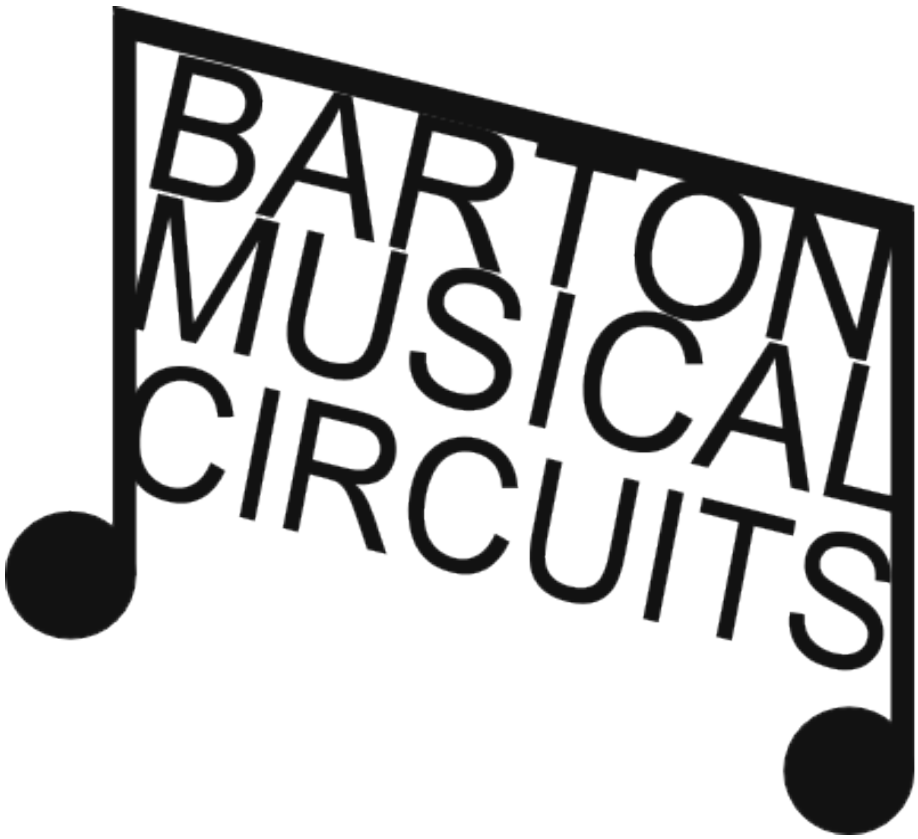
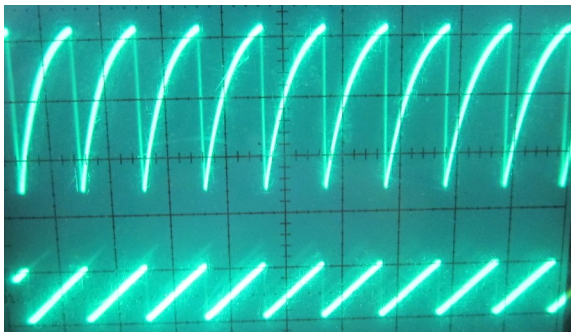
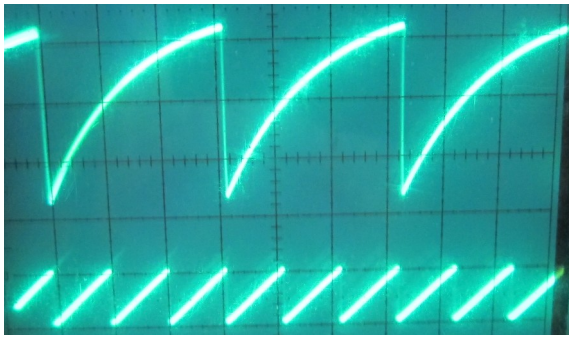


BMC 095. NOR Sub Harmonizer
Build Documentation.

I. Using The Module.

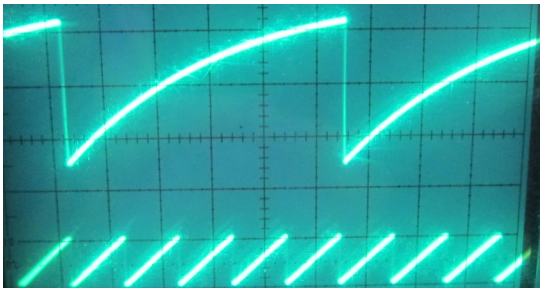


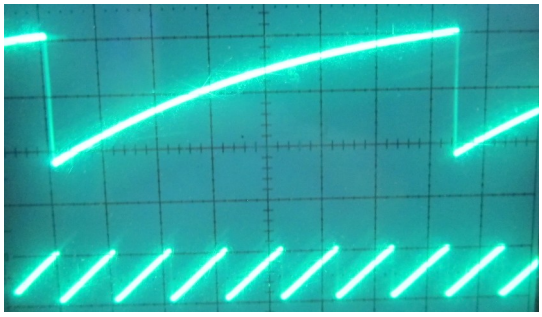


This module is a subharmonizer with 4 channels which outputs saw waves synchronized to an input signal. Each channel has a frequency control which sets the length of it's saw wave. A new wave is only triggered when it's completed it's cycle and a new input cycle has started, so by setting the wavelength to longer than the input signal, you divide the input.

A "Tight" control allows you to control when a cycle is considered "complete." This helps synchronize the frequencies between channels more, but reduces the amplitude when the output frequency is much lower than the input.

To the right are photos of oscilloscope shots. The input frequency is at the bottom and the output of the module is at the top. After taking the photos, I realized I had an inverter in the signal chain, so they appear as ramp waves, but are actually saw waves.





CONTROLS/INPUTS/OUTPUTS

1.Frequency Knobs – One for each channel. Turn clockwise to reduce the length of a wave, and counterclockwise to increase. With the Tight control at 0%, the frequency range is approximately 25hz, to 1.2khz

2.Tight Knob – This controls how low the voltage must fall on a wave before the input signal can trigger a new wave.

3.Tight CV Knob – Attenuates a control voltage that can modulate the Tight knob's setting.

4.Input Jack – Input a waveform here. A saw input works best, but short pulses or ramp waves should also be fine. Using triangle or sine inputs can create odd resonances.

5.CV Jack – CV input for the Tight CV.

6.Channel Output Jacks – One for each channel.

7.MIX Output Jack – All four outputs mixed together. The mixer inverts the signals, so this will be an odd ramp wave instead of saw.

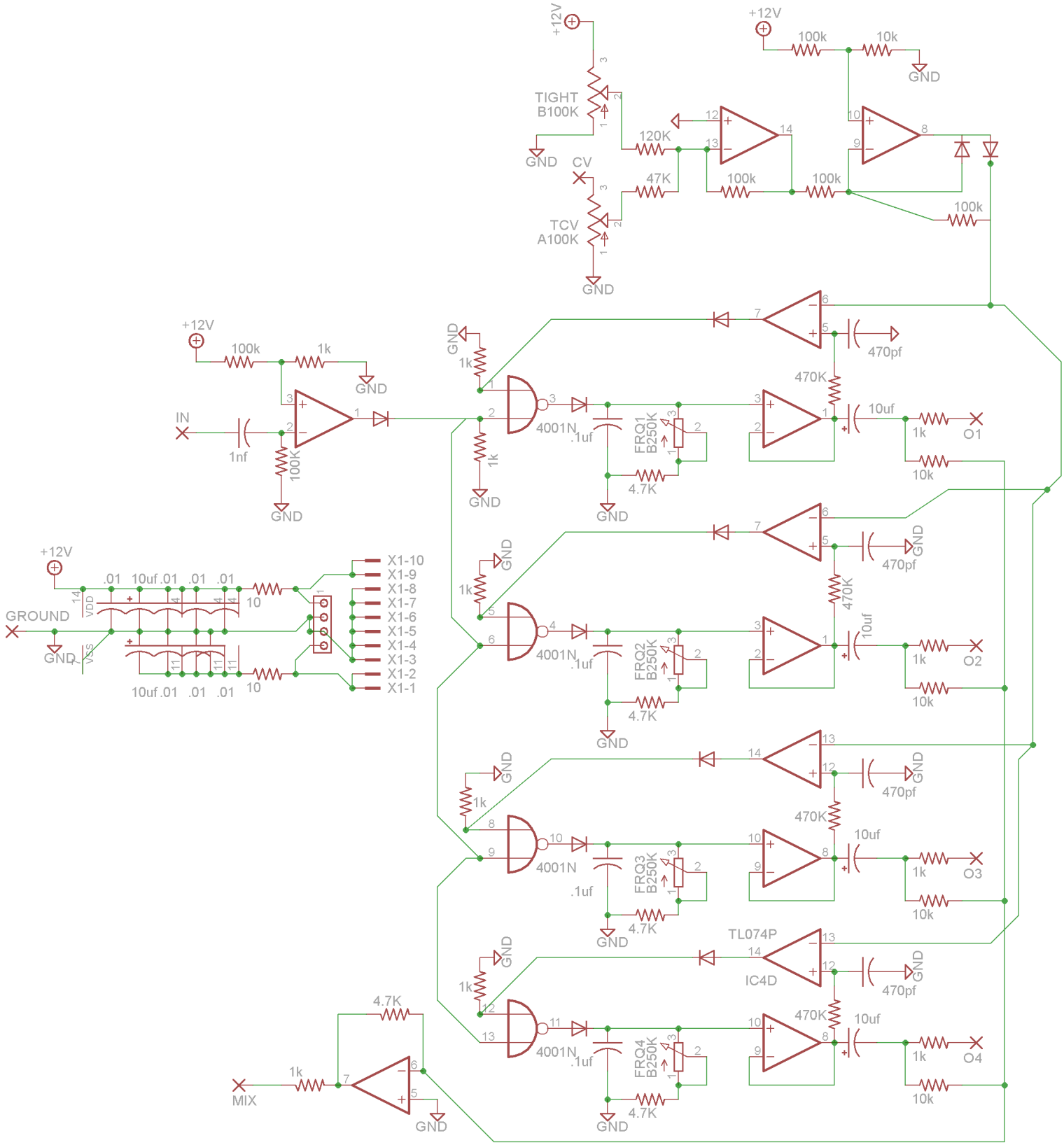
MP3 DEMOS

Demo 1

Single channel, frequency knob is turned from highest to lowest setting with TIGHT control set to zero. Then repeated with Tight control at 50%, 75%, 100%.

Demo 2

4 channels panned out in stereo. A arppegiator controls the input frequency and feeds a release generator connected to the CV input of the subharmonizer. The Tight, Tight CV and release settings are adjusted through this demo.


+12V
TIGHT
B100K
GND
CV
TCV
A100K
120K
47K
100k
10k
470pf
470K
10uf
1k
10k
4001N
.1uf
FRQ1
B250K
FRQ2
B250K
FRQ3
B250K
FRQ4
B250K
4.7K
1nf
100K
IN
O1
O2
O3
O4
TL074P
IC4D
MIX
GROUND
VDD
VSS
.01
10uf
10
X1-10
X1-9
X1-8
X1-7
X1-6
X1-5
X1-4
X1-3
X1-2
X1-1

II. Schematic.

On the previous page is the schematic for this module. On the left is the IN wirepad, this connects to a 1nf capacitor in series with a 100K resistor to ground. These two components form a high pass filter which reduces the input signal to a very short pulse. This pulse is input to an op-amp wired as an inverting comparator with its threshold set at 0.12V by a 100K/1K voltage divider. The comparator's output connects to a diode so that it only passes positive voltages. This diode connects to a NOR gate input on each channel.

The NOR gate's output is low (0V) until both of it's inputs are low. Each input has a 1K pull-down resistor so that the inputs go to 0V when the diodes feeding them stop passing positive voltages. The diodes are necessary as the comparators outputs swing positive to negative, so this prevents negative voltages reaching the NOR gates which could cause errors.

The NOR's outputs go through a diode to charge a .1uf timing capacitor connected to ground. In parallel with this capacitor is a B250K pot that's in series with a 4.7K ressitor to ground. The pot controls how quickly this timing capacitor discharges after the NOR's output goes low. The voltage on the cap is buffered by an op-amp. The output of this op-amp connects to a 10uf de-coupling capacitor and then to the output jack through a 1K resistor, as well as a 10K resistor going to the mixer.

The buffer's output also connects to a 470K/470pf low pass filter that connects to the input of a comparator. This low pass filter creates a slight delay at the comparator's input which allows the timing capacitor to fully charge before the comparator notices its begun to charge. The threshold of this comparator is set by the Tight/Tight CV which we'll get to. The output of the comparator connects to the other input of the NOR through a diode and 1K pull down resistor.

So, the NOR has two inputs. One is normally high, but then goes low for a very short window when the input signal changes. The other input is connected to the comparator watching the voltage from the timing capacitor. So when the timing capacitor is charged, the comparator's output is high and the NOR will ignore the pulses from the input. When the timing capacitor discharges, the comparator's output will go low and the next input timing pulse will cause the timing capacitor to charge.

At the top of the schematic we see the Tight and TCV pots. Tight attenuates the 12V supply and TCV attenuates an external CV input. These voltages are mixed together by an op-amp wired as an inverting gain stage and are then sent to an inverting half-wave rectifier. This keeps the threshold voltages always at least slightly positive. If the threshold went negative or close enough to 0V it would create a situation where the comparators monitoring output voltages never turn off, or take an extremely long time. This voltage is sent to all four channels.

In the bottom left is the MIX output. An inverting op-amp gain stage mixes all the outputs through their 10K resistors. The 4.7K resistor in it's feedback path sets the overall gain of the mix output.

Between mix and input are the power connections for the ICs. Footprints for Eurorack and MOTM style connecters are in parallel. The positive and negative rails are filtered by a 10ohm/10uf capacitor pair and further filtered at the TL074's power rails by .01uf capacitors.

III. Construction

A. Parts List

Semiconductors

Value	Quantity	Notes
TL074	3	14 pin DIP. TL064, LM324 or other quad op-amp should work.
CD4001	1	14 pin DIP.
1N4148	11	

Resistors

Value	Quantity	Notes
10 ohm	2	1/4W Metal film
1K ohm	6	
4.7K ohm	5	
10K ohm	5	
47K ohm	1	
100K ohm	6	
470K ohm	4	
B250K Potentiometer	4	PC Mounted 16mm
A100K Potentiometer	1	Solder Lugs 16mm
B100K Potentiometer	1	Solder Lugs 16mm

Capacitors

Value	Quantity	Notes
470pf	4	Ceramic disc
1nf	1	Ceramic or film
.01uf	7	Ceramic disc, value not critical
.1uf	4	Polyester or Polypropelene Film
10uf	6	Electrolytic

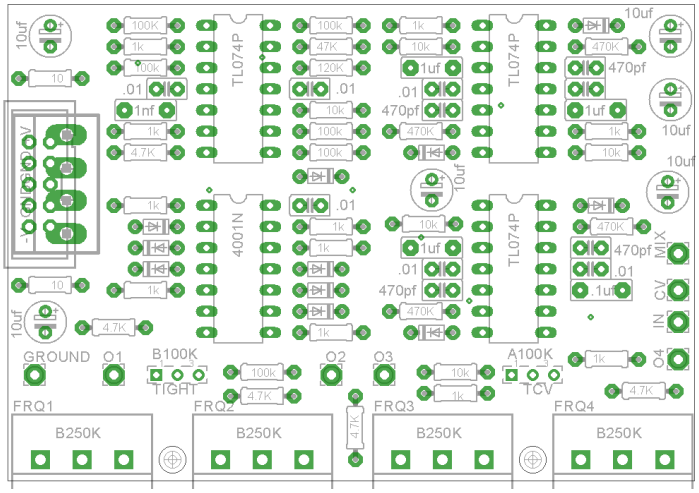
Other/Off Panel

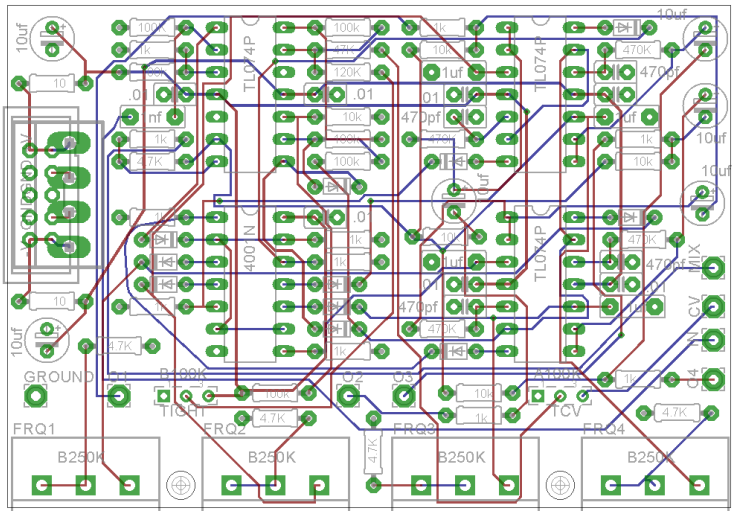
Value	Quantity	Notes
Power connecter	1	Eurorack or MOTM style
Jacks	7	
14 pin DIP Socket	4	
Knobs	6	

B. PCB Layout

Below are renderings of the PCB. The rendering showing the traces does not show the ground fill plane, so assume any missing connection is a ground fill.

The PCB measures 83mm x 57mm and the pots are spaced 21.59mm apart.





C. Wiring.

The wirepads should be connected as follows:

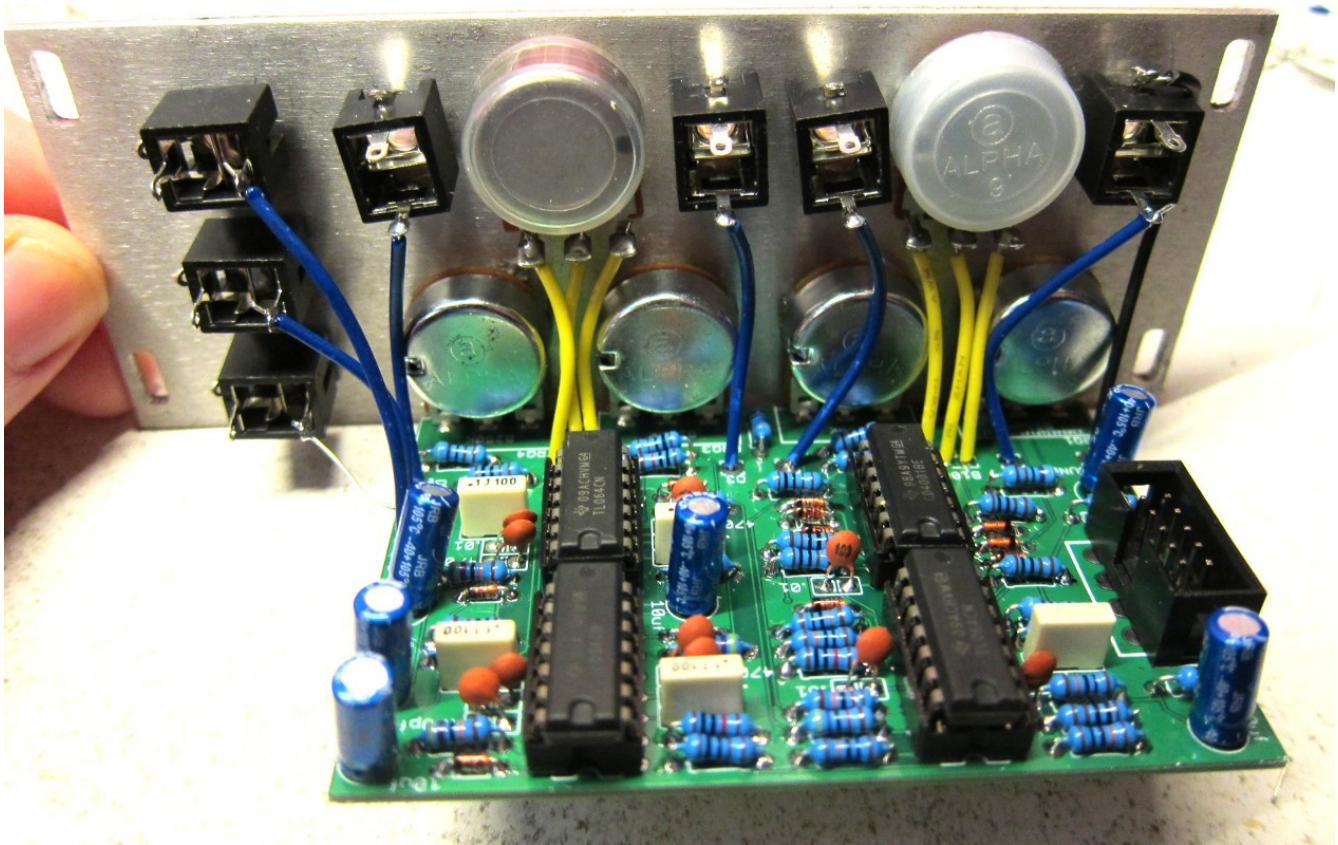
GROUND – Connect to the sleeve of any jack.

O1, O2, O3, O4 – Connect to the tips of their respective jacks.

TIGHT and TCV – Connect to the pots. The pots should be placed with their solder lugs facing the PCB.

IN, CV, MIX – Connect to the tips of their respective jacks.

Below is a photo of a completed module.



D. Tweaks

The resistor values changed in these tweaks are highlighted in the board image below.

1.15V builds - The 120K resistor that mixes the TIGHT control with TCV should be increased to 150K (Blue). The MIX level will also probably need to be reduced as the individual channels will all have slightly higher outputs.

2.Adjusting mix out level – The mix output level can go greater than +/-5V, if this is unacceptable, the 4.7K (Red) in the mixer's feedback path should be reduced to reduce the mix out. A 2.2K should make it so the the output never exceeds this. For 15V systems a 2K resistor may be needed.

3.Adjusting frequency range – To increase the maximum frequency, the 4.7K resistors highlighted in yellow should be reduced. To lower the minimum frequency the .1uf capacitors (Green) should be replaced with larger value capacitors.