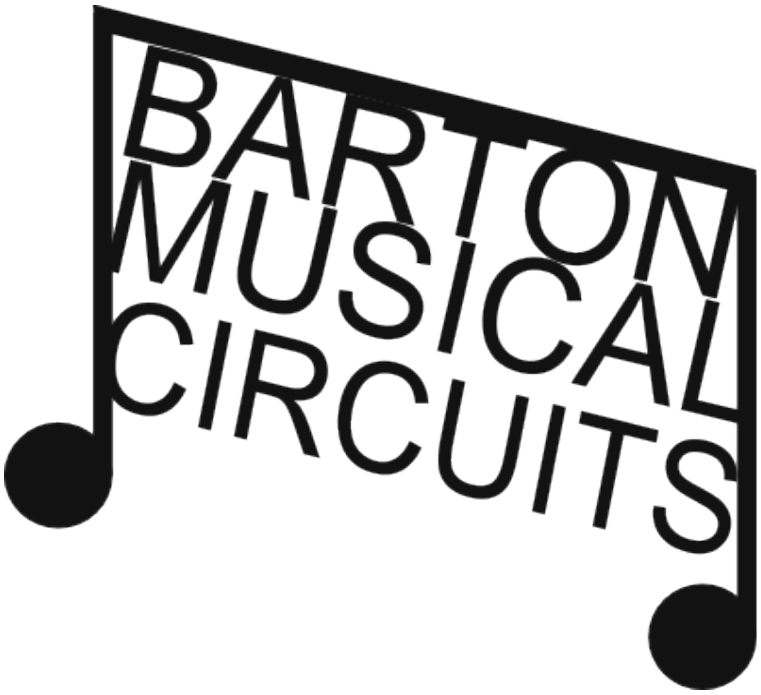

BMC115. Resonance Loop Low Pass Filter

If you have any questions, or need help trouble shooting, please e-mail
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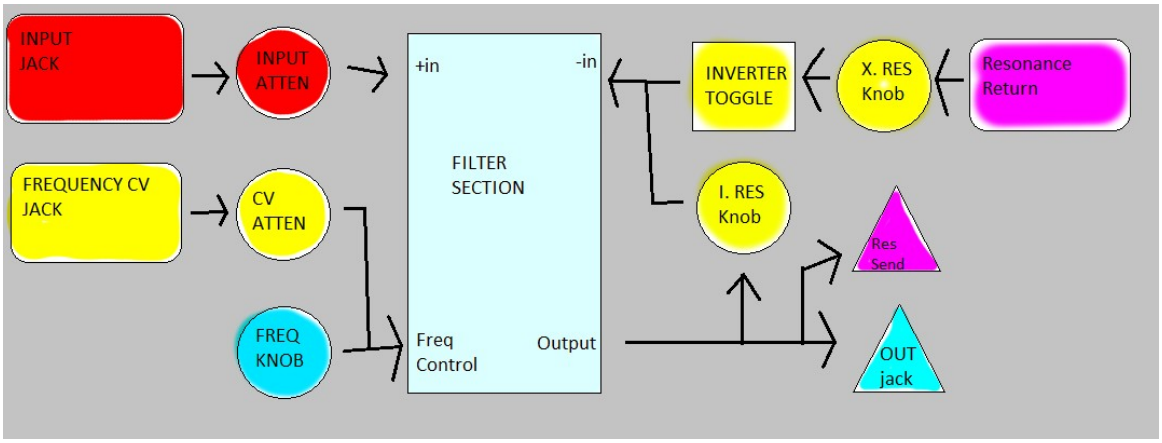
I. What it Does

This is a voltage controlled 4-pole low pass filter module with the ability to patch other modules into the resonance path. When a VCA is patched into the resonance path, this creates a standard voltage controlled resonance circuit. When another filter is patched into the resonance path, the frequency response of the filter can change dramatically. The signal path is presented below.



CONTROLS/INPUTS/OUTPUTS

1.Input Jack and Attenuator – Audio to be filtered is input here and attenuated by the knob. Attenuating the input will make the resonance more dominant in the sound.

2.Frequency Cutoff, Frequency CV Input Jack, Frequency CV Attenuator – This jack and pair of knobs control the cutoff frequency of the filter.

3.Resonance Send and Return Jacks – Audio is sent to another module from the Resonance Send jack, and the signal from that module or chain of modules is then returned to the filter through the Return Jack

4.External Resonance Knob and inverter switch – the External resonance knob attenuates the signal from the return jack. The inverter toggle switch inverts the signal after the resonance knob. This can be used to compensate for a module in the send/return loop that inverts the signal, or can be used to create positive feedback loops.

5.Internal Resonance Knob – This acts like a resonance knob in a normal filter, it can be used to provide resonance when not using the send/return loop, or to blend internal and external resonances together.

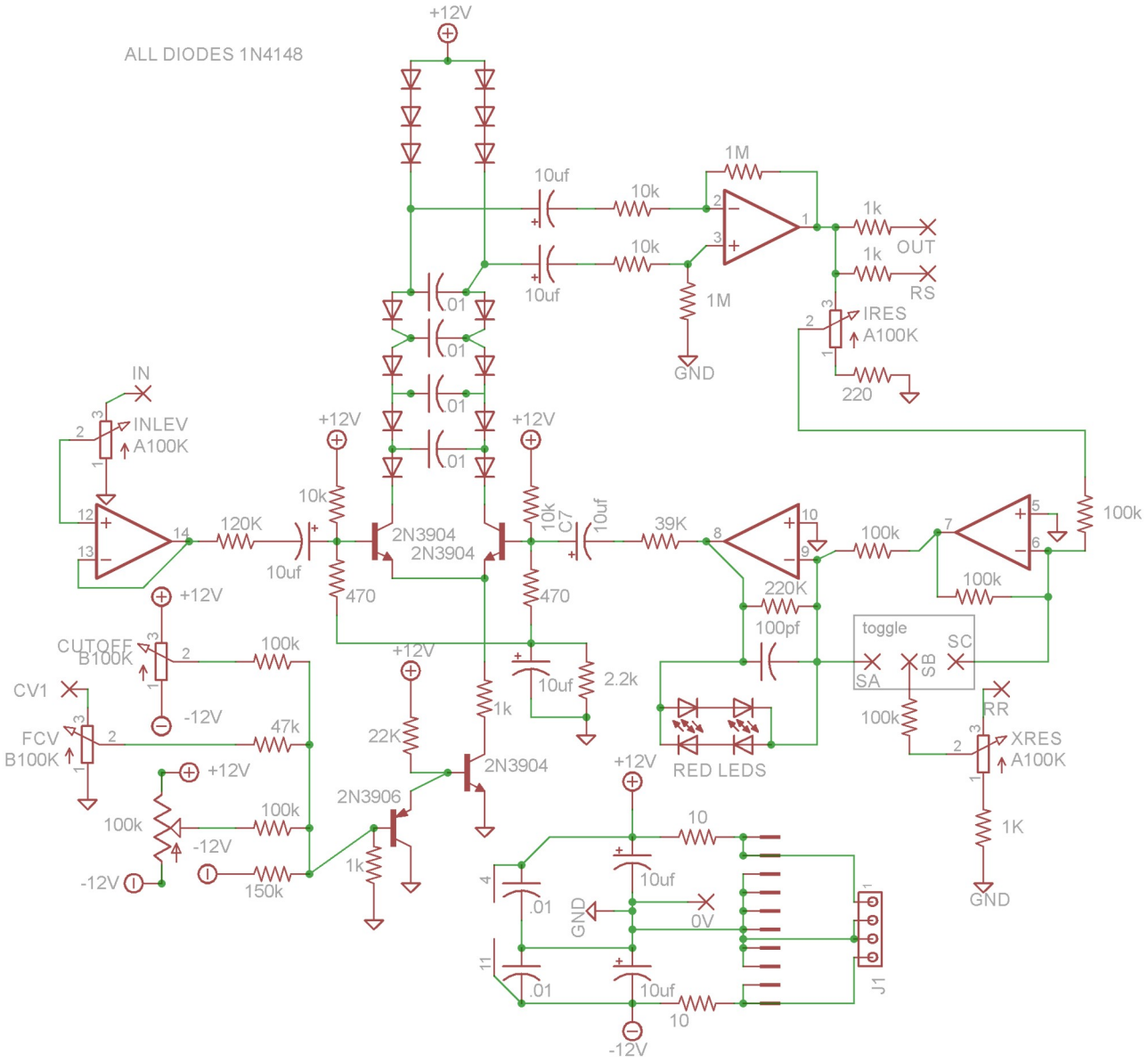
6.Output Jack - Outputs the audio from the module.

SOUND SAMPLES

VCA in Resonance Loop – This is VC resonance, towards the end I hit the inverter switch to change the response.

HPF in Resonance Loop – The high pass filter cuts out bass from the negative feedback loop, increasing the bass response in the output.

LPF in Resonance Loop – A resonant filter set to a different frequency is in the resonance loop creating dueling resonances.



II. Schematic

Above is the schematic for this module. I used BMC080 Diode Low Pass Filter as the basis for this module. Starting on the left is the "IN" wirepad, the input signal is attenuated by a A100K pot wired as a voltage divider and then buffered by an op-amp. The op-amp connects to the filter section through a 120K resistor in series with a 10uf capacitor, the capacitor removes any DC offset from the signal and the 100K resistor forms an attenuator with the bias setting resistors (10K and 470) after the capacitor.

These bias setting resistors bias a pair of 2N3904 transistors at the bottom of a configuration of diodes and capacitors. The inverted input signal is coupled to the right hand transistor through the emitter of the left hand transistor. Both emitters connect down to a 2N3904/2N3906 pair which are configured as a voltage controlled current sink.

In the bottom left corner, we see CV and Cutoff potentiometers and the frequency trimpot. The wiper of each potentiometer is connected to a mixing resistor, 100Ks for everything but CV, the mixed voltage then has a slight negative offset applied to it by the 150K resistor to -12V and the 1k resistor to ground. The summed voltage controls the the current sink formed by the 2N3904/2N3906.

The diodes above the pair of 2N3904 have current flowing through them almost constantly. The amount of current is altered by both the voltage controlled current source and the input signal. As the amount of current changes, the voltage drop across the diodes changes slightly. This results in the diodes acting like resistors for the purpose of creating a filter with the .01uf capacitors.

At the top of the ladder 10uf capacitors connect to both sides. These remove the DC bias

present. The signal is then sent to an op-amp set up as a differential amplifier. The amplifier's gain is set by the 10K/1M resistor pairs. The output of the differential amplifier is sent to the output jack through a 1K resistor, to the Resonance Send jack through a 1K resistor and to the Internal Resonance Knob, which has it's maximum attenuation controlled by a 220 ohm pot.

The Resonance Return jack is on the botom right of the schematic. This connets to the attenuator knob, and the output of the knob goes through a 100K to the center lug of the inverter toggle. The two outside lugs of the toggle each connect to the negative inputs of op-amps wired as inverting gainstages. These two gainstages are in series with each other and then connect to the negative input of the filter section. When connected to the inverter on the right, the signal will invert twice and came out the same phase as it came in. When connected to the op amp on the left it will be inverted.

The Internal resonance knob connects to the right hand inverter, so its signal is always in phase and not affected by the inverter toggle. The right op-amp has a gain of -1, and the left has a gain of -2.2, but has it's output level limited by LEDs in the feedback path. When the output level exceeds the breakdown voltage of the diodes, they will pass the signal directly to the negative input, clipping the output. These diodes and the 100pf capacitor together help prevent self oscillation from becoming too loud or too high of a frequency to damage your ears.

The PCB has footprints for eurorack and MOTM style power connectors. Positive and negative voltage rails are filtered by 10 ohm/ 10 uf low pass filters and .01 uf capacitors are placed near the power pins of ICs for further filtering.

III Construction

A.PARTS LIST

SEMICONDUCTORS

Name/Value	QTY	Notes
TL084	1	Or other quad op-amp
1N4148	14	Or other small switching diode
2N3904	3	TO-92 package
2N3906	1	
3mm LED	4	I used red LEDs when tuning the circuit, feel free to try others

RESISTORS

Name/Value	QTY	Notes
10	2	1/4W metal film
220	1	1/4W metal film
470	2	1/4W metal film
1K	5	1/4W metal film
10K	4	1/4W metal film
22K	1	1/4W metal film
39K	1	1/4W metal film
47K	1	1/4W metal film
100K	6	1/4W metal film
120K	1	1/4W metal film

150K	1	1/4W metal film
220K	1	1/4W metal film
1Meg	2	1/4W metal film
100K Trimpot	1	3296W package
A100K	2	9mm pots like this.
B100K	3	9mm pots like this.

CAPACITORS

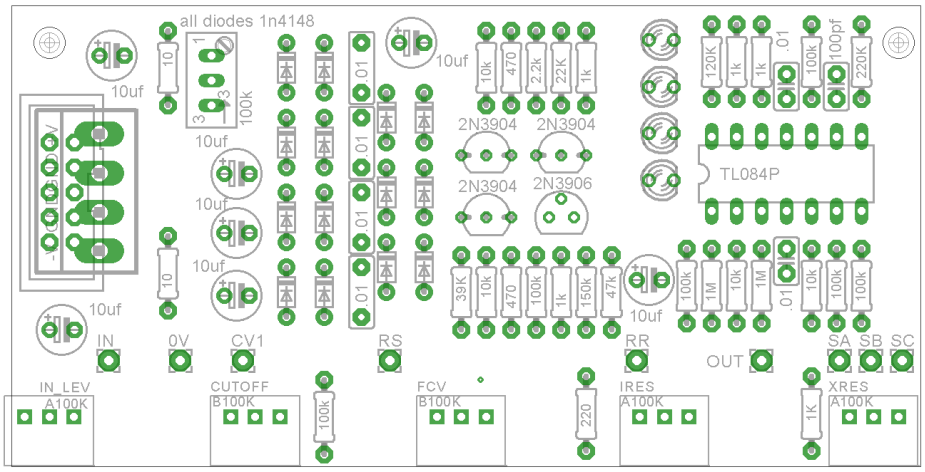
Name/Value	QTY	Notes
.01uf	2	Ceramic disc
.01uf	4	Box film type
10uf	7	Electrolytic

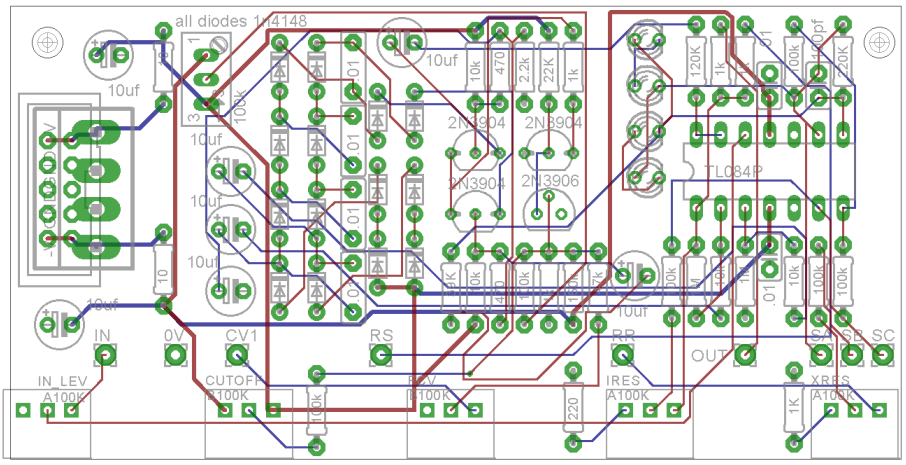
OTHER

Name/Value	QTY	Notes
SPDT Toggle	1	
3.5mm Jack	5	
Power connector	1	
14 pin DIP socket	1	

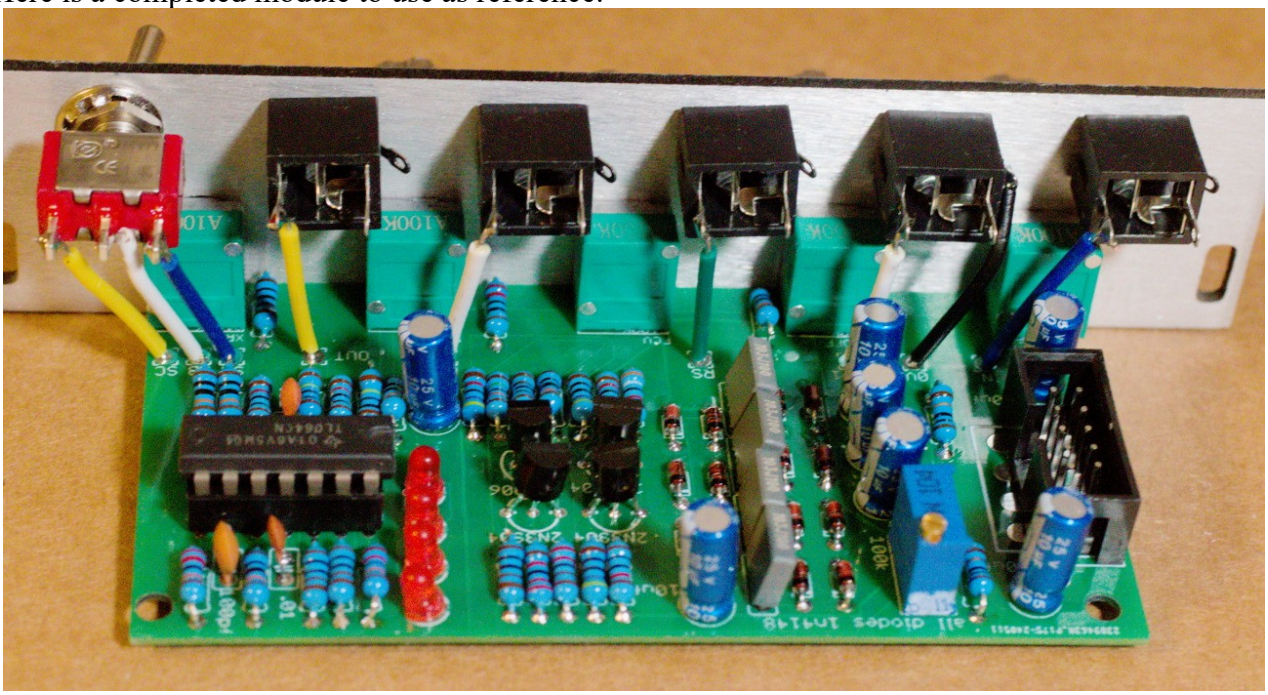
B. THE BOARD

Below are renderings of the PCB, both with and without traces present. The PCB is 93mmx48mm, the pots are spaced 21mm apart.





C. Wiring.
Wirepads should be connected as follows:
IN – tip of the Input jack
0V – Ground, connect to the sleeve of any jack.
CV1 – tip of the cv input jack
RS – Tip of the resonance send jack.
RR – Tip of the rsonance return jack.
Out – Tip of the Output jack
SA – Top lug of the inverter toggle
SB – Center lug of the inverter toggle
SC – Bottom lug of the inverter toggle.
Here is a completed module to use as reference:



D. Calibration.
Calibration is done in two steps.
1.Input a signal to the input, turn th cutoff knob completely counter-clockwise and listen to the output.
2.Adjust the trimpot until the signal at the output has been completely filtered out.