PARTS LIST * AR-314 * VOLTAGE CONTROLLED LOWPASS FILTER

PART NUMBERS	QUANTITY	DESCRIPTION	VOLTAGE AND RATINGS
C1,2	2	Capacitor,Disc	0.01 mfd
C3	1	" "	0.001 mfd
C4	1	" "	33 pf
C5,7	2	Capacitor,Mica	330 pf
C6,8	2	Capacitor,Disc	150 pf
Q4,5	2	N-Channel FET	Siliconix E-212
R1,38	2	Potentiometer	100K,linear
R2	1	Resistor	150K, 10%
R3,8,39,40,41	5	Resistor	100K, 5%
R4	1	"	33K,5%
R5,6,20	3	Trimpot	50K,linear
R7	1	Resistor	470K,5%
R9	1	"	1 meg,5%
R14	1	"	330K,5%
R11	1	"	10 ohm,10%
R12,21,25	3	"	4.7K, 10%
R13	1	Trimpot	10K,linear
R15,18,19,22,29,34,35,36	8	Resistor	100K, 10%
R16,17	2	"	100 ohm,10%
R23	1	"	12K, 10%
R24,27	2	"	39 ohm,10%
R26	1	"	15K, 10%
R28	1	Potentiometer	1 meg log
R30,31,32,33	4	Resistor	1K,10%
R37	1	Potentiometer	100K, log
U1,3,5	3	OperationalAmplifier	LM301A
U2,4	2	Operational Transconductance Amp	CA3080
	1	Printed Circuit Board	
	1	Front Panel	
	1	Frame	
	4	Knobs	
	12	Jack,Mini-phone	
	1	Bracket,large	
	1	Bracket,small	
	6	Screw,4-40x3/16"	
	6	Nut,4-40	
	2	PC Card Guides	

ARIES System 300 Music Synthesizer
Module AR 314
Voltage Control Filter Assembly Instructions

The previous pages were written as a general guide, to familiarize the builder with the components. Here, now, are the specific assembly instructions for building your
It is recommended that you do the following before you proceed:

Find a place where you can work through completion, without disturbing your set-up.
Use adequate lighting.
Wash your hands before starting. This removes contaminating oils and perspiration and makes assembly more comfortable.
As you proceed, check off each step with a pencil.

( ) 1. Preparation
Lay the circuit board down on a sheet of white paper. PLACE METAL SIDE DOWN! Turn boaed so that connector strip is to the left.

Lay the assembly drawing down near the boaed.

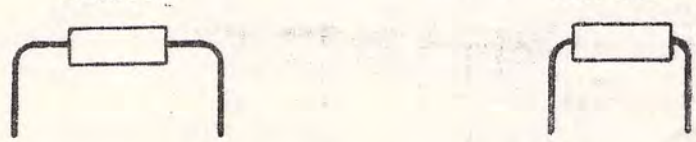
Unpack the parts carefully and place in a large box or tray <u>so they won't get lost</u>.

Have the following tools nearby:
- Pencil tip soldering iron, hot and tinned (solder coated)
- Solder--Use only thin rosin core solder!
- Small diagonal wire cutters
- Small wire strippers
- Small long-nose pliers
- Regular pliers
- Flat blade screw driver

( ) 2. Jumpers
Find jumper J1 on the drawing. Measure J1 on the PCboard. Cut a piece of insulated wire one inch longer than J1 measures on the PC board. Strip 1/2 inch of insulation from each end being careful not to damage the wire itself. Bend the bare ends to a right angle and insert into the holes on the boaed, according to the drawing. While holding the ends down against the board to hold the wire in place. Solder and cut off the excess. (Refer to the introduction on parts installation.) Install all 3 jumpers in the same manner.

( ) 3. Resistors
Carefully install all 37 resistors on the circuit board. R13 is a 10Ktrim pot R5,6, and 20 are 50K trim pots. R 1,28,37,and 38 are potentiometers and will later be mounted on the panel.
To avoid breaking the resistors leads, bend the leads at least 1/16 of an inch away from the body of the resistor.
For example:

Correct Incorrect



( ) 4. Capacitors
Install all 6 capacitors on the board. (C3 through C8)

( ) 5. Transistors
Install both transistors on the board. (Q4 and Q5)

( ) 6. Integrated Circuit Amplifiers
Install all five Integrated Circuit Amplifiers on the board.
U2and 4 are CA3080. U1,3,and 5 are LM301.

ALL BOARD COMPONENTS ARE NOW MOUNTED.

MODULE ASSEMBLY-- Please refer to Module Assembly Drawing

( ) 1. Unpack the frame, bag of hardware, and front panel.

( ) 2. Snap the two plastic card guides into the holes in the frame. Be sure that the pairs of tabs in the guides which hold the board point toward the rear of the frame. (The bottom one is shown installed in the drawing.)

( ) 3. Slide the circuit board into the frame, holding the top and bottom of the frame together against the board so that the board fits snugly in the card guides. Be sure that the pairs of plastic tabs pinch the edge of the circuit board properly.

( ) 4. Using 4-40X3/8" screws and nuts, mount the two angle brackets to the frame as shown in the drawing. The brackets should be entirely on the component side of the board.

( ) 5. Now screw the board to the brackets. Insert the 4-40 X 3/8" screw from the foil side of the board. DOUBLE CHECK THAT THE HEAD OF THE SCREW DOES NOT TOUCH ANY FOIL!!!

( ) 6. Unpack the front panel carefully. Avoid scratching its surface. AT THIS POINT you may if you wish skip steps 7-8 and proceed through the first few steps in the panel wiring (those in which wiring is done between components on the panel, but not to the board) before finishing the module assembly.

( ) 7. Mount the top of the panel to the top of the module frame using the top two potentiometers as follows: If there are tabs sticking up parallel to the shaft on the pots, bend 90 degrees inward out of the way. Put the locking washer on the pots. Insert the pot shafts through the matching 3/8" holes in the frame and the top of the panel. Put on the nuts and tighten them very snugly, but avoid scratching the panel.

( ) 8. Attach the bottom of the panel to the frame using the remaining 4-40 screws and nuts.

( ) 9. Install the other pots onto the panel.

( ) 10. Install all 12 mini-phone jacks as shown in the panel drawing.

( ) 11. Turn all pot shafts fully counterclockwise and mount the knobs pointing to the leftmost number. Tighten knob screws.

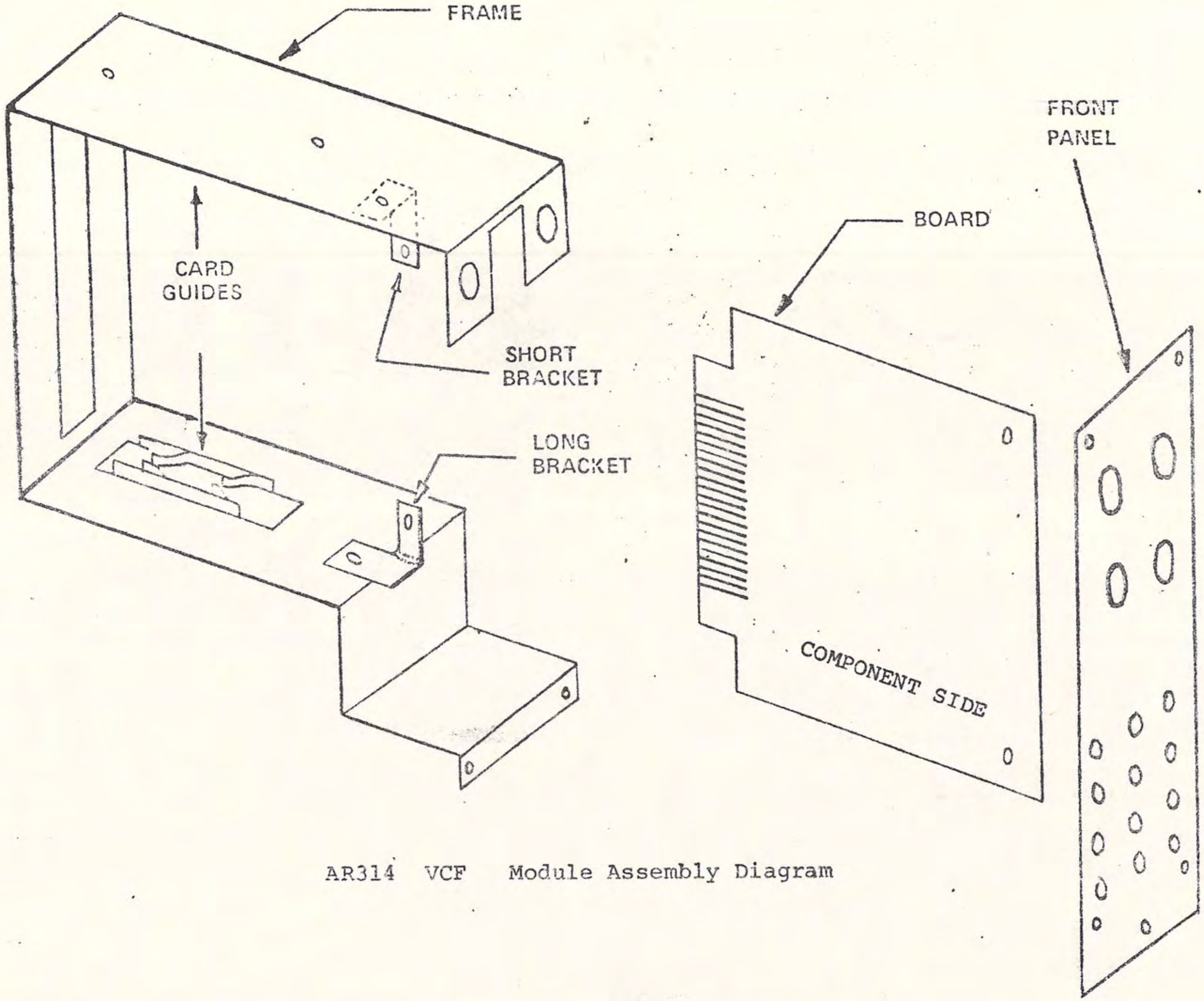
PANEL WIRING--Refer to panel wiring diagram and board assembly drawing.

( ) 1. Run a wire connecting the grounds of all 12 mini-jacks, as shown, and from there to the point on the board labelled M on the assembly drawing. Note the shunt grounds on the 4 audio input jacks.

( ) 2. Run a wire connecting pins 1,2,and 3 of each pot on the panel to the appropriate point on the board as labelled on the assembly drawing. Wire one pot at a time to avoid confusion.

( ) 3. Wire all jacks with arrows and a letter designation to the appropriate point on the board as labelled on the assembly drawing.

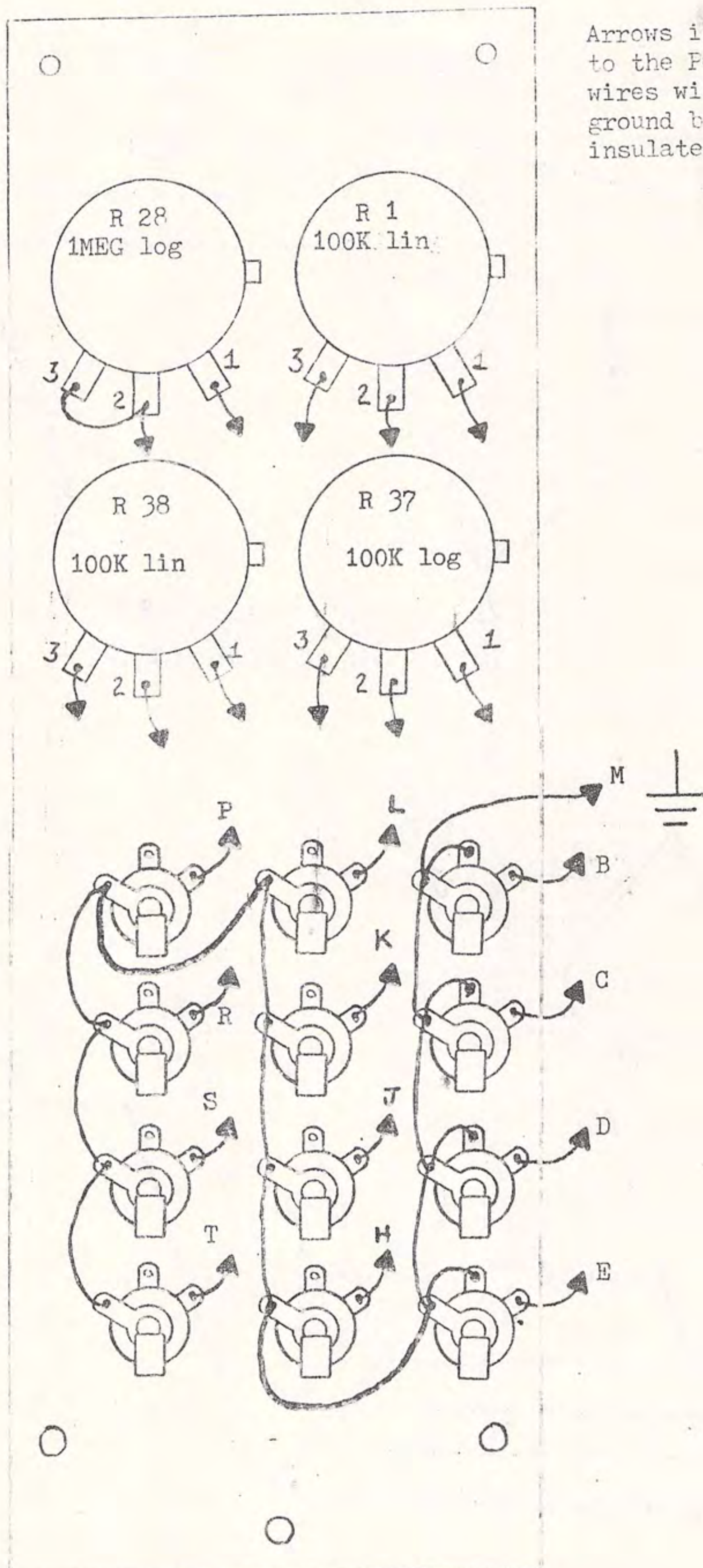
THIS COMPLETES ASSEMBLY OF YOUR AR 314 VOLTAGE CONTROLLED FILTER.



AR314 VCF Module Assembly Diagram

AR 314 VOLTAGE CONTROL FILTER PANEL WIRING DIAGRAM--rear view

Arrows indicate a wire to the PCboard. All wires with arrows and ground bus must be insulated.



AR-314 V C F TRIM PROCEDURE

RECOMMENDED EQUIPMENT: Audio Sine Wave Generator, or AR-317 VCO, DC and AC voltmeter. OPTIONAL: Square Wave Generator, Oscilloscope

( ) 1. Turn all 4 trimpots to center position.
( ) 2. Connect a D C voltmeter or scope to one of the outputs.
( ) 3. Set FREQ dial to 1 KHz, and RESONANCE at Min.
( ) 4. Turn on power, and adjust trimpot R20 for zero volts D C at output (within + or - 0.5 v).
( ) 5. Set the RESONANCE control to approximately 2/3 of its maximum, and FREQ to 16 Hz. Connect VCF output to an AC voltmeter or scope. Feed a sine wave of 16 Hz, and about 1 volt RMS, into the variable signal input (#1) of the VCF. Adjust trimpot R6 (Frequency trim) for the maximum amplitude response at the output. Keep the input level low enough to be able to observe a smooth variation of the output as the trim is adjusted, so that the VCF amplifier stages do not clip the waveform at the maximum response. Check the setting by varying the input frequency around 16 Hz and observing the peak response.
( ) 6. Change input frequency to 16 KHz. Adjust R5 (1 volt per octave trim) for maximum output amplitude. Again, keep the input level low enough to avoid distortion. Vary input frequency to verify accurate setting.
( ) 7. Repeat steps 5 and 6 once, as they interact slightly.
( ) 8. Remove the input. Set the RESONANCE control to minimun, and the FREQ control to 256 Hz. Connect the output to a DC voltmeter or scope. Adjust offset trimpot R20 for zero volts DC, within + or - 0.1 volt.

OPTIONAL SYMMETRY TRIM

FIRST TRIM ACCORDING TO PREVIOUS STEPS 1 through 8.

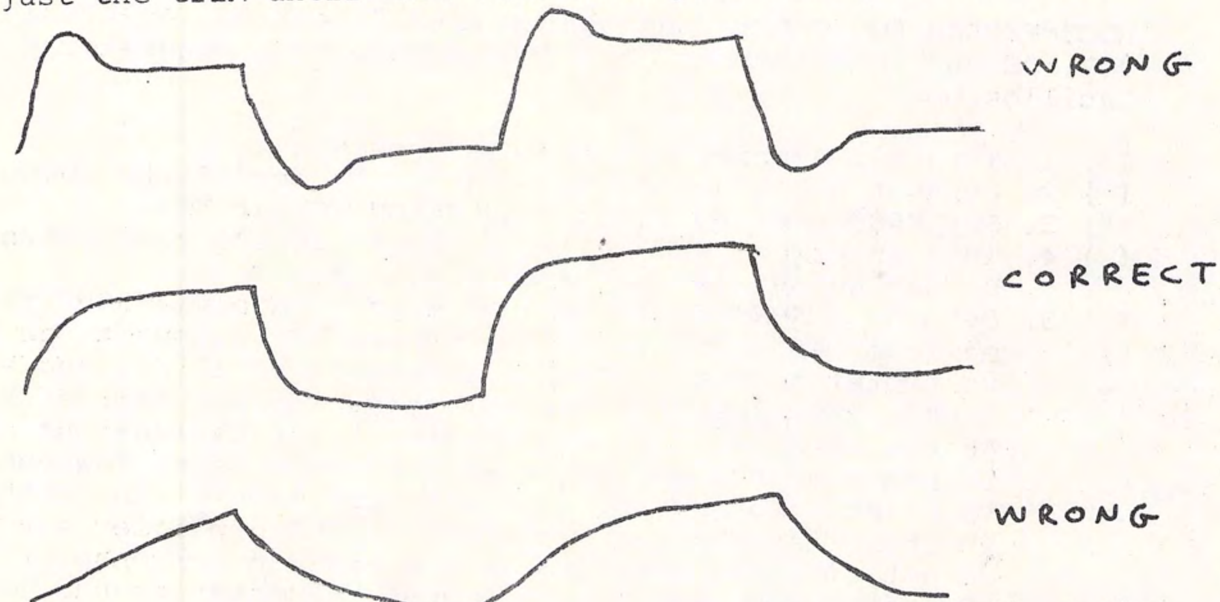
METHOD A:

( ) 1. Set FREQ. control to maximum, and RESONANCE to minimum.
( ) 2. Connect a DC voltmeter between R21 and R25, using the ends away from the CA3080 amplifiers.
( ) 3. Adjust symmetry trimpot R13 for zero volts DC, within + or - 0.1 volt.

METHOD B : (more accurate)

( ) 1. Set FREQ control tp 1 KHz, and RESONANCE to minimum.
( ) 2. Feed in a square wave, of approximately 200 Hz, and less than 10 v peak to peak, to the VCF variable signal output.
( ) 3. Observe output on an oscilloscope. Adjust symmetry trimpot R13 over its full range. Notice that at one end, the square wave "overshoots", that is, it momentarily exceeds its final value. (See next page for illustration.)

Adjust the trim until this overshoot just barely disappears:



IMPORTANT: If you perform any symmetry trimming, re-adjust the FREQUENCY trim at 16 Hz, per step 5 of the previous procedure.

THEORY OF OPERATION...AR 314 VCF

The basic VCF circuit involves two feedback loops, two integrators, and two variable gain circuits. It is known as a state-variable filter. To help understand its operation, consider the block diagram. Part numbers refer to schematic diagram.

The two gain blocks are set by the exponential generator to have equal, but variable gains. So, an input signal will be fed to the first integrator, through the second gain block, and will appear out of the second integrator. The signal will be integrated twice. Thus, the overall gain at D.C. will be enormous, and would cause saturation, except for the low frequency feedback path. This causes the output to reach the same D.C. level as the input. Then, the two inputs cancel, resulting in no output from the gain block, and the system is stable.

Thus, the filter always unity gain at D.C. At very high frequencies, the gain of the integrators becomes very low (an integrator has a frequency response that falls off at 6 db. per octave, and always has a phase lag of 90 degrees).

So, very high frequencies will be attenuated by 12 db. per octave total, and shifted a total of 180 degrees.

Now, the frequency where attenuation starts depends on the gain of the gain blocks. If their gain is raised, then it takes a higher frequency to reduce the total forward gain, since the integrators must see a higher FREQUENCY to attenuate the signal by as much as the gain blocks have increased it.

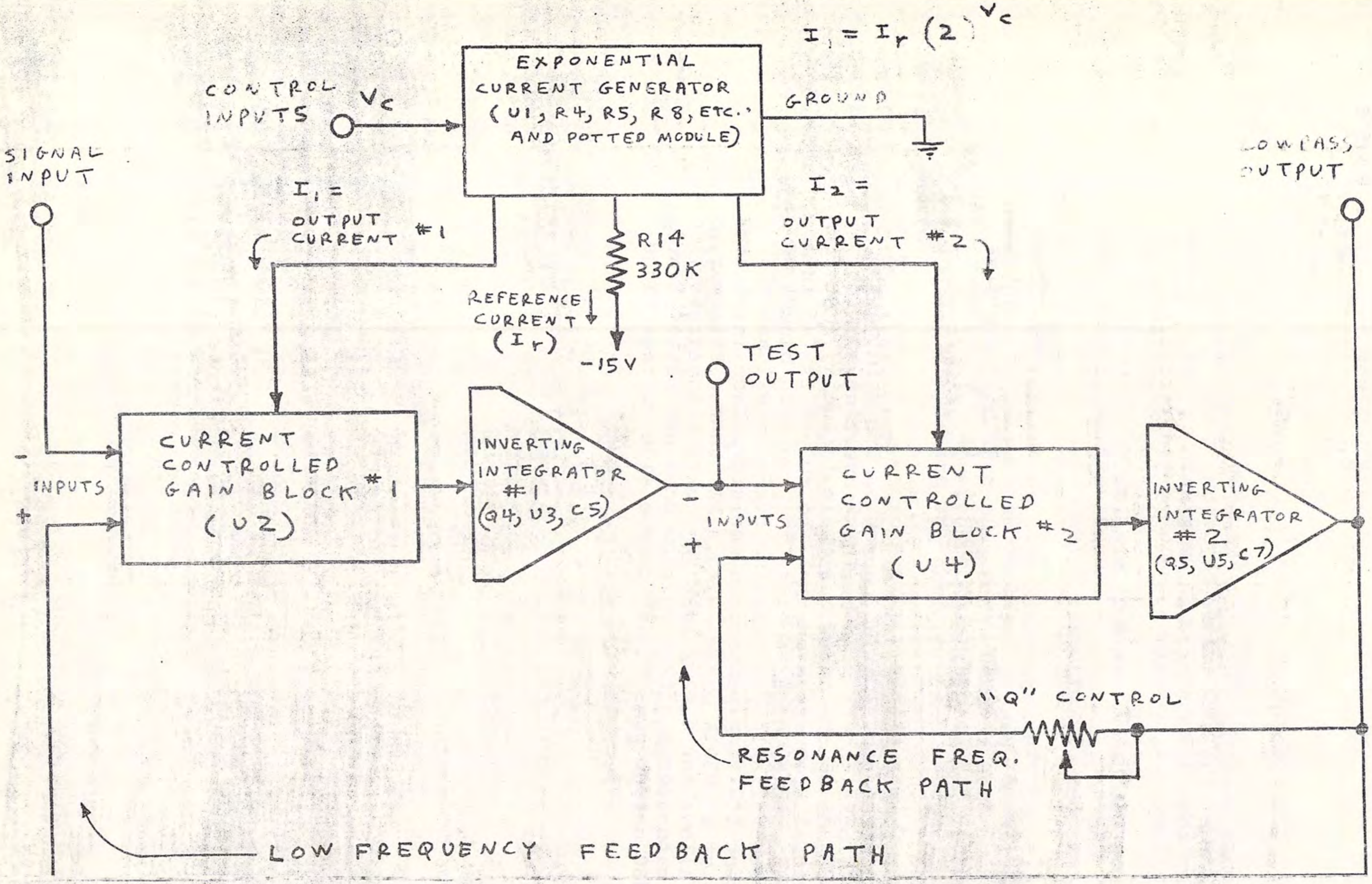
Ther is one frequency where the forward gain equals unity. Now, since the integrators always provide a 180 degree phase shift, there will be positive feedback at the input equal to the output signal. At this frequency, the system would be unstable and oscillate, except for the "resonant frequency" feedback path. This provides negative feedback with a phase lag of 90 degrees. The total filter gain at the response frequency depends on the "Q" control setting. (Q is equal to the gain at this frequency).

The response is,therefore,unity gain at D.C. and starts to roll off at the resonance frequency.If the "Q" is set higher than 0.7,there will be a peak in the response before falling off at higher frequencies.

The test output has a response similar to a bandpass filter if the "Q" is high.At low "Q" values,it acts more like a 6 db. per octave lowpass response.

Actually,if the resonance feedback were around the first integrator,the lowpass filter response would be identical but the test output point would be a true bandpass responce.However,this was sacrificed because the present configuration provides much less out put offset.

Now for some details:
The exponential generator,which varies the gain of the two gain blocks,starts with U1.This inverting,summing amplifier adds up the control signals,including that from the "I nitial Frequency" control.The output is fed into the potted module,which supplies the two gain blocks,U2 and U4,with variable but tracking currents.R21 and R25 are current limiting protection resistors.Each integrator consists of a LM301A op-amp with a FET source follower. The FET allows for a very low bias current integrator, and its gate-source offset voltage does not matter,since the CA3080 output can "float" over a wide voltage range.



ARIES AR-314 VCF BLOCK DIAGRAM

Notes on the Exponential Current Generator

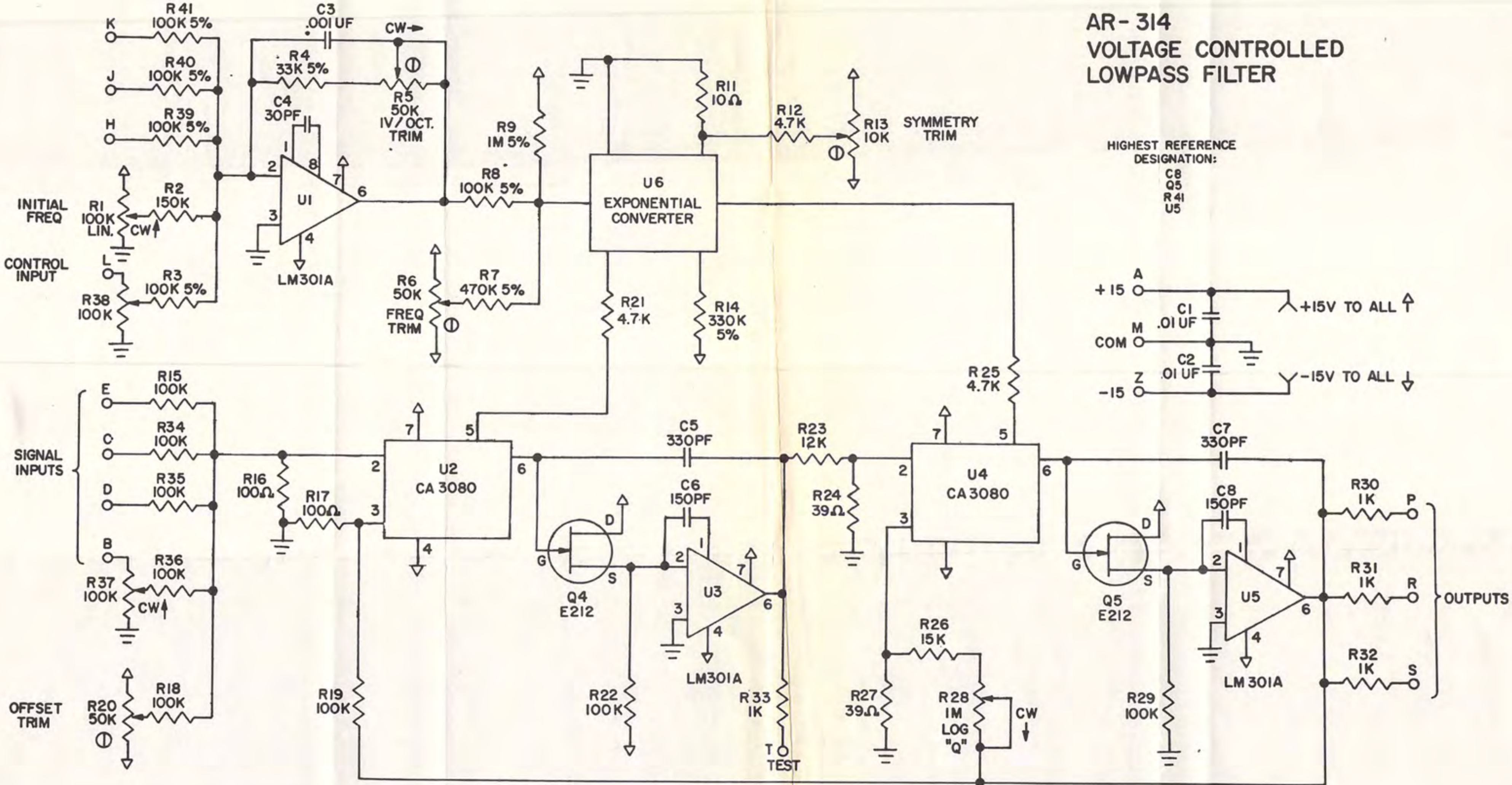
This is the potted module mounted on the board. It is encapsulated to insure freedom from drift due to temperature changes.
Six connections are necessary:

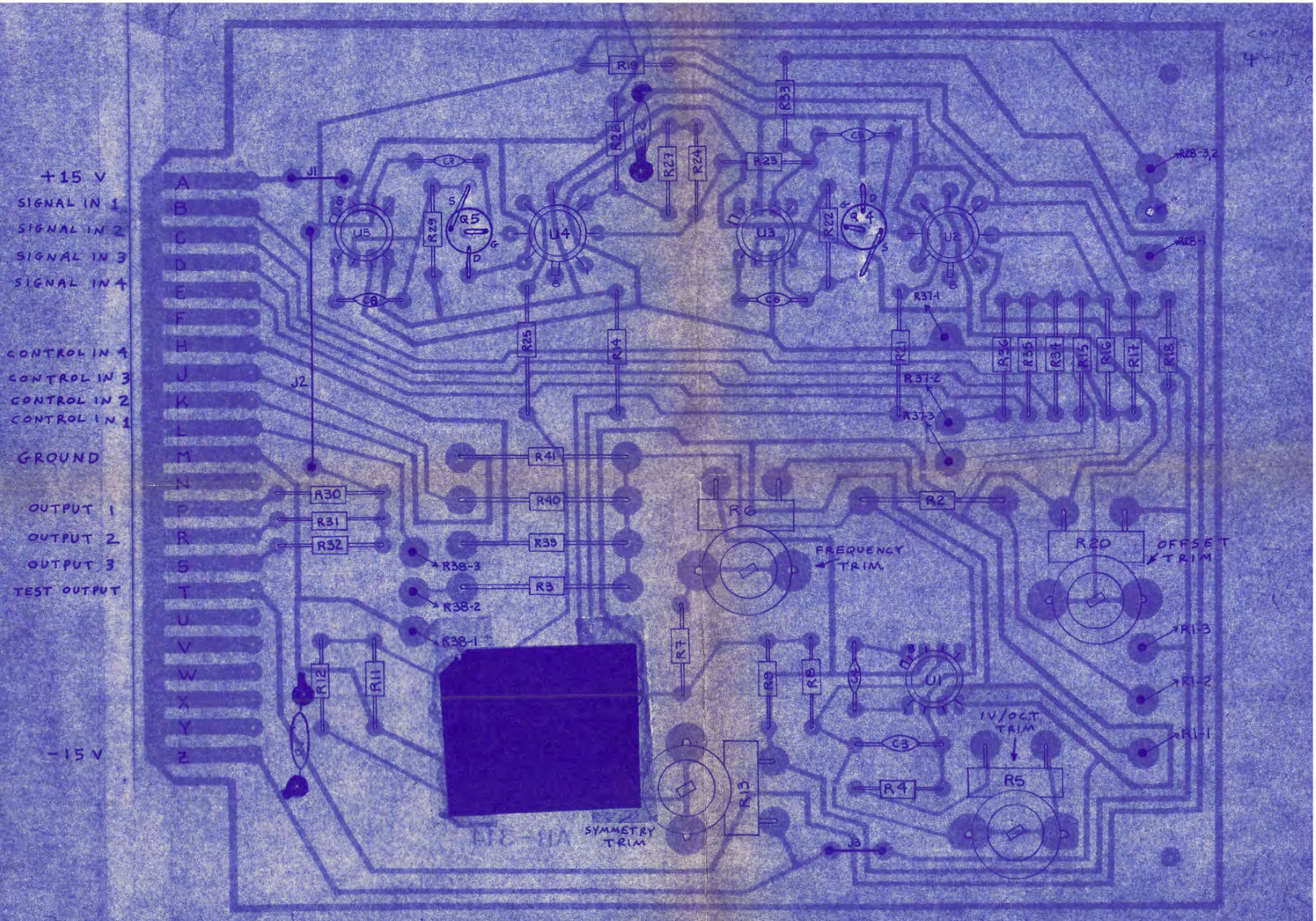
1. Ground
2. Control voltage summing input. Scale factor = -6 microamps per octave. When connected in series with 160k, scale factor= 1 volt per octave.
3. Reference current terminal. Needs negative current source, for example 330K resistor to -15 v supply. Typical reference current= 40 microamps.
4. Output Current #1.
5. Output Current #2.
6. Output Current #2 trim. If desired, this terminal is connected to a 10 ohm resistor to ground, and through a resistor of around 4.7K to a 10 K trimpot, which supplies -15v to +15v. This trims output #2 over the range from 1/3 to 3 times output #1.

When trimmed for 1 volt per octave, the relationship is:

$$\text{OUTPUT CURRENT \#1} = \text{REFERENCE CURRENT} \times (2)^{-\text{CONTROL VOLTAGE}}$$

AR-314
VOLTAGE CONTROLLED LOWPASS FILTER





AR-314 VCF COMPONENT LAYOUT

3 JUMPERS

3-29-75