Analog Metropolis

AM2005
Voltage
Controlled Amplifier
(SSM2010)

Project Notes
V1.0

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1 Module Description

This module is a clone of the single VCA in the Eμ Systems Analog Modular Synthesizer. It has both linear and exponential control modes.

The original Revision 1 single VCA design dates back to the autumn of 1972 when Dave and Scott were setting up their new synthesizer company in Santa Clara, and it's based around the CA3080 OTA. From October 1974 the front panel toggle switch had a centre position for simultaneous linear and exponential control.

The CA3080 VCA was a bit noisy, so around 1978 it was replaced by a SSM2010 based version, which improved the S/N ratio and reduced the audio distortion. It is this Revision 2 design that has been replicated, although it uses extremely rare SSM2010 chips!

INPUTS:	SIGNAL +, SIGNAL -, FULL SIGNAL CV1, CV2, FULL CV
OUTPUT:	AUDIO SIGNAL
POTS:	SIGNAL +, SIGNAL - CV1 LEVEL, CV2 LEVEL, GAIN
SWITCH:	MODE = EXP or LINEAR
LED:	AUDIO OUTPUT LEVEL

The front panel controls for the VCA consists of GAIN, AUDIO SIGNAL LEVELS and CV LEVELS. There is a switch that selects exponential or linear control mode and a LED that shows overall audio output level. The front panel jacks are SIGNAL1, SIGNAL2, FULL SIGNAL, CV1, CV2, FULL CV and OUTPUT.

Specifications:

Maximum signal attenuation	120dB
Control Rejection (trimmed)	50dB
Noise (10 – 10 kHz)	0.1mV RMS
Distortion	0.05%

2 The Original Circuit

The original module dates back to around 1978 and I have used the schematics from 1980. This Revision 2 has been designed to harness the first analog chips that Dave Rossum co-designed with Ron Dow in the late 1970's. The single VCA uses the SSM2010, which was the first SSM chip to use dual 15V power rails and therefore be usable in E-mu synthesizers.

The circuit has TL082 Op Amp buffers for the audio signals before and after the VCA and a TL082 for summing CV signals into the exponential control pin. A CA3046 transistor array is used to create a linear response for the exponential control pin, rather than using the separate linear control pin on the SSM2010.

3 The AM Circuit

The AM circuit is a straight copy of the original Eμ Systems VCA circuit. The audio input and summing Op Amps can be left as TL082's or upgraded to modern devices such as OP2134 for audio and LT1013 for CV processing.

I have added a simple LED driver circuit using a TL082. This LED shows the audio signal output level. You can fit a bi-colour LED and omit the signal diode D1 if you want the LED to respond to both positive and negative waveform energy. I use a blue/red bi-colour LED.

The REV01 board is the production board. There are no errors.
Some PCB's are marked as AM2001; this is the same PCB as AM2005.

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 80mm x 100mm.

The PCB is held to the front panel at 90 degrees by the use of two pot brackets manufactured by Omeg (www.omeg.co.uk). These brackets (and pots) are centred at 40mm apart. The SIGNAL+ and SIGNAL- 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?
INPUTS	Pin 1	Audio Input	Jack Socket Full Signal
	Pin 2	Audio Input	Jack Socket Signal+
	Pin 3	Audio Input	Jack Socket Signal-
CV-INS1	Pin 1	CV Input	Jack Socket CV2
	Pin 2	CV Input	Jack Socket CV1
	Pin 3	CV Input	Jack Socket Full CV
CV1	Pin 1	CV1 Level Pot	CV1 pot Pin 1
	Pin 2	CV1 Level Pot	CV1 pot Pin 2
	Pin 3	CV1 Level Pot	CV1 pot Pin 3
CV2	Pin 1	CV2 Level Pot	CV2 pot Pin 1
	Pin 2	CV2 Level Pot	CV2 pot Pin 2
	Pin 3	CV2 Level Pot	CV2 pot Pin 3
GAIN	Pin 1	Gain Pot	GAIN pot Pin 1
	Pin 2	Gain Pot	GAIN pot Pin 2
	Pin 3	Gain Pot	GAIN pot Pin 3
LED	Pin A	LED	LED Anode
	Pin C	LED	LED Cathode
OUTS	Pin 1	Audio Output	Jack Socket Output
	Pin 2	Audio Output	Firmware connection
PAD	Pin 1	Panel Earth	Jack socket earth bus

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 PCB can be used with other pots such as sliders provided they are all mounted off the PCB.

7 Switch

The switch is configured for selecting either linear or exponential mode.

Switch Name	Pin #	What is it?	Where does it go?
MODE	Top	Lin Input	SWITCH Pin 3
	Centre	CV Inputs	SWITCH Pin 1
	Bottom	Exp Input	SWITCH Pin 2

8 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 ground (PAD).

9 Front Panel

The AM2005 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.

10 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 VCA. Then proceed to trimming.

10 Trimming

This module is simple to set-up.

ETRIM This trimmer adjusts the accuracy of the exponential mode.

GTRIM This trimmer adjusts the gain of the VCA. Apply a 10V peak to peak audio signal into the VCA, and set GAIN to maximum. Trim for the same audio level at input and output.

DIST This trimmer adjusts the distortion of the SSM2010 VCA. Apply a 10V peak to peak audio signal into the VCA, and set GAIN to maximum. Trim for minimum signal output distortion observing using an oscilloscope or listening.

REJECT This trimmer adjusts the control rejection of the VCA. Apply a 10V peak to peak audio signal into the VCA and trim for minimum signal output.

11 Special Components

The AM2005 makes use of a small number of specialist components:

SSM2010
The SSM2010 chip is hard to locate, contact me for details.

ECO/Omeg Pot Brackets
These can be obtained from Omeg in the UK. http://www.omeg.co.uk/. Oakley have them again, and I have stock them too.

12 Parts Listing

Part Number	Value	Quantity	Comments
Capacitors			
C1, C2	100nF 63V	2	Multi-layer Polyester
C3, C4	22uF 25V	2	Radial Electrolytic
C5	2nF	1	Multi-layer Polyester
C6	4p7F	1	Low K Ceramic
C7	1nF	1	Multi-layer Polyester
C8	10pF	1	Low K Ceramic
C9	5nF	1	Multi-layer Polyester
C24	100pF	1	Low K Ceramic
C25, C26	10uF 25V	2	Radial Electrolytic
Resistors			All 1/4W 1% metal film
R1, R2, R4, R5, R9, R11, R13, R14, R19, R20, R23, R26	100K	11	
R3	470K	1	
R6, R8	33R	2	
R7	330K	1	
R10, R32	1K	2	
R12	270K	1	
R15, R16	22M	2	
R17, R30	22K	2	
R18, R21	3K	2	
R22, R24	47K	2	
R25	680K	1	
R31	10K	1	
R33	LEDR	1	Value to suit LED
R34, R35	22R	2	
Trimmers			
REJECT, DIST	1M	2	25 turn cermet trimmer
ETRIM	100K	1	25 turn cermet trimmer
GTRIM	200K	1	25 turn cermet trimmer
Potentiometers			
CV1, CV2, GAIN	100K LIN	3	Spectrol 248
SIGNAL+ SIGNAL-	100K LOG	2	Spectrol 248
Passives			
L1, L2		2	Inductor
Semiconductors			
IC1	SSM2010	1	VCA chip
IC2	OPA2134	1	Dual Op Amp, audio
IC3	LT1013	1	Dual Op Amp, low offset
IC4	CA3046	1	Transistor Array
IC5	TL072	1	Dual Op Amp
D1	1N914	1	Signal diode

Part Number	Value	Quantity	Comments
D3	1N4148	1	Signal diode
LED		1	LED (can be bi-colour see text)
Hardware			
OUTS, LED		2	0.1” MTA 2-Pin Header
INPUTS, CV_INS, GAIN, CV1, CV2, SWITCH		6	0.156” MTA 3-Pin Header
MODE		1	DPDT Toggle Switch