KS-20 VCF

Kassutronics

Board revision 1.1, build documentation revision C

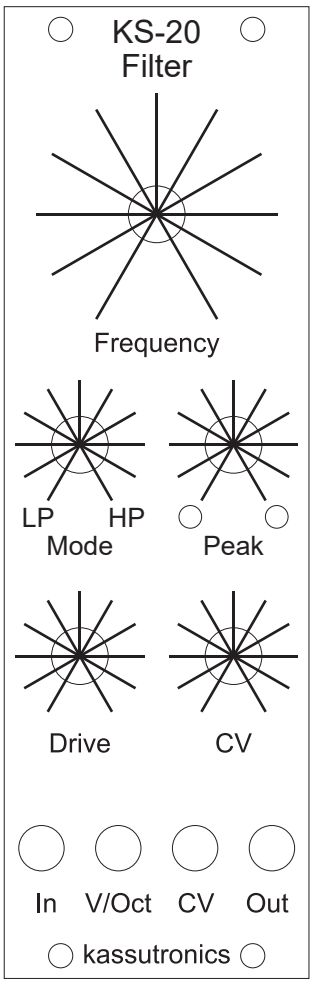
April 26, 2020

Description

The Korg MS-20 synthesizer had two filters in series, one high-pass and one low-pass. Internally, these filters are nearly identical, differing only in where the signal is fed to the filter. This module contains one such filter core (of the later, OTA-based variant), and a front panel knob to smoothly transition between the two modes of the original MS-20 filters. It blends from a two-pole low pass, via a resonant all-pass, to a one-pole resonant high-pass. Using two KS-20 modules in series the original MS-20 configuration can be created.

What sets the MS-20 style filter apart from other classic filter designs is a nonlinear resonance path, created by diodes or in this module LEDs. This nonlinearity is needed to avoid clipping when self-oscillating. More interestingly however, the nonlinear resonance makes the sound of the filter strongly depend on the amplitude of the incoming signal. This is where the drive knob comes in, allowing you to drastically change the character of the filter. At low drive settings, the filter is mostly linear and has a clean resonance. When increasing the drive level, the sound starts to "break up", and there is a sweet spot where the incoming sound and the filter resonance are competing with each other. At even higher drive level, the incoming signal starts to take over and pushes the resonance away, even when the resonance is set to self-oscillation.

This module is strongly based on the schematic published by René Schmitz, and all credit should go to him. In particular the choice to replace the string of diodes with an LED in the resonance feedback path was his. I did verify that this makes no notable difference to the sound. My additions were the variable mode control and drive knob.



Front panel

Features

- Multi-mode filter
- No loss of bottom end at high resonance
- Will mess up your sound
- 8hp Eurorack format
- Current consumption 25 mA per rail.

Build instructions

The component values on the silkscreen and schematic agree. Solder all components on the front side of the PCB, except the power header J5 which should go on the back.

When sourcing parts, pay special attention to the component height of C4, C9 and RV6, as noted in the Bill of materials, such that they fit between the PCB and panel.

The two LEDs are in the signal path, and should be green LEDs. Other colors will work but may change the amplitude of the signal at high resonance.

Calibration

The trimmer RV6 allows the unit to be calibrated to approximately track 1V/Oct CV signals. To adjust it, turn up the resonance to self-oscillation and connect a CV keyboard or similar 1V/Oct source to the 1V/Oct input jack. Set the frequency to somewhere around 200 – 400 Hz, and adjust the trimmer such that the frequency exactly doubles when changing the CV by one octave. Note that the frequency of all notes will change when adjusting the trimmer, and you should aim for an interval of exactly one octave, not for any particular absolute frequency.

The KS-20 should track reasonably well over several octaves, but is not designed to be an accurate oscillator. Due to the nonlinear resonance described in the introduction, the oscillation frequency depends on the resonance amount, temperature and even changes when a signal is input to the filter.

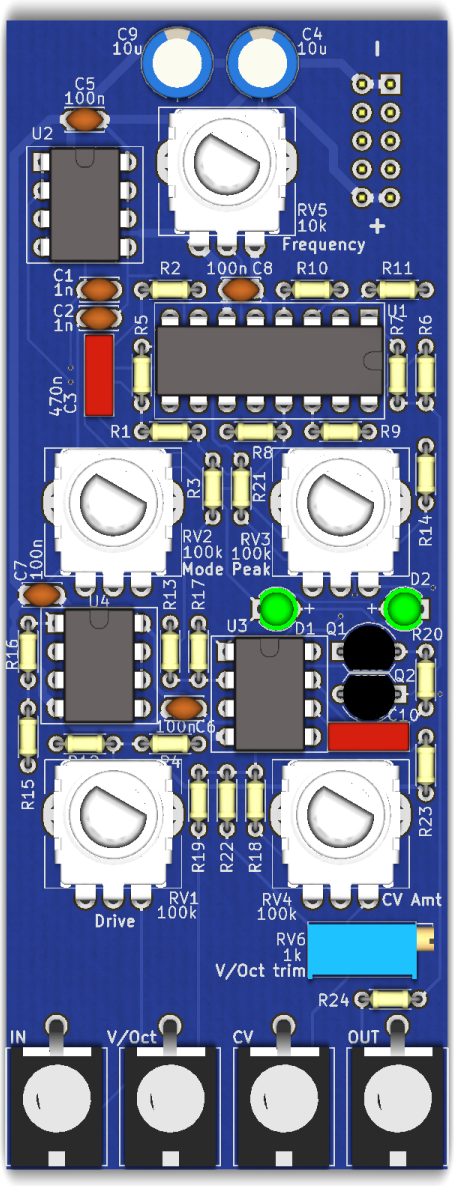
Extra notes only for Rev 1.0 PCBs

- R21 should be 220k (silkscreen shows 100k)
- C4 and C9 should be 10uF low profile (max height 9mm) (silkscreen shows CP)
- For the LEDs, the square pad is the negative side (shorter lead).
- If you want to bring out the LEDs to the front panel (they give some nice visual effect when the resonance is high), you will need to bend the leads somewhat creatively. The hole position on the front panel is in the center of the module, but the LED footprints are a bit towards the left.
- Note that the front panel has changed between revisions 1.0 and 1.1.

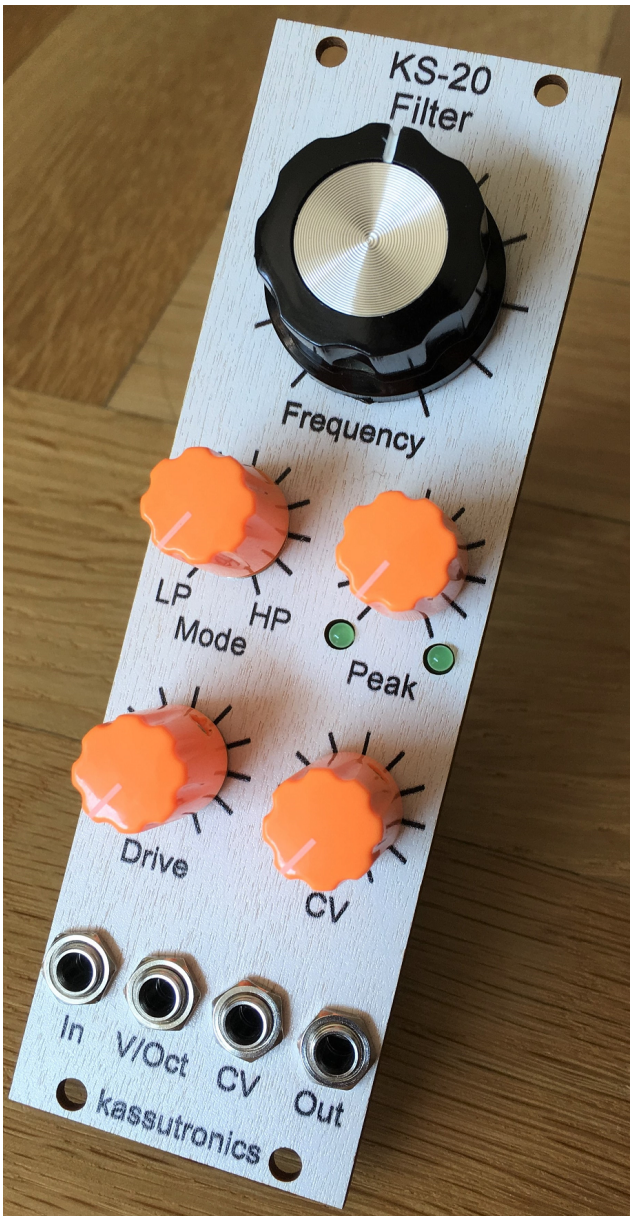
Bill of materials

Qty	Designator	Value	Note
2	C1, C2	1n	C0G ceramic, pitch 2.5mm
1	C10	4.7n	Film or X7R ceramic, pitch 5mm
4	C5, C6, C7, C8	100n	X7R ceramic, pitch 2.5mm
1	C3	470n	Film, pitch 5mm
2	C4, C9	10μ	min 25V, diameter 6.3mm, height max 9mm, pitch 2.5mm, e.g. Nichicon UST1H100MDD
2	D1, D2	LED	3mm green LED
4	J1,J2,J3,J4		Thonkiconn jack (PJ398SM or PJ301M-12)
1	J5		2x5 pin header, 2.54mm pitch (boxed or unboxed)
2	Q1, Q2	BC557C	TO-92 (pinout: Collector, Base, Emitter is marked on the silk screen)
1	R24	1k	All resistors 1/8W metal film
4	R8, R9, R10, R11	220	
1	R22	1.5k	
3	R3, R13, R20	4.7k	
6	R1, R2, R5, R6, R7, R17	10k	
1	R14	47k	
6	R4, R12, R15, R16, R18, R19	100k	
1	R21	220k	
1	R23	470k	
1	RV6	1k	Bourns 3296X or TME T910-X
1	RV5	10k	Alpha 9mm, metal shaft required
4	RV1, RV2, RV3, RV4	100k	Alpha 9mm, metal shaft preferred
1	U1	LM13700	DIP-16
1	U2	NE5532	DIP-8
2	U3, U4	TL072	DIP-8

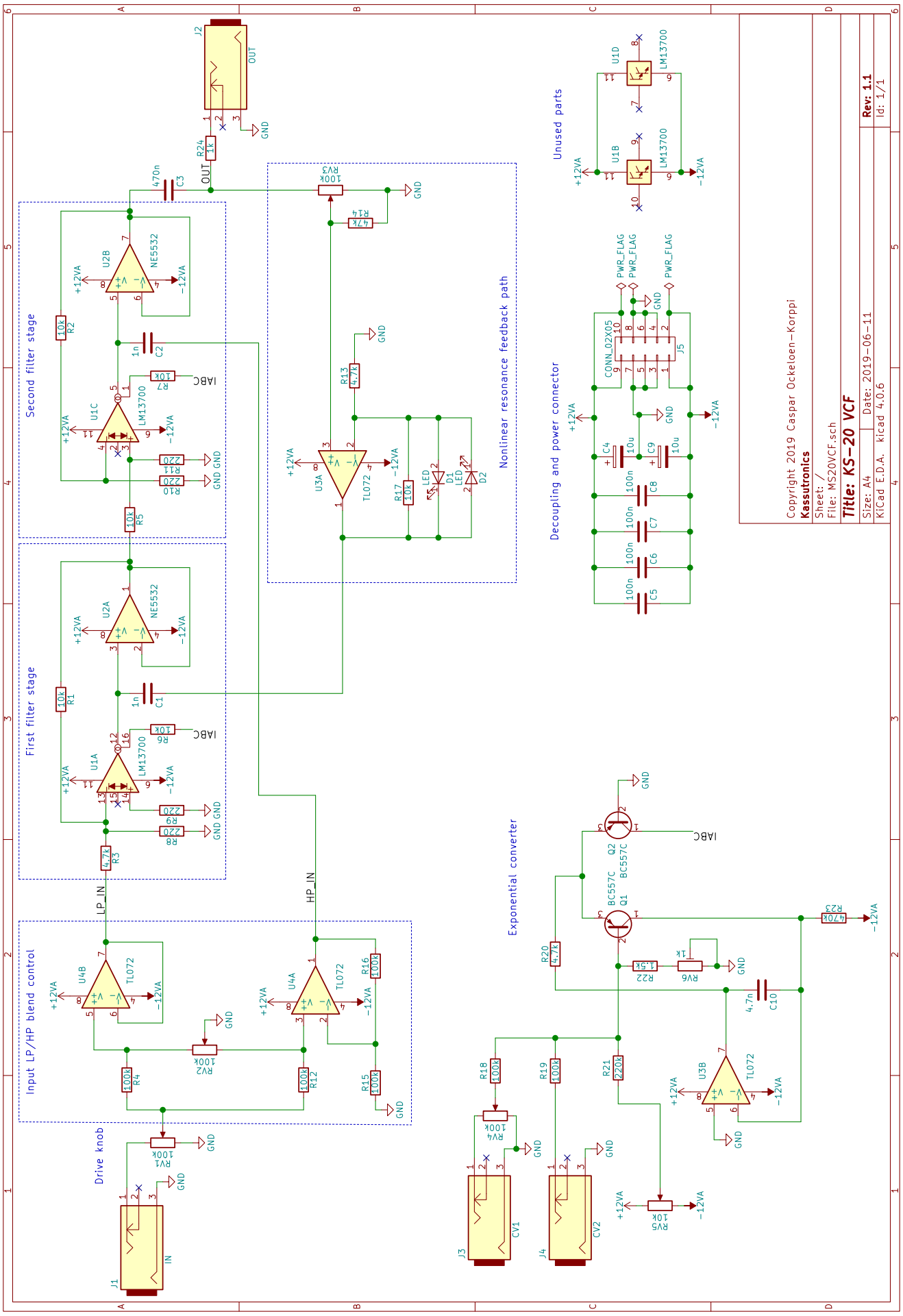
Pictures



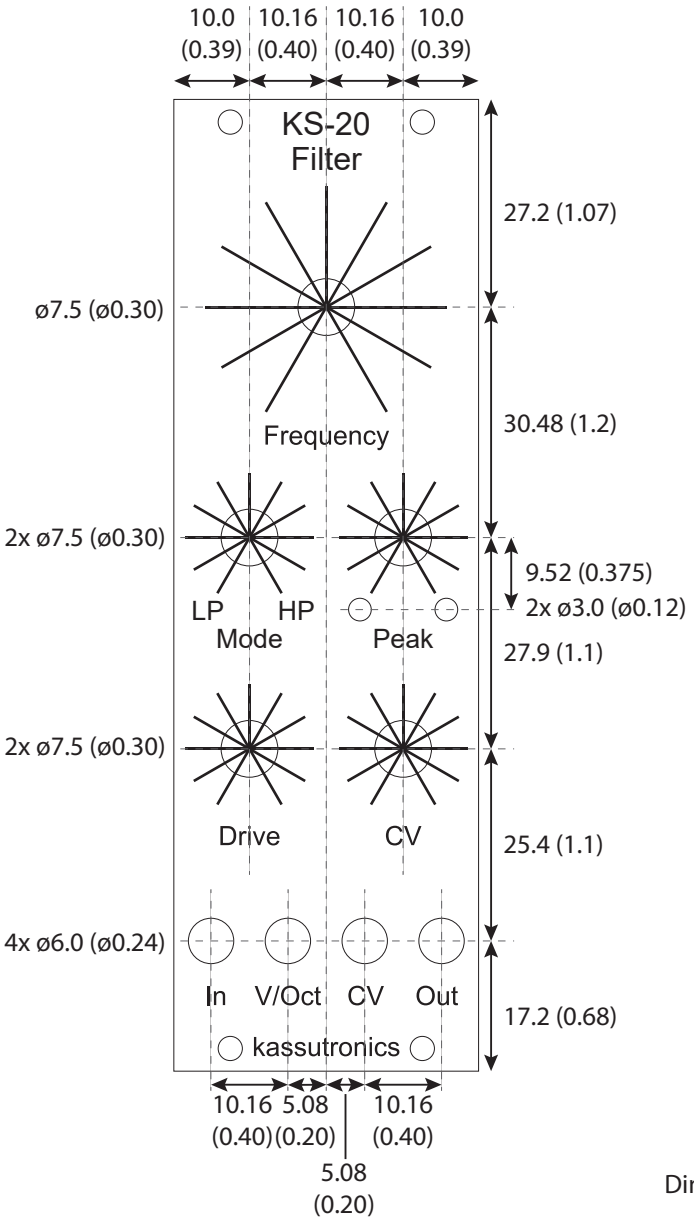
PCB front view



Assembled module


Second filter stage
First filter stage
Input LP/HP blend control
Drive knob
Nonlinear resonance feedback path
Unused parts
Decoupling and power connector
Exponential converter
Copyright 2019 Caspar Ockeloen-Korppi
Kassutronics
Sheet: /
File: MS20VCF.sch
Title: KS-20 VCF
Size: A4
Date: 2019-06-11
KiCad E.D.A. kicad 4.0.6
Rev: 1.1
Id: 1/1

Front panel dimensions



Dimensions in mm (inch)

Revision history

Board revisions

1.0 Initial prototype design

1.1 First design made generally available

Documentation revisions

A Initial documentation for board revision 1.0.

B Documentation for board revision 1.1.

C Fix pinout comment for Q1, Q2 in the documentation.

Contact

Check for updated documentation and other information on my blog at kassu2000.blogspot.com. I am always happy to answer questions and receive feedback at kassutronics@gmail.com.