Analog Metropolis

AM8060
Roland Jupiter 6
Multi Mode Filter

Project Notes
V1.0

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08 May 2010

1 Module Description

The AM8060 is a clone of the multi mode filter from the legendary Roland Jupiter 6 analog polyphonic synthesizer that was launched in 1983. The synthesizer is remembered as being the first Japanese product with MID, and as a cheaper version of the Jupiter 8, thanks to the use of more custom chips rather than discrete circuits. The Jupiter 6 uses two special Roland VCF chips – the IR3109. This 16-pin DIL chip contains four OTA filter blocks, which when connected to external capacitors and Op Amps can create 2 pole or 4 pole, low or high pass voltage controlled filters. The second IR3109 is used as VCA's for the resonance control.

Roland used the IR3109 chip as a 24dB LPF in the Jupiter 4 and 8, and the MKS80 Rev 4, but only in the Jupiter 6 did Roland wire up two of these chips to form two independent 2-pole high or low pass filters with voltage controlled resonance. On the front panel two illuminated buttons in the filter section select 24dB LPF or 24dB HPF, or if pressed together 12dB Band Pass. This is the most powerful and versatile analog filter that Roland created in the 1980's.

The filter frequency is adjusted by the FREQUENCY front panel control and there are two external CV inputs for frequency modulation. The two separate filter stages can be independently switched from LPF to HPF using two locking push buttons. This gives four different configurations:

- HPF + HPF = 24dB HPF
- LPF + LPF = 24dB LPF
- LPF + HPF = 12dB BPF with a tighter response
- HPF + LPF = 12dB BPF with a wider response

The filter has a Q control (RESONANCE) to adjust the resonance of the filter, and higher settings of the Q control will take the filter into sine wave oscillation on ALL filter modes.

INPUTS: SIGNALA, SIGNALB, SIGNALC
CV1, CV2

OUTPUTS: AUDIO SIGNAL

POTS: SIGNAL A, SIGNAL B, SIGNAL C
FREQUENCY, RESONANCE, CV1, CV2

SWITCHES:
STAGE 1 FILTER MODE (LPF or HPF)
STAGE 2 FILTER MODE (LPF or HPF)

2 The Original Circuit

The original design comprises two parallel filter stages each with a 2 pole OTA filter which can be set as high pass or low pass. The VCF is built from one IR3109 with external capacitors, and an internal exponential CV generator to control the frequency cut off. A second IR3109 is used merely as 2 VCA's to control the resonance in each filter stage. The feedback circuit in each stage is subtlety different, so the sound of each stage is also different. This is especially audible when trying the two different BP modes in the AM8060.

The same circuit topology was used by Roland in the MKS80 REV4 but strangely hard wired as a 24dB LPF. The second filter stage (like the JP-6) uses diodes in the resonance feedback circuit to try and control the volume at high resonance settings. However Roland eventually gave up, and in the REV5 switched to using the IR3R05 chip which has a more contained resonance.

This is all good news for the AM8060, as the filter is far from being tame once released into modular format. With the constraints from mixing six channels in unison mode into one output level, we can open up the full potential of this design and get the filter to scream and shout. A multi mode filter with maximum resonance into powerful self oscillation in all modes, the AM8060 is not a smooth sound.

3 The AM8060 Circuit

The cloned circuit is similar to the original with the core of the filter based on a single voice of the original Jupiter 6, in fact we used the MKS80 REV4 schematics. The frequency control circuit is from the SH101 with temperature compensation via a 10K NTC. There is a main FREQUENCY pot and then two additional CV inputs and pots.

A front panel RESONANCE pot controls the two IR3109 resonance control circuits that provide voltage control of the feedback loop. Setting up this circuit was very interesting; by experimenting with the control voltage levels I was able to push the levels of self oscillation into zones not possible on the "tamed" Jupiter 6.

There are Op Amp buffers before and after the core to translate the signal levels to and from the higher levels used in a modular synthesizers. You can use high quality Op Amps like the OPA134 (audio) and OP177 (CV), or just plan old TL071. I do recommend using high quality audio grade Panasonic capacitors in the signal path for improved sound quality. Please note that some of the signal path capacitors are Bi Polar, these are marked as BP on the schematic – do not fit polarised capacitors.

The design uses two C&K locking push button switches to control the filter modes.

Trimmers have been added to enable the Frequency cutoff to be set, as well as the onset of oscillation as the Resonance pot is turned up. This is an aggressive sounding filter which breaks into full sine wave oscillation at high resonance settings. The difference between HP, LP and BP modes is dramatic.

The REV01 or REV02 boards are production status, with no errors or corrections.

4 Front Panel Format

The AM8060 is designed to be used with a standard 3" FracRac panel, although other shapes and sizes can be used, for example Doepfer. 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.

5 PCB, Pots and Power

The PCB is high quality, 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 three pot brackets (available from Omeg). 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 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).

6 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?
RESO	Pin 1	Resonance Pot	RESONANCE Pot Pin 1
	Pin 2	Resonance Pot	RESONANCE Pot Pin 2
	Pin 3	Resonance Pot	RESONANCE Pot Pin 3
CV_INS	Pin 1	CV1 In	Jack socket CV1 IN
	Pin 2	CV2 In	Jack socket CV2 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 AM8060 has a MTA connector for 3 signal inputs (INS) 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 as shown below:

SIGNALA	Pin 1	Signal A Pot	Wire to GND (INS Pin 4)
	Pin 2	Signal A Pot	Wire to INS Pin 1
	Pin 3	Signal A Pot	Wire to SIGNALA Jack Socket
SIGNALB	Pin 1	Signal B Pot	Wire to GND (INS Pin 4)
	Pin 2	Signal B Pot	Wire to INS Pin 2
	Pin 3	Signal B Pot	Wire to SIGNALB Jack Socket
SIGNALC	Pin 1	Signal C Pot	Wire to GND (INS Pin 4)
	Pin 2	Signal C Pot	Wire to INS Pin 3
	Pin 3	Signal C Pot	Wire to SIGNALC Jack Socket

If you are using your own switches here is how they are wired up:

SW1	Pin 1	Low Pass1 out	Wire to top of switch
	Pin 2	Op Amp In	Wire to centre pole of switch
	Pin 3	High Pass1 Out	Wire to bottom of switch
SW2	Pin 1	Low Pass2 out	Wire to top of switch
	Pin 2	Op Amp In	Wire to centre pole of switch
	Pin 3	High Pass2 Out	Wire to bottom of switch

7 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. This is highly recommended!

Power up and try out the filter. Then proceed to trimming. Job done!

8 Trimming

This module has one trimmer which need to be adjusted for accurate operation of the filter.

FTRIM This trimmer adjusts the initial cut-off frequency of the filter. Set the FREQ to minimum and connect a VCO output of around 80Hz to a filter input with the SIGNAL pot at maximum. Monitor the filter audio output and adjust FTRIM so that the FREQ pot cuts off the signal at low values, or to taste.

9 Special Components

The AM8060 makes use of a small number of specialist components:

IR3109

This chip can be occasionally found on eBay or you can buy a second hand Boss PH-2 Super Phaser and carefully retrieve two IR3109 chips. You will need to cut them out with a fretsaw as they are soldered to the PCB.

Tempco Resistor

The 10k NTC Tempco resistor can be obtained from Farnell, the part number is 1672384.

Push Switch

The module uses two PCB mounted SPDT C&K Locking Push button switches, the PN12SHNA03QE and a suitable button like the G003. These are available from Farnell, Mouser and Digikey. You can choose a round or square push button in red, grey or black colour.

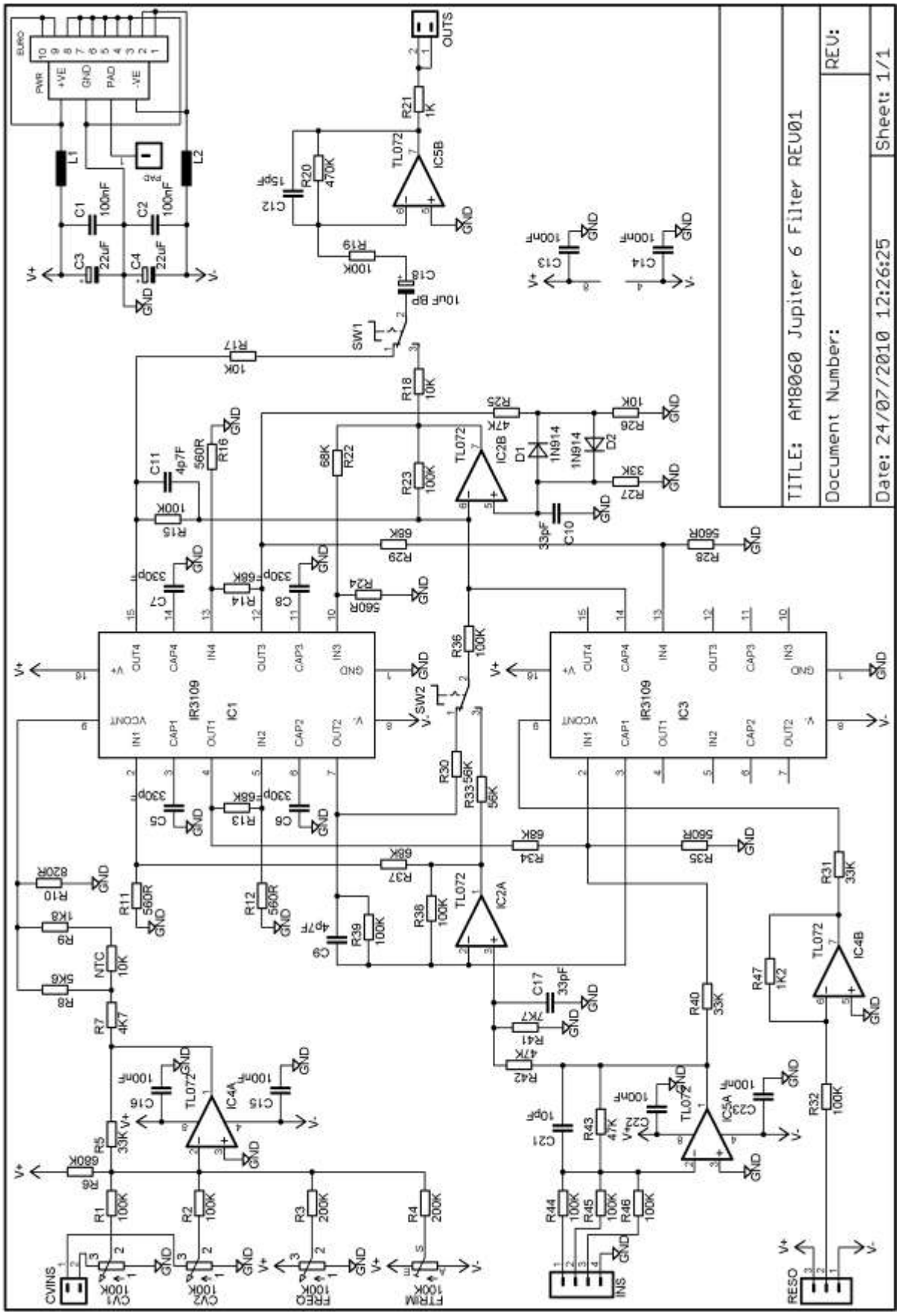
Pot Bracket

ECO pot brackets can be obtained from Omeg in the UK.
http://www.omeg.co.uk/

10 Parts Listing

Part Number	Value	Quantity	Comments
Capacitors			All 5mm spacing
C1, C2, C13, C14, C15, C16, C22, C23	100nF	8	Axial Ceramic
C3, C4	22uF 25V	2	Radial Electrolytic
C5, C6, C7, C8	330pF	4	1% Polystyrene or Polypropylene capacitors
C9, C11	4p7F	2	Low-K Ceramic
C10, C17	33pF	2	Low-K Ceramic
C12	15pF	1	Low-K Ceramic
C18	10uF	1	Bi Polar Radial Electrolytic
C21	10pF	1	Low-K Ceramic
Resistors			All 1% Metal Film
R1, R2, R15, R19, R23, R32, R36, R38, R39, R44, R45, R46	100K	12	
R3, R4	200K	2	
R5, R27, R31, R40	33K	4	
R6	680K	1	
R7	4K7	1	
R8	5K6	1	
R9	1K8	1	
R10	820R	1	
R11, R12, R16, R24, R28, R35	560R	6	
R13, R14, R22, R29, R30, R34 R37	68K	7	
R17, R18, R26	10K	3	
R20	470K	1	
R21	1K	1	
R25, R42, R43	47K	3	
R33	56K	1	
R41	7K7	1	
R47	1K2	1	
NTC	10K	1	NTC Tempco
Potentiometers			
CV1, CV2, FREQ, RESO	100K LIN	4	Alpha 16mm
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	Alpha 16mm
FTRIM	100K	1	25 turn cermet trimmer
Semiconductors			
D1, D2	1N914	1	Transistor
IC1, IC3	IR3109	2	VCF chip
IC2, IC4, IC5	TL072	3	Dual Op Amp
Passives			
L1, L2		2	Inductor

Part Number	Value	Quantity	Comments
Hardware			
SW1, SW2		2	C&K Latching Push Switch
CVINS, OUTS		1	MTA 0.1” 2-pin header
RESO		1	MTA 0.1” 3-pin header
INS		1	MTA 0.1” 4-pin header
POWER		1	MTA 0.156” 4-pin header


TITLE: AM8060 Jupiter 6 Filter REV01
Document Number:
REV:
Date: 24/07/2010 12:26:25
Sheet: 1/1
IR3109
TL072
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