

RAMA Diode Clipper 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 Diode Clipper is a small real-time audio demo of the circuit-emulation method presented in the paper. The plugin emulates a diode clipper circuit by keeping an explicit circuit model instead of learning only an input-output curve. In simplified form, the circuit is written as

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}\mathbf{u} + \mathbf{G}\mathbf{q}, \quad \mathbf{H}\mathbf{q} = \mathbf{D}\mathbf{x} + \mathbf{E}\mathbf{u}, \quad \boldsymbol{\eta}(\mathbf{q}; \boldsymbol{\theta}) = \mathbf{0}.$$

Here, $\mathbf{x}$ contains the dynamic circuit state, $\mathbf{u}$ is the input signal, and $\mathbf{q}$ contains the nonlinear diode voltages and currents. The nonlinear diode behavior is collected in $\boldsymbol{\eta}$, whose parameters are denoted by $\boldsymbol{\theta}$.

The important idea is that RAMA keeps the linear circuit matrices and the nonlinear device equations separated. This makes it possible to expose virtual diode parameters as plugin knobs, while still preserving a circuit-based interpretation.

Why this is useful

Compared with a standard audio effect, this plugin is not just applying an arbitrary waveshaper. It is solving a compact circuit model at audio rate.

Compared with a full SPICE simulation, 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 plugin.

Compared with black-box or purely data-driven models, RAMA keeps meaningful circuit and device parameters. This makes the model easier to interpret, easier to modify, and more suitable for parameter modulation during performance.

In short, the demo highlights three practical advantages:

circuit interpretability + real-time feasibility + direct nonlinear-device modulation.

Plugin controls

Control	What it changes	What you should hear
Drive	Input gain before the clipper.	More drive pushes the signal harder into the diodes, increasing distortion and sustain.
Output	Output gain after the circuit.	Compensates the loudness change caused by clipping.
Cutoff	The RC cutoff frequency of the surrounding linear circuit.	Lower values sound darker and smoother; higher values retain more brightness.
Softness	The effective diode slope factor, related to nV_T in the diode equation.	Higher softness gives rounder clipping; lower softness gives sharper clipping.
Diode Morph	A continuous interpolation between diode parameter sets.	Changes the clipping character as if moving between different virtual diode behaviors.
Asymmetry	Mismatch between the positive and negative diode branches.	Adds uneven clipping and more even-harmonic character.
Leakage	Scales the diode saturation-current behavior.	Changes how early and how strongly the virtual diode begins to conduct.

The most important demo knobs

For a quick demo, start with these four controls:

- **Drive:** increases the amount of clipping.
- **Softness:** changes the diode law directly.
- **Diode Morph:** smoothly changes the virtual diode type.
- **Asymmetry:** makes the positive and negative clipping behavior different.

These controls are especially relevant to the paper because they modify the nonlinear device model $\eta(\mathbf{q}; \boldsymbol{\theta})$ directly. In many circuit-emulation workflows, changing these device parameters can require re-deriving or rebuilding part of the model. In RAMA, they enter naturally through the nonlinear residual and its Jacobian.

Suggested starting point

A good neutral starting point is:

$$\begin{aligned} \text{Drive} &= 12 \text{ dB}, & \text{Output} &= -6 \text{ dB}, & \text{Cutoff} &= 3.4 \text{ kHz}, \\ \text{Softness} &= 1, & \text{Diode Morph} &= 0, & \text{Asymmetry} &= 0, & \text{Leakage} &= 1. \end{aligned}$$

How this connects to the paper

The paper formalizes the RAMA simulation step as a one-step solve for a circuit DAE. Instead of solving the nonlinear algebraic equation exactly at every sample like a SPICE-style simulator, RAMA uses a local linear surrogate of the nonlinear residual. This gives a compact equality-constrained solve that is easier to run in real time and easier to connect to adaptive residual control.

The plugin is a practical demonstration of the same idea: a circuit-derived nonlinear model, solved in a lightweight form, with parameters that remain meaningful and modulable.