

PHYS 406 Project: Gimmick Tuner Pedal

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Introduction:

I first heard about this class from a friend of mine because we were both interested in building different guitar pedals and whatnot. So when it came time to decide on what I would do for my final project, I wanted to build a guitar pedal that would fit in well with the other pedals that I currently have. Seeing that I currently do not have a tuner pedal in my possession, I decided to look around to see if there were any tuner pedal schematics that I could possibly use and modify a little bit. There was only one that I was able to find: a chromatic tuner called "theGimmick". Seeing that the person who designed it (nILS Podewski) had information on the schematic, parts, and other things, I decided to give a shot at creating this tuner pedal. This was the very first pedal that I built and while it is a lot harder than a traditional overdrive pedal, I was up for the challenge.

Schematic changes/prebuilding design

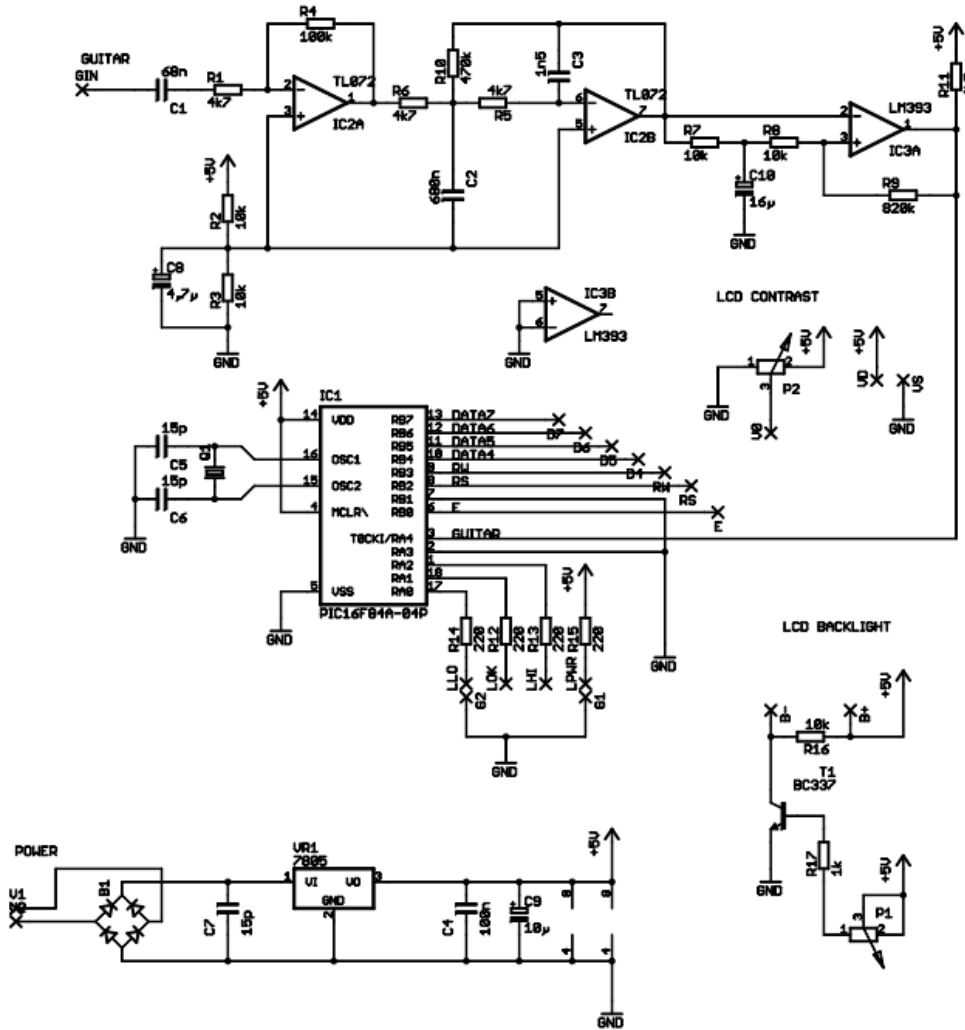
The website that nILS had provided a few things for me. To start off there was a list of parts and a basic schematic. The parts that I needed were pretty typical of a standard guitar pedal. Resistors, capacitors, op amps, etc... Here is a list of the different parts that I used:

| Value | Amt | Part |
|-----------|-----|------------------------|
| BC80 | 1 | Rectifier |
| 68n | 1 | Capacitor |
| 680n | 1 | Capacitor |
| 1n5 | 1 | Capacitor |
| 100n | 1 | Capacitor |
| 15p | 3 | Capacitor |
| 4,7 μ | 1 | Electrolytic Capacitor |
| 10 μ | 2 | Electrolytic Capacitor |
| PIC16F84A | 1 | Microcontroller, DIP18 |
| TL072 | 1 | Op Amp, DIP08 |
| LM393 | 1 | Comparator, DIP08 |
| 4Mhz | 1 | Crystal |
| 1k | 1 | Resistor |
| 220* | 4 | Resistor |
| 4k7 | 4 | Resistor |
| 10k | 5 | Resistor |
| 100k | 1 | Resistor |
| 470k | 1 | Resistor |
| 820k | 1 | Resistor |
| 10k | 2 | Potentiometer |
| BC337 | 1 | NPN Transistor |
| 7805 | 1 | Voltage regulator |
| DIP08** | 2 | IC-Socket |
| DIP18** | 1 | IC-Socket |

The one thing that made this pedal different from a typical distortion pedal is that there is a lot of analysis involved in this circuit. A lot of times a pedal simply alters the incoming signal and sends it out again. Needing analyze the signal coming in is what makes a tuner pedal special. This means that the pedal needs a little extra something; in this case, we added in a microcontroller that will take in the signal and analyze it. To be very honest, I was not told how the code works.

My best guess is that the microcontroller takes in the analog signal and performs a dft or dfft of the signal. From there we compare it to the frequencies of more commonly used notes, such as the 440 Hz ‘A’.

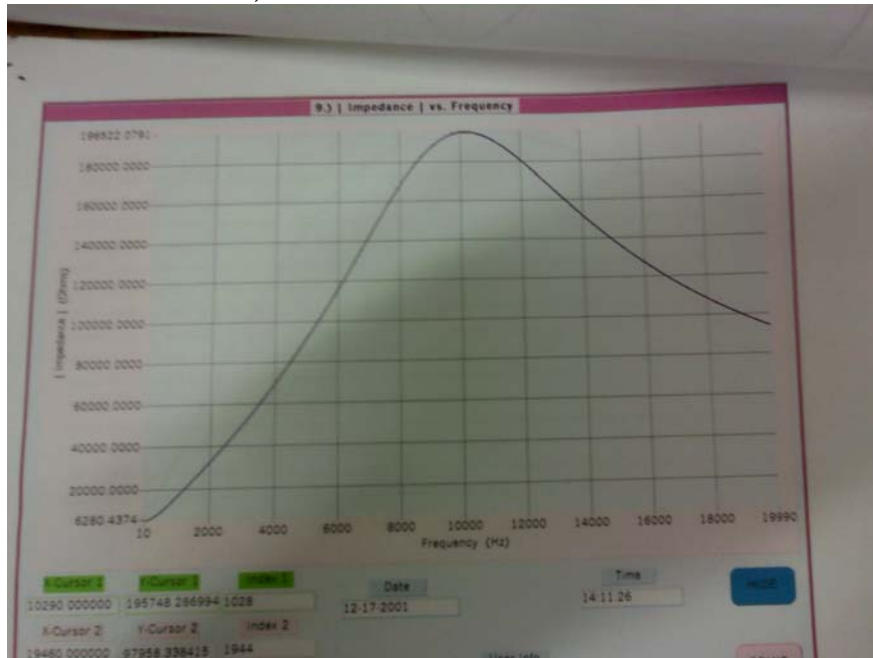
The schematic that was provided to me is shown below:



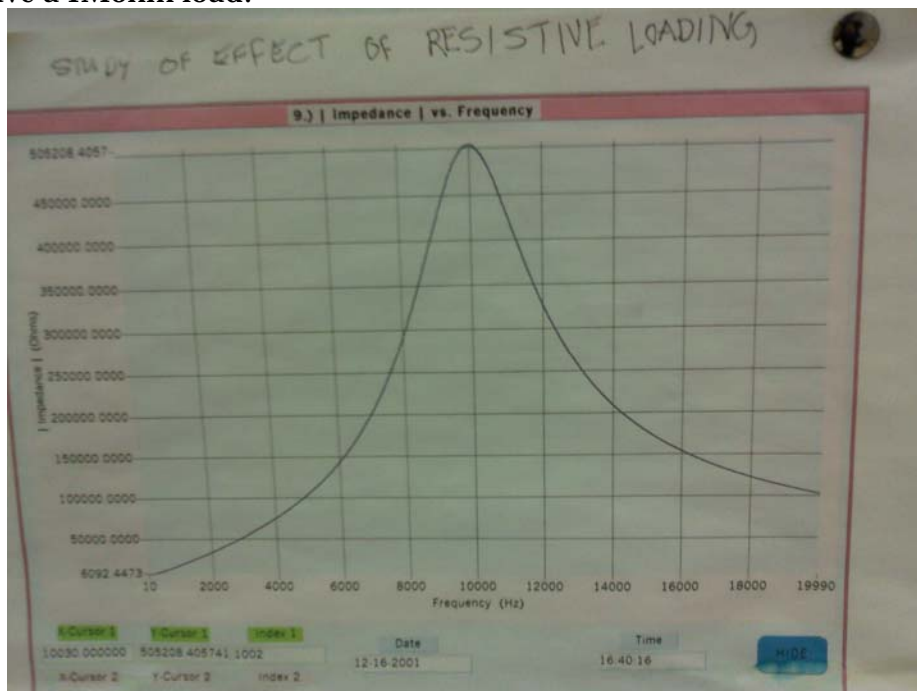
As one can see, there is an input circuit (on the top) that fixes the signal that eventually inputs to the microcontroller that is shown in the middle. The op amps and resistors in this part of the circuit control the gain of the signal; this essentially makes sure that the input signal going into the microcontroller is not too large. The microcontroller itself takes in the signal from the guitar, analyzes the signal, the sends out data to a LCD screen that is attached to the overall circuit. The bottom part of the schematic is the power circuit; this part of the circuit converts an AC power source using a rectifier (4 diodes connected in a square, allow in the output voltage in between two of them to be constantly positive) and a voltage regulator to convert the AC power to a positive DC source.

Looking at this schematic, with the help of Professor Errede I made a few modifications to this circuit. The first one was at the input point of the circuit. Instead of connecting the input to the negative terminal of the op-amp, we connected the input to the positive terminal. Also, we added a 1Mohm resistor to the input to allow the signal to be better received. Professor Errede had done some research on the impedance at the input and the effect it had on the signal:

If we have a 250Kohm load,

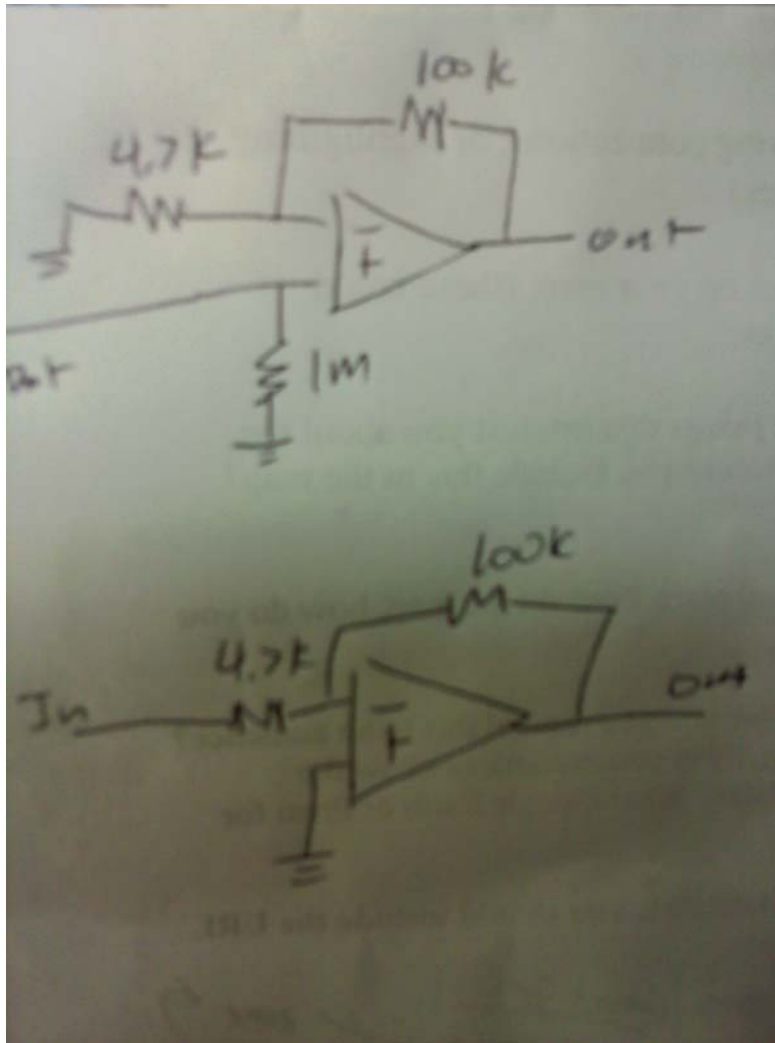


If we have a 1Mohm load:



As we can see, the higher the resistance the clearer the peak was. This would allow for us to get a better DFT and possibly a better reading on the signal that I was sending into the circuit.

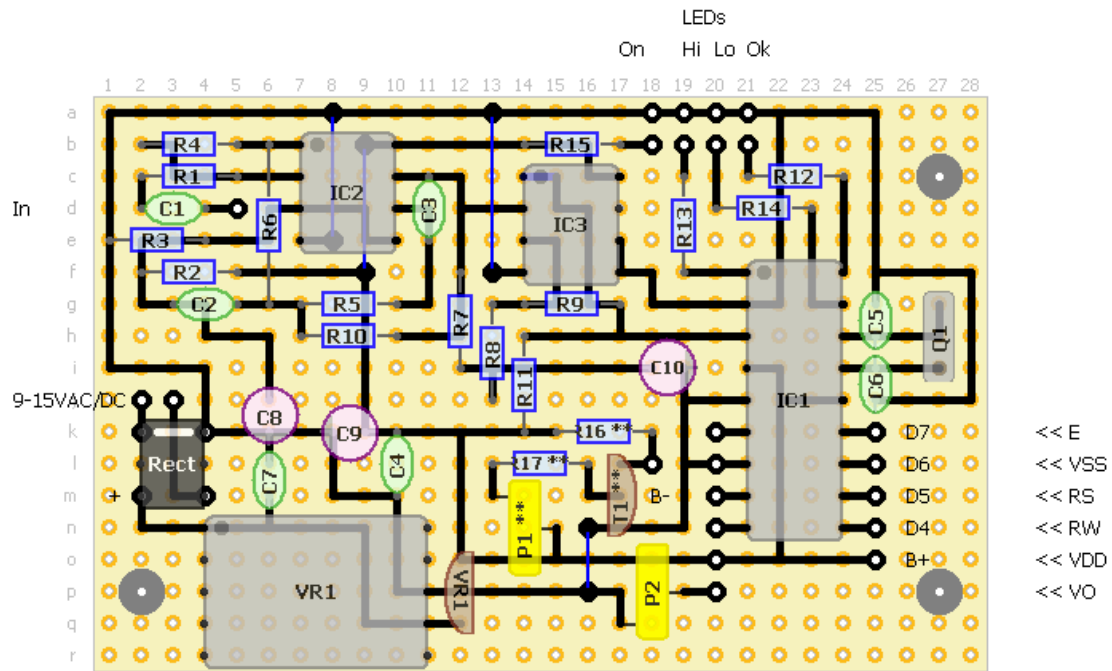
Below photo of the new schematic. The new version is on the top.



Another part of the circuit that I modified was in the power section. Seeing that the power supply that I planned on using for this circuit was a DC power source, there was no need for the rectifier that is implemented here. So I just took it out and connected the positive and negative terminals to the node directly after the rectifier.

Building Process

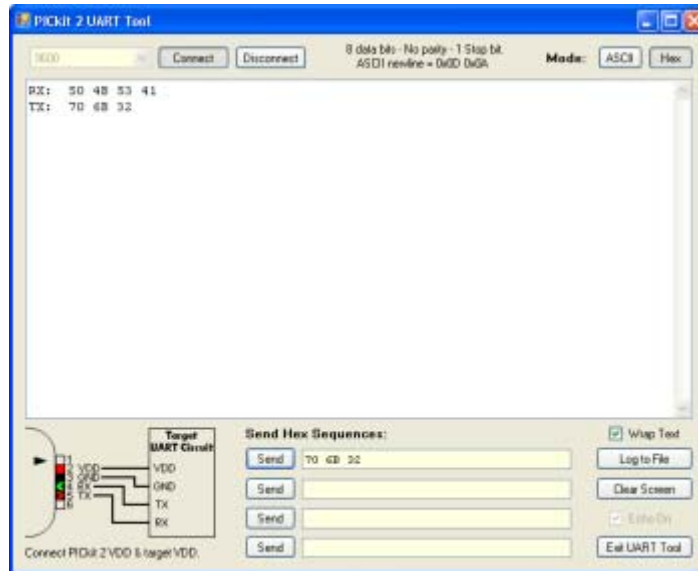
At this point, I had to decide whether or not I was going to use a PCB board or perf board. At the time I believed that using perfboard was a better way or going about things. Creating the PCB would take time on the computer and the website had already provided a perfboard layout that I could use:



Having the perfboard and the design, I ordered the parts that I needed off of the internet (mainly Digikey). For a few weeks I was stuck sitting around making sure that I had ordered all of my parts. It took a few weeks in order for all of my parts to finally come in.

The first thing I did once I bought everything was program my microchip. The website also had the code that I was to program onto the chip, but no software itself. Because this microchip was a simple PIC chip, I bought a microchip controller off of MicroChip.

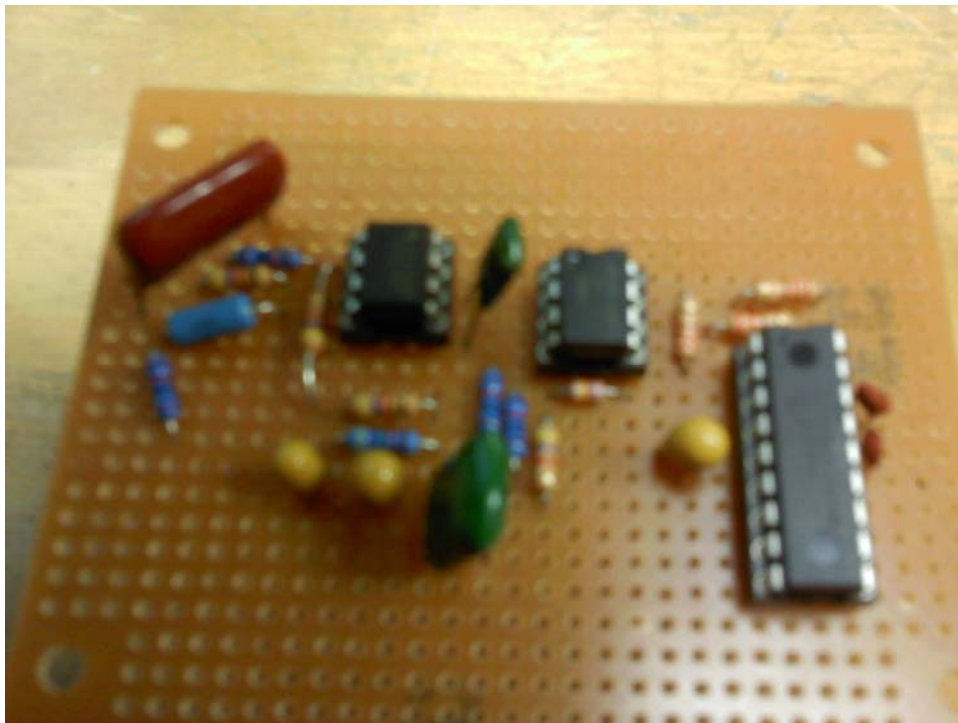




Using this programmer and the PICKIT 2 software (seen above), I was able to successfully program my microchip.

Once all of the parts that were needed to build this circuit in, I started to place them according to the perfboard layout.

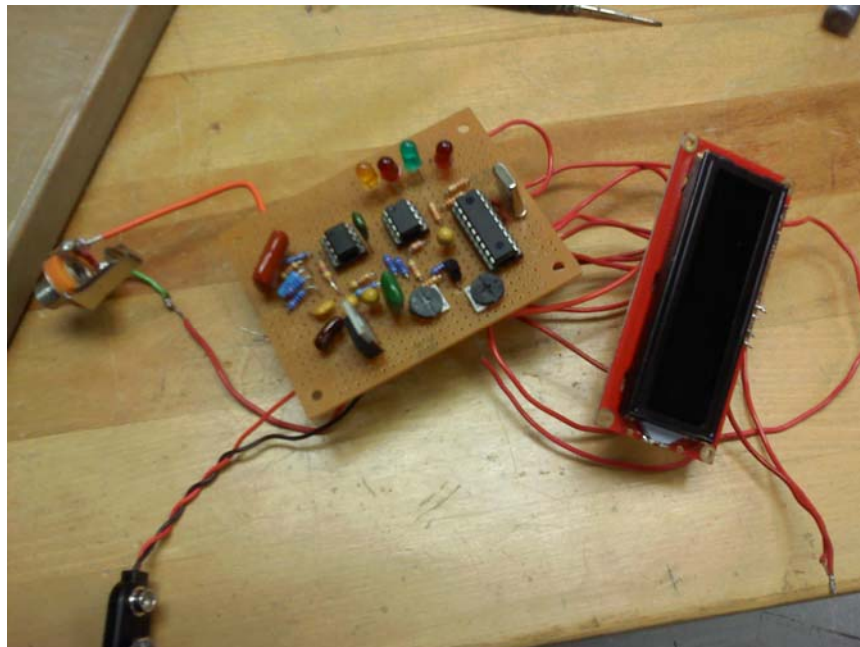
Here are pictures of it about halfway through placement:

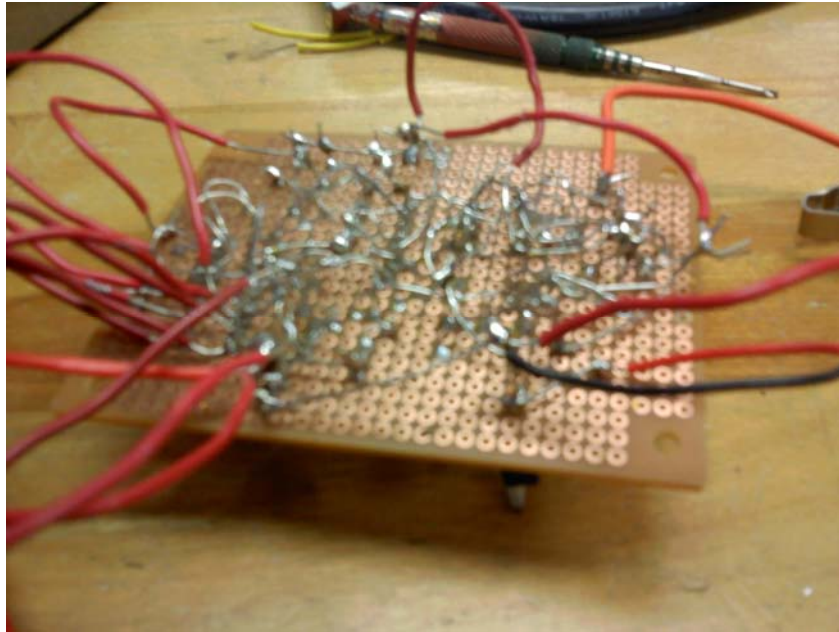




As one can see, I decided not to cut off the leads off of the parts that I soldered into the perfboard. These leads would eventually act as connections between the different parts that are in the circuit.

Once everything had been placed and soldered together, the final product looked something like this:



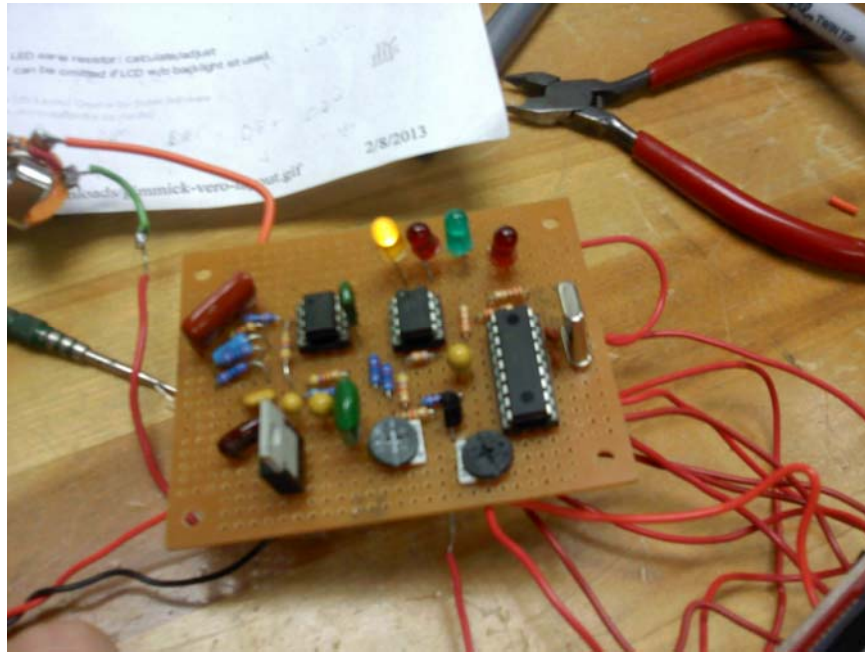


At this time I did not have enough time to make the circuit look pretty; in other words, I did not have time to create a casing for it. Also, it only has one input and does not have a line out. This means that it cannot be used in a chain of pedals; I would have to bend down and unplug the input and plug it into my chain.

Testing/Results

Seen in the previous photos, I used a 9-volt attachment as my power supply. This was mainly for testing purposes. If the circuit was successful I would buy an adapter so my power supply would be compatible with the circuit.

When I plugged in the 9 volt battery, the “on” LED that I used lit up. However, the LCD screen was still blank.



Possible Errors:

There are a few possible reasons as to why the LCD screen was blank. The first was that I simply made a wrong connection when soldering the entire circuit together. As depicted in the photos above, the circuit was a little more complicated than it looked. This forced me to solder a lot of random different things together. Throughout this process it is very likely that I may have mis-soldered something. Another possible error that may have occurred was that some of the wires and leads were touching each other when I plugged in the 9-volt battery. This would have messed up the signal path and therefore not have allowed the LCD to turn on.

Conclusion /Final Thoughts:

As I wrap up this project, a few things come to mind. The first is that I was not able to get the pedal to work. This did not allow me to be able to try to compare the results that this pedal provides with another typical tuner that can be found elsewhere. I plan on perhaps further investigating my circuit to see if I can find any places where I have slipped up. If I had to go back and do something differently in this project, it would definitely not use a perf board. When it comes to more complicated circuits like this one, designing a PCB is probably not going to generate as many mistakes. Overall, I would say that I bit off a bit more than I could chew; the more complicated circuit got the best of me and as a result I was unable to have a fully working product at the time I am writing this. I would like to thank nILS and Prof. Errede for helping me through this project.