

# M104A Low Pass Filter (Moog 904A)

## FUNCTION DESCRIPTION



The 104A Low Pass Filter is a complete clone of the renowned Moog 904A module. Here is a detailed description of its functions copied from the Archive Moog web site:

<http://www.moogarchives.com/m904a.htm>

The 904A Low Pass Filter attenuates frequencies above the fixed control voltage cutoff point at a rate of 24dB per octave. The cutoff point {cutoff frequency} is voltage controlled through the control input jacks. The sum of the applied control voltages doubles the frequency of the cutoff point for each one volt increase {volt per octave standardization at input named 1V/oct}. For compatibility reasons the 2 other control inputs have a gain raised to accommodate 0-5v control as opposed to Moog's 0-6volts levels. The regeneration potentiometer varies the amount of internal feedback, creating a resonant peak at the cutoff frequency. This resonant peak will break into oscillation at clockwise settings of the regeneration pot, creating a voltage controlled sine wave generator. The fixed control voltage pot covers a 12 volts {octave} range. The overall range of the FCV pot is determined by the Frequency Range switch which moves the frequency cutoff range in two-octave steps.

The basic cutoff frequency of the lowpass Filter is determined by the combination of Fixed Control Voltage and Frequency range in addition to the control input signals. An increase in regeneration narrows and increases the strength of the cutoff frequency peak, while decreasing the amplitude of the lower frequencies.

## Musical Application

The voltage Controlled Lowpass Filter is one of the building blocks of analog synthesis. The characteristic upper spectral sweep found in wind instrument articulation {transient generation} is simulated utilizing this filter and the DC voltage supplied by an Envelope Generator with each trigger from a controller. Virtually, every instrumental simulation can use this filter arrangement as part of its overall patch.

As we generally associate the lowest frequency of complex harmonic sound as the fundamental of a pitch, and the upper partials as tone "color", the lowpass filter is a key module in creating widely varying timbres via subtractive synthesis. Utilizing the pink noise output of the Random Signal Generator as a signal, and sweeping the lowpass Filter with envelope or low frequency voltages, the predominant low frequency noise of thunder and surf can be simulated with their related upper frequency sweeps or clashes.

With fairly high regeneration settings, varying the control input voltages will emphasize the upper harmonics of a sound to the point of selecting pitches in counterpoint to the movement of the signal frequency itself. As an oscillator {with regeneration turned fully clockwise} the Lowpass Filter produces a very pure sine wave easily identified as a purely electronic "timbre". Additional vibrato {low frequency control voltage input} and attenuated white noise gives the lowpass filter a flute-like quality of pitch.

### ***The printed circuit board***

The module uses a 2U Moog style front panel. The PCB is a double side board, 4.25" X 5.5", has 4 mounting holes, one on each corner and is mounted on 4 x 4-40 1/4" "standoffs. All the parts are through hole types. Connectors P1 & P6 are positioned to be adjacent to their dedicated pots. A front panel 5k $\Omega$  lin potentiometer is used for Fixed Control Voltage smooth response while a 50k $\Omega$  reverse log pot is used for easy feedback control. Four 4 pins Molex connectors (H3,4,5,6) link the PCB to the 3 positions FREQUENCY RANGE front panel rotary switch. A small 6 pins Molex connector (H2) is used to link the 104A to both 104B & 104C modules to achieve Bandpass or Band Reject functions.

Power is connected by use of a 6 pins 0.156" Molex type connector. All the wiring cables are shielded type. 2 shielded conductors for all the pots wiring, and Belden RG-174 coax are used for all the input/output jacks connections.

### **Adjustments and trimmings:**

-Set P5 to mid position.

-Set FIXED CONTROL VOLTAGE front panel pot to '6' position, FREQUENCY RANGE to '2' and REGENERATION to '0'.

-Using a DC VOLTMETER, check the voltages at R35 and R39. Both levels will be approximately 1.0 volt. Adjust P4 {Zero Adjust} for approximately the same voltages on R35 & R39.

-Connect a DC voltmeter across R23 (470 ohms) and adjust P3 (LADDER CURRENT) for 2.0 volts. Disconnect DC VOLTMETER after adjusting.

-Apply a 20khz 0dB sinewave to the SIGNAL INPUT jack.

-Signal output should be -8dB (+/-2dB) 20khz.

-Set input frequency to 312hz, 0dB and set FIXED CONTROL VOLTAGE to '0'.

-Adjust SCALE trimpot (P2) for -8dB.

-Remove input signal, set REGENERATION to '8', RANGE to '2' and FIXED CONTROL VOLTAGE to '0'.

-Connect a Decade Resistance Box across R111 (1.8k ohms) and determine what shunt resistance is required to establish the threshold of regeneration. Permanently install the proper shunt resistor (approximately 2.2k) and set REGENERATION control between 7 and 8.

-With a zero dB sinewave at the SIGNAL INPUT, REGENERATION at '0', no external input control voltage and the FIXED CONTROL VOLTAGE at '0', check the FREQUENCY RANGE switch for compliance with the following:

RANGE	-3dB (approximately)
1	60 to 80hz
2	260 to 340hz
3	1.0 to 1.3khz

-Check to see that the cutoff frequency decreases one octave for each one volt decrease in control voltage first jack. Use RANGE '2' and FIXED CONTROL VOLTAGE of '0'. Adjust generator frequency so that output is at -3dB (260 to 340hz). Set FIXED CONTROL VOLTAGE at -5.5 volts and apply +5volts to one of the CONTROL INPUTS. The output should be -3dB (+/-2dB). Set FIXED CONTROL VOLTAGE at +5.5 volts and apply -6.0 volts to one of the CONTROL INPUTS. The output should be -3dB (+/-2dB).

The M104A (Moog 904A) is now ready for use.

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## ***ELECTRONIC SPECIFICATIONS***

### ***POWER CONNECTOR***

#### ***PIN ASSIGNMENTS***

1	-15V
2	A GND
3	A GND
4	+15V
5	D GND
6	+5V

**Panel Size:** Double width 4.240" w x 8.75" h.

**Filter control inputs:** 3 summed

**1v/oct Channel input impedance:** 100k +/-1%

**Modulation Chan. input impedances:** 43k +/-5%

**Fixed Cont. Voltage pot response:** Lin

**Regeneration pot response:** Reverse Log

**Frequency Range Switch:**

**1:** 1hz to 5khz

**2:** 4hz to 20khz

**3:** 16hz to 80khz

**Signal input impedance:** 100kohms +/-5%

**Signal output impedance:** 100ohms +/-5%

### **Power:**

+15V @ 75mA,

-15V @ 43mA,

+5V @ 0mA.

