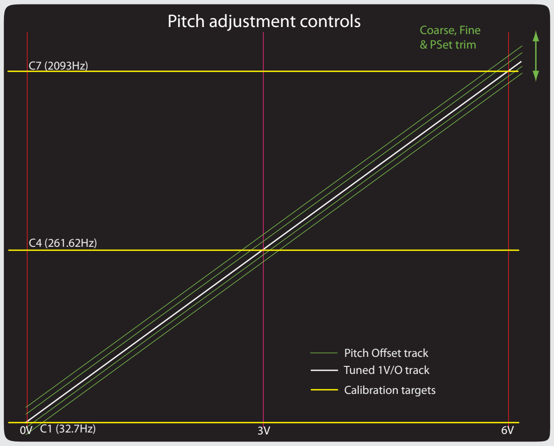
VCO 2 Calibration

Page 1

(The vertical axis on these charts are a logarithmic scale)

Graphic views of the pitch related controls and calibration trim adjustments



Pitch change controls:

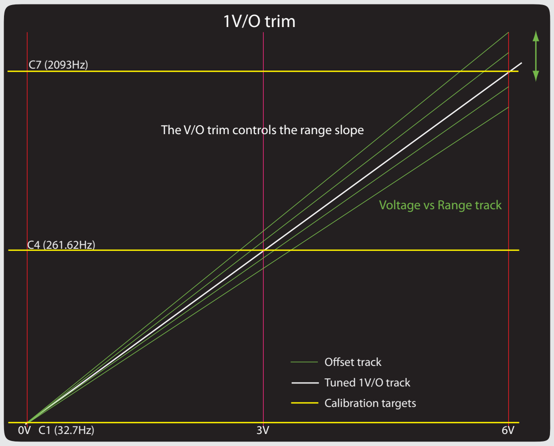
The **Coarse, Fine Tune** panel controls, **1V/O in, Mod in** CV inputs and the **PSet trim pot** all vary the pitch of the VCO up and down without changing the tracking scale.

The **Octave switch** performs the same task. But, it provides the pitch changes in one octave jumps rather than continuously.

All of the voltages that change the pitch, with the exception of the **Octave Switch**, sum to a single point at **U7, Pin 1** before being processed by the exponential converter.

Pitch is an exponential function, doubling in frequency for each octave increase. (conversely, cut in half for each octave decrease).

The graph on the left is pitch shown as a linear function. Assume that the background is a logarithmic scale...



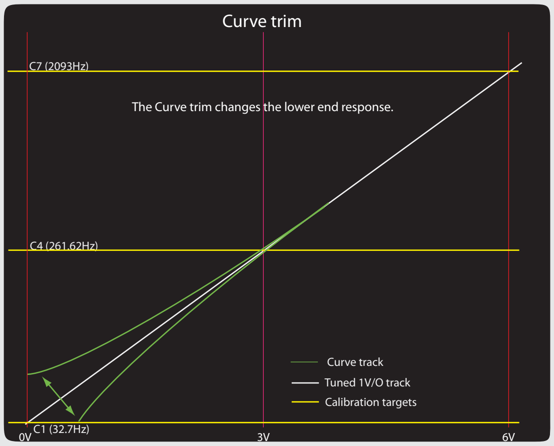
1Volt/Octave (1V/O) trim function:

The **1V/O trim** (R23, 100K multi-turn trim pot) is in line between the **1V/O input jack** and the summation node with the rest of the pitch change controls.

The **1V/O trim** changes the gain ratio into the summation amplifier (**U7-A),** changing the amount of pitch change at the top end of the range. while not affecting the 0V base setting.

There is nothing mystical about 1V/O. It's just a current "standard" for controlling a VCO range scale. Some early manufacturers chose 1.2V/O for CV control of a VCO pitch. You can see by the graph that any scale can be set by adjusting the V/O trim... within the limits of the trim pot range...

The 1V/O trim acts just like the Mod in control by limiting the range of the input CV. But, it's designed to be precise and not subject to operator adjustment during normal use.



Curve trim function: R17

The **Curve trim** (R17, 10K single-turn trim) changes the biasing balance on the final amplifier of the exponential converter network prior to the VCO core.

It changes the exponential curve function by altering the low-end curve of the V/O scale.

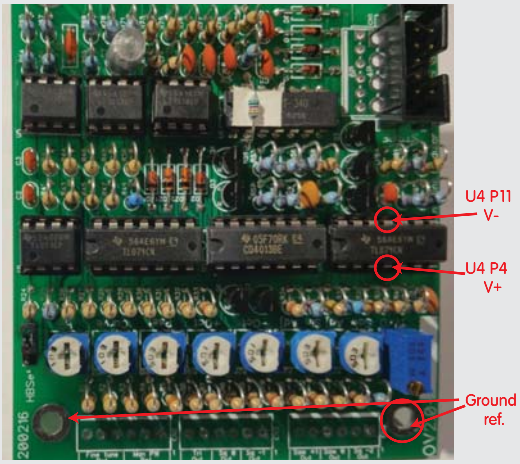
It's important to know what these controls do in order to understand why the following calibration procedure is performed in the order it is presented.

As you can see, we can change the entire range up and down with the pitch related controls. We can alter the top-end range with the V/O trim and we can change the bottom-end portion of the response curve with the Curve trim.

Basically, we have the control to make it do weird pitch related responses. Or, we can set it to respond to a 1V/O CV input. Since that's our goal, let's do that!

VCO 2 Calibration

Calibrating the VCO



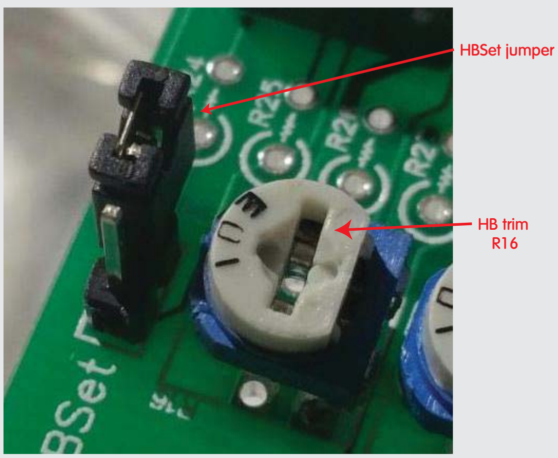
Setup and initial checks:

Connect the panel controls and I/O as described in the **VCO 2 DIY Panel Wiring** instructions.

Take the time to double check the board and wiring for proper installation of the parts, the parts are the correct values and making sure all of the solder connections are good with no solder bridges.

Disconnect anything plugged into the jacks, leaving them open and set the panel controls as follows:
Center: Oct switch, **Coarse**, **Fine** and **Man PW** controls.
Set ful CCW: PWM amt and **Mod amt** controls.

Power the VCO. Using a DC Volt meter, measure between one of the corner grounds and **U4, pin 4**. You should see the power supply voltage less around a volt.
Measure between ground and **U4, pin 11.** You should see the negative voltage present plus about a volt.
If the voltages check out, proceed to the next step.



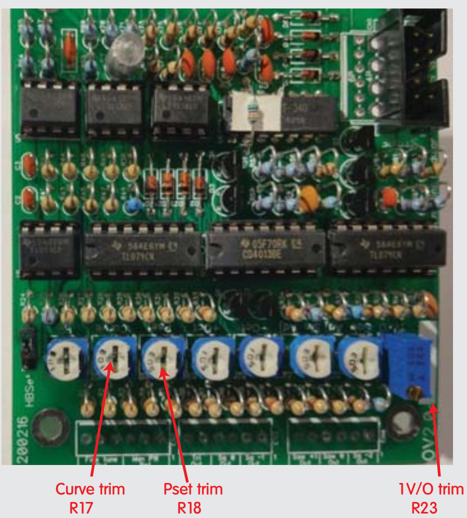
Setting the heartbeat:

Once the power is verified, Patch a pair of headphones into the triangle output jack. Or, patch the triangle output into an amplifier. Adjust the volume to a comfortable level. You should hear a tone.
Once you hear a tone, move the headphones or amplifier patch cable to the other waveform outputs just to verify that you have a tone output from them. The saw+1 will be an octave higher, the square-1 wil be one octave lower and the square-2 will be two octaves lower than the other waveform outputs.
Return to monitoring the Triangle waveform output.

The **HBSet** jumper grounds the CV input to the VCO core. The VCO has a linear response. Once the HBSet jumper is installed across both pins, it essentially disables any CV inputs and any offsets generated by the exponential converter circuitry. **Place the shorting bar across both pins of the HBSet jumper.**

Adjust the **HB trim (R16**) with a small screwdriver until the pitch drops to a click every one to two seconds.

This is adjusting the linearity of the VCO. When complete, remove the jumper and store it back on one of the HBSet header pins.



Calibrating the 1V/O response

You will need the following items to perform the 1V/O calibration:
* A 1V/O CV source (a keyboard w/MIDI/CV) capable of 6 octaves C1-C7.
* A tuner. I like PitchLab. It's a free app that can be downloaded to a smart phone.
* A small screwdriver for turning the trim pots.

1- Apply a **C1 (0V)** to the **1V/O in**put jack. Adjust **Pset** trim until the pitch is **C1 (32.7 Hz)**
2- Apply a **C7 (6V)** to the **1V/O in**put jack. Adjust **1V/O** trim until the pitch is **C7 (2093 Hz)**
3- Apply a **C4 (3V)** to the **1V/O in**put jack. It should be close to **C4 (261.6 Hz)**
If the **C4 Pich is sharp**, adjust the **Curve trim (R17) to make the pitch a bit MORE sharp.**
If the **C4 Pitch is flat,** adjust the **Curve trim (R17) to make the pitch a bit MORE flat.**
Note: *Make slight adjustments to the Curve trim. Large adjustments are bad...*
Repeat steps 1-3 until all 3 target points are in tune (C1, C7 and C4).
After the first step 1, You can use the panel **Fine** tune control to adjust the **C1** pitch.
Once the calibration is complete, center the Coarse and Fine pots and adjust the **Pset** trim to C1.

Why is this procedure such a PITA??

If you refer to page 1. Adjusting C1 is moving the entire range up or down. Adjusting the 1V/O is changing the range. Adjusting the Curve is changing the bottom end while you're monitoring the center point. So, you have to reset the bottom pitch and the top end slope in order to verify the center C4. I've had some pop right in and had to wrestle others.

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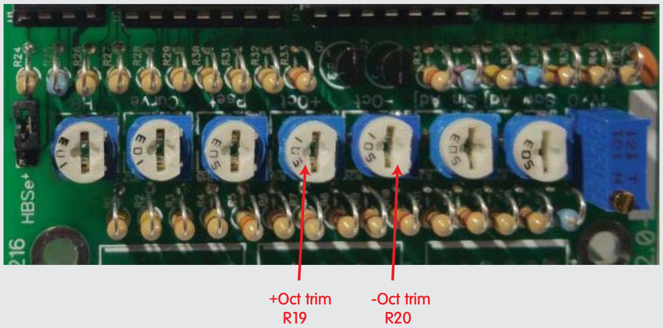
Calibrating the VCO

Notes about the 1V/O calibration:

Make sure that the **Curve trim (R17)** is centered before you start.
If the **V/O trim (R23**) can't reach C7 (2093 Hz) after turning R23 fully CW or CCW once C1 is set, the Curve trim was probably adjusted too far. Also, re-check the heartbeat.

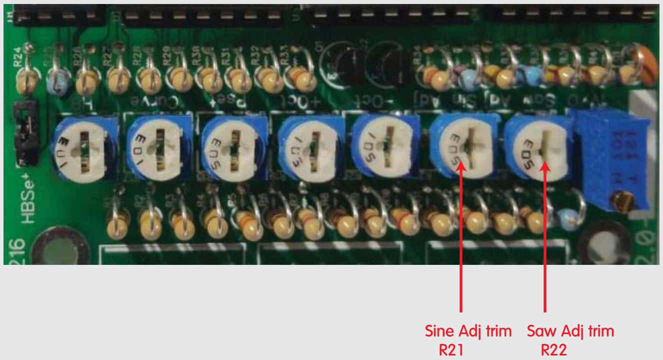


+/- Octave calibration:

Place the VCO panel octave switch in the center position and adjust the pitch to any frequency.

Place the octave switch in the plus octave position. Adjust +Oct trim (R19) until the pitch is one octave higher.

Place the octave switch in the minus octave position. Adjust -Oct trim (R20) until the pitch is one octave lower.

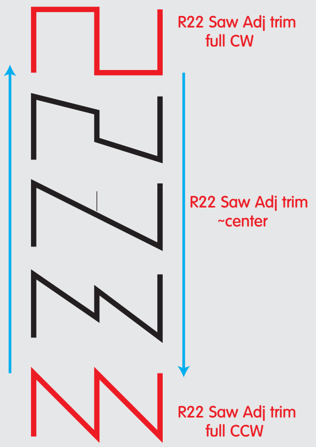


Sine adjustment: R21

The **Sine Adj (R21**) trim balances the weighting of the positive and negative transitions of the sine generator.

Monitor the Sine output and adjust for the "purest" tone. Or, monitor with an oscilloscope and adjust for upper and lower waveform symmetry.

Saw adjustment: R22



The **Saw Adj (R22)** trim is a waveform mixer trim that merges the double saw and square waveforms.

Basically, it's just simple waveform mixing in order to provide a sawtooth waveform at the root frequency for the user.

The VCO generates the double saw waveform naturally. That waveform is applied to the CCW terminal of R22. The square wave is applied to the CW terminal of R22.

As R22 is turned from full CW to full CCW, the waveforms mix, sloping the upper and lower peaks of the square wave toward the 0V point. Half way through the transition, the ends meet, creating a sawtooth waveform at the root frequency.

To adjust, start at the full CCW position of the double saw and turn clockwise until the pitch drops an octave. Or, monitor with an oscilloscope until it becomes a sawtooth.

Of course, it can be adjusted anywhere in between as desired.

When adjusted as a sawtooth waveform, there may be a vertical artifact in the center of the waveform. It is caused by component tolerances and inherent thermionic activity in the circuit.