Voltage Modular: Cherry Audio MRB modules

This content was taken from the product pages on 28 October 2021.

Table of Contents

1 CP3 Console Panel Mixer 4
2 VM901 Voltage Controlled Oscillator 6
3 VM901ABBB Voltage Controlled Oscillator 8
4 VM902 Amplifier 10
5 VM903 Random Signal Generator 11
6 VM904A/B/C Filters 12
7 VM905 Reverb 16
8 VM907A Fixed Filter Bank 17
9 VM911 Envelope Generator 18
10 VM911-A Dual Trigger Delay 21
11 VM912 Envelope Follower 22
12 VM914 Fixed Filter Bank 24
13 VM921ABBB Oscillator Bank 25
14 VM921 Voltage Controlled Oscillator 25
15 VM923 Filters/Noise 29
16 VM927 Multiple 31
17 VM928 Sample Hold 32
18 VM958 Keyboard/VCO Interface 34
19 VM960 Sequencer 37
20 VM962 Sequential Switch 40
21 VM984 Four-Channel Matrix Mixer 41
22 VM995 Attenuators 42
23 VM1630 Frequency Shifter 43
24 VM2500 Blank Panel Module 1001 45
25 VM2500 Clocked Sequential Control Module 1027 46
26 VM2500 Dual Envelope Generator Module 1003 51
27 VM2500 Dual Envelope Generator Module 1033 54
28 VM2500 Dual Four-Channel Mixer Module 1051 57
29 VM2500 Dual Noise/Random Voltage Generator Module 1016 oscillators 58
30 VM2500 Dual Oscillator Module 1023 59
31 VM2500 Dual Reverberator Module 1025 61
32 VM2500 Filtamp Module 1006 63
33 VM2500 Mix-Sequencer Module 1050 65
34 VM2500 Modamp Module 1005 68
35 VM2500 Multimode Filter Resonator Module 1047 70
36 VM2500 Oscillator Module 1004-P 73
37 VM2500 Oscillator Module 1004-R 75

38 VM2500 Oscillator Module 1004-T 77
39 VM2500 Oscilloscope Module 1019 79
40 VM2500 Preset Voltage Module 1026 81
41 VM2500 Quad Envelope Generator Module 1046 83
42 VM2500 Sample & Hold Module 1036 86
43 VM2500 Synthesizer Voice Module 1045 88
44 VM2500 Triple VCA Module 1042 93

1 CP3 Console Panel Mixer

The VM900 CP3 is a recreation of the classic Moog "Console Panel Mixer." At high inputs levels, it had a tendency to clip the tops and bottoms of waveforms for a characteristic overdriven tone. We've also included a switch that allows selection between the more overdriven tone and the later, cleaner-sounding version.

Note that CP3 is DC-coupled and can be used to mix audio or sub-audio CV signals.

1.1 Inputs, Outputs, and Controls

The four inputs are stacked vertically on the left side of the panel; we'll go over the repeated controls just once.

Mixer Inputs jacks and level knobs- Plug inputs into the jacks and set volumes with the knobs. Signals will tend to clip at higher input levels, particularly when the *Model* switch is set to the *Rev. 1* position.

Model- Selects the audio characteristics of the earlier or later production CP3 circuit. *Rev. 1* has more of a tendency to clip waveforms, whereas *Rev. 2* is less inclined to break up.

Click Filter- When engaged, this rounds of sharp waveform edges to reduce clicking - it's intended for use with edgy control signals to reduce clicking when patched to something such as a VCA CV. **The Click Filter is generally not recommended for use with audio signals.**

Master Gain- Sets overall output volume. While turning up the four input levels will increase distortion (especially in rev1), *Master Gain* is pure output gain and has no effect on distortion.

+/- Output jacks - Signal outputs for positive and inverted mixed signals. The (-) out, in addition to being inverted from the (+) out, does not sound the same in *Rev. 1* mode - the distortion characteristics are very different between the two jacks. In fact, the outputs are so different that there is quite a stereo image to be had between them. *Rev. 2* mode is purely clean and does not exhibit these quirks.

2 VM901 Voltage Controlled Oscillator

The VM901 is a full-function oscillator module. It can be used in the audio range, or as a low-frequency modulation source.

2.1 Inputs, Outputs, and Controls

Fixed Voltage Control- Sets the range down five octaves or up six octaves.

Frequency Range- Sets the coarse frequency range to sub-audio or standard audio ranges in standard organ footages. Use the *Lo* setting when using VM901 as low-frequency modulation source.

Fine Tuning (0/1/2)- Allows continuously variable tuning down (*0*) or up (*2*) one octave.

Width Of Pulse Waveform- Sets the width or "duty-cycle" of the rectangular (aka, pulse) wave. It has no effect on any other waveform. Its default setting of 50% produces a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

Control Inputs- These are 1V/octave exponential inputs. They're used for pitch CV as well as modulating the oscillator frequency. All three jacks are the same and their incoming voltages are summed.

Sine/Saw/Triangular/Pulse volume knobs- These set the volume of each waveform for each respective output jack in the bottom row.

Fixed Level Outputs- These are outputs for the sine, sawtooth, triangular, and pulse waves, respectively. They not affected by the *Sine/Saw/Triangular/Pulse* knobs and are always at full output level.

Sine/Saw/Triangular/Pulse adjustable outputs- These are outputs for the sine, sawtooth, triangular, and pulse waves, respectively. Their output level is set by the *Sine*, *Sawtooth*, *Triangular*, and *Pulse* volume knobs.

3 VM901ABBB Voltage Controlled Oscillator

The VM901ABBB is an oscillator bank that replicates the unique oscillator controller/slave arrangement of classic Moog synthesizers.

The concept is that the Oscillator Controller module sets the overall coarse tuning as well as rectangular wave pulse width for the three slave oscillators.

In the original hardware modular systems, the oscillator controller and slaves were connected internally.

Any number of slave oscillators could be used, but the "one+three" combo was common, and we felt it represented a good compromise of utility and size. Though these have the appearance of four individual single-width modules, VM901ABBB is a single quad-width module. If for you need something physically narrower, use the VM901 oscillator module.

3.1 901-A Oscillator Controller

The oscillator driver is the "master control" center; all of its control settings will affect the three slave oscillators. Changing its *Frequency* setting will equally offset all three slave oscillators, for example.

3.1.1 Inputs, Outputs, and Controls

Fixed Voltage Control- Sets the range down five octaves or up six octaves.

Frequency Range- Sets the coarse frequency range to sub-audio or standard audio ranges in standard organ footages. Use the *Lo* setting when using VM901 as low-frequency modulation source.

Fine Tuning (0/1/2)- Allows continuously variable tuning down (*0*) or up (*2*) one octave.

Width Of Pulse Waveform- Sets the width or "duty-cycle" of the rectangular (aka, pulse) wave. It has no effect on any other waveform. Its default setting of 50% produces a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

Control Inputs jacks- These are 1V/octave exponential inputs. They're used for pitch CV as well as modulating the oscillator frequency. All three jacks are the same; signals received will be summed and are multed to all three slave oscillators.

3.2 901-B Slave Oscillators

As mentioned, 901-A oscillator driver settings equally affect all three slave oscillators. Conversely, settings on individual 901-B slave oscillators are independent and have no affect on the adjacent oscillators.

3.2.1 Inputs, Outputs, and Controls

Frequency Range- Sets the coarse frequency range to sub-audio or standard audio ranges in standard organ footages. Use the *Lo* setting when using VM901 as low-frequency modulation source.

Frequency Vernier- Allows continuously variable tuning down or up by about one octave and a major third.

Sine/Saw/Triangular/Pulse output jacks- Outputs for the sawtooth, sine, pulse, and triangular waves, respectively.

4 VM902 Amplifier

The idea of a voltage-controlled amplifier (VCA) is that an audio or control signal is patched to its input, and externally controlled voltage controlled via the *Control Inputs* jacks. This is useful for turning audio or control signals on or off, applying envelope volume curves to sounds, regulating the amount of modulation signals applied to audio signals, and more.

A simple analogy would be to think of a water faucet, with the control voltage affecting how much the faucet is opened.

4.1 Inputs, Outputs, and Controls

Linear (Lin.)/Exponential (Exp.)- Selects the "curve" of the amplifier's response as the input CV rises from 0 to 5V. *Lin.* or linear response curve is equally proportional across the voltage input range, whereas *Exp.* or exponential curve is closer to how the human ear perceives volume. You'll likely want to use the *Lin.* setting for modulation or control voltage situations, and use the *Exp.* setting when an envelope generator is used to control an audio signal with the amplifier. Or just use whatever sounds best, we won't tell.

Fixed Control voltage- Adds up to 5V of gain. This works in addition to incoming and *Control Inputs* jack voltages. It's useful for manually "opening" the amplifier for drones.

Control Inputs jacks- Control signal inputs are patched in here. These have no attenuators and are "wide open" all the time - typically these would be used to patch an envelope generator. All three jacks are the same, and when more than one is used, incoming voltages are summed.

Signal Inputs jacks- Use this jack to patch in audio or control signals to be controlled by the VCA. Both inputs are summed.

Signal Outputs jacks- These carry the CV-modified version of input signals.

5 VM903 Random Signal Generator

Random Signal Generator simultaneously outputs white and pink noise.

Noise signals are random-voltage signals that can be used as audio or control signals. As an audio signal, noise is often used to emulate the percussive hit of a drum or the breathiness of a voice. As a control signal, it can be a great source for creating randomness in a patch.

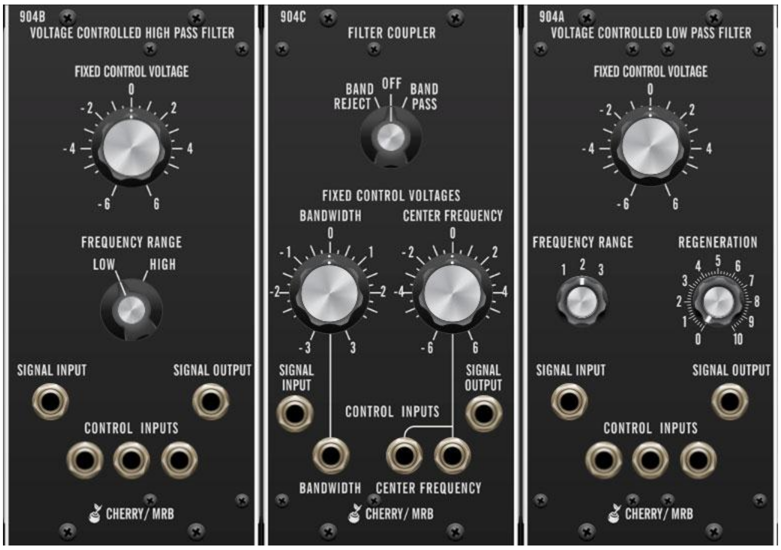
Noise signals are often used as the input signal of a Sample and Hold module which can adjust the rate at which random voltages are output.

5.1 Outputs

White Noise- Outputs a random signal in which all frequencies across the frequency spectrum are represented equally. Both jacks carry the same signal.

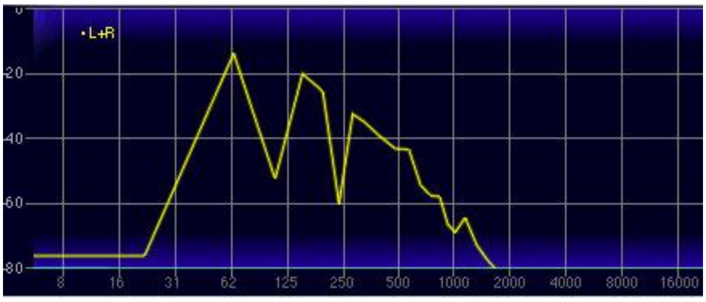
Pink Noise- Outputs a random signal in which each octave across the frequency spectrum is represented equally. Pink noise will sound duller to the ear than white noise, and as a control signal, will be less likely to output higher frequencies. Both jacks carry the same signal.

6 VM904A/B/C Filters

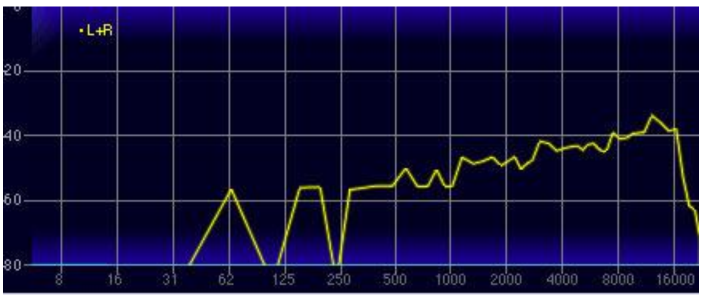


The 904A and 904B modules are emulations of the classic transistor ladder-style low pass and high pass filters, respectively. There are three separate modules: 904A is the classic 24dB/oct, low pass filter, 904B is a 24dB/oct high pass filter, and the 904C Filter Coupler allows 904A and 904B to be combined for band reject and band pass responses.

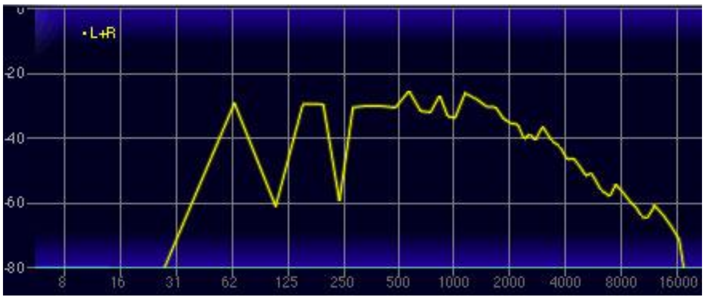
Following is an explanation of how each filter type works:



A low pass filter allows frequencies *below* the cutoff frequency setting to pass through, but blocks frequencies *above* the cutoff frequency. The frequency plot above shows the effect of a low pass filter with its cutoff set at 412 Hz on a sawtooth wave. (The vertical axis represents amplitude and the horizontal axis represents frequency.) You can see how the high-frequency content trails off as it gets higher.



This plot shows the same oscillator signal and cutoff frequency setting using the high pass mode. This is the opposite of low pass mode: high-frequency content remains, but low frequencies are removed as the cutoff frequency increases.



The plot above shows the same oscillator signal and cutoff frequency using a band pass filter. Band pass mode combines *both* low pass and high pass modes, leaving sound only "in the middle," aka the pass band... which should not be confused with The Gap Band, who will let frequencies across the audio spectrum pass through, and drop the bomb on you, baby.

A band reject filter is the inverse of band pass filter: a small spectrum of frequencies between the low pass and high pass settings are eliminated. This may not seem useful, but when the cutoff frequencies are modulated, band reject filters (also known as "notch" filters) can be used to create nifty sweeping phaser-like sounds ("phasers" as in the guitar stomp box effect, not the gun Capt. Kirk stunned green aliens with).

6.1 Module Configurations

The 904 modules are unique in that they can be used independently or in conjunction. As such we've provided a couple different versions - the 904A Low Pass and 904B High Pass filters are provided as individual modules, as well as together with the 904C Filter Coupler as one large module. In this configuration, the low pass and high pass filters are internally connected to the 904C Coupler, allowing band reject and band pass responses. **The 904C Filter Coupler doesn't process sound on its own; in a hardware Moog modular system, it is internally connected to the 904A and 904B modules. Because of this, 904C isn't provided as a single module.**

6.2 Inputs, Outputs, and Controls

6.2.1 904A Voltage Controlled Low Pass Filter

Fixed Control Voltage- Sets the frequency where high-frequency attenuation begins, over a 12-octave range. This control is generally called "cutoff frequency" on just about every other synth on the planet (remember that these designs date from the mid-60s). Turning to the left "closes" the filter for darker tone, and turning to the right "opens" it for brighter tone.

Frequency Range- Shifts the overall range of the *Fixed Control Voltage* knob in two-octave increments.

Regeneration- Also known as resonance or "Q," regeneration emphasizes sound energy at and around the current cutoff frequency by adding feedback from the filter's output back to its input. At lower settings, this can be used to create mild resonances such as those heard in acoustic instruments. At more extreme settings, resonance can create a pure sine wave at its own frequency (variable via the *Fixed Control Voltage* knob). Be careful with this knob as it can get loud at extreme settings.

Signal Input jack- Patch audio signals in here.

Control Inputs jacks- CV mod inputs. These sum with the *Fixed Control Voltage* frequency.

Signal Output jack- The filter output signal.

6.2.2 904B Voltage Controlled High Pass Filter

Fixed Control Voltage- Sets the frequency where low-frequency attenuation begins, over a 12-octave range. This control is generally called "cutoff frequency" on just about every other synth on the planet. Turning to the left lets more low/fundamental frequencies pass through, and turning to the right attenuates low frequencies.

Frequency Range- Shifts the overall range of the *Fixed Control Voltage* knob in 1.25 octave increments.

Signal Input jack- Patch audio signals in here.

Control Inputs jacks- CV mod inputs. These sum with the *Fixed Control Voltage* frequency.

Signal Output jack- The filter output signal.

6.2.3 904C Filter Coupler

As mentioned above, the 904C Filter Coupler internally connects the 904A Low Pass and 904B High Pass filter to enable band reject and band pass responses. Signals can be patched directly to and from the coupler module when using band reject and band pass modes.

Band Reject/Off/Band Pass switch- Selects the overall filter response behavior. In the *Off* position, the low pass and high pass filters are effectively disconnected and function as normal; their respective panel signal input and output jacks can be used for signal routing.

When set to the *Band Pass* position, the low pass and high pass filters are connected in series; i.e. the low pass filter removes high frequencies, and the high pass filter simultaneously removes low frequencies, allowing the "in-between" frequencies to pass.

The *Band Reject* setting is the inverse of the *Band Pass* setting - the central frequencies *between* the low pass filters are removed.

Bandwidth- Sets the frequency span of the pass band up to three octaves.

Center Frequency- Sets the central frequency.

For correct Filter Coupler control behavior, the 904A Low Pass and 904B High Pass Fixed Control Voltage and Frequency Range controls should all be set to center position.

Setting the 904A and 904B controls differently won't hurt anything, but the coupler controls may not behave as expected.

Signal Input jack- Patch audio signals in here.

Bandwidth jack- CV mod input affecting bandwidth.

Control Inputs jacks- CV mod inputs. These sum with the *Center Frequency*.

Signal Output jack- The filter output signal.

7 VM905 Reverb

The VM905 is an accurate emulation of a vintage-style dual-spring reverb.

7.1 Inputs, Outputs, and Controls

Reverberation- Increases the mix level of the reverberated signal. The dry signal always passes at 100%.

Input- Patch inputs signals here.

Output- Patch outputs signals here.

8 VM907A Fixed Filter Bank

The VM907A Fixed Filter Bank consists of eight bandpass filters that attenuate frequencies at 1/2-octave intervals as well as fixed corner-frequency lowpass and highpass filters.

Its intended use is to create more realistic instrumental sounds by imparting a pattern of peaks and dips to the audio spectrum of synthesizer waveforms.

8.1 Inputs, Outputs, and Controls

Lowpass- A low pass filter allows frequencies *below* the cutoff frequency setting to pass through, but blocks frequencies *above* the cutoff frequency. This knob does not control the cutoff frequency; it controls the volume of frequencies below the fixed 175 Hz cutoff frequency.

Bandpass Filter volume knobs- Each of the eight main knobs corresponds to a medium-Q, four pole, dual stagger-tuned bandpass filter. The input signal is presented to all the filters and the knobs collectively behave like an output mixer. At zero, that channel is completely off. When everything is turned up, all filters are heard and the response is a bumpy spectrum with a peak at every center frequency and a dip in between.

Highpass- A high pass filter allows frequencies *above* the cutoff frequency setting to pass through, but blocks frequencies *below* the cutoff frequency. This knob does not control the cutoff frequency; it controls the volume of frequencies above the fixed 4000 Hz cutoff frequency.

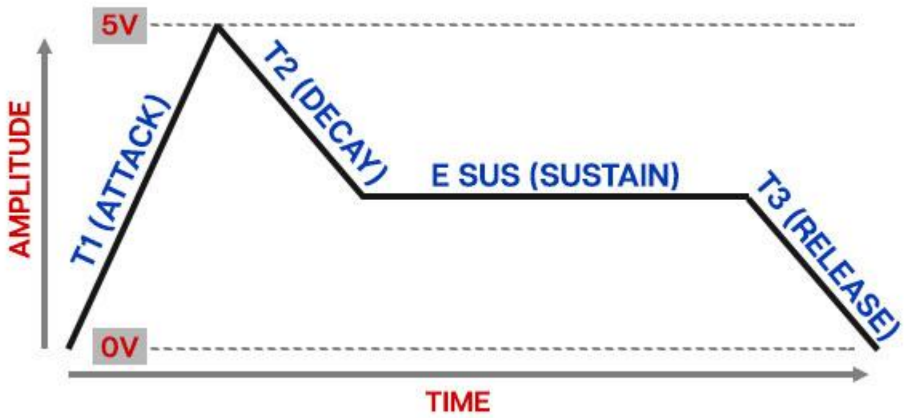
Input jacks- Patch audio signals in here.

Output jacks- Summed output of the fixed filter bank.

9 VM911 Envelope Generator

The VM911 Envelope Generator module is a standard "ADSR"-style envelope generator, with slightly unconventional control names. Remember that this modules was originally developed in the mid-60s, before analog synthesis terminology was cemented.

If you're not familiar with the operation of envelope generators, here's an overview:



When a gate voltage is sent to the *Gate* jack, the envelope generator outputs a voltage that changes dynamically according to the settings of its four stages.

The *T1* (attack) stage defines how long it takes for the output voltage to rise from 0 to 5 volts. Once the attack stage reaches 5V, it moves to the *T2* (decay) phase, which defines how long it takes to fall from 5V to the setting of the *E Sus* (sustain) phase. Unlike the *T1, T2*, and *T3* phases, each of which define a time, *E Sus* simply sets the held voltage level following the *T1* and *T2* phases - this usually equates to the envelope output level while holding down a key on a keyboard controller. Finally, the *T3* knob defines the the length of time it takes for the voltage to fall back to 0V when the gate input voltage is removed (typically when you let go of a key on a keyboard controller).

For those interested, the T1 is (almost) linear, and T2 and T3 curve logarithmically.

(BTW, *Esus* is so named because E is the symbol for voltage in electro-speak. Make sure to spout this kind of knowledge at social gatherings - we guarantee you'll be the hit of the party.)

9.1 V-Triggers vs. S-Triggers

If you haven't used actual vintage Moog synthesizers, you can probably skip this section with no life-altering consequences. If you're a cork-sniffin', vintage analog aficionado, this section is ALL you.

V-triggers and S-triggers refer to two types of signal used to activate envelope generators. The most common type is a V-trigger, more commonly referred to as a "gate" signal. This is usually a +5V DC signal. As long as the the gate voltage is high, the envelope generator runs through its attack and decay phases, then holds at the sustain voltage until the gate goes to zero (typically this occurs when a key is released), at which point the envelope moves to the release stage.

For most triggering applications, Moog used S-triggers, short for "shorting" triggers. This was a simple switch circuit where shorting the two conductors triggered envelopes; the envelope would run through its stages as above as long as the conductors were shorted. When the the conductors were disconnected, the envelope would move to the release stage. The thinking was was that any switch could be used to trigger the envelopes - footswitches, toggles, etc.

Ultimately, S-triggers proved to be the Betamax of envelope triggering methods - just about every modern synth uses gate signals. Additionally, in order to avoid operational calamity, S-triggers used a non-standard, two-blade "Cinch-Jones" connector, further complicating things.

Though we strove for accuracy in every aspect of these modules, to put it bluntly, we saw no benefit in recreating S-triggers within the confines of the Voltage Modular environment. The end result would have no impact on response or sound quality - it would've just complicated interfacing with other modules. With that in mind, the Cherry Audio/MRB VM900 modules all make use of standard gate voltages and "normal" Voltage Modular cables for triggering purposes.

9.2 Inputs, Outputs, and Controls

T1 (Attack)- Defines the length of time for voltage to rise from 0V to 5V when the gate voltage is applied. The time range is from 2ms to 10 seconds.

T2 (Decay)- Defines the length of time for voltage to fall from the *T1* stage 5V peak to *Sustain* level setting. The time range is from 2ms to 10 seconds. Also sets how long until an Arnold Schwarzenegger cyborg storms your studio.

T3 (Release)- Defines the length of time for voltage to fall from *E Sus* level to 0V when the gate is released. The time range is from 2ms to 10 seconds.

E Sus (Sustain)- Sets the held voltage level following *T1* and *T2* phases.

Gate jack- This is where you'll patch gate voltages to initiate the envelope generator cycle. Most often this will come from the IO Panel *Gate* output.

- **Can I use a "trigger" to trigger an envelope generator?** It would seem logical, but the answer is, "basicallly, no." First let's clarify the difference between a gate signal and a trigger signal:
  - A **gate** is a *constant* voltage. If you're playing a keyboard, it remains high (i.e. +5V) as long as the key is held down.
  - A **trigger** is a *rapid spike* of +5V. It's useful for a number of things (like turning stuff on and off, or triggering "one-shot" drum sounds or modules).

Though a trigger signal technically will work, it happens so quickly that the resulting envelope generator output would be inaudible.

Like most standard envelope generators, the VM911A needs to see a constant gate voltage to move through the *T1* and *T2* phases and hold during the *E Sus* phase. Removing the gate voltage following the *E Sus* phase instantly jumps to the *T3* stage.

Env Out- This is the envelope voltage output. The *Env Out* voltage ranges from 0V to +5V.

10 VM911-A Dual Trigger Delay

The VM911-A Dual Trigger Delay module is similar to the VM911 Envelope Generator, but instead of outputting dynamic envelope voltages, it simply delays voltages. With short time settings, it's useful for "double-attack" type sounds; with longer settings, it can be used to delay the onset of layered sounds.

When a gate voltage is sent to the *Gate* jack, the envelope generator outputs a voltage that changes dynamically according to the settings of its four stages.

10.1 Inputs, Outputs, and Controls

Delay Time- Defines the length of time the gate voltage is delayed. The time range is from 2ms to 10 seconds.

Input- Patch gate voltages to this input.

Output- The delayed gate output voltage.

Coupling Mode- Coupling allows the top and bottom sections to operate in a couple ways depending on the current setting, as follows:

- **Off**: Top and bottom sections work independently.
- **Parallel**: The top delay section's Input jack triggers the timing circuit for both top and bottom sections simultaneously.
- **Series**: The top delay section's *Input* jack triggers the timing circuit for the top section, then triggers the bottom sections timing circuit when it's done. This is the same as patching the top *Output* to the bottom *Input*, and is useful for achieving longer delay times, or guaranteeing that the second output will always follow the first regardless of time settings.

11 VM912 Envelope Follower

The VM912 Envelope Follower outputs a dynamically changing voltage that follows the amplitude of an incoming signal, either from within Voltage Modular, or from an external audio source, via Voltage Modular's sidechain in and IO Panel *Audio Sources* jacks. (See **Audio Sources** in the IO Panel section of the Voltage Modular user guide for more information about using sidechain inputs).

This is a great tool for creating dynamic CV signals that can be used to modulate just about anything in Voltage Modular. A drum loop, for example, could be used to modulate the cutoff frequency of a filter, the pitch or pulse-width of an oscillator, etc.

11.1 Input, Output, and Controls

Response Time- Sets how fast the follower circuit responds to incoming signals, from 0.01 to 0.1 seconds. Low-frequency input signals generally require the longer response times and vice-versa with high-frequency input signals.

Threshold- Adjusts the voltage level necessary to output a 5V gate signal at the *Gate Out* jack.

Signal Input jack- Input jack for the AC audio signal that will be converted to a CV output.

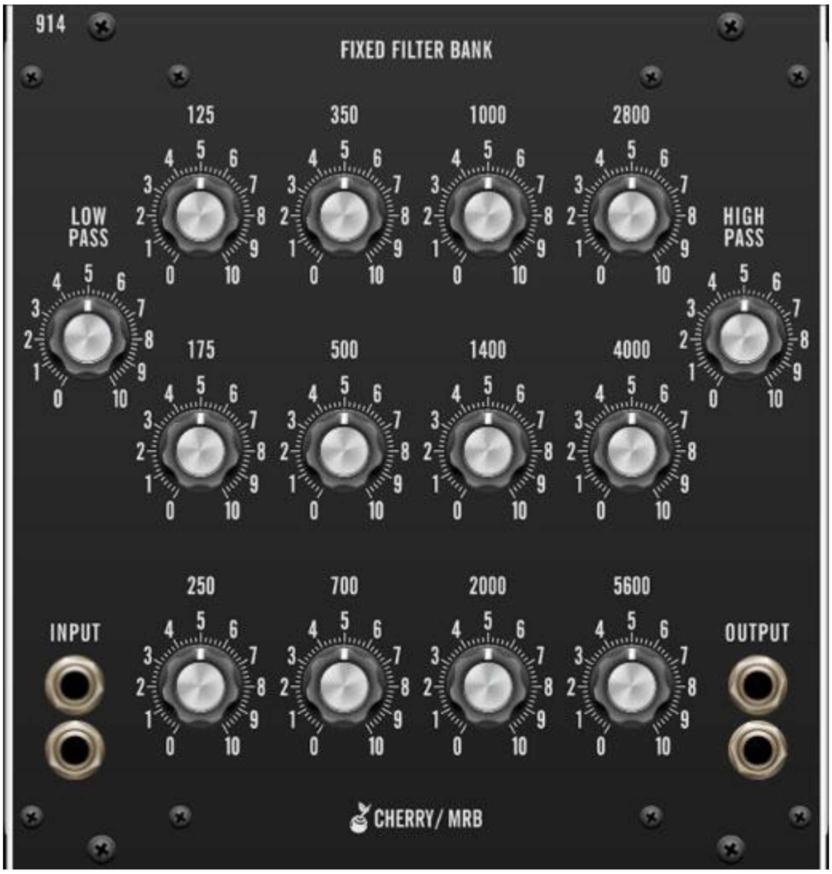
Control Output- Output for the dynamically changing DC voltage derived from the input signal.

Of note is that the original 912 envelope follower is unique among all other envelope followers in that the output is in dB, which is essentially the log of the amplitude instead of the amplitude itself. This is huge, as in really huge. In all other envelope followers, the output is linearly proportional to amplitude, but that’s not how the human ear perceives sound, hence the superiority of the 912 design. It should go without saying that the VM912 module accurately recreates the response of the original.

Control Input- This input expects a positive control signal similar to what is output by the follower. It is then sent to a voltage comparator which compares this signal with the *Threshold* setting. If the signal is greater than the *Threshold*, 5V is output at the *Gate Output* jack. A slight amount of hysteresis is applied to keep the *Gate Output* from chattering. A useful application for this section alone might be the deriving of a gate signal from an LFO anywhere in its phase, or anything else a voltage comparator might be useful for.

If nothing is plugged into the *Control Input* jack, the *Control Output* signal is normalled, as indicated by the dotted line. This allows one signal to provide a dynamically changing DC voltage at the *Control Output* jack, as well as a +5V gate signal at the *Gate Output* jack.

12 VM914 Fixed Filter Bank



The VM914 Fixed Filter Bank consists of 12 bandpass filters that attenuate frequencies at 1/2-octave intervals as well as fixed corner-frequency lowpass and highpass filters.

Its intended use is to create more realistic instrumental sounds by imparting a pattern of peaks and dips to the audio spectrum of synthesizer waveforms.

12.1 Inputs, Outputs, and Controls

Lowpass- A low pass filter allows frequencies *below* the cutoff frequency setting to pass through, but blocks frequencies *above* the cutoff frequency. This knob does not control the cutoff frequency; it controls the volume of frequencies below the fixed 90 Hz cutoff frequency.

Bandpass Filter volume knobs- Each of the twelve main knobs corresponds to a medium-Q, four pole, dual stagger-tuned bandpass filter. The input signal is presented to all the filters and the knobs collectively behave like an output mixer. At zero, that channel is completely off. When everything is turned up, all filters are heard and the response is a bumpy spectrum with a peak at every center frequency and a dip in between.

Lowpass- A low pass filter allows frequencies *above* the cutoff frequency setting to pass through, but blocks frequencies *below* the cutoff frequency. This knob does not control the cutoff frequency; it controls the volume of frequencies above the fixed 8000 Hz cutoff frequency.

Input jacks- Patch audio signals in here. Both jacks are the same, there are just two of them, because... more is better?

Output jacks- Summed output of the fixed filter bank. Both outputs are the same.

13 VM921 Voltage Controlled Oscillator

The VM921 is a full-function oscillator module. It can be used in the audio range, or as a low-frequency modulation source.

13.1 Inputs, Outputs, and Controls

Scale- Sets the *Frequency* knob range to +/- 12 or +/- 6 semitones.

Coarse Range- Sets the coarse frequency range to sub-audio or standard audio range. Use the *Sub-Audio* setting when using VM921 as low-frequency modulation source; use the *Audio* setting when using as standard audio source.

Frequency- Continuously sets the base oscillator frequency range to +/- 12 or +/- 6 semitones depending on the *Scale* switch setting.

Range- Sets the base oscillator frequency in standard organ-style footage increments.

Waveform Volume- Sets the volume of the sine, triangle, square, ramp, and pulse waves in the master output. These do not affect volume of the individual wave out jacks.

Rectangular Width (Pulse Width) and Width Control jacks- Sets the width or "duty-cycle" of the rectangular (aka, pulse) wave (the waveform on bottom right of the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

The Width Control In jacks allow CV control of the width of the rectangular (pulse) wave. Both jacks are the same; their input voltages will be summed.

Clamping Point and Clamp Trig. jack- This is commonly known as oscillator sync. Sending a trigger or gate voltage to the *Clamp Trig.* jack restarts the wave from a point defined by the *Clamping Point* knob, from 0% to 100% of its cycle. (Incidentally, my family used to vacation at Clamping Point Knob in rural Maine in the 70s, but that's not important right now).

The *V* input is sensitive to rising edges passing through a +1V threshold. The *S* input is sensitive to falling edges passing through +1V. This reproduces the logic of S-trigger action without the headache.

Aux. Out. Waveform and Aux. Out. Level- Since all of the waveforms are concurrently available at the bottom jacks, these acts as convenient selectable wave outs with a dedicated volume knob. The right output jack signal is normal, and the left output jack signal is inverted. This section's settings have no effect on the dedicated wave out jacks at the bottom of the module.

Frequency Control Input jacks- Accepts a 1V/oct CV input for pitch or modulation. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, a sequencer CV out, or a mod source. All three mod input jacks are the same and their CV's are summed.

These mod inputs are exponential, that is, for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Sine/Triangular/Sawtooth/Rectangular output jacks- Output jacks for all oscillator waves. These can be used simultaneously, or in any combination. These are always at full amplitude.

14 VM921ABBB Oscillator Bank

The VM921ABBB is an oscillator bank that replicates the unique oscillator driver/slave arrangement of classic Moog synthesizers.

The concept is that the the Oscillator Driver module sets the overall coarse tuning as well as rectangular wave pulse width for the three slave oscillators.

In the original hardware modular systems, the oscillator driver and slaves were connected internally.

Any number of slave oscillators could be used, but the "one+three" combo was common, and we felt it represented a good compromise of utility and size. Though these have the appearance of four individual single-width modules, VM901ABBB is a single quad-width module. If you need something physically narrower, use the VM921 oscillator module.

14.1 921A Oscillator Driver

The oscillator driver is the "master control" center; all of its control settings will affect the three slave oscillators. Changing its *Frequency* setting will equally offset all three slave oscillators, for example.

14.1.1 Inputs, Outputs, and Controls

Frequency- Continuously sets the frequency range to +/- 12 semitones or +/- 6 octaves depending on the *Semitone/Octave* switch setting.

Semitone/Octave switch- Sets the *Frequency* knob range to +/- 12 semitones or +/- 6 octaves .

Width Of Rectangular Wave (Pulse Width) - Sets the width or "duty-cycle" of slave oscillator rectangular (aka, pulse) waves. It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

Control Inputs/Frequency jacks- These are 1V/octave exponential inputs. They're used for pitch CV as well as modulating the oscillator frequency. All three jacks are the same and their incoming voltages are summed.

Control Inputs/Width jacks- Allows CV control of the width of slave oscillator rectangular (pulse) waves. Both jacks are the same; their input voltages are summed.

14.2 921B Slave Oscillators

As mentioned, 921A oscillator driver settings equally affect all three slave oscillators. Conversely, settings on individual 921B slave oscillators are independent and have no affect on the adjacent oscillators.

14.2.1 Inputs, Outputs, and Controls

Frequency- Continuously offsets the frequency range +/- 12 semitones or . This is useful for creating stacked-harmony "chords."

Range- Sets the base oscillator frequency in standard organ-style footage increments. The *Lo* setting is below the audible hearing range and is intended for modulation purposes (unless you enjoy the sound of "click-click-click.")

Synch. Weak-Strong and Synch In. jack- Vintage Moog oscillator synch is unlike a conventional cycle reset type of synch, thus it doesn't lend itself to classic "tearing" sync sweep sounds. 921 oscillator synch is based on phase-lock-loop principles: the oscillator waveform and the incoming synch waveform are put through a phase comparator which outputs out a voltage proportional to the difference between the two frequencies. This voltage is added to the VCO control voltage sum as a kind of “error correction” signal in an attempt to bring the oscillator into tune with the synch signal. It’s akin to attempting to tune a guitar with a friend’s: you apply a “correction” to the tuning peg. However, the correction voltage is limited in strength. The weak/strong switch determines how far the correction can reach. What makes it interesting is that the phase comparator is sensitive to harmonics and will lock on to them as well. During a frequency sweep of one of the oscillators while the other is held still, you'll hear the tone grab on, get stretched, and then let go because the phase comparator loses its "magnetic" grip. It’s a unique sound, and it’s interesting to note that the 921 and the 921ABBB sport completely different synch capabilities.

Sine/Triangular/Sawtooth/Rectangular output jacks- Output jacks for all oscillator waves. These can be used simultaneously, or in any combination. These are always at full amplitude.

A.C. Modulate- AC-coupled linear modulation input. Preferred input for FM effects.

D.C. Modulate- DC-coupled linear modulation input.

15 VM923 Filters/Noise

The VM923 is a multi-function modules featuring white and pink noise as well as independent single-pole 6 dB/octave low pass and high pass filters.

15.1 Inputs, Outputs, and Controls

15.1.1 Low Pass and High Pass Filters

Low Pass frequency- Sets the cutoff frequency of the low pass filter from 10 hz to 10 kHz.

In jack- Patch low pass filter inputs signals here.

Out jack- The output of the low pass filter.

High Pass frequency- Sets the cutoff frequency of the high pass pass filter from 10 hz to 10 kHz.

In jack- Patch low pass filter inputs signals here.

Out jack- The output of the low pass filter.

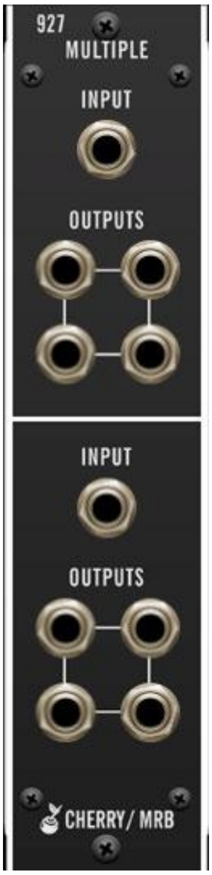
15.1.2 Noise Source

White noise output jacks - Two identical outputs for white noise. White noise is a random signal in which all frequencies across the frequency spectrum are represented equally, and is useful for wind and surf effects.

Pink noise output jacks - Pink noise is a random signal in which each octave across the frequency spectrum is represented equally. It tends to sound darker and bassier, and often works better as a mod source if you don't want total chaos.

Pink Lady was a short-lived Japanese novelty vocal duo from 70s. They briefly had their own NBC variety show, back when that corny crap was the business (kinda literally). It later was changed to *Pink Lady and Jeff*, but we don't talk about him, ok?

16 VM927 Multiple



The VM927 Multiple is a dual module that duplicates the CV or audio signal received at its input to the four output jacks beneath for routing to multiple destinations.

The Multiple module can also be used to help organize or quickly re-route signals. Copying the *Pitch* and *Gate* jacks from the I/O panel, for example, is a common practice for keeping things tidy and versatile. By using the outputs of a Multiple to send pitch and gate CVs to all of the oscillators and envelopes in a patch, the input source can easily be changed, to an arpeggiator or sequencer for example, without having to re-patch every pitch and gate CV.

Remember that all Voltage Modular input and output jacks feature unlimited mults; the idea behind using a mult module is to make it easier to visualize cable routing. Using a dedicated multiple module also lets you take advantage of Voltage's *Add Label* right-click command for better organization.

16.1 Inputs, Outputs and Controls

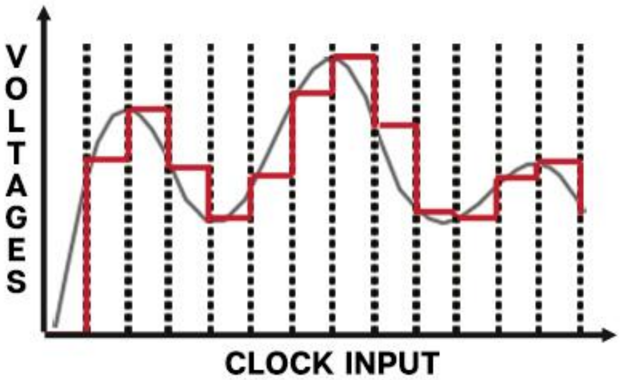
Input jack- This is the input jack for the CV or audio signal that will be copied to the output jacks.

Outputs jacks- These four jacks will output a copy of the signal received at the input jack.

17 VM928 Sample Hold

The VM928 is a sample and hold with an internal clock source and a glide section.

Below we've illustrated how a sample & hold works. In the image below, the smooth gray line shows a continuous input signal. Each time the module is triggered by an incoming clock signal, the current voltage is “sampled” and “held” until the next trigger. The red line shows the stepped output signal.



17.1 Inputs, Outputs, and Controls

Clock Rate- Sets the speed of the onboard clock from 0.3 to 30 Hz.

Trig In- Patch external trigger signals here when the *Sampling* switch is set tothe *Ext* position.

Control Input- Patch a clock source here. By default, the *Clock* input is normalled from EG 1, but the connection can be overridden by patching any CV source to the *Control Input* jack. Typical clock sources would be the modulation generator, or one of the oscillators square or pulse wave outs.

Out- The "stepped" sample and hold output.

The most common use for a sample and hold is the familiar "random robot pitches" heard in a zillion sci-fi movies and 70s game shows (if you're old enough to remember *Tic-Tac-Doe* - how 'bout that Wink Martindale?!?). Requiring just two cables, this is a super easy patch to make with PS-20:

Reverberation- Increases the mix level of the reverberated signal. The dry signal always passes at 100%.

Input- Patch inputs signals here.

Output- Patch outputs signals here.

18 VM958 Keyboard/VCO Interface

The VM958 is a MIDI-to-CV converter that outputs monophonic control CV's. It also features a "trio" mode that can output three individual pitch CV's for "paraphonic" operation (three-note polyphony with common gate/envelope). It also includes independent glide time controls for each pitch CV.

18.1.1 MIDI Input Section

MIDI Input- This is where incoming MIDI signals are routed, either from Voltage's I/O Panel MIDI *From Host* jack, or from a module with a MIDI output.

Scale- Sets pitch tracking across the keyboard from *0/50%* (24 keyboard half-steps = one octave) to *10/200%* (6 keyboard half-steps = one octave). The default setting is *5/100%*, i.e., standard 12 keyboard half-steps = one octave.

Range- Continuously sets pitch offset, up or down one octave, with *5* being nominal.

Glide Shape- Sets the voltage "curve" when using glide to linear, logarithmic or anywhere in between. When set to *Linear*, the voltage changes at the same rate for the duration of the note change; when set to *Logarithmic*, the voltage change gets slower as it approaches the destination CV.

18.1.2 Glide Section

Glide- Enables or disables glide for all three pitch CV's.

Glide Enable jack- Allows CV control of the *Glide* switch position. Voltages > 1V enable glide, voltages < 1V disable it. When a jack is inserted, the switch is disabled; when CV control is used, the switch automatically moves, Harry Potter-style for a visual indication of the glide state.

Glide Times- These individually set the speed of transition between pitch CVs for each of the three pitch CVs. If *Note Priority* is set to one of the mono modes (i.e. *Low*, *High*, or *Last*), only the left-most *Glide Times* knob is used. "*Glide Times*" also may or may not be a smash disco hit from the band *Chic*.

Glide Control Voltage Inputs- CV inputs for individually controlling the rate of glide for each *Glide Time* knob.

18.1.3 Control Voltage Outputs Section

Legato/Retrigger switch- If *Legato* is selected, the envelopes will only retrigger if no other notes are currently held. Legato mode is useful for emulating the sounds of some acoustic instruments - for example, the sound of plucking a note on a guitar, then sliding on the string to different notes without plucking again. If *Retrig.* is selected, the gate signal will restart every time a new key is pressed, thus retriggering any patched envelope generators. Retrigger mode generally feels more responsive to play and is useful for more aggressive passages.

Note Priority- Modular synths are most played monophonically (i.e. one note at a time), but VM958 also includes a three-note polyphonic "trio" mode. Below are the triggering characteristics for each *Note Priority* setting:

- **Low**- If more than key is pressed, the lowest note will always sound. *CV1*, *CV2*, *CV3* all output the same mono CV.
- **High**- If more than key is pressed, the highest note will always sound. *CV1*, *CV2*, *CV3* all output the same mono CV.
- **Last**- This is the default voice mode. If more than one key is pressed, the most recently struck note will always take priority. *CV1*, *CV2*, *CV3* all output the same mono CV.
- **Trio**- Trio mode outputs up to three separate pitch CVs at the *CV1*, *CV2*, *CV3* jacks, depending on how many notes are currently played. Note assignment is as follows:
- *CV1* = lowest note
- *CV2* = most recent middle note
- *CV3* = highest note

Gate- This is an "on/off" (0 or 5V) voltage typically used to engage envelope generators.

Velocity- Outputs a voltage upon keydown varying from 0-5V, dependent on how hard the key is struck. Useful for controlling filter cutoff amount and amplitude envelope intensity.

Bend- Outputs a variable negative or positive voltage as the pitch wheel is moved from its center position. range is one octave, up or down.

Mod- Outputs a variable constant voltage dependent on mod wheel position.

Sustain- Outputs a constant 5V when a controller's sustain pedal is down.

19 VM960 Sequencer

The VM960 is a super-accurate reproduction of THE classic three-channel, eight-stage sequencer, famously used by Tangerine Dream, Kraftwerk, and a guy named Keith something or other. When combined with the VM962 Sequential Switch module, the eight-stage rows can run sequentially for 16- or 24-stage sequences.

For information on syncing the 960 sequencer to a host DAW, check out this swell video: https://youtu.be/fqasWvcVke4

19.1 Basic Operation

Each step comprises a vertical column with an indicator lamp, three CV knobs, a switch specifying stage behavior, a "manual" button to instantly jump to the step, and gate in and out jacks. When the internal oscillator is enabled, the sequencer plays through the steps from left to right according to each step's *Skip/Normal/Stop* selector, and outputs voltages to the jacks at the right of the panel according to CV knob settings. The CV's are most frequently patched to oscillator CV inputs for pitch control, but sequencer outputs can be patched to any CV-controllable module parameter, such as filter cutoff frequency, VCA amplitude, etc. Envelope generators can be gated using the onboard oscillator *Control Out* (i.e. clock) jack or via one of the *Out* jacks at each stage.

Since the onboard oscillator isn't used for audio duties, we'll refer to it as a "clock," to make it easier to understand its function.

19.2 Oscillator (Clock) Section

This is VM960's internal clock. When activated, this causes the sequencer to run through its stages. It has a range of 0.1-1000 Hz.

Oscillator On lamp- Glows when the oscillator is active - consider this a "play" light.

Frequency Range- Sets the clock oscillator speed is one-octave increments.

Frequency Vernier- Fine tunes clock speed, and has a fancy name... say it out loud, it's fun!

Osc. On/Osc. Off buttons- Activates the clock oscillator. Basically these are play and stop buttons, respectively.

Osc. On/Osc. Off CV inputs- Allows starting and stopping of the clock via gate or trigger CV's.

Control Input- Allows CV control of clock oscillator frequency. The oscillator and *Control Input* are calibrated to the 1V/oct standard, allowing VM960 to be used as a complex oscillator when played at audio rates.

Oscillator Output- Pulse wave CV output of the oscillator.

19.3 Sequencer Stage Controls

There are nine sequencer stages - eight standard stages, and one special "stop" stage. We'll go over the controls for the eight standard steps first:

Stage Active lamp- The stage lamp illuminates to show the current stage is active.

Row 1/2/3 CV knob- Sets the DC voltage for the stage. Depending on the current setting of the Voltage Range knob at the far right, the range for each stage will be 0-2V, 0-4V, or 0-8V. Since Voltage Modular follows the 1V/oct standard, this translates to two, four, or eight octaves.

Skip/Normal/Stop selector- Defines the behavior for each stage when playback "arrives" at the stage as follows:

- **Skip**- Immediately jumps to the next stage.
- **Normal**- Outputs the voltages as defined by the CV knobs for the current clock duration.
- **Stop**- Inhibits shifting to the next stage (clock oscillator will remain on though).

Set- Instantly jumps to the stage when pressed (regardless of whether the internal clock is running).

In CV jack- Instantly jumps to the stage when a gate or trigger voltage is received.

Out CV jack- Outputs a gate voltage as long as the stage is active.

19.3.1 Stage 9 (Off)

This stage defines VM960's behavior following stage 8, depending on the the setting of its *Skip*/*Stop* selector. We'll go over the controls from top to bottom again, as they're a little different from a standard stage.

Stage Active (Off) lamp- The stage lamp illuminates to indicate the sequence is currently at the "stop" step.

Skip/Stop selector- Defines the stage 9 behavior as follows:

- **Skip**- Following stage 8, the sequence immediately returns to stage 1 for continuously looping playback.
- **Stop**- Following stage 8, the clock is stopped and sequence playback stops.

Set- Instantly jumps to stage 9 when pressed (regardless of whether the internal clock is running).

In CV jack- Instantly jumps to stage 9 when a gate or trigger voltage is received.

Out CV jack- Outputs a gate voltage as long as stage 9 is active.

The *In*/*Out* CV jacks can be used to create sequence patterns less than 8 steps by patching the output of the desired last stage to the desired first stage. For example, to create a six-step sequence, patch stage 7 *Out* jack to stage 1's *In* jack.

19.3.2 Right-Side Controls and Jacks

Row A/B/C CV Out Jacks- Each row has two corresponding CV out jacks. On the original 960, the output signals were identical, but we've taken the liberty of making the left jack a 1/2 step (volt) quantized output. This greatly simplifies the creation of diatonic and chromatic melodies. The right jack is not quantized; this is likely more useful for non-melodic CV purposes, such as filter cutoff frequency or amplitude modulation.

Row A/B/C X1/X2/X4 Range selectors- Selects the voltage range for the each horizontal row of CV knobs as follows:

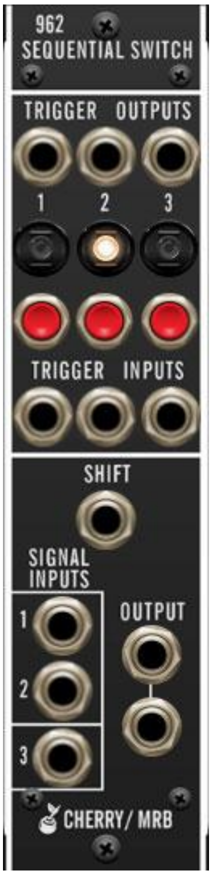
- **X1**- 0-2V
- **X2**- 0-4V
- **X4**- 0-8V

3rd Row Control Of Timing- This hard wires row C's non-quantized output to the clock oscillator's *Control Input* jack. If the CV knob is set to zero, clock frequency will not be affected; every volt will double the oscillator frequency.

Shift button- Pressing this advances to the next stage (with the internal clock on or off).

Shift jack- Advances the sequence to the next stage when a trigger or gate voltage is received, with internal clock on or off. If the clock is off, the shift jack is useful as an external clock in, using any kind of repeating oscillator or LFO (we recommend something with a hard edge, such as a pulse or sawtooth wave). With the clock enabled, shift jack will cause the sequence to "jump," which may or may not be useful depending on how crazy you want to get with sequence timing.

20 VM962 Sequential Switch



The VM962 Sequential Switch is essentially a 3-stage sequencer, intended as a companion module for the VM960 sequencer. It allows VM960's 8-stage rows to play consecutively in order to create 16- or 24-stage sequence patterns. Groups of stages can also be selected via pushbutton or CV.

Have a look at this video for step-by-step info on how to set up 16- or 24-step sequences using the VM960 and VM962 modules: https://youtu.be/a_RB0CXa9Mc

20.1 Inputs, Outputs, and Controls

Trigger Outputs 1/2/3- Outputs a constant 5V gate signal when the current stage is active.

Stage 1/2/3 lamps - Glows when the current stage is active.

Set 1/2/3 buttons- Jumps to the stage when pressed.

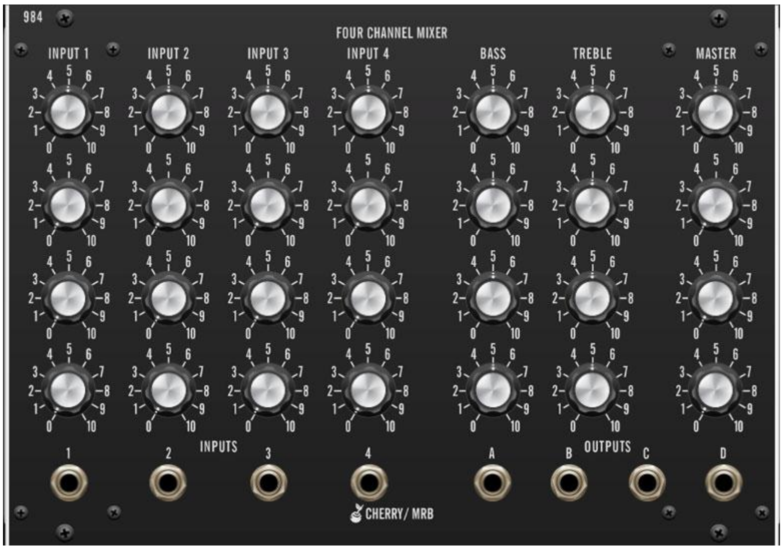
Trigger Input jacks 1/2/3- Jumps to the stage when a gate or trigger voltage is received.

Shift jack- Advances the sequence to the next stage when a trigger or gate voltage is received. Normally, VM962 will alternate between stages 1 and 2. If an input is plugged into the *Signal Inputs 3* jack, *Shift* will step through all three stages consecutively. **An input must be plugged into the *Signal Inputs 3* jack to use all three stages.**

Signal Inputs- Patch the sequencer output row CVs in here. Keep mind that VM962 can be used with any kind of audio or control signal though.

Output jacks- Combined output of all three stages. The jacks are duplicated - both carry the same signal.

21 VM984 Four-Channel Matrix Mixer



The VM984 Four-Channel Matrix Mixer is a four-input/four-output mixer that allows highly flexible routing and level setting of up to four audio signal paths to four individual outputs. Note that VM984 is AC-coupled and intended for use with audio signals only.

21.1 Inputs, Outputs, and Controls

Inputs (bottom row jacks)- Patch up to four inputs signals to these.

Input 1-4 level knobs- The A, B, C, and D output busses are arranged vertically. This means that each vertical column of knobs controls the signal level of one of the inputs to the four output busses.

Bass/Treble knobs- These are shelf-type filters that cut or boost bass and treble respectively. A setting of *5* (middle) is flat.

Master 1-4 level knobs- Sets the master level of busses A, B, C, and D respectively.

22 VM995 Attenuators

The VM995 Attenuators module features three independent modules for attenuating and/or inverting audio or control signals. Attenuators are used to reduce the level of signals while inverters “flip” the polarity of a signal making positive voltage negative and negative voltage positive. While that doesn’t sound like too much fun, it is an extremely useful and invaluable tool within any modular system.

Signals within Voltage Modular start out as full-amplitude signals that often need to be turned down. An LFO, for example, can be used to create vibrato by subtly modulating an oscillator’s frequency. If the LFO signal is not attenuated first, the result will sound more like a sci-fi laser than vibrato!

Attenuverters are also handy when multiple CVs patched to a single input. Reducing their levels individually before the CV input is an effective way to "dial in" the perfect amount of modulation from each signal.

22.1 Inputs, Outputs and Controls

The 995 module includes three identical attenuverter sections; we'll go over the controls just one time.

Amount knob- Adjusts signal amplitude 0 to 100% from center position to full-clockwise or from 0 to -100% in the full counter-clockwise position.

In jack- Input jack for the signal.

Out jack- Output jack for the attenuated and/or inverted signal.

22.1.1 Input Jack Normalling

Inputs 2 and 3 are normalled to the input jack immediately above; this lets VM928 function as something of a "level-controlled mult." For example, if input 1 has a cable connected , but the other inputs have nothing plugged in, the input 1 signal will be routed to all three attenuator inputs.

23 VM1630 Frequency Shifter

The VM1630 is a super-accurate recreation of the vintage Moog/Bode 1630 Frequency Shifter.

A frequency shifter is an audio modifier that "shifts" the entire frequency spectrum of the signal by a given amount. The VM1630 can shift the spectrum up or down by up to 5000 Hz, and the "downshifted" and "upshifted" signals are simultaneously available.

The shift amount and regeneration controls are fully voltage controllable.

23.1 What Is A Frequency Shifter?

It's important to understand how a frequency shifter differs from a modern digital pitch shifter (aka, a "harmonizer"). A pitch shifter maintains harmonic relationships between tones and harmonics of the input signal (or at least, tries to). If you speak or sing into a pitch shifter, this means the voice sounds like a larger or smaller person, because the harmonic relationships are maintained. Conversely, these harmonic relationships are *not* maintained with frequency shifter, and as a result, processed audio starts to sound unnatural beyond very small amounts of shift. Small amounts of shift are useful for phase-y types of sounds (particularly when the *Regeneration* knob is up). Large amounts generally create harmonically rich and clangorous metallic timbres.

In the layman-est of layman's terms, even if you don't 100% understand what's going on under the hood, the frequency shifter can make a whole lot of incredible sounds, and it's very easy to use.

23.2 Inputs, Outputs, and Controls

Signal Input- Patch inputs signals here.

Amount Of Shift / Scale selector- These determine the amount of shift. The *Scale* selector switch determines the range, and the *Amount Of Shift* knob sets the specific shift amount (and looks real cool). The *Scale* positions are as follows:

- **Zero**- No shift, aka bypass mode. All three output pairs pass the input signal unaltered.
- **Exponential**- The *Amount Of Shift* knob scale is exponential, with frequency shift amounts represented in the outer concentric circle. In exponential mode, the shift range is 2 Hz to 2 kHz, from full counterclockwise to full clockwise.
- **5/50/500/5k**- The *Amount Of Shift* knob scale is linear, with frequency shift amounts represented in the inner concentric circle. Shift amount starts at zero (center position) and goes down or up when the *Amount Of Shift* knob is turned counterclockwise or clockwise, respectively. The maximum setting in either direction is determined by the current *Scale* range.

Shift Control jacks- These CV inputs allow voltage control of *Amount Of Shift*.

Squelch and LED- Allows fine-tuning of input level to prevent bleedthrough in the processed signal. This is typically more of an issue with hardware frequency shifter, but we've included it for accuracy. If it's set too high, it will mute signal entirely. The LED illuminates to indicate signal is passing.

Regeneration- This is a feedback control that sends the output back to the input at an amount determined by the knob setting. It really opens up a lot of sonic possibilities, and is particular useful for phaser-type sounds.

Regen. Control- CV input for voltage control of the *Regeneration* knob.

Mixture- Sets the mix level between downshifted (*A*) and upshifted (*B*) signal at the *Mixture Output* jacks. It has no effect on the *Output A* and *Output B* jacks.

Mixture Output jacks- Audio output of the downshifted (*A*) and upshifted (*B*) signals. Both jacks carry the same signal.

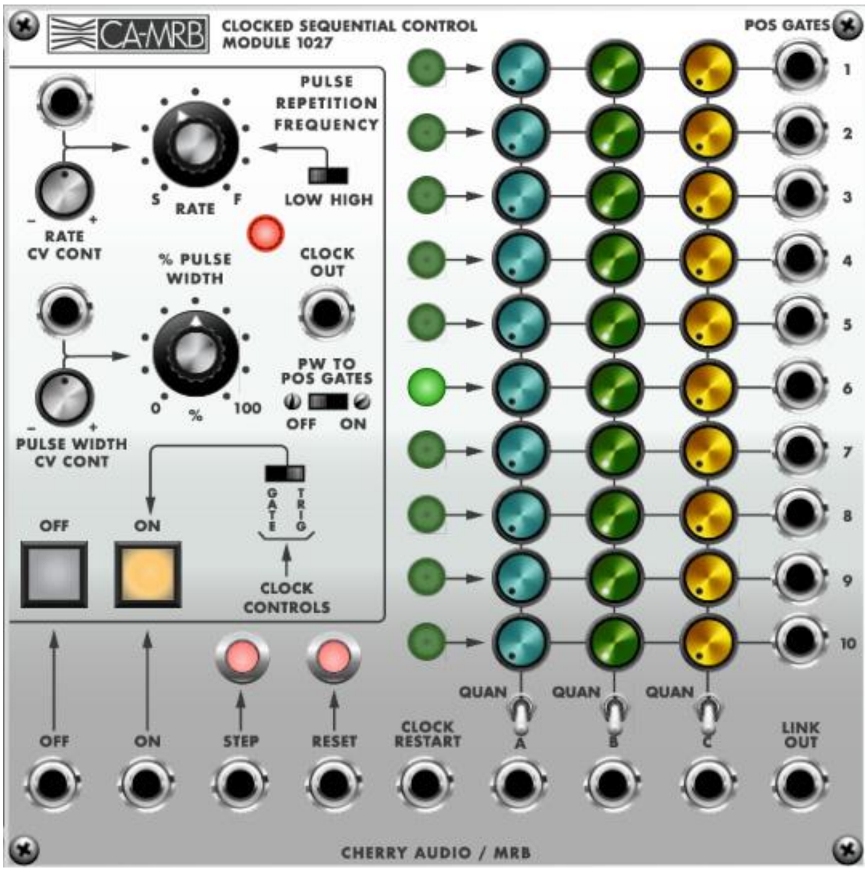
Output A jacks- Audio output of the downshifted signal. Both jacks carry the same signal.

Output B jacks- Audio output of the upshifted signal. Both jacks carry the same signal.

24 VM2500 Blank Panel Module 1001

The 1001 obviously doesn't make any sound, but it has one cool trick: double-clicking on it allows text to be entered, which is handy for patch notes, custom control names, lyrics, addresses, prototyping greeting cards, etc.

25 VM2500 Clocked Sequential Control Module 1027



The 1027 Clocked Sequential Control is an impressively wordy name for a "sequencer." With ten steps, arranged in three columns, it can output three independent CV's per step. It has a CV-controllable onboard clock, as well as a separate gate CV out for each step. Because the ARP 1027 is one of the earliest CV sequencers, it has a few unique quirks, but by and large, it functions like most modern step sequencers.

25.1 Sequencer Step Controls, Inputs and Outputs

Controls are repeated for each of the ten steps. In case you're wondering why they chose ten steps instead of the more musically sensible eight, it's because the 1027 is built upon the newfangled (in 1970) "decade counter" chip which, as its name implies, has ten stages, so they used all the available stages in the design (if you've ever explored DIY hardware sequencers, you've probably encountered the ten-step 4017 IC-based *Baby 10* sequencer - this design uses the same type of decade counter IC).

Stage active lamp- Glows to indicate the current step.

Control Voltage knobs- Each vertical column of knobs sends a separate voltages to the corresponding A, B, or C output jack, depending on which stage is currently active. These can be set from 0 to +5V.

POS Gates- These output a 5V gate when the step is active. They can be used for a number of functions, but the most important application is to set the number of sequencer steps. This can be done by patching the POS gate after the max number of steps to the *Reset* jack. For example, to set an eight-step sequence, patch a cable from jack nine to the *Reset* jack. (Don't think we didn't notice that *POS Gate* is a funny name, but there wasn't enough room on the panel to fit "position." Huh huh.)

Quantize switches- In the off (toggle down) position, the CV knobs can be freely set to any voltage between 0 to +5V. If the CV outs are used to control oscillators, this can make tuning melodies difficult. In the *Quan* position (toggle up), the CV knobs move in 1/12V steps , which equates to semitones.

Output A/B/C jacks- The jacks at the bottom of each knob column outputs the voltage for the currently active stage.

25.2 All Other Controls, Inputs and Outputs

Rate knob- This sets the *Pulse Repetition Frequency*, which is a super hoity-toity way of saying "speed."

Rate CV Control jack and attenuator- Allows CV control of the *Rate* knob. The attenuator knob is bipolar - center setting=off.

Low/High range- Sets the range of the *Rate* knob. Low is pretty slow and more useful for switching-things kind of applications; high is typically what you'll want for playing melodies.

Rate/Active lamp- Flashes at the current rate when the sequencer is playing.

% Pulse Width- Sets the width (aka, duty cycle) of the clock wave at the *Clock Out* jack, with a setting of 50% equivalent to a perfect square wave. If the clock out is being used to trigger an envelope generator (or directly control a VCA), the pulse width sets the note length.

Pulse Width CV Control jack and attenuator- Allows CV control of the *% Pulse Width* knob. The attenuator knob is bipolar - center setting=off.

PW To Position Gates- In the *On* position, the pulse width setting affects the duration of gate voltages sent to the *POS Gates* outputs. This control isn't present on the original 1027 - we're added it to address a sometimes-annoying quirk of the original design, and we'll explain why it's useful in the *Gating Steps With The VM1027* section below.

Off/On and CV ins- Turns the onboard clock on and off - the equivalent of play and stop buttons. These can be triggered via the corresponding jacks beneath.

Clock Controls / Gate/Trigger- This determines the behavior of the *On* button. In *Trig* mode, clicking or sending a trigger CV to the *On* button CV jack latches playback - i.e., the sequencer stays in play mode with a single click or trigger CV input until the *Off* button is clicked, or a CV is received at the *Off* CV jack. When set to *Gate* mode, the sequence only plays when the *On* button is held, or a gate voltage is present at the *On* CV jack.

At either setting, the sequence always starts at its current position and does not reset to step one unless the *Reset* button is clicked, or a CV is sent to the *Reset* CV jack.

Step button and CV in jack- Clicking the button or sending a trigger or gate CV to the CV in jack advances the sequence one step. This is useful for configuring tuning (with the clock in *Off* mode), or using an external source to move through steps. The *Step* CV jack essentially functions as an external clock input.

Reset button and CV in jack- Clicking the button or sending a trigger or gate CV to the CV in jack resets the sequence to step one. This can be used in conjunction with the POS Gates to set the number of sequence steps.

Clock Restart CV in jack- Though the *Reset* button and CV jack explained above will reset the pattern to step one, this doesn't reset the internal clock (it essentially "waits" until the next clock step). This behavior is inherent to the original 1027 design. This can cause timing issues, particularly if you want a sequence to begin the instant a key is pressed, for example. For this reason, we've added the *Clock Restart* CV input; sending this a trigger or gate voltage instantly restarts the internal clock to guarantee tight timing.

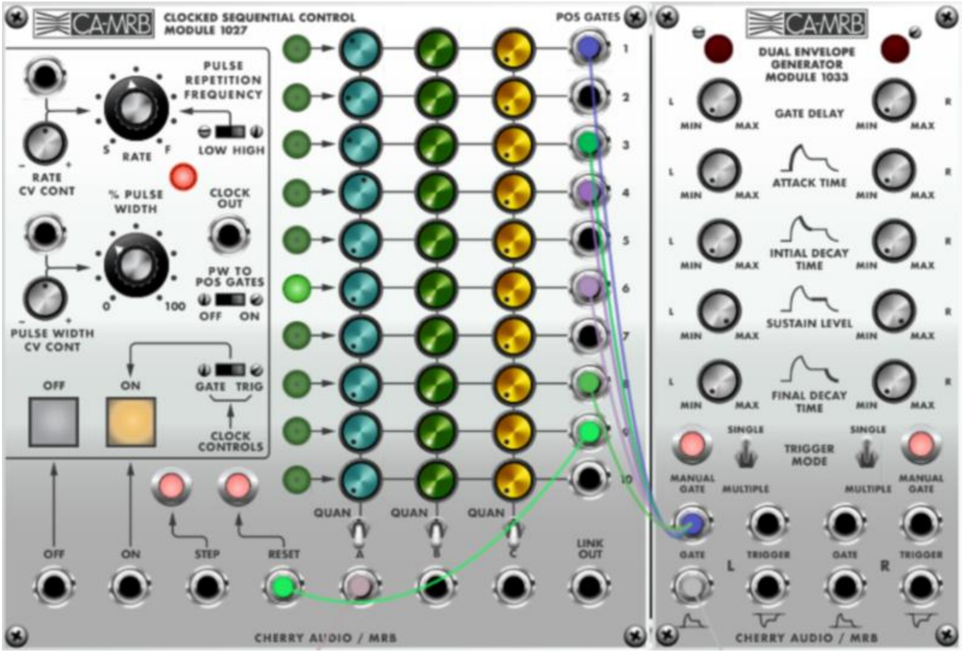
Link Out- The *Link Out* jack allows synchronization between modules. Specifically, the 1027 Clocked Sequential Controller module is intended to be the master clock, and its *Link Out* jack can be patched to one or more 1026 Preset Voltage and/or 1050 Mix Sequencer modules.

Because *Link Out* jack uses stepped voltages to control other modules, further control of step ranges is possible by adding an attenuator between connections.

25.2.1 Gating Steps With The VM1027

Perhaps the biggest difference between the 1027 and most modern sequencers is its lack of dedicated per-step gate buttons and an accompanying gate CV output. This leaves us a couple of options for gating note envelopes on and off:

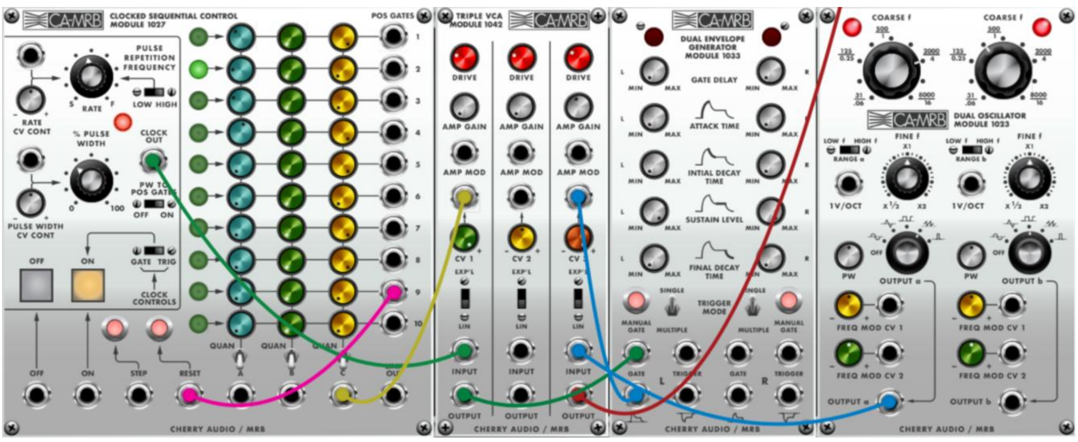
- **Gating Envelopes With Clock CV Out**- The easiest way to gate envelopes is to patch the *Clock Out* jack to the gate in of an envelope generator. The *% Pulse Width* knob can be used to set the length of time a gate voltage is sent to the envelope generator, i.e. the overall note length (this will of course be affected by envelope generator settings.) The problem with this arrangement is that individual steps cannot be disabled - all sequence steps play a note.



- **Routing POS Gate Outs To An Envelope Generator**- Patch individual cables from the *POS Gate* jacks of all steps you'd like active to the gate input of an envelope generator. This works fine, but with two caveats: as can be seen in the above image, it creates a mess of cables, and isn't really conducive to experimenting with turning steps on and off. The other potential issue is that two or more consecutive steps will output a single gate that lasts the duration of all consecutive steps. In other words, multiple consecutive steps won't individually re-trigger an envelope generator. The good news is that we addressed this by adding the *PW To POS Gates* switch. With this enabled, the *POS Gate* voltage durations correspond to the *% Pulse Width* knob setting, enabling individual envelope triggering for consecutive notes.

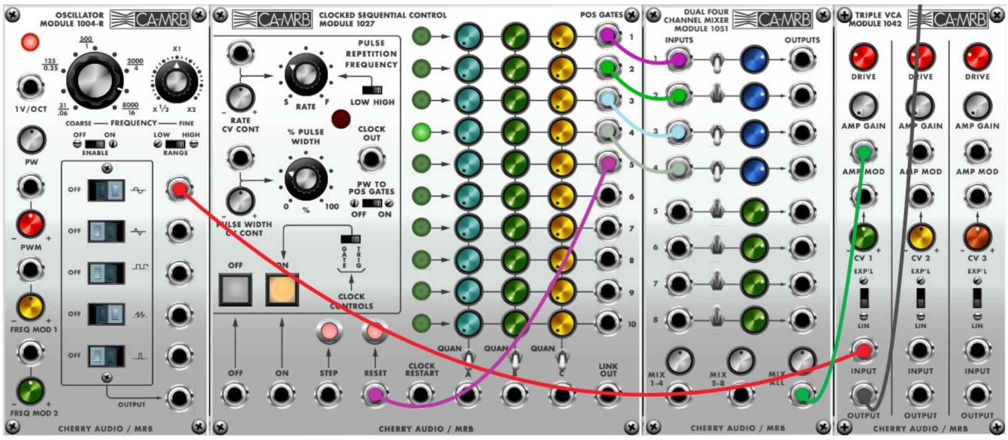
- (If you're not hip to the [SHIFT]-click-drag shortcut for simultaneously moving or deleting multiple cable connections, now would be swell time to check it out.)

As a little historical aside, setting up sequences in this manner with the original 2500 was a little easier because it didn't use jacks and cables - it used a large grid of 20-position slide switches. In this example, note gate steps could be enabled by switching the desired position gate outputs to the same horizontal switch row.



- **The Fancypants Clock-Through-VCA Method**- Patch the *Clock Out* jack to the input of a VCA, and the out of the VCA to the gate in of an envelope generator. Now patch a cable from one the the vertical CV knob row output jacks to the CV control in of a VCA. To enable a step, turn up the appropriate CV knob.

- The only downside is that a column of CV knobs is "lost," but the good news is that it's easy to gang up multiple 1027's for as many CV columns as needed by patching the *Clock Out* jack to the *Step* CV in jacks of one or more 1027's.

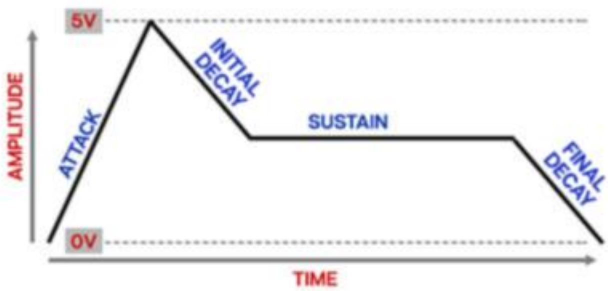


- **The Mixer Switches Method**- This approach uses the 1051 Dual Four Channel Mixer's toggle switches to switch steps on and off. *POS Gates* 1-4 are patched to mixer inputs 1-4, and *POS Gate* 5 is patched to the *Reset* jack to create a four-step sequence. Oscillator output is patched to VCA *Input*, and VCA *Output* is patched to the IO Panel *Main Out*. The mixer's *Mix All* output is patched to VCA *Amp Mod* control input, and steps are enabled or disabled using the mixer toggles.

26 VM2500 Dual Envelope Generator Module 1003

The 1003 is an ADSR envelope generator with two identical and fully independent envelopes. It functions exactly like the original 2500 version, and has a few operational quirks which we'll explain. If you're not familiar with the operation of envelope generators, here's an overview:

When a gate voltage is sent to the *Gate In* jack (or the *Gate* button is held), the envelope generator outputs a voltage that changes dynamically according to the settings of its four stages.



The *Attack* stage defines how long it takes for the output voltage to rise from 0 to 5 volts. Once the attack stage reaches 5V, it moves to the *Initial Decay* phase, which defines how long it takes to fall from 5V to the setting of the *Sustain* phase. Unlike the *Attack*, *Initial Decay*, and *Final Decay* phases, each of which define a time, *Sustain Level* simply sets the held voltage level following the *Attack* and *Initial Decay* phases - this usually equates to the envelope output level while holding down a key on a keyboard controller. The *Final Decay Time* knob defines the the length of time it takes for the voltage to fall back to 0V when the gate input voltage is removed (typically when a key is released).

26.1 Inputs, Outputs, and Controls

As the "dual" in its name implies, the 1003 module contains two completely independent envelope generators, with identical controls, inputs, and outputs.

Gate indicator lamp- Illuminates to show an incoming gate voltage of > 1V has initiated the envelope.

Attack Time- Defines the length of time for voltage to rise from 0V to 5V when the gate voltage is applied.

Initial Decay Time- Defines the length of time for voltage to fall from the *Attack Time* stage 5V peak to *Sustain Level* setting.

Sustain Level- Sets the held voltage level following *Attack Time* and *Initial Decay Time* phases.

Final Decay Time- Defines the length of time for voltage to fall from *Sustain Level* to 0V when gate is released. This is called Release on just about every synthesizer on the planet.

Manual Gate button- Manually initiates the envelope generator cycle for as long as it's held. This is the same as sending a gate voltage to the *Gate In* jack.

Trigger Modes switch- In a situation where a note is already held down (gate input is high), these determine whether or not the envelope retriggers when a new note is played. When set to *Single*, new notes will not retrigger the envelope; when set to *Multiple* the envelope retriggers every time a new note is played, regardless of previously held notes.

26.1.1 IMPORTANT

Unlike most envelope generators, both the Gate and Trigger CV inputs must be connected, or else the 1003 will behave a little strangely.

It's important to remember that the 2500 modules were designed during the infancy of analog synthesizer development, so they don't always work exactly like their modern counterparts.

If Voltage Modular's IO Panel *Trig* CV output isn't connected to *Trigger* CV input, it will work fine in *Single* mode, but *Multiple* trigger mode will not work correctly (the *Attack Time* control won't do anything, and the *Initial Decay Time* knob will behave as the *Attack Time* control).

For proper envelope and triggering behavior:

- Set the Voltage IO Panel *Single/Multi* selector to *Single.*
- Patch the IO Panel *Gate* and *Trig* CV outputs to the 1003 *Gate* and *Trigger* CV inputs, respectively.

Because the *Trigger* CV input restarts the envelope from the decay phase, the *Gate* and *Trigger* CV inputs can be combined for interesting rhythmic effects. For example, a note could be held with the keyboard (via the IO Panel *Gate CV* out) while retriggering from a sequencer for emphasis on particular beats.

It should go without saying that you won't hurt anything if you hook it up "wrong," but the envelope generator may not behave as expected.

____

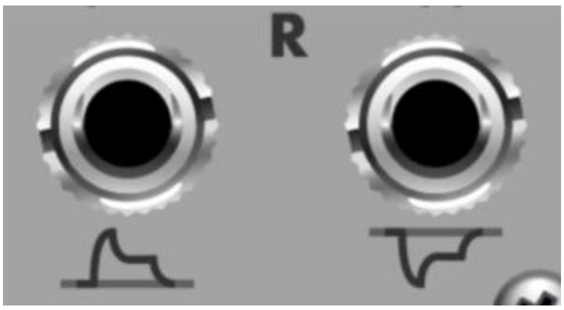
Gate input jack- This is where you'll patch gate voltages to initiate the envelope generator cycle. Most often this will come from the IO Panel *Gate* output.

Trigger input jack- This is where you'll patch trigger voltages to reset the envelope generator cycle. This can originate from the IO Panel *Trig* output, a sequencer, or other modules.

"What's the difference between a gate and a trigger?"

- A **gate** is a *constant* voltage. If you're playing a keyboard, it remains high (i.e. +5V) as long as the key is held down.
- A **trigger** is a *rapid spike* of +5V. It's useful for a number of things (like turning stuff on and off, triggering "one-shot" drum sounds or modules, or restarting the 1003 envelope).

In the case of most envelope generators, the gate voltage is usually all you need to be concerned about, but the 1003 is a bit quirky and requires both for proper multi-triggering behavior. Please see the section that says IMPORTANT in giant letters for more information about this gate and trigger business.



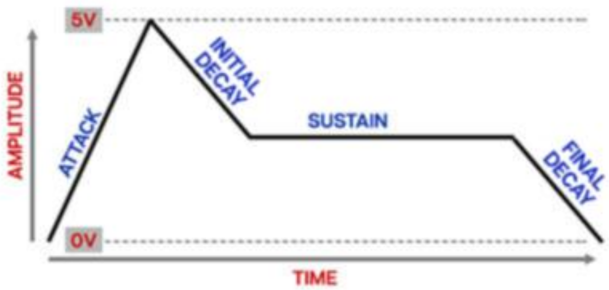
Normal/Inverted out- These are the envelope voltage outputs. The standard jack (icon going up from centerline) outputs voltage ranges from 0V to +5V, whereas the inverted jack ((icon going down from centerline) is inverted, with output ranging from 0V to -5V.

27 VM2500 Dual Envelope Generator Module 1033

The 1033 is an ADSR envelope generator with two identical and fully independent envelopes. It functions exactly like the original 2500 version, and has a few operational quirks which we'll explain.

It's basically identical to the 1003 envelope generator module, but adds a *Gate Delay* knob which allows a "pause" of up to three seconds prior to the initiating the attack phase. If you're not familiar with the operation of envelope generators, here's an overview:

When a gate voltage is sent to the *Gate In* jack (or the *Gate* button is held), the envelope generator outputs a voltage that changes dynamically according to the settings of its five stages.



The *Gate Delay* knob adds a "pause" of up to three seconds prior to the initiating the *Attack* phase. The *Attack* stage defines how long it takes for the output voltage to rise from 0 to 5 volts. Once the attack stage reaches 5V, it moves to the *Initial Decay* phase, which defines how long it takes to fall from 5V to the setting of the *Sustain* phase. Unlike the *Attack*, *Initial Decay*, and *Final Decay* phases, each of which define a time, *Sustain Level* simply sets the held voltage level following the *Attack* and *Initial Decay* phases - this usually equates to the envelope output level while holding down a key on a keyboard controller. The *Final Decay Time* knob defines the the length of time it takes for the voltage to fall back to 0V when the gate input voltage is removed (typically when a key is released).

27.1 Inputs, Outputs, and Controls

As the "dual" in its name implies, the 1033 module contains two completely independent envelope generators, with identical controls, inputs, and outputs.

Gate indicator lamp- Illuminates to show an incoming gate voltage of > 1V has initiated the envelope.

Gate Delay- Adds a "pause" of up to three seconds prior to the initiating the attack phase. Removal of a gate signal during the delay cancels the envelope and resets the delay timer.

Attack Time- Defines the length of time for voltage to rise from 0V to 5V when the gate voltage is applied.

Initial Decay Time- Defines the length of time for voltage to fall from the *Attack Time* stage 5V peak to *Sustain Level* setting.

Sustain Level- Sets the held voltage level following *Attack Time* and *Initial Decay Time* phases.

Final Decay Time- Defines the length of time for voltage to fall from *Sustain Level* to 0V when gate is released. This is called Release on just about every synthesizer on the planet.

Manual Gate button- Manually initiates the envelope generator cycle for as long as it's held. This is the same as sending a gate voltage to the *Gate In* jack.

Trigger Modes switch- In a situation where a note is already held down (gate input is high), these determine whether or not the envelope retriggers when a new note is played. When set to *Single*, new notes will not retrigger the envelope; when set to *Multiple* the envelope retriggers every time a new note is played, regardless of previously held notes.

____

27.1.1 IMPORTANT

Unlike most envelope generators, both the Gate and Trigger CV inputs must be connected, or else the 1033 will behave a little strangely.

It's important to remember that the 2500 modules were designed during the infancy of analog synthesizer development, so they don't always work exactly like their modern counterparts.

If Voltage Modular's IO Panel *Trig* CV output isn't connected to *Trigger* CV input, it will work fine in *Single* mode, but *Multiple* trigger mode will not work correctly (the *Attack Time* control won't do anything, and the *Initial Decay Time* knob will behave as the *Attack Time* control).

For proper envelope and triggering behavior:

- Set the Voltage IO Panel *Single/Multi* selector to *Single.*
- Patch the IO Panel *Gate* and *Trig* CV outputs to the 1033 *Gate* and *Trigger* CV inputs, respectively.

Because the *Trigger* CV input restarts the envelope from the attack phase, the *Gate* and *Trigger* CV inputs can be combined for interesting rhythmic effects. For example, a note could be held with the keyboard (via the IO Panel *Gate CV* out) while retriggering from a sequencer for emphasis on particular beats.

It should go without saying that you won't hurt anything if you hook it up "wrong," but the envelope generator may not behave as expected.

____

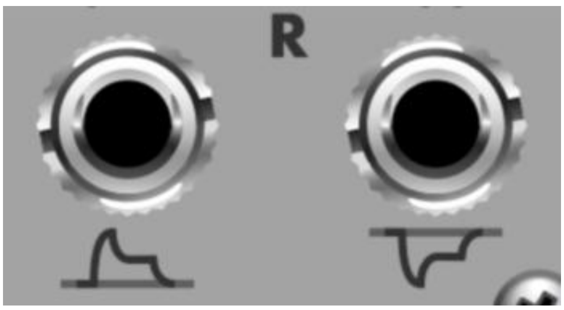
Gate input jack- This is where you'll patch gate voltages to initiate the envelope generator cycle. Most often this will come from the IO Panel *Gate* output.

Trigger input jack- This is where you'll patch trigger voltages to reset the envelope generator cycle. This can originate from the IO Panel *Trig* output, a sequencer, or other modules.

"What's the difference between a gate and a trigger?"

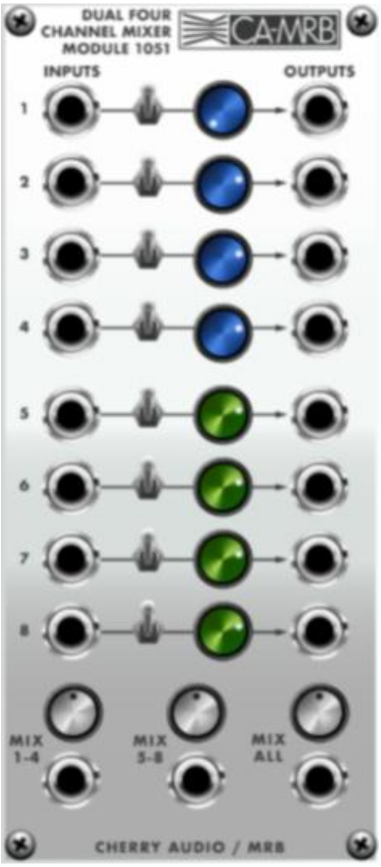
- A **gate** is a *constant* voltage. If you're playing a keyboard, it remains high (i.e. +5V) as long as the key is held down.
- A **trigger** is a *rapid spike* of +5V. It's useful for a number of things (like turning stuff on and off, triggering "one-shot" drum sounds or modules, or restarting the 1033 envelope).

In the case of most envelope generators, the gate voltage is usually all you need to be concerned about, but the 1033 is a bit quirky and requires both for proper multi-triggering behavior. Please see the section that says IMPORTANT in giant letters for more information about this gate and trigger business.



Normal/Inverted out- These are the envelope voltage outputs. The standard jack (icon going up from centerline) outputs voltage ranges from 0V to +5V, whereas the inverted jack ((icon going down from centerline) is inverted, with output ranging from 0V to -5V.

28 VM2500 Dual Four-Channel Mixer Module 1051



The 1051 Dual Four-Channel Mixer module is a "split" eight-channel mixer for audio or CV signals with a number of unique features. Each of its channels includes a separate out, so it can be used an attenuator or mixer, and in addition to the master 1-8 out, it also includes outputs for channels 1-4 and 5-8 for added flexibility.

This module does not actually exist for the original ARP 2500. The original instrument relied on a combination of mixing through it matrix switches and multiple filter inputs, but we created the 1051 module, because we often found ourselves wishing for a dedicated mix module.

28.1 Inputs, Outputs and Controls

28.1.1 Input Channels

Input jack- Audio or CV input jack.

Enable switch- Turns the input on when in the up position. Down is the same as a typical mixer "mute" button.

Level- This knob adjusts the level at which the input signal is sent to its associated individual output as well as the master outs at the bottom.

Outputs individual out jacks- The output of the signal plugged into the channel only - this allows the switch and knob to be used as a mute and an attenuator respectively.

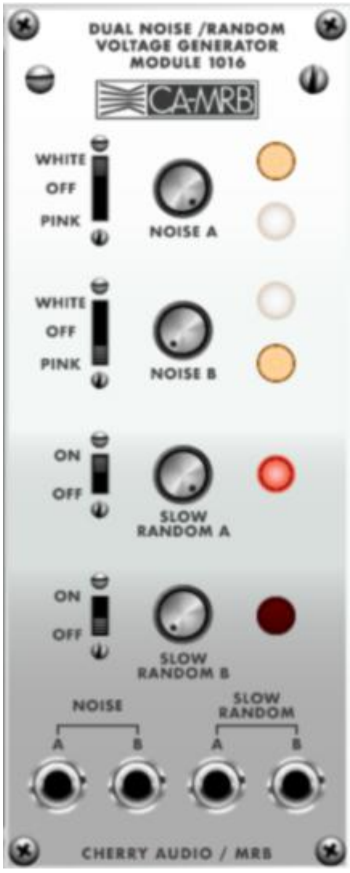
28.1.2 Outputs

Mix 1-4- The sum of channels 1-4 only.

Mix 5-8- The sum of channels 5-8 only.

Mix All- The sum of all channels.

29 VM2500 Dual Noise/Random Voltage Generator Module 1016 oscillators



The 1016 Dual Noise/Random Voltage Generator consists of two independent noise generators and two random, unstepped mod generators.

29.1 Inputs, Outputs, and Controls

White/Off/Pink switch A/B and indicator lamps- Enables noise and selects the noise type. White noise is a random signal in which all frequencies across the frequency spectrum are represented equally. Pink noise containts equal energy per octave, and audibly has more low-frequency components than white noise (and has a cooler sounding name). The lamps at the right of the panel illuminate to show which noise type is currently active.

Noise A/B level- Sets the volume for each noise generator.

Slow Random A/B on/off switches and indicator lamps- These turn the "slow random" signal on and off. You can think of slow random as a sort of slowed-down noise - it's a constantly changing voltage below the audible hearing range, intended for use as a control signal.

Slow Random A/B level- Sets the volume for each of the slow random sections.

Noise A/B output jacks- Outputs for the noise signals.

Slow Random A/B output jacks- Outputs for the slow random signals.

30 VM2500 Dual Oscillator Module 1023

The 1023 Dual Oscillator contains two independent, full-function oscillator modules. It's essentially the same as two of the 1004-style oscillators in one module, less the pulse-width modulation CV inputs.

These can be used in the audio range, or as low-frequency modulation sources. Since the controls for each side are exact duplicates, we'll go over them just once.

30.1 Inputs, Outputs, and Controls

Oscillator active lamp- The red lamps in the upper corners glow to indicate the oscillator is enabled (either side can be disabled by setting the waveform selector knob to *Off*).

Frequency / Coarse and Fine- The *Coarse* control sets the base frequency over a nine-octave range, in octave increments. The *Fine* control allows continuous fine pitch control and is configured as a "multiplier" with center position being nominal and a range of 1/2 pitch to the left or double the pitch to the right (i.e., +/- one octave).

Range- Generally this will be set to *Low* when using as a mod source, or high for audio-range signals.

1V/Oct jack- Accepts a CV input for pitch. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Pulse Width (PW)- This sets the width or "duty-cycle" of the pulse wave (the very bottom waveform on the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

Output a/b wave selector- Selects off, sine, triangle, square, ramp, or pulse wave output. The red lamp in the upper corner dims in *Off* position.

Frequency Mod 1 and 2 input jack and attenuator- This is used for externally modulating the oscillator frequency. It's useful for adding vibrato with an LFO, siren noises, envelope-controlled pitch sweeps, etc. The attenuator knob is bipolar; it allow positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

All mod inputs are exponential, that is for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Output a/b jacks- Audio output of oscillator waveforms.

31 VM2500 Dual Reverberator Module 1025

The 1025 Dual Reverberator contains two independent classic spring-type reverbs. Though ARP planned a spring reverb module, it was never actually produced - this is our take on what it might have been.

31.1 Inputs, Outputs, and Controls

Tank- Choose from five different tank choices, each with its own unique tonal and decay characteristics.

Tone- Adds or removes reverb signal brightness by turning left or right from center position. *Tone* has no effect on dry signals.

Wet/Dry Mix- Balances dry vs. wet signal, with center position corresponding to equal mix.

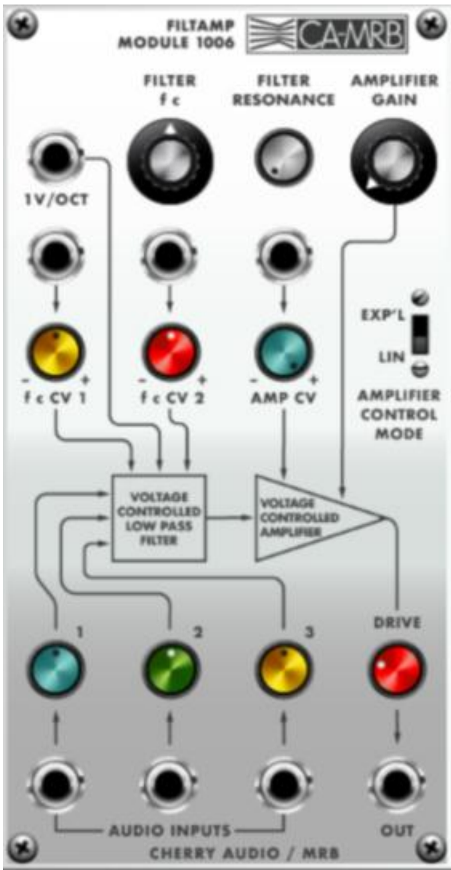
Mix CV Mod- Allows CV modulation of the *Wet/Dry Mix* control. The attenuator knob is bipolar; it allow positive (turn right) or inverted voltage control (turn left).

Input jack- Mono audio signal input.

L(M)/R Output jacks- Audio output dry and reverb signal mix. Use the *L/M* jack for mono applications. The output of the *L/M* and *R* jacks are slightly different for effective stereoization of mono signal sources.

Secret "Super Stereo" : The two reverb sections are actually slightly different and as a result can be used for a sort of "super stereo" mode. Even though each section has a stereo output, better stereo can be had by separately patching stereo inputs to the left and right sections, selecting identical tanks, and taking the stereo outputs from each *L(M) Output* jack.

32 VM2500 Filtamp Module 1006



The 1006 Filtamp module is ARP's take on the classic 24 db/oct transistor ladder filter, combined with a VCA. It has the "fat" sound associated with this design and rich overdrive characteristics when its VCA *Drive* knob is pushed.

32.1 Inputs, Outputs, and Controls

1V/Oct jack- Accepts a CV input for scaling the cutoff frequency to match ascending notes. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Cutoff Frequency- Sets the cutoff frequency. Since this is a low-pass filter, all frequencies lower than this value will be allowed to pass through the filter while frequencies higher than the cutoff will be attenuated at a rate of 24db per/octave.

Filter Resonance- Turning this knob up emphasizes sound energy at and around the cutoff frequency by adding feedback from the filter's output back to its input. With higher settings, modulation of the cutoff frequency becomes more pronounced and the filter will go into self-oscillation. *Filter Resonance* can cause loud squelches at high settings, so be careful.

Amplifier Gain- This is an initial gain setting for the voltage-controlled amplifier. Typically this will be set to zero, as the VCA level will usually be controlled by an envelope. Opening it up is useful for drones, or when setting pitches on a sequencer.

f c (frequency) CV 1/2 jack and attenuator- These are CV input jacks and attenuators for externally controlling cutoff frequency. Both jacks can be used simultaneously. The attenuators are bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

Amp CV jack and attenuator- Controls VCA amplitude. Typically, you'll patch the output of an envelope generator to this input. The attenuator is bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

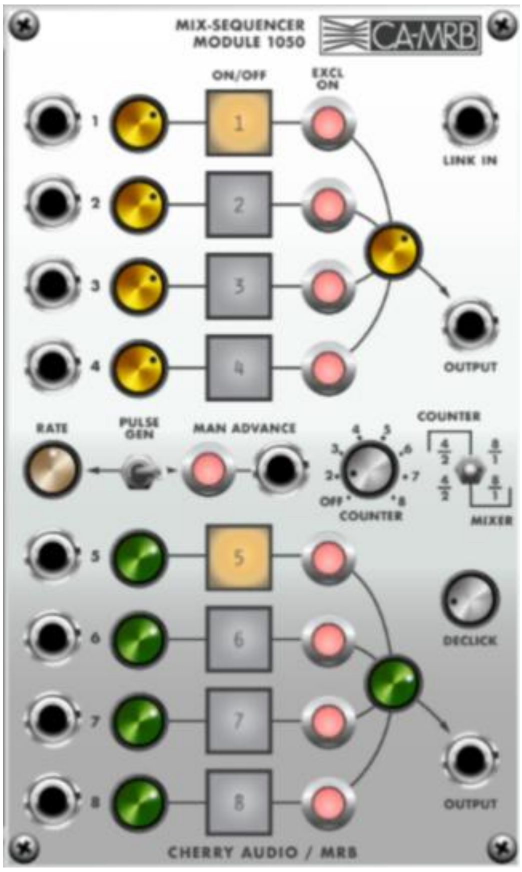
Amplifier Control Mode / Exponential/Linear - These select the curve of the amplifier's response as the input CV rises from 0 to 5V. *Lin* or linear response curve is equally proportional across the voltage input range, whereas an exponential (*Exp'l*) curve is closer to how the human ear perceives volume. With that in mind, you'll likely want to use the *Lin* setting for modulation or control voltage situations, and use the *Expo* setting when an envelope generator is used to control the shape of an audio signal.

Input jack and attenuator 1/2/3- Patch audio signals in here. These essentially act as an input mixer for signals.

Drive- Adds warm overdrive to the signal by overdriving the internal VCA. Though the original 2500 module didn't have a drive control, its VCA inherently distorted a bit and the default setting of 32% accurately reflects this. Independent of VCA *Drive* distortion, the 1006 Filtamp can also be overdriven by patching a hot input signal.

Output jack- Audio signal output.

33 VM2500 Mix-Sequencer Module 1050



As its name implies, the 1050 Mix-Sequencer module is a unique combination of an eight-channel mixer and a sequencer that can enable and disable stages either manually, by CV, or via its own internal clock.

It's functionally similar to the Voltage Modular Eight To One switch module, but with the addition of attenuators on each step, an onboard clock, and perhaps most importantly, the ability to simultaneously enable steps in any combination.

When its internal clock is enabled, it can cycle through a single eight-step pattern, or dual four-step patterns. (My aunt was a regional Dual Four-Step champion in Galveston.)

33.1 Stage/Input Controls

The stage controls are repeated in each of the eight stages. Like that awful "Life Is Beautiful" music festival that I can hear from my house, multiple stages can be simultaneously active.

Input jack- Plug incoming signals in here. Inputs can be control signals or audio signals.

Input attenuator knobs- These act as level controls for incoming signals.

Step On/Off buttons- These enable or disable the signal. If the *Pulse Gen* (i.e. internal clock) is disabled (toggle switch right), the buttons can manually be turned on and off. If the *Pulse Gen* is enabled (toggle switch left), the buttons will step sequentially with their patterns dependent upon the *Counter* and *Counter/Mixer* toggle settings.

Excl On buttons- Excellent? Excelsior? Excedrin? Actually "excl" is short for exclusive. The buttons function like the solo buttons of a standard mixer channel - they shut off all other currently enabled stages. If the *Counter/Reset* switch is in the far left *4/2* position, the *Excl On* buttons only affect stages within their group of four. (i.e., the 1-4 and 5-8 stages are independent)

33.1.1 SUPER-DUPER IMPORTANT THING ABOUT STEP ON/OFF BUTTONS, SO LIKE, READ THIS:

When the module is in "manual" mode (*Pulse Gen* disabled, toggle switch right), you'll probably notice that one of the stages cannot be disabled (or two of the stages, if the *Counter/Mixer* switch is in one of the four-step positions). To shut off the "stuck" stage(s), set the *Counter* control to the *Off* position. (This is exactly how the original 2500 modules works, so please don't trash us on your favorite synth forum for this.)

1-4 and 5-8 Mix Volume knobs- These act as master volumes for each four-stage group.

Output jacks- These output the signal for the currently active stage.

33.1.2 Pulse Gen and Stage Advance

The 1050 Mix-Sequencer includes an onboard clock, aka "Pulse Gen" that can step through the stages like a sequencer (we're refer to it as a clock). If the clock is disabled, the module behaves much like a conventional mixer with channel on/off (the big square buttons) and solo buttons (the red *Excl On* buttons). If the *Pulse Gen* switch is enabled (toggle left), it behaves more like a sequencer, stepping through and enabling/disabling stages as it steps. The controls in the center of the module define the stepping behavior.

Rate- Sets the *Pulse Gen* (clock) speed when enabled.

Pulse Gen- Setting the toggle left enables the internal clock. Setting the *Counter* knob to *Off* and the toggle to right position disables counting (advancing).

Man Advance button and CV jack- Advances the active step forward when the button pressed or a trigger or gate CV is sent to the jack. The *Pulse Gen* must be disabled for the Man Advance to work.

Counter- Sets the number of stages when *Pulse Gen* or *Man Advance* is used. Setting it to the *Off* position will disable the *Pulse Gen* and *Man Advance*, so if these appear to be dead, be sure to set the *Counter* to a number. If the *Counter/Mixer* switch is set to one of the four-step settings, setting the *Counter* to anything higher than *4* won't make a difference - it will behave as if it was set to *4*.

Counter/Mixer switch- Sets the grouping of the eight stages when using *Pulse Gen* and *Man Advance* as follows:

- **4/2 (toggle left)**- Configures stages 1-4 and 5-8 as two independent four-step groups; signals are routed to their respective 1-4 and 5-8 *Output* jacks.
- **4/2 (toggle center)**- Configures stages 1-4 and 5-8 as two independent four-step groups. All stages mixed to upper and lower *Output* jacks, master out level knobs affect each *Output* jack.
- **8/1 (toggle right)**- Moves through all steps sequentially, dependent upon *Counter* knob setting. Mixed output is the same for upper and lower *Output* jacks, master out level knobs affect each *Output* jack.

Declick- Adds an adjustable duration of crossfade when changing stages to prevent nasty clicks. The knob is set to 10% by default. This feature is not present on the original 2500 module, but set the knob to zero and you'll quickly understand why we added it.

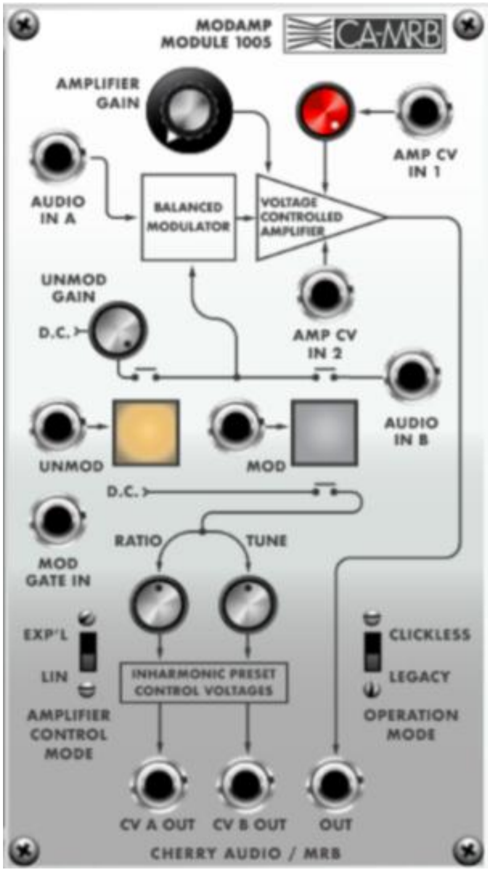
Link In- Not to be confused with the not-cleverly-misspelled 90s band "Linkin Park," the *Link In* jack uses a dynamic CV to enable synchronization between modules. Specifically, the 1027 Clocked Sequential Controller module is intended to be the master clock, and its *Link Out* jack should be patched to one or more 1050 Mix-Sequencer and/or 1026 Preset Voltage modules.

Note that plugging a source into the *Link In* jack overrides the *Pulse Gen* and *Manual Advance* button and CV jack. When using linking, the *Counter* knob should be set to any value other than *Off*; its number setting will have no effect on timing or step length.

If the Mix-Sequencer is set to one of the 4/2 modes, and the 1027 Clocked Sequential Control (can't I just type "sequencer?") is set to greater than four steps, the Mix-Sequencer will "wrap around," and begin counting again from step 1, but both modules always reset to step 1 at the same time. For example, if the 1027 master is set to six steps and the 1050 set to one of the four-step modes, the 1050 will count 1-2-3-4-1-2 then back to 1.

The *Link In* jack can also be slightly misused for step control with positive-polarity LFO waves - the positive polarity saw wave from any of the 1004 or 1023 oscillators is perfect for this. The idea is to use waves that change voltage over their duration, so square waves won't work well (they'll simply alternate between two positions). Adding an attenuator module (such as the Attenuverter) between the LFO and the *Link In* jack allows control of the number of steps as well.

34 VM2500 Modamp Module 1005



The 1005 Modamp performs a couple functions, but it's mainly a "balanced modulator," (aka, ring modulator). If two waves are input, the output contains only the sum and difference frequencies, but removes the original.

The audio result is useful for creating sounds with inharmonic frequency content, which is useful for synthesizing bell and metallic sounds (but not that useful for creating the sounds of Metallica, which nobody wants anyway).

Though the front panel says "balanced modulator," this effect is almost always referred to as "ring modulation" these days, so we'll call it that.

34.1 Inputs, Outputs, and Controls

Audio In A / Audio In B- Patch the two signals to be combined into these jacks. Plug signals into Audio In A to use Modamp 1005 as a conventional VCA.

Amplifier Gain- Sets the VCA initial gain level. Set this to zero if an envelope generator is being used to modulate VCA level.

Amp CV In 1 / Amp CV In 2- These are CV mod inputs for the VCA stage. *Amp CV In 1* includes an attenuator; *Amp CV In 2* is always at full with not attenuation. Amp CV 2 is useful with an envelope generator, whereas *Amp CV 1*'s attenuator is useful with LFOs or other mod sources.

Unmod/Mod buttons and CV jacks- These enable (*Mod*) and disable (*Unmod*) ring modulation when they receive a trigger or gate voltage.

Unmod Gain- Sets an initial level for *Audio In A* when ring mod is disabled (i.e. *Unmod* mode). This is useful for balancing level between *Mod* and *Unmod* modes. (It won't help you when listening to Depeche Mode... I mean, can anyone really help them since Wilder left?)

BTW, the *D.C.* labels refer to the direct current voltage applied to the ring modulator when only one audio source is present (aka *Unmod* mode). This voltage is applied to the unused input in order to allow the *Audio In A* signal to pass; without it, sound wouldn't be able to pass through the ring mod processor.

Amplifier Control Mode / Exponential/Linear- Changes the VCA response from linear (constant rate of change as control voltage rises) to exponential response (rate of change increases as voltage increases - this is how the human ear works). General speaking, exponential mode is used when the VCA is regulating the volume of a signal (typically in conjunction with an envelope generator), and linear mode is used when the VCA is regulating a CV (a mod wheel routed to a VCA CV in regulating how much LFO signal is routed to pitch, for example).

Inharmonic Preset Control Voltages / Ratio/Tune / CV A Out / CV B Out- This one's a little kooky, but relatively simple, so bear with us - remember that it was still the wild west in synth design when the original 2500 was designed. As you may have noticed, the Modamp module was designed with the premise that the user would frequently switch between *Mod* and *Unmod* modes, that is, enabling and disabling ring mod. Because ring mod can wildly affect tuning, these "extra" CV outs to allow users to (sort of) match up pitches for harmonically seamless transition between ring mod on and off modes. With that in mind, *Inharmonic Preset Control Voltages* CV outs are only active when *Mod* is enabled - they have no output when *Unmod* is engaged (i.e. ring mod off).

To use this feature, patch *CV A Out* to the frequency CV of the oscillator patched to *Audio In A*, and *CV B Out* to the frequency CV in of the oscillator patched to *Audio In B* (open up the corresponding freq CV attenuators all the way on the oscillators). Now switch back and forth between *Mod* and *Unmod* and use the *Ratio* and *Tune* knobs to match the pitch when in *Unmod* mode.

Mod Gate In- This is similar to the *Unmod* and *Mod* switch CV ins, but allows switching back and forth with one CV source. Typically this would be used with an LFO pulse or square wave; when the voltage is high, *Mod* mode is engaged, when the voltage is 0V, *Unmod* is engaged.

The nifty part is that it can switch REALLY fast - try patching an oscillator running in audio range for a smorgasbord of dastardly overtones. Keep reading, because the next switch is important...

Operation Mode / Clickless/Legacy- When set to *Clickless* mode, a tiny crossfade is added when switching between *Unmod* and *Mod* modes with the buttons, CV inputs, or the *Mod Gate In* to prevent clicking artifacts. The clicking between modes isn't all that noticeable when switching slowly, but it adds ugly artifacts as mod rates are increased. This feature is not present on the original 2500 Modamp, we've included a *Legacy* (no crossfade) mode for vintage correctness. (BTW, *Cliqueless Mode* had a huge new wave hit in France in 1981, and followed it with a huge tour featuring Trans-X and Pseudo Echo.)

Out- Output of all signals.

35 VM2500 Multimode Filter Resonator Module 1047

The 1047 Multimode Filter/Resonator module is a 12 dB state-variable filter. It can function as a lowpass, bandpass, highpass, or notch filter. This gives it a great deal of flexibility, and its generally a bit brighter than a typical "ladder"-style filter as a result of its shallower 12 dB/oct curve. The 1047 Filter also extremely rich-sounding overdrive characteristics when pushed hard.

If you're not familiar with how filters work, a lowpass filter allows frequencies *below* the cutoff frequency setting to pass through, but blocks frequencies *above* the cutoff frequency. Highpass is the opposite of lowpass mode: high-frequency content remains, but low frequencies are removed as the cutoff frequency increases. The bandpass output combines both lowpass and highpass modes, leaving sound only "in the middle" with amplitude falling off symmetrically on either side of the cutoff frequency. Each slope is 6db/octave. Finally, the notch output is the opposite of bandpass mode, removing a section of signal "in between" the lowpass and highpass frequencies. This isn't necessarily all that useful on its own, but makes interesting colors when its frequency is swept.

35.1 Inputs, Outputs, and Controls

1V/Oct jack- Accepts a CV input for scaling the cutoff frequency to match ascending notes. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Frequency fc / Coarse and Fine- Sets the frequency where frequency attenuation begins with its effect dependent upon the currently chosen lowpass/bandpass/notch/highpass/etc. filter mode. The *Coarse* knob affects overall cutoff frequency from 30 to 8000 Hz, and the *Fine* knob allows "fine-tuning" in more precise increments.

Frequency Mod 1/2 CV jacks and attenuators- These are CV input jacks and attenuators for externally controlling cutoff frequency. Both jacks can be used simultaneously. The attenuators are bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

Resonance (Q)- Emphasizes sound energy at and around the cutoff frequency. This is useful for creating commonly heard synth "wah" tones, especially when the cutoff frequency is modulated with an envelope generator or one of the LFO's.

Res Mod CV jack and attenuator- CV input jack and attenuator for externally controlling filter resonance. The attenuator is bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

Notch Frequency fc- Sets the frequency of the notch filter mode as a multiple of the cutoff frequency, ranging from 1/4 to four times the cutoff frequency. The *Notch Freq fc* knob only affects the notch output, shown above.

Pure notch response occurs when *Notch Frequency fc* is set to the middle position; LP or HP response is heard when the knob is moved left or right. Notch response is best heard at low resonance settings - high resonance settings "closes up" the notch, rendering it inaudible. If *Notch Frequency fc* is moved and resonance is audible, it's because the LP or HP outputs are coming through.

Resonance - Norm/Lim switch- Limit mode causes the filter to be unity gain at the resonant frequency. In normal mode, the filter gain at the resonant frequency is equal to Q, which on this filter can get very large - over 50dB!

To better understand the functionality of the *Norm/Lim* switch, turn the *Coarse/Frequency fc* knob all the way down and the *Resonance (Q)* knob all the way up. Patch in a sawtooth wave around middle C and slowly start turning the *Coarse/Frequency fc* knob up - you'll be able to sweep through the harmonics like a magnifying glass and the filter will never clip.

Overload lamp- This lights up when the incoming signal is too hot. Back off ye olde gain if this lights up.

Keyb Percussion- This is a unique feature of the original 2500 1047 filter. It uses a gate signal to briefly "ping" the filter for ringing sine-wave filter effects - no other oscillator or audio inputs are necessary. The *Keyb Percussion* function works on all four filter outputs, but the bandpass output is perhaps the most suited to this effect (the lowpass output tends to thump and the highpass tends to tick). It can be used for anything from Hammond organ-type attack transients (we suspect that was the original intention) to booming 808-style kick drums, dependent upon cutoff frequency and resonance settings. Its controls are as follow:

- **Gate**- Patch a gate CV to this input to trigger keyboard percussion
- **Off/On** - Enables and disables keyboard percussion.
- **Final Q**- Sets the amount of resonant ringing *after* gate voltage goes to zero, i.e. on key-up. Effectively functions as a release control. *Final Q* can be set either higher or lower than the resonance control. This creates different effects such as choking or extended ringing after the key is released.

  Final Q might also be a *Star Trek: The Next Generation* episode... uh... maybe not.

1/2/3 Input jacks and attenuators - Patch audio signals in here. These essentially act as an input mixer for signals. Note that the 1047 filter is really sensitive to levels - different mixes of fundamental vs. resonance, as well as overdrive levels can be achieved by adjusting input gain.

Audio Out jacks- Individual outs for bandpass, notch (top row), highpass, and lowpass (bottom row) filter outputs. Try patching all four to a mixer and using the level controls to create unique filter curves.

36 VM2500 Oscillator Module 1004-P

The 1004P is one of three primary oscillator modules. All three versions are similar with slight control variations, but their underlying sound generation is essentially the same.

They can be used in the audio range, or as low-frequency modulation sources.

36.1 Inputs, Outputs, and Controls

1V/Oct jack- Accepts a CV input for pitch. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Frequency / Coarse and Fine- The *Coarse* control sets the base frequency over a nine-octave range, in octave increments. The *Fine* control allows continuous fine pitch control and is configured as a "multiplier" with center position being nominal and a range of 1/2 pitch to the left or double the pitch to the right (i.e. +/- one octave).

Enable- Turns the oscillator on and off.

Range- Generally this will be set to *Low* when using as a mod source, or high for audio-range signals.

Waveform Volume- Sets the volume of the sine, triangle, square, ramp, and pulse waves in the master output. These do not affect volume of the individual wave out jacks.

Pulse Width (PW)- This sets the width or "duty-cycle" of the pulse wave (the very bottom waveform on the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

PWM mod input jack and attenuator and PWM - You may have noticed that moving the *Pulse Width* knob back and forth creates a nifty sound; instead of wearing our your mouse hand, the *PWM Mod* input can be used in conjunction with an LFO, envelope generator, or other mod source to continuously vary the pulse width. The attenuator knob is bipolar; it allow positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

Frequency Mod 1 and 2 input jack and attenuator- This is used for externally modulating the oscillator frequency. It's useful for adding vibrato with an LFO, siren noises, envelope-controlled pitch sweeps, etc. The attenuator knob is bipolar; it allows positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

All mod inputs are exponential, that is, for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Waveform volume knobs- Five waveforms are available: ramp, sawtooth, pulse, sine, and triangle. The corresponding volume knobs affect the waveform level at the master *Output.* The middle position is zero; dialing the knobs clockwise increases the positive waveform polarity output and dialing counterclockwise increases the volume of inverted waveform polarity output.

Waveform individual output jacks- These are output jacks for ramp, sawtooth, pulse, sine, and triangle waves. These can be used simultaneously, or in any combination. These are always at full amplitude and are unaffected by their corresponding volume knobs.

Master output knob and jack- Mix of all individual waveforms, dependent on corresponding volume knob settings and the silver master *Output* knob.

37 VM2500 Oscillator Module 1004-R

functionally identical to the 1004-T oscillator, min The 1004-R is one of three primary oscillator modules. It's us 1004-T's ability to invert waveforms.

We included it for completeness, it's cool-looking rocker switches, and for that one weirdo who will swear that the 1004-R is the best-sounding 2500 oscillator. It can be used in the audio range, or as low-frequency modulation sources.

37.1 Inputs, Outputs, and Controls

1V/Oct jack- Accepts a CV input for pitch. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Frequency / Coarse and Fine- The *Coarse* control sets the base frequency over a nine-octave range, in octave increments. The *Fine* control allows continuous fine pitch control and is configured as a "multiplier" with center position being nominal and a range of 1/2 pitch to the left or double the pitch to the right (i.e. +/- one octave).

Enable- Turns the oscillator on and off.

Range- Generally this will be set to *Low* when using as a mod source, or high for audio-range signals.

Pulse Width (PW)- This sets the width or "duty-cycle" of the pulse wave (the very bottom waveform on the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

PWM mod input jack and attenuator and PWM - You may have noticed that moving the *Pulse Width* knob back and forth creates a nifty sound; instead of wearing our your mouse hand, the *PWM Mod* input can be used in conjunction with an LFO, envelope generator, or other mod source to continuously vary the pulse width. The attenuator knob is bipolar; it allows positive (clockwise) or inverted voltage control (counterclockwise). It defaults to center zero position.

Frequency Mod 1 and 2 input jack and attenuator- This is used for externally modulating the oscillator frequency. It's useful for adding vibrato with an LFO, siren noises, envelope-controlled pitch sweeps, etc. The attenuator knob is bipolar; it allows positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

All mod inputs are exponential, that is, for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Waveform rocker switches- Five waveforms are available: ramp, sawtooth, pulse, sine, and triangle waves. Each wave can be turned on and off individually. Waveforms are output to the master *Output* jack at the bottom right of the panel.

Waveform individual output jacks- These can be used simultaneously, or in any combination. **They are unaffected by their corresponding rocker switches.**

Master output jack- Mix of all individual waveforms, dependent on wave rocker switch settings.

38 VM2500 Oscillator Module 1004-T

The 1004-T is one of three primary oscillator modules. All three versions are similar with slight control variations, but their underlying sound generation is essentially the same.

They can be used in the audio range, or as low-frequency modulation sources.

38.1 Inputs, Outputs, and Controls

1V/Oct jack- Accepts a CV input for pitch. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Frequency / Coarse and Fine- The *Coarse* control sets the base frequency over a nine-octave range, in octave increments. The *Fine* control allows continuous fine pitch control and is configured as a "multiplier" with center position being nominal and a range of 1/2 pitch to the left or double the pitch to the right (i.e. +/- one octave).

Enable- Turns the oscillator on and off.

Range- Generally this will be set to *Low* when using as a mod source, or high for audio-range signals.

Waveform Volume- Sets the volume of the sine, triangle, square, ramp, and pulse waves in the master output. These do not affect volume of the individual wave out jacks.

Pulse Width (PW)- This sets the width or "duty-cycle" of the pulse wave (the very bottom waveform on the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

PWM mod input jack and attenuator and PWM - You may have noticed that moving the *Pulse Width* knob back and forth creates a nifty sound; instead of wearing our your mouse hand, the *PWM Mod* input can be used in conjunction with an LFO, envelope generator, or other mod source to continuously vary the pulse width. The attenuator knob is bipolar; it allow positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

Frequency Mod 1 and 2 input jack and attenuator- This is used for externally modulating the oscillator frequency. It's useful for adding vibrato with an LFO, siren noises, envelope-controlled pitch sweeps, etc. The attenuator knob is bipolar; it allows positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

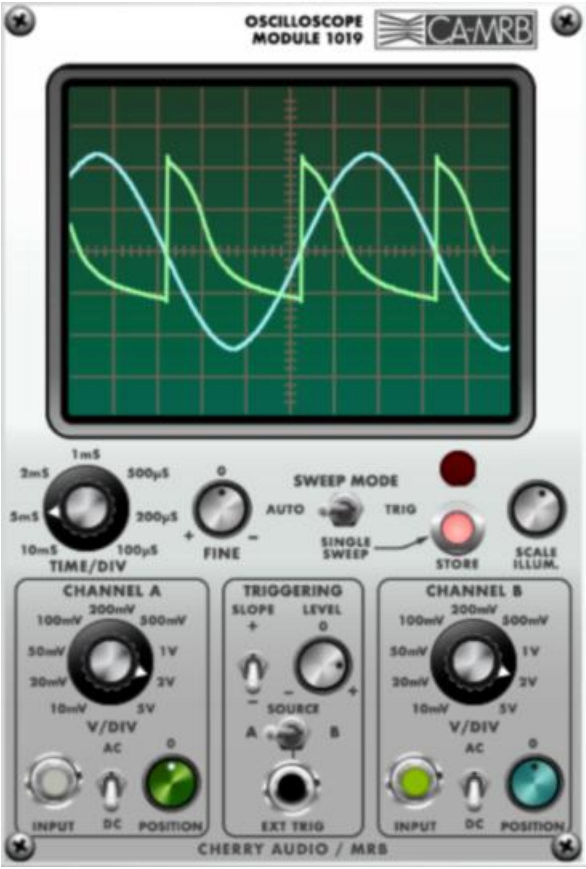
All mod inputs are exponential, that is, for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Waveform toggle switches- Five waveforms are available: ramp, sawtooth, pulse, sine, and triangle waves. The switches have three positions allowing normal, off, or inverted output to the master *Output* jack at the bottom right of the panel.

Waveform individual output jacks- These can be used simultaneously, or in any combination. These are always at full 10 V peak-to-peak amplitude and positive polarity. **They are unaffected by their corresponding toggle switches.**

Master output jack- Mix of all individual waveforms, dependent on wave toggle switch settings.

39 VM2500 Oscilloscope Module 1019



The Cherry Audio / MRB VM2500 module 1019 Oscilloscope is a versatile dual-trace scope modeled after analog units of the 1970s.

The 1019 is one of several modules ARP planned to add to the 2500 line, but unfortunately never did. There is no detailed description of what this scope might have been like, so this is our take on it, and it's likely far better than what was planned.

The 1019 has features found on high-end scopes such as AC/DC coupled inputs, calibrated sweep and vertical amplifiers, single-sweep mode, and variable level triggering from either of the two input channels or an external source.

39.1 Inputs and Controls

Time/Div- Controls the horizontal sweep speed of the trace. As the knob is turned clockwise, the sweep speed increases and the waveform display spreads out (i.e., zooms). The dial markings, in milliseconds (mS) and microseconds (uS), indicate how much time it takes for the sweep to pass one square (division) of the grid. Because it is calibrated, the period and frequency of waveforms can be determined by noting how much time the displayed cycles take.

Example: If the dial is set to 1mS and the waveform takes four divisions to complete a cycle, that means one cycle takes four milliseconds (0.004sec). Using the reciprocal (1/0.004), the frequency of the waveform can be determined: 250Hz. Oscilloscopes can measure frequencies this way when frequency counters have an impossible time with complicated waveforms.

Fine- Provides fine adjustment of the sweep speed. Keep this control at *0* to retain the *Time/Div* calibration (if you care).

Sweep Mode- Determines how horizontal sweeps are initiated. In *Auto* mode, the sweep is in "free run" mode, with the next sweep starting immediately after the last one finishes. *Single Sweep* allows single events to be captured by pressing the *Store* button. When pressed, one sweep will occur and freeze. The LED illuminates to indicate that this is a stored, frozen waveform. *Trig* (probably the most frequently used mode) utilizes the *Triggering* controls in the center and enables stabilization of complex waveforms.

Scale Illum.- Changes the "backlighting" of the grid.

Channel A/Channel B- These are the vertical amplifiers for the two traces. *Channel A* controls the green trace; *Channel B* controls the blue trace. Having two different colored traces is not "70s-correct," but we thought everyone would go crazy deciphering two green traces like an old CRT scope.

V/Div (Volts per Division)- Controls the vertical sensitivity. The dial markings indicate how many volts occupy one vertical square.

Input- Patch input signals here.

AC/DC- In the *AC* position, this switch allows you to remove any DC offset from the input signal by passing it through a 1Hz highpass filter. The result will always be a vertically centered waveform. In the *DC* position, the signal passes through unchanged. This control has no effect on the world's most famous mediocre rock band.

Position- Moves the trace up and down. This is very handy for separating the two traces on the screen for easier viewing and comparison. It can also be used to line up features of the wave on the grid for simplified voltage measurements.

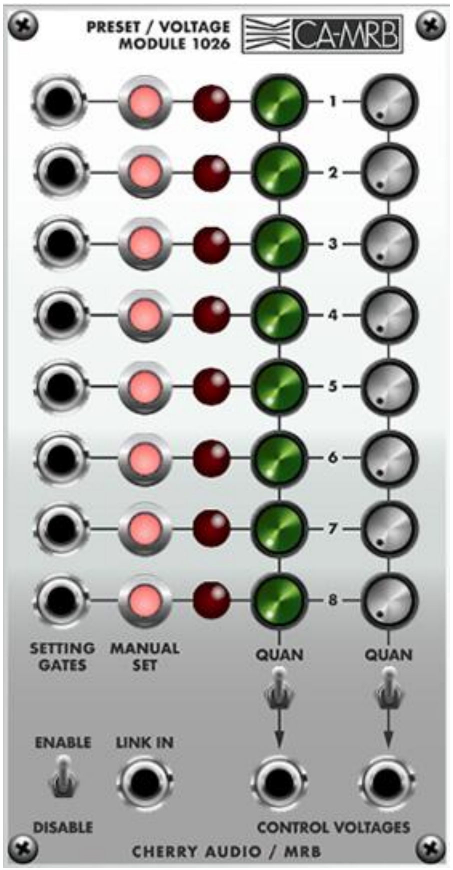
Triggering- When *Sweep Mode* is set to *Trig*, these controls are used to adjust the sweep triggering to create a stable display. The idea is to start the sweep at the same point in the waveform every time - this way, the waveform doesn't jump all over the place from one sweep to the next.

Slope- Determines which direction the waveform has to be traveling to initiate a trigger (i.e., up or down).

Level- Controls the voltage threshold at which triggering occurs. For example, when viewing a sawtooth wave running through a highly resonant filter (i.e., a very complex waveform), the *Level* control can be set to trigger at the very top of the highest peak. By picking out this unique feature of the wave, the sweep always triggers at this spot, resulting in a stable display. If *Trig* mode is currently enabled and no waveform is visible, this means triggering has not occurred - this can be corrected by adjusting the *Level* control.

Source- Selects triggering from the signal in *Channel A* or *Channel B*, or from an external source. Sometimes when looking at complex signals, a simpler signal can be tapped elsewhere in the patch for use as a trigger - this is where *Ext Trig* comes in handy.

40 VM2500 Preset Voltage Module 1026



The 1026 Preset Voltage module is similar to a conventional dual eight-step sequencer, but instead of playing consecutively through its steps, it has buttons and CV inputs allowing random selection of any stage. It contains no onboard clocking or transport controls. With that that said, its Link In jack allows CV control of stages, allowing sequential step playback - more on this later.

It's useful for making slow changes, for example, changing the key center of another sequencer (such as the 1027 Clocked Sequential Control) but it can run at any speed, in any order depending upon the CV sources it's paired with.

40.1 Inputs, Outputs, and Controls

Most of the controls are repeated in each of the eight stages; note that the panel labels are beneath the last stage at the bottom. Unlike Coachella, only one stage can be active at any time.

Setting Gates inputs- Sending a +5V trigger or gate signal to these selects the stage.

Setting Gates Enable switch- The toggle beneath the *Settings Gates* jacks enables and disables CV reception. The *Manual Set* buttons still work when disabled.

Manual Set- Clicking the button selects the stage.

Stage active lamp- Glows to indicate the currently selected stage.

Control Voltages knobs- Each vertical column of knobs sends a separate voltages to its corresponding output jack, depending on which stage is currently active. These can be set from 0 to +5V.

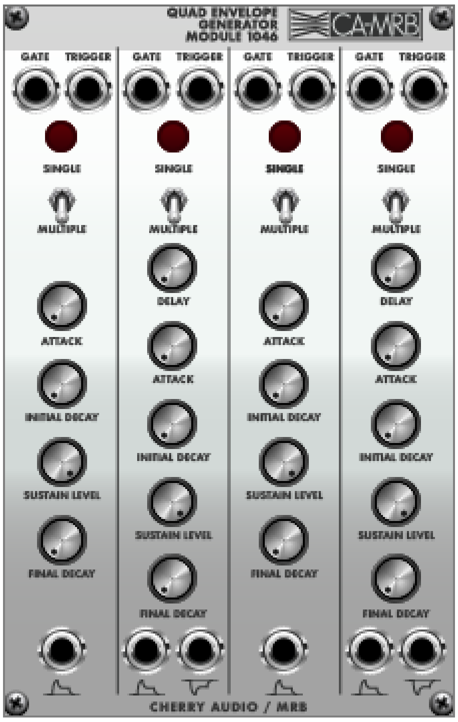
Link In- Not to be confused with the job networking web site that nobody actually uses, the *Link In* jack uses a dynamic CV to enable synchronization between modules. Specifically, the 1027 Clocked Sequential Controller module is intended to be the master clock, and its *Link Out* jack should be patched to one or more 1026 Preset Voltage and/or 1050 Mix Sequencer modules. The *Enable* switch makes the *Link* input active.

The *Link In* jack can also be slightly misused for step control with positive-polarity LFO waves - the positive polarity saw wave from any of the 1004 or 1023 oscillators is perfect for this. The idea is to use waves that change voltage over their duration, so square waves won't work well (they'll simply alternate between two positions). Adding an attenuator module (such as the Attenuverter) between the LFO and the *Link In* jack allows control of the number of steps as well.

Quantize switches- In the down position, the control knobs can be freely set to any voltage between 0 to +5V. If the CV outs are used to control oscillators, it can make tuning melodies difficult. When engaged, the CV knobs move in 1/12V steps , which equates to semitones.

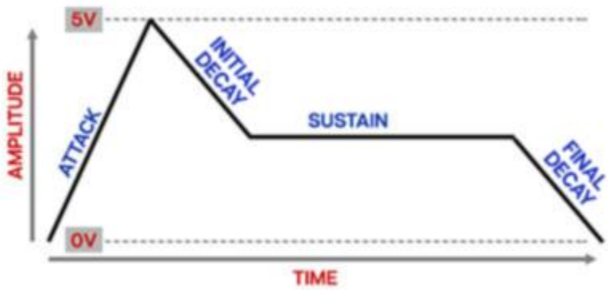
Output jacks- The jacks at the bottom of each knob column outputs the voltage for the currently active stage.

41 VM2500 Quad Envelope Generator Module 1046



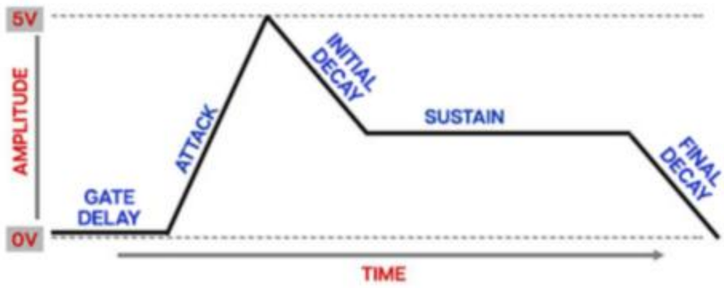
The 1046 is an ADSR envelope generator with four fully independent envelopes. It functions exactly like the original 2500 version and is essentially a 1003 and a 1033 envelope generator in a single module. If you're not familiar with the operation of envelope generators, here's an overview:

When a gate voltage is sent to the *Gate In* jack (or the *Gate* button is held), the envelope generator outputs a voltage that changes dynamically according to the settings of its four stages.



The *Attack* stage defines how long it takes for the output voltage to rise from 0 to 5 volts. Once the attack stage reaches 5V, it moves to the *Initial Decay* phase, which defines how long it takes to fall from 5V to the setting of the *Sustain* phase. Unlike the *Attack*, *Initial Decay*, and *Final Decay* phases, each of which define a time, *Sustain Level* simply sets the held voltage level following the *Attack* and *Initial Decay* phases - this usually equates to the envelope output level while holding down a key on a keyboard controller. The *Final Decay Time* knob defines the the length of time it takes for the voltage to fall back to 0V when the gate input voltage is removed (typically when you let go of a key on a keyboard controller).

The second and fourth envelopes add a *Gate Delay* stage that defines how long the envelope waits between receiving a gate/trigger CV and initiating the *Attack* stage - their diagram looks like this:



41.1 Inputs, Outputs, and Controls

As the "quad" in its name implies, the 1046 module contains four envelope generators, with independent controls, inputs, and outputs.

Gate input jack- This is where you'll patch gate voltages to initiate the envelope generator cycle. Most often this will come from the IO Panel *Gate* output.

Trigger input jack- This is where you'll patch trigger voltages to reset the envelope generator cycle. This can originate from the IO Panel *Trig* output, a sequencer, or other modules.

"What's the difference between a gate and a trigger?"

- A **gate** is a *constant* voltage. If you're playing a keyboard, it remains high (i.e. +5V) as long as the key is held down.
- A **trigger** is a *rapid spike* of +5V. It's useful for a number of things (like turning stuff on and off, triggering "one-shot" drum sounds or modules, or restarting the 1046 envelope).

Gate indicator lamp- Illuminates to show an incoming gate voltage of > 1V has initiated the envelope.

Gate Delay- Adds a "pause" of up to three seconds prior to the initiating the attack phase. Removal of a gate signal during the delay cancels the envelope and resets the delay timer.

Attack Time- Defines the length of time for voltage to rise from 0V to 5V when the gate voltage is applied.

Initial Decay Time- Defines the length of time for voltage to fall from the *Attack Time* stage 5V peak to *Sustain Level* setting.

Sustain Level- Sets the held voltage level following *Attack Time* and *Initial Decay Time* phases.

Final Decay Time- Defines the length of time for voltage to fall from *Sustain Level* to 0V when gate is released. This is called Release on just about every synthesizer on the planet.

Trigger Modes switch- In a situation where a note is already held down (gate input is high), these regulate whether or not the envelope retriggers when a new note is played. When set to *Single*, new notes will not retrigger the envelope; when set to *Multiple* the envelope retriggers every time a new note is played, regardless of previously held notes.

____

41.1.1 IMPORTANT

Unlike most envelope generators, both the Gate and Trigger CV inputs must be connected, or else the 1046 will behave a little strangely.

It's important to remember that the 2500 modules were designed during the infancy of analog synthesizer development, so they don't always work exactly like their modern counterparts.

If Voltage Modular's IO Panel *Trig* CV output isn't connected to a *Trigger* CV input, it will work fine in *Single* mode, but *Multiple* trigger mode will not work correctly (the *Attack Time* control won't do anything, and the *Initial Decay Time* knob will behave as the *Attack Time* control).

For correct envelope and triggering behavior:

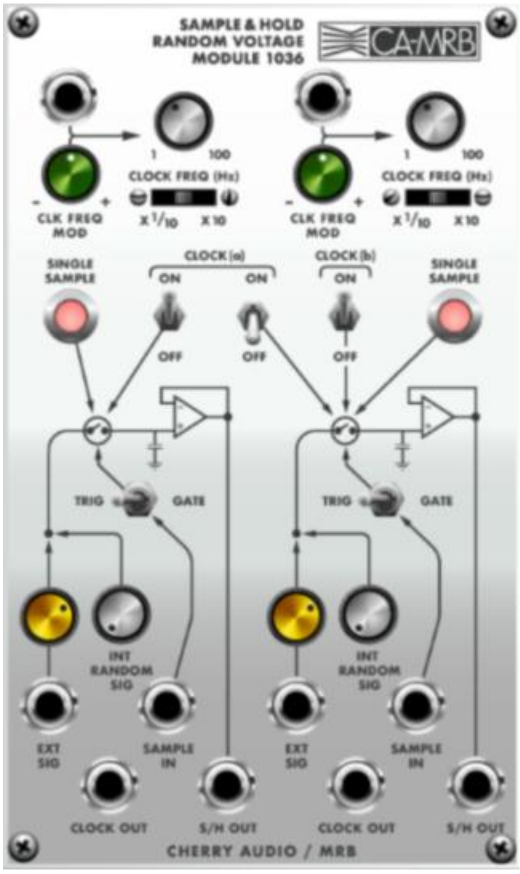
- Set the Voltage IO Panel *Single/Multi* selector to *Single.*
- Patch the IO Panel *Gate* and *Trig* CV outputs to the 1046 *Gate* and *Trigger* CV inputs, respectively.

Because the *Trigger* CV input restarts the envelope from the attack phase, the *Gate* and *Trigger* CV inputs can be combined for interesting rhythmic effects. For example, a note could be held with the keyboard (via the IO Panel Gate CV out) while retriggering from a sequencer for emphasis on particular beats.

It should go without saying that you won't hurt anything if you hook it up "wrong," but the envelope generator may not behave as expected.

Normal/Inverted out- These are the envelope voltage outputs. The standard jack (icon going up from centerline) outputs voltage ranges from 0V to +5V, whereas the inverted jack ((icon going down from centerline) is inverted, with output ranging from 0V to -5V. Envelopes one and three are positive output only; envelopes two and four have positive and inverted outputs.

42 VM2500 Sample & Hold Module 1036



The 1036 Sample & Hold Random Voltage module is a synthesis tool that repetitively “samples” an input signal and outputs its voltage until triggered again. This module features two identical sample & holds and includes a built-in white noise generator - the most common "sample" source for creating random voltages. It also includes two independent clock sources - both sample & holds can run from one clock or they can run independently. The original 1036 module also features and extensive front-panel circuit schematic, which is helpful, should it ever need servicing...

Kidding aside, we've illustrated how a sample & hold works to make its operation easier to understand. In the image below, the smooth gray line shows a continuous input signal. Each time the module is triggered the current voltage is “sampled” and “held” until the next trigger. The red line shows the stepped output signal.

42.1 Inputs, Outputs, and Controls

Clock Freq- The clock "samples" the incoming signal at intervals defined by its current setting. Its range is from 0.1 Hz - 1000 Hz (depending on the current *Clock Multiplier* slide switch setting).

Clock Multiplier Switch- Center position is nominal; moving the switch left divides clock frequency by 10, moving it to the right multiplies clock frequency by 10.

Clock Frequency Mod CV jack and attenuator- Allows CV control of the clock frequency. The attenuator is bipolar with center position = no modulation.

42.1.1 The Sampling Switch

If you're familiar with circuit schematics, you probably recognize this as the symbol for a switch. This represents the "sampling" the input voltage. Looking at the panel, we see three arrows around its perimeter - each of these represents a way the switch circuit can be triggered, via either the momentary *Single Sample* button, the onboard clocks, or the *Sample In* jack. Note that all three trigger inputs are simultaneously active.

Single Sample button- This momentary button "grabs" an instantaneous sample of the input signal - either white noise (if the *Int Random Sig* knob is up) or from a source patched to the *Ext Sig* input jack.

Clock (a) and Clock (b)- The two independent onboard clocks are used to sample input signals at regular intervals. When disabled (toggles in Off position, duh), new sample voltages are output by clicking the Single Sample button. Sample & hold B (the one on the right) can be clocked with clock (a) (both sample & holds synchronized) or clock (b) (each sample & hold running independently), or *both* clock (a) and clock (b) simultaneously for all manner of asynchronous sample & hold clockin' fun.

Sample In jack and Trig/Gate switch- The *Sample In* jack triggers sampling when it receives a CV. In *Trig* mode a single instantaneous sample is taken when a trigger or gate voltage is received.

In *Gate* mode, the sample switch is held closed as long as a gate signal is present - the audible result is that the sample and hold output "follows" the Int *Random Sig* (i.e. onboard white noise) and/or the *Ext Sig* input, until the gate voltage falls, at which time the latest value is held. This is called "track and hold".

Int Random Sig jack and attenuator- Sets the level of the internal white noise sample source. White noise is frequently used as a source in sample & holds because the resulting voltages will be completely random. The attenuator sets the amount of white noise routed to the sample & hold circuit.

Ext Sig input jack and attenuator- Allows any signal to be used as a source to be sampled. Interesting results can be achieved with any the standard "rising" or "falling" oscillator waves at sub-audio speeds (i.e. ramp, saw, triangle, or sine waves). Endless semi-melodic permutations can be created by varying the frequency of the waveform in combination with the sample & hold clock speed. The attenuator knobs sets the amount of external signal routed to the sample & hold circuit.

Note that the onboard white noise signal and external signals can be combined.

Clock Out- An output for the internal clock circuit for syncing to other modules.

S/H Out- Output voltage of the sample and hold circuit.

43 VM2500 Synthesizer Voice Module 1045

The 1045 Synthesizer Voice Module packs an entire 2500-style voice into one compact module.

Though it sacrifices a few controls and inputs, it essentially contains the equivalent of a 1004 oscillator, a 1006 lowpass filter, two 1003 envelope generators, and a VCA.

43.1 Inputs, Outputs, and Controls

43.1.1 Oscillator

The 1045 Synthesizer includes a single oscillator.

Oscillator enabled lamp- Illuminates when the *Oscillator Wave* selector knob set to any position other than *Off*.

1V/Oct jack- Accepts a CV input for pitch. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Frequency / Coarse and Fine- The *Coarse* control sets the base frequency over a nine-octave range, in octave increments. The *Fine* control allows continuous fine pitch control and is configured as a "multiplier" with center position being nominal and a range of 1/2 pitch to the left or double the pitch to the right (i.e., +/- one octave).

Oscillator Wave selector- Five waveforms are available: sine, triangle, square, ramp, and pulse waves. The pulse wave's duty-signal (i.e., width) can be set using the *Pulse Width* knob. The *Off* position disables the oscillator - this is useful for using other sections to process signals from other modules.

Freq Mod jack and attenuator- Used for externally modulating the oscillator frequency. It's useful for adding vibrato with an LFO, siren noises, envelope-controlled pitch sweeps, etc. The attenuator knob is bipolar; it allow positive (turn right) or inverted voltage control (turn left). It defaults to center zero position.

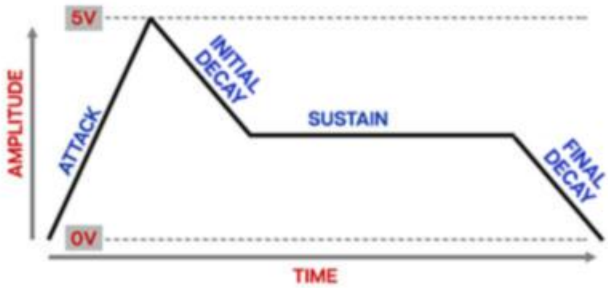
All of 1045's mod inputs are exponential, that is for a given mod input voltage, the mod amount increases as frequency increases. For example, if the base frequency is 1000 Hz, and a bipolar wave is applied to the mod CV input, the frequency falls to 500 Hz and rises to 2000 Hz. Because audio frequencies are inherently exponential in nature, the resulting frequency rises and falls exactly one octave.

Pulse Width (PW)- This sets the width or "duty-cycle" of the pulse wave (the very bottom waveform on the panel). It has no effect on any other waveform. Its default setting of 50% outputs a perfect square wave, rich in odd-order harmonics. Moving the knob left or right narrows its width as well as the thickness of sound until it almost disappears at its extremes.

Osc Out jack- Raw oscillator waveform output, dependent on wave selector switch settings.

43.1.2 Envelopes

The 1045 Synthesizer includes two independent envelope generators: the one the left controls filter cutoff frequency; the one at far right controls VCA amplitude. That said, they include independent CV ins and outs and can be patched to control other destinations. Here's how they work:



When a gate voltage is sent to the *Gate In* jack (or the *Gate* button is held), the envelope generator outputs a voltage that changes dynamically according to the settings of its four stages.

The *Attack* stage defines how long it takes for the output voltage to rise from 0 to 5 volts. Once the attack stage reaches 5V, it moves to the *Initial Decay* phase, which defines how long it takes to fall from 5V to the setting of the *Sustain* phase. Unlike the *Attack*, *Initial Decay*, and *Final Decay* phases, each of which define a time, *Sustain Level* simply sets the held voltage level following the *Attack* and *Initial Decay* phases - this usually equates to the envelope output level while holding down a key on a keyboard controller. The *Final Decay Time* knob defines the the length of time it takes for the voltage to fall back to 0V when the gate input voltage is removed (typically when you let go of a key on a keyboard controller).

Gate input jack (gate wave icon)- This is where you'll patch gate voltages to initiate the envelope generator cycle. Most often this will come from the IO Panel *Gate* output.

The gate input jacks for the filter and VCA envelope generators are normalled, as indicated by the bidirectional arrows on the panel. Patching a single gate signal into either one of the jacks automatically connects to both. The gate inputs function independently if separate cables are patched to each input (i.e. the normalled connection is broken).

Trigger input jack (spike wave icon)- This is where you'll patch trigger voltages to reset the envelope generator cycle. This can originate from the IO Panel *Trig* output, a sequencer, or other modules.

As with the gate input jacks, the trigger input jacks for the filter and VCA envelope generators are normalled. Patching a single trigger signal into either one of the jacks automatically connects to both. The trigger inputs function independently if separate cables are patched to each input (i.e. the normalled connection is broken).

"What's the difference between a gate and a trigger?"

- A **gate** is a *constant* voltage. If you're playing a keyboard, it remains high (i.e. +5V) as long as the key is held down.
- A **trigger** is a *rapid spike* of +5V. It's useful for a number of things (like turning stuff on and off, triggering "one-shot" drum sounds or modules, or restarting the envelope).

Attack Time- Defines the length of time for voltage to rise from 0V to 5V when the gate voltage is applied.

Initial Decay Time- Defines the length of time for voltage to fall from the *Attack Time* stage 5V peak to *Sustain Level* setting.

Sustain Level- Sets the held voltage level following *Attack Time* and *Initial Decay Time* phases.

Final Decay Time- Defines the length of time for voltage to fall from *Sustain Level* to 0V when gate is released. This is typically called "release" on most other synths.

Single Multiple trigger modes switches- In a situation where a note is already held down (gate input is high), these determine whether or not the envelope retriggers when a new note is played. When set to *Single*, new notes will not retrigger the envelope; when set to *Multiple* the envelope retriggers every time a new note is played, regardless of previously held notes.

____

43.1.3 IMPORTANT

Unlike most envelope generators, both the Gate and Trigger CV inputs must be connected, or else the 1045 will behave a little strangely.

It's important to remember that the 2500 modules were designed during the infancy of analog synthesizer development, so they don't always work exactly like their modern counterparts.

If Voltage Modular's IO Panel *Trig* CV output isn't connected to *Trigger* CV input, it will work fine in *Single* mode, but *Multiple* trigger mode will not work correctly (the *Attack Time* control won't do anything, and the *Initial Decay Time* knob will behave as the *Attack Time* control).

For proper envelope and triggering behavior:

- Set the Voltage IO Panel *Single/Multi* selector to *Single.*
- Patch the IO Panel *Gate* and *Trig* CV outputs to the 1045 *Gate* and *Trigger* CV inputs, respectively.

Because the *Trigger* CV input restarts the envelope from the decay phase, the *Gate* and *Trigger* CV inputs can be combined for interesting rhythmic effects. For example, a note could be held with the keyboard (via the IO Panel *Gate CV* out) while retriggering from a sequencer for emphasis on particular beats.

It should go without saying that you won't hurt anything if you hook it up "wrong," but the envelope generator may not behave as expected.

43.1.4 Filter

The filter section is ARP's take on the classic 24 db/oct transistor ladder filter. It has the "fat" sound associated with this design.

Filter In- Audio input to the filter. The internal oscillator is normalled to the filter input, so it isn't necessary to patch a cable - this input is intended for patching external signals. Note that this connection does not "break" the connection from the onboard oscillator. The onboard oscillator signal is combined with the filter input jack.

1V/Oct jack- Accepts a CV input for scaling the cutoff frequency to match ascending notes. Typically this would come from the *Pitch* jack in the IO Panel *CV Out* section, or from a sequencer CV out.

Filter fc (cutoff frequency)- Sets the cutoff frequency. Since this is a low-pass filter, all frequencies lower than this value will be allowed to pass through the filter while frequencies higher than the cutoff will be attenuated at a rate of 24db per/octave.

Resonance- Turning this knob up emphasizes sound energy at and around the cutoff frequency by adding feedback from the filter's output back to its input. With higher settings, modulation of the cutoff frequency becomes more pronounced. *Filter Resonance* can cause loud squelches at high settings, so be careful.

Env Ampl- Sets the amount of cutoff frequency modulation from the filter mod envelope generator (to the left of the filter section).

Frequency Mod CV jack and attenuator- These are CV input jacks and attenuators for externally controlling cutoff frequency. The attenuators are bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

Filter Out- Output of the filter signal.

43.1.5 VCA

A voltage-controlled amplifier with authentic vintage style overdrive characteristics.

VCA In- Audio input to the VCA. The filter output is normalled to the VCA input, so it isn't necessary to patch a cable - this input is intended for patching external signals. Note that this connection does not "break" the connection from the onboard filter. The onboard filter signal is combined with the VCA input jack.

Drive- Sets the amount of inherent overdrive. Its default setting of 32.2% is very close to the overdrive inherent to a vintage 2500 VCA.

Amplifier Gain- This is an initial gain setting for the voltage-controlled amplifier. Typically this will be set to zero, as the VCA level will usually be controlled by an envelope. Opening it up is useful for drones, or when setting pitches on a sequencer.

Ex/Lin- These select the "curve" of the amplifier's response as the input CV rises from 0 to 5V. *Ex* or exponential curve is a close representation of how the human ear perceives volume, whereas *Lin* or linear response curve is equally proportional across the voltage input range. You'll likely want to use the *Lin* setting for modulation or control voltage situations, and use the *Ex* setting when an envelope generator is used to control an audio signal with the amplifier.

Env Ampl- Sets the amount of amplitude modulation from the amp mod envelope generator (to the left of the VCA section).

VCA Mod CV jack and attenuator- Controls VCA amplitude. This can be used for patching an alternate envelope generator, or for amp mod via LFO's, etc. The attenuator is bipolar - center position is zero; turn right for positive CV or left for inverted (negative) CV values.

VCA Out- The output of the VCA, i.e. 1045's final output.

44 VM2500 Triple VCA Module 1042

The 1042 consists of three identical voltage-controlled amplifiers. Though this module was planned, it was never produced. We felt there was a need for a dedicated multiple-VCA module, so we created it for the VM2500 series. We've included *Drive* knobs to give them an authentic vintage ARP sound.

The idea of a voltage-controlled amplifier (VCA) is that an audio or control signal is patched to its input, then its amplitude can be externally controlled via the *CV In* jack. This is useful for turning audio or control signals on or off, applying envelope volume curves to sounds, regulating the amount of modulation signals applied to audio signals, and more. Think of it as a voltage-controlled gate, with a variable amount of gate opening.

44.1 Inputs, Outputs, and Controls

Drive- Replicates the inherent mild overdrive characteristics of the original ARP VCA's. At the default setting of 32%, this is very close the original, and of course can be adjusted for more or less overdrive (or way too much). "Drive" is also a really great song by The Cars, and a horrific song by Incubus, a 90s band currently residing in the, "where are they now?" file.

Amp Gain- Adds up to 5V of gain. This works in addition to incoming *Amp Mod* and *CV 1/2/3* jack voltages. It's also useful for manually "opening" the amplifier.

Amp Mod CV in jack- Control signal inputs are patched in here. This has no attenuator and is "wide open" all the time - typically this would be used to patch an envelope generator.

CV 1/2/3 CV in jack and attenuator- Any control signal can be patched here, including gates, LFO's, sequencers, noise generators, sample and holds, etc. Audio-rate signals can also be patched in for insane ring-mod type modulation, etc. The attenuator is bipolar, with center position = no modulation.

Exp'l/Lin- These select the "curve" of the amplifier's response as the input CV rises from 0 to 5V. *Lin* or linear response curve is equally proportional across the voltage input range, whereas the weirdly abbreviated *Exp'l* or exponential curve is closer to how the human ear perceives volume. You'll likely want to use the *Lin* setting for modulation or control voltage situations, and use the *Exp'l* setting when an envelope generator is used to control an audio signal with the amplifier. Or just use whatever sounds best, we won't tell.

Input jack- Use this jack to patch in audio or control signals to be affected by the *CV In* jack.

Output jack- The *Output* jack carries the CV-modified version of the input signal.