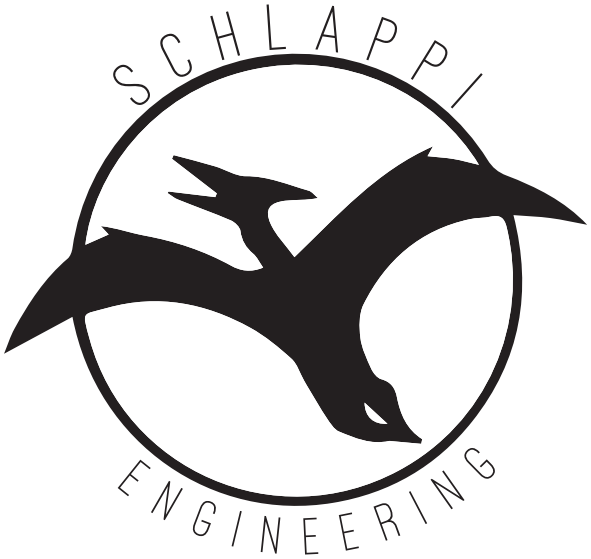


BOUNDARY MANUAL

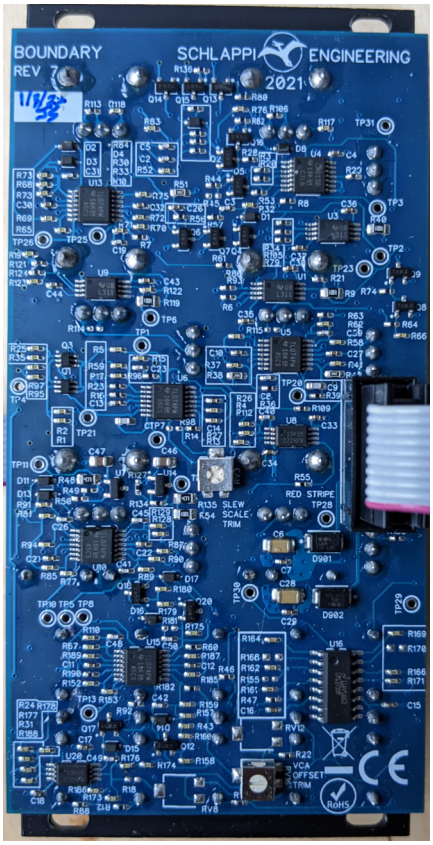
INSTALLATION

Turn your eurorack system off while installing the module. Included 10 pin keyed header cable will line up the red stripe on the cable with -12V (labeled RED STRIPE) on the module.

Please ensure that the red stripe is aligned to the -12V rail on the eurorack case power as well.

If you are not using the included cable please be careful to align the -12V (generally indicated with a red stripe) to the side of the jack labeled RED STRIPE.

The Boundary is diode protected so is unlikely to be damaged in the case that reverse voltage is applied, but if you think this is happening turn off your system and remedy this as quickly as possible.



VOLTAGE STANDARDS AND LEVELS

We design our modules to the Doepfer Eurorack standard http://www.doepfer.de/home_e.htm

All inputs will handle anything from ground to the Eurorack rails +-12V (24V peak to peak, or Vpp) without damage.

The TRIG input has a comparator that will trigger at around a volt off of any shape or rate signal.

Audio path of the VCA is optimized for +-5V (10Vpp) and has soft limiting on the output around +-6V (12Vpp).

CV input for the VCA gives unity gain at +-5V and 2x gain at +-10V.

The envelope output (when using the TRIG input and nothing in the BOUND input) will be a unipolar signal with +10V peak amplitude.

The EOR output will be a 0 or 10V logic signal.

When using the slew SLEW input the envelope output amplitude will follow the input.

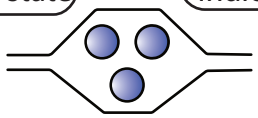
All inputs have 100k input impedance and 1k output impedance, except for the SLEW OUT which has a 0 ohm output impedance to facilitate processing volts per octave signals.

INDICATORS

There are two types of LED indicators on the Boundary
ON/OFF: Blue LEDs only indicating a binary state
BIPOLAR : follows an analog voltage, blue if positive, red if negative, purple if bipolar at audio rate

RISE LED
ON/OFF
Indicates RISE state

FALL LED
ON/OFF
Indicates FALL state

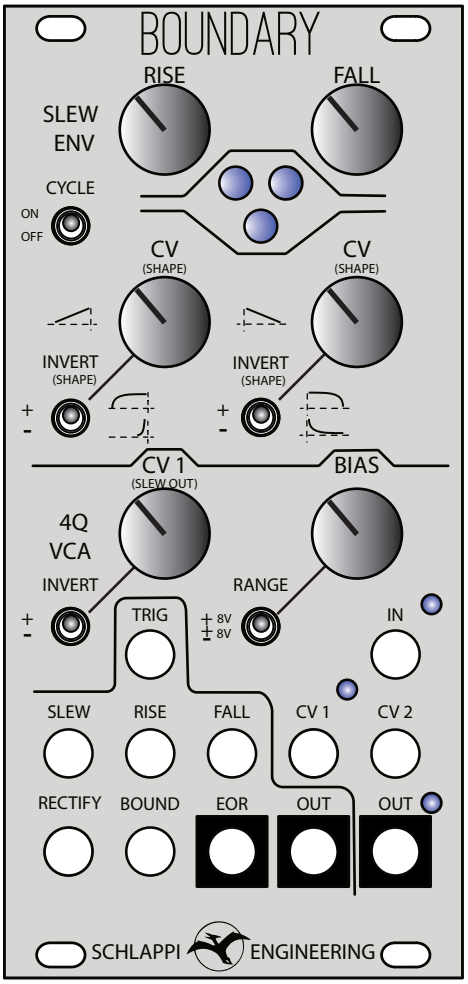


SLEW OUT LED
BIPOLAR
Follows SLEW OUT
If you use the TRIG in this will always be blue, with a bipolar SLEW input this can be red or purple

IN LED
Bipolar, follows input

CV LED
Bipolar, shows sum of CV1, CV2, and BIAS

OUT LED
Bipolar, follows output



SLEW ENV CONTROLS

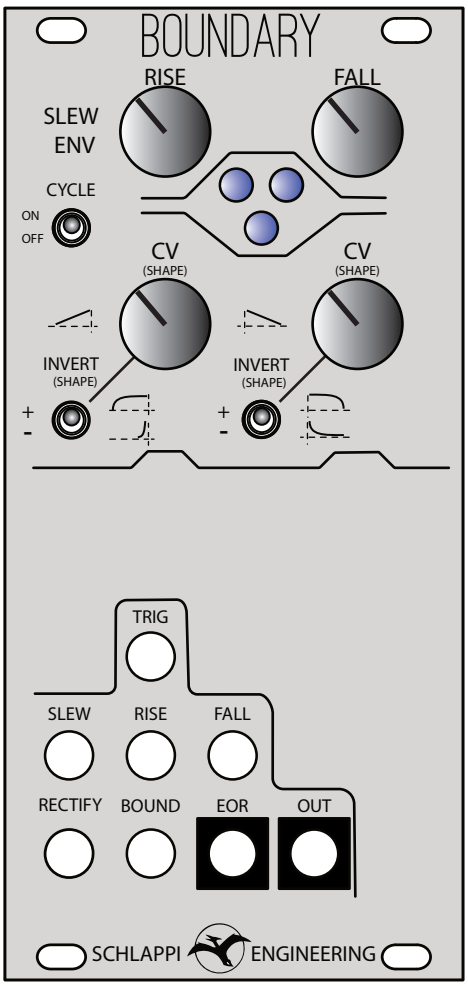
RISE
The rate of rise (or attack)

FALL
The rate of fall (or decay)

CYCLE SWITCH
The SLEW/ENV section will oscillate on its own

CV (SHAPE) x2
Allows external voltage control over the rise or fall rate.
If no cable is inserted the knob controls the shape of the rise

INVERT (SHAPE) SWITCH x2
Inverts the CV being added to the RISE or FALL controls.
In the up (+) position CV will increase the length of the rise, and down (-) decrease.
If no cable is present it switches between logarithmic and exponential curves.



SLEW ENV INPUTS

TRIG INPUT
Starts the Rise cycle of the slew.
It will not retrigger during the rise cycle, allowing for use as a frequency divider or trigger delay

SLEW INPUT
Input to use to control the rate of a bipolar input signal.
The slew is scaled to be accurate enough to use as a portamento with volts per octave signals

RECTIFY INPUT
Full wave rectified input.
Flips the negative half of a bipolar signal up to be wholly positive.
Useful for envelope following or frequency doubling

BOUND INPUT
Replaces the threshold for the cycling slew.
Insert another envelope to achieve bouncing ball effects or use as a pseudo VCA to control the envelope output

RISE
Rise CV input. Attenuated by CV potentiometer, adds to RISE control and breaks SHAPE normalization

FALL
Fall CV input. Attenuated by CV potentiometer, adds to RISE control and breaks SHAPE normalization

SLEW ENV OUTPUTS

EOR
End of rise output
Square wave logic output mirror the FALL LED

OUT
Main slew and envelope output
Bipolar or unipolar depending on SLEW or TRIG input
Normalized to VCA CV1

4Q VCA CONTROLS

CV 1
CV control for the 4Q multiplier.
Normalized to the slew out.

INVERT SWITCH
Inverts CV 1
Useful for ducking or compression effects

BIAS
Controls default level of the VCA
Adds to CV inputs

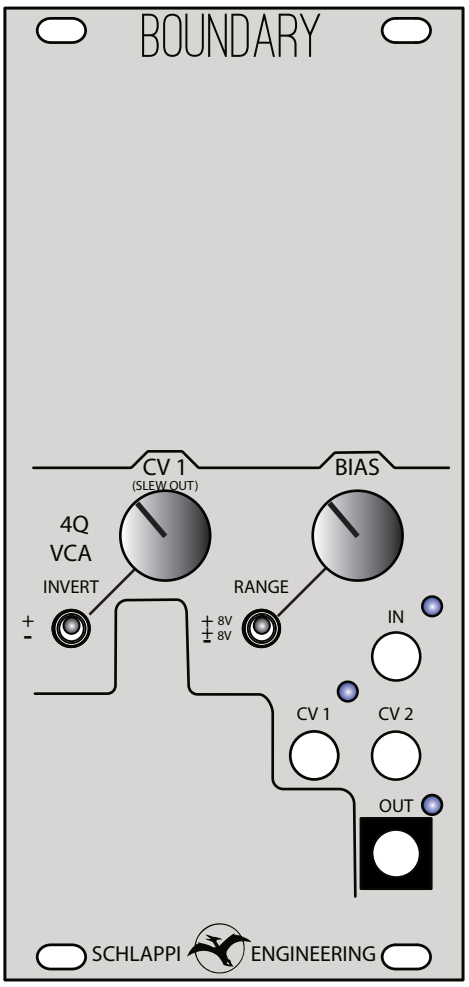
RANGE SWITCH
Determines whether the BIAS is positive only (for traditional VCA usage) or can travel negative to invert the signal.
Useful to offset a ring modulated signal.

4Q VCA INPUTS

IN
VCA input
DC coupled input

CV 1
CV for the 4Q multiplier.
Breaks the normalization to the CV1 control, allows for attenuated control over the VCA.
Adds to the BIAS control and CV2

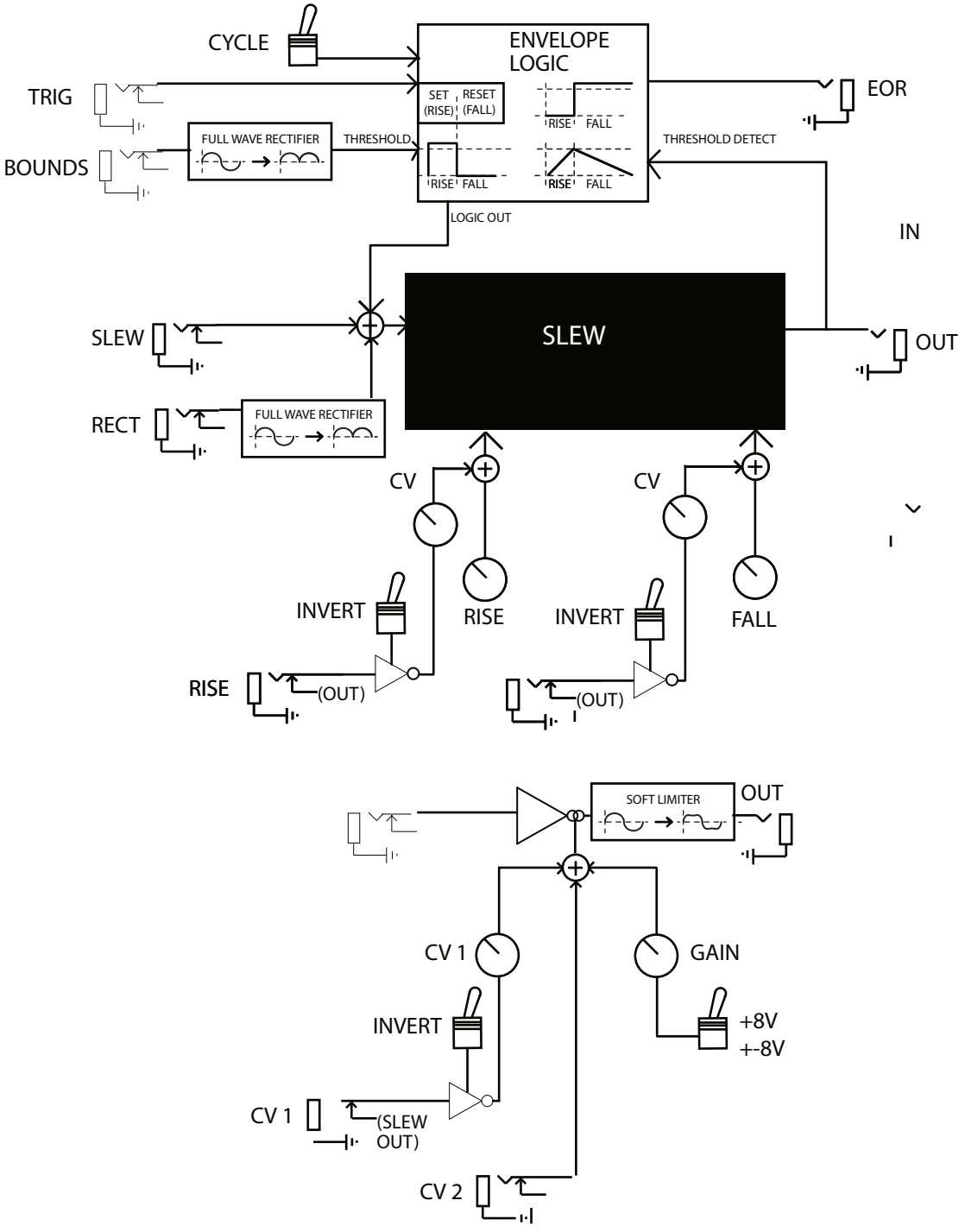
CV 2
CV for the 4Q multiplier.
Unattenuated secondary CV input to the VCA, adds to CV1 and the BIAS control.



4Q VCA OUTPUT

OUT
Main VCA output
Soft limited around 12Vpp (+-6V)

OVERVIEW



(parentheses indicate connections normalled to unconnected inputs)

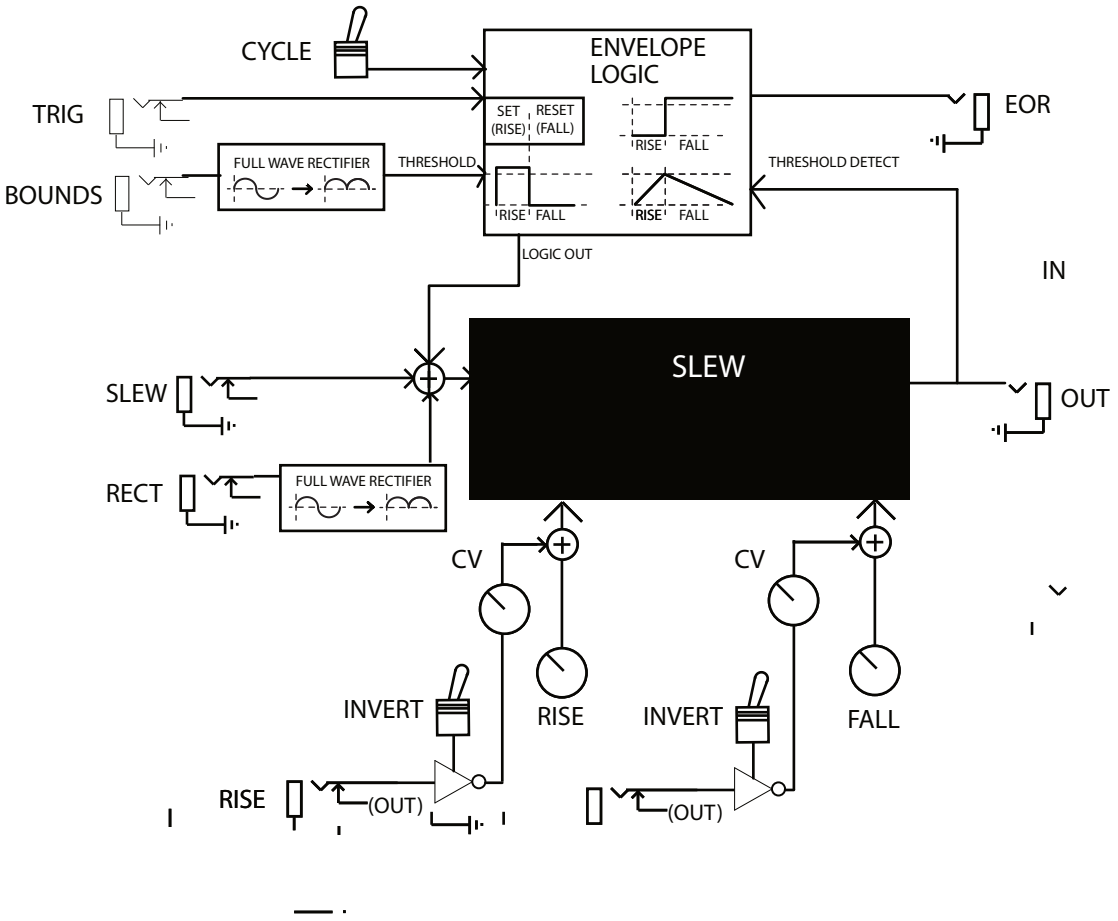
OVERVIEW

The Boundary consists of two independent but complementary sections, the SLEW and the 4Q VCA.

The slew creates shapes (such as envelopes or LFOs) and the 4Q VCA is an analog multiplier used to control signal amplitude or modulate it, from DC to audio rate.

These are connected through the normalization of the SLEW OUT to CV1 of the VCA, enabling envelopes and modulation of a signal without additional patching.

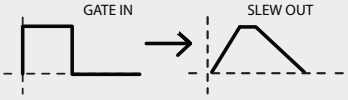
SLEW



SLEW

The slew is essentially a low pass filter with separate rise and fall controls using a scheme heavily influenced by Serge in their various slope generators.

If the SLEW input is used with a gate signal then it will act as an Attack-Sustain-Release (ASR) envelope, where the sustain level is controlled by input level of the gate or the output level of the envelope.

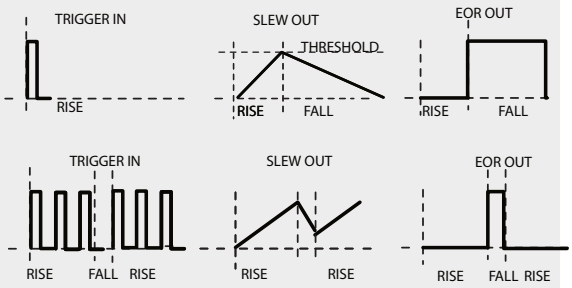


This is the standard way to use the envelope with a keyboard gate out.

TRIGGER

The slew core is complemented with a set-reset CMOS latch for the envelope logic. Once the latch is set it will not reset until after the output meets the high threshold.

The latch is set by the TRIG input and allows it to act as an Attack Release (AR) envelope, ignoring the length of the input signal. This is the recommended input to use with a sequencer to trigger envelopes unless you have control over the gate length.

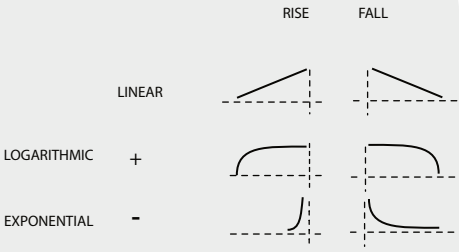


This behavior also allows for frequency division.
If you use the trigger input any pulses during the rise stage will be ignored and the end of rise EOR output can be used as a square wave output.

SHAPE

The shape of the envelope can be controlled separately for the rise and fall stages of the envelope.

If the shape controls are fully counter clockwise they are linear, clockwise they can be logarithmic or exponential depending on the setting of the switches.



This is done by normalizing the output (feedback) as voltage control. If the output is high it will provide more control voltage and this can (for example) cause the fall shape to start fast then go slower as it drops. Or if the output is low it will start slow then speed up providing an exponential curve. The opposite will occur if the inverting switches are used.

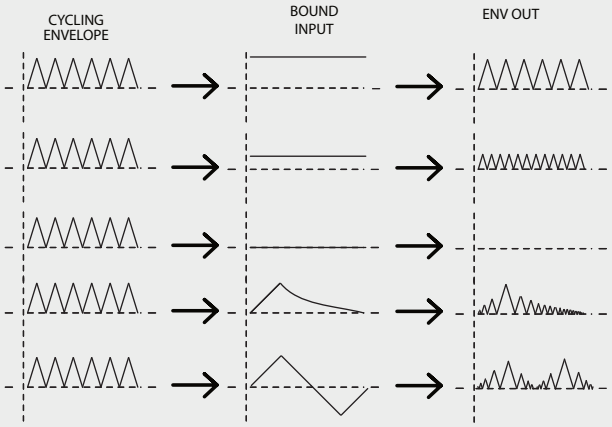
By setting the shape to exponential on the rise stage and raising the control you can get the envelope fast enough to make a significant clicking sound, this can be useful when designing percussion sounds.

If both stages are set to exponential you can get the Boundary to cycle in moderately high audio rates (several kHz).

If CV is inserted into the RISE and FALL jacks then the shape controls become attenuators (with invert switches) for external control over the

BOUND

The BOUND input replaces the logic's high threshold with an external signal. This allows for bouncing ball and other unusual rhythmic effects. There is also a full wave rectifier on this input so that bipolar signals can be used.



This will only have an effect when the TRIG input is used, since that is what activates the envelopes logic.

Since it replaces the threshold without changing the rate of rise and fall it will raise the frequency of oscillation when the amplitude is lowered and vice versa.

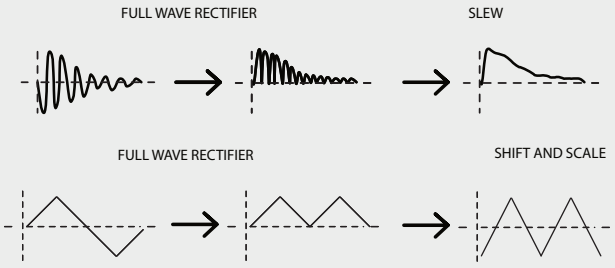
To get the best bouncing ball type effect you will probably want to have the CYCLE on and experiment with the shape of both the envelope whose bounds you are modulating and whatever is doing the modulating.

Another use for this input is as a pseudo VCA. Since it controls the height of the envelope you can use an external signal to control the amount of the envelope.

RECTIFY

The RECTIFY input to the SLEW is a full wave rectifier. Which means it takes the negative parts of a signal and makes them positive.

The primary intent is to catch negative transients for use in envelope following. Some kick drums, for example, have strong initial negative transients, so you will not get a nice snappy kick envelope from them if you only use the positive part of the waveform.

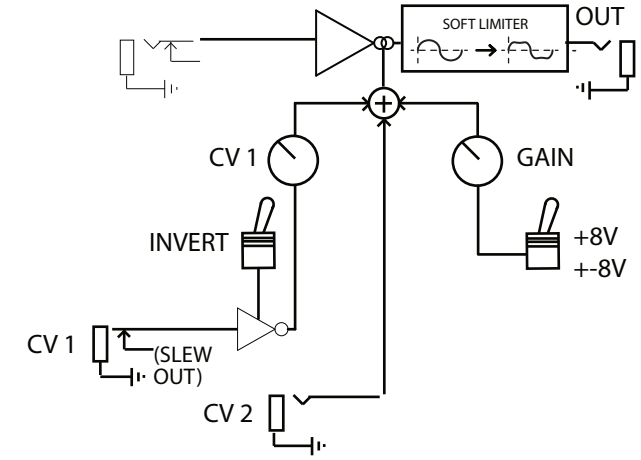


The rectify input can also be used as part of a frequency doubler (with triangle input) or waveshaper (with most other waveforms.

In this usage the waveform will half have the amplitude of the original as well as a DC offset, you may want to scale and shift (or AC couple) the resulting waveform.

One thing to watch out for if a bipolar square wave is input here the output will be a spike the width of the transition time or just a DC signal.

4Q VCA



(parentheses indicate connections normalled to unconnected inputs)

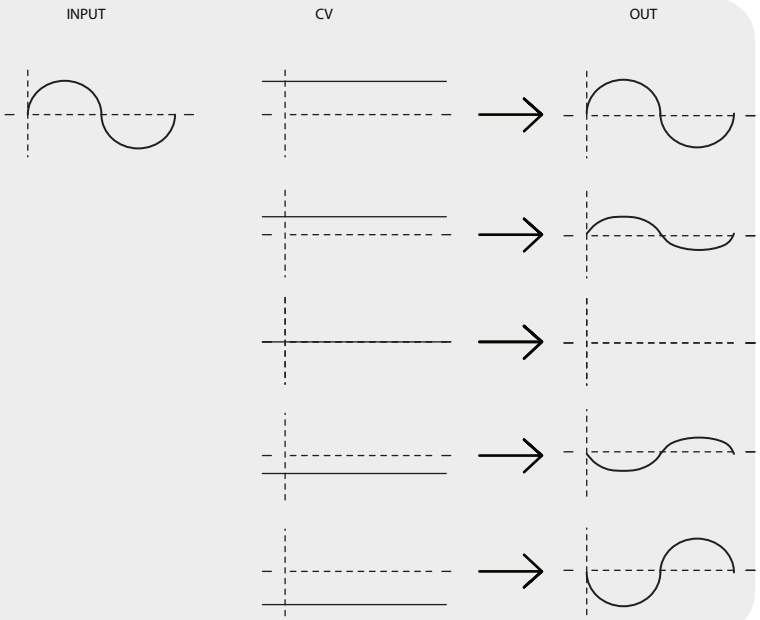
VCA

The 4Q VCA is a voltage controlled amplifier that accepts both positive and negative control voltage.

This has the property of multiplying the input voltage by a value from (approximately) -2 to positive 2.

Unity gain is 5V, 2x gain is 10V.

A negative gain will invert the signal, so an inverted signal at unity gain corresponds to -5V.



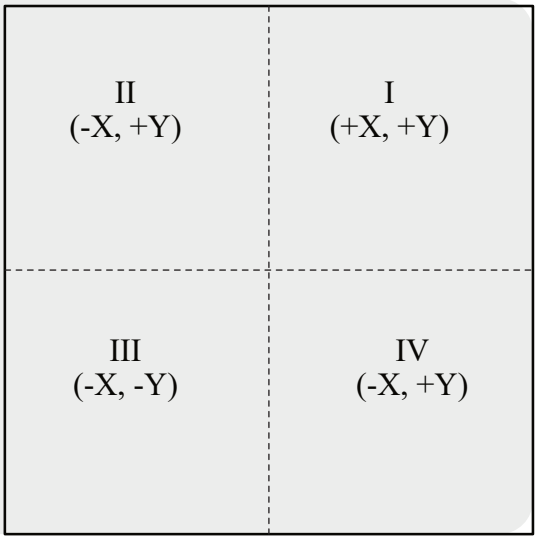
QUADRANTS

"Quadrant" refers to the two dimensional Cartesian system.

In this application the input is X and the CV input is Y.

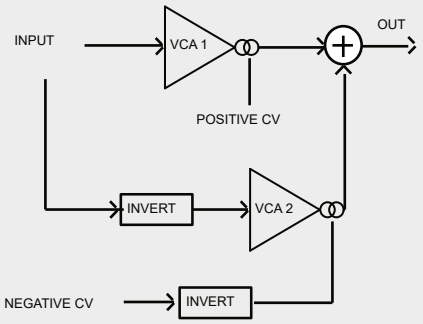
A two quadrant multiplier can take inputs from the first two quadrants, positive and negative X, positive Y.

A four quadrant multiplier can take inputs from all four quadrants (positive and negative signals).



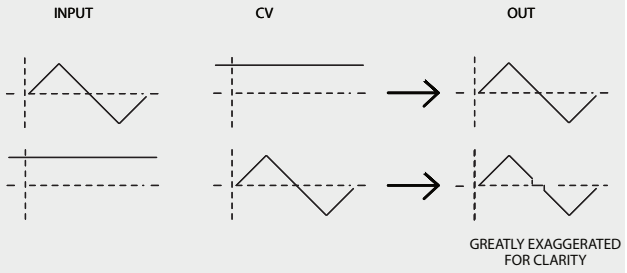
VCA STRUCTURE

This particular four quadrant VCA is built out of two, two quadrant OTA VCAs arranged so that one inverts the signal and receives negative voltage as positive.



This arrangement is a little crude (there are more elegant ways to make a four quadrant VCA) but has the advantage of being able to create a small dead zone where the VCA is pretty thoroughly shut off (avoiding bleed).

This does mean there is is some crossover distortion when used as a ring modulator, but it think for the intended application it sounds pretty good. If a more elegant four quadrant multiplier (without this dead zone) is used then it would be better for audio rate modulation but difficult to use as a traditional VCA.



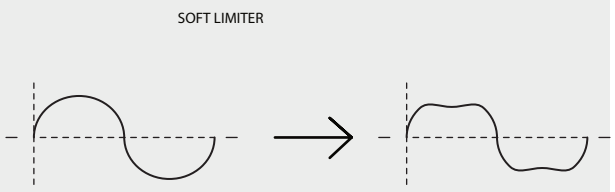
When used as a ring modulator with the cycling slew you may want to use the negative switch on the bias to offset the unipolar signal into a bipolar signal.

4 quadrant amplitude modulation (ring modulation) theoretically outputs only the sum and difference frequency components of the input signals.

In practice any DC offset (including that which is inherent to a unipolar signal) will let through some of the input signal as well.

OUTPUT LIMITER

The 4Q VCA also has a transistor based soft clipper/limiter on the output, set to kick in around 12Vpp (or +-6V).



The intent here is to allow the VCA to be placed in feedback loops or on the output of some unruly modules and tame them a bit. It can also be pushed into saturation as a fairly mild overdrive/distortion effect.

SUGGESTED PATCHES

Here are a few basic patches to start out with

ENV/VCA

CYCLE OFF
RISE 100%CCW
FALL %50

•Trigger signal at TRIG in or gate signal at SLEW in
•Insert audio at IN, listen at OUT (VCA section)
•Turn up CV1 to apply envelope to to VCA signal
•BIAS will add (or subtract) from CV1
•Experiment with RISE and FALL CV (shape) knobs
•INVERT CV1 and turn BIAS control CW to create a ducking effect

BOUNCING BALL

•Start from ENV/VCA patch
•TRIG signal at TRIG in
•CYCLE switch UP (ON)
•Apply another envelope at BOUND
•Explore RISE, FALL and SHAPE

ENVELOPE FOLLOWER

•Apply audio to slew or "follow" to RECTIFY input
•Turn RISE and FALL to taste
•Use the slew OUT

TIPS
•Applying the slew OUT to a filter CV will give you the classic auto filter or auto wah effect

COMPRESSOR

•Start with envelope follower patch
•Use the same signal in the SLEW and VCA IN
• Invert CV1
• Increase CV1 to subtract the slewed signal from the original
• Slower rise (attack) will allow faster signals through
• Fall will be the release control

TIPS
•If you have a way to threshold or gate the signal before applying it to the slew it will be a more complete compressor
•Applying a different signal to the SLEW and the IN is the same as side chaining with a compressor

RING MOD

•Input audio at VCA IN
•Input modulating signal at CV1
•Flip BIAS RANGE switch to bipolar and offset modulator signal to taste
(necessary with unipolar modulators)
• Listen at VCA OUT

To use the SLEW ENV as a modulator
•CYCLE switch ON (UP)
•Turn RISE/FALL CCW until audio rate

FREQUENCY DIVIDER

•CYCLE switch OFF (DOWN)
•Insert signal to divide at TRIG
•Take output from EOR out
•Try changing RISE and FALL (start fully CCW)
•RISE controls division
•FALL affects pulse width

TIPS
Try CVing RISE for a sort of dirty arpeggio effect

AUDIO RATE SYNC EFFECTS

•CYCLE switch ON (UP)
•Insert Audio in TRIG input
•Listen to the slew OUT
•Try changing RISE and FALL (start fully CCW)
•Add CV to RISE and FALL
•Move input to SLEW or RECTIFY for different effects

PORTAMENTO

•V/OCT in at SLEW
•V/OCT out from slew OUT

TIPS
Applying voltage control to RISE and FALL CV to create dynamic slides

CALIBRATION

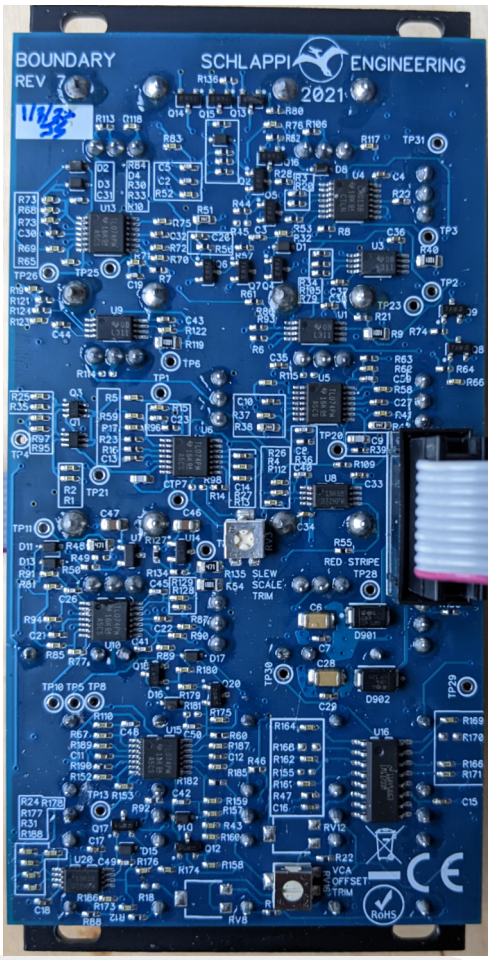
There are two total trimmers on the back of the Boundary. VCA offset trim, slew scale trim. These should be properly trimmed with lab grade test equipment, please don't touch them if you don't have the required equipment and technical knowledge.

SCALE TRIM CALIBRATION

a. Insert 7V from DC power supply
b. View slew out on multimeter with Volt setting
c. Turn trim RV3 until the output matches the input

OFFSET TRIM CALIBRATION

a. Change oscilloscope channel 2 scale to 20mV
b. Ensure you still have a signal at the input for this next step
c. Turn RV16 VCA OFFSET TRIM to the right until you see some signal bleeding through
d. Turn RV16 to the left until the exact point that the bleedthrough goes away (no further)



REVISION

There are currently two revisions of the Boundary in the wild. The first one is labeled REV 6 and had an important issue that was corrected with modifications before many had shipped and a couple minor ones that were only addressed with rev 7

If you encounter any issues or an unmodified unit feel free to contact us and we will fix or modify you unit for you.

Rev 6 issues:
Lockup while cycling with audio rate modulation into the BOUND input and/or the FALL CV input
-This was fixed with a through hole resistor on the back of the PCB and a few resistor changes.
Was not saturating in the negative direction on the output
-Fixed with a resistor change in REV 7
Not triggering correctly with some sequencers
-Hysteresis on input comparator caused an effective input impedance of 50k instead of 100k.
-Fixed with resistor change on REV 7

Other changes between REV 6 and REV 7:
-Through hole LEDs replaced with SMD LEDs

CONTACT US

If you have any questions or feel like we have left anything out please feel free to contact us at: eric@schlappiengineering.com