

Ravel manual

Ravel is a custom firmware for the M-VAVE FM-1 that turns the FM-1 into a pocket groovebox for sound design. It has 8 tracks that synthesize, catch what they play onto a shared tape, cut it up & rebuild it with tracks that can play, excite, and reshape one another

Status: playable in the emulator; the FM-1 firmware builds, but has not been run on an FM-1 yet. The whole instrument runs in the browser emulator and the desktop simulator, from the same C sources the firmware is built from. The FM-1 firmware is bare metal (no vendor SDK) on the open hardware layer of the Felucca family of community firmwares, and installs from a web installer over USB. Until it has been tried on hardware, treat it as experimental.

What it is

- **Synth tracks** (T1 to T4), fourteen engines: **VA** (saw to pulse, supersaw, sync, sub, noise, through-zero FM), **CZ** (a full Casio CZ: two lines, the eight CZ waves, 8-step DCO, DCW and DCA envelopes, ring and noise modulation, vibrato and a Juno-60 style chorus), **FM** (4 operators, 12 algorithms, a wave per operator), **PHYS** (string, bowed, blown, membrane), **FORMANT** (vowel filter bank or FOF grains), **PARTICLE** (pulsar emitters that pull into sync), **CHIP** (SID-style waves arpeggiating through offsets, then a decompose stage that crushes and breaks the sound apart), **SQ** (after the Ensoniq SQ-80: three oscillators on 8-bit waves, sync and AM, a CEM-style filter and the DOC chip's grit), **WAVE** (after the PPG Wave and Waldorf Microwave: two wavetable oscillators, sync, ring and FM, phase warps, a looping wave envelope), **LOGIC** (oscillators built from function blocks: arithmetic, bit logic and comparators between three sources, then pitch-synchronous grains), **ORGAN** (a pipe organ played like a synthesizer: ranks by footage, pipes that speak in their own time, chiff, air and wind), **MONO** (an SH-101-style voice played like a horn: legato, scoops, delayed vibrato), **RESIN** (a bowed string or a reed, pushed toward breaking down: scrape, flageolet, growl, multiphonics and a QUAKE knob that makes the player's hand shake), **TINE** (struck and plucked bars and tines: a rusty kalimba with buzzing rings, a marimba or balafon, and an electric piano after the Rhodes).
- **Strike tracks** (T5, T6), with GRAIN, a small difference in every hit (as on perc tracks): an exciter (click, noise, metal, FM burst, dust, rain, bow, breath, or EXT: another track's sound) strikes a body (ping filters, modal bars, a struck disc or coupled strings), with a transient layer, ring mod and a pitch drop.
- **Perc tracks** (any track, KIND PERC): 33 drum machines after the Elektron Machinedrum's synthesis families: TRX (analog-style), EFM (FM), P-I (physical models) and GND, each with the Machinedrum's track effects.
- **Tape tracks** (T7, T8): the sampler, playing the shared 120 KB capture tape (filled by resampling Ravel itself): **MLR** playheads (four rows, jumps on the keys, rates from -2× to 4×), **KEYS** (a span across the keys, up to four voices), **STRETCH** (speed apart from pitch), **SHARDS** (the span in pieces, one at a time, in an order, with gaps), **slices**, or a **kit** of six lanes, each its own span. START and END can be moved by LFOs, so loops breathe.
- **Capture tape**: records the master, one track, the buses or the audio input. **Catch** keeps what is on it, **resample** records a bar (or 2 or 4) onto row 1 on the downbeat, erosion and "dirty" half-rate μ -law for more time.
- **Influence**: an 8 × 8 grid where any track can modulate, trigger, excite, ring, jump the tape of, clock, or spark (tap the body of) any other.
- **Articulation**: onset, continuant and termination stages with curve, overshoot, a loop, a tail and **Give** (a spring that lets the level lag and bounce), two destinations, its own FILTER ENV, and a library of 32 chainable step envelopes that steps start to move any parameter across the steps.

- **Sequencer:** each track runs in **STEPS** or **GRAPH** mode. Steps: length, rate and direction, parameter locks, microtiming, ratchets that bounce, climb, fall or darken as they roll, conditions, chance, microcuts of the mix with their own shape and size, and a EUCLID page that writes evenly spread hits into the steps. Graph (from Silt): cords set where a playhead goes next, two playheads walk the same graph, each playing notes, only the gate, or only the pitch (so rhythm and melody can take different paths), head 2 can play another track, and each head has a function generator (rise, fall, arch, decay, swell, or an LFO or dust) that moves its speed, times or plus the clock. Plus density arcs, a per-track note interval, scale quantizing, René-style clocking from LFOs or dust, and a two-oscillator master clock. Recording keeps what you play live, chords included (up to four notes on a step), and each kit lane can run at its own rate.
- **Modulation:** two LFOs, dust, an 8-slot matrix and 4 macros with 8 destinations each (curves and windows).
- **Buses:** a granular tape delay (echoes and a grain cloud from one half-rate tape; wow, flutter, saturation, age, double tracking, freeze), a space reverb (motion, diffusion, low cut; ROOM, a long Clouds-style plate, or 12-BIT, a gritty late-80s rack plate), a feedback bus (filter, comb, smear, shift, fold or crush, returning to the master or into a track), a filter pair (low, band or high pass each; series, parallel or feedback, with two LFOs), an 8-band vocoder (its body is dust, drops, noise, the tape or a track; attack, release, shift, width), BANDS (eight resonant bands, like a fixed filter bank), a BED of dust on a tuned wood-to-metal body that sinks under busy tracks and rises in the gaps, and master drive with microcuts (even, bouncing or dragging) and punch-in effects on the keys. Each bus page shows the current track's send into it. Every effect starts off: a new project sends nothing into any bus, and a bus with nothing coming in does not run at all.
- **Song:** patterns A and B per track, 16 scenes that switch or glide over 1-8 bars, a 32-row arrangement, mute and solo, tap tempo, 8 named project slots, and a sound bank of your own; projects and sounds move between the emulator and an FM-1 as a .ravel file.

New here? Open the emulator ([Opening it](#)), load a demo, press Play, then read [The five moves](#). Everything else is reference.

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On the FM-1: Installing · If the FM-1 will not start

Everything below works the same in the browser emulator and on the FM-1. The pictures are the real screen, taken from the simulator.

1. Opening it

In a browser. Open `ravel-emulator.html` . It is one file, works offline and needs no install. Click anywhere or press a key once to start the sound; browsers stay silent until you do. On a computer keyboard, Z X C V B N M play the lowest seven keys in order (F, F#, G, G#, A, A#, B), then A S D F G H J K L ; ' play the white keys from C up, with W E T Y U O P the black keys. [and] are OCT- and OCT+, 1-8 choose the track and the space bar is PLAY.

The emulator page has three parts:

- **The left panel (the workbench)** is a set of shortcuts:
- pick a demo and press **Load**;
- **Play** and **Record**;
- **T1-T8** pick a track;
- **Sound** chooses the track's kind, engine and a preset;
- **Page** **← Back / Forward →** steps through the section's pages (the same as turning SELECT, or the **← →** keys);
- **Go to** jumps straight to a section;
- **Catch** and **Resample** for the tape;
- **Audio in** plays a file into the input;
- **Output** has a level meter and the volume.
- **The FM-1 in the middle** is the instrument itself. Everything in this manual is done there.
- **The Controls guide and Eight tracks** below are short reminders and a level meter for each track. Click a track card to select it; **M** mutes it.

Using the emulator's controls:

To	Do this
Turn a knob or encoder	Drag it up or down, or scroll on it
Press a button	Click it
Hold a button (for the hold layers)	Right-click or shift-click it; it stays held (lit) until you click it again. Esc lets go of everything.
Play keys	Click or touch them, or use the computer keys A W S E D F T G Y H U J K O L P ; ' (A is middle C, the 5th white key)
Octave	[and]
Start or stop	Space
Pick track 1-8	Number keys 1-8
Turn SELECT (next or previous page)	← / → arrow keys
Stop everything at once	Panic / stop all , top right

The page has a safety limiter, so nothing can reach your speakers or interface at full scale.

Volume starts at 70.

Projects you save in the emulator are kept in your browser, so they are still there next time on the same computer and browser.

On the FM-1. Install it with the web installer (see [Installing on the FM-1](#)). Everything works the same as in the emulator, with these differences:

- **MASTER** is the output volume (the emulator's Volume slider).
- **No audio input.** The FM-1's USB carries Ravel's sound *to* a computer (it shows up as an audio input named "Ravel FM-1" you can record), but nothing comes in. So the FM-1 hides the input's controls: the tape has no INPUT source, and the ROWS page has no IN GAIN or INPUT knob. The EXT exciter still works there, from other tracks.
- **Saving pauses the sound for a moment**, because the code runs from the same flash the project is written to.
- **No Bluetooth.**

2. The panel



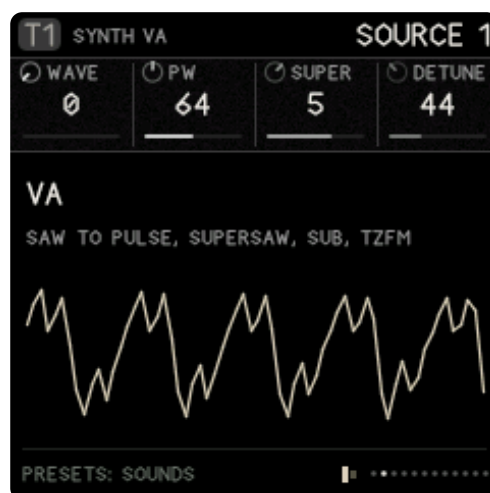
Control	What it does in Ravel
MASTER	Output volume
SELECT	Moves to the next page (turn right) or back to the previous one (turn left) in the section you are in
ALGORITHM	Picks the track you are working on, T1 to T8 . The keys play this track.
PRESETS	Browses the list that belongs to the page: sounds on most pages, patterns on SEQ, scenes on SONG, slots on SAVE (projects or sounds), rows on TAPE, steps on GRAPH, routes on INFLUENCE. The footer tells you which.
KNOB 1-4	Change the four values in the row at the top of the screen, left to right
OCT- / OCT+	Move the keyboard down or up an octave. On SEQ pages they move between step pages (1-16, 17-32, ...). On pages with more settings than knobs they move the knobs to the next row instead; those pages show the rows on screen, number the knobs, and the footer says what OCT brings next: a kit's LANE pages (machine parameters, then LEVEL, CHANCE, LENGTH), the CZ's DCO , DCW and DCA envelopes (two stages at a time, then SUS and END), and LFO SHAPE (LFO 1 or LFO 2).
10 section buttons	Each one opens a section (a group of pages). Tap it again for the section's next page.
PLAY	Starts and stops the sequencer
REC	Tap to arm recording on the current track; hold it for catch and resample
Keys	Play the current track, or act as steps, tape positions, scenes or switches depending on the page and on what you hold

The ten sections:

Button	Section	What lives there
HOME	Tracks	All eight tracks at a glance, and the influence grid
EDIT	Voice	The current track's sound: engine, source pages, pitch, filter, skin, insert, mix, sends
ENV	Articulation	How a note starts, holds and ends, the FILTER ENV, and the step envelopes (STEP ENV, LIBRARY)
LFO	Mod	Mod matrix, the two LFOs, dust, macros
FX	Buses	Delay, space, feedback, filter pair, vocoder, bands, master
SCL	Scale	Root, scale, transpose, interval
ARP	Tape	Capture, rows, and how a tape track plays the tape
SEQ	Steps	Steps, step timing and shape, track settings, direction, graph and playheads
GLO	Song	Mixers, scenes, arrangement, density arcs, clock
SAVE	Projects and sounds	Save, load, demos, new project; your own sound bank

Section or layer? A quick **tap** (less than about half a second) opens the section. **Holding** a button and using keys or knobs while it is down turns it into a *layer* instead: SEQ held makes the keys steps, LFO held puts the macros on the knobs, and so on. When you use a button as a layer, letting go of it does not change the page. See [Hold layers](#).

Reading the screen



- **Top bar:**
- **left:** the track (T1-T8, its badge coloured by kind: white synth, slate strike, verdigris tape, maroon perc), its kind and engine;
- **right:** the page title, and on the FM-1 the audio load (**CPU 43%** with a thin bar, held a moment at its peak; amber from 75%, red from 90%). The emulator doesn't measure it, so it doesn't show there.

- **Value row:** a strip divided into four cells, one for each physical knob, always KNOB 1, 2, 3 and 4 in that order. Each cell has a small dial, the name and the value, and a bar showing where it sits in its range; bipolar values have a centre mark. An empty cell keeps its dividers, so you can see which knobs do something on the page. A greyed name and value means that knob does nothing with the track set as it is.
- **Picture:** what the page does, drawn live (a waveform, a filter curve, the step grid, the graph, the tape). Tracks keep their kind's colour in the pictures (their meters, waves and steps); what belongs to no one track (the buses, the graph's two heads, the two WAVE tables) is drawn in white and greys with bone and verdigris.
- **Footer:**
- **left:** what the controls do *right now*. It changes when you hold a button, so read it whenever you are unsure.
- **right:** small dots, one per page in the section, with the current one lit.
- **Also shown:** a play indicator while running, and a red dot when recording is armed.

Short messages ("CAUGHT", "PATTERN B", "SAVED TO 3") flash on the screen when something happens.

3. The five moves (how every page works)

Every page in Ravel works the same way:

1. **Press a section button** to open the section.
2. **Turn SELECT** (or tap the same button again) to walk its pages. On FX, tapping FX again jumps to the next bus (DELAY, SPACE, FEEDBACK, FILTER PAIR, BANDS, VOCODER, MASTER); SELECT still goes page by page.
3. **Turn ALGORITHM** to choose which track you are editing.
4. **Turn KNOB 1-4** to change the four values shown.
5. **Turn PRESETS** to browse whatever the page holds.

Knobs speed up when you turn them quickly, so a fast turn crosses a whole range and a slow turn moves one step.

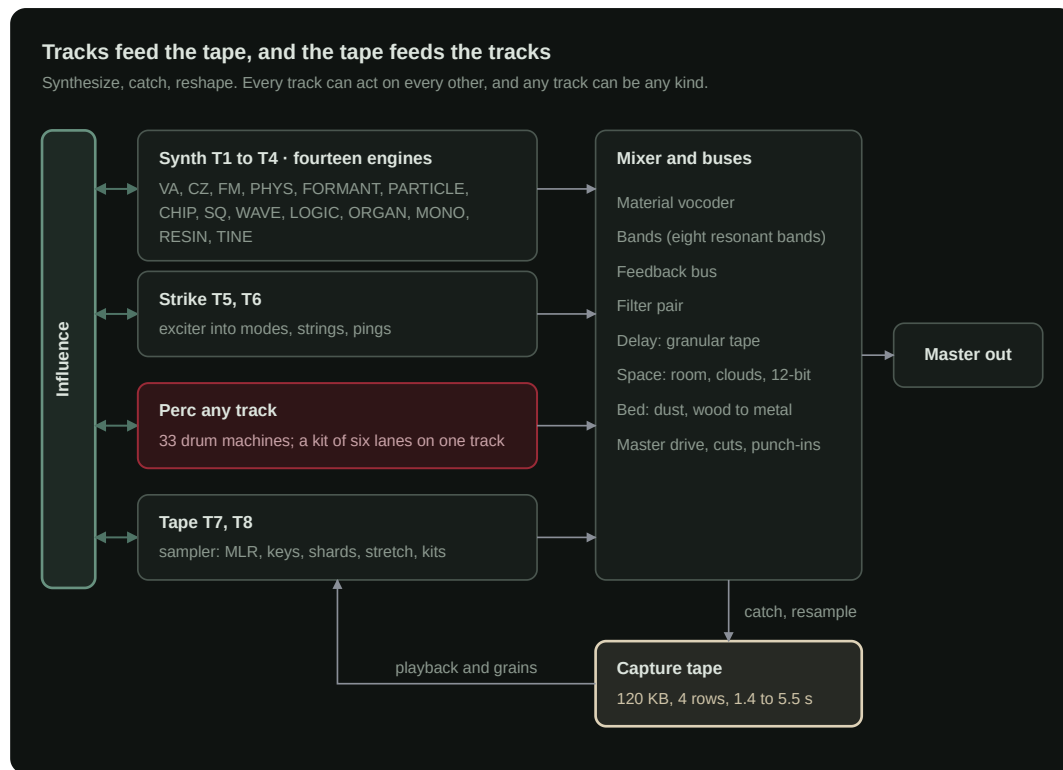
Pages appear and disappear. A section only shows the pages that apply to the current track:

- a VA synth has three SOURCE pages, FM has four;
- a tape track has no SOURCE pages but gets PLAYBACK, then MLR, SAMPLE, STRETCH, SHARDS or SLICES depending on its mode;
- the graph's HEAD pages only appear when the track is in GRAPH mode, and HEAD 2's pages only when head 2 is on.

So if a page seems to be "skipped", it is hidden because it does not apply to this track. Change the track or the setting and it comes back.

Greyed-out knobs. When a knob does nothing with the track set as it is, its name and value turn grey. For example, on a strike track with the PING body, DAMP, INHARM, GEOMETRY and MODES are grey, because a ping filter has none of those. The value is kept, so it is ready if you change the setup. So are ENGINE and VELO on strike and tape tracks (engines are for synth tracks; strike and tape take velocity as it comes), VOICES on a tape track (one playhead; a strike track offers MONO or 2), T DECAY until TRANS is up, RING F until RING is up, ORDER, RATE and SEED except with the DUST or RAIN exciter, and on PHYS, POSITN for BLOWN and MEMBRAN.

4. How the parts connect



Ravel has **8 tracks**. Each track is one of four kinds, and any track can be any kind (HOME › TRACKS › KIND):

Kind	What it is	Default tracks
SYNTH	An oscillator voice with fourteen engines: VA, CZ, FM, PHYS, FORMANT, PARTICLE, CHIP, SQ, WAVE, LOGIC, ORGAN, MONO, RESIN, TINE. Up to 4 voices.	T1-T4
STRIKE	An exciter hitting a resonant body: drums, metal, wood, rain on glass	T5-T6
TAPE	The sampler. It plays the shared capture tape: MLR playheads, across the keys (up to 4 voices), stretched, as shards, as slices, or as a kit of six lanes.	T7-T8
PERC	A drum machine: 33 machines after the Elektron Machinedrum (TRX, EFM, P-I, GND). It starts as a KIT, six machines in lanes sequenced together on one track; MODE SINGLE is one machine played by notes.	– (choose PERC on any track)

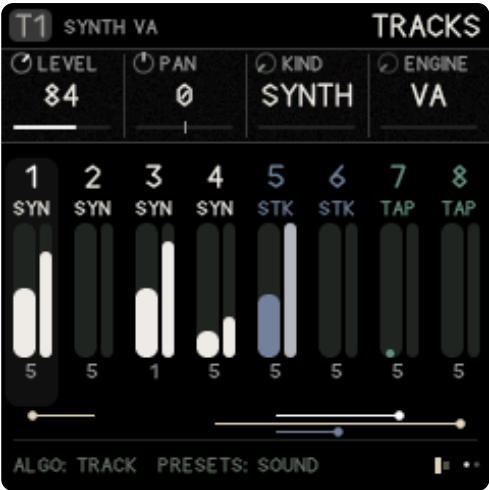
How the sound flows:

1. **Each track** makes sound. On synth, strike and perc tracks the sound goes: source → filter → skin (drive, fold, bits) → insert effect → articulation (the amplitude envelope) → level and pan.
2. **The mixer** adds the tracks together. Each track also **sends** some of its sound to the six **buses** (delay or grains, space, feedback, filter pair, vocoder, bands), and the buses return into the mix.
3. **The master** applies drive and microcuts, then a safety limiter, then goes to the output.

4. **The capture tape** is always listening. By default it hears the master, but it can hear one track, the buses or the audio input instead (ARP › CAPTURE › SOURCE). When you **catch** or **resample**, what it heard is kept, and the **tape tracks** play it back. That is the loop at the heart of Ravel: *synthesize → catch → rebuild*.
5. **Influence** connects tracks to each other. One track's notes or audio can trigger, modulate, excite, ring, clock or jump the tape of another (HOME › INFLUENCE).
6. **The sequencer** plays every track from its own pattern. The **modulation** (LFOs, dust, matrix, macros) moves parameters over time. **Scenes** and the **arrangement** switch patterns and states.

5. HOME: tracks and influence

TRACKS



The overview shows all eight tracks:

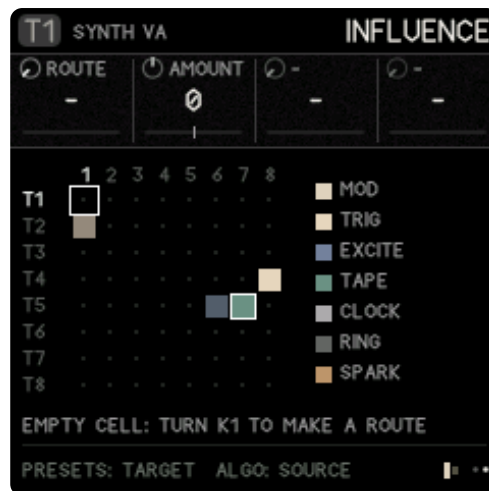
- each track's number and kind;
- a live level meter;
- how many voices it is using;
- along the bottom, the influence routes drawn as lines.

The current track is highlighted.

Knob	Value
1 LEVEL	Track volume, 0-127
2 PAN	-64 left to +63 right
3 KIND	SYNTH, STRIKE, TAPE or PERC. Changing it resets the track to that kind's defaults.
4 ENGINE	For synth tracks: VA, CZ, FM, PHYS, FORMANT, PARTICLE, CHIP, SQ, WAVE, LOGIC, ORGAN, MONO, RESIN, TINE

ALGORITHM picks the track; **PRESETS** loads a sound of the track's kind.

INFLUENCE



An 8×8 grid: rows are **sources**, columns are **targets**. Each filled cell is a route, coloured by type.

1. Turn **ALGORITHM** to the source track (its row is highlighted).
2. Turn **PRESETS** to the target column (the box moves along the row).
3. Turn **KNOB 1 (ROUTE)** to choose what the route does. An empty cell says "TURN K1 TO MAKE A ROUTE".
4. Set the other knobs. They change name to suit the route.

Route	What happens	KNOB 2	KNOB 3	KNOB 4
MOD	The source's envelope moves one of the target's parameters, every time the source plays	AMOUNT ($\pm$)	PARAM: which of the target's parameters	–
TRIG	Each note on the source also plays the target, with the same pitch	AMOUNT (below 0 plays the target softer)	DELAY: 0–16 steps later	CHANCE: 0–100 %
EXCITE	The source's audio feeds into the target's body or string (best into a strike or PHYS track)	AMOUNT	–	–
TAPE	Each source note jumps the target tape track's playhead	AMOUNT	JUMP TO: a position 0–15, or 16 = catch the tape	–
CLOCK	Each source note moves the target's sequencer one step (René-style: rhythm drives rhythm)	AMOUNT	–	–
RING	Ring modulates the target with the source's audio	AMOUNT	–	–
SPARK	Each source hit taps the target's body: a strike track rings at its last note, with no exciter and no attack of its own, and plays no note (so it starts no chain of its own). Only strike tracks can be sparked	AMOUNT: how hard the tap	–	–

To remove a route, turn KNOB 1 back to **–**.

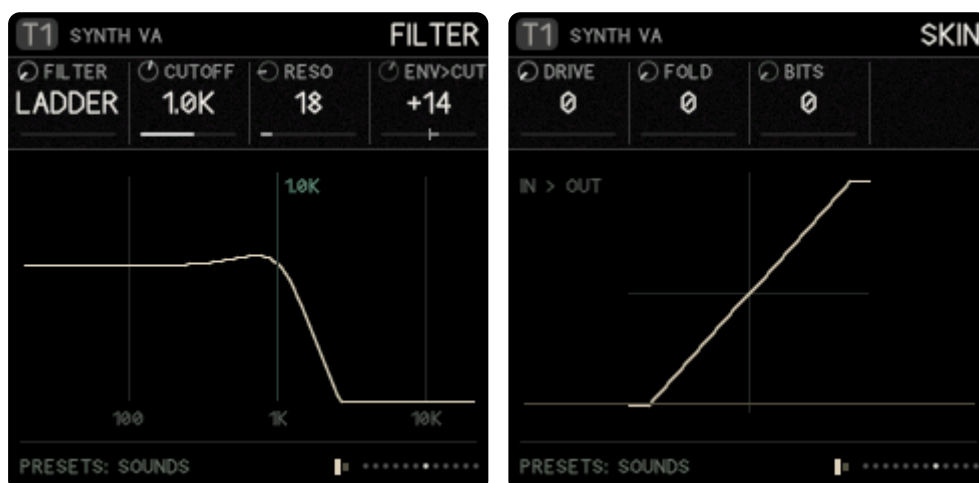
A trigger chain never plays the same track twice in one pass, so routes can form loops safely (T1 triggers T2, which triggers T1).

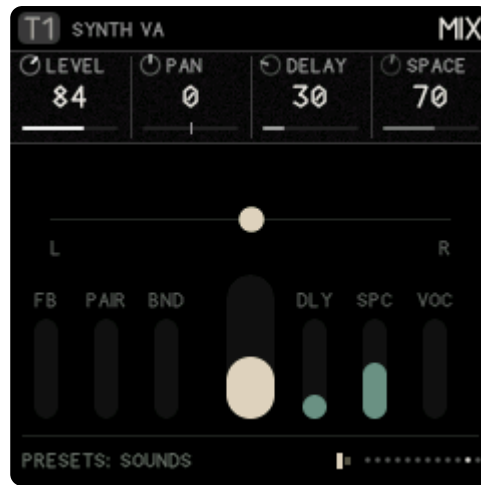
6. EDIT: the voice

All pages here act on the current track (ALGORITHM). **PRESETS** browses sounds for the track's kind on every voice page; the sound's name flashes on screen. A preset doesn't touch the track's sends into the effects (FX): they stay where you set them.

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4
SOUND	KIND	ENGINE	VOICES (mono, 2, 3, 4)	VELO: how much key velocity changes the level
SOURCE 1-4	the engine's own controls, see below			
OSC MIX	each oscillator's level, side by side: VA OSC LVL, SUB, NOISE · FM LEVEL1-4 · SQ LEVEL 1-3 · WAVE LEVEL 1, ASIC · CHIP OSC LVL, SUB · MONO SAW, PULSE, SUB, NOISE			

OSC MIX appears on engines with more than one sound source. **OSC LVL** (LEVEL1 on FM, LEVEL 1 on SQ and WAVE) is the first oscillator's own level, new here; the others are the engine's existing level knobs, shown together (they stay on the SOURCE pages too). The CZ's two lines are levelled by their DCA envelopes, ORGAN's by its rank footages. | **PITCH** | PITCH (± 24 semitones) | FINE (± 50 cents) | GLIDE | VCF KEY: the filter's cutoff (or a Z filter's morph) follows the note || **FILTER** | FILTER type: LADDER, LOWPASS, BANDPASS, HIGHPASS, LPG, MS-20, SH-101, SQ-80, and six Z filters (Z VOWEL, Z TALK, Z PHASER, Z PEAKS, Z SWEEP, Z METAL) five XT filters (XT LP24, XT BP24, XT NOTCH, XT S&H, XT SHAPE) and SEM | CUTOFF (Hz); on a Z filter, MORPH | RESO; on a Z filter, XFORM | ENV>CUT: how much the FILTER ENV opens the filter ($\pm$); the same setting as on ENV > FENV ROUTE, so turning either moves both || **SKIN** | DRIVE (saturation of everything the track plays at once: 0 by default, so chords stay clean; turn it up to make them break up together) | FOLD (wavefolding) | BITS (bit reduction) | - || **SKIN 2** | BITMASK (digital grit) | DEREZ (sample-rate reduction) | GRAIN (strike and perc tracks): each hit a little different, see below | - || **INSERT** | INSERT effect: OFF, COMB, SHIFT, CRUSH, SMEAR | TUNE: on COMB its note (C4 at the middle, a semitone a step); on SHIFT the shift | AMOUNT | MIX || **MIX** | LEVEL | PAN | DELAY send | SPACE send || **SENDS** | FEEDBK send | PAIR send (filter pair) | VOCODER send | BANDS send |





MS-20 is hot and dirty: a two-pole filter whose resonance runs through clipping diodes, with the input driven. Turned up, it barks, then screams. **SH-101** is round and liquid: four smooth stages whose resonance sings rather than bites, and keeps its bass as it rises. **SQ-80** is warm and a touch dark: four transistor-style stages (after the CEM3379 chip in the Ensoniq SQ-80) whose resonance whistles rather than screams, and thins the bass as it rises, as the SQ-80's does. All three are on synth tracks (all engines); try the 101 BASS and MS SCREAM presets, and any SQ preset. Picking the SQ engine sets the filter to SQ-80.

The Z filters morph, in the manner of E-mu's Z-plane filters (Morpheus, the Audity, the later samplers). Each is twelve poles: six sections, peaks, dips and slopes, laid out at the four corners of a square. CUTOFF becomes **MORPH**, which moves across the square one way, and RESO becomes **XFORM**, which moves it the other. In between, every peak glides at once, so the whole shape turns into the next one rather than a single cutoff moving. The filter envelope (ENV), VCF KEY, the LFOs and the matrix move MORPH like any cutoff. The FILTER picture draws the real response as it morphs. The shapes are Ravel's own:

Type	MORPH (0 to 127)	XFORM (0 to 127)
Z VOWEL	"ah" to "ee"	a lower, softer voice to a higher, sharper one
Z TALK	"oo" to "ae": a talk box, best moved by the envelope	to "aw" and "er": tighter, more nasal
Z PHASER	six notches sweeping up from low to high	from plain notches to notch-and-peak pairs: a phaser with its feedback up
Z PEAKS	six resonant peaks rising together	from broad and glassy to narrow and ringing
Z SWEEP	closed (a steep twelve-pole lowpass) to open	from smooth to a resonant peak riding the slope
Z METAL	one set of clangorous, inharmonic peaks to another	from struck to long and ringing

Try the TALK BOX, PHASE PAD, Z VOX and Z SWEEP presets. The Z filters are on synth tracks, on any engine.

SEM is after the Oberheim SEM: a single 12 dB state-variable filter, open and creamy rather than fat, whose resonance rises to a vocal peak but never quite self-oscillates. Choosing it

adds a **SEM** page after **FILTER**: **LP-HP** sweeps continuously from low pass (0) through a notch (64) to high pass (127), and the matrix and LFOs can move it; **BP** switches to its band pass, which grows louder as **RESO** rises (LP-HP is then greyed); **CUTOFF** and **RESO** are repeated there. Try the SEM BRASS and SEM NOTCH presets.

The XT filters are digital filters in the manner of the Waldorf Microwave II/XT's: **XT LP24** is a clean four-pole lowpass whose resonance rings sharp and glassy, **XT BP24** a four-pole bandpass, **XT NOTCH** cuts a hole at **CUTOFF** (**RESO** widens and deepens it), **XT S&H** samples and holds the sound at a rate **CUTOFF** sets (a sample-rate reducer that follows the keys with **VCF KEY**; **RESO** keeps more of the raw steps) and **XT SHAPE** is a wave shaper, **CUTOFF** driving it and **RESO** folding it further. They suit the **WAVE** engine but work on every synth engine.

The filter belongs to synth voices. On strike and tape tracks the **FILTER** page's knobs are greyed out.

LPG is a low-pass gate: the filter closes as the note fades, so sounds get darker as they die away (good for plucks and Buchla-style bongos).

Changing **ENGINE** resets the **SOURCE** values to that engine's defaults. Use **PRESETS** to start from a finished sound instead.

GRAIN (**EDIT** > **SKIN 2**, on strike and perc tracks) makes each hit slightly different from the last: a little sharper or flatter (up to half a semitone), a little louder or softer, now and then darker or shorter. Most hits move a little and a few a lot, the way a hand never strikes twice the same. It changes nothing about which steps play or when: it is texture, so sixteen hats sound like sixteen hits instead of one copied. On a kit it acts on every lane.

The fourteen synth engines (**SOURCE** pages)

VA (virtual analog): the familiar subtractive oscillator, and more.

SOURCE 1	SOURCE 2	SOURCE 3
WAVE: saw through to pulse	SUB: sub-oscillator level	SYNC: hard-sync sweep
PW: pulse width	NOISE level	DRIFT: slow analog wander
SUPER: 1-7 stacked oscillators (supersaw)	TZFM: through-zero FM depth	
DETUNE: spread of the stack	FMRATIO: modulator ratio (1/2 to 7)	

CZ: a full Casio CZ (the CZ-101, 1000, 3000, 5000 and CZ-1 all share this voice). It works as the CZ's own sound chip does: a cosine read through a bent phase, where **DCW** is how bent it is (at 0 every wave is a sine). Each note plays one or two **lines**, and each line has two waves and three 8-step envelopes: **DCO** (pitch), **DCW** (waveform) and **DCA** (level). Ravel's filter, skin, inserts, LFOs and matrix all still work on top.

General settings, on the **SOURCE** pages:

SOURCE 1	SOURCE 2 (detune: line 2)	SOURCE 3 (vibrato)	SOURCE 4
LINE: 1, 2, 1+1' (line 1 twice, the second detuned), 1+2' (both lines, line 2 detuned)	DETUNE: + or -	VIB WAV: TRI, SQUARE, UP, DOWN	DCW + -: shifts both lines' DCW; give it an LFO in the matrix to sweep the timbre (the CZ itself could not)
OCTAVE: -1, 0, +1	DT OCT: 0-3 octaves	DELAY before it starts (0-99)	FOAM: takes the fundamental out, leaves the sidebands
MOD: OFF, RING (line 2 times line 1), NOISE (line 2's pitch kicked by noise)	DT NOTE: 0-11 semitones	RATE (0-99)	VEL DCW: how much a softer touch closes DCW (0-9, CZ-1 style)
CHORUS: OFF, I, II, I+II (Juno-60 style)	DT FINE: 0-60 (60 = a semitone)	DEPTH (0-99; 0 = none)	-

Then, per line (LINE 1, LINE 2):

KNOB 1	KNOB 2	KNOB 3	KNOB 4
WAVE 1: SAW, SQUARE, PULSE, DBL SIN, SAW PLS, RESO 1 (saw window), RESO 2 (triangle), RESO 3 (trapezoid)	WAVE 2: OFF, or a second wave	DCA KF: the level envelope runs faster on higher notes (0-9)	DCW KF: higher notes are duller (0-9)

And the envelopes, DCO 1, DCW 1, DCA 1 (and DCO 2, DCW 2, DCA 2):

Each envelope page holds all eight stages. **OCT+ and OCT-** move the four knobs through five rows; the picture lights the two stages on the knobs and marks them with the knob numbers (1, 2, 3, 4), and the footer says what OCT+ brings next. PRESETS still picks a sound.

OCT row	KNOB 1	KNOB 2	KNOB 3	KNOB 4
1 (stages 1-2)	RATE 1: how fast stage 1 moves (0-99)	LEVEL 1: the level it moves to (0-99)	RATE 2	LEVEL 2
2 (stages 3-4)	RATE 3	LEVEL 3	RATE 4	LEVEL 4
3 (stages 5-6)	RATE 5	LEVEL 5	RATE 6	LEVEL 6
4 (stages 7-8)	RATE 7	LEVEL 7	RATE 8	LEVEL 8
5	SUS: the stage the envelope holds while the key is down (OFF, 1-8)	END: its last stage (1-8)	-	-

Stages after END are drawn dim: they keep their settings but don't play until END reaches them (set END to 8 to use all eight).

- **How an envelope runs:** from step 1, each step moves at its RATE to its LEVEL, then the next step starts. At the SUS step it waits while the key is held; when you let go it goes on from the step after SUS. It stops at END. Rates and levels follow the CZ's own curves: rate 99 is a few milliseconds, rate 0 almost forever; DCA levels are on the CZ's logarithmic scale.
- **DCO levels:** up to 63 the pitch rises in 6.25-cent steps (63 is almost 4 semitones); from 64 it jumps in 2-semitone steps (64 is 8 semitones, 99 is 78). The DCO envelope can only raise the pitch, as on the CZ.
- **Two waves on a line** alternate cycle by cycle, so the note sounds an octave lower with a mix of both characters (the CZ's "cascade"). Two RESO waves cannot be combined, as on the CZ.
- **RESO waves** are a sine whose frequency rises with DCW, restarting every cycle under a falling window: like sweeping a resonant filter, with no filter.
- **High notes** narrow DCW automatically, as the CZ does, so thin pulses stay audible.
- **The DCA is the level envelope.** On a CZ track the ARTICULATION pages' shape knobs are greyed out; the envelope's DESTINATIONS and the influence routes follow the DCA instead; the filter has its own FILTER ENV.
- **The pictures:** LINE pages draw the line's two cycles at its brightest DCW. Envelope pages draw the 8 stages, the SUS and END points, the two stages on the knobs (white, numbered with their knobs) and where the playing note is (amber dots).
- **Presets:** CZ BRASS, CZ BELL (ring-modulated lines a twelfth apart), CZ STRINGS, RESO SWEEP, CZ BASS, NOISE HIT and FOAM.
- **Projects from before the CZ** load with each CZ track set to a plain CZ tone.

FM: 4 operators.

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
ALGO: 12 routings (shown as 1>2>3>4 and so on; > means "modulates", + means "mixed")	RATIO3	LEVEL4	WAVE4
FEEDBK: operator 1 feedback	RATIO4	WAVE1	MOD DEC: how fast the modulators fade (the classic FM "pluck")
RATIO1	LEVEL2	WAVE2	TZFM: through-zero FM
RATIO2	LEVEL3	WAVE3	VEL MOD: velocity brightens the sound

Each operator can be SINE, TRI, SAW, SQUARE, HALF, ABS, QUART or BITS.

PHYS (physical modelling): a virtual instrument that you strike, bow or blow.

SOURCE 1	SOURCE 2
MODEL: STRING (plucked), BOWED, BLOWN, MEMBRAN (drum skin)	EXCITE: how hard it is played: pluck strength, bow speed, breath
BRIGHT: brightness of the excitation	INHARM: detunes the overtones (metallic); on BOWED, lighter bow pressure (scratchier, airier)
DAMP: how quickly highs die	BODY: resonance of the body (not MEMBRAN)
POSITN: where it is plucked or bowed (STRING, BOWED)	DECAY

BOWED and BLOWN keep sounding for as long as the key is held, like a violin or a clarinet. BLOWN speaks an octave lower in character (a clarinet's hollow, odd-harmonic tone) but plays the note you press.

FORMANT: vowels and voices.

SOURCE 1	SOURCE 2
VOWEL: sweeps A-E-I-O-U	BREATH: air in the voice
SHIFT: moves the formants (smaller or bigger "throat")	GLOTTAL: the shape of the pulse
WIDTH of the formants	SPREAD: stereo or choir spread
MODE: FILTER (a filter bank on a pulse) or FOF (grain-based, more vocal)	VIBRATO

PARTICLE: pulsars. Short bursts of a waveform at the note's pitch that can pull each other into sync.

SOURCE 1	SOURCE 2
TABLE: SINE, GLASS, REED, VOICE, BELL, BITS, NOISE, DROP	COUPLE: how strongly the emitters pull into sync
DUTY: burst length (short = buzzy, long = tonal)	MASK: drop bursts at random
EMIT: 1-3 emitters	FORMANT: the burst's own pitch
RATIO between emitters	SCATTER: timing randomness

CHIP: a glitchy chiptune voice, after the Syntakt's SY CHIP. A SID-style oscillator steps through the note you play and up to three offsets at RATE, so one voice plays a fast arpeggio, a chord or a "complex voice". A square sub oscillator sits under it, and a decompose stage after it reduces, crushes and breaks the sound apart.

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4 (decompose)
WAVE: TRI, SAW, PULSE, NOISE (the SID's noise register), SAW&PUL (the SID's combined wave), RING (a ring-modulated triangle), PWM (the width sweeps by itself), KICK and SNARE (drum tables)	OF2: the arp's second note, in semitones	SUB: a square sub oscillator on the note you play (it does not follow the arp)	SRR: sample-rate reduction (aliasing, grit)
PW: pulse width (on RING, the ring partner's ratio; on PWM, how far it sweeps)	OF3: the third note	SUB OCT: the sub's octave, -3 to +1	CRUSH: bits, 16 (clean) down to 1
RATE: how fast the arp steps, 2-128 steps a second (classic chip arps are around 50)	OF4: the fourth note	SYNC: the main oscillator restarts with the sub (hard sync), so as the arp moves the notes, the timbre sweeps	DECOMP: how often the sound breaks
MODE: UP, DOWN, PINGPONG, RANDOM, ONCE (up through the notes, then stays)	STEPS: how many of the root, OF2, OF3 and OF4 the arp walks (1 = no arp)	OVER: overdrive	FRAG: the size of each piece, 1.5-46 ms

- **The arp:** for a minor chord, set OF2 +3, OF3 +7, OF4 +12 and STEPS 4. Multiples of 12 jump octaves. RATE, MODE and the offsets grey out while STEPS is 1.
- **Sync:** with SYNC on and SUB OCT at -1, the sub holds the root while the arp's notes become synced, tearing timbres over it (the SYNC ARP preset). SUB OCT greys out while SUB is 0 and SYNC is off.
- **Decompose:** the voice keeps its last 46 ms. At the end of each fragment, DECOMP is the chance that the next one breaks: the last fragment repeats, plays backwards, drops out, has its bits flipped, or plays at double speed. FRAG greys out while DECOMP is 0.
- **Presets:** CHIP ARP, SID BASS (through the MS-20 filter), CHIP KICK, CHIP SNARE, DECOMPOSED and SYNC ARP.

SQ: after the Ensoniq SQ-80. Three oscillators play 8-bit single-cycle waves, osc 1 can hard-sync and amplitude-modulate osc 2, a second envelope moves the filter, the pitch and an attack layer, a delayed vibrato fades in, and GRIT dials in what made the SQ-80 sound the way it does: its DOC sound chip reading 8-bit waves without smoothing, at its own sample rate, into a coarse converter. The SQ-80's many parameters are folded into these sixteen. The waves are Ravel's own, built from harmonic recipes in the SQ's families; none come from Ensoniq's ROM.

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
WAVE 1: the main oscillator's wave	SEMI 3: osc 3's interval, ± 24 semitones	MOD: OFF, SYNC (osc 2 restarts with osc 1), AM (osc 1's level opens and closes osc 2), SYNC+AM	TRANS: osc 3 lifted by ENV 2's decay, for a struck, plucked or breathy onset
WAVE 2	DETUNE: osc 2 up and osc 3 down, up to a quarter tone	E2 DEC: ENV 2's decay, 4 ms to about 6 s	VIBRATO: depth (fades in over half a second, like the SQ's delayed LFO)
WAVE 3	LEVEL 2: osc 2's level	E2 SUS: where ENV 2 settles while the note is held	VIB RATE: 0.5 to 11 Hz
SEMI 2: osc 2's interval, ± 24 semitones	LEVEL 3: osc 3's level	P ENV: pitch from ENV 2's decay, ± 24 semitones	GRIT: 0 clean; to 64 the waves alias and lose their smoothing; to 127 the samples are held and the converter coarsens

- **The waves:** SAW, SQUARE, PULSE, SINE, TRI, BELL, BASS, PIANO, EPIANO, VOICE1 (an "ah"), VOICE2 (an "oh"), ORGAN, REED, SYNTH1, SYNTH2, FORMT1 to FORMT3 (formant peaks, low to high), OCTAVE, DIGIT (bit logic, harsh), GLINT and SPIKE.
- **The envelopes:** the track's ADSR on the ENV page is the SQ's ENV 4, the level. ENV 2 is the filter's: FILTER's ENV amount follows it, not the level. Its decay alone drives P ENV and TRANS, so they fall away even while ENV 2 holds at E2 SUS.
- **More movement:** the LFO page's LFOs and the matrix reach every SOURCE knob, so wave levels, GRIT and the intervals can all be modulated, as the SQ-80's own modulators could.
- **Greyed knobs:** WAVE 2 and SEMI 2 grey out while LEVEL 2 is 0 and MOD is off; WAVE 3 and SEMI 3 while LEVEL 3 and TRANS are 0; VIB RATE while VIBRATO is 0.
- **Presets:** SQ PIANO, SQ VOX, SQ BELLS, SQ BASS, SQ SYNC, SQ PAD and SQ ORGAN.

WAVE: a wavetable synth after the PPG Wave and the Waldorf Microwave. Two oscillators each read a wavetable: 8 key waves, with POS moving through 64 positions between them. Osc 1 can sync, ring-modulate or frequency-modulate osc 2, both read through a phase warp (after Serum's), and a mixer adds a sweet saturation as you push it. The wave envelope sweeps the positions in a loop, as the Microwave's does. ASIC dials in the hardware: from smooth to the PPG's stepping to the early Microwave's sizzle. The 20 tables are Ravel's own, built in the families the PPG made famous; none come from a PPG or Waldorf ROM.

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
TABLE 1: osc 1's wavetable	SEMI 2: osc 2's interval, ± 24 semitones	XMOD: OFF, SYNC (osc 2 restarts with osc 1), RING, FM (osc 1 bends osc 2's phase), SYNC+FM	WAVE ENV: OFF, or one of 32 shapes (PLUCK, SWELL, STAIRS and the rest) that sweeps both positions
POS 1: where in the table (0-63)	DETUNE: osc 2 a little sharp	XM AMT: how much	WE AMT: how far it sweeps (± 63 positions)
TABLE 2: osc 2's wavetable	MIX: osc 1 to osc 2 (0 = osc 1 alone)	WARP: OFF, SYNC, BEND, PWM, MIRROR, REMAP 2, REMAP 4, SQUEEZE, FLIP, QUANT	WE TIME: one pass of the wave envelope
POS 2	SAT: the mixer's saturation	WARP AMT	VELO: velocity sensitivity (on WAVE it lives here; its place on SOUND holds MIX)

- **The tables:** PPG SWEEP (sine to saw, harmonic by harmonic), RESONANT (a resonant peak climbing), PULSE (wide to thin), SYNC (a synced sweep), VOICES (vowels), ORGAN (drawbar settings), BELLS, FORMANT, DIGITAL (bit patterns), SQR TO SAW, PARTIALS (one harmonic walking up), OCTAVES, FM (an index sweep), BRASS, STRINGS, PPG HARD, RANDOM, CHOIR, E-PIANO and WAVEFOLD.
- **The warps:** SYNC squeezes several cycles into one; BEND leans the wave left or right; PWM squeezes its first half; MIRROR plays it forward then back; REMAP 2 and 4 blend in the wave read two or four times a cycle; SQUEEZE pinches it toward the middle; FLIP turns the end of the cycle upside down; QUANT steps the phase (bit-crushed reading).
- **The wave envelope** loops while the key is held, then finishes its pass. Pair it with a slow WE TIME for evolving pads, or a fast one with STUTTER or STAIRS UP for rhythmic wave sequences. POS 1 and POS 2 are modulation destinations too: an LFO on POS is the classic PPG sweep.
- **Greyed knobs:** osc 2 is only heard through MIX (or RING, which multiplies it into osc 1), so osc 2's knobs grey out while MIX is 0 and XMOD isn't RING, and so does XM AMT for SYNC and FM, which change osc 2: turn MIX up to hear them. XM AMT also greys while XMOD is off; WARP AMT while WARP is off; WE AMT and WE TIME while WAVE ENV is off.
- **Where MIX, VELO and ASIC sit:** on a WAVE track, SOUND's fourth knob is **MIX** (so bringing in table 2 is one turn from the first page), VELO moves to SOURCE 4's fourth knob, and **ASIC** sits on OSC MIX beside LEVEL 1: 0 smooth; 1-63 the positions step through 64 whole waves (the PPG's zipper); 64-127 raw, unsmoothed reading, a truncated phase and a coarser output (sizzle). MIX also stays on SOURCE 2.
- **The picture:** table 1's waves stacked back to front, the one playing lit in POS 1's knob colour. With MIX up, table 2 is drawn below it the same way, lit in POS 2's colour, each stack half as deep.
- **Presets:** PPG PAD, WAVE BELLS, MW SYNC, DIGI BASS, VOX SWEEP and REMAP STEP.

LOGIC: oscillators built out of function blocks, after Kurzweil's VAST, whose FUNs compute a function of two signals, and E-mu's patch-cord functions. Three simple sources play: **A** on the note, **B** and **C** at musical ratios of it. **OP 1** combines A and B, then **OP 2** combines that with C. The functions range from arithmetic to bit logic, so the result can be anything from a soft sum to a broken digital pattern that repeats at the sources' common period. A pitch-

synchronous grain stage can then turn it into a granular wave: every cycle it plays a grain of the voice's own last few milliseconds.

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
A WAVE: SAW, TRI, SQUARE, SINE, PULSE, NOISE	C WAVE	BITS: the word size the bit operators and QUANT work in, 1–12 (fewer is cruder)	SMOOTH: rounds off the hard edges (the engine also runs at twice the rate to keep them cleaner)
B RATIO: 1/4 to 16 times A	OP 1: how A and B combine	PW: the width of any PULSE source	GRAIN: 0 off; short grains leave gaps (pulsar-like), long ones overlap into a cloud
B WAVE	OP 2: how OP 1's result and C combine	B DRIFT: B up to 30 cents off its ratio, so the pattern slowly turns	G SPRAY: how far back, at random, each grain starts
C RATIO	OP 2 AMT: how much of OP 2 (0 = OP 1 alone)	DRY A: mixes A itself back in	G PITCH: the grains' content transposed, ± 24 semitones (the period stays on the note)

- **The functions:** A+B (a sum), A*B (ring modulation), MIN and MAX (the lower or higher of the two), AND, OR, XOR and NAND (the two as BITS-bit numbers, combined bit by bit), A>B (a comparator: high where A is above B, so two slightly detuned sources make a pulse whose width sweeps), GATE (A only while B is high), DIFF (how far apart they are), QUANT (A in steps that B sets), MOD (A wrapped around a size B sets), SIN(A+B) (a sine of the sum: phase modulation) and A(B) (A's wave read at the position B gives: waveshaping).
- **Where to start:** XOR or NAND between a SAW and a TRI at a ratio of 3/2 or 2, then fewer BITS for a cruder pattern. A>B between a SINE and a TRI at ratio 1 with a little B DRIFT gives a slowly breathing pulse. Ratios that aren't whole numbers make the pattern repeat at a lower common period, so the pitch can drop: 3/2 sounds an octave down, for example.
- **Greyed knobs:** C, OP 2 and C RATIO grey out while OP 2 AMT is 0; BITS while no bit operator or QUANT is in use; PW while no source is PULSE; G SPRAY and G PITCH while GRAIN is 0.
- **Presets:** LOGIC XOR, COMPARATOR, GRAIN VOX and BIT CRUNCH.

ORGAN: a pipe organ played like a synthesizer, after the euphoric, breathing organ records of Maxime Denuc (Nachthorn, made on a computer-controlled church organ). Seven ranks of pipes, one per footage, sound together over one stop family, and each pipe behaves like a pipe: it speaks a moment after the key, comes in slightly flat and with a puff of air (the chiff), and the wind that feeds it is never quite steady. The pipe spectra are Ravel's own, from harmonic recipes; there are no samples. The church is the SPACE bus: set its MODE to CLOUDS and turn DECAY up for the long, stone-room tail, and give the track plenty of SPACE send (the ORGAN presets do).

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
STOP: FLUTE (stopped, nearly pure), NACHTHORN (a wide open flute, hollow and soft), PRINCIPAL (the bright, even organ tone), GAMBA (a string stop), TRUMPET (a reed)	2 2/3': the twelfth (a fifth over the 4')	CHIFF: the puff of air as each pipe starts	WIND: the air supply wavers, pitch and level, and pipes sit a few cents apart
16': an octave down	2': two octaves up	SPEECH: how long a pipe takes to speak, 10 to 150 ms	TREMLNT: the tremulant, a throb in level and pitch
8': the pitch you play	1 3/5': the tierce (two octaves and a third up)	SPREAD: how far apart the ranks start, up to 35 ms	TREM RT: its speed, 3 to 9 Hz
4': an octave up	1': three octaves up	AIR: a breath under the tone	CELESTE: a second 8' rank tuned sharp, so it beats (a voix céleste)

- **Registration:** the seven footage knobs are the drawstops: pull out 8' and 4' for a clear voice, add 2 2/3' and 2' for a bright, singing mixture, 16' for weight. Ranks too high for a note fall silent, as real pipes run out.
- **Playing it:** organs don't respond to how hard you play, so VELO starts at 0. The track's ENV is the swell around it all: leave ATTACK short and let SPEECH do the onset; RELEASE about 100 ms is a pipe letting go. The sequencer's interlocking patterns (two playheads in GRAPH mode, INTERVAL, scenes changing registration via the macros) do what the record's pattern-based organ playing does.
- **Presets:** INFINITE, PLENUM, VOX CELESTE, FLUTE 4' and TROMPETTE.

MONO: a monosynth after the Roland SH-101, played like a wind or bowed instrument, after the way Dorian Concept phrases it. One oscillator, as on the 101: saw, pulse and sub all come from the same source, so nothing detunes or thickens. Choosing MONO sets the track up as the 101 does it: one voice, the SH-101 filter, key tracking full, cutoff about 1.1 kHz, resonance about 12%, the envelope opening the filter by about half, and a bowed-or-plucked envelope (22 ms attack, 260 ms decay, sustain about half, 120 ms release).

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
SAW: its level	NOISE	SCOOP T: how quickly the scoop arrives	VEL>CUT: a harder note opens the filter further
PULSE	PW: the pulse's width	VIBRATO: depth, up to 50 cents	DRIFT: the pitch breathes a few cents
SUB: the sub oscillator's level	PWM: the vibrato's LFO moves the width	VIB RATE: 1 to 9 Hz	RETRIG: LEGATO (overlapping notes slur: the envelope carries on and GLIDE slides) or ALWAYS (every note starts again)
SUB OCT: -1 OCT, -2 OCT, -2 PULSE (a quarter-width pulse, as on the 101)	SCOOP: a detached note starts below and bends up into pitch, up to 3 semitones	VIB DLY: the vibrato fades in after this long, up to 1.5 s	DRIVE: pushes the oscillator into the filter

- **Playing it:** overlap notes for slurred phrases (the envelope doesn't restart and GLIDE carries the pitch), lift between notes to articulate them (each starts again, with its scoop). A little vibrato that waits before it starts, and VELO with VEL>CUT, make held notes feel blown or bowed. For layered parts, record one mono line, then another on a second MONO track, as Dorian Concept builds his from many single passes.
- **Presets:** ORGANIC SAW (the settings above with a hint of vibrato), WOODWIND, CELLO LINE, RUBBER BASS and SCOOP LEAD.

RESIN: a bowed string or a reed, built to be played hard. Where PHYS models a well-behaved instrument, RESIN is about the edges: the bow pressed until it scrapes, a harmonic touched lightly, a reed overblown into a growl or a split multiphonic. Each note is one player, with vibrato built in, and the **QUAKE** knob shakes the player's hand: the pressure and pitch waver more and more, and at the top the note squeals and breaks. MODEL chooses **BOW** (a bowed string: the bow sticks and slips on the string, and a wooden body rings with it) or **HORN** (a reed on a bore: the breath pushes the reed, which opens and closes the tube). Changing MODEL sets the other knobs to that model's defaults; their names change with it.

	SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
BOW	MODEL	SCRAPE: noise and grit as the bow slips, more with pressure	VIB RT: vibrato rate, 3 to 9 Hz	QUAKE: the hand shakes; pressure and pitch waver, then squeal
	PRESS: bow pressure; past about three quarters, the tone breaks into a raw crunch	HARMON: touch the string lightly at its middle, for the flageolet an octave up	VIB DP: vibrato depth, up to 60 cents	BOW ATK: how quickly the bow gets moving
	SPEED: bow speed, the loudness and brightness	BODY: how much the wooden body rings	ONSET: how long the vibrato takes to arrive, up to 2.5 s	ROSIN: grip; more rosin bites harder
	POSITN: where the bow meets the string, from the bridge (glassy) to over the fingerboard (soft)	SIZE: violin to cello to bass, the body's resonances	DRIFT: the pitch wanders a few cents	HISS: the bow hair's noise
HORN	MODEL	GROWL: singing into the horn; the breath beats at half the pitch	(as BOW)	QUAKE
	PRESS: breath pressure; more overblows	MULTI: a second reflection in the bore, which splits the note into a multiphonic		ATTACK: how quickly the breath arrives
	REED: the reed's stiffness, soft and buzzy to hard and pure	THROAT: the player's throat, a resonance from 250 Hz to 2 kHz		KEYS: the click of the keys at each note
	BORE: where along the bore the reed sits, which colours the tone	SIZE: the bore, small and bright to large and dark		AIR: breath noise

- **Playing it:** the filter is open by default; shape the note with the volume envelope (a slow attack and long release for a bowed line) and VELO. Use one voice and GLIDE for a single player sliding between notes. QUAKE is the performance knob: put it on an LFO, the matrix or a step envelope (STEP ENV) for a hand that gives out on certain steps.
- **Presets:** WRAITH (a low cello, pressed hard, with wide slow vibrato and drift), UPSTAIRS (a frantic, scraping violin line, one voice gliding), RESIN VIOLIN (a cleaner violin), FOGHORN (a low, overblown reed) and THROAT SAX (a growling, sung-into reed).

TINE: things that are struck or plucked and then ring: metal tines and wooden bars. Each note is a handful of resonant modes (the bar's or tine's own overtones, which are not the harmonics of a string) set ringing by a short strike; a harder PLUCK, Mallet or HAMMER is a shorter strike, which reaches the higher modes. Choosing TINE opens the track up for it: four voices, the filter open, the envelope held at full sustain so the instrument decays by itself, and velocity at 100. MODEL chooses **KALIMBA**, **MARIMBA** or **EPIANO**; changing it sets the other knobs to that model's defaults, and their names change with it.

	SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
KALIMBA	MODEL	RUST: old iron tines, out of true: stray partials that die fast, grit in the pluck, a slow beat between the tine's two swings	BOX: the wooden box's resonance	DETUNE: each note a little off, as hand-tuned tines are, up to 40 cents
	PLUCK: how sharply the thumb lets go	BUZZ: the metal rings (or bottle caps) on the tines, rattling	HOLE: the sound hole, covered (lower, darker) to open	BEND: a hard pluck starts sharp and settles
	DECAY: how long the tines ring	RATTLE: how readily the rings rattle; low, only on hard plucks	WAH: a hand opening and closing the hole, 1 to 8 Hz (0 off)	DAMP: how fast a released note stops (0 lets it ring)
	TONE: how long the high partials last	THICK: thick tines, fuller and lower in their overtones	THUMB: the thumbnail's click	DRIFT: the pitch wanders a few cents
MARIMBA	MODEL	POSITN: where the mallet lands, from the centre (pure) toward the end (more overtones)	ROLL: held notes are rolled, struck again and again (0 off)	DETUNE
	MALLET: soft yarn to hard	TUBE: the resonator tube under each bar, which carries the fundamental	ROLL RT: 5 to 24 strokes a second	HUMAN: an uneven roll
	DECAY	WOOD: the bar's wood, darker to brighter	BUZZ: a balafon's gourds, their membranes buzzing	DAMP
	TONE	STICK: the mallet's click	RATTLE: how readily the gourds buzz	DRIFT
EPIANO	MODEL	BELL: the tine's bright, quick high partial	TREM: tremolo depth (0 off)	DETUNE
	HAMMER: felt soft to hard	BARK: how hard a hard note drives the pickup, for the growl	TREM RT: 1.5 to 9 Hz	KEY OFF: the dampers' noise as a key is let go
	DECAY	PICKUP: how far off centre the tine swings past its pickup: more of the second harmonic	DRIVE: the amp breaking up	DAMP: how fast the dampers stop a released note
	TONE	TONEBAR: the tonebar's sustain and its slow beat with the tine	THUMP: the hammer's low thud	DRIFT

- **Playing it:** TINE answers velocity: harder notes are brighter, a kalimba's rings rattle and an electric piano barks. With DAMP at 0 notes ring on after release, like a kalimba or a marimba without dampers; raise it for an electric piano's dampers.
- **Presets:** THUMB PIANO, NAIL KALIMBA (thick, rusty tines with loud rings, an octave down), HAND WAH, MARIMBA, MARIMBA ROLL, BALAFON, SUITCASE (an electric piano with tremolo), GLASS TINE (all bell, little bark) and BARKING EP.

Strike tracks (SOURCE pages)

A strike is an **exciter** (what hits) and a **body** (what rings).

SOURCE 1	SOURCE 2	SOURCE 3	SOURCE 4
EXCITER: CLICK, NOISE, METAL, FM, DUST, RAIN, BOW, BLOW, EXT (only from outside)	DAMP	ORDER: how the modes are laid out	RING F: ring-mod frequency
BODY: PING (filters), MODAL (bars and bells), DISC (cymbals, plates), STRINGS (coupled strings)	INHARM: how un-harmonic the modes are	RATE: for DUST and RAIN, how often grains fall	RING amount
DECAY	GEOMTRY: the shape of the body	TRANS: level of the attack transient	P DROP: pitch drop at the hit (toms, kicks)
TONE: brightness	MODES: 2-8 resonances	T DECAY: length of the transient	SEED: a different random variation

With **EXT** as the exciter, the track makes no strike of its own: the body rings only from what comes in from outside. That is another track's sound through an **EXCITE** route (HOME › INFLUENCE), the feedback bus returning into this track, or, in the emulator, a file under Audio in. If nothing is coming in, the SOURCE page says so, and you will hear only the attack layer and the inserts, the same on every note. The body's pitch still follows the notes, so a track exciting it through an EXCITE route rings at the note you play.

Perc tracks (SOURCE pages)

A PERC track is a drum machine after the **Elektron Machinedrum**. Its 33 machines come from the Machinedrum's four synthesis families. Elektron never published how the Machinedrum makes its sounds, so these are Ravel's own designs, built from what the Machinedrum's manual documents: each machine has the manual's parameters, in its order, doing what the manual says they do. They are not sample-perfect copies; the sampled E12 and ROM machines are left out.

A PERC track has two MODEs (EDIT › SOUND, KNOB 2). It starts as a **KIT**: six machines in lanes, sequenced together on the one track (see *Kits* below). **SINGLE** is one machine played by notes, on the SOURCE pages:

- **SOURCE 1, KNOB 1: MACHINE.** Choosing a machine loads its own defaults.
- **The rest of SOURCE 1 and SOURCE 2:** the machine's own eight parameters (A-H on the Machinedrum). A machine with fewer leaves the rest greyed out.
- **SOURCE 3 and 4: the Machinedrum's track effects.** AMD and AMF (amplitude modulation: depth and rate, up to audio rates), EQF and EQG (a one-band EQ: frequency and boost or cut), FLTF, FLTW and FLTQ (the band filter: a high-pass at FLTF and a low-pass FLTW above it; FLTF at 0 turns the high-pass off, FLTW at 127 the low-pass, FLTQ adds resonance to both). The Machinedrum's SRR and DIST are the track's own DEREZ and DRIVE on EDIT › SKIN.

- **Playing it:** the key you play transposes every pitched machine (C4 plays it at its PTCH setting). VELO sets how much velocity changes the level. The machines make their own envelopes, so the ENV pages grey out; a hit plays out whatever the key does. VOICES: MONO (each hit chokes the last, as on the Machinedrum) or 2.

Family	Machines	What they are
TRX	BD, B2, SD, XT, CP, RS, CB, CH, OH, CY, MA, CL, XC	Analog-style drums in the TR tradition: sines with pitch ramps, filtered noise, square-wave metal
EFM	BD, SD, XT, CP, RS, CB, HH, CY	Two-operator FM with feedback: from realistic drums to clangs and chaos
P-I	BD, SD, MT, RS, ML, MA, HH, RC, CC	Physical models: membranes, bars and cymbals, ringing as resonators struck by a mallet
GND	SN, NS, IM	A sine with a pitch ramp, noise, and a programmable impulse

The machines and their parameters

Machine	A	B	C	D	E	F	G	H
TRX-BD bass drum	PTCH	DEC	RAMP	RDEC	STRT	NOIS	HARM	CLIP
TRX-B2 bass drum 2	PTCH	DEC	RAMP	HOLD	TICK	NOIS	DIRT	DIST
TRX-SD snare	PTCH	DEC	BUMP	BENV	SNAP	TONE	TUNE	CLIP
TRX-XT tom	PTCH	DEC	RAMP	RDEC	DAMP	DIST	DTYP	-
TRX-CP clap	CLPY	TONE	HARD	RICH	RATE	ROOM	RSIZ	RTUN
TRX-RS rim shot	PTCH	DEC	DIST	-	-	-	-	-
TRX-CB cow bell	PTCH	DEC	ENH	DAMP	TONE	BUMP	-	-
TRX-CH / OH hihats	GAP	DEC	HPF	LPF	MTAL	-	-	-
TRX-CY cymbal	RICH	DEC	TOP	TTUN	SIZE	PEAK	-	-
TRX-MA maracas	ATT	SUS	REV	DAMP	RATL	RTYP	TONE	HARD
TRX-CL claves	PTCH	DEC	DUAL	ENH	TUNE	CLIC	-	-
TRX-XC conga	PTCH	DEC	RAMP	RDEC	DAMP	DIST	DTYP	-
EFM-BD	PTCH	DEC	RAMP	RDEC	MOD	MFRQ	MDEC	MFB
EFM-SD	PTCH	DEC	NOIS	NDEC	MOD	MFRQ	MDEC	HPF
EFM-XT	PTCH	DEC	RAMP	RDEC	MOD	MFRQ	MDEC	CLIC
EFM-CP	PTCH	DEC	CLPS	CDEC	MOD	MFRQ	MDEC	HPF
EFM-RS	PTCH	DEC	MOD	HPF	SNAR	SPTC	SDEC	SMOD
EFM-CB	PTCH	DEC	SNAP	FB	MOD	MFRQ	MDEC	-
EFM-HH	PTCH	DEC	TREM	TFRQ	MOD	MFRQ	MDEC	FB
EFM-CY	PTCH	DEC	FB	HPF	MOD	MFRQ	MDEC	-
PI-BD	PTCH	DEC	HARD	HAMR	TENS	DAMP	-	-
PI-SD	PTCH	DEC	HARD	RING	TENS	RVOL	RDEC	-
PI-MT tom	PTCH	DEC	HARD	HAMR	TUNE	DAMP	SIZE	POS
PI-RS rim shot	PTCH	DEC	HARD	RING	RVOL	RDEC	-	-
PI-ML metallica	PTCH	DEC	HARD	TENS	-	-	-	-
PI-MA maracas	DEC	GRNS	GLEN	SIZE	HARD	-	-	-
PI-HH hihat	PTCH	DEC	CLSN	RING	AG	AU	BR	CLOS
PI-RC / CC ride, crash	PTCH	DEC	HARD	RING	AG	AU	BR	GRAB
GND-SN sine	PTCH	DEC	RAMP	RDEC	-	-	-	-
GND-NS noise	DEC	-	-	-	-	-	-	-

Machine	A	B	C	D	E	F	G	H
GND-IM impulse	UP	UVAL	DOWN	DVAL	-	-	-	-

- **What they mean:** PTCH pitch, DEC decay, RAMP and RDEC a pitch drop and how fast it falls, BUMP and BENV a pitch kick at the start and its length, STRT, TICK, CLIC and SNAP a harder start, NOIS noise at the start, HOLD how long the level holds, HARM extra harmonics, CLIP, DIST and DTYP distortion and its hardness, DIRT fewer bits, TONE and TUNE the colour and detune, DAMP a shorter tail. Clap: CLPY how many claps, HARD sharper ones, RICH a wider band, RATE their spacing, ROOM, RSIZ and RTUN a room after them. Hats: GAP how far apart the metal's tones sit, HPF and LPF the filters, MTAL more metal than noise. Cymbal: RICH, TOP and TTUN the top end and its tuning, SIZE, PEAK an edge. Maracas: ATT and SUS the shake, REV backwards, RATL and RTYP the rattle and its colour.
- **EFM:** MOD is the FM depth, MFRQ the modulator's frequency (low ratios are tonal, high and odd ones clang), MDEC how quickly the FM fades, MFB and FB feedback (grit, then noise). NOIS and NDEC add noise (snare), CLPS and CDEC repeat the hit (clap), SNAR, SPTC, SDEC and SMOD a second FM pair for a snare timbre (rim shot), TREM and TFRQ a tremolo.
- **P-I:** HARD a harder hit, HAMR a softer mallet, TENS the pitch bend of a tight skin hit hard, DAMP damping, TUNE how the skin is tuned, SIZE the drum's size, POS where it is struck (centre to edge), RING metal that rings on, RVOL and RDEC the snare wires, GRNS and GLEN the maracas' grains and their length, CLSN the two hats touching, AG and AU more or fewer highs, BR the lows, CLOS and GRAB when the hat closes or a hand grabs the cymbal (127: never).

Kits: six drums on one track

A PERC track starts as a **KIT**: six **lanes**, each its own machine with its own sound, all sequenced together on that one track, so a full rhythm takes one track and leaves the others free. The kit's six sounds live inside the track: they are its lanes, not other tracks. (MODE SINGLE turns the track back into one machine played by notes. Changing MODE, or turning a track into or out of a kit by KIND or a preset, starts its steps clean, since notes and lane hits can't read each other; if the track has steps, the first turn only warns, and turning again after a moment does it.)

Editing a kit: one page per lane. Each of the six sounds is edited like a track of its own, on EDIT > **LANE 1** to **LANE 6**. On EDIT, **black keys 3-8** jump straight to lanes 1-6 (in other sections they do nothing on a kit) (black keys 1 and 2 stay patterns A and B). A LANE page shows tabs for the six lanes, the lane's machine and family, and every setting it has, in one list like a file browser's details view: the machine's eight parameters, then LEVEL, CHANCE, LENGTH and RATE, each with its bar and value.

- **PRESETS chooses the lane's machine** (any of the 33; each loads its own defaults).
- **The knobs work through the list a row at a time:** OCT- and OCT+ move the knobs to the next group (parameters 1-4, parameters 5-8, then LEVEL, CHANCE, LENGTH and RATE). The rows the knobs are on are lit and numbered 1-4 in the list.

- **LEVEL** is the lane's level in the kit. **CHANCE** is how likely the lane plays its hits. **LENGTH** is the lane's own loop (TRK follows the track's **LENGTH**; any other length runs against it: a 12-step hat over a 16-step kick shifts every bar).
- **RATE** is the lane's own speed against the track's: X1/4, X1/3, X1/2, X2/3, TRK (the track's), X3/2, X2, X3 or X4. A hat at X2 runs through its steps twice as fast as the kick (sixteenths over eighths, or 32nds as rolls); a lane at X2/3 or X3/2 plays triplets against straight steps; X1/2 stretches a lane's pattern over twice the time. Each lane keeps its own place, wrapping at its own **LENGTH**, and its hits fall between the track's steps where the rate puts them. Lanes at a rate of their own play forward. The **DRUM** page marks a lane's rate under its name when it isn't TRK.
- **Shared by the whole kit:** EDIT > **KIT FX** (AMD, AMF, EQF, EQG) and **KIT FILTER** (FLTF, FLTW, FLTQ), **SKIN** (DEREZ is the Machinedrum's SRR), **INSERT**, **MIX** and **SENDS**. A kit has no **PITCH** or synth **FILTER** page: each machine has its own pitch and tone.

SEQ is the drum sequencer, and the only place the lanes are drawn as steps. On a kit track **SEQ** opens on the **DRUM** page instead of **STEPS**: all six lanes over sixteen steps, the chosen lane in red, accents white, ratchets marked above, locked steps marked with a dot, each lane's playhead in teal. The note pages (**STEPS**, **STEP SHAPE**, the graphs) are hidden on a kit, since a drum hit has no note or length. Every kit **SEQ** page draws the lanes: **STEP TIMING** keeps **MICRO**, **R CURVE** and **CONDITN** (a step's timing is shared by the lanes on it), and **TRACK** keeps **LENGTH**, **RATE** and **CLOCK**. A kit's ratchets are set per lane on **DRUM STEP** only.

- In **SEQ**, **black keys 3-8 choose the lane** you are sequencing, and **the white keys are its sixteen steps**: one tap puts a hit there, the next tap clears it (and its locks). **OCT-** and **OCT+** page through longer patterns.
- **The DRUM pages:**

Page	Knob 1	Knob 2	Knob 3	Knob 4
DRUM	LANE	LENGTH of the lane's loop (as on its LANE page)	RATE of the lane, against the track's (as on its LANE page)	CHANCE
DRUM STEP (hold a step)	ACCENT: the chosen lane's hit on this step plays at full force	VELO	CHANCE	RATCHET: the chosen lane rolls on this step (1 = no roll; lanes rolling on one step share the count)

- **Parameter locks.** Go to a lane's **LANE** page, hold **SEQ** and a step key, and turn a knob: that value (a machine parameter, or **LEVEL**) is locked for that lane on that step only, and the knob shows the locked value while the step is held. A teal dot marks the step on **DRUM**. A lock on an empty step puts the lane's hit there. Each kit holds 48 locks; clearing a hit clears its locks. The kit-wide sound (**KIT FX**, **KIT FILTER**, **SKIN**, the insert) locks the usual way.
- **Playing it live:** outside **SEQ**, the white keys play the lanes, 1-6 and again (key 7 is lane 1). With **REC** armed, what you play is recorded into the lanes.
- A step's velocity, chance, timing and condition are shared by the lanes that play on it; each lane adds its own **CHANCE**. Each lane is one voice: a new hit cuts its last.
- **SWING** is on **GLO** > **CLOCK** (it was **DRUM**'s fourth knob before lanes had their own **RATE**).

- **EUCLID** (the last SEQ page) writes evenly spread hits into the chosen lane; **R CURVE** and **R MOVE** (STEP TIMING) shape its rolls.
- **Presets:** TRX KIT (kick, snare, hats, clap, rim; the kit a new PERC track starts with), EFM KIT, PI KIT and MD MIX KIT (machines from every family).
- **Presets:** TRX KICK, TRX SNARE, TRX CLAP, TRX HAT, TRX OPEN HAT, TRX COWBELL, EFM KICK, EFM SNARE, EFM HAT, EFM BELL, PI KICK, PI SNARE, PI TOM, PI RIDE, PI SHAKER, METALLICA, GND SUB and IMPULSE.

7. ENV: articulation



Each track has two envelopes. The **volume envelope** (ENVELOPE, ONSET, LOOP / TAIL, DESTINATIONS) shapes the level and can move two more parameters. The **FILTER ENV** (three pages after it) opens and closes the filter.

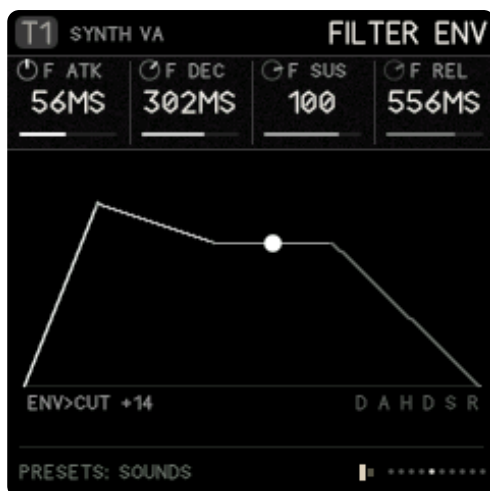
The volume envelope is in three stages, named after how speech is described: the **onset** (how a sound starts), the **continuant** (how it holds) and the **termination** (how it ends). The first page holds the four times and the level you reach for most, attack, decay, sustain and release; the pages after it shape them. The picture draws the shape as you turn the knobs.

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4
ENVELOPE	ATTACK time (0.5 ms to 8 s)	DECAY time	SUSTAIN level	RELEASE time
ONSET	CURVE: – is a fast swell, + a slow one	OVERSHT: the attack overshoots and settles (a "bite")	GIVE: a spring in the level. It lags and bounces instead of moving straight.	–
LOOP / TAIL	LOOP: repeats the attack and decay while held (a rhythmic flutter; higher is faster)	TAIL: a quiet tail after the release (room for reverbs to bloom)	–	–

(VELO, velocity sensitivity, is on EDIT > SOUND.) | **DESTINATIONS** | DEST 1: any parameter of this track | AMOUNT 1(±) | DEST 2 | AMOUNT 2(±) |

DESTINATIONS lets the envelope move up to two more parameters, such as FM's LEVEL2 or CZ's DCW +/-, so the timbre changes with the note.

FILTER ENV



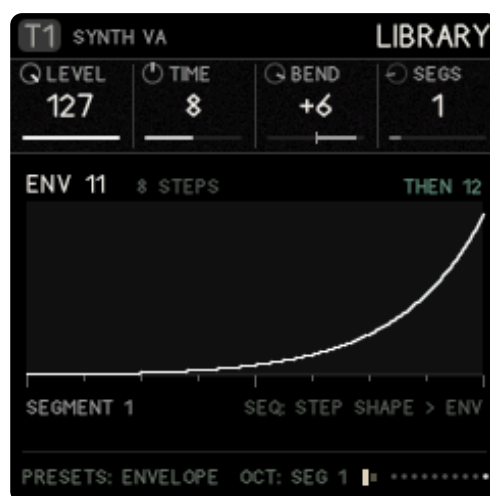
The filter has its own envelope: delay, attack, hold, decay, sustain and release, with a bend on the attack and one on the falls, a loop and a speed. **ENV>CUT** sets how far it moves the cutoff, up or down (+40 on a new track). It is the same setting as on EDIT > FILTER, so turning either moves both. The envelope can also move one more thing of the track's, **F DEST**, by **F AMT**: with F LOOP on it is an LFO of the track's own, started by each note, where the two LFOS are shared by all tracks.

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4
FILTER ENV	F ATK: attack time (0.5 ms to 8 s)	F DEC: decay time	F SUS: sustain level	F REL: release time
FENV SHAPE	F DELAY: a wait before the attack	F HOLD: how long it stays at the top before the decay	A BEND: the attack's curve, + exponential (slow, then a rush), – logarithmic (a rush, then slow)	D BEND: the decay's and release's curve, + exponential (a fast fall, a long tail), – logarithmic
FENV LOOP	F LOOP: ON runs delay, attack, hold and decay round again while the key is held (with SUSTAIN at 0 it is a filter LFO that starts with the note)	F RATE: every stage faster (+) or slower (–), up to 16 times	–	–
FENV ROUTE	ENV>CUT: how far it moves the cutoff (±)	F DEST: a second destination, any of the track's modulation destinations (pitch, pan, drive, an engine's knobs, the volume envelope's times...)	F AMT: how far it moves F DEST (±; 0 off)	VCF KEY (also on PITCH)

- **The picture** draws the whole envelope with its bends, marks the loop when it is on, and shows the playing note as a dot.

- **Which tracks:** synth tracks. With the LPG the filter follows the volume envelope instead, and the SQ engine's ENV 2 (on its source pages) is its own filter envelope, so these pages grey out there, unless F AMT sends the envelope somewhere: then it runs for F DEST. The CZ engine uses it like any other.
- **F DEST and F AMT:** the newest note's envelope, 0 to its peak, moves F DEST up by F AMT (or down, with F AMT below 0), as the volume envelope's DEST 1 and 2 do. The picture shows where it goes (INTO PAN +20, say). F DEST steps only through what can be moved.
- **Moving it:** F ATK, F DEC, F SUS, F REL, F RATE, ENV>CUT and F AMT are modulation destinations, so an LFO or the matrix can deepen the track's own one.
- **Older projects and sounds** load with a FILTER ENV copied from their volume envelope, so they sound as they did (the one envelope used to drive both). The factory presets do the same. The SHAPE envelopes of earlier versions are gone; a project that used one plays the classic volume envelope.

STEP ENV and the LIBRARY



The **LIBRARY** holds 32 **step envelopes**: shapes a step starts, that move one parameter across that step and on through the steps after it. A filter blip on one step, a fold that climbs over four, a pitch that drops on the last step of a bar. One number on a step calls up a whole motion, and envelopes can chain into each other for longer, more complicated moves.

STEP ENV says where they go, one destination per track:

Page	Knob 1	Knob 2	Knob 3	Knob 4
STEP ENV	SE DEST: the parameter it moves (any modulation destination of the track)	SE DEPTH: how far ($\pm$)	SE NOTE: OFF, or an envelope every note starts when its step names none	-

- **Starting one:** set a step's **ENV** on SEQ > STEP SHAPE (or hold SEQ and ENV, hold the step's key and turn KNOB 1). When that step plays, its envelope starts from the beginning and replaces the one running.
- **Carrying on:** steps without an ENV leave the running envelope alone, so a long envelope or a chain moves through them. Set **SE NOTE** to have every such note start an envelope instead.

- **At the end** an envelope loops back to one of its segments, or hands over to its **NEXT** (a chain: the next one starts from where the last ended), or holds its last level. Stopping the sequencer puts the parameter back where its knob is.
- The picture on STEP ENV draws the envelope playing on the track, with a dot where it is.

Editing an envelope (LIBRARY): PRESETS picks the envelope (1-32). **OCT- / OCT+** step through its rows; the picture marks the segment on the knobs.

Row	Knob 1	Knob 2	Knob 3	Knob 4
Segment 1-8	LEVEL it goes to (0-127)	TIME it takes: in steps, to an eighth of a step (0 = a jump), or 0.5 ms to 8 s in FREE time	BEND: + exponential (slow, then a rush), - logarithmic (a rush, then slow)	SEGS: how many segments it has (1-8)
The envelope's own	START level	TIME: STEPS (synced to the track, the default) or FREE	LOOP: OFF, or back to segment 1-8 at the end	NEXT: NONE, or the envelope (1-32) that takes over

Editing a segment past the last one adds it. The twelve factory envelopes, all synced:

#	Name	What it does
1	RAMP UP	rises over four steps and stays
2	RAMP DOWN	falls over four steps
3	BLIP	up at once, down in half a step
4	SWELL	in and out over four steps
5	DOUBLE	two blips half a step apart
6	STAIRS	four stairs, a step each
7	TRIANGLE	a two-step cycle, looping
8	S CURVE	slow, quick, slow, over four steps
9	DROP	holds a step, then falls
10	WOBBLE	a quarter-step flutter, looping
11	BUILD	eight steps up, then chains to 12
12	FALL	down in a step (BUILD's ending)

13 to 32 start empty. Projects made before this version get the twelve factory envelopes, and their steps' old library numbers are cleared (the old library swapped a step's volume envelope; set SE DEST to LEVEL for something like it).

8. LFO: modulation and macros

Page	Knob 1	Knob 2	Knob 3	Knob 4	PRESETS
MATRIX	SOURCE	TRACK (1-8, GLOBAL, or MATRIX: another row)	PARAM (with MATRIX: ROW 1-8, that row's AMOUNT)	AMOUNT (±)	slot 1-8
LFOS	L1 RATE	L1 SHAPE: SINE, TRI, RAMP, SAW, SQUARE, S&H, DRIFT	L2 RATE	L2 SHAPE	–
LFO SHAPE (OCT- / OCT+: LFO 1 or LFO 2)	SYM: skews the wave either way (± 64)	PHASE: where the wave starts, 0–359°	MODE: LOOP, RETRIG, 1 SHOT	–	–
DUST	RATE: how often random spikes happen	DECAY: how long each spike lasts	–	–	–
MACRO	DEST: what this slot moves	START value (±)	END value (±)	CURVE: LINEAR, EXP, LOG, S	which macro and slot
MACRO WINDOW	FROM %: where on the macro's travel this slot starts moving	TO %: where it stops	MACRO 1	MACRO 2	which macro and slot

- **SYM** moves the middle of the cycle from 5% to 95%, so each half of the wave speeds up or slows down: a sine leans, a triangle turns into a rising or falling ramp, a square becomes a narrow or wide pulse. The matrix can move it (target GLOBAL › L1SYM or L2SYM), so another LFO, dust or an envelope can reshape an LFO as it runs.
- **A row can move another row:** set TRACK to **MATRIX** and PARAM picks a row (ROW 1 AMT to ROW 8 AMT, any but its own). This row's source then moves that row's AMOUNT, by up to this row's AMOUNT either way, on top of what it is set to. For example, row 1 is LFO 1 into a cutoff at 0, and row 2 is MACRO 1 into ROW 1 AMT at +63: the macro fades the LFO's sweep in. Rows can chain (row 3 moving row 2 moving row 1). On the MATRIX picture a moved row's amount turns bone and its bar shows the amount as it is now.
- **PHASE** is where the cycle starts. In LOOP it offsets the wave; in RETRIG and 1 SHOT it is where a note restarts it.
- **MODE:** LOOP (the default) runs freely. RETRIG starts the cycle over on every note, on any track. 1 SHOT plays one cycle from each note, then rests at the cycle's end: an extra envelope.
- The LFOS and LFO SHAPE pages draw both waves as SYM and PHASE make them; on LFO SHAPE the one on the knobs is lit.



Matrix sources:

- **LF01, LF02;**
- **DUST:** random impulses, like crackle;
- **ENV and VELO:** the *target* track's own envelope and velocity;
- **MACR01-4;**
- **CLOCK:** a pulse on every clock tick;
- **KEY:** the note the *target* track is playing, centred on C4. At AMOUNT **+63** the parameter follows the keyboard exactly, one semitone per key (see below);
- **WHEEL:** reserved for MIDI; nothing drives it in this version.

The matrix: 8 slots, each "this source moves that parameter by this much".

1. Turn PRESETS to pick a slot.
2. Turn KNOB 1 to pick the source.
3. Turn KNOB 2 to pick the track.
4. Turn KNOB 3 to pick the parameter (only parameters that can move smoothly are offered).
5. Turn KNOB 4 to set the amount.

Key tracking with KEY. At AMOUNT +63, KEY moves these parameters by exactly one semitone a key: the **INSERT TUNE** of a COMB insert, **CUTOFF**, **PITCH** and **FINE**. Any other parameter moves one step a key. Smaller amounts track part of the way, and negative amounts turn the keyboard upside down. KEY reads the target track's newest note, so with several voices the comb follows the last key played.

Example: a strike track whose comb rings in tune with the keys.

1. On T5's **INSERT** page (EDIT), set INSERT to **COMB**. Leave TUNE at **C4**, its default. AMOUNT sets how strongly the comb rings (try 90–127), and MIX how much of it you hear (try 127).
2. Press **LFO** for the **MATRIX** page (not HOME › INFLUENCE: influence routes move a parameter by another track's envelope, not by the keys). Set SOURCE **KEY**, TRACK **T5**, PARAM **TUNE**, AMOUNT **+63**.
3. Play: the comb now rings in unison with every key. Turn TUNE to C5 for an octave above, or G4 for a fifth.

The comb reaches down to about F3; notes below that stop there.

Macros: 4 macros, each moving up to 8 destinations at once. Each destination has its own start and end values, curve, and window (FROM % / TO %).

- The window lets one knob turn do several things in sequence. For example, macro 1 from 0 to 50 % opens a filter, and from 50 to 100 % adds feedback.
- PRESETS walks through 32 slots: macro 1's eight destinations, then macro 2's, and so on.
- **To play the macros**, hold **LFO** and turn KNOB 1–4: they are macros 1–4 on any page.

9. FX: the buses

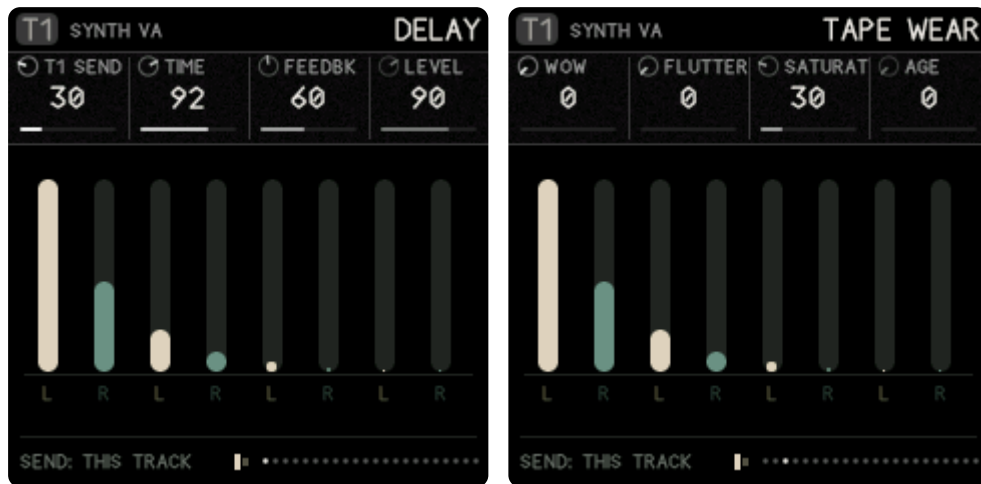
Each track can send part of its sound into six shared effects (buses). Their outputs go back into the mix.

How the sends work.

- On every FX page, one knob is called **T1 SEND** (or T2, T3...): that is how much of the *current track* goes into this bus.
- Turn **ALGORITHM** to set another track's send without leaving the page.
- The other knobs on the page set the bus itself, which is shared by every track.
- The same sends are also on EDIT › MIX and EDIT › SENDS.
- **Every effect starts off.** A new project's sends are all 0, the space is ROOM and MASTER DRIVE is 0. Picking a sound with PRESETS leaves the track's sends where you had them, so no effect starts running because of a preset. The demos are the exception: they come with their own sends. A bus with nothing sent into it stops running once its tail has died away, so it costs nothing.

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4
DELAY	T SEND	TIME: free below the middle (10 ms to 0.5 s), tempo-synced divisions above	FEEDBK	LEVEL
DELAY 2	TONE: darker or brighter repeats	SPREAD: stereo ping-pong width (and how widely grains scatter)	DOUBLE: double tracking, a second wavering copy close behind	FREEZE: ON holds the repeats forever
TAPE WEAR	WOW: a slow, drifting sway of the tape's speed	FLUTTER: a fast waver	SATURAT: the tape driven, warm then gritty	AGE: darker repeats, hiss, dropouts
GRAINS	GRAINS: how much of the delay is a grain cloud (0: none)	DENSITY: how often grains start	SIZE: each grain, 20 ms to 0.4 s	PITCH: ± 24 semitones
SPACE	T SEND	SIZE	DAMP: darker tail	LEVEL
SPACE 2	MOTION: slow movement in the tail (chorus-like)	DIFFUSE: smooth wash vs. distinct echoes	LOW CUT: keeps the tail out of the bass	MODE: ROOM, CLOUDS or 12-BIT
BED	LEVEL (0: off)	DENSITY: how often its dust falls	TONE: wood (left) to metal (right)	SHIMMER: the body an octave and two up, slowly beating
BED 2	DUCK: how far busy tracks hold it down	DECAY: how long the body rings	SPACE: how much of it goes into the space reverb	-
FEEDBACK	T SEND	TIME of the loop	REGEN: how much goes round again	LEVEL
FEEDBACK 2	PROCESS inside the loop: FILTER, COMB, SMEAR, SHIFT, FOLD, CRUSH	AMOUNT of the process	TUNE of the process	CUTOFF of the loop's filter
FEEDBACK 3	EDGE: a guard that keeps the loop from running away	RETURN: to the MASTER, or into a track (T1-T8)	-	-
FILTER PAIR	T SEND	ROUTING: SERIES, PARALLEL, FEEDBACK	FREQ 1	FREQ 2
PAIR 2	RESO	TYPE 1: LOWPASS, BANDPASS, HIGHPASS	TYPE 2	LEVEL
PAIR LFOS	LFO 1 rate (moves filter 1)	LFO 2 rate (moves filter 2)	DEPTH	-
BANDS	T SEND	LEVEL	RESO: from broad bands to narrow, ringing ones	SHIFT: moves all eight bands, ± 12 semitones
BAND SWEEP	SWEEP: UP, DOWN, PINGPONG, RANDOM (a new band each	RATE: about 0.03 to 20 sweeps a second	DEPTH: how dark the unlit bands go (0 = no	WIDTH: how many bands the sweep

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4
	cycle), STEP UP and STEP RND (band to band, eight steps a cycle)		sweep)	lights at once
BANDS 1-4	150 Hz band's level	240 Hz	380 Hz	600 Hz
BANDS 5-8	950 Hz	1.5 kHz	2.4 kHz	3.8 kHz
VOCODER	T SEND	BODY: what gets shaped (DUST, DROPS, NOISE, TAPE, or a track T1-T8)	TILT: darker or brighter	LEVEL
VOCODER 2	ATTACK	RELEASE	SHIFT: moves the bands (± 24 semitones)	NARROW: sharper, more resonant bands
MASTER	DRIVE: master saturation (0, off, by default)	CUT SIZE: length of a microcut	REPEATS: how many times a microcut repeats	CUT MIX
MASTER 2	C SHAPE: the punch-ins' cuts EVEN, BOUNCE or DRAG (as on SEQ > STEP CUT)	-	-	-



The delay is a tape. One short loop of tape, written at half rate and 12 bits (about half a second), driven on the way in (**SATURAT**). The echoes read it at **TIME** while the tape's speed sways (**WOW**, slow and drifting) and wavers (**FLUTTER**, fast and shallow); each pass goes through **TONE**, the tape's **AGE** (darker, a little hiss, and now and then a dropout, more as it ages) and the saturation again, so the repeats wear down like an old tape echo's. **DOUBLE** adds two copies of what comes in, 18 and 27 ms behind and wavering apart: double tracking, one knob. **GRAINS** mixes in a cloud of up to eight grains read from the same tape around the echo (after Mutable Instruments' Beads, kept lofi): **DENSITY**, **SIZE** and **PITCH** shape them, **WOW** scatters them, **SPREAD** widens them, and the cloud feeds back into the tape with the echoes. **FREEZE** stops the tape recording, so the echoes and the cloud play what it holds: freeze a phrase, then turn **GRAINS**, **SIZE** and **PITCH**.

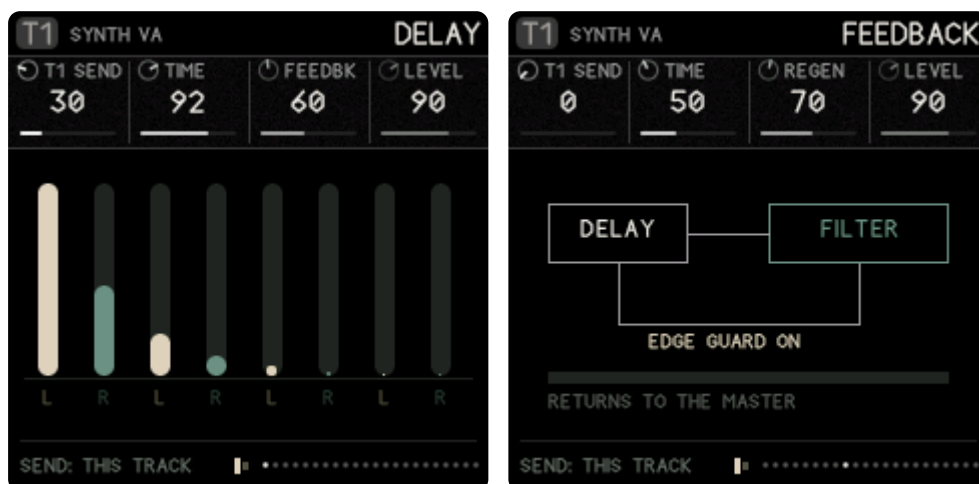
The buses follow the matrix and the macros. On LFO > MATRIX, TRACK = GLOBAL, the PARAM knob walks the settings that can be moved: the clock, the LFOs and dust, and each bus's main settings (delay time, feedback, tone, level, wow, grains; space size, damp, level, motion; the feedback bus, the filter pair's frequencies, resonance and level; the bands' and vocoder's levels; the BED; master drive and cut mix). The macros reach the same ones.

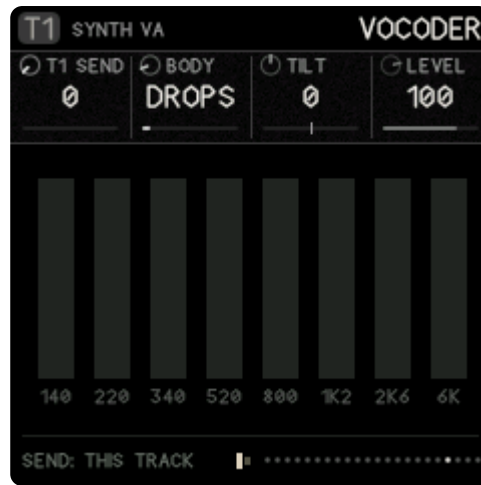
CLOUDS (SPACE, MODE CLOUDS) is a long, smooth plate in the manner of the reverb in Mutable Instruments' Clouds: a figure-eight tank of allpasses and delays that feed each other. SIZE becomes **DECAY**, from about half a second to a tail of twenty seconds or more. DAMP, DIFFUSE, MOTION and LOW CUT work as they do in ROOM. Switching MODE clears the tail.

12-BIT (MODE 12-BIT) is a bright, metallic plate in the manner of late-1980s rack reverbs such as the Alesis Quadraverb: combs and allpasses run at half rate and kept in 12 bits, with the output held step by step, so the tail lisps, grains and aliases as it fades. SIZE becomes **DECAY** and DIFFUSE becomes **CRUNCH**, which takes the stored samples from 12 bits down to 8. DAMP darkens it and MOTION adds a little chorus in the combs.

All four modes share one block of memory, so the two new ones cost no extra RAM; they run at half rate and cost about what CLOUDS does.

BANDS is a resonant filter bank in the manner of the Moog MuRF: eight bandpass filters at fixed frequencies, each with its own level. With DEPTH at 0 it sculpts: turn bands down to carve the sound into a few ringing peaks, and raise RESO to make them sing. Raise DEPTH and a spotlight travels across the bands at RATE, lighting WIDTH bands at a time and dimming the rest, so a held chord or a drum loop becomes a moving, rhythmic pattern of resonances. STEP UP and STEP RND jump from band to band like the MuRF's patterns; UP, DOWN and PINGPONG glide. Odd bands lean left and even ones right, so the sweep moves across the stereo field. The picture shows each band's level (outline) and its gain right now (filled). LFO 1 and 2, the macros and the matrix can move every BANDS knob.



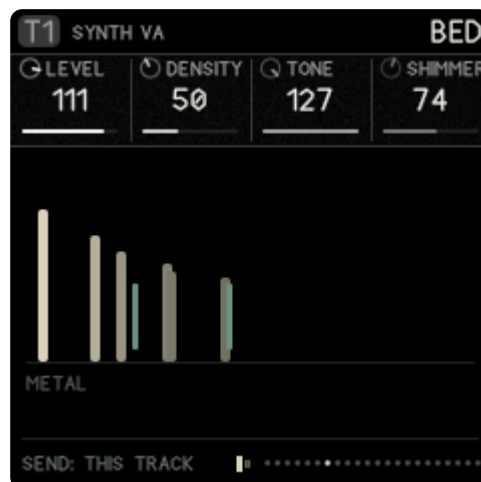


The vocoder works backwards from a normal one.

- The tracks you **send** into it are the *voice*: their spectrum is measured in 8 bands.
- The **BODY** is the material that gets shaped by that spectrum.
- So T1's melody can be played on dust crackle, water drops, the tape, or another track's sound.
- The body is levelled band by band, so a quiet track works as well as a loud one. How loud the vocoder is follows the voice: the SEND, how hard the voice is played, and LEVEL.
- If a body track is also playing in the mix, turn its LEVEL down to hear only the vocoded version.

The feedback bus is a delay loop with an effect inside. Each pass goes through the effect again, so a comb rises into a ringing pitch, a shift climbs or falls, and a fold grows harsher.

- Send it into a track (**RETURN** T1-T8) and the loop feeds back through that track's own filter and skin.
- If it gets too loud, turn down REGEN or turn EDGE on.



The BED is a quiet layer under everything: grains of dust, and a breath of soft noise, falling on a small body tuned to the scale's root (SCL > ROOT). At TONE's left the body is wood, its modes spread like a marimba bar's and short; at the right it is metal, its modes clustered and inharmonic, and it rings long. SHIMMER adds its two lowest modes an octave and two octaves up, beating slowly. **DUCK** lets the tracks hold it down, quickly when they play and slowly letting go, so the bed comes up in the gaps between hits. **SPACE** sends it into the space reverb: into CLOUDS with a long DECAY it becomes a deep floor under the clicks. The picture shows the

body's modes, the shimmer, the dust as it falls and, with DUCK up, how far it is held down. The dust is random, as dust is; the bed plays no notes and changes nothing in the patterns.

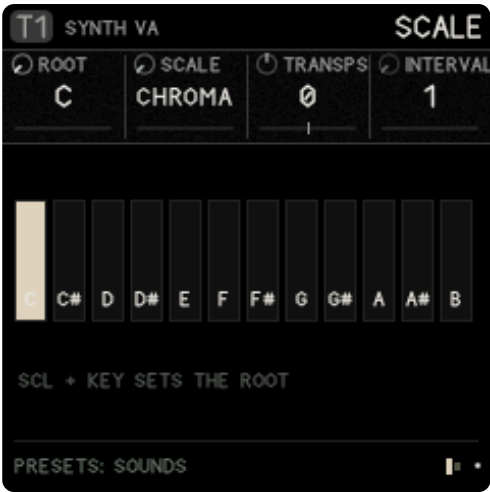
Microcuts (MASTER page) are slivers of the master output, looped, reversed or stuttered. Trigger them from steps (SEQ > STEP SHAPE > CUT, with their own shape and size on STEP CUT) or with the FX punch-ins (their shape: MASTER 2 > C SHAPE).

Punch-in effects: hold **FX** and press white keys **1–8**:

Key	1	2	3	4	5	6	7	8
Effect	LOOP (microcut)	REVERSE	STUTTER	FREEZE the delay	LOW PASS sweep	HIGH PASS sweep	THROW: everything into delay and space	FILL: steps set to FILL play

The effects last while the key is held. Letting go of FX releases them all.

10. SCL: scale



Knob 1	Knob 2	Knob 3	Knob 4
ROOT: C to B	SCALE: CHROMA (off), MAJOR, MINOR, DORIAN, PHRYG, LYDIAN, MIXO, PENTA, MINPENT, WHOLE, HIRAJO, IWATO	TRANSPS: transposes everything that plays from steps (± 24)	INTERVAL: this track plays only notes this many semitones apart from the root (1-12)

- **The keys fold into the scale** (like Elektron's fold mode). With a scale set, every key plays: the lowest key plays the first scale note at or above F, and each key after it plays the next note of the scale, so the keyboard runs up through the scale across several octaves and no key is wrong or dead. With CHROMA the keys are chromatic again. Notes you record from the keys are recorded as played.
- **The sequencer snaps** each step's note to the nearest scale note (a note exactly between two goes down).
- **INTERVAL** (per track): a track with interval N only plays notes that are a multiple of N semitones from the root; other notes are skipped. INTERVAL 1 plays everything, 12 only the roots, 7 the root and the notes a fifth apart (stacked fifths: the fifth, the ninth...), 2 every other semitone. Give two tracks the same notes with different intervals and they split them between them.
- **Set the root from the keys:** hold **SCL** and press a key.

11. ARP: the tape

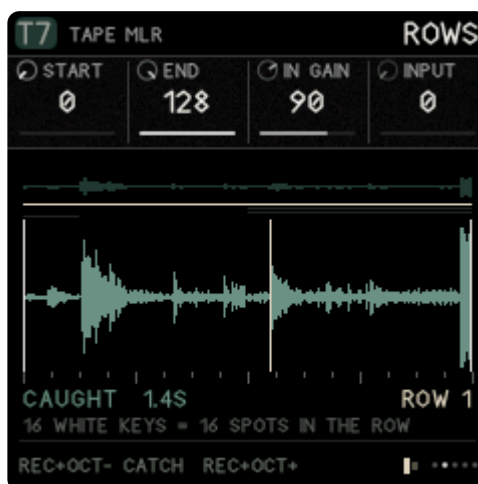
The tape is Ravel's memory: one short loop of audio that every tape track plays from.

- It is always **listening** to its source, a rolling recording of the last moment.
- When you **catch**, it stops listening and keeps what it heard. Now the tape tracks have something to play.
- **ARP** opens the TAPE section. If the current track is not a tape track, it jumps to the first tape track ("T7: THE TAPE TRACK").

How long is the tape? About 1.4 s in CLEAN quality, more in TAPE (12-bit), and about 5.5 s in DIRTY (8-bit μ -law at half rate). Choose on the CAPTURE page.

Getting sound onto the tape

To	Do this
Catch (keep what the tape just heard)	Hold REC , press OCT- . Or on any tape page, black key 9 . Do it again to let the tape listen again ("LISTENING").
Resample (record the next bars cleanly)	Hold REC , press OCT+ . Or black key 10 . On the next bar it records 1, 2, 4 or ½ bar (CAPTURE › RESAMPL) into row 1 , then catches.
Catch from a pattern	An influence TAPE route with JUMP TO = 16 catches when the source track plays



Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4	PRESETS
CAPTURE	QUALITY: DIRTY, TAPE, CLEAN	SOURCE: MASTER, T1-T8, BUSES, INPUT	RESAMPL: 1 BAR, 2 BARS, 4 BARS, 1/2 BAR	ERODE: the tape wears a little each pass	row
ROWS	START of the row (0-127, in 128ths of the tape)	END of the row	IN GAIN: audio input level	INPUT: hear the input through the output	row 1-4
PLAYBACK (tape tracks)	MODE: MLR, KEYS, SLICE, STRETCH, SHARDS	ROW it plays	START: where in the row it begins (0-127)	END: where it ends	sounds
MLR	JUMP: when a jump lands: NOW, STEP, BEAT, BAR	XFADE: smoothing at jumps	RATE: -2× to 4×	HEAD 2: a second playhead (+1/4, +1/2, +3/4 of the row, or REV)	sounds
MLR 2	PITCH	LEVEL	-	-	sounds
SAMPLE (KEYS, STRETCH, SHARDS)	PLAY: FWD, LOOP, PINGPONG, REV, REV LOOP	PITCH	VOICES: 1-4	LEVEL	sounds
STRETCH	SPEED: 0-200 % of the sample's own time, its pitch apart	-	-	-	sounds
SHARDS	SHARDS: 2-16 pieces	ORDER: FWD, REV, SKIP, SWAP, INWARD, SHUF 1-3	GAP: silence after each piece	-	sounds
SLICES	SLICES: 4-32	SENS: how easily a hit counts as a slice (0: an even grid)	PITCH	LEVEL	sounds

Rows. The tape is divided into four **rows**, which are windows onto the tape. By default row 1 is the whole tape, rows 2 and 3 are its first and second halves, and row 4 is its first eighth. A tape track plays one row at a time.

The five ways a tape track plays

A tape track is Ravel's sampler. It plays its **row** of the tape between **START** and **END** (PLAYBACK). START and END are ordinary parameters: the matrix, the macros, the LFOs and influence can move them, so a loop can shrink, stretch and wander while it plays. The picture dims what lies outside them.

MLR (named after the monome app). The current row is laid across the **16 white keys**.

Key	Action
Tap a white key	The playhead jumps to that sixteenth of the row and plays on (while the sequencer runs, on the next step, beat or bar, set by JUMP; stopped, at once)
Hold two white keys	Loops the span between them. Let go to play on.
Black keys 1-4	Switch to row 1, 2, 3 or 4
Black key 5	Reverse on/off
Black key 6	Half speed (press again to slow further, down to ¼)
Black key 7	Double speed (up to 4×)
Black key 8	Hold / release: stop and start the playhead
PLAY (stopping)	Stops the loops too; tap a key to start one again
Black keys 9 / 10	Catch / resample
From any other page	Hold ARP and press white keys to jump

The picture shows the whole tape, the four rows (the current one bright), the playhead(s) and "CAUGHT 1.4S" or "LISTENING".



KEYS: the row (START to END) played across the keys, like an early sampling keyboard. C4 plays it as it was caught; each key up or down is a semitone. Up to four at once (VOICES), each with the track's envelope. **PLAY** says what happens at the ends: **FWD** plays once, **LOOP** goes round while the key is held, **PINGPONG** goes back and forth, **REV** and **REV LOOP** run backwards. With LOOP on and an LFO on END, the loop breathes.

STRETCH: as KEYS, with its **SPEED** apart from its pitch. At 100 % it keeps the sample's own time; at 50 % it takes twice as long at the same pitch; at 0 it stands still on one moment and hums it. Two short windows read the tape, so it smears a little: lofi on purpose.

SHARDS: the span broken into **SHARDS** pieces (2-16), played one at a time, never overlapping, in an **ORDER:** forward, reversed, SKIP (the odd pieces, then the even), SWAP (each pair

changed round), INWARD (the ends toward the middle) or one of three fixed shuffles. **GAP** leaves a silence after each piece, from none to most of it, so a phrase falls apart into clicks and fragments. Each piece fades in and out quickly, so there are no clicks except the ones you want. PLAY LOOP goes round; REV plays each piece backwards. The picture marks the pieces.

SLICE: the row is cut where it hits (onsets).

- Keys play slices from left to right, and so do steps.
- SENS sets how many hits count; SLICES sets the maximum. **SENS 0** cuts an even grid of SLICES instead.

A tape KIT (EDIT › SOUND, MODE = KIT): six lanes, each its own span of the tape, sequenced on SEQ › DRUM like a perc kit, with each lane's own length, rate, chance, ratchets, R MOVE and EUCLID. A new tape kit cuts row 1 into six. Each lane (EDIT › LANE 1-6) has its **ROW** (PRESETS walks them) and **PITCH** (64: as caught, ± 24 semitones), **START**, **END**, **PLAY**, **DECAY** (127: plays to its end), **SHARDS** (below 2: off; 2-16 plays it as shards), **ORDER** and **GAP**. A lane plays one hit at a time; outside SEQ the white keys play the lanes. Parameter locks work as on a perc kit.

Steps on a tape track in MLR jump the playhead: the step's note picks the position. A pattern on T7 can therefore cut the loop up rhythmically, and recorded MLR jumps become these steps (see [Recording](#)). In KEYS, STRETCH and SHARDS steps play notes, through the scale like a synth's; in SLICE a step's note picks the slice.

Samples are kept in RAM: what is on the tape is gone when the FM-1 is switched off. Resample it again from the project.

Audio in.

- In the emulator, choose a file under **Audio in**; "Record it onto the tape" sets the tape's source to INPUT. The FM-1 has no audio input in Ravel.
- Set SOURCE to INPUT to catch it, or ring a strike body with it (EXCITER = EXT).

12. SEQ: steps and the graph

Every track has its own sequencer, with **two patterns (A and B)** of up to **64 steps**.

- **PRESETS** switches pattern while on SEQ pages, and so do black keys **1** and **2**.
- **Black key 9 (COPY)** picks the current pattern as the source. **Black key 10 (PASTE)** copies that pattern, as it is at that moment and with a kit's locks, into the current one: switch to the other pattern, or to another track, first. A kit's pattern pastes only into a kit, and a note pattern only into a note track. Pasting over steps asks first: press it twice. The pattern's steps are copied; the track's LENGTH and RATE stay the target's own.
- **Black key 11** clears the pattern: press it twice (the first press asks).
- A pattern launched while playing waits for the current one to finish (its LENGTH, at its RATE), then starts from its first step, so patterns of any length change cleanly. (A GRAPH track has no end, so it changes on the next bar.) Scenes change on the next bar.

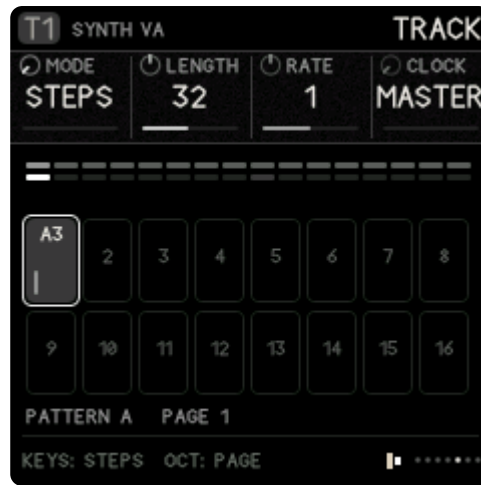
The step keys

While you are on any SEQ page, or while you **hold SEQ** on any other page, the **16 white keys are steps**.

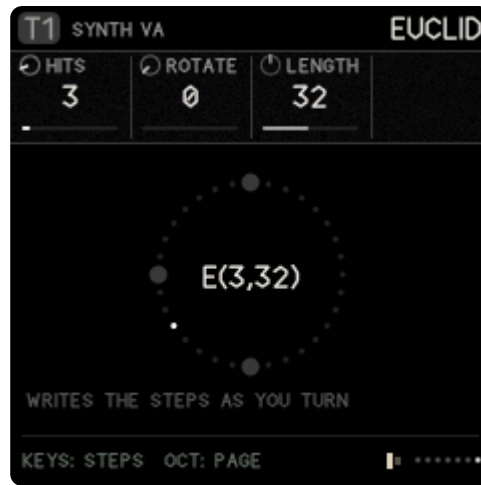
Action	Result
Tap a key	The step toggles on/off
Hold a key, turn a knob	Edits that step's value (on STEPS, STEP TIMING, STEP SHAPE, GRAPH)
Hold a key, turn a knob on a non-SEQ page (with SEQ held)	A parameter lock : that step plays with that value (cutoff, drive, a source value...). Up to two locks per step.
OCT- / OCT+	Step page 1-16, 17-32, 33-48, 49-64

Editing a held empty step switches it on.





Page	Knob 1	Knob 2	Knob 3	Knob 4
STEPS	NOTE	VELO	LENGTH: how long the note holds, in eighths of a step to 16 steps ("7 1/2"), then in half steps up to 64 steps	CHANCE: 0-100 % that it plays
STEP TIMING	MICRO: nudge -6 to +12 (in 24ths of a step)	RATCHET: 1-8 repeats within the step	R CURVE: EVEN, FASTER, SLOWER, BOUNCE (see below); "-F" versions fade out	CONDITN, see below
STEP SHAPE	ENV: the LIBRARY envelope this step starts (- = none; see ENV > STEP ENV)	CUT: NONE, LOOP, REVERSE, STUTTER (a master microcut on this step)	TIE: ON holds the note until the track's next note starts	R MOVE: what each repeat of a ratchet does (see below)
STEP CUT	CUT (as on STEP SHAPE)	C SHAPE: EVEN, BOUNCE, DRAG	C SIZE: MASTER (the MASTER page's CUT SIZE), or 1/32 to 1/2 of a step	-
TRACK	MODE: STEPS or GRAPH	LENGTH: 1-64	RATE: 1/4x to 4x the master clock	CLOCK: MASTER, LF01, LF02, DUST
DIRECTION (steps mode)	FWD, REV, PINGPONG, SNAKE (rows of four, walked back and forth)	-	-	-
EUCLID (the last SEQ page)	HITS	ROTATE	LENGTH (the track's)	-



EUCLID spreads HITS as evenly as they go over the track's LENGTH (5 over 16 is x..x..x..x..x..., the first on step 1) and ROTATE turns the pattern round. It writes ordinary steps as you turn: the steps it lights are steps like any others, with their notes, locks and ratchets, and you can edit them by hand from there. HITS starts from how many steps play now. Each turn rewrites which steps play (up to LENGTH), so turn it to find a rhythm, then leave it. On a kit the page is LANE, HITS, ROTATE and the lane's LENGTH, and it writes the chosen lane only: give each lane its own length and hits for rhythms that interlock and drift. The picture is the pattern as a ring, E(hits, length) in the middle.

Ratchets that move. A ratchet repeats the step's note within the step. Two settings change how the repeats fall and sound:

- **R CURVE BOUNCE** spaces the repeats like a ball dropped on a table: the gaps shrink and each repeat is softer than the last. (EVEN, FASTER and SLOWER place them evenly, closing up or opening out; their "-F" versions fade.)
- **R MOVE** changes each repeat: **UP** and **DOWN** climb or fall a step of the scale per repeat (on a kit lane, two semitones); **DARK** closes each repeat down, darker, quieter and shorter than the one before, so a metal hit turns to wood as it rolls.

Together they give the bouncing, tumbling bursts of IDM: a hat on RATCHET 6, BOUNCE, DARK falls like a coin; a snare on 4, FASTER, UP rises into the next bar. On a kit, R CURVE and R MOVE are on STEP TIMING (KNOB 2 and KNOB 4) and act on the lanes that roll on that step.

Cuts with a shape. A step's CUT is a microcut of the whole mix (see FX > MASTER). On STEP CUT:

- **C SHAPE EVEN** repeats the sliver as it is; **BOUNCE** makes each repeat shorter and a little higher, like a ball settling (it adds a few repeats to settle in); **DRAG** plays each slower and lower, a tape winding down.
- **C SIZE** sets the sliver against the step, from 1/32 to 1/2 of a step (at most 93 ms), so it follows the tempo; MASTER uses CUT SIZE.

While a cut plays its sliver is held, so every repeat is of the same moment.

Conditions (CONDITN) decide on which passes through the pattern a step plays:

- **ALWAYS;**

- **FIRST** (only the first time) and **NOT 1ST**;
- **1:2, 2:2** (first or second of every two passes);
- **1:3 ... 3:3**;
- **1:4 ... 4:4**;
- **FILL** (only while the FILL punch-in is held) and **NO FILL**.

CLOCK lets a track step by something other than the master clock:

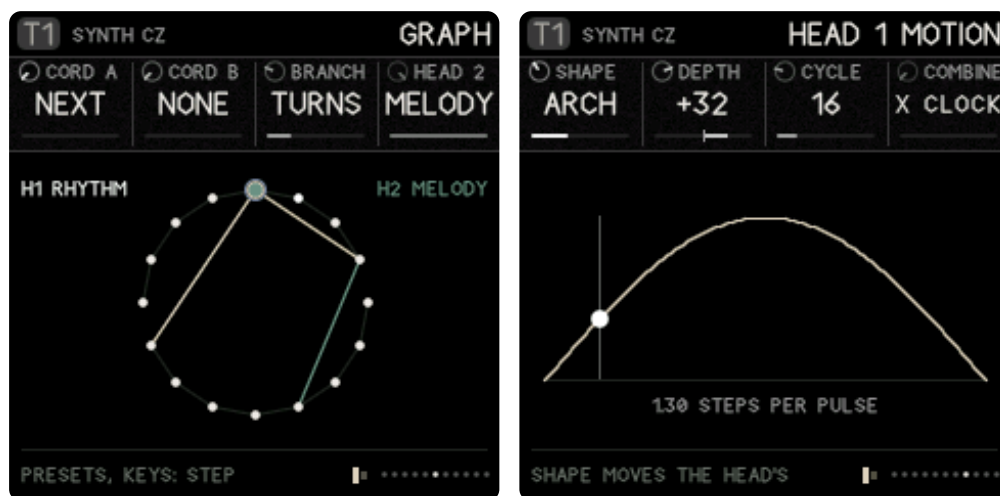
- **LF01/LF02** step on each LFO cycle;
- **DUST** steps at random;
- an influence **CLOCK** route steps on another track's notes.

All of these give rhythms that drift against the grid.

On the STEPS picture:

- the top strip is the whole pattern, with the playing step bright;
- the grid is the current page of 16;
- each box shows the note and a velocity bar;
- outlined boxes are where the playheads are.

GRAPH mode (Silt's sequencer)



Set **SEQ › TRACK › MODE** to **GRAPH**. Now the steps sit in a circle, and each step has **cords** that say where a playhead goes next, instead of always moving to the following step. The pages after TRACK change to GRAPH, HEAD 1, HEAD 1 MOTION (and HEAD 2, HEAD 2 MOTION when head 2 is on).

GRAPH drives the same steps. It is not a second sequencer: the steps you set on the STEPS pages (which are on, their notes, velocity, length, locks, ratchets and the rest) are exactly what plays in GRAPH mode too. GRAPH only changes **the order the playhead visits them**, and adds a second playhead. Edit the steps on STEPS, STEP TIMING and STEP SHAPE in either mode; draw the cords on GRAPH.

Page	Knob 1	Knob 2	Knob 3	Knob 4	PRESETS
GRAPH	CORD A: the step to go to next, 1 to LENGTH (NEXT = just the following step)	CORD B: a second choice (NONE = no branch)	BRANCH: how to choose between A and B	HEAD 2: OFF, NOTES, RHYTHM, MELODY	step to edit
HEAD 1	TRANSP: head 1's transpose	–	–	–	–
HEAD 1 MOTION	SHAPE	DEPTH (±)	CYCLE: 2-64 steps	COMBINE: × CLOCK or + CLOCK	–
HEAD 2	PLAYS: THIS track, or T1-T8	H2 RATE	H2 START: the step it starts on (1 to LENGTH)	TRANSP	step
HEAD 2 MOTION	SHAPE	DEPTH	CYCLE	COMBINE	–

Making a graph:

1. Go to the GRAPH page.
2. Pick a step with **PRESETS**, or hold its white key. With more than 16 steps (TRACK > LENGTH), the white keys hold 16 at a time: **OCT+** and **OCT–** move them to steps 17–32, 33–48 and 49–64 (and put that page's first step on the knobs). The steps on the keys turn slate on the circle, the step on the knobs keeps its colour with a slate edge, the footer says which steps the keys hold (KEYS: 17–32), and the step on the knobs is named (STEP 17).
3. Set **CORD A** (where it goes) and, if you want a branch, **CORD B**. The cords are drawn on the circle. A cord can only point at a step that exists (1 to the track's LENGTH). If you shorten LENGTH later, cords to steps past the end are ignored: they read NEXT or NONE until LENGTH grows again.
4. Choose **BRANCH**, which decides between A and B at a fork: – **CHANCE**: a coin toss; – **TURNS**: alternate each visit; – **LF01/LF02**: by the LFO's sign; – **MOTION**: by the head's function generator (above half way takes B).

Two playheads walk the same graph at once.

- **Head 1** plays this track.
- **Head 2** is off until you choose what it does with **HEAD 2** on the GRAPH page. It has its own rate and start step, and can play **another track** (HEAD 2 > PLAYS).

HEAD 2 chooses how the two heads share the work. Head 1 always takes the other half, so no setting leaves the track silent:

HEAD 2	Head 2	Head 1
OFF	–	plays the steps it visits
NOTES	plays the steps it visits too: two voices on one graph	plays the steps it visits
MELODY	picks the notes, plays nothing itself	plays the rhythm, with head 2's latest note
RHYTHM	plays the rhythm, with head 1's latest note	picks the notes, plays nothing itself

With **MELODY** or **RHYTHM**, rhythm and melody walk two different paths at two different speeds, so they never quite line up the same way twice. The picture shows each head's job at the top (H1 and H2).

MOTION (Silt's function generators) moves a head's *speed* as it travels.

- **SHAPE:**
- RISE, FALL, ARCH, DECAY or SWELL, traced once every CYCLE steps;
- or LFO 1, LFO 2 or DUST, followed live.
- **DEPTH** sets how far it pushes; negative reverses the effect.
- **COMBINE** sets how it meets the clock:
- **× CLOCK** multiplies or divides the clock (up to two octaves faster or slower), so it accelerates and decelerates musically;
- **+ CLOCK** adds to the clock's rate (from slowing to a near halt up to racing).
- The MOTION picture draws the shape, where the head is on it, and its current speed in steps per pulse.

13. GL0: song, scenes and clock

T1 SYNTH VA

MIXER 1-4

LEVEL 84

LEVEL 96

LEVEL 108

LEVEL 83

1

2

3

4

5

6

7

8

PRESETS: SOUNDS

T1 SYNTH VA

SCENES

PLAYS SONG

S1 TEMPO KEEP

TEMPO 104

GLIDE JUMP

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

WHITE KEYS LAUNCH ON THE BAR
HOLD SAVE + WHITE KEY TO STORE
BLACK 1-2: THIS TRACK'S PATTERN A, B

KEYS: LAUNCH SAVE+KEY: STORE

T1 SYNTH VA

ARRANGE

SCENE 1

BARS 8

ROWS 1

PLAYS SONG

1

PLAYS THE ARRANGEMENT (SONG)
NUMBERS ARE SCENES. END STOPS THE SONG
NO END: THE SONG LOOPS

PRESETS: ROW

Page	KNOB 1	KNOB 2	KNOB 3	KNOB 4	PRESETS
MIXER 1-4	T1 LEVEL	T2 LEVEL	T3 LEVEL	T4 LEVEL	-
MIXER 5-8	T5 LEVEL	T6 LEVEL	T7 LEVEL	T8 LEVEL	-
SCENES	PLAYS: PATTERN (you launch) or SONG (the arrangement runs)	S1 TEMPO ... S16 TEMPO: the tempo the current scene sets when it launches, or KEEP (turn fully left) to leave the tempo alone	TEMPO: the tempo now	GLIDE: JUMP, or 1-8 bars (see below)	scene
ARRANGE	SCENE for this row, or END (past 16): the song stops when it gets there	BARS it lasts (1-64)	ROWS: how many rows the song has	PLAYS (as above)	row
ARCS	DENSITY of this point (0-100 %) for the current track	SPAN: each point lasts 1, 2 or 4 bars (16, 32 or 64 bars in all)	-	-	point 1-16
CLOCK	TEMPO (30-240)	SWING: 50 % is straight, 66 % a triplet shuffle, up to 100 % (every second 16th pushed late)	B DOES: how oscillator B bends the clock	DEPTH of that bending	-
CLOCK B	A SHAPE: the main clock's wave	B RATE	B SHAPE	THRESH: where a pulse fires	-
CLOCK FEEL	TEMPO IS: LOCKED (keeps the average tempo) or FREE (drifts)	QUANTZE: pulls microtiming back to the grid (0-100 %)	METRO: the metronome, OFF, QUIET or LOUD (a click on each beat, higher on the bar's first)	COUNT-IN: OFF, 1 BAR (the default) or 2 BARS	-
CPU	CORES: 1, or 2 to put half the synth voices on the FM-1's second core (see below; back to 1 at power-off)	FLASH WT: OFF, or ON to count how much of the render waits for its code to come from the flash	-	-	-
STRESS	STEP: OFF, or 1-16, each adding load to the last (below)	ENGINE: the synth engine the voices use	AUTO: RUN walks the steps, three seconds each, and fills in the table	-	-



(Taken on the desktop simulator, a far faster machine: the same project reads many times higher on the FM-1.)

CPU: where the audio's time goes. The bars show how much of the time the audio has each part of the render takes: CONTROL (the sequencer, modulation, the knobs), SYNTH, STRIKE, PERC, TAPE (the sample voices), TRACK FX, BED, VOCODER, FEEDBACK, PAIR, BANDS, DELAY, SPACE and MASTER. A bar's full length is 50 %. RENDER is the total; past about 90 % the FM-1 falls behind. **XRUNS** counts the blocks that came too late: each one is a crackle, and a steady stream of them is the loud noise an overloaded FM-1 makes. Measured on the FM-1 and the desktop simulator; the browser has no clock for it.

The overload guard. When the render takes more than 80 % of the time it has, the guard fades out the oldest voice (a released one first, over about 7 ms) and holds the voice count there: a new note past the limit fades out the oldest to make room. When there is room again, the limit comes back up a voice at a time. The CPU page shows it (GUARD: 6 VOICES, and how many it has faded). It only acts when the voices are what costs; if the effects alone are too much, turn some sends down. It never acts in the browser.

Two cores. The FM-1's chip has a second core that Ravel normally leaves off: on some units it misreads memory. CORES 2 starts it and gives it the synth voices of half the tracks (split by how many voices each has), while the first core plays the strikes, drums and samples. If it ever fails, by reading a wrong job or not finishing one in time, the first core takes the work back at once and the second stays off until the FM-1 is switched off (CORE 2 FAILED on the CPU page). It only helps when synth voices sound on two tracks or more. It goes back to 1 at power-off.

FLASH WAIT. The FM-1 runs Ravel's code straight from its flash memory, through a cache. When the code the render needs is not in the cache, the core waits for the flash. FLASH WT ON counts those waits and shows them as a share of the render (FLASH WAIT 30 %). A high number means moving the busiest code into the chip's RAM would help. The counters are not verified on hardware yet, so it is off by default.

STRESS: how much this FM-1 takes. The stress test replaces the project in memory (save yours first; it asks twice), builds a project that adds load a step at a time, and plays it, with the overload guard off so you see the real edge:

Step	Adds	Step	Adds
1	nothing (the idle cost)	9	every track into the DELAY
2	1 voice of ENGINE, held	10	every track into the SPACE (ROOM)
3	2 voices	11	the SPACE as CLOUDS
4	4 voices	12	the FEEDBACK bus
5	8 voices	13	the filter PAIR
6	2 strike voices, hit on every other step	14	BANDS
7	a drum kit, a hit on every step	15	the VOCODER
8	3 sample voices, held	16	MASTER DRIVE

Each step is measured from its first second to its third; the table shows the RENDER % for each step, red with a ! where XRUNS started. AUTO RUN walks all sixteen in under a minute and leaves the table on screen: a photo of it says exactly what this FM-1 can do. Change ENGINE to compare engines (STEP 5 is 8 voices of it). Turn STEP to OFF to stop. Loading any project or demo ends the test.

Metronome and count-in. METRO clicks while the sequencer plays; the click goes straight to the output and is never recorded. With REC armed, PLAY first counts in (the clicks sound even with METRO off, and the screen shows COUNT-IN with the beats left), then starts at step 1. Notes played during the count-in are not recorded, except one played just before step 1, which lands on it. Without REC, PLAY starts at once.

Scenes are snapshots of every track's pattern (A/B), levels, influence routes, mutes and macros.

- **Store:** hold **SAVE** and press a white key (1-16). Over a stored scene, the first press asks: press again to overwrite.
- **Launch:** on the SCENES page, press a white key. It changes on the next bar. Black keys 1-2 there switch the current track's pattern.
- **Glide:** with **GLIDE** set to 1-8 bars, a launched scene (or an arrangement row) changes its patterns and mutes on the bar as before, but the track levels, the macros and the influence routes' amounts travel to the scene's over that many bars, easing in and out. A route the new scene adds grows from nothing; a route it drops fades, then goes. GLIDE JUMP switches everything at once, as before. Stopping mid-glide lands on the scene.

Arrangement: a list of up to 32 rows, each "play scene S for B bars".

1. Set **ROWS** to the number of rows the song needs.
2. Pick each row with **PRESETS** and set its SCENE and BARS.
3. Set **PLAYS** to SONG and press PLAY.

Without an END row the song loops back to row 1. Give the last row the scene END to have the transport stop there. A scene with its own tempo (S TEMPO) changes the tempo when its row starts.

Density arcs. For each track, draw 16 points of density, each lasting SPAN bars (1, 2 or 4: an arc of 16, 32 or 64 bars, so a part can stay quiet for a long stretch and open up once).

- At 100 % every step plays. Lower values thin the part out, off-beats first and downbeats last.
- One pattern can then breathe across a phrase without writing new patterns.
- Pick the bar with PRESETS and the track with ALGORITHM.

The clock (after Silt's two-oscillator clock).

- Oscillator A is the tempo. **B DOES** lets a second, slower oscillator bend it:

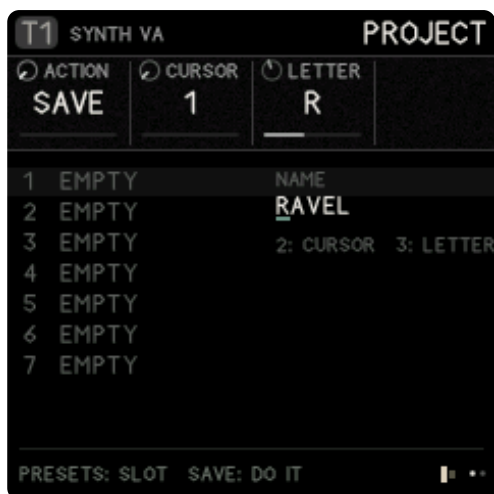
B DOES	Effect
STEADY	No bending
RATE	Speeds up and slows down
SHAPE	Changes the swing-like shape
PHASE	Pushes and pulls the pulses
SUM	Adds the waves
AND, OR, XOR	Logic rhythms between the two

- With **DEPTH** at 0 the clock is straight.
- **TEMPO IS: FREE** lets it drift like an old drum machine.
- **Tap tempo:** hold **GLO** and tap black key **1**.
- **Mute and solo:** hold **GLO** and press white keys **1-8** to mute tracks 1-8, or **9-16** to solo tracks 1-8.

14. SAVE: projects and sounds

SAVE has two pages: **PROJECT** (the whole song) and **SOUNDS** (one track's sound at a time). Turn **SELECT** to go from one to the other.

Projects



1. Press **SAVE** to open the page.
2. Turn **PRESETS** to choose a slot (1-7). The picture shows which slots are used and their names.
3. Turn **KNOB 1 (ACTION)**:

Action	What it does
SAVE	Saves the project to the slot
LOAD	Loads the slot
DEMO 1	The Ravel demo
DEMO 2	Dust
DEMO 3	The graph demo
INIT	A new, blank project

4. To name the project, use **KNOB 2 (CURSOR)** to pick a letter's place (1-11) and **KNOB 3 (LETTER)** to choose it (A-Z, 0-9, space and - + # & ' .), as on SOUNDS. The name shows on the right, with a mark under the letter on the cursor. It belongs to the project you are working on, so name it before you SAVE; LOAD brings back the name it was saved with.
5. Press **SAVE** once: the footer says "PRESS SAVE AGAIN TO CONFIRM".
6. Press **SAVE** again to do it.

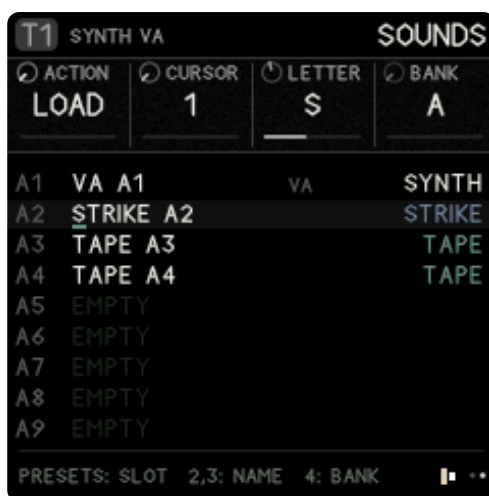
Ravel starts on a blank project every time it is switched on (or the emulator is opened). Saved projects stay in their slots: load one with **LOAD**.

There are seven project slots. (Before v0.5.0 there were eight; the eighth's room now holds the sound banks, so a project saved in slot 8 is gone after updating. Load it and save it to slots

1-7 first.)

A project holds everything: all eight tracks and their patterns, influence, modulation, buses, scenes, the arrangement, arcs and the LIBRARY of step envelopes. **It does not hold the tape audio.** Catch or resample again after loading.

Sounds: your own bank



Four banks (**A-D**) of 32 slots for your own sounds, 128 in all, of any kind: a synth on any engine, a strike, a perc machine, a whole kit, or a tape track's settings. Each has a name, and its kind is shown on the right of the list (**SYNTH**, **STRIKE**, **PERC**, **KIT**, **TAPE**; a synth also shows its engine). The banks are shared by every project and stay when you load another project or switch off.

A sound is the track's voice: its kind and engine, every sound setting (source, filter, skin, envelopes, insert, sends, the CZ patch, a kit's lanes). It is not the track's steps, sequencer settings or pan.

1. Press **SAVE**, then turn **SELECT** to **SOUNDS**.
2. Turn **KNOB 4 (BANK)** to a bank, then **PRESETS** to a slot. Slots are named by bank and number (A1 ... D32), and PRESETS runs on from one bank into the next (A32, then B1).
3. Turn **KNOB 1 (ACTION)**:

Action	What pressing SAVE does
LOAD	Puts the sound on the current track. A sound of another kind turns the track into that kind (a PERC sound on a synth track makes it a perc track).
SAVE	Keeps the current track's sound in the slot. An empty slot saves at once, named after the factory preset it came from (or its engine and slot, like VA B3). Over a used slot, press SAVE twice; the slot keeps its name.
CLEAR	Empties the slot (press SAVE twice)

4. **Name it:** on a used slot, **KNOB 2 (CURSOR)** picks a letter position (1-11) and **KNOB 3 (LETTER)** changes the letter (A-Z, 0-9, space and **- + # & ' .**). The cursor is the amber line under the name. The name is kept a moment after you stop turning.

Loading a sound that changes a track between a kit and notes (lanes and notes don't read each other's steps) clears that track's steps, so it asks first: press **SAVE** again.

In the emulator, your sounds are at the top of the sound menu under **My sounds**, one group per bank, each with its slot (A1 ... D32) before the name and its kind in brackets after it. Choosing one loads it into the current track, switching its kind if needed. **Save sound...** keeps the current track's sound (it asks for a slot such as B5, offering the first empty one, and a name), and **Delete sound...** removes one. The panel's SAVE > SOUNDS page works too.

Moving projects and sounds to an FM-1 (and back)

Everything you have saved, the projects in slots 1-7 and the sound banks A-D, can leave the emulator as a file and go onto an FM-1 running Ravel, and the other way. The FM-1's own update leaves its saved projects and banks alone, so install the firmware first, then bring your work over.

In the emulator (the *Projects & sounds* panel on the left):

Button	What it does
Export file	Every saved project and sound bank, as one <code>.ravel</code> file to keep
Import file	A <code>.ravel</code> file into the emulator's slots (it asks before replacing used ones)
Send to FM-1	This page's saved projects and banks straight onto an FM-1 connected by USB with Ravel running (Chrome or Edge: allow MIDI when asked; it asks before replacing slots on the FM-1)
Get from FM-1	The FM-1's saved projects and banks, read into a <code>.ravel</code> file (Import file then brings them into the emulator)

From the command line (`pip3 install mido python-rtmidi`), with the FM-1 connected and Ravel running:

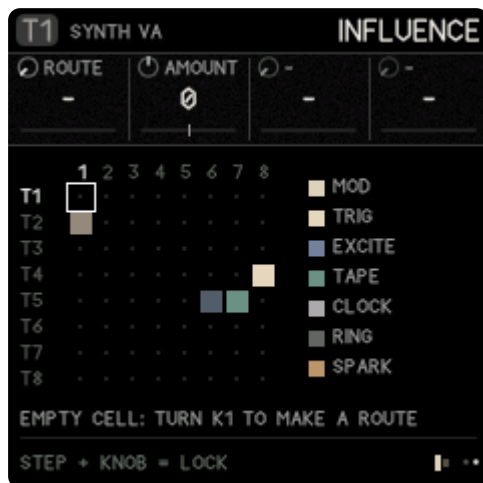
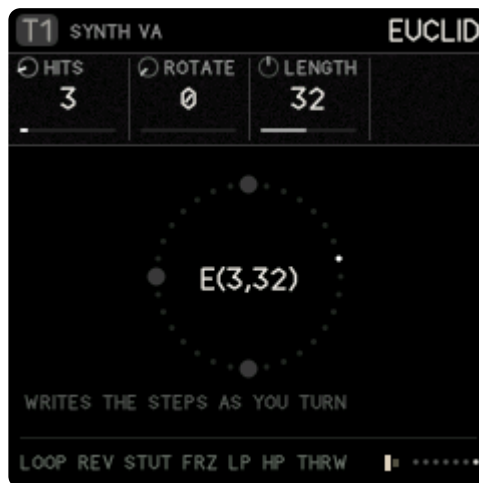
```
python3 tools/fm1_data.py info                # what the FM-1 holds
python3 tools/fm1_data.py restore my-work.ravel  # the file's projects and banks
python3 tools/fm1_data.py backup fm1-work.ravel  # the FM-1's, into a file
python3 tools/fm1_data.py restore my-work.ravel --only project3,bankB
```

Each project and bank goes to the same slot it came from (project 3 to project 3, bank B to bank B) and replaces what was there; slots not in the file are left as they are. Every piece is checked as it arrives (a CRC over the whole slot), and a slot only becomes valid on the FM-1 once all of it has arrived intact; the screen says RECEIVED PROJECT 3 or RECEIVED BANK B as each one lands. Load a project afterwards with SAVE > PROJECT > LOAD. The tape's audio is not part of a project, so it doesn't travel.

15. Hold layers

Hold a button (in the emulator: right-click or shift-click to latch it) and the keys or knobs do something else. The footer always shows the layer's hint.

Hold	Then	Does
SEQ	white keys	Steps, from any page. Hold a step and turn a knob to lock that value on that step.
SEQ + ENV	hold a step, turn KNOB 1	The step's LIBRARY envelope
LF0	KNOB 1-4	Macros 1-4
FX	white keys 1-8	Punch-ins: loop, reverse, stutter, freeze, low pass, high pass, throw, fill
ARP	white keys	Jump the tape track's playhead from any page
GLO	white keys 1-8 / 9-16, black 1	Mute / solo, tap tempo
SAVE	white key	Store scene 1-16
SCL	any key	Set the root
REC	OCT- / OCT+	Catch / resample



16. Recording

1. Choose the track with **ALGORITHM**.
2. **Tap REC**. "RECORDING ARMED" flashes and a red dot appears in the footer.
3. Press **PLAY**.
4. Now, while it plays: - **notes you play** are written into the steps, with their timing kept as microtiming; **chords** too: keys pressed together land on one step as a chord of up to four notes (the step's note and up to three more), and play back together. A note played on a step while none of its keys is still down replaces what was there; - **knobs you turn** are written as parameter locks on the playing step; - on a tape track in MLR, **jumps you make** are written as jump steps.
5. **Tap REC** again to stop recording.

Turning ALGORITHM while armed moves recording to the new track.

Chords on steps. A step with a chord shows **X2**, **X3** or **X4** (how many notes) under its note on the STEPS page. NOTE moves the whole chord, its shape kept; transposition, the scale and INTERVAL apply to each note. The chord's notes share the step's velocity, length, ratchets and timing. To make a step a single note again, record one note over it. Chords need the voices: a synth track plays up to four notes at once (VOICES on EDIT > SOUND).

Recording from a SEQ page. On the SEQ pages the keys are normally the steps. With REC armed on a synth, strike or tape track they play notes instead, so you can watch the steps fill in as you play (the footer says REC: KEYS PLAY); OCT- and OCT+ change the octave rather than the step page. Hold **SEQ** for the keys to be steps again for a moment: tap one to add or remove a step, then let go and keep playing. Tap REC to stop, and the keys are steps again. A kit keeps its keys as steps on SEQ pages; play its lanes from any other page.

17. Recipes, step by step

Make a first sound

1. Turn **ALGORITHM** to T1.
2. Press **EDIT** (SOUND page). Turn **KNOB 2** to **CZ**.
3. Turn **PRESETS** to hear the CZ sounds (CZ BRASS, CZ BELL, CZ STRINGS...); play the keys.
4. Turn **SELECT** to **DCW 1**. Turn **PRESETS** to step 1 and turn **KNOB 2 (LEVEL)** up to make the attack brighter.
5. **SELECT** to **DCA 1**. On step 1, turn **KNOB 1 (RATE)** down for a slow swell.

Write a beat

1. Turn **ALGORITHM** to T5 (strike).
2. Press **SEQ**. Tap white keys **1, 5, 9, 13**. Press **PLAY**.
3. Hold key **13** and turn **KNOB 2 (VELO)** down for a softer hit.
4. **SELECT** to STEP TIMING. Hold key **9** and turn **KNOB 2 (RATCHET)** to 3 for a roll.
5. To lock a sound change on one step:
6. Press **EDIT**, **SELECT** to SOURCE 1.
7. Hold **SEQ**, hold key **5**, turn **KNOB 4 (TONE)**.
8. Let go. Only step 5 is brighter.

Catch and cut up a loop (MLR)

1. Get something playing (load DEMO 1, press PLAY).
2. Hold **REC**, press **OCT+** (resample). At the next bar, a bar is recorded into row 1.
3. Press **ARP**, which jumps to T7, a tape track. **SELECT** to PLAYBACK and set **MODE** to MLR.
4. Tap white keys to jump around the loop. Hold two keys to loop between them.
5. Press black **5** for reverse, **6** for half speed.
6. Tap **REC**, then jump around while it plays. Your jumps become a pattern.

Play the tape across the keys

1. With something caught, **ALGORITHM** to T8. Press **ARP**, **SELECT** to PLAYBACK, **MODE** = KEYS.
2. **SELECT** to SAMPLE: **PLAY** = LOOP. Back on PLAYBACK, turn **END** down for a shorter loop.
3. Play chords. For a loop that breathes: LFO › MATRIX, SOURCE LFO1, TRACK T8, PARAM END.

Break a phrase into shards

1. On T8, **MODE** = SHARDS, **PLAY** = LOOP.
2. **SELECT** to SHARDS: **SHARDS** 8, **ORDER SHUF** 1, **GAP** 50.
3. Hold a key. Turn **ORDER** and **GAP** while it plays.

Two-headed graph melody

1. **ALGORITHM** to T1. **SEQ**, switch some steps on with different **NOTES** (hold a key, turn **KNOB 1**).
2. **SELECT** to TRACK, **MODE** = GRAPH.
3. **GRAPH** page: pick step 4 with **PRESETS**, set **CORD A** = 1 (it loops back), **CORD B** = 8 (or branches ahead), **BRANCH** = TURNS.
4. **HEAD 1**: **ROLE** = GATE, **HEAD 2** = PITCH.

5. HEAD 2: **H2 RATE** = 2/3, **H2 START** = 5.
6. HEAD 1 MOTION: **SHAPE** = ARCH, **DEPTH** = +32, **CYCLE** = 16. The rhythm speeds up and slows down over 16 steps while the melody walks its own path.

Put reverb on just one track

1. ALGORITHM to the track. Press **FX**, SELECT to SPACE.
2. **KNOB 4** (T3 SEND , for example) up. The other tracks' sends stay where they were.
3. SPACE 2: raise **MOTION** for a moving tail and **LOW CUT** to keep it out of the bass.

One track plays another

1. ALGORITHM to T5 (the source). Press **HOME**, SELECT to INFLUENCE.
2. **PRESETS** to column 2, T2 (the target). **KNOB 1** = TRIG, **KNOB 3 (DELAY)** = 2, **KNOB 4 (CHANCE)** = 60.
3. Now 60 % of T5's hits also play T2 two steps later.

Save your work

1. **SAVE, PRESETS** to a slot, **KNOB 1** = SAVE.
2. Press **SAVE**, then **SAVE** again.

Keep a sound and use it on another track

1. Pick the track with the sound. **SAVE, SELECT** to SOUNDS.
2. **PRESETS** to an empty slot, **KNOB 1** = SAVE, press **SAVE**.
3. Name it with **KNOB 2** (position) and **KNOB 3** (letter).
4. ALGORITHM to another track, **KNOB 1** = LOAD, press **SAVE**. The track becomes the sound's kind if it wasn't already.

18. Quick reference

I want to...	Press / turn
Pick a track	ALGORITHM (emulator: 1-8)
Next page	SELECT, or tap the section button again (FX: the next bus)
Change a sound	PRESETS on any EDIT page
Start / stop	PLAY (emulator: Space)
Turn steps on	SEQ, tap white keys
Edit one step	Hold its key, turn knobs
Lock a value on a step	Hold SEQ + step, turn a knob on any page
Pattern A / B	Black key 1 / 2 on SEQ, or PRESETS
Catch the tape	Hold REC + OCT-
Resample a bar	Hold REC + OCT+
Jump the tape from anywhere	Hold ARP + white key
Mute / solo	Hold GLO + white 1-8 / 9-16
Tap tempo	Hold GLO + black 1
Store a scene	Hold SAVE + white key (twice over a stored one)
Launch a scene	GLO › SCENES, white key
Play macros	Hold LFO, turn KNOB 1-4
Punch-in effects	Hold FX + white 1-8
Record	Tap REC, then PLAY (on SEQ pages the keys then play notes; hold SEQ for steps)
Name a project	SAVE › PROJECT, KNOB 2 cursor, KNOB 3 letter
Save	SAVE, choose slot and action, SAVE twice
Keep or load a sound	SAVE › SOUNDS (SELECT), KNOB 4 bank, PRESETS slot, KNOB 1 = SAVE or LOAD, SAVE
Move projects and sounds to an FM-1	Emulator: Export file / Send to FM-1; or <code>tools/fm1_data.py restore FILE</code>
A per-track LFO	ENV › FENV LOOP: F LOOP on; FENV ROUTE: F DEST and F AMT
One row of the matrix moving another	LFO › MATRIX: TRACK = MATRIX, PARAM = ROW n
A kit lane faster or slower	SEQ › DRUM, KNOB 3 RATE (or the lane's LANE page)
Choose a kit lane's machine	EDIT › LANE n (black keys 3-8), PRESETS
Spread hits evenly (a track or a kit lane)	SEQ › EUCLID: HITS, ROTATE

I want to...	Press / turn
A bouncing, darkening roll	SEQ › STEP TIMING: RATCHET, R CURVE BOUNCE; STEP SHAPE: R MOVE DARK
A stutter that settles or drags	SEQ › STEP CUT: C SHAPE, C SIZE (punch-ins: FX › MASTER 2)
Every hit a little different	EDIT › SKIN 2: GRAIN (strike, perc)
A dusty bed under everything	FX › BED: LEVEL, TONE; BED 2: DUCK, SPACE
One track's hits ringing a strike track	HOME › INFLUENCE: route SPARK
Scenes that glide	GLO › SCENES: GLIDE 1-8 bars
Record a chord onto a step	Tap REC, PLAY, press the keys together
Graph steps past 16	GRAPH page, OCT+ / OCT-
A huge, long reverb	FX › SPACE 2: MODE CLOUDS; then SPACE: DECAY near the top
A worn tape echo	FX › DELAY, then TAPE WEAR: WOW, FLUTTER, SATURAT, AGE
Grains in the delay	FX › GRAINS: GRAINS up
A sample across the keys	ARP › PLAYBACK: MODE KEYS (T7/T8, with something caught)
A loop whose end breathes	Matrix: LF01 → T8 END
A tape kit	EDIT › SOUND on a tape track: MODE KIT
A lo-fi 12-bit reverb	FX › SPACE 2: MODE 12-BIT, DIFFUSE becomes CRUNCH (fewer bits)

19. Questions people ask

A page I saw before is gone.

- It only shows when it applies. SOURCE 3 and 4 depend on the engine. MLR, SAMPLE, STRETCH, SHARDS and SLICES depend on the tape mode. The graph's HEAD pages appear only in GRAPH mode, HEAD 2's only when head 2 is on.
- Holding LFO does not change pages: it puts the macros on the knobs.

The FX page changes a value for every track.

- Only the knob named **T_ SEND** is per track. Everything else on a bus page is the shared effect.

The tape track is silent.

- The tape has to hold something: catch (REC + OCT-) or resample (REC + OCT+).
- In MLR, tap a white key on the TAPE page to start the playhead (black 8 starts and stops it).
- Check its LEVEL and that the row is not tiny (ROWS page).

The graph doesn't seem to do anything.

- Check SEQ > TRACK > MODE is GRAPH.
- Steps need to be on (tap them).
- With no cords, each step just goes to the next one, so it sounds like a normal sequence until you add cords or branches.

The FM-1 crackles, or makes a loud noise.

- The audio is taking longer than it has. Open GLO > CPU: if RENDER is near or over 90 % and XRUNS is counting, that's it. The bars show which part costs most.
- Fewer voices (EDIT > SOUND > VOICES), fewer tracks playing at once, or lower effect sends bring it down. The overload guard fades out voices on its own, but it can't help when the effects alone are too much.
- To know this unit's limits, run GLO > STRESS with AUTO.

Something got loud or stuck.

- Press **Panic / stop all** (emulator), or stop and start.
- High FEEDBACK REGEN and delay FEEDBK can build up; the master limiter stops it reaching your speakers.

Installing on the FM-1

Ravel has not been tested on FM-1 hardware yet. Installing it is at your own risk.

1. Open Ravel's site (the repository's GitHub Pages: the emulator) in Chrome or Edge on a computer, and press **Install on FM-1** at the top.
2. Connect the FM-1, switched on, directly to the computer with a USB data cable.
3. Press **Install**, allow MIDI when the browser asks, and wait until it says it is done. Don't unplug part way. The FM-1 restarts into Ravel.

From the command line instead (`pip3 install mido python-rtmidi`): `python3 tools/fm1_install.py Ravel-FM1.fwsc` . The `.fwsc` is on the site (`firmware/Ravel-FM1.fwsc`) and on the repository's releases.

The installer works from M-VAVE's own firmware, from Ravel, and from the other community firmwares. **To go back**, the same page writes M-VAVE's own FM-1 firmware (which you download from M-VAVE) back over the same cable; M-VAVE's own updater, M-UPGRADE, works too.

If the FM-1 will not start

- **Hold OCT- and OCT+ for 5 seconds** while Ravel runs: the FM-1 goes into its update mode, and the installer can write any firmware.
- **Safe mode:** if Ravel crashes twice while starting, it starts in a safe mode instead: no sound, USB on, so the web installer can reach it. PLAY tries Ravel again.
- **Calibration:** hold OCT- and OCT+ while switching on to teach Ravel which button and knob is which, if the panel seems mixed up.
- **Last resort:** if nothing shows on the screen but the FM-1 appears on USB in the chip's update mode, `tools/fm1_rescue.sh` (from XOX) puts M-VAVE's firmware back from a Mac. Beyond that, recovery needs the **FM-1-transporter**.

Licence

GPL-3.0 only (see `LICENSE`). The FM-1 platform layer, loader, installer and tools are Felucca's and XOX's (GPL-3.0). The Beads port keeps Mutable Instruments' MIT licence. A firmware package also contains three files of JieLi's AC79 SDK (Apache-2.0). The CZ engine is a port of MAME's uPD933 emulation (BSD-3-Clause). Third-party code is listed in `THIRD_PARTY.md` .

Credits

- Mutable Instruments (Émilie Gillet) for Beads, whose tape formats the capture tape keeps and whose grains the delay's GRAINS follows, and for Clouds, whose reverb the CLOUDS mode follows.
- **Felucca** by Leo Kuroshita (@kurogedelic), Hügelton Instruments: the FM-1's open hardware layer, USB, storage, update loader and web installer that Ravel runs on.
- **XOX**, a Felucca fork, for the platform as Ravel takes it, the simulator's design, its PNG writer and the build, install and rescue tools.
- The authors of JIANT, SLOOP and sloopDX, and everyone who mapped the FM-1.
- XAOC Devices' Zadar, whose library of morphing shapes the WAVE engine's WAVE ENV follows (the shapes are Ravel's own).
- The screen is set in Ravel's own runic stroke alphabet (`tools/runic_glyphs.py` : straight strokes only, curves turned into points), drawn at eight times the size and brought down to the screen at 16 levels. The palette is black and greys with bone and verdigris accents; tracks are told apart by colour: synth white, strike slate, tape verdigris, perc maroon.
- Moog's MF-105 MuRF, whose fixed resonant bands and patterns the BANDS bus follows.
- E-mu Systems, whose Z-plane filters the Z filters follow in spirit (the frames are Ravel's own designs).
- Maxime Denuc's Nachthorn and Dorian Concept's SH-101 playing, which the ORGAN and MONO engines are made to sound like (Ravel's own synthesis; no recordings used).
- Elektron's Machinedrum, whose synthesis machines and their documented parameters the PERC tracks are built from (Ravel's own designs; no Elektron code or data).
- Kurzweil's VAST and E-mu's patch-cord functions, whose idea of building sound from function blocks the LOGIC engine follows.
- Wolfgang Palm's PPG Wave and Waldorf's Microwave, whose wavetables, stepping and wave envelope the WAVE engine follows, and Xfer's Serum, whose phase warps it borrows the idea of (the tables are Ravel's own).
- Ensoniq's SQ-80, the instrument the SQ engine is modelled on, and the SQ8L plugin by Siegfried Kullmann, which showed how much of the SQ-80's character is in its digital path (no code or waves are taken from either).
- Devin Acker and MAME, whose uPD933 emulation shows how the Casio CZ's sound chip works (the CZ engine follows it; BSD-3-Clause, see `THIRD_PARTY.md`).

