Analog Metropolis

AM3320
Voltage Controlled
Filter (CEM3320)

Project Notes
V1.0

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 AM3320 has the following controls and connections:

INPUTS   CV1, CV2
             SIGNALA, SIGNALB, SIGNALC

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

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 two pot brackets manufactured by Omeg (www.omeg.oc.uk). These brackets (and pots) are centred at 40mm apart. The FREQ and FINE pots hold the PCB to the front panel.

5   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

6   Pots

The PCB is designed to be used with Spectrol 248J conductive plastic pots; they are a reasonable price and very high quality. The PCB will work with either 3.18mm or 6.35mm spindle diameter models. The PCB can be used with other pots such as sliders provided they are all mounted off the PCB.

7   Power

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 ground (PAD).

8   Front Panel Format

The AM3030 PCB is designed to work with the AM Low and High Density panel format, to be mounted to the front panel by using two ECO pot brackets which fit Spectrol 248 potentiometers.

AM High Density

This panel format enables a higher density of controls on each panel, and panels are usually 90mm wide. All the pots have a small spindle diameter of 3.18mm which enables the control knobs to be located closer together. Both 19mm and 13mm control knobs can be used. The "look and feel" is similar to the ARP 2500.

Panels are 4U high and 90mm wide. Panels are fitted to horizontal 12mm angled aluminium strip using 4mm diameter machine screws in each corner of the panel. The strip is mounted into a standard 19" rack unit with small wooden end strips.

AM Low Density

This panel format has a lower density of controls on each panel, and panels sometimes have to be 135mm wide to accommodate all the controls. All the pots have a spindle diameter of 6.35mm which means the Eµ Systems replica 19mm control knobs can be used. The "look and feel" is similar to the Eµ Systems Modular.

Panels are 4U high and 90mm or 135mm wide. Panels are fitted to horizontal 12mm angled aluminium strip using 4mm diameter machine screws in each corner of the panel. The strip is mounted into a standard 19" rack unit with small wooden end strips.

MOTM Panels
This established panel format has pot spacing very close in dimensions to the AM PCB's, MOTM is 41.275mm compared with 40mm of the AM format. This means you can design MOTM style front panels but with 40mm spacing and this won't look significantly different. Alternatively you maybe be able to mount the AM PCB on 41.275mm hole centres by slightly bend the pot brackets to fit.

9 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.

10 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 rading is obtained. This cancels the DC coltage 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.

Note: The filter may not fully oscillate when at high resonance settings. If this happens you simply need to reduce the value of R19 to 24K.

11   Special Components
The AM3320 makes use of a small number of specialist components:

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

ECO/Omeg Pot Brackets
These can be obtained from Omeg in the UK. http://www.omeg.co.uk/.
Oakley have them again, and I have stock them too.

12 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, R18, R25, R26, R29, R33	100K	12	1/4W 1% metal film
R4	15K	1	1/4W 1% metal film
R5	36K	1	1/4W 1% metal film
R6, R8, R13, R14, R23	91K	5	1/4W 1% metal film
R9, R11, R16	240K	3	1/4W 1% metal film
R17, R21, R32	1K	3	1/4W 1% metal film
R19, R20	51K	2	1/4W 1% metal film
R22	56K	1	1/4W 1% metal film
R24, R30	180K	2	1/4W 1% metal film
R27	150K	1	1/4W 1% metal film
R28	1M5	1	1/4W 1% metal film
R31	300K	1	1/4W 1% metal film
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	SPECTROL 248
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	SPECTROL 248
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
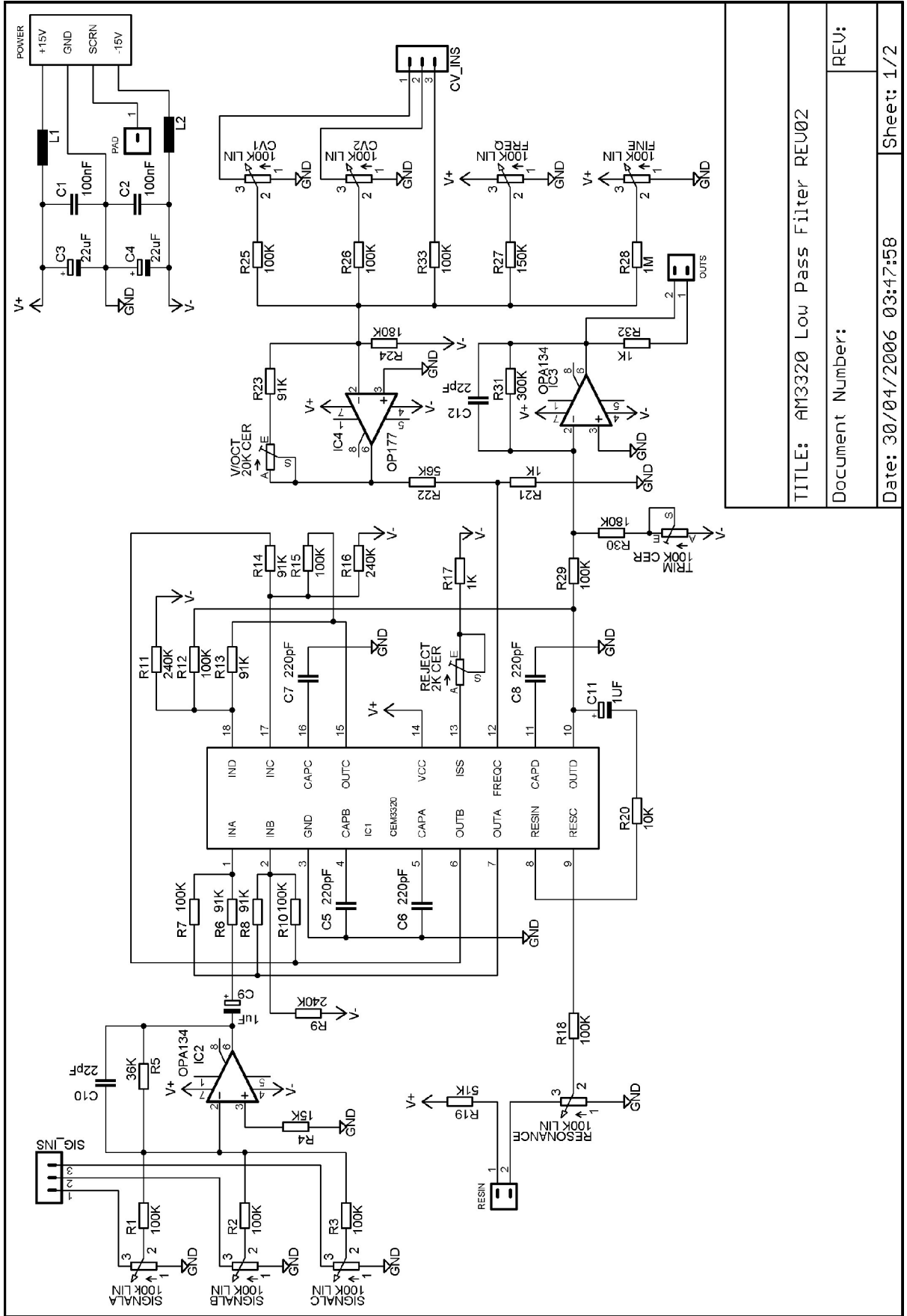
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