

### I. Introduction

Thanks for your purchase of our Mark 4 Driver Upgrade PC Board. It has been designed to replace the original Dynaco input driver card (Dyna PC-4) with an improved all triode design that will drop into the original PC-4 position without any electrical or mechanical changes to your Mark 4. Once installed, your Mark 4 will be greatly improved both audibly and in traditional THD & IMD measurements (factor of 10 improvement). Given the conservative nature of the design, its stability will allow the user to directly substitute alternate 9 pin miniature triodes having only the same pin-out and filament voltage. Finally, the low distortion and noise performance permit the end user to operate the amplifier without the original negative feedback if desired.

This document describes the specific instructions and steps associated with our Dynaco Upgrade board (PC-4U). Additional documents referenced (and available from our web page [www.curcioaudio.com](http://www.curcioaudio.com) - go to the tech support section) are :

- a. General Overview Assembly Notes (CAE Tech Note # 1)
- b. Soldering Tutorial (CAE Tech Note # 2)
- c. Recommended Tools & Test Instruments (CAE Tech Note # 3)

Please take the time to familiarize yourself with all of these documents in particular Tech Note # 1.

### II. General Overview

Take time to review all of the documentation provided including the aforementioned tech notes related to soldering technique and proper tools and test equipment. In the following sections we will guide you through several project phases. Each section has been carefully prepared with our own notes and comments from our customers to be sure that any anticipated question has been considered. The sequence is identical to that which we follow when we complete the fabrication for our customers. Please follow the same sequence to maximize efficiency and eliminate errors. It is also very helpful to read each section before beginning to gain a visual idea of the construction.

Your project will be built in stages. If you have purchased the PC Board in its unassembled form (PWB-PC-4U) you will first assemble the components onto that board. Next, you will remove the original Dynaco PC-4 board and its associated wires. You will then install the CAE replacement upgrade PC Board. It will be necessary to install new wires to connect all but two of the original terminals. This is easy and will improve the reliability of your amplifier. You will then perform a few electrical tests and power up sequence.

Finally you will adjust the operating parameters of the amplifier. If you ordered the AC Balance and / or DC Balance options, in addition to the original Dynaco Output tubes adjustment you will be instructed to adjust the DC Balance of the output tubes and AC Balance of the driver stage.

**Please note that this module houses components having lethal voltages present on their leads and cases. Please take the appropriate care in both installing and operating this module.**

Although you are unlikely to encounter any problems, should they occur they would almost certainly be based on an improper assembly of the PC Board or the wiring to the Mark 4. Therefore to avoid the time consuming and frustrating task of troubleshooting afterwards please remember these simple suggestions:

- a. **Proper soldering is crucial.** Please refer to our soldering tutorial and practice on surplus boards until you master the technique. Be especially careful to avoid solder bridges or “cold” solder joints. Our experience shows that nearly **95% of all problems are associated with soldering related errors.** We strongly recommend the use of a temperature controlled soldering station along with a “Solder Sucker” and Solder-Wick braid. Download our Solder Tutorial Tech note at our webpage ([www.curcioaudio.com](http://www.curcioaudio.com)) Technical Support section for suggested suppliers.
- b. Diodes, transistors, IC’s, (all semiconductors) and many capacitors (always electrolytic types) are polar - this means that **there is a right and wrong way to insert polarized components in the board.** If placed backwards, the component and probably others nearby will be damaged upon initial power application. Double check each step associated with these parts and once again later after you have had a chance to take a break.
- c. Some components are color coded with their value (mostly resistors, but there may be others). If you are not proficient at reading these codes, use an ohmmeter to double check the value of each resistor before insertion. It is very easy to confuse a 100 ohm metal film resistor with a 1000 ohm resistor or worse with a 100K ohm resistor.

### III. Internal Wiring

Unless otherwise specified, **you should use 20 to 22 gauge stranded wire with Teflon insulation.** Thicker wire, solid wire, or PVC insulation will cause problems - if not now (too much strain on the boards or parts) or later (reliability issues). We can’t overemphasize this issue.

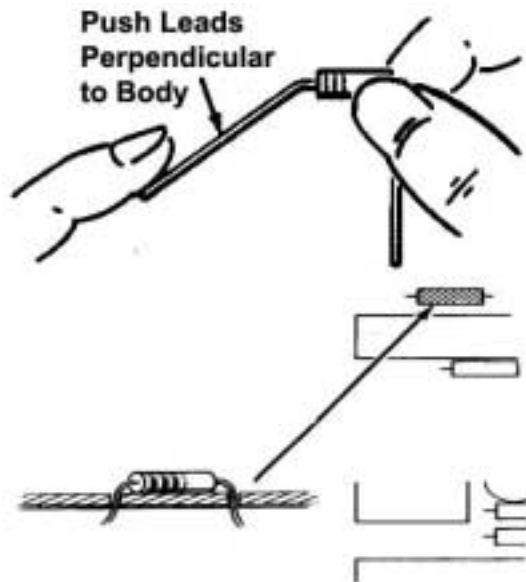
### III. Assembly

#### A. Building the PC Board (PC-4U)

Components are to be inserted on the non foil side and soldered on the foil side. The sequence of assembly has been chosen so that the components with the lowest profile (such as jumpers, low power resistors, IC's etc.) are installed first with higher profile components added until the highest profile components are installed last.

Refer to the component placement drawing (Figure 1). Be sure to observe correct orientation of polar components (capacitors). Be sure also to check with an ohmmeter resistor values if you are not absolutely sure of how to read metal film resistor color codes.

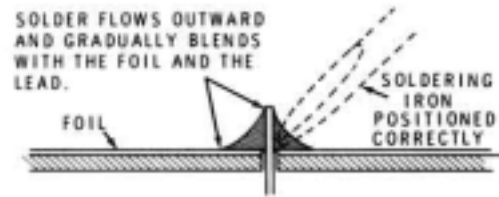
1. Begin by installing all of the ½ Watt resistors. There are a total of 10 ½ Watt resistors specified (plus 1 more for the DC BAL option). Refer to Figure 1 (Top View PC Board Component Placement Diagram). The board has been designed so that a gentle radius near the body of the resistor will position the leads in alignment with the associated holes in the PC Board. Note that the ½ Watt resistors should be inserted so that the body of the resistor rests gently against the PC Board. After inserting the resistor leads thru the board, a slight bending outward of the leads will hold the part in place until you can solder it in place.



2. If you have purchased the DC BAL option, install the small square (P2) potentiometer near the short edge of the PC Board.
3. Install the Four (4) 3 Watt metal Oxide resistors. You should also gently bend the leads of these resistors similar to the ½ Watt resistors (but of course with a greater radius). But unlike the ½ Watt resistors, the 3 Watt Resistors should be spaced away from the plane of the PC Board by 1/16" to allow for heat dissipation.
4. Install the two (2) nine pin miniature tube sockets. Be careful to insure that the leads fully extend thru the PC Board and that you have sufficient tab length to obtain a solid solder connection.
5. Install the silver mica capacitor (C4). This is a small (3/8" by 3/16") device with both leads attached to one side. C5 is not used.
6. Install the 3 film capacitors (C1, C2, & C3).

6. If you have not purchased the AC BAL option you must replace the AC BAL pot (P1) with a wire jumper. Notice that the hole pattern for P1 is a triangle – install a jumper into the two holes that form the longer edge of the triangle (parallel to the long edge of the pc board). If you have purchased the AC BAL option, install the large horizontal triangular potentiometer (P1) near capacitor C3.

7. Visually inspect all of your solder connections. Refer to the adjacent diagram. Quality solder connections should be smooth and shiny. Dull surface or large blobs on the PC board should be cleaned and resoldered. In this case remove the old solder with solder wick or similar and resolder the connection.



8. Install the 2 Tubes.

### B. Removing the Original Dynaco Mark 4 PC-4 Board

OK – that was pretty easy.

1. To begin removing the original Dynaco PC-4 board, remove the top cover (should be held in place with either 4 or six screws - depending upon the vintage) along the side. These screws will release both the top perforated metal cage and the bottom “U” cover.
2. Remove the 2 output tubes (and label them for reinstallation later) and the rectifier tube. I recommend that you clean the dust and grime from the topside both inside and outside of the amplifier. A vacuum cleaner with a soft paintbrush will work very well here.
3. Next begin desoldering wires numbered 4 & 5 (the filament connections) from the original PC-4 card. The original Dynaco wires were solid PVC insulated. The PVC is not very tolerant of heat and therefore you should be very careful not to melt the insulation. Normally a “wetted” soldering iron tip will have better thermal transfer causing the solder to melt quickly before the heat travels up the lead of the wire compromising the PVC insulation. Also, when you remove the wire from the PC Board, it is not uncommon for the wire to “snap” at the other end. I suggest having some replacement wire available. You can use solid PVC wire as in the original however if possible, I strongly recommend using 22 ga. stranded Teflon Insulated wire in this application. Please do not use anything larger – it is not necessary and it will compromise the reliability of your amplifier

as you attempt to make reliable connections on terminals unable to withstand the strain.

4. Desolder the two 1K ohm resistors connected to PC-4 terminals 9 & 10. These will be removed and reinstalled on the output tube sockets later. For now, just let them remain connected to the tube pins.
5. All of the remaining wires connected to the original Dynaco PC-4 will be replaced and therefore you should disconnect the remainder of the wires at the end opposite of the PC-4 printed circuit board. For example, the wire connected to PC terminal # 7 is connected to pin 4 of the upper output tube. Disconnect that wire at the end connected to pin 7 of the output tube. Do likewise for all of the remaining wires.
6. After you have desoldered all of the wires as described, remove the original Dynaco driver board (PC-4) removing the four (4) 4-40 nuts from the bottom of the board. The board should fall loose.

### C . Installation of the New CAE Mark 3 Driver Board (CAE-PC-4U)

1. Locate the CAE replacement Driver board (PC-4U) and orient it so that the single film capacitor C1 is nearest the side of the amplifier with the Input Connector. The board should be mounted so that the top surface of the PC Board rests inside the Dynaco Mark 4 chassis cutout (as per the original). Be careful not to capture any wires and secure the board in place with the original 4, 4-40 screws/nuts.
2. Refer to Figure 2 You will begin by installing new wires as described in Figure 2. I suggest that you install the wires in the same sequence as the terminal numbers however, save terminal 4 & 5 (the only original wires) for last. You should cut each wire to the length suggested and then strip and solder tin each end. Be careful when you make your connections to the pc board that you are making a solid connection to the wire (and not piling solder around the insulation).
3. The 11” wires connected to terminals 6 & 8 can be lightly twisted together and routed as indicated in Figure 2 towards the Quad Electrolytic capacitor (the 1.25” Aluminum Cylinder located between the two transformers).
4. Also the other two 11” wires connected to terminals 1&3 can also be slightly twisted together and routed along the outer edge of the amplifier towards their final connection point – the output transformer speaker terminals.

5. On each of the two output tubes, there is a 1K ohm / ½ watt resistor connected to pin 5. For each tube, remove the resistor and reconnect it to the tube pin terminal 5 & 6 as shown in figure 2. Although one end of this resistor was originally connected to pin 5, and you will be reconnecting one end again to pin 5, it is suggested that you completely remove the resistor, dress the leads, and re-install it as shown in Figure 2. This will insure that the solder connections are fresh and that it is position so that its leads will not come in contact with the remaining tube pins. Make sure you do this for both of the output tubes.
6. Once you have installed the new wires and made the connections as shown in Figure 2, you can make the final two connections to terminals 4 & 5.
7. Once completed, inspect each connection again and carefully look for signs of melted insulation near adjacent wires.

### Optional DC Balance Circuitry

The original Dynaco Mark 4 used one bias potentiometer to adjust a pair of output tubes (one bias pot for the two tubes in each channel). To measure the bias current flowing in the pair of output tubes, Dynaco had placed a single 13.5 ohm resistor in the current path for both tubes (from pins 1&8 to ground). Our DC BALance option includes an additional potentiometer to allow you to balance the currents in each output tube individually. Once adjusted, you can still use the original Bias Pot to set the overall bias in the pair but still be assured that they are both equal. In order to allow you to initially set the BALance between the pair of output tubes, you will need to remove the original single 13.5 ohm resistor and replace it with a pair of resistors – one for each output tube. In this way you can measure the voltage across each resistor and therefore the current thru each output tube individually. Here are the steps:

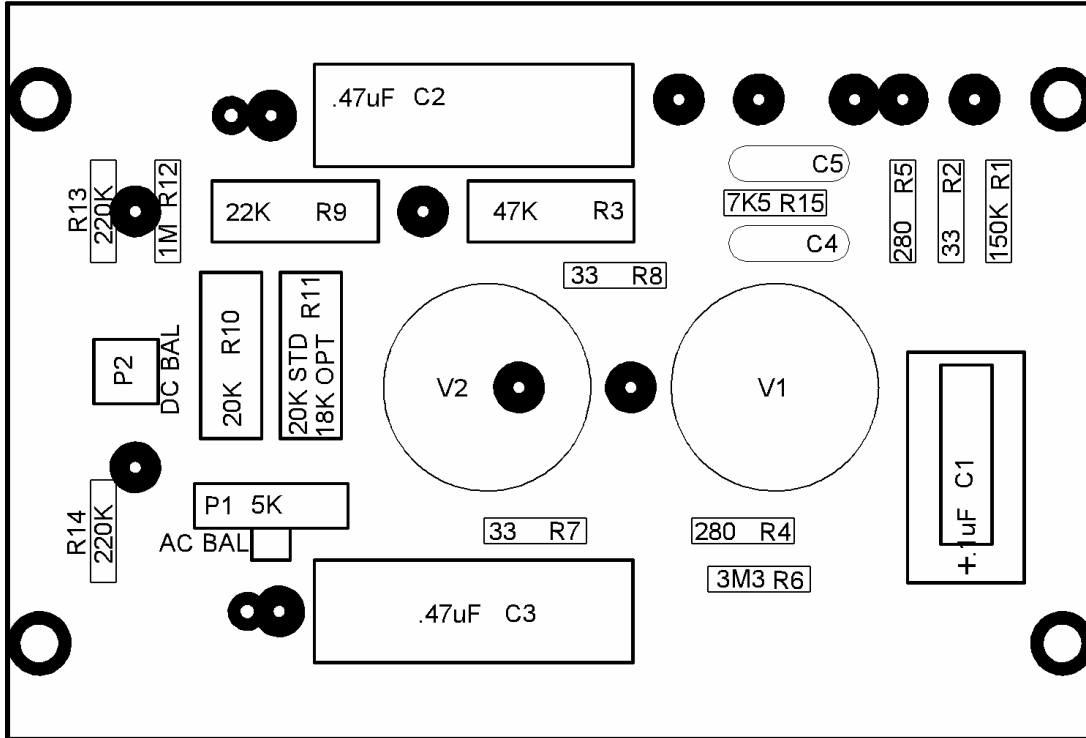
1. Remove the original 13.5 ohm bias adjust resistor located near the output tube. Each output tube has a short jumper connecting pin “1” to pin “8” – leave this jumper in place on both output tubes. There is also a wire connecting pins 1&8 from one tube to the other tube – you should remove this wire. Connect a 10 ohm 3 Watt resistor from each output tube pins 1&8 to the chassis. A convenient chassis point is the ground lug found at the base of each tube socket.
2. Dynaco conveniently routed a wire from the original 13.5 ohm resistor to pin 8 of the octal socket mounted on the front of the amplifier. You will now need to add an additional wire to another unused pin – I suggest pin 7. This will permit both output tube cathode voltages to be present at the octal socket. You should also label pin 7 with a permanent marker on the outside of the chassis to remind you that this is now a bias measuring point.

### D . Final Checkout & Initial Power Application

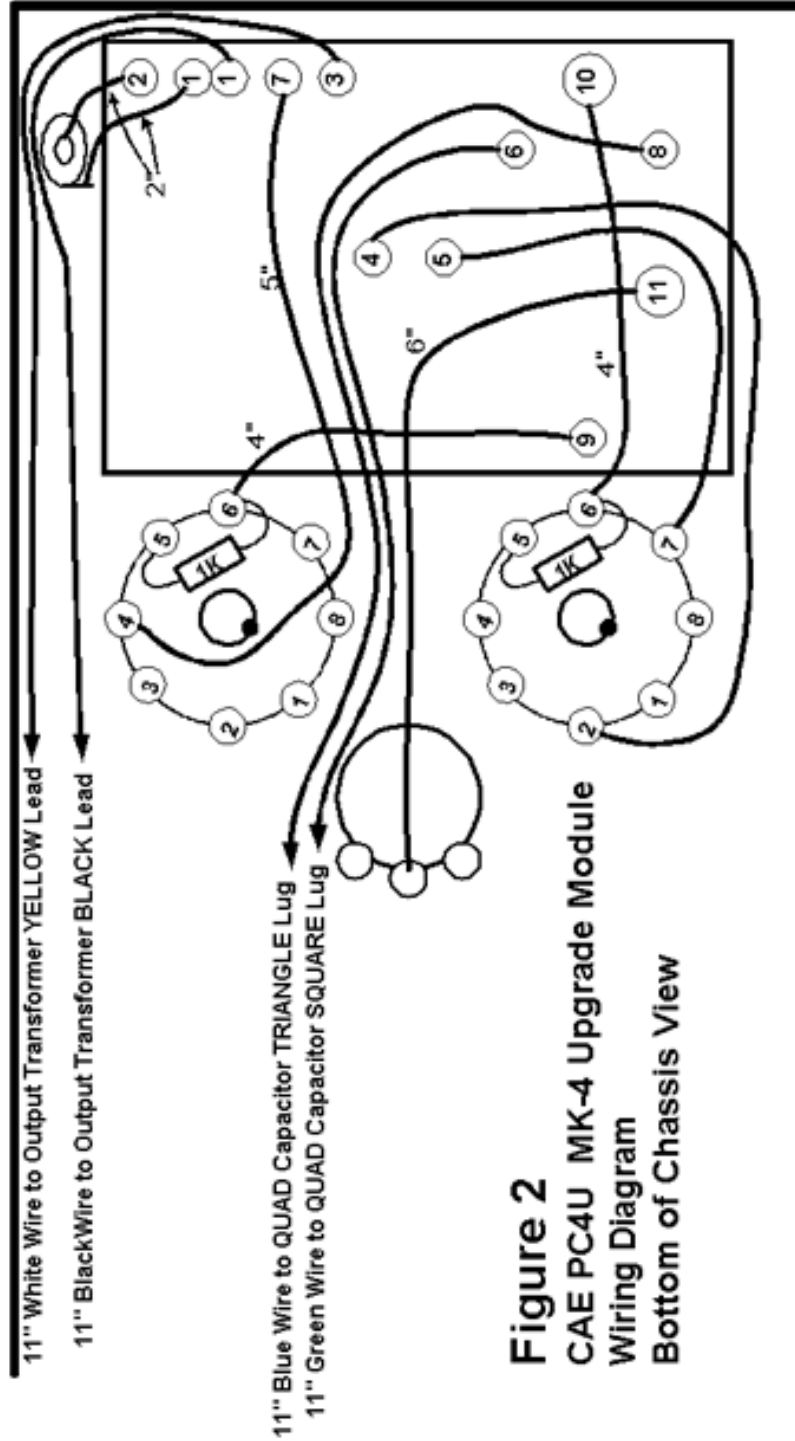
1. Replace the power fuse (3A Slo-Blo) with a 1A AGC (quick trip).
2. If you haven't already, remove the rectifier tube. Plug in and turn on the amplifier. Examine the filaments on the new replacement driver board. Both should be illuminated. Remove power from the amplifier.
3. Remove the two driver tubes (small tubes on the new driver board, PC-1U) and insert the rectifier tube and the two output tubes. Replace the original 2A fuse. Rotate the Bias Potentiometer fully counterclockwise. Connect your DC Voltmeter to monitor the current thru the output tubes by measuring the voltage across the 13.5 ohm (or one of the 10 ohm 3W resistors if you have the DC BALance option) resistor located at pins 1 & 8 of the output tubes - connect the negative lead (Black) to the chassis and connect the Positive lead (Red) to the junction of the 13.5 ohm resistor (or one of the 10 ohm 3W resistors if you have the DC BALance option) and the Output Tube pins 1 & 8.
4. Apply power. Monitor the voltage as the tubes reach operating temperature. If the voltage begins to exceed 2.5 volts quickly remove power. Otherwise adjust the Bias pot to obtain 15.6 volts. If you have the DC BALance option, you should adjust for 0.5 volts at one cathode. Then check the other cathode – it should be near or at 0.5 volts as well. Adjust the DC BALance potentiometer (it is located on the short edge of your CAE Upgrade driver board, PC-4U) until you obtain the same reading on both cathodes. Once they are the same, readjust the Bias pot to get 0.5 volts at either cathode. Remove power.
5. Install the two small signal driver tubes.
6. If you have purchased the AC BALance option, connect your amplifier to an IMD distortion analyzer. The AC BALance potentiometers should be set for minimum IMD at an output power of 10W RMS with an 8 ohm load.
7. Replace the cover and enjoy.

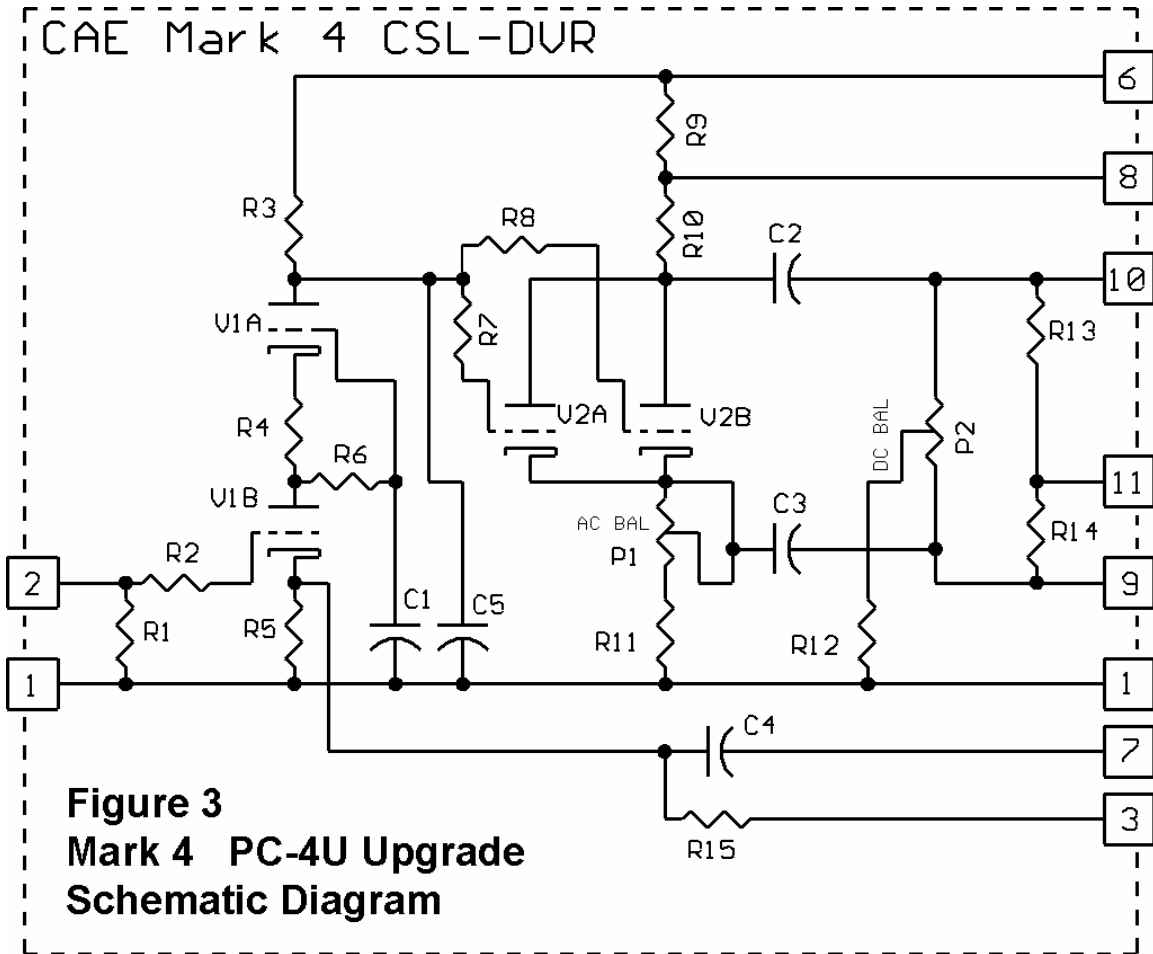
### Figure 1

Figure 1 Top View PC-4U Component Placement









# CAE Mark 4 Driver Upgrade Module

03-03 R1

## Dynaco Mark 4 Driver Amplifier Replacement Module, CAE# ASM-4U

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DESIG	DESCRIPTION	QNTY	PART NUMBER	VAL / VOLT
C1	CAPACITOR, MYLAR or POLYPRO	1		0.1uF/200VDC
C2, C3	CAPACITOR, MYLAR or POLYPRO	2		0.47uF/400VDC
C4	CAPACITOR, SILVER MICA	1	MSR#5982-5-300V390	390pF, 5%
C5	Not Used	0		
R1	RESISTOR, CARBON FILM	1	MSR#29SJ500-150K	150K, 1/2W
R2, R7, R8	RESISTOR, CARBON FILM	3	MSR#29SJ500-33	33, 1/2 W
R3	RESISTOR, METAL OXIDE	1	DK#P47KW-3BK-ND	47 K , 3W
R4 & R5	RESISTOR, METAL FILM	2	MSR#29MF500-280	280, 1/2 W
R6	RESISTOR, CARBON FILM	1	MSR#29SJ500-3.3M	3.3M, 1/2 W
R9	RESISTOR, METAL OXIDE	1	DK#P22KW-3BK-ND	22 K , 3W
R10 & R11(STD)	RESISTOR, METAL OXIDE	2	DK#P20KW-3BK-ND	20 K , 3W
R11 (AC BAL OPT)	RESISTOR, METAL OXIDE	1	DK#P18KW-3BK-ND	18 K , 3W
R12	RESISTOR, CARBON FILM	1	MSR#29SJ500-1M	1MEG, 1/2 W
R13 & R14	RESISTOR, CARBON FILM	2	MSR#29SJ500-220K	220K, 1/2 W
R15	RESISTOR, CARBON FILM	1	MSR#29SJ500-7.5K	7.5K, 1/2 W
P1 (DC BAL OPT)	POTENTIOMETER	1	DK#D4AA55-ND	500K
P3 (AC BAL OPT)	POTENTIOMETER	1	DK#X201R502B-ND	5K
V1 & V2	PREMIUM TUBE, TRIODE	2	CAE# 6922	6922 / 7308
X1	PRINTED CIRCUIT BOARD	1	CAE# PC-4U	
X4	PC BOARD TUBE SOCKETS, 9 PIN	2	CAE# PC-9	

NOTES:

CAE# - Curcio Audio Part Number  
 DK# - DigiKey Part Number      MSR# - Mouser Part Number  
 AES# - Antique Electronic Supply Part Number