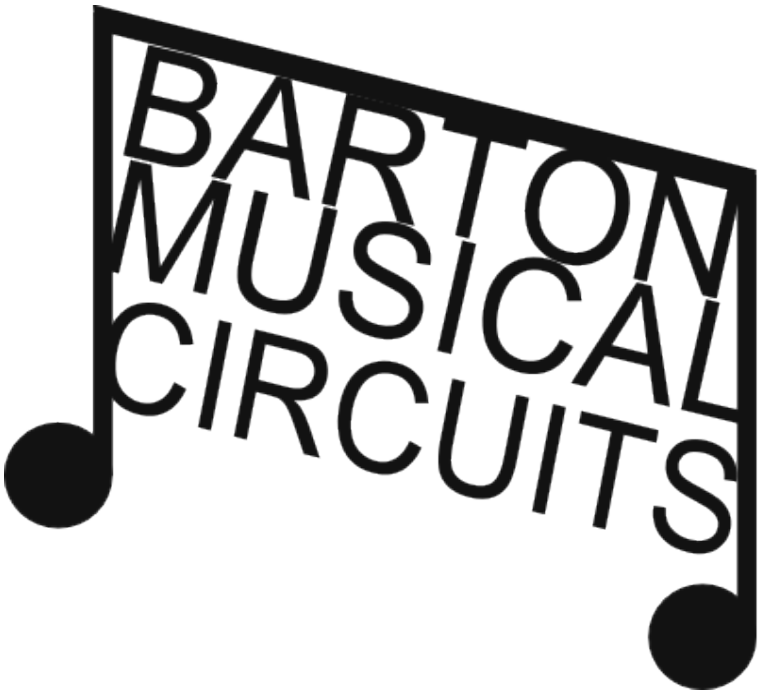


BMC116 Simple Square VCO

Last updated 8-24-2024

If you have any questions, or need help trouble shooting, please e-mail
Michael@Bartonmusicalcircuits.com

I. Overview/Features

This is a simple microcontroller based VCO. My design goal was to make a small 1V/octave VCO with minimal calibration that would be useful for beginners and those needing to quickly add more voices to their system. The VCO has a range of 18hz (D0) to 3770hz (A#7).

CONTROLS
1.Coarse Frequency Knob – This is the main frequency control, turning this knob will take you from the minimum frequency to the maximum frequency.
2.Fine Frequency Knob – This knob has 1/10th the control over frequency that the coarse knob does, allowing you to make very small adjustments to frequency.
3.Frequency CV Knob – This attenuates external control voltages that modulate the frequency.

INPUTS/OUTPUTS
1. 1V/O input – Control voltage input, increasing the input by a volt will double the frequency.
2. CV input – Control voltage input, this is attenuated by the frequency knob. Patch an LFO to this to create vibrato, a VCO for FM or an envelope for pitched percussion sounds.
3. Output – A square wave going from -5V to +5V

MP3 DEMOS
Pitch Sweep – I turn the coarse frequency knob up and then back down for you to hear the frequency range.
FM – I first turn the Frequency CV knob to show how deep pitch modulation can go, and then turn it back down to a reasonable level and adjust the frequency of the VCO being fed into CV input. The module has some filtering in the CV mixing circuit and at high frequencies it will start to ignore frequency modulation.

II. Schematic.

On the next page is the schematic for this project. The 12F683 microcontroller is the heart of this module. Pins 1 and 8 are its power connections going to +5V and ground. It's timing is set by a 20mhz crystal oscillator with two 22 pf caps going to ground on pins 2 and 3. Pin 7 is the frequency CV input pin.

At the top of the module are the various frequency controls and inputs. The Fine and Coarse frequency controls are simple potentiometers outputting a voltage from +5V to ground through their wipers, the difference is the value of the resistor that connects the wiper to the mixing node, the coarse control uses a 100K while the Fine uses a 1M. The Frequency CV knob is set up the same way as the coarse knob, but instead of attenuating +5V down to ground, it attenuates an external control voltage.

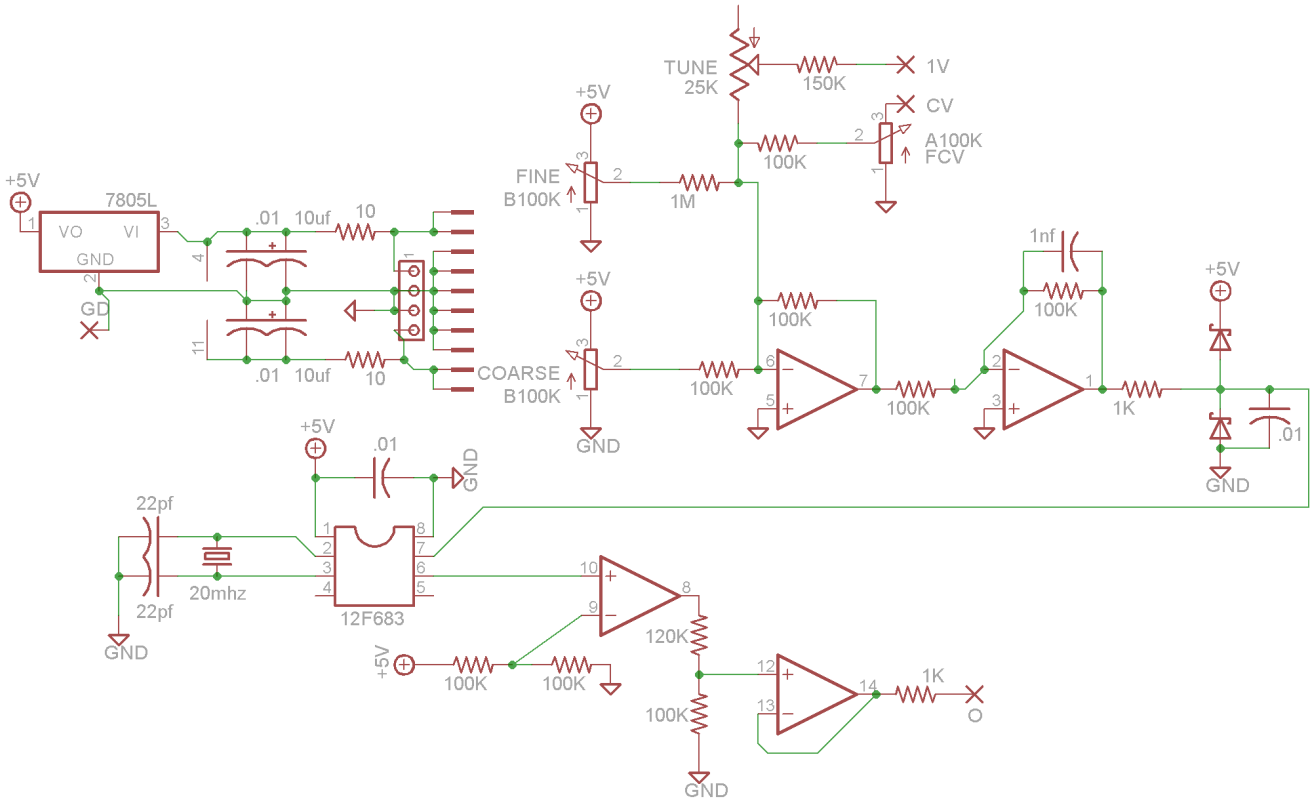
The 1V/O input is set up going through a 150K resistor and then a 25K trim pot set up as a variable resistor. These two resistors in series will add up to a resistance somewhere between 150K and 175K that perfectly tunes the module, usually around 165K, but will vary.

These voltages are summed together at a mixing node on pin 6 of the TL074. This op-amp is wired as an inverting amplifier with a gain of -1 and it feeds into a second op-amp wired with the same gain. The second op-amp also has a 1nf capacitor in its feedback which acts as an active low pass filter. This smooths out the tuning of the module, making it less sensitive to noise and power supply issues. The output of the 2nd amplifier then has its voltage range limited by the two schottky diodes going to +5V and ground which will short out voltages too positive or negative for the 12F683. The .01uf cap to ground acts as a 2nd filter.

The output pin of the 12F683 is pin 6 which connects to an op-amp wired as a comparator. This will output a +12V/-12V square wave, so it's output is attenuated by the 120K/100K resistor voltage divider down to a +5V/-5V square wave and then buffered by a final op-amp. The 1K resistor on the output protects against short circuits when patching.

The power connections are on the left hand side. The +5V supply is created locally by a

78L05 regulator. The +12V and -12V power rails are filtered by a 10 ohm / 10 uf passive low pass filter and additional .01uf capacitors are placed at the power pins of all ICs.



III. Construction

A.Parts List

Semiconductors

Name	Quantity	Notes
12F683	1	Comes with your PCB
TL074	1	14 pin DIP or any quad op amp with same pinout
7805	1	TO-92 package
1N60P	2	Or other schottky diode,

Resistors

Name/Value	Quantity	Notes
10 ohm	2	1/4W Metal film for resistors unless otherwise noted
1K	2	
100K	8	
120K	1	
150K	1	
1M	1	
25K Trim pot	1	3296W package
B100K Pot	2	9mm package like this
A100K Pot	1	9mm package like this

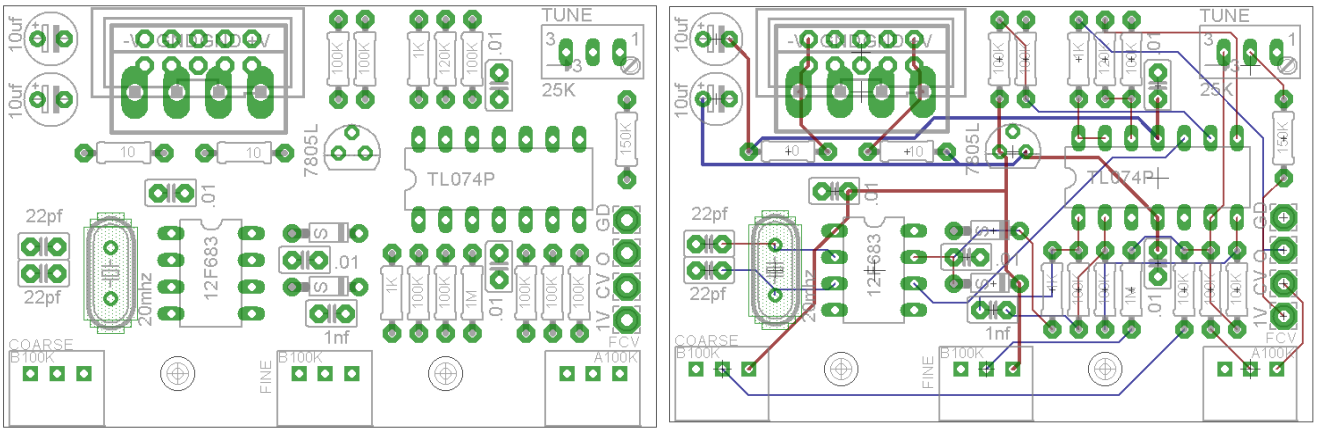
Capacitors

Name/Value	Quantity	Notes
22pf	2	Ceramic disk
1nf	1	Ceramic disk
.01uf	4	Ceramic disk
10uf	2	Eletrolytic

Other

Name/Value	Quantity	Notes
20Mhz Crystal	1	HC-49 Package
Power connecter	1	Eurorack or MOTM
Jack	3	
8 pin DIP socket	1	
14 pin DIP socket	1	
Knob	3	

B. The PCB

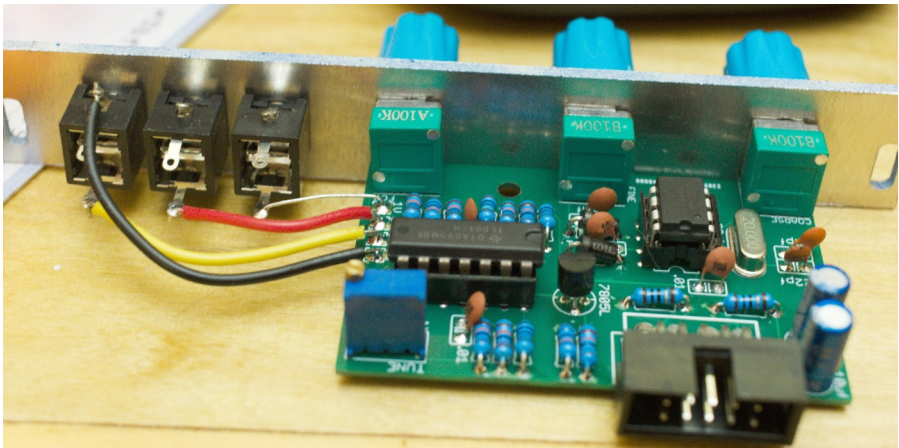


Above are renderings of the PCB with and without traces shown. The ground plane isn't shown, so some empty pads are connecting to ground. The PCB is 62mm x40mm. The pots are spaced 25.4mm apart and the mounting holes are 25.4mm apart from each other.

C. Wiring

GD – Ground wirepad. Connect to the sleeve of any jack if using a metal panel. If using a non-conductive panel, wire the sleeves of all jacks together and then connect to ground.
1V – 1 Volt/Octave input, connect to the tip of the 1V/O input jck.
CV – Connect to the tip of CV input jack.
O – Output, connect to the tip of the output jack.

To the right is a completed module for reference.



D. Calibration.

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. Tuning is usually easier when not dealing with very or very low frequences. Patch in your voltage source and patch out to your DAW, tuner or amplifier.
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.