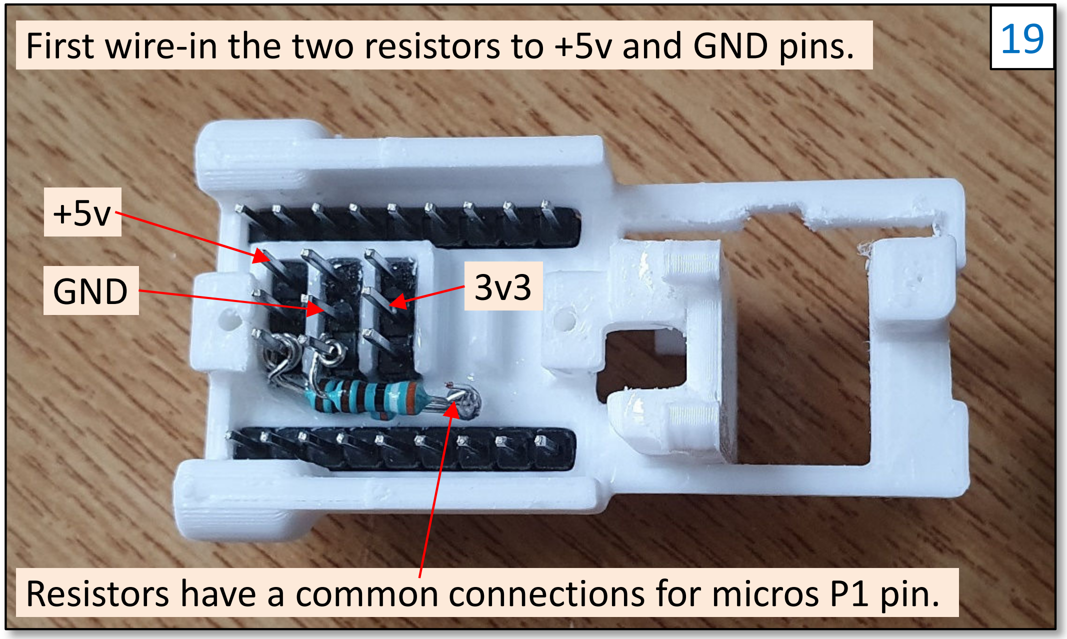
It shows the micros pins, and the pin strip connections.

Recorded Build Sequence



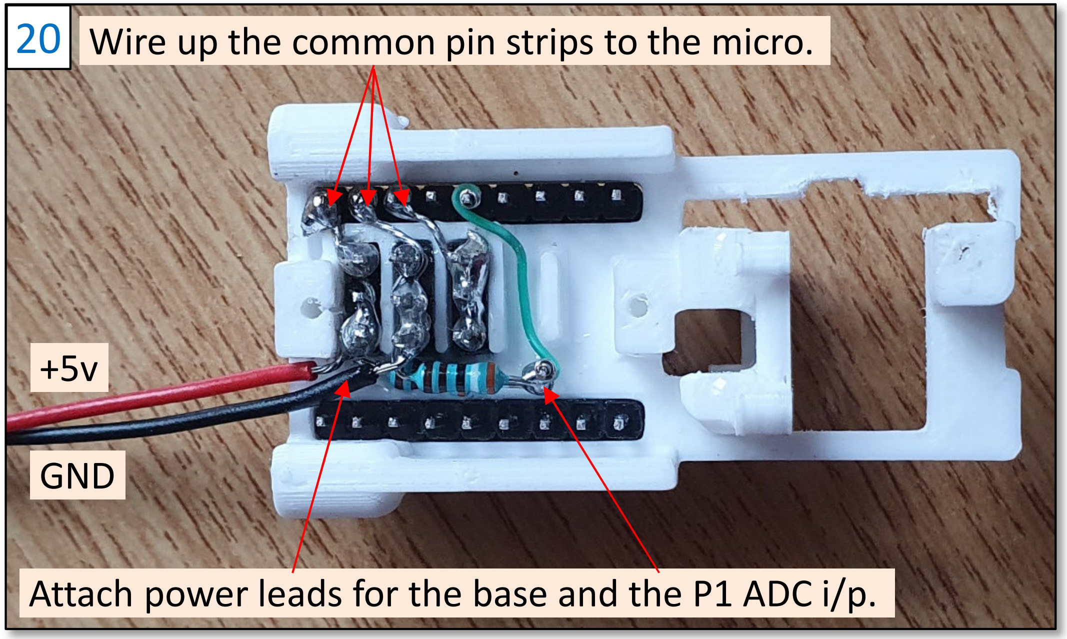
18 This shows the light sensor glued into the back cover.

These pins will need to be copped once wired.



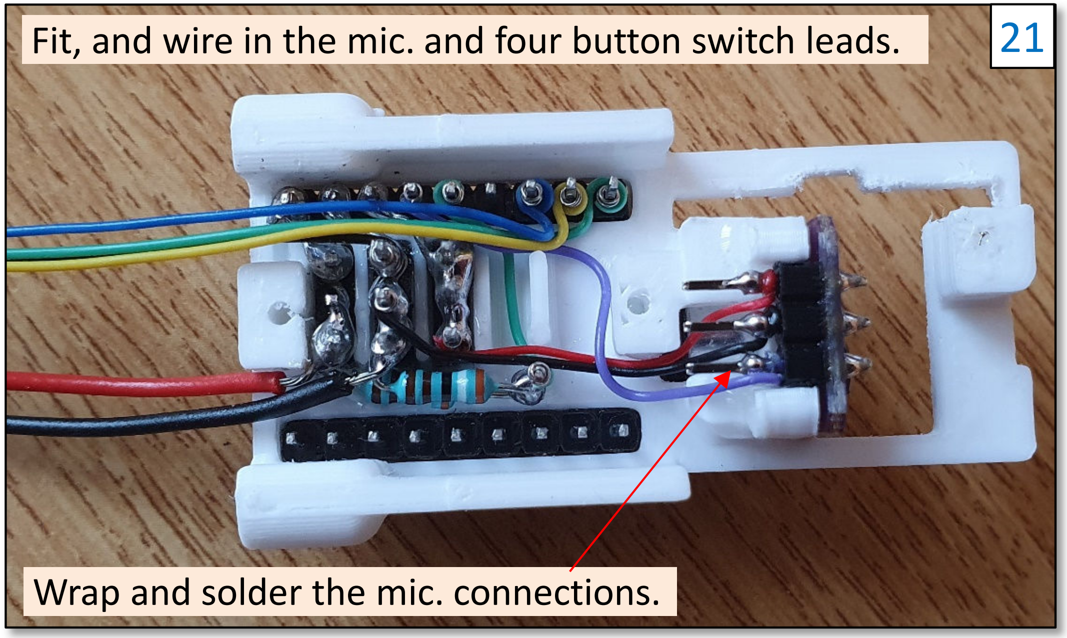
19 First wire-in the two resistors to +5v and GND pins.

Resistors have a common connections for micros P1 pin.



20 Wire up the common pin strips to the micro.

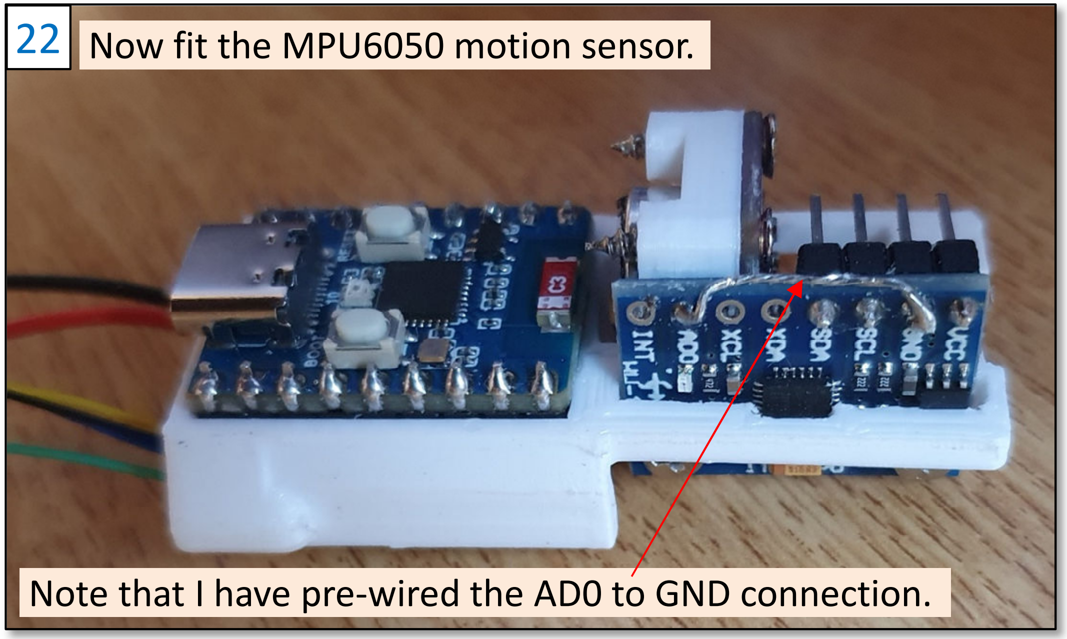
Attach power leads for the base and the P1 ADC i/p.


21 Fit, and wire in the mic. and four button switch leads.

Wrap and solder the mic. connections.

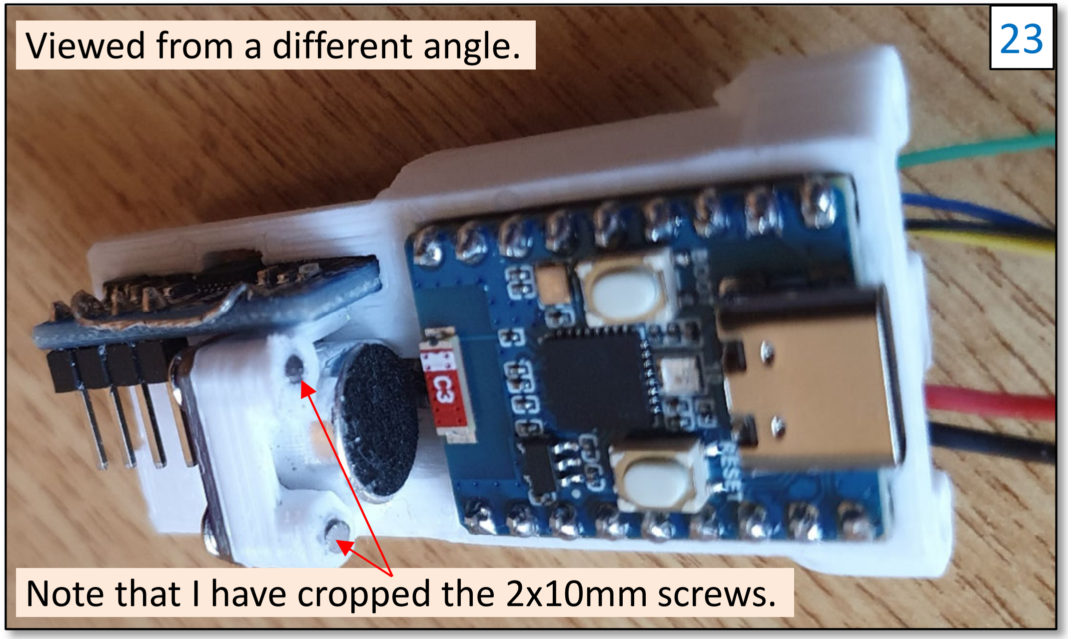
Recorded Build Sequence

22 Now fit the MPU6050 motion sensor.



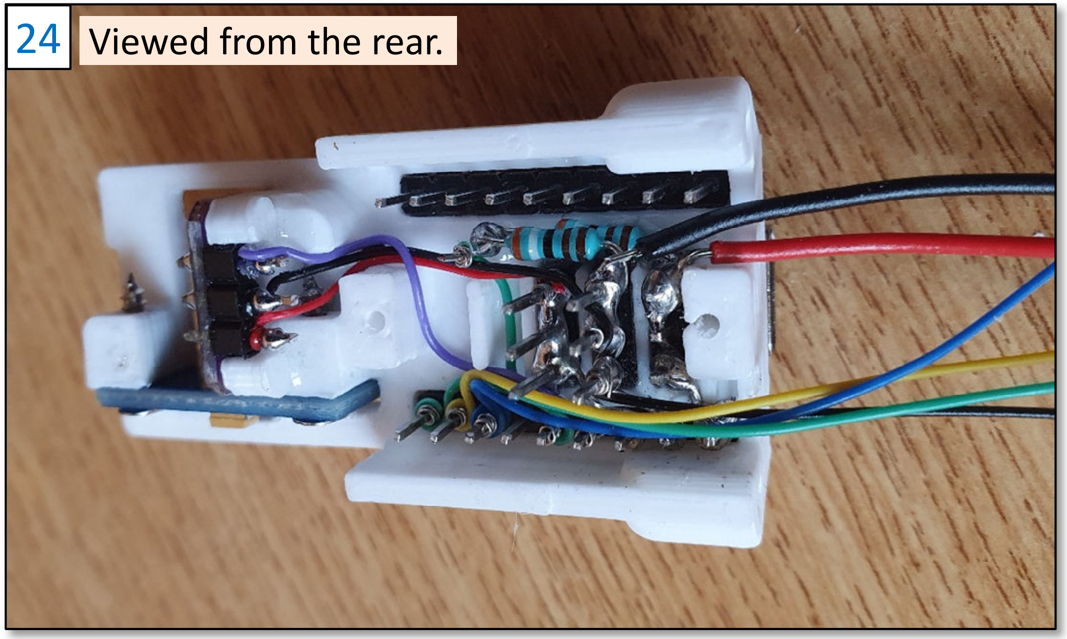
Note that I have pre-wired the AD0 to GND connection.

23 Viewed from a different angle.

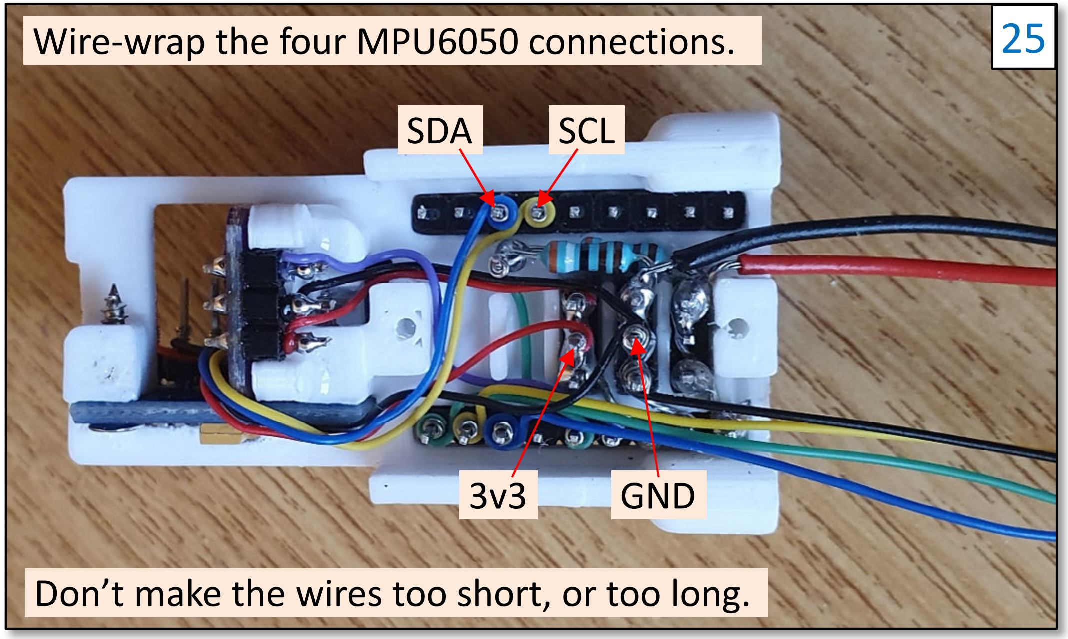


Note that I have cropped the 2x10mm screws.

24 Viewed from the rear.

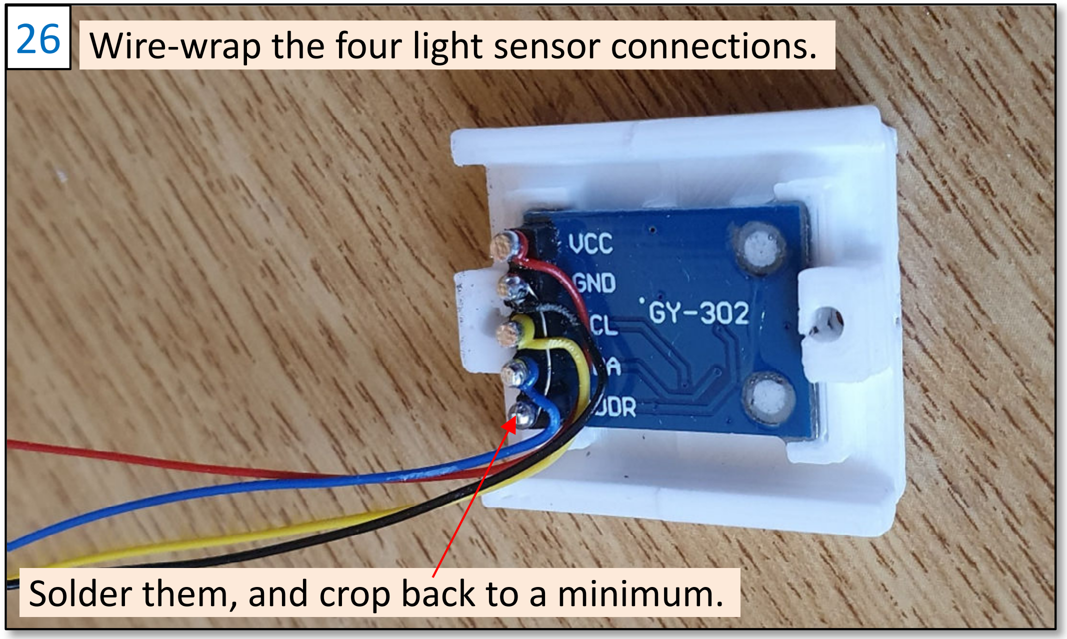


25 Wire-wrap the four MPU6050 connections.



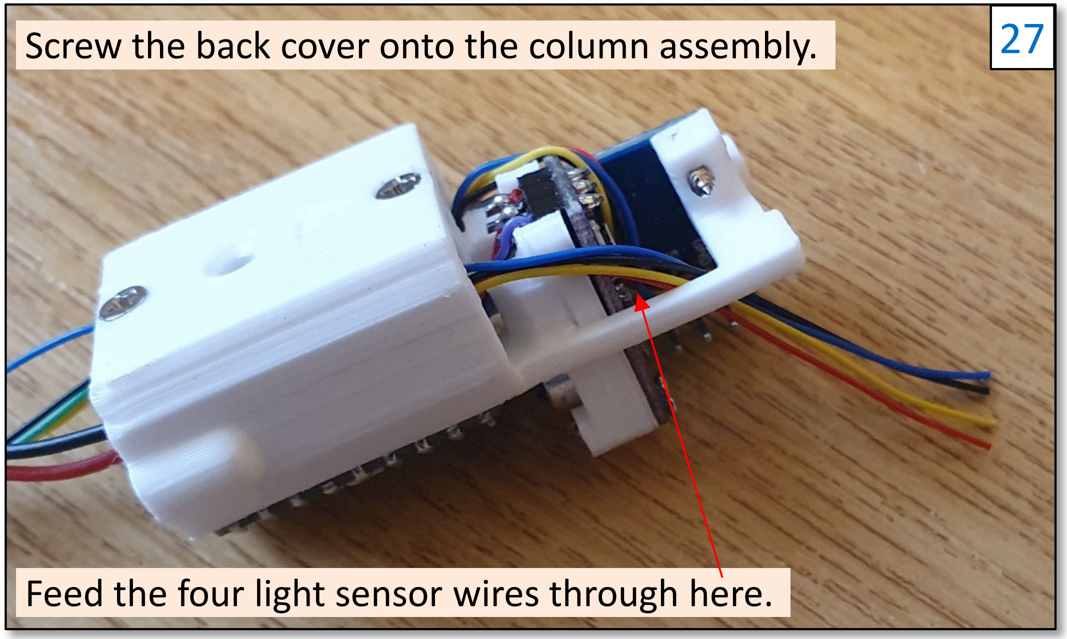
Don’t make the wires too short, or too long.

Recorded Build Sequence

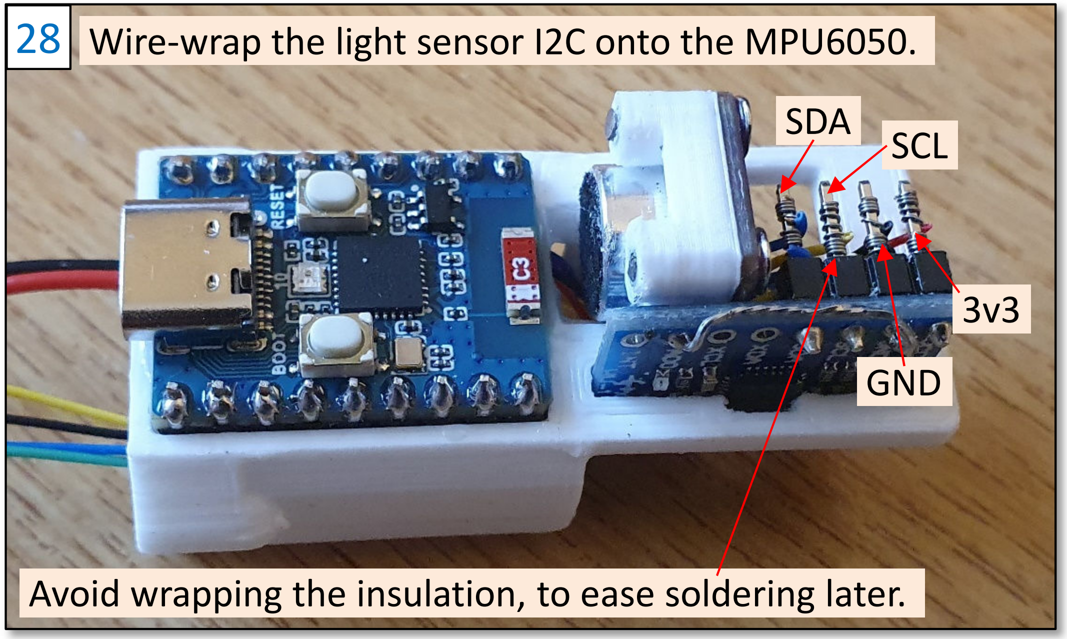


26 Wire-wrap the four light sensor connections.

Solder them, and crop back to a minimum.

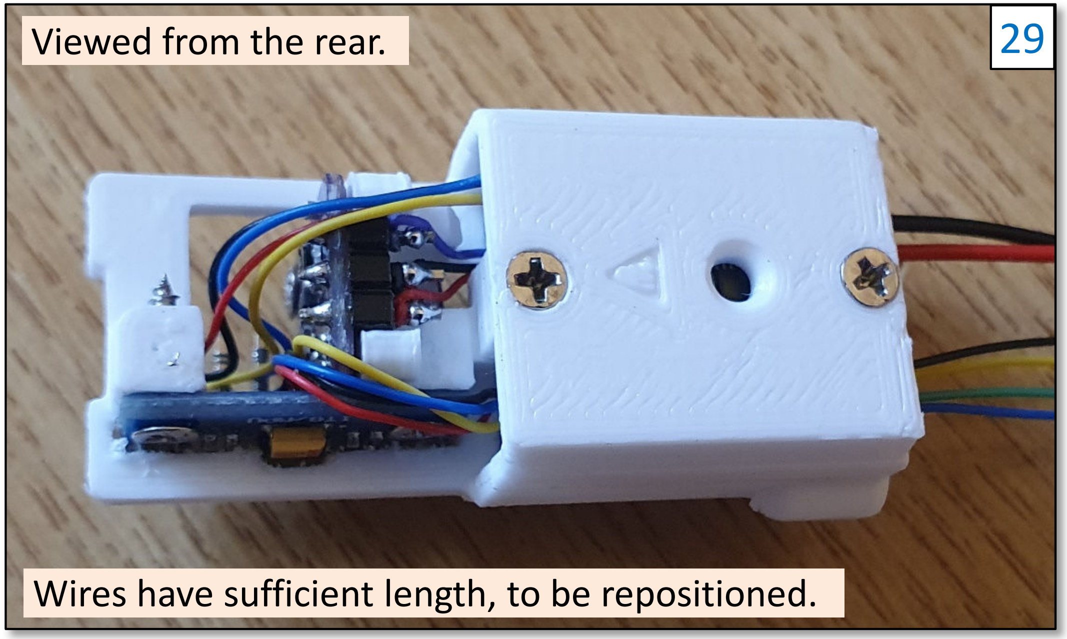

27 Screw the back cover onto the column assembly.

Feed the four light sensor wires through here.



28 Wire-wrap the light sensor I2C onto the MPU6050.

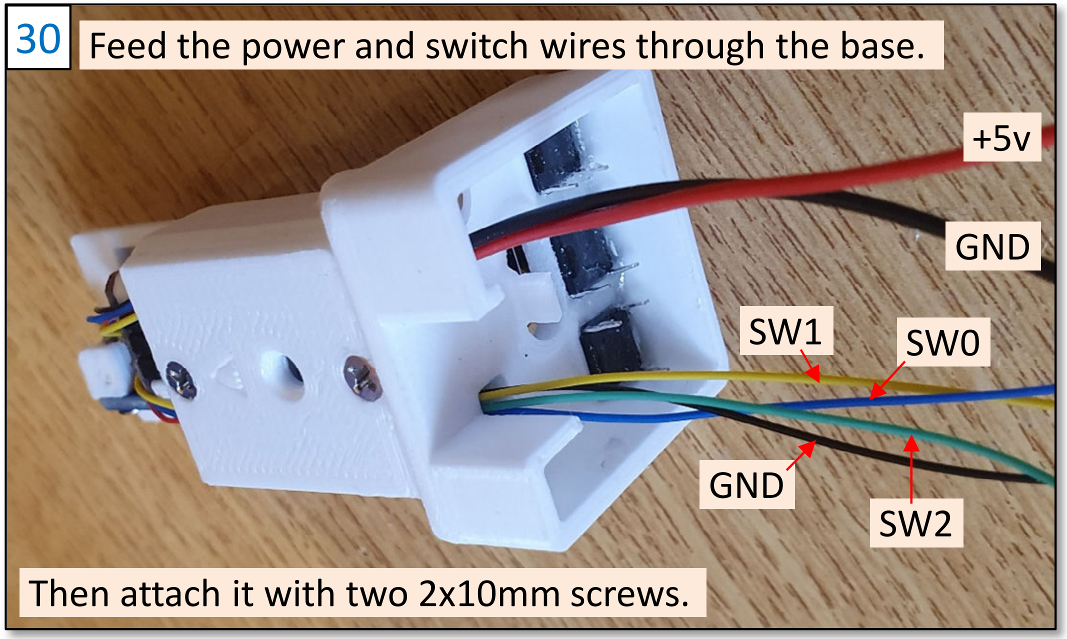
Avoid wrapping the insulation, to ease soldering later.


29 Viewed from the rear.

Wires have sufficient length, to be repositioned.

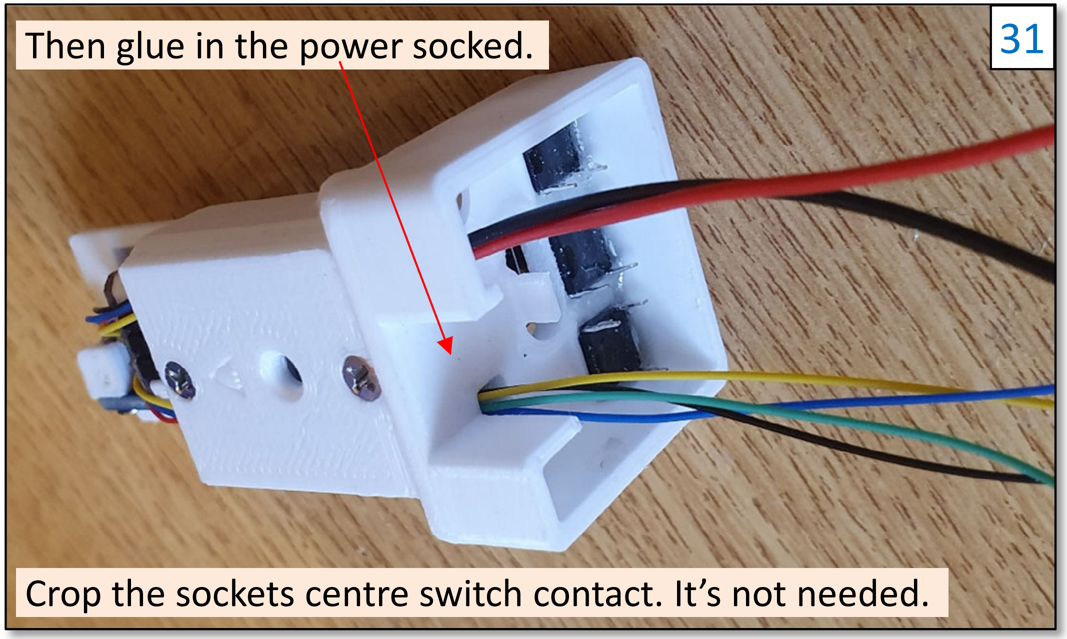
Recorded Build Sequence

30 Feed the power and switch wires through the base.



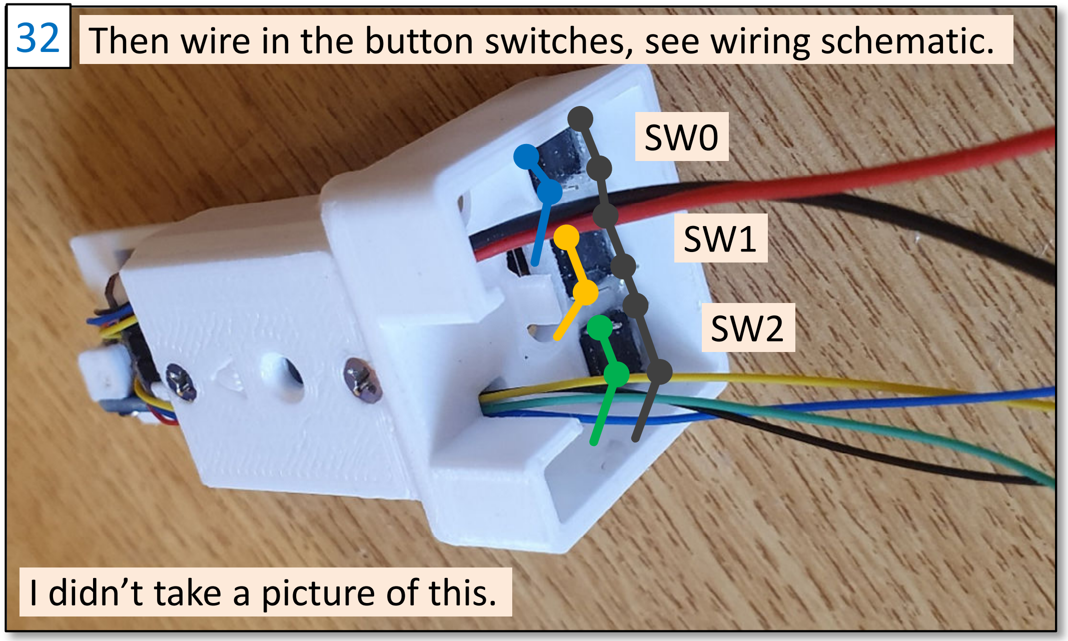
Then attach it with two 2x10mm screws.

31 Then glue in the power socked.



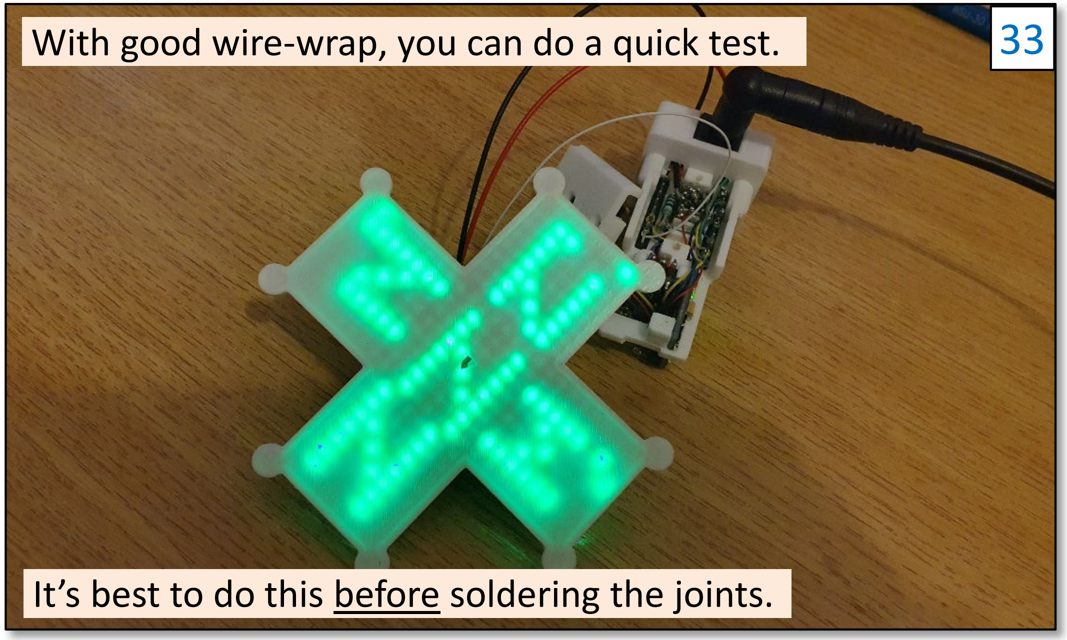
Crop the sockets centre switch contact. It's not needed.

32 Then wire in the button switches, see wiring schematic.



I didn't take a picture of this.

33 With good wire-wrap, you can do a quick test.

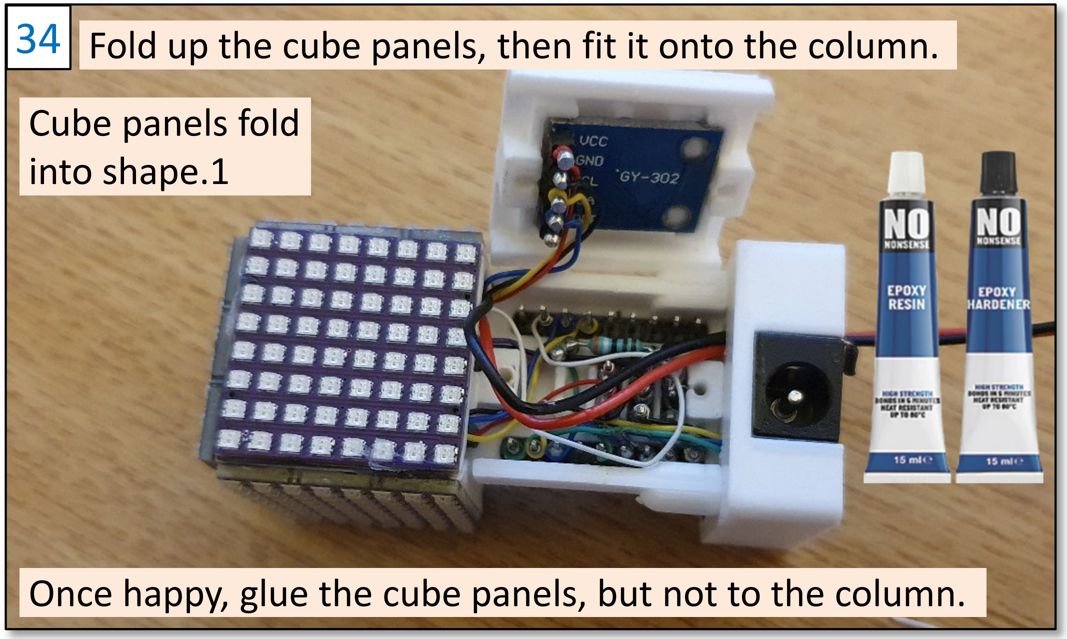


It's best to do this before soldering the joints.

Recordeded Build Sequence

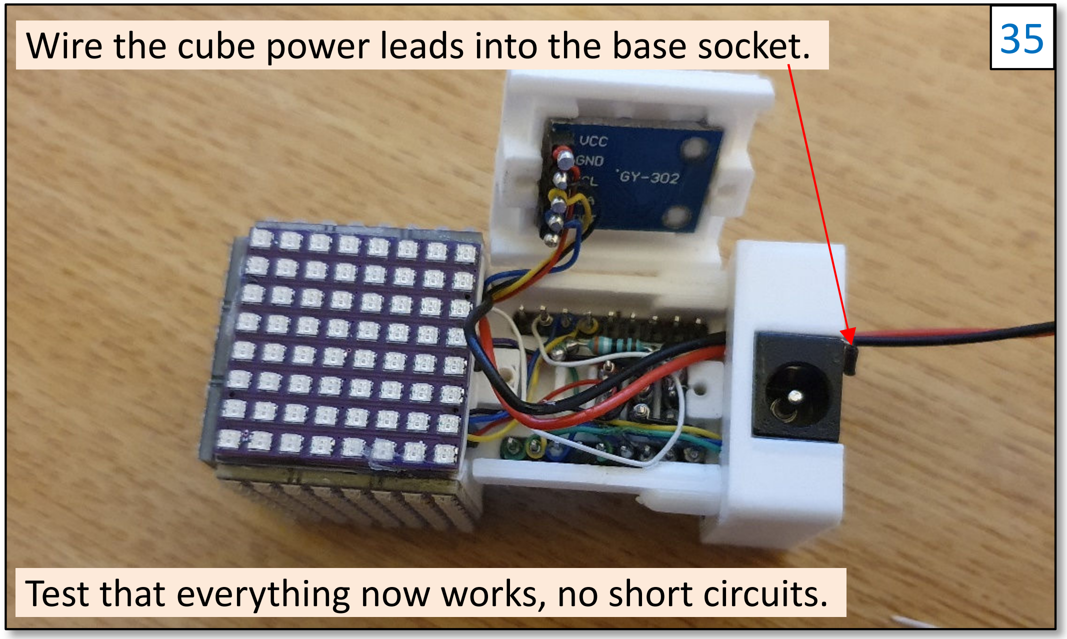
34 Fold up the cube panels, then fit it onto the column.

Cube panels fold into shape.1



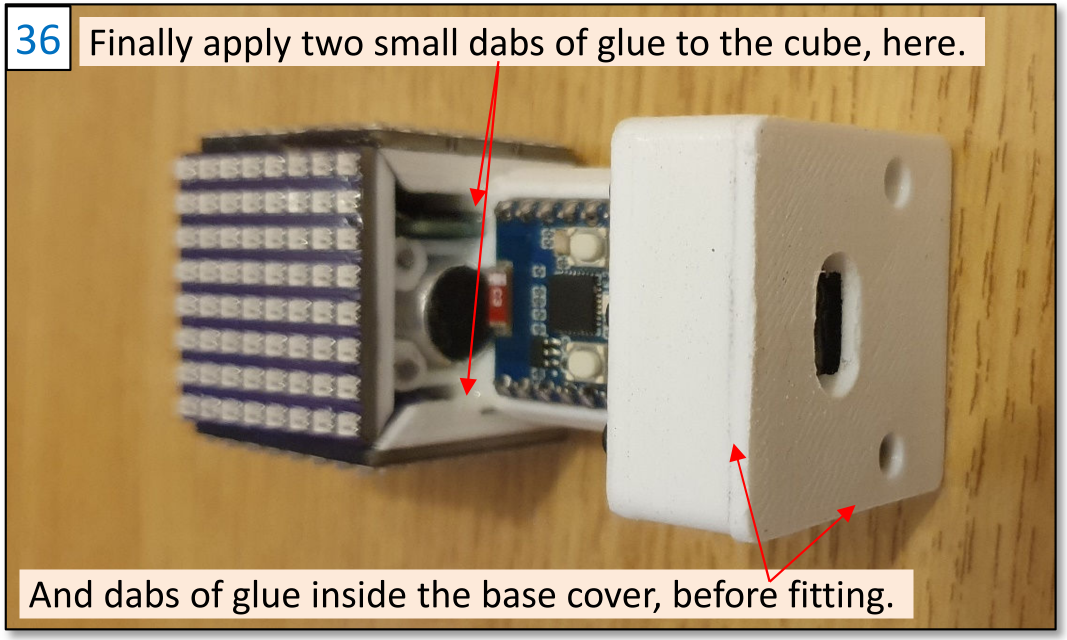
Once happy, glue the cube panels, but not to the column.

35 Wire the cube power leads into the base socket.



Test that everything now works, no short circuits.

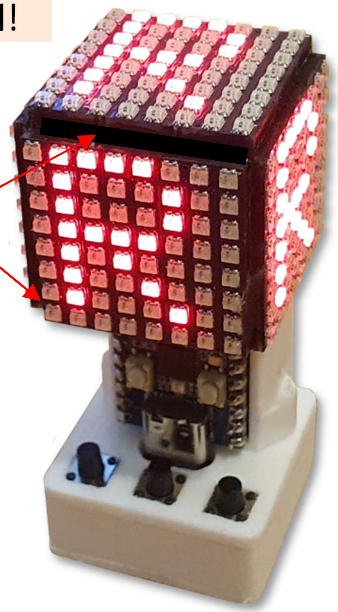
36 Finally apply two small dabs of glue to the cube, here.

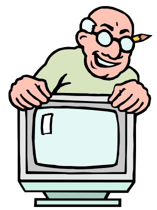


And dabs of glue inside the base cover, before fitting.

37 That's the cube completed!

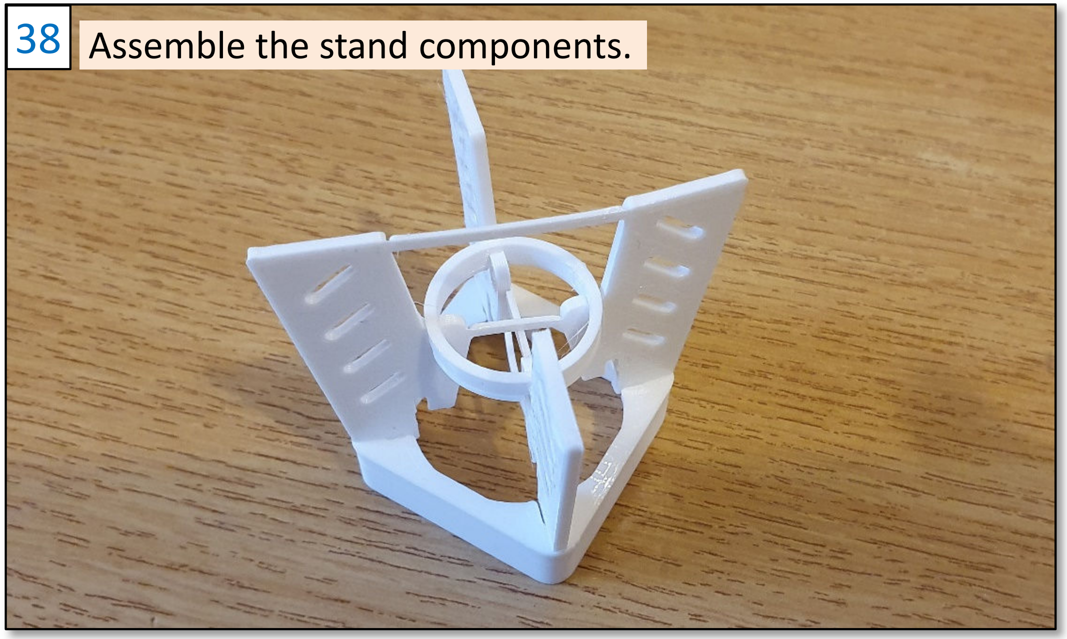
Use a black marker pen on the joints, to hide the PLA colour.



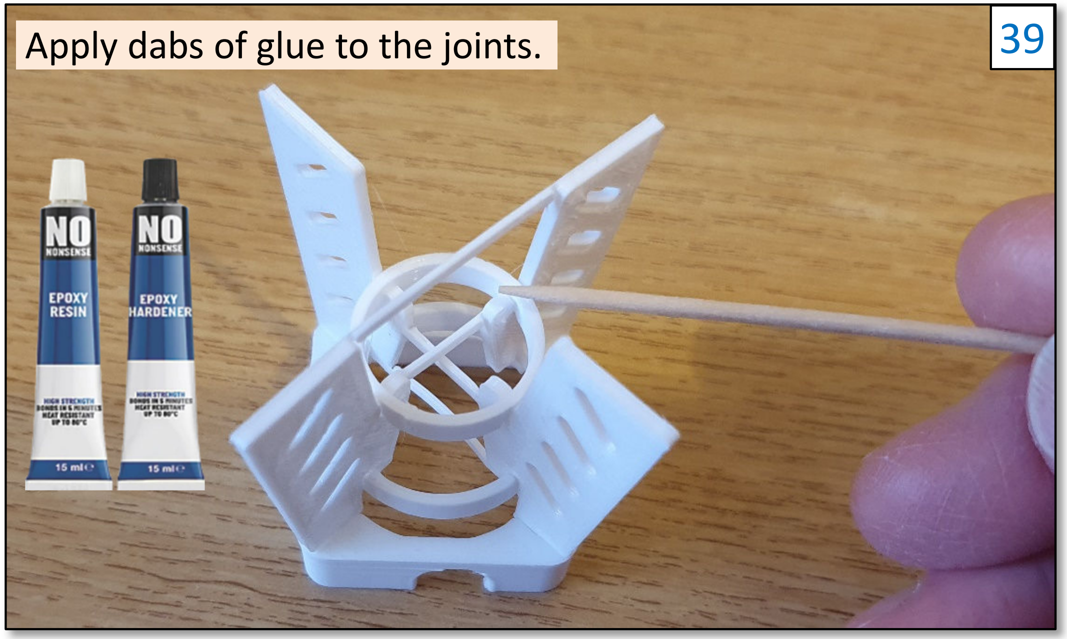


Make it outstanding!

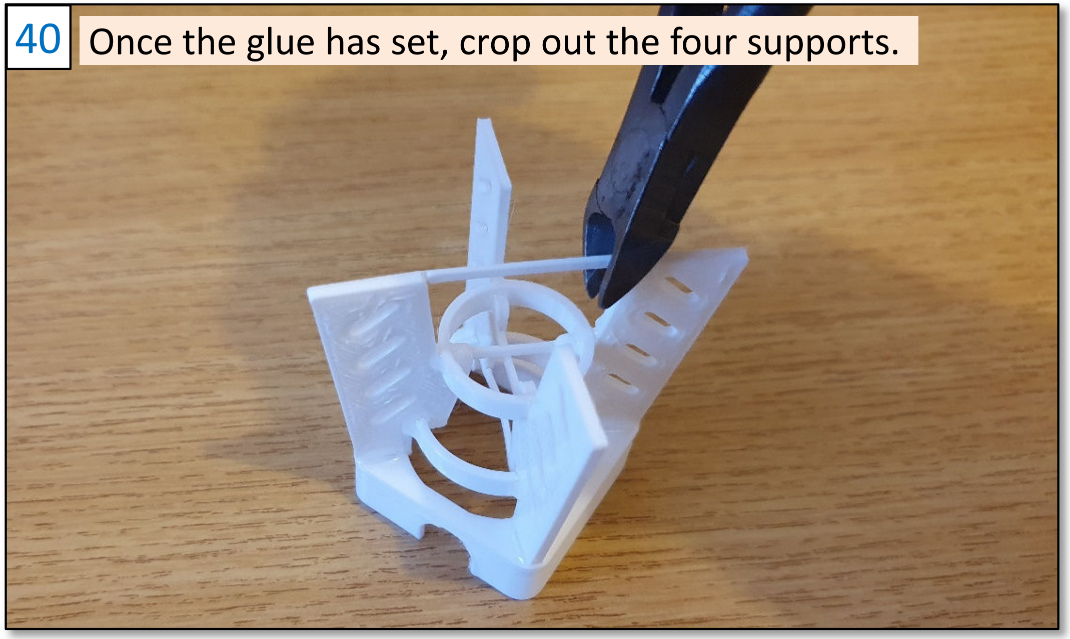
38 Assemble the stand components.



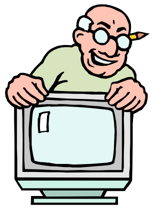
39 Apply dabs of glue to the joints.



40 Once the glue has set, crop out the four supports.



41 And that's it.



Outstanding!

ESP32C3 Flashing

If you have not used an ESP32C3 before, then this should help you put code into it using the Arduino IDE.

Within the Board Manager you need to have installed the definitions from **esp32** by Espressif Systems.

Connect the micro to a USB port, and within the IDE select that port and the board type as: **ESP32C3 Dev Module**

The dropped down menu should then display this in **bold** text.

In the Tools menu you should have the following settings:

- USB CDC On Boot: “Enabled”
- Flash Mode: “QIO”
- JTAG Adapter: “Disabled”
- Upload Speed: “115200”

Press and <u>hold</u> down the **Reset** button on the ESP32C3 micro.

The board name in the drop-down combo should lose its boldness.

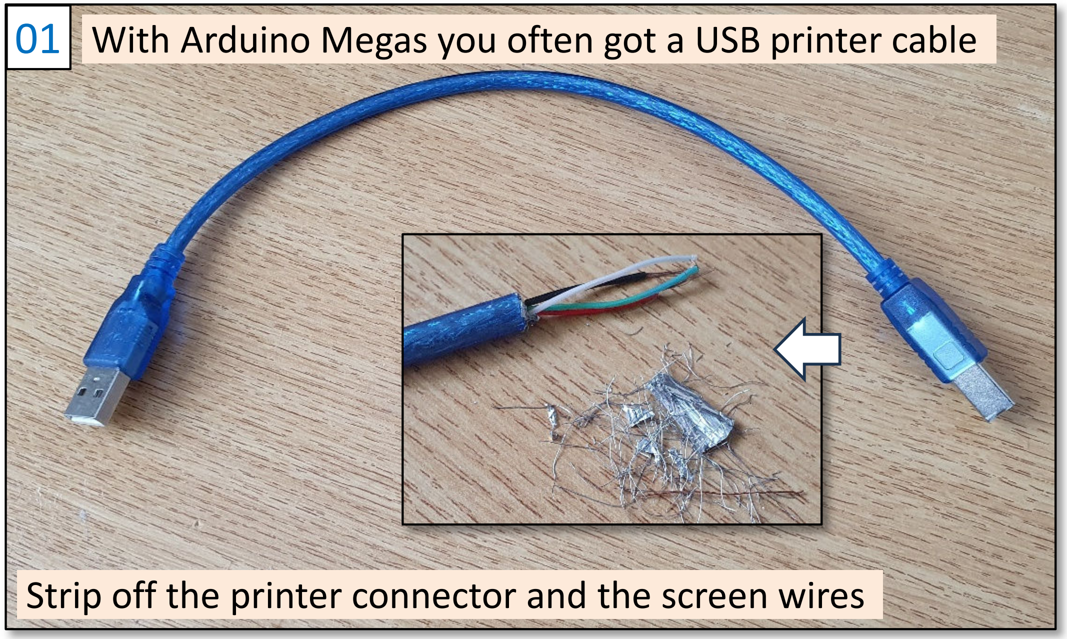
Now press and <u>hold</u> down the **Boot** button.

Then release the Reset button, whilst the Boot button is still pressed, and after a second or two the board listed in the drop-down combo should once again be **bold**, indicating that the board has re-connected to the IDE in Boot mode.

Now release the Boot button. And you can flash the device from the IDE in the usual fashion. Then press **Reset** to run the code, <u>after</u> flashing is completed.

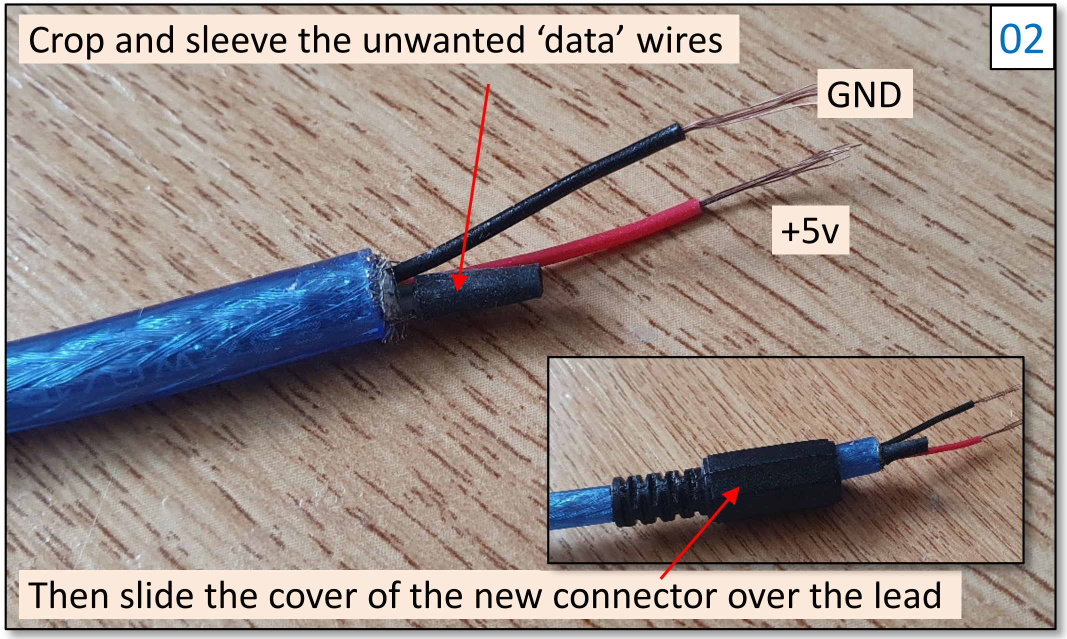
USB Cable – made from an old Printer cable

01 With Arduino Megas you often got a USB printer cable



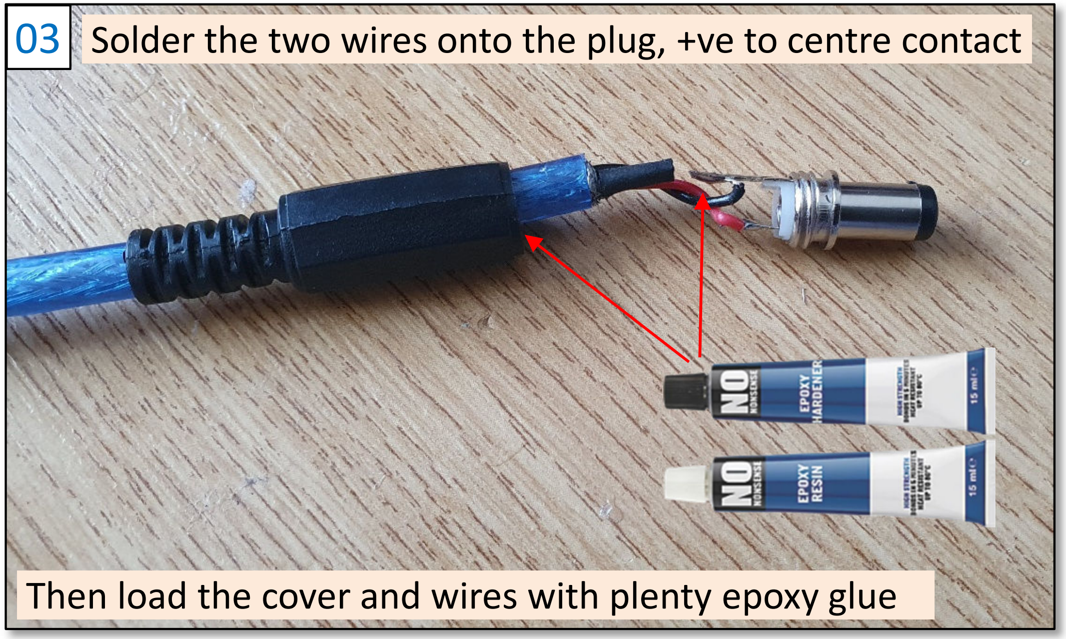
Strip off the printer connector and the screen wires

02 Crop and sleeve the unwanted 'data' wires



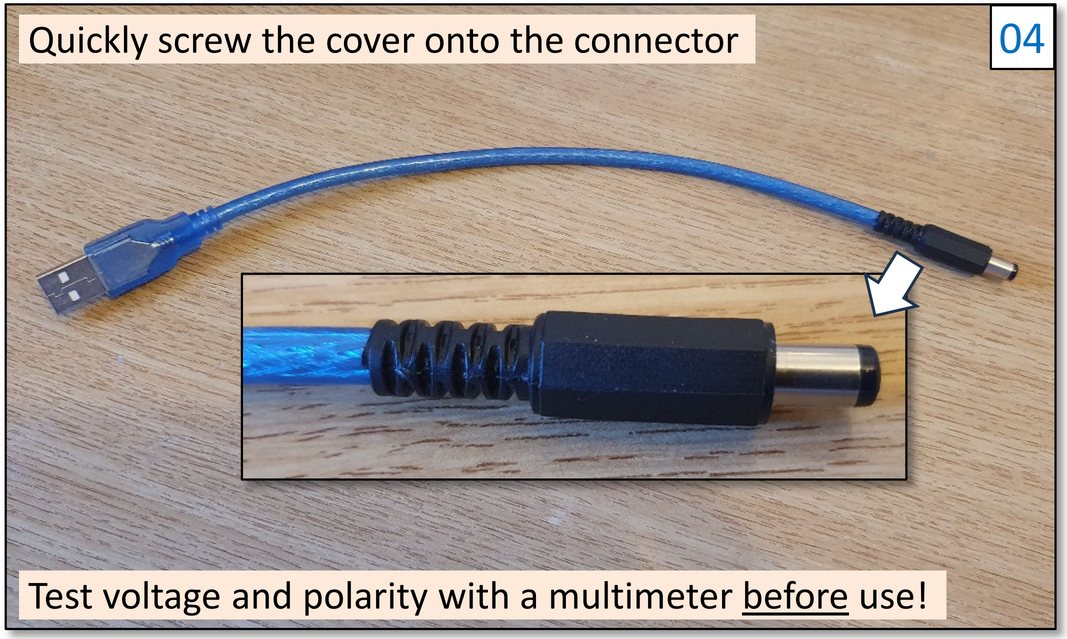
Then slide the cover of the new connector over the lead

03 Solder the two wires onto the plug, +ve to centre contact



Then load the cover and wires with plenty epoxy glue

04 Quickly screw the cover onto the connector



Test voltage and polarity with a multimeter <u>before</u> use!

MPU6050 Motion Sensor

The MPU6050 3-axis motion sensor is mounted inside the cube as shown.

The X-axis aligns front to rear. The Y-axis is vertical, and the Z-axis is right to left.

We will define pitch, roll and yaw motions as follows:

Pitch – determined by gyro Z and accelerometer X. Positive pitch, is when the cube is leaning forwards. Gyro Z will be positive, when tipping forwards, and accelerometer X will be positive. When the cube is perpendicular, X is zero.

Roll – is determined by gyro X and accelerometer Z. Positive Roll, is when the cube is leaning to the right. Gyro X will be negative, when tipping to the right, and accelerometer Z will be positive. When the cube is perpendicular, Z is zero.

Yaw – is determined by gyro Y. The Y accelerometer will be reading gravity, and normally outputting a large positive value.

When the cube is in the upright position, the Y accelerometer is +ve and –ve when it is upside down.