

## **BMC 080. Diode Ladder Low Pass Filter Build Documentation.**

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## I. Using The Module.

This module is a 4-pole low-pass filter using the diode-ladder topology.

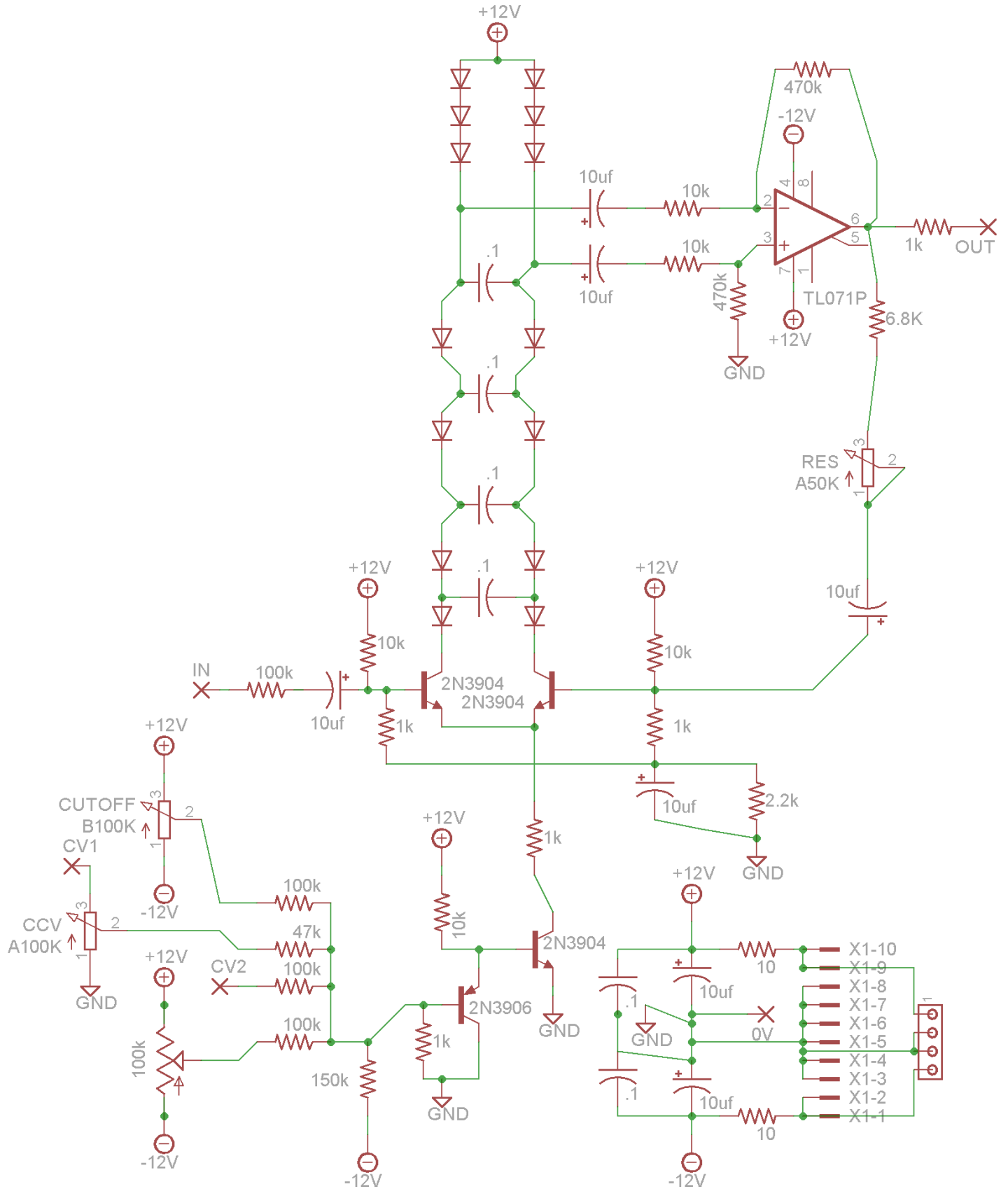
### INPUTS/OUTPUTS

1. Audio Input – AC coupled, expects a +/-5V signal
- 2/3. Cutoff CV Inputs – One of these has a built in attenuator and one does not.
4. Audio Output – DC coupled

### CONTROLS

1. Cutoff – This controls how much of the frequency range is filtered.
2. Cutoff CV (CCV) – This attenuates voltage applied to the first cutoff CV input.
3. Resonance – This controls how much positive feedback is applied to the filter, this creates greater emphasis on the highest frequencies passed by the filter.
4. Cutoff Trimpot – Not a control the panel but a trimpot that can be adjusted to set the range of the cutoff control.

## II. Schematic.



On the previous page is the schematic for this module. The diode-ladder filter is a descendant of the transistor-ladder filter with diodes substituting for transistors. Fuller explanations of how a transistor-ladder filter are available online with a little searching and can give you a deeper understanding of how this module works than I'm able to convey. I'd particularly suggest the lectures that Prof. Aaron Lanterman gave at Georgia Tech which are [available here](#).

Starting on the left is the "IN" wirepad, the signal from this wirepad goes through a 100K resistor and a 10uf capacitor in series. The capacitor removes any DC offset from the signal and the 100K resistor forms an attenuator with the bias setting resistors (10K and 1K) 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 CCV and Cutoff potentiometers, the CV2 input and the trimpot. The wiper of each potentiometer is connected to a mixing resistor, 100Ks for everything but CCV, 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 .1uf 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/470K resistor pairs. The output of the differential amplifier is sent to the output jack through a 1K resistor and then down to the resonance potentiometer through a 6.8K resistor. This output signal is then AC coupled through a 10uf capacitor before being sent down to the bottom of the diode-ladder.

At the bottom right of the module are the power connections. Footprints for Eurorack and MOTM style connectors are in parallel. The positive and negative rails are filtered by a 10ohm/10uf capacitor pair and further filtered at the TL071's power rails by .01uf capacitors.

### III. Construction

#### A. Parts List

##### Semiconductors

Value	Quantity	Notes
TL071	1	8 pin DIP
1N4148	14	Or other small switching diode
2N3904	3	TO-92 package
2N3906	1	TO-92 package

##### Resistors

Value	Quantity	Notes
10 ohm	2	5mm lead spacing. Use 3.5mm body length or stand up
1K ohm	5	
2.2K ohm	1	
6.8K ohm	1	
10K ohm	5	
47K Ohm	1	
100K ohm	4	
150K ohm	1	
470K ohm	2	
A50K Potentiometer	1	PC Mounted 16mm <a href="#">like this</a> .
A100K Potentiometer	1	PC Mounted 16mm
B100K Potentiometer	1	PC Mounted 16mm
100K trimpot	1	3296W package

##### Capacitors

Value	Quantity	Notes
.01uf	2	Small ceramic disc. Value not critical
.1uf	4	Polyester or Polypropelene Film
10uf	7	Electrolytic

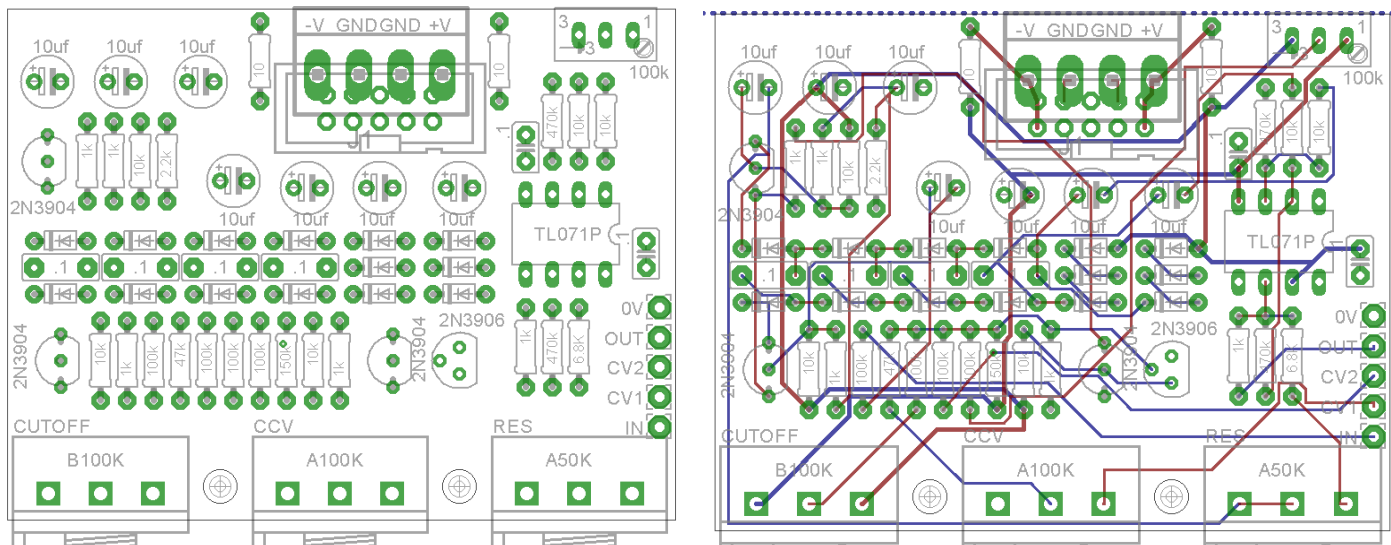
##### Other/Off Panel

Value	Quantity	Notes
Power connecter	1	Eurorack or MOTM style
Jacks	4	
8 pin DIP Socket	1	
Knobs	3	

## B. PCB Layout

Below are renderings of the PCB. The rendering showing the traces does not show the ground fill plane, so assume any missing connection is a ground fill.

The PCB measures 64mm x 49mm and the pots are spaced 22.86mm apart.



**Wiring** of this module is very straightforward. The tip connector of each jack should be wired to the corresponding wirepad. The GND wirepad should then be wired to the sleeve connector of one of the jacks.

**Calibration** is done in two steps.

1. Input a signal to the input, turn the 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.

Below is a photo of a completed module

