Salix VCF

A Transistor Ladder Filter

Build Documentation for PCB v1.3

Description

Features

- Based on the Moog Transistor Ladder Filter
- Compensation for loss of bass in high resonance settings via potentiometer
- 6,12,18,24 dB/Oct selectable via potentiometer or CV!
- 2 inputs with attenuator for audio and CV
- Separate V/Oct input
- Input-overdrive indicator LED
- 3 optional jumpers on the back to normalize signals internally:
    - Input 1 to input 2: Get some extra input gain, to overdrive the filter heavily
    - Output to CV2: easy access to self-FM
    - Input to CV1: easy access to oscillator-FM
- 8HP, 40mA @ +12V, 25mA @ -12V

General Information

- fully open-source CC BY-NC-SA 4.0 (DO NOT USE COMMERCIALY!)
  https://github.com/Cs4System/Eurorack/tree/main/Salix_VCF

- Small and dense SMD build (0603, SOIC, SOT-363!) Not a beginners build, please be sure to have some SMDsoldering practice

Build Instructions

Parts

- Order the components according to BOM. Make sure to order some extra for all small parts (it is very easy to lose components while building!)
- If Mouser-parts are not available and you are not sure whether your replacement part is fine, please do not hesitate and contact me: blattwerk-audio@posteo.de
- The BOM says A100k type potentiometer for RV7 and RV8. You can install B100k as well, I prefer log-type (A100k) potentiometer for audio levels.

Soldering

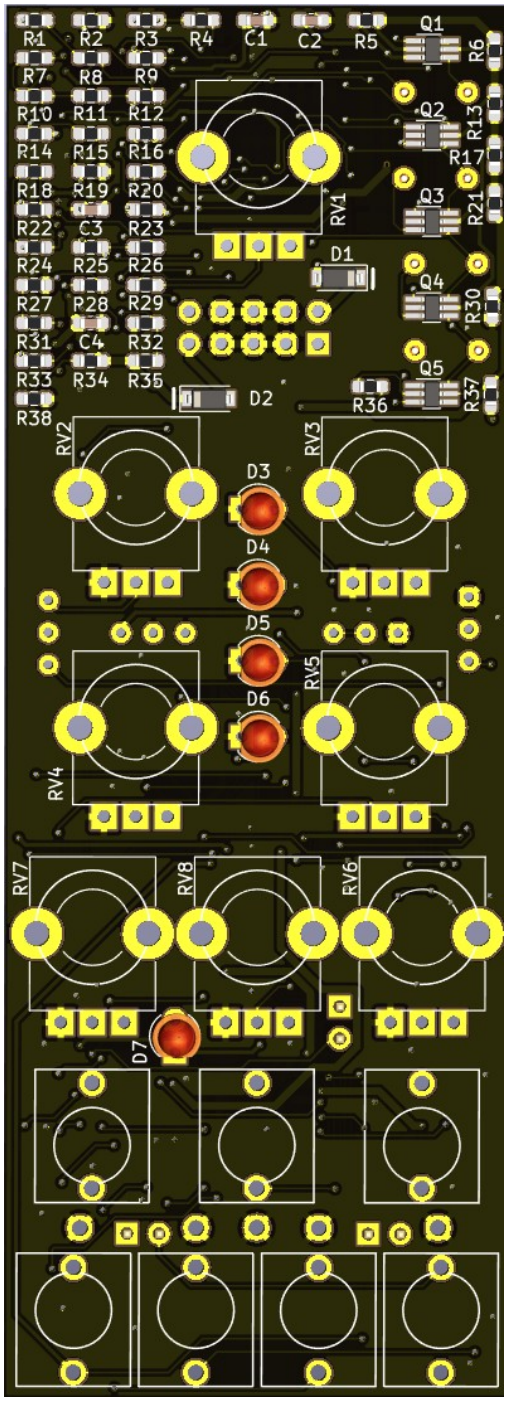
It is not a beginners SMD build. But it is easier to solder than most Mutable Instruments modules.

- Start with all flat SMD components (R, C, D, Q, U)

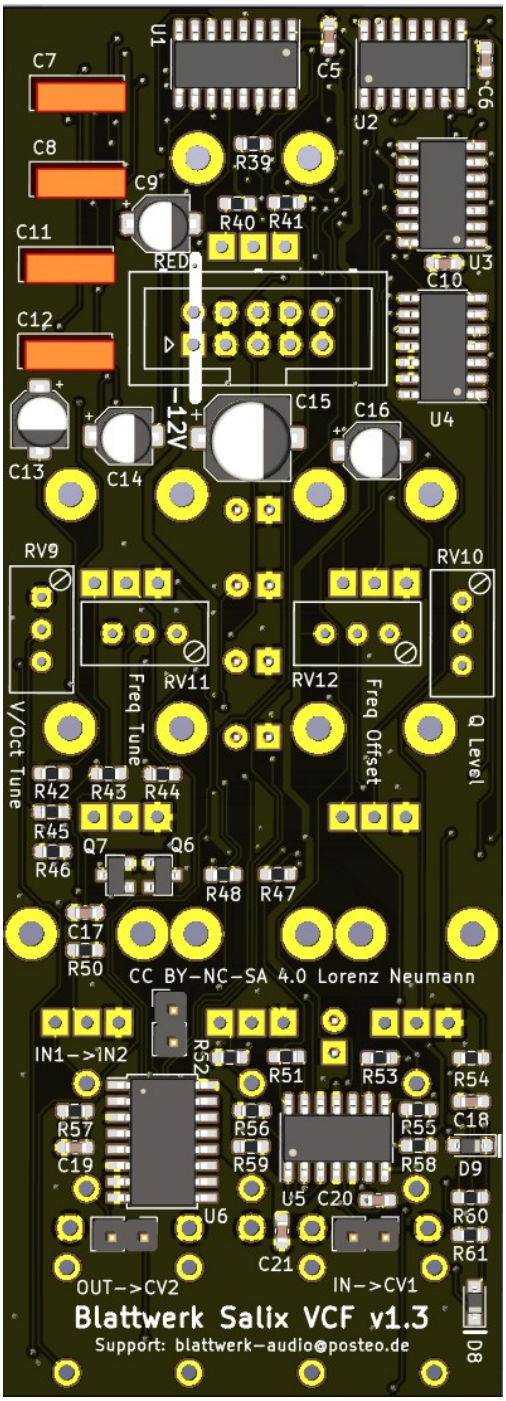
  IC-Pin 1 is marked twice: with a dot and with an extended line next to pin 1. Be sure to get the orientation right.

  Orientation of Q1-Q5 does not matter!

- Add all electrolytic and film capacitors.
- Solder the power header, multiturn-potentiometers and jumpers.
- Place all jacks, potentiometers and LEDs, do NOT solder them yet!
  Note: Each outer pair of jacks shares a GND connector!
- Put the panel into place, fix all nuts, push LEDs into their place, check twice, solder.
- Check for shorts at the power header and over C16 and C9 (GND to 12V and -12V) with a Multimeter.



PCB front



PCB back

Calibration

This calibration must only be done on first startup.

General

- Feed a signal into the inputs. (Do not forget to open IN1/IN2 Attenuator). Check whether any output-signal is present.
- Note: If there is no output-signal on first powerup, adjust the frequency offset (RV12) over its hole range. This brings Q2 into its forward-active region. If not successful go to "Troubleshooting"
- Set dB/OCT to 24 and remove input signal.
- Set the Cutoff at 12 o'clock. Set Q to max. Adjust "Q Level" (RV10) until there is stable self-oscillation. Check hole Cutoff-Range, if necessary.

Cutoff-Frequency

- Adjust "Freq. Offset" and "Freq. Tune"(determines the Range of the cutoff-potentiometer) until the filter can be closed and opened fully by the Frequency potentiometer.
- Note: This is best done in self-oscillation (At max and min cutoff there should be no audible signal (~40Hz < Cutoff-Frequency > ~20kHz)

  This method will set the cutoff range in a way that the Filter will close for 24,18 and 12dB/Oct. 6dB will not fully close. Adjust to your taste!

Self-oscillation

- Set ”Q” to 3 o'clock and “Frequency” to 12 o'clock. Adjust the max resonance/self-oscillation level with "Q Level" (RV10) until self-oscillation is barely present.

1V/Oct Tuning

Although this filter can be tuned to 1V/Oct, don't expect temperature-stable tuning, it’s not an oscillator!
Every change to the calibration of the cutoff-frequency will affect the tuning!

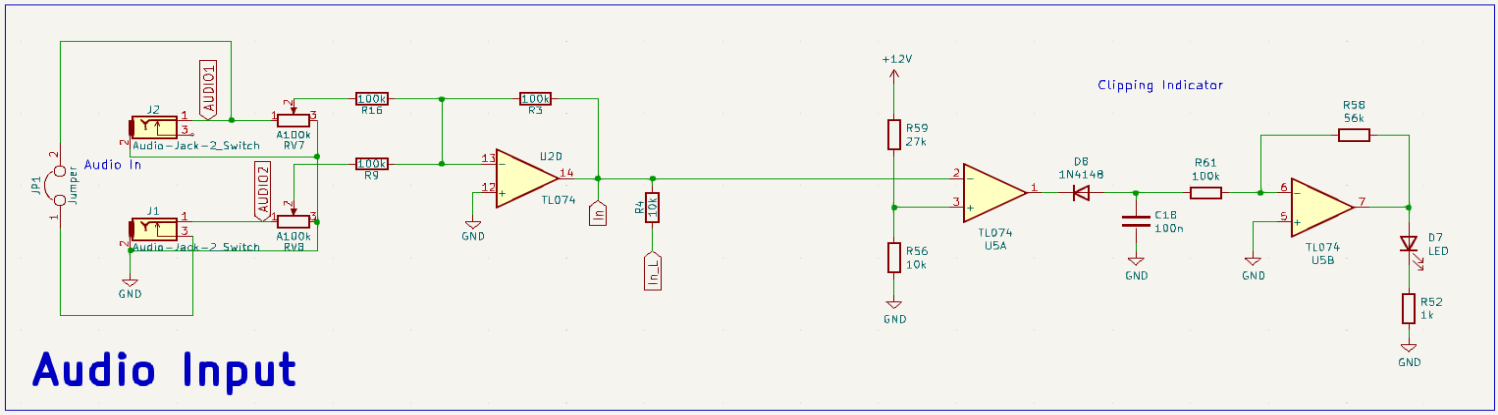
- Let the Filter self-oscillate, insert a 1V/Oct signal and try to calibrate as good as possible. (Matching octaves is the easiest way for me)

Troubleshooting

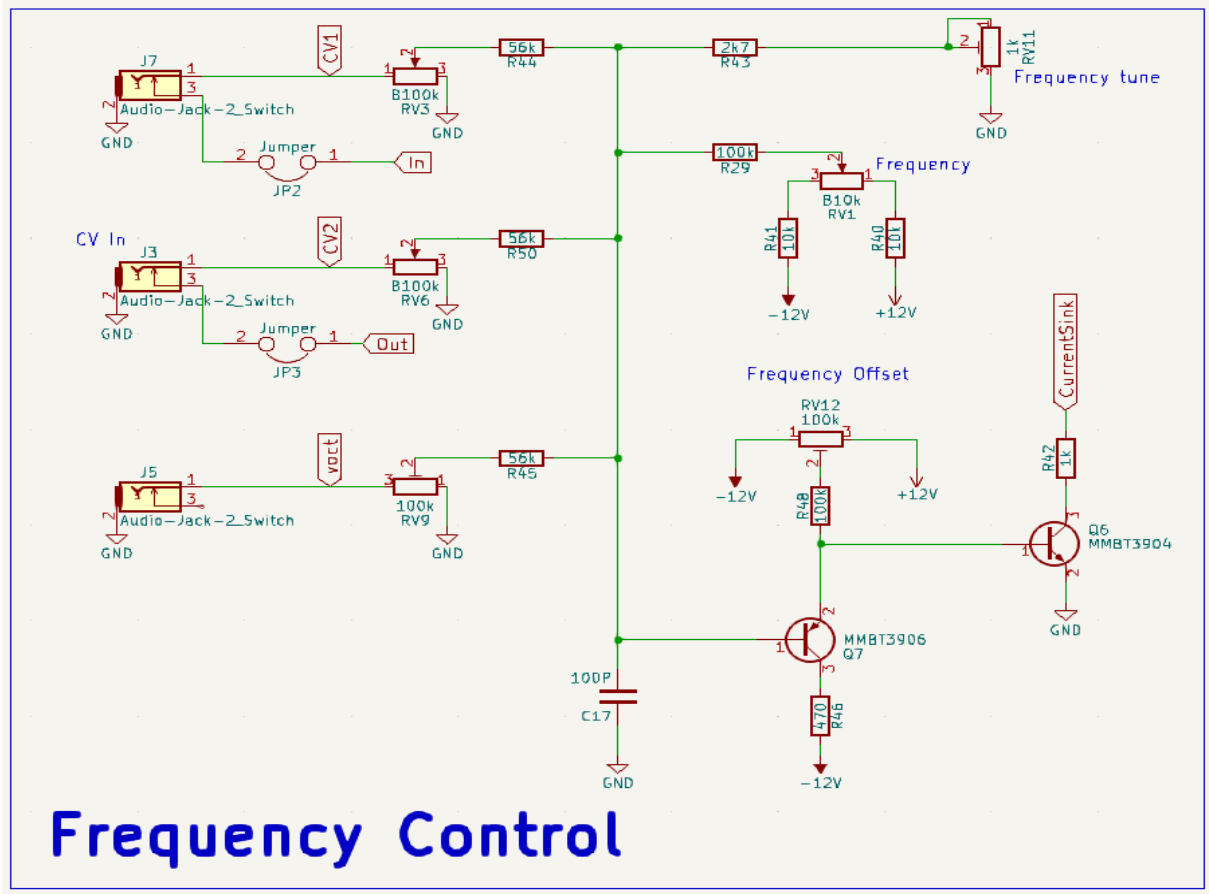
Please use the schematics!

No output:

- Check all solder joints for bridges and bad soldering. Especially Check Q1-Q5!
- Are all ICs and diodes in the right orientation?
- Does the “Drive” LED light up, if there is a hot input signal and both “IN1” and “IN2” are fully open?
- If Yes, your input is probably fine.
  If No, check this part of the circuit:



- Check voltage over R42. For max and min cutoff frequency this should be in the range of min: ~0V; max: ~1V(+0.3V). You don't have to match these values exactly, but you should see some changes while varying the cutoff frequency.



If there is no voltage across R42 or it is not varying, your current sink is not working.

If you have not tried yet: adjust frequency offset (RV12) over its hole range. This brings Q2 into its forwardactive region. If not successful check Q7, Q6 and all connected components.

Need more help?

If you need help, please check the schematics first.

If you can't help yourself, you can write me an e-mail, the address is on your PCB.

Please describe the problem as detailed as possible, describe what you have tried by now. And please make some good photos so I can check your soldering!

Tips, Tricks and more Information

Compensation

In most filter designs negative feedback is used to create resonance (output signal is inverted and fed back to the input of the filter). Transistor Ladder Filters are no exception.

In case of a Ladder Filter the fundamental frequency is attenuated the more feedback (resonance) is applied. That effect is highly sensitive to the input level. Especially when you are close to, or at saturation the loss of bass is less present. But you can clearly hear the filter is overdriven in that case.

In some cases, it might be totally fine to lose some bass and some people would agree, that this is part of the characteristic sound of a Minimog'ish filter.
A fat Bassline may need that fundamental, so it is nice to have the opportunity to choose!

How it works (simplified):

With the "Q Comp" potentiometer you can add the input signal to that feedback signal. As you increase the feedback gain (resonance) you end up with a higher level of your original input signal. That can stop the cancelation of the bass frequencies.
In case your input signal is very hot the resonance can become a bit grittier, since the filter may be close to saturation. In very high compensation settings it may even add distortion.

Here a few tips:

- Try to use the "Drive" LED to find a reproduceable input level. For a classic sound keep the level well below clipping so there is some headroom for the hotter feedback signal.
- At 12 o'clock "Q Comp" has a strong effect and compensates the loss of bass quiet well, while the sound stays well controlled. Higher settings potentially overdrive the filter in a unsymmetric way, that can lead to interesting sounds, but is not what I would call a typical "ladder sound".

- Overdriving the filter reduces the loss of bass but changes the sound drastically.

- The compensation has no effect when resonance is at min!

In the end, it is a tradeoff between a clean resonance and a decent amount of bass.

Jumper

On the back of the module are 3 jumpers. As mentioned above, they normalize signals internally. That means, if no cable is patched to the destination of the normalization the source signal is present.

- IN1 to IN2: Get some extra input gain, to overdrive the filter heavily.
- OUT to CV2: easy access to Self-FM
- Input (post attenuator, both inputs) to CV1: easy access to Oscillator-FM

If you never ever will use one or all of these, I suggest removing the according jumper(s). Otherwise, you will always have to keep an eye on the according attenuator.

dB/Oct

It may not be that common that a filter can switch its slope by a control voltage.
However, it is possible here. Knowing some technical background can be helpful while using it:

As you may know, a low pass filter (LPF) will always add a phase shift between input and output signal.
The amount of phase shift depends on the slope of the filter. Each 6dB/Oct (each pole) will add 90° phase shift. So, there will be 90,180,270 and 360° possible.
If you now switch between these signals you will end up with a big step in your signal, you can hear that as a very small click.

The switching is possible well into audio rate.

V/Oct Input

The 1V/Oct input can be used to play the self-oscillating filter like you do with an oscillator.

Do not expect temperature-stable tuning, and not more then 3 octaves!

There are a few ways the 1V/Oct input can be useful:

- Patch the same 1V/Oct signal which is driving the oscillator of your subtractive voice into the filter in order to move its cutoff frequency along to your melody. That way the harmonic content relative to the fundamental frequency is the same no matter of the pitch.
- Use the input as a third CV input! It just has no attenuator!

Self-FM

As mentioned above, there is a jumper to normalize the output to the CV2 input.
That gives you easy access to self-FM. Just give it a try.

I can really recommend patching a saw wave into the input, set a low cutoff frequency and then increase CV2.
As a result the filter starts to resonate in a kind of suboctave! Exciting!!

Every Waveform sounds different, and every dB/Oct setting has different effects!