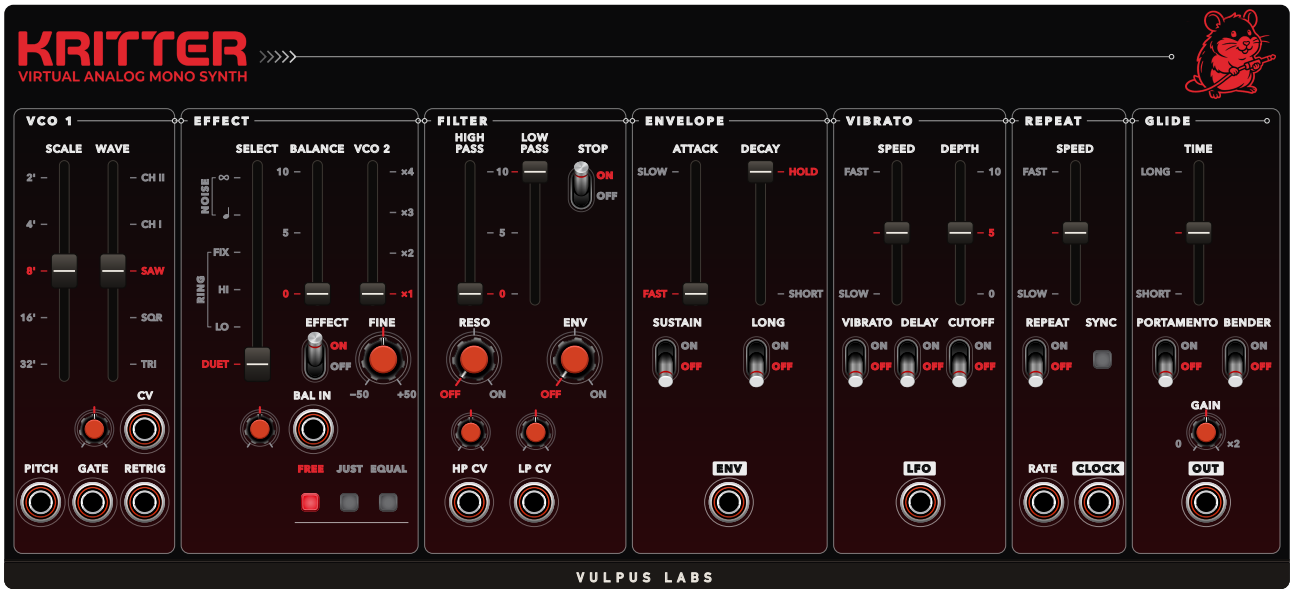
Kritter

Monophonic synthesizer for Voltage Modular



Kritter is a monophonic synthesizer based on one from the 1970s: a divider oscillator with five footages, a second oscillator, a ring modulator and noise, a high-pass and a low-pass filter in series, a two-slider envelope and a VCA, with vibrato, delay vibrato, Repeat, portamento and the Bender. The sections run left to right in signal order.

This manual describes every control and jack, and gives measurements taken from the module's own DSP code: filter responses, envelope shapes, control ranges, spectra and aliasing.

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Overview

What it is

Kritter is one voice, its sections in signal order from left to right. Several of its controls and jacks start where they have no effect:

Control	What it does	No effect at
CV (VCO 1)	VCO 1's own pitch, through its amount knob	the knob's centre, or 0 V
RETRIG (VCO 1)	re-strikes the envelope while the gate is held	unpatched
BAL IN (EFFECT)	a CV on BALANCE, through its amount knob	the knob's centre, or 0 V
FREE, **JUST**, **EQUAL**	how VCO 2's fader is read	FREE
STOP off	lets LOW PASS go below HIGH PASS	ON
RESO, **ENV** between their ends	resonance, and envelope on the filter, between off and on	OFF or ON
HP CV, **LP CV** (FILTER)	a CV on each filter slider, through its amount knob	the knob's centre, or 0 V
SYNC (REPEAT)	Repeat's rate as a division of the host's tempo	off
RATE (REPEAT)	a CV on Repeat's rate, 1 V/oct	0 V
GAIN (GLIDE)	a trim on OUT	its centre, unity
ENV, **LFO**, **CLOCK**	the envelope, the vibrato LFO and Repeat's clock as outputs	always
The display	OUT's waveform	always

Signal path

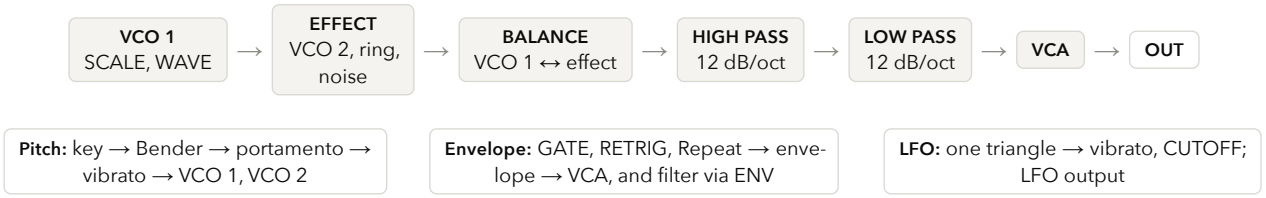


Figure 1. The oscillators, effect section and filter run at twice the host's sample rate and are brought down to it after the VCA. The pitch effects work in hertz, not in volts per octave; see Section 9.

Connecting it

Patch a pitch into **PITCH** and a gate into **GATE**, from a keyboard or a sequencer, and take **OUT** to a mixer. With every control where it starts, Kritter plays one sawtooth at 8' through an open filter, with an organ envelope: the note sounds while the gate is high and stops when it falls.

The face

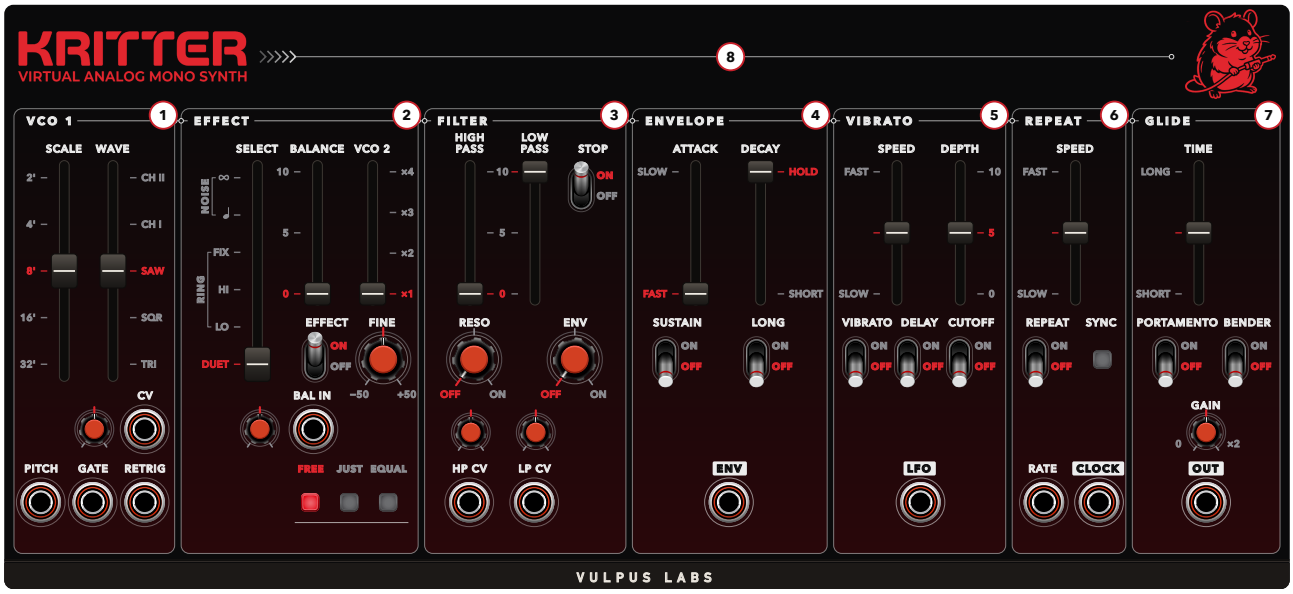


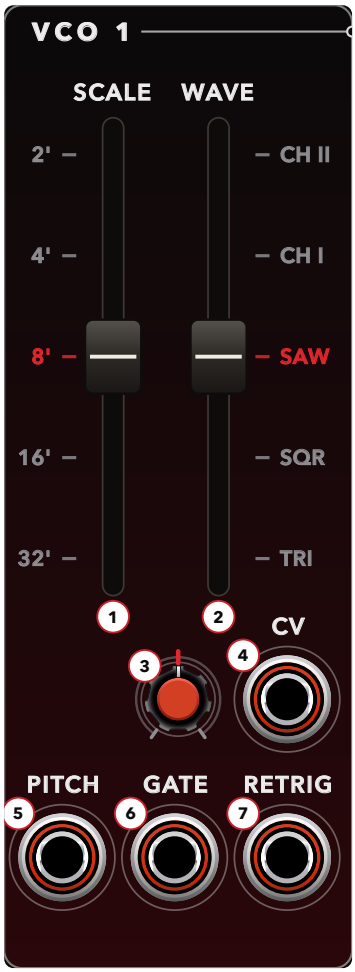
Figure 2. The face, by section. Each number is the section of this manual that describes it.

1 **VCO 1**	the oscillator, and the key's jacks	2 **EFFECT**	VCO 2, ring modulator and noise
3 **FILTER**	high-pass and low-pass	4 **ENVELOPE**	two sliders, two switches
5 **VIBRATO**	the LFO and its three destinations	6 **REPEAT**	re-strikes held notes
7 **GLIDE**	portamento, the Bender, GAIN and OUT	8 **Display**	OUT's waveform

Faders read upwards, and switches have ON at the top. The red tick beside each control marks its starting position.

Each jack sits in the section it belongs to. Every input reads 0 V when unpatched, and at 0 V each leaves the module as it would be without it. **GATE** and **RETRIG** are read every sample. Every other input is read once every 32 samples (0.67 ms at 48 kHz).

1 · VCO 1



1. **SCALE** — octave: 32' to 2'
2. **WAVE** — TRI, SQR, SAW, CH I, CH II
3. **CV amount** — how far CV moves VCO 1
4. **CV** — VCO 1's own pitch, 1 V/oct at full amount
5. **PITCH** — 1 V/oct, 0 V = C2 at 8'
6. **GATE** — high above 0 V
7. **RETRIG** — re-strikes a held note

VCO 1 is a single oscillator followed by a chain of frequency dividers. Each footage is a divider output, so the five footages are always exactly in tune with one another.

SCALE selects the footage in five steps: 32', 16', 8', 4', 2', with 2' at the top. At 8' the oscillator plays the pitch at **PITCH**; each step is one octave. It starts at 8'.

SCALE also moves both filters' cutoffs by one octave per step, so a filter setting keeps the same relation to the notes when the footage changes. The filters do not follow the key played, only this switch.

WAVE selects the waveform. It starts at SAW.

Position	Waveform
TRI	Triangle. Odd harmonics only, falling at 12 dB per octave ($1/n^2$).
SQR	Square. Odd harmonics only, falling at 6 dB per octave ($1/n$).
SAW	Sawtooth. Every harmonic, falling at 6 dB per octave ($1/n$).
CH I	Pulse, its width swept by a 0.8 Hz triangle between 15% and 85%.
CH II	Pulse, its width swept by a 5 Hz triangle between 40% and 60%.

The chorus sweep has its own oscillator; the VIBRATO section does not affect it. It runs continuously, through notes and through changes between CH I and CH II. There is no sine wave.

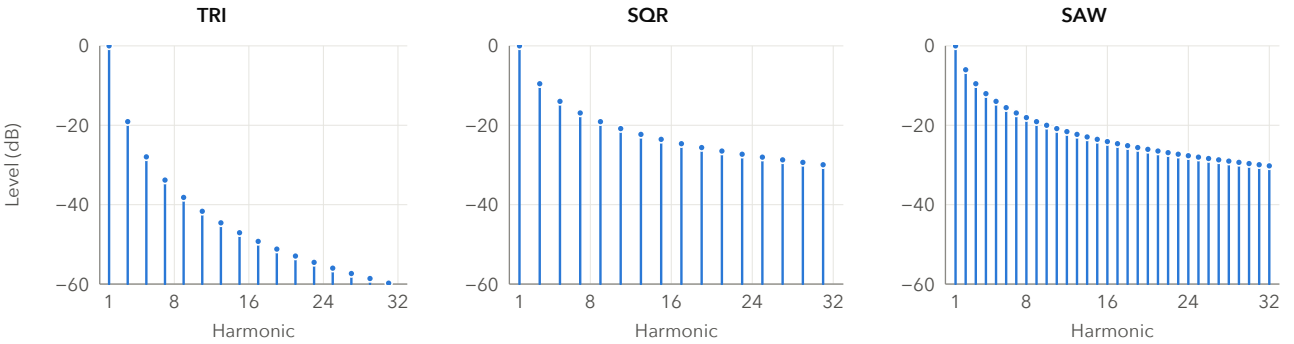


Figure 3. Harmonic levels against the fundamental, measured at OUT with the filter open, C3 (130.8 Hz). Even harmonics of TRI and SQR are below −140 dB.

PITCH is the pitch input, 1 V/oct, 0 V at C2 (65.41 Hz) with SCALE at 8'. Tracking is exact.

GATE is the gate input. A voltage above 0 V is a held key. A rise starts a note: it strikes the envelope, starts the Bender's swoop and delay vibrato's fade-in, and restarts Repeat's clock. A gate that stays high while the pitch changes is a legato note, and nothing restarts.

RETRIG re-strikes the envelope while the gate is held, from its current level, and restarts Repeat's clock so that its repeats follow on from the strike. It is not a new note: the Bender's swoop and delay vibrato's fade carry on from the key. A voltage above 0 V is high, and a high that persists strikes once. With the gate low it does nothing, so it can re-play a held note but cannot start one. A clock patched here with a gate held gives re-struck notes at any rate; a sequencer's trigger here and its gate at GATE gives legato lines that still re-attack.

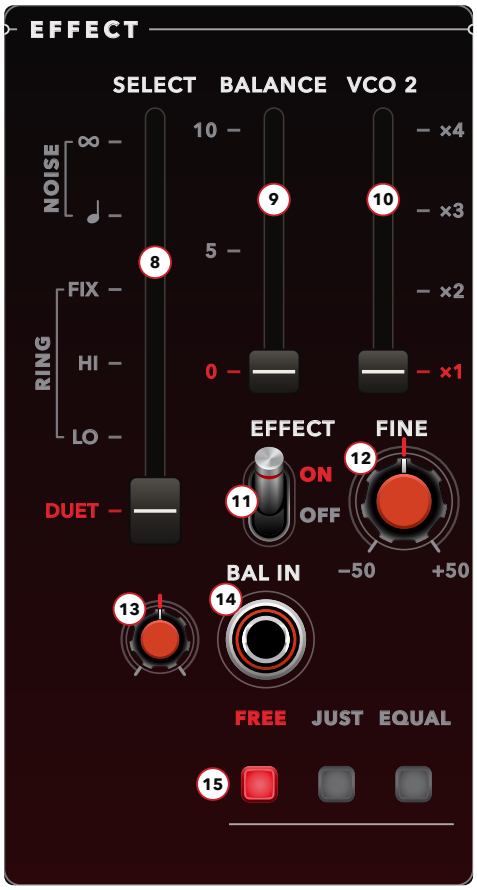
CV moves VCO 1's pitch, added after SCALE, through the **amount knob** to its left. At the knob's centre, where it starts, the CV has no effect; at either end it is 1 V/oct, inverted to the left of centre. The amount is linear in the knob's rotation, and the tooltip shows it in octaves per volt. CV moves VCO 1 only. VCO 2, the ring modulator's fixed carrier and the filters are unaffected, so an LFO here in DUET gives a slow beating against VCO 2, and a fixed voltage detunes the two.

Output level

WAVE	RMS (V)	Peak (V)
TRI	2.885	4.875
SQR	4.988	8.639
SAW	2.874	8.032
CH I	4.593	11.204
CH II	4.956	9.564

Measured at **OUT**, C3, the filter open, GAIN at its centre. The waveforms are ±5 V before the filters. The peaks are higher because the high-pass filter at its lowest setting (20 Hz) and the band-limiting shift the phases of the harmonics, which raises the peaks of waveforms with steep edges. The RMS level is the better guide to loudness.

2 · EFFECT



8	**SELECT**	the effect section's source
9	**BALANCE**	VCO 1 against the effect
10	**VCO 2**	VCO 2's ratio to VCO 1, ×1 to ×4
11	**EFFECT**	the section on or off
12	**FINE**	VCO 2's fine tuning, ±50 cents
13	**BAL IN amount**	how far BAL IN moves BALANCE
14	**BAL IN**	a CV on BALANCE
15	**FREE · JUST · EQUAL**	how the VCO 2 fader is read

The effect section contains a second oscillator, a ring modulator and a noise source. **SELECT** chooses what the section produces, and **BALANCE** mixes it with VCO 1.

With BALANCE at 0, where it starts, the effect section is not heard.

SELECT has six positions, DUET at the bottom. It starts at DUET. The three ring-modulator positions are marked LO, HI and FIX on the face, under RING.

Position	Output
DUET	VCO 2, sawtooth, following the key at the ratio set by the VCO 2 fader.
RING LO	VCO 1 ring-modulated by VCO 2, VCO 2 following the key as at DUET.
RING HI	As RING LO, with VCO 2 two octaves higher.
RING FIX	VCO 1 ring-modulated by VCO 2 at a fixed frequency, not following the key.
NOISE ♩	Noise ring-modulated by VCO 2, VCO 2 following the key two octaves up: noise with a pitch.
NOISE ∞	White noise.

The selector switches without a crossfade; moving it during a note gives a click.

The ring modulator

The ring modulator switches the polarity of its input at VCO 2's frequency. VCO 2 is clipped into a square with rounded edges, and the input is multiplied by that square. The output contains the sums and differences of the input's frequencies and the square's odd harmonics; it contains neither the input's own frequencies nor the carrier's. Only VCO 2's zero crossings matter, so its waveform does not.

With VCO 2 following the key (RING LO, RING HI), the sidebands keep the same relation to every note, and the result plays in tune. At RING FIX, VCO 2 stays at one frequency while VCO 1 follows the key, so each note produces

a different, inharmonic set of sidebands. The fixed carrier is set by the VCO 2 fader and FINE, from 110 Hz at ×1 to 440 Hz at ×4.

BALANCE (0 to 10) crossfades linearly between VCO 1 at 0 and the effect section at 10. At 5 the two are equal. In DUET it sets VCO 2's level against VCO 1; in the ring and noise positions it sets how much plain VCO 1 remains.

BAL IN is a CV on BALANCE, through the amount knob to its left: none at the knob's centre, where it starts, and at either end ±5 V moves BALANCE across its whole range, inverted to the left of centre. The CV is added to the fader's position, and the sum is held within 0 to 10.

VCO 2 sets VCO 2's frequency as a ratio of VCO 1's 8' pitch, from ×1 (unison) to ×4 (two octaves up). The fader is linear in frequency: ×2 is a third of the way up and ×3 two thirds. VCO 2 counts from VCO 1's 8' whatever SCALE is set to, so at 16' the two are an octave apart with the fader at ×1. It starts at ×1.

FREE, **JUST** and **EQUAL** set how the fader is read; one is lit at a time. **FREE** is continuous. **JUST** snaps it to the nearest whole-number ratio: unison, the thirds, fourth, fifth, sixths and sevenths (5/4, 3/2, 5/3 …), the octave, the same intervals an octave higher, and ×4. **EQUAL** snaps it to the nearest equal-tempered semitone. **FINE** detunes from wherever the fader lands, in all three. The fader's tooltip names the interval. It starts at FREE.

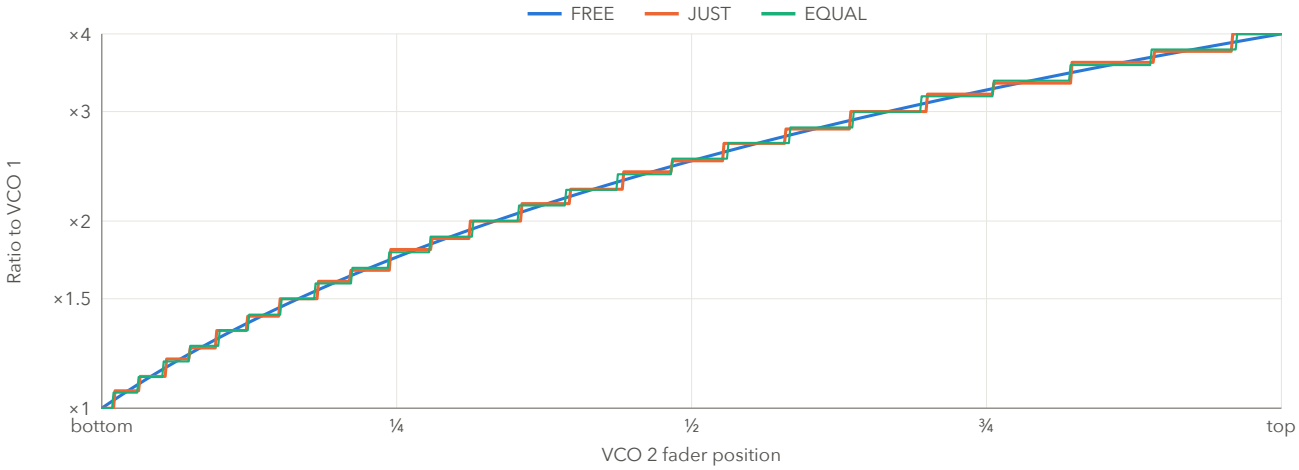


Figure 4. VCO 2's frequency ratio against fader position under FREE, JUST and EQUAL, FINE centred. The vertical scale is logarithmic, so equal heights are equal musical intervals.

FINE (−50 to +50) is VCO 2's fine tuning in cents. It starts at its centre.

At ×1 with FINE centred, VCO 1 and VCO 2 produce identical samples, so in DUET with VCO 1 on SAW the sound does not change as BALANCE moves. Detune FINE by a few cents to hear the two oscillators beat.

EFFECT switches the section on and off. Off, Kritter plays VCO 1 alone whatever BALANCE is set to. It does not affect LONG or CUTOFF. It starts on.

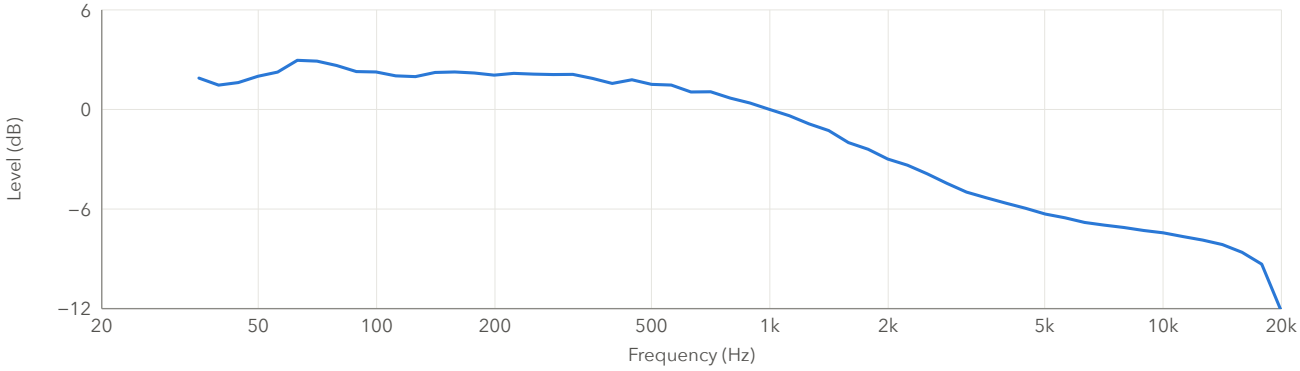
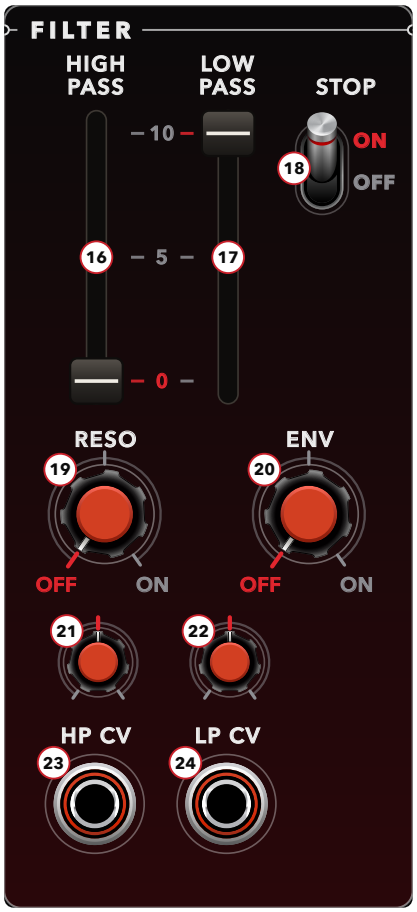


Figure 5. Spectrum of NOISE ∞ at OUT, in sixth-octave bands, relative to the band at 1 kHz. The noise source's own filtering tilts it down by about 10 dB between 50 Hz and 12 kHz.

3 · FILTER



16	**HIGH PASS**	high-pass cutoff, 0 to 10
17	**LOW PASS**	low-pass cutoff, 0 to 10
18	**STOP**	keeps LOW PASS at or above HIGH PASS
19	**RESO**	resonance of both filters
20	**ENV**	envelope amount on both cutoffs
21	**HP CV amount**	how far HP CV moves HIGH PASS
22	**LP CV amount**	how far LP CV moves LOW PASS
23	**HP CV**	a CV on HIGH PASS
24	**LP CV**	a CV on LOW PASS

The filter is a 12 dB/oct high-pass followed by a 12 dB/oct low-pass. Each is a two-pole diode-ring filter with its own slider. Together they pass a band: moving both sliders together moves the band, moving them apart widens it, and bringing them together narrows it to a single peak.

HIGH PASS and **LOW PASS** (0 to 10) set the two cutoffs. Each mark is one octave:

Mark	0	1	2	3	4	5	6	7	8	9	10
Cutoff (Hz)	20	40	80	160	320	640	1280	2560	5120	10240	20480

The figures are for SCALE at 8'; each step of SCALE moves both cutoffs by one octave. The sliders start at HIGH PASS 0 and LOW PASS 10, which leaves the audio band open.

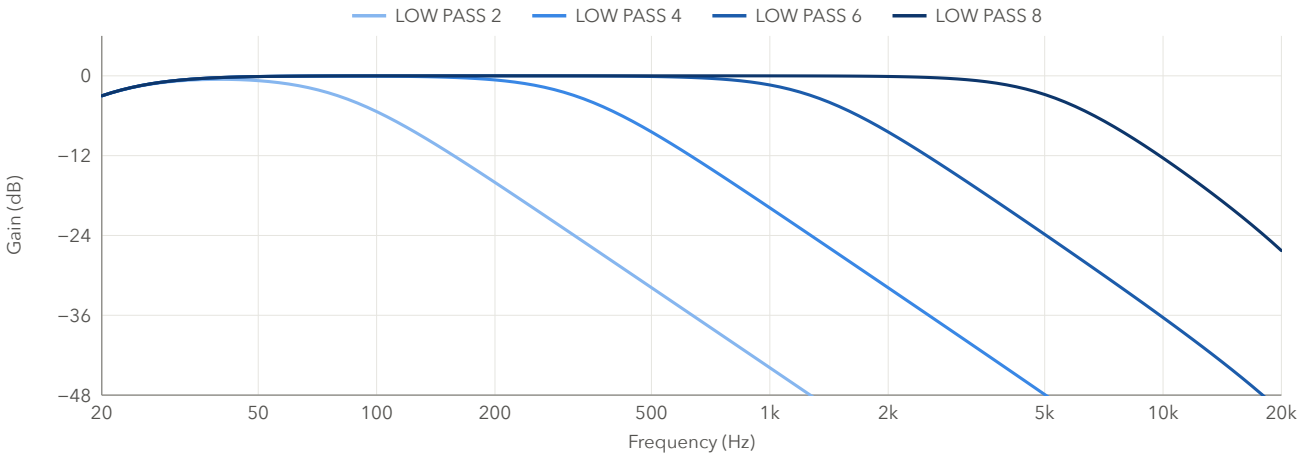


Figure 6. Low-pass response at four LOW PASS settings, HIGH PASS at 0, RESO off. At each cutoff the gain is −3 dB, and an octave above it −12 dB. The fall at 20 Hz is the high-pass at its lowest setting.

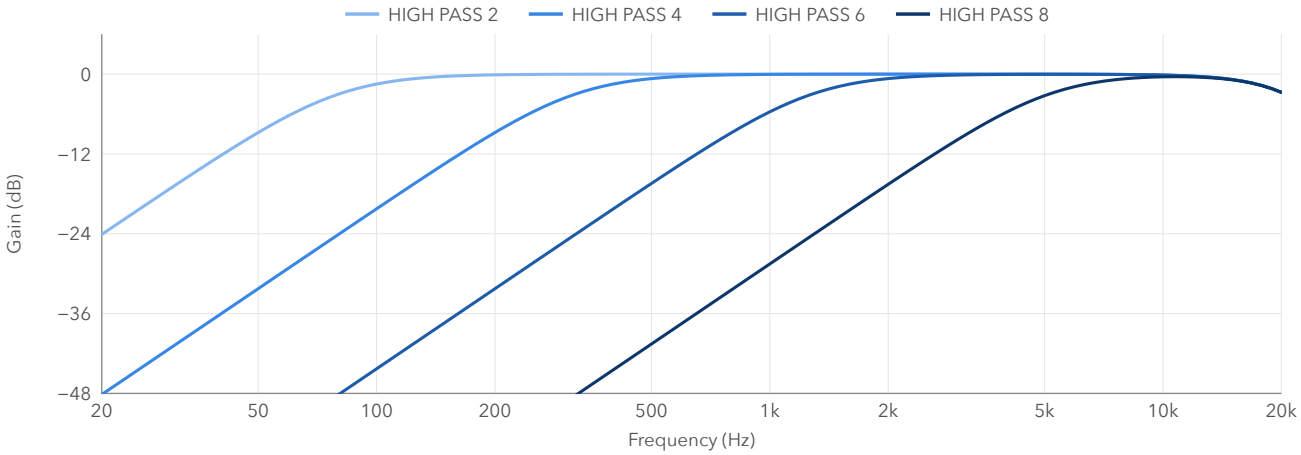


Figure 7. High-pass response at four HIGH PASS settings, LOW PASS at 10, RESO off.

The diode rings compress large signals smoothly rather than clipping them. Below full scale the effect is small with RESO off.

RESO (OFF to ON) sets the resonance of both filters together. At OFF each filter has a Q of 0.71, the flattest response without a peak. At ON the low-pass rings for about five cycles (Q 4.7) and the high-pass for about four (Q 3.7). The passband level does not change; the response rises at each cutoff. Settings between OFF and ON give a resonance between the two. It starts at OFF.

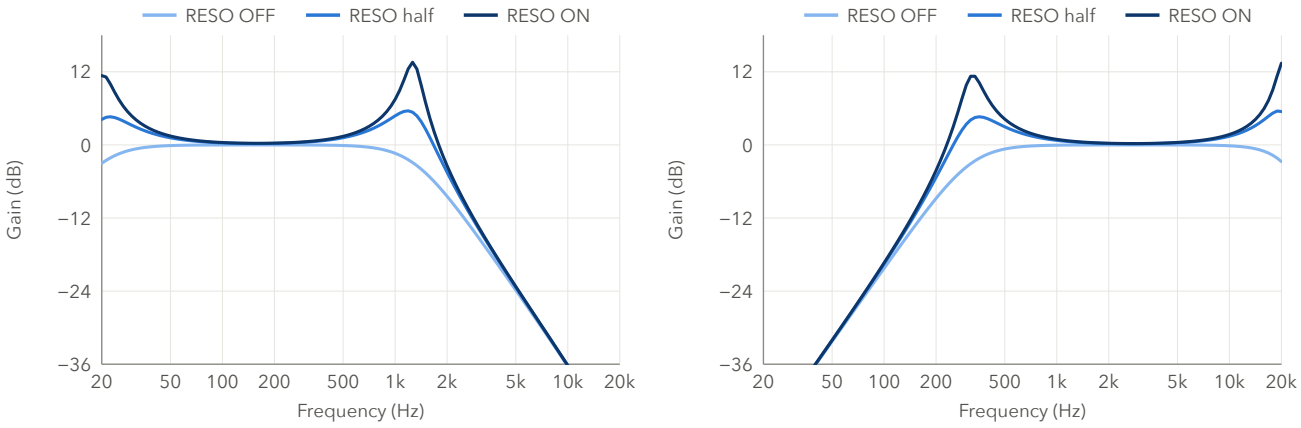


Figure 8. RESO at three settings. Left: LOW PASS at 6, HIGH PASS at 0. Right: HIGH PASS at 4, LOW PASS at 10. RESO acts on both filters, so each graph also shows the other filter's peak at the edge of the band: at 20 Hz on the left, near 20 kHz on the right. Small-signal measurement.

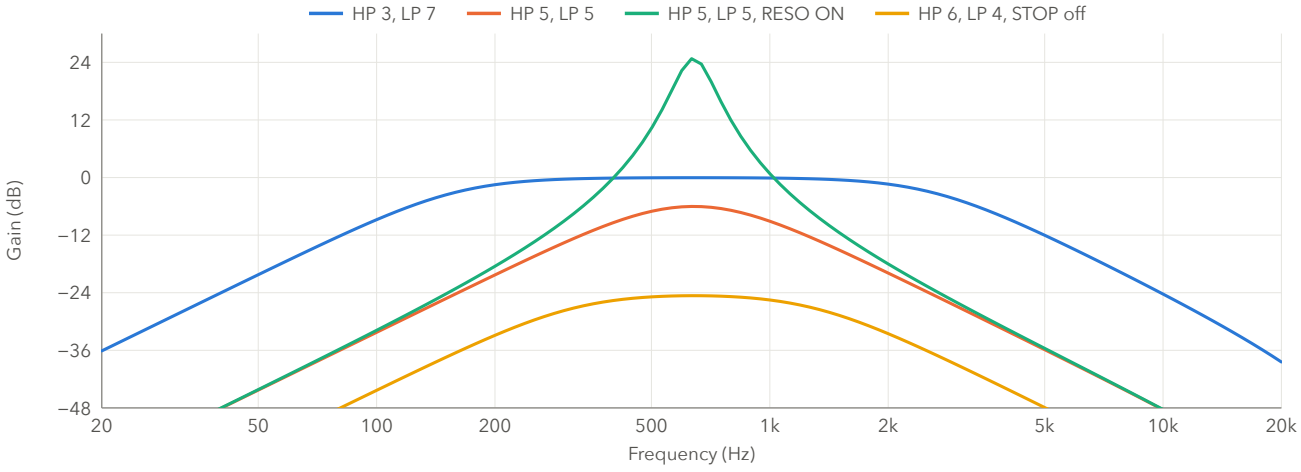


Figure 9. The two filters together. With both cutoffs at one setting the band narrows to a peak 6 dB down; with RESO on, the two resonances add to +25 dB. With STOP off and LOW PASS below HIGH PASS, the slopes overlap and the level falls by about 25 dB.

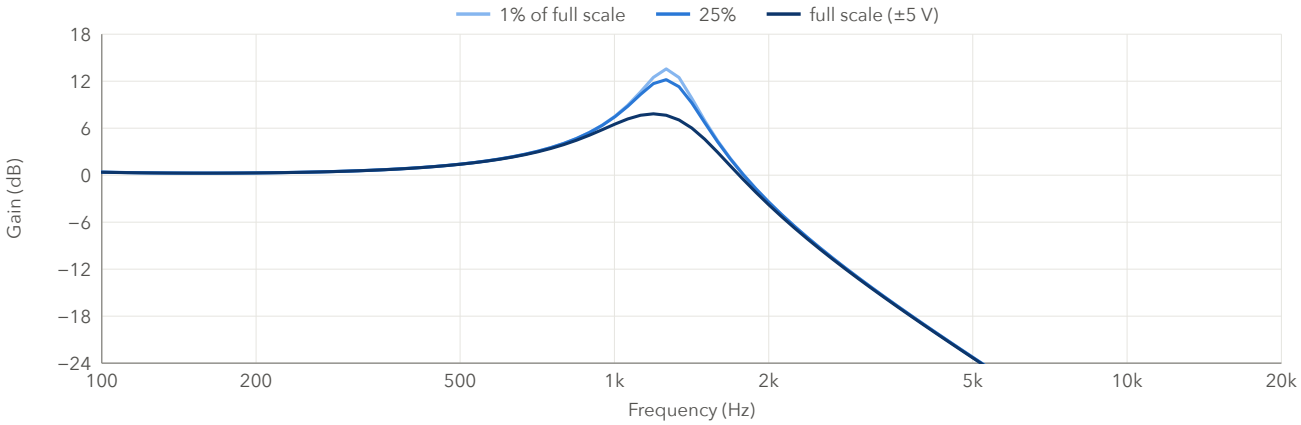


Figure 10. LOW PASS at 6 with RESO ON, measured with sine waves at three levels. The diodes and the output stage compress the resonant peak: +13.6 dB for small signals, +12.2 dB at a quarter of full scale, +7.8 dB at full scale.

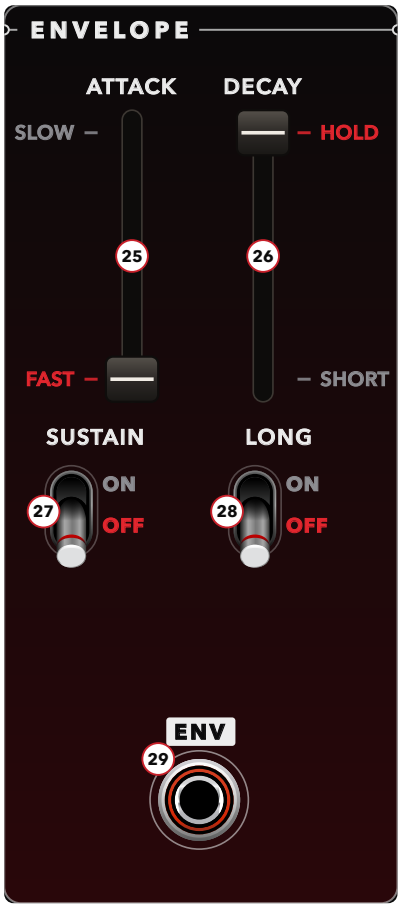
STOP keeps the low-pass at or above the high-pass. On, the low-pass cutoff cannot go below the high-pass: if LOW PASS (with its CV) is set below HIGH PASS (with its CV), it is held at HIGH PASS. ENV, CUTOFF vibrato and SCALE move both cutoffs by the same amount, so they cannot break the rule. It starts on.

Off, the two are independent, and LOW PASS can be set below HIGH PASS. The pass band then closes: the slopes overlap, and the level drops (see the band figure).

ENV (OFF to ON) sets how far each note's envelope moves both cutoffs upwards. At ON both cutoffs rise by up to four octaves at the envelope's peak; between OFF and ON the movement is proportionally less. The same ATTACK and DECAY that shape the level therefore shape the tone. It starts at OFF. (This is not the **ENV** output jack in ENVELOPE.)

HP CV and **LP CV** are CVs on the two sliders, each through the amount knob above its jack: none at the knob's centre, where it starts, and one mark (one octave) per volt at either end, inverted to the left of centre. The CV is added to the slider's position, and the sum is held within the slider's 0 to 10. STOP applies to the result. ENV and CUTOFF vibrato act on top. Slider and CV changes are smoothed over 5 ms. The CVs are meant for envelopes, LFOs and sequences, not audio-rate modulation.

4 · ENVELOPE



25 **ATTACK** rise time, FAST to SLOW
26 **DECAY** what a held note does, SHORT to HOLD
27 **SUSTAIN** a long release after the key
28 **LONG** attack, decay and SUSTAIN eleven times longer
29 **ENV** the envelope, 0 to 5 V

The envelope has two sliders, not four, and it is not an ADSR. There is no sustain level. While the key is held, the envelope rises to its peak and then either holds there or decays towards silence. When the key is released it falls: quickly, or more slowly with **SUSTAIN** on. The envelope drives the VCA, and the filter through the filter's **ENV**.

Each segment is the charge or discharge of a capacitor: an exponential curve towards a target. A new note starts its attack from the envelope's current level, so a note played during another's release does not drop to zero first. A legato note does not restart the envelope.

ATTACK (FAST to SLOW) sets the rise from zero to the peak: 2 ms at FAST to 1 s at SLOW, exponentially along the slider. The rise aims at 1.5 times the peak and stops at the peak, so it is fast at first and slows into the top. It starts at FAST.

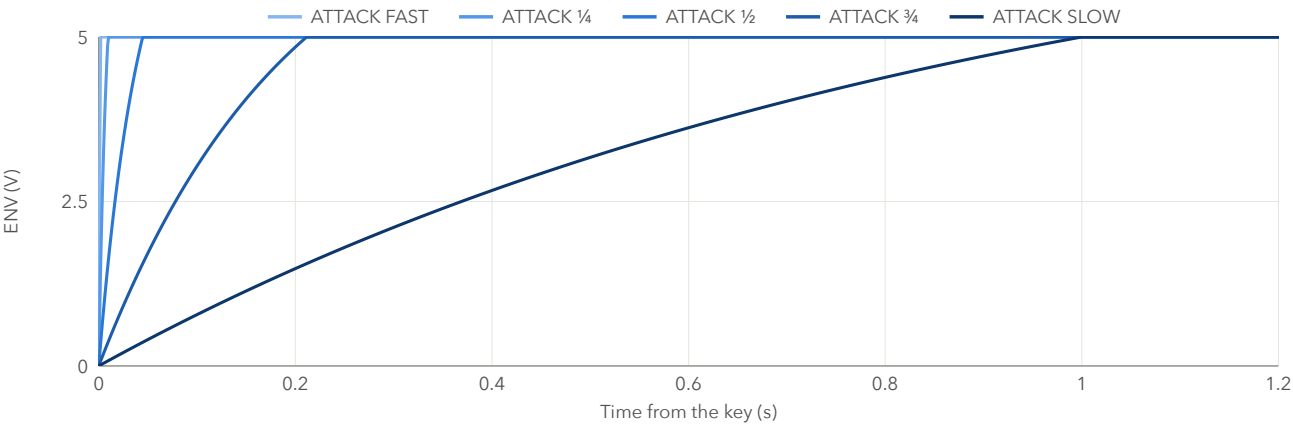


Figure 11. The attack at five ATTACK positions, DECAY at HOLD. Times to the peak: 2 ms, 9 ms, 45 ms, 0.21 s and 1 s.

DECAY (SHORT to HOLD) sets what a held note does after the attack. At HOLD the envelope stays at its peak while the key is held. Below HOLD it decays towards zero with a time constant of 0.15 s at SHORT, lengthening without limit towards HOLD. At SHORT a held note falls 40 dB in 0.7 s. It starts at HOLD.

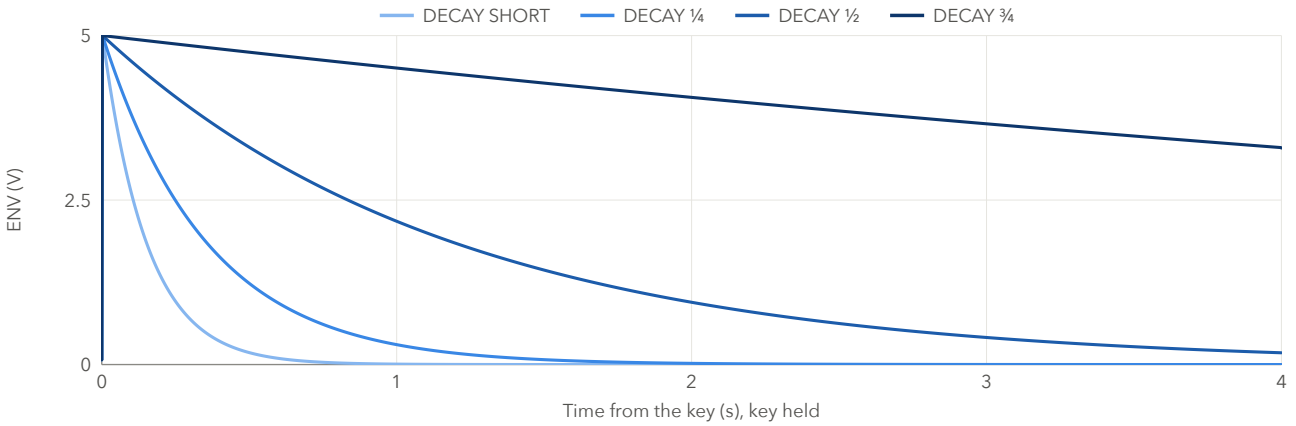


Figure 12. The held decay at four DECAY positions, ATTACK at FAST. Time constants: 0.15 s, 0.36 s, 1.2 s and 9.6 s.

SUSTAIN sets the release, and only the release. Off, the envelope falls with a 10 ms time constant when the key is released, and the VCA shuts 46 ms after the key: fast, but without a click. On, the time constant is 0.3 s, and the note is audible for about 1.4 s after the key. The release time is fixed. It starts off.

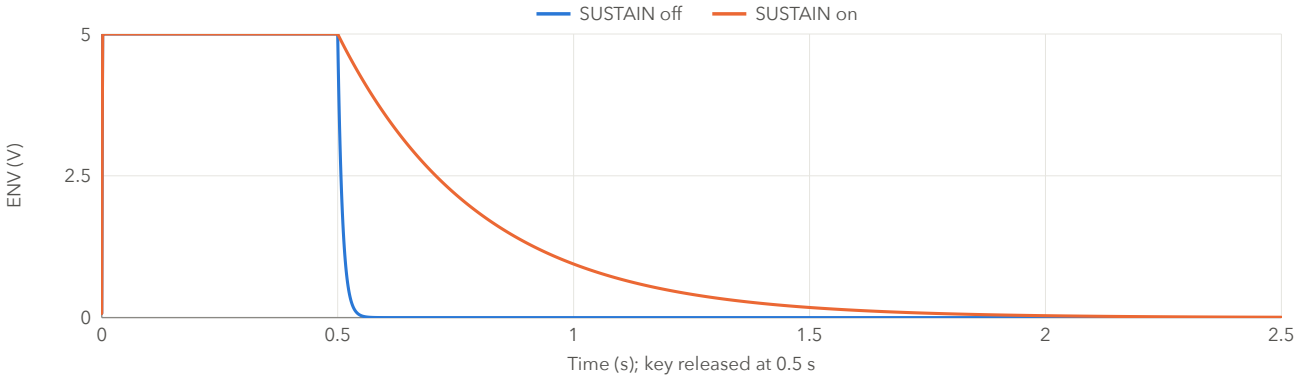


Figure 13. The release, ATTACK at FAST and DECAY at HOLD.

LONG multiplies the attack, the held decay and the SUSTAIN release by eleven. At SLOW the attack takes 11 s; with SUSTAIN on, the release is audible for about 15 s. It does not change the short release, so a note with SUSTAIN off still stops with the key. It starts off.

The VCA is linear in the envelope, and shuts completely when the envelope falls below 1% of its peak (−40 dB), so a released note ends in silence rather than a long low-level tail.

ENV outputs the envelope, 0 to 5 V: the curve the VCA and the filter receive, including Repeat's re-strikes.

Sound	ATTACK	DECAY	SUSTAIN
Organ	FAST	HOLD	off
Plucked string, harpsichord	FAST	¼ up from SHORT	off
Struck bar	FAST	SHORT	on
Flute, bowed string	just under ½	HOLD	off
Bass with a ring after the key	FAST	¼ up from SHORT	on
Chime	FAST	most of the way to HOLD	on, with LONG

5 · VIBRATO



30	**SPEED**	LFO rate, 2 to 15 Hz
31	**DEPTH**	depth of vibrato and CUTOFF
32	**VIBRATO**	vibrato from the start of each note
33	**DELAY**	vibrato that fades in
34	**CUTOFF**	the LFO on both filter cutoffs
35	**LFO**	the LFO's triangle, ±5 V

One triangle LFO, and three switches that send it to the pitch or the filter.

SPEED (SLOW to FAST) sets the rate, from 2 Hz to 15 Hz, exponentially along the slider. The centre is 5.5 Hz. It starts at the centre.

DEPTH (0 to 10) sets the depth of both the vibrato and CUTOFF. The slider has an audio taper: its centre is a tenth of full depth, so the lower half gives fine control of normal vibrato and the upper half gives large depths. It starts at the centre.

VIBRATO applies vibrato to the pitch from the start of each note. It starts off.

DELAY fades vibrato in over 0.6 s from each new note. The fade advances only while the key is held, and a legato note does not restart it. With VIBRATO and DELAY both on, VIBRATO takes precedence: full depth from the start. It starts off.

The vibrato is a fixed deviation in hertz, not in pitch, so it is wider in cents on low notes than on high ones. At the centre of DEPTH the deviation is ±2.7 Hz: ±71 cents at C2, ±25 cents at F♯3, ±9 cents at C5. Section 9 explains why.

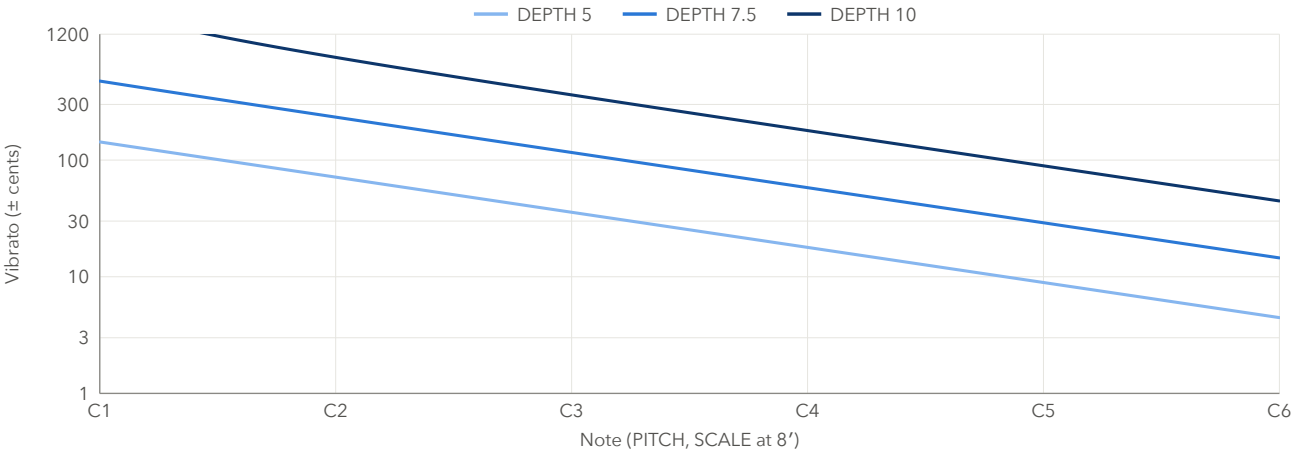
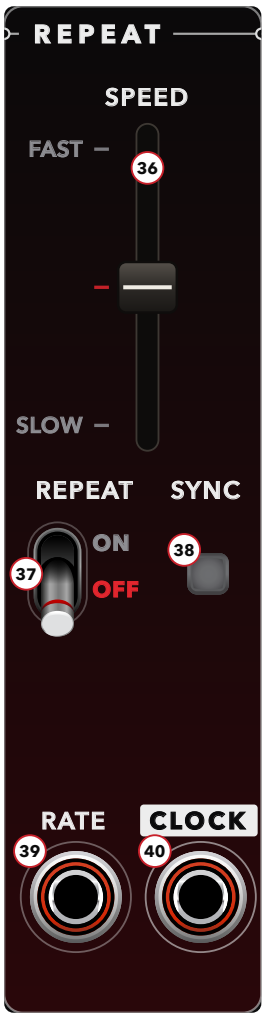


Figure 14. Vibrato depth across the keyboard at three DEPTH settings, measured on the pitch handed to the oscillators. The depth halves with each octave up. At full DEPTH on the lowest notes the swing exceeds an octave.

CUTOFF applies the LFO to both filter cutoffs, so the band moves up and down at SPEED. At the centre of DEPTH it swings ±0.4 octave; at full DEPTH, ±4 octaves. It works without VIBRATO or DELAY, is never delayed, and is not switched off by EFFECT. It starts off.

LFO outputs the LFO's triangle, ±5 V, before DEPTH. It runs at SPEED whatever the switches are set to. Patched into **HP CV** with STOP on, for example, it moves only the bottom of the band.

6 · REPEAT



36 **SPEED** clock rate, 2 to 25 Hz
37 **REPEAT** re-strikes the held note
38 **SYNC** SPEED as a division of the host's tempo
39 **RATE** the clock's rate, 1 V/oct
40 **CLOCK** the clock, 0 or 5 V

Repeat is a clock that re-strikes the held note at a steady rate.

SPEED (SLOW to FAST) sets the clock's rate, from 2 to 25 Hz, exponentially along the slider. The centre is 7.1 Hz. It starts at the centre.

REPEAT turns re-striking on. While the key is held, the clock opens the envelope's gate for the first half of each period and closes it for the second half, so each period is a new attack and each gap a release. The first repeat comes one period after the key. With the key up, or REPEAT off, nothing is re-struck. It starts off.

Every new key, and every RETRIG, restarts the clock, so the repeats always count from the latest strike.

Because Repeat works through the envelope, the envelope settings decide what it sounds like. With ATTACK at FAST and SUSTAIN off, each strike is sharp and each gap silent. With SUSTAIN on, the gaps fill in and the strikes become a pulse on a held note. With a slow attack and a fast SPEED, the envelope does not reach its peak before the next strike.

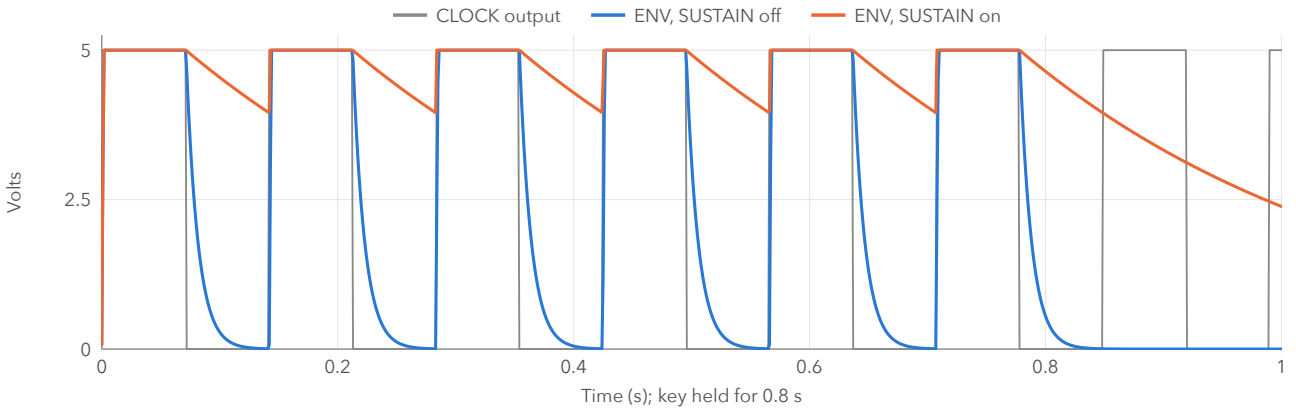


Figure 15. Repeat at SPEED's centre (7.1 Hz), ATTACK at FAST, DECAY at HOLD. The clock runs on after the key is released.

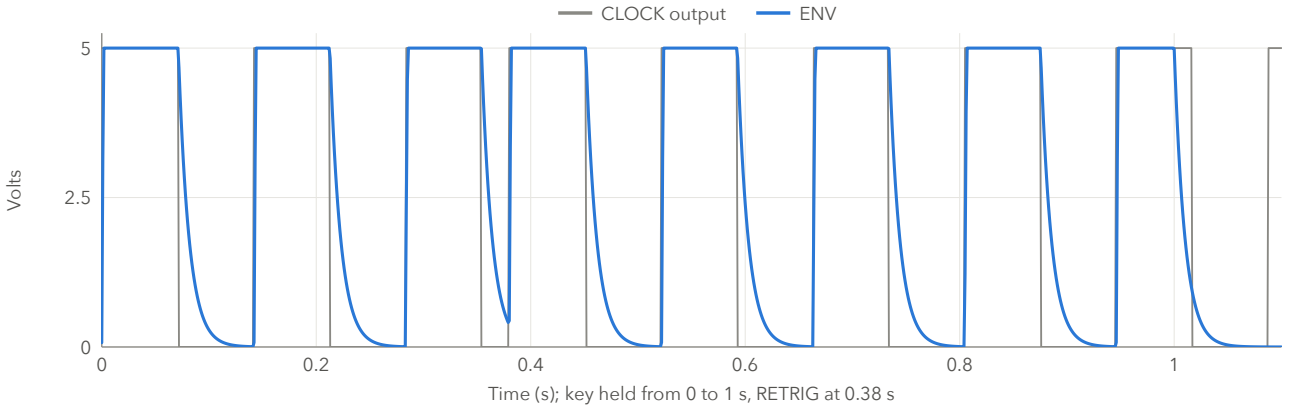
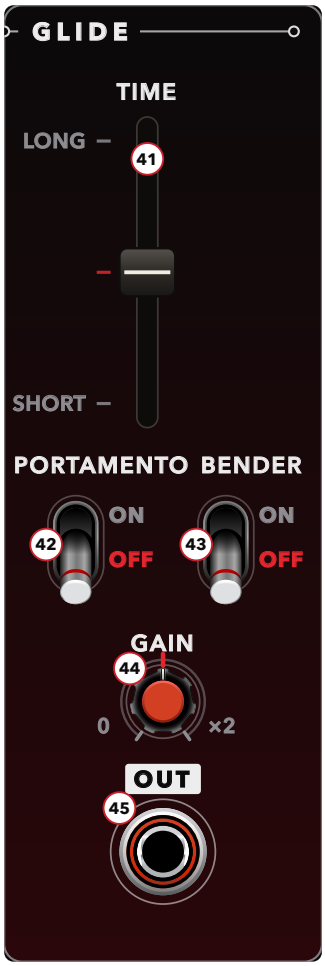


Figure 16. A RETRIG under Repeat, SPEED at its centre, SUSTAIN off. The RETRIG falls in one of the clock's gaps: it strikes the envelope at once and restarts the clock, which counts its periods from there.

SYNC locks the clock to the host's tempo. With SYNC on, SPEED selects a note value, from four bars at the bottom to a thirty-second-note triplet at the top, and the clock runs at that value at the current tempo, following it if it changes. The tooltip on SPEED shows the value and its rate. A new key still restarts the clock, so the strikes fall on the beat when the key does. It starts off.

RATE moves the clock's rate at 1 V/oct, in both modes: +1 V doubles it. With SYNC on it scales the note value's rate, so whole volts stay on the beat. **CLOCK** outputs the clock as a 0/5 V square wave. It runs whether REPEAT is on or off, and between notes, and restarts with each key and each RETRIG, so whatever it drives lands on the note's strikes.

7 · GLIDE and OUT



41	**TIME**	portamento time
42	**PORTAMENTO**	glides between notes
43	**BENDER**	a swoop up into each note
44	**GAIN**	level of OUT, 0 to ×2
45	**OUT**	the audio output

PORTAMENTO glides from the previous pitch to each new one, at **TIME**. It starts off.

TIME (SHORT to LONG) sets the glide's time constant: none at the bottom, 0.2 s at the centre (where it starts), and 2 s at the top. A glide covers 95% of the distance in three time constants: 0.6 s at the centre and 6 s at the top. The slider has an audio taper, so most of its travel is given to short times.

The glide is exponential in frequency, not in pitch. It covers the same fraction of the distance in hertz in the same time, so a rising glide moves most of its pitch distance early, and a falling glide spreads it more evenly. Over an octave, a rising glide has covered seven semitones when a falling glide has covered five.

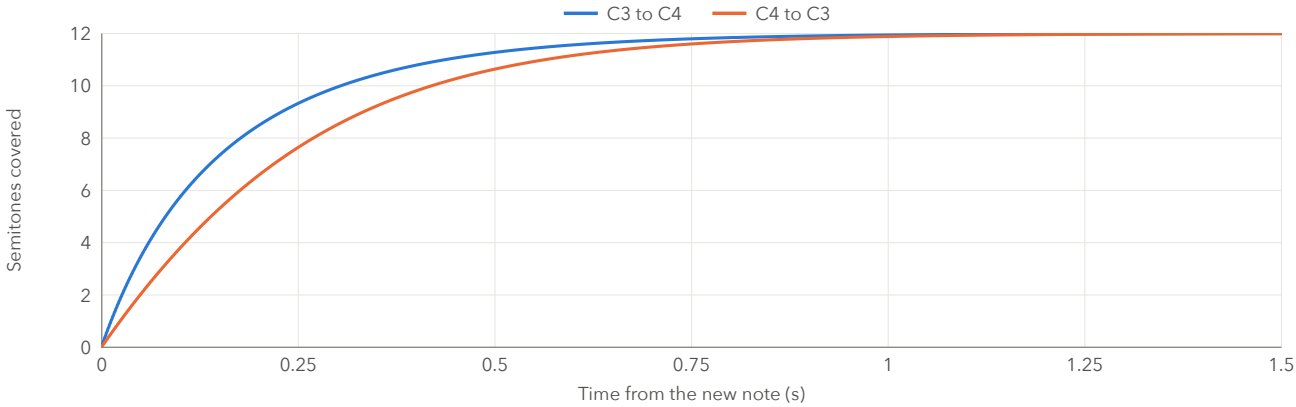


Figure 17. Portamento over an octave up and an octave down, TIME at its centre.

BENDER starts each new note 20 Hz below its pitch and lets it rise into the pitch, with a time constant of 80 ms: 95% of the way in 0.24 s. It is a switch, not a wheel. Like the vibrato, the depth is in hertz, so the swoop is about

six semitones on C2, two on F♯3 and under one from C5 up. Turning BENDER off ends a swoop at once. With PORTAMENTO on as well, the swoop is glided too. It starts off.

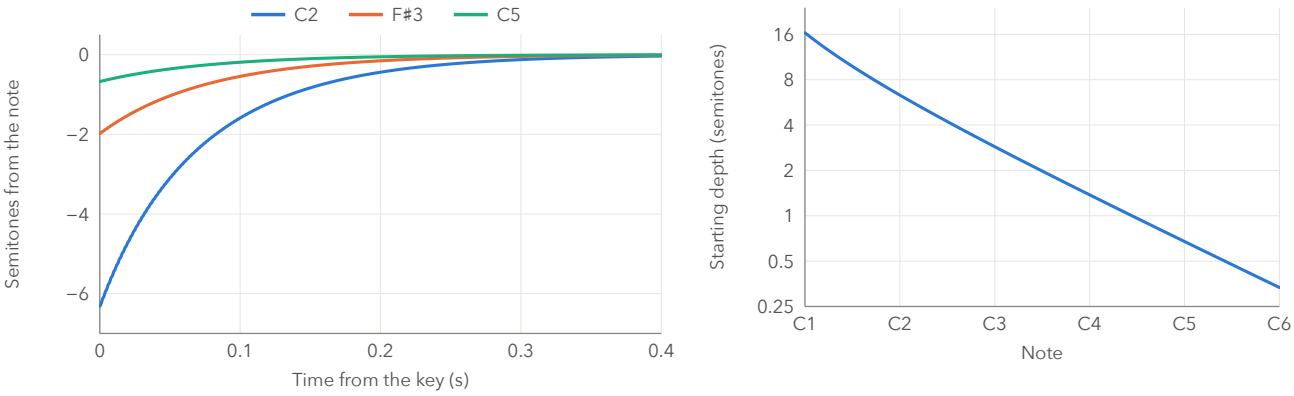


Figure 18. The Bender. Left: the swoop into three notes. Right: how far below the note each swoop starts, across the keyboard.

OUT is the audio output: about ±5 V for one oscillator, with GAIN at its centre (Section 1 gives measured levels). It sits under GLIDE, but it is the last stage of the signal path, after the VCA.

GAIN scales OUT, linearly from silence at the left, through unity at the centre (where it starts), to ×2 (+6 dB) at the right. The tooltip shows it in dB. Its changes are smoothed over 5 ms, so turning it does not click. ENV, LFO and CLOCK do not pass through it.

Aliasing

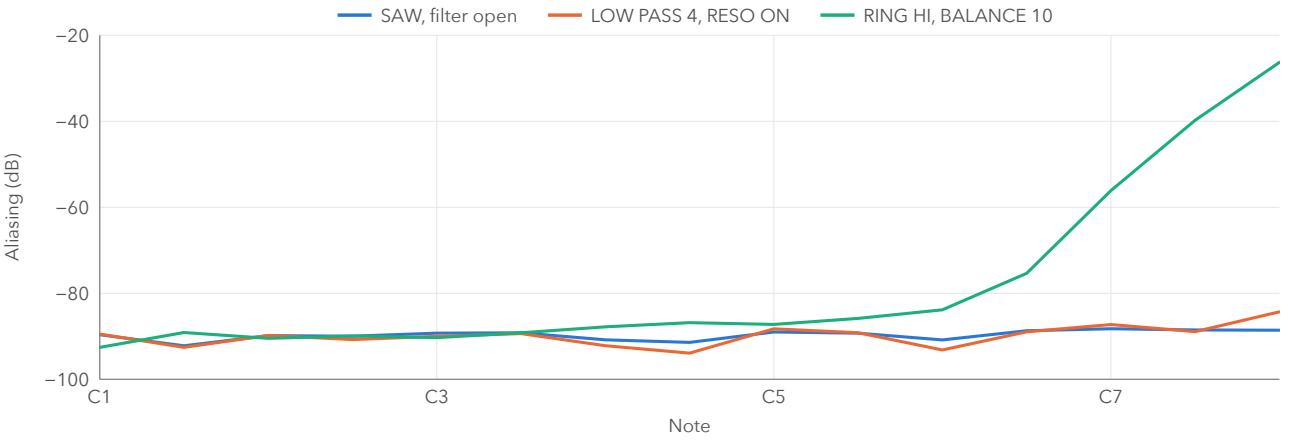


Figure 19. Alias energy below 15 kHz against the signal, measured at OUT across the keyboard, for three sounds. Plain and filtered sounds stay near −90 dB. RING HI's carrier runs two octaves above the note, so from C6 up its sidebands reach past the top of the band and fold back: −75 dB at F♯6, −56 dB at C7, −26 dB at C8.

8 · The display

The strip across the top of the face shows **OUT** as an oscilloscope trace, after GAIN: about 21 ms at 48 kHz, starting at a rising zero crossing, so a held note stands still while the filter, WAVE or BALANCE moves. With no zero crossing (silence, or a very slow sweep) it shows the latest samples. Its vertical range is ±7 V, past OUT's ±5 V, so the overshoot at a sawtooth's or a square's edge is drawn rather than clipped; with GAIN above about +3 dB the peaks run off it. It has no controls and does not affect the sound.

9 · Hertz, not pitch

The vibrato, the Bender and portamento act on the pitch in hertz, not in volts per octave. A fixed deviation in hertz is a large interval on a low note and a small one on a high note, and an exponential glide in hertz is not symmetrical in pitch.

Kritter takes 1 V/oct pitch, so that it works with the rest of the rack. It converts the pitch to hertz, applies the Bender, then portamento, then vibrato, and converts the result back to 1 V/oct for the oscillators. With all three off, **PITCH** passes through exactly.

The effects:

- Vibrato at one DEPTH is deeper on low notes: it halves with each octave up.
- The Bender's swoop is wide on low notes and slight on high ones.
- Portamento covers more of its pitch distance early when rising than when falling.

There is no switch for a 1 V/oct behaviour. For vibrato that is equal in pitch across the keyboard, patch **LFO** through an attenuator into VCO 1's **CV**, with its amount knob at full; it moves VCO 1 only.

10 · Control ranges

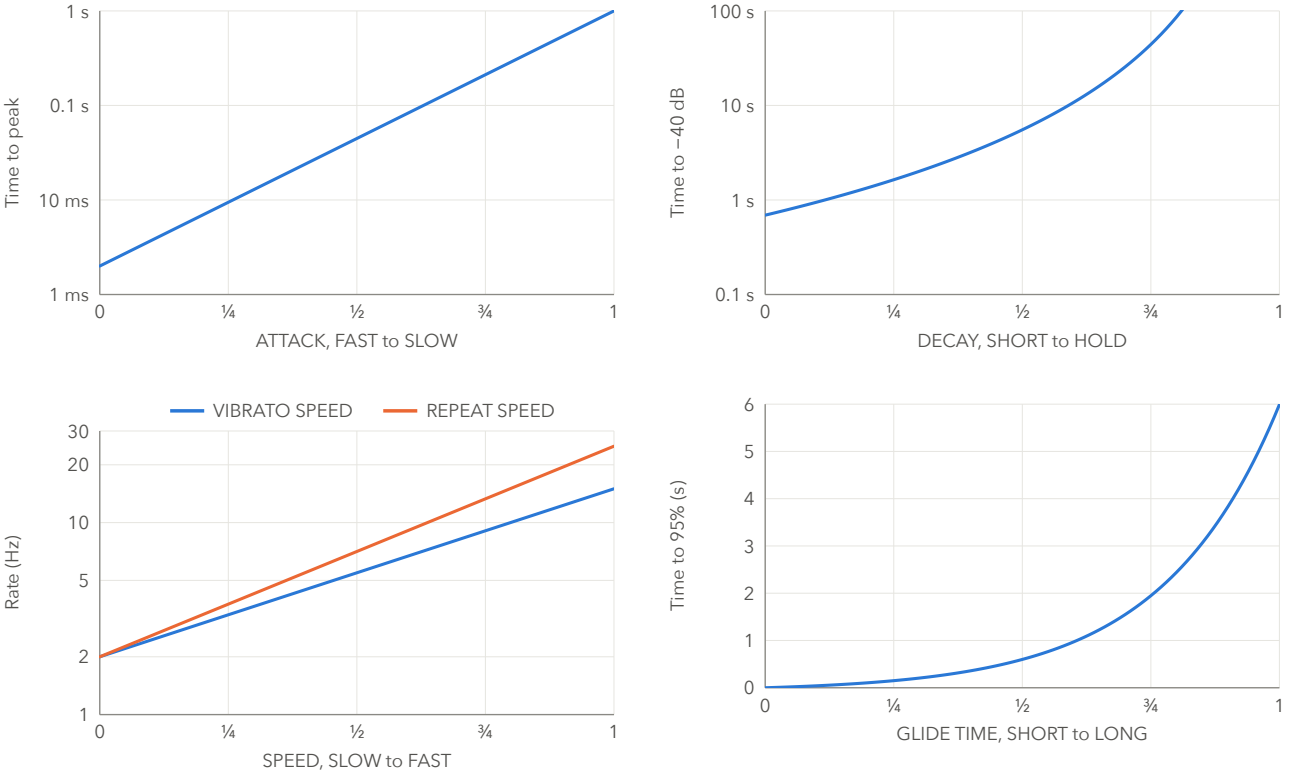


Figure 20. The slider laws. Each is the function the engine runs. DECAY's time is infinite at HOLD. LONG multiplies ATTACK and DECAY by eleven. VIBRATO DEPTH and GLIDE TIME share the audio taper: 10% of full value at half travel.

Quantity	Value	Notes
Pitch input	1 V/oct	0 V = C2, 65.41 Hz, at 8'
Internal sample rate	2 × host	the oscillators, effect section and filter
CV read rate	every 32 samples	GATE and RETRIG every sample
Filter cutoff	20 Hz × 2^{mark}	at 8'; 12 dB/oct each filter
Filter Q	0.71 / 4.7 (LP), 3.7 (HP)	RESO OFF / ON
ENV on the filter	up to +4 octaves	at the envelope's peak, ENV at ON

CUTOFF vibrato	±0.4 oct / ±4 oct	DEPTH at centre / full
Attack	2 ms to 1 s	time to peak; ×11 with LONG
Held decay	τ 0.15 s to ∞	×11 with LONG
Release	τ 10 ms / 0.3 s	SUSTAIN off / on; 0.3 s × 11 with LONG
VCA shut-off	1% of peak	−40 dB
Vibrato rate	2 to 15 Hz	centre 5.5 Hz
Vibrato depth	±27 Hz at full	±2.7 Hz at centre
Delay vibrato	0.6 s	linear fade-in
Repeat rate	2 to 25 Hz	centre 7.1 Hz; 50% duty
Portamento	τ 0 to 2 s	0.2 s at centre
Bender	−20 Hz, τ 80 ms	
CH I / CH II	0.8 Hz, 15–85% / 5 Hz, 40–60%	pulse width sweep
VCO 2	×1 to ×4, FINE ±50 cents	fixed carrier 110 to 440 Hz
OUT	±5 V	per oscillator, before the filter
GAIN	0 to ×2	unity at centre

Jack	Section	Direction	What it carries
PITCH	VCO 1	in	the key's pitch, 1 V/oct, 0 V = C2 at 8'
GATE	VCO 1	in	the key, high above 0 V
CV	VCO 1	in	VCO 1's own pitch, 1 V/oct at full amount
RETRIG	VCO 1	in	a re-strike of the envelope, high above 0 V
BAL IN	EFFECT	in	BALANCE, ±5 V its whole range at full amount
HP CV, **LP CV**	FILTER	in	each slider, one mark per volt at full amount
ENV	ENVELOPE	out	the envelope, 0 to 5 V
LFO	VIBRATO	out	the LFO's triangle, ±5 V
RATE	REPEAT	in	Repeat's rate, 1 V/oct
CLOCK	REPEAT	out	Repeat's clock, 0 or 5 V
OUT	GLIDE	out	the audio, about ±5 V at unity GAIN

The measurements in this manual are taken from the module's code: the filter responses by passing sine waves through the filter alone at the internal rate, and everything else by running the module's engine at 48 kHz.

Troubleshooting

- **No sound from the effect section:** BALANCE is at 0, or EFFECT is off.
- **The filter goes quiet as a slider moves:** STOP is off, and LOW PASS is below HIGH PASS.
- **Vibrato is too wide on low notes and too narrow on high ones:** see Section 9.
- **A patched CV does nothing:** its amount knob is at the centre.
- **Kritter plays one note at a time:** it is monophonic. For chords, use PolyKritter, or more than one Kritter.