8x8x8 RGB Cube PCB v1.0 - Assembly Instructions

Instructions to populate 8x8x8 RGB Cube PCB version 1.0 by James Pryor

Bill of Material

I have reference here part numbers from [www.farnell.com](http://www.farnell.com). They offer a one day service and competitive prices. The quantities below are the actual numbers required. I would recommend adding a few spares given the low individual prices.

<table>
<thead>
<tr>
<th>Part Desc</th>
<th>Quantity</th>
<th>Part</th>
<th>Use on PCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.54mm Ceramic Capacitor 0.1µF</td>
<td>25</td>
<td>2309020</td>
<td>Filter for shift registers</td>
</tr>
<tr>
<td>Aluminium Capacitor 100µF</td>
<td>8</td>
<td>1219466</td>
<td>Filter for MOSFET anode drivers</td>
</tr>
<tr>
<td>IR9Z34N P channel MOSFET</td>
<td>8</td>
<td>8648689</td>
<td>MOSFET Anode drivers</td>
</tr>
<tr>
<td>2N3904 NPN transistors</td>
<td>200</td>
<td>1700648</td>
<td>Cathode drivers</td>
</tr>
<tr>
<td>74HC595 Shift Register</td>
<td>25</td>
<td>9591664</td>
<td>Shift registers</td>
</tr>
<tr>
<td>10kOhm 3.5mm resistors 1/8W</td>
<td>200</td>
<td>9342419</td>
<td>Pull up resistors</td>
</tr>
<tr>
<td>1kOhm 3.5mm resistors 1/8W</td>
<td>213</td>
<td>9342419</td>
<td>Buffer between Shift registers and cathode drivers</td>
</tr>
<tr>
<td>TBC 3.5mm resistors 1/8W</td>
<td>192</td>
<td></td>
<td>LED current limiting resistors (See further instructions)</td>
</tr>
</tbody>
</table>

In addition you will need the following: (I sourced these items predominantly from eBay).

- 2M Solid Core Hookup Wire 1/0.6 mm 22AWG
- AC 110V/220V to DC 5V 20A 100W Voltage Transformer
- Mains plug and lead to power transformer
- Wire and connectors to provide 5V and Ground supply to PCB
- Arduino Mega, and connecting wire and headers to provide following signals to PCB; Ground, +5V, Clock, Data (SOut), Latch and Output Enable (OE). I used some 6 core 2.54mm ribbon cable but only found this available in 5M lengths.
Calculation of LED resistor values

The resistor value of the LED current limiting resistor is dependant on the RGB LEDs you have chosen. I would expect to require different values for the different colours. There are several calculators available, EG http://www.ohmslawcalculator.com/led-resistor-calculator

I have labeled the current limiting resistors as A, B & C. Depending on the orientation of your LEDs on the PCB you should note which colour is linked to which LED resistor on the board and populate accordingly. On my boards the Red LED cathode leads were connected to LED resistor C

The green boxes above identify which LED resistor (A, B & C) is connected to which Cathode wire from the RGB LED cube.

Notes

- I would recommend soldering all components of one type at the same time, this avoids any confusion on mixing up parts.
- These components are quite small and the soldering can be fiddly at times. I would recommend you use a small tip on your soldering iron and 0.5mm solder. If in doubt get some soldering practice in first.
- I recommend you have to hand a solder pump and solder wick to correct any mistakes and remove solder bridges.
- A magnifying glass is recommended to review your work - especially if your eyes are as bad as mine :-)
- Watch out for the orientation of some components - I will highlight these in the instructions.
- All components should be populated on the silkscreen side of the PCB and soldered from the plain side.
- When turned over the RGB LED cube can be soldered onto the plain side of the PCB.

Resistors first for the cathode drivers

I suggest you start with all the resistors first

- 1 = 1kOhm resistors
- A, B & C are the LED current limiting resistors (see above)
- 2 = 10kOhm resistors
Additional Resistors required

There are additional resistors required at a couple of other locations

A single 1kOhm resistor is required at the bottom LHS edge of the board above the CPU connections as a pull up on the OE line

The IRF9Z34N anode drivers are switched by their own 2N3904 transistor. These also require three resistors as identified here

• 1 & 3 = 1kOhm resistors
• 2 = 10kOhm resistors

I added the option to put a few simple push button switches onto the board for future functionality. I have yet to populate and use these myself. These resistors provide a pull down when the switch open. The switch provides a HIGH logic signal when pressed which can be passed back to the Arduino

Next onto the transistors

There are 200 2N3904 NPN transistors required on the PCB. 192 to drive the cathodes and 8 to drive the anode MOSFETs

Note the orientation. The two outside leads are together on the flat face of the transistor and the middle lead is bent back towards the rounded face
Shift registers and filter capacitors

The 74HC595 shift registers are placed in pairs driving a single colour (A, B or C) one each for the row above and below. There is an additional one on the LHS of the board to drive the anodes.

IMPORTANT - Note the orientation

These IC’s have an indentation on one side, this indent should match the indent drawn on the silkscreen. Each IC has a 0.1uF ceramic capacitor by the side.

Anode MOSFET drivers and capacitors

There are 8 MOSFET anode drivers and a 100uF capacitor with each one

IMPORTANT - Note the orientation of both these components

The MOSFETs have a tab on the top which is drawn onto the silkscreen. Each one is reversed from it’s neighbour. The capacitors have an indication on the negative lead (a gold line a “-“ on the picture above. The negative lead should go into the hole indicated on the white silkscreen. The positive lead should go on the hole with the uncovered trace.

I originally left this +5V trace uncovered in case I needed to add additional wires and solder to it to increase it’s current carrying capacity. This is not needed an on future versions of this PCB this trace will be covered.
Shift register signal wires

The shift registers are daisy chained together with Solid Core Hookup Wire (1/0.6 mm 22AWG).

The first wire passes from the CPU connection to the anode driver 74HC595 and the second then goes into the first pair of cathode driver 74HC595’s. **Follow the lines on the silkscreen.**

After you have wired in the anode driver to the first of the cathode driver chips then we need to wire the rest of the cathode drivers together from A0 to A7 then B0 to B7 then C0 to C7.
You can see the routes of the data lines with the blue wires in the picture below.

**PCB board connection**

**Connections to the Arduino Mega**

- GND to GND pin
- +5V to 5V power pin
- Clock to pin 54 (SPI Clk)
- SOut to pin 51 (SPI MOSI)
- Latch to pin 44
- OE to pin 45

Finally +5V power and Ground from the transformer here
Specific notes for Version 1.0

There are 5 missing traces on the v1.0 PCB. Whilst not imperative for use they are easy to fix.

Missing grounds to capacitors next to 74HC595 chips C1, C3, C5 & C7 only.

The pin on the 0.1uF capacitor FURTHEST away from the 74HC595 chip should be connected to ground.

the nearest most convenient ground source is the first pin on the top LHS of the 74HC595 chip.

You can see the RED wire here connecting the two.

Missing 5v source to fourth switch only

That's it, your good to go.