

# **Analog Metropolis**

## **AM8018 Precision Exponential Voltage Controlled Amplifier**

### **Project Notes V1.0**

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## 1 Module Description

This module is a new design based on the high quality single VCA chip from Analog Devices - the SSM2018. The chip is available as a trimless version SSM2018T, and it is this chip I have used. The module provides a high quality VCA with audio and control voltage mixing, an exponential response to CV's and a level monitoring LED. The specifications of the chip are:

- 117dB Dynamic Range
- 0.01% THD
- 140dB gain range

The VCA's used in analog synthesizers are usually linear in response as they are typically used with an ADSR with an exponential varying CV. This provides the most natural response to the ear.

The AM8018 VCA has an exponential response, so when used with an exponential ADSR it provides a double exponential response which sounds less natural to the ear, although it is still valid musically and very useful for experimental synthesis. Of course when used with linear CV's like triangle and sawtooth LFO's the response is "natural".

**INPUTS**      AUDIO SIGNALS:              SIGNALA, SIGNALB, SIGNALC  
                  CONTROL VOLTAGES:      CV1, CV2

**OUTPUTS**    AUDIO SIGNAL

**POTS**            SIGNAL A LEVEL, SIGNAL B LEVEL, SIGNAL C LEVEL  
                  GAIN, CV1 LEVEL, CV2 LEVEL

**DISPLAY**      A LED displaying output level.

## 2 The AM Circuit

The circuit follows the SSM2018T datasheet suggestion for a core VCA design, and then adds an OPA2134 dual Op Amp for audio signal mixing on the input side and output buffering. An LT1013 dual Op Amp performs CV summing duties, whilst the trusty TL072 provides the LED monitoring of the signal output

The REV02 board is the production board, with no errors or corrections.

### 3 Parts

The parts for the AM8018 are easy to find, including the essential SSM2018T VCA chip. There is an optional Tempco 1K resistor at R21. This can be the more easily obtained 3000ppm version, such as Farnell part number 1174306.

### 4 Front Panel Format

The AM8018 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.

### 5 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.

## 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.

<b>PCB Header Name</b>	<b>Pin #</b>	<b>What is it?</b>	<b>Where does it go?</b>
<b>INS</b>	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
	Pin 4	GND	Lower tap of all SIGNALs
<b>CVINS</b>	Pin 1	Full CV	Optional to Keyboard CV bus
	Pin 2	CV2 In	Centre tap of CV1
	Pin 3	CV In	Centre tap of CV2
	Pin 4	GND	Lower tap of CV1 and CV2
<b>OUTS</b>	Pin 1	Signal Output	Jack socket OUT
	Pin 2	Signal Output	Not Used
<b>PAD</b>	Pin 1	Panel Earth	Jack socket earth bus

The AM8018 has a MTA connector for multiple signal and CV inputs but there are no individual connectors for each signal level pot (as per many other AM modules). The individual pots for each signal levels need to be manually wired up as shown below:

<b>SIGNAL OR CV</b>	Pin 1	Signal A Pot	Wire to GND (Pin4)
	Pin 2	Signal A Pot	Wire to PCB
	Pin 3	Signal A Pot	Wire to Jack Socket

## 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.

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

## 8 Trimming

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

**TRIM** This trimmer adjusts the output level of the VCA and needs setting so that the output signal is the same as the input signal at the maximum GAIN pot setting. You can do this by ear or using an oscilloscope. Feed a 5V signal input one of the signal ins and keep all other pots at minimum, whilst gain (and the signal pot for the input you are using) are at maximum. Let the VCA warm up for 15 minutes before setting the trimmer.

## 9 Parts Listing

<b>Capacitors</b>			
C1, C2, C10, C11, C12, C13, C15, C16	100nF	8	Axial Ceramic
C3, C4	22uF	2	Radial Electrolytic, 5mm spacing
C5	1uF	1	Multi-layer Polyester
C6	82pF	1	Ceramic Low K
C7, C9	22pF	2	Ceramic Low K
C8, C24	100pF	2	Ceramic Low K
C14	2n2F	2	Multi-layer Polyester
C25, C26	10uF	2	Radial Electrolytic, 5mm spacing
<b>Resistors</b>			
R1, R2, R3, R6, R8, R11, R15, R16, R19, R23	100K	10	All 1/4W 1% metal resistors
R4	33K2	1	
R5, R7	18K2	2	
R9	50K	1	
R12	150K	1	
R13	332K	1	
R14	649K	1	
R17	374K	1	
R18	38K3	1	
R10, R20, R32	1K	3	
R22, R31	10K	2	
R30	22K	1	
R21	1K	1	Tempco resistor
R33	LEDR	1	Value depends on LED used
R34, R35	22R	2	
<b>Potentiometers</b>			
CV1, CV2, GAIN	100K LIN	3	Alpha 16mm
SIGNAL A, SIGNALB	100K LOG	2	Alpha 16mm
<b>Trimmers</b>			
TRIM	20K	1	Ceramic Multi-turn
<b>Semiconductors</b>			
IC1	SSM2018T	1	High Quality VCA
IC2	OPA2134	1	High Quality Op Amp
IC3	LT1013	1	Low Offset Op Amp
IC5	TL072	1	Op Amp
D1	1N4148	1	Diode
<b>Other Passives</b>			
L1, L2		2	Inductor
<b>Hardware</b>			
LED, OUTS		2	MTA 0.1" 2-pin header
INS, CVINS		2	MTA 0.1" 4-pin header
POWER		1	MTA 0.156" 4-pin header

