Make Noise DPO — Complex Dual VCO Module

The **DPO** is a dual VCO designed for generating complex waveforms and implementing FM synthesis in the analog domain. Expanding on the classic arrangement of primary and mod oscillators, the DPO has both of the VCOs operable as complex signal sources. It is, in essence, a Dual Primary Oscillator. Dynamic FM, Circular FM, Hard Sync and Additive Harmonic synthesis processes are all achieved with internal routing on the DPO. The DPO has two modulation buses (Mod & FM), each with multiple destinations, the depth of which is adjustable per destination. The DPO is a 100% analog, vintage voiced musical instrument.

OSCILLATOR A WAVEFORM OUTS: Triangle wave output. 10Vpp. Sawtooth wave output. 9Vpp. Sine wave output. 10Vpp.

BEAT FREQUENCY LED: Provides visual indication of the phase difference between VCOs A & B.

OSCILLATOR B WAVEFORM OUTS: Sine wave output. 10Vpp. Square wave output. 9Vpp. Final wave output is processed by the Shape, Angle & Fold circuits. 10Vpp.

FOLLOW CV IN & ATTENUATOR: The **Follow CV Input** is a unipolar control. Range: 0V to 5V. The **Follow Attenuator** determines how well VCO A follows VCO B. With nothing patched to Follow CV In, it acts as a standard control. When patched, it acts as an attenuator for that signal.

SHAPE ROTARY, SHAPE CV IN & ATTENUATOR: The **Shape Rotary** is a unipolar control that determines the shape of the waveform feeding the Fold circuit. Morphs from *Sine* to *Spike* to *Glitched Triangle*. The **Shape CV In** is a unipolar control signal input normalled into the Mod Bus. Range: 0V to +5V. The **Shape Attenuator** is a unipolar level control for the Shape CV Input.

VCO A COARSE TUNE ROTARY: Controls coarse tuning for oscillator A frequency. Range: 9.5 octaves; 12hz-6khz.

VCO A 1V/OCT SCALE TRIM: Used to calibrate VCO A.

VCO A FINE TUNE ROTARY: Controls fine tuning for oscillator A frequency. Range: 1.75 octaves.

VCO MODE BUTTON: Cycles between 4 modes (indicated by LED): **No LED**: Standard, **Lock** (Blue LED): VCO A is phase locked to VCO B. **Sync** (Pink LED): VCO A is Hard Synced to VCO B. **LFO** (Amber LED): VCO A acts as a low frequency oscillator.

VCO A EXPONENTIAL CV IN & ATTENUATOR: Bipolar exponential frequency CV input for VCO A. Normalled to FM Bus. Range: 10V. The associated **Exponential Attenuator** acts as a unipolar level control for the Exponential CV Input.

VCO A 1V/OCTAVE CV IN: Bipolar pitch control for VCO A. Optimal range: +/-5V.

VCO A LINEAR CV IN & ATTENUATOR: Unipolar linear frequency CV input for VCO A. AC coupled. Normalled to FM Bus. Range: 10V. The associated **Linear Attenuator** acts as a unipolar level control for the Linear CV Input.

FM BUS ROTARY, INDEX CV IN, ATTENUVERTOR & LED: The **FM Bus Rotary** is a unipolar control that sets the depth of the FM. The **FM Bus Index CV Input** is a bipolar CV input. Range: +/-4V. The **FM Bus Index Attenuvertor** acts as a bipolar level control for the FM Bus Index CV Input. The **FM Bus Index LED** provides visual indication of the currently programmed FM Index value.

VCO B 1V/OCTAVE CV IN: Bipolar pitch control for VCO B. Optimal range: +/-5V.

VCO B LINEAR CV IN, LINEAR ATTENUATOR & EXTERNAL LOCK IN: Unipolar linear frequency CV input for VCO B. AC coupled. Normalled to FM Bus. Range: 10V. The associated **Linear Attenuator** acts as a unipolar level control for the Linear CV Input. **External Lock In** allows VCO B to be phase locked to a hard-edged signal (square, pulse or Sawtooth) from other VCOs.

VCO B COARSE TUNE ROTARY & VCO B 1V/OCT SCALE TRIM: Controls coarse tuning for oscillator B frequency. Range: 9.5 octaves; 12hz-6khz. The **1V/Octave Scale Trim** control is used to calibrate VCO B.

ANGLE ROTARY, ANGLE CV IN & ATTENUATOR: The **Angle Rotary** tilts the added harmonics to either end of the wave-cycle. The **Angle CV In** is a bipolar control signal input normalled into the Mod Bus. Range: 8V. The **Angle Attenuator** is a unipolar level control for the Angle CV Input.

VCO B FINE TUNE ROTARY: Controls fine tuning for oscillator B frequency. Range: 1.75 octaves.

FOLD ROTARY, FOLD CV IN, FOLD ATTENUATOR & STRIKE GATE IN: The **Fold Rotary** is a unipolar control that continuously varies the low-order harmonics of the signal by folding the waveform into itself. **Fold CV In** is a unipolar control signal input normalled into the Mod Bus. **Fold Attenuator** is a unipolar level control for the Fold CV Input. The **Strike Gate In**, when patched, briefly opens the Fold circuit to 100%. Requires an 8V - 10V gate or clock to operate.

MOD BUS INDEX ROTARY, EXTERNAL SOURCE IN, INDEX IN, ATTENUVERTOR & LED: The **Mod Bus Index Rotary** is a unipolar control that sets the depth of the Mod Bus. The **Mod Bus External Source Input** interrupts internal routing of VCO A sine wave as a modulation source. Range: +/- 8V. The **Mod Bus Index CV Input** is a bipolar CV input signal. Range: +/- 4V. The associated **Mod Bus Index Attenuvertor** acts as a bipolar level control for the Mod Bus Index CV Input. The **Mod Bus Index LED** provides visual indication of the currently programmed Mod Index value.

VCO B EXPONENTIAL CV IN & ATTENUATOR: Bipolar exponential frequency CV input for VCO B. Normalled to FM Bus. Range: 10V. The **Exponential Attenuator** acts as a unipolar level control for the CV Input.

Follow: 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 100% will introduce 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.

FM Bus: The internal FM bus is hardwired for Sine wave in both directions. 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 90% Index, all four FM bus lines (Linear & Expo for both VCOs) go into overdrive when the associated attenuators are set to beyond about 80%. The FM overdrive, combined with the bi-directional dynamic FM, results in some extreme circular FM capabilities. These sounds will 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 limit.

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 External Source CV In. 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 those three destinations (Shape, Angle, and Fold).

Make Noise Soundhack Echophon — Pitch Shift / Echo FX Module

The **Soundhack Echophon** is a digital Echo, Delay, and Pitch-shifting device programmed by Tom Erbe & produced by Make Noise.

SIGNAL IN & ATTENUATOR: Audio input for the Echophon. AC coupled. Accommodates modular synth signals of 10Vpp for the first 70% of its rotation. Beyond 70%, there will be clipping followed by digital overloading.

Feedback IN: AC coupled return for the external Feedback loop. Expects standard signal level of 10Vpp.

PITCH ROTARY & LEDS: Bipolar panel control. Turn CCW for pitch shifting down. Turn CW for pitch shifting up. At 12 noon, there is no pitch shifting. The range is always dependent on the Depth setting. The associated **Pitch LEDs** display the pitch shifting mechanics and whether the pitch is travelling downward or upward.

This rotary controls alter the perceived pitch of the sound. It has an associated bi-polar attenuator, allowing you to add or subtract the control signal patched from the setting of the Pitch rotary and Pitch 2 CV In. Pitch 1 CV In is perfect for patching an LFO for Vibrato effects. By adjusting the Pitch 1 Attenuvertor, the depth of the Vibrato is programmable. Pitch 2 is well suited for patching a sequencer CV or Keyboard CV. Since most analog sequencers generate unipolar CV in the range of 0V to 5V, you will need to set the Pitch rotary fully CCW in order to control the entire range of pitch.

DEPTH ROTARY: Unipolar rotary that sets the index of the pitch shift, ranging from sub-microtonal chorusing to 4 octaves harmonizing.

The Depth rotary acts to set the index or range of the pitch shifting. It could be thought of as a Digital VCA for the CV patched to Pitch 1 & Pitch 2, as well as the Pitch rotary. Fully CCW there is no pitch shifting. Up to around 12 noon, the pitch shifting is subtle, introducing chorusing effects. Increasing the Depth CW creates increasingly deeper pitch shifting, until fully CW the full 4-octave range of harmonizing is possible. Depth is best modulated with linear functions, such as an envelope generated by Maths into the Depth CV In.

DEPTH CV IN & ATTENUATOR:: Unipolar control signal input. Range: 0V to +5V. The associated **Depth CV Attenuator** sets the level for the incoming CV.

MIX CV IN & ATTENUATOR: Unipolar CV input. Range 0V to +5V. The **Mix Attenuator** blends between the Dry (un-processed) & Wet (processed) Signal. With nothing patched to Mix CV In, works as standard panel control. With a signal patched to Mix CV In, it works as an attenuator for that signal. Set to 12 o'clock for a typical patch.

PITCH 1 CV IN & ATTENUVERTOR: Bipolar CV input. Range: +/-4V. The associated **Pitch 1 CV Attenuvertor** sets the bipolar level for the incoming CV.

PITCH 2 CV IN: Bipolar CV input. Range: +/- 2V; total 4-octaves. Set the **Pitch rotary** fully CCW for unipolar control, such as an analog sequencer, or set to 12 noon for a bipolar signal, such as a CV Keyboard.

FEEDBACK ROTARY: Bipolar rotary determining the amount & direction of Feedback. Turning CCW sends more feedback to the Pitch Shifting loop. Turning CW sends more feedback to the Echo loop. At 12 noon, there is no feedback.

FEEDBACK CV IN & ATTENUVERTOR: Bipolar CV input. Range: +/-8V. The associated **Feedback Attenuvertor** sets the bipolar level for the incoming CV.

MIX OUT: Patch the Audio signal output here.10Vpp (depending upon level setting and source material). AC coupled.

FEEDBACK OUT: AC coupled, 10Vpp send for external FB loop.

CLOCK OUT & LED: Outputs the echo time as 4ms wide clock pulse. Range: 0V to 5Vpp. The associated **Clock LED** pulses to the tempo of the echo clock.

ECHO TIME ROTARY: Sets the time/length of the echo. Range: 7ms (fully CCW) to 1,700ms (1.7sec) fully CW.

Echo CV IN & ATTENUATOR: Patch into Echo CV In, and adjust the associated unipolar attenuator to modulate the Echo Time. Just about any source will work wonderfully, as this parameter has a smooth exponential response tailored for great modulations. The associated **Echo Attenuator** sets the unipolar level for the incoming CV.

TEMPO GATE IN: Allows synchronization of echoes to a multiple or division of an external clock. While following external tempo, the Echo Time rotary Multiplies (CCW) or divides (CW) the incoming clock. Requires a clock/gate signal amplitude of at least 1.5V and width of at least 6ms.

FREEZE GATE IN, FREEZE BUTTON & LED: Pushing the **Freeze Button** or sending a gate high signal (1.5V) to the **Freeze Gate In** causes Echophon to close the echo chamber and hold the sound inside. The **Freeze LED** lights to indicate this state. The Freeze Button is a latching toggle. Press once to enable. Press again to turn off. While frozen, the Pitch controls can be used, but Feedback controls do nothing. The Echo Time controls change the sound destructively. Note: the Freeze Button is top priority, meaning the Freeze Gate In has no effect when the Freeze Button enabled.

Echophon Tips & Tricks

- **Feedback:** Loop 1 goes around the Pitch Shifter, and so each regeneration will be pitch shifting again, resulting in spiraling echoes that rise out of audibility or fall into sub sonic obscurity. Loop 2 will create traditional echo repeats. Patch a VCA or attenuator in front of the Feedback In. Or use Feedback In for a secret sound that will occur only as an echo repeat. Use Feedback Out to skip the Pitch Shifting machine. Conversly, to achieve pitch-shifting, Depth must be set to greater than 10%. Modulate Depth to create Harmonic sequences. Feedback will affect the harmonics being emphasized.
- **External Feedback Loop:** Patch the Feedback Out to an external module such as the modDemix. Set up the external module to process the Feedback Out signal. For the modDemix you could set up the typical Ring Modulation patch where you have a sine or triangle waveform from a VCO patched to the Carrier input on the modDemix. The Feedback Out signal would be patched to the Signal In on the modDemix. Take modDemix Signal Out and patch to the final stage in the external feedback loop, the VCA. The Optomix works nicely as the nal VCA stage in an external feedback loop patch. Patch the Signal OUT from the modDemix to the Signal IN on the Optomix. Take the Signal Out from the Optomix to the Feedback In on the Echophon. Set the Optomix Control level to determine the amount of regenerations. Other modules could be placed in the loop to create more complex sounds, but it is important to have a VCA (or manual attenuator) at the end of the loop for gain control. Without this nal gain control stage, the external feedback loop might be hard to tame and utilize in a musical way.
- **Echophon as Clock Multiplier / Divider:** If you patch an external clock signal to the Tempo In, the Echophon follow that clock's tempo, and the Echo Time controls act to set a Divisor or Multiplier of that master tempo. The slowest clock (input or output) is limited to the delay time, so to get 12/1 out, you need a fairly fast clock in (1.7s/12 or 15s).
- **Sequencing Pitch & Comb Filtering:** To sequence the full range of Pitch, set the Pitch rotary to full CCW, and patch a sequencer CV to Pitch 2. When the delay time is below 20 milliseconds, the delay is acting like a comb filter.
- **Dry Mix Bleed:** Because the Mix control uses a vactrol, it is prone to bleeding. As a result, the Mix signal may not go fully dry. You may be able to acheive something closer to a fully dry signal by opening the Mix Attenuator fully CW, and patching a negative DC offset to the Mix CV In.

Make Noise Soundhack Erbe-Verb

Reverb FX Module

The **Soundhack Erbe-Verb** is more than a collection of reverb algorithms or presets, it is a unique, modeless, continuously variable reverb algorithm with complete voltage control. Typical reverb types such as plate, room, hall, shimmer and others may be programmed by adjusting the knobs. The continuously variable algorithm allows for hybrid and unreal spaces to be found. Traveling between spaces is possible by modulating the algorithm or manually sweeping parameters. More than an end-of-chain effects unit, it's a whole new building block for modular synthesis. Like the Echophon, it's coded by Tom Erbe of soundhack.

SIGNAL IN & ATTENUATOR: AC Coupled Audio input for the Erbe-Verb. Expects standard signal level of 10Vpp. The associated **Input Attenuator** sets the input level. Unity is set at 3 o'clock.

MIX CV IN & ATTENUATOR: Unipolar CV input. Range 0V to +5V. The **Mix Attenuator** blends between the Dry (un-processed) & Wet (processed) Signal. With nothing patched to Mix CV In, works as standard panel control. With a signal patched to Mix CV In, it works as an attenuator for that signal.

L (MONO) & R OUTS: Patch the Audio signal output here. Both outputs are AC coupled, 10Vpp (depending upon level setting & source material). **L (Mono):** Left portion of stereo reverb image, which also serves as MONO reverb image. **R:** Right portion of stereo reverb image.

SIZE ROTARY: Unipolar rotary that sets the Size of the space. Ranges from "coffin" CCW (~35 cu. ft.) to "heavens." CW (~9.3 million cu. ft.).

This is the most defining parameter of the Erbe-Verb sound. It is an ultra-wide range control over the size of the virtual space. It goes from unrealistically small to unrealistically large, with the full spectrum of realism between. The entire range of possible sizes are available at all times. This means it is possible to travel from one space to another, or to modulate between several spaces. Typical settings for the Size parameter are: **Coffin:** Full CCW; **Room:** 12 o' clock; **Plate:** 1 - 2 o' clock; **Hall:** 3 o' clock; **Ambient:** 4 o' clock; **Heaven:** Full CW.

REVERSE BUTTON, GATE IN & LED: The **Reverse Button** toggles the Reverse on/off. In Reverse, Pre-Delay determines the Reverse buffer size — using internal clock: 42ms - 500ms; using external clock (**Tempo In**): 0.1ms - 5.46s synchronized. The **Reverse Gate In** will Reverse momentarily on Gate high. Requires a 1.5V trigger signal to operate. The **Reverse LED** provides visual indication of Reverse state. When lit, Reverse is enabled. Flickering indicates the Reverse buffer rate.

TEMPO IN: Allows synchronization of echoes to multiple or division of an external clock. While following external tempo, the **Speed** and **Pre-Delay** are multiple or division of the incoming clock. Requires clock/gate signal amplitude of at least 1.5V and width of at least 6ms.

CV OUT & LED: Control signal representing the average energy of the algorithm. Range 0V - 10V. The associated **CV LED** provides visual indication of the CV being output.

SIZE CV IN & ATTENUVERTOR: CV input for the Size parameter. Range: +/- 5V. Patch here to morph between spaces or create spaces that are large at one end and small at the other. Modulation of this parameter will be very dramatic. Use the associated **Size Attenuvertor** for subtle modulations. It is a bipolar level control for the Size CV Input.

SPEED CV IN, SPEED ROTARY & LED: CV input for the Speed parameter. Range: +/- 5V. The **Speed Rotary** is a unipolar control for Speed of internal modulation. Using internal clock: 1/2 - 256 cps; using external clock (**Tempo In**): 1/48 - 9,000 cps. The **Speed LED** provides visual indication of Internal Modulation rate.

ABSORB CV IN & ABSORB ROTARY: CV input for the Absorption parameter. Range: +/- 5V. The **Absorb Rotary** is a unipolar control for absorption. Full CCW = 0 diffusion / 0 damping; 10 o'clock = full diffusion / 0 damping; full CW = full diffusion / full damping. Absorb will affect both the tone and the time of the Decay. Increasing the Absorb parameter value will decrease the Decay times and also have the effect of making the reverb tail sound darker. Absorb is feedback based, so the response is slower than that of Size or Pre-Delay. Greater impact is achieved with slower CV signals, such as envelopes from Maths with long Rise/Fall settings, for example. Note: Absorb is highly inuenced by the Decay parameter. The greater the Decay setting, the more dramatic the Absorb response.

DECAY ROTARY, DECAY CV IN & ATTENUVERTOR: The **Decay Rotary** is a unipolar control for Decay. 0-120% reflection gain. This changes the length of the reverb "tail," from very short all the way up to infinity (Full CW). Decay uses internal feedback to put energy back into the reverb algorithm, resulting in sustaining the reverb. This sustaining increases the time it takes for the reverberations to settle, or decay to zero amplitude. Decay is by nature a function of Size. Smaller spaces tend to have shorter Decay times while Larger spaces tend to have longer Decay times. The **Decay CV In** is a CV input for the Decay parameter. Range: +/- 5V. The associated **Decay Attenuvertor** is a bipolar level control for the Decay CV Input.

DEPTH ROTARY, DEPTH CV IN & ATTENUVERTOR: The **Depth Rotary** is a bipolar control for Depth and type of Internal Modulation. Minimum modulation at 12 o'clock. Cyclic modulation CCW from 12 o'clock. Cyclic modulation is a multiphase cascaded chorus effect, which ranges from very subtle chorusing to extreme doppler swirls. Ergodic modulation CW from 12 o'clock. Ergodic modulation causes random room dimension shifting, which can become very granular at high depth. Shimmer at Full CW. The **Depth CV In** is a CV input for the Depth parameter. Range: +/- 5V. The associated **Depth Attenuvertor** is a bipolar level control for the Depth CV Input.

PRE-DELAY ROTARY & PRE-DELAY CV IN: The **Pre-Delay Rotary** controls the amount of Pre-Delay or Reverse time. Using the internal clock, it operates as unipolar, with a range of 7ms - 500ms. Using external clock (Tempo In), it operates as bipolar, with divisors & multipliers of 1/12, 1/8, 1/6, 1/4, 1/3, 1/2, 2/3, 1/1, 3/2, 2/1, 3/1, 4/1, 6/1, 8/1, and 12/1, where 1/1 is at 12 o'clock. Pre-delay is independent of the SIze parameter. The **Pre-Delay CV In** is a CV input for the Pre-Delay parameter. Range: +/- 5V.

TILT ROTARY, TILT CV IN & ATTENUVERTOR: The **Tilt Rotary** is a bipolar control for Tilt. Low Gain: +12 dB to -12 dB, High Gain: -24dB to + 24dB. Unity at 12 o'clock.). Tilt is a reverb EQ; it shapes the final tone of the reverb. It is the last operation in the algorithm, so it has no effect on energy, feedback, or nature of the reverberations. At 12 o'clock, Tilt has no effect. As you turn CCW, the high end is cut and the low end boosted, resulting in thick, thunderous sounds that fill out empty spaces. Turn CW, and the low end is cut and high end boosted, resulting in thin, bright sounds that give room in the space. Tilt is useful for tailoring the reverb to sit well in the rest of your patch. The **Tilt CV In** is a CV input for the Tilt parameter. Range: +/- 5V. The associated **Tilt Attenuvertor** is a bipolar level control for the Tilt CV Input.

Typical Reverb Space Emulations

Coffin: Size: full CCW / PreDelay: full CCW / Decay: 9:00 / Absorb: (low-cost oak) 9:00; (luxury) 2:00

Room: Size: 12:00 / PreDelay: 12:00 / Decay: 12:00 / Depth: 12:00 / Absorb: 2:00

Plate: Size: 1:00 / PreDelay: full CCW / Decay: 1:00 / Depth: 12:00 / Absorb:10:00

Hall: Size: 3:00 / PreDelay: 11:00 / Decay: 1:00 / Depth: 1:00 / Speed: 11:00 / Absorb: 11:00

Heaven: Size: full CW / PreDelay: full CW / Decay: full CW

Ambient: Size: 4:00 / PreDelay: 11:00 / Decay: 2:00 / Depth: 2:00 - 3:00 / Speed: 12:00 - 3:00

Reverse: Mix: full CW / Size: full CCW / PreDelay: 3:00 - full CW / Decay: full CCW / Absorb: full CCW / Depth: 12:00 / Reverse: ON

Shimmer: Size: 4:00 / PreDelay: 11:00 / Decay: 2:00 / Depth: full CW / Speed: 12:00 - 3:00

Make Noise Maths — Function Module

Maths is an analog computer designed for musical purposes. Amongst other things, it can: 1. Generate a variety of linear, logarithmic, or exponential triggered or continuous functions 2. Integrate an incoming signal 3. Amplify, attenuate and Invert an incoming signal 4. Add, subtract and OR up to 4 signals 5. Generate analog signals from digital information (Gate/ Clock) 6. Generate digital information (Gate/ Clock) from analog signals 7. Delay digital (Gate/ Clock) information.

If the above list reads like science rather than music, here is the translation: 1. Voltage Controlled Envelope or LFO as slow as 25 minutes and as fast as 1khz 2. Apply Lag, Slew or Portamento to control voltages 3. Change the depth of modulation and modulate backwards! 4. Combine up to 4 control signals to create more complex modulations 5. Musical Events such as Ramping up or Down in Tempo, on command 6. Initiating Musical events upon sensing motion in the system 7. Musical note division and/ or Flam.

CHANNEL NOTE: Channel 1 & 4 are identical, except for **EOR** / **EOC**. So only Channel 1 (in Green), and any differences, are explained below. Channel 4 Input is shown below, for reference.

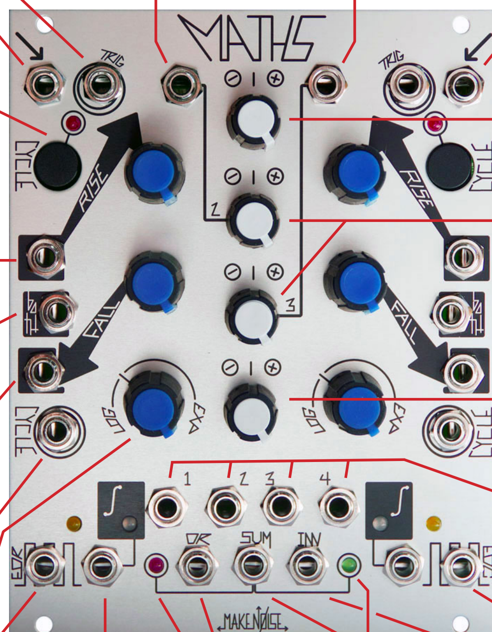
CHANNEL 1 IN: DC input to circuit. Use for lag, portamento, or ASR envelopes. Also input to **SUM**/**OR** bus. Range: +/-10V.

TRIG IN: Gate or pulse at input triggers the circuit regardless of Signal In activity. Result is a 0V - 10V function (envelope), whose characteristics are defined by the **Rise**, **Fall**, and **Vari-Response** parameters. Use for envelope, pulse delay, clock division, LFO Reset (only during falling portion).

CHANNEL 2 IN: DC input to attenuvertor and **SUM**/**OR** bus. Normalized to a +10V reference for generation of voltage offsets. Input Range: +/-10V.

CHANNEL 3 IN: DC input to attenuvertor and **SUM**/**OR** bus. Normalized to a +5V reference for generation of voltage offsets. Input Range: +/-10V.

CHANNEL 4 IN: DC input to circuit. Use for lag, portamento, or ASR envelopes. Also input to **SUM**/**OR** bus. Range: +/-10V.



CYCLE BUTTON & LED: Causes the circuit to self cycle, generating a repeating voltage function, aka LFO. Use for LFO, clock, or VCO. The associated LED displays red when the cycle is enabled.

RISE ROTARY & CV IN: The rotary sets the time it takes for the voltage function to ramp up. CCW roation decreases rise time, while CW rotation increases rise time. CV In is the linear CV input for the **Rise** parameter. Positive CV signals increase rise time, negative CV signals decrease rise time, with respect to the **Rise** rotary setting. Range: +/-8V.

BOTH CV IN: Bi-Polar Exponential CV signal input for entire function. Positive CV signals decrease total time while negative CV signals increase total time. Range: +/-8V.

FALL ROTARY & CV IN: The rotary Sets the time it takes for the voltage function to ramp down. CCW rotation decreases fall time, while CW rotation increases fall time. CV In is the linear CV signal input for the **Fall** parameter. Positive CV signals increase fall time, while negative CV signals decrease fall time, with respect to the **Fall** rotary setting. Range: +/-8V.

CYCLE IN: On gate high, circuit will cycle. On gate low, the circuit will not cycle (unless the **CYCLE button** is engaged). Requires minimum +2.5V for high.

VARI-RESPONSE ROTARY: Sets the response curve of the voltage function. Response is continuously variable from Logarithmic through Linear to Exponential to Hyper-Exponential. The tick mark shows the Linear setting.

EOR (END OF RISE OUT) & LED: Goes high at the end of the rise portion of the function. 0V or 10V. The associated LED indicates the states of the EOR output. Lights when EOR is high.

UNITY SIGNAL OUT & LED: Signal from the Channel 1 circuit. 8V peak to peak when cycling. Otherwise, the output follows the amplitude of the input. The associated LED indicates activity within the circuit. Positive voltages display green, while negative voltages display red.

OR BUS OUT: Result of the Analog Logic OR function with respect to the settings of the **Attenuvertor rotaries** for channels 1, 2, 3 and 4. Range: 0V to 10V.

SUM BUS OUT: Sum of the applied voltages with respect to the settings of the **Attenuvertor rotaries** for channels 1, 2, 3 and 4. Range: +/-10V.

CHANNEL 1 ATTENUVERTOR ROTARY: Provides for scaling, attenuation and inversion of the signal being processed or generated by channel 1. Connected to **Channel 1 Variable Out** and **SUM**/**OR** bus.

CHANNEL 2 & 3 ATTENUVERTOR ROTARIES: Provides for scaling, attenuation, amplification, and inversion of the signal patched into Channel 2 or 3. Connected to **Channel 2/3 Variable Out** and **SUM**/**OR** bus.

CHANNEL 4 ATTENUVERTOR ROTARY: Provides for scaling, attenuation and inversion of the signal being processed or generated by channel 4. Connected to **Channel 4 Variable Out** and **SUM**/**OR** bus.

VARIABLE OUTS: The applied signal, as processed by channels 1, 2, 3, or 4 controls. Normalized to the **SUM** and **OR** busses. Inserting a patch cable will remove the signal from the **SUM** and **OR** busses. Output range: +/-10V.

EOC (END OF CYCLE OUT) & LED: Goes high at the end of the fall portion of the function. 0V or 10V. The associated LED indicates the states of the EOC output. Lights when EOC is high.

INV BUS OUT: Signal from **SUM Out** turned upside down. Range: +/-10V.

MATHS is laid out top to bottom, with symmetrical features between Channel 1 and Channel 4.

The signal inputs are at the top, followed by the panel controls and control signal inputs at the middle.

The signal outputs are at the bottom of the module. LEDs are placed near the signal they are indicating.

SUM BUS LEDS: Indicates voltage activity in the **SUM** bus (and therefore the **INVerted SUM** as well). A red LED indicates negative voltages. A green LED indicates positive voltages.

Maths Tips & Tricks

- Longer cycles are achieved with more Log. response curves. The fastest, sharpest functions are achieved with extreme Exp. response curves.
- Adjustment to the response curve will affect **Rise** and **Fall** times.
- To achieve longer or shorter **Rise** & **Fall** times than available from the Rotaries, apply a voltage offset to the CV Signal Inputs. Use Ch.2 or 3 for this.
- Use the **INV SUM Out** where you require reversed modulation but don't have means for inversion at the CV destination (ex.: Mix CV In on Echophon).
- An **INV** signal from Maths back into the Maths at any CV input is useful for creating responses not covered by the **Vari-Response rotaries** alone.
- When utilizing the **SUM** and **OR** outputs, set any unused Ch. 2 or 3 **Attenuvertor Rotaries** to Noon, or insert a dummy patch cable into the associated channel Input. This will avoid unwanted offsets.
- The **OR** output will not respond to, or generate, negative voltages.
- The **EOR** and **EOC** are useful for generating complex CV functions where Ch. 1 and Ch. 4 trigger from each other. Patch to each other's **Trigger**, **Signal**, and **CYCLE** inputs.

The **Passive Multiple** is a simple but important module that allows for sending a signal to multiple destinations. Within the Make Noise system the Multiple may also be used for combining clock, gate and pulse signals together to create interesting timing sources (in other words, it acts as a Gate combiner aka logic OR circuit). It has 9 inter-connected sockets that may be split into different group combinations depending upon how it is patched. The jacks circled in white will make or break the interconnects between the 3 groups of three, thus allowing for three 3-way, one 5-way / one 3-way or one 7-way multiple. The Multiple is passive. The Make Noise system does not require Buffered Multiples since all critical control signals are already buffered.

The **CV Bus** provides visual indication of level, rate and polarity for up to 4 color-coded control signals that will be shared throughout a patch. They are distributed across the center of the system allowing for quick, clean and intuitive patching. The visual indication makes navigating complex patches easier and intuitive. The CV Bus also has the tools needed for integrating the Make Noise system with the outside world. A 1/4" Mono input with plenty of gain allows for bringing external signals into the system. The optimal 10Vpp signal level is visually indicated. A high quality Stereo Line Driver converts powerful modular synthesizer signal levels to the commonly used Line Level. There is mini-jack inputs for Left and Right, a single Master Volume control, and a TRS Stereo 1/4" output jack. This output is capable of driving long cable out to a PA System or a set of Headphones. It has AC coupling and a built-in limiting circuit (with visual indication).

PASSIVE MULTIPLE

INPUTS & OUTPUTS: Each jack can operate as an input or an output, except the white-circled jacks, which are "input only." Patching into one input creates a split of that input into all other jacks, which can then operate as outputs, where the input signal can be tapped. A few other notes:

- You can input a signal into any one of the 9 jacks. The output is tapped from any of the other jacks.
- You can split any kind of signal: audio, CV, or gates.
- You can also mix (combine) clock, gate and pulse signals (OR logic). You cannot mix audio or other CV signals. Combination of Audio / other CV signals is not supported, but will not damage anything.
- The only time a buffered multiple is needed is when control voltage is sent from an unbuffered output to multiple destinations that require unity at the input; typically, 1v/oct inputs. Because all critical CV outputs in the Make Noise System are buffered, a passive multiple is all that is needed.
- White-circled jacks make or break connections within the Multiple. While all other jacks are normalled, meaning, they split the signal to all other outputs, the white-circled jacks are "input only," and are not used as outputs. In this way, you can create various multiple combinations: three 3-way, one 5-way & one 3-way, or one 7-way multiple. From a practical standpoint, here's what that means:
  - 3x (1 input / 2 outputs)
  - 1x (1 input / 4 outputs) and 1x (1 input / 2 outputs)
  - 1x (1 input / 6 outputs)

CV BUS (available as part of the *Shared System with CV Bus* and *Black & Gold Shared System*)

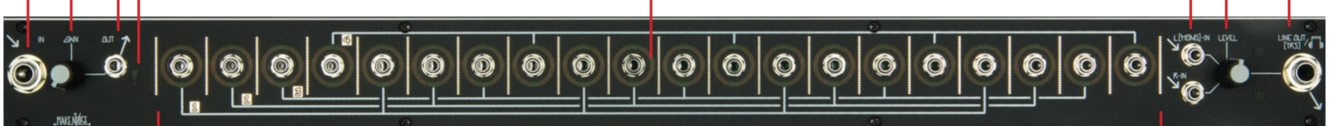
INPUT & GAIN ROTARY: 1/4 inch audio input jack for outside sources to be brought into the modular system. Since line levels are lower than modular levels, there is a unipolar **Gain Rotary** to increase the amplitude of the audio input signal.

OUTPUT & LED CLIP INDICATOR: After the audio signal / gain path, you can use this 1/8 inch jack to output the audio to any destination in your modular system. The **LED Clip Indicator** will show as a red exclammation mark if the level is too hot / volume too high. If this happens, ease back on the Gain Rotary.

IN/OUT LEVEL, RATE, POLARITY & COLOR CODING: Surrounding each Input & output jack is an LED. This indicates the following: **Level** is indicated by the brightness of the LED. Brighter = higher level, duller = lower level. **Rate** is indicated by the pulse of the LED. **Polarity** is indicated by position of the LED. Positive = upper circle half lit, negative = lower circle half lit. **Color** indicates the different busses on the system. Green is bus 1, red is bus 2, yellow is bus 3, and orange is bus 4. The colors are a great visual indicator, so that you can see which signals are being output on each bus.

L (MONO) & R INPUT & LEVEL ROTARY: This is the mono / stereo audio output from the modular system. The associated unipolar **Level Rotary** allows you to adjust the output volume.

LINE OUT (TRS): 1/4 inch Stereo TRS audio jack that can be used to send the final modular output to headphones, PA system, or DAW for recording.



INPUTS & OUTPUTS: As with the standard Multiple, each jack can operate as an input or an output. However, there are no "input only" jacks, and jacks are not "normalled" along the entiere bus. Instead, there are four distinct busses. This means that you can patch an input anywhere on the system to produce four corresponding output splits. The lines on the faceplate denote the four busses.

- You can input a signal into any one of the 20 jacks. The outputs are then tapped from the four jacks associated to the input (noted by the lines on the faceplate). In order to create additional splits of a single input, patch from one of the split outputs into a second bus line. For example, if you input a signal on the first jack (at the left), Bus 1 outputs 4 signals via the Bus one output jacks. Take on of those outputs and patch into the second jack (from the left) to create an additional set of 4 output splits. Bus 1 now has 3 outputs (the fourth being sent into Bust 2 input), and Bus 2 has 4 outputs (for a total of 7 splits of the one input signal). The CV Bus is a 4 input / 16 output multiple.
- You can split any kind of signal: audio, CV, or gates.
- You can also mix (combine) clock, gate and pulse signals (OR logic). You cannot mix audio or other CV signals. Combination of Audio / other CV signals is not supported, but will not damage anything.
- The only time a buffered multiple is needed is when control voltage is sent from an unbuffered output to multiple destinations that require unity at the input; typically, 1v/oct inputs. Because all critical CV outputs in the Make Noise System are buffered, a passive multiple is all that is needed.
- Here are some of the combinations that can be created with the CV Bus:
  - 4x (1 input / 4 outputs)
  - 2x (1 input / 7 outputs) -- *note: 1 split output is sent into a second bus input.*
  - 1x (1 input / 10 outputs) -- *note: 2 split outputs are sent into second and third bus inputs.* and 1x (1 input / 4 outputs)
  - 1x (1 input / 13 outputs) -- *note: 3 split outputs are sent into second, third, and fourth bus inputs.*

For an informative video about the CV Bus, see here: [Make Noise System Tutorial 3: Control Voltage (CV) and Polarity](#).

Make Noise Mysteron — Digital Waveguide Module

The **Mysteron** is a voltage controlled dual digital waveguide algorithm that is a bit of a mystery even to those of us involved in its design. Despite being completely digital, it is highly organic, displaying variation in outcome often seen only in nature. It is a formless blob of DSP that you grow, modulate and patch program into new sounds, some vaguely recognizable and others completely otherworldly. The range of sounds possible is quite large. From pianissimo to fortissimo, short percussive bursts to bowed, sustaining pitches. The two waveguides can be pitched together or independently, mutated with harmonic or inharmonic waveforms and fed back into themselves or each other.

COARSE PITCH ROTARY & LED: Sets length of waveguide or perceived pitch of sound, roughly 5 octaves. Quantized mode when set fully CCW. The **"Mystery" LED** indicates mutations. It flashes slowly on bowed/cross-feedback modes, and flashes quickly in quantized mode.

FINE PITCH ROTARY: Adjust perceived pitch by +/- 12%.

PITCH 1 CV INPUT & ATTENUVERTOR: The **Pitch 1 CV Input** is the exponential pitch control input. It is not applicable in quantized mode. Range: +/-5V. The associated **Pitch 1 Attenuvertor** is a bipolar control which adjusts the level of the signal coming into the Pitch 1 CV Input.

PITCH 2 CV INPUT: The exponential pitch control input. Range: 0V to +5V. Quantized mode range: 0V to +3V. Response is 1V/Oct. Engage quantize mode for superior tracking.

EXCITE INPUTS & LEDS: Gate inputs for excitation. Mysteron will create no sound unless you patch something to at least one of these inputs. Requires a clock/gate signal amplitude of at least 1.5V and width of at least 6ms. The associated **Excite LEDs** provide visual indication of the Mysteron's excitation.

TYPE ROTARY, ATTENUATOR & CV INPUT: The **Type Rotary** sets the Type of Mutation. The **Type CV Attenuator** is a unipolar level control for the Type CV Input. The **Type CV Input** is a unipolar CV input for the Type parameter. Range: 0V to +5V.

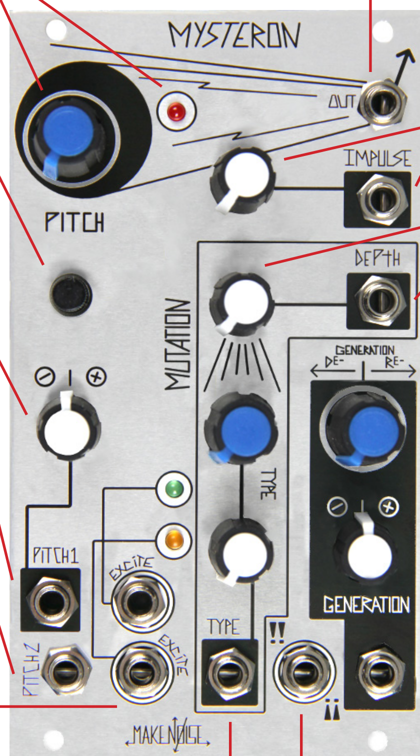
OUTPUT: AC coupled audio output. Range: ~10Vpp (depending on settings; especially Impulse).

IMPULSE CV INPUT & ATTENUATOR: The **Impulse CV Input** is unipolar. Range: 0V to +5V. The associated **Impulse Attenuator** sets the strength of excitation, allowing for control over amplitude and harmonics. It is a unipolar combo control. With nothing patched to Impulse CV In, it works as a standard panel control. With a signal patched, it works as a level control for that signal. Must be set greater than 0% to achieve an audible sound.

DEPTH CV INPUT & ATTENUATOR: The **Depth CV Input** is unipolar. Range: 0V to +5V. The associated **Depth Attenuator** sets how much the waveguides are mutated. It is a unipolar combo control. With nothing patched to Depth CV In, it works as a standard panel control. With a signal patched, it works as a level control for that signal.

GENERATION ROTARY, ATTENUVERTOR & CV INPUT: The **Generation Rotary** sets feedback of the output of the waveguides back to their inputs. At 12 noon there is no feedback. Degenerative feedback is CCW from NOON, and Regenerative feedback is CW from NOON. The **Generation CV Attenuvertor** is a bipolar attenuator for Generation CV In. The **Generation CV Input** is a bipolar signal input. Range: +/-4V.

!! IN (GATE): This is the gate input for determining the algorithm behavior. With Mutation Depth fully CCW, this changes the response of the Excite parameter for bowed attack. When not fully CCW, cross couples feedback paths of waveguides into each other (the "Mystery" LED Flashes to indicate the status). Requires a clock/gate signal amplitude of at least 1.5V and width of at least 6ms to operate.



Mysteron 101

Making Sound: When the Mysteron is Excited (via the Excite Inputs), a burst of energy (in the form of noise and other waveforms) is injected into the waveguide. The Impulse parameter sets the strength of this excitation, thus allowing for control over both amplitude and harmonics. Impulse must be set greater then 0% to achieve audible sound. At lower settings, the sound will have fewer harmonics and less impact. This parameter could also be used as a digital VCA while the Mysteron is self-oscillating.The Excite inputs are wired in a normalization scheme, so that with either one patched, the other is triggered as well. Using both Excite inputs results in the two waveguides having different lengths, with the possibility of creating two independent pitches and timbres.

Controlling Pitch: The Pitch control sets the length of both waveguides. The length of the waveguide determines perceived pitch of the resulting sound. It will also alter the timbre of the sound. The Pitch Rotary, Pitch 1 and Pitch 2 all have an exponential response with a range of roughly 5 octaves. At the lowest end, the sounds are lower pitched and take longer to decay. Therefore, it is harder to discern the pitch, as there are greater harmonics. At the middle, the sounds are shorter and have fewer harmonics, making it easier to discern their pitch. At the highest end, the sounds have the potential to become so short it is hard to determine the pitch. Changes to the Pitch controls are applied to the most recently excited waveguide. If both waveguides are excited together, then both are the same length. The Excite inputs are normalled so patching into just one excites both together. Using both Excite Inputs independently, it is possible to have the two waveguides at different lengths, thus making two differently-pitched sounds. Removing all modulation from the Pitch 1 CV In, and setting the Pitch Rotary fully CCW engages quantize mode. The Mysteron remains in quantize mode as long as the Pitch Rotary remains at 0% with nothing patched into Pitch 1 CV In. Quantize mode is indicated by the double flashing of the "Mystery" LED. This forces the Mysteron to adhere to a 12-tone chromatic scale, with the pitch determined by Pitch 2 CV In. This is excellent for using the Mysteron in a melodic way alongside other sound sources such as an STO or DPO VCO.

Sound Sculpting: Once the Mysteron is excited, the Generation Rotary sets the feedback of the output of the waveguide back to the input. Degenerative feedback saps energy from the algorithm, making the sounds shorter and more percussive. Regenerative Feedback grows energy in the algorithm, making the sounds longer and less percussive. At 100% feedback, the sound is almost a bowed type dynamic. With Depth fully CCW (no Mutation), the "!!" Gate Input engages an alternate response to the Excite inputs for a bowing effect. With Depth greater than 0%, the "!!" Gate Input cross couples the output of each waveguide into the input of the other waveguide. This is influenced by the analog acoustic modeling synthesis of Ron Berry. With Mutations occurring, the results are more complex and depend upon the Type and Depth settings. The Mystery LED flashes to indicate these behaviors. The Mutation section features contains the Depth and Type controls. With Depth set fully CCW, Type will do nothing. To hear the effects of Type, Depth must be turned to at least 10%. Depth sets the amount of mutated energy injected into the waveguide and Type selects the form of mutation. What is actually happening is that the waveguide is being excited more than just noise. The Type control is scanning through other waveforms to be used to excite the waveguide. Depth blends these other waveforms with the noise (from 0% WT/100% Noise to 100% WT/0% Noise). This dramatically changes the timbre and pitch of the sound. The "Mystery" LED lights to indicate Mutation. All other controls (Pitch, Impulse, Generation, !!) are still effective during Mutation.

Tips & Tricks: 1) The Impulse parameter could be used as digital VCA. 2) For melodic tracking, set the Pitch Rotary fully CCW (quantize mode), and use only Pitch 2. Fine Tune will help to match the Mysteron to a VCO tuning. 3) For simplest usage, patch a gate or clock to only one Excite input.

Make Noise Optomix & modDemix
Low Pass Gate & VCA Mixer Modules

The **Optomix** is a two channel Low Pass Gate, providing simultaneous voltage control over amplitude and frequency content of a signal. It is in essence, a Voltage Controlled Filter Amplifier (VCFA) that has an extremely organic response to control signals. Additionally, the Optomix offers a summing stage complete with an auxiliary input, allowing for the chaining of multiple units to create larger mixes (this also works well in combination with the modDemix. The **modDemix** features 2 identical direct-coupled balanced modulator circuits that may be used together or independently for Ring Modulation, VCA, Mixer, Signal Multiplication, Voltage Controlled Polarization, Attenuation and more.

CHANNEL 1 SIGNAL IN: DC signal input, capable of accepting audio or CV. Range: Up to 18Vpp.

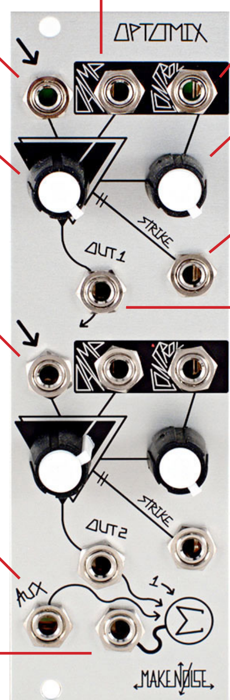
DAMP ATTENUATOR: Unipolar attenuator for the Damp CV Input. With nothing patched to the Damp CV In, the attenuator acts as a manual damping attenuator.

CHANNEL 2 SIGNAL IN: DC signal input, capable of accepting audio or CV. Normalized to Channel 1 Signal Out, for series processing. Range: up to 10Vpp (depending on settings and source material).

AUXILIARY IN: DC signal input to the Sum circuit, to allow for the chaining of multiple Optomix and modDemix units to create larger mixes. Capable of accepting audio or CV signals. Range: up to 10Vpp (depending on settings and source material).

SUM OUT: The sum or mix of all signals processed by the Optomix (Channel 1 & 2 In, and Aux In) is sent out here. Range: 10Vpp (depending on settings and source material).

DAMP CV IN: DC CV input for the corresponding channel's damping parameter. Normalized to +8V. Range: 0V-8V.



CONTROL CV IN: DC, highly sensitive CV input for the corresponding channel's vactrol gate. Normalized to +8V. Range: 0V-8V.

CONTROL ATTENUATOR: Unipolar attenuator for the Control Input. With nothing patched to the Control CV In, the attenuator acts as a manual control attenuator.

Channel 1 vs Channel 2: both channels are identical, except as noted here. If you don't see a description of the Channel 2 parameter, refer to the Channel 1 descriptions for information.

STRIKE INPUT: Gate input for striking or plucking the vactrol. Expects 8V Gate. It acts as a fast attack envelope with slow amplitude response affecting the LPG. Combined with the Damp parameter, Strike allows for the programming of percussive sounds (sharp Attack w/ CV Decay), without the need for a separate envelope generator.

CHANNEL 1 SIGNAL OUT: DC output of the signal applied to the input, as pro-cessed by the LPG. Range: 10Vpp (depending on settings and source material).

CHANNEL 1 SIGNAL IN: DC signal input, capable of accepting audio or CV.

CHANNEL 1 LEDs: LED indication of signal activity in four quadrants. Vertical position represents amplitude and phase of input signal; horizontal position represents amplitude and phase of Carrier CV In signal.

CHANNEL 1 SIGNAL OUT: Output of the processed signal from Channel 1.

CHANNEL 2 SIGNAL IN: DC signal input, capable of accepting audio or CV. Normalized to Channel 1 Signal Out, for series processing.

SUM OUT: The sum or mix of all signals processed by the modDemix (Channel 1 & 2 In, and Aux In) is sent out here.

CARRIER CV IN: Determines amplitude & phase of Channel 1 Signal In.

STRENGTH ATTENUATOR: Unipolar attenuator for Carrier CV In: Normalized to +5V so that with nothing patched to the Carrier CV In, the attenuator acts as a manual Carrier attenuator. Range: 0V-5V.

AUXILIARY IN: DC signal input to the Sum circuit, to allow for the chaining of multiple modDemix and Optomix units to create larger mixes. Capable of accepting audio or CV signals. Range: up to 10Vpp (depending on settings and source material).

Channel 1 vs Channel 2: Similar to the Optomix, both modDemix channels are identical, except as noted here. If you don't see a description of the Channel 2 parameter, refer to the Channel 1 descriptions for information.

Further Information

Optomix: As a VCA, Optomix has a moderate attack response and slow decay response, meaning that it turns on quickly, but takes a while to shut off, yielding a smooth natural sounding decay to almost any sound processed dynamically. The sound is often described as "ringing," and while the circuit is not technically ringing, that does describe many of the sounds possible when using the Optomix to process complex signals generated through FM or Ring Modulation. As a VCF it is a mild, nonresonant Low Pass circuit acting to gently reveal (or hide) the sharper edges of a sound. This characteristic also adds to the "ringing" effect. As the amplitude of the sound decays, there is a simultaneous loss in high frequency content that is similar to the natural loss of energy in idio and membranophonic instruments. The Optomix, being a vactrol-based circuit, will never have the speed or tight tolerances found in many other VCA and VCF circuits. If you seek to program extremely short sounds, clicks, pops and ticks, then the Optomix is not the best choice. What the Optomix does offer is extremely low noise and low distortion and a smooth, natural sounding circuit.

modDemix: The modDemix consist of 2 identical direct coupled circuits that may be used together or independently to process audio or control signals by means of amplitude modulation and the many derivatives of AM such as double/ single-sideband, voltage controlled amplification/ attenuation, voltage controlled polarization or multiplication and of course, ring modulation. The modDemix is a specialized amplitude modulation circuit that could be thought of as a "Thru-Zero VCA," meaning that in addition to the AM, when the Carrier signal (called Carrier CV) changes phase, the resulting signal's phase will flip as well. What makes the modDemix unique when compared to other balanced modulators, is that because it is Direct Coupled, it will perform wonderfully both as anaudio rate modulator to implement Ring-Modulation, and as a control rate modulator to implement multiplication of CV. Also, the circuit used will, with ease, turn off around 0V at the Carrier CV In; a characteristic that makes the circuit behave very well as a VCA. Both circuits feed a "Sum" stage, allowing the module to be used as a voltage controlled mixer. The Strength attenuators are "combo knobs," acting as unipolar panel controls. In practice, this means the summing stage can also be a mixer with amplitudes set by the 2 Strength controls. An Aux In allows for chaining multiple modDemix (or Optomix) units to create larger mixes. The attenuator allows for setting the Strength or Level of the incoming signal. When performing ring modulation, adjusting Strength will alter the integrity of the resulting modulated and/or demodulated signal, thus affecting the timbre as well as the amplitude. In most other uses, Strength is directly related to the amplitude of the resultant signal.

Make Noise Phonogene

Sampler / Looper Module

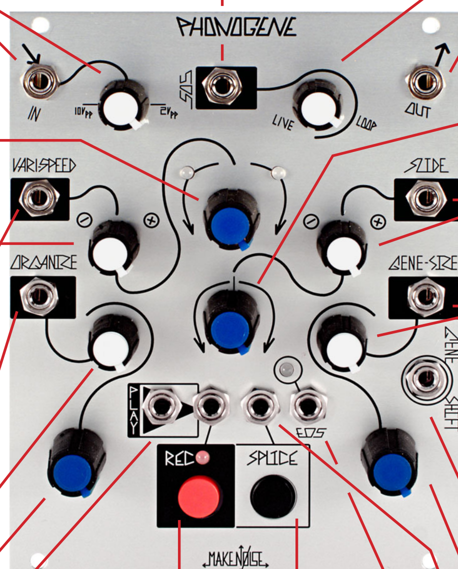
The **Phonogene** is a digital re-visioning and elaboration of the tape recorder as musical instrument. It takes its name from a little known, one of a kind instrument, used by composer Pierre Schaeffer. While not an emulation, it expands upon the original concepts. It is informed by the worlds of Musique Concrète (where speed and direction variation were combined with creative tape splicing to pioneer new sounds) and Microsound (where computers allow for sound to be divided into pieces smaller then 1/10 of a second, and manipulated like sub-atomic particles). Having CV control over every parameter, it is most dynamic as a digital audio buffer for the modular synthesist. The Phonogene is comprised of a pair of tool-sets: Tape Music tools allow for sounds to be recorded on the fly, layered, manually cut into pieces, re-organized, and played backward or forward at differing speeds. The Microsound Tools allow for you to divide the audio buffer into progressively smaller pieces called Genes (aka particles, grains, granules). You can then step through those pieces in chronological order, and/or in nonlinear fashion (providing random access of the audio buffer). Both sets of tools complement each other, which is why they were grouped into one module.

SIGNAL IN & ATTENUATOR: Audio input. Line level or modular synth levels are acceptable. AC Coupled. The associated **Signal In Attenuator** sets the input level. For line level, set at 70% CW (2Vpp), and for mod synth levels, set at 30% CW (10Vpp); noted on the faceplate.

SOUND ON SOUND CV IN: Sets the mix of previously recorded loop with live Signal input when recording, to allow for SOS-type "overdubs." Also allows for setting monitoring level of live input signals with previously recorded loop. Can also be used as a CV cross-fader (between live & loop) or VCA for loop (no live signal). Range: 0V to 10V, linear response. Normalized to +10V.

SOUND ON SOUND ATTENUATOR: With nothing patched to SOS CV In, this works as a standard panel control. With signal patched to SOS CV In, this works as an attenuator for that signal.

SIGNAL OUT: Audio signal output. 10Vpp, depending on Signal In Attenuator setting and the source material. AC coupled.



VARISPEED ROTARY & LEDS: Manual bipolar speed and direction control. When set to 50% playback is stopped, turning CCW from 50% decreases playback speed in backward direction, turning CW from 50% increases playback speed in forward direction. Two LEDs are associated with this rotary. The **2 associated LEDs** show in which direction the Phonogene is playing. The left (blue) LED indicates reverse playback. The right (orange) LED indicates forward playback. When no LEDs are lit, playback is stopped. LEDs also flash when a new splice is found (see the **Organize** controls).

VARISPEED CV IN & ATTENUVERTOR: Bipolar speed and direction control where 0V stops playback, positive control signal increases playback speed in forward direction, negative control signal increases playback speed in reverse direction. Range +/-4V. The associated **Varispeed Attenuvertor** sets the bipolar level for the incoming CV.

ORGANIZE CV IN & ATTENUATOR: Unipolar CV input which selects the next Splice to be played. The currently selected Splice will play to the end before the next Splice is selected. The Varispeed LEDs flash whenever this control finds a new Splice. Range: 0V to +5V. The associated **Organize Attenuator** sets the level for the incoming CV. It is unipolar.

ORGANIZE Rotary: Manual Unipolar control which selects the next Splice to be played. The Varispeed LEDs will flash whenever this control finds a new Splice.

RECORD BUTTON & LED: Manual, momentary button to toggle record on/ off. The Record LED indicates when recording is taking place. When not lit, recording is not taking place.

SPLICE BUTTON: Pressing drops splice marker on a loop. When loop is Organized, the splices (resulting audio segments) are re-arranged according to the Organize CV. Phonogene plays whichever splice is selected by Organize parameter.

PLAY & RECORD CV INS: **Play CV In:** At each rising edge signal applied to Play CV In, playback is triggered. At the end of loop or splice, Phonogene looks at the incoming CV, and if high, it plays again. If low, it does not play. This Input is normalized high. With nothing patched, play is continuous. Needs at least 1.5V trigger signal to operate. **Record CV In:** Toggles Record on/off. When recording from a cleared buffer, the first record cycle sets the record length, so be sure to perform the **Erase Routine** to achieve a new recording. Sees only rising edge of signal. Needs at least 1.5V trigger signal to operate.

SLIDE ROTARY: Manual bipolar rotary for scanning the pieces of sound that result from setting Gene-Size to greater than 10%. Moves/slides through the Genes (aka grains). Allows for scrubbing of the recorded material, and is always dependent upon the Gene-size setting.

SLIDE CV IN & ATTENUVERTOR: Bipolar CV input for Slide. Range +/-4V. The associated **Slide Attenuvertor** sets the bipolar level for the incoming CV.

GENE-SIZE CV IN & ATTENUATOR: Unipolar CV input setting size divisor of audio buffer, dividing with respect to the buffer size as set by Record or Splice length. This parameter "auto-splices" the recorded material like a machine. Operates with great precision and can cut pieces to a granular level. Nondestructive. At 0V there is no effect. Range 0V to +8V. The associated **Gene-size Attenuator** sets the level for the incoming CV. It is unipolar.

GENE SHIFT CV IN: A clock signal at this input advances Phonogene to the next Gene, in chronological order. Always dependent upon the Gene-size setting. Needs at least 1.5V trigger signal to operate.

GENE-SIZE ROTARY: Manual unipolar control which sets Gene-Size divisor.

SPLICE CV IN: Input for using external signal to splice the loop. Sees only rising edge of the signal. Needs at least 1.5V trigger signal to operate.

EOS CV OUT & LED: Outputs a short 4 ms pulse at the end of each Splice. With no Splices, EOS outputs a pulse at the end of each loop. The associated **EOS LED** flashes at each pulse output.

Recording Time and Quality: The Phonogene audio buffer is 2MB, nonvolatile, high number of fast read and write cycles. Nonvolatile means the Phonogene remembers both samples and splices on power down. The high number of read and write cycles is key to longevity of the module. High speed read and write cycles allow for short sample times, making microsound possible. Because the record and playback frequency is continuously variable from 88.2khz to 5.5khz by the Varispeed controls, the longest possible recording or loop length is determined by the speed of the playback/recording. Therefore, long recordings may be achieved, but at the cost of a lower sample rate, meaning the resulting recordings will be of lower sound quality. A "Mid-Fi" setting may be achieved by setting the Varispeed rotary at around 50%, so that both Varispeed LEDs are off. This records a good quality, 2-second sample length, and allows for a good range of speed variation. Playback is stopped while you record. To record shorter samples at higher quality, set the Varispeed rotary CCW. To record longer samples at lower quality, set the Varispeed rotary CW. Sample length can range from approximately >0 to 30 seconds.

Erase Routine: Hold the Splice button for 3 seconds to erase all splices at once. The Rec LED flashes to indicate splices have been erased. If you then press the REC button while still holding the Splice button down, the Recording is also erased. Note: Erasing splices is non-destructive to your audio.

Broken Echo Mode: This hidden function allows for realtime processing of audio signals. To enter Broken Echo mode, create a sample/loop/Splice (just press the Rec button and record enitre memory bland, for example). Then press and hold the Rec button until you pass through the EOS (EOS flashes) and Rec will be stuck On. To exit Broken Echo mode, press the Rec button again (do not Hold it though, or you will go back into Broken Echo mode). In this mode the Phonogene is similar to the Echoplex, with the SOS switch activated. This is similar to covering the Erase head of a tape recorder, allowing a spool of tape to be recorded over and over and over again, without erasing the previous recordings. This is a great mode for building walls of sound, drones, or making crude echo FX. Phonogene still minds Splices, Varispeed, Gene-size, Gene Shift, and Slide. Any modulation of these parameters are recorded. Be sure to set the SOS Attenuator control according to your desired results. For example, live input processing requires the attenuator to be set at around 50%, while massaging captured content requires a setting of 100% Wet. Adding or removing splices during Broken Echo Mode is not supported.

Make Noise Pressure Points & Brains Expander — Control Module

Pressure Points is a controller in which 1 of 4 sets of 3 tuned voltages are selected by touching the corresponding printed copper wire at the bottom of the instrument. Touching Pressure Points, you become part of the circuit, generating a gate signal (Gate Out), a control signal proportional to the amount of pressure applied (Press Out) and activating the corresponding Stage. The Tuned Voltages for the activated Stage appear at their respective X, Y and Z Outs. In this way, Pressure Points is like an analog sequencer that is played by hand.

2 pots allow the circuit to be adjusted for desired playing response. Up to 4 of these modules may be chained together to create controllers of varying size and complexity. The Gate and Press Outs are normalized to their respective Combined bus which is output at the last Gate or Press Out in the chain. In addition, stages can also be selected via clock inputs with the separately purchased expander module, **Brains**.

PRESSURE OUTS: Unipolar CV Outputs 1, 2, 3, and 4. Sends out a CV signal based on the pressure applied to the corresponding touch plate. Pressure Outputs are displayed using yellow output arrows on Pressure Points.

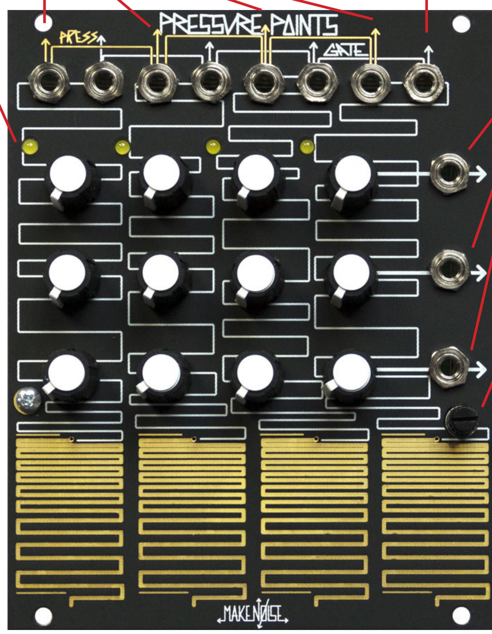
GATE OUTS: Gate Outputs 1, 2, 3, and 4. Sends out a high gate signal when the corresponding touch plate is pressed, and stays high until a new touch plate is pressed (a new "stage" is enabled). Gate Outputs are displayed using white output arrows on Pressure Points. Only one is referenced here (Gate Out 4).

ACTIVE STAGE LEDS: Lights yellow to indicate which stage (1, 2, 3, or 4) is currently active.

TUNED VOLTAGE ROTARIES: The top row is Tuned Voltage row X, the middle row is Y, and the bottom row is Z. X range: 0V to 8V. Y & Z range: 0V to 5.5V.

TOUCH PLATES: Touch Plates 1, 2, 3, & 4. Pressure Points requires the development of a technique, and clean, bare hands. Touching the upper-most portion of the touchplate with as little of your finger as needed to activate the circuit, will generate simultaneous Pressure and Gate signals, which are sent to the Outs at the top of the associated vertical column. Also, the three Tuned Voltages X, Y, & Z (as set by the column's Tuned Voltage rotaries), found in the middle of the module, are sent out to their corresponding Outs on the module's left side. Each time a Touch Plate is pressed, 5 signals are simultaneously sent out to control other parameters in your system: Pressure, Gate, and 3 Tuned Voltages.

Laying more of your finger down on the touchplate, and pressing harder, will generate a pressure control voltage proportional to amount flesh mashed into the copper of the touchplate. Pressing harder, more of your flesh comes into contact with a sensitive point in the circuit.



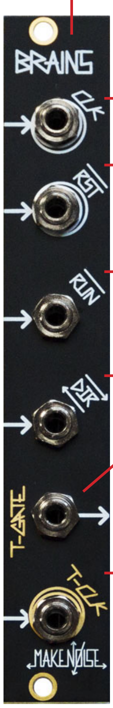
TUNED VOLTAGE OUTS: Each row of Tuned Voltages has a corresponding CV Output that that can be sent to other CV inputs in your system. When a "stage" is enabled with Pressure Points by pressing a touch plate, the corresponding vertical column of Tuned Voltages are simultaneously sent out to all 3 CV Outputs.

TOUCH SENSITIVITY POTENTIOMETER: Set the Touch Sensitivity Adjustment Potentiometer further CCW when you want coarser Touch Plate response (less sensitive to the touch). Set it CW when you want finer Touch Plate response (more sensitive to the touch).

DIGITAL TRIMMER: If you cannot obtain the desired response, you might need to adjust the internal Digit Trimmer to compensate for size & moisture of your fingers, as well as playing technique and style of system setup (vertical, horizontal, angled). This requires a trimmer tool or jeweler's screwdriver, and access to the module from the right side, where the Digit Trimmer is located on the circuit board.

Always turn the power for Pressure Points off while adjusting the trimmer. Default setting is 40% CW. CCW = less sensitivity. CW = more sensitivity. You will need to experiment with settings to achieve the desired playing response.

Brains is a clocked sequential binary event machine, intended to be connected to tactile controllers such as the Pressure Points. as an expansion module. Once connected, Pressure Points provides data input to Brains in the form of touch-selectable Reset stage and Hold stage. Pressure Points also provides the tuned voltages and pulses per stage. Brains, when connected to either 1 or 2 Pressure Points, will drive the stage selection in a sequential fashion, at a rate determined by the incoming clock at Clock In, thus forming a 4-Step or 8-Step, 3-channel analog sequencer. Binary control over Direction of the stage selection, Run/Stop and Reset are provided.



CLOCK IN: Selects next stage or number to be counted on rising edge of clock, gate, pulse or trigger, of at least 1V. Patch here to sequence.

RESET IN: Jumps to last touched stage on rising edge of clock, gate, pulse or trigger, of at least 1V. Use this input to control when the sequence is reset to the start or beginning of the sequence.

RUN IN: Gate or logic high (of at least 1V) will tell Brains to count, and thus run gate. Gate or logic low (below 1V) will stop Brains. Use this input to control when the sequence is turned on or turned off.

DIRECTION IN: Gate or logic high (of at least 1V) tells Brains to count forward. Gate or logic low (below 1V) tells Brains to count backward. Use this input to control the forward / backward movement of the sequence.

TOUCH-GATE OUT: Generates gate high, 10V, when any Touch Plate on a connected Pressure Points is touched.

TOUCH-CLOCK IN: Secondary clock activated when Pressure Points is touched. This input serves a dual purpose. Used without a Master Clock applied to the Clock In, events initiated by touching Pressure Points will be quantized to the timing signal applied to the Touch-Clock In. When used along with the Clock In, a secondary sequence will be initiated whenever Pressure Points is touched, where the length and timing is determined by the relationship of the Touch-Clock to the Master Clock. Also, patching a dummy cable into this input breaks the connection between the Pressure Points Touch Plates and the sequence (stage) selection. In other words, the Pressure Output from the Touch Plates are independant of the stage sequence, and thus, independant of the Gate Output and Tuned Voltage Outputs.

Pressure Points Tips & Tricks

- The top row of Tuned Voltages range 0 to +8V, and may be used to generate gate signals, where full CCW is Gate Off and full CW is Gate On.
- Process the Pressure CV Signal with a slew limiter and attenuator on Channels 1 or 4 of **Maths** to achieve larger than life modulations.
- Achieve a "Latched," "Toggled," or "Switching" CV signal, use two stages of Pressure Points, where one has a tuned voltage set to 0V (toggled Off), and the other has a Tuned Voltage set to the desired On state (+8V, or full CW, for example). Touch one stage to turn On, and the other to turn Off.
- Use for preset storage, where you have 4 presets of 3 variables in a patch; variables being set by Tuned Voltages X, Y & Z. Additional variation is preset by applying the independent Press and/ or Gate signals from each stage to different patch points. If the Gate is not needed to initiate an event, apply it to a patch point via an Attenuator, and use it as a touch-controlled momentary modulation.
- All Tuned Voltage and Press CV Outs will drive a passive 4-way mult with no loading.
- All Gate Outs may be stacked to one Gate In for Gate mixing.

René is deep, but all you really need to know: Patch one clock to XCLK, and a second clock to YCLK, adjust clock rates and/ or divisors, tune voltages per location (the knobs) as desired. Adjusting those two clocks relative to each other will create seemingly innite variations on the theme that is your sequence.

René is the world's first and only Cartesian sequencer for music synthesizers. It uses Descarte's cartesian coordinate system to unlock the analog step sequencer from the shackles of linearity. Like the classic analog sequencers, there are only 16 steps, each having an associated knob with which the note for that step is tuned. However, using René, the patterns are not limited to 16 steps in length because the path taken through those steps is, for all practical purposes, infinite. In fact, René does not "step" at all, but rather it maps coordinates to locations in a grid. As a result, it is possible to move in ways that you would never imagine. The 16 steps on René are called "locations," and rather than one clock input, there are two; the X axis, and the Y axis.

X-CLOCK IN: Clock/ Gate signal (of width >.5ms and amp >2.5V) input drives the X-axis counter. If using Maths to clock, then set Vari-Response to Linear. When René counts Snake style, X-CLK steps linearly through a stored set of coordinates; it drives the sequence.

X-MOD IN: The state of this input (either high or low) further determines behavior of René, depending on the selections made in the X-Fun PGM page. For example, when CLK-RST is selected under X-Fun, a logic high at this input will Reset the X-axis counter to 0.

X-CV IN: CV at this input generates a number that is added to the number generated by the X-axis counter, to create the X coordinate. When René counts Snake style, X-CV scans linearly through a set of stored coordinates. X-CV is normalled to +5V so that with nothing patched the attenuator acts as an offset generator.

Y INPUTS: Identical to the X-inputs, but applied to the Y-Axis. See the X- inputs for an explanation.

QCV OUT: The quantized CV of the currently active location. QCV may also yield a stored quantized CV (if selected on Q Page), in which case the corresponding location potentiometer is no longer "live." Range: 4 octaves.

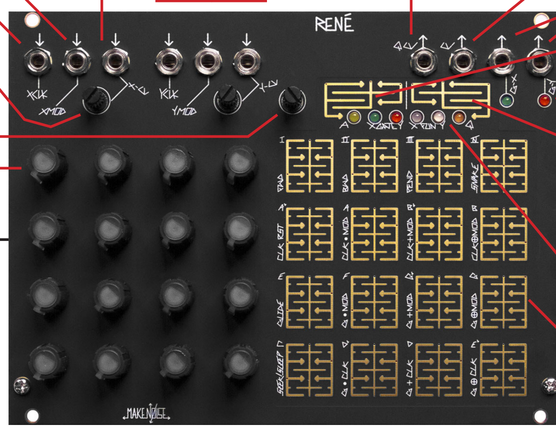
CV OUT: The un-quantized CV of the currently active location. At the CV Out, the location potentiometers are always "live." Range: 0 to 4.5V.

GATE X & Y OUTS: These outs reflect the X- & Y-Gate Page programming. When René hits a location, and it is on (lit) on the X- and/or Y-Gate PGM Page, the out(s) go high for a duration determined by the X-CLK width and any PGM logic operations for that axis clock or gate. When counting Snake style, the Gate Out is always a skinny pulse (2ms). Range: 0V (off) or +8V (on).

X IN CV ATTENUATOR: Attenuates the incoming X-CV input signal.

TOUCH PLATE SENSITIVITY CONTROL: To decrease sensitivity, turn CCW. To increase sensitivity, turn CW.

CV PROGRAMMING GRID: Pots used for programming (PGM). LED lights indicate currently active location(s).



PGM 1: Used to cycle through the six programming (PGM) Pages.

GATE-X & -Y LEDS: Flashes to indicate gate activity at the output.

PGM 2: When in a PGM Page, press to return to "play" mode. While in "play" mode, press to latch currently-held locations. Also used to store module settings on power-down. When in "play" mode, press and hold until all PGM LED's blink (about 2-3 seconds).

PGM PAGE LEDS: Lights when associated PGM Page is accessed.

TOUCH PLATE GRID: Used to select locations for programming (PGM) and latching.

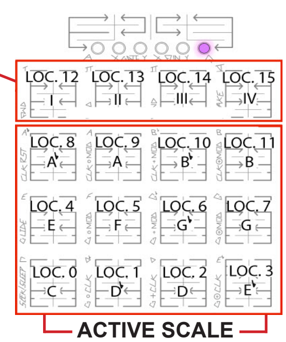
RENE CONCEPTS: The primary goal of René is to have a maximum amount of artist-controlled musical variation, with a minimum amount of data input. There are no menus. All editing is done real-time, and the programming becomes a key performance element.

The basic concept: each axis is being driven by the corresponding clock and CV, to generate a number from 0 to 3. These numbers together make up the coordinates for the jump to the next location (ex.: If X hits 2 and Y is at 3, then René goes to Loc.14).

Stored Quantized Voltages (SQV - Q PGM Page - Locations 12, 13, 14, and 15)

To store all 16 Voltages as set by the potentiometers and the PGM Scale as set by touch grid Locations 0 thru 11, touch and hold either Location 12, 13, 14, or 15 until all 6 PGM LEDs flash. When one of these four locations are on (lit), the QCV Out produces voltages per location as well as the scale in which they were initially stored. The scale may still be edited on the fly, but the pots on the CV Programming Grid is no longer "live." To turn off the active SQV, press it once again to toggle off.

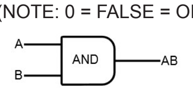
With the scale and the voltages you have programmed stored, you effectively have two channels of CV. The most common use would be to apply the QCV to 1V/ Octave input on your VCO, program your scale and the notes you want to use in your composition, and store those to one of the 4 locations (12, 13, 14, 15). If you want variations, then store those variations to the remaining locations. Now, patch the CV Out (un-quantized) to a timbre control, such as FM Index, wave shape, or filter resonance. Because your QCV is using the SQV to drive the VCO, the un-quantized CV Out is now independent, and you are able to turn the pots on the CV Programming Grid to program new timbre CV, without changing the notes/pattern driving your VCO pitch. Apply the Gate Outs to EG/VCA combo, or Low Pass Gate, and you have full control of one voice.



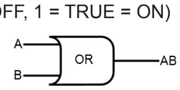
René Logic (X-Fun / Y-Fun PGM Page)

There are 3 rows of the logic processing. **CLK by MOD**, **Gate by MOD** and **Gate by opposing CLK**. With the Clock Logic Ops (locations 9, 10, 11) the MOD input is **AND**, **OR**, **XOR** against the CLK, and the result drives the counter for the associated axis. With the Gate Logic Ops (locations 5, 6, 7) the MOD is AND, OR, XOR against the CLK and the result drives the gate programming logic (X gate or Y gate pages). The last part of the chain is the gate on/ off, thus giving gate programming top level control. When you want a location to not generate an event, turn off the gate.

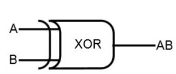
(NOTE: 0 = FALSE = OFF, 1 = TRUE = ON)



A	B	Out
0	0	0
0	1	0
1	0	0
1	1	1



A	B	Out
0	0	0
0	1	1
1	0	1
1	1	1



A	B	Out
0	0	0
0	1	1
1	0	1
1	1	0

For CLK by MOD logic ops, the results apply to both the sequence movement and the associated gate outs. For Gate by MOD logic ops, the results apply only to the associated gate outs.

Programming (PGM) Pages

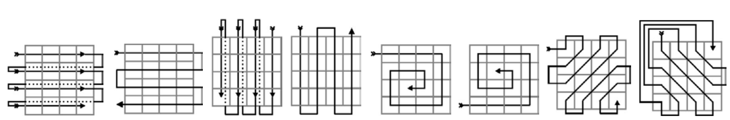
Access Page (A): Allow access (on; lit) or deny access (off; unlit) to a location.

X-Gate & Y-Gate: Turn on/off locations that generate a gate at the G-X / G-Y Outs.

X-Fun & Y-Fun: Edit the behavior of the X & Y axis. **FWD:** counts forward. **BWD:** counts backward. **PEND:** counts forward, then backward. **SNAKE:** Scans linearly through 8 preset coordinate patterns. Uses both X- and Y-axes, so this can be set on either "FUN" page. **CLK RST:** Pulse at the MOD Input will reset the associated axis counter to 0. Used to reset the counter. **GLIDE:** Glides between locations when a gate is present at the MOD In. Only one axis needs to be programmed for glides to function. **SEEK** (on; lit)/**SLEEP** (off; unlit): Lets you program rests in sleep mode. When an Access location is off, the step is counted and silent. In Seek mode, this same location is ignored, and next available location is played (without the rest between locations).

Quantize (Q): Lets you select scales to be used at the QCV Out. You can also store quantized voltages (see SQV section).

8 Snake Mode Memorized Coordinate Sets *(conceived & illustrated by yerpa58).*



The tELHARMONIC is a multi-voice, multi-algorithm synthesizer module named for the music hall considered by some to be the location of the first electronic music concerts. It was coded by Tom Erbe, with the goal of presenting three historically important pioneering electronic tone generation techniques less often implemented within the modular synthesizer.

The tELHARMONIC's roots go back further than the advent of electronic music, as it also takes a new approach to handling music theory in the modular context. TONIC, INTERVAL, DEGREE and D-GATE, allow for patch-programming of complex chord progressions, scales, melodies and playing styles. This voltage-controlled music theory guides the algorithms in a unified way, whereas CENTROID, FLUX and H-LOCK sculpt the timbre of each algorithm uniquely, allowing for complex sounds to be created around a unified melodic structure and pattern.

GATE OUT: Outputs a gate signal at each change in **Degree**. DC-coupled. 10V gate. The associated LED provides visual indication of activity.

FM IN: Input for linear frequency modulation of the tELHARMONIC core. Modulates all 3 algorithms (**N Out**, **H Out**, and **P Out**). AC-coupled. Expects maximum signal level of 15Vpp.

N OUT: Output for the single-voice noise algorithm. Pitch is set by the **Tonic** and **Degree**. Bandwidth is set by **Flux**. Does not respond to **Interval**, **Centroid**, or **H-Lock**. AC-coupled. 8Vpp signal.

H OUT: Output for the 3 voices of the harmonic algorithm. Core frequency is set by **Tonic** and **Degree**. The pitch spacing (harmonic relationship of the 3 voices to one another) is set by **Interval** and **Degree**. Timbre of this output is controlled by **Flux**, **Centroid**, and **H-Lock**. AC-coupled. 10Vpp signal.

P OUT: Output for the 3 voices of the phase mod algorithm. Core frequency is set by **Tonic** and **Degree**. The pitch spacing (harmonic relationship of the 3 voices to one another) is set by **Interval** and **Degree**. Timbre of this output is controlled by **Flux** and **Centroid**. Response to Flux is the inverse of that of the **N Out** and **H Out**. Does not respond to **H-Lock**. AC-coupled. 10Vpp signal.

TONIC ROTARY: Adjusts the pitch of all 3 Voices across 6 octaves.

TONIC CV IN: Unity, unquantized 1V/octave pitch control input. Range: 0-6V.

INTERVAL ROTARY: Sets the pitch spacing of the 3 harmonic and phase mod voices to form triads (with 2 inversions), fifths, unison, or octave relationships. Continuously variable, aside from the 2 inversions for triads.

COLOR STAFF: Visual indicator that changes color to display the state of **Interval** and **Degree**. Pulse indicates frequency of the **Tonic**.

DEGREE ROTARY: Quantized note selection, relative to the pitch as defined by **Tonic**. Also determines sonority of the triad, where applicable.

INTERVAL CV ATTENUATOR: Bi-polar attenuator for **Intrvl** CV input.

DEGREE CV ATTENUATOR: Bi-polar attenuator for **Degree** CV input.

INTERVAL CV IN: CV input for **Interval**. Range: 0-5V.

D-Gate IN: Gate input for activation of the **Degree** parameter. Normalled high, so with nothing patched, **Degree** is always active. Requires a clock/gate signal of at least 5V. and width of at least 10ms.

DEGREE CV IN: Quantized CV input for **Degree**. Range: +/- 2V.

CENTROID ROTARY: This rotary has a different effect on the output: **H Out-** modulates or selects harmonics for emphasis by **Flux** and **H-Lock** parameters. **P Out-** sets the phase modulation ratio. **N Out-** No effect.

FLUX COMBO POT: Unipolar combo rotary. With nothing patched to **Flux CV in**, this functions as a standard panel control. When a control signal is patched to the **Flux CV in**, it functions as an attenuator for that signal, as it is applied to the **Flux** paramater.

Flux has a different effect on the 3 outs: **N Out-** increasing **Flux** focuses the noise around the fundamental, as set by **Tonic** and **Degree**. **H Out-** At 0V (**Flux** fully CCW), all harmonics are equally emphasized. Increasing **Flux** de-emphasizes all harmonics surrounding the Centroid, with the exception of those that are currently locked by **H-Lock**. This de-emphasis has the effect of emphasizing the **Centroid**. **P Out- Flux** sets the index of phase modulation — the ratio is set by **Centroid**. The response is inverse to that of the **H Out** and **N Out**. At 0V (**Flux** fully CCW), maximum phase modulation is achieved. Gradually increasing this parameter decreases the index of the phase modulation.

FLUX CV IN: Unipolar CV input for Flux. Range: 0 to +8V.

CENTROID CV ATTENUATOR: Bi-polar attenuator for **Centroid** CV input.

CENTROID CV IN: CV input for **Centroid**. Range: 0-8V.

H-LOCK IN: Gate input for setting harmonics to be locked ON. Requires a clock/gate signal amplitude of at least 5V and a width of at least 10ms.

H-LOCK BUTTON/LED: With **Flux** greater than 10%, this sets the harmonic selected by the **Centroid** parameter to be locked on. Multiple harmonics may be locked on. LED brightness indicates the number of harmonics locked on. To un-lock Harmonics, set **Flux** to 0% or press and hold the **H-Lock Button** for one second, until the **H-Lock LED** fades off. This parameter only affects the harmonic algorithm. Press and hold for 5 seconds to enter the **Spiratone** mode. Press without holding to return to **Harmonic** mode.

Composing with tELHARMONIC 101

- The left side of the module allows for patch programming chord progressions, scales, and melodies. It consists of the TONIC, INTERVAL, DEGREE and D-GATE parameters and the visual indication of the Color Staff. Although you will find great detail below about the inner workings in the next section, no knowledge of music theory is required. These parameters respond to cv, just like anything else in your system. Here are some quick pointers:
- Think of Tonic as the main pitch/frequency control, similar to the grey knob on a DPO or STO. It is continuous (not quantized) and responds 1V/Oct.
- Interval sets the spread of the pitch/frequency between voices in the H Out and P Out. There are 3 voices that can be set to triad, fifth, unison, octaves and anywhere in-between. Whatever Interval is selected will be maintained when TONIC is manipulated. Unison (about 3 o'clock) has all 3 voices set to the same note for behavior typical of a VCO.
- Degree adds or subtract up to two octaves from the base frequency set by Tonic. It has a Quantized response and also tracks 1v/Oct. when the DEGREE CV Attenuator is set Full CW. Because DEGREE is a quantized parameter, it has a "musically valid" response to any cv used.
- Whenever Degree changes values, a gate is generated and available for use at the Gate Out.
- The D-Gate Input operates as a Track & Hold for the DEGREE parameter. With nothing patched, D-Gate is held high and DEGREE will always be actively tracking the signal patched to the DEGREE CV IN. With a clock, gate, pulse or trigger patched to D-Gate, the DEGREE parameter will only track the signal patched to DEGREE CV IN while the D-Gate is held high.

Make Noise Richter Wogglebug

Random Generation Module

The **Richter Wogglebug**, among other things, contains: 1 Voltage-Controlled Clock, 1 Sample & Hold, 2 Lag Processors, 1 Random Gate Burst Generator, and 2 VCO Digital Ring Mods. Most of these are patchable via the instrument's panel, in a system capable of CV and Audio Signal generation and processing.

While the Panel Controls & Input/Output descriptions are found below, please understand that all portions of the Wogglebug interact with each other. For example, changing the Ego/Id Balance will affect the Stepped, Smooth, and Woggle CVs, the Smooth VCO, Ring Mod and Woggle VCO Outs. The Woggle circuit is chasing the Smooth/ Stepped circuit, which is being kicked in the ass by the internal clock. It is very possible to make patches and panel settings which lock up the Wogglebug, and thus the CV outputs will hang at the last voltage level while the VCOs will drone on almost unchanging. When this happens, adjusting just about any panel control will disturb and wake the Wogglebug. Finally, consider that many changes in the system are not immediate, because the Wogglebug is a complex feedback system where several sub-circuits are responding to each other.

SMOOTH VCO OUT: Shark's Fin wave audio rate signal controlled by the External Input, Ego/Id Balance rotary setting, Influence CV In, and Clock Speed rotary. 10Vpp.

EGO/ID BALANCE ROTARY: with nothing inserted at the External Input, this sets the range of probable values. Turning the rotary CCW, random values generated by the system tend to "cluster." With a signal applied to the External In, it allows that external signal to be balanced with the internal signal source, to generate random voltages.

EXTERNAL IN: External input for Sample & Hold. Signals applied here will be injected directly to the uncertain, beating heart of the Wogglebug. Accepts CV or audio rate signals. Expects 10Vpp max.

INFLUENCE IN: CV and/ or Audio Signal input that performs the following duties: modulates frequency of Smooth and Woggle VCOs, inputs to the Ring Mod circuit, and level shifts the Woggle CV signal. Responds 0V to 10V.

WOGGLE ROTARY: Sets how quickly (or slowly) the Woggle circuit is able to catch the Smooth/ Stepped circuit. CW slows the Woggle CV, CCW speeds it up.

SPEED CV ATTENUATOR: Unipolar attenuator for Speed CV IN. Normalled to 8V.

SPEED CV IN: Unipolar CV In for **Speed** parameter. Normalized to +8V so that with nothing patched, the associated Speed CV Attenuator will extend the internal clock generator range up to around 200hz. Range: 0V to +8V.

EXTERNAL CLOCK IN: Any signal may be applied here, allowing for independent control of rate and smoothness.

DISTURB BUTTON: Direct control of the Sample & Hold circuit. Pressing will sample, and holding will hold.

SYSTEM CLOCK LED: Displays rate of Sample & Hold clock. When a signal is applied to the External Clock In, this shows the rate of the incoming clock/rising edge. With nothing patched, this LED will mirror the Internal clock.

RING MOD OUT: Pulse wave audio rate signal, ring modulated product of Smooth VCO, Woggle VCO, and audio rate signal at the Influence In (if present). It gets messy fast. The digital nature of the Ring Mod circuit makes simple waveforms (Pulse, Square, Triangle, Sine, Saw) almost necessary to achieve something remotely musical, but don't let that stop you from pumping Motown samples into this circuit. 10Vpp.

WOGGLE VCO OUT: Square Wave audio rate signal, controlled by Woggle rotary control, External In, Ego/Id Balance rotary, Influence CV In, and Clock Speed rotary. 10Vpp.

STEPPED OUT & LED: At lower Clock rates, the Stepped Random Voltage appears here: new value occurring at every clock pulse indicated by the blue system clock LED. At higher (audio) clock rates, bit reduction effects may be achieved by inserting an audio signal into External In and setting Ego/Id Balance rotary to full CCW. 10Vpp range. The **Stepped Out LED** gives visual indication of Stepped Random Voltage value.

SMOOTH OUT: Smooth CV appears here, the smoothness of which is set by the Clock Speed rotary control. Range: 0V to 10V.

WOGGLE OUT: A of product of the Smooth/ Stepped CV, this voltage quivers, shakes, and always chases after the heart of the system. Smoothed by the Woggle rotary; 0V to10V.

BURST OUT & BURST LED: Square random gate signal, synced to the clock and influenced by the Stepped, Smooth and Woggle rotaries. Range: 0 to +10V. The **Burst Out LED** provides visual respresentation of random gates.

CLOCK OUT & INTERNAL CLOCK LED: Square clock signal from the internal clock generator. Not influenced by signal at External Clock In. Range: 0V to +10V. The **Internal Clock LED** provides visual representation of the rate of the internal clock. It is not affected by the External Clock In.

SPEED ROTARY: Dual purpose control that sets the Rate of the Wogglebug's internal clock generator and lag processor feeding the Smooth CV circuit. Turning CCW slows the system and smoothes its response. Turning CW quickens the system with the Smooth CV response becoming jittery. Internal Clock generator range: 1 minute/cycle up to 40hz (extended range pushes upper limit to around 200hz).

NOTE: The gold lines on the Wogglebug denote the three key areas: 1. Audio at the top (noted here with gold text), 2. CV in the middle (noted here with blue text), and 3. Clock at the bottom (noted here with green text).

Is the Wogglebug my synthesizer's ID Monster? Yes! Should I beware of the Wogglebug? Maybe.

The Wogglebug is a random voltage generator, originally designed by Grant Richter of Wiard Synthesizers. The Wogglebug's purpose is to overtake the CV produced by your keyboard or sequencer during performance and give a voice to your synthesizer's ID. A continuation of the Smooth and Stepped, flucutuating, random voltage sources, pioneered by Don Buchla, the core of the circuit is based on the Buchla Model 265 "Source of Uncertainty" module, which many consider to be the most musical of all random voltage generators. Like the 265, the Wogglebug utilizes a lag processor (low frequency smoothing filter), a VCO, and a Sample & Hold in order to produce Stepped and Smooth (lagged; slewed) CV in the range of 0V to 10V.

Grant Richter's Wogglebug design expands on this system to include the otherworldly Woggle CVs (stepped voltages with decaying sinusoids at the edges), which must be heard in action to be truly appreciated. In a moment of considerable noise, Richter decided to tap into the sound sources at the uncertainly beating heart of the Wogglebug and bring them forth to the instrument's panel. He then figured a clever way to Ring Modulate these sounds and that, too, is on the panel of all Wogglebugs. Thus, the Wogglebug is a complete system. No external modules are required to Woggle; however, all voltage-controlled systems long to be tickled, bitten, plagued, and eventually destroyed, by the Wogglebug.

The Make Noise Wogglebug is not a clone. Instead, it is a tribute to all that Woggles and is an evolution of the original Grant Richter design. The Wogglebug is a single system. It also offers further functionality, such as an Influence In to the Ring Mod circuit, the ability to directly inject a signal to the heart of the Wogglebug via the Ego In, and a random gate Burst function. All of this has never appeared on any other Wogglebug. The Cluster circuit was also redesigned, and thus it has been renamed Ego/Id Balance, to reflect its further purposes, allowing for new functionality.