Color Organ

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Objectives:

- Create a working color organ
    - 3D print a box to put the color organ in
    - Solder a perfboard
    - Understand how to create a bode plot for each set of LEDs

Materials:

- Multisim
- Breadboard
- 4.5inx3in Perfboard
- Ultiboard
- 3 100 Ω resistors
- 180 Ω resistor
- 270 Ω resistor
- 2 10K Ω resistors
- 2 1K Ω resistors
- 4 2.2K Ω resistors
- BJT_NPN transistor, 2N2222A
- 3 BJT_PNP transistors, 2N2907
- SWITCHING_DIODE, 1N4448
- AUDIO_VIDEO, SJ1-3515N
- 10µfd capacitor
- .047µfd capacitor
- .47µfd capacitor
- .01µfd capacitor
- 1µfd capacitor
- 2 green LEDs
- 2 red LEDs
- 2 yellow LEDs
- Various Test Leads
- DMM
- 4 6-32/3/8” slotted screws

Procedure:

1. First, construct the circuit shown in Figure 1-1 on Multisim and Figure 1-2 on a protoboard.

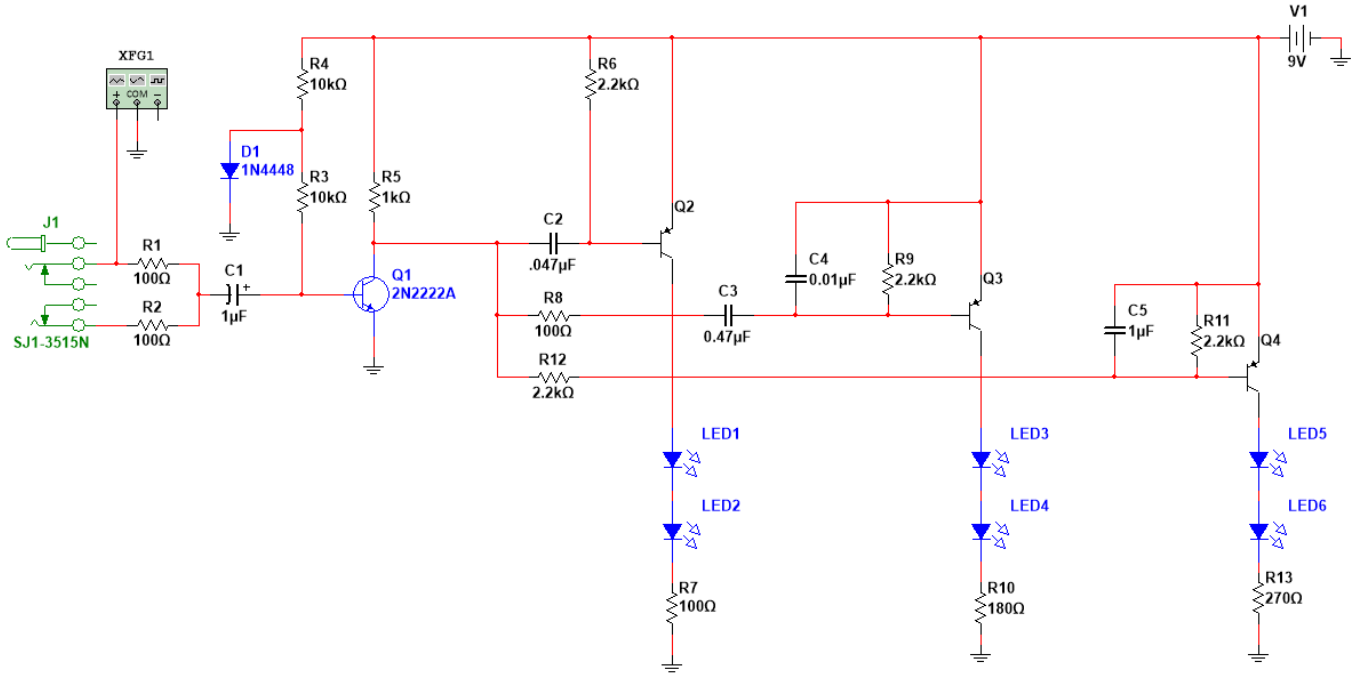

Figure 1-1

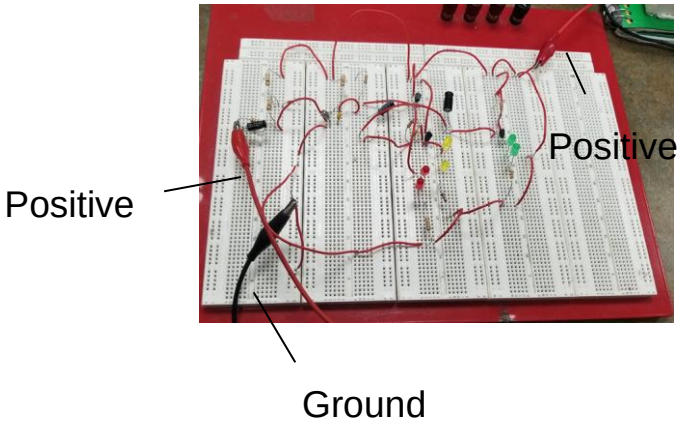

Figure 1-2

2. Next, adjust the frequency while recording when each LED turned on and off then record the data. Those frequencies should match the ones recorded in Table 1-1.

Status	Measured Frequency (Hz)	Multisim Frequency (Hz)
Red LEDs (Off)	2	3
Red LEDs (On)	3	4
Red LEDs (Off)	91	95
Yellow LEDs (On)	113	122
Yellow LEDs (Off)	1.1k	1.2k
Green LEDs (On)	1.2k	1.3k
Green LEDs (Off)	N/A	16M

Table 1-1

The frequency generator maxed out at 3 MHz and the green LED was still on.
If the measured frequencies match closely with the multisim frequencies as shown in Table 1-1, the circuit is functional.

4. Next, plug a voltmeter parallel to one LED of each set of color then adjust the frequency while recording the voltages. Those voltages should match the ones recorded in Tables 1-2, 1-3, and 1-4.

Frequency (Hz)	Measured Red LED Voltage (VRMS)	Multisim Red LED Voltage (VRMS)
1	0.00	0.043
2	0.42	0.441
3	0.54	0.562
4	0.56	0.575
5	0.55	0.572
10	0.46	0.483
20	0.39	0.402
30	0.35	0.361
40	0.33	0.343
50	0.32	0.332
60	0.30	0.311
70	0.29	0.303
80	0.28	0.291
90	0.26	0.273
95	0.26	0.262
100	0.25	0.252

Table 1-2

Frequency (Hz)	Measured Yellow LED Voltage (VRMS)	Multisim Yellow LED Voltage (VRMS)
120	0.21	0.223
122	0.22	0.229
140	0.23	0.230
160	0.23	0.230
180	0.23	0.229
200	0.22	0.227
0.3k	0.22	0.224
0.4k	0.22	0.219
0.5k	0.21	0.215
0.6k	0.21	0.209
0.7k	0.20	0.196
0.8k	0.19	0.194
0.9k	0.18	0.185
1.0k	0.18	0.183
1.1k	0.18	0.179
1.2k	0.17	0.173

Table 1-3

Frequency (Hz)	Measured Green LED Voltage (VRMS)	Multisim Green LED Voltage (VRMS)
400	0.21	0.22
800	0.35	0.37
1.0k	0.37	0.38
1.3k	0.38	0.39
2.0k	0.43	0.46
3.0k	0.45	0.48
4.0k	0.47	0.49
5.0k	0.47	0.49
10k	0.42	0.44
25k	0.39	0.4
50k	0.34	0.34
100k	0.32	0.33
250k	0.28	0.29
500k	0.26	0.27
1M	0.22	0.25
4M	N/A	0.2
8M	N/A	0.16
16M	N/A	0.07

Table 1-4

Tables 1-2, 1-3, and 1-4 represent the voltage across the LEDs thus the brightness of them; the larger the voltage drop across them the brighter they are.

6. Use the data that you collected to create bode plots for each LED. The bode plots should appear similar to ones shown in Figures 1-3, 1-4, and 1-5.

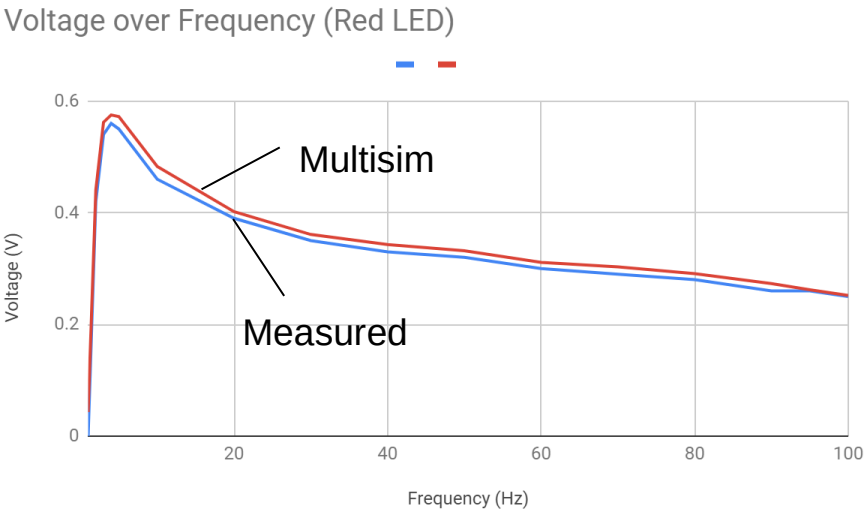

Figure 1-3

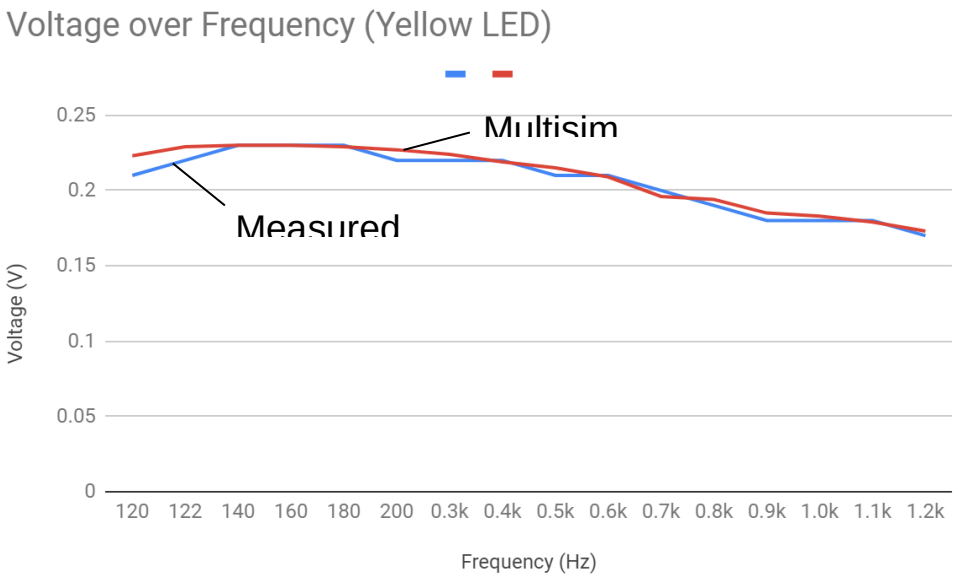

Figure 1-4

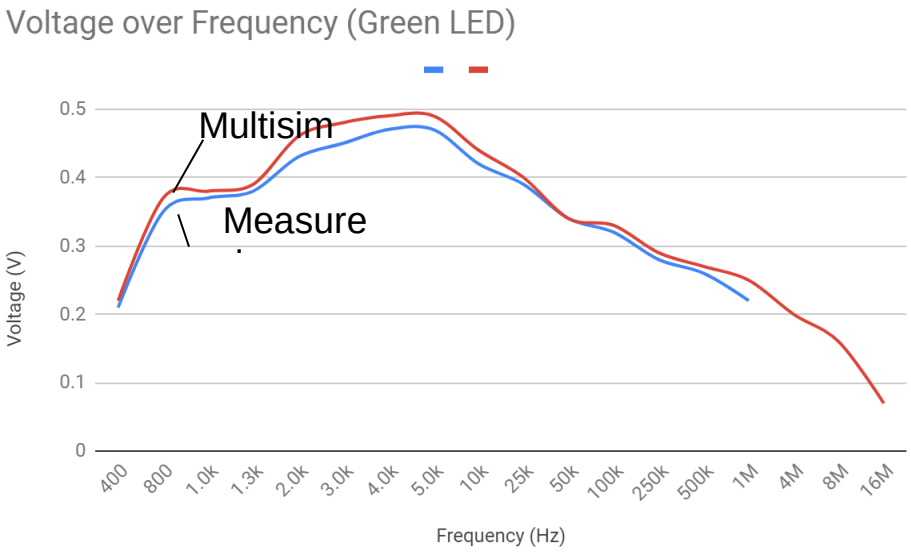

Figure 1-5

Figures 1-3, 1-4, and 1-5 represent the relationship between the frequencies and voltage across the LEDs.

7. Cut a 4.5in by 3in of perfboard then place all of the components to make the circuit shown in Figure 1-1 as shown in Figure 1-6. Use jumper wire to make any connections that are far apart.

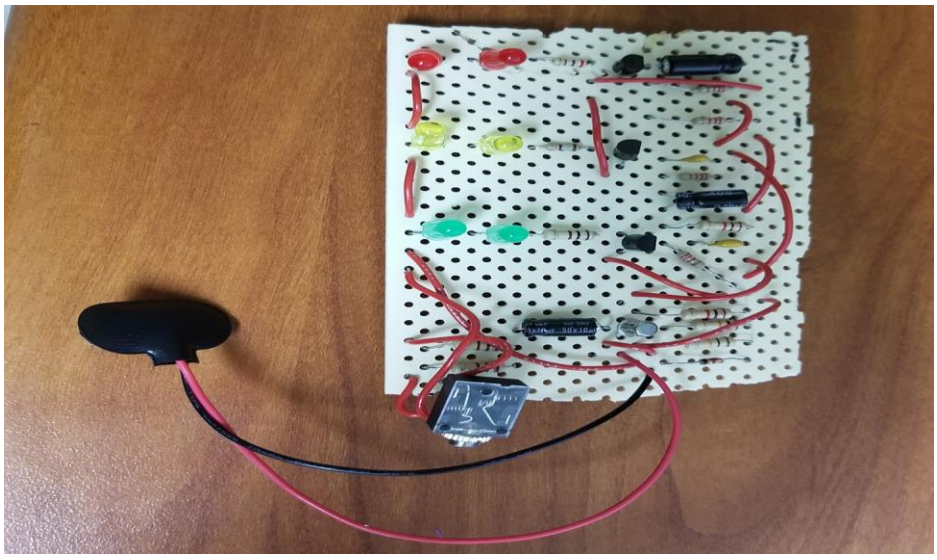

Figure 1-6

8. Next, flip the perfboard over to the back to solder the connections of the circuit as shown in Figure 1-7.

Figure 1-7 (Back)

9. Design the following schematics shown in Figures 1-8 and 1-9 on Inventor.

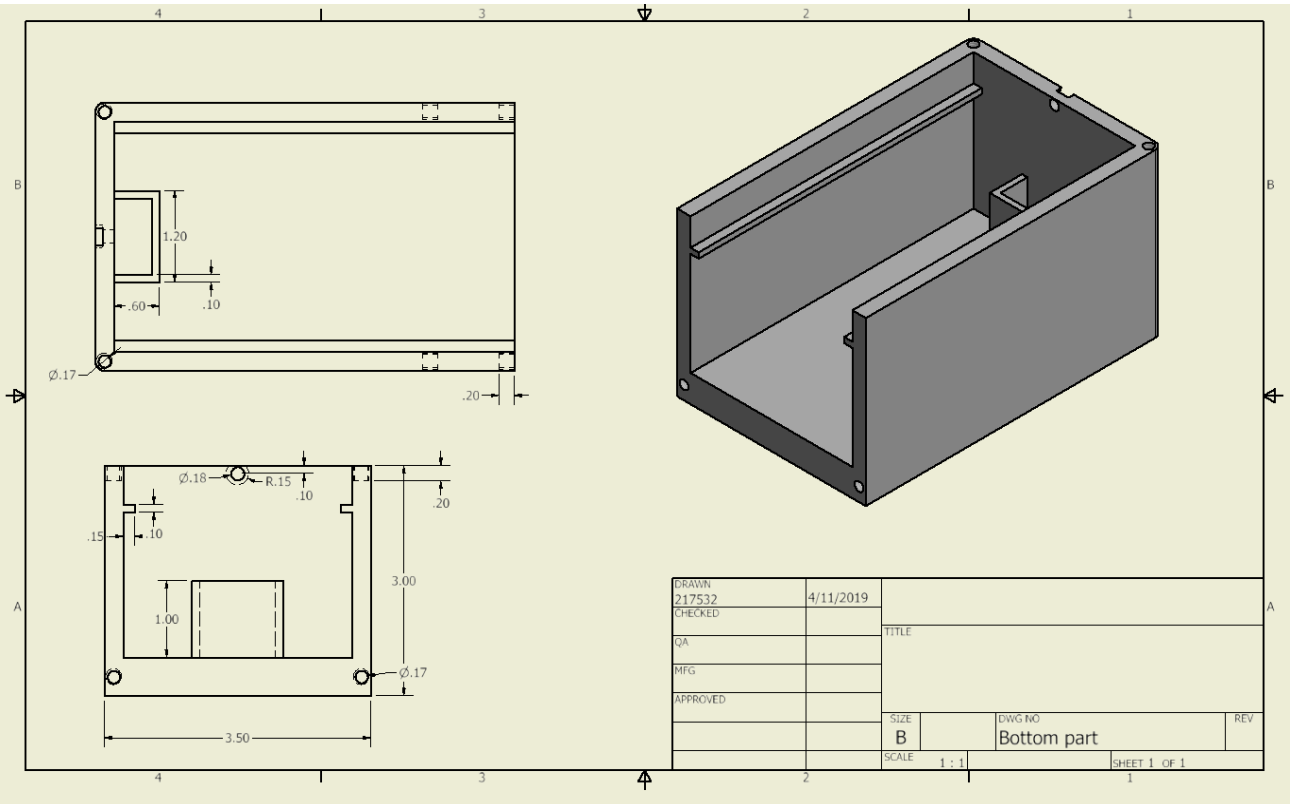

Figure 1-8

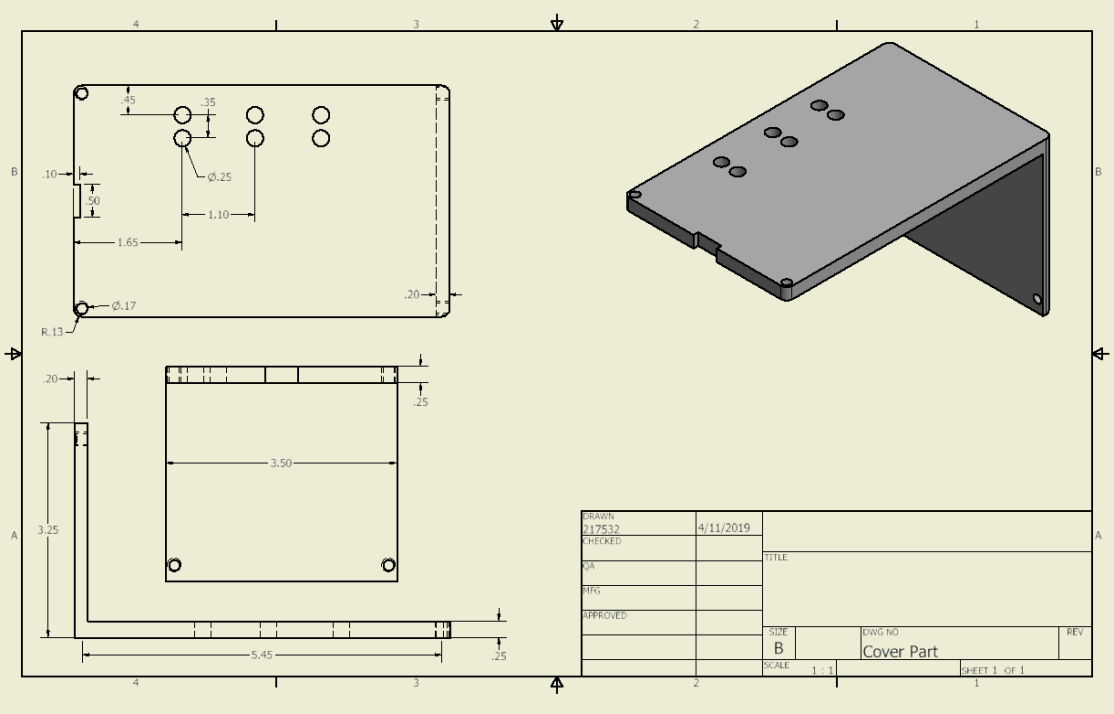

Figure 1-9

10. Next, export the Inventor file to Makerbot then after placing the components onto the digital platform print the box.

11. Once the box is printed, place the cover on top of the LEDs so that they go through the hole and are within the cover.

12. Place the cover on top of the box then screw in 6-32/3/8” slotted screws into the remaining holes. The final product is shown in Figure 1-10.

Figure 1-10

Discussion:

In this color organ project, we had run into a couple problems. One of the first problems was that we couldn't print the ultiboard that we designed because the head in the printer for the boards was broken and it needed a new one. The unused design for the PC board is shown in Figure 1-11. There was one issue with multisim and that was with the time settings, it was set to milliseconds instead of adjusting to the needs of the circuit. There was an issue proto boarding and that was that there wasn't any wire connecting the emitter of the three PNP transistors to the battery. Instead of printing out ultiboard design, we simply just used a perfboard to solder all of our connections. Another problem was on our perfboard, after all of the connections were soldered on, a piece snapped off. To fix this, we used hot glue to put the piece of the perfboard back on. Also, when we tried to print our box overnight on wednesday night, it failed due to extruder slip notification and since our print is a 17 hour print, we needed to wait until thursday night to print it overnight and build the final product of our color organ on friday. The printer was fixed by removing notifications for the extruder slip.

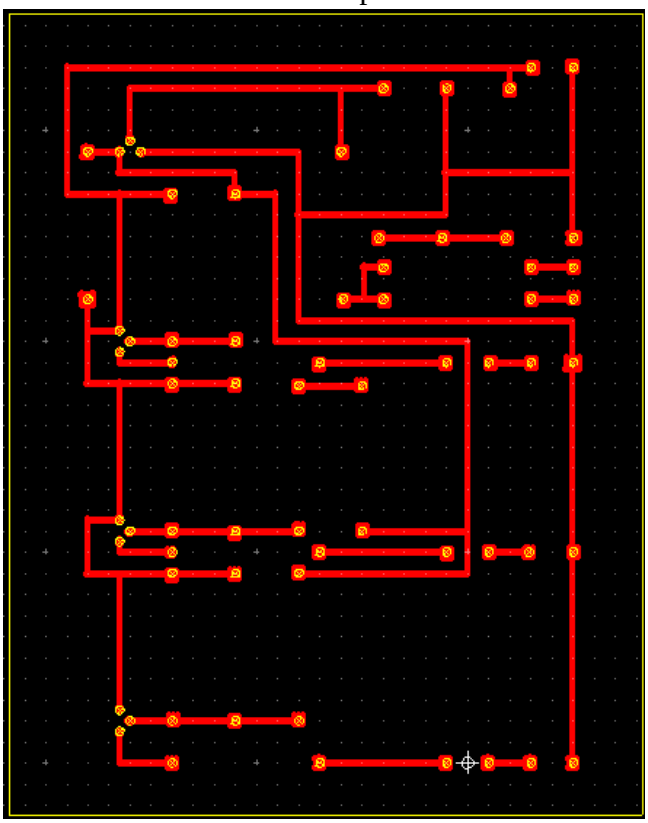

Figure 1-11

Conclusion:

To create a box on inventor we first needed the dimensions for the circuit made on ultiboard. This was needed to know how big we would have to make the box so it wouldn't be too small and the circuit wouldn't fit or too big and the circuit would be moving around and wouldn't hold the LEDs in place. Then once we had the dimensions we could start making the box which we decided to be a rectangular prism. The size of the entire box was 5.375in by 3.25in by 3in, which was split into the main box and a cover piece. The main box was three of the long sides, which are 5.375in by 3in or 5.375in by 3.25in and one of the short sides which is 3.25in by 3in. The cover piece had the other short side and the other long side, which also included the holes for the LEDs to stick out. These two together took about 15 hours to print on the 3D printer.

In order to create the circuit on the perfboard, we first needed to place all of the components into their correct spot. We knew where these components went based on our ultiboard design shown in figure 1-11. After placing all of the components in the correct spots, we then soldered what we could together, and if the components were too far away from each other, then we had to place jumper wire to connect them.

In order to create a bode plot for each set of LEDs, first you have to adjust the frequency to figure out when each set of LEDs turn on in order to give an idea of what range to use. Knowing the frequencies for when the LEDs turn on rather than the cutoff frequencies is more useful as they are the entire visual aspect of the color organ and will provide more representative information for how bright the LEDs are for certain frequencies. Once, the ranges of frequencies are determined a voltmeter, set to measure AC (this will measure the RMS voltage) voltage, is connected parallel to one of the LEDs for each color. The frequency is then adjust and the RMS voltage is recorded as shown in Tables 1-2, 1-3, and 1-4. The data is then used to create a graph with the voltage as the vertical axis and the frequency as the horizontal axis as shown in Figure 1-3, 1-4, and 1-5.