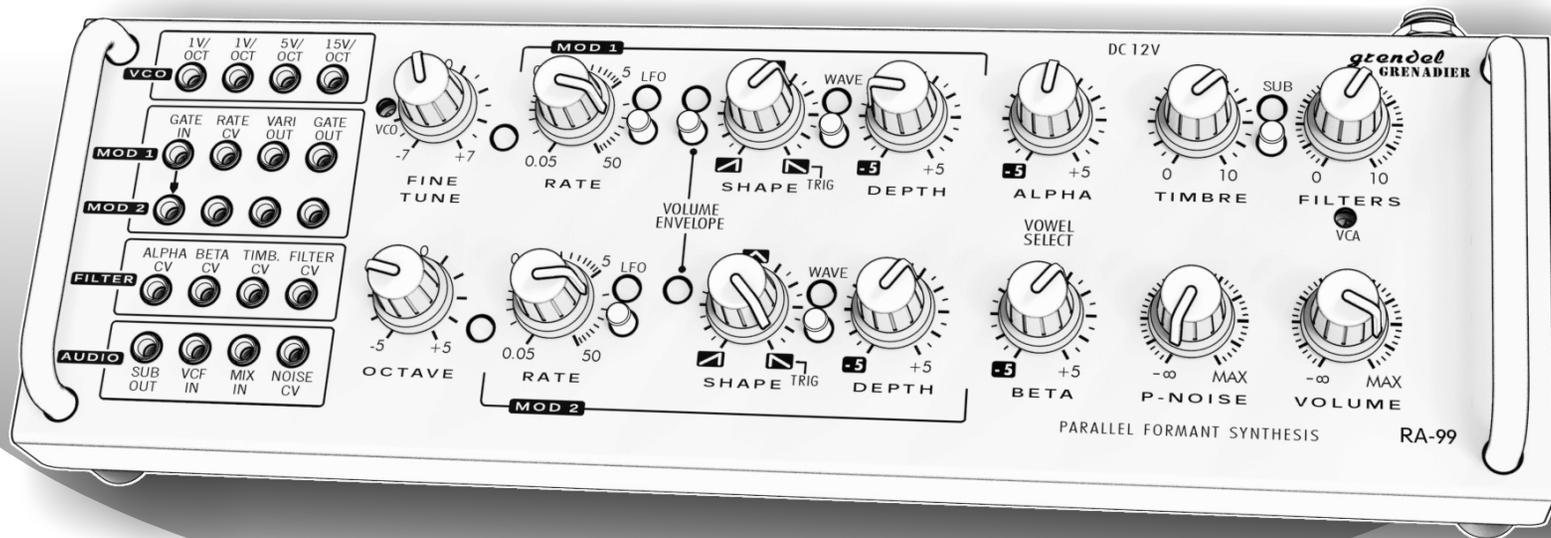


# gtendel



## GRENADIER RA-99

CV-Gate Analog Music Synthesizer

Rare Waves LLC  
RAREWAVES.NET

## Introduction

In the spirit of sonic exploration and musical evolution we bring you the Grendel RA-99 Grenadier, an all-analog synthesizer with an original and unique tone palette. It implements parallel formant synthesis with a bank of three voltage controlled filters to generate tones inspired by the human voice, without being limited by the conventional boundaries of speech modeling. Twenty patch points give you extensive self-patching options plus creative compatibility with analog modulars, sequencers and keyboard controllers.

### Oscillator

The RA-99 sound engine is based on an accurate voltage controlled oscillator with variable wave shape. The VCO has multiple CV (control voltage) inputs for creative stacking of the various CV sources available in your studio. There are two 1 volt per octave inputs for melody. It also has a 5 volts per octave input that is ideal for creating octave modulations from an LFO with 5V output. Finally, the 15 volts per octave input is suited to narrow pitch modulations like vibrato and pitch bend. The CV inputs of the RA-99 VCO have wide response bandwidth, allowing FM with audio frequency waveforms.

A subharmonic square wave is generated at a frequency 1 octave below the VCO. Activating the SUB switch mixes this with the VCO output. Raw subharmonic waveform is available from the SUB OUT jack.

### Noise Source

A pink noise generator is included to add complexity to the sound. Pink noise is mixed with the VCO at the input to the filter bank. Pink noise volume is adjustable with the knob labeled P-NOISE, and by CV input to the NOISE CV jack. The noise source also adds a subtle amount of jitter to the VCO waveform.

### Modulation

The RA-99 modulation section contains a pair of multifunction waveform generators called MOD1 and MOD2. They can provide (1) gated attack-release envelope, (2) triggered decay envelope, (3) pulse LFO with variable pulse width, or (4) saw-triangle LFO with variable symmetry. In envelope mode, the output is a true exponential slope. In addition, RA-99's MODs can create time delayed gate events, serve as low-frequency audio VCOs (with limitations), or act as frequency dividers. Both MODs have variable output level that is sweepable from normal to inverted polarity. Either MOD1 or MOD2 can serve as the main volume envelope.

### Filter Bank

The Grenadier RA-99 filter bank combines one low pass and two band pass filters to produce full-bodied tones with resonant character of vowels. The filter bank has three control parameters: ALPHA, BETA, and FILTERS. These parameters are also fully controllable with CV inputs.

## Patch Points

### VCO

1V/oct (x 2), 5V/oct, 15V/oct,  
Timbre CV In (controls wave shape)

### MOD1

Gate In, Rate CV In, Vari Out, Gate Out

### MOD2

Gate In, Rate CV In, Vari Out, Gate Out

### Filter Bank

Alpha CV In, Beta CV In, Filter CV In

### Audio

Subharmonic Out, VCF audio In,  
Mix audio In, Noise VCA CV

## Compatibility

CV-Gate In:	1 V/oct, +5V Gate
Patch cables:	3.5 mm mono
Audio output:	1/4" analog unbalanced
CV output range:	0 to +5 volts
MIDI:	Not included
Polyphony:	Monophonic

## Specification

Power Input:	12 VDC @ 1.2 Watt
Dimension:	30 x 10 x 6 cm
Mass:	0.53 kg
Case Material:	Anodized aluminum
RoHS-Compliant:	YES
Lead-free:	YES

## Manufacturer

Made by Rare Waves® (Texas, USA)

RAREWAVES.NET

Design and Support:  
Eric Archer

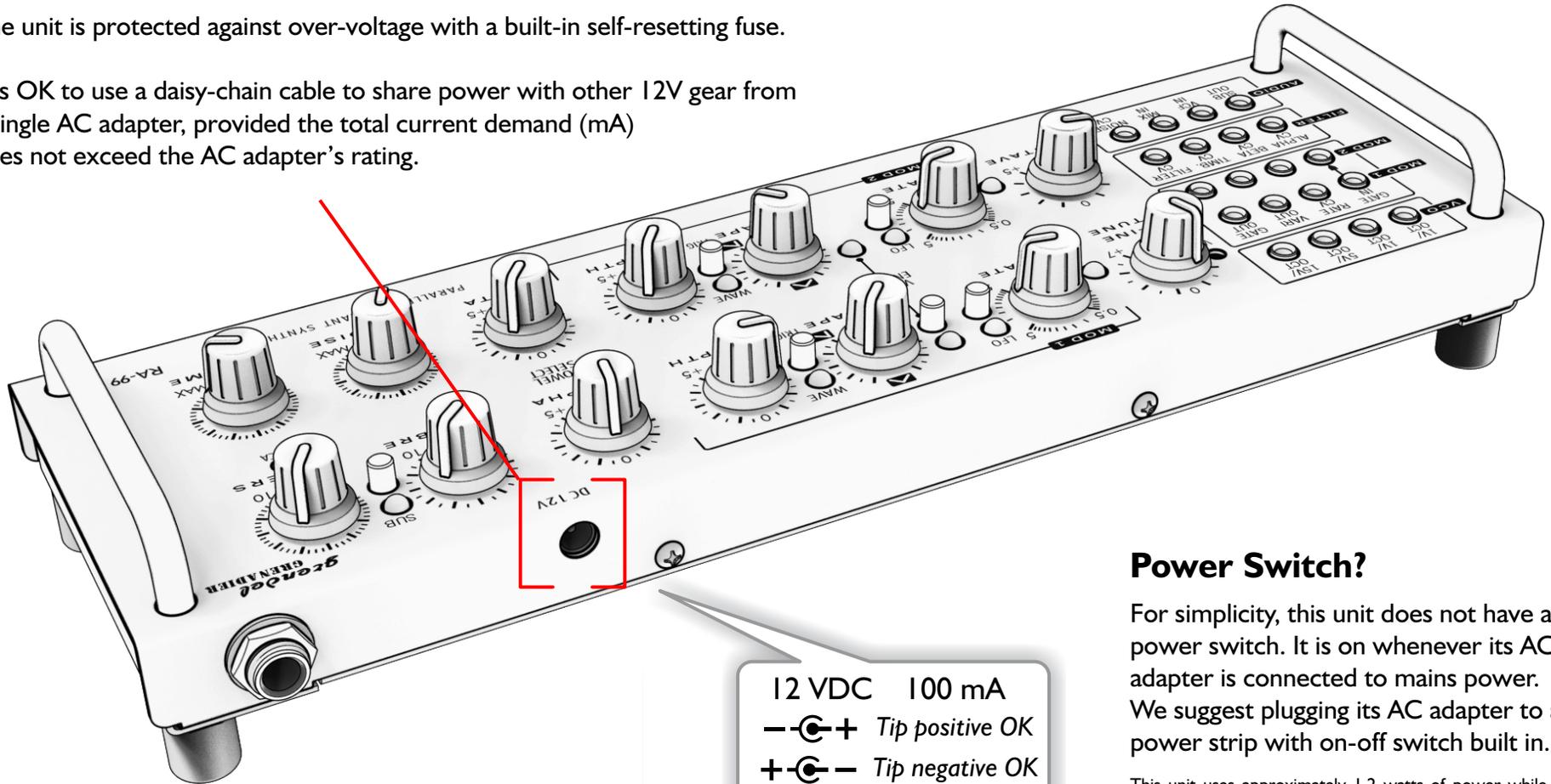
# Power Input

This unit requires 12 volts DC and draws a maximum current of 100 mA.  
Polarity of the AC adapter connector does not matter. It can be tip positive or tip negative.

\* Grenadier RA-99 will also operate from 9 volts DC, but please note that the pink noise source will be unavailable in this situation, and distortion may be heard in the output.

The unit is protected against over-voltage with a built-in self-resetting fuse.

It is OK to use a daisy-chain cable to share power with other 12V gear from a single AC adapter, provided the total current demand (mA) does not exceed the AC adapter's rating.



12 VDC 100 mA  
- ⊕ Tip positive OK  
+ ⊖ Tip negative OK  
2.1 mm tip

## Power Switch?

For simplicity, this unit does not have a power switch. It is on whenever its AC adapter is connected to mains power. We suggest plugging its AC adapter to a power strip with on-off switch built in.

This unit uses approximately 1.2 watts of power while in operation. Assuming an energy cost of \$0.13 per kWh, it would cost about \$1.35 per year to leave it on all the time.



## Quick Start

Here are some suggestions for connecting the Grenadier RA-99 to other analog equipment in the music studio.

RA-99 uses the 1 volt per octave tuning standard (not V/Hz). Its Gate inputs interpret  $>2.5$  volts as Gate On, and  $< 2.5$  volts as Gate Off.

Nominal Gate input is 5 volts, but there is no harm in connecting a 10 volt gate input.

## Standalone operation

Grendel RA-99 Grenadier can be played manually for sound effects and drone tones without connecting a sequencer or keyboard. You'll need a handful of patch cables to get started.

Self-patching MOD GATE OUT to the other MOD GATE IN and using the LFO switches allows its envelope to re-trigger. You can also patch SUB OUT to GATE IN to self-trigger the modulation generators.

## Connection to a sequencer

Patch the sequencer's V/OCT output to RA-99's IV/OCT. Patch the sequencer's GATE output to RA-99's MOD1 GATE IN.

A sequencer's ACCENT GATE output is not directly supported, but you can experiment by connecting it to ALPHA CV, BETA CV, TIMBRE CV, or FILTER CV. Or, connect ACCENT GATE to MOD2 GATE IN. Then the second envelope generator will trigger just for accented notes.

\* If you have two analog sequencers, or a 2-track sequencer, try using both of RA-99's IV/OCT inputs simultaneously. This greatly expands the musical possibilities. For example, one sequencer could play a fast octave arpeggio while the other transposes the root note.

## Connection to a keyboard controller

Patch your analog key controller's V/OCT output to RA-99's IV/OCT. Patch the keyboard's GATE output to RA-99's MOD1 GATE IN.

If the key controller has Velocity Out, you can experiment patching it to RATE CV, ALPHA, BETA, TIMBRE, FILTER, or NOISE CV. You can also use any MIDI keyboard to play the Grenadier, but this requires a MIDI-to-CV converter. See *Connection to a Computer* below.

## Connection to a computer

You can play the Grenadier RA-99 with DAW software on a computer. A MIDI-to-CV converter is required. Remember, the Grenadier is a monophonic instrument, which means it only sounds one note at a time. It can't play chords.

Patch the MIDI-to-CV's V/OCT output to RA-99's IV/OCT. Patch the MIDI-to-CV's GATE output to RA-99's MOD1 GATE IN.

Experiment with patching any auxiliary outputs of the MIDI-to-CV converter (Velocity, Wheel, Bender) to the various CV inputs on the Grenadier. If your MIDI-to-CV converter has multiple channels, try using both of Grenadier's IV/OCT inputs simultaneously to expand your compositions.

## Connection to a modular

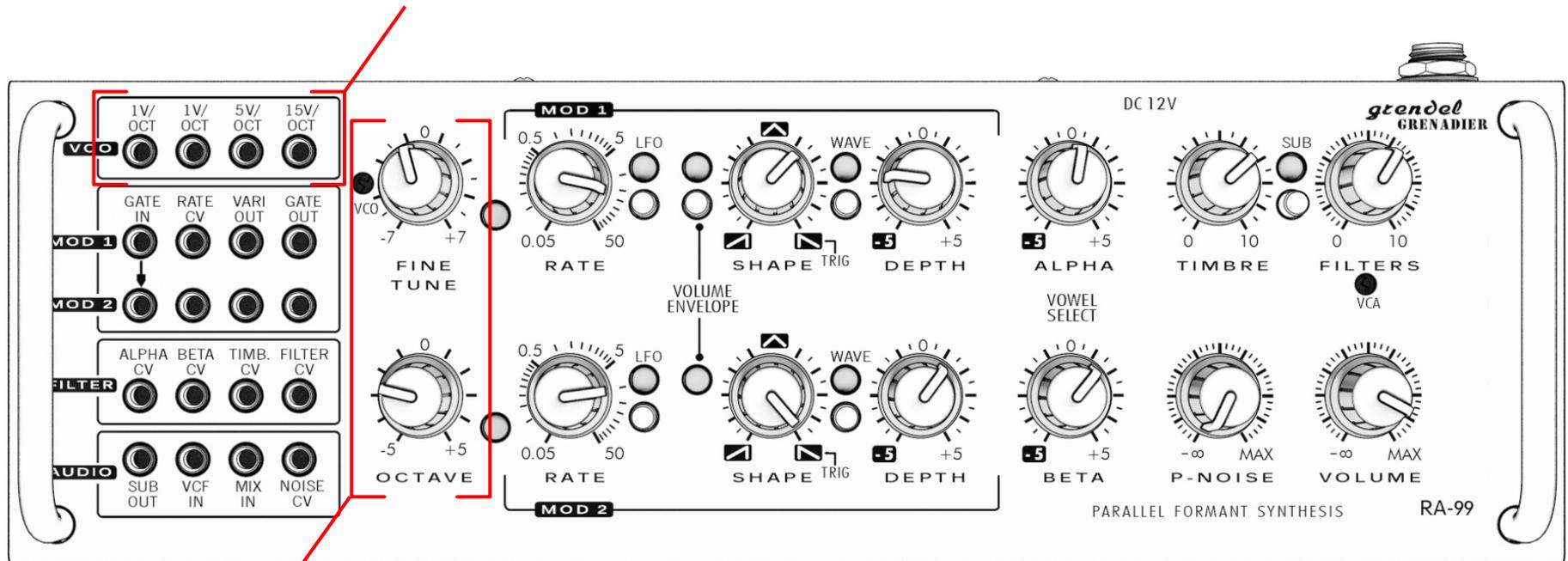
Grenadier RA-99 is generally compatible with Eurorack style equipment. There are many options ... have fun. Remember, the more patch cables you use, the better it sounds!

# V/OCT IN jacks

Patch 1V/OCT to the V/OCT output from your sequencer, MIDI-CV converter, or analog keyboard controller

5V/OCT is less sensitive. A change of 5 volts tunes the oscillator by 1 octave. It works well for octave trills when you patch it to an LFO with 5 volt square wave output. For example, patch MOD2 GATE OUT to 5V/OCT.

15V/OCT is the least sensitive CV input. A change of 15 volts would tune the oscillator by 1 octave. A change of 1.25 volts equals 1 semitone. Therefore, if you connect a pitch bender with +/-2.5 volts output, you'll have the standard +/- 2 semitone bend range. 15V/OCT is also useful for vibrato and other narrow pitch expressions.



## Tuning Controls

FINE TUNE has a range of +/- 7 semitones. In other words, if you start with the knob centered, turning it all the way will transpose the pitch by a perfect 5th interval.

OCTAVE has a range of +/- 5 octaves. This is a rotary potentiometer (not a “clicks” switch).

### Q. Any tips on tuning this instrument to match my sequenced compositions?

A. If you are controlling it from a keyboard and a sequencer or DAW: Begin by setting FINE TUNE to its center position. Play a reference note on the key controller such as middle A. Adjust OCTAVE carefully until the Grenadier is sounding the reference note approximately in tune. Then use FINE TUNE to tweak and transpose the pitch.

Be careful not to turn OCTAVE by mistake during a performance.

# GATE IN jacks

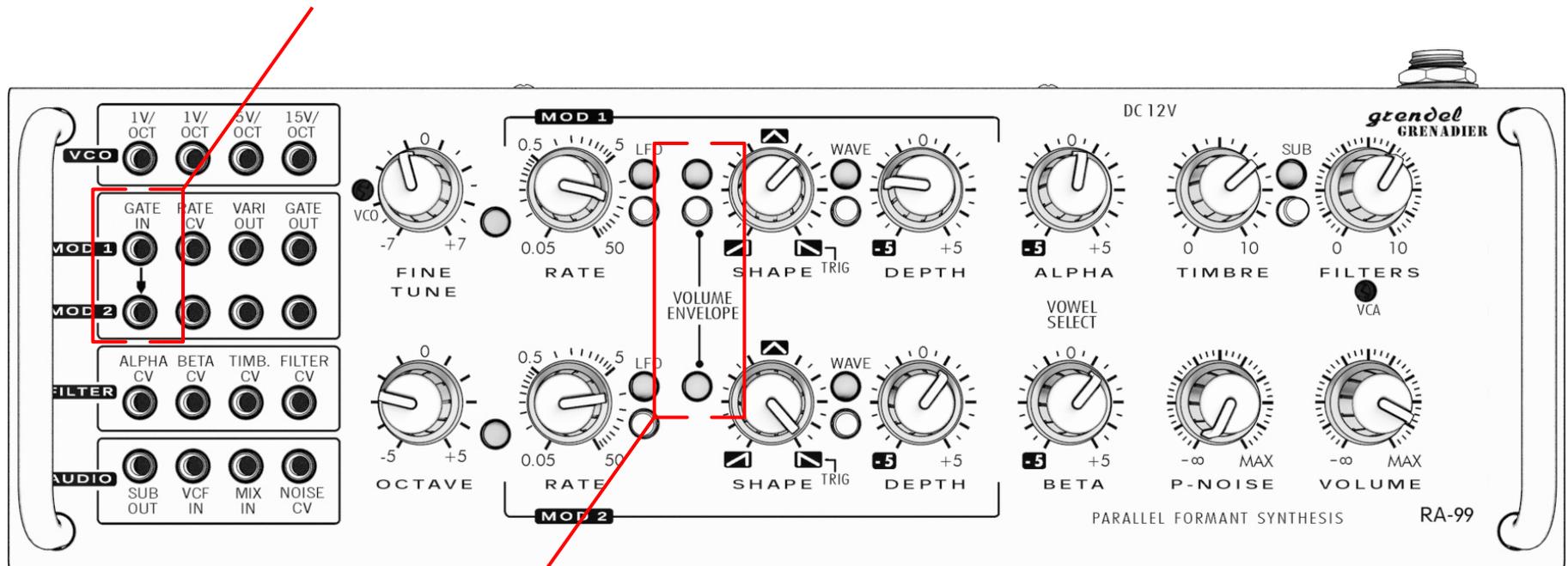
Patch GATE IN to the GATE output of your sequencer, MIDI-CV converter, or analog keyboard controller



MOD2 GATE IN is normalled to MOD1 GATE IN.

In other words, MOD2 gets the same gate as MOD1 unless a patch cable is connected to MOD2 GATE IN.

It is OK to patch other types of signals to GATE IN. There is no harm in connecting it to an LFO, envelope, oscillator, etc. Any waveform that crosses the 2.5 volt threshold will generate gate events.

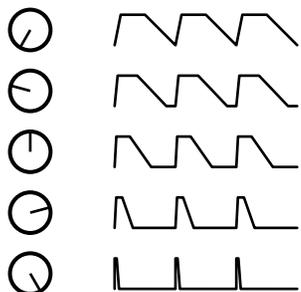


# VOLUME ENVELOPE switch

Either MOD1 or MOD2 can control the synthesizer's main volume envelope. Press the VOLUME ENVELOPE switch to alternate between the options.

*There is no direct CV input for the volume envelope.*

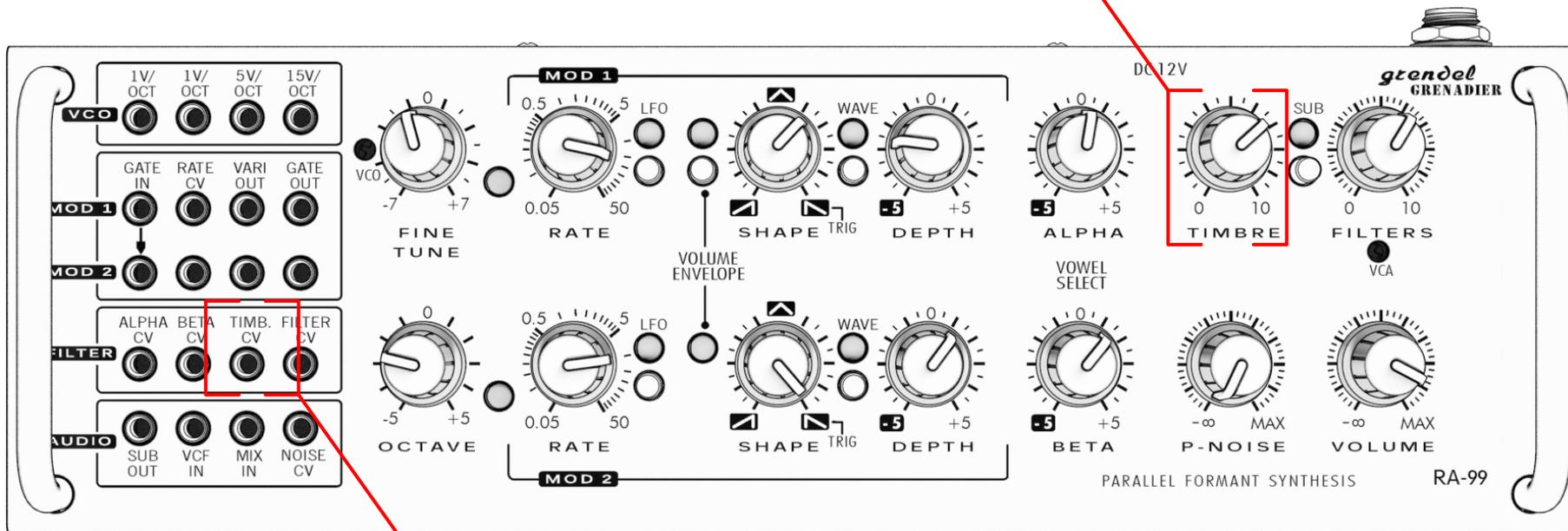
TIMBRE VCO waveform



## TIMBRE knob

The controls the VCO's wave shape to alter its harmonic content. The slope and pulse width vary simultaneously in a trapezoidal shape.

The effect on the waveform is illustrated in the diagram to the left.



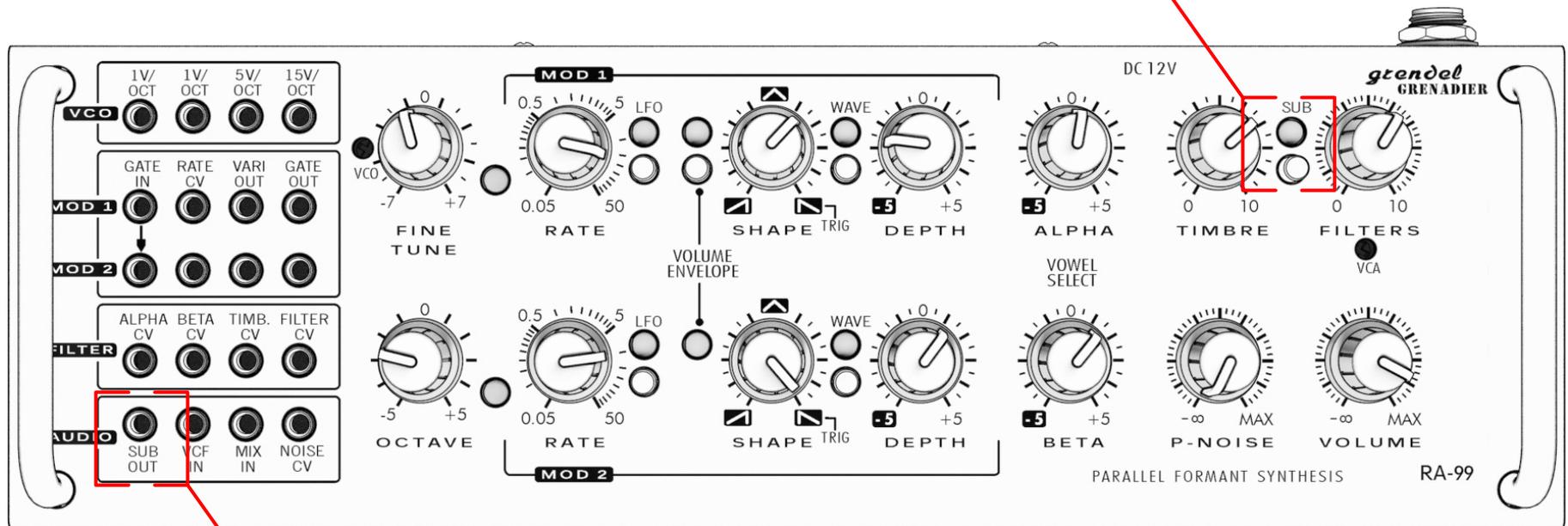
## TIMB. CV jack

Patching a CV input to this jack has the same effect as turning the TIMBRE knob. Both the knob and the jack can be used simultaneously.

TIMB. CV responds well when controlled by an envelope or LFO, adding smooth modulations to the VCO waveform's harmonic content.

## SUB switch

Activating this switch blends subharmonic square wave with the VCO waveform



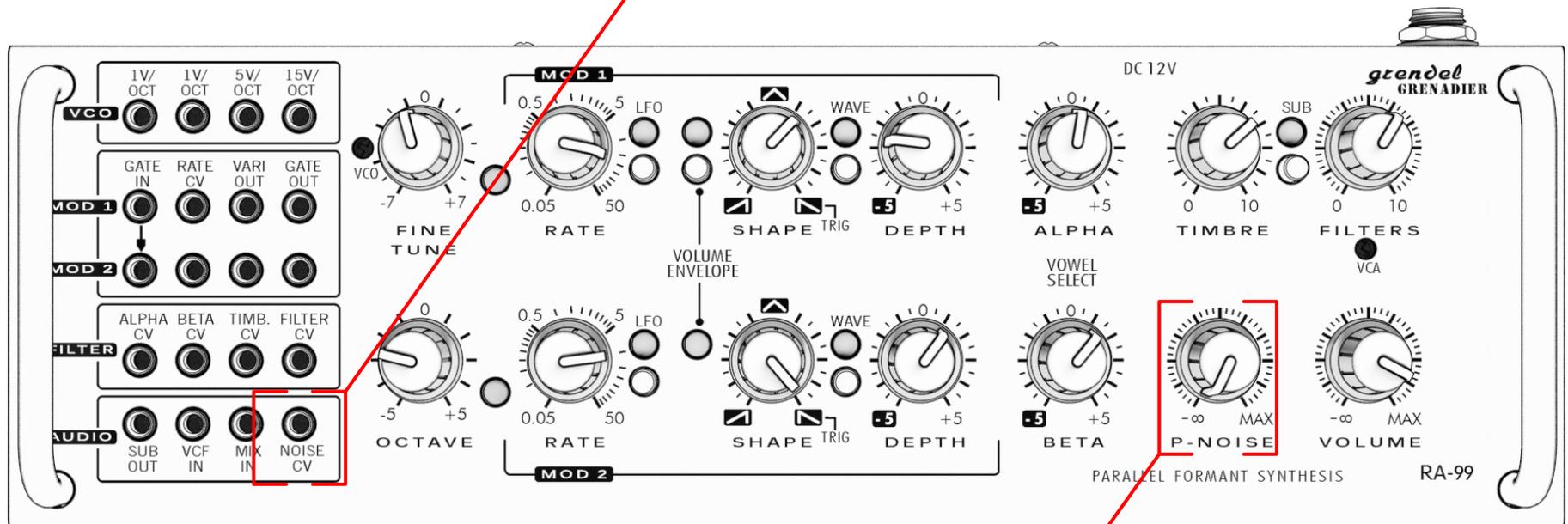
## SUB OUT jack

The unfiltered subharmonic waveform is available from this jack. It is a square wave with 5 volts amplitude.

You can self-patch this output to the RA-99's other CV, Gate and audio inputs for many tone variations.

## NOISE CV jack

This input controls the volume of the pink noise source VCA.  
It has the same effect as the P-NOISE knob.  
Both the knob and the jack can be used together.



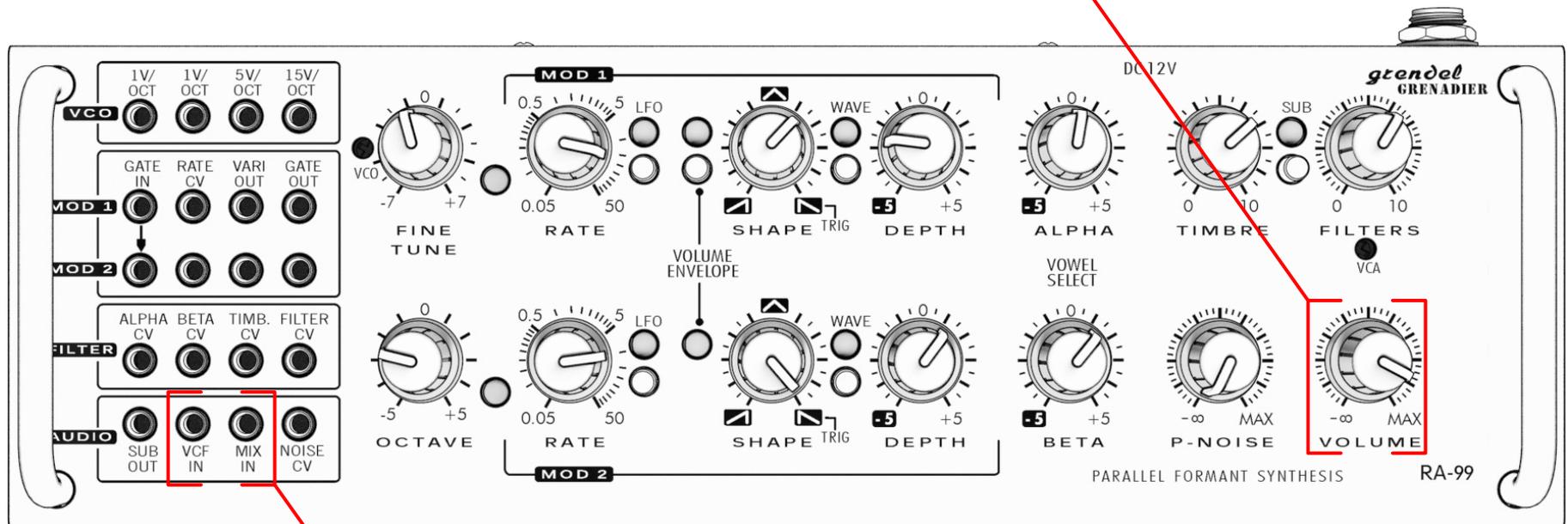
## P-NOISE knob

Controls the volume of the pink noise source.  
Noise is mixed with the VCO and subharmonic and fed to the filter bank.

*If the noise source does not seem to be working, make sure you are using a 12 volt DC power supply.  
If you connect a power adapter with lower voltage such as 9 volts, the unit will appear to operate normally, but the noise source will not work.*

## VOLUME knob

Sets the audio level at the main output



## VCF IN & MIX IN jacks

These are analog audio inputs to the filter bank.

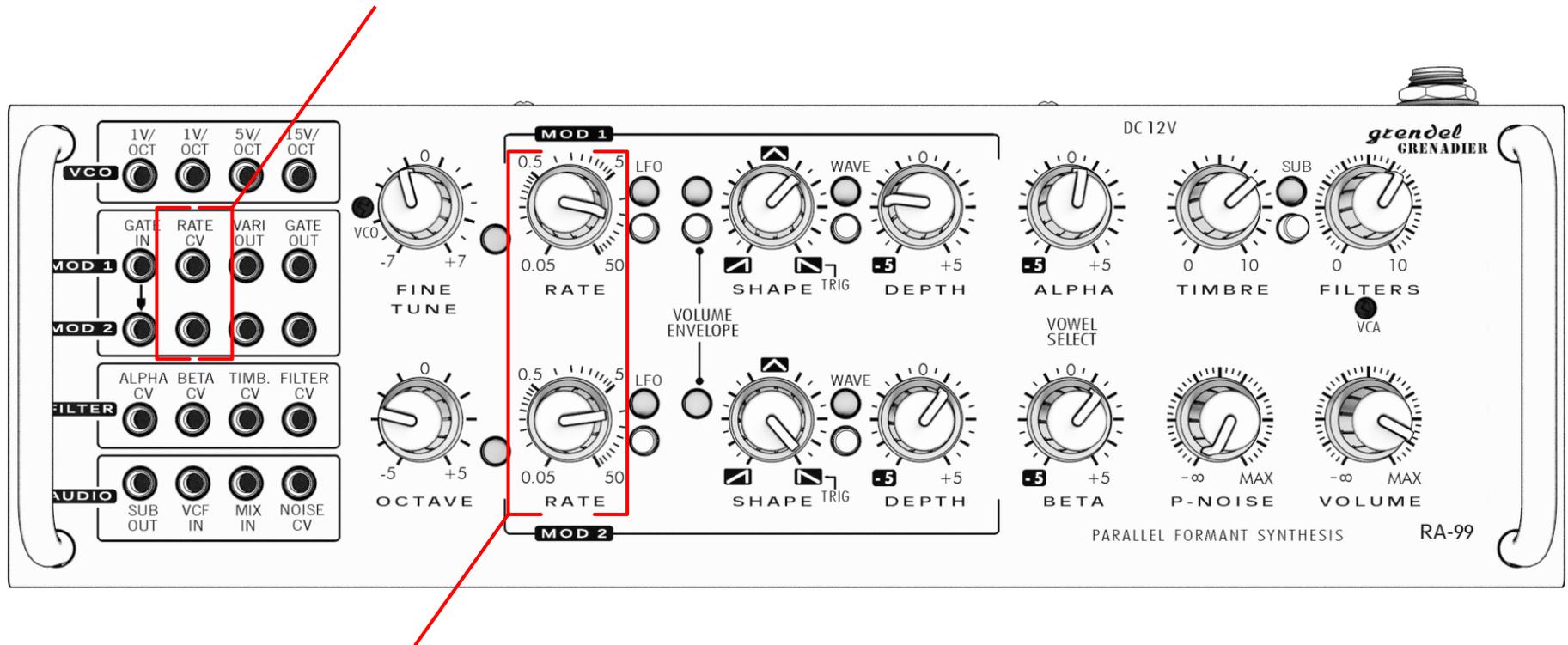
Patching to VCF IN mutes the internal VCO, replacing it with external audio.

Patching to MIX IN blends external audio with the internal tone generator.

Both can be used simultaneously

## RATE CV jacks

These voltage control inputs set the speed of the envelope or LFO. They have the same function as the RATE knobs and can be used simultaneously. The response is approximately 1 volt per octave.



## RATE knobs

These set the speed of the envelope and LFO. The control range is approximately 1000:1

The maximum LFO frequency is approximately 50 Hz, and minimum is approximately 0.05 Hz (about 3 cycles per minute).

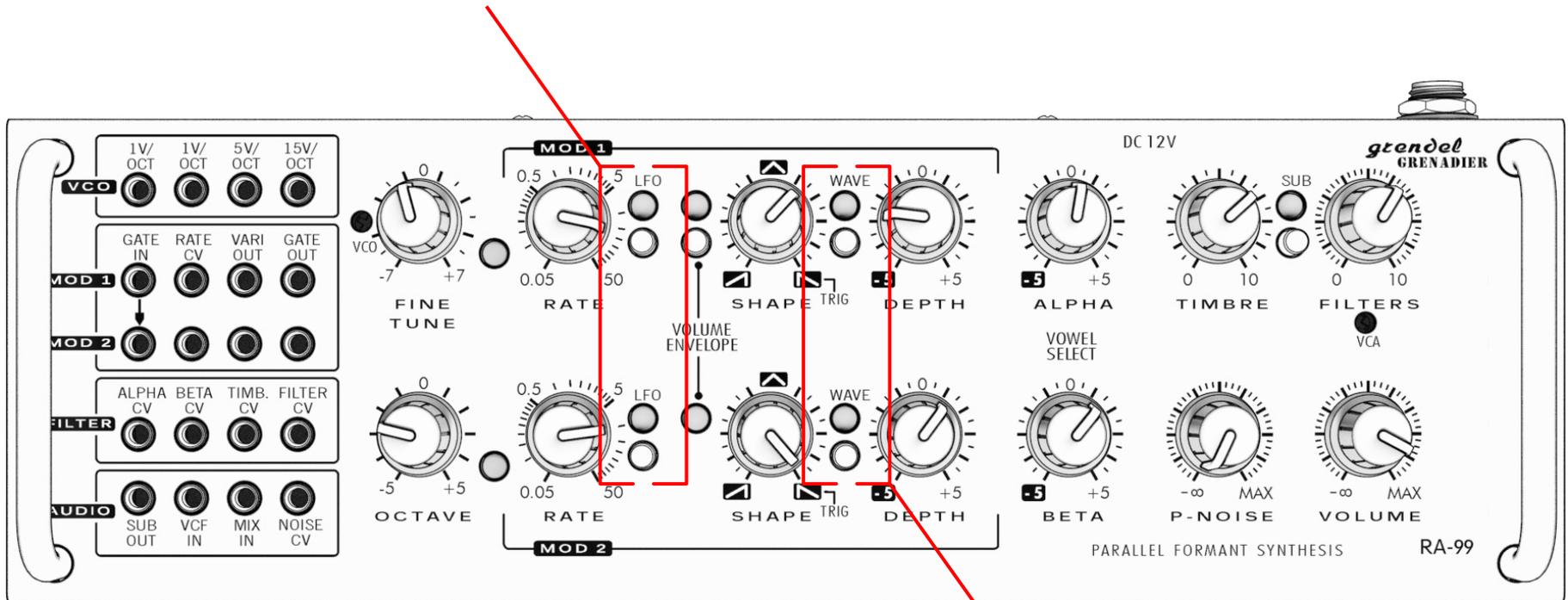
The SHAPE knob also affects the rate. With SHAPE rotated to either extreme, the LFO runs about half as fast as when SHAPE is centered. For slowest possible LFO, set SHAPE to either limit and turn RATE to minimum. The LFO rate will be about one cycle per 50 seconds.

The LED indicators to the left of the RATE knobs flash in time with the LFO and indicate the phase of the envelope.

# LFO switches

When its LFO switch is Off, a MOD is an envelope generator controlled by its GATE IN jack.

When its LFO switch is On, a MOD is an LFO with sawtooth, triangle, and pulse waveforms.



LFO	WAVE	SHAPE	GATE IN	MOD function
off	off	--	Gate In	Attack - Release envelope, exponential slope
off	off	TRIG	Trigger In	Decay envelope, exponential slope
off	ON	--	Gate In	Pulse envelope (Gated)
off	ON	TRIG	Trigger In	Pulse envelope (Triggered)
ON	off	--	<i>ignored</i>	Sawtooth - Triangle LFO, variable symmetry
ON	off	TRIG	LFO Sync	Falling sawtooth LFO, retriggered by Gate In
ON	ON	--	<i>ignored</i>	Pulse LFO, variable symmetry
ON	ON	TRIG	LFO Sync	Narrow pulse LFO, retriggered by Gate In

# WAVE switches

These change the waveform that is applied to the DEPTH knob and VARI OUT jacks.

When WAVE is Off, the output is smooth, gliding  
When WAVE is On, the output is pulses, discontinuous

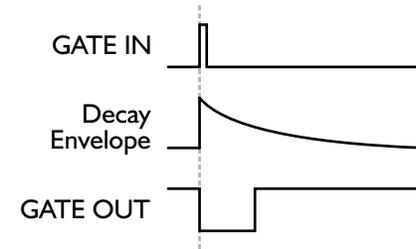
The WAVE switches do not affect Volume Envelope

# GATE OUT jacks

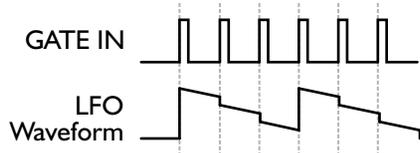
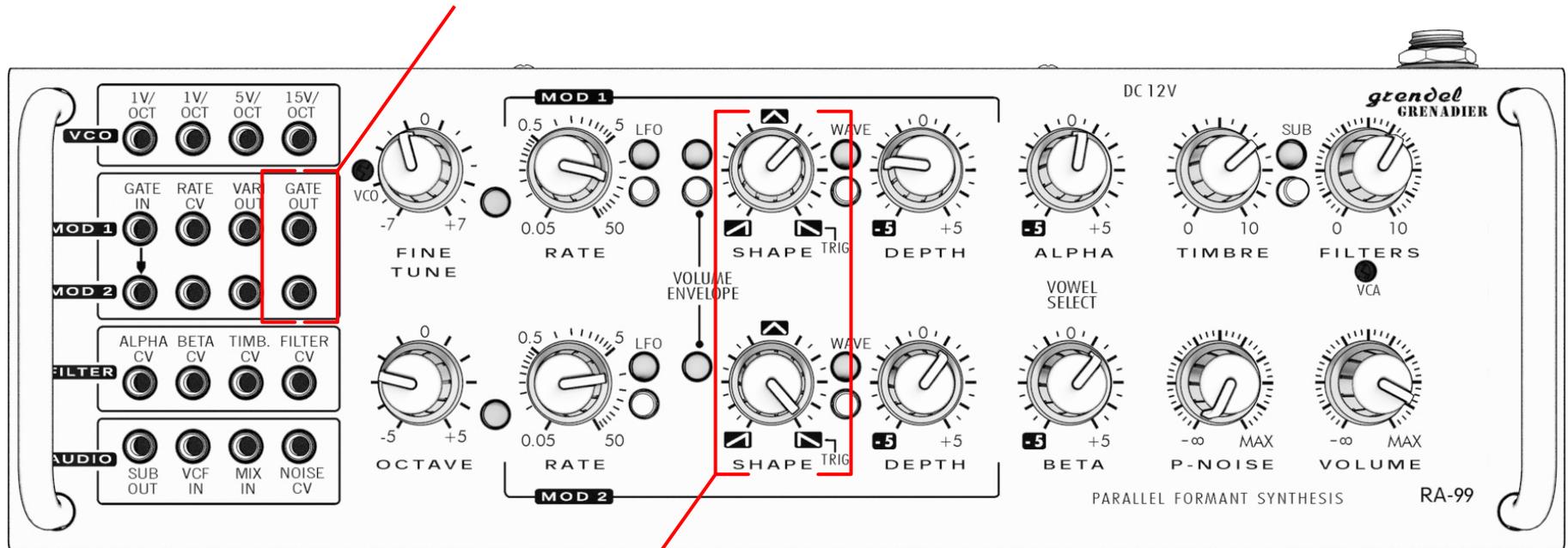
In LFO mode, GATE OUT is a pulse wave with fixed amplitude of 5 volts.

In envelope mode, the output is an inverted gate. When the GATE IN is inactive, and the envelope is settled, the output is high (+5V). When you trigger the GATE IN, GATE OUT goes low (0V) until the envelope expires, then goes high again.

Therefore you can use GATE OUT as a variable gate delay. For example, if you patch MOD 1 GATE OUT to MOD 2 GATE IN, it works as a 2-stage envelope generator.



Gate Delay example with Gate Out  
Time delay factor is adjustable with RATE knob.



Frequency divider example with LFO in TRIG mode.

If the LFO is retriggered before it completes 1/3 of a cycle, the output is a stair-step waveform at a frequency equal to the input divided by a whole number.

... That is to say, triggering the LFO rapidly can do interesting and useful things!

# SHAPE knobs

In envelope mode, SHAPE varies the attack-release times of the envelope generator. Turn SHAPE to the TRIG position and it becomes a decay envelope triggered by GATE IN.

In LFO mode, SHAPE varies the symmetry of the LFO output.

Turn SHAPE to the TRIG position and it becomes a falling sawtooth LFO that is re-triggered (synced) by GATE IN events.

These parameters do not have voltage control CV inputs.

## DEPTH knobs

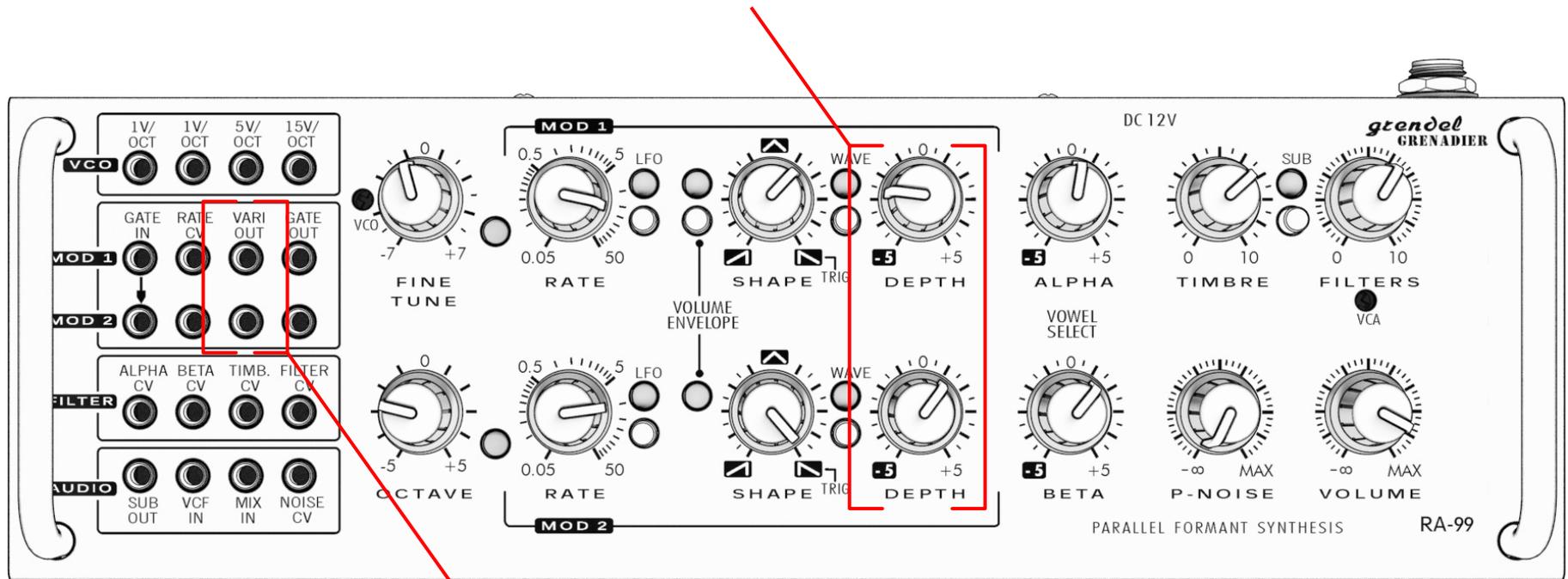
These are bipolar attenuators for the MOD outputs.

To cancel the modulation, set the DEPTH knob straight up (12 o'clock).

By default, MOD1 DEPTH controls the ALPHA parameter, and MOD2 DEPTH controls BETA.

You can change this assignment with the patch bay.

These parameters do not have voltage control CV inputs.



## VARI OUT jacks

These are the outputs from MOD1 and MOD2, after attenuation by the DEPTH knobs.

The output voltage range is 0 to +5 volts.

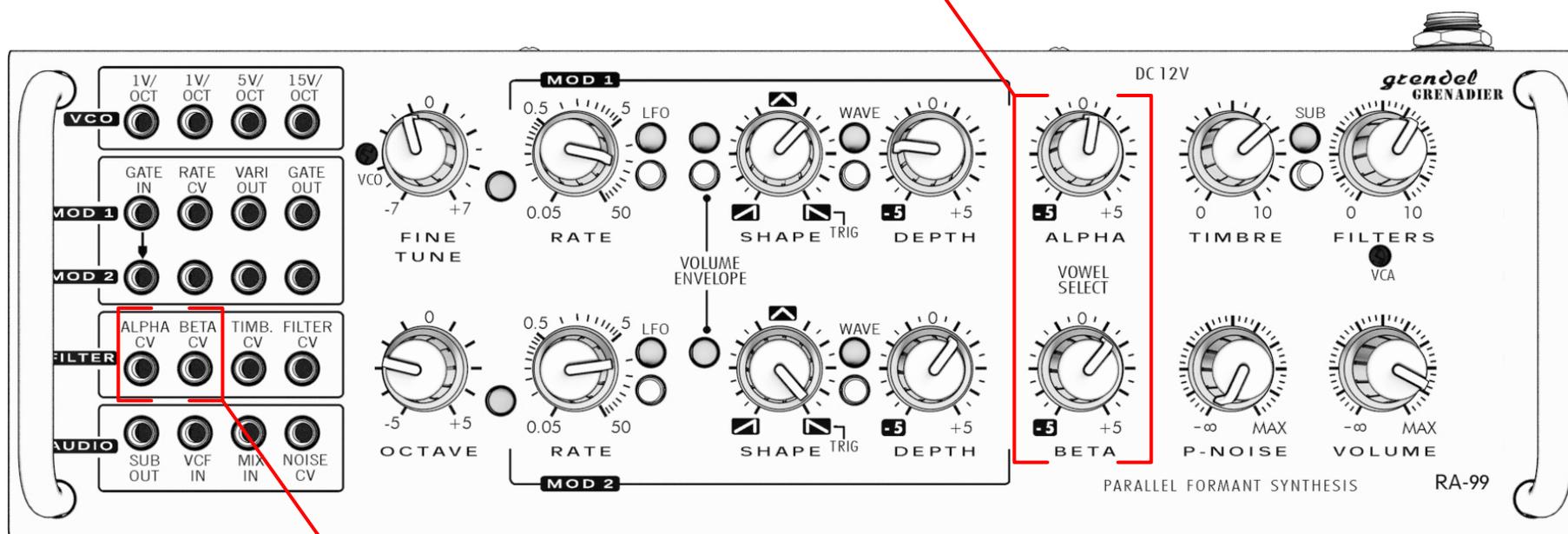
When DEPTH is set at minimum (straight up, 12 o'clock), VARI OUT is steady at 2.5 volts.

MOD1 VARI OUT is internally connected to ALPHA CV.

MOD2 VARI OUT is internally connected to BETA CV. See the following page for options...

## ALPHA and BETA knobs

These control the filter bank and can morph between vowel tones when you find a sweet spot.



## ALPHA CV and BETA CV jacks

These affect the filter bank in the same manner as the ALPHA and BETA knobs, and can be used simultaneously.



### Remember:

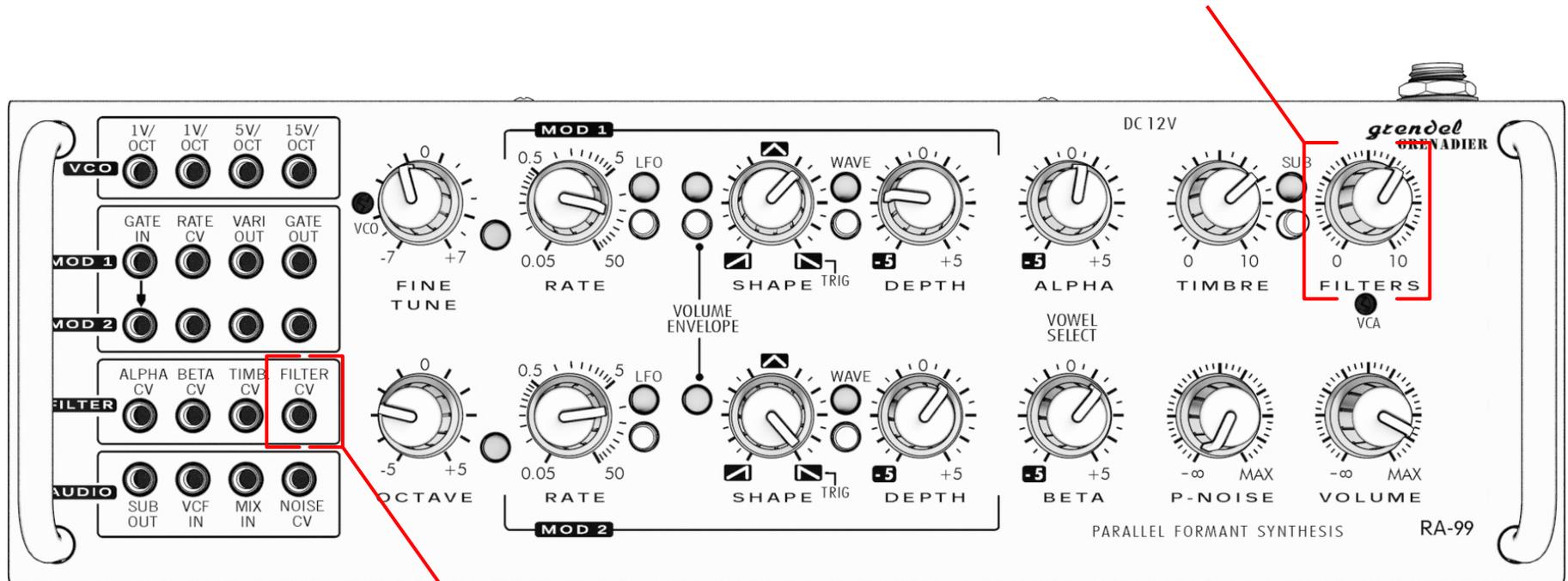
By default, MOD 1 VARI OUT is internally connected to ALPHA CV. Plugging a patch cable in to ALPHA CV breaks this connection. By default, MOD 2 VARI OUT is internally connected to BETA CV. Plugging a patch cable in to BETA CV breaks this connection.

To stop MOD DEPTH from modulating the filters so you can use VARI OUT for other purposes, dead patch ALPHA CV or BETA CV. To dead patch, just plug in a patch cord to ALPHA CV or BETA CV and leave its other end unconnected.

## FILTERS knob

This is an important filter bank parameter that has the general effect of tuning it from from low to high. It can also influence the vowel tones, depending on the settings of Alpha and Beta.

*Please note, the RA-99 filter bank is not designed for full cutoff, as in a conventional low pass filter.*



## FILTER CV jack

This has the same effect as the FILTERS knob, providing the option of voltage control. Both the knob and the jack can be used simultaneously.

*The resonance (Q factor) of the filter bank is not adjustable.  
The filter bank can not be bypassed.*

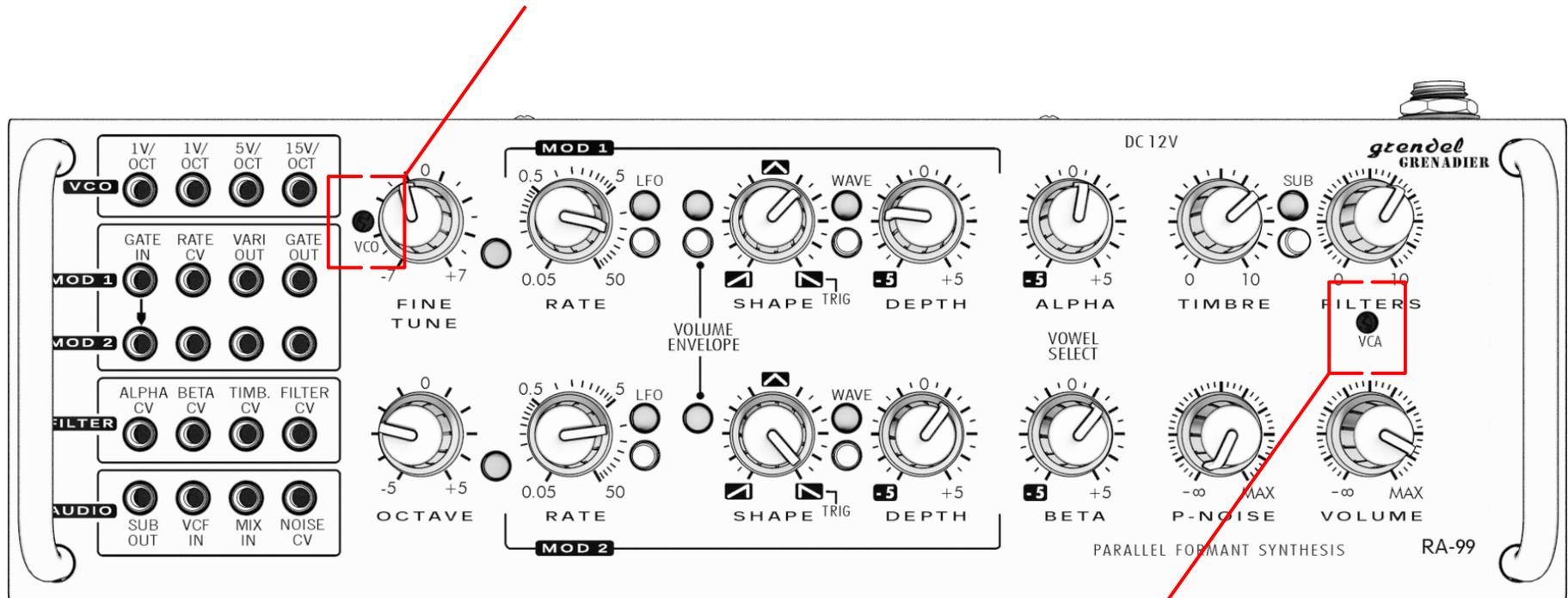
## VCO trimmer

This is used to calibrate the V/OCT inputs for accurate pitch scaling. It affects all of the V/OCT inputs.

For a quick tuning check, patch MOD 2 GATE OUT to 5V/OCT. Set MOD2's LFO switch ON. The VCO should be playing a sequence of alternating octaves.

Q: What type of tool do I use to adjust the trimmers?

A: Use a screwdriver with flat blade or Philips tip, 2.5 mm, 3.0mm or 1/8"



## VCA trimmer

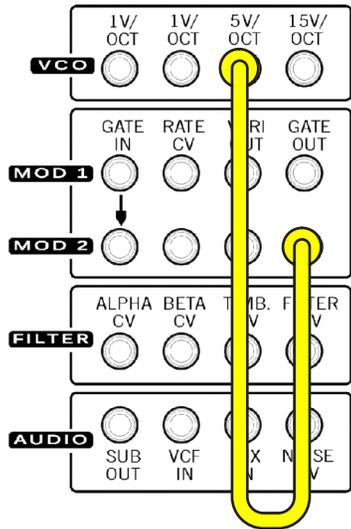
This is used to calibrate the Volume Envelope VCA to match the envelope generators. When it is set properly, decaying notes fade away to silence with accurate exponential character.

If it is not set correctly, notes may continue to sound after the envelope decays fully.

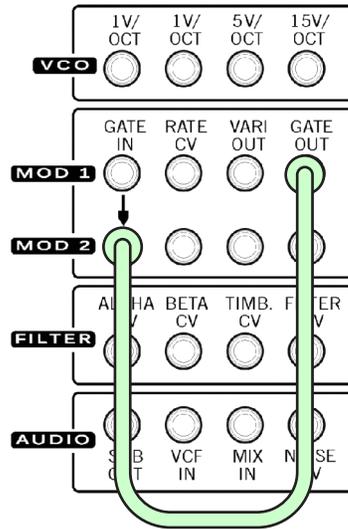
If it is not set correctly, the tails of decaying notes may be clipped off prematurely.

\*\* Note that there are two envelope generators, and their RATE knobs have a slight influence on the envelope baseline (quiescent) voltage level. So its best not to obsess over setting this trimmer perfectly. Just make sure the decay envelope fades completely to silence at any combination of settings on VOLUME ENVELOPE and RATE.

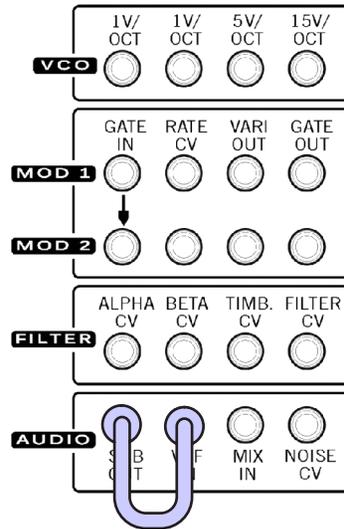
Creative self-patching will let you uncover many tone variations in the Grendel RA-99. This page presents a few ideas as starting points.  
 \*\* These patches don't show CV-Gate input from your controller or sequencer, which are usually connected to 1V/OCT and MOD1 GATE IN.



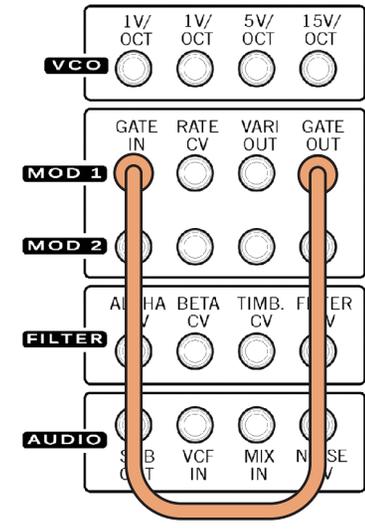
**Octave Trills**  
 MOD2 LFO = ON



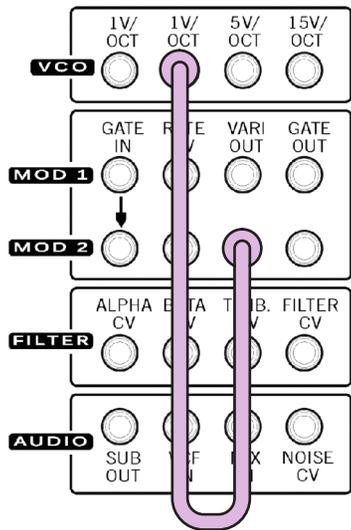
**2-Stage Envelope**  
 MOD1 LFO = off  
 MOD2 LFO = off



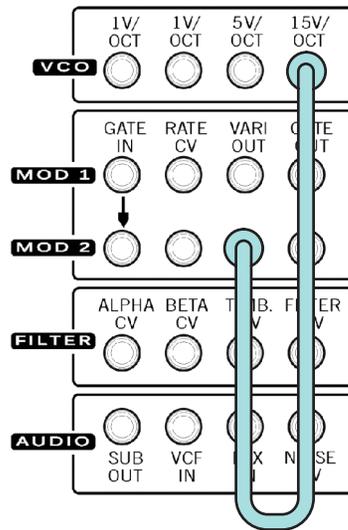
**Pure Square Wave**



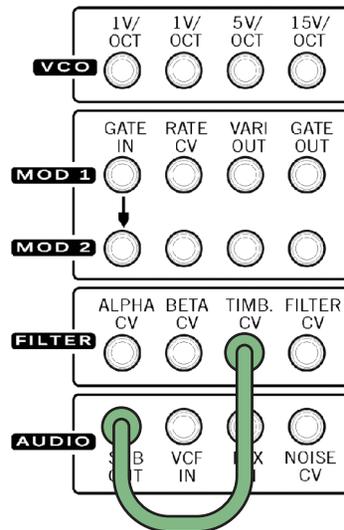
**Drone Mode**  
 Volume Envelope = MOD1  
 MOD1 LFO = off



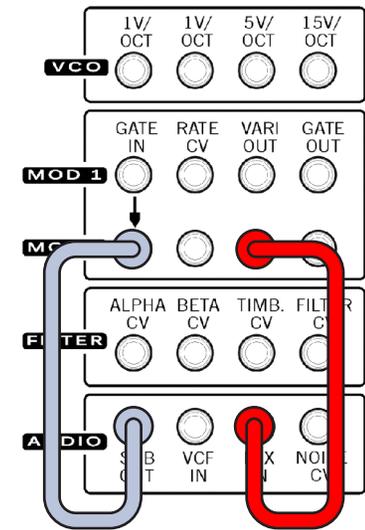
**Bass Drop**  
 MOD2 LFO = off  
 MOD2 SHAPE = TRIG  
 MOD2 WAVE = off  
 MOD2 DEPTH = full CW



**Vibrato**  
 MOD2 LFO = ON  
 MOD2 SHAPE = center  
 MOD2 WAVE = off

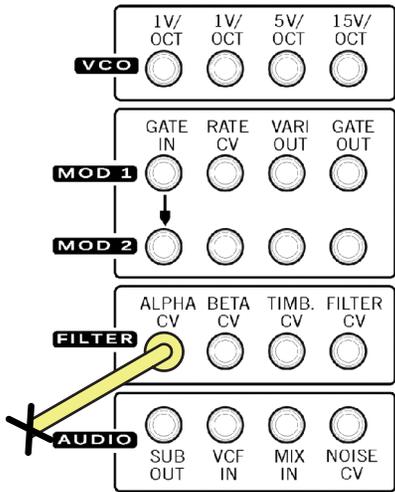


**Waveform Variation**

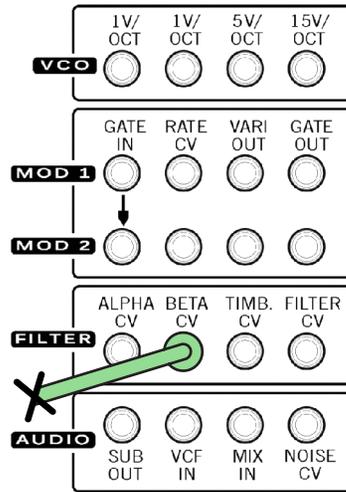


**Subharmonic Divider**  
 MOD2 LFO = ON  
 MOD2 SHAPE = TRIG  
 MOD2 DEPTH = full CW

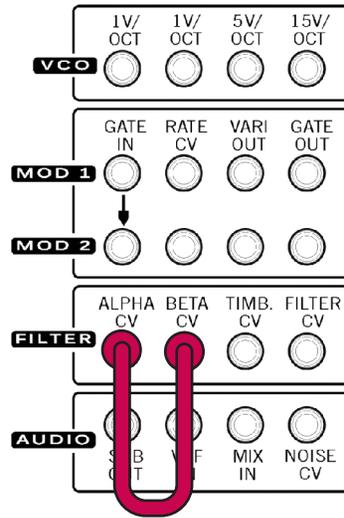
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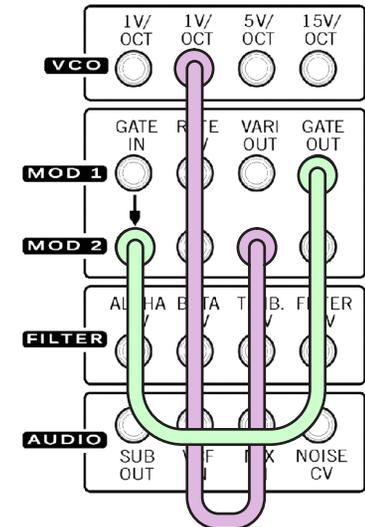
**Dead Patch Alpha**  
 MOD1 is disconnected  
 from filter bank



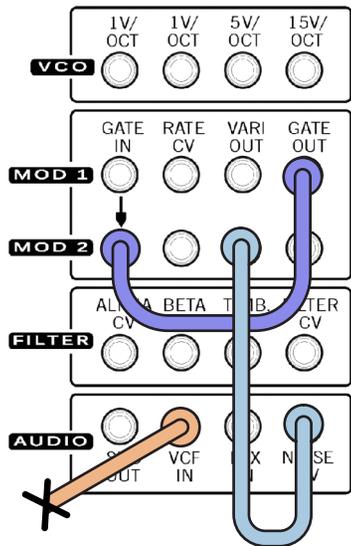
**Dead Patch Beta**  
 MOD2 is disconnected  
 from filter bank



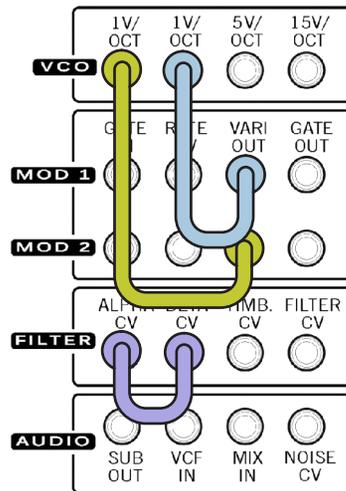
**Die Twice**  
 MOD1 and MOD2 are both  
 disconnected from filters



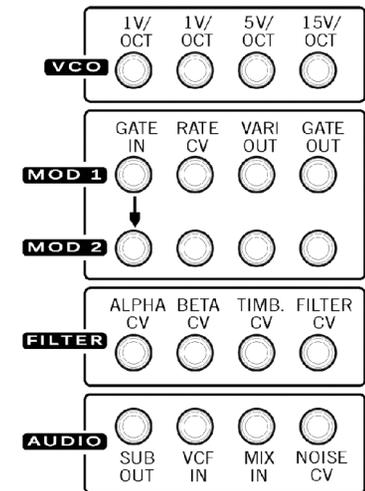
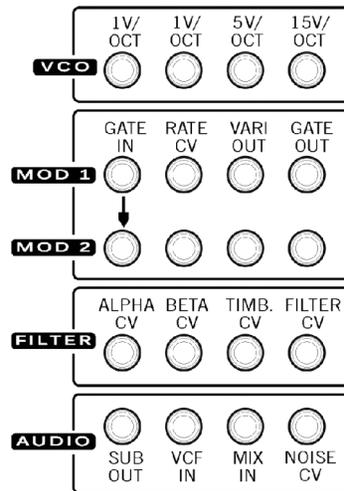
**Auto Drum**  
 MOD1: LFO ON  
 MOD2: LFO OFF, Shape = TRIG, DEPTH = +5

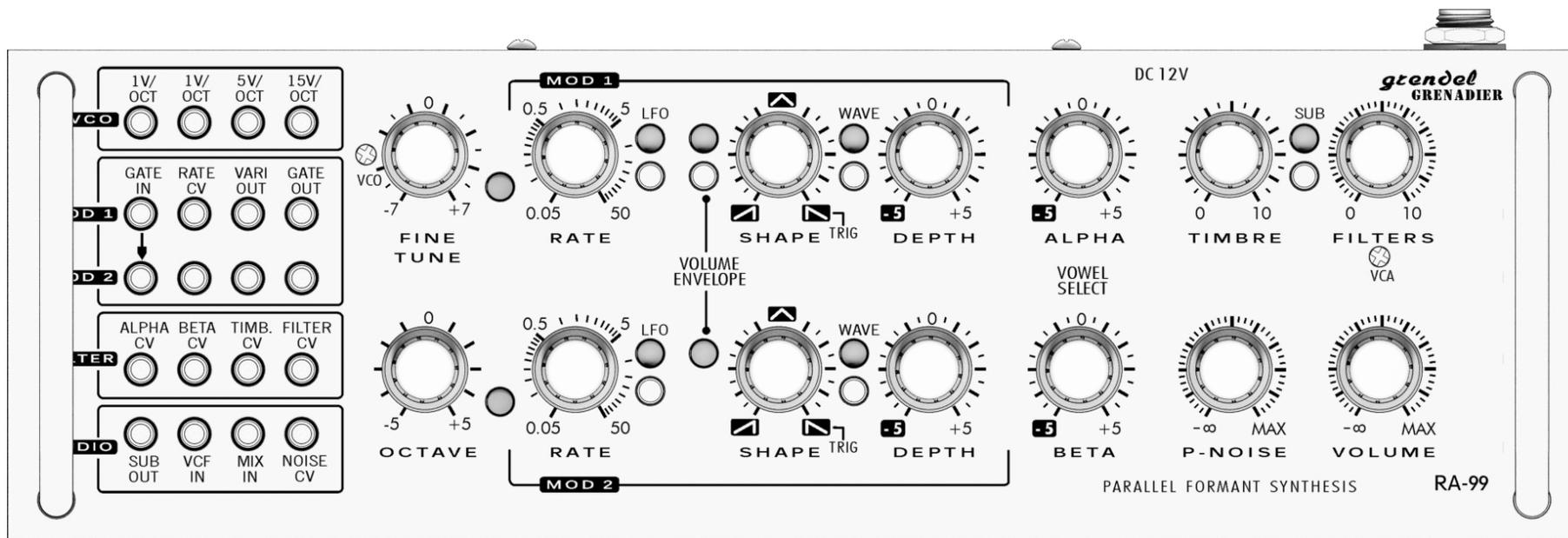


**Breathing**  
 MOD1: LFO ON, WAVE ON, SHAPE = center,  
 RATE = 0.2, DEPTH = -1  
 MOD2: LFO OFF, WAVE OFF, DEPTH = +3  
 P-NOISE = 4



**FM Drone**  
 MOD1: LFO ON, RATE = 30..50  
 MOD2: LFO ON, RATE = 30..50





Patch Name \_\_\_\_\_

## User Support

For questions, service, and technical support, please contact us by email through our website:

[RAREWAVES.NET](mailto:RAREWAVES.NET)

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