



S U P R A

Hybrid Granular Synthesizer // VST3 Plugin

ALGEBRA WITHIN

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Version 1.0.0 (June 2026)

INTRODUCTION

SUPRA is a premium monophonic hybrid granular synthesizer designed to blend organic analog modeling with state-of-the-art digital grain manipulation. At its core, SUPRA combines a custom analog-modeled, diode-shaping asymmetric triangle-core oscillator, a high-frequency FM modulator, a sample-synchronized granular engine, a state-variable morphing filter, and a feedback-delay pitch shifter. This manual provides a guide to the architecture, parameter descriptions, and sound design techniques.

HOW THE SYNTHESIZER WORKS

The signal path flows sequentially through six distinct DSP modules. Understanding this linear topology is key to mastering the instrument's sound design:

- * **1. Analog-Drifted Carrier:** A primary triangle oscillator runs through an asymmetric diode wave-shaping network, emulating vintage hardware saturation. A slow dual-sine wave generator introduces subtle, organic pitch drift.
- * **2. FM Modulator:** A high-frequency modulating sine oscillator applies linear frequency modulation (FM) to the carrier wave, generating rich harmonics ranging from metallic bells to aggressive growls.
- * **3. Granular Capture:** The dry carrier signal is recorded into a circular audio buffer. Grains are triggered, pitched, and crossfaded smoothly using a sample-accurate window envelope that eliminates click artifacts.
- * **4. State-Variable Filter:** The blended dry/granular signal passes through a morphing SVF filter, sweeping continuously between Lowpass, Bandpass, and Highpass curves.
- * **5. Comb Filter & Dynamics:** A high-resonance comb filter introduces metallic resonance and physical modeling style string textures. A feedback compressor acts on the filter tail to tame peaks.
- * **6. Pitch Shifting Delay:** The final signal is routed through a stereo auto-panner and a delay line featuring a built-in pitch shifter inside the feedback loop, enabling cascading shimmer trails.

THE MODULATION SYSTEM

SUPRA features a unique, indirect modulation architecture. Instead of routing the LFOs directly to individual synthesis parameters, the LFOs modulate two master macro controls, which are then mapped to target parameters via local modulation sliders.

The Two Master Macros

The interface features two prominent master controls: Macro 1 and Macro 2. These serve as central morphing hubs for your patches:

- * **Macro 1:** Controls the overall morph state of modulation path 1. The value is smoothed to prevent abrupt jumps.
- * **Macro 2:** Controls the overall morph state of modulation path 2. Similar to Macro 1, it is smoothed to ensure fluid parameter movements.

The Dual-Macro Modulating System

Every primary knob in SUPRA has two dedicated horizontal sliders beneath it: M1 and M2. These sliders represent the modulation depth of Macro 1 (M1) and Macro 2 (M2):

- * Dragging an M1 slider to the right maps Macro 1 to positively modulate that knob's parameter. Dragging it to the left maps it negatively.
- * Dragging an M2 slider maps Macro 2 to modulate that knob's parameter.

By setting the modulation depth locally on each knob, you can control how much they respond to Macro 1 and Macro 2.

The Low Frequency Oscillators (LFOs)

SUPRA is equipped with two highly configurable LFOs. Crucially, the LFOs modulate the Macros ONLY, rather than routing directly to the synthesis knobs:

- * **LFO1** modulates Macro 1 only (governed by the LFO1 Amount control).
- * **LFO2** modulates Macro 2 only (governed by the LFO2 Amount control).

If the LFO amounts are set to 0%, the Macro 1 and Macro 2 knobs act as standard manual morph controls (like a Mod Wheel). As you turn up the LFO amounts, the LFOs automatically sweep the macros, driving all parameters assigned to the corresponding M1 and M2 sliders.

LFO Controls & Parameters

- * **Rate:** Determines the speed of the LFO (0.1 Hz to 50 Hz). If Sync is enabled, the rate locks to DAW host tempo divisions (e.g. 1/4, 1/8, 1/16 notes).
- * **Amount:** Sets the depth of the LFO modulation applied to the corresponding macro (0% to 100%).
- * **Morph:** Smoothly morphs the LFO waveform shape through: Sine -> Triangle -> Sawtooth -> Square -> Inverse Sawtooth -> Random Sample & Hold -> Interpolated Random.
- * **Phase:** Adjusts the start phase offset of the LFO cycle (0.0 to 1.0).
- * **Sync:** Toggles DAW BPM host tempo synchronization.
- * **Retrig:** Retrigger the LFO cycle to start at 0.0 on every note-on event.
- * **Rnd:** Instantly randomizes the LFO start phase on note-on events, ideal for organic, non-repetitive textures.

THE DUAL RANDOMIZER SYSTEM & INIT

SUPRA features a performance-focused dual randomizer system. To prevent clicks, pops, or audio glitches, the randomization process is executed asynchronously on the main user interface thread, keeping the audio DSP thread 100% clean and glitch-free. The system randomizes two distinct parts of the synthesizer's patch state upon receiving a MIDI Note-On event:

Note-Triggered Randomization Modes

These modes are controlled by the small toggle buttons marked with a PIANO KEYS icon next to the main RND buttons:

- * **Note Sliders Rnd (Right Toggle):** When active, pressing any MIDI note will instantly randomize the positions of all M1 and M2 modulation depth sliders under the knobs, creating a dynamically changing modulation matrix on every single keypress.
- * **Note Knobs Rnd (Left Toggle):** When active, pressing any MIDI note will randomize all primary control knobs (frequencies, FM amount, filter cutoff, resonance, morph, comb filter, and delay settings), generating a completely new timbre per note.

Manual Randomization & Reset (INIT)

In addition to note-triggered automation, you can randomize or initialize the synth parameters manually at any time:

- * **RND Buttons:** Clicking the main RND buttons instantly randomizes all knobs (left side) or all sliders (right side).
- * **INIT (Sliders) (Right Side):** Resets all M1 and M2 modulation depth sliders back to their exact center position (neutral 0.5 value, which routes 0% LFO modulation).
- * **INIT (Knobs) (Left Side):** Resets all primary synthesis control knobs and LFO parameters to their default factory initialization values.

Randomizer Parameters

- * **Note Sliders Toggle (Piano Keys Icon):** Toggles note-on randomization of all M1/M2 modulation depth sliders on/off.
- * **Note Knobs Toggle (Piano Keys Icon):** Toggles note-on randomization of all primary control knobs on/off.
- * **LFO1 Rnd / LFO2 Rnd:** Toggled in the LFO sections; determines whether LFO waveform shape, speed, and depth are randomized along with the primary knobs when Note Knobs Rnd is active.

PARAMETER REFERENCE

Every primary knob in SUPRA features two dedicated horizontal sliders (M1 and M2) beneath it. These sliders map the modulation depth of LFO1 (M1) and LFO2 (M2) to that specific parameter. Every control is fully persistent and saves automatically with your DAW project.

Primary Oscillators & Modulation

- * **Carrier Freq:** Sets the base pitch offset of the diode-shaped carrier oscillator (1 Hz to 3000 Hz).
- * **Modulator Freq:** Sets the speed of the frequency modulator oscillator (0.1 Hz to 3000 Hz).
- * **Mod Amount:** Sets the depth of the frequency modulation (0.0 to 10,000.0). Higher values create complex FM sidebands.

Granular Processor

- * **Grain Size:** Determines the duration of each spawned grain (10 ms to 1000 ms).
- * **Grain Pitch:** Controls the speed (pitch ratio) of the grain playback head (0.1x to 4.0x).
- * **Grain Retrig:** Determines the trigger frequency for recording and spawning new grains (0.1 Hz to 20 Hz).
- * **Dry/Wet:** Blends the clean carrier signal (0.0) with the granular output (1.0).

Filters & Feedback Dynamics

- * **Filter Cutoff:** Sets the cutoff frequency of the state-variable filter (20 Hz to 10,000 Hz).
- * **Filter Res:** Sets the resonance peak of the filter, up to self-oscillation.
- * **Filter Morph:** Morphs the filter response smoothly from Lowpass (0.0) to Bandpass (0.5) to Highpass (1.0).
- * **Comb Freq:** Sets the frequency tuning of the comb filter delay line (10 Hz to 4000 Hz).
- * **Comb Res:** Controls the feedback level of the comb filter (0.0 to 1.0) to create metallic resonance.

Amplifier & Spatial FX

- * **VCA Attack/Release:** Controls the envelope attack time (3ms - 2s) and exponential release decay time (3ms - 2s).
- * **Panner Freq/Amt:** Sets the speed and depth of the stereo panner.
- * **Delay Time/Feedback:** Controls the feedback delay loop time (1ms - 2s) and decay length.
- * **Delay Shift:** Alters the pitch of the delayed signal in semitones (-12 to +12 st) inside the loop.

SOUND DESIGN GUIDE

Here are step-by-step guides to programming classic patches using SUPRA's unique modulation routing:

1. Pitch Drop / Sine Drop Kick

- * **Base settings:** Set Carrier Freq to 50 Hz. Set Mod Amount to 0 (FM off). Set VCA Attack to minimum (3 ms) and VCA Release to 300 ms.
- * **LFO Configuration:** Set LFO1 Rate to 2.0 Hz. Turn off LFO1 Sync. Set LFO1 Morph to 0.6 (Sawtooth shape). Enable LFO1 Retrigger (so the envelope shape resets on every key press).
- * **Modulation routing:** Turn the Carrier Freq M1 slider up to +0.8. When you press a note, LFO1 will instantly jump the pitch up and slide it down exponentially, creating a clean sub-bass pitch drop.

2. Classic FM Growls and Bells

- * **Bells:** Set Carrier Freq to 800 Hz. Set Modulator Freq to 1200 Hz (a harmonic 1.5:1 ratio). Set Mod Amount to 1500. Set VCA Attack to 3 ms and Release to 1000 ms. This generates metallic, chime-like FM sidebands.
- * **Growls (Wobbles):** Set Carrier Freq to 100 Hz. Set Modulator Freq to 250 Hz. Set Mod Amount to 2000. Set LFO1 to a Triangle shape (Morph 0.2) and sync it to DAW BPM (Sync ON). Turn up Mod Amount M1 slider to +0.6. The FM timber will cycle in sync with your project tempo.

3. Chiptune / Laser Siren

- * **Base settings:** Set Carrier Freq to 440 Hz. Set VCA Release to 800 ms. Set Mod Amount to 0.
- * **Modulation routing:** Set LFO1 to a fast rate (8 Hz to 12 Hz) with a Square wave shape (Morph 0.5) or Triangle (Morph 0.2). Drag the Carrier Freq M1 slider to +0.5. This cycles the pitch rapidly, creating retro chip laser shots or sirens.

4. Granular Cloud Pad (Shimmer)

- * **Base settings:** Set Carrier Freq to 250 Hz. Set VCA Attack to 800 ms and Release to 1200 ms.
- * **Granular routing:** Turn Grain Dry/Wet to 0.7 (70% wet). Set Grain Size to 150 ms. Set Grain Retrigger to 8 Hz. Set Grain Pitch to 2.0x (one octave up). Grains will capture the dry carrier and play it back pitch-shifted, creating a cloud effect.
- * **Shimmer Delay:** Turn Delay Time to 400 ms and Feedback to 0.6. Set Delay Shift to +12 st (+1 octave). Set FX Volume to 0.5. Each delay repeat is pitched up another octave, creating a shimmer tail.

BEST PRACTICES & SOUND DESIGN TIPS

To get the most out of SUPRA and keep your CPU healthy, follow these professional guidelines:

1. Prevent Clipping with the Master Limiter

Because SUPRA features multiple cumulative stages (FM, high-resonance filters, and feedback-based delay lines), the signal can occasionally clip. We have integrated a master brickwall limiter set at -0.1 dB into the plugin's output stage. If you hear distortion when driving the Master Gain knob, simply reduce the gain slightly. The limiter keeps your DAW output safe, but driving it too hard will compress the dynamic range of your patch.

2. Manage CPU Usage

Granular synthesis can be CPU intensive. The granular engine in SUPRA is highly optimized but triggers multiple computations per grain. If you experience CPU spikes, try the following:

- * Increase the Grain Size: Shorter grain sizes require faster trigger rates (higher Retrig) to maintain a continuous sound, which consumes more CPU.
- * Disable FX tail processing when silent: SUPRA includes an automatic idle detection circuit. When no note is active and the VCA envelope decays to zero, the DSP block suspends itself. Enable the 'Kill' button to immediately clear the delay buffer and free up CPU when notes stop.

3. Smooth Legato Transitions

SUPRA uses a monophonic note stack (legato fallback tracking). If you hold Note A and press Note B, the sound shifts to Note B. When you release Note B while still holding Note A, the synth smoothly falls back to Note A. Use this to perform complex synth solos, fast trills, and pitch-bending lead lines without cutting off the VCA envelope.

4. Avoid Denormal Spikes

We have injected minute background noise (1e-15f) into the feedback loops of the SVF filter, comb filter, and delay lines. This completely prevents CPU spikes caused by 'denormal numbers' (extremely small values close to zero computed by the CPU when a sound decays). This keeps performance optimal, even when leaving a high-feedback patch idle in your DAW track.