dPO

MAKENOISE

v2.6

DPO

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Limited WARRANTY:

Make Noise warrants this product to be free of defects in materials or construction for a period of one year from the date of purchase (proof of purchase/invoice required).

Malfunction resulting from wrong power supply voltages, backwards or reversed eurorack bus board cable connection, abuse of the product, removing knobs, changing face plates, or any other causes determined by Make Noise to be the fault of the user are not covered by this warranty, and normal service rates will apply.

During the warranty period, any defective products will be repaired or replaced, at the option of Make Noise, on a return-to-Make Noise basis with the customer paying the transit cost to Make Noise.

Make Noise implies and accepts no responsibility for harm to person or apparatus caused through operation of this product.

Please contact technical@makenoisemusic.com with any questions, Return To Manufacturer Authorization, or any needs & comments.

http://www.makenoisemusic.com

About this Manual:
Written by Tony Rolando
Edited by Walker Farrell
Illustrated by W.Lee Coleman

THANK YOU
Beta Analyst: Surachai
Test Subjects: Rob Lowe, Joseph Raglani
Spiritual Advisor: Richard Devine

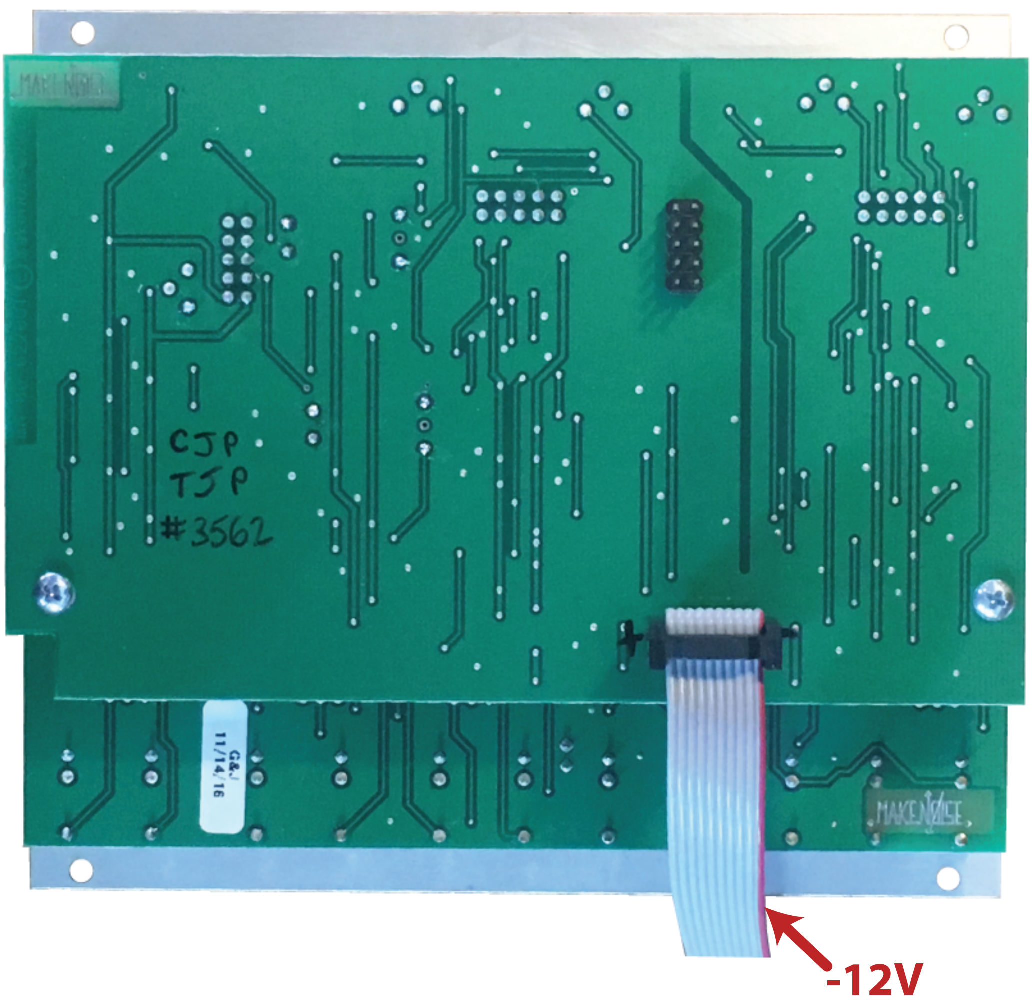
Electrocution hazard!

Always turn the Eurorack case off and unplug the power cord before plugging or un-plugging any Eurorack bus board connection cable.
Do not touch any electrical terminals when attaching any Eurorack bus board cable.

The Make Noise DPO is an electronic music module requiring 70mA of +12VDC and 70 mA of -12VDC regulated voltage and a properly formatted distribution receptacle to operate. It must be properly installed into a Eurorack format modular synthesizer system case.

Go to http://www.makenoisemusic.com/ for examples of Eurorack Systems and Cases.

To install, find 28HP in your Eurorack synthesizer case, confirm proper installation of included eurorack bus board connector cable on backside of module (see picture below), plug the bus board connector cable into the Eurorack style bus board, minding the polarity so that the RED stripe on the cable is oriented to the NEGATIVE 12 Volt line on both the module and the bus board. On the Make Noise 6U or 3U Busboard, the negative 12 Volt line is indicated by the white stripe.



Please refer to your case manufacturer's specifications for location of the negative supply.

Overview:

The DPO is a voltage controlled oscillator designed for generating complex waveforms and implementing FM synthesis within the analog domain. Expanding on the classic arrangement of Primary and Modulator Oscillators, the DPO has both of the VCOs operable as complex signal sources. It is in essence a Dual Primary Oscillator.

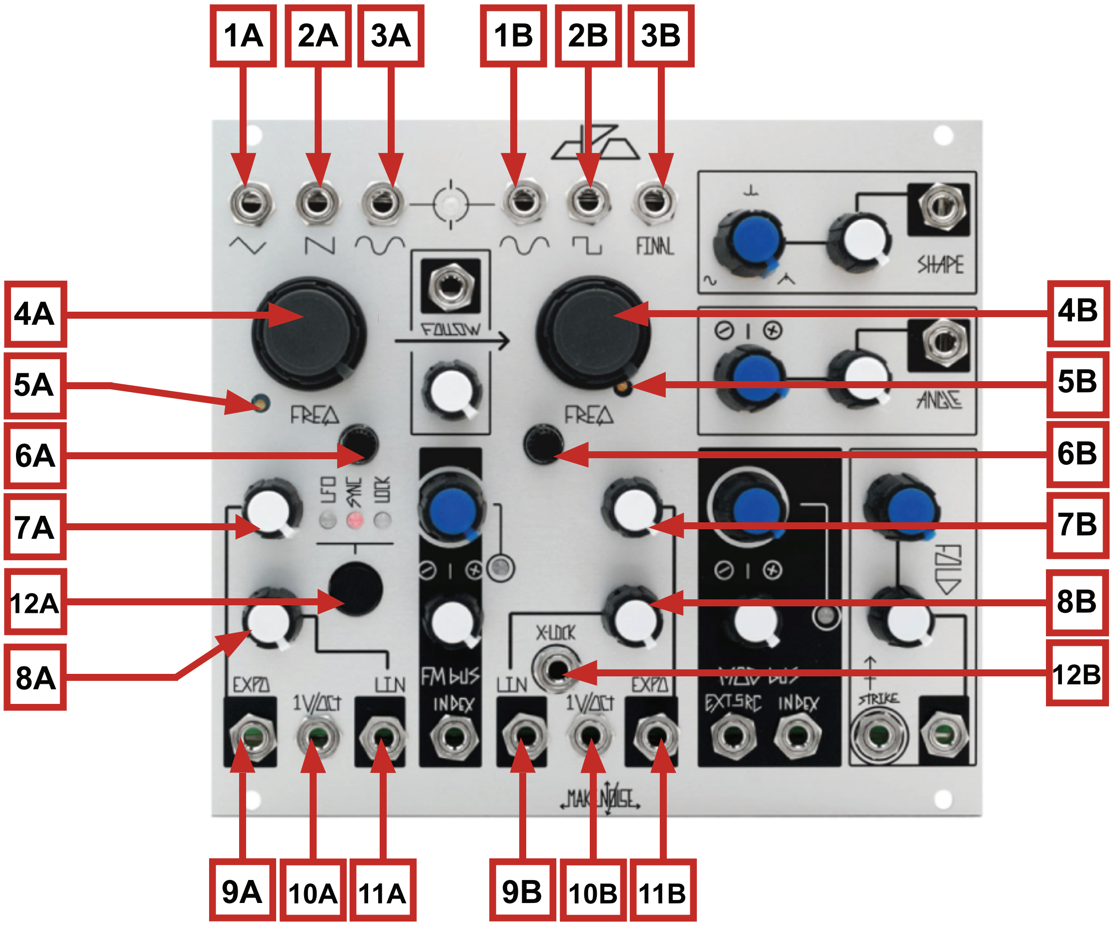
The DPO is also designed for fast live sound creation. The module groups functionality intuitively to make complex patching move more quickly, while still interacting in an exciting way with all other modules.
Dynamic FM, Circular FM, Hard Sync and Additive Harmonic synthesis processes are all achieved with internal routing on the DPO. The idea being that the artist will utilize patch cables to expand upon these standard concepts or interrupt them completely by simply patching into the associated modulation destinations.

The DPO has two modulation buses, each with multiple destinations, the depth of which is adjustable per destination. The original 259 style modulation routing is split within the DPO into dedicated FM and Mod buses and switching jacks are utilized to create internal routings that may be undone by patching an external signal to the CV inputs. The attenuator associated with the destination CV input sets the final depth while the Mod and FM Index controls act as the dynamic master depth controls.

Throughout the DPO opto-isolators, commonly called Vactrols, are utilized as gain cells, and the result is that the module have a slow and organic response to control signals. This manifests itself in the smooth crossfading and phase reversal of the Shape parameter, for example.

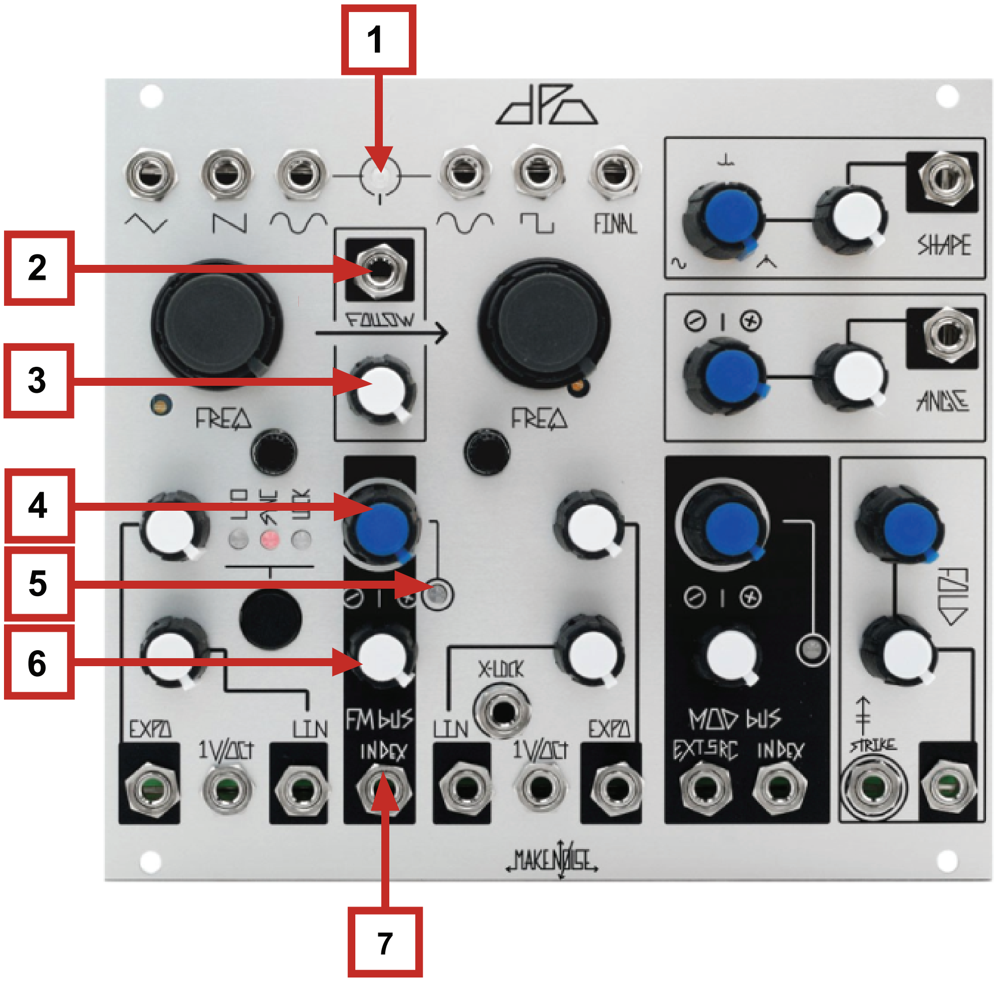
The DPO is a 100% analog, vintage voiced musical instrument and is not suitable for laboratory use.

Panel Controls:



VCO A
1A Triangle Waveform Output: 10Vpp
2A Sawtooth Waveform Output: 9Vpp
3A Sine Waveform Output: 10Vpp
4A Coarse Tune panel control: 9.5 octave range 12hz-6khz
5A 1V/Octave Scale Trimmer (Calibration Use Only)
6A Fine Tune panel control: 1.75 octave range
7A Expo Attenuator: uni-polar attenuator for Exponential frequency control input
8A Linear FM Attenuator: uni-polar attenuator for Linear FM input
9A Expo Input: Exponential frequency control input. normalled to FM Bus. bi-polar, 10V range
10A 1V/Octave control Input: bi-polar pitch control, optimal range +/-5V
11A Linear FM Input: AC coupled, normalled to FM Bus, 10V range
12A VCO core behavior (Indicated by LED): No LED: Standard, Blue: Phase Lock to VCO B; Pink: Hard Sync to VCO B; Amber: Low Frequency Oscillator.

VCO B
1B Sine Waveform Output: 10Vpp
2B Square Waveform Output: 9Vpp Asymmetrical
3B FINAL Waveform: max 10Vpp Waveform as processed by Shape, Angle & Fold circuits
4B Coarse Tune panel control: 9.5 octave range 12hz-6khz
5B 1V/Octave Scale Trimmer (Calibration Use Only)
6B Fine Tune Panel Control: 1.75 octave range
7B Exponential Attenuator: uni-polar attenuator for Exponential frequency control input
8B Linear FM Attenuverter: uni-polar attenuator for Linear FM input
9B Linear FM Input: AC coupled, normalled to FM Bus, 10V range
10B 1V/Octave control Input: uni-polar pitch control, optimal range +/-5V
11B Expo Input: Exponential frequency control input. normalled to FM Bus. bi-polar, 10V range
12B External Lock: allows VCO B to phase locked to hard edged signal (square, pulse or Sawtooth) from other VCOs.



VCO Interaction

1. Beat Frequency LED: visual indication of Phase difference between VCOs A & B.

2. Follow CV Input: unipolar control input. Range 0V to 5V.

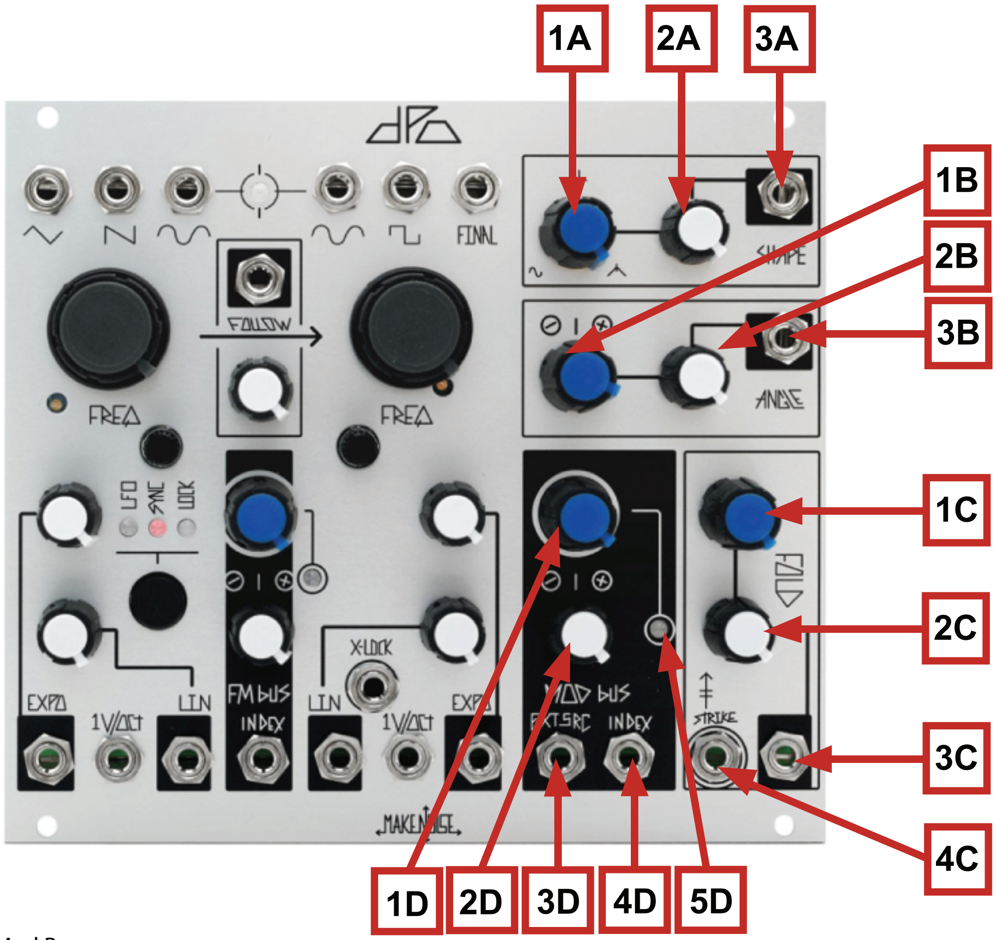
3. Follow Attenuator: determines how well VCO A Follows VCO B. With nothing patched to Follow CV Input works as standard panel control. With Signal Patched to Follow CV Input, works as an attenuator for that signal.

4. FM Bus Index: unipolar panel control that sets the index (depth) of the FM.

5. FM Bus Index LED: indicates the currently programmed FM Index Value.

6. FM Bus Index CV Attenuverter: bipolar attenuator for FM Bus Index CV Input.

7. FM Bus Index CV Input: bipolar control signal input. Range +/- 4V



VCO B Timbre Controls and Mod Bus

1A. Shape Panel Control: unipolar control that determines the shape of the waveform feeding the Folding circuit. Morphs from Sine to Spike to Glitched Triangle.

2A. Shape CV Attenuator: unipolar attenuator for Shape CV Input.

3A. Shape CV Input: unipolar control signal input. Normalled into the Mod Bus. Range 0V to +5V.

1B. Angle Panel Control: tilts the added harmonics to either end of the wave-cycle.

2B: Angle CV Attenuator: unipolar attenuator for Angle CV Input.

3B. Angle CV Input: bi-polar control signal input. Normalled into the Mod Bus. Range 8V.

1C. Fold Panel Control: unipolar control that continuously varies the low-order harmonics of the signal by folding the waveform into itself.

2C. Fold CV Attenuator: unipolar attenuator for Fold CV Input.

3C. Fold CV Input: unipolar control signal input. Normalled into the Mod Bus. Range 0V to +8V.

4C. Strike Input: briefly opens the Fold circuit to 100%, 8 to 10V Gate or clock.

1D. Mod Bus Index Panel Control: unipolar panel control that sets the index (depth) of the MOD Bus.

2D. Mod Bus Index CV Attenuverter: bipolar attenuator for Mod Bus Index CV Input.

3D. External Source Input: interrupts internal routing of VCO A Sine as modulation source. +/-8V range.

4D. Mod Bus Index CV Input: bipolar control signal input. Range +/- 4V.

5D. Mod Bus Index LED: indicates the currently programmed MOD Index Value.

On the DPO both VCOs are capable of generating complex and harmonically rich waveforms. This is accomplished through the use of FM and Hard Sync on VCO A, and FM and Timbre Shaping on VCO B.

FM Bus
The internal FM bus is hardwired for Sine wave in both directions and makes use of the Normalization Switch found on the mini-jacks, so with nothing patched to the Linear and/ or Expo FM inputs the associated attenuator sets the final index of FM applied to each destination. As you increase the Index Level, the Amplitude of VCO A Sine Bused to VCO B Linear FM and Expo FM attenuators is increased. At the same time the Amplitude of VCO B Sine Bused to VCO A Linear FM and Expo FM attenuators is increased. Therefore you could have different amounts of Linear and Expo FM in Both directions, all at once. At greater than 5:00 Index, all of the FM bus lines (Linear, Expo for both VCOs) go into overdrive when the associated attenua-tors are set to beyond about 80%. The FM overdrive combined with the Bi-Directional Dynamic FM results in some extreme Cross Modulation capabilities. These sounds get out of hand quickly. The key to controlled FM within the DPO is attenuation since setting the Index to 100% really does push the circuit to its limits.

VCO A core behavior
With none of the LEDs lighted VCO A operates as a Standard Triangle Core oscillator. When performing FM and Audio Rate modulations of Timbre parameters, there is a greater chance for error in the frequency ratios. This is not always a bad thing. These errors manifest themselves in a looser interpretation of the ratio programmed, making each note have subtle differences.

The Blue LED indicates Lock, an extremely-weak synchronization of VCO A to VCO B, where as VCO A's frequency approaches an integer of VCO B frequency, VCO A resets to match VCO B and thus small tuning errors will be corrected. Lock is useful for cleaning up FM patches where VCO A is acting as the modulator and VCO B is the carrier (the signal that is heard), as well as audio rate modulation of the VCO B Timbre parameters (via the Mod Bus). Lock will not impart much change in the timbre of VCO A. It does not introduce strong harmonics. It is mostly used when VCO A is the modulating signal in an FM patch.

The Pink LED indicates Hard Sync of VCO A to VCO B where VCO B will restart the period of VCO A at each cycle so they have the same base frequency. Sync introduces strong harmonics to VCO A. Sync is achieved when VCO A Frequency is higher than that of VCO B. The timbre of VCO A may be altered by varying it's frequency against that of the Master Frequency set by VCO B. Slow modulation of VCO A Frequency, such as an envelope or LFO patched to VCO A Expo CV Input, results in sweeping of harmonics. The best results are achieved by setting VCO B to at least 100hz (around A2) and sweeping VCO A Frequency from 100hz up!

The Amber LED indicates that VCO A is being operated as a Low Frequency Oscillator. This is very useful with the Mod Bus. Especially the Shape and Angle parameters respond well to LFO modulation.

VCO B is not directly affected by the VCO A Lock, Sync, and LFO modes. However, if VCO A is used to modulate VCO B through the FM or MOD Buses, the resulting modulations are affected by these settings.

There is one way to affect the behavior of the VCO B core. The External Lock input allows for an extremely weak, phase reversed synchronization of VCO B to an external VCO where as VCO B approaches an integer frequency of the applied external VCO, VCO B resets to match the external VCO and small tuning errors are corrected. External Lock is useful for cleaning up FM and audio rate modulation and does not impart much change in the timbre or introduce strong harmonics to VCO B. It is useful for chaining together multiple DPOs (or DPO and other VCO) for more complex FM, chords and other patches where tuning errors need to be minimized.

Because External Lock input is phase-reversed, it is also possible to achieve very interesting amplitude modulations by summing VCO B along with a signal from the VCO supplying the External Lock input. Because their phase is reversed, as long at the VCO cores remains locked, there are varying degrees of cancellation between the two VCOs, depending upon the wave shapes and levels programmed at the summing stage. By modulating VCO B frequency (through Expo CV Input), it is possible to knock VCO B out of External Lock and thus, amplitude is regained.

The External Lock input expects a 10Vpp square or pulse shaped signal; however, just about any signal could be used with varying degrees of success. The Duty Cycle (width) and Amplitude (height) of the signal will have some affect on the outcome.

FOLLOW

If you patch a sequencer or keyboard controller to the VCO B 1V/Octave input and set the Follow control to full clockwise, VCO A follows the pitch tracking of VCO B. As Follow is decreased from full clockwise, VCO A lags further and further behind VCO B to the point of not actually following. At full counter clockwise Follow, VCO A is independent of VCO B. If you patch into the Follow CV Input, then the associated potentiometer becomes an attenuator for the incoming CV (as on the Optomix CV ins), allowing for external control over how VCO A follows VCO B.

Follow is useful in maintaining FM or Sync Ratios while controlling the DPO with a sequencer or keyboard. The lag that occurs when Follow is set to less than full clockwise introduces moments of dissonance and noise due to the temporary tracking errors. This is a wonderful way to introduce uncertainty to an otherwise stable sequence of notes.

Beat Frequency LED

This LED gives visual indication of phase difference between VCO A and B. It is useful for fine tuning simple oscillator frequency relationships such as unison, octaves and fifths. As the two oscillators approach these musical relationships, the LED flashes more slowly. This LED is also useful for visual indication of the rate of the LFO when VCO A is programmed for LFO operation.

Mod Bus
The internal Mod Bus Source is hardwired for VCO A Sine wave, with the power to use any external source by patching to the EXT. Source Input. The internal Mod bus system makes use of the Normalization Switch found on the mini-jacks, so with nothing patched to the Shape, Angle, and Fold CV inputs the associated attenuator sets the final amount of modulation applied to the destination. As you increase the Index level, the amplitude of VCO A Sine bused to the Shape, Angle, and Fold jacks is increased. Therefore, you could have different amounts of modulation at each of the destinations (Shape, Angle, Fold).

Timbre
The 3 parameters that are modulated by the Mod Bus shape the signal that is output at the Final Output. The top-most parameter in the Timbre section, Shape, adds higher order harmonics to the signal by morphing from Sine (full counter clockwise) to Spike (12:00) to Glitched Triangle (full clockwise) while at the same time inducing phase reversal and amplitude modulation around the 12:00 range of the parameter value. This might sound like an odd collection of waveforms and functions, but the selection is quite useful.

The **Sine** wave is the classic waveform that would feed a wave folder, as utilized in both the Buchla 259 and the Buchla Music Easel Timbre circuits. Since wave-folding introduces lower order harmonics to the signal, the extremely low amount of harmonics in a Sine wave allows the circuit to do its job perfectly, resulting in smooth and glitch-free folding of the waveform.

The **Spike** shape on the other hand is rich in higher ordered harmonics and morphing from Sine to Spike without any folding of the waveform (Fold set 7:00 to 8:00) provides something like the effect of high pass filtering. The Spike waveform is useful in providing a strong group of harmonics for the ear to follow while modulating the Angle parameter or utilizing the lower octaves (mix with the Sine Output to brighten bass sounds). The Spike wave shape is thin and resonant sounding, making the Fold circuit feel almost anemic (in contrast to being fed a full blooded Sine shape).

The **Glitched Triangle** brings the combination of the strong Harmonic that makes the Angle modulations so animated and the girth of the Sine wave that gives the Fold circuit some fat to chew, er Fold!

The phase reversal and Amplitude Modulation that occurs around the 12:00 range of the Shape parameter value is useful on it's own (before Folding occurs) for subtle and pleasing modulations via LFO. The Shape circuit is slow and smooth with a unique response quite unlike the typical balanced modulator or VCA. When this element of the Shape circuit is utilized with Folding, the AM and Phase Reversal acts to drop and/or reverse folds resulting in deeper animation of the Timbre. When combined with slow modulation of the Fold and Angle parameters, it is possible to achieve extremely animated sounds with just a single modulation source.

The Angle parameter injects a signal into the Fold circuit at a node that results in pushing or tilting the circuit to one side or another. The net result is quite dependent upon the Shape and Fold parameters. Sine shape results in asymmetrical folding and additionally, thresholds of the Fold circuit may be prematurely exceeded resulting in linear amplitude loss in some Folds. It is almost subtractive in nature.

Where the Angle parameter really shines, is in the animation of the higher order harmonics added to the signal by the Shape control. Slow modulation of the Angle parameter will push the Spike shape through-out the entire wave cycle continuously, and the result sounds like a combination of Phase Shifting and deep Pulse Width Modulation. The Glitched Triangle is a combination of the Asymmetrical folding and this Phase Shift/PWM effect. Again, slow modulation is the key here, giving the ear a strong and entertaining harmonic to follow as it dances atop the long wave-cycles of the lower octaves. Perfect for animating bass lines. It also adds shimmer to the upper octaves, especially when the rate of modulation is increased to the lower audio registers.

The Fold parameter is the final stage of the Timbre section and its behavior is greatly determined by the Shape and Angle parameters. The first 30% or the parameter value acts as a VCA and is useful for creating percussive sounds. Then after about 30%, the Fold circuit reaches its first threshold and from this point on is nothing like a VCA.

When Shape is set to full counter clockwise and Angle is set to around 12:00, the Fold circuit is fed a symmetrical Sine wave, and increasing the Fold parameter beyond 30% results in the continuous introduction of lower order harmonics. This Additive process was unique to the Buchla instruments developed in the early days of synthesis (Music Easel and 259 module) and is opposite to the process of filtering utilized for Subtractive synthesis popularized by the Moog synthesizers (Minimoog). The sound is large and quite aggressive. While it is the opposite of the filtering process it responds to modulations is a very similar way, with sweeping envelopes, Sine or Triangle LFOs and Audio Rate modulations being quite effective.

When Shape is set to Spike or Glitched Triangle, there are fewer of the lower order harmonics audible and the higher order harmonics present in the Spike and Glitched Triangle signals smear the sound with soft noise. The Fold circuit is not able to work perfectly with these signals, and the results are very interesting.

On the reception of a Gate or Clock Pulse, Strike briefly opens the Fold circuit to 100%. Strike is useful for creating percussive sounds, accents and audio rate modulation of the Fold circuit.

In addition to the Final Output, there are several wave shapes that are all tapped or derived from the oscillator cores. Except for the VCO A Saw and VCO B Square, these signals are all around 10V peak to peak and centered around 0V (bi-polar).

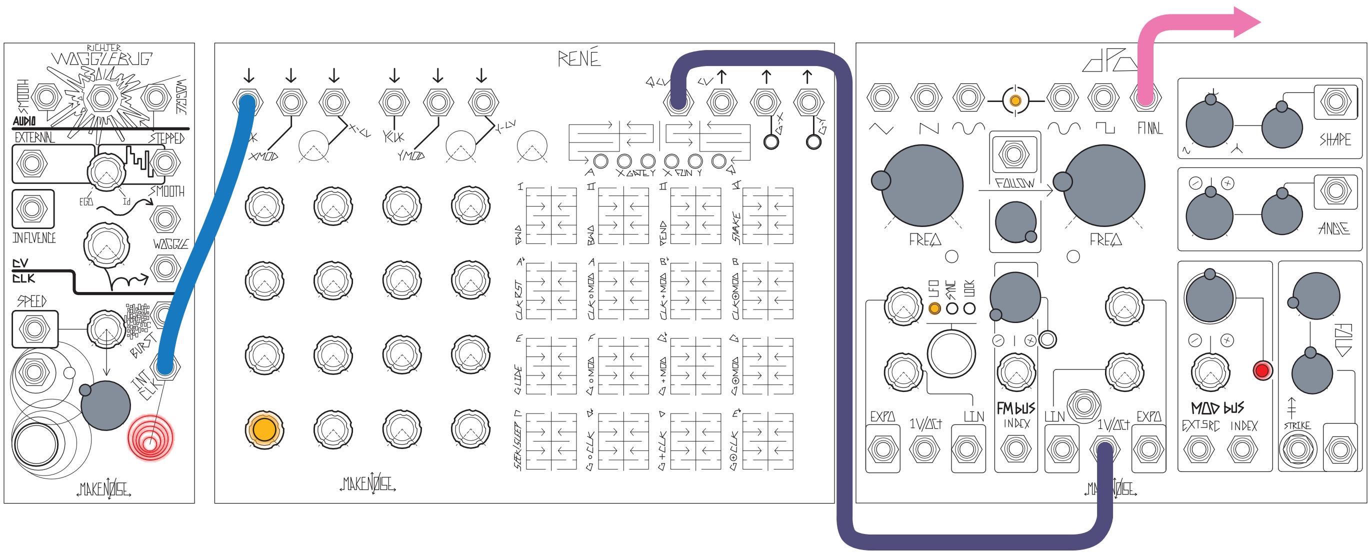
The Sine wave is derived from the Triangle core of both oscillators and is provided as an output for both VCO A and B because it is great for blending with signals of greater harmonic content in order to strengthen the fundamental. The Sine shape has almost no harmonics, so it is also a good starting point for creating complex FM sounds because the sidebands introduced through FM are not be obscured by harmonics present in the signals utilized.

For VCO A the Triangle shape is tapped from the core of the oscillator. The Triangle is especially useful for modulation of the Shape parameter. The narrower top and bottom portions of the waveform let the Shape circuit breath a bit more than the Sine wave and the result is that deeper modulation is possible before complete saturation of the Shape circuit occurs. The Triangle shape is also a great signal to tap when performing Hard Sync. The small amount of additional harmonics makes the Sync process more audible (than it will be when using the Sine), without getting quite as aggressive as the Saw shape. Like the Sine wave, the Triangle shape is also excellent for blending with signals of greater harmonic content in order to strengthen the fundamental.

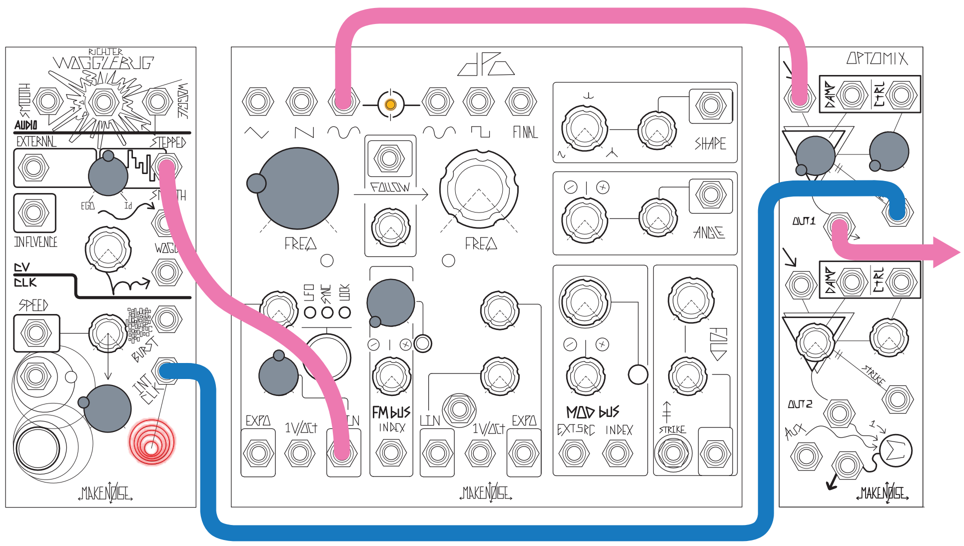
VCO A also offers a unique Saw shape that is derived from the Triangle core. It is not the typical saw waveform as it has a stronger fundamental then is usually heard in a sawtooth shape. This waveform is selected for VCO A in order to provide a unique response to the harmonically rich Final Output signal of VCO B. The Saw shape carries the harmonics and sidebands introduced through Hard Sync and FM with greater presence then the Triangle or Sine shapes. The end result is that the Saw is the most aggressive signal when using Hard Sync or FM. The Saw shape is also a good alternative to the Sine shape utilized throughout the Mod Bus. Patching the Saw to the External Source Input of the Mod Bus with yield a completely different set of timbres. Especially the Fold circuit responds wonderfully to the more aggressive Saw shape. Finally, the Saw output is also excellent for patching Subtractive synthesis sounds.

In addition to the Sine shape, VCO B offers the Final Output (discussed at length in the Mod Bus and Timbre Shaping Sections) and an Asymmetrical Square waveform that is tapped off the core of the oscillator. The Square is not AC coupled and it therefore has very steep slopes and hard edges. The asymmetrical shape was chosen so that when blended with symmetrical signals, it is possible to achieve asymmetrical clipping of those signals at the input of a filter or summing stage. Square is the waveform of choice for performing External Lock patches between multiple DPOs where the chain of command is passed from one DPO down to the next. Like the Saw, the Square shape is also very useful for performing Subtractive synthesis.

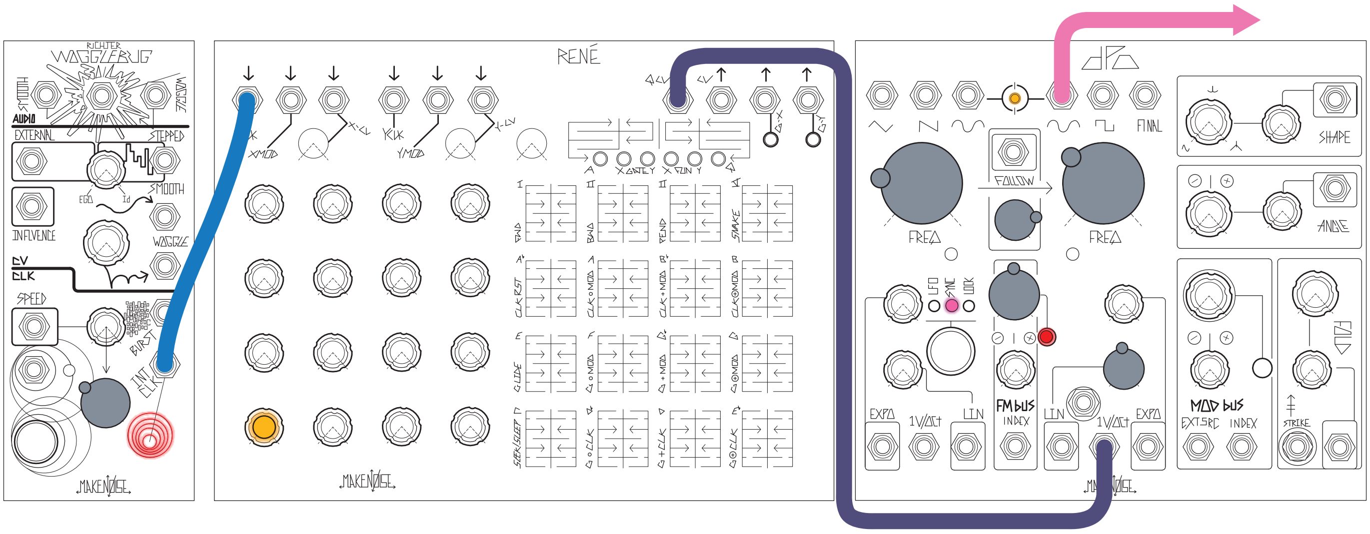
Animated Lead:
Patch sequencer or keyboard CV to VCO B 1V/Oct Input. Monitor VCO B Final Output. Set Shape and Angle panel controls and CV Attenuators to 12:00. Set Fold to 9:00 and set Fold CV attenuator to 12:00. Set Mod Bus panel control to 12:00. Patch Gate from sequencer or CV KB to Strike Input of DPO. Push button to select LFO behavior at VCO A. Set VCO A Freq. to around 9:00 and set Follow to full clockwise (100%). Varying the Mod Bus parameter greatly alters the sound.



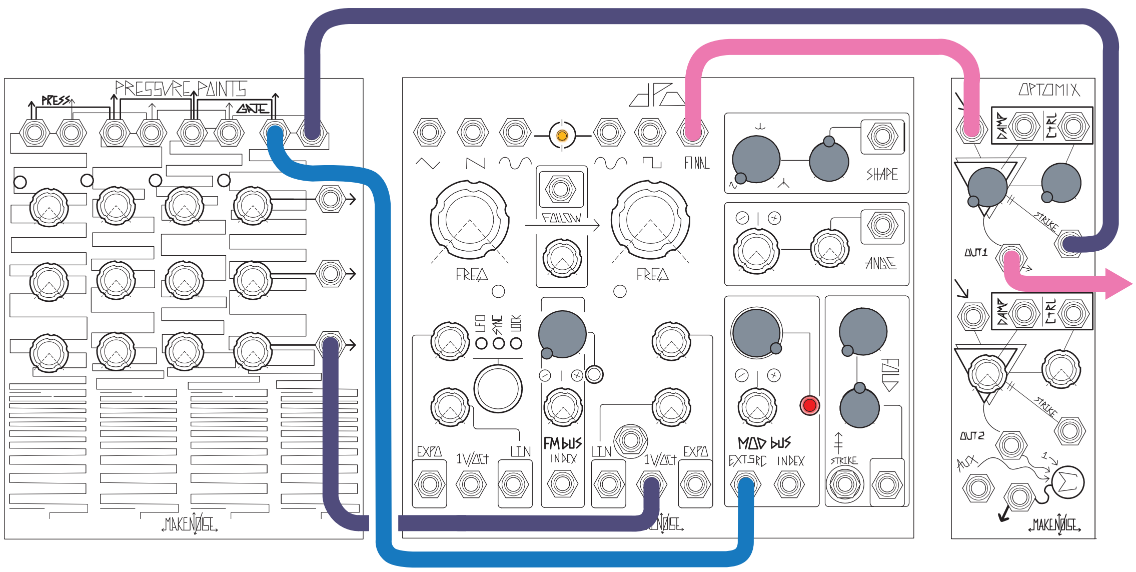
Bass Drum:
Patch VCO A Sine to Optomix CH. 1 Signal Input. Patch Random Stepped Voltage Output from Wogglebug to DPO VCO A Linear FM Input and the Wogglebug Clock Output and patch the Wogglebug Clock Output to Optomix CH. 1 Strike Input. Set DPO VCO A Linear FM amount to 12:00 and Frequency panel control to roughly 9:00. Set Optomix CH. 1 Damp and Control panel controls to full Counter Clockwise. Monitor Optomix CH. 1 Signal Output. Adjusting the Linear FM amount, Frequency setting and Damp settings allow you to create many different Bass Drum sounds. Adding Dynamic Expo FM from VCO B by patching same gate to FM Index Input with the Attenuverter clockwise also expands the possibilities.



Skronky FM:
Engage Sync mode on VCO A. Monitor VCO B Sine Output. Tune the two oscillators to a simple interval such as unison, a fifth or an octave. Adjust Follow panel control to about 3:00. Turn up VCO B Lin FM attenuator to 12:00. Turn FM BUS to 12:00. Send a sequence or keyboard voltage to VCO B 1v/oct. Each note change is accompanied by a discordant squelch of FM as VCO A "slides" to the correct note. Adjust Follow and FM amounts to taste.



Strike Force:
Monitor Final output. Turn Folds and Shape to 0 (full CCW). Turn Shape and Fold CV input attenuators to 12:00. Patch Pressure Points common Gate out to Strike input, Pressure Points tuned voltage B or C to DPO VCO B 1V/Oct, and Pressure Points common Pressure out to Mod Bus External Source Input. Sound will become simultaneously louder and more "damped" as more pressure is applied. Adjust Pressure Points sensitivity and Shape/Fold CV input attenuators to taste.



Wobble Bass:
Monitor Final output. Adjust Fold, Angle, Shape panel controls and input attenuators to 12:00. Set VCO A to LFO mode with coarse Freq ~9:00. Adjust Mod Bus Index Panel control full CW, and FM Bus Index panel control full CCW. Adjust Follow panel control full CW. Patch sequencer or keyboard CV to VCO B 1V/Oct. "Wobbling" changes speed with the pitch of the “bassline,” doubling frequency per octave. Adjust coarse frequency knobs and Final parameters and CV input attenuators to taste.