Voltage Controlled ADSR Envelope Generator

Operation

This module is a linear voltage-controlled ADSR envelope generator, with additional features inspired mostly from the Serge Universal Slope Generator. This allows the module to generate a variety of envelope shapes and to even act as a VCO.

Knobs

- **Attack:** controls the attack slope
- **Decay:** controls the decay slope or time, depending on the **JP1** jumper setting
- **Sustain:** controls the sustain level
- **Release:** controls the release slope
- $\mathbf{CV_{A,D,S,R}}$: attenuverts $\mathbf{CV_{A,D,S,R}}$ (see Inputs), from -1V/oct to 1V/oct (or a bit more than that, see the second point in Configuration)
- **Out Amp:** attenuverts **Out** (see Outputs), up to 10 Vpp
- **Out Offset:** shifts **Out** (see Outputs) up and down. The off level of the envelope will range from -5 to 5 V

Switches

- **CYC:** when this switch is up, the envelope continuously cycles between the attack and release phases, causing it to act as a triangle wave oscillator. It can be thought of as if one were to connect the **End** output to the **Gate** input.
- **FBK:** when this switch is up, it connects the **AC Out** output to the $\mathbf{CV_{A,D,R}}$ inputs. This was inspired by the Serge Universal Slope Generator, and it allows the user to obtain variable logarithmic and exponential attack, decay and release phases by turning the $\mathbf{CV_{A,D,S,R}}$ knobs.
- **RNG:** selects the attack, decay and release time ranges.

Inputs

- $\mathbf{CV_A}$: controls the attack slope, and through the use of switched jacks it also controls the decay slope if no input is patched to $\mathbf{CV_D}$ and the release slope if no inputs are patched to $\mathbf{CV_{D,R}}$.
- $\mathbf{CV_D}$: controls the decay slope or time, depending on the **JP1** jumper setting, and through the use of switched jacks it also controls the release slope if no input is patched to $\mathbf{CV_R}$.
- $\mathbf{CV_S}$: controls the sustain level
- $\mathbf{CV_R}$: controls the release slope
- **Gate:** envelope gate input
- **Trigger:** envelope trigger input

Outputs

- **End:** this signal is high during the off and attack phases and low during the decay, sustain and release phases
- **Out:** envelope output
- **AC Out:** zero-centered 10Vpp envelope output

Configuration

Jumpers

There are four jumpers used for configuration. Their location and default position are specified in figure 1.

- **JP1:** this controls whether the **Decay** knob and $\mathbf{CV_D}$ input control the decay slope (default setting) or time. Let us suppose that the sustain knob is centered, so the sustain level will be halfway between the envelope's maximum value and its off value, and the decay phase lasts n milliseconds. If one were to now turn the sustain all the way down (to the off value), the envelope will either mantain its decay slope and take twice the time

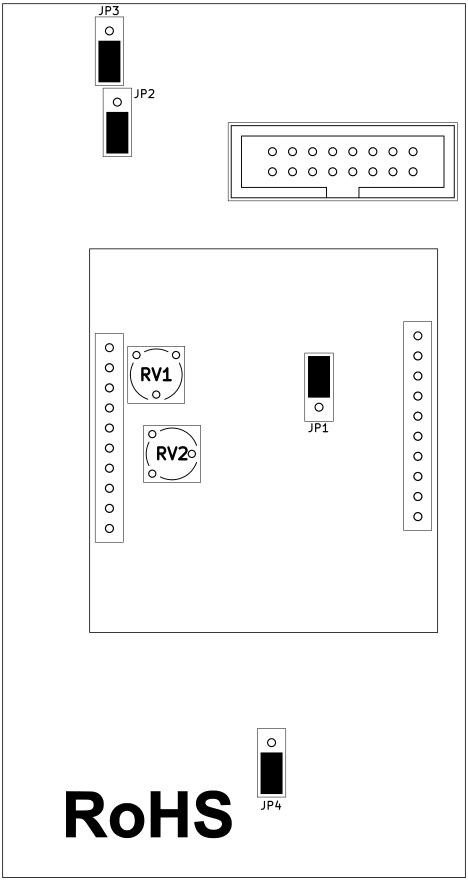

Figure 1: Jumper (in their default position) and trimmer location

($2n$ milliseconds) to get there (default setting) or take the same time but in order to do so it has to move at twice the initial speed (constant time setting). The same logic applies if the sustain level is near the envelope's maximum value, except that now the envelope has to move slower to maintain a constant decay time. The goal of this extra setting is to try to mimic what happens in the simplest exponential RC-charge envelope generators, which some users may be more familiar with.

For technical reasons, it is more difficult to also provide the equivalent of this setting for the release time without redesigning it as a digital module, so as an alternative we recommend turning on the **FBK** switch and turning the $\mathbf{CV_R}$ knob to get an exponential release phase, whose completion time is less dependant on the voltage it departs from. Note that this approach also works for the decay time: taking that into account, it is unlikely that you will feel a need to adjust this jumper, so don't worry if all of this sounds too convoluted.

- **JP2:** this controls whether the $\mathbf{CV_A}$ input can range from $-1V/\text{Oct}$ to $1V/\text{Oct}$ when the corresponding attenuverting knob is turned across its entire range or if the range is approximately $-1.1V/\text{Oct}$ to $1.1V/\text{Oct}$. This was made in mind to allow the user to fine tune the input scaling in case the tracking is too flat without having to calibrate it with the trimmer.
- **JP3:** this controls whether the $\mathbf{CV_R}$ input can range from $-1V/\text{Oct}$ to $1V/\text{Oct}$ when the corresponding attenuverting knob is turned across its entire range or if the range is approximately $-1.1V/\text{Oct}$ to $1.1V/\text{Oct}$. This was made in mind to allow the user to fine tune the input scaling in case the tracking is too flat without having to calibrate it with the trimmer.
- **JP4:** this controls the output level of the **OUT** output, from $0V$ to $5V$ or from $0V$ to $12V$.

Trimmers

- **RV1:** this controls the scaling of the $\mathbf{CV_A}$ input, to allow for $1V/\text{Oct}$ tuning (see Tuning for tuning instructions).
- **RV2:** this controls the scaling of the $\mathbf{CV_R}$ input, to allow for $1V/\text{Oct}$ tuning (see Tuning for tuning instructions).

Tuning

In case the tracking of the attack and release inputs deviate from the $1V$/Oct standard, the following instructions should be followed:

- **Attack tuning:**

  1. Let the module run for 20 min
  2. Disconnect all inputs
  3. Make sure the **JP2** jumper is in the default position
  4. Turn the $\mathbf{CV_A}$ and $\mathbf{CV_R}$ knobs all the way to the right
  5. Turn the **RNG** switch up
  6. Turn the **FBK** switch down
  7. Turn the **CYC** switch up
  8. Turn the **Release** knob to about 8 o'clock
  9. Turn the **Attack** knob enough to the right so that the output on **AC OUT** resembles a positive ramp sawtooth. If you want good tracking in the low to mid frequency range, turn the knob so that the output oscillates at around 100 Hz or so.
  10. Apply 1 V to the $\mathbf{CV_A}$ input. If you don't have a precise 1 V source, plug in the CV output of a keyboard and play the lowest note. This may or may not cause you to deviate from the frequency you had in the previous step, so readjust the **Attack** knob if needed (or play some other note that gets you closer to that). Once that is done, play a note an octave above. This should cause the output to double in frequency: if it's below that, the tuning is flat and the trimmer should be turned slightly counterclockwise; if it's above that, the tuning is sharp and the the trimmer should be turned slightly clockwise.
  11. Remove the 1 V source, or play the original note an octave down again. Readjust the **Attack** knob back to your original frequency and apply the 1 V source again (or play a note an octave above) and repeat the trimming process. Repeat this step until you're satisfied.
  12. Once you're satisfied, repeat the previous step but with a 2 V volt source or more, that should cause an increase of n octaves.

- **Release tuning:**
  1. Let the module run for 20 min
  2. Disconnect all inputs
  3. Make sure the **JP3** jumper is in the default position
  4. Turn the $\mathbf{CV_A}$ and $\mathbf{CV_R}$ knobs all the way to the right
  5. Turn the **Range** switch up
  6. Turn the **FBK** switch down
  7. Turn the **CYC** switch up
  8. Turn the **Release** knob to about 8 o'clock
  9. Turn the **Release** knob enough to the right so that the output on **AC OUT** resembles a negative ramp sawtooth. If you want good tracking in the low to mid frequency range, turn the knob so that the output oscillates at around 100 Hz or so.
  10. Apply 1 V to the $\mathbf{CV_R}$ input. If you don't have a precise 1 V source, plug in the CV output of a keyboard and play the lowest note. This may or may not cause you to deviate from the frequency you had in the previous step, so readjust the **Release** knob if needed (or play some other note that gets you closer to that). Once that is done, play a note an octave above. This should cause the output to double in frequency: if it's below that, the tuning is flat and the trimmer should be turned slightly counterclockwise; if it's above that, the tuning is sharp and the the trimmer should be turned slightly clockwise.
  11. Remove the 1 V source, or play the original note an octave down again. Readjust the **Release** knob back to your original frequency and apply the 1 V source again (or play a note an octave above) and repeat the trimming process. Repeat this step until you're satisfied.
  12. Once you're satisfied, repeat the previous step but with a 2 V volt source or more, that should cause an increase of n octaves.

Note: the module's attack and release times can't go faster than around 50 µs (when the **Attack** or **Release** knobs are turned all the way to the left), which is higher than most sawtooth core VCO's reset times. If perfect tracking is important and you need a sawtooth waveform, it's better not to turn the **Attack** or **Release** knobs (for a negative and positive sawtooth, respectively) all the way to the left, but to "leave some room" instead and settle for a less sharp sawtooth so that both slopes can track the CV input without hitting the 50 µs ceiling.

Uses

This module can be used as:

- a linear envelope generator;
- a mixed linear/logarithmic/exponential envelope generator (see FBK in Switches)
- a VCO controlled by $\mathbf{CV_A}$ (see Inputs). With the $\mathbf{CV_{A,R}}$ knobs turned all the way to the right, it will track 1V/oct. By turning the $\mathbf{CV_A}$ and $\mathbf{CV_R}$ knobs, one can shift the base pitch up and down and generate triangle and sawtooth waveforms, and also get a variable duty cycle square wave on the **OUT** output.

Warnings

- Do not apply power to the module with reverse polarity. Follow the markings on the board's silkscren to know which way is −12V.
- Do not patch two outputs together, neither within this module nor between this and other module.
- Do not apply voltages beyond the supply rails (±12V) to any inputs.
- If you detach the two PCB's that are part of the module, make sure to plug them back together the right way before turning on the power.