

RAMA Common Emitter AMP Plugin

Demo guide and parameter description

AI-generated documentation note

This document was automatically drafted with the assistance of an AI language model and then reviewed as part of the preparation of the RAMA supplementary/demo material. The plugin behavior and parameter descriptions correspond to the authors' implementation and intended conference demo.

What this plugin demonstrates

The RAMA Common Emitter AMP is a real-time audio demo of a circuit-derived common-emitter transistor amplifier. Unlike a generic distortion or saturation effect, the plugin is based on a compact circuit model with dynamic states, linear circuit relations, and nonlinear BJT equations.

In simplified form, the circuit is written as

$$\dot{\mathbf{x}} = \mathbf{Ax} + \mathbf{Bu} + \mathbf{Gq}, \quad \mathbf{Hq} = \mathbf{Dx} + \mathbf{Eu}, \quad \boldsymbol{\eta}(\mathbf{q}; \boldsymbol{\theta}) = \mathbf{0}.$$

Here, $\mathbf{x}$ contains the dynamic circuit state, $\mathbf{u}$ is the input, and $\mathbf{q}$ contains nonlinear transistor-related voltages and currents. The BJT behavior is collected in $\boldsymbol{\eta}(\mathbf{q}; \boldsymbol{\theta})$, where $\boldsymbol{\theta}$ represents the transistor parameters.

The plugin shows how RAMA can expose meaningful circuit and device controls in a real-time audio setting. Instead of asking the user to directly tune raw transistor parameters, this version uses macro controls that move several physical parameters together in safer and more musical directions.

Why this is useful

A common-emitter amplifier is more sensitive than a diode clipper because its sound depends strongly on its bias point, transistor gain, local feedback, and small-signal operating range. This makes it a good demonstration of why circuit-aware emulation matters.

Compared with a standard audio plugin, RAMA is not simply applying a static waveshaper. It keeps a circuit-derived model, so the controls can be tied to amplifier behavior such as bias, headroom, transistor character, temperature, and emitter feedback.

Compared with SPICE, RAMA is designed to be lighter and more suitable for real-time audio. SPICE is excellent as an engineering reference, but it is usually too expensive and too general-purpose to run directly as an interactive audio plugin.

Compared with black-box or purely data-driven models, RAMA keeps the internal parameters interpretable. This makes it easier to understand what each control does and easier to create virtual circuit modifications that would be difficult or impractical to implement in a physical circuit.

In short, the demo highlights:

circuit interpretability + real-time feasibility + safe virtual component modulation.

Plugin controls

Control	What it changes	What you should hear
Drive	Input level before the amplifier.	More drive pushes the transistor stage harder, increasing saturation and compression.
Level	Output trim after the circuit.	Compensates loudness changes when the amplifier is driven harder.
Bias	Sets the amplifier operating point and headroom. The center setting corresponds to the 9 V benchmark supply.	Lower settings tend to clip earlier and feel more asymmetric; higher settings usually provide more headroom.
Tone	A circuit-level brightness control. The center setting preserves the benchmark high-frequency capacitor value.	Lower settings sound darker and smoother; higher settings keep more brightness and edge.
Character	A virtual transistor morph control. The zero setting uses the benchmark BJT parameters.	Changes the amplifier's nonlinear character, sensitivity, and clipping feel.
Heat	An effective temperature/leakage macro. A setting of 0.1 corresponds to the 25 °C benchmark point.	Changes how the transistor enters nonlinear behavior. Higher settings can make the stage feel warmer, softer, or slightly more compressed.
Feedback	Controls effective emitter degeneration. The center setting reproduces the 22 Ω benchmark value.	Lower feedback gives more raw gain and stronger nonlinear coloration; higher feedback gives a cleaner, more controlled response.

Why macro controls are used

The underlying BJT model includes physically meaningful quantities such as current gain, thermal voltage, saturation current, and effective emitter degeneration. These parameters are useful for research, but they interact strongly. Changing one of them can also change the gain, bias point, headroom, and amount of distortion.

For a live demo, the plugin therefore uses macro controls:

Character, Heat, Feedback, Bias.

Each macro changes the circuit or transistor model in a controlled way. This makes the plugin easier to use while still demonstrating the main RAMA idea: the nonlinear device and circuit parameters remain directly modifiable.

Suggested starting point

A good neutral starting point is:

$$\begin{aligned} \text{Drive} &= 24 \text{ dB}, & \text{Level} &= 0 \text{ dB}, & \text{Bias} &= 0.5, & \text{Tone} &= 0.5, \\ \text{Character} &= 0, & \text{Heat} &= 0.1, & \text{Feedback} &= 0.5. \end{aligned}$$

For a quick demonstration, try the following:

- Increase **Drive** to hear the amplifier move from small-signal behavior into stronger saturation.
- Move **Bias** to hear how the operating point affects headroom and asymmetry.
- Increase **Character** to hear a different virtual transistor behavior.
- Move **Feedback** down for a more aggressive response, or up for a cleaner and more controlled response.

How this connects to the paper

The paper presents RAMA as a way to solve circuit-derived nonlinear models through a compact one-step equality solve. The nonlinear device behavior is not hidden inside a black-box model. Instead, it appears explicitly through

$$\boldsymbol{\eta}(\mathbf{q}; \boldsymbol{\theta})$$

and its Jacobian.

This is what makes the plugin controls meaningful. Parameters such as **Character**, **Heat**, and **Feedback** are not arbitrary post-processing effects. They modify the virtual circuit or the transistor model used by the RAMA step.

The Common Emitter AMP plugin is therefore a practical demonstration of the paper’s main motivation: RAMA can preserve a circuit-based interpretation while remaining light enough for real-time audio and flexible enough for parameter modulation.