Analog Metropolis

AM4075
ARP Voltage Controlled
24dB Low Pass Filter

Project Notes
V1.2

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8 May 2006

1 Module Description

The AM4075 is a clone of the ARP 4075 4-pole 24dB low pass filter in the ARP Odyssey. It is very similar to the 4072 filter, the only difference being the signal levels used.

It is temperature compensated and it appeared in later ARP 2600 models as well. Its cut-off range was severely limited to just 12kHz by a design error, which can be easily corrected. This is an excellent filter, with a clean low distortion output that will oscillate at higher resonance settings. The control inputs are accurately calibrated to 1V/octave, and there are two CV inputs which have front panel attenuators (CV1 and CV2). There is also an un-attenuated CV in for direct connection to a keyboard CV.

The filter frequency has two front panel controls; FREQ for coarse adjustment and FINE for fine adjustment, there is also an on-board trimmer to set the initial cut-off frequency.

The filter has a Q control (RESO) to adjust the resonance of the filter. Higher settings of the Q control will take the filter into sine wave oscillation.

INPUTS	AUDIO SIGNALS:	SIGNALA, SIGNALB, SIGNALC
	CONTROL VOLTAGES:	CV1, CV2
OUTPUTS	AUDIO SIGNAL	
POTS	SIGNAL A LEVEL, SIGNAL B LEVEL, SIGNAL C LEVEL FREQUENCY, FINE, RESONANCE CV1, CV2	
SWITCH	An optional 2-way centre off for selecting a control CV from a keyboard or sequencer	
DISPLAY	An optional 10 bar LED indicator which shows audio output level	

2 The Original Circuit

The original design uses 2N5087 matched and thermally coupled transistor pairs, as well as the LM3900 Norton amplifier chip. Both of these components are still available. ARP sensibly ditched the old LM301 Op Amp used in previous filters, and replaced it with a slightly better LM1458.

3 The AM Circuit

The cloned circuit is exactly the same as the original, as all the components are easy to locate. The AM module contains the original ARP module circuit as well as the additional circuitry of CV and signal summing which is held on the main ARP PCB's. This provides a self contained module for use within any modular system, rather than a replacement module for ARP synthesizers.

Hand matched transistor pairs have been used, rather than expensive pre-matched transistor pairs (e.g. SSM2210). However the filter works perfectly well without hand matching the transistors. The CV summing Op Amp is a high quality (low offset) OP177 rather than the original LM1458.

All capacitors have been upgraded as well; 1% polystyrene capacitors are used in the main filter core, WIMA and Panasonic Audio capacitors in the audio signal paths and Panasonic FC capacitors in the power supply. The trimmers are all cermet 20 turn. These upgrades pay off, the filter sounds fantastic!

The Tempco resistor can be omitted (and a standard metal film resistor used) if you are not concerned about the filter oscillation tracking properly. We have had 1K87 3500ppm Tempco resistors specially manufactured, and we recommend fitting one of them.

The frequency control circuitry of the original has been expanded to include a dedicated keyboard CV input, as well as a FINE front panel control and an internal frequency trimmer for setting up the filters response.

The REV03 board is the production board, with no errors or corrections.

4 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 80mmx125mm.

The PCB is held to the front panel at 90 degrees by the use of two pot brackets manufactured by ECO. 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	Input Signal A	Centre tap of SIGNALA
	Pin 2	Input Signal B	Centre tap of SIGNALB
	Pin 3	Input Signal C	Centre tap of SIGNALC
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
	Pin 3	CV In	Keyboard CV bus or optional CV
CV1	Pin 1	CV1 Pot	CV1 Pot Pin 1
	Pin 2	CV1 Pot	CV1 Pot Pin 2
	Pin 3	CV1 Pot	CV1 Pot Pin 3
CV2	Pin 1	CV2 Pot	CV2 Pot Pin 1
	Pin 2	CV2 Pot	CV2 Pot Pin 2
	Pin 3	CV2 Pot	CV2 Pot Pin 3
OUTPUTS	Pin 1	Signal Output	Not Used
	Pin 2	Signal Output	Jack socket OUT
PAD	Pin 1	Panel Earth	Jack socket earth bus

The AM4075 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 125x80mm 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 (CV Pin 1)
	Pin 2	Signal A Pot	Wire to SIG_INS Pin 1
	Pin 3	Signal A Pot	Wire to SIGNALA Jack Socket
SIGNALB	Pin 1	Signal B Pot	Wire to GND (CV Pin 1)
	Pin 2	Signal B Pot	Wire to SIG_INS Pin 2
	Pin 3	Signal B Pot	Wire to SIGNALB Jack Socket
SIGNALC	Pin 1	Signal C Pot	Wire to GND (CV Pin 1)
	Pin 2	Signal C Pot	Wire to SIG_INS Pin 3
	Pin 3	Signal C Pot	Wire to SIGNALC Jack Socket

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 6.35mm pot connections don't quite fit into the PCB holes so you'll need to extend the pot connections with bare wire. 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 (PAD).

8 Front Panel

The AM4075 is a standard AM format module which can be built into a number of panel formats. You can use your own format or choose from the following:

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 19mm control knobs can be used, such as those used in the Eμ Systems Modular. 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 AM4075 PCB is designed to work with ECO pot brackets and Spectrol 248 conductive plastic pots.

I built my module using 3.18mm spindle Spectrol 248 pots and a High Density panel format.

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.

Power up and try out the filter. Then proceed to trimming. Watch out for the speaker shredding resonance.

10 Trimming

This module has three trimmers which need to be adjusted for accurate operation of the filter.

TRIM This trimmer adjusts the initial cut-off frequency of the filter. Set the FREQ and FINE pots to minimum and turn RESO (Q) up so that the filter begins to oscillate. Monitor the filter output with an oscilloscope or frequency counter and adjust FC_TRIM for a 62.5ms period or 16Hz.

REJECT This trimmer adjusts the filter for minimum CV bleed through. Listen to the audio output whilst patching an ADSR into the CV1 input. Adjust the trimmer for minimal output whilst repeatly triggering the ADSR.

V/OCT This trimmer adjusts the CV input response, so that the filter accurately tracks the keyboard and oscillators. Turn RESO (Q) so that the filter begins to oscillate. Patch the keyboard CV into the CV1 socket on the PCB. 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 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.

11 Special Components

The AM4075 makes use of a small number of specialist components:

Tempco Resistor

The 1K87 3500ppm/°C Tempco can be obtained from Precision Resistors, they have UK and USA distribution. You need the PT146 resistor, and they may ask for a minimum order of 5 or 10 items.

http://www.precisionresistor.com/

A 1K87 1% resistor can be used if you aren't concerned about the filter tracking the keyboard when it is self-oscillating.

Pot Brackets

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

12 Parts Listing

Part Number	Value	Quantity	Comments
C1, C7	100nF 100V	2	Multi-layer Polyester
C2, C17	47nF 100V	2	Multi-layer Polyester
C3, C4	10nF 100V	2	Multi-layer Polyester
C5, C6, C11, C12	4700pF	4	1% Polystyrene
C8, C9	22uF 25V	2	Radial Electrolytic
C10	220pF	1	Low-K Ceramic
C13, C14, C15, C16	10uF 25V	4	Radial Electrolytic
R1, R2, R3	680K	3	1% Metal Film
R4, R5, R7	100K	3	1% Metal Film
R6	1K	1	1% Metal Film
R9, R15	470K	2	1% Metal Film
R11	150K	1	1% Metal Film
R12	91K	1	1% Metal Film
R13	196K	1	1% Metal Film
R14	22K	1	1% Metal Film
R16	39K	1	1% Metal Film
R17	56K	1	1% Metal Film
R18, R19	3K3	2	1% Metal Film
R20, R22, R26, R28, R32, R34, R38, R40	220	8	1% Metal Film
R21, R39	2K2	2	1% Metal Film
R23, R24, R29, R30, R35, R36, R41	12K1	7	1% Metal Film
R25, R31, R42, R44	22M	4	1% Metal Film
R27, R33	2K2	2	1% Metal Film
R43, R45	15K	2	1% Metal Film
R46	4K7	1	1% Metal Film
R47, R48, R49	10K	3	1% Metal Film
PTC1	1K87	1	3500ppm 1% Tempco
CV1, CV2, FREQ, RESO, FINE	100K LIN	5	SPECTROL 248
SIGNALA, SIGNALB, SIGNALC	100K LOG	3	SPECTROL 248
REJECT	100	1	25 turn cermet trimmer
TRIM	100K	1	25 turn cermet trimmer
V/OCT	20K	1	25 turn cermet trimmer
IC1	OP177GP	1	Single Op Amp
IC2	LM3900	1	OTA
T1, T2, T13, T14,T15	2N3906	5	PNP Transistor
T3, T4, T5, T6, T7, T8, T9, T10, T11,T12	2N5087	10	Matched PNP Transistors Unmatched works fine!
T16	2N3904	1	NPN Transistor
D1	1N914	1	Diode
L1, L2		2	Inductor
CV_INS, OUTPUT		2	MTA 0.1” 2-pin header
SIG_INS		1	MTA 0.1” 3-pin header
POWER		1	MTA 0.156” 4-pin header