

Analog Metropolis

AM8320 Voltage Controlled Filter (CEM3320)

Project Notes V1.0

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1 **Module Description**

This module is a Voltage Controlled Low Pass Filter based around the classic CEM3320 chip that was used in the Prophet 5 Revision 3.

The CEM3320 was introduced in 1980 and it quickly established itself as a smooth sounding low pass filter, the basis of the SCI Prophet 5 Rev 3, Oberheim OBXA, PPG Wave 2.0 and SCI Pro One. Each of the internal four filter sections is based on a variable gain cell that Doug Curtis patented in 1977. This enables internal temperature compensation and made the design attractive to polyphonic synthesizer designers in the early 1980's. The cells can be configured as LP, HP or BP, as well as 2-pole and 4-pole slopes.

The AM8320 has the following controls and connections:

INPUTS	CV1, CV2 SIGNALA, SIGNALB, SIGNALC RESONANCE CV (optional)
OUTPUTS	AUDIO
POTS	FREQUENCY, FINE, RESONANCE CV1, CV2, SIGNALA, SIGNALB, SIGNALC

2 **The AM Circuit**

The Analog Metropolis circuit is based around the Digisound modular design, which is a bit more sophisticated than some of the basic SCI implementations which miss out the CV rejection trimmer.

A high quality Op Amp is used to mix the audio signals and bring them down to the low level needed by the CEM3320. A similar Op Amp buffers the output and a low offset Op Amp sums the CV's. CV/Octave and CV rejection trimming are on board.

The circuit can only be built as a LPF, but you can vary the value of the four frequency capacitors to replicate the OB8, SCI Prophet or Digisound sound.

- 300pF Oberheim OB8
- 220pF Digisound
- 150pF SCI Prophet 5

The REV02 board is the production board. There are no errors.

3 PCB Connections

The PCB has a number of connections designed for MTA 0.1" headers, so that the panel components can be connected to the PCB. I use headers and sockets to enable the board to be easily replaced, however you can solder wires straight to the PCB.

PCB Header Name	Pin #	What is it?	Where does it go?
SIG_INS	Pin 1	Audio Input	Jack Socket Audio Input A
	Pin 2	Audio Input	Jack Socket Audio Input B
	Pin 3	Audio Input	Jack Socket Audio Input C
SIGNALA	Pin 1	Pot	Signal A Pot Pin 1
	Pin 2	Pot	Signal A Pot Pin 2
	Pin 3	Pot	Signal A Pot Pin 3
SIGNALB	Pin 1	Pot	Signal B Pot Pin 1
	Pin 2	Pot	Signal B Pot Pin 2
	Pin 3	Pot	Signal B Pot Pin 3
SIGNALC	Pin 1	Pot	Signal C Pot Pin 1
	Pin 2	Pot	Signal C Pot Pin 2
	Pin 3	Pot	Signal C Pot Pin 3
CV-INS	Pin 1	CV Input	Jack Socket CV Input 1
	Pin 2	CV Input	Jack Socket CV Input 2
	Pin 3	CV Input	Full level CV
CV1	Pin 1	Pot	CV1 Pot Pin 1
	Pin 2	Pot	CV1 Pot Pin 2
	Pin 3	Pot	CV1 Pot Pin 3
CV2	Pin 1	Pot	CV2 Pot Pin 1
	Pin 2	Pot	CV2 Pot Pin 2
	Pin 3	Pot	CV2 Pot Pin 3
RESONANCE	Pin 1	Pot	Resonance Pot Pin 1
	Pin 2	Pot	Resonance Pot Pin 2
	Pin 3	Pot	Resonance Pot Pin 3
RESIN	Pin 1	+10V	Resonance CV Input Jack normalised pin
	Pin 2	CV Input	Resonance CV Input Jack input pin
OUTS	Pin 1	Audio Output	Jack Socket VCA2 Audio Output
	Pin 2	Not Used	
PAD	Pin 1	Panel Earth	Jack socket earth bus

4 PCB, Pots and Power

The PCB is double sided with solder mask and silkscreen on the upper surface. The component names are shown in the silk screen but not the component values. The size of the PCB is 80mmx100mm.

The PCB is held to the front panel at 90 degrees by the use of four pot brackets. These brackets are centred at 1.0 inch apart. These brackets can be omitted if you wish; the pots will still hold the PCB in place. The PCB is designed to take 16mm Alpha PCB mounted pots, either round or splined shaft. Other makes of the same pin spacing and size will work.



The PCB is double sided with solder mask, component names are shown in the silk screen but not the component values. The size of the PCB is 80mmx100mm.

The module should be powered from a well regulated +15V and -15V power supply, current consumption is around 25mA. The power connector is the standard two ground MOTM/Oakley 4-pin Molex connector. One ground is for the circuit, the other is for the panel (PAD).

5 Front Panel Format

The AM8320 is designed to be used with a standard 3" FracRac panel, although other shapes and sizes can be used. I built my module with 6 jack sockets on the left hand side, the PCB mounted in the middle with the on board pots and then the off board pots for the signal levels and resonance on the right.

6 Building the Module

This module is simple to build. The recommended build order is:

- Resistors
- Inductors
- IC Sockets
- Capacitors
- Trimmers
- Connectors

- Transistors
- Pot Brackets and Potentiometers

Check all the electrolytic capacitors and transistors are fitted the right way round. Before fitting the IC's its worth connecting up the module to a power supply and checking that the power rail voltages are as expected at each IC socket, then power down, and fit the IC's ensuring correct orientation.

The resonance CV input is configured to enable an external control signal to be patched in front of the RESONANCE pot. This is implemented by using a jack socket that is normalised to +10V. The RESIN connection has two pins. Pin 1 is the CV input, Pin 2 is +10V. The jack socket should therefore be normalised to pin 2.

Power up and try out the VCF, then proceed to trimming.

7 Trimming

This module is simple to set-up, and three trimmers need to be adjusted.

V/OCT This trimmer adjusts the CV input response, so that the filter accurately tracks the keyboard and oscillators. Turn Q so that the filter begins to oscillate. Patch the keyboard CV into the CV_IN socket on the PCB. Press C4 on the keyboard and adjust the FREQUENCY control so that turning V/OCT trimmer has minimal effect. Tune a reference oscillator so that it zero-beats with the note appearing at the Band Pass output. Be sure the reference oscillator is not controlled by the keyboard. Now, press C5 on the keyboard and trim V/OCT so the note from the filter zero-beats with the reference oscillator. Repeat as necessary.

TRIM This trimmer adjusts the DC offset of the audio output to as close to 0V as possible. Turn RESONANCE fully anti-clockwise and FREQ to mid position. Measure the voltage at the output of the filter module and adjust the trimmer until a zero reading is obtained. This cancels the DC voltage from Pin 10 of the CEM3230.

REJECT This trimmer reduced the control voltage feed through from the CEM3320. Connect a +/-5V sine or triangle wave into CV1 input, the frequency should be 50 – 100Hz. Set FREQ and CV1 to mid positions and all other potentiometers to fully anti-clockwise. Connect the output of the filter module to an amplifier or oscilloscope and adjust the trimmer for minimum output. At low settings the REJECT trimmer will cut out filter oscillation, so don't go this far.

Note: The filter may not oscillate when at high resonance settings. If this happens, first check that the REJECT trimmer has not been set so low that it has stopped the filter oscillating. Typically the REJECT trimmer should be at 10%. If the filter still won't oscillate then reduce the value of R19 to

30K. Do not reduce R19 too far as it will put +15V into the CEM3320 Q input, which can fry the CEM.

8 Special Components

The AM8320 makes use of a small number of specialist components:

CEM3320

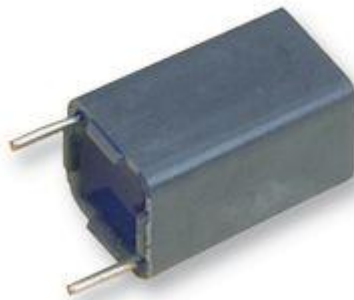
The CEM3320 chip is hard to locate, but it be found especially on eBay.

Pot Brackets

These can be obtained from Omeg in the UK. <http://www.omeg.co.uk>

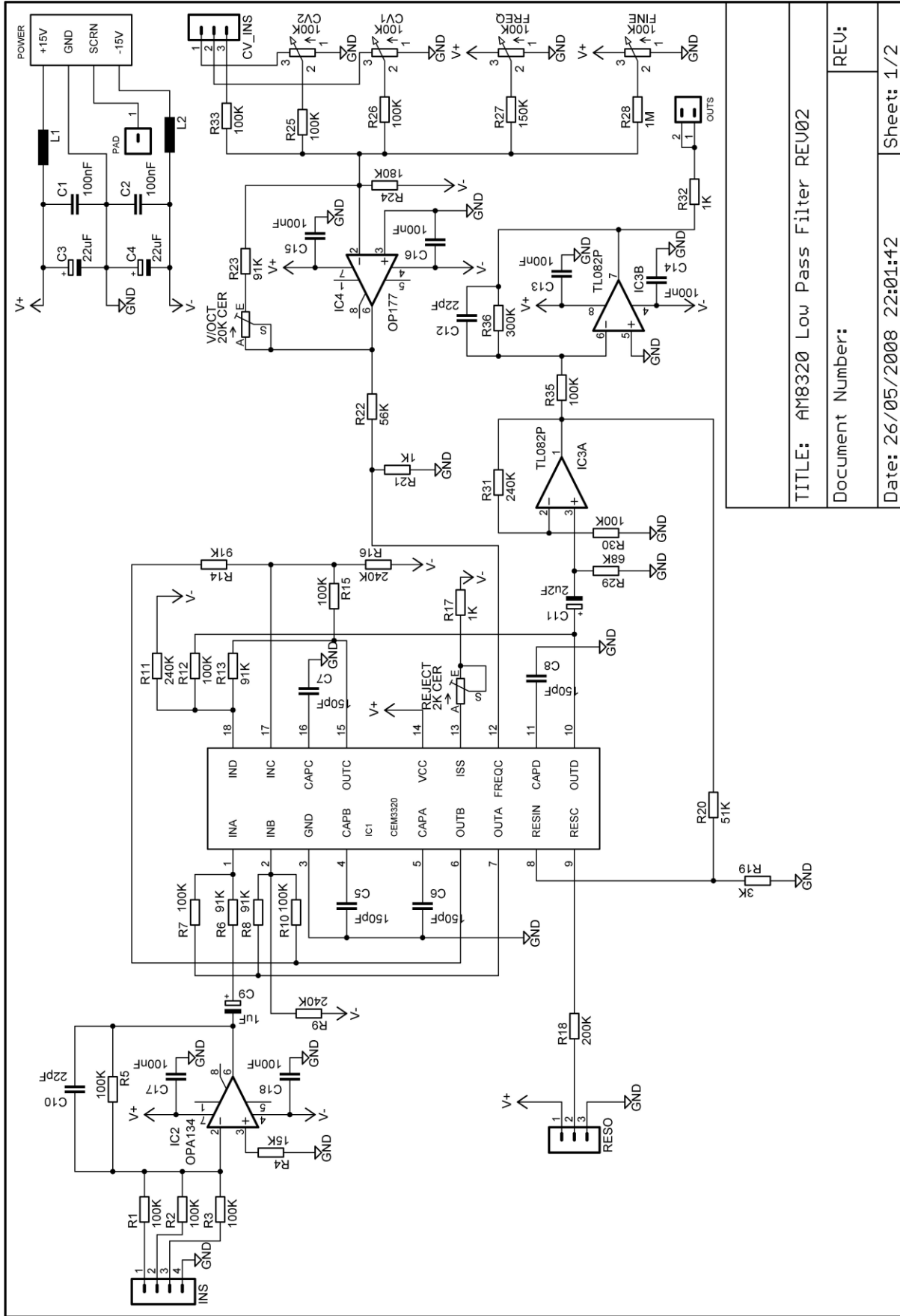
Polystyrene Capacitors

The filter uses 1% polystyrene capacitors, which improve the sound quality of the filter. Axial versions can be fitted vertically, but the PCB is design for using a version manufactured by LCR Components in an enclosed radial package, the EXF/HR. These are available from Farnell.



9 Parts Listing

Part Number	Value	Quantity	Comments
Capacitors			
C1, C2	100nF	2	Multi-layer Polyester
C3, C4	22uF 25V	2	Radial Electrolytic
C9, C11	1uF 25V	2	Radial Electrolytic
C10, C12	22pF	2	Low-K Ceramic
C5, C6, C7, C8	220pF	1	1% Polystyrene
Resistors			
R1, R2, R3, R7, R10, R12, R15, R25, R26, R29, R33, R35	100K	12	All 1/4W 1% metal film
R4	15K	1	
R5	75K	1	
R19	3K	2	
R6, R8, R13, R14, R23	91K	5	
R9, R11, R16, R31	240K	3	
R17, R21, R32	1K	3	
R19, R20	51K	2	
R22	56K	1	
R24, R30	180K	2	
R27	150K	1	
R28	1M	1	
R18	200K	1	
R36	300K	1	
Trimmers			
TRIM	100K	1	25 turn cermet trimmer
V/OCT	20K	1	25 turn cermet trimmer
REJECT	2K	1	Single turn trimmer
Potentiometers			
COARSE, FINE, RESO, CV1, CV2	100K LIN	5	Alpha 16mm
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	Alpha 16mm
Passives			
L1, L2		2	Inductor
Semiconductors			
IC1	CEM3320	1	
IC2, IC3	OPA134	2	Precision Op Amp
IC4	OP177G	1	Precision Op Amp
Hardware			
RESIN, OUTS		2	MTA 0.1" 2-pin header
CV_INS, SIG_INS		2	MTA 0.1" 3-pin header
POWER		1	MTA 0.156" 4-pin header



TITLE: AM8320 Low Pass Filter REV02
 Document Number:
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Sheet: 1/2