Analog Metropolis

AM8044
Voltage Controlled
Low Pass Filter

Project Notes
V1.0

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1 Module Description

This module is designed around the SSM2044 VCF chip that appeared in a variety of analog synthesizers and drum machines in the early 1980's, including the Korg PolySix, PPG Wave 2.2 and the E-mu System SP1200.

A direct descendent of the legendary SSM2040 chip, and designed by Dave Rossum and Ron Dow in 1980, the design was patented in the USA (4,404,529) and described as a low pass filter circuit, employing feedback current mirrors as dynamic resistive elements, and characterized by high accuracy, low noise, and low distortion. Whatever the specification, it is a very nice and fat - low pass filter!

The filter is exponentially controlled 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 FINE) and the three control voltage inputs. The cut-off is 24dB/octave and the signal is DC coupled.

The control inputs can be accurately calibrated to 1V/octave, and there are two attenuated inputs and one un-attenuated input. This 4-pole filter has a Q control to adjust the resonance of the filter and higher settings will take the filter into clean sine wave oscillation.

INPUTS	SIGNALA, SIGNALB, SIGNALC CV1, CV2
OUTPUTS	AUDIO OUTPUT
POTS	SIGNAL A LEVEL, SIGNAL B LEVEL, SIGNAL C LEVEL FREQUENCY, FINE, Q CV1 LEVEL, CV2 LEVEL

2 Circuit Description

The AM8044 module is based around the original datasheet, with an Op Amp to mix the audio signals and take attenuate the signal down to a level suitable for the SSM chip. An output Op Amp buffer takes the signals back up. Another Op Amp mixes the control voltages and enables frequency cut-off to be varied. The SSM2044 delivers a 4-pole voltage controlled low pass filter, with the added feature of the resonance being voltage controlled, but this is a reverse log response. Designed to be used with micro processors this is not a problem in poly synthesizers such as the Korg Poly Six, but when used in an analog module (with no digital electronics) this is a bit trickier.

I initially tried out a circuit design from Polyphony magazine (using an OTA) from 1982, which was rather useless. The Q was voltage controllable but the response curve was dreadful. Other designs on the Internet

attempt to replicate the reverse log control with Op Amps...and provide external control of Q.

However after many tests I have found that the original datasheet design of a reverse log 5K pot and the correct value resistors to define the upper and lower voltage ranges works extremely well - and gives a much better control of the resonance.

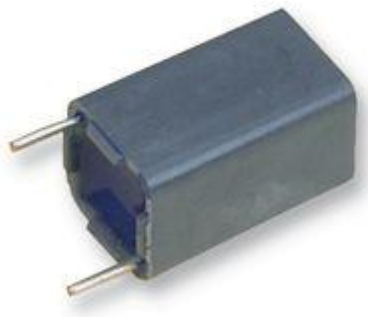
The Op Amps can be upgraded from the usual TL071/72's. A high quality audio version such as the OPA2134 is suggested as IC4 and a low offset Op Amp such as the OP177 is suggested for IC2. The circuit can be temperature compensated if required, by using a 1K Tempco resistor at R11.

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

4 Parts

The parts for the AM8044 are easy to find except the SSM2044 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 for the 10nF capacitors. These are available from Farnell.



I recommended using a high quality audio specification capacitor for the Electrolytic capacitor that is in the audio path (C11). Panasonic make a nice range.

There is an optional Tempco 1K resistor at R11. This can be the more easily obtained 3000ppm version, such as Farnell part number 1174306.

5 Front Panel Format

The AM8044 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 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 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 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?
SIGINS	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
CVINS	Pin 1	CV1 In	Jack socket CV1
	Pin 2	CV2 In	Jack socket CV2
	Pin 3	Full CV In	Spare Full CV Input
OUT	Pin 1	Signal Output	Jack socket OUTPUT
	Pin 2	Signal Output	Not used
PAD	Pin 1	Panel Earth	Jack socket earth bus

The AM8044 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 SSM2044.
Power up and try out the filter. Then proceed to trimming.

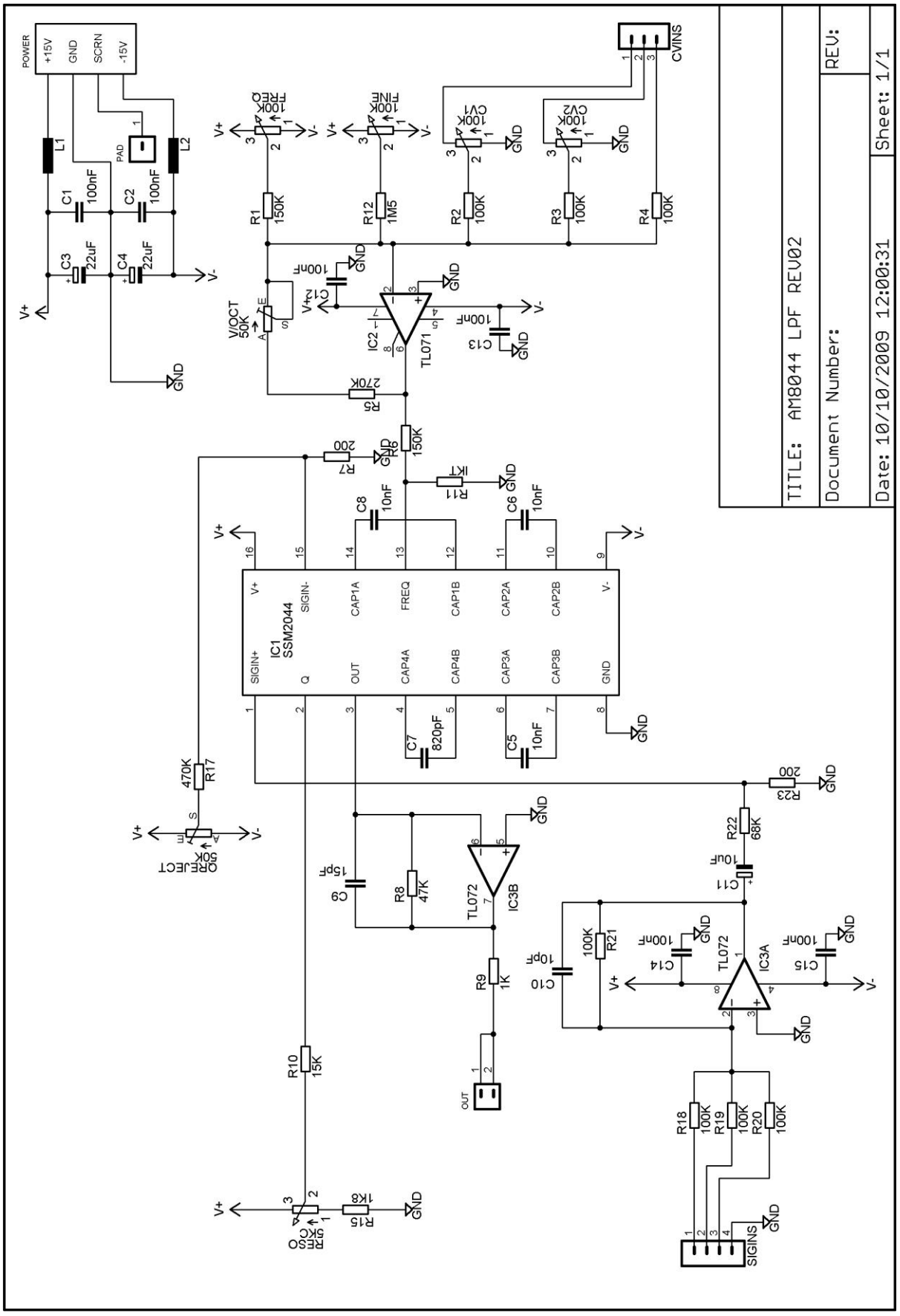
9 Trimming

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

QREJECT This trimmer is used to minimise Q control feed through, which is about- 60db when trimmed correctly. Set to mid range, or feed a LFO signal into R5 and monitor the signal output whilst adjusting the trimmer to give minimum feed through.

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 a CV IN socket. Press C4 on the keyboard and adjust the FREQ 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, C12, C13, C14, C15	100nF	6	Multi-layer Ceramic 5mm spacing
C3, C4	22uF	2	Radial Electrolytic 5mm spacing
C5, C6, C8	10nF	3	1% polystyrene LCR EXFS/HR type
C7	820pF	1	1% polystyrene LCR EXFS/HR type
C9	15pF	1	Low K ceramic 5mm spacing
C10	10pF	1	Low K ceramic 5mm spacing
C11	10uF	1	Radial Electrolytic 5mm spacing
Resistors			All 1/4W 1% metal resistors
R1, R6	150K	2	
R2, R3, R4 , R18, R19 , R20, R21	100K	7	
R5	270K	1	
R7, R23	200R	2	
R8	47K	1	
R9	1K	1	
R10	15K	1	
R11	1K	1	1K 3000ppm/°C Tempco
R12	1M5	1	
R15	1K8	1	
R17	470K	1	
R22	68K	1	
Potentiometers			
CV1, CV2, FREQ, FINE	100K LIN	4	Alpha 16mm – PCB mounted
RESO	5KC REV LOG	1	Reverse Log
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	
QREJECT, V/OCT	50K	2	25 turn ceramic trimmer
Other Passives			
L1, L2		2	Inductor
Semiconductors			
IC1	SSM2044	1	VCF Chip
IC2	TL071	1	Optional Upgrade to OP177
IC3	TL072	1	Optional Upgrade to OPA2134
Hardware			
OUTPUT		1	MTA 0.1” 2-pin header
CVINS		1	MTA 0.1” 3-pin header
SIGINS		1	MTA 0.1” 4-pin header
POWER	MTA04	1	MTA 0.156” 4-pin header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IC1 SSM2044
TL072
IC2
IC3A
IC3B
CVINS
SIGINS
OUT
POWER