ALPHARAIL

Op-amp preamp character · by Pointless Audio



WHAT IT DOES

An op-amp preamp inspired by the ARP 2600 (1971), now with two engines. Bandwidth crashes, slew gives up — gloriously.

AlphaRail is an op-amp preamp inspired by the ARP 2600 (1971), the semi-modular synthesizer designed by Alan R. Pearlman. It takes one stage of that machine: the input preamp, a Teledyne 1339 op-amp with three gain ranges. It was a utility amplifier, there to bring outside signals into the synth voice; it was never meant to be musical.

Since v0.5.0 AlphaRail has two engines, selected with the CIRCUIT button.

Circuit is the default for new instances. It is built from the preamp's service-manual schematic and the datasheet of its op-amp: the input pot, the gain network that RANGE switches, the compensation network and the op-amp's own limits. Ahead of the stage sits a soft limiter and after it a soft saturator; both are the plug-in's own design, not a measurement of the chip. The circuit's own noise is part of the model.

Classic is AlphaRail as it was in v0.4, unchanged: the stage pushed past its 1971 specification. Closed-loop preamps built around the 1339 lose bandwidth and slew rate as the gain goes up, and

Classic does the same: the top end falls from 100 kHz at x10 to 1 kHz at x1000, and the slew limit drops from 12 V/µs at x10 to 1.5 V/µs at x1000. A third effect is added on purpose: an asymmetric saturation, where one side of the wave clips before the other. That one is the plug-in's character, not a measurement of the chip. At x1000 Classic is no longer a preamp: it is a bandlimit + slew + one-sided clip lo-fi shaper. We kept it.

This is not warm transistor saturation. It is not tube. It is what an op-amp sounds like when you ask it to do impossible things.

FORMAT	VST3 · AU · CLAP (macOS Universal Binary) · VST3 · CLAP (Windows x64)
OS	macOS 10.13+ on Intel · macOS 11+ on Apple Silicon · Windows 64-bit (x64)
CHANNELS	Mono · Stereo
ENGINES	Circuit (default) · Classic
PARAMS	4 automatable parameters · CIRCUIT button (not automatable) · 5 factory presets

THE ARP 2600 LEGACY

> Designed in 1971 by Alan R. Pearlman, the ARP 2600 is the instrument behind Ben Burtt's voice for R2-D2 (*Star Wars*, 1977): he built it by putting a tape-recorder microphone inside the synth and pushing his own voice through the resonant filter. Its documented users are a scene rather than a single record — Stevie Wonder, Pete Townshend, Edgar Winter, Jean-Michel Jarre, Weather Report, Depeche Mode, Joy Division, Nine Inch Nails.
>
> AlphaRail models one specific stage of that machine — the input preamp op-amp pushed past spec. Not the filter, not the oscillators, not the spring reverb. The op-amp character, isolated and made playable on any source.
>
> Since v0.5.0 the Circuit engine starts from that stage as drawn in the 2600 service manual (the preamp on Board 1) and the datasheet of its op-amp.

PARAMETERS

AlphaRail has four controls and one button. RANGE sets the gain of the stage; GAIN sets how hard you drive it; OUTPUT and AUTOGAIN handle level; CIRCUIT picks the engine. The four controls are automatable. Drag a knob, or hover over it, and its value shows in a popup.

PARAMETER	RANGE	DEFAULT	WHAT IT DOES
GAIN	0–100%	55%	How hard you drive the stage
RANGE	3 positions	x10	The gain of the stage: x10, x100, x1000 (20, 40, 60 dB)
OUTPUT	−24 / +24 dB	0 dB	Makeup level after the stage
AUTOGAIN	toggle	ON	Holds the level close to the dry signal across GAIN and RANGE
CIRCUIT	button	ON	The engine: Circuit (LED on) or Classic (LED off). Not automatable

In your host's parameter list the four controls appear as Gain, Range, Output and Auto Gain, and RANGE reads x10 (20dB), x100 (40dB) and x1000 (60dB).

> **Changed in 0.5.0** — A new instance opens in the Circuit with AUTOGAIN on and OUTPUT at 0 dB. In 0.4, AUTOGAIN was off and OUTPUT was +4 dB. Projects and presets saved with 0.4 keep their own values and open in Classic.

GAIN

How hard you push the stage. It works differently in the two engines.

- **Circuit.** GAIN is the input pot in front of the op-amp, on a log taper, and it only attenuates: at 0 the signal is fully attenuated, as on the hardware. RANGE sets the gain; GAIN sets how much signal reaches it. With AUTOGAIN on, the level is made up after the stage, so GAIN plays like a drive control: the higher it goes, the harder the stage is pushed.
- **Classic.** GAIN is a trim of −12 to +12 dB ahead of the stage. Low and it stays clean; around the default it settles into a light, sustained saturation; wide open it drives hard into saturation for a heavy, squared-off clip. It sets the amount of drive, not the loudness — that's what OUTPUT and AUTOGAIN are for.

You can also type a value into your host's parameter field: "39" and "39%" both set GAIN to 39%.

RANGE

RANGE sets the gain of the stage: x10, x100 or x1000, that is 20, 40 or 60 dB. In the Circuit it switches the gain network around the op-amp; each step up moves the level at which the stage saturates down by about 20 dB. The input is calibrated so that 0 dBFS is about 3 V at the stage input. In Classic it sets how far past spec the stage runs, and it defines the whole character.

POSITION	CIRCUIT	CLASSIC
x10	Full bandwidth. The circuit's noise sits at about −113 dBFS (A-weighted, AUTOGAIN off)	Full bandwidth, light coloring
x100	Saturates about 20 dB lower than x10. Noise at about −93 dBFS	Mid character — audible bite, the top starting to close in
x1000	Saturates about 20 dB lower than x100. The circuit's noise is audible here, about −73 dBFS	Lo-fi shaper — the top end crashes, transients smear, peaks square off

Click the lever to switch directly: top = x1000, mid = x100, bottom = x10.

OUTPUT

Makeup level after the stage, −24 to +24 dB. The default is 0 dB: with AUTOGAIN on, a new instance opens within 0.1 dB of the dry level on pink noise at −18 dBFS RMS. Projects saved with 0.4 keep the OUTPUT they were saved with: +4 dB if they used the old default.

AUTOGAIN

A loudness match. At the same GAIN, x100 and x1000 come out louder than x10, so RANGE would double as a volume jump. AUTOGAIN evens that out: you hear only the character change.

- **ON** (default). The level is held close to the dry signal across GAIN and RANGE. A red LED lights to the right of the button.
- **OFF**. You hear exactly what RANGE does, level jump included.

AUTOGAIN is a fixed table, one for each engine, both calibrated on pink noise at −18 dBFS RMS (K-weighted): nothing pumps on transients, and the match is closest near that level. On much hotter or quieter material, trim with OUTPUT. With AUTOGAIN off, the Circuit at the default settings sits about 11 dB below the dry signal.

In the Circuit, AUTOGAIN makes up at most 24 dB. With GAIN turned well down, the input pot takes away more than that and the output falls below the dry level. AUTOGAIN raises the signal, not the circuit's noise: with AUTOGAIN on, the noise is never louder than with AUTOGAIN off.

CIRCUIT

Picks the engine. The button sits under AUTOGAIN, to the right of RANGE. Amber LED on: the Circuit. LED off: Classic.

- **Circuit** (default for new instances). The preamp from its schematic, with a soft limiter ahead of the stage and a soft saturator after it, and the circuit's noise. A new instance, or a project reopened with AUTOGAIN off, opens without a level bump.
- **Classic**. AlphaRail as it was in 0.4, unchanged down to the bit: bandwidth and slew shrink as RANGE goes up, and one side of the wave clips first. No noise.

Switching is a 20 ms crossfade. AUTOGAIN has its own table for each engine: with AUTOGAIN on, the level moves by less than about 3 dB for 15 to 50 ms during the switch. With AUTOGAIN off the two engines are not level-matched.

CIRCUIT is saved with the project, with user presets and with the A/B snapshots. It is not a host parameter, so it cannot be automated. Factory presets and INIT select the Circuit; projects and presets saved with 0.4 open in Classic.

FACTORY PRESETS

> **Hint** — Click the preset name in the bottom strip to switch. The **A/B** buttons compare the current state to an alternate snapshot. **SAVE** appears when the state is dirty. **INIT** returns every control to the defaults of a new instance and selects the Circuit.

#	NAME	GAIN	RANGE	OUTPUT	AUTOGAIN	CHARACTER
1	**Init**	55%	x10	0.0 dB	ON	The defaults of a new instance.
2	**Clean Glue**	30%	x10	0.0 dB	ON	Low drive on x10.
3	**Rail Bite**	20%	x100	0.0 dB	ON	x100 at low drive. In Classic the second harmonic stays louder than the third.
4	**GBW Wall**	80%	x1000	−11.7 dB	OFF	x1000 with GAIN at 80%. The name comes from Classic, where x1000 hits a wall at 1 kHz.
5	**Slew Crush**	100%	x1000	−11.7 dB	OFF	GAIN all the way up on x1000.

> **Changed in 0.5.0** — The factory presets load the Circuit, and their OUTPUT is set for it: on pink noise at −18 dBFS RMS (K-weighted) each comes out within 0.1 dB of the dry level. Switch CIRCUIT off to hear a preset in Classic: Init and Rail Bite stay at about the same level, while Clean Glue, GBW Wall and Slew Crush are not level-matched in Classic and can differ in level. On x1000 the output barely follows the input level, so the match holds at the calibration level, and on much quieter material GBW Wall and Slew Crush come out above the dry level. Projects store parameter values, not preset names, so sessions saved with 0.4 keep their values and open in Classic.

User presets are stored as `.papreset` files in `~/Library/Pointless Audio/AlphaRail/Presets/` (macOS) or `%APPDATA%\Pointless Audio\AlphaRail\Presets\` (Windows). They store the engine too; a 0.4 preset has no engine and opens in Classic.

HOW IT WORKS

You don't need any of this to use AlphaRail — but if you're curious why it sounds the way it does:

CIRCUIT

It starts from the stage as drawn. The core of the Circuit is the whole preamp, rebuilt from its service-manual schematic and the datasheet of its op-amp: the input pot, the gain network that RANGE switches, the compensation network that keeps the op-amp stable, the op-amp's own limits and the diodes across its inputs. The op-amp is a model fitted to the datasheet curves, and the datasheet contradicts itself in places; what holds across the fitted variants is the response with the preamp's own compensation. The input is calibrated so that 0 dBFS is about 3 V, set against the saturation thresholds of one hardware 2600 unit with GAIN at maximum. It follows the behavior of that unit; it is not a measurement of the original machine.

GAIN is a pot, RANGE is the gain. GAIN only attenuates, in front of the op-amp. RANGE sets how much the stage amplifies whatever gets through.

The top end stays open. With the preamp's compensation network the op-amp keeps its bandwidth on every range: in the model the response at x1000 stays within half a dB up to 20 kHz. That is where the Circuit parts from Classic, whose x1000 hits a wall at 1 kHz.

It colors gradually. Ahead of the stage sits a soft limiter that keeps the stage output under 8 V. After the stage, a soft saturator with a small asymmetry adds second harmonic, and a 10 Hz high-pass removes the DC that creates. At x100 the distortion goes from 1% to 10% over about 16 dB of input level. This is the plug-in's own design, chosen for playability and CPU; it is not a measurement of the original chip.

It has its own noise. The op-amp and its resistors make noise, so the model does too: 2 µV rms at the input (10 Hz–10 kHz), which is audible mostly at x1000. AUTOGAIN does not raise it. Classic has none.

It runs oversampled. The Circuit works at an internal rate of about 350–384 kHz at 44.1 and 48 kHz host rates. Latency is the same as in 0.4: 49 samples.

CLASSIC

You don't need any of this to use AlphaRail — but if you're curious why Classic sounds the way it does:

It's an op-amp pushed past spec. The original stage was a plain utility amplifier, never meant to be driven hard. Ask it for far more gain than it was built for — that's what RANGE does — and two things give out at once.

The top end collapses. The more gain you demand, the less high frequency the stage can pass. At x10 it stays open and clean; by x1000 almost everything above the low mids is gone. That darkening is the circuit running out of bandwidth, not an EQ. In the model the corner is the gain-bandwidth product of the 1339 (1 MHz) divided by the gain: 100 kHz, 10 kHz and 1 kHz. At 44.1 and 48 kHz host rates the x10 corner is held at 0.45 of the internal rate (twice the host rate): about 40 and 43 kHz.

The slew rate runs out. The stage can't swing fast enough to follow sharp transients, so they smear and soften.

Then one side clips first — by design. Classic saturates lopsided: one half of the wave bends early, the other only much later. That imbalance is where the second harmonic comes from. It is a choice made for the sound, not something measured on the original chip. Lost highs, smeared transients, one-sided clipping: the three together are the whole character of Classic. Take any one away and it disappears.

That's why x1000 in Classic isn't a "more drive" knob — it's a bandwidth-and-slew shaper. GAIN sets how hard you push in, OUTPUT makes up the level on the way out, and AUTOGAIN keeps things loudness-matched so the character switch doesn't double as a volume jump.

DESIGN NOTES

Three effects, one character (Classic). Two come from the op-amp pushed past spec: the top end collapsing and the transients smearing. The third, one side of the wave clipping first, is ours. Take any one away and the character is gone, which is why Classic runs all three rather than a single distortion curve.

x1000 in Classic is not "more saturation". It's a bandwidth-and-slew shaper. On sustained low material it strips the top away; on transients — snare, kick, percussive synth — it turns into a lo-fi shaper. Reach for it deliberately, not as a "more drive" setting.

One Classic model, not three. We had three variants ready to ship as Blue, Grey and Orange. You couldn't hear the difference between them, so there's one. The Circuit is not a fourth color: it is a different model of the stage.

Defaults that don't flatter. A new instance opens with AUTOGAIN on and OUTPUT at 0 dB, within 0.1 dB of the dry signal, so the first comparison isn't won by volume. The Circuit needs it: its GAIN is a pot in front of the op-amp, and without AUTOGAIN the default settings come out about 11 dB below the dry signal. Turn AUTOGAIN off to hear what RANGE really does, level jump included.

We kept the noise. The op-amp and its resistors make noise, so the Circuit does too. AUTOGAIN doesn't raise it, and below x1000 it stays low. Classic has none.

INSTALLATION

MACOS

Double-click the `.pkg` installer in the download to launch it.

> **Note:** The installer is signed with an Apple Developer ID and notarized by Apple — macOS opens it directly, with no security warnings.

VST3 installs to `/Library/Audio/Plug-Ins/VST3/`, AU to `/Library/Audio/Plug-Ins/Components/`, CLAP (for Bitwig, Reaper, MultitrackStudio) to `/Library/Audio/Plug-Ins/CLAP/`. The Customize step in the installer lets you pick the formats. All binaries are Universal: macOS 10.13 or later on Intel, 11.0 or later on Apple Silicon. Restart your DAW.

WINDOWS

No installer: the zip holds both formats. Copy the `PA AlphaRail.vst3` folder to `C:\Program Files\Common Files\VST3\` and the `PA AlphaRail.clap` file to `C:\Program Files\Common Files\CLAP\` — or just the one your DAW uses. Restart your DAW.

> **Note:** SmartScreen may warn — click "More info" → "Run anyway". The Windows binaries are **not Authenticode signed**.

UPDATING FROM 0.4

Projects and presets saved with any 0.4 version open in Classic with the same settings, OUTPUT included: +4 dB if they used the old default. They render bit-identical to 0.4.8 (216 test renders: 12 saved states, three sample rates, two block sizes, three signals). Against 0.4.5 the output is the same except where the saturation is driven very hard, and there the difference stays more than 58 dB below the peak. To try the Circuit on an old project, turn AUTOGAIN on and press CIRCUIT: with AUTOGAIN off the Circuit comes out quieter.

TROUBLESHOOTING

> **CPU usage seems high** — the Circuit costs more than Classic, and more the harder you drive it. Measured on one core at 48 kHz with pink noise at −18 dBFS RMS, whole plug-in: about 3.9% at the default settings, against about 1.2% for Classic. Driven hard it costs more: up to about 11% (x10 with GAIN at maximum, the worst case we measured), 4 to 9% on x100 and 7 to 8% on x1000. Raise the buffer size if needed, or switch CIRCUIT off.
>
> **Hiss on x1000** — expected in the Circuit. It is the circuit's own noise, about −73 dBFS A-weighted with AUTOGAIN off, whatever the GAIN. AUTOGAIN never makes it louder. Classic has no noise.
>
> **Silence with GAIN at 0** — expected in the Circuit. GAIN is the input pot, and at 0 it closes completely, as on the hardware. On x1000 only the noise is left.
>
> **Much quieter after pressing CIRCUIT** — with AUTOGAIN off the two engines are not level-matched. Turn AUTOGAIN on, or trim with OUTPUT.
>
> **Plugin doesn't appear in DAW** — most DAWs rescan plugins on launch. In Logic Pro: Preferences → Plug-In Manager → Reset & Rescan. In Ableton: Preferences → Plug-Ins → Rescan. In Reaper: Preferences → Plug-ins → VST → Re-scan.
>
> **Bottom bar ignores clicks in Logic on macOS Tahoe** — a Logic/GarageBand bug on macOS Tahoe (Apple Silicon) can stop the bottom-left corner of a plugin window from responding to clicks after the window is moved or resized, and that is where AlphaRail's bar sits (presets, A/B, INIT, S/M/L). AlphaRail applies the known workaround: it redraws a single pixel in that corner, only in Logic, GarageBand and MainStage. Other hosts are unaffected.
>
> **State doesn't persist between sessions** — verify your DAW saves plugin state in the project. AlphaRail uses APVTS standard, supported by every modern DAW. The CIRCUIT setting is saved with it.

CREDITS

- Inspired by the input preamp section of the ARP 2600 (1971). Listening reference for Classic: a recorded demo of the Korg ARP 2600 FS reissue.
- Circuit engine: starts from the ARP 2600 service manual (the preamp on Board 1) and the datasheet of its op-amp. Input calibration set against the behavior of one hardware 2600 unit.
- Brand, name and visual language: Pointless Audio, 2026.
- The license and the third-party notices are in `LICENSE.txt`, in the download.

SUPPORT

Bug reports, questions, feature requests: hello@pointlessaudio.studio

What to include so it gets fixed faster: https://pointlessaudio.studio/support/

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