Voltage Controlled Low-Pass Filter

Operation

This module is a $1V/\text{Oct}$ voltage controlled low-pass filter. The filtering is achieved through the use of a transistor ladder. It also has variable resonance, that can be either be adjusted manually or voltage-controlled.

Knobs

- **Cutoff:** controls the filter cutoff frequency.
- **Resonance:** controls the filter resonance (i.e. the ammount of positive feedback, or the Q factor), from no resonance (left) all the way to self-oscillation (right).
- **Out:** controls the output level, or the gain of the filter.
- **CV:** attenuates the **CV** input.

Inputs

- **CV:** controls the cutoff frequency (tracks $1V/\text{Oct}$ if the **CV** knob is turned all the way to the right).
- **Res CV:** CV input that controls the resonance. A $-5\,\text{V}$ input means no resonance, and a $5\,\text{V}$ input means self-oscillation.
- **In:** filter input

Outputs

- **Out:** filter output

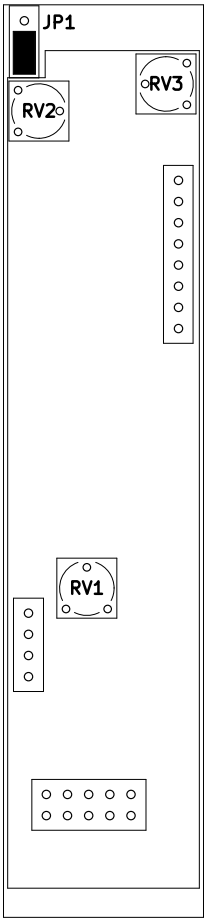

Figure 1: Jumper (in their default position) and trimmer location

Configuration

Jumpers

- **JP1:** the transistor ladder topology has the characteristic of losing DC gain whenever the resonance is turned up. To prevent this, the module

has additional circuitry that can compensate for this loss. The jumper can alternate between full compensation (constant DC gain throughout the entire resonance range) or half compensation (some gain is added but some gain will be lost). If the jumper is removed from the board entirely, no compensation will be added.

Trimmers

- **RV1:** this controls the scaling of the **CV** input, to allow for $1V/\text{Oct}$ tuning (see Adjustements/Tuning for tuning instructions).
- **RV2:** this controls the DC offset for the output stage (see Adjustements/DC offset for tuning instructions).
- **RV3:** this controls the DC offset for the resonance feedback path (see Adjustements/DC offset for tuning instructions).

Adjustements

DC offset

Should the filter add DC offset to the output, follow this procedure:

- Disconnect all inputs
- Turn the **Cutoff** knob all the way to the right
- Turn the **Resonance** knob all the way to the left
- Turn the **Out** knob all the way to the right
- Apply a signal with no DC offset to the **In** input
- Turn the **RV2** trimmer until no DC offset is present on the **Out** output
- Disconnect the input signal
- Turn the **Resonance** knob all the way to the right
- Turn the **Out** knob to the left until a 10 Vpp sine wave appears on the output
- Turn the **RV3** trimmer until no DC offset is present on the **Out** output

Tuning

In case the tracking of the cutoff frequency deviates from the $1V/\text{Oct}$ standard, the following instructions should be followed:

1. Let the module run for 20 min
2. Disconnect all inputs
3. Turn the **Cutoff** knob to about 9 o'clock
4. Turn the **Out** knob to the left until a 10 Vpp sine wave appears on the output
5. If you want good tracking in the low to mid frequency range, turn the **Cutoff** knob so that the output oscillates at around 100 Hz or so.
6. 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 note which causes you to deviate the least from the frequency you had in the previous step, and readjust the **Cutoff** knob if needed. Once that is done, play a note an octave above. This should cause the output to more or less double in frequency (take note of how far off you are). If it's not good enough, turn the **RV1** trimmer (see Configuration, Trimmers) a tiny bit to either side (around 20° or so).
7. Remove the 1 V source, or play the original note an octave down again. Readjust the **Cutoff** knob back to your original frequency and apply the 1 V source again (or play a note an octave above). If you're better off this time, this means you've turned the trimmer the correct way. Otherwise, you've turned it the wrong way. Take note of which way the trimmer causes the tracking to go flat or sharp.
8. Repeat the previous step, taking into account that you now know which way to correctly turn the trimmer. 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.

Applications

This module can be used as:

- a voltage controlled low pass filter
- a voltage controlled low distortion sine wave oscillator, when in self oscillation

Usage

- You may have noticed that in this module the unusual decision was made to add an attenuator for the output and not the input. This is because in self oscillation, the output stage of the filter has a tendency to saturate (try doing it with the **Out** knob turned all the way to the right), which is definitely an interesting feature in its own right that we suggest you explore. However, if a low distortion sine-wave is desired, the **Out** knob attenuates the signal right before the output stage so that it can be avoided, while also providing the same functionality you would expect from an input attenuator knob.

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.