SAW - 1 Discovery

by J. Chris Griffin

Reference Manual

Revision 1.02

October 2018

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Concept and Introduction

I have always been enthralled with sawtooth waveforms on a synthesizer. From first experiences with a borrowed MiniMoog to the first time playing a 16-voice Waldorf Q+ with the analog filter set (so utterly amazing to me at the time) the quest has been to recreate what my mind recalls from those special moments. Unfortunately, my mind recalls a much thicker (and better) sound than what was actually presented, so the search has been nearly impossible.

In 2016 Propellerheads asked me to update a series of patches I had created for their Rigs Bundles. Normally there are strict guidelines to follow with factory patches, but I have been working with Propellerheads since 2004 (my first product was the Electromechanical Refill if anyone remembers) and they finally set me free to create 'ultimate' patches regardless of CPU hit. I realized that modern computers were nearly able to create those sawtooth textures that were in my mind – just waiting for technology to catch up.

I say 'nearly' because there's no way computers in 2018 can synthesize 1000 unique polyphonic sawtooth waves in real time. Indeed, the largest so-called SuperSaw oscillators I know of only generate a few hundred distinct sawtooth waves at their highest settings. Play a two-handed Altered 5 chord (or the preceding two-minor chord) with 3 of these oscillators layered together and you're rebooting the computer. Yes, modern synths generate a ton of oscillators, but it takes WAY more to generate a compelling and engaging sound for a Pop hit. Until now, no single synthesizer could dare make that kind of sound, but I had a stash of raw recordings that just might be ready for life...

I make Pop records for a living – most days. Other days I'm prepping sounds and repairing equipment so I can make hits. The reason SAW-1 Discovery was made is because I wanted to use it on Pop hits.

Since my gear collection sometimes gets out of hand, I have a rough policy that whatever doesn't make an actual record in one year's time gets considered for sale. Then I buy something new that will actually make a record. Unfortunately, in 2011 my beloved ARP 2600 (early 1972 CMS Upgraded - TONUS logo) found itself in this category. I couldn't believe it! Even when I gave it another year it still hadn't made it onto a real record. A small snow-white synth just ate it for lunch every time. So bummed – until it sold for $8500 more than I paid for it. Not so bummed after all. Before it sold however, I set about sampling it every-which-way it could be sampled. After 3 or 4 weeks it occurred to me that I could "stack" ARP 2600 recordings the same way we stack background vocals or power-chord electric guitars. The ARP has free-running oscillators, so the chance of any (same) note sounding the same as a preceding note is near zero. Digital synths can't do this well – they play a note a similar way every time. Yes, there are analog models that detune and push the waveform out a few degrees at random - and there are modern 'free-running' options - but nothing like what a non-synced analog oscillator is capable of.

So, I set the external clock to 96k, fired up Pro Tools, the LA2A and tube mic-pre (each with very expensive vintage tubes – just spend the money on good tubes – you have no idea…), then set about recording ARP 2600 sawtooth waves. The system was set on a loop overnight for several weeks, getting every single key from Midi note 0 to note 127. That's a ton of data. That's also a ton of editing and looping, but the result sounds absolutely fantastic. You might have realized that the ARP sold in 2012 and now it's late 2018 (unless you're reading this in 2022, then it's 2022). Yep. It's taken nearly 6 years from those recordings to product release. Maybe that's why I haven't had a record in a while…

Please enjoy this synth. I hope it inspires true artistry. My desire is that this tool takes you exactly where you want to go.

All the best to you,

Chris

Overview

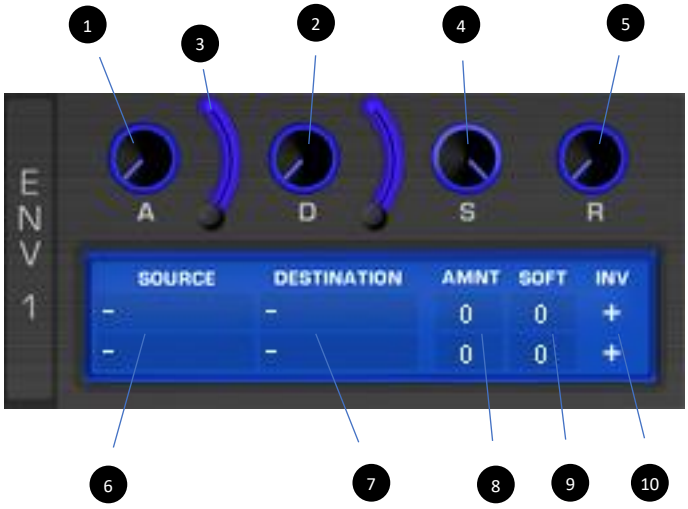
SAW-1 Discovery is a sawtooth-only synthesizer. A dual-oscillator engine uses vintage ARP 2600 sawtooth waveform samples, along with a few extra synths in waveforms 6 and 7. More on that later.

One of the unique features of the ARP 2600 is the ability to continuously and seamlessly change the pitch of an oscillator on the fly. It was important to implement this same feature in SAW-1 Discovery, thus the second oscillator 'layer' was added. SAW-1 Discovery uses two individual sample engines running separate (and different) sawtooth recordings for one waveform stack. In other words, there are two synths paired together in one GUI. Selecting "The Trinity" waveform causes over 2000 individual, unique sawtooth waves to generate the sound you hear.

This dual-layer architecture allows for sub-octave, unison, up-octave, 4ths, 5ths, or any combination of notes with one key press, thereby emulating not only the ARP, but other recognized synths from the 1970s onward. Because each layer contains unique and different recordings of each key, SAW-1 is free of phasing artifacts that often occur with traditional "unison" detuning and layering.

There are 3 routable envelopes and one dedicated amplifier envelope, three routable LFOs and two filter sections – low-Pass and high-Pass. There is an Oscillator Matrix section for advanced patch creation and a 16-note Step Sequencer covering 2 octaves. A fully-automatable Effects Section includes custom convolution samples built from my own high-end outboard equipment (the Spring Reverb samples are taken directly from the ARP 2600). Four polyphony modes, 6 factory 'skins,' performance controls, a bus compressor and Quality settings round out an extensive feature set.

Envelope Section

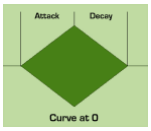


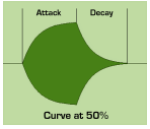
SAW-1 Discovery has 4 polyphonic ASDR envelopes with variable attack and decay curves.

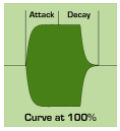
1 **Attack**
All Envelopes begin when a note is played. Attack sets the time it takes for the envelope to reach full value from an initial note-on. Lower Attack settings are faster, higher settings are slower. At 0 the Envelope reaches full value instantaneously. Range is from 0 to 16 seconds.

2 **Decay**
Decay determines how long the Envelope takes to go from full value to the Sustain value (discussed below). Low Decay values are faster, high values are slower (see a pattern yet?). Decay works in tandem with Sustain.

3 **Attack Curve and Decay Curve**
Attack and Decay controls are fully linear when Curve is at 0 and increase exponentially as Curve reaches full value. In other words, Attack and Decay controls take the same amount of *time* to reach the next envelope step, but *level* is altered differently as time passes. Combining Curve control with differing Attack and Decay times allows SAW-1 Discovery to emulate many famous synthesizers.





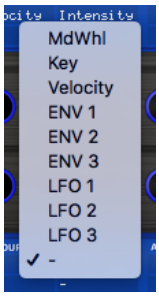


4 **Sustain**
Sustain is the 'resting' level, or the lowest level of the envelope. Low Sustain values result in low levels, high values result in high envelope levels. The highest Sustain level renders Decay useless since the resting level of the Envelope is full-on (there's no change from full value at the end of the Attack cycle to full value at Sustain). Note that Sustain indicates a level while other Envelope parameters alter time.

5 **Release**
Release begins at note-release. It determines the time it takes for the Envelope to drop down to 0 after a note ends.

Envelopes 1, 2 and AMP have a dedicated Matrix section allowing a performer to vary envelope operation (in real-time) as SAW-1 Discovery is played.

6 Source Assignment



This menu is from the AmpEnv Matrix. Notice there is no AmpEnv source available because an envelope cannot modulate itself. Each Envelope Matrix behaves this way.

Modulation Wheel (CC-1) – the left-hand wheel on many keyboard controllers or the joystick-up position on older KORG and Roland instruments.

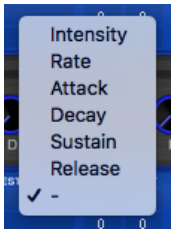
Key Number - use when high notes should be treated differently than lower notes. Ideal for envelope decay or filter cutoff as notes move up the keyboard.

Velocity – use to dynamically alter parameters as notes are played harder and softer.

Envelopes 1 through 3 and Amp Envelope – One envelope can modulate another. Useful for varying individual components of other envelopes. Results may vary. Envelopes cannot modulate themselves; parameters are displayed accordingly. For instance, there's no ENV 1 source option on Envelope 1 as it would put the envelope into an internal feedback loop and cause the sun to grow uncontrollably, then implode, ultimately becoming a planetary nebula and degenerate dwarf star. We don't want that.

LFO 1 through 3 – Low Frequency Oscillators can modulate envelope parameters. Try modulating envelope Attack times with an LFO for very interesting sounds. Slower LFO speeds give better results. There aren't many synths that can do this…

7 Destination Assignment



Intensity – indicates how 'much' the envelope affects its target. This can be assigned along with Velocity to increase the effect of an envelope as notes are played harder.

Rate – how fast the overall envelope moves. Rate alters envelope length from note-on to note end. Assigning the Mod Wheel to Rate will allow different envelope 'speeds' as the control is moved.

Attack – Alters Attack time. Perfect for low velocities triggering slow note entrances and hard velocities forcing immediate sound.

Decay - Alters Decay time. Ideal for sounds where low velocities require fast decays and hard velocities should 'stretch' decay time accordingly.

Sustain – Alters Sustain level. Try modulating Sustain with another envelope or an LFO for seemingly random results.

Release – Alters Release time. Modulating Release with Key makes high notes release differently than low notes. Modulating release with velocity is a great way to affect sound length in real time.

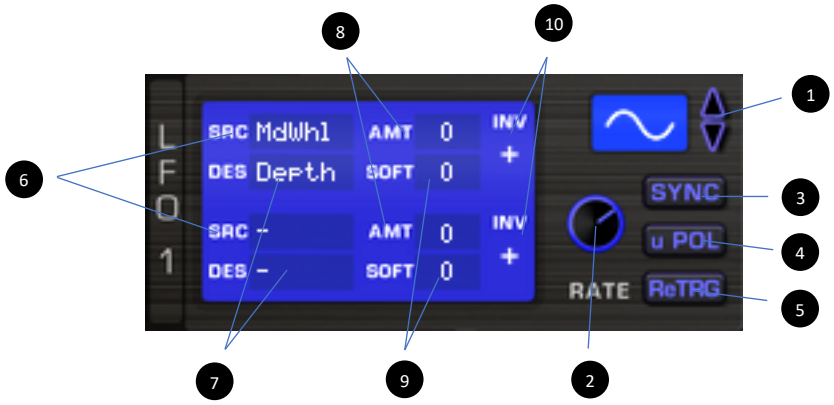
8 **Amount**
The amount of Modulation. At zero, there is no modulation, despite Source and Destination settings. Full modulation is 100.

9 **Soft**
This is a 'rounding' parameter known in vintage circles as "Lag." It slows and smoothly stretches the time between source input and destination output. The Soft control is not a delay but a 'stretching' parameter. Perfect for eliminating artifacts that occur when using low resolution controllers (like the modwheel) to control filter cutoff. Setting Soft to 15 or 20 eliminates the zipper effect as the filter opens and closes without changing the feel of a control. Long Soft times result in a gradual, delayed effect.

10 **Invert**
Invert changes polarity of the envelope as it affects the corresponding Destination parameter. Think of Invert as 'opposite' or 'upside down' (not *The* Upside Down, but that is a great analogy too).

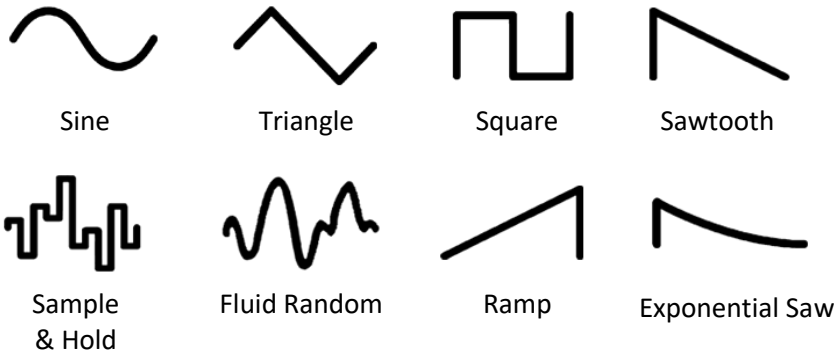
NOTE: When Attack and Release are at 0.0ms a slight 'snap' or pop may occur depending on the patch. Simply adjust Attack and Release slightly (use the Shift key for fine control in Reason) to reduce pops without notably altering envelope characteristics.

LFO – Low Frequency Oscillator



SAW-1 Discovery has three Low Frequency Oscillators, each with 2 individual routing matrixes. LFOs are identical except that LFO2 can be modulated by LFO1, and LFO3 can be modulated by both LFO1 and LFO2.

1 **Waveform**



2 **Rate**
Rate indicates frequency or speed of the LFO.

3 **SYNC**
Engaging SYNC forces the LFO to synchronize with song tempo. Rate indication will change to beats if the popup text indicator is active (see Reason Preferences).

4 **Unipolar**
Unipolar (or one-sided) changes the LFO to positive-pole output only. Normally the LFO is centered on the zero 'pole' and produces negative values when low and positive values when high. Unipolar is useful for pitch modulation that forces notes higher than an active note - never lower (and vice versa). See SAW-1 Discovery Factory patches for more examples of this parameter. You won't use Unipolar often, but it's a fabulous tool in the right situation.

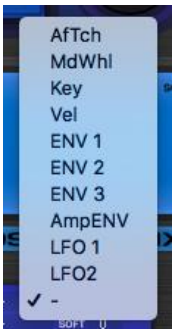
5 **ReTrigger**

Sometimes it is useful to restart the LFO each time a note is pressed, thus resetting LFO phase from the beginning. Normally, Low Frequency Oscillators are 'free-running' and move through a waveform cycle continuously regardless of note-on commands or note-release commands. ReTrigger stops the cycle and re-starts with each new note-on command, even as previous notes may still be held. Use ReTrigger for LFO modulation predictability as a note begins.

LFO Matrix

Each LFO has a dedicated Matrix section allowing a performer to vary operation (in real-time) as SAW-1 Discovery is played.

6 **Source Assignment**



LFO 3 Sources

Aftertouch – Some keyboards have a special strip underneath the keybed that senses pressure after a note is struck and held. Pressing harder on the held key activates Aftertouch. Firm pressure gives more intense results and soft pressure may not even be noticeable.

Modulation Wheel (CC-1) – the left-hand wheel on many keyboard controllers, or the joystick-up position on older KORG and Roland instruments.

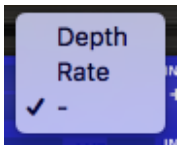
Key Number - use when high notes should be treated differently than lower notes – for decay and filter adjustments as notes move up the keyboard.

Velocity – use to dynamically alter parameters as notes are played harder and softer.

Envelopes 1 through 3 and Amp Envelope – Envelopes can change LFO rate or intensity as time progresses.

LFO 1 and 2 – Low Frequency Oscillator 1 can modulate LFO 2 and 3. LFO 2 can also modulate LFO 3. One can imagine a three-way modulation scenario, but this is a family synth…
Slower LFO speeds give better results. There aren't many synths that can do this either…

7 **Destination Assignment**



Depth – indicates how 'much' the LFO affects its target. This can be assigned along with the ModWheel or Aftertouch to control LFO amount.

Rate – Rate alters LFO speed. Assigning an Envelope to Rate will force different LFO speeds as the Envelope moves through time.

8 **Amount**
The amount that Source affects Destination – same as in the Envelope section.

9 **Soft**
This is a 'rounding' parameter known in vintage circles as "Lag." It slows and smoothly stretches the time between source input and destination output. The Soft control is not a delay but a 'stretching' parameter. Use Soft to even out LFO ripple or 'round off' a square wave.

> ***NOTE**: Sometimes Soft is more effective if used at the destination. For example, if LFO1 controls Volume A+B in the OSC Matrix, it will be more effective to alter Soft parameters at the OSC Matrix.*

10 **Invert**
Invert changes polarity of the LFO as it affects the corresponding Destination parameter. Think of Invert as 'opposite' or 'upside down' (see the Envelope section for a lame analogy…).

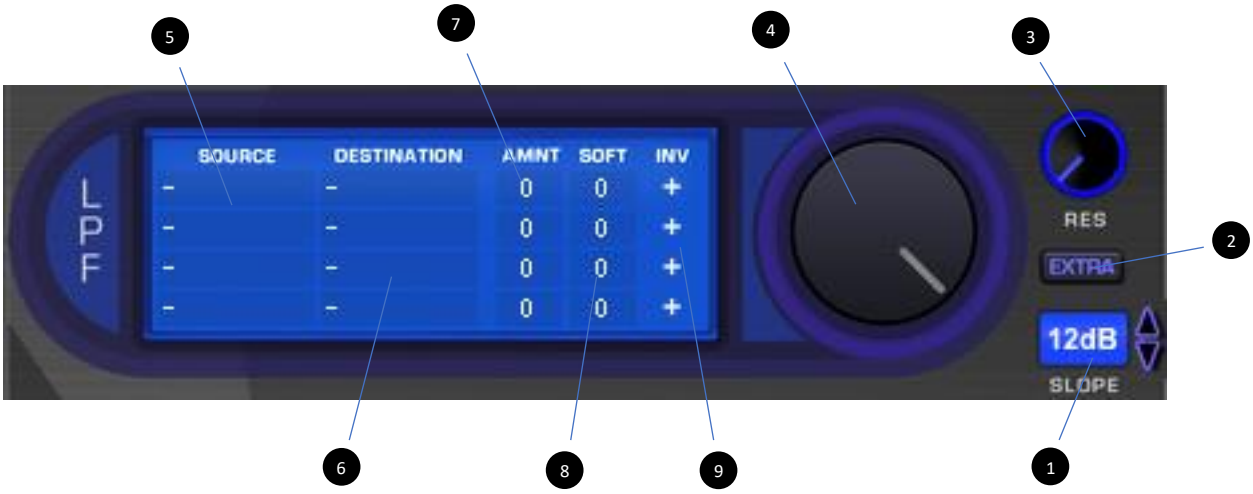
Filters

It's very difficult to program software filters that sound as 'violent' or 'rough' as filters in vintage monophonic synths. Predictability and "organic vintage behavior" do not go together easily. The filters in SAW-1 Discovery are violent and powerful. They will take your head off – be careful. Seriously, hearing damage is very real. Keep volumes low while experimenting with filter parameters. As indicated on the rear panel, few attempts have been made to reduce artifacts and distortion caused by excessive filter resonance. Many weeks of work went into the sound of these filters, especially the EXTRA parameter. The one drawback is that these filters are a bit CPU intensive.

These filters sound and behave very much like the 4012 filter in an early ARP (and if you know your history, early Moog synthesizers). Additionally, variable slopes allow vintage polyphonic synthesizer filter sounds from the 1980s. You're not stuck with just the 24dB/Octave slope that the 4012 ARP and Minimoog used.

Have fun!

Low Pass Filter



1 **Slope**

There are 4 different Low Pass Filter slopes available; 24, 18, 12 and 6 dB/octave. 24 dB/octave filters out most high frequencies above the cutoff point. Shallow slopes (6 and 12) allow more high frequencies to be heard above the cutoff frequency. Shallow slopes give an aggressive “roundness” to the sound without giving up benefits of the filter cut. Deeper slopes filter out more high frequencies. 18 and 24dB/octave slopes make the “underwater” sound that club DJs use when climbing back up after a musical drop.

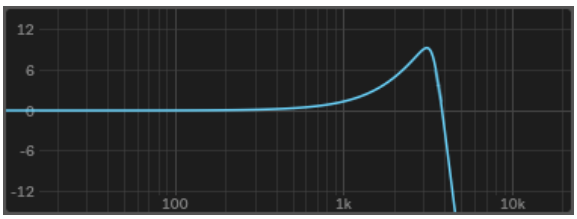
Choosing “OFF” bypasses the entire Low Pass filter.

2 **EXTRA**

The EXTRA button engages behind-the-scenes magic to make the Low Pass Filter come alive. There is no EQ or compression involved; it’s extra programming love that changes character and slope of the filter. In many cases it adds distortion and increases the resonance peak. To my ears the EXTRA parameter makes the SAW-1 LP Filter sound like my old ARP and Moog filters.

3 **Resonance**

Resonance changes filter timbre. It raises and enhances frequencies at (and slightly around) the cutoff frequency. Resonance gives a sharper, more pronounced filter “sweep”. Higher the resonance values give an aggressive ‘bite’ to the filter and can be made to self-oscillate slightly if pushed to maximum. This will produce a very distinct cutoff point - quite evident at certain frequencies. One can definitely overdrive SAW-1 Discovery with high Resonance values. You can’t hurt the synth – nothing will break internally, but it will sound like you are destroying the world. Go ahead! Have fun (have I said this before?)!



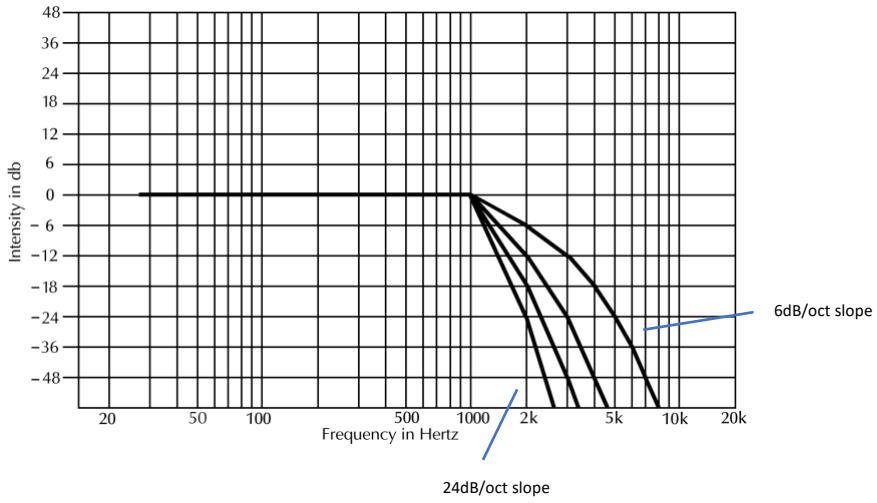
4 **Cutoff**

Cutoff defines the exact frequency where the filter begins attenuating high frequencies. This filter has a range of 20Hz to 25kHz. When LPF cutoff is fully clockwise there is no attenuation of high frequencies (although the filter still uses DSP resources). Moving the cutoff knob counterclockwise lowers the cutoff frequency and attenuates high frequencies above the cutoff point according to slope settings (that's a big chunk of info…).

As an example, if the cutoff frequency is 1kHz with a slope of 6dB/octave, then 2kHz will be 6dB lower in volume (because 2kHz is one octave up). 4kHz will be down 12dB and frequencies will be too low to hear at 8kHz.

A 24dB/octave slope is down (you guessed it) 24dB at 2k and doesn't even make it to the next octave before frequencies above almost 3k are too low to hear.

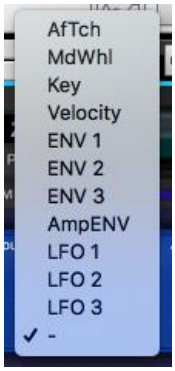
The graph is drawn with straight lines to aid visualization. The actual drop per octave is more exponential (curved).



Low Pass Filter Matrix

The Low Pass Filter has a four-position Matrix section similar to the other Matrix Sections.

6 **Source Assignment**



Aftertouch – Some keyboards have a special strip underneath the keybed that senses pressure after a note is struck and held. Pressing harder on the held key activates Aftertouch. Firm pressure gives more intense results and soft pressure may not even be noticeable.

Modulation Wheel (CC-1) – the left-hand wheel on many keyboard controllers, or the joystick-up position on older KORG and Roland instruments.

Key Number – use when high notes should be treated differently than lower notes – for decay and filter adjustments as notes move up the keyboard.

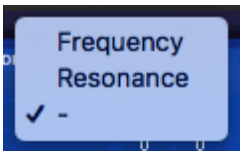
Velocity – use to dynamically alter parameters as notes are played harder and softer.

Envelopes 1 through 3 and Amp Envelope – Envelopes can change filter cutoff and/or resonance as time progresses.

LFO 1, 2 and 3 – Assigning LFOs to filter cutoff (and resonance) is an easy way to give movement to a sound. Use sine wave LFOs tied to frequency for that classic "bass wobble" effect. Use a Sawtooth LFO for beat-matched filter drops and assign a Sample & Hold wave to frequency (and pitch) for classic 1960s robot sounds. Add 'key' as a frequency modulator to annoy a particular protocol droid (is anyone even getting these references?).

7 **Destination Assignment**

Frequency – allows sources to modulate frequency cutoff. Use ModWheel or Aftertouch as a source to control cutoff in real time. Use envelopes as sources for filter dives and Classic Rock filter sweeps (think "Tom Sawyer" by Rush).



Resonance – allows sources to modulate Low Pass resonance. Assign sources in conjunction with frequency to enhance a filter sweep.

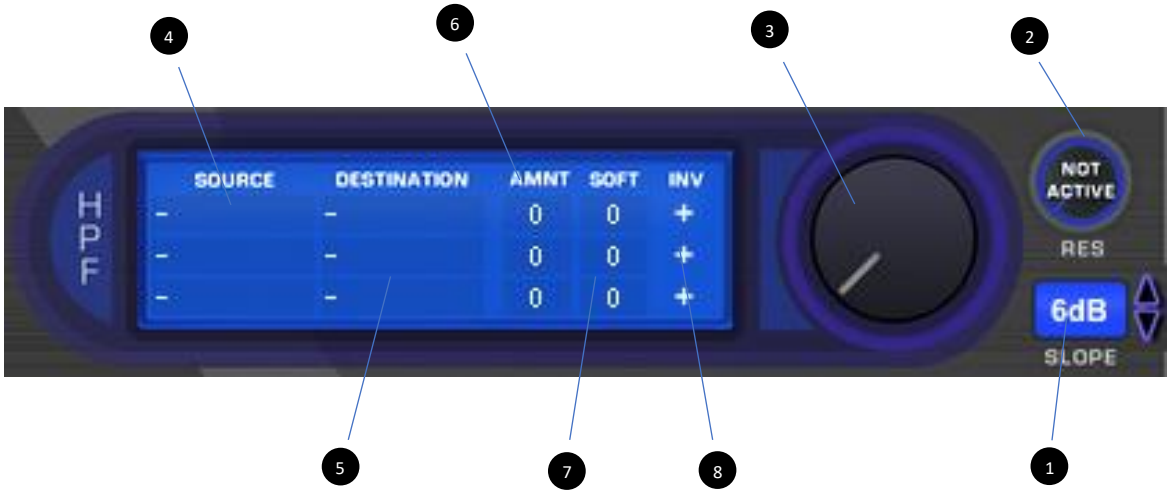
8 **Amount**
The amount that Source affects Destination – same as in the Envelope and LFO section.

9 **Soft**
This is a 'rounding' parameter known in vintage circles as "Lag." It slows and smoothly stretches the time between source input and destination output. The Soft control is not a delay but a 'stretching' parameter. Use Soft to even out Modwheel zipper artifacts or rein in Aftertouch.

10 **Invert**
Invert changes polarity of the filter source as it affects the corresponding Destination parameter. Think of Invert as polarity swap.

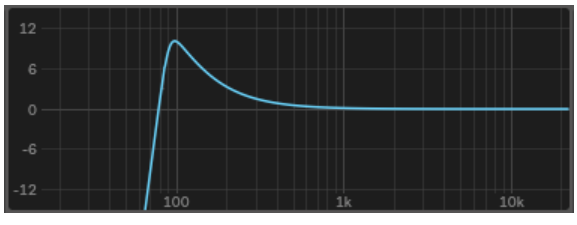
High Pass Filter

One of my gripes with the ARP and some Roland synths is the lack of a high-pass filter, so I added one (I HAVE THE POWER!!!). As discussed in the introduction, SAW-1 Discovery was built for me, so here it is…



1 **Slope**
There are 2 different High Pass Filter slopes available; 12 and 6 dB/octave. 12 dB/octave filters out most low frequencies below the cutoff point. 6 dB/octave offers a pleasing reduction of low frequencies, somewhat like the 6dB/octave slope in the Low Pass Filter. However, there is no resonance available with the 6db/octave slope (you will see that it's grayed out). Choosing "OFF" bypasses the entire High Pass filter.

2 **Resonance**
The Resonance control in the High Pass filter is nearly the same as in the Low Pass filter, just tailored for high pass applications. It raises and enhances frequencies at (and slightly around) the cutoff frequency and gives a sharper, more pronounced filter "sweep" just as Low Pass resonance does. High resonance values give an aggressive 'bite' to the filter and can be made to self-oscillate slightly if pushed to maximum.



Combining High Pass resonance with Low Pass resonance results in an incredible sound that DEFINITELY distorts the synth. Reducing Layer A and Layer B level will help reduce resonance distortion if desired. Layer A and Layer B level is pre-everything – adjust accordingly to reduce or increase filter overload.

NOTE: there is no resonance control when the High Pass filter is set to 6dB/octave slope. The resonance knob indicates this behavior. You may realize the resonance knob underneath the cap can still be adjusted, but be assured there is no effect.

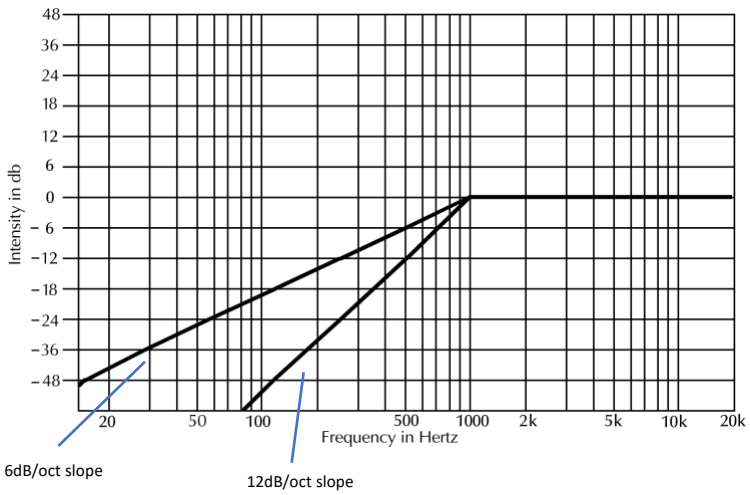
3 **Cutoff**

Cutoff defines the exact frequency where the filter begins attenuating low frequencies. This filter has a range of 20Hz to 25kHz. When HPF cutoff is fully counterclockwise (just the opposite of the Low Pass Filter) there is no attenuation of low frequencies (although the filter still uses DSP resources, but again, not as much as the Low Pass filter). Moving the cutoff knob clockwise raises the cutoff frequency and attenuates low frequencies below the cutoff point according to slope settings (still too much info for one read…).

If the cutoff frequency is 1kHz with a slope of 6dB/octave, then 500Hz will be 6dB lower in volume (because 500Hz is one octave down). 250Hz will be down 12dB and frequencies will be almost 40dB down at 20Hz.

A 12dB/octave slope is down (you guessed it again!) 12dB at 500Hz, 24dB at 250Hz – and so on. Frequencies below 80Hz are too low to hear.

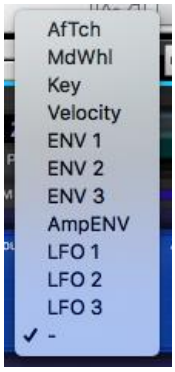
The actual drop per octave is indeed linear - as indicated on the graph, human hearing quirks notwithstanding. Harvey and Widen can tell you more, as can ISO 226.



High Pass Filter Matrix

The How Pass Filter has a three-position Matrix section identical to the Low Pass Matrix.

4 **Source Assignment**



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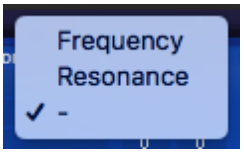
Envelopes 1 through 3 and Amp Envelope – Envelopes can change filter cutoff and/or resonance as time progresses.

LFO 1, 2 and 3 – Assigning LFOs to filter cutoff (and resonance) is an easy way to give movement to a sound. Use sine wave LFOs tied to HP frequency for "disappearing" effects. Sample & Hold waves assigned to frequency and resonance in conjunction with the Low Pass filter enhances the 'craziness' of classic filter effects.

5 **Destination Assignment**

Frequency – allows sources to modulate frequency cutoff. Use ModWheel or Aftertouch as a source to control cutoff in real time. Use envelopes as sources for filter reverses and 1980s synth emulations (but only the expensive ones).



Resonance – allows sources to modulate High Pass resonance. Assign sources in conjunction with frequency to enhance a filter sweep.

6 **Amount**
The amount that Source affects Destination – same as in the Envelope and LFO section (and Low Pass Section and OSC Section).

7 **Soft**
This is a 'rounding' parameter known in vintage circles as "Lag." It slows and smoothly stretches the time between Doctor emergence and regeneration (did you get that?). Use Soft to even out Modwheel zipper artifacts or rein in Aftertouch.

8 **Invert**
Invert changes polarity of the filter source as it affects the corresponding Destination parameter. Think of Invert as polarity swap.

IMPORTANT NOTE ON SAMPLE RATE!!

Keep in mind that sample rate will affect the clarity of high frequencies. This will be especially apparent when using extreme filter settings with high resonance. For instance, a patch that sounds perfect at 44.1kHz will have more filter headroom at 96kHz. The result will be clearer – without so much "crunch" at extreme filter settings. The reverse is also true. A beautiful, clear filter sweep at 88.2 or 96kHz will sound crunchy and perhaps distorted at lower sample rates. This is expected behavior with digital software audio devices and cannot be changed today, next week, or next year.

Yes, there are oversampling and other code techniques to mitigate this change, but PCM filter designs will always be susceptible to sample rate differences due to digital filtering just before the Nyquist frequency. At 44.1kHz, audio frequency filtering begins just after 20.5kHz (so signal can be fully filtered by 22.05kHz – the Nyquist Frequency) and it's right at that point where Low Pass and High Pass filters on SAW-1 Discovery exit the range of human hearing (for babies and small children – the rest of us roll off rapidly around 17.5-18k).

The result is double-filtering at 44.1 and 48kHz at precisely the worst point filtering could occur. There is no double-filtering at 88.2 and 96kHz, resulting in an open and clear sound at these higher sample rates.

High Timbre settings exacerbate this sample rate phenomenon…

All factory patches and Combinators were designed to sound best at a sample rate of 44.1kHz.

Oscillator Section

If the heart of a synthesizer is the filter section, the oscillator is the brain. While this brain focuses on one thing – sawtooth waves – it does so in a unique and distinctive way.

Let's break down Oscillator choices…

One single ARP 2600 sawtooth wave. Layer A comes from one sample set, Layer B from another. Two single sawtooth waves per note.

One two-oscillator sawtooth wave. Layer A and Layer B have unique sample sets. Combined, there are 4 sawtooth waves making the sound you hear.

A 12 oscillator "stack' from multiple recordings layered together. Recorded in stereo and evenly split. Layer A and B combine for 24 oscillators.

Seeing a trend here? Similar to Multi-Saw 1 only more detuned and 4 more waveforms per layer. Layer A and B still have unique recording passes.

Taking several ARP stacks and layering them on top of one another begins to get crazy. At least 100 sawtooth waves. Layer A and B are still unique.

The beginnings of insanity. Superstack is layered with saw waves from my other favorite synths. Layers are still unique. Hundreds of saws per layer.

You have just seen heaven. It's more than we can bear in this state and so very big... Deep and Wide indeed. Unsafe and dangerous - but GOOD.

To reiterate, each sample set is unique to each layer. In other words, there are two sets of Superstack, two sets of Multi-Saw 1, two sets of The Trinity and so on. One set is Layer A and one is Layer B. This dual-layer architecture solves the problem of phasing when identical waves are stacked too many times, even with delay and pitch shifting on individual waves, because each and every SAW-1 sawtooth wave is unique and distinct.

It's important to understand the sheer number of samples making up each oscillator choice. Every single white key is a different sample. Only five notes per octave share a recording – C# shares C, D# shares D, F# shares the F sample, G# shares G and A# shares A. This is why the lowest notes in SAW-1 Discovery sound just as beefy and crisp as the high notes – there is no interpolation or re-pitching to speak of. It's a TON of samples – 940 to be exact.

Lastly, the original tuning of the analog-voltage scale is presented here unaltered. It's tight and in-tune globally, but you will notice individual notes might be sharp or flat by a (very) few cents. Certainly not enough to be called out-of-tune (that wouldn't work for next-level music) but enough to annoy those who might value perfection over vibe. For example, Single Saw Layer A is about 3 cents over Layer B on most notes – but not all. This is the joy of analog (without having to retune every hour as the tempcos change temperature)!! One can compensate by setting Fine Tune and Detune relative to whatever temperament seems best.

Oscillator Control

1 **TIMB**
Timbre (rhymes with 'amber,' not 'September') shifts the voicing of SAW-1 Discovery's sample maps up several octaves but keeps pitch the same. Wonderful for cold, aliased, digital-sounding patches. At 0 the effect is off.

NOTE: High Timbre settings may change pitch slightly (7 to 15 cents sharp depending on the waveform).

2 **OCT**
Octave - literally sets the global octave transposition for SAW-1 Discovery. At 0 there is no transposition. Range is up or down 3 octaves.

3 **SEMI**
Global semitone transposition of SAW-1. Range is up or down 11 half-steps.

4 **FINE**
Global fine tuning of SAW-1. Range is +-50 cents.

5 **TONE**
a global parameter that enhances or decreases harmonics. There are 4 settings:

Position 1: OFF
Position 2: enhances higher frequencies only
Position 3: reduces 'muddiness' and low-mid buildup.
Position 4: enhances higher frequencies *and* reduces 'muddiness' and low-mid buildup.

6 **ANLG**
Though SAW-1 Discovery is built using analog samples, it isn't analog. ANLG (Analog) counters digital coldness with several random parameters interacting to alter notes behind the scenes. Low values seem to enhance the sound while high values just make the synth sound out of tune, but that has a use too… Use ANLG to keep repeating notes from phasing, especially if single-note polyphony is high.

7 **VOL A**

Volume or level of Layer A. Factory default is -6dB. This control is pre-effects and pre-compressor but post Tone. Use to balance overall blend, and to reduce (or increase) SAW-1 Discovery's internal level overload independently or in conjunction with VOL B.

8 **VOL B**

Volume or level of Layer B. Factory default is -6dB. This control is also pre-effects/pre-compressor/post Tone. Use to balance overall blend and alter SAW-1 Discovery's internal level overload independently or in conjunction with VOL A.

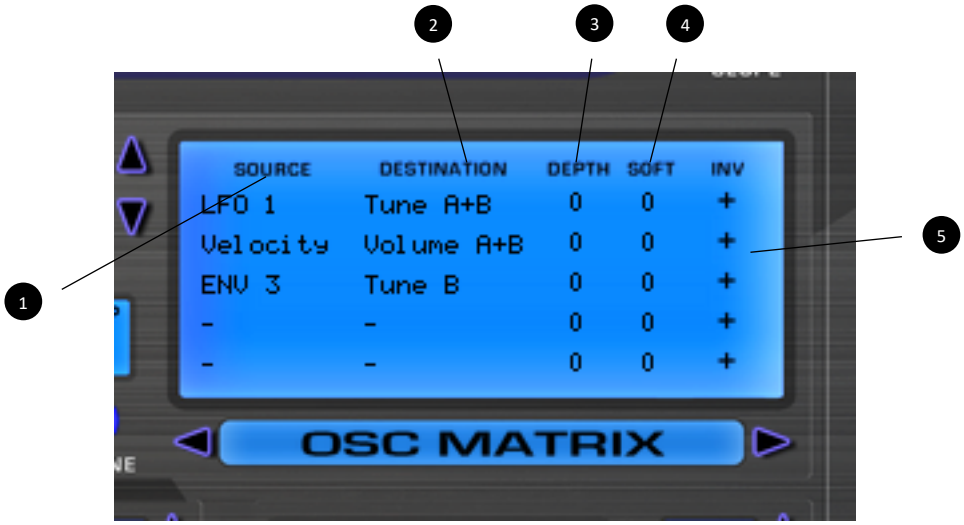
9 **DETUNE**

One of the unique features of the ARP 2600 is the ability to continuously and seamlessly change the pitch of an oscillator on the fly. It was important to implement this same feature in SAW-1 Discovery. This allows for sub-octave, unison, up-octave, 4ths, 5ths, or any combination of notes with one key press, thereby emulating not only the ARP, but other recognized synths from the 1970s onward.

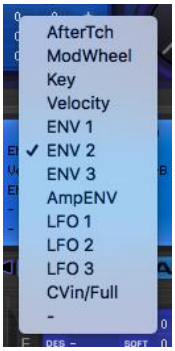
DETUNE only affects Layer B. Factory position is one octave below Layer A. Range is continuous from -12 to +12 semitones.

Oscillator Matrix

The Oscillator Matrix is a 5-place matrix that can control volume, panning and tuning individually for Layers A and B. Users can employ envelopes and LFOs to pan, tune and alter volume of each layer independently, ideal for EMS Putney and modular synthesizer sounds that pan single oscillators independently (use the Single Saw waveform for full authenticity).



1 Source Assignment



Aftertouch – Some keyboards have a special strip underneath the keybed that senses pressure after a note is struck and held. Pressing harder on the held key activates Aftertouch. Firm pressure gives more intense results and soft pressure may not even be noticeable.

Modulation Wheel (CC-1) – the left-hand wheel on many keyboard controllers, or the joystick-up position on older KORG and Roland instruments.

Key Number – use when high notes should be treated differently than lower notes – for decay and filter adjustments as notes move up the keyboard.

Velocity – use to dynamically alter parameters as notes are played harder and softer.

Envelopes 1 through 3 and Amp Envelope – Envelopes alter level and intensity as time progresses.

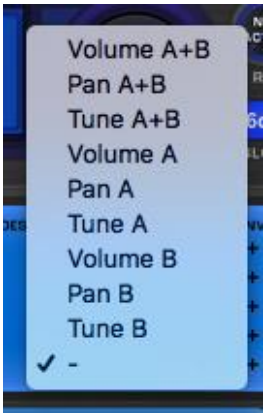
LFO 1, 2 and 3 – Assigning LFOs to OSC Matrix destinations gives movement to a sound. Use sine wave LFOs tied to Pan for stereo sweeps. Sample & Hold waves assigned to Tune or Volume turns SAW-1 Discovery into a classic 1970s synth lab.

CVin/Full – CVin/Full is a 100% full-on value made for CV input and static placement. *OSC Matrix CV inputs will not be active unless CVin/Full is chosen in the OSC Matrix.*

You can also use CVin/Full when setting pan position or offsetting static pitch of Oscillator layers. CV inputs do not need to be connected when used as a "full" static parameter.

Important Note: Control Voltages (and their virtual equivalent) are one-pole controls. This means that CV can push values from 0 to 100 (positive) or from 0 to -100 (negative), never from -100 all the way through to +100 (positive and negative). Implications are that Pan, Pitch and Volume will be 'one-sided' only (when using CV inputs). If you need full panning or bipolar movement, use another OSC Matrix source.

2 **Destination Assignment**



Volume A + B - volume of both layers together.

Pan A + B - pan of both layers together.

Tune A + B - pitch of both layers together.

Volume A - volume of Layer A only. Leaves Layer B unaffected.

Pan A - pan volume of Layer A only. Leaves Layer B unaffected

Tune A - pitch volume of Layer A only. Leaves Layer B unaffected

Volume B - volume of Layer B only. Leaves Layer A unaffected

Pan B -pan volume of Layer B only. Leaves Layer A unaffected

Tune B - volume of Layer B only. Leaves Layer A unaffected

3 **Amount**
The amount that Source affects Destination – same as in the Filter, Envelope and LFO section.

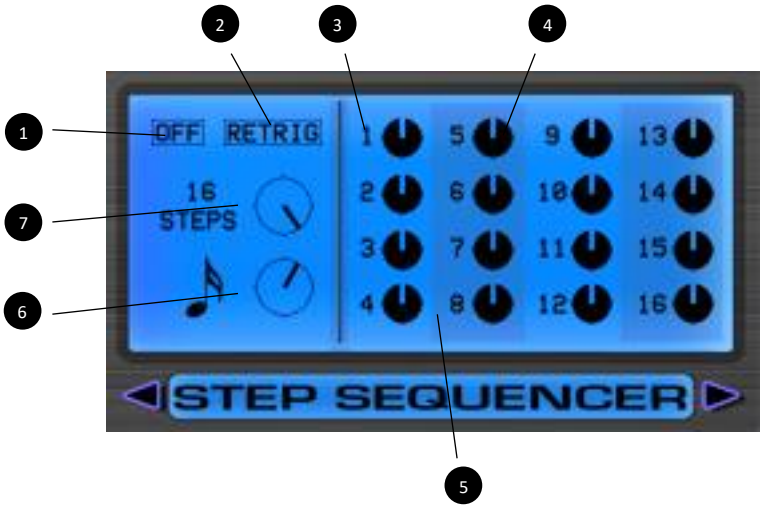
4 **Soft**
This is a 'rounding' parameter known in vintage circles as "Lag." Use Soft to even out Modwheel zipper artifacts or control excessive Aftertouch swings.

5 **Invert**
Invert changes polarity of the filter source as it affects the corresponding Destination parameter. Think of Invert as polarity swap.

The Oscillator Matrix is situated outside of the normal flow of audio in Saw-1 Discovery. When sources and destinations are connected, audio components are altered within their normal range of operation - never above or below this range. However, there is a cheat available for pitch. Connecting the same source and destination several times within the OSC Matrix (or any SAW-1 Matrix) behaves like a multiplier. For example, utilizing three Matrix positions alters pitch three octaves instead of just one octave. Note that pitch has a much wider range than pan or volume and can expand up to the limits of SAW-1. When, for example, maximum pan or volume is reached, that's it. Nothing more will have an effect.

Step Sequencer

SAW-1 Discovery includes a Step-Sequencer with 16 steps. Each step can be muted and tuned over a two octave range (24 semitones). If you've ever used an ARP 2600 with a related 1600 series step-sequencer, you'll immediately know why this is implemented. Gate times are controlled via the Amplifier Envelope. Individual Step Muting is activated by clicking the Step Number icon. Not surprisingly, semitone tuning is controlled via the knobs. Each parameter of the step sequencer can be automated in Reason.



1 **ON/OFF**
Activation of the step sequencer. A note press is required to start the sequencer. SAW-1 Discovery's Step Sequencer is monophonic, and held notes are played until released. If other notes are also held, they are played one-at-a-time, in order, as previous notes are released, until all are released.

2 **Retrigger**
Normally, when the Step Sequencer receives a note-on command, it starts sequencer steps that occur sequentially, 1 through 16. The steps cycle over and over until the last note is released. Subsequent note-on commands will not alter sequence motion or time. However, if Retrigger is activated, each new note-on will restart the sequencer from Step 1, regardless of where it is in the cycle. Each subsequent note press (with previous notes held) will also restart the sequencer from Step 1.

Put simply, both Retrigger On and Retrigger Off work the same way *until notes are held.* With Retrigger off, new notes on top of held notes do NOT retrigger the sequencer, keeping the sequence phrase flowing in order with relative pitch referencing the currently held note. When Retrigger is on new notes on top of held notes DO retrigger the sequence from Step 1. So, to notice the difference between Retrigger modes, hold notes while playing new ones.

NOTE: Sustain pedal has no effect on held notes when the step sequencer is active.
NOTE: The sequencer **always** starts and re-starts from position 1.

3 **Step Mute**
Simply click on the step number to mute a step. The number will turn transparent and the step will be muted.

4 **Step Tuning**

Each step can be individually tuned over a 24 semitone (two octave) range. Default position is Zero transposition. Steps can be tuned down and up from zero position, with a maximum range of one octave up and one octave down. Of course, if you want the illusion of 2 octaves from zero position, turn down each tuning knob to -12 (or up to +12) and use that as your starting pitch.

5 **Step Location indicator**

As the step sequencer progresses, two indicators offer information on the location of the currently playing step. This aids programming as one can visualize steps which need adjustment in real time.

The first indicator is on the Step Sequencer itself, immediately to the left of each number. A small black 'lamp' illuminates when the current step is active. Fast tempos give the impression that a single black lamp is moving through the steps, but it's simply an animated optical illusion.

The second indicator is a small LCD screen next to the larger Step Sequencer/OSC Matrix display. This small LCD panel indicates Step Sequencer position and operation and comes in handy when the Step Sequencer is hidden by the OSC Matrix display.

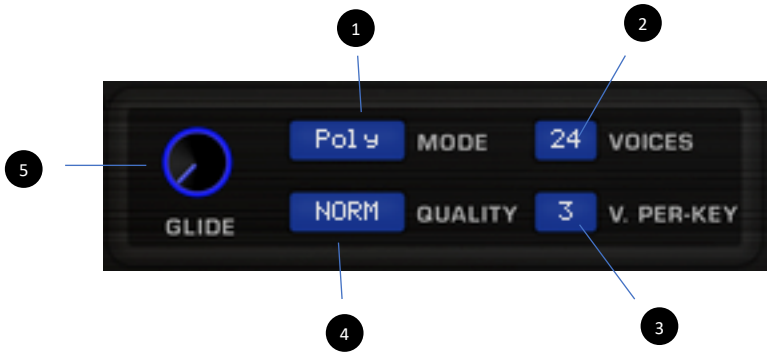
6 **Sequence Rate**

SAW-1 references Reason's global clock, but the Step Sequencer can further subdivide or consolidate clock pulses with this setting. Sequence Rate ranges from 1/4 note steps to 1/64 steps. Any setting is valid and will sync to global tempo perfectly.

7 **Sequence Step Number**

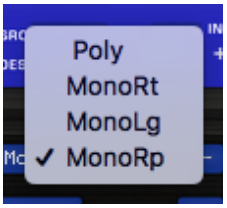
The Step Sequencer has 16 step positions, but this number can be shortened to accommodate odd-meter time signatures. For example, 6/8 or 3/4 meters will function best with either 6 or 12 steps. 5/8 will use 5 or 10 steps. For polyrhythms where beat 1 progresses through time, 11, 13 or 15 steps work nicely.

Polyphony, Glide and Quality



1 **Mode**
SAW-1 Discovery has 1 polyphonic mode and 3 different monophonic modes. They are as follows:

Poly – multi note operation with each key triggering an independent note. Limited only by the Voices setting (more below).



MonoRt – Monophonic Retrigger Mode
One note at-a-time operation with each new note retriggering envelopes from the beginning.

MonoLg – Monophonic Legato Mode
One note at-a-time operation like MonoRt except with a crossfade between adjacent notes.

MonoRp – Monophonic RePitch Mode
One note at-a-time operation that neither retriggers envelopes or crossfades between adjacent notes. Instead the current note is simply re-pitched to the next using the current sample. Because the of SAW-1 architecture there are very few artifacts with this method. However, the crispness of lower notes will diminish if the pitch comes from a very high note to a very low one without re-attacking.

2 **Voices**
SAW-1 can play as many notes at a time as your computer can handle. However, unlimited voices on a single patch may not be practical. You may want to reserve resources for other processing tasks, even if you use the fastest computer available. Therefore, it may be wise to limit the amount of voices that play simultaneously. Normally, 24 to 40 voices is perfect. If your processor gets bogged down when large chords are played, reduce polyphony by lowering the number of available voices. If you have enough CPU power to get crazy, set voices higher and enjoy the sound.

NOTE: SAW-1 Discovery is a dual-engine device. One note takes two voices - one for Layer A and one for Layer B. A voice setting of 12 will therefore only allow 6 simultaneous notes.

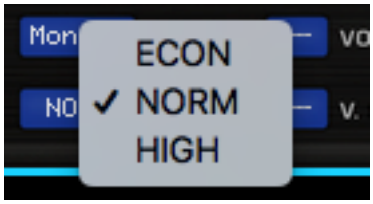
3 **Voices Per-Key**
Similar to Voices but concerning repeated notes on the same key. It helps realism to have envelopes continue a previous note while the repeated one is being triggered. Per-Key Voices determines how many notes are allowed to retrigger before cutting off previous sustaining (repeated) notes. If this sounds hard to grasp, understand that Voices Per-Key is just that; it controls how many voices are allowed on the same key at the same time.

4 **Quality**

Quality determines the sample interpolation algorithm SAW-1 will utilize. There is virtually no difference in the sound of these modes with lower notes. Higher notes will generally benefit from higher quality settings, but there are always exceptions. Quality is also related to CPU resource utilization: lower Quality, lower CPU hit.

Quality modes are:

ECON – Economy Mode for lower CPU requirements. Low notes sound great. High notes exhibit moderate aliasing and interpolation artifacts. However, Low Pass filter settings can mitigate any errors, especially if most high frequency material is filtered to begin with. In other words, you might not hear a difference if high frequencies are filtered out.



NORM – Normal operation. Slight aliasing but few interpolation issues. Moderate to high CPU utilization. This is the Factory default setting.

HIGH – High quality. Beautiful high frequencies. High CPU needs.

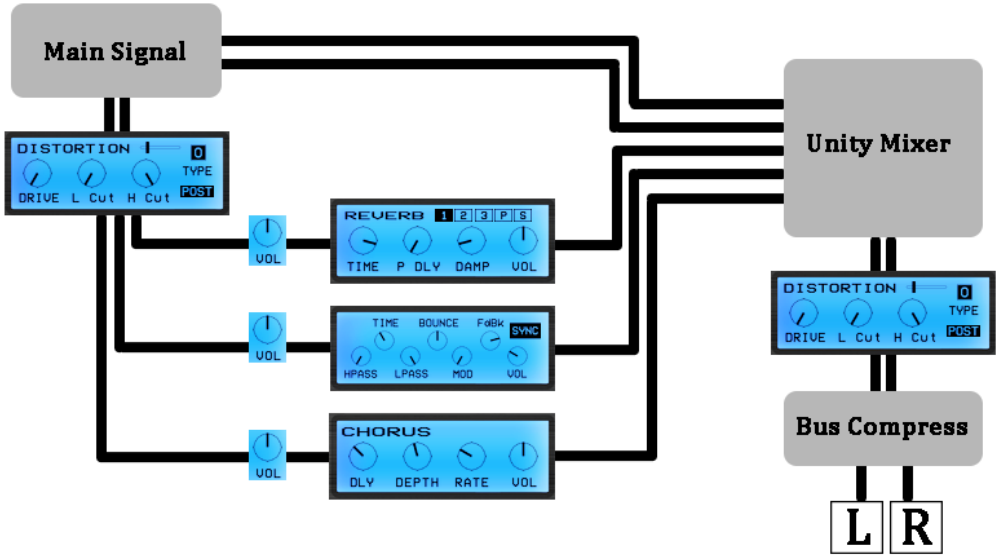
NOTE: *Interpolation is the process of making one sample work across several notes while tracking pitch correctly. It's not difficult, but the computer has to recalculate some things before a note can be repitched. Aliasing aside, there won't be many interpolation issues in SAW-1 Discovery because there's never more than a half-step of interpolation, even in the highest octaves.*

5 **Glide**

Glide is good old-fashioned Portamento. ARP and other manufacturers call it Glide. It's the speed of slur from one note to the next. At 0 there is no slur. When full, slurring might take a whole minute. Use glide liberally – it's a wonderful feature and a beautiful sound.

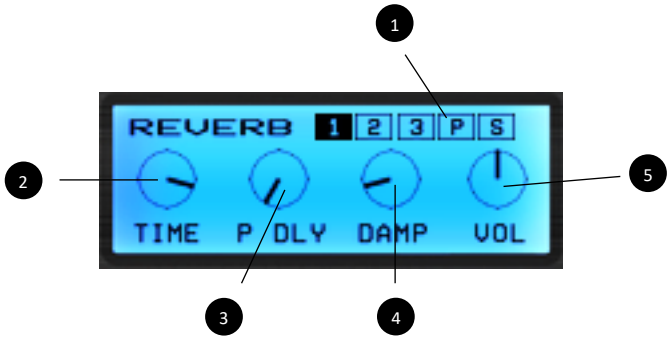
Effects

Saw-1 Discovery includes a great sounding effects section with next-level Reverberation, Delay, Chorus and Distortion. Many combinations of effects can be active and stored with the patch. Note that Distortion is indicated twice. SAW-1 doesn't have two Distortion modules. One position is Pre-effects, the other is Post effects. More below…



Effects run in parallel with synth output using a classic send and return combination.

Reverb



1 **Convolutions**

The reverb in SAW-1 Discovery was built with 5 world-class 24-bit convolutions developed specifically for SAW-1 from my personal mix templates. They are as follows:

1 **Bright Medium**

A bright mid-sized hall with medium-long decay. Made from a layer of 2 PCM 96 hardware reverbs (like tubes, just spend the money for a good hardware unit – plugins STILL can't come close) and 5 non-convolution plug-in reverbs, each serving a specific function inside the larger reverberated decay. There are 7 other devices with varying degrees of subtlety making up the final mix. Insane? Absolutely.

2 **Dark Long**
A darker hall with long decay. Made from the same stack as Bright Medium (on the same day) but tweaked for a longer tail and darker refection.

3 **Drop Cave**
A reverb sound made for the 'drop' after Chorus 2 of many songs. Made from a different stack (on a different day) after several days of testing and tweaking. It's very dark and very big. However, it's not so big that it overpowers the source. It blooms then gets out of the way nicely.

P **Phased-Stereo Spring**
The ARP 2600 had one spring reverb tank. The designers split the output into two, flipped the pahse of one, then sent the signals to the Left and Right channel respectively. It's quasi stereo and sounds cool. This is the convolution of that exact setup – directly from the source.

S **Mono Spring**
The living, breathing organic 2-spring reverb directly from the ARP 2600. The quintessential 1970s synth laboratory sound. SAW-1 patches that use this reverb setting sound SO GOOD.

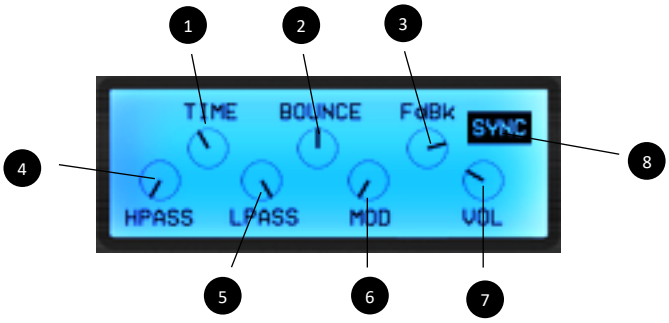
2 **Time**
Determines reverb tail length. A setting of 50 is the unaltered, true size of the sampled reverb. Range is from 0 to 60.

3 **Pre Delay**
The amount of time between signal input and reverberated sound output. 0 is no pre delay/original. Range is from 0 to 200ms. Use for an initial attack that sounds dry but subsequently gets drenched with reverb.

4 **Damp**
Damping (not damp***en***ing – that just makes things wetter) reduces high frequencies in the reverberated decay. It's like a low pass filter for just the reverb but with a shallow slope. Use to remove sizzle and excessive 'splash' from hard attacks as they reverberate. This is a custom damping filter built especially for SAW-1 Discovery.

5 **Volume (Send)**
Volume controls the amount of signal sent to the reverb device. Yes, it's technically a send, but calling it a send didn't seem right (and it didn't look right either). Reverb return is behind-the-scenes and set at 0dB.

Delay



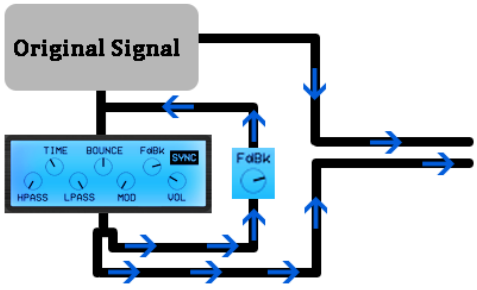
1 **Time**
Determines Delay time. Range is from 0 to 4 seconds. When SYNC is selected (more below) range is from 1/64th note to a whole note (4/4).

2 **Bounce**
Bounce controls side-to-side movement of delay and feedback. At 50 delay is monophonic. At 0 the delay bounces evenly from left to right at straight intervals (no swing). 100 is the same except panning is reversed – right to left. A setting of 25 or 75 gives an eighth – dotted eighth bounce. Other settings offer swing or downright crazy. Enjoy!

3 **Feedback**
Just as in every other delay on the planet, feedback is basically repeated delays with a smooth decay. If you care to know how it's done, keep reading. If not, just set Feedback to wherever and move on.

Imagine a signal entering a delay device. That signal gets delayed a bit then exits the processor. Take that signal output and split it into two identical signals. Send one signal down the line to wherever it goes (probably the amp and speakers) but take the other and send it right back into the delay unit. Normally if a signal output is re-injected back into its input massive feedback occurs. However, in our case the signal is *delayed,* so massive feedback doesn't occur, it just gets delayed again and sent back out to our split line. Of course, this newly delayed signal has already been around the signal path once, so there's some degradation compared to the original signal. Still with us?

So, here's the newly delayed signal that's been around once and it's entering the device *again*, only now it's been degraded twice and starts to sound different. Repeat *ad infinitum.*



You may be wondering "if the signal is going in and out of the device unchecked – wouldn't it just keep going and keep repeating/degrading forever?" Yes, young Padawan, it will. You have just discovered a little slice of Heaven. However, most people (and certainly most designers) don't see this as a good thing, so they placed a volume control on the signal going back into the delay. That volume control alters the level of signal returning to the delay input. This fed-back signal is now lower in volume, and it comes around and gets lowered *again.* Decay is smooth and predictable with each fed-back generation being softer than the last - until the whole thing reaches zero.

The control marked **Feedback** is this volume control. It's actually an attenuator limiting the signal re-entering delay input. Turn it full-on and it will repeat forever (unless the manufacturer limits full volume – which some do). No feedback means the delay will send signal out only once, then stay silent. You're welcome.

4 **Hi Pass**
This is a high pass filter just for the delay device (cool right?). Sometimes low frequencies build up when delay is added. A high pass filter solves this problem by letting only higher frequencies through. Super effective on bass instruments.

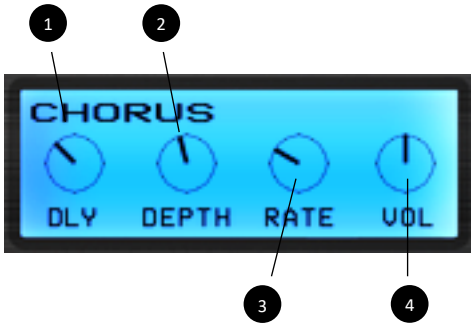
5 **Low Pass**
As with High Pass, there is also a low pass filter just for the delay device. High frequencies don't build up like low ones, but delayed, repeated 'sizzle' of sibilant vocals or bright percussion can be distracting. Filtering these 'sizzle' frequencies out keeps delay from overwhelming the source.

6 **Modulation**
Sometimes repeated delays get a bit sterile or clinical as feedback decays. Modulation adds a touch of movement by pitch-shifting the signal slightly as it develops.

7 **Volume (Send)**
Volume controls the amount of signal sent to the delay. Again, it's technically a send, but in the case of Delay it's a good way to handle things. Delay return is behind-the-scenes and set to 0dB.

7 **SYNC**
Delay time can be set in either milliseconds or beats. SYNC determines how time is measured. When SYNC is On, delay is timed to the selected note value, despite tempo changes. When SYNC is OFF, time remains the same (in seconds) regardless of tempo changes. In other words, SYNC On moves with tempo changes, SYNC Off doesn't.

Chorus



Many synthesizer sounds from the 80s were saturated with chorus. In many cases it wasn't the patch itself that was special, but the chorus settings. Many of SAW-1 Discovery's patches utilize Chorus accordingly.
Want to know how Chorus works? Get a life. We aren't wasting time here like we did with Delay. Maybe in the next revision of the manual once I am convinced more than 6 people have read it…

1 **Delay**
Chorus works because of delay (and modulation), but the times are super short. Changing these short delay times can give a more pronounced phase/flange effect. Sometimes extreme chorus delay sounds like a short reverb.

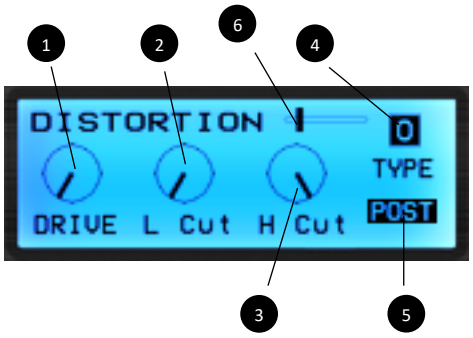
2 **Depth**
Modulation inside a delay device, with a real LFO controlling time, is altered in two ways: Depth of LFO and Rate of LFO. Depth determines the size of the chorus' time movement. Low settings don't move time much at all, and higher settings give the impression of 'warped' pitch. Use in conjunction with Rate.

3 **Rate**
Rate is LFO modulation speed. Modulation can be slow or fast depending on the setting. For example, high Depth and low Rate gives a pronounced stereo effect. High Rate and high Depth sounds somewhat robotic. Medium Depth and medium Rate sounds stereotypically chorusy.

4 **Volume (Send)**
Volume controls the amount of signal sent to the Chorus. Don't be afraid to turn this up more than normal, even if it adds relative volume. Just reduce volume via VOL A and VOL B in the Oscillator section. The effects can be profound.

Chorus return is behind-the-scenes and set to 0dB.

Distortion



A world without distortion is like milk without chocolate; what's the point? Seriously though, this module might look tame, but it's so powerful that initial users asked us to dial it back. We didn't.

1 **Drive**
Simply the amount of signal allowed into the unit. However, unlike nearly every other control in SAW-1 Discovery, 0 is not OFF. There *will* be distortion once the unit is active unless VOL A and VOL B are unusually low. Speaking of Oscillator volume, VOL A and VOL B interact with Drive more than you might expect. If there's too much distortion when Drive is at 0, lower VOL A and VOL B until distortion is manageable. Not enough juice? Hard to believe. Raise VOL A and VOL B until your head is sufficiently fried.

2 **Low Cut**
This is an actual high-pass filter. To be honest, when distortion is high, low notes become mush anyway so filtering them may not be noticeable. With moderate distortion levels, cutting low frequencies might be just the thing to make a sound come to life.

3 **High Cut**
Like Low Cut, this control is actually a low-pass filter cutoff specifically for Distortion. This setting *will* be noticeable, especially with high distortion. Use High Cut to take the edge off searing harmonics or to completely filter the module. Modest filtering can warm up aggressive sounds without destroying character or vibe.

NOTE: IMPORTANT!! Though it may be obvious to some, these filters affect the **ENTIRE** signal – not just the distortion effect. Stay mindful of scenarios where double filtering is unintended.

4 **Type**
Determines whether even or odd harmonics are emphasized. Theoretically, odd harmonics sound "harsh" while even harmonics sound fuzzier and "warmer." There's a lot we wrote (and then erased) on why this isn't totally correct, but whatever – moving on. E stands for Even and O stand for Odd. For SAW-1 Discovery we like O the best.

5 **Pre/Post**
Distortion can be positioned before the effects chain (at the device send) or after the internal mixer (just before the Bus Compressor). Use Pre to send distorted sound into clean effects, Post for distorting the entire signal – effects and all.

6 **Gain**
Distortion changes the volume of a signal (almost by definition). Furthermore, if too much signal is fed into the distortion module, the wrong 'color' of distortion might make the resulting sound undesirable. Sometimes it's good to distort a quiet signal rather than a louder one. Gain will address volume mismatches as this process takes shape.

Effects Chooser and On/Off

Buttons seemed to be the best way to show and hide the effects pages. The active page mirrors the illuminated switch. Click Reverb, the Reverb page shows. Likewise clicking Distort brings up the Distortion page. Any setting made on an active page is remembered and automated controls follow automation as expected when the control is hidden. The Effects Chooser itself cannot be automated (well, it could, but no).

Be aware that an active display page doesn't mean the effect itself is active. It did not make sense to place effect On and Off switches inside a hideable page, so a bank of power switches is included just beside the Effects Chooser. These are traditional On/Off toggle switches that allow any or all effects to be turned On or Off, regardless of the effect displayed on the screen.

GUI Skins

SAW-1 Discovery comes with 6 Factory GUI Skins. Skin choice is cycled via the SAW-1 Discovery nameplate (clever huh? How long did it take you to find?).

Factory skins are:

Black Aluminum

Matte Black

Midnight

White

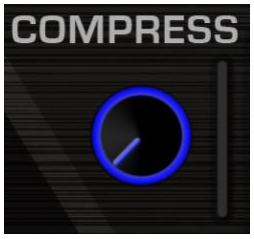
Vivid

Aluminum

Custom skins for SAW-1 Discovery would be welcome. If you have Photoshop skills and would be interested in designing a new skin, please let us know. Anyone remember ReBirth?

Master Controls

Master Controls are presented below:



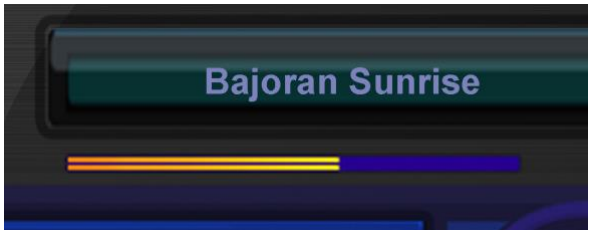
The **Bus Compressor** is the last processor in the audio path before output to Reason. One knob is presented for ease of use. It is a combination of Threshold, Ratio and a secret sauce known only to those who hope to attend the wedding feast of the Lamb. (Ha!)
It's designed to reduce excessive gain, especially with intense filter sweeps. Gain reduction is displayed accordingly.

NOTE: The Bus Compressor is not a limiter. **It doesn't keep SAW-1 Discovery from clipping.**

Master Volume is the final level control, situated after the Bus Compressor.

The MIDI Indicator Lamp illuminates when MIDI signals are received.

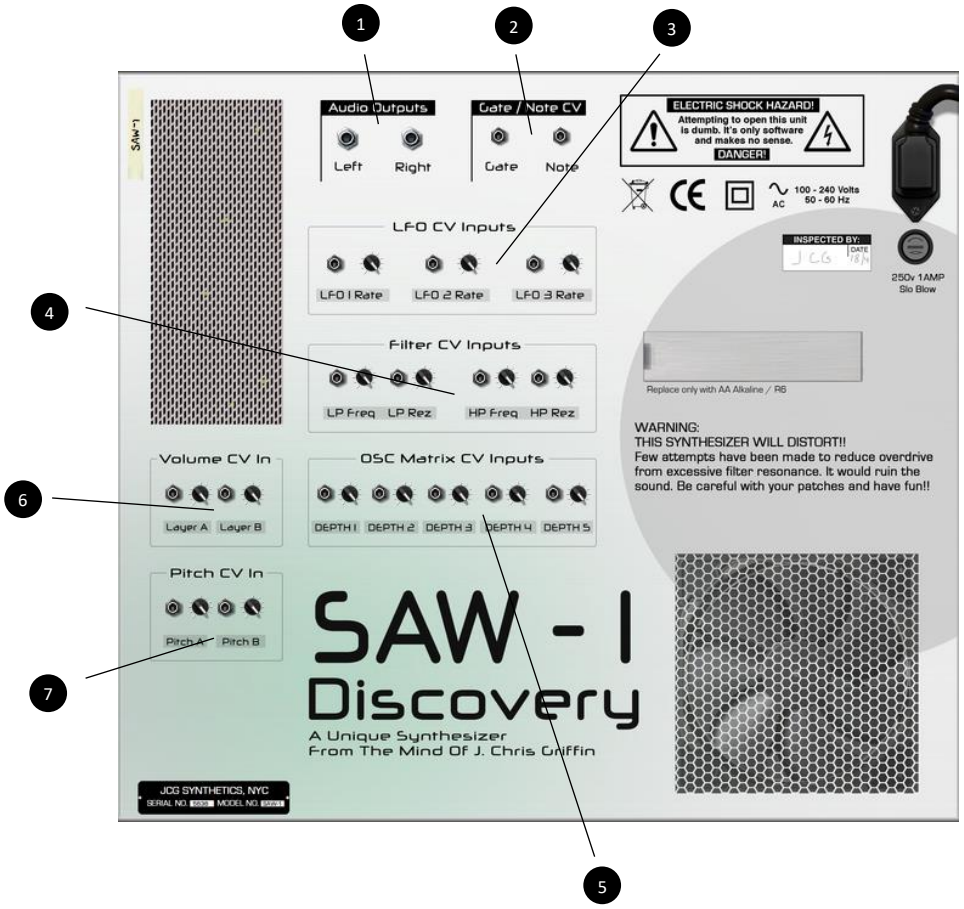
PitchBend Range is set by clicking and dragging in the display area. Range is 0-12 half steps.



Ultra-high resolution **Stereo Meters** round out SAW-1 Discovery. Placed just before Master Volume, these 112-position meters indicate output level. Good practice is to keep SAW-1 Discovery's output below red indicators. By the time these meters show red, it probably sounds wonderful or terrible. Either way you've clipped the output of SAW-1.

Rear Panel / Control Voltage

SAW-1 Discovery has many CV inputs to expand creative possibilities and to satisfy your modular synth fetish.



1 **Audio Output**
The main (and only) audio output for SAW-1 Discovery.

2 **Gate/Note CV Input**
Reason will automatically connect to devices like The Matrix, RPG-8, and other gate/pitch CV devices with these jacks. Gate is the pulse that opens the synth and triggers envelopes, Note is a continuous stream indicating pitch. The two work together in tandem.

3 **LFO CV Inputs**
CV inputs are available to modulate LFO Rate. It's a direct modulation tied directly to the LFO rate parameter. CV input adds to any previous LFO routing inside the related LFO matrix.

4 **Filter CV Inputs**
CV inputs are available for direct control over cutoff and resonance for both Low Pass and High Pass filters.

5 **Oscillator Matrix CV Inputs**
It seemed good to incorporate control voltage inputs for the Oscillator Matrix. CV input alters Matrix depth in each respective matrix position.

Important Note: Control Voltages (and their virtual equivalent) are one-pole controls. This means that CV can push values from 0 to 100 (positive) or from 0 to -100 (negative), never from -100 all the way through to +100 (positive and negative). Implications are that Pan, Pitch and Volume will be 'one-sided' only (when using CV inputs). If you need full panning or bipolar movement, use another OSC Matrix source.

Note: Volume control from the Oscillator Matrix **attenuates** level from 100%. It does not add gain or volume. The Invert switch is hard-programmed behind-the-scenes to reflect this (slight) limitation. Therefore, Invert has no effect when CVin/Full is set to any of the Volume destinations.

6 **Volume CV In**
These inputs directly control VOL A and VOL B level.

7 **Pitch CV In**
You guessed it… Control pitch of Layer A and Layer B with these CV inputs.

Factory Patch Bank

Factory patches in SAW-1 Discovery follow a few organizational rules. Device patches (patches made specifically for SAW-1 Discovery) are in a folder separate from Combinator patches containing SAW-1. I've personally never appreciated device patches and Combinator patches in the same folder because it slows down patch browsing. The device patch folder therefore is the to use one for super-fast patch browsing.

Combinators follow a basic pattern as well:

Device Patches (abbreviated **DevcPtch**) are combinator versions of raw device patches with a bit of sweetening. Additional reverb, delay and modulation devices are added with controls assigned to commonly used parameters. These are simply over-glorified versions of the related SAW-1 device patch and (in most cases) can be used interchangeably.

If a combinator patch name does not include 'DevcPtch' it is a full-on multi device creation worthy of praise and adoration (actually, it's not - there is another that is actually worthy of such things). These combinator patches are what one would expect a combinator creation to be. Multiple SAW-1 Discovery devices, Thor, Subtractor, Scream and other Reason factory modules are part of the mix. Bigger than Big. Larger than Large. Further Up and Further In…

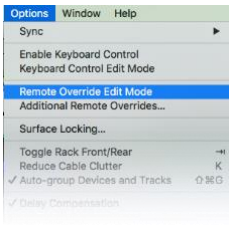
Automation and Remote Override

Every SAW-1 Discovery parameter – with the exception of Matrix Sources and Matrix Destinations – can be assigned for automation and remote control overrides, just like other Reason Rack devices.

Assigned automation and remote control is active whether or not a particular control is hidden – it doesn't matter at all. Effect parameters can be simultaneously automated and/or controlled remotely just as any Oscillator Matrix or Step Sequencer control can be controlled – regardless of the panel actually displayed.

Automation Assignments
As with any other Reason Rack device, automation is activated by hitting Option/Alt and clicking on a valid knob or button. A new "lane" will present itself in the sequencer dedicated to this assigned control. Simply hit Record on the Reason Transport panel, move the control and BAM! Automation Fascination!

Remote Override Edit Mode
For custom control of SAW-1 Discovery (and every other Reason Rack device) by the knobs and buttons of a connected hardware controller, simply head to the OPTIONS menu within Reason and select REMOTE OVERRIDE EDIT MODE.



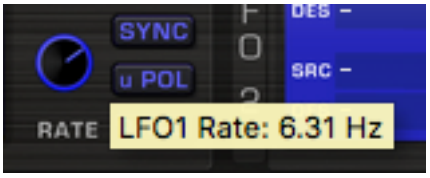
Reason will place an arrow icon over parameters available for remote control. Double-click on the arrow icon. The arrow will change into a lightning bolt icon and Reason will drop a menu asking for input. Once the control has been assigned, the lightning bolt icon turns yellow and is ready for Remote operation.

Special Considerations

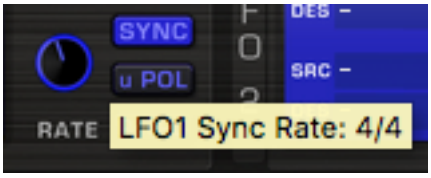
Delay Time and LFO Rate

Delay Time and LFO Rate can be synchronized to tempo or left free-running. This presents an interesting programming dilemma solved by offering two controls under one knob, switched by the SYNC button. This will likely never be a problem but 'could' become a slight issue if switching SYNC on and off as automation occurs. Therefore, make sure to use the correct control.

Think of it this way: Rate with SYNC on is one control, and Rate with SYNC off is another control – both occupying the same space on the GUI. You can see this change occur in real time when switching SYNC on and off and observing the rate knob change position. That's really two controls but in one 'spot' on the GUI. They are named differently as well. Observe:

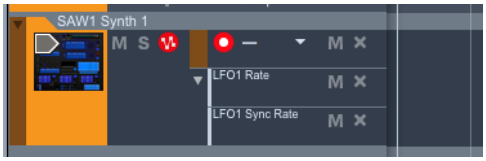


LFO SYNC is off. The knob is named 'LFO1 Rate.'

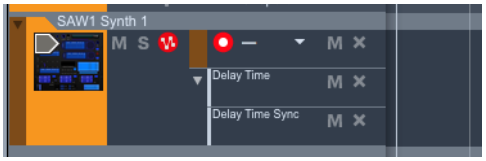


LFO SYNC is on. The knob is named 'LFO1 Sync Rate.' Notice the added word 'Sync.' It is a different control.

The Rate knob is named 'LFO1 Rate' when SYNC is off and named 'LFO1 Sync Rate' when SYNC is switched on. Notice the added word 'Sync.' These are two individual controls and have their own parameters for automation and Remote control.

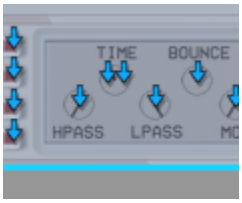


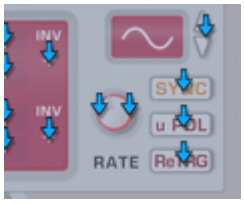
The automation lane considers these two controls separate – because they are!



Same here – Delay Time and Delay Time Sync are different controls.

This also explains why there are two Remote indicators on Delay Time and LFO Rate controls.





Known Issues

There is a small graphic display bug that involves display of remoteable parameters on some skins.

The issue is that remoteable parameters are displayed *in full* on some GUI skins *but only partially* on other skins. Controls are still remoteable, but indication and assignability is not complete from some skins. There is no operational effect – it is only a display quirk – but assignments of some controls cannot be made if the GUI skin doesn't display the control.

All knobs, buttons and available Matrix controls are ready for remote assignment in this skin. Everything works as it is supposed to.

Most knobs and buttons are NOT available for assignment in this skin. Use the workaround to make remote assignments, then come back to this skin.

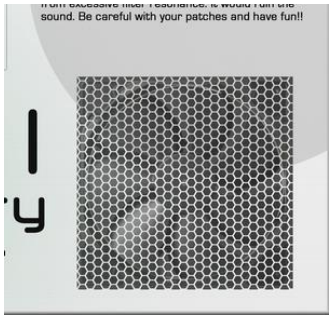
The workaround is to assign remoteables using a GUI skin that contains the assignability arrow. After assigning, feel free to return to another skin if desired. Your control maintains assignment through every each and every GUI skin.

NOTE: Matrix Sources and Destinations are never available for Remote control or Automation.

Maintenance

SAW-1 Discovery is designed to resist air-borne contaminants. Potentiometers and switches are virtually impervious to dust and dirt. From time to time, use a damp cloth to clean the front panel and aluminum enclosure. Then stop drinking.

Rear Fan Maintenance



The internal fan has an air filter that will need quarterly cleaning. Simply remove the rear panel, locate the filter behind the fan and gently remove it. Wash in warm, soapy water until clean. Wait until fully dry before reinstalling. Do not reinstall a wet or damp filter as internal damage can result. Actually, if you've gotten this far, internal damage has already occurred somewhere.

Service

I can guarantee that SAW-1 Discovery will never fail from an internal hardware-related issue. In the unlikely event you require service on your unit, contact us for instructions. We will ask questions concerning your unit and inquire about current medications.

STATEMENT OF ENVIRONMENTAL IMPACT

SAW-1 Discovery incorporates the latest available materials for minimum environmental impact. All circuitry is RoHS compliant, plastics used are nearly instantly biodegradable and no known carcinogenic materials were used in the construction of this device. LCD and fluorescent panels are mercury-free and the aluminum panels chosen for SAW-1 Discovery contain no harmful mining residue. SAW-1 Discovery will no-doubt bring you happiness and pleasure for many years, but the end will inevitably come. Rest secure knowing that this device will *never* harm the environment or contaminate landfill soil as it decays.

Credits and Thanks

SAW-1 Discovery would not be possible without the kind help and dedication of several people.

First, my wife Janet, and our daughter Scotlyn for their understanding and grace as this synth was developed. Many nights were spent working with the laptop instead of hanging with my family. Thank you so much for supporting me and believing in this work. May it be prosperous for us all.

Special thanks to Giles Reaves of Selig Audio. Without his help and fabulous insight, SAW-1 Discovery would be nowhere near the synth it is now. He spent hours taking notes and offering thorough critique as development progressed. So happy to reconnect and become colleagues again. Yeah, he's a competitor, but his stuff sounds great and I own many of his products. http://www.seligaudio.com.

John Engström at Propellerheads has been a cheerleader, coach, confidant and Revealer of Earthly Secrets. I am indebted to him for his care and expertise as SAW-1 was coded and put together.

Paul Kellet at Ujam for literally rewriting platform specs while I waited. Thanks for a serious amount of help.

Harald "Eagleizer" Øhm has been an amazing resource for improvements and suggestions. Many features in SAW-1 are from his direct request. He has persevered through patch format changes and revisions like a champ. Thank you for your help.

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