Analog Metropolis

AM8040
Voltage Controlled
Low Pass Filter

Project Notes
V1.0

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1 Module Description

This module is a clone of the low pass filter in the Eμ Systems Audity Synthesizer and SSM Voice Card.

The Low Pass Filter is an exponentially controlled low pass filter with variable Q. Three audio signals are mixed together (SIGNAL A, B C) and then low pass filtered with a cut-off frequency determined by the sum of the initial frequency set by the front panel controls (FREQ and FREQFINE) and the three control inputs. The cut-off is 24dB/octave and the signal is DC coupled.

The control inputs are accurately calibrated to 1V/octave, and there are two full level un-attenuated inputs (one for the front panel, another for an internal CV bus from a CV keyboard or MIDI to CV controller), as well as + and – CV inputs, which have front panel attenuators (+FREQ CNTL and – FREQ CNTL).

This 4-pole filter has a Q control to adjust the resonance of the filter from 0 to 20. Higher settings of the Q control will take the filter into sine wave oscillation.

INPUTS	SIGNALA, SIGNALB, SIGNALC +FREQ CNTL, -FREQ CNTL
OUTPUTS	AUDIO OUTPUT
POTS	SIGNAL A LEVEL, SIGNAL B LEVEL, SIGNAL C LEVEL FREQUENCY, FINE, Q +FREQ CNTL, -FREQ CNTL
SWITCH	An optional 2-way centre off for control CV from keyboard or sequencer

2 The Original Circuit

This module is based on a Dave Rossum filter design that never made it into the Eμ Systems Modular - a SSM2040 Low Pass VCF. The stock Modular filter was a very clean transistor ladder dating from October 1972, but whilst the HPF was updated to use the SSM2040, the original low pass module escaped. I have filled in some history, by taking the Dave's design from the SSM Voice Card and Audity, and produced a low pass 24dB VCF based on the SSM2040.

3 The Analog Metropolis Circuit

The Analog Metropolis circuit is a straight copy of the original Eμ Systems Low Pass Filter in the SSM Voice Card. The design uses a SSM2040 filter chip, with a dual Op Amp performing audio summing duties and a single Op Amp serving as the CV summer. The Op Amps can be upgraded; use an OPA2134 to replace the original TL082 with improved offset and faster slew rate, and OP177 and OPA134'ss to replace the 741's. The circuit can be temperature compensated if required, by using a 1K 3600ppm Tempco resistor.

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

4 Parts

The parts for the AM8040 are easy to find except the SSM2040 chip which is obsolete and quite rare. Try Vintage Planet or eBay.

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 a radial package, the EXF/HR. These are available from Farnell (part number 950236).

5 Front Panel Format

The AM8040 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 PCB, Pots and Power

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 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 PCB is designed to be used with Alpha 16mm potentiometers, either round or splined shaft.

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 or jack socket earth bus.

7 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?
INS	Pin 1	Input Signal A	Centre pin of SIGNALA pot
	Pin 2	Input Signal B	Centre pin of SIGNALB pot
	Pin 3	Input Signal C	Centre pin of SIGNALC pot
	Pin 4	Ground	Lower pin of SIGNALA, SIGNALB, SIGNALC Pots
RESO	Pin 1	Resonance Pot	RESONANCE Pot Pin lower
	Pin 2	Resonance Pot	RESONANCE Pot Pin centre
	Pin 3	Resonance Pot	RESONANCE Pot Pin upper
CVS	Pin 1	Full CV In	Spare Full CV Input
	Pin 2	CV+ In	Jack socket CV+ IN
	Pin 3	CV- In	Jack socket CV- IN
OUTS	Pin 1	Signal Output	Jack socket OUT
	Pin 2	Signal Output	Not used
PAD	Pin 1	Panel Earth	Jack socket earth bus

The AM8040 has a MTA connector for 3 signal inputs but there are no individual connectors for each signal level pot (as per many other AM modules). This has been done to save PCB space and achieve a 100x80mm PCB size. The individual pots for each signal levels need to be manually wired up.

8 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.

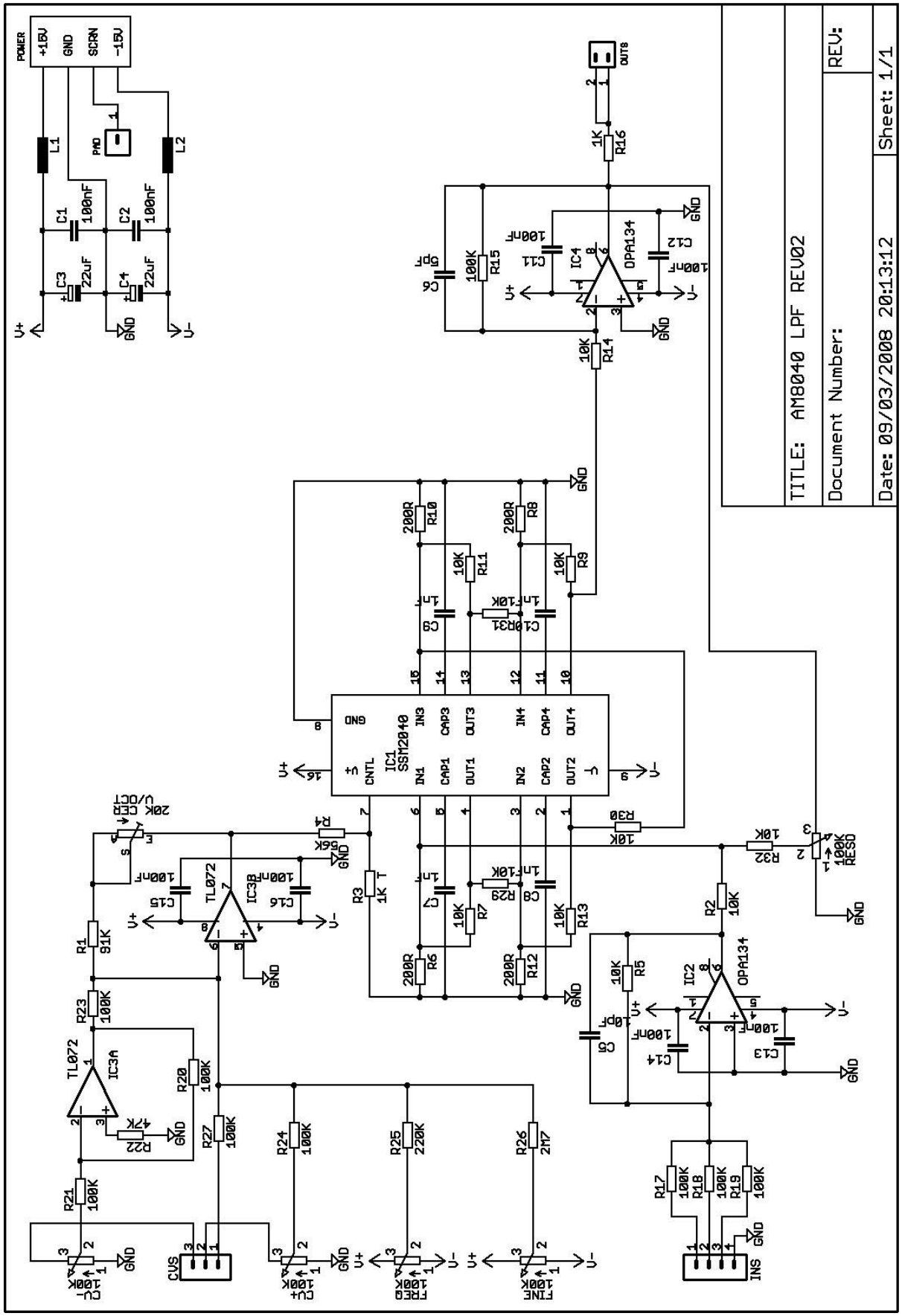
Check voltage rails are correct at IC1 before inserting SSM2040.
Power up and try out the filter. Then proceed to trimming.

9 Trimming

This module is simple to set-up, and only one trimmer needs 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 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.

Component	Value	#	Comments
Capacitors			
C1, C2	100nF 100V	2	Multi-layer Ceramic 5mm spacing
C3, C4	22uF 25V	2	Radial Electrolytic 5mm spacing
C5	10pF 100V	1	Low K ceramic 5mm spacing
C6	3.3pF 100V	1	Low K ceramic 5mm spacing
C7, C8, C9, C10	1000pF 630V	4	1% polystyrene LCR EXFS/HR type
Resistors			All 1/4W 1% metal resistors
R1	91K	1	
R2, R5, R7, R9, R11, R13, R14, R29, R30, R31, R32	10K	11	
R3	1K Tempco	1	1K 3000ppm/°C Tempco is possible with less accuracy Farnell part number 732-278
R16	1K	1	
R4	56K	1	
R6, R8, R10, R12	200R	4	
R15, R17, R18, R19 R20, R21, R23, R24, R27, R28	100K	10	
R22	47K	1	
R25	220K	1	
R26	2M7	1	
Potentiometers			
CV+, CV-, FREQ, FINE, RESO	100K LIN	5	Alpha 16mm
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	Alpha 16mm
V/OCT	20K	1	25 turn ceramic trimmer
Other Passives			
L1, L2		2	Inductor
Semiconductors			
IC1	SSM2040	1	VCF Chip
IC2	TL071	1	Dual FET Op Amp Upgrade to OP177
IC3	TL082	1	Single Op Amp Upgrade to OPA2134
IC4	TL071	1	Single Op Amp Upgrade to OPA134
Hardware			
OUTPUTS		1	MTA 0.1” 2-pin header
CVS		1	MTA 0.1” 3-pin header
INS		1	MTA 0.1” 4-pin header
POWER	MTA04	1	MTA 0.156” 4-pin header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Document Number:
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Date: 09/03/2008 20:13:12
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IC1 SSM2040
IC2 OPA134
IC3A TL072
IC3B TL072
IC4 OPA134
POWER
+15V
GND
SCRN
-15V
CUTO
RESO
CVS
FINE
INS
GND