
FRACTAOS
Multitimbral
polyphonic oscillator
with fractal synthesis
User manual version 1.5
Type
Pitch
Primitive Chaos
Primitive Depth
Morph
Spread
Texture
Ingenious Instruments for Creative Minds

Sommaire

Specifications

Width: 32 HP

Power consumption:

+12 V: 210 mA

–12 V: 20 mA

+5 V: 0 mA

Depth: 28 mm

Installation

Connect Fractaos to an Eurorack power supply using the supplied cable. The module is protected against reverse polarity, and the keyed connector on the cable ensures that it can only be inserted in the correct orientation.

1. General overview

Fractaos is a four-voice polyphonic, multitimbral Eurorack module for fractal synthesis. It does not use a sample bank (wavetable or sample) or a conventional oscillator model. Its sound source is a set of fractal curves computed in real time, scanned at audio rate and combined in pairs (driver oscillator / follower oscillator) to produce an evolving timbre.

To keep menu navigation to a minimum, most controls are directly accessible through potentiometers and switches, with eight CV inputs fitted with attenuators. Only preset selection (loading and saving) and envelope adjustment are handled with the encoder and the screen. The four polyphonic voices (each made up of two oscillators) can operate in LIVE mode, preset loading mode, Drone mode (held note, ideal for drones and chords), or multitimbral mode (each voice on a separate MIDI channel, with different presets per voice). Polyphony can be accessed either through MIDI or through CV, with four trig inputs and four 1 V/octave inputs.

1.1 Audio architecture

- 8 fractal oscillators computed in real time, organized into 4 driver/follower pairs.
- Each voice (0 to 3) includes the driver oscillator and the follower oscillator.
- One ADSR envelope per voice, with variable curvature (linear, exponential or logarithmic), shared between driver and follower.
- One resonant fractal filter per voice (4 polyphonic filters).

1.2 Basic concept

The sound produced by Fractaos is based on several elements:

- The “driver” fractal is a curve generated by a fractal algorithm (Mandelbrot, Hénon, Hilbert, etc.), shared by each driver oscillator (but evolving individually).
- The “follower” primitive is a curve generated by a second fractal algorithm, shared by each follower oscillator (but evolving individually).
- The primitive acts as a modulation element for the driver fractal, with many possible intervention parameters.
- Morphing between the two fractals within the same oscillator, which can be animated by the primitive.
- “Detune”: the frequency offset between driver and follower, or more broadly between the 8 oscillators in Drone mode, controlled by the Spread potentiometer.
- “Texture”: a fractal filter that detects interactions between the curves and extracts formants and resonances from them.

2. Controls

Fractaos has 14 potentiometers, 5 push-button switches, a rotary encoder with push-button, two selection micro-switches, a color TFT screen, and CV/Gate/MIDI jacks.

2.1 Potentiometers

Potentiometer	Role
Fractal Type	Selects the main fractal from the 20 available options (14 geometric or iterative fractals and 6 atonal textures).
Primitive Type	Selects the secondary modulation fractal from the 14 geometric fractals only; the 6 textures are not available for the primitive.
Chaos	Amount of chaos applied to the main fractal. This parameter is quantized in steps depending on the fractal type. For some fractals it is highly expressive; for others, its effect is more subtle. When Chaos is at maximum, the instability of the fractal becomes audible.
Primitive Chaos	Amount of chaos applied to the secondary modulation fractal. Same principle as Chaos.
Depth	Recursion depth of the main fractal. The higher the value, the denser the fractal is in fine detail. The useful range depends on each fractal. This parameter changes abruptly in steps and cannot be modulated by CV.
Primitive Depth	Recursion depth of the secondary modulation fractal. Same logic as Depth.

Morph	Continuous blend between the driver oscillator and the follower oscillator. At 0, you mostly hear the main fractal; at 1, mostly the secondary one; between the two, an audible morphing occurs. The primitive always acts as a modulation source on the main fractal: Morph is therefore more complex than a simple audio balance.
Spread	Spread (detune) between driver and follower in normal mode; chord selection or global spacing in Drone mode.
Texture	Amount of "texture" applied to the final shape produced by the two oscillators of each voice. This parameter controls the resonance of the fractal filter, formant detection and application, the amplitude of organic micro-detunings, and the intensity of the filter.
Speed	Speed of the LFO derived from the primitive. Range from 0.001 Hz to 12 Hz, with exponential mapping to favor slow speeds.
Amount	Amplitude of the LFO. Amount also acts as an intensity parameter for "Texture" curves and for Texture detection. In FM mode, it becomes a bipolar control: from 0 to 50%, it sets the internal feedback of the main fractal; at the center, FM is neutral; from 50 to 100%, primitive 2 modulates the frequency of the main fractal.
Pitch	Shifts the overall pitch (continuous transposition, about ±2 octaves).
Out L and Out R	The volume of each stereo output.

2.2 Switches

The five switches Loop, Trig, Morph (FM), Spread and Chaos determine what is modulated by the LFO derived from the primitive and how that LFO behaves.

Switch	Effect
Loop	LFO loop mode. ON = free-running looped LFO. OFF = triggered LFO mode (one-shot) if Trig is ON; otherwise the LFO is inactive — except in certain special modes such as FM.
Trig	Enables primitive triggering. If Loop = OFF, each note restarts the LFO from the beginning and it stops at the end of the curve until a new note is played. If Loop = ON, the LFO loops as long as the note is held.
Morph (FM)	Enables LFO modulation on the Morph parameter. When Morph is enabled alone, with Loop, Trig, Spread and Chaos disabled, Fractaos enters simplified FM mode.
Spread	Enables LFO modulation to create strong oscillating detune.
Chaos	Enables LFO modulation on the Chaos of the main fractal.
Drone	Enables Drone mode with status LED.
PREV and NEXT	Navigation in the menus.

Notable combinations

Simplified FM mode: Loop OFF, Trig OFF, Morph ON, Spread OFF and Chaos OFF. In this configuration, the Amount potentiometer acts as a bipolar control around its center position. From 0 to 50%, it introduces internal feedback: the main fractal modulates itself, producing

a sharper, denser sound, sometimes close to a deformed sawtooth. At the center, FM is neutral. From 50 to 100%, primitive 2 modulates the frequency of the main fractal: this is fractal FM proper, closer to modulation between two operators. The higher Amount is in this zone, the richer, more metallic or more unstable the timbre becomes, depending on the chosen fractals. FM is not active when the main fractal is a Texture, and its intensity is limited in the high register to preserve the sound quality.

Loop and Trig also determine whether the primitive behaves as a looping LFO or as a modulation retriggered with each note.

2.3 Encoder and screen navigation

The rotary encoder is used to navigate between the different screens (Display, Save, Load, Setup, Multi, ADSR).

A short press on the encoder button while the curves are displayed on the screen gives access to the envelope settings.

A long press switches from the curve display functions (the main screen) to the preset handling functions.

Two additional navigation buttons, “Prev/Next”, move the cursor through lists (for example, choosing the selected voice in Multi mode, navigating between rows on the Settings screen, etc.).

Pressing **PREV** while the main screen is displayed takes you directly to the LOAD screen, where you can use the presets. You can exit this screen directly with a long press on the encoder.

Pressing **NEXT** while the main screen is displayed takes you directly to the MULTI screen, where you can organize presets in multitimbral mode. You can exit this screen directly with a long press on the encoder.

2.4 Hardware inputs/outputs

- 8 CV inputs with attenuator (-5 V to +5 V for Texture, Pitch, Spread and Morph; 0 to 5 V for Speed, Amount, F-Chaos and P-Chaos).
- 4 1 V/octave CV inputs, one per voice.
- 4 Trig inputs, one per voice.
- One TRS type B MIDI input.
- One stereo audio output per channel.
- An SD card on the rear of the module for preset storage. This card normally does not need to be handled, except to add or directly save preset files.
- A micro-USB input on the rear of the module for possible updates (see the Kaona.fr website).
- A TFT screen (color interface).

3. Fractals

Fractaos offers 25 fractal generation algorithms. The “Fractal Type” potentiometer gives access to all 20 algorithms for the main fractal. The “Primitive Type” potentiometer provides access only to the first 14: the 6 textures and the 5 percussion models are not available as the second fractal, in order to preserve the harmonic rendering.

3.1 Geometric fractals

These 14 fractals have been modeled to produce waveforms with a fairly clear spectral signature, with defined harmonics and stable dynamics. They can be used both as the main fractal AND as the primitive. Depending on their chaotic drift, they may sometimes produce singular effects, but they are almost always reproducible and can therefore be saved in presets. However, some configurations with the most unstable curves may produce results that are not always homogeneous across certain frequency ranges.

Fractal	Sound character
Mandelbrot	Rich in high harmonics, with a “crystalline” and complex structure. High Depth values can produce internal resonances.
Julia	Related to Mandelbrot but with a softer texture. Chaos moves the attraction zones.
Cantor	A “gapped” wave, with an asymmetrical sawpulse character, very articulated and even grating.
Sierpinski	Recursive triangular shape: marked odd harmonics, with a slight asymmetry that creates a “bright” timbre.
Dragon	A winding wave, rich in internal beating. Very expressive under chaos modulation.

Rule30	Pseudo-random cellular automaton. Dense, granular spectrum, perfect for percussive sounds, basses, etc.
Lorenz	Continuous strange attractor — a complex waveform in permanent internal evolution: it can produce strong spectral drifts, sometimes even atonal and irregular depending on pitch. Chaos acts on the divergence.
Hénon	Discrete attractor interpolated with a cosine spline. At low chaos, a smooth oscillating curve; at high chaos, an extended strange attractor. A very experimental curve that will not always produce the same sound on every note.
Rössler	Spiral trajectories leading to deformed sine waves.
Logistic	Logistic map, bifurcations. Chaos creates period jumps.
Collatz	Arithmetic sequence, stepped and jerky profile, ideal for rhythmic textures.
Hilbert	Oscillations driven by the segments of the Hilbert curve. Produces audible “evolving rectangles”: stable frequency plateaus separated by abrupt changes. Chaos densifies the pattern and permutes the sub-cells, sometimes reaching a slight self-resonance.
Fibonacci	Although not a fractal in the mathematical sense, the modulated Fibonacci sequence, with harmonics linked to the golden ratio, produces a warm sound and is a good basis for many timbres.
Koch	Koch snowflake, self-similar fractal harmonics, perfect for subtle “crystal” sounds in the high register or “brass” colors in the low register.

3.2 “Texture” fractals

The following 6 fractals are designed as noisy, wide and atmospheric textures. They do not follow the same tonal logic as geometric fractals: their fundamental frequency is less defined, and they are intended for pads, drones and ambiences. For this reason, they are available ONLY as the main curve, and not as a modulation primitive. This avoids incoherent morphing between a tonal geometry and a noisy pad. These curves are shown on the screen in red.

Their behavior requires more computation; depending on the settings, some internal processes may therefore become slightly less responsive.

Texture	Sound character
Cloud	Cloud of harmonic particles, with complex noise.
Storm	Structured, dynamic wide-band noise. Sounds of thunder or dense rain may be heard depending on the Amount, Chaos, Depth and Texture settings.
Aliasing	Resonant texture with intentional aliasing. A special playback method amplifies digital artifacts for an assumed “digital” character.
String	Evokes a bowed or plucked string, rich in noisy secondary harmonics.
Ensemble	Dense ensemble, with more or less present tonal grains.
Cluster	Tight harmonic aggregation, dissonant, but capable of being made coherent depending on the settings.

3.3 “Drum” Fractals

The 5 Drum curves are real-time percussion models, not samples. Each hit combines excitation, resonances, filtered noise, and micro-variations.

They are available only as the main fractal and appear in orange on the screen, so they can be distinguished from the geometric fractals in cyan and the textures in red.

A Drum curve is a one-shot percussive event. Depth mainly controls the duration of the process: tail length, HiHat opening/closing, and resonance decay. Chaos controls hit variations, instability, roughness, internal detuning, and the more or less explosive character of the sound.

MIDI pitch is still taken into account. On Kick and Tom, it acts in a fairly tonal way; on Snare, HiHat, and Cymbal, it more strongly shifts the color, resonances, and internal filters.

FM has no effect on Drum curves. Morph, however, makes it possible to blend them with the second geometric fractal: percussive attack, harmonic tail, or polyphonic note depending on the selected primitive.

Drum	Sound character
Kick	Bass drum: short impact, pitch drop, and resonant low body. Depth lengthens the tail; Chaos hardens or dirties the hit.
Tom	Tunable drum shell, with several membrane modes. MIDI pitch is clear; Chaos slightly detunes the modes and modifies the strike energy.
Snare	Snare drum with an aluminum shell impact, snare-wire noise, and short metallic resonance. At high Chaos, it becomes sharper and more explosive.

HiHat	Hi-hat in several phases: hit, opening, then closing/choke. Depth controls the duration of the gesture; Chaos varies brightness and closing.
Cymbal	Cymbal with resonant metallic modes, more structured than simple noise. Depth lengthens the tail; Chaos varies roughness and color.

Differences between geometric fractals, textures, and percussion models

Filter: the resonant fractal filter acts normally on geometric fractals and textures, but on textures it can produce self-oscillation that adds a tonal component. On Drums, the internal filters are part of the percussion model.

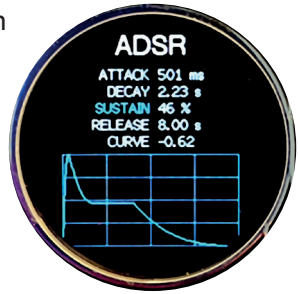
Organic Drift: textures tend to produce very slow sub-oscillations that slightly modulate phase, harmonic mix, and internal cutoff frequency.

Morph: since the primitive cannot be a texture or a percussion model, a geometric reference is kept on the variation side. With a Drum curve, Morph therefore blends the percussion with a polyphonic geometric fractal, without turning the percussion itself into FM modulation.

4. Envelopes

Each Fractaos voice has its own variable-curvature ADSR envelope. The envelope is shared by the two oscillators of a single voice.

4.1 ADSR parameters



- **Attack (A):** rise time from 0 to the maximum Sustain level, triggered by Note ON (from 1 ms to 8 s).
- **Decay (D):** time for the attack peak to fall toward the maintained Sustain level (up to 8 s).
- **Sustain (S):** level maintained as long as the note is held.
- **Release (R):** time to fall back to zero on Note OFF (up to 12 s).
- **Curve:** curvature of the ramps (linear, exponential, logarithmic).

Note: when Sustain is at 0, Release remains active in Fractaos. This allows dynamic playing: if the note is held until the end of Decay, Sustain at 0 applies and the note “disappears”. However, if the note is not held to the end, Release is activated and can therefore make the note “disappear” gradually.

4.2 Editing

The ADSR screen is used to adjust the 5 parameters shared by the 4 voices (even though there are indeed 4 polyphonic envelopes, they share the same settings). Envelope saving is automatic in EEPROM or in presets.

4.3 Drone mode

In Drone mode, the envelope is no longer triggered by Note ON/OFF events: the sound is held continuously. The behavior is close to a permanently held note, with a stable amplitude.

4.4 Fractal envelope

Independently of the main ADSR, each oscillator has an internal “fractal envelope” derived from the primitive. The Amount potentiometer controls its intensity, Speed controls its rate, and Texture controls the amount applied to the fractal filter. This envelope produces slow, organic modulations on the filter per voice.

5. Drone mode

Drone mode is enabled by the dedicated Drone button. It turns Fractaos into a polyphonic drone synthesizer: the 8 oscillators play simultaneously and continuously, without requiring a MIDI note or CV. The potentiometers remain active and can be adjusted in real time.

5.1 Differences from normal mode

- The note is held permanently: the ADSR envelope is no longer triggered as in conventional polyphonic playing.
- The 8 oscillators are distinct (no driver/follower grouping by voice): each can have its own detune relative to the others.
- The Spread potentiometer has a special two-zone behavior (see below).
- The 1 V/oct pitch CVs of the 4 voices as well as MIDI notes can still transpose the individual pairs.

5.2 Spread behavior in Drone mode

The Spread potentiometer is divided into three distinct zones:

Zone 1: 0 — 0.02

All oscillators are in unison, with no detune. This makes it easy to return to a neutral point.

Zone 2: 0.02 — 0.50 (linear spread)

The 8 oscillators gradually spread between 0 and +1 octave relative to oscillator 0 (which remains anchored to the base frequency). At 0.50, oscillator 7 reaches exactly +1 octave. The screen shows the detune percentage.

Zone 3: 0.50 — 1.00 (chords / micro-tunings)

The upper range of the potentiometer scans through 13 predefined "chords". Each chord assigns each of the 8 oscillators a transposition in octaves according to a specific definition. The transition from one chord to the next is progressive (smoothed by detune slew), and the chord name appears on the screen.

List of available chords (in potentiometer order)

Chord	Description
Unison cluster	Compact cluster around unison: +2, -2, +4, -5, +7, +9, +12 semitones.
Maj triad spread	Major chord spread over three octaves: 0, +4, +7, +12, +16, +19, +24, +28 semitones.
Min triad spread	Minor chord spread: 0, +3, +7, +12, +15, +19, +24, +27 semitones.
Sus4 / Fifths	Suspended chord in fourths/fifths: 0, +5, +7, +12, +17, +19, +24, +29 semitones.
Major 7th	Spread major seventh chord: 0, +4, +7, +11, +12, +16, +19, +23.
Minor 7th	Minor seventh chord: 0, +3, +7, +10, +12, +15, +19, +22.
Add 9	Chord with added ninth: 0, +2, +4, +7, +10, +14, +16, +19.
Add 11	Chord with added eleventh: 0, +5, +7, +10, +12, +17, +19, +22.
Add 13	Chord with added thirteenth: 0, +2, +5, +9, +12, +14, +17, +21.
Just intonation	Just temperament: major 7 chord with micro-corrections (–14 cents on the 7th and some thirds) to obtain pure consonances.

7-limit flavor	7-limit approximation: microtonal temperament with characteristic lowerings on the minor third and seventh, plus a slight push on the second.
19-TET slice	Slice of 19-TET (19-tone equal temperament per octave): ratios 4/19, 7/19, 10/19, 12/19, 15/19, 16/19, 19/19.
BP subset	Bohlen-Pierce scale (13.5-semitone octave).

5.3 Spread in non-Drone mode

Outside Drone mode, Spread behaves more simply: it introduces progressive detune between the driver and the follower of each voice (the driver remains at 0 octave, while the follower rises up to +1 octave).

6. Saving and preset system

6.1 Automatic saving in EEPROM

Three sets of information are automatically saved in EEPROM as soon as they change:

- MIDI calibration parameters (channels per voice, etc.).
- The 4 ADSR envelopes of each voice (A, D, S, R, curvature).
- The MULTI configuration: name of the preset assigned to each voice, volume per voice, active state.

At startup, Fractaos automatically restores these three sets from EEPROM.

6.2 Presets stored on SD card

Presets are stored as .frk files on the SD card. Each file contains:

- The 11 raw values of the main potentiometers.
- The 5 switch states.
- The 5 envelope parameters (A, D, S, R, curve) for the voice.

6.3 Saving a preset (SAVE screen)

From the main screen, a long press on the encoder gives access to the parameter screens. The SAVE screen appears first.

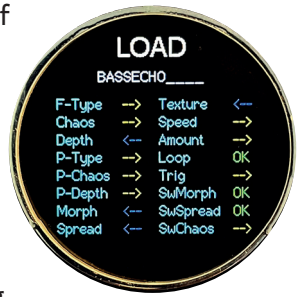
- Turn the encoder to enter a letter or number.
- Move to the next character by pressing the NEXT button (the PREV button lets you go back to previous characters to correct them).
- When the name is complete, press the NEXT button once more and “confirm” appears in large text. Pressing the encoder then saves the preset and returns to the main screen.

Warning: pressing the encoder when the word "confirm" is not displayed in large text at the bottom of the screen switches to the next screen without saving the name that may have been entered.

6.4 Loading a preset (LOAD screen)

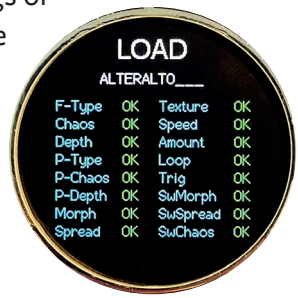
The LOAD screen appears after a click on the encoder while the SAVE screen is displayed.

LOAD shows the current preset and the list of parameters with a difference indicator (equal to, higher than, or lower than the current value of the potentiometers). Turning the encoder scrolls through the available presets. Each selected preset is applied immediately and can be played. However, the physical potentiometers and CVs do not control anything while you remain in LOAD.



Applying the selected preset to LIVE mode

Fractaos makes it possible to recover the settings of the selected preset: the colored arrows indicate the direction in which to turn each potentiometer, and when OK is displayed, this means that the LIVE setting matches the preset. A long press on the encoder then returns to the main screen, allowing you to experiment with other settings from the selected preset.



The “LIVE” choice

In the preset list, an option named “LIVE” appears (displayed in red). It is used to return to the initial manual configuration (= the real values of the potentiometers and the envelope that was active before entering LOAD mode).

In concrete terms: when entering LOAD mode, the current envelope is captured. As long as the user explores presets, this reference envelope is memorized. Selecting “LIVE” from the list restores this envelope and disables potentiometer override (the device returns to “live” operation with no preset loaded). Validating on LIVE (long click) exits LOAD mode with the original configuration restored.

7. Multitimbral mode (MULTI)

MULTI mode allows each of the 4 Fractaos voices to be assigned a different preset, or to be left in LIVE mode. Each voice can be driven by a separate MIDI channel, turning Fractaos into a multitimbral expander. The MULTI configuration is persistent: it is kept between sessions (automatic saving in EEPROM).

7.1 Accessing the MULTI screen

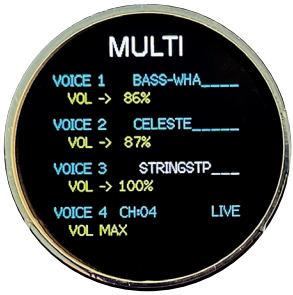
The MULTI screen is displayed after a short click on the LOAD screen.

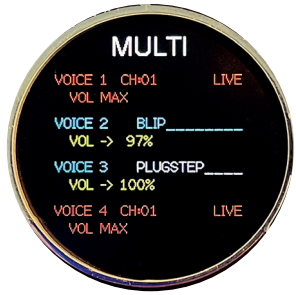
The screen shows 8 rows, two per voice. The Prev / Next buttons move the selection from one row to another.

- Preset row: displays “LIVE” or the name of the loaded preset. Turning the encoder scrolls through the available presets.
- Volume row: shows the voice volume value.
-

The row colors help with setup:

- **White:** row selected by the user.
- **Cyan:** normal voice (configurable).
- **Red:** voice locked in LIVE because of a MIDI channel conflict (two voices cannot listen to the same channel in MULTI).





7.3 Persistence

Every MULTI modification is written to EEPROM. At startup, Fractaos rereads this configuration and automatically restores the presets.

7.4 Audio behavior of LIVE voices in MULTI

LIVE voices in MULTI mode behave EXACTLY as they do outside MULTI: the panel of potentiometers and switches controls their timbre, their modulations (LFO, FM, Texture), and their filter.

7.5 Spread in MULTI

The handling of the Spread potentiometer is particular in MULTI mode:

- Outside Drone mode: each preset voice keeps the Spread saved in its preset (fixed). The global Spread potentiometer acts only on LIVE voices.
- In Drone mode: the global Spread potentiometer regains control over all 8 oscillators, including preset voices. This is useful for playing a global chord while keeping the preset timbres.

7.6 Exiting MULTI mode

MULTI mode is persistent: leaving the MULTI screen does not disable the mode.

If at least one preset is loaded, MULTI remains active. To return fully to LIVE, each preset voice must explicitly be set back to “LIVE” using the encoder (or the same MIDI channel can be selected for all voices). As soon as no preset is loaded anymore, the system automatically exits MULTI mode.

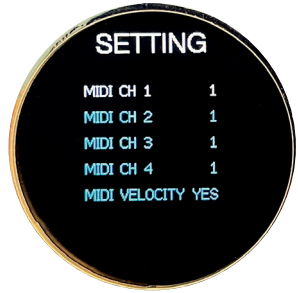
8. SETTING

This screen is activated after a short click on the MULTI screen.

This is where the MIDI parameters are adjusted.

8.1 Polyphonic mode (single channel)

All voices use the same MIDI channel (MIDI 1 by default, selectable). Notes are distributed between the 4 voices. It is of course possible to assign a MIDI channel other than the default channel 1. The choices are automatically saved for the next session.

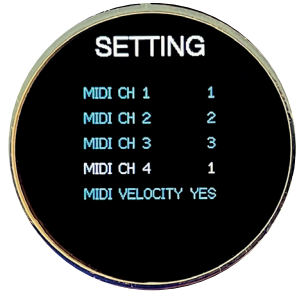


8.2 Multitimbral mode (separate channels per voice)

Each voice uses its own MIDI channel. In MULTI mode, this is the mode that is used: each preset assigned to a voice plays independently of the others, on its own channel.

If two voices are configured on the same channel, the system detects the conflict and locks the affected voices in LIVE (shown in red on the MULTI screen).

To use the four voices with four different presets, four different MIDI channels must therefore be chosen. However, it is entirely possible to assign a preset to any channel and continue playing polyphonically on the remaining voices, which will then share the same MIDI channel number.



8.3 MIDI velocity

Set to “YES” by default, Fractaos reads keyboard playing dynamics. This mode is not always suitable for every playing style; MIDI velocity can be set to “NO” to operate in Note ON/OFF mode.

8.4 MIDI aftertouch

If your MIDI keyboard or sequencer transmits aftertouch, Fractaos can use it as an additional source of expression after the note attack. Aftertouch does not directly change pitch: instead, it acts on the internal movement of the sound, reinforcing organic drift and certain timbral variations. The effect therefore depends strongly on the fractal, the texture and the current settings.

Not all MIDI keyboards transmit aftertouch. When available, it is most often channel aftertouch, applied globally to the voice or voices being played, rather than independent polyphonic aftertouch for each note.

Acknowledgements

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Gilles from Kaona

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