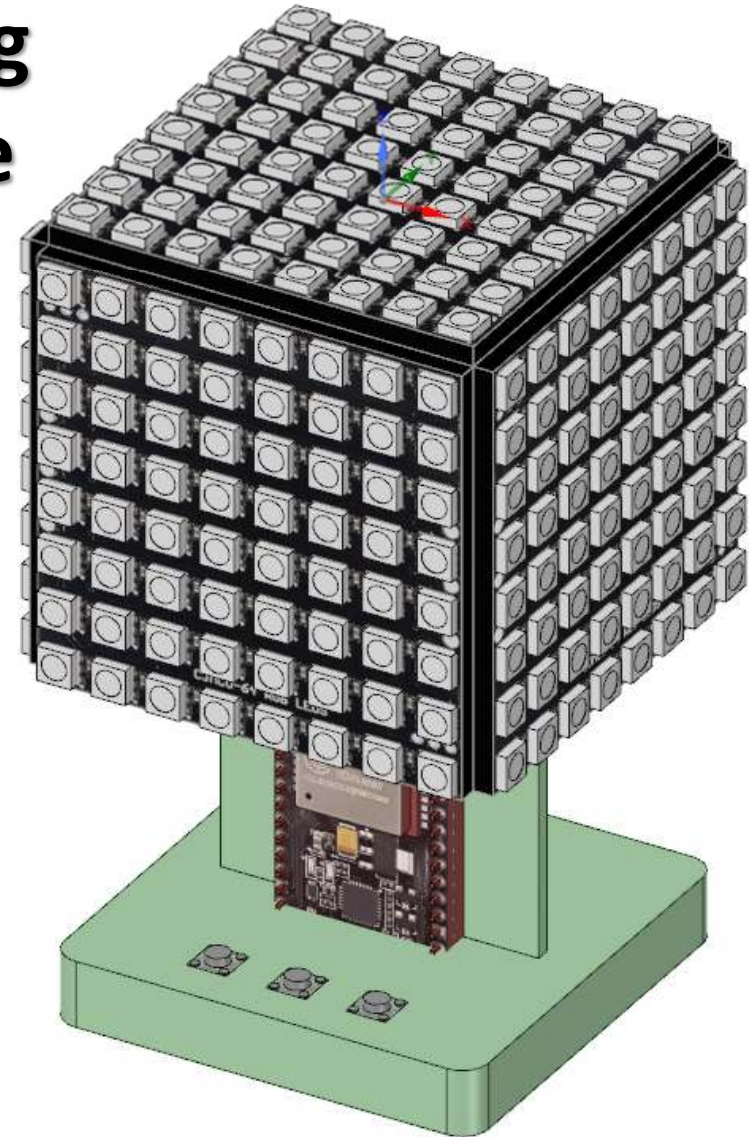
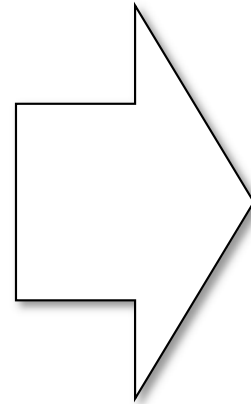
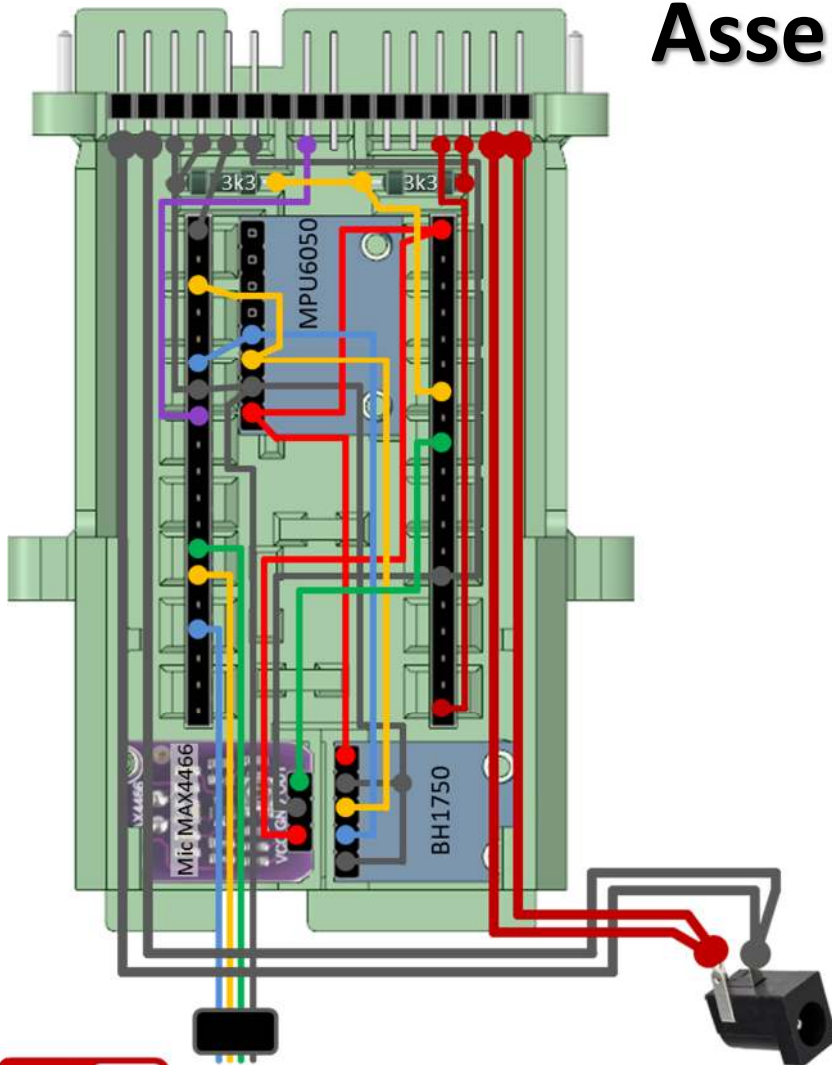


# Magic Cube 8x8x5

## Circuits & Wiring Assembly Guide



# Hand Tools:

## Recommended:

- Fine Nosed Pliers
- Side Cutters
- 1.5 mm Drill
- 2.0 mm Drill
- 4.0 mm Drill
- Needle Files
- Screwdriver
- Craft Knife



Note: Not all items are shown here.

# Tools & Materials:

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

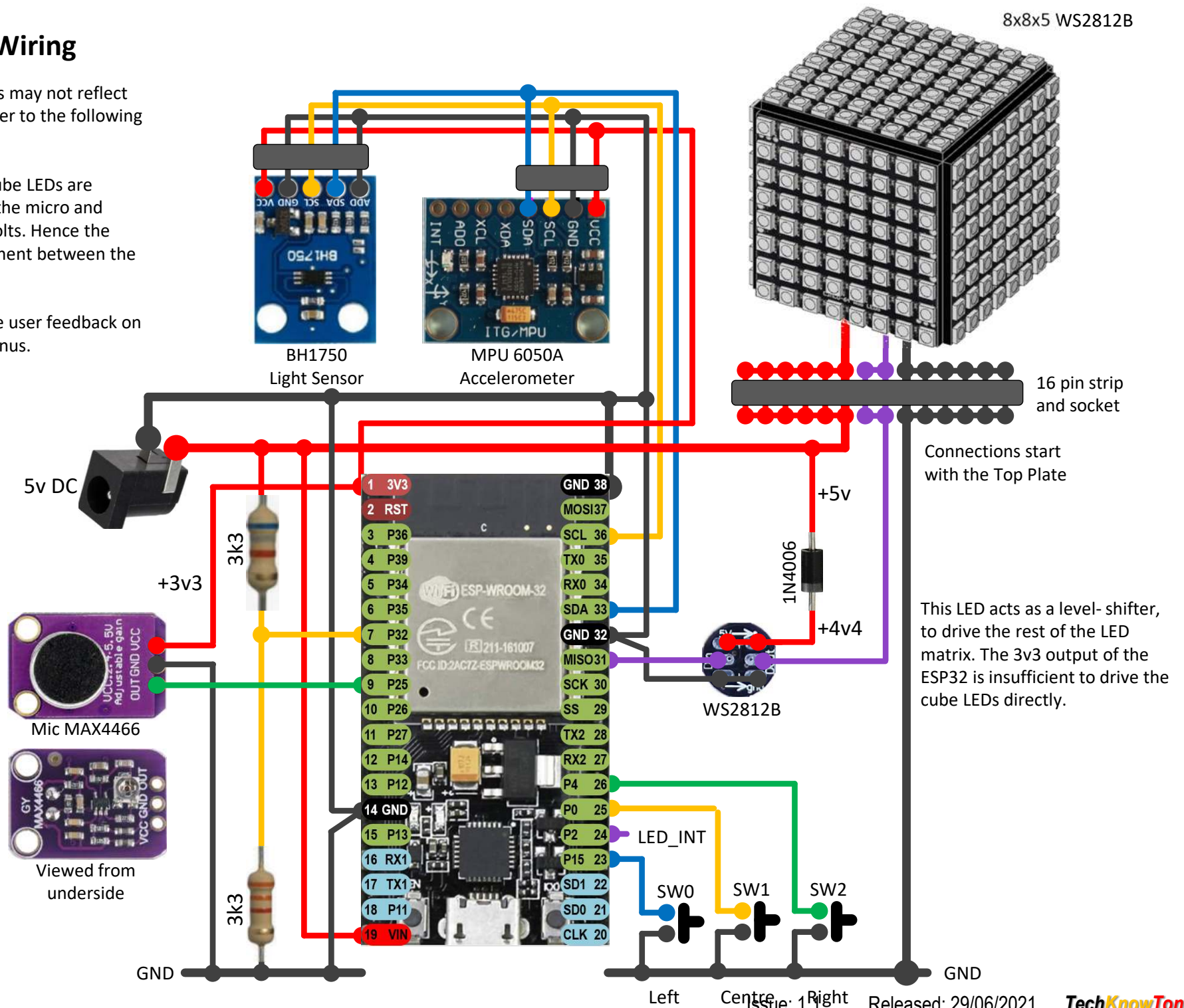


# Magic Cube 8x8x5 Wiring

Note that physical wiring routes may not reflect this wiring diagram exactly. Refer to the following pages for further details.

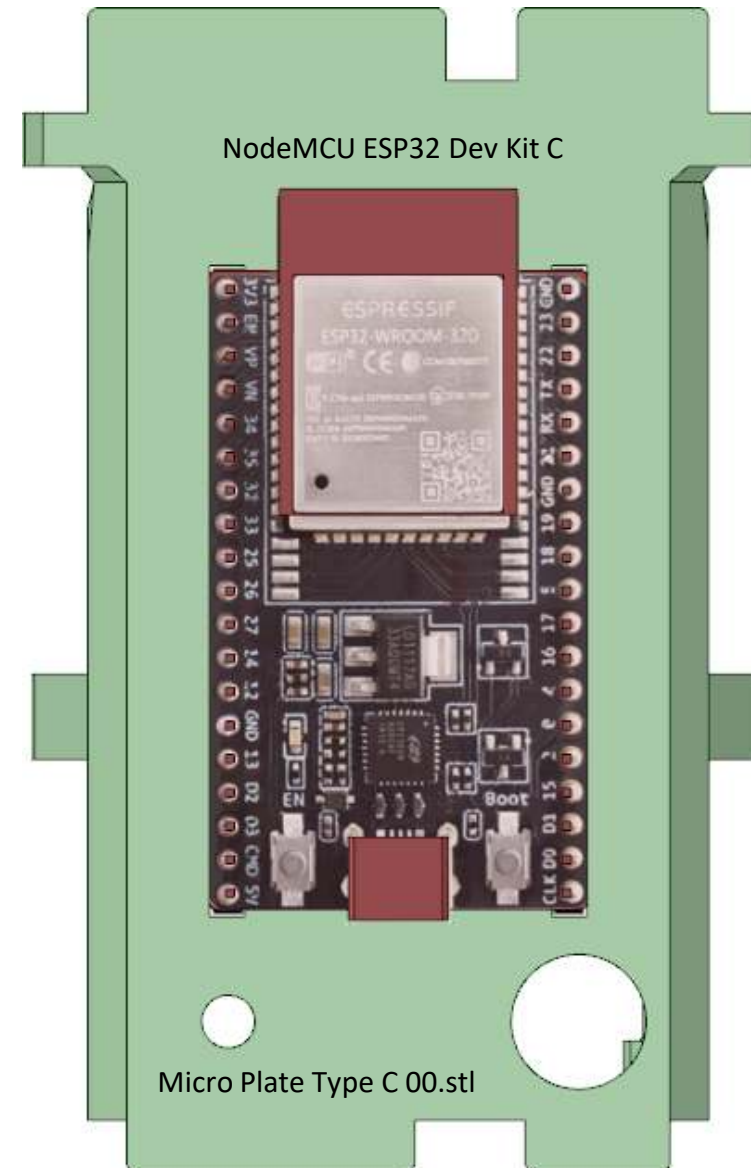
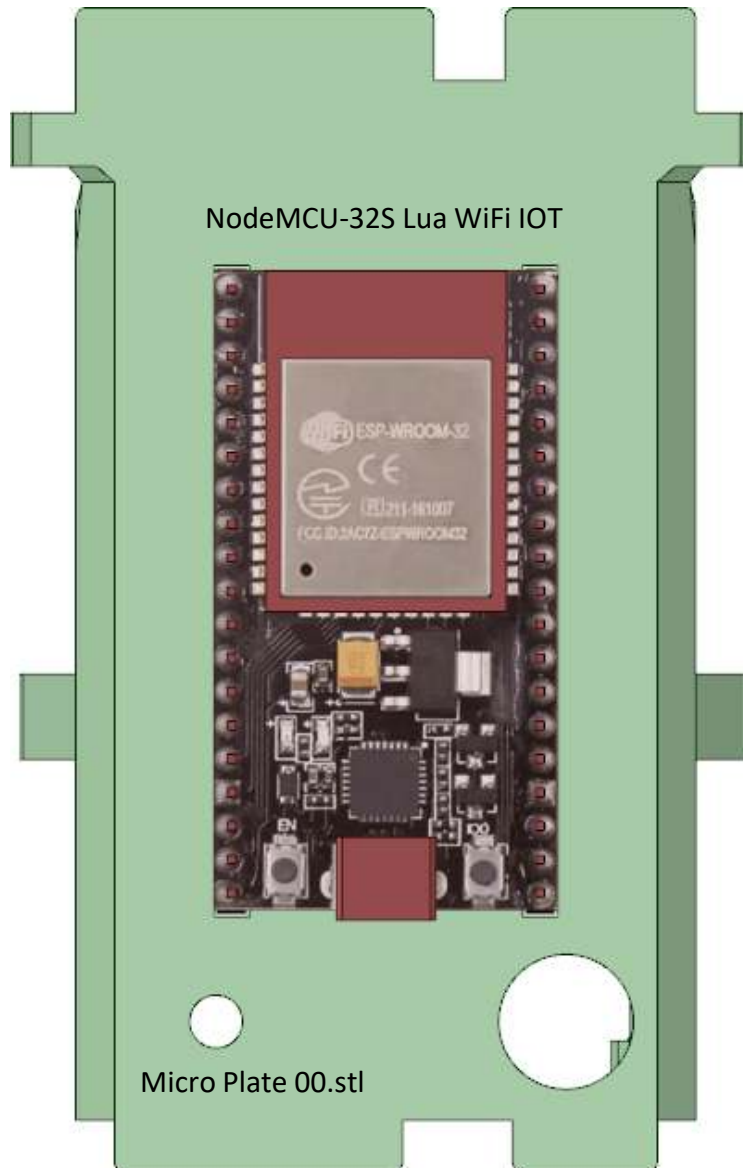
Whilst the cube circuitry and cube LEDs are powered from a 5v DC supply, the micro and associated parts work off 3.3 volts. Hence the need for a level shifting component between the micro and the cubes 1<sup>st</sup> LED.

The single RGB LED also provide user feedback on button presses, as an added bonus.



## ESP32 Microcontroller's

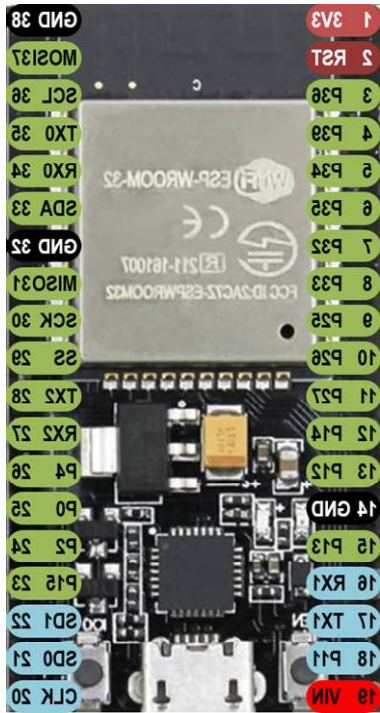
The ESP-WROOM-32 NodeMCU is manufactured in different form factors. The latest Dev Kit C is wider than its predecessor by 2.54mm. For this reason I have provided two micro plate .stl files, so that you can choose the one you need to suit your board type.



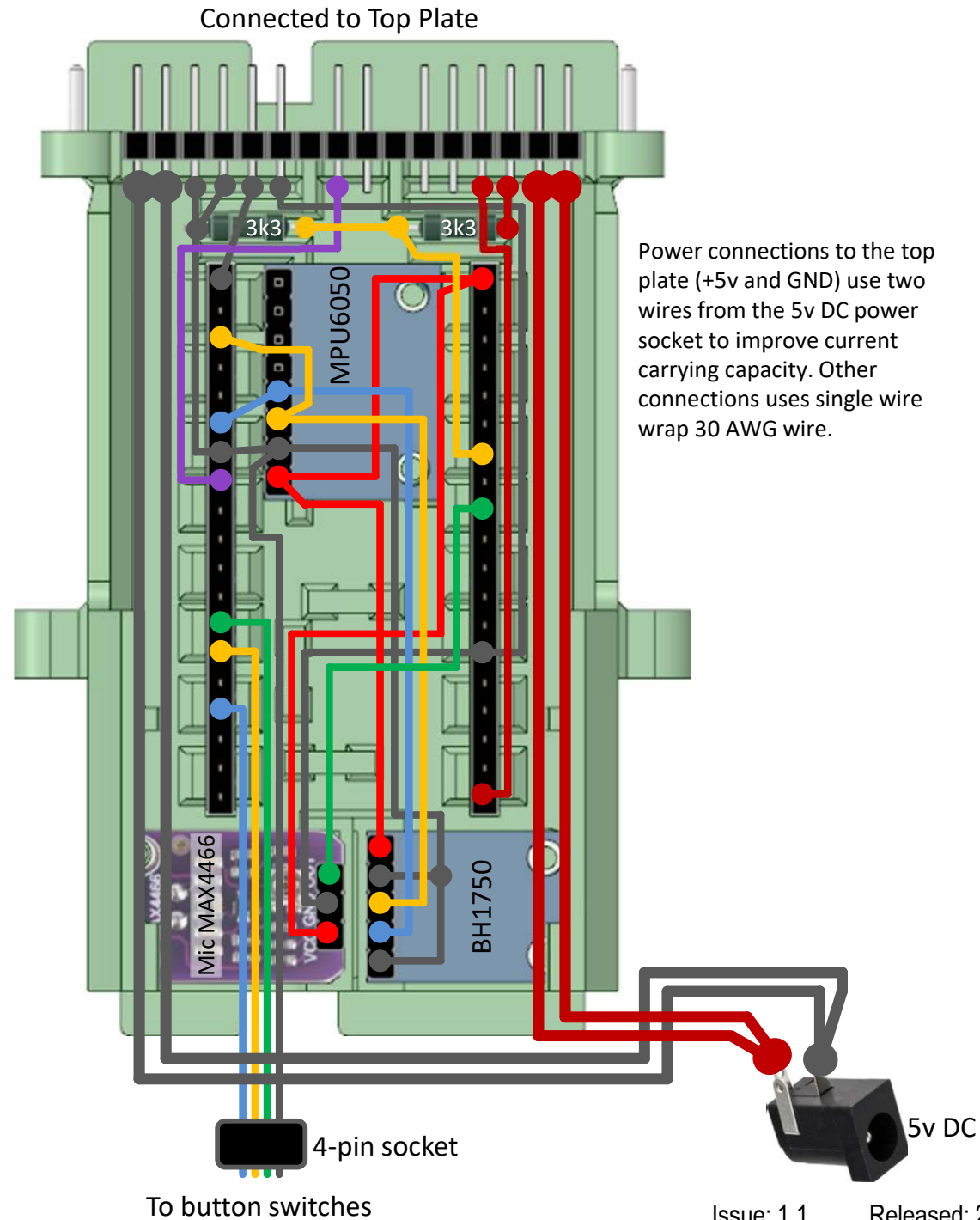
# Micro Plate Wiring

Use this wiring diagram and associate photos on the following pages to complete the wiring of the micro plate.

You will connect the Top Plate, sensor pcb's and 16-pin strips before commencing the wiring.



When viewed from below connections are reversed

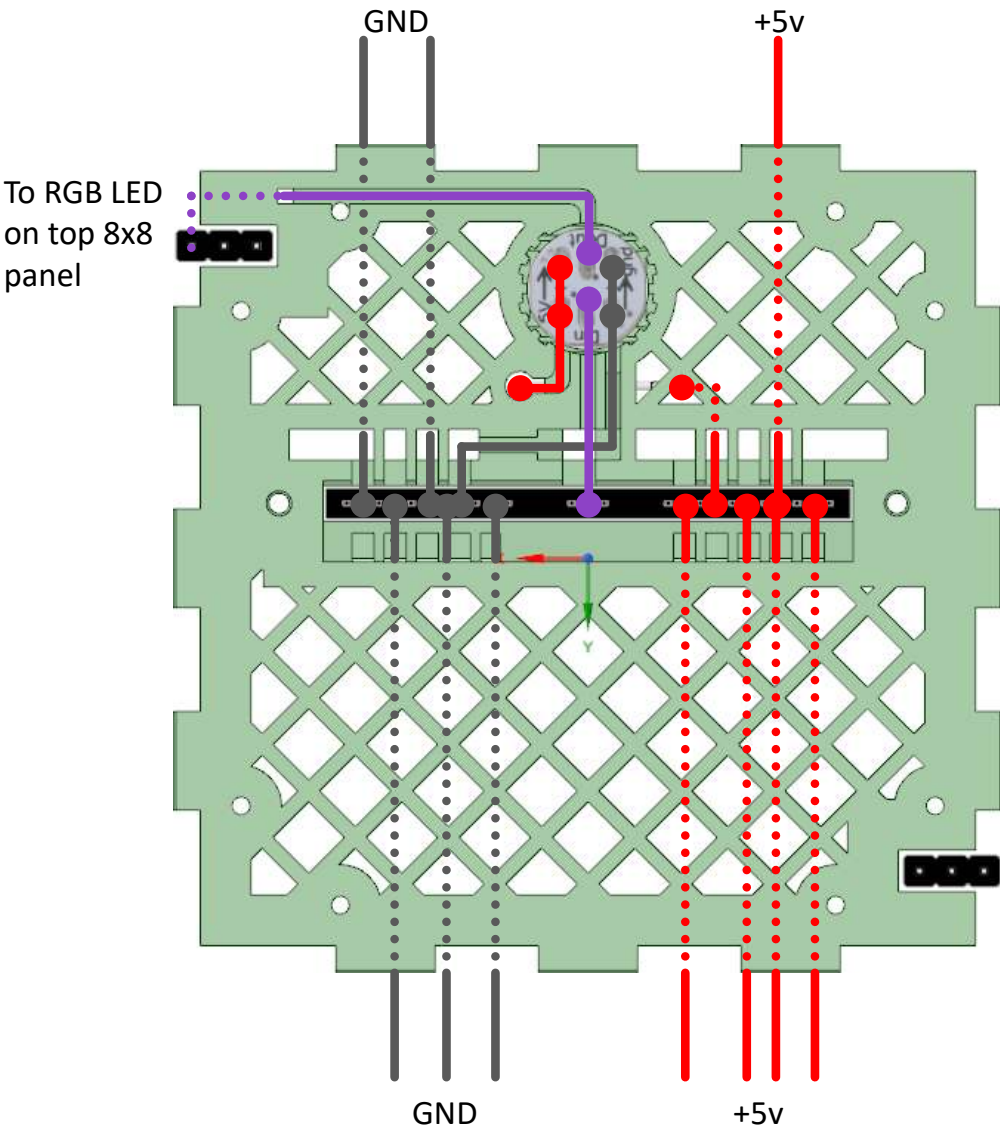


Power connections to the top plate (+5v and GND) use two wires from the 5v DC power socket to improve current carrying capacity. Other connections uses single wire wrap 30 AWG wire.

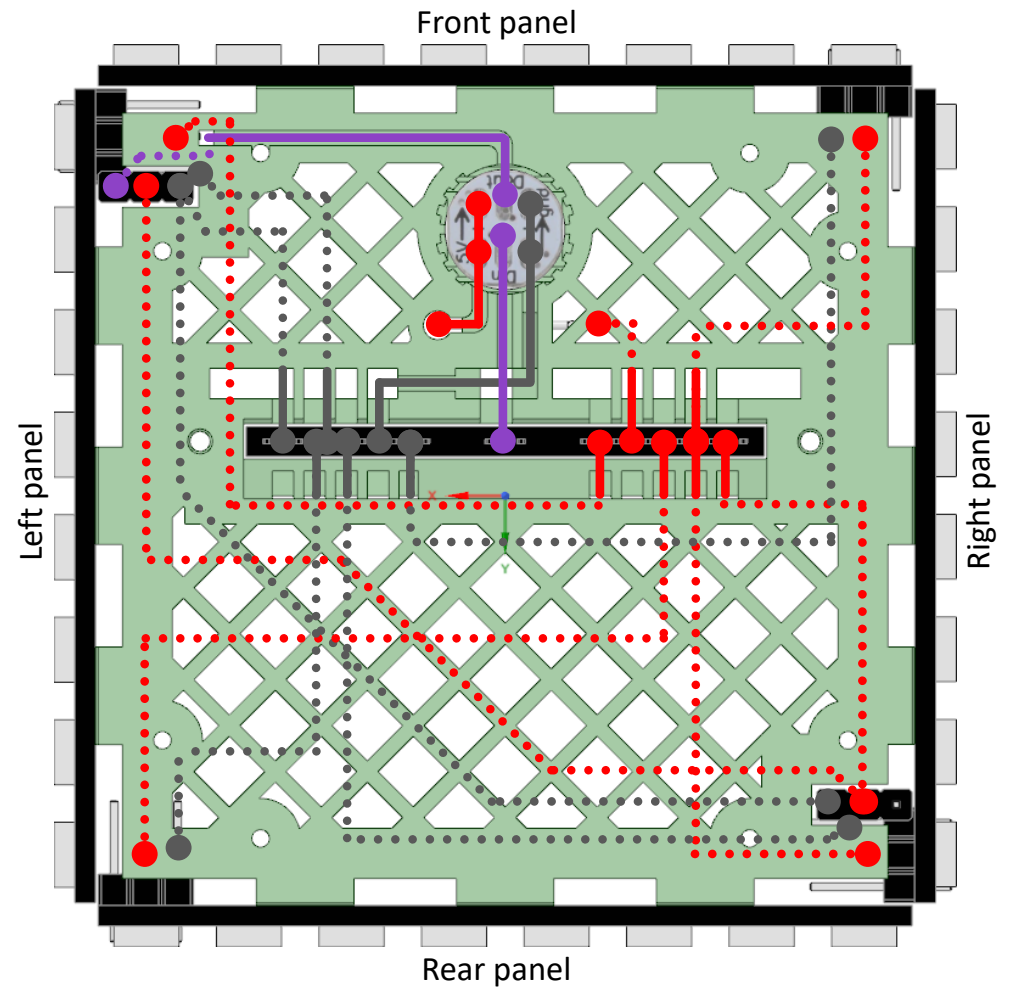


# 8x8 Top Panel Initial Panel Wiring

Study this wiring to ensure that you understand how it relates to the previous diagrams.

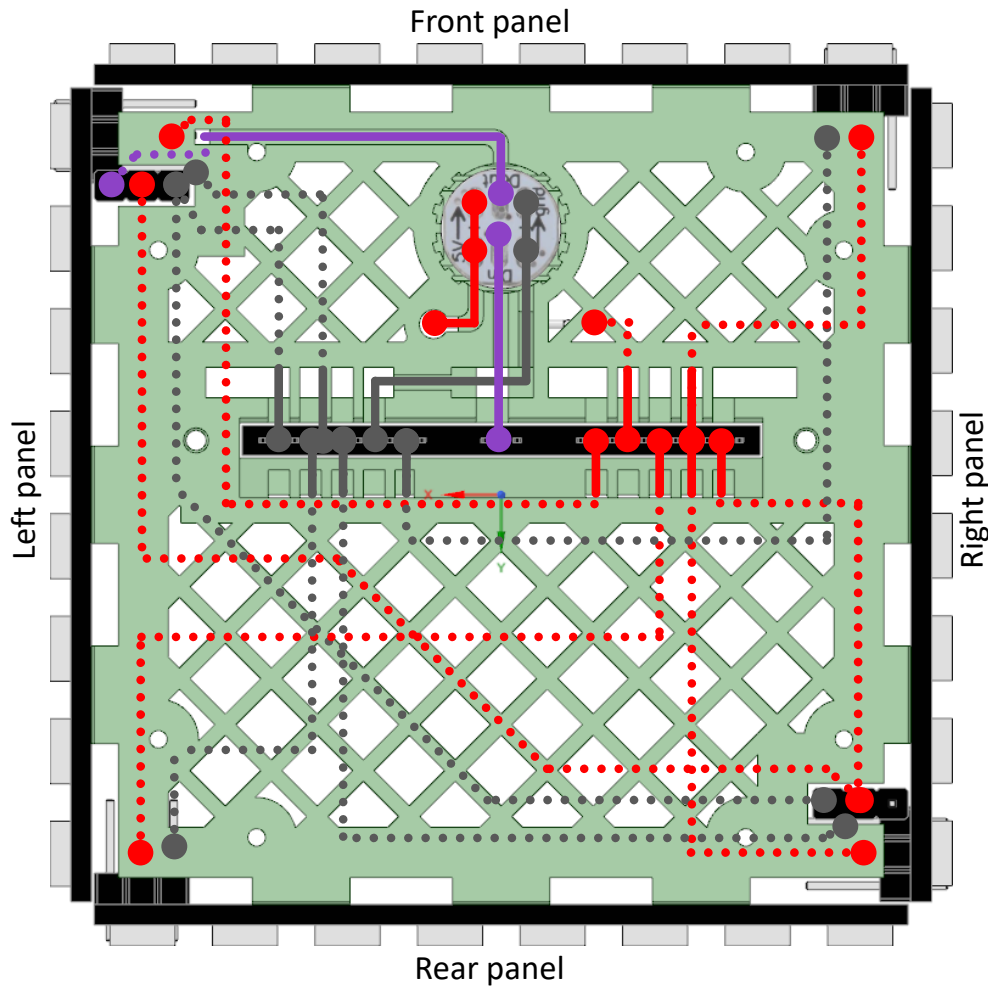


Initial wiring coming off the 16 pin socket strip.



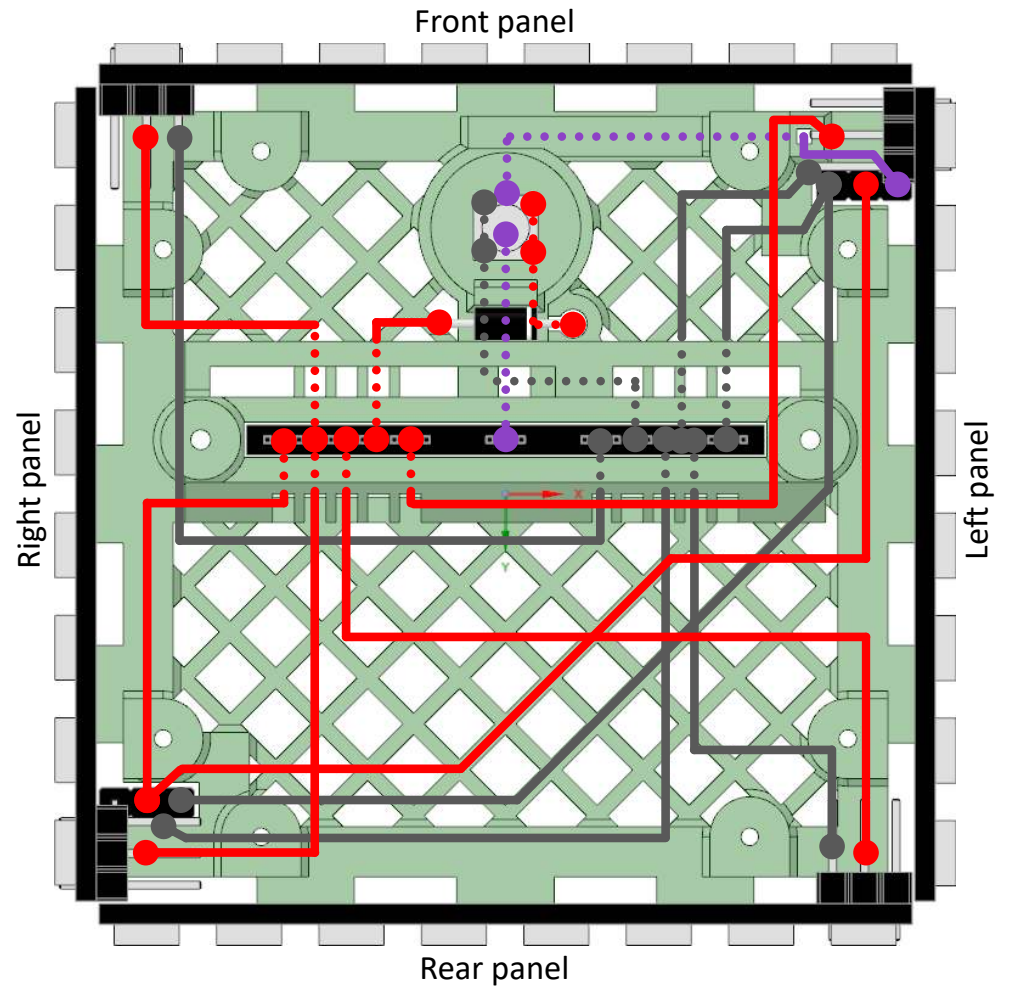
Viewed from top  
8x8 LED matrix removed  
Majority of wiring (dotted line) is on the other side

# 8x8 Top Panel To Side Panel Wiring



Viewed from top  
8x8 matrix removed

Majority of wiring (dotted line) is on the other side

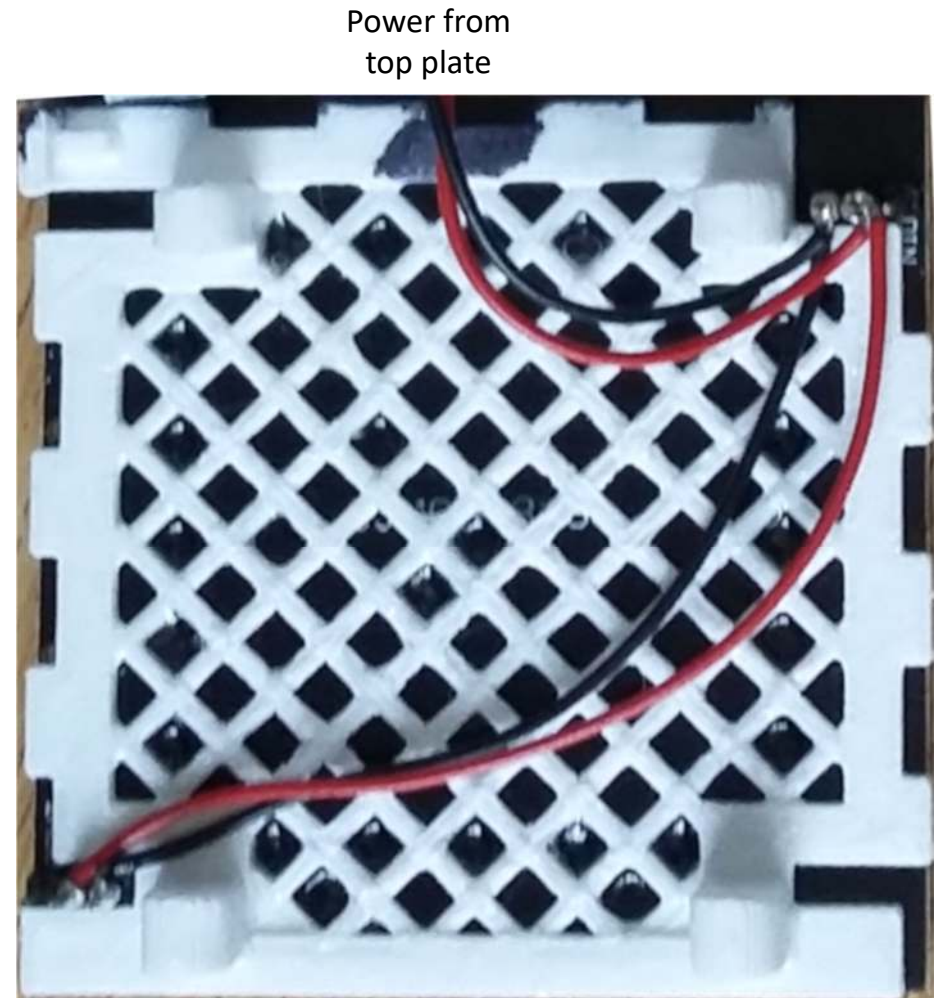
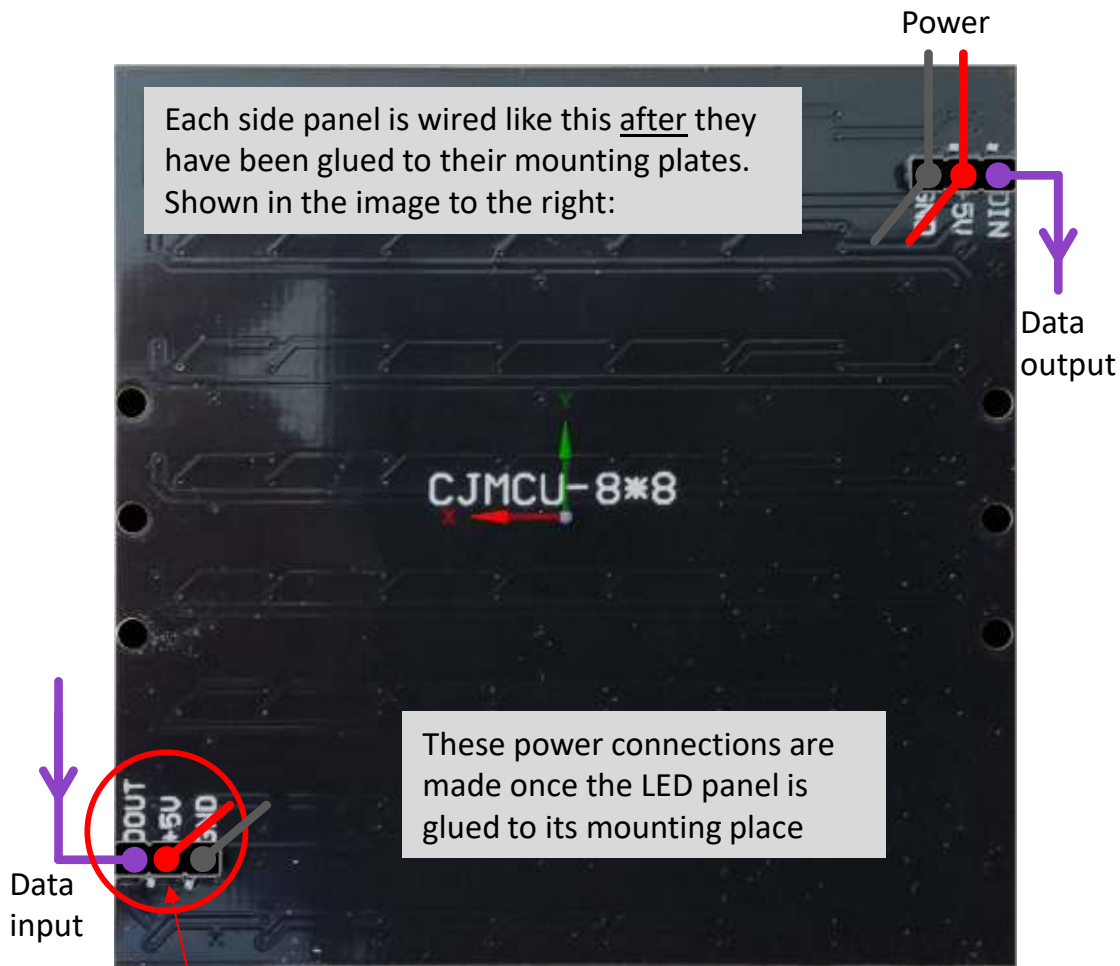


Viewed from inside  
8x8 matrix removed

Majority of wiring (solid line) is on this side

## Side Panel Wiring

Power connections are made to the top connectors on each panel, from the top plate later. We also run wires between the panels 3 pin strips to improve current capacity.

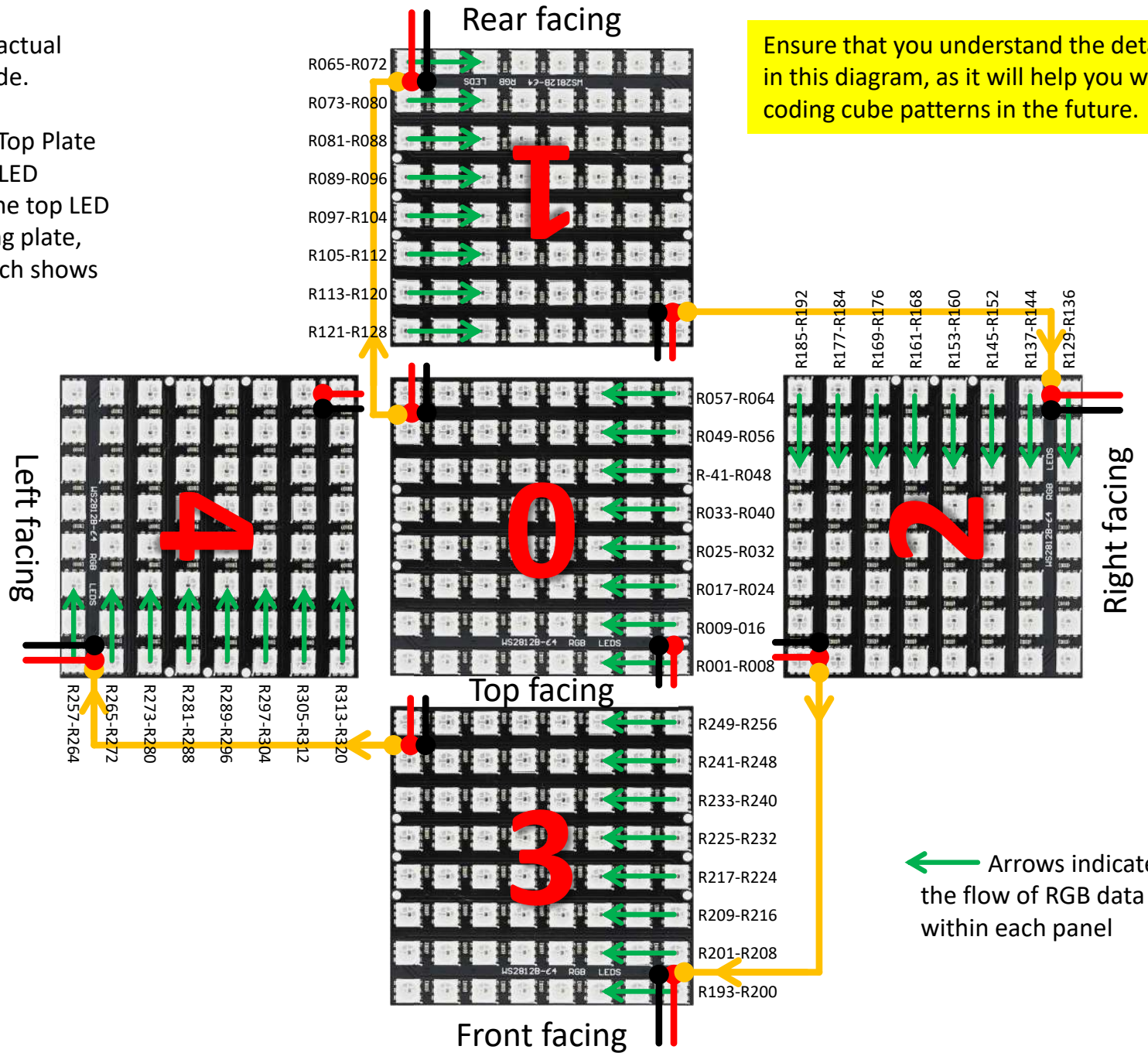
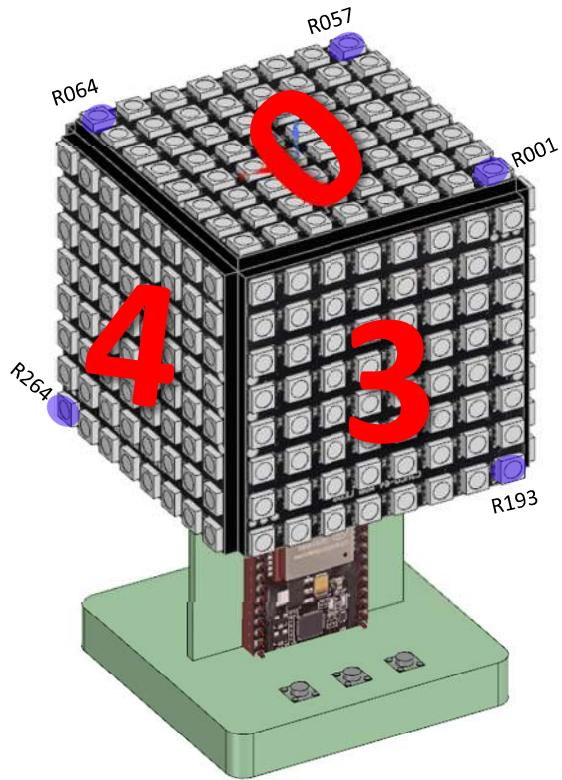


**Note:** that on some low cost CJMCU-8\*8 boards the silk screen legends can be incorrect for DIN and DOUT. This was the case for my boards, hence 'Data input' is wired to DOUT, and visa versa to correct this Manufacturing fault. Test your panels for this fault before wiring up your cube, it wont work if this fault is present in your panels. The benefit of using wire wrap tech for signal wires is that you can test the system before soldering those connections.

# 8x8 LED Matrix Wiring

Connections shown from the outside, but actual wiring will need to be mirrored on the inside.

Beyond the single level shifting LED in the Top Plate the first LED in the sequence is on the top LED matrix, at the bottom right-hand corner. The top LED matrix then drives LED 65 on the rear facing plate, and so on as indicated in this diagram, which shows how LEDs are addressed on each panel.



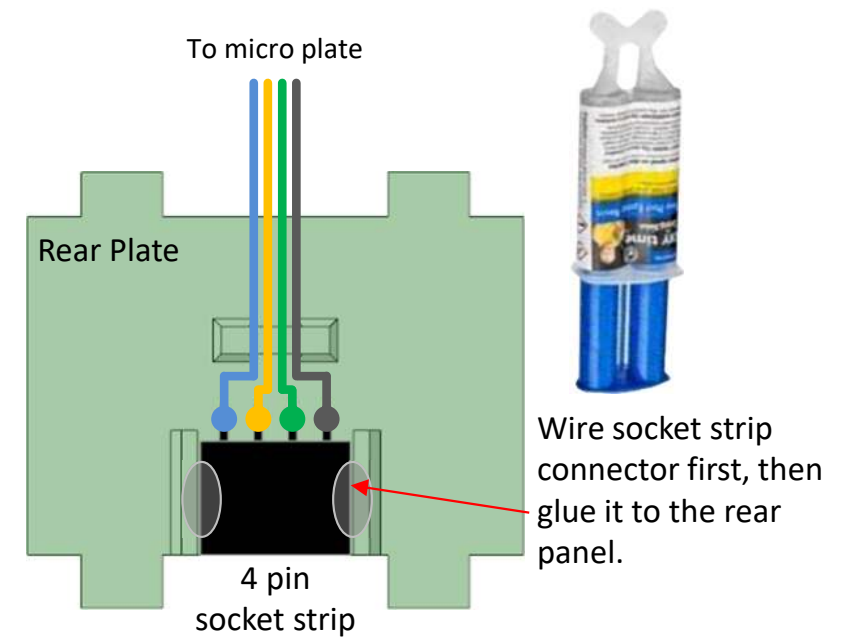
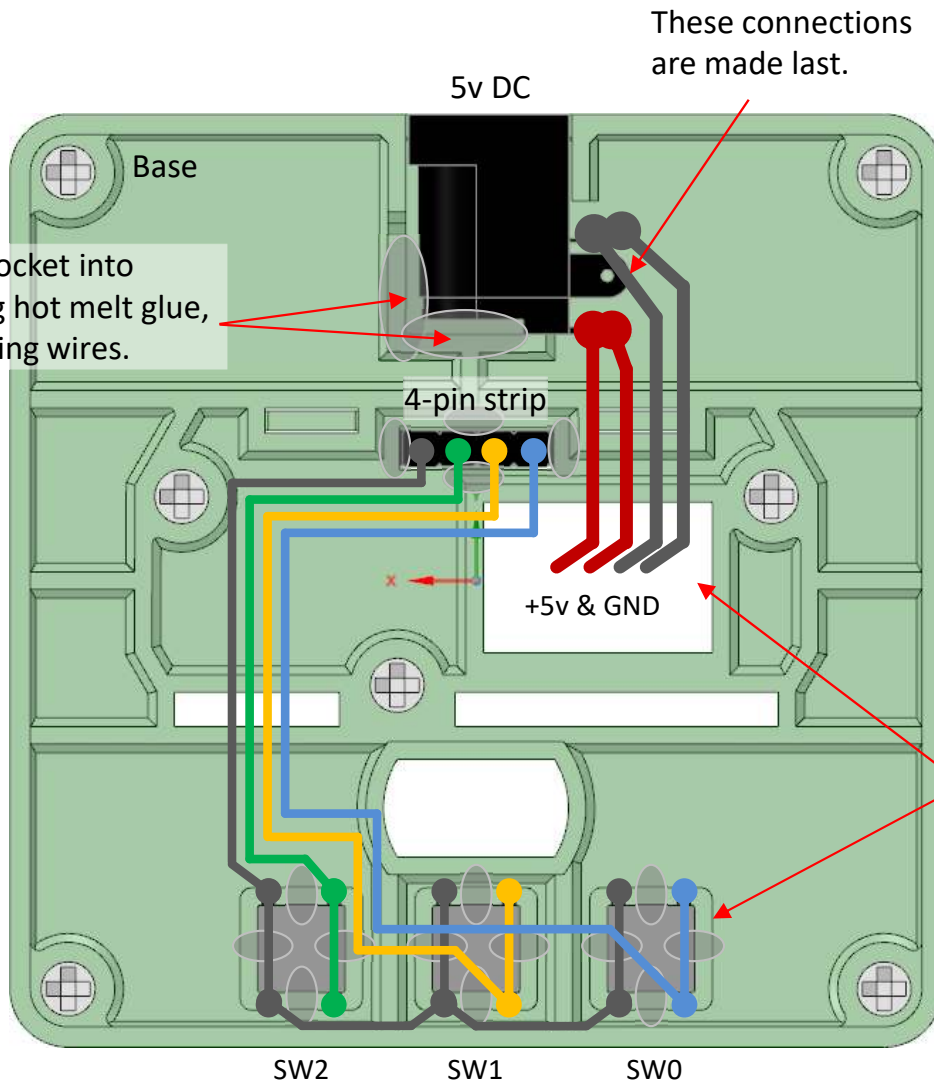
Ensure that you understand the detail in this diagram, as it will help you with coding cube patterns in the future.

← Arrows indicate the flow of RGB data within each panel

## Base Wiring



Glue power socket into position using hot melt glue, before soldering wires.



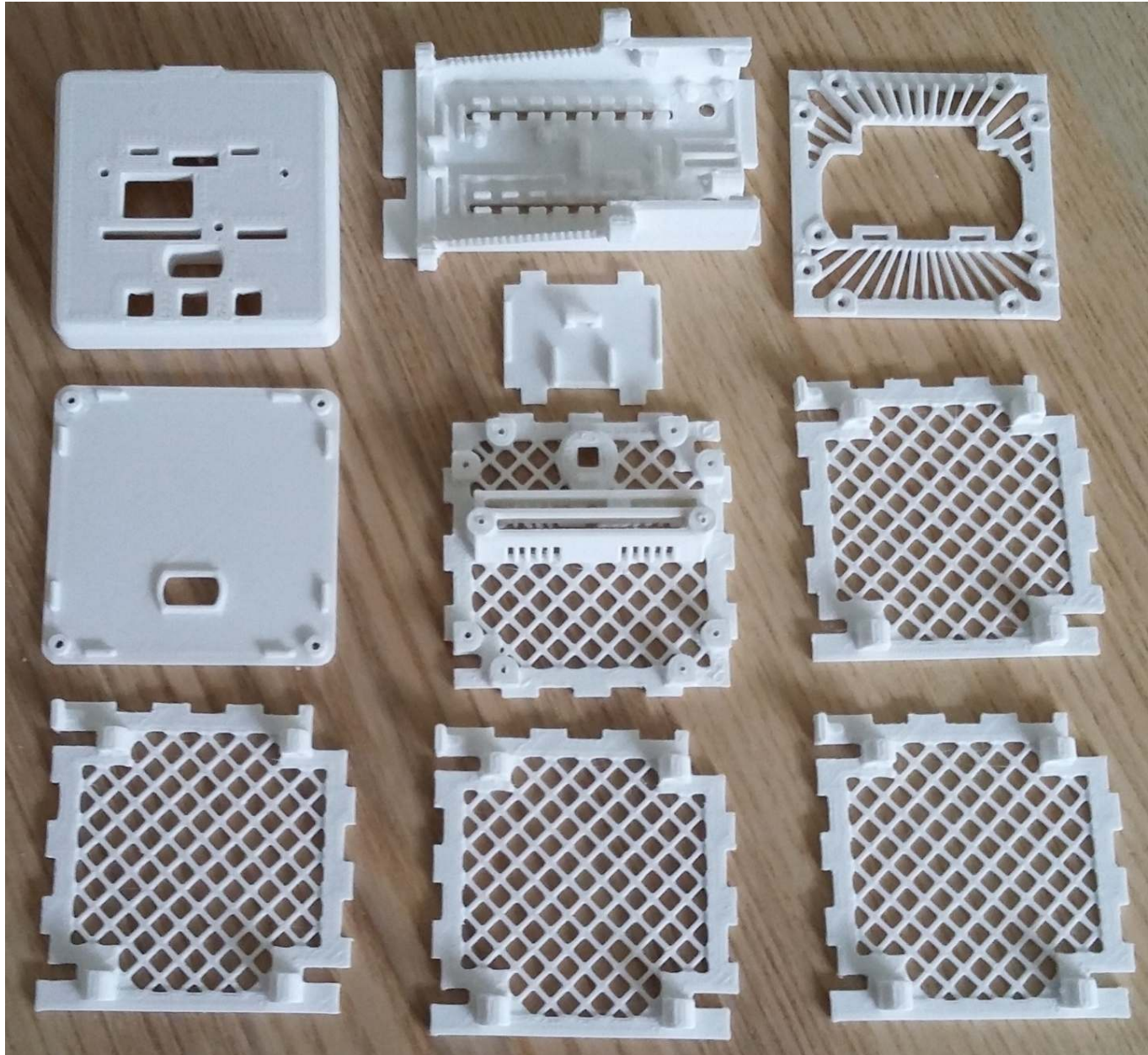
1. Insert button switches and 4-pin strip.
2. Make connections using wire wrap.
3. Test connectivity using a Multimeter.
4. If good, then solder connections.
5. Apply 2-part epoxy glue to 4-pin strip and buttons.



**Note.** Hot melt glue is used on the power socket, so that it can be easily removed if needed. To do so use a temperature controlled iron, set to 230°C and cotton wool buds to absorb and remove the glue.

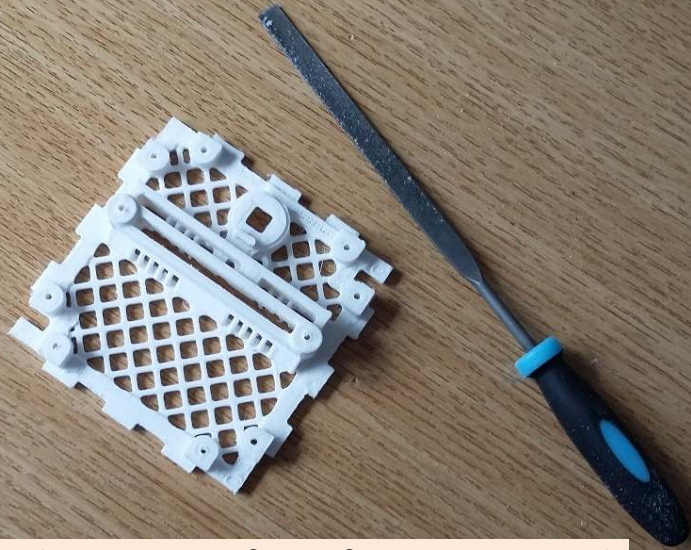
## Assembly Guide

The full set of 3D printed parts will look like this... Read through this guide fully before starting the assembly process.



# Assembly Sequence

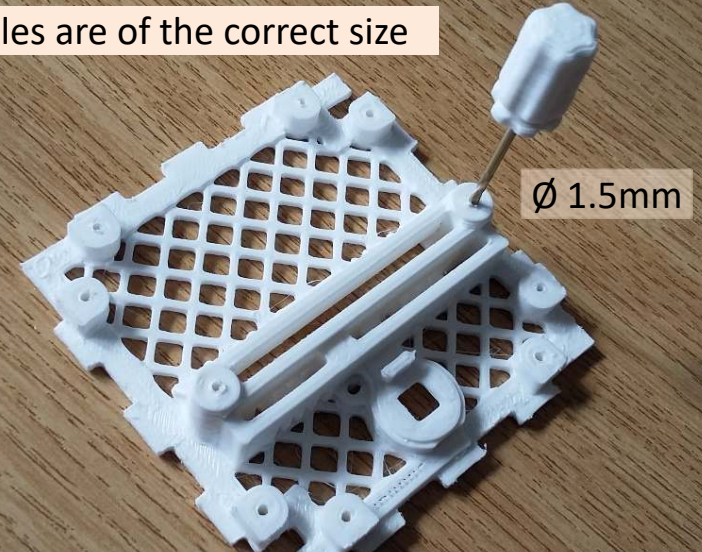
01



Ensure that the parts are free of excess material

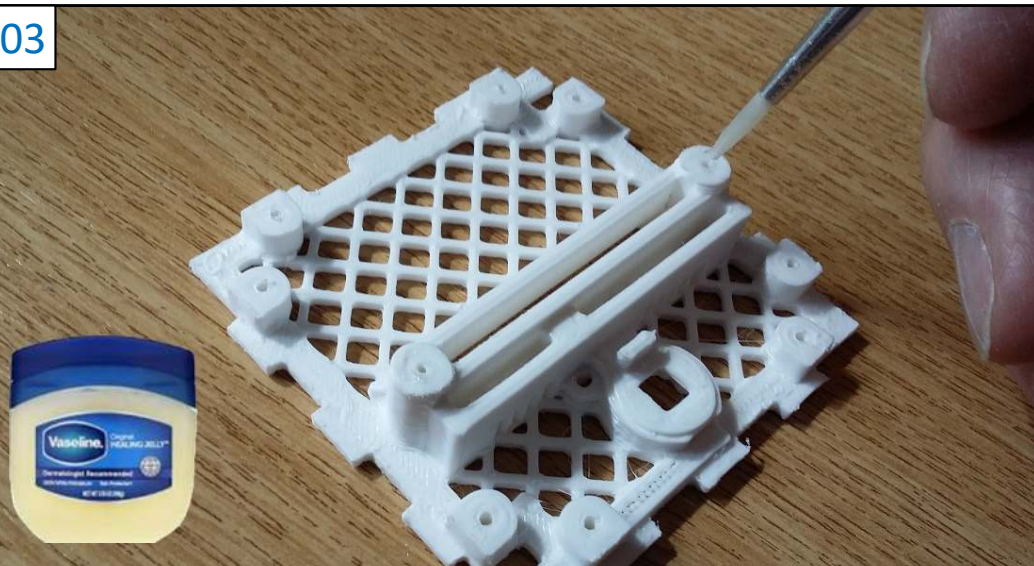
Ensure pilot holes are of the correct size

02



Refer to 3D model guide for all pilot hole sizes

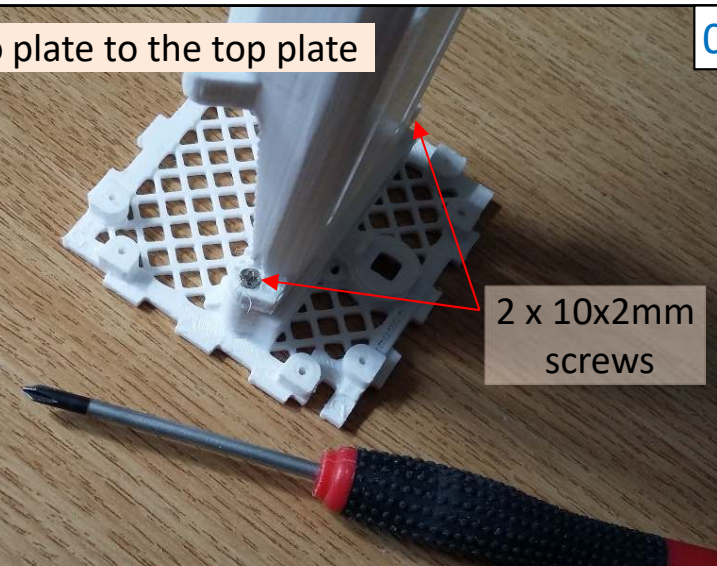
03



Put a small amount of Vaseline in each  $\text{Ø}1.5\text{mm}$  pilot hole

Attach the micro plate to the top plate

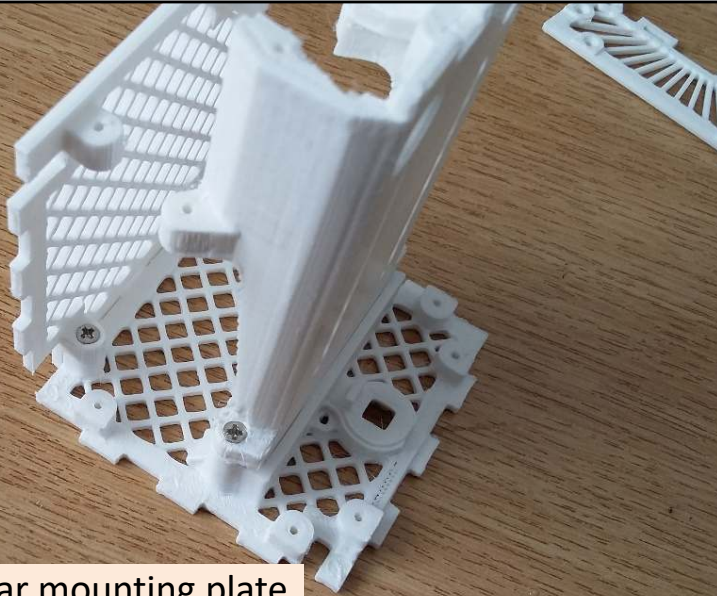
04



Alternate screw tightening, a few turns at a time

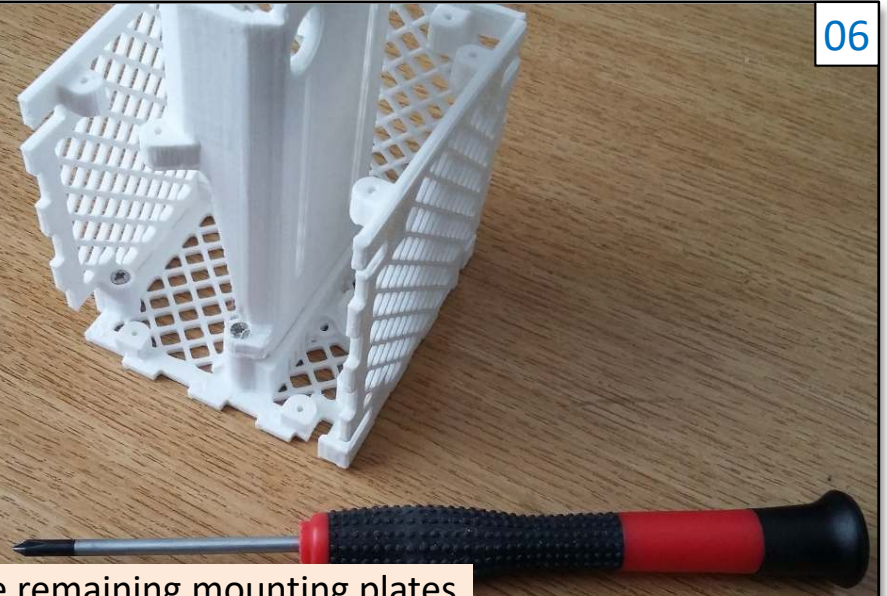
# Assembly Sequence

05



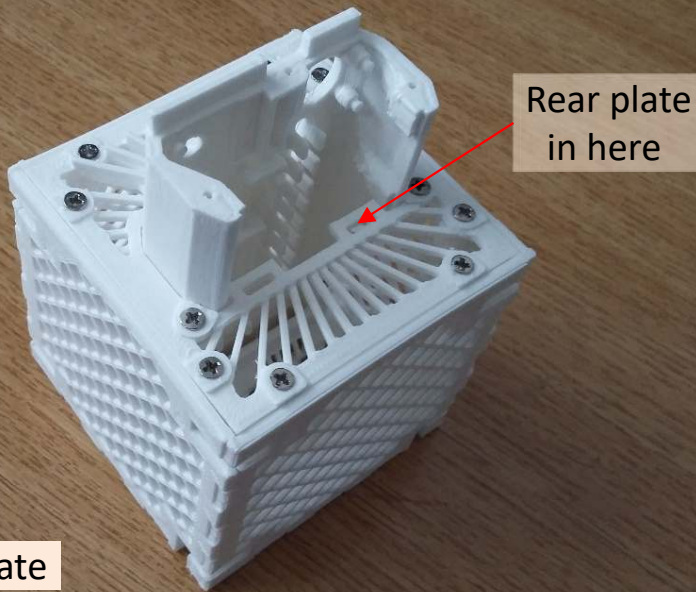
Then attach the rear mounting plate

06



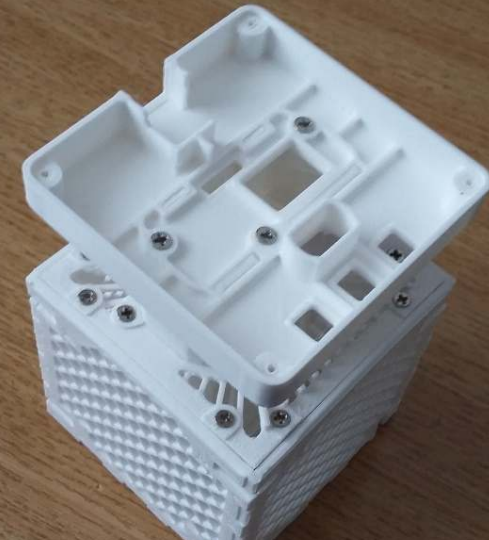
Then the remaining mounting plates

07



Then the lower plate

08



Then the rear plate, before attaching the base

## Assembly Sequence

09



Then the base cover plate

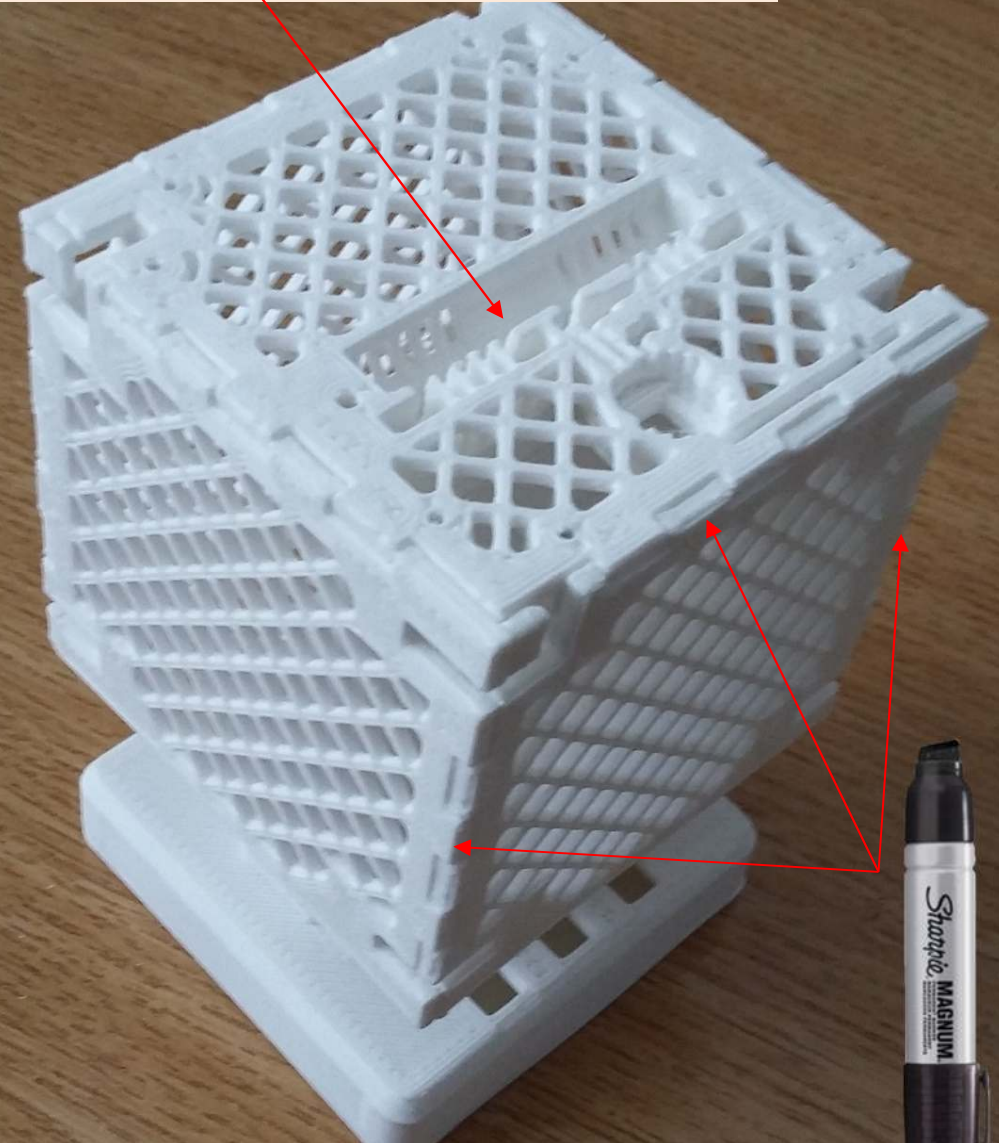
By assembling the cubes empty chassis first, we are confirming that all of the parts fit together well; and if not, we have the opportunity to adjust them by dressing with a needle file.

This is important as we will be gluing the 8x8 LED panels onto the side mounting panels later, and it will be extremely difficult to make any adjustments after that.

**Note** that the screws can be removed and reused many times, provided that when inserting a screw into a used hole, we jiggle it with the screwdriver as we lightly turn it, in order for it to find the original thread it had cut previously. If you don't do this, you are likely to cut a new thread and that will be much weaker, and could fail on tightening.

Ensure 16 pin/socket strips will fit this aperture

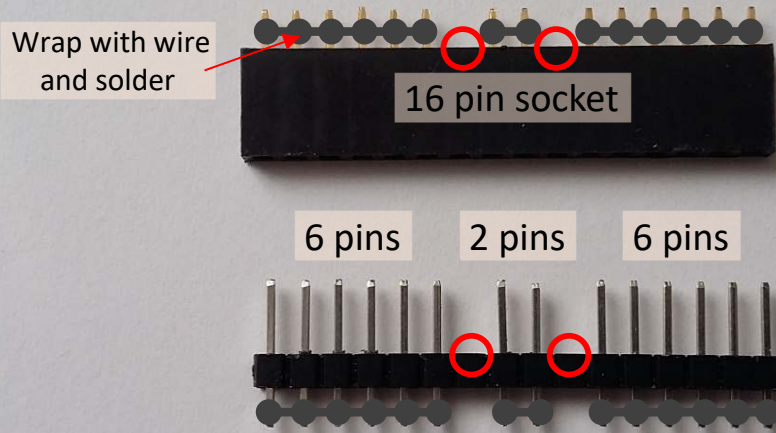
10



If printed in white, blacken top and side edges

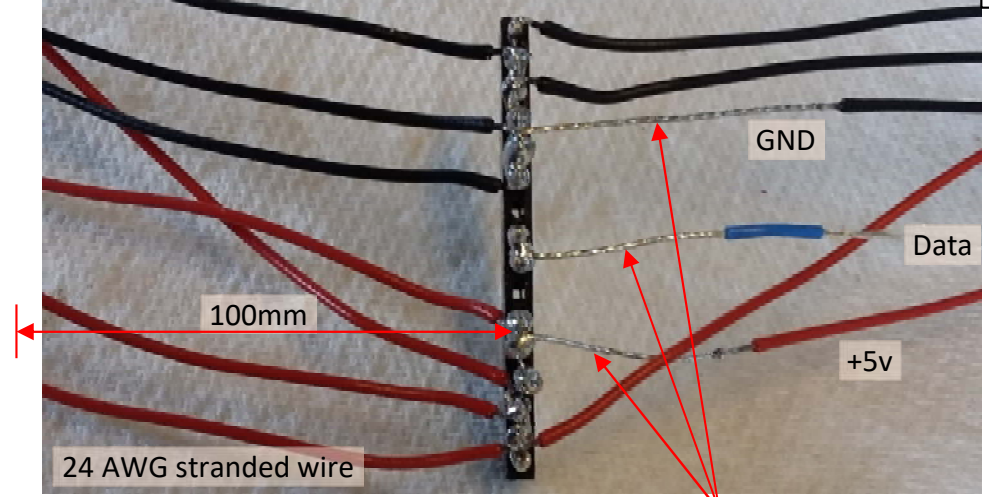
# Assembly Sequence

11 Remove the 2 unused pins from the socket and pin strip



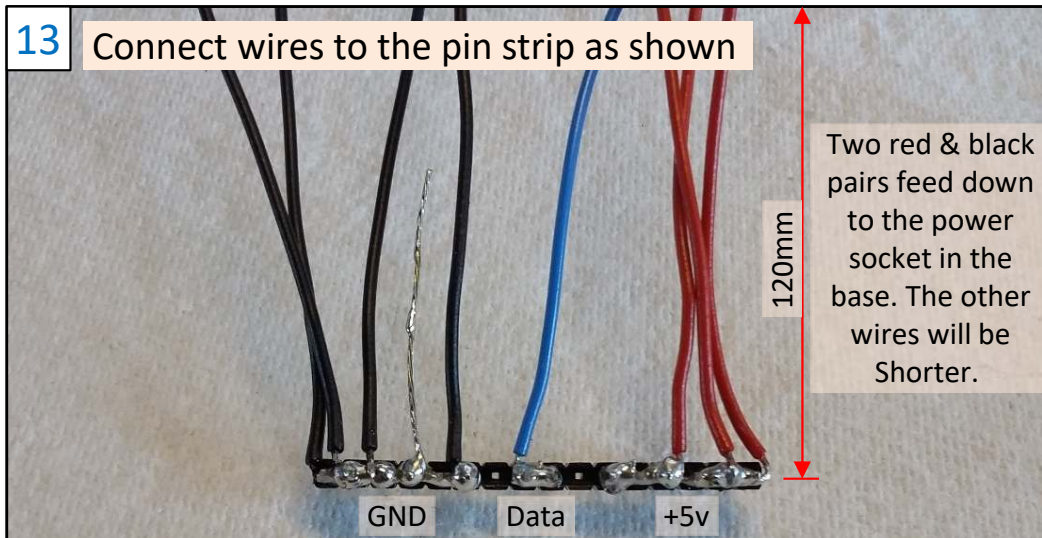
Pin groups are wired and soldered together as common

12 Connect wires to the socket strip as shown



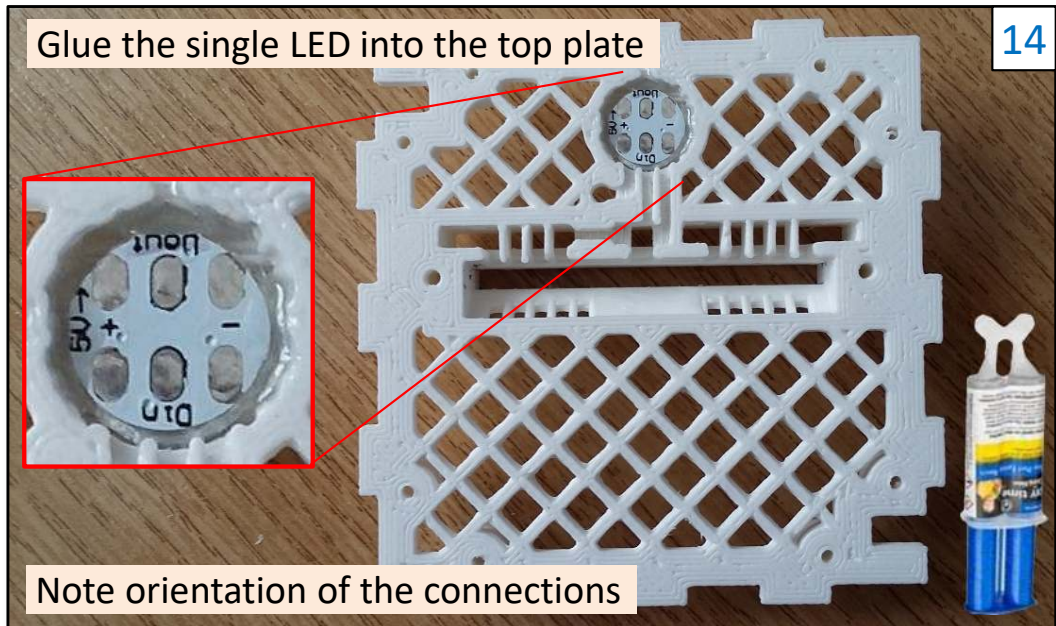
Wires connecting to the WS2812B LED are not insulated

13 Connect wires to the pin strip as shown



Pin groups are wired and soldered together as common

14 Glue the single LED into the top plate

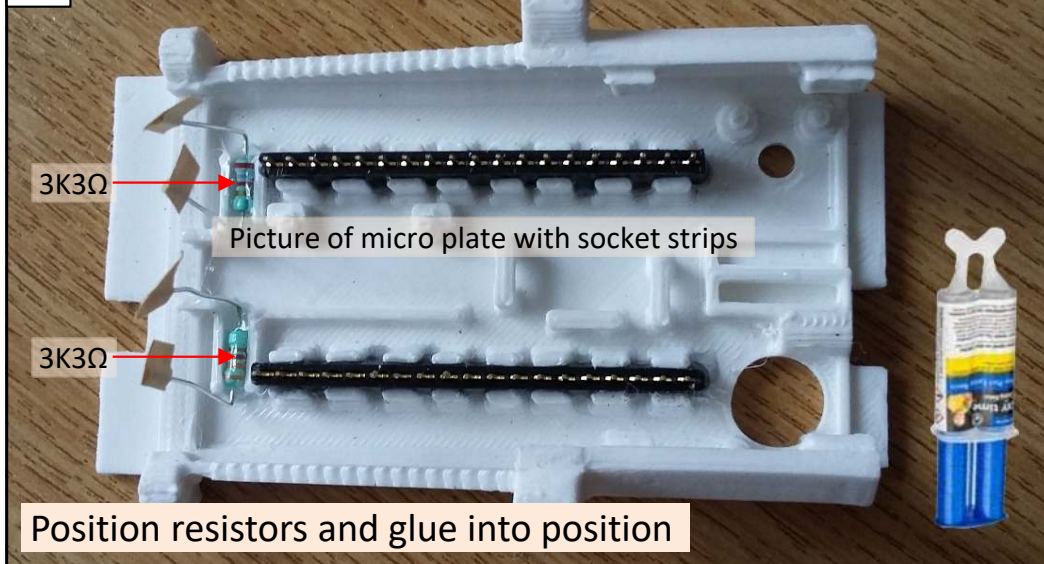


Note orientation of the connections

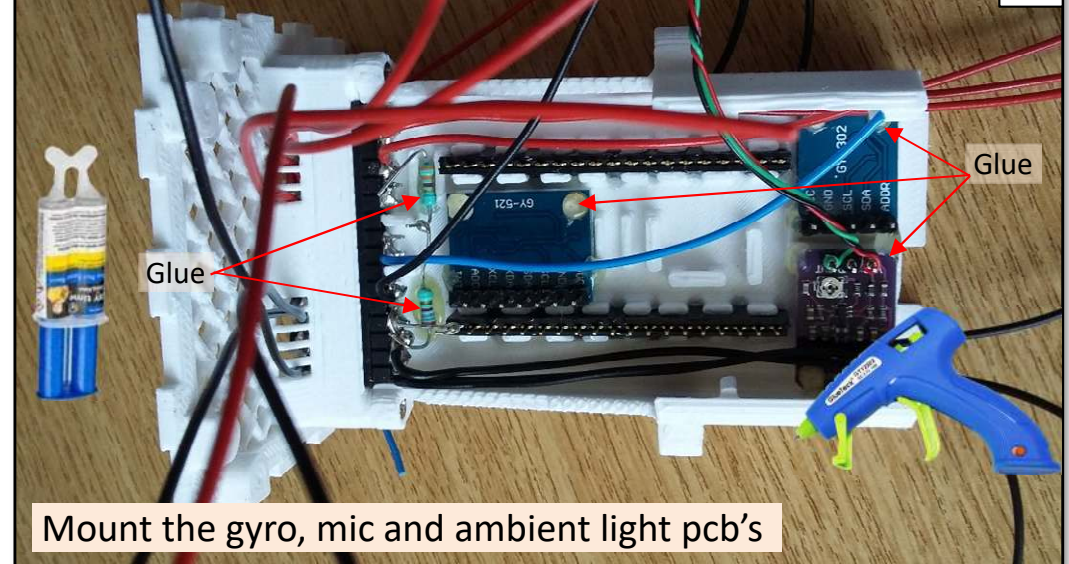


# Assembly Sequence

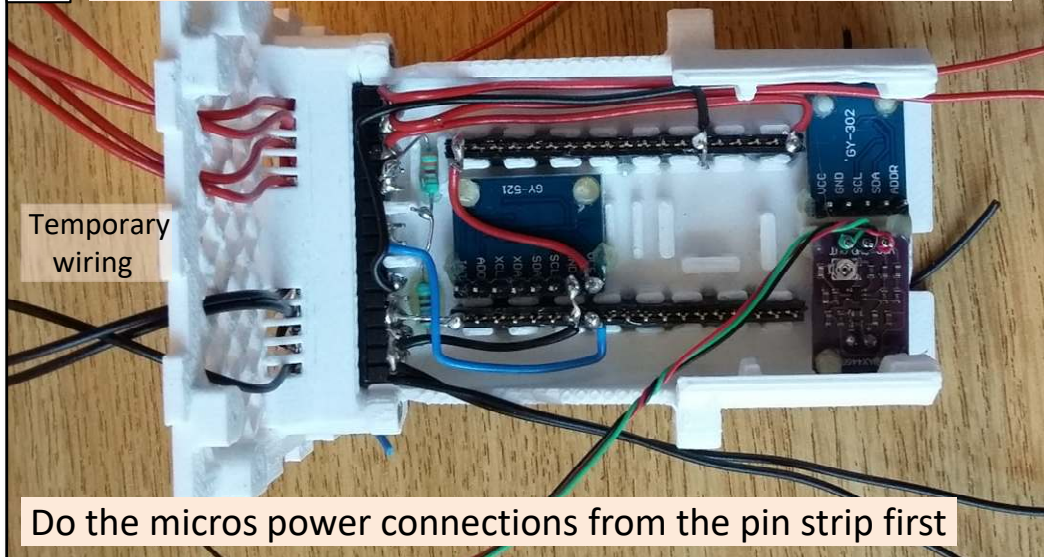
19 Insert micros 19 pin socket strips and glue into position



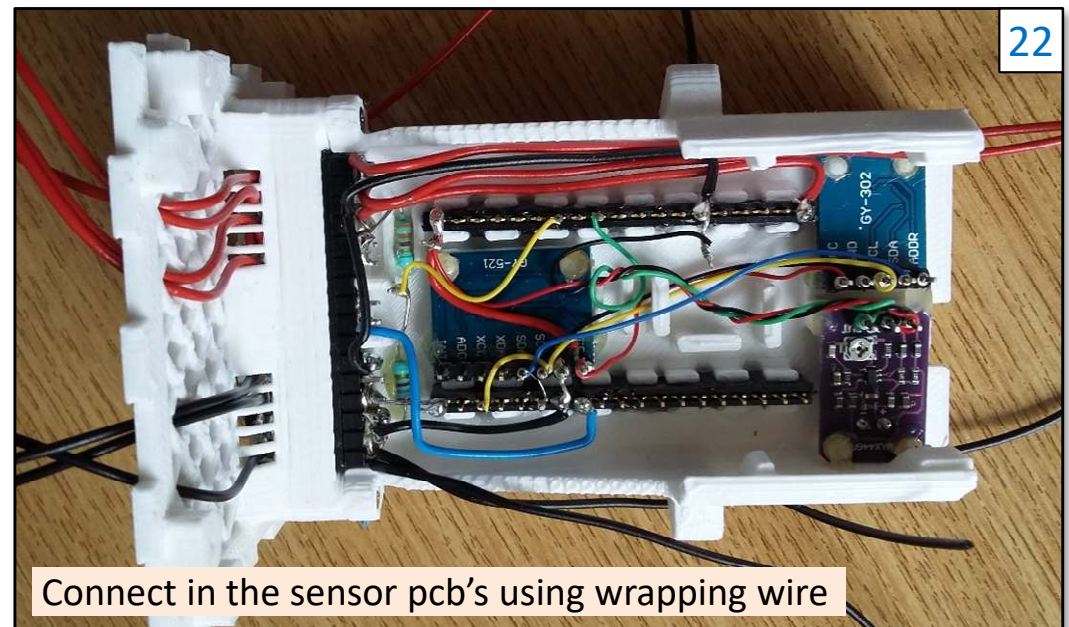
20 Attach the micro plate to the top plate



21 Feed panel wires through Top Plate to keep them away



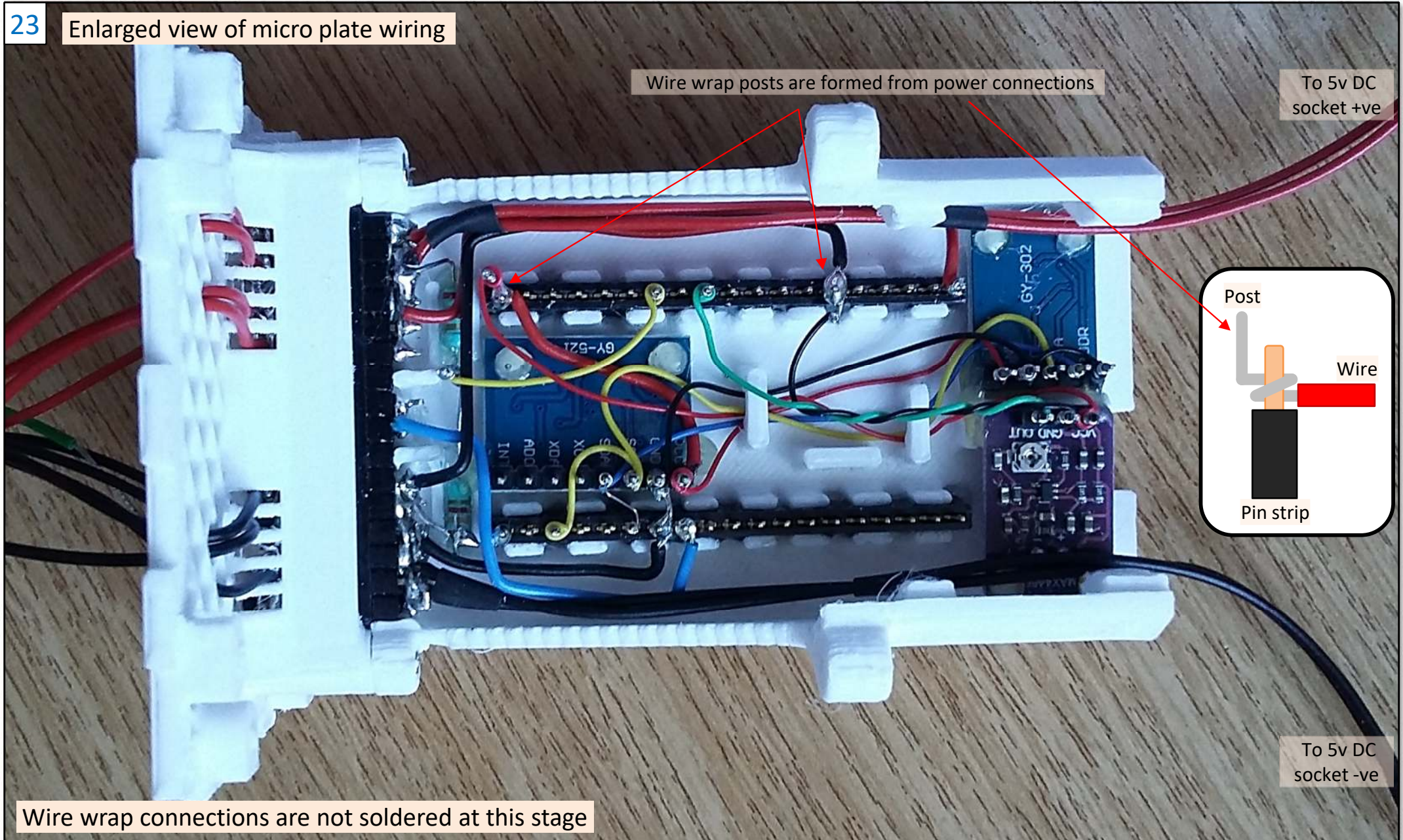
22



# Assembly Sequence

23

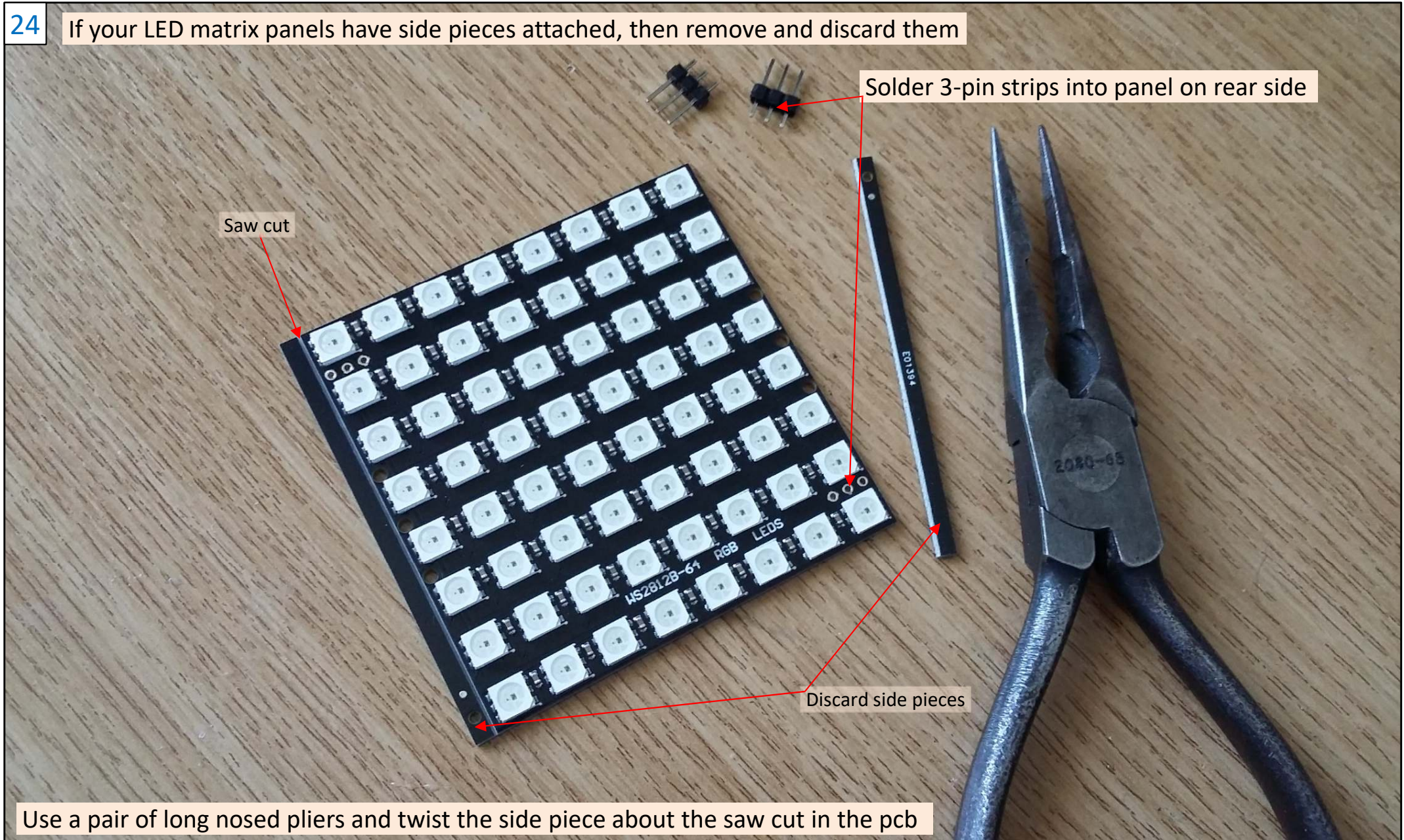
Enlarged view of micro plate wiring



## Assembly Sequence

24

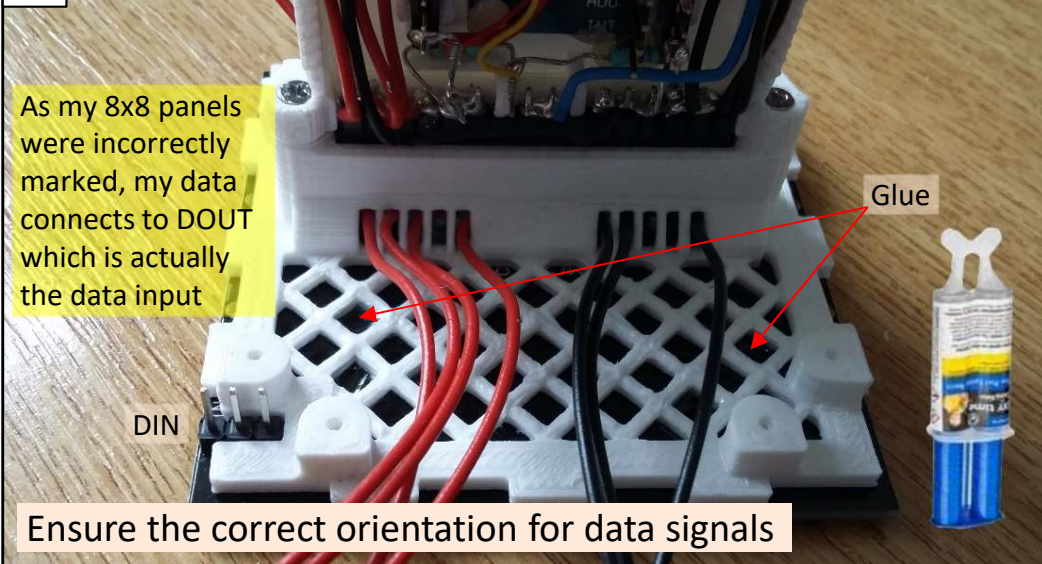
If your LED matrix panels have side pieces attached, then remove and discard them



# Assembly Sequence

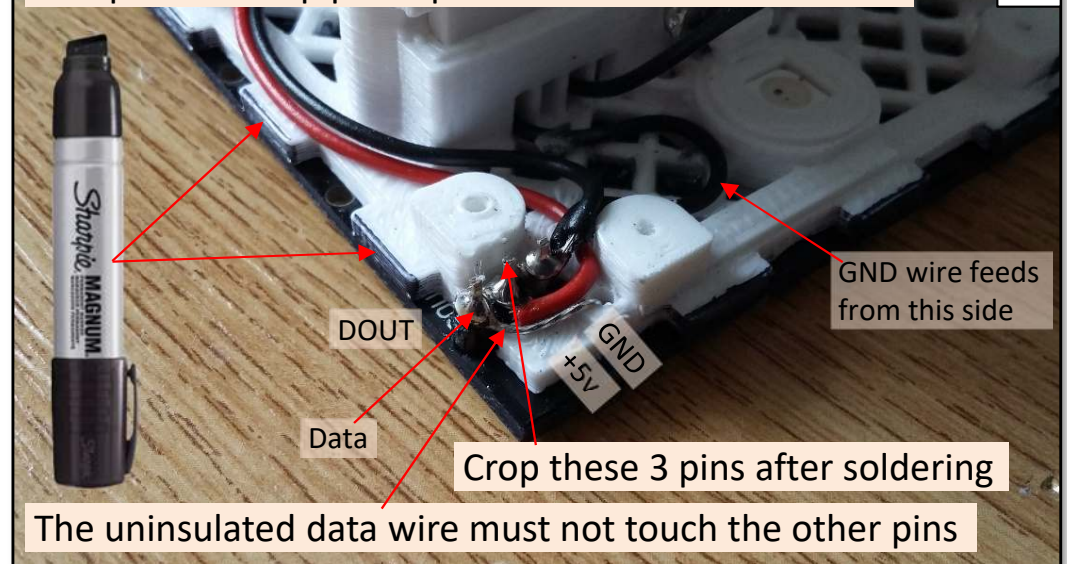
25 Glue an 8x8 LED panel onto the top mounting plate

As my 8x8 panels were incorrectly marked, my data connects to DOUT which is actually the data input

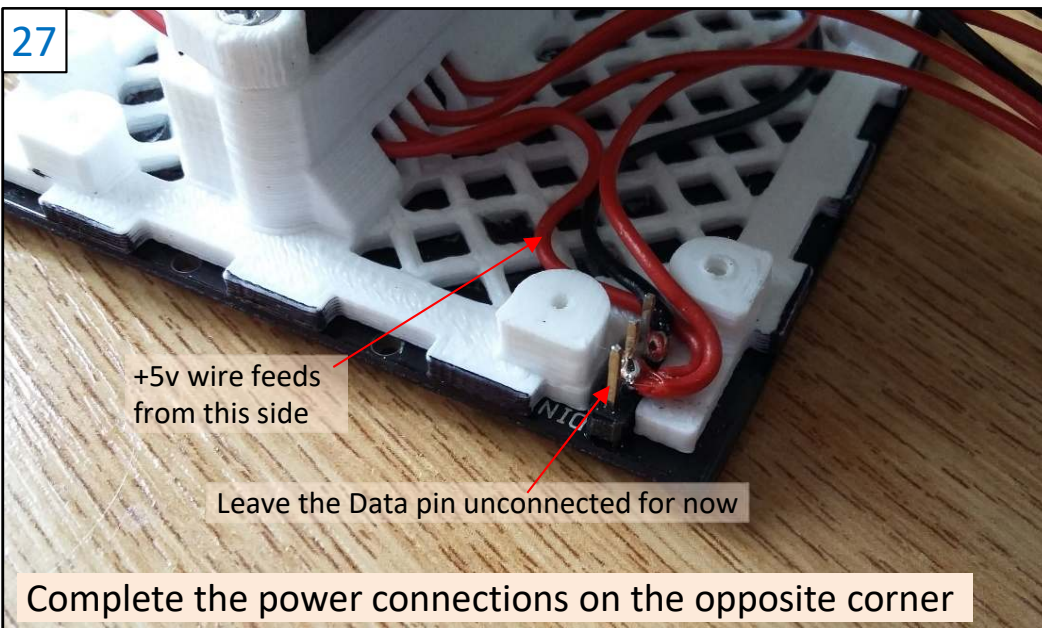


Complete the top panel power and data connections

26

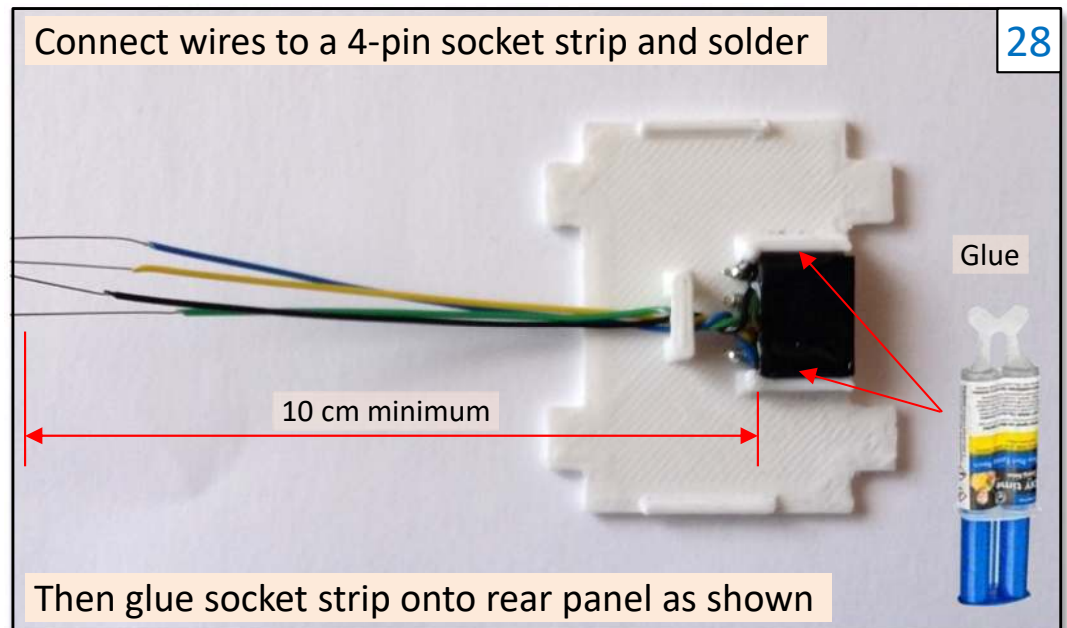


27



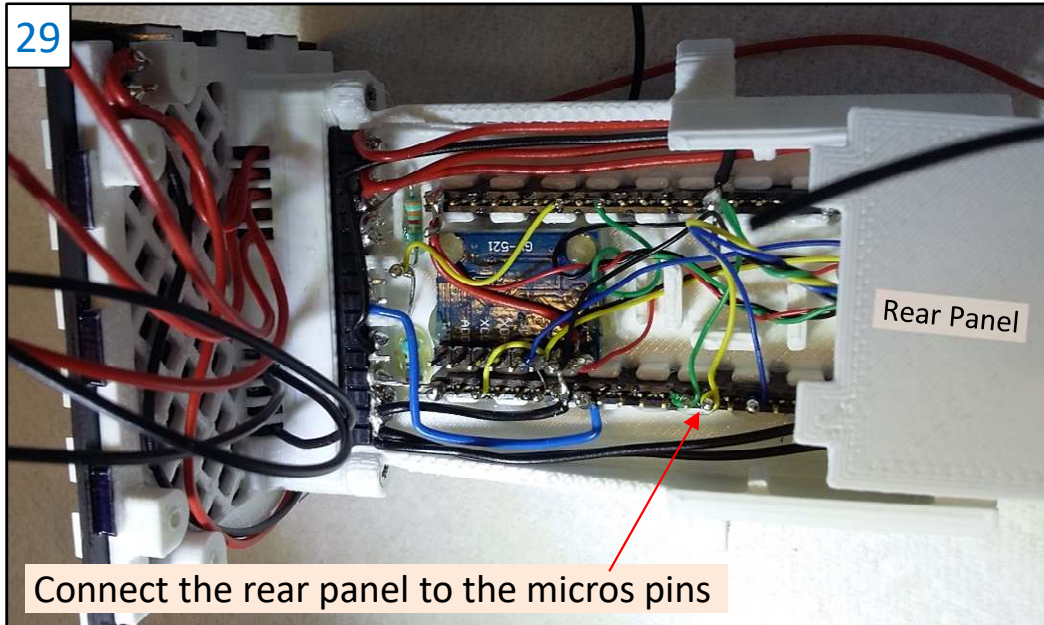
Connect wires to a 4-pin socket strip and solder

28

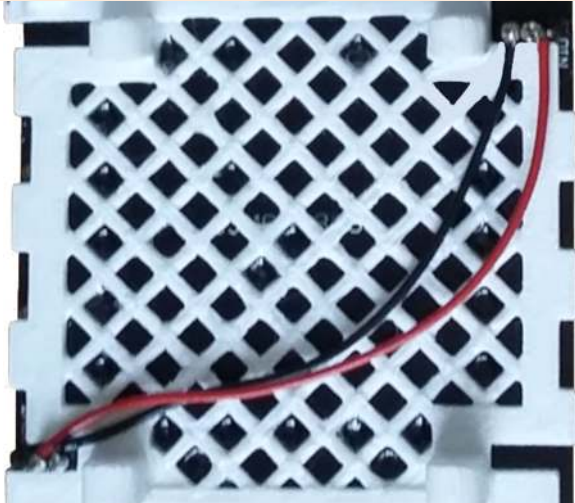


## Assembly Sequence

29



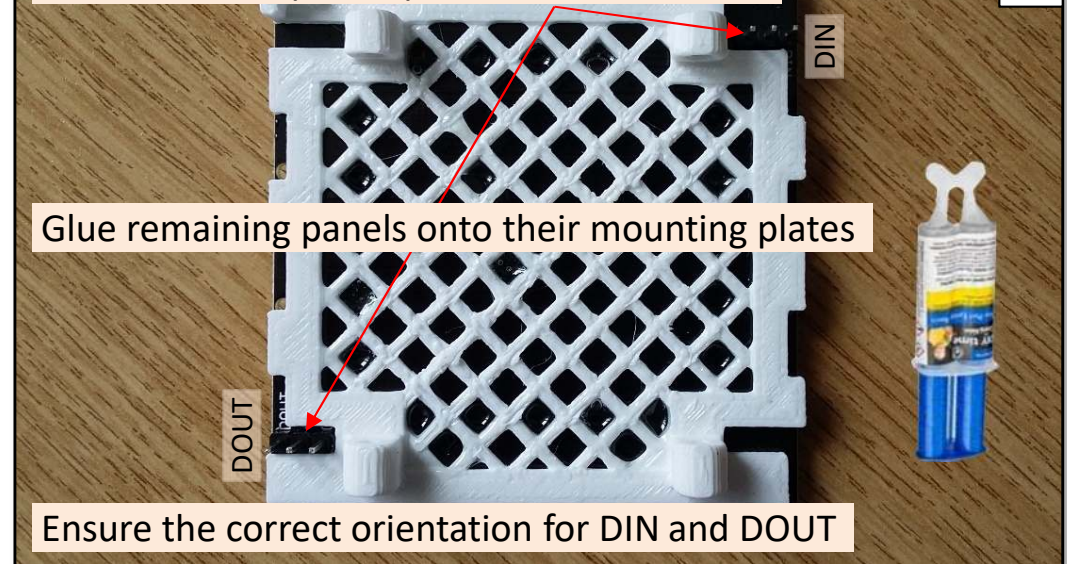
31 Connect the power wires to GND and +5v on each panel



This additional wiring also applies to the top panel

Solder in the 3-pin strips from the underside

30



The 4 wires to the rear panel need to be long enough for it to be moved to the end of the micro plate, whilst sliding the lower plate into position. If not you won't get the lower plate over both items.

With these tasks done we are now ready to complete the assembly process, in which we will attach each side panel to the Top Plate and wire wrap the LED data pins as we go.

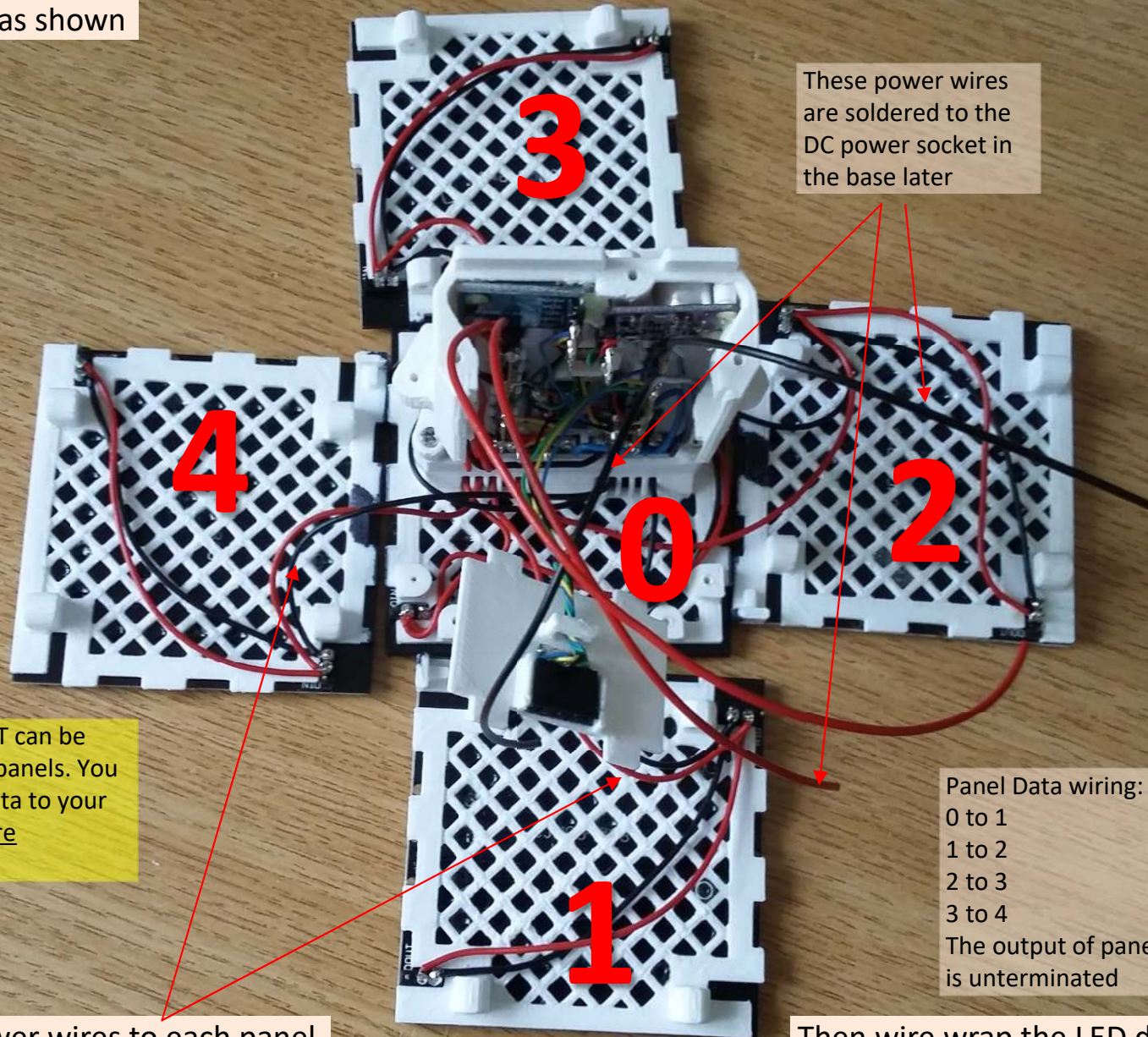
We attach the side panels in the order in which they are connected, starting with the rear panel. Refer to the diagram on page 9 for more clarity on the data connections.

**Note** I would recommend that you do not solder the wire wrap connections until you have fully assembled and tested the cube, just in case there is an error in your wiring.

# Assembly Sequence

32

Position the panels as shown



These power wires are soldered to the DC power socket in the base later

Remember that DIN and DOUT can be incorrectly assigned on some panels. You should test by sending RGB data to your panels to determine this before completing this part.

Panel Data wiring:  
0 to 1  
1 to 2  
2 to 3  
3 to 4  
The output of panel 4 is unterminated

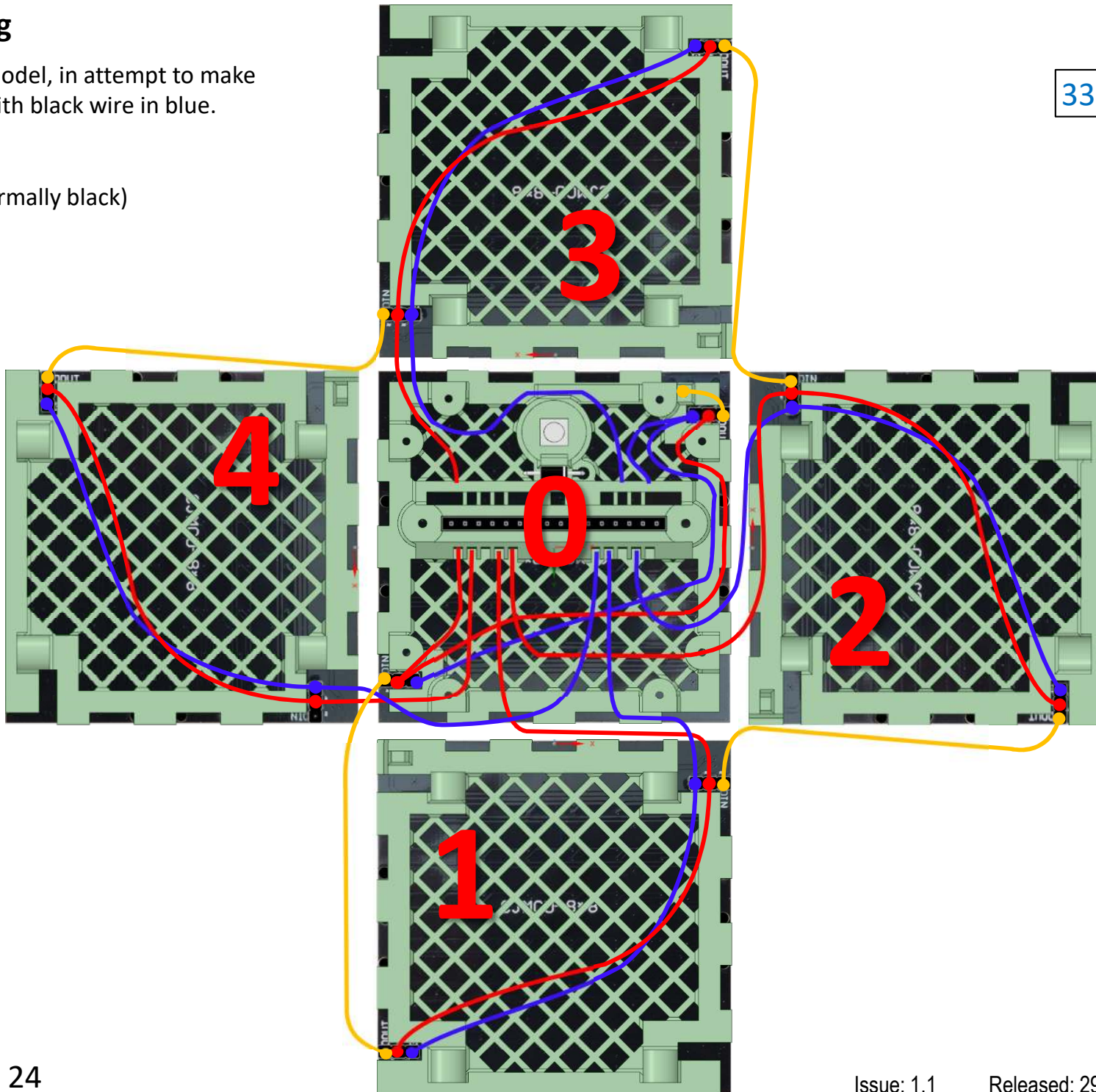
Solder the Top Plate power wires to each panel

Then wire wrap the LED data wires

# Final Panel Wiring

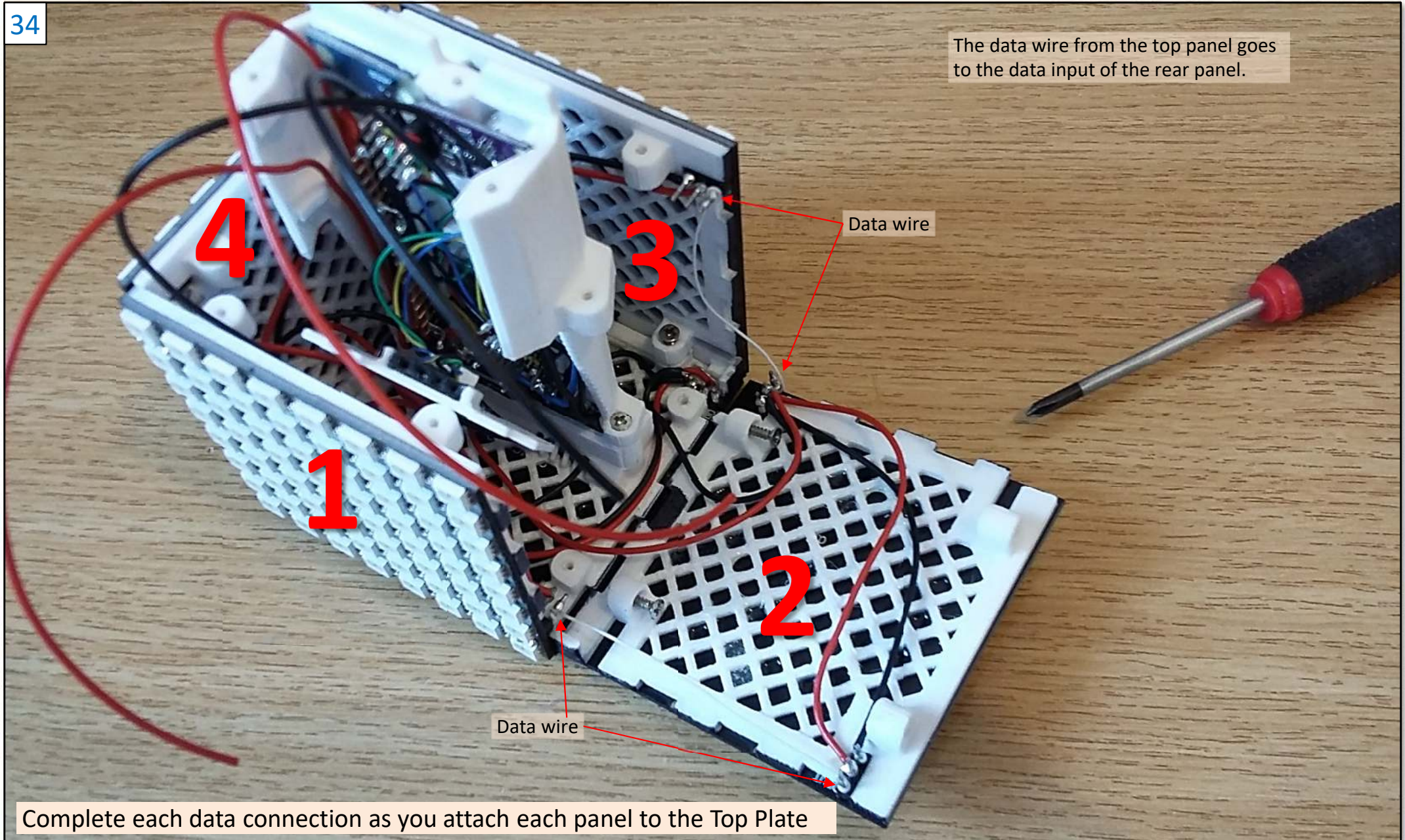
Views taken from 3D model, in attempt to make panel wiring clearer; with black wire in blue.

- — +5v power
- — GND power (normally black)
- — data wire



## Assembly Sequence

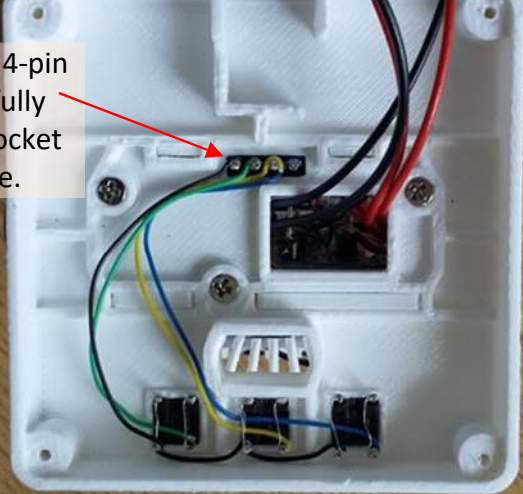
34



# Assembly Sequence

35 Attach the base to the micro plate and rear plate

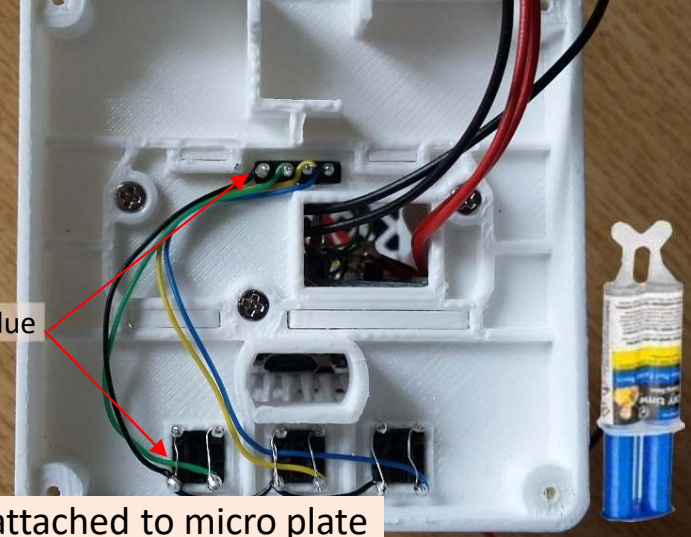
Ensure that the 4-pin strip is pushed fully into the 4-pin socket on the rear plate.



Wire wrap the button switch connections to the 4-pin strip

36 Solder connections, then liberally glue in components

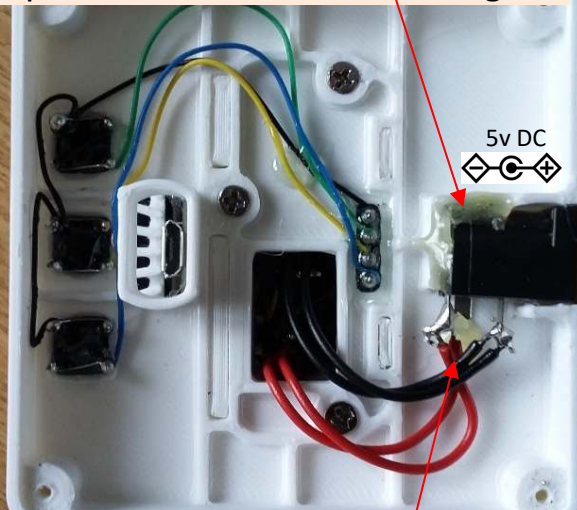
Glue



Note base is attached to micro plate

37 Glue in power socket with hot melt glue

5v DC



Connect +5v and GND power leads

38 Attach the base



You're ready to test!

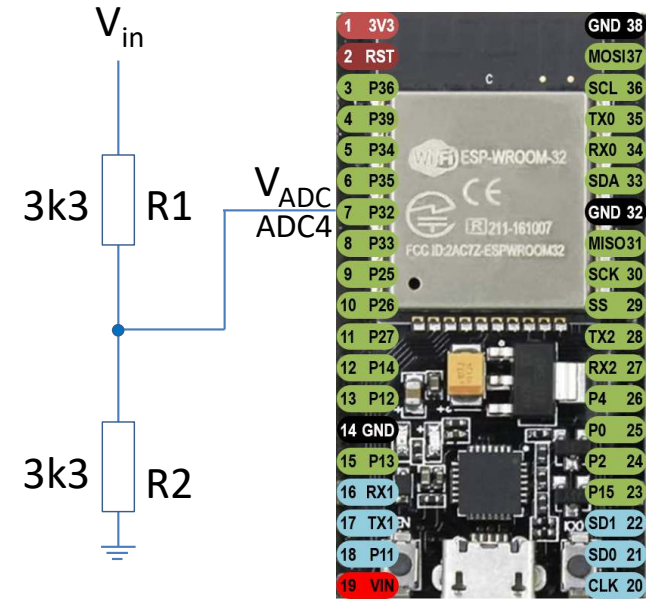
# Supply Voltage Health Monitoring

The ESP32 is powered from a DC supply connected to  $V_{in}$ . This supply voltage is measured via a resistor divider circuit. 3.3v at  $V_{ADC} == 4095$  on 12-bit converter (4095 max). If we use a 3k3 resistor feeding A0 and a 3k3 resistor to GND, we get a conversion factor of  $V_{in} = 5.0v$  equates to  $V_{ADC} = 3102$

Conversely, if we want to measure  $V_{in}$  using the micro:

$$V_{in} = \frac{V_{ADC} * 6.6}{4095} = \frac{3102 * 6.6}{4095} = 4.999v$$

In the code you can set a threshold to shut down the cube if the supply voltage drops below a critical value, say 4.0v. Which would be useful if the unit was being powered from a battery supply and you wanted to prevent deep discharge occurring.



In order to achieve a sufficient brightness level from your cube it is recommended that you power it from a 5v DC adapter rated at 3A or more.

This is what is assumed in the code, which actually limits the maximum brightness of the white lamp. Otherwise the LEDs could be set to a brightness which draws a greater current from the power source, than it can supply and a brown out event would occur.