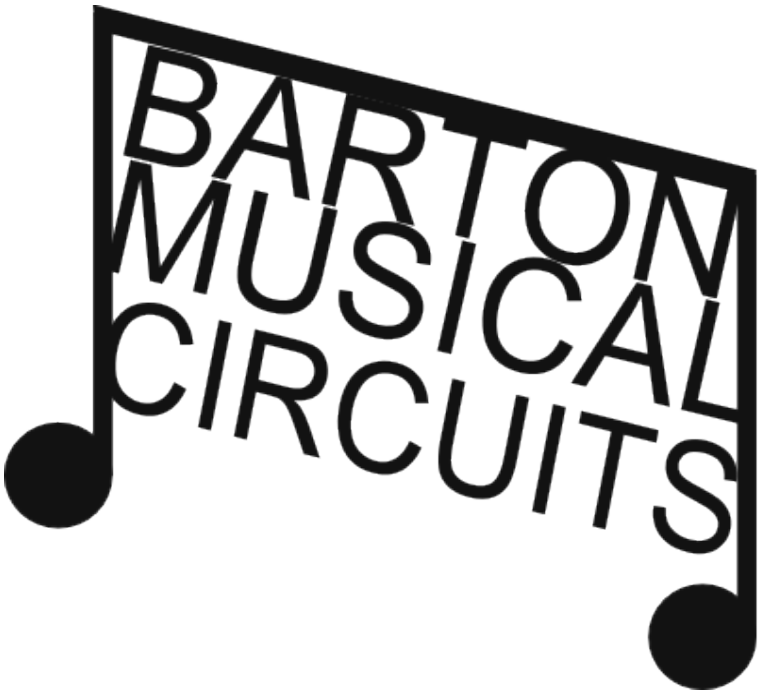

BMC120. Digital Depth VCO

If you have any questions, or need help trouble shooting, please e-mail
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I What it does, controls, sound demos.
II Schematics
III Construction
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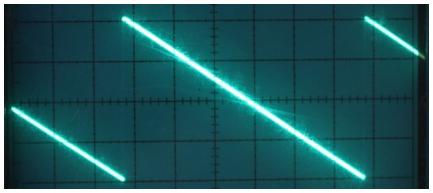
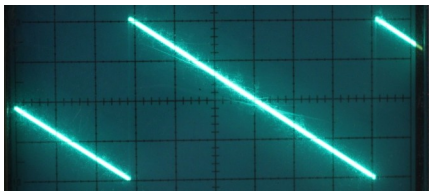
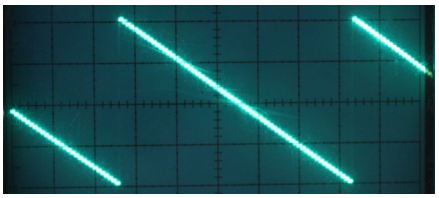
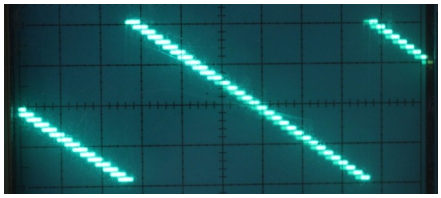
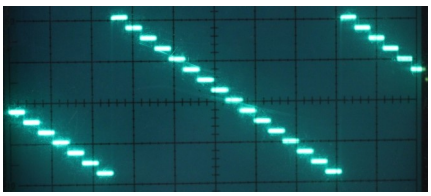
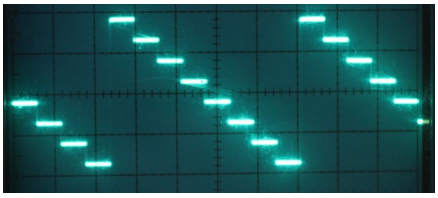
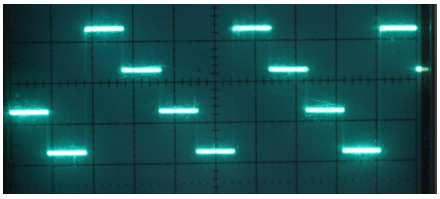
- **B. The Board**
- **C. Wiring/Calibration.**

I. What it Does

This module is a microcontroller based VCO designed to respond to 1V/O CV signals like an analog VCO. In addition to normal frequency controls, it also has control over the bit depth of the output signals, lowering the bit depth will increase the frequency and add new harmonic content as the output becomes less smooth. On the right are images of the Saw output as the bit rate lowers going from 8 bit to 2 bit, note that frequency adjusted as bit rate changed to try and keep the same size waveform in the image.

CONTROLS

1. COARSE FREQ KNOB – Sets the frequency of the module, turning this knob takes you from the lowest to highest frequency.
2. FINE FREQ KNOB – Makes fine adjustments to the frequency.
3. FREQ CV KNOB – Attenuates external CV used to modulate the frequency.
4. DEPTH KNOB – Sets the bit depth of the outputs. Turning it clockwise will lower the depth. 8, 7, 6, 5, 4, 3, 2 bit depths are available normally.
5. DEPTH CV KNOB – Attenuates external CV used to modulate the bit depth.
6. DEPTH MODE TOGGLE – In the lower position bit depth changes smoothly, as you turn the Depth knob you'll have jumps of an octave. In the upper position, fractional depths become available, these will result in odd sounding outputs that are a little more difficult to tune, but are interesting.

INPUTS/OUTPUTS

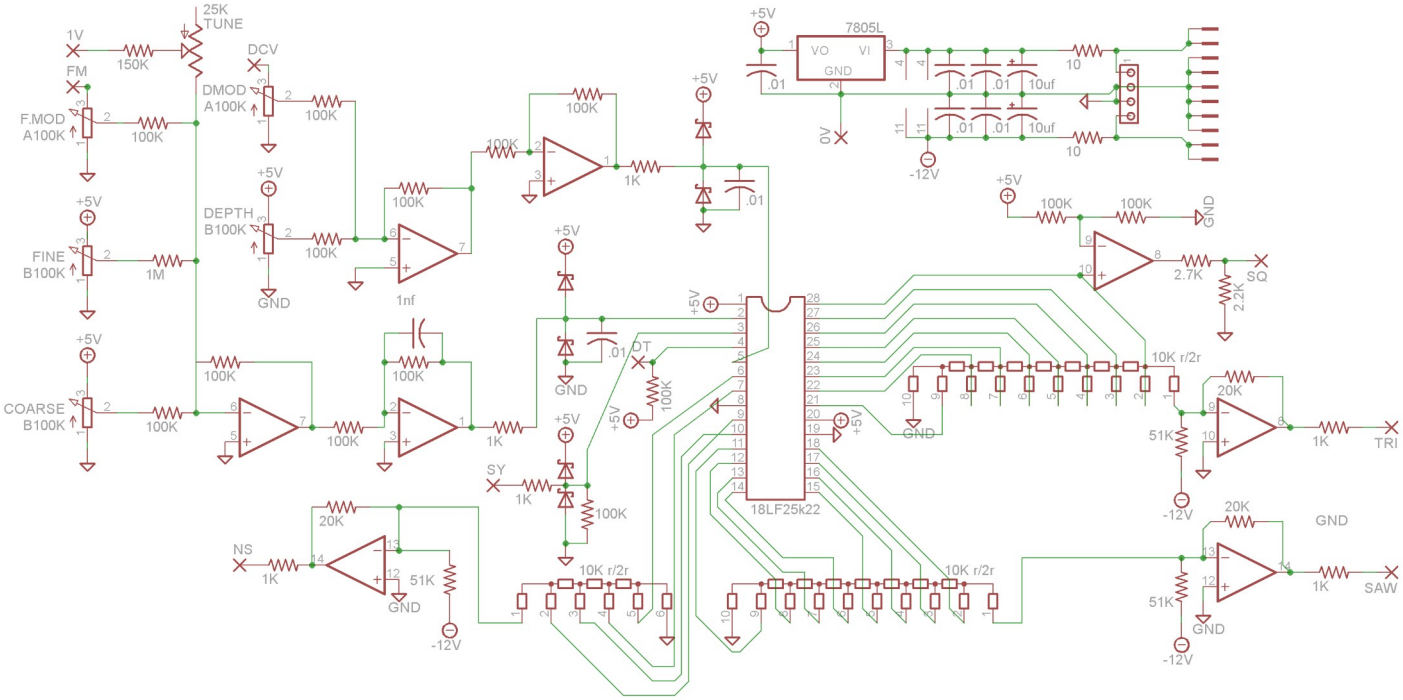
1. 1Volt/Octave input – Input a 1v/o CV signal here to control frequency of the module. The module responds to a range of 1V/O signals from 0V to +8V.
2. Freq CV input – Input a signal to modulate the frequency. Modulating with frequencies over 1.5Khz will have little effect.
3. Depth CV input – Input a signal to mdoulate the bit depth.
4. Sync input – Input a saw, square or pulse waveform here, the output will syncronize to the input signal.
5. Noise output – 4-bit digital noise is output here, it responds to the frequency control, but not the depth control.
6. Square output – Square wave signal is output here. The Square output is just the most significant bit of the saw signal.
7. Saw output – Saw waveform output.
8. Triangle output – Triangle waveform output.

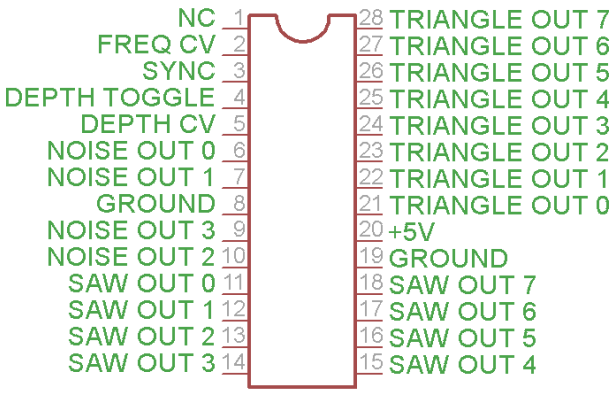
DEMOS.

Waveforms – I adjust the frequency and depth knobs on the module and switch between outputs. The depth toggle is low at the start and high at the end.

Depth Envelope Modulation – I use an envelope generator to modulate the bit depth with a saw wave, first with the toggle down, then up.

II. Schematic





Above is the schematic for this module. At the center of the module is an 18LF25K22 PIC microcontroller. The pinout for that is to the right.

The 1V/O input is at the top left, it's attenuated by a 150K resistor in series with a 25K trimpot. Adjusting this trimpot will control the tuning of the 1V/O signals by attenuating the signal down to the appropriate size.

The coarse and fine frequency knobs are wired the same, except the fine uses a 1M mixing resistor instead of a 100K. These mix with the voltage from the frequency CV knob and the 1V/O input at an inverting op-amp used as an active mixer, but which will output a negative signal. A 2nd op-amp inverts the signal back to positive, and this also has a 1nf capacitor in its feedback path which forms a low pass filter to keep higher frequencies out of the CV signal that might create errors in the analog to digital conversion. The output of that op-amp has it's voltage limited to the 0 to +5V range by a pair of schottky diodes and a 1K resistor. A .01uf capacitor at the CV input pin of the PIC provides some ifnal filtering.

The Depth CV and Depth control are wired in the same way using two op-amps as a mixer. The depth toggle input wirepad connects to a pin on the PIC and a pull up resistor setting the pin +5V until the toggle grounds the pin out.

The sync input goes through a 1K and two schottky arrangement for voltage limiting like the other analog inputs.

The Noise, Saw and Triangle outputs all work the same way. The pins on the PIC form a parallel output with each pin providing one bit of data. 10K R/2R resistor arrays turn these parallel digital signals into analog signals, and an inverting op-amp with a 51K resistor to -12V will amplify the signal up to +/-5V range centered at 0V. The Square output is simply a comparator using the most significant bit of the saw output as its input.

III Construction

A.PARTS LIST

SEMICONDUCTORS

Name/Value	QTY	Notes
18LF25K22	1	Should have come with your PCB
TL074	2	Or any quad op-amp with the same pinout
78L05	1	TO-92 +5V regulator
Schottky Diode	6	Like BAT-46 or 1N5817 any small schottky should be fine

RESISTORS

Name/Value	QTY	Notes
10	2	1/4W metal film for all resistors unless noted
1K	6	
2.2K	1	
2.7K	1	
20K	3	
51K	3	For +/-15V systems will need to be replaced. Not sure exact value, but I'd try 68K to start.
100K	14	
150K	1	
1M	1	
10K R/2R Array 6-pin	1	SIP array like this
10K R/2R Array 10-pin	2	SIP array like this
25K trimpot	1	3296W package
B100K pot	3	Either 9mm or 16mm PC mount package. My Eurorack panel layout is for 9mm pots
A100K pot	2	Either 9mm or 16mm PC mount package. My Eurorack panel layout is for 9mm pots

CAPACITORS

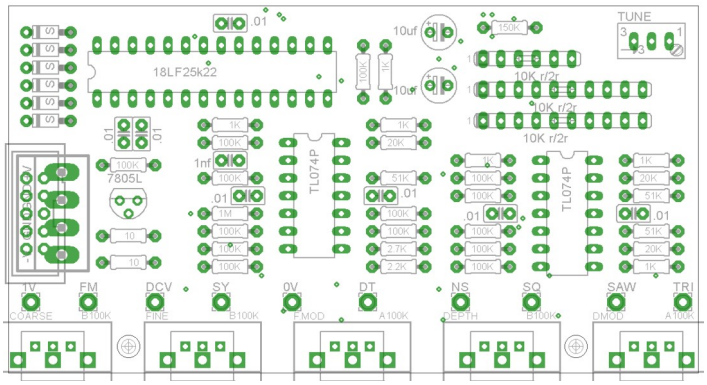
Name/Value	QTY	Notes
1nf	1	Ceramic disc
.01uf	7	Ceramic disc
10uf	2	Electrolytic

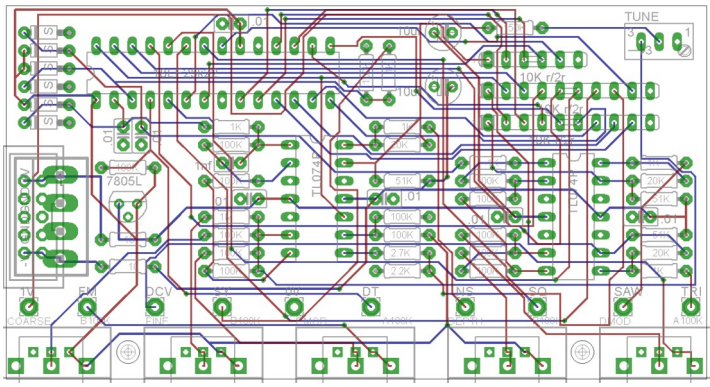
OTHER

Name/Value	QTY	Notes
3.5mm Jack	8	
SPDT Toggle	1	Or SPST
Power connector	1	
28 pin DIP Socket	1	
14 pin DIP socket	2	

B. THE BOARD

Below are renderings of the PCB, both with and without traces present. The PCB is 99mm x 53mm and the pots are spaced 21.6mm apart.





C. Wiring.

Wirepads should be connected as follows:

1V – 1V/O input, tip of jack

FM – Frequency CV input jack, tip of jack.

DCV – Depth CV input jack, tip of jack.

SY – Sync input jack, tip of jack.

0V – Ground, top lug of depth toggle and sleeve of any jack.

DT – Center lug of Depth toggle

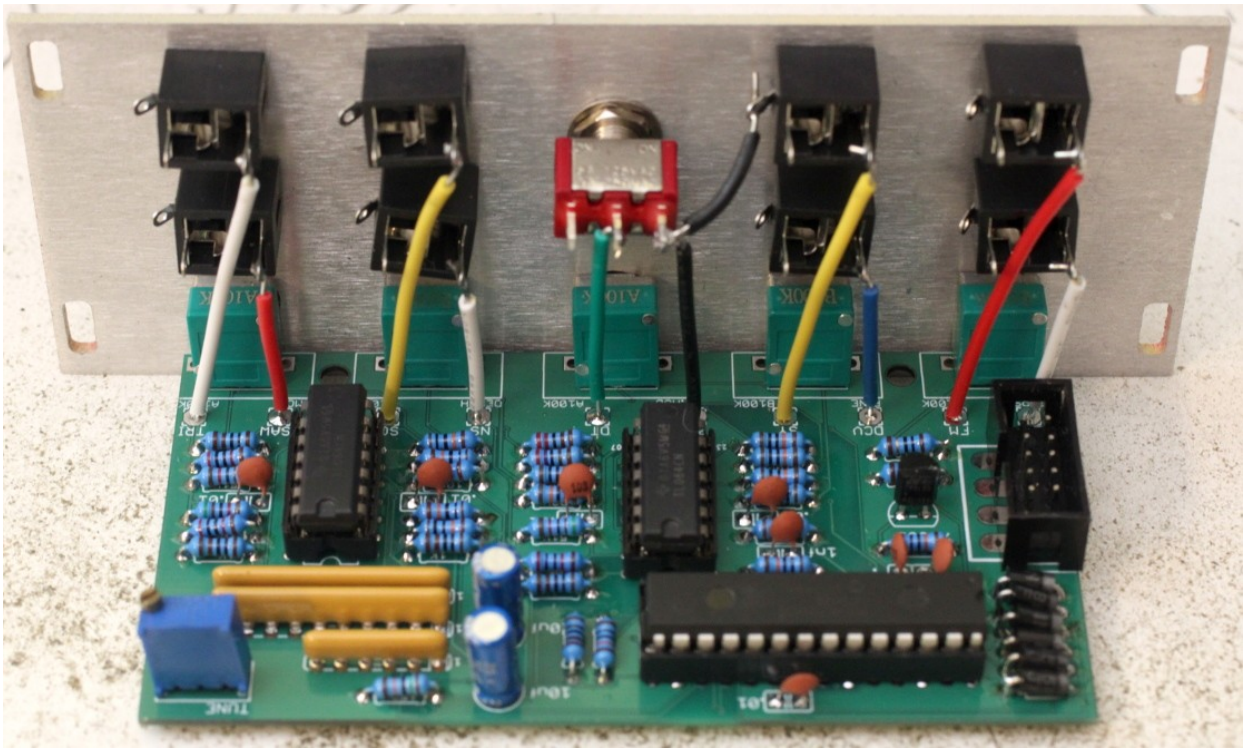
NS – Noise output jack, tip

SQ – Square output jack, tip

SAW – Saw output jack, tip

TRI – Triangle output jack, tip.

Below is an image of a wired module.



TO CALIBRATE.
To calibrate this module you'll need a controlled voltage source like a keyboard with a CV output, a Midi-to-Cv converter (like BMC108) or a module that provides preset offsets (like BMC089).

Additionally, you'll need a way to monitor the frequencies of the module's output like a tuner or a DAW or just a good internal sense of pitch.
1.Center the coarse and fine frequency knobs on the VCO. Patch in your voltage source and patch out the Saw to your DAW, tuner or amplifier. Adjust the depth knob until it's a frequency that your tuner is able to easily track.
2.Adjust the frequency knobs until you're centered on a pitch. If your tuner is telling you, you're slightly sharp of being at D3, turn the fine knob down until the tuner is showing exactly D3. This is your "starting pitch"
3.Go up exactly 1 volt on your voltage source. On a keyboard this will be an octave. Adjust the TUNE trimpot until the tuner shows that you're at exactly an octave above your starting pitch (if it was D3, it should be at D4).
4.Go down exactly 1 volt on your voltage source. If you're not at exactly your starting pitch (D3 in the example), repeat steps 2 and 3. Each time you repeat you should get closer and closer to being perfectly in tune

The calibration is the same as BMC117 Simple Square VCO, the calibration for that module may be useful. It can be found here.