harmonic oscillator

S F E
devices

INSTRUMENT · FOUR VOICES · MPE

WHAT IT DOES

harmonic oscillator is an additive instrument. Eight partials stand on one fundamental and are mixed with eight level dials. A scan window can select partials instead, an eight step sequencer can strike them one at a time, and two reverbs sit at the end.

Four voices; a fifth note takes the place of the oldest one. Velocity scales the loudness of each note. Pitch bend on channel 1 moves all voices by up to 2 semitones. Played from an MPE controller such as Push, every finger shapes its own voice with pressure, slide and bend (see **expression**).

The first two cards of the panel carry no heading: the first holds the level dials and the step menus, the second the scan window, the oscillator and sequencer menus and the two strike dials.

LEVELS

`1 to 8`	the mixer, one dial per partial, 0 to 100: **level 1** is the fundamental, then **level 2**, **level 3**, **level 4**, **level 5**, **level 6**, **level 7** and **level 8** for the partials above it. On the panel they are labelled **1** to **8**. On load only the fundamental is up. The dials are squared, so the lower half of the travel is finely resolved. **mix** crossfades between these dials and the scan window.

SCAN

A window that travels across the eight partials, as an alternative to the level dials.

`scan`	the centre of the window, 1 to 8.
`width`	the width of the window, 0 to 100, from one partial to almost the whole series. At the minimum the window still covers one partial, so it never falls silent between two of them.
`tilt`	**spectral tilt**, -100 to +100: tilts the series toward the low partials (left) or the high ones (right), up to 12 dB up and down at the two ends of the series. It acts on the level dials and on the scan window.
`mix`	**scan mix**, 0 to 100: crossfades between the eight level dials (0) and the scan window (100).

OSCILLATOR

The two menus under the label oscillator.

`wave`	the upper menu: the waveform of the fundamental, `sine`, `triangle`, `square`, `saw`, `pulse 75` or `pulse 90` (a square with 75 or 90 percent pulse width). All are anti aliased.
`partials`	the lower menu: the waveform of partials 2 to 8, the same six shapes. On `sine` the partials are sine tones. On any other entry each partial becomes a full waveform of its own, which adds its own overtones on top of the series and makes a dense spectrum.

SEQUENCER

Eight steps strike the partials one at a time. The clock runs in the tempo of the set and the pattern starts again with the first note of a phrase.

`sequencer`	the upper menu under the label sequencer. `off`: the partials sound steadily, without strikes. `on`: the steps in order. `random`: a random step each time.
`rate`	the lower menu: the length of a step as a note value, `1/1`, `1/2`, `1/4`, `1/8`, `1/16`, `1/32`, `1/4T`, `1/8T` or `1/16T`.
`attack`	**sequencer attack**, 0 to 100: the rise time of each strike, 0.5 ms to 4 s.
`step decay`	**sequencer decay**, 0 to 100: the decay time of each strike, 5 ms to 30 s. With long settings the strikes ring over each other and build up into a standing chord.
`step menus`	the eight menus in the first card, **step 1**, **step 2**, **step 3**, **step 4**, **step 5**, **step 6**, **step 7** and **step 8**, one per step, left to right in two rows. Each chooses the partial struck on its step, `1` to `8`; the hyphen entry (`-`) is a rest.

The level of a strike comes from the level dials: a step only sounds if the partial it chooses has its level up, and the scan window masks the pattern as well. The fundamental is not sequenced; it stays on the main envelope and carries the note.

SERIES AND TUNING

series, the second menu of the out card, sets the ratios of the eight channels to the fundamental. The fundamental follows the MIDI note.

entry	ratios
`1-8`	1, 2, 3, 4, 5, 6, 7, 8: the harmonic series
`sub`	1/4, 1/2, 1, 1.5, 2, 3, 4, 5: two subharmonics below the fundamental
`odd`	1, 3, 5, 7, 9, 11, 13, 15
`fifths`	1, 1.5, 2.25, 3.375, 5.06, 7.59, 11.39, 17.09
`stretch`	k to the power 1.1: 1, 2.14, 3.35, 4.59, 5.87, 7.18, 8.50, 9.85
`octaves`	0.5, 1, 2, 4, 8, 16, 32, 64
`free`	set per channel with the ratio dials

`tune`	**tune view**: a button that appears in the second card, under the step decay dial, only while **series** is on `free`. It swaps the level dials for the eight ratio dials and back. Both sets stay active whichever is shown.
`ratio 1 to 8`	**ratio 1**, **ratio 2**, **ratio 3**, **ratio 4**, **ratio 5**, **ratio 6**, **ratio 7**, **ratio 8**: shown in place of the level dials. Each sweeps the table 1/4, 1/2, 1, 1.5, 2, 3, 4, 5, 6 and 8 times the fundamental, latches on those values and glides between them, so intermediate tunings are possible. They sound only on `free`; the levels still come from the level dials.

REVERB

The first of the two reverbs, a feedback delay network with a diffusion stage. The second one, **plate**, sits in the out card after it. This one is grainy rather than clean: the tail carries noise and grain, the more so with absorb to the left, with decay high and with depth turned up.

`blend`	dry to wet, 0 to 100, on a cosine curve. At 0 the reverb is fully off.
`size`	the room size in metres, 1 to 500 (the travel time is the size over the speed of sound). Changing it while the tail rings shifts the pitch of the tail.
`decay`	the reverb time, 0 to 120. Above about 99 the tail sustains without end; a saturation stage keeps the loop bounded.
`absorb`	0 to 100, the damping low pass in the loop together with the strength of the diffusion allpasses: left metallic, right soft and dark.
`reverb tilt`	**tilt** of the reverb, -100 to +100: a shelving eq at 300 Hz and 6 kHz that tilts the reverb dark or bright, up to 12 and 24 dB.
`pre`	the pre delay, 7 to 500 ms. With **reverse** on, the loop runs backwards through this window.
`pre div`	shown in place of **pre** while **sync** is on: the pre delay as a note value in the tempo of the set, `1/64`, `1/32`, `1/16T`, `1/16`, `1/8T`, `1/16.`, `1/8`, `1/4T`, `1/8.` or `1/4`. It is capped at 500 ms, the longest setting of the pre dial.
`speed`	0 to 100, the rate of the modulation inside the reverb, 0.1 to 256 Hz on an exponential scale; 29 is about 1 Hz.
`depth`	-100 to +100, amount and kind of that modulation. Left of the centre a sine chorus, right of it granular random motion; above +80 reversed grains are added to the feedback. At 0 the room is static.
`reverse`	the pre delay plays backwards in two crossfading grains.
`sync`	**pre sync**: the pre delay as a note value instead of milliseconds; the pre dial turns into the menu **pre div**.

OUT

attack2	the attack of the envelope (its full name is **attack**), 0 to 100: the rise time per voice, 1 ms to 5 s; at 0 the note starts at once. It applies to gate as well as pluck.
env decay	0 to 100: after the attack the level falls to the sustain level in 50 ms to 10 s. Gate only; at **sustain** 100 it has nothing to do.
sustain	0 to 100, the level the note holds while the key is down, after the decay. At 100 it holds at full level and decay does nothing, at 0 the decay takes it all the way down. Gate only.
release	0 to 100, a decay of 50 ms to 10 s: in gate after the key is released, in pluck after the attack. 28 is about 220 ms.
spread	0 to 100, places the partials across the stereo field: channels 2 and 3 go fully out, 4 and 5 half, 6 and 7 slightly, 1 and 8 stay in the centre. At 0 the output is mono.
fine	-100 to +100 cents around the MIDI note, on the whole instrument.
plate	0 to 100, the second reverb, after the first one: a plate with a long tail of fixed length, dry to wet. At 0 it is off and not computed.
output	the master level after the sum, -24 to +12 dB.
envelope	the first menu of the card. `gate` sounds while the key is held. `pluck` strikes once on the note and decays even while the key is held. `drone` keeps the voices that were played sounding as a standing chord after the keys are released; the first of the four voices sounds from the start, on C3 until a note reaches it.
series	the second menu: `1-8`, `sub`, `odd`, `fifths`, `stretch`, `octaves` or `free`. See series and tuning.
lofi	runs the synthesis internally at 31.25 kHz and holds the output between those samples: more aliasing, duller highs. Off, it runs clean at the rate of the set.

MPE

Played from an MPE controller such as Push, every note arrives on a MIDI channel of its own, and each finger shapes the voice it plays.

expression	0 to 100, how much pressure and slide shape each voice. Pressure makes that note louder: at 100 the level follows the pressure from silence to full, at 50 it runs from half to full. Sliding up and down tilts the partials of that voice toward the high or the low ones, the same way as **tilt**, up to 12 dB at the two ends of the series at 100. Bend always follows the finger, 48 semitones either way over its whole range, whatever this dial is set to. At 0 only the bend is left.

A voice starts from the pressure and slide last sent on the channel of its note. A keyboard that sends neither leaves every voice at full level and without tilt, so it plays as without MPE.

WAVE

The display in the last card shows two periods of the output waveform at the pitch of the last note, held still on the screen.

PUSH

Eight parameter banks:

play	scan, width, spectral tilt, scan mix, sequencer, blend, size, decay
tone	wave, partials, series, fine, lofi, spread, plate, output
envelopes	envelope, attack, env decay, sustain, release, rate, sequencer attack, sequencer decay
reverb	absorb, tilt, speed, depth, pre, pre sync, pre div, reverse
levels	level 1 to level 8
steps	step 1 to step 8
ratio	ratio 1 to ratio 8
mpe	expression

The banks name the parameters by their full names; Push shows the short names of the panel.