Analog Metropolis

AM2100
Voltage Controlled
Low Pass Filter

Project Notes
V1.1

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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 AM 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 TL082 FET Op Amp performing audio summing duties and a 741 Op Amp serving as the CV summer. The Op Amps can be upgraded; use an OPA2134 to replace the TL082 with improved offset and faster

slew rate, and OP177's to replace the 741's with improved offset. The circuit can be temperature compensated if required, by using a 1K 3600ppm Tempco resistor.

The SSM2040 chip is hard to locate, but some can still be found.

The REV02B board is the prototype and production board. There are no errors in the PCB.

4 Front Panel Format

The AM2100 is a standard AM format module which can be built into a number of panel formats:

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.

The AM2100 PCB is designed to work with the AM Low Density panel format, as the brackets supplied are for the larger 6.35mm spindle diameters and the PCB is designed to be used with Bourns 91A conductive plastic pots.

5 PCB, Pots and Power

The PCB is held to the front panel at 90 degrees by the use of two pot brackets. These brackets are centred at 40mm apart.

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 Bourns 91A conductive plastic pots; they are expensive but very high quality. Alternatively the cheaper Spectrol 248J pots can be used but they will need their pins angled out to meet the top of the PCB, and the pins rest on top of the PCB holes and do not go through the holes (unlike the Bourns, which are a perfect fit).

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.

6 Building the Module

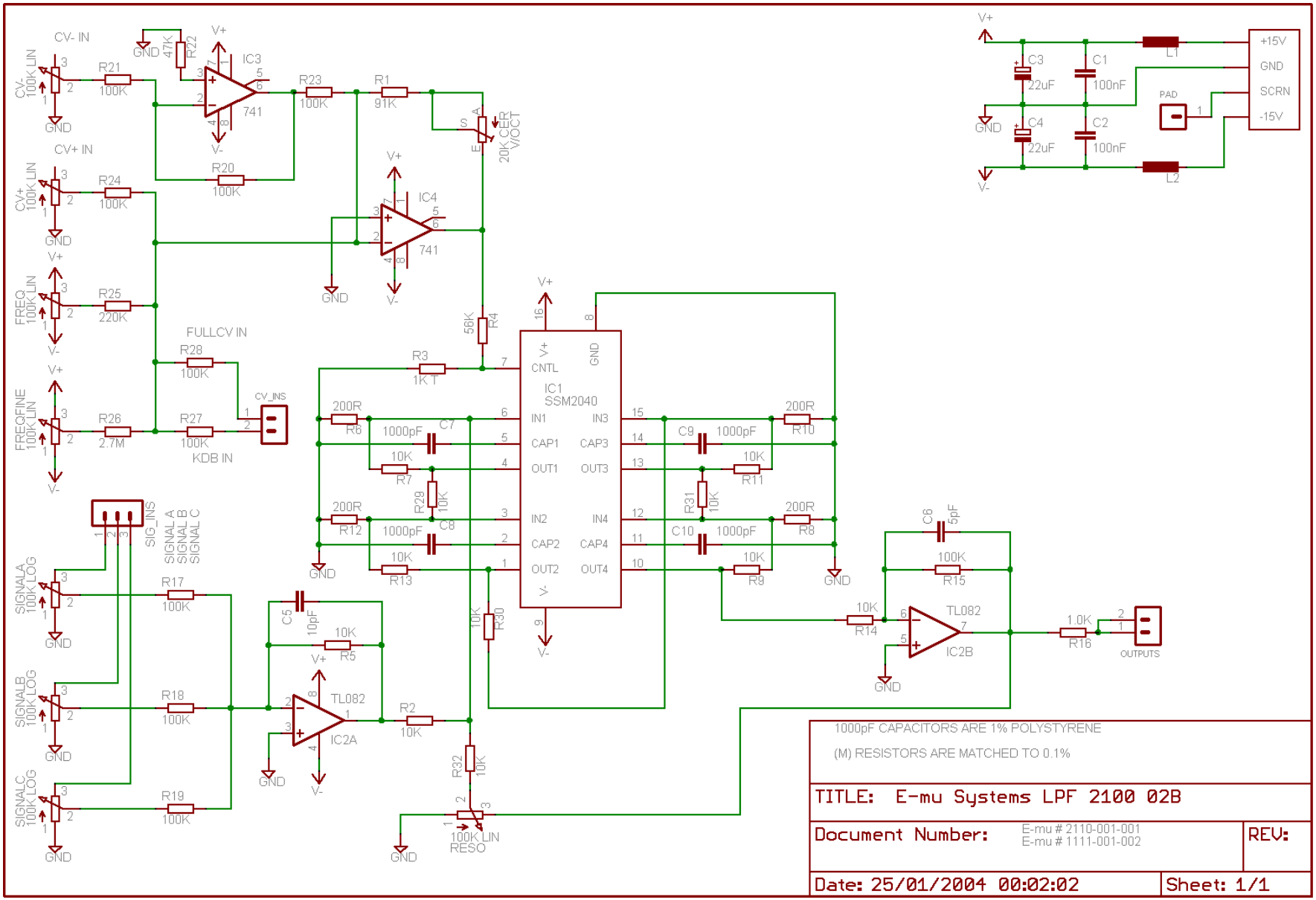
To follow.
Check voltage rails are correct at IC1 before inserting SSM2040.

7 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 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.

Part	Value	Device	Comments
Capacitors			
C1, C2	100nF 100V	Multi-layer polyester	
C3, C4	22uF 25V	Radial Electrolytic	
C5	10pF 100V	Low K ceramic	
C6	3.3pF 100V	Low K ceramic	
C7, C8, C9, C10	1000pF 630V	1% polystyrene	
Resistors			
R1	91K		
R2, R5, R7, R9, R11, R13, R14, R29, R30, R31, R32	10K		
R3	1K Tempco	1K 3600ppm/°C Tempco is ideal	1K 3000ppm/°C Tempco is possible with less accuracy Farnell part number 732-278
R16	1K		
R4	56K		
R6, R8, R10, R12	200R		
R15, R17, R18, R19 R20, R21, R23, R24, R27, R28	100K		
R22	47K		
R25	220K		
R26	2.7M		
Potentiometers			
CV+, CV-, FREQ, FREQFINE, RESO	100K LIN	Bourns 91A	
SIGNALA, SIGNALB, SIGNALC	100K LOG	Bourns 91A	
V/OCT	20K	25 turn ceramic trimmer	
Other Passives			
L1, L2		Inductor	
Semiconductors			
IC1	SSM2040	VCF Chip	
IC2	TL082	Dual FET Op Amp	
IC3, IC4	LM741	Op Amp	
Hardware			
CV_INS, OUTPUTS		MTA 0.1” 2-pin header	
SIG_INS		MTA 0.1” 3-pin header	
PSU1	MTA04	MTA 0.156” 4-pin header	


CV- IN
CV+ IN
FREQ
FREQFINE
FULLCV IN
KDB IN
CV_INS
SIG_INS
SIGNAL A
SIGNAL B
SIGNAL C
SIGNALA 100K LOG
SIGNALB 100K LOG
SIGNALC 100K LOG
CV 100K LIN
CV+ 100K LIN
FREQ 100K LIN
FREQFINE 100K LIN
R21 100K
R22 47K
R23 100K
R1 91K
R20 100K
R24 100K
R25 220K
R28 100K
R26 2.7M
R27 100K
R17 100K
R18 100K
R19 100K
R5 10K
C5 10pF
R2 10K
R32 10K
100K LIN RESO
20K CER V/OCT
IC3 741
IC4 741
IC2A TL082
R4 56K
R3 1K T
IC1 SSM2040
CNTL
IN1
IN2
IN3
IN4
CAP1
CAP2
CAP3
CAP4
OUT1
OUT2
OUT3
OUT4
R6 200R
R12 200R
R10 200R
R8 200R
C7 1000pF
C8 1000pF
C9 1000pF
C10 1000pF
R7 10K
R13 10K
R11 10K
R9 10K
R29 10K
R31 10K
R30 10K
C6 5pF
R15 100K
R14 10K
IC2B TL082
R16 1.0K
OUTPUTS
V+
V-
GND
+15V
SCRN
-15V
PAD
L1
L2
C3 22uF
C4 22uF
C1 100nF
C2 100nF
1000pF CAPACITORS ARE 1% POLYSTYRENE
(M) RESISTORS ARE MATCHED TO 0.1%
TITLE: E-mu Systems LPF 2100 02B
Document Number:
E-mu # 2110-001-001
E-mu # 1111-001-002
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Date: 25/01/2004 00:02:02
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