The Circuit Slices **Dual Parallel VCO** combines two oscillators in one narrow module for Eurorack-compatible synthesizers. The 12HP width makes it smaller than most single VCOs. It is pre-patched, or normalled with the VCOs controlled in parallel; the FREQ knob controls both VCOs while there are two independent fine-tune controls (FINE 1 and FINE 2). This allows overall pitch adjustment while retaining an interesting interval or modulation effect between the two VCOs. You may also supply separate pitch control voltages to each VCO individually, but the PWM and FM inputs always go to both VCOs. See the functional block diagram for this module at the end of this manual. The VCOs are high quality, matched-transistor, temperature-compensated type with triangle, sawtooth and pulse outputs. It makes cool thick sounds for just one narrow module.

Specifications for the Dual Parallel VCO, part number CS023
Eurorack format
Standard one-volt-per-octave pitch control
Over 10V control range
Frequency range for VCO 1 and VCO 2: less than 10Hz to over 15KHz
Typical pitch tracking errors for 10 octaves:
- 0% error for first 4 octaves
- Less than 1% error for next 4 octaves
- Less than 2% error up to the 10th octave

Outputs: Sawtooth, Triangle, Pulse
Output levels: 10Vp-p (+/- 5V)
Power: +12VDC @ 52mA, -12DC @ 52mA
12 HP, Depth from front panel: 1.55"

Features for the Dual Parallel VCO, part number CS023

- Narrow width
- Incredibly fat sounds for one small module
- Modern SMT design for small footprint and decreased cost

High quality VCOs:

- Matched-transistor pair oscillator design (triangular-type core)
- VCO cores use high-performance, low noise, zero drift, op-amps (OPA series or similar)
- Each VCO is temperature-compensated (TEMPCO) for frequency stability
- Oscillators track up to 10 octaves

Six inputs:

- **1V / octave 1** for VCO 1
- **1V / octave 2** for VCO 2*
- **FM 1, 2** frequency modulation for both VCOs
- **PWM 1, 2** pulse with modulation for both VCOs
- **Sync 1**
- **Sync 2**
  *Note that a signal or CV patched to VCO 2 is "Normalled" with VCO 1
  CV patched into "1V / oct 2" only, controls both VCOs
  CV patched into "1V / oct 1" separates the two VCOs into independently controllable oscillators

Six outputs:

- 2 Triangle,
- 2 Sawtooth,
- 2 Pulse
  (Outputs can be passively summed using "stackable" cables or a passive "multiple")

Controls:

- **FREQ** knob controls course pitch for both VCOs
- **FINE 1** and **TUNE 2** knobs fine-tune the VCO pitch separation over two octaves
  (Adjust FINE controls for a given interval and it tracks as the FREQ control is adjusted)
- **PULSE WIDTH** knob controls the initial pulse width of the pulse output
- **PWM** knob controls the amount of pulse width modulation applied to both VCOs
- **FM** knob controls the amount of modulation (lin or exp) to both VCOs
- **VCO 2 RANGE** switch lowers the range of VCO 2 for greater separation between the two oscillators
- **FM MODE** switch selects between Linear and Exponential frequency modulation

AC or DC FM coupling is PCB jumper selected using shorting header J14, located on the upper right edge of the base board. For DC coupling move the shorting jumper between the center

pin of J14 and the pin close to the text, "DC". Short between the center pin of J14 and the pin near "AC" for AC coupling. AC coupling prevents an average pitch-shift when using an FM signal with a DC component.

Installation

The module is ready to install in your Eurorack case. Simply mount the panel using the supplied screws and route the ribbon-cable power connector to your power bus.
Be careful making the connection to your power bus and double check your connection before applying power. The red stripe on the ribbon cable must be toward the -12V pin on the power bus.
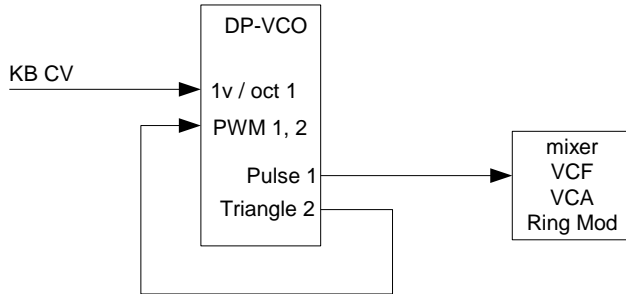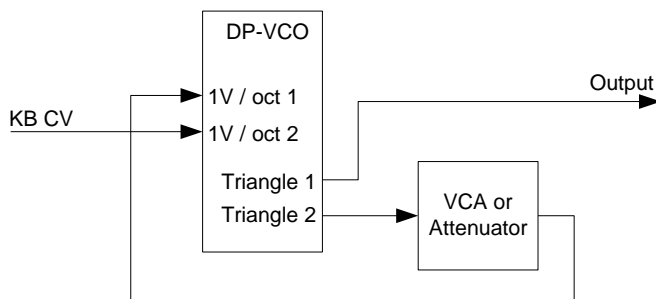
Patch Ideas
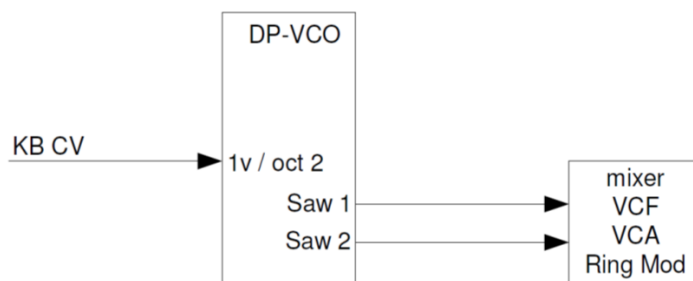
Patch a CV from a keyboard, sequencer or MIDI-CV to the "1V / oct 2" input. This will route the CV to both internal VCOs. Adjust the FINE controls for unison, octave apart, 1/5th, etc. If patching to the two inputs of a ring modulator, try using the triangle outputs from the Dual VCO.
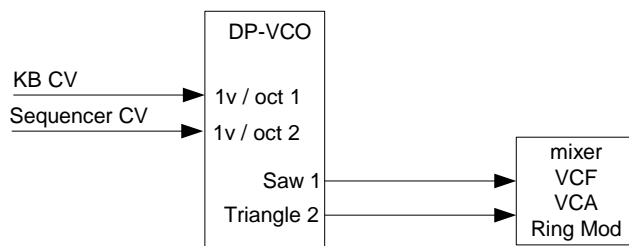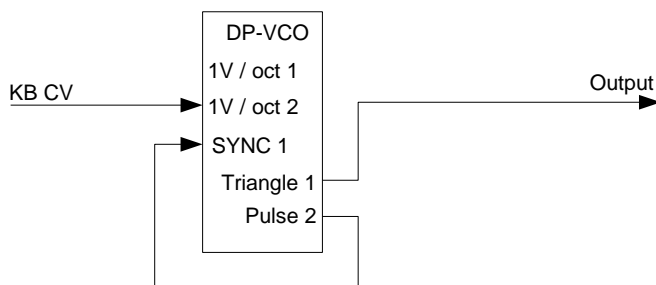

Try using the VCOs separately, patching a keyboard CV to input 1 and a sequencer CV to input 2. Use a sawtooth output for the "lead keyboard" sound and set the VCO 2 RANGE switch to low for a bass line from the sequencer. Also, try adding an external LFO output to the FM 1, 2 input with the FM MODE switch set to "lin" for vibrato to both VCOs.

```
        DP-VCO

KB CV   1v / oct 1

        PWM 1, 2                        mixer
                                        VCF
        Pulse 1                         VCA
        Triangle 2                    Ring Mod
```

Use the VCO 2 output to modulate the pulse width of VCO 1.

```
        DP-VCO
                              Output
KB CV   1V / oct 1

        1V / oct 2

        Triangle 1
        Triangle 2          VCA or
                          Attenuator
```

Try modulating one VCO with the output of the other VCO. Remember that the "FM 1, 2" input will control both VCOs, but you can still send one VCO output to the other VCO independently, by using the "1V / oct" input. Try using a VCA or attenuator to control the level of the signal going to the modulated VCO. An ADSR patched to the VCA will control the percent of modulation over time.

```
        DP-VCO
        1V / oct 1
                              Output
KB CV   1V / oct 2

        SYNC 1
        Triangle 1
        Pulse 2
```

You can get some very interesting sounds using the SYNC inputs. Here the VCO 2 output hard-synchronizes VCO 1. Note that the input control voltage is going to both VCOs. Carefully adjust the TUNE controls and apply just a little LIN FM, with some portamento from your keyboard, to make some almost vowel-like sounds. Pretty cool for such a simple patch!

Of course, this just scratches the surface of patches you can try with this module. Have fun and let us know of any interesting patches that you are willing to share.

Calibration

The two VCOs are on separate PCBs that plug into 26-pin header sockets. Each board has multi-turn trimmers. P1 is adjusted for a 1-volt-per-octave pitch response. P3 is used to adjust the shape of the sawtooth output. This module ships factory calibrated. If it becomes necessary to adjust one or both oscillators, a frequency counter and oscilloscope will be needed. Adjust P1 for a one octave shift from 100Hz to 200Hz for a 1 volt control voltage change. Then adjust the FREQ control to 2000Hz and make an increase in the CV by 1 volt for a change to 4000Hz. You may have to compromise a little to get it tuned over the entire range. The oscillator pitch may become a little "sharp" or "flat" as you go above the musically useful range (8 kHz) but will still respond, increasing up to 15KHz. Adjust P3 so that the sawtooth output displays a smooth ramp on your oscilloscope.

The FINE controls were designed to give the most range and still retain enough sensitivity to tune an interval between the two VCOs. So, you may find the FINE controls a little more 'course' than you would expect, but still easy to adjust. For more pitch separation between VCOs, select "low" at the "VCO 2 Range" toggle switch.

Output Impedance

Each output includes a series 1K ohm resistor, like classic VCO designs. While not really necessary for output protection with today's op-amps, the resistors make it possible to passively add two signals together using "stackable" cables or a passive "multiple". This means you can patch two outputs into a single VCF or VCA input, without needing to use a mixer. Try combining different waveforms for interesting timbers.
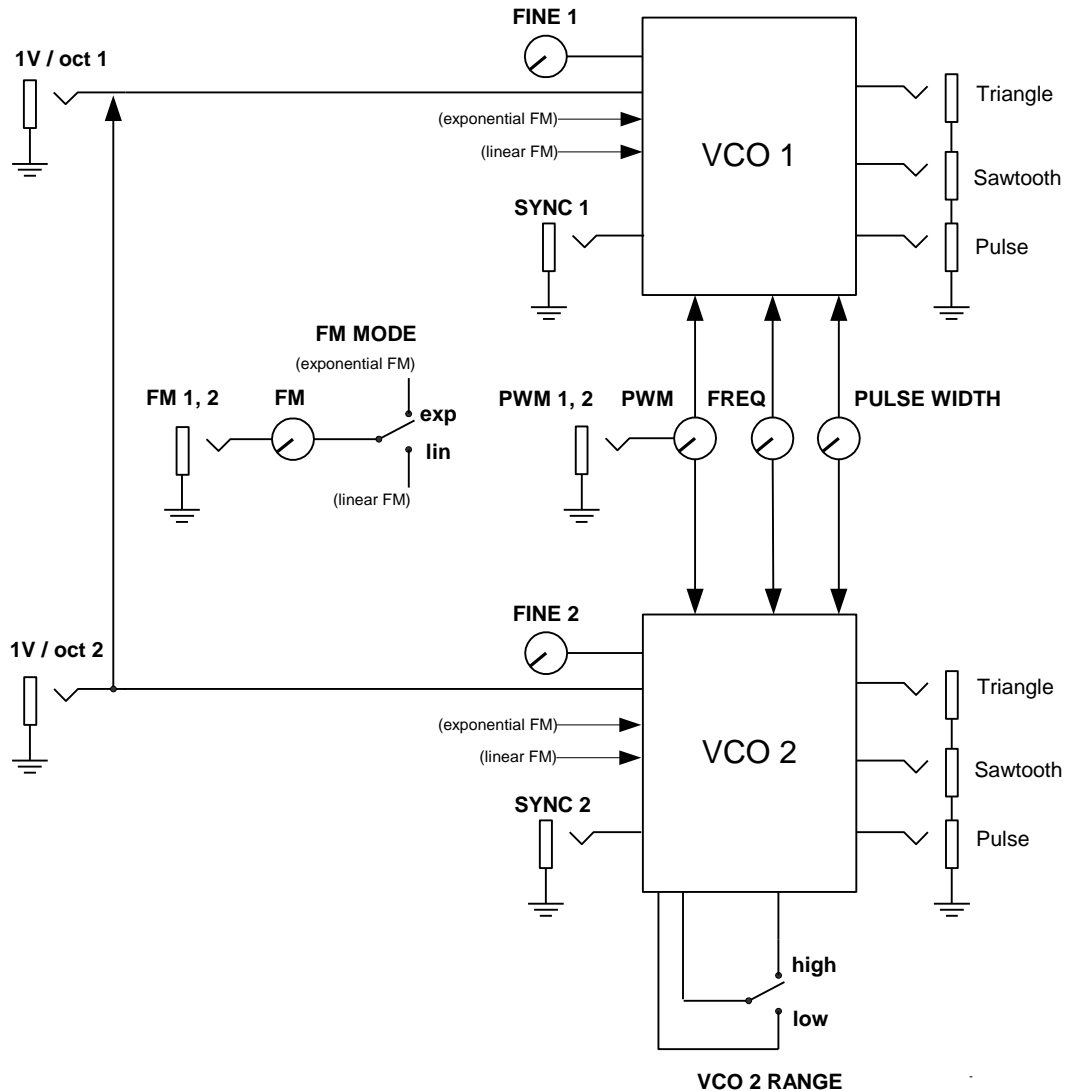
Block Diagram of the Dual Parallel VCO

This module is warranted for one year with parts, under normal use – not including the application of reverse or over-voltage power by the customer. Return shipping to Circuit Slices from customer not included. Return to Circuit Slices, LLC for repairs. Circuit Slices, LLC reserves the right to replace the module if necessary. Please keep your receipt / packing slip for warranty information.

Circuit Slices, LLC
10028 Windjammer Trail
Aurora, OH 44202