

Modular Synthesizer

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Project

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From recording lots of parts in songs in the album Event Horizon, I became inspired by the digitally emulated modular synthesizers the arp 26000, minimoog that we used during production, so I decided to make my own modular synthesizer by utilizing a pedalboard I made as the horizontal rack for audio effects, and a euro rack for the technical VCOs and filters connected to a old midi keyboard.

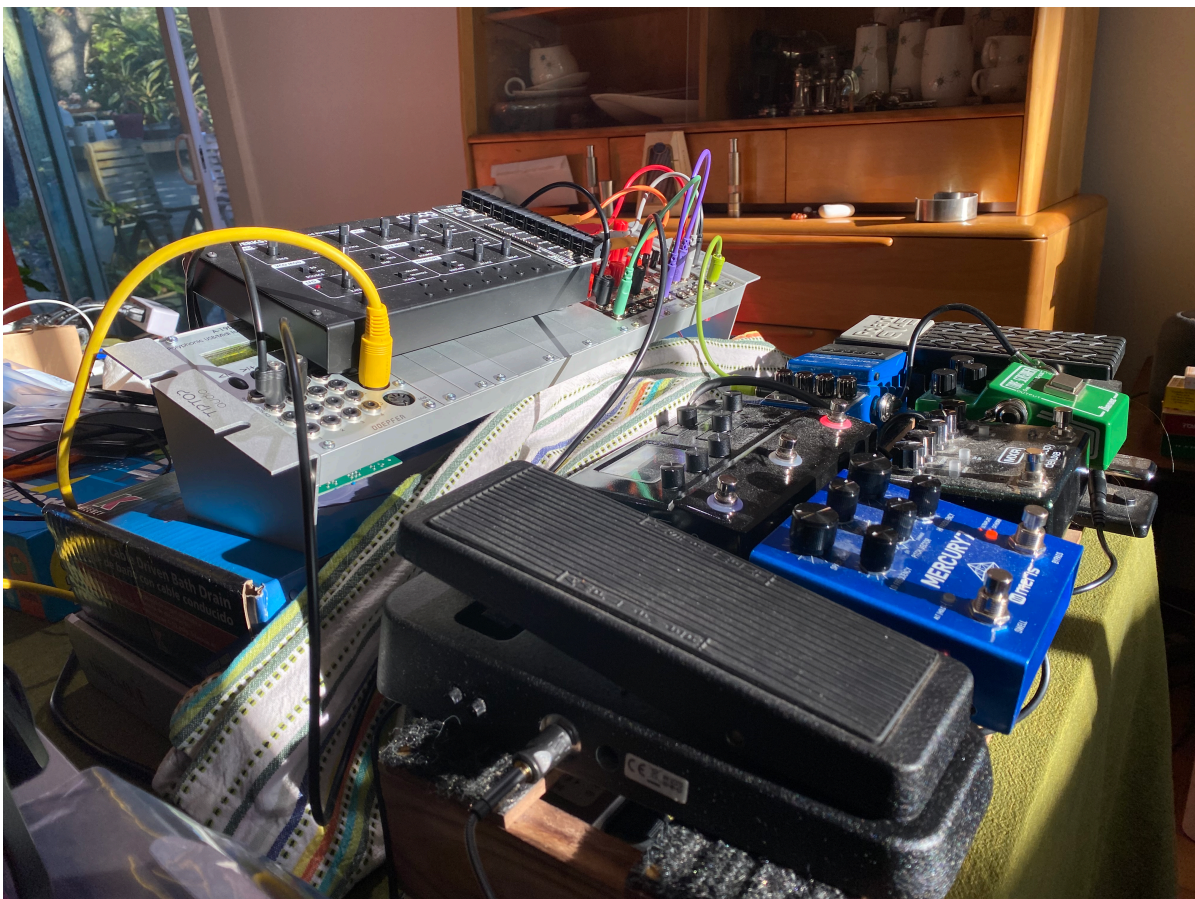


Figure 1.1 (The completed modular synthesizer)

Part 1: The Pedalboard

While not initially intended for use in the modular synthesizer, the pedalboard I made lended itself well as the main ‘effects’ of the synthesizer altering the tones into something epic to record. With a growing number of pedals and a new incentive to move them back and forth to the studio, I constructed a pedalboard out of walnut (Fig. 2.1) using a table saw and made it two stories to store the electronics underneath the board.



Figure 2.1 (structural pedalboard)

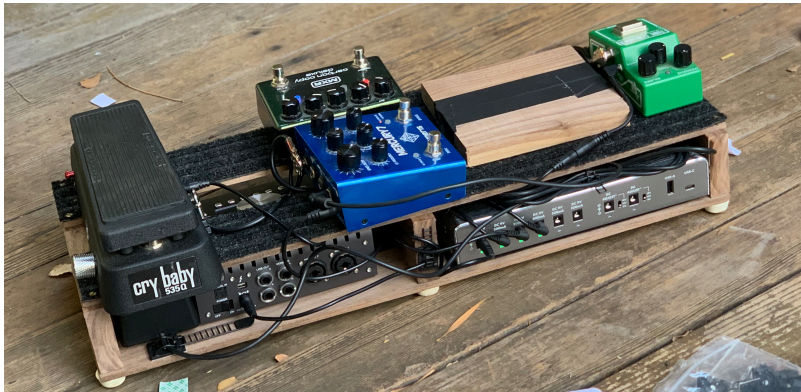


Figure 2.2 (Organizing and setting up the board)

After assembling the wooden components of the board I glued and drilled on the door-mat carpet and routed the 9 Volt DC electronics as well as planned out which pedals should go where. (Fig. 2.2)

Wah-pedal, a foot-controlled pitch filter

Multi-effects pedal
(Controllable by exp)

Compressor

Expression foot controllers

Pedals with (Controllable by exp) tags mean their effects can be controlled by a variable resistor, and thus controllable by the modular synthesizer



Figure 2.3
(The finished pedalboard)

Plate and hall reverb, pitch-vector chamber, and swell
(Controllable by exp)

Digital-delay + modulation, foot taped tempo
(Controllable by exp)

Overdrive: adds upper harmonics

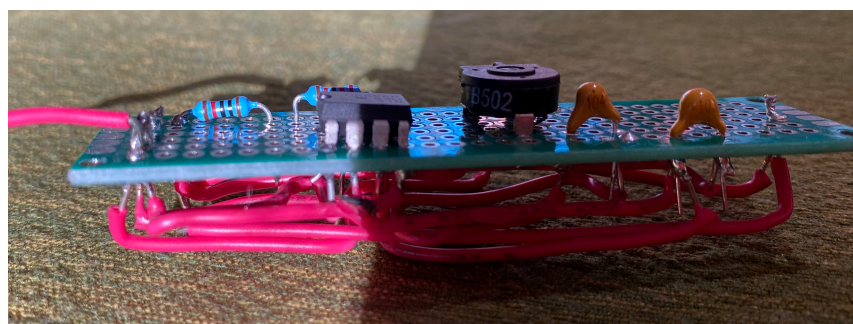
Above is the complete pedalboard (Fig. 2.3), the effects for my guitar but also what acts as the bottom rack of my modular synth. (Note: many of the companies making these pedals also make rack modules too. These cleanly screw in but I am using guitar pedals as modular synthesis modules using the expression inputs.)

Part 2: Synthesizer Modules

My first exposure to analog modular synthesis was in little bits cards and I used these to get an understanding of the basics so I could outline the components of a synthesizer that I needed, but from there I wanted to go further.

VCO

The first module I created was a voltage controlled oscillator (VCO). The VCO allows the user to control the pitch with a variable resistor knob. I built this chip (Fig. 3.2) from a 555 oscillator from a diagram similar to the one depicted (Fig. 3.1) to produce a square wave, and connected it to capacitors to filter the signal into a shark fin wave. This success lead me to continue making modules.



^ Figure 3.2 (my homemade square wave oscillator)

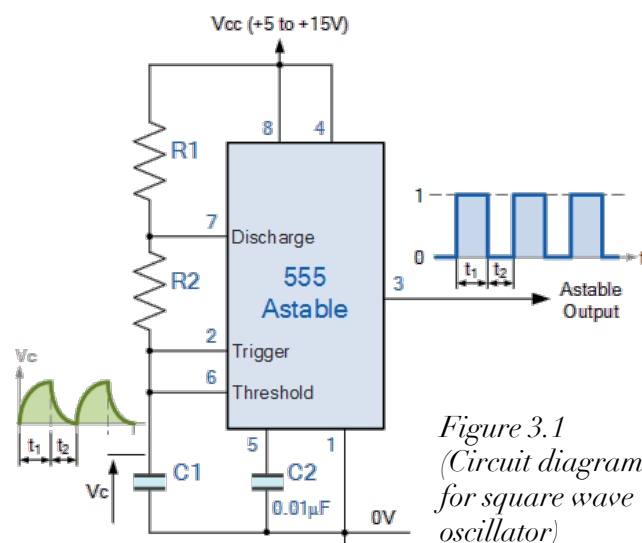


Figure 3.1
(Circuit diagram
for square wave
oscillator)

Running signals from
two VCO's into the
oscilloscope looks
wild —>

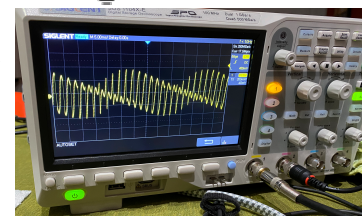
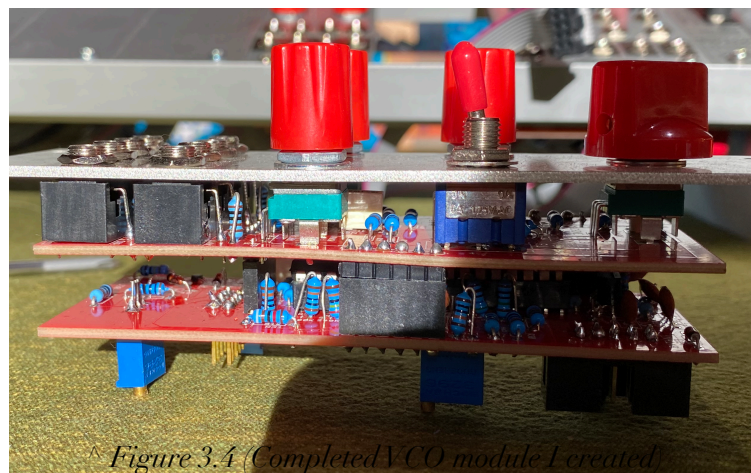


Figure 3.3 (oscilloscope)



^ Figure 3.4 (Completed VCO module I created)

Mixer

The third module I created was a mixer (Fig. 3.5). Through this module I can patch multiple signals into one output to mix simultaneous tones and timbres and effects, which I deemed necessary now that I had an assortment of oscillators to patch together.

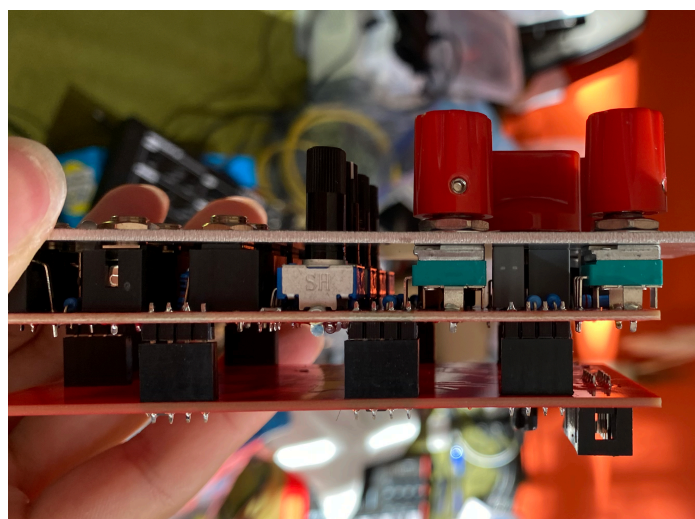
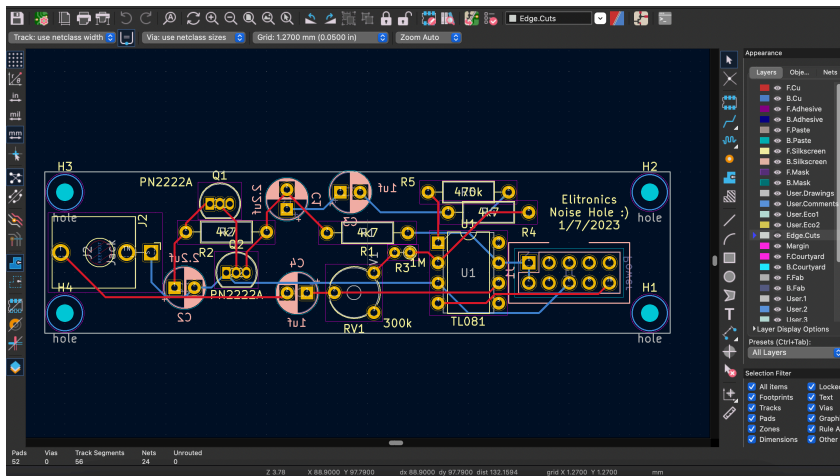
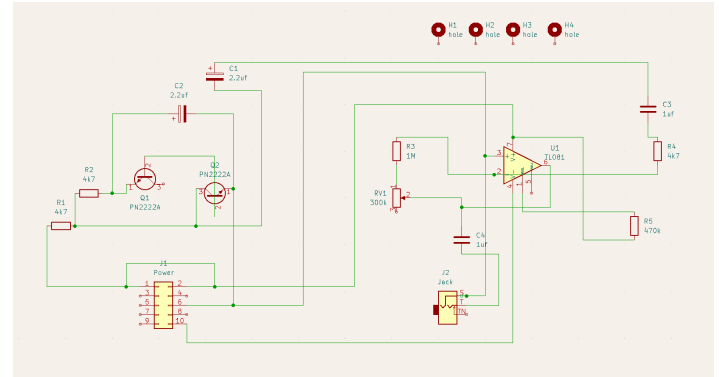


Figure 3.5 (Completed mixer module)

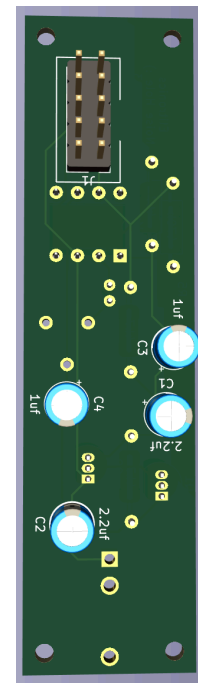
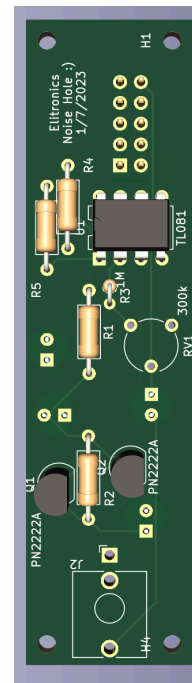
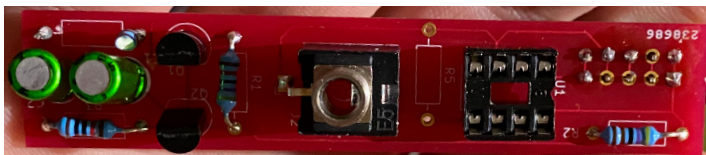
To take my circuit to the next level, I decided to implement my board in a more professional presentation. Learning how to use KiCad – a circuit board design development tool – I created files I can mail to a factory to assemble in small batches for relatively cheap.

By working backwards my design – leading to a very messy diagram – I derived a circuit diagram for the noise generator.

After creating the diagram, I could then move on to the physical design of the circuit through KiCad's circuit layout tool.



While I still wait for my new updated circuit design to arrive, I did order an older model of the circuit earlier that I have pictured here.



Part 3: Assembling the Rack + Conclusion

After completing the pedalboard, the basic modular synthesis racks, and acquiring a barebones Moog synth from a friend, and dusting off an old midi keyboard I could finally put all four pieces together to make a modular synthesizer (Fig. 4.1).

Figure 4.1 (Completed modular synthesizer connected to a keyboard)



I am proud of the results of this synthesizer. While combining a seemingly separate combinations of components, learning how to take the midi signal from an old digital piano into volts per octave, tuning an oscillator to equal temperament, and running a modular signal into a guitar effects pedalboard showcased just how much crossover there is in our modern technology. This project is important to me because it involves a lot of circuitry work that inspires me to pursue working with electronics and applicable engineering.

From this project I learned how to solder, how to make circuits, and how to perform signal processing, how a 555 and an OP Amp circuit works.

Since I documented this project, my synthesizer has taken a fairly different form with the addition of all the modules I created, so here is the updated version of the synthesizer



Part 4: Other Electrical Projects

Figure 4.2 (Side shot of modular synthesizer)

At the end here I also wanted to show pictures of other projects I made that wouldn't fit an entire project, but still relate to electrical engineering.

1: Ribbon microphone (foil in a magnetic field through a 1:50voltage transformer)	2: Coil microphone, coil around a magnet on cellophane	3: Repairing a coil microphone
4 & 5: Radio, antenna & ground connected to a large coil with 2 variable capacitors + capacitor low pass & variable resistor volume control		6: speaker cabinet for a amplifier

