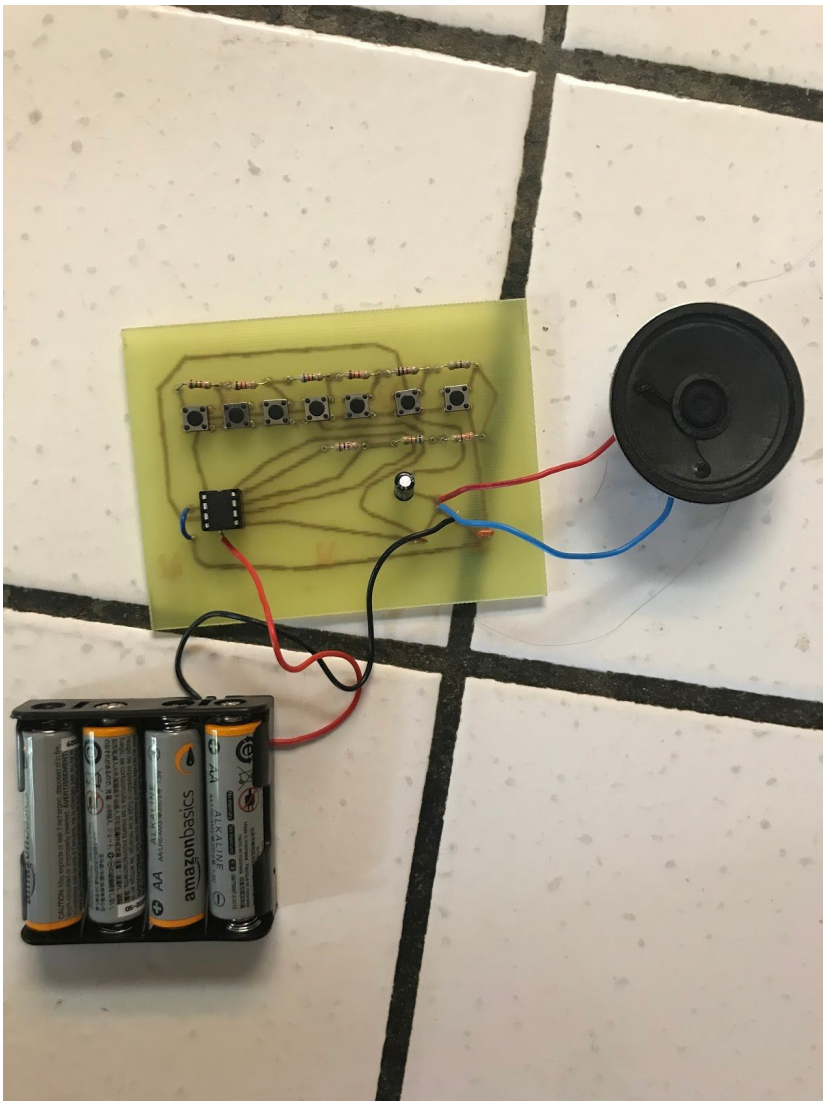
P127 PCB Design



Thomas Meagher
October 23, 2019
5th period

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Daily Log

10/7: Today, I brainstormed and looked online for ideas for my PCB project.	10/8: Today, I continued to brainstorm and look for ideas for my project. And at the end of the period, I decided to do the electronic piano circuit.	10/9: Today, I started working on my breadboard for my project. I found all of the parts needed to start my project including all nine of the resistor values that I needed
10/10: Today, I continued to work on my breadboard and finished working on my breadboard. It did not work. Troubleshooted until end of the period.	10/11: Today, I found out that I did not plug in two wires connecting my capacitors to some of my pins in my 555 timer. I rearranged my breadboard to space them out.	10/14: Today, I finished rearranging my breadboard components. My breadboard started working, so now I was able to start working on fritzing. While fritzing downloaded, I researched online ways to fritz your PCB without using jumper wires.
10/15: Today, I started working on the schematic view of my PCB layout. Button switches are different than they look on the breadboard so I had to take a couple of minutes figuring out how to arrange my schematic.	10/16: Today, I finished working on my schematic view halfway through the period and started working on the PCB layout of the fritzing. I spent the rest of the period untangling and reorganizing the autoroutes.	10/17: Today, I continued working on my PCB layout, as I rearranged all of my components to where I wanted them, and to where it would create the least amount of jumper wires.
10/18: Today, I continued to work on my PCB layout, as I finally gave in to using one jumper wire in my circuit. I finished working on my PCB layout and checked over to make sure I wasn't missing components or flipping ICs.	10/21: Today, I exported my PCB layout to a Word Doc and then printed two of my circuits. Once I finished printing, I obtained a copper board and started and finished ironing out my board.	10/22: Today, I accidently placed acetone on my board and most of my copper wiring went away. I scrubbed everything off and restarted on my ironing. I finished ironing and was going to start etching the next day.
10/23: Today, I placed my board in the ferric chloride bath. I waited 50 minutes	10/24: Today, I placed my board in the ferric chloride bath again for 5-10	10/25: Today, I finished the rest of my drilling holes and was going to start to

for my board to etch, and took it out of the bath. I sandpapered my board and cleaned it up. I realized that there were still copper spots on my board that could interfere with the functionality of my circuit, so I traced over my wiring with sharpie.	minutes to get rid of the remaining copper spots. Then I started drilling. I finished half of my drills by the time the period ended.	solder. I then realized that I forgot to put holes for the battery pack. I then discussed with Ms. Chou what to, and came up with two spots to place the holes for the battery pack. I drilled out the two holes and began to solder. I soldered ¼ of it at school, and finished the rest of the soldering at home.
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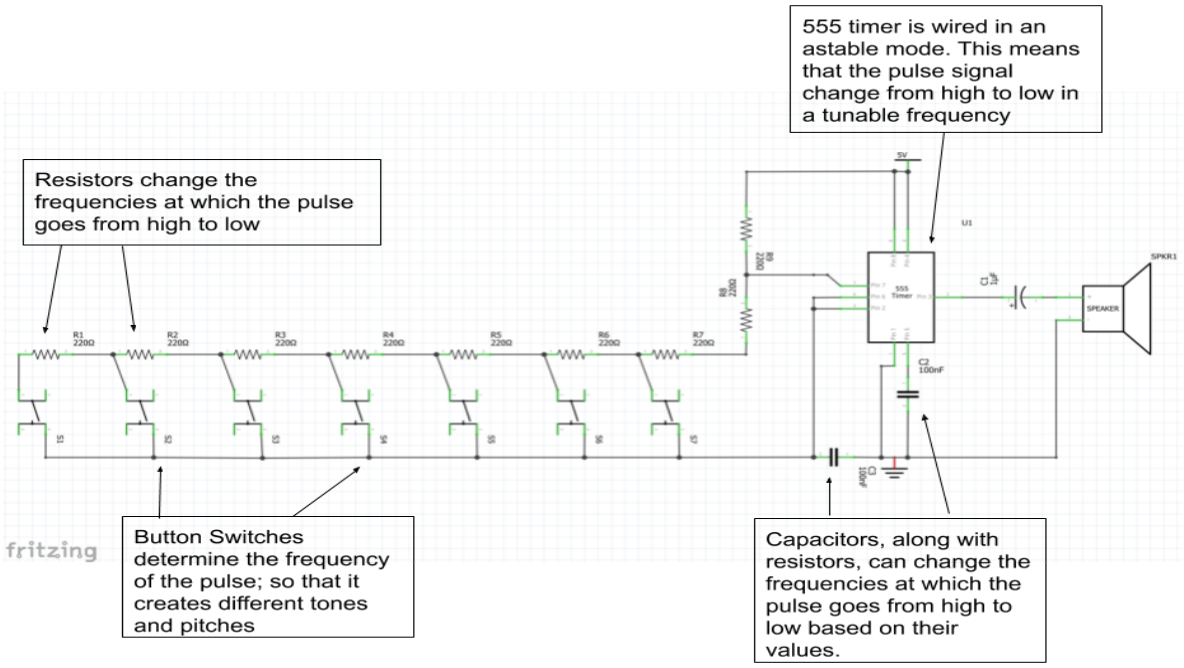
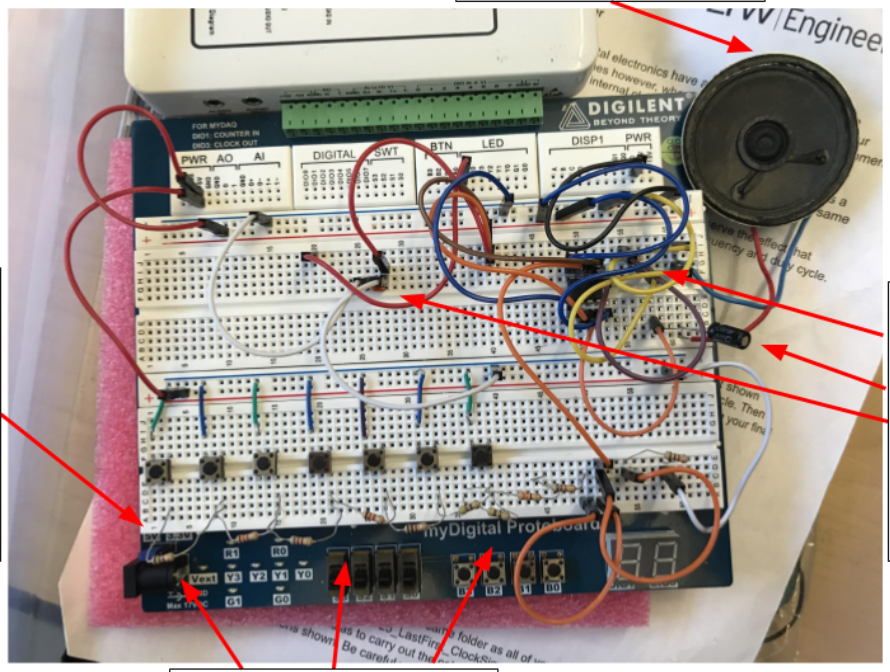
Circuit Description

For this project, I decided to go with an electronic piano circuit. I did not come up with this idea on my own, and instead found the circuit on electroSome - Electronics Tutorials, Projects and Products. (n.d.). Retrieved from https://electrosome.com/. and Instructables - Yours for the making. (n.d.). Retrieved from https://www.instructables.com/. on the internet. As a brief description of the circuit, we used a 555 timer, resistors, and capacitors to factor in to create the different pitches which will then output from a speaker. For the intended use of each part, we used a 555 timer to control the tone of the piano as we wired the circuit in an astable mode. This means that it has an oscillating pulse signal as the output and is switching between high and low states at a tunable frequency. The resistors and capacitors change the frequency at which the pulse signal goes from high to low states which creates the different tones in my piano. The buttons switch acts as a piano key, so that when a button is pressed it will create a different frequency based on the formula, $F = 1.44/((Ra + 2Rb) * C)$. The Ra and C values are always the same for this formula, but the Rb value varies because each switch goes through a different amount of resistors.

Schematic:


555 timer is wired in an astable mode. This means that the pulse signal change from high to low in a tunable frequency
Resistors change the frequencies at which the pulse goes from high to low
Button Switches determine the frequency of the pulse; so that it creates different tones and pitches
Capacitors, along with resistors, can change the frequencies at which the pulse goes from high to low based on their values.
fritzing

Breadboard:



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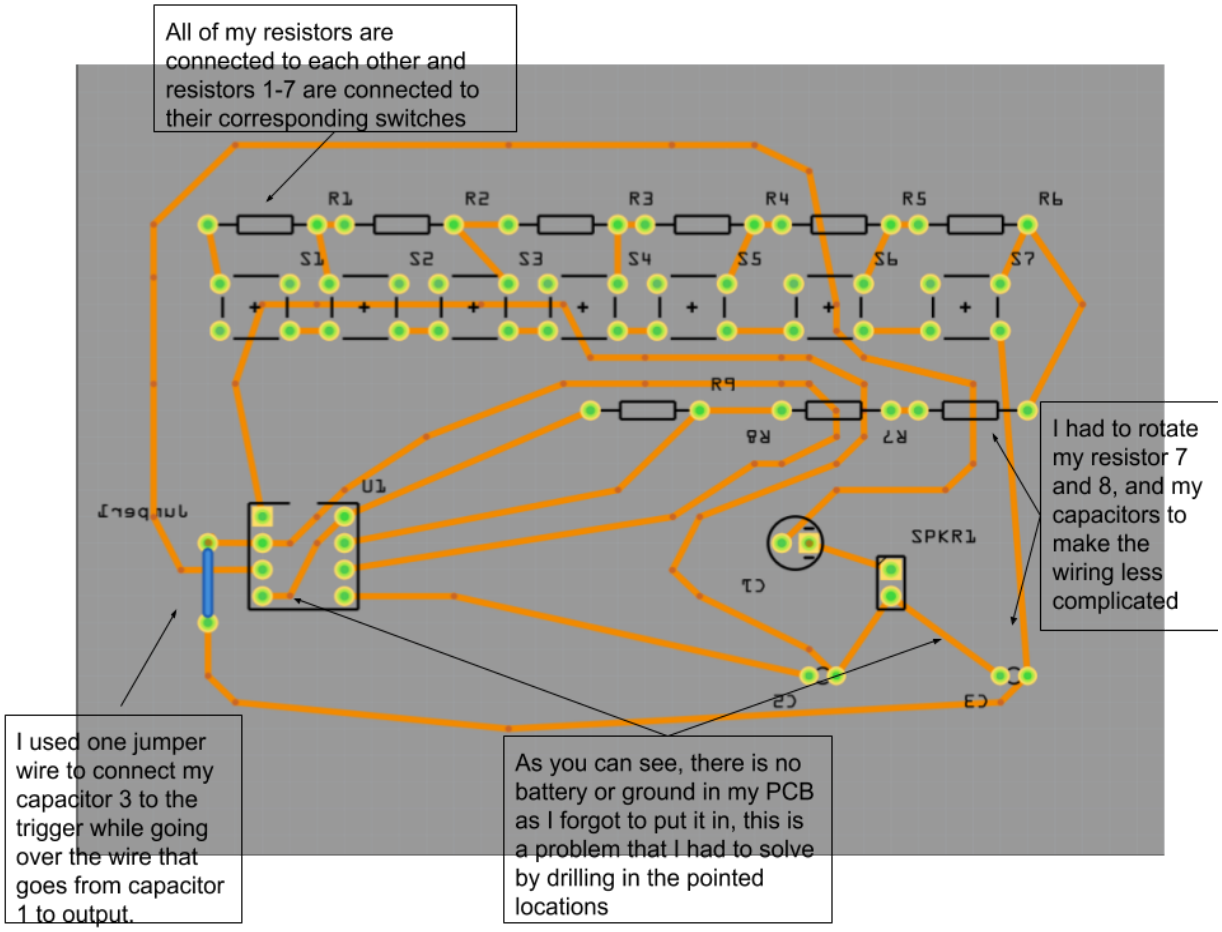
Fabrication Design

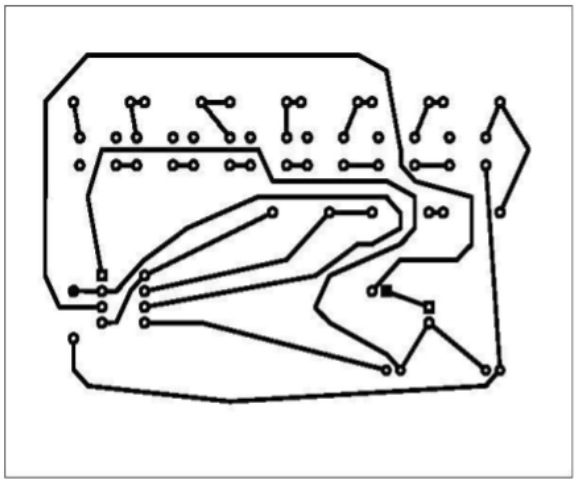
PCB Layout:



Copper Mask:

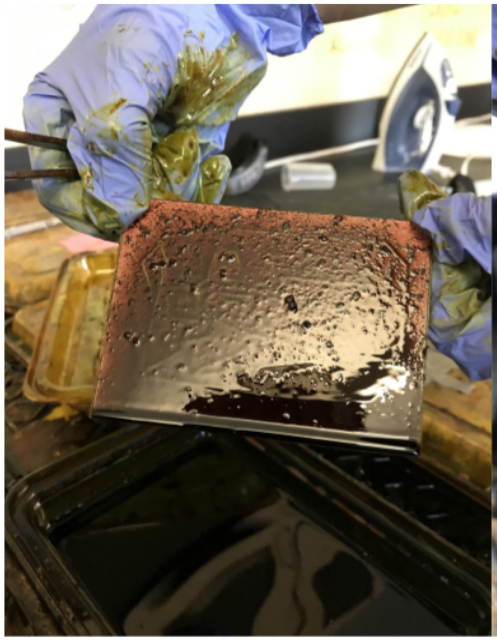
As you can see, my PCB layout, has no right angles or sharp turns, as most of them are obtuse angles of 135 degrees.

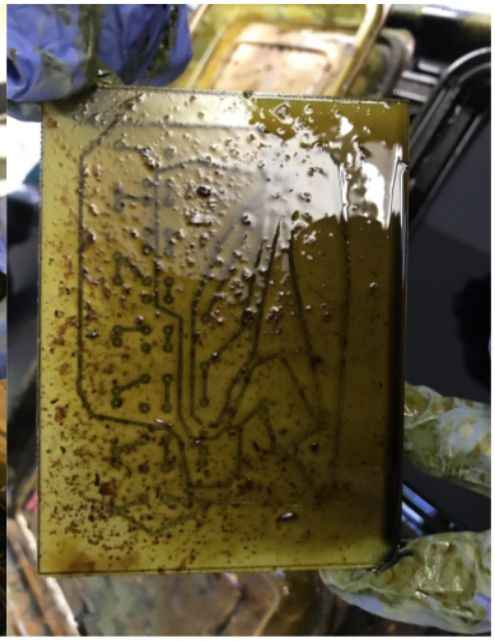
Some of the holes are colored in to help me identify where to put the positive leg or negative leg of a component



Once I finished my fritzing, I printed out my PCB layout and then ironed it onto my 4x3 copper board for about 20 minutes. I had to do this process twice because after I ironed on my copper board the first time, I scrubbed part of the copper wiring away with acetone. After ironing for the second time, I put my copper mask into the ferric chloride bath.

Etching Process:





I prematurely took out my board before all of the copper spots went away, so I had to cover all of my lines with sharpie and place it in the bath for about 5 to 10 more minutes.

On the left is a photo of my copper mask about 20 minutes into its etching process. As you can see, there is still a lot of copper left on the board as it is still a reddish, brown color.

On the right is a photo of my copper mask about 45 minutes into its etching process. As you can see, most of the copper has gone away as it is now a yellow color but there is still a lot of copper spots still on my board.

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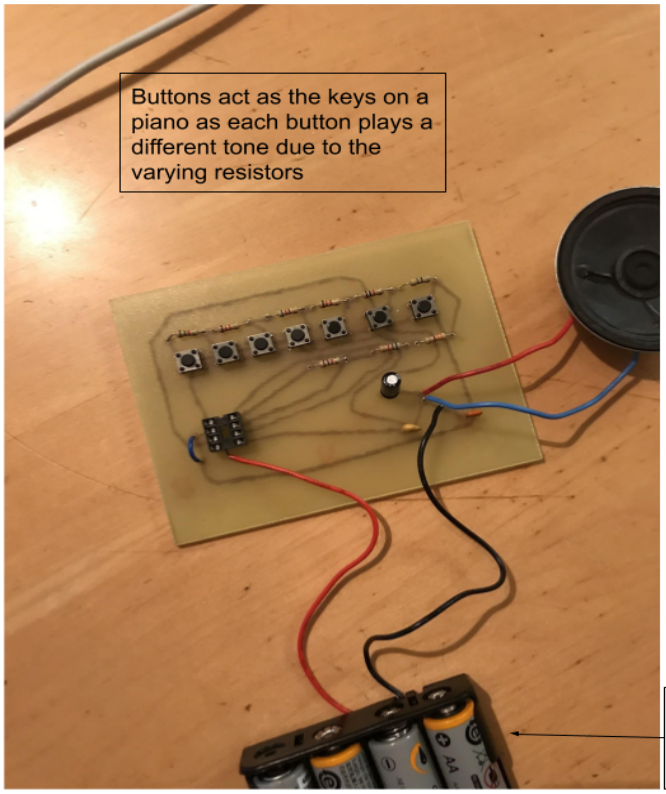
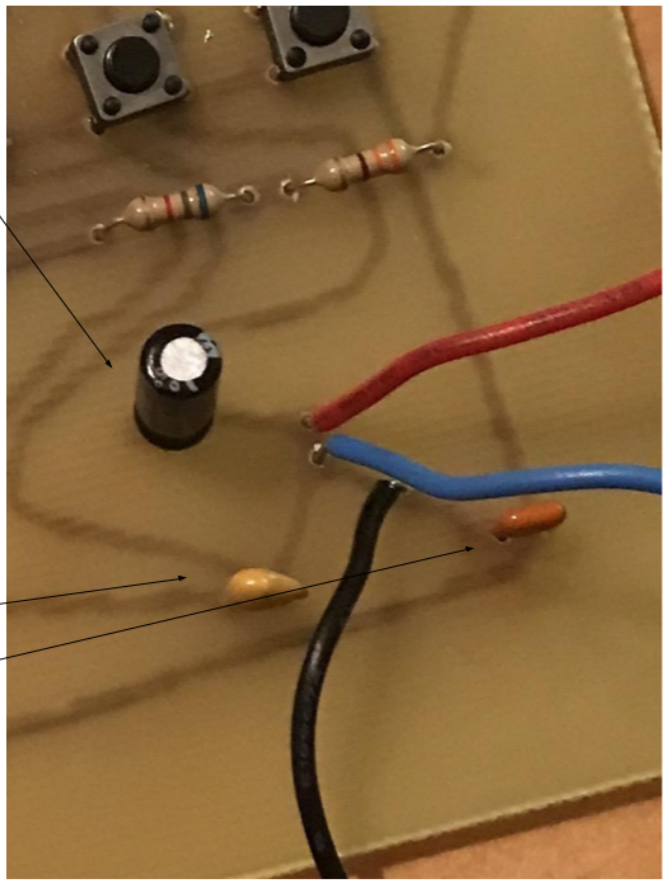
Final Circuit Description

After my etching process, I took my board out of the bath. Once I looked over and checked for extra copper spots, I went over to the drilling station. There, I used the drills to create holes where my components were supposed to be. When I was about to solder, I realized that I forgot to add holes for the voltage and ground of my battery pack in my fritzing. So, I drilled two new holes in the copper wiring of my board to fix the problem. Once I drilled those two holes, I finished soldering the rest of my components to my board. The functionality of my circuit is supposed to simulate that of a piano. The button switches represent the piano keys as each time one of them gets pressed, a different note plays. The resistors allow this to happen because they are varying values, and each resistor value has a different frequency. The capacitor also allows this to happen as the certain capacitor values determine whether the speaker gives off a high frequency or a low frequency. Lastly, the 555 timer is the main component that makes my circuit work. The 555 timer works with the resistors and capacitors to wire it into an astable mode. If it weren't in an astable mode, the output would not have a tone. The astable mode allows the oscillating signal to go from high to low with a frequency that acts like a tone. By adding all of the pieces together and by going through this long process, I was able to create a functionable, working electronic piano.

Full View:



Capacitor View:



Capacitor 1 allows signals from the 555 timer to be transferred to the speaker

Red and blue wires are connected to the speaker. The speaker is the output of this circuit as all of the capacitors meet up at the speaker

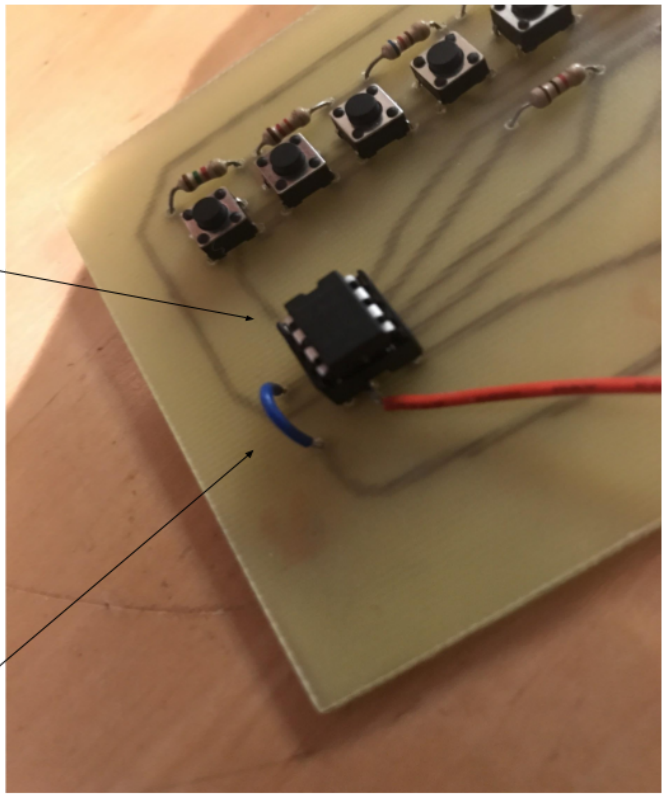
Capacitors 2 and 3 determine the frequency of each signal with the help of the resistors.

The black wire is from the battery pack. This acts as the ground for the circuit. I forgot to add separate holes in for ground so I had to drill into the existing copper wiring. Based on the schematic, I had to connect it to where the speaker and capacitors 2 and 3 could flow.

555 timer View:

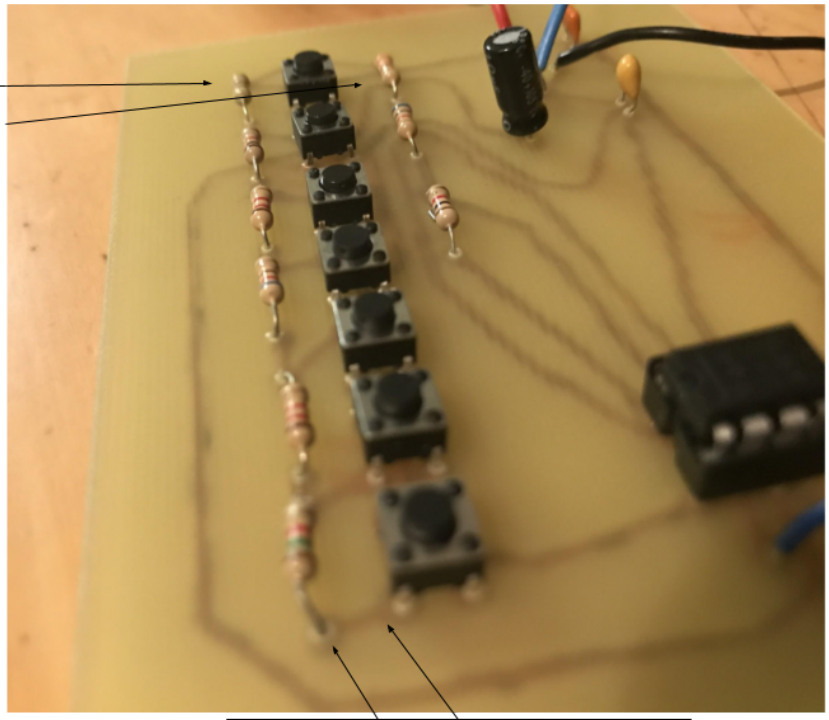
555 timer is the major component of the circuit as it connects the rest of the components together. 555 timer is in astable mode which determines the frequency.

I used a jumper wire to connect my copper wires without going through them. This allows capacitor 3 to go to trigger, and capacitor 1 to go to output.



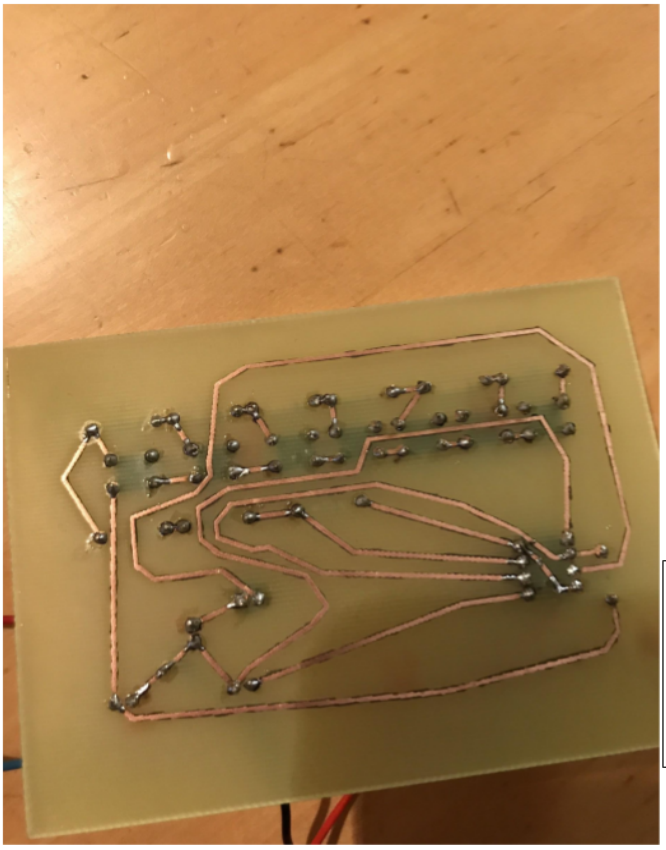
Red wire is apart of the battery pack. Because I forgot to drill a hole for the voltage, I had to drill a hole in the copper wire that connects pin 4 to pin 8 and solder the wire underneath the 555 timer.

Buttons and Resistors View:



Underside View:

All of my soldering joints are covered fully and there are no soldering bridges to be seen.



Some of the copper wiring is outlined with black. This is because I had to trace over all of my copper wiring to put it back in the bath, and the remaining black could not be scrubbed off.

Parts of the board around the soldering joints appears to be black because while soldering some of the components, the iron would touch my board.

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