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hp AC-4



HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL


AC-4

DECADE COUNTERS

hp AC-4

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OPERATING AND SERVICING MANUAL D22

MODEL AC-4

DECADE COUNTERS



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01106-3

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SPECIFICATIONS

CHARACTERISTICS	AC-4C	AC-4E	AC-4G
MAXIMUM COUNTING RATE	220 kc	1.2 mc	120 kc
DISPLAY	Illuminated numerals in a column.	Illuminated numerals in a column.	Illuminated numerals in a column.
DOUBLE PULSE RESOLUTION	4 μ sec	0.7 μ sec	7 μ sec
DRIVING VOLTAGE	-55 v pulse, 1.5 μ sec rise time (less amplitude with faster rise).	-20 v pulse, 0.2 μ sec rise time	-80 v pulse, 1 μ sec rise time (less amplitude with faster rise).
OUTPUT VOLTAGE	-80 volt pulse, nominal. Drives AC-4G.	-80 volt pulse, nominal. Drives AC-4G, AC-4C.	-80 volt pulse.
RESET	To zero: Open base pin connection or apply +90v pulse, rc decay.	To zero: apply +40v pulse, 5 μ sec duration, rc decay.	To zero: Open base pin connection or apply +90v pulse, 5 μ sec duration.
OUTPUT CODE	Staircase voltage +135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms. - - - - -	Staircase voltage +135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms. - - - - -	Staircase voltage +135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms. - - - - -
MOUNTING	12-pin male plug.	12-pin male plug.	12-pin male plug.
POWER	+300 v \pm 10% at 18ma 6.3vac \pm 10% at 1.2a	+300 v \pm 10% at 30ma 6.3vac \pm 10% at 1.2a	+300 v \pm 10% at 15ma 6.3vac \pm 10% at 1.2a
DIMENSIONS	5-5/8" high above flush mounted plug. 6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.	5-5/8" high above flush mounted plug. 6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.	5-5/8" high above flush mounted plug. 6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.
OPTIONAL	4-line binary-coded decimal (1-2-2-4) output	4-line binary-coded decimal (1-2-2-4) output	4-line binary-coded decimal (1-2-2-4) output

SPECIFICATIONS (Cont'd)

AC-4J	AC-4K	AC-4L	CHARACTERISTICS
1.2 mc	120 kc	220 kc	MAXIMUM COUNTING RATE
Digital display tube.	Digital display tube.	Digital display tube.	DISPLAY
0.7 μ sec	7 μ sec	4 μ sec	DOUBLE PULSE RESOLUTION
-20 v pulse, 0.2 μ sec rise time.	-80 v pulse, 1 μ sec rise time (less amplitude with faster rise).	-55 v pulse, 1.5 μ sec rise time (less amplitude with faster rise).	DRIVING VOLTAGE
-80 volt pulse, nominal Drives AC-4K, AC-4L	-80 volt pulse	-80 volt pulse, nominal, Drives AC-4K	OUTPUT VOLTAGE
To zero: apply +40 v pulse 5 μ sec duration, rc decay.	To zero: Open base pin connection or apply +90v pulse, 5 μ sec duration.	To zero: Open base pin connection or apply +90v pulse, rc decay.	RESET
Staircase voltage + 135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms.	Staircase voltage + 135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms.	Staircase voltage + 135 v at count of zero, +55 v at count of nine. Source impedance approximately 700K ohms.	OUTPUT CODE
10-line code	10-line code	10-line code	
Two 12-pin male plugs	Two 12-pin male plugs	Two 12-pin male plugs	MOUNTING
+ 300 v \pm 10% at 30ma + 230 v \pm 10% at 2ma 6.3vac \pm 10% at 1.2a	+ 300 v \pm 10% at 15ma + 230 v \pm 10% at 2ma 6.3vac \pm 10% at 1.2a	+ 300 v \pm 10% at 18ma + 230 v \pm 10% at 2ma 6.3vac \pm 10% at 1.2a	POWER
5-5/8" high above flush mounted plug.	5-5/8" high above flush mounted plug.	5-5/8" high above flush mounted plug.	DIMENSIONS
6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.	6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.	6-1/8" high incl. plug 1-3/8" wide, 5-3/4" deep.	
4-line binary-coded decimal (1-2-2-4) output	4-line binary-coded decimal (1-2-2-4) output	4-line binary-coded decimal (1-2-2-4) output	OPTIONAL

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SECTION I GENERAL DESCRIPTION

1-1 GENERAL

Hewlett-Packard AC-4 series Decade Counters count negative pulses. The AC-4C, AC-4E, and AC-4G indicate the count by lighting a number in a column of numerals; the AC-4J, AC-4K, and AC-4L use a single digital display tube to indicate the count.

The decade counters produce one output pulse for every ten input pulses. The output pulse is generated when the units step from 9 to 0. Thus any count storage capacity may be obtained by connecting the units in series and placing them side by side so that the first unit provides the "units"

digit, the second unit provides the "tens" digit, etc. The total count appears as a number across the row of counters.

All AC-4 series Decade Counters provide a staircase voltage output, which may be used to program the hp Model 560A Digital Recorder. The AC-4J, AC-4K and AC-4L also provide a ten-line code output, which may be used to program the hp Model 561B Digital Recorder, or operate a remote readout units with digital display tubes.

On special order, a four-line binary coded decimal (1-2-2-4) output is available on any Decade Counter unit.

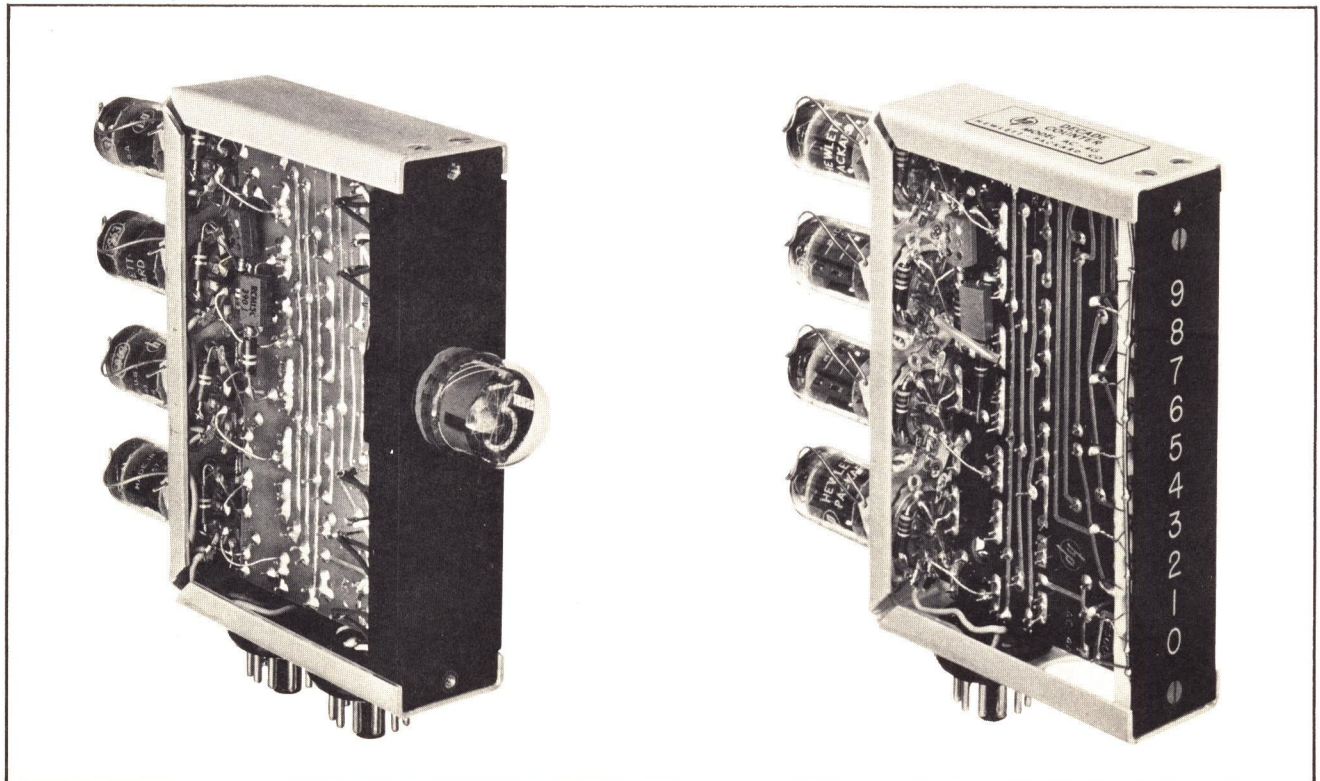


Figure 1-1. AC-4 Decade Counters

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SECTION II INSTALLATION

2-1 GENERAL

This section contains installation information of the AC-4 series Decade Counter units. The Decade Counter units in $\text{\textcircled{hp}}$ electronic counters and digital voltmeters are installed at the factory and are ready to operate. Table 2-1 shows the arrangement of Decade Counter units in $\text{\textcircled{hp}}$ electronic counters. When Decade Counter units are used for other application refer to figures 4-15 and 4-16 for mounting dimensions.

2-2 ELECTRICAL CONNECTIONS

The pins of base plug P1 of the Decade Counter units are listed below with their connections:

- Pin 1 Heater. Pins 1 and 7 receive heater power Either may be grounded.
- Pin 2 + 300 volts. This voltage need not be regulated unless staircase is used. Transients or rippled must be less than 20 volts peak for AC-4G, and AC-4K; less than 10 volts peak for AC-4E, and AC-4J.

Table 2-1. Decade Counters used in $\text{\textcircled{hp}}$ Electronic Counters

$\text{\textcircled{hp}}$ Electronic Counter	Ten-millions Counter	Millions Counter	Hundred-thousands Counter	Ten-thousands Counter	Thousands Counter	Hundreds Counter	Tens Counter	Units Counter
521A					AC-4G	AC-4G	AC-4G	AC-4G*
521C				AC-4G	AC-4G	AC-4G	AC-4G	AC-4G*
521D					AC-4K	AC-4K	AC-4K	AC-4K*
521E				AC-4K	AC-4K	AC-4K	AC-4K	AC-4K*
521G				AC-4G	AC-4G	AC-4G	AC-4G	AC-4E
522B				AC-4G	AC-4G	AC 4G	AC-4G	AC-4G*
523C			AC-4K	AC-4K	AC-4K	AC-4K	AC-4K	AC-4J
523D			AC-4G	AC-4G	AC-4G	AC-4G	AC-4G	AC-4E
524C	AC-4K	AC-4K	AC-4K	AC-4K	AC-4K	AC-4K	AC-4J	-----
524D	AC-4G	AC-4G	AC-4G	AC-4G	AC-4G	AC-4G	AC-4E	-----

* For counters having 220 kc option, the unit counter is replaced by AC-4C or AC-4L.

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- Pin 3 Signal input. Input impedance, AC-4E, and AC-4J: Approximately 4.7K in series with 47 pf. Input impedance, AC-4G, and AC-4K: Approximately 15K in series with 100 pf. Input impedance, AC-4C and AC-4L: 11K in series with 200 pf.
- Pin 4 Staircase output. Load does not affect counting of units, but may lower staircase voltages. With regulated +300 volts supply applied to pin 2, the staircase voltage levels are as follows: Approximately +135 volts at the count of "0" and approximately +55 volts at the count of "9". Source impedance is approximately 700,000 ohms.
- Pin 5 Reset to "0". Must be grounded through resistance not more than 750 ohms.
- Pin 6 Ground.
- Pin 7 Heater. See pin 1.
- Pin 8 Readout voltage for digital display tube. For reliable readout, apply $230\text{ v} \pm 5\%$. To blank readout, apply less than +100v.
- Pin 9 No connection.
- Pin 10 No connection.
- Pin 11 No connection.
- Pin 12 Output signal. Maximum load, AC-4E, and AC-4J: 150,000 ohms or 15,000 ohms in series with 100 pf. Maximum load, AC-4C, AC-4G, AC-4K, and AC-4L: 300,000 ohms or 6,000 ohms in series with 100 pf. Note: When the output signal is not used to drive another decade counter unit, connect a 47 pf capacitor to pin 12 of base socket and ground.

2-3 TEN-LINE CODE CONNECTION

Models AC-4J, AC-4K, and AC-4L Decade Counters have a second base plug P2, which supplies ten-line code information. Pins 1 through 9 of base plug P2 are connected to numerals 1 through 9 of the digital display tube. Pin 10 of P2 is connected to the numeral 0. Ten-line code information should be taken with respect to +115 volts reference bus (pin 11 of P2). The external load connected between the reference bus and any numeral output should be no less than 200,000 ohms and preferably at least 500,000 ohms. Loads should not be connected between the numeral output and ground. An approximate output waveform of ten-line code output is shown in figure 2-1.

2-4 4-LINE BINARY-CODED-DECIMAL (1-2-2-4) OUTPUT

The 4-line binary-coded-decimal (BCD) output is obtained by adding four 1-megohm resistors to the decade counter unit. The resistor is connected

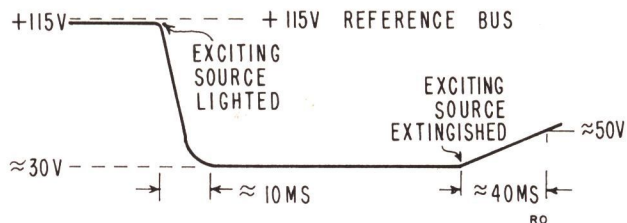


Figure 2-1. Output waveform of 10-line code

from the output plate of each binary to a pin of the base plug. The numerals, 1, 2, 2, and 4, which define the BCD code specify the weights assigned to each of the four output plates. When the output section is conducting steadily, the output plate is in "0" state (low plate voltage). When the output section is cut-off, the plate is in "1" state (high plate voltage).

Upon completion of a count the four output sections in the decade counter unit have a unique combination of low and high plate voltages. The decimal equivalent is found by adding the weights of the output plates which are in "1" state. For example, if all output sections are in "1" state, the decimal equivalent is 9 (1 + 2 + 2 + 4). Zero is obtained when all four output sections are in "0" state. The following table shows the state of each output section and its plate voltage of decade counter unit.

Table 2-2. (1-2-2-4) Output

Decimal Count	First Binary (V1)	Second Binary (V2)	Third Binary (V3)	Fourth Binary (V4)
	Binary Weighting			
	1	2	2	4
	State of Binary			
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
Output plate voltages AC-4C, AC-4G, AC-4K, and AC-4L				
0 state	+ 62V	+ 53V	+ 53V	+ 53V
1 state	+ 172V	+ 135V	+ 135V	+ 135V
AC-4E and AC-4J				
0 state	+ 52V	+ 52	+ 52	+ 52
1 state	+ 145V	+ 137V	+ 137V	+ 137V
Source impedance of BCD output is approx. 1 meg.				

SECTION III CIRCUIT DESCRIPTION

3-1 GENERAL

The decade counter units consist of four bi-stable multivibrators (binaries) and a bank of ten neon lamps. The sum of the voltages from three binary halves is applied to each neon lamp. After any number of input pulses, only one of the ten possible sums is large enough to light its lamp. In the AC-4C, AC-4E, and AC-4G, the neon lamps are behind a numbered mask, and the lighted lamp illuminates the number of the mask which corresponds to the number stored in the positions of the four binaries. In the AC-4J, AC-4K, and AC-4L, the lighted lamp illuminates a particular one of ten photoconductors. The photoconductor, when illuminated, lights the number in a digital display tube corresponding to the number stored in the position of the four binaries.

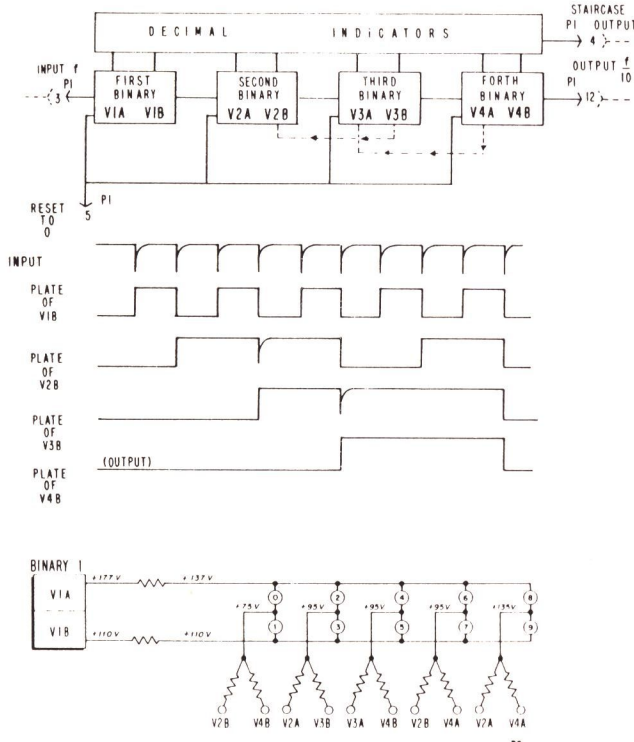


Figure 3-1. Block Diagram

The first binary determines whether an odd or even number is lighted; the remaining three binaries determine which odd or which even number is lighted.

The four binaries are connected in cascade so the output from the first is fed to the input of the second, and so on. Each binary responds only to negative pulses and, as shown in Figure 3-1, produces alternately positive-going and negative-going wavefronts. These wavefronts become pulses when differentiated by the coupling capacitors and the circuit resistances. Thus each binary divides its input frequency by two.

With four such binaries, one negative output pulse would result from every 16 negative input pulses. However, two feedback loops add 6 extra counts for each 10 input pulses, providing a division ratio of 10:1 instead of 16:1.

Figure 3-1 shows how the feedback reduces the overall division from 16 to 10 and how the neon lamps are lighted.

3-2 BINARY

Binaries used in the decade counter units are shown in Figures 3-2 and 3-3. These binaries have two stable states. In one state, section A conducts and section B is cut off. In the second state, section A is cut off and section B conducts.

Consider the binary in Figure 3-2. If section B is conducting the voltages are as shown in the figure. Note that the charge on C2 is much larger than the charge on C3. An 80-volt negative pulse, differentiated by C1 and the circuit resistance, is applied to the common plate load. The pulse cuts off section B and drives the plate potential of section A down near that of section B. The plate potential of section B is not affected much because it is already low. As the pulse decays, the plates and grids of both sections become more positive. However, the grid of section A is more positive than the grid of section B because of the unequal charges

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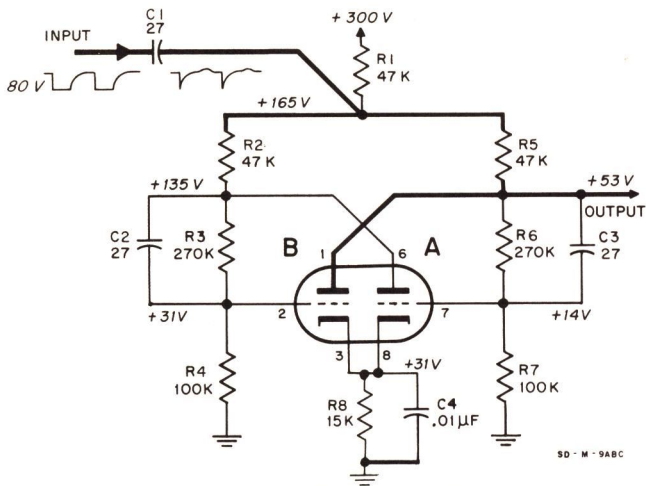


Figure 3-2. Low-Frequency Binary

of C2 and C3. Therefore, section A starts to conduct first and holds section B cut off. In this condition, C3 has more charge than C2. Thus, the next negative pulse flips the binary back to the first condition. A positive pulse will not trigger the binary.

Consider the binary of Figure 3-3. If section B is conducting, the voltages are as shown in the figure. Note that CR1 has no bias and that CR2 has reverse bias. The differentiated negative pulse, which has

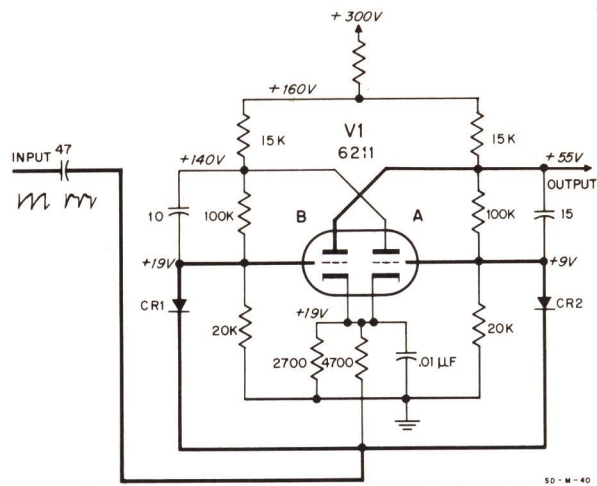


Figure 3-3. High-Frequency Binary

an amplitude of only 5 to 10 volts, reaches only the grid of section B, through CR1. Reverse bias keeps CR2 open. The pulse is amplified and inverted in the plate of section B. The positive signal on the plate of section B brings section A into conduction, and the resulting negative signal on the plate of section A drives section B to cut-off. In this condition, CR1 has reverse bias and CR2 has none. Thus, the next negative pulse will flip the binary back to the first condition. A positive pulse will not trigger the binary.

SECTION IV MAINTENANCE

4-1 GENERAL

A majority of failures in counter units can be remedied by tube replacement. Systematically replace one tube at a time to prevent masking other possible circuit failures. If you replace a tube without improving the operation, return the original tube to its socket.

You may exchange any counter unit with a like unit without adjustment or change in operation; therefore, to determine if a counter is faulty, replace it with one known to be operating properly. When exchanging units in this manner, keep in mind that a defective unit can upset the operation of cascaded units that follow. If several units seem to operate improperly, service the first faulty one, that is, the one operating at the highest speed.

CAUTION

Remove the digital display tube before attempting to remove an AC-4J, AC-4K, or AC-4L from its installation. Thus avoid breaking the tube by bumping it against a panel, another unit, etc. when the unit comes free from its socket.

4-2 CHECKING AN INDIVIDUAL COUNTER UNIT AT LOW SPEED

You can analyze some failures by applying pulses at a very low rate and observing the counting sequence that results. Figure 4-1 shows a circuit which will apply a reliable pulse for low-speed operation of the counter units.

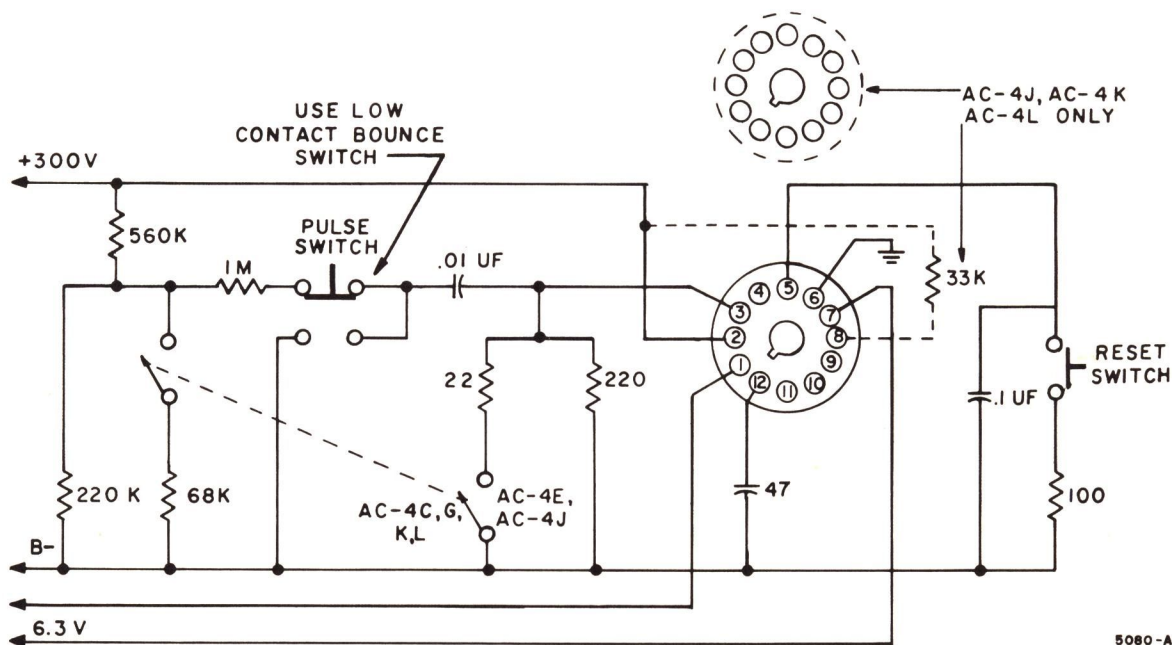


Figure 4-1. Triggering Circuit

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If the counting sequence is incorrect, but the unit still has ten stable indications for ten pulses applied, first check the lamp connections and the printed wiring for short circuits; then check for a defective lamp which does not light with the normal applied voltage.

If the counter has 12 or 16 stable states, one or both of the feedback networks is defective.

The following chart shows some incorrect indications obtained when making a low-speed operational check and gives the circuit most likely to be at fault.

Table 4-1. Troubleshooting Chart

Resets to	Counting Cycle	Faulty Circuit
0	0, 1, 8, 9, (AC-4G, AC-4H and AC-4K then repeat 6, 7, 8, 9)	V3
0	0, 2, 4, 6, 8	V1
0	0, 1, 2, 3, 4, 5	V4 or output circuit grounded
0	0, 1, 2, 3	V3
0	0, 1, 2, 3, 4 & 0, 5 & 1, 4, 5, 6, 7, 8, 9	Feedback between V2 and V3
0	0, 1, 2, 3, 4, 5, 6, 7, 8 & 2, 9 & 3, 8, 9	Feedback between V4 and V3
0	0, 1, 2, 3, 4 & 0, 5 & 1, 4, 5, 6, 7, 8 & 2, 9 & 3, 6, 7, 8, 9	Both feedback loops
1	Will not count	V1
2	2, 3	V4 or V2
4	4, 5	V2 or V3
6	6, 7, 8 & 2, 9 & 3, 8, 9	V4

4-3 CHECKING AN INDIVIDUAL COUNTER UNIT AT HIGH SPEED

Some kinds of circuit failures can cause counter units to count incorrectly at high counting rates only. Analyze these troubles by observing waveforms throughout the circuit. Use a high-speed oscilloscope such as the ϕ 150A. Begin by measuring the output of the first binary and proceed with each succeeding binary. Adjust the input signal frequency just below and above the frequency where the counting failure occurs and observe the difference in the waveforms. Typical waveforms taken at the plate of each binary are shown in Figures 4-3 and 4-4.

As shown in Figures 4-3 and 4-4, the waveforms deteriorate near the upper frequency limit of the counter units. Faulty capacitors or leakage between conductors on the printed circuit board can cause deterioration at lower frequencies.

Diodes having low back resistance can cause erratic counting by AC-4E, and AC-4J units at low frequencies, yet the units will operate normally at high frequencies. To detect a faulty diode, set the line voltage to 102 V and carefully observe each plate waveform with the unit counting correctly. Negative pips like those shown in Figure 4-2, indicate a faulty diode. Generally, the pips will not be as large as shown in the figures.

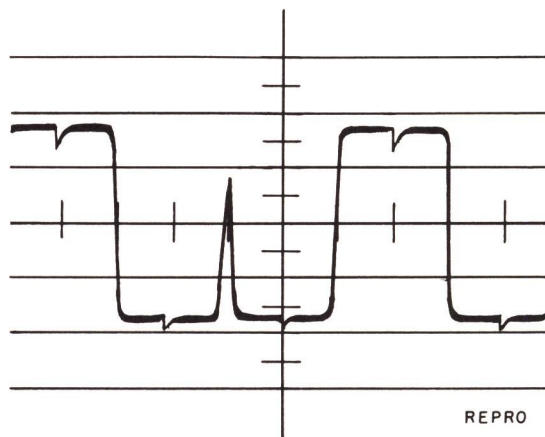


Figure 4-2. Negative Pips Indicating a Poor Diode in the Trigger Circuit of the 2nd Binary of an AC-4E, or AC-4J.

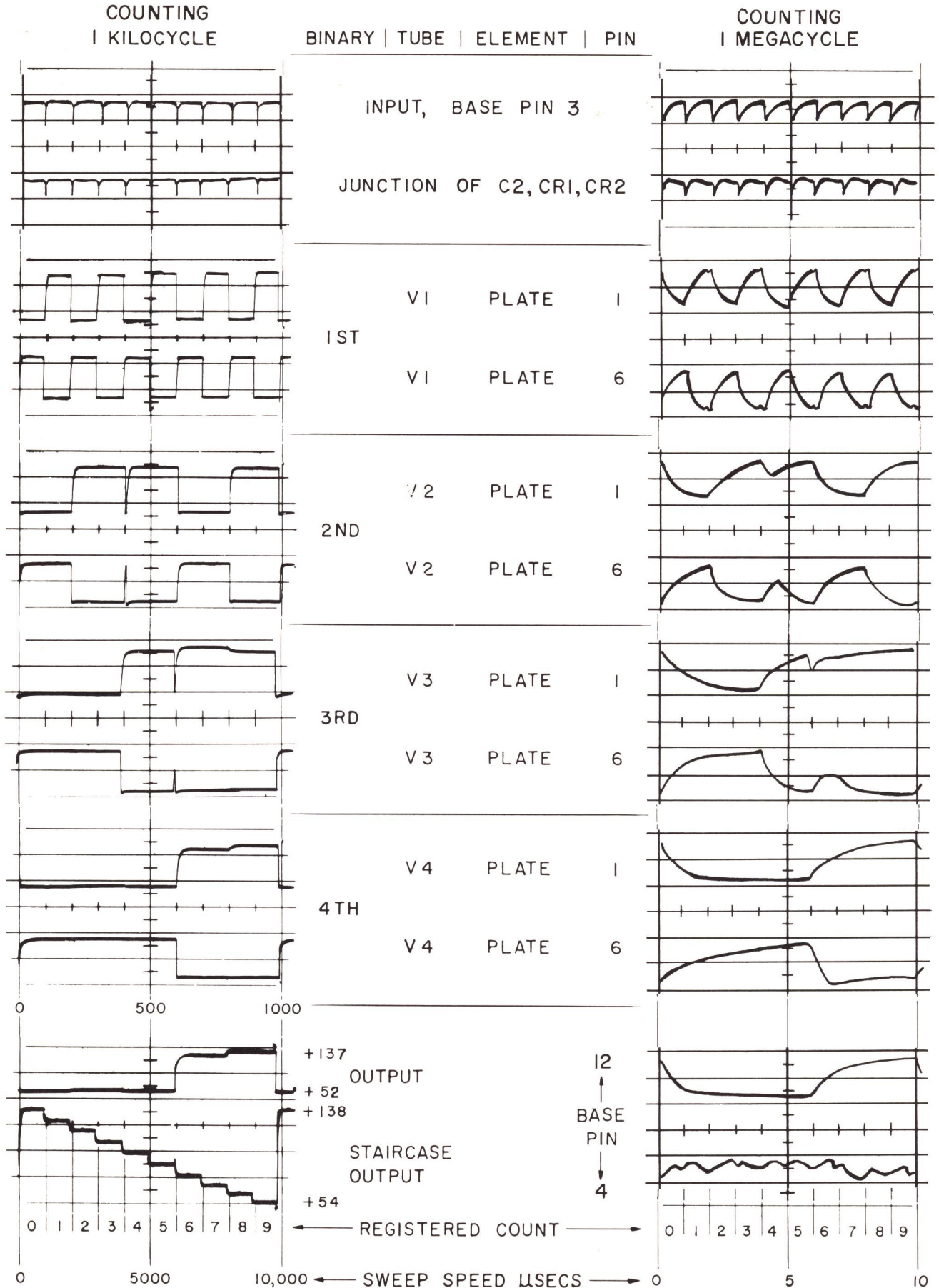


Figure 4-3. Waveforms from an AC-4E, or AC-4J. Amplitude calibration 20 volts/cm for input waveforms, 50 volts/cm for plate waveforms.

REPRO

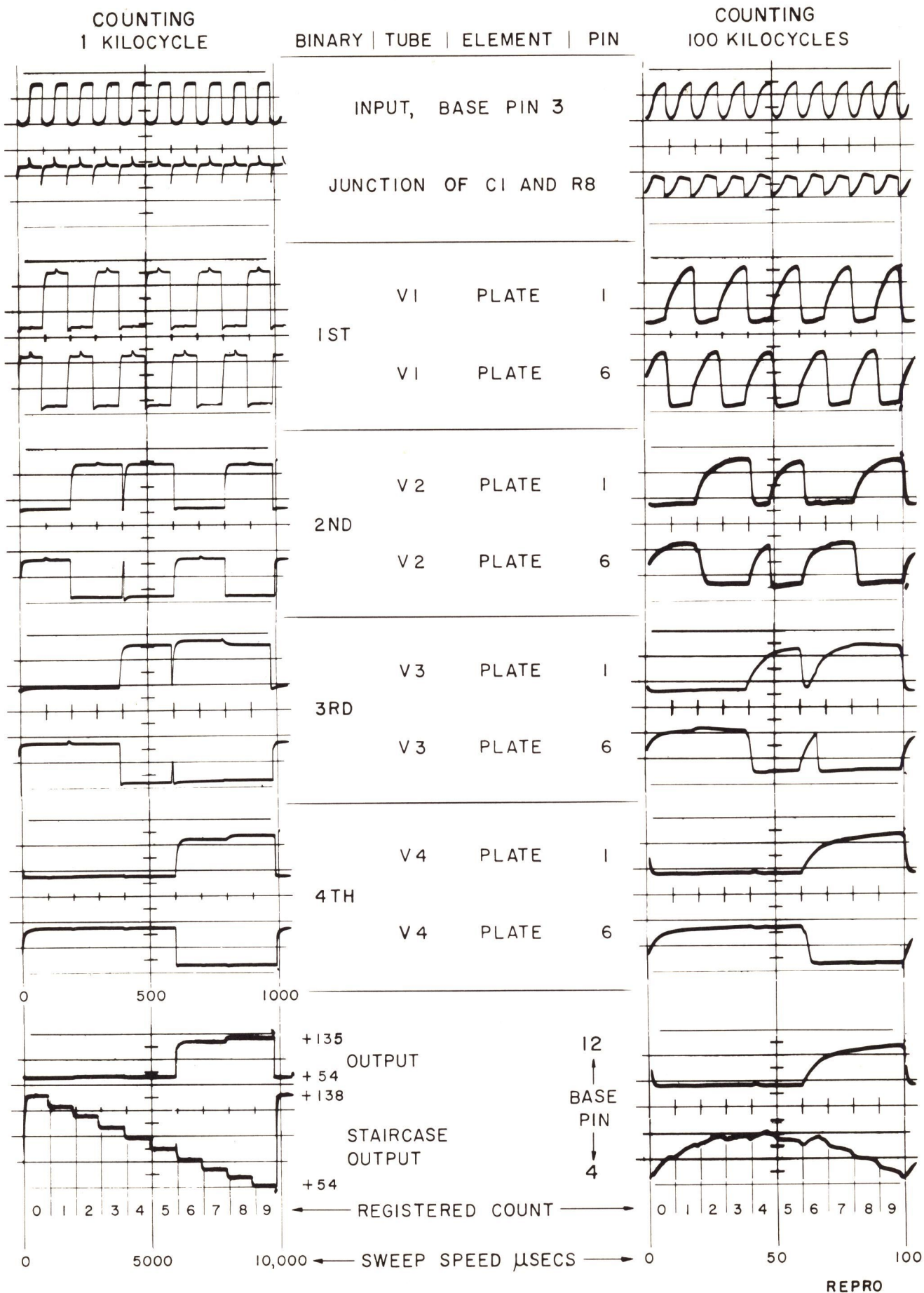


Figure 4-4. Waveforms from an AC-4G, H, or K. Amplitude calibration 50 volts/cm unless otherwise noted.

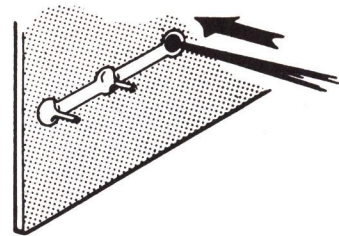
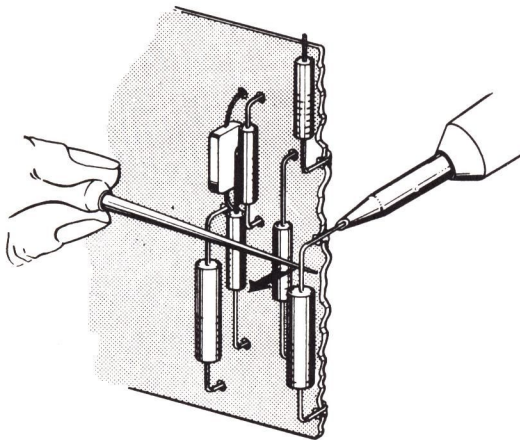
SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

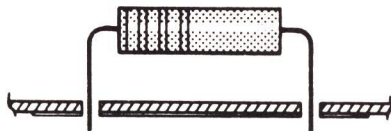
Use only high quality rosin core solder when repairing etched circuit boards. **NEVER USE PASTE FLUX.** After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

When replacing tube sockets it will be necessary to lift each pin slightly, working around the socket several times until it is free.

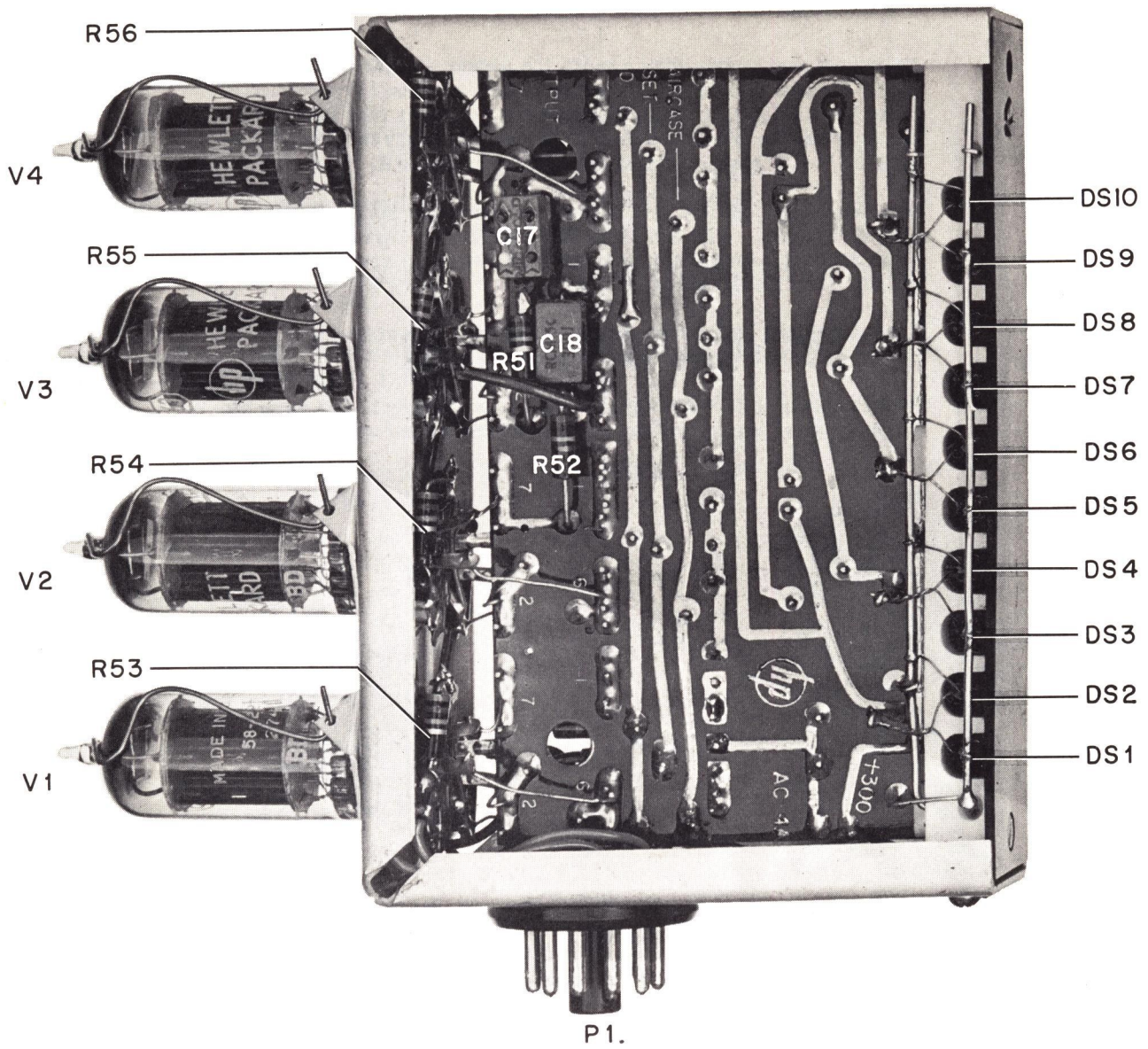


1. Apply heat sparingly to lead of part to be replaced. Remove part from card as iron heats the lead.
2. Using a small awl, carefully clean inside of hole left by old part.



3. Bend clean tinned leads on new part and carefully insert through holes on board.
4. Hold part against board and solder leads. Avoid overheating the board.

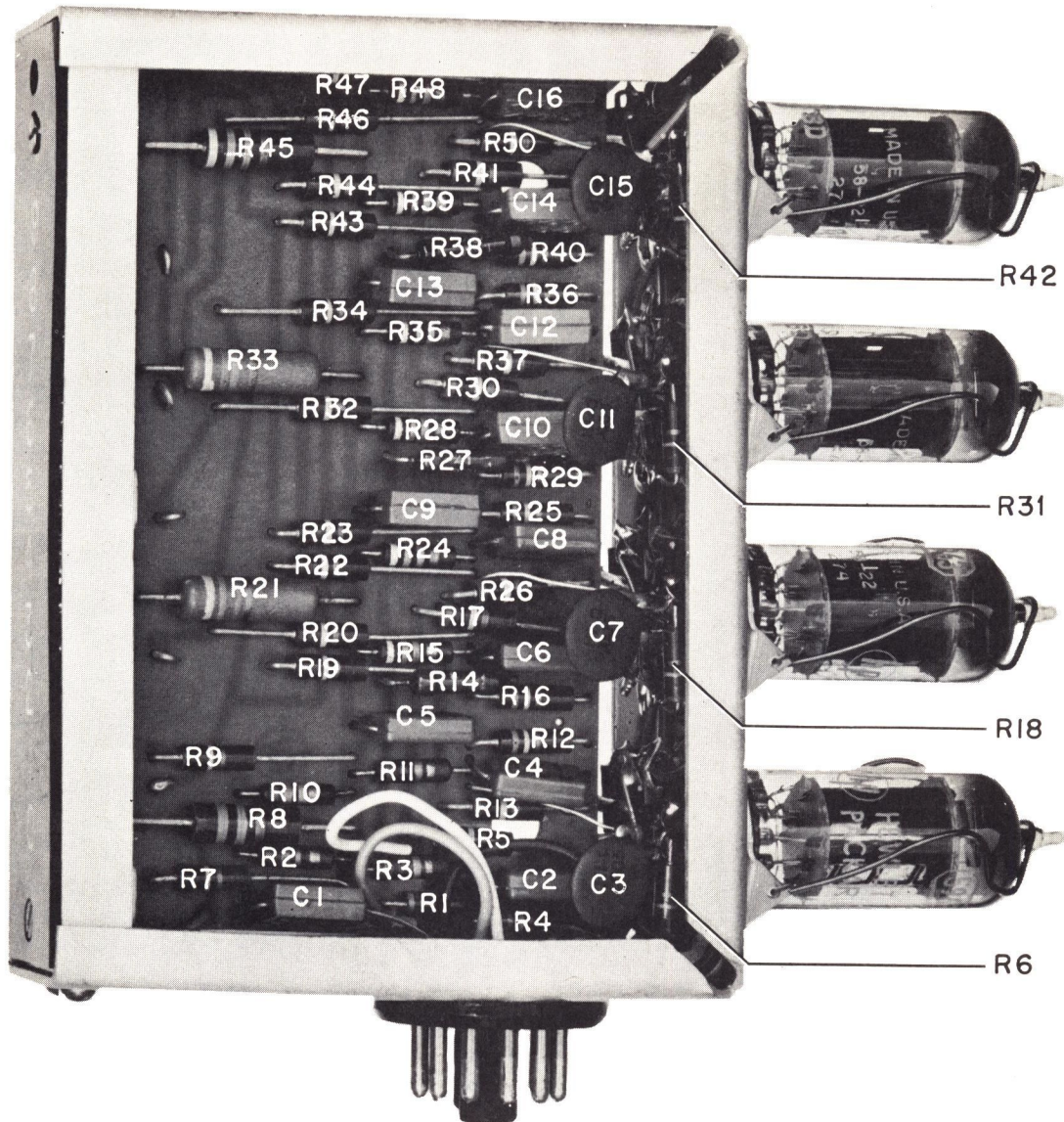
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MP-S-394

Figure 4-5. Left Side View, AC-4C/G

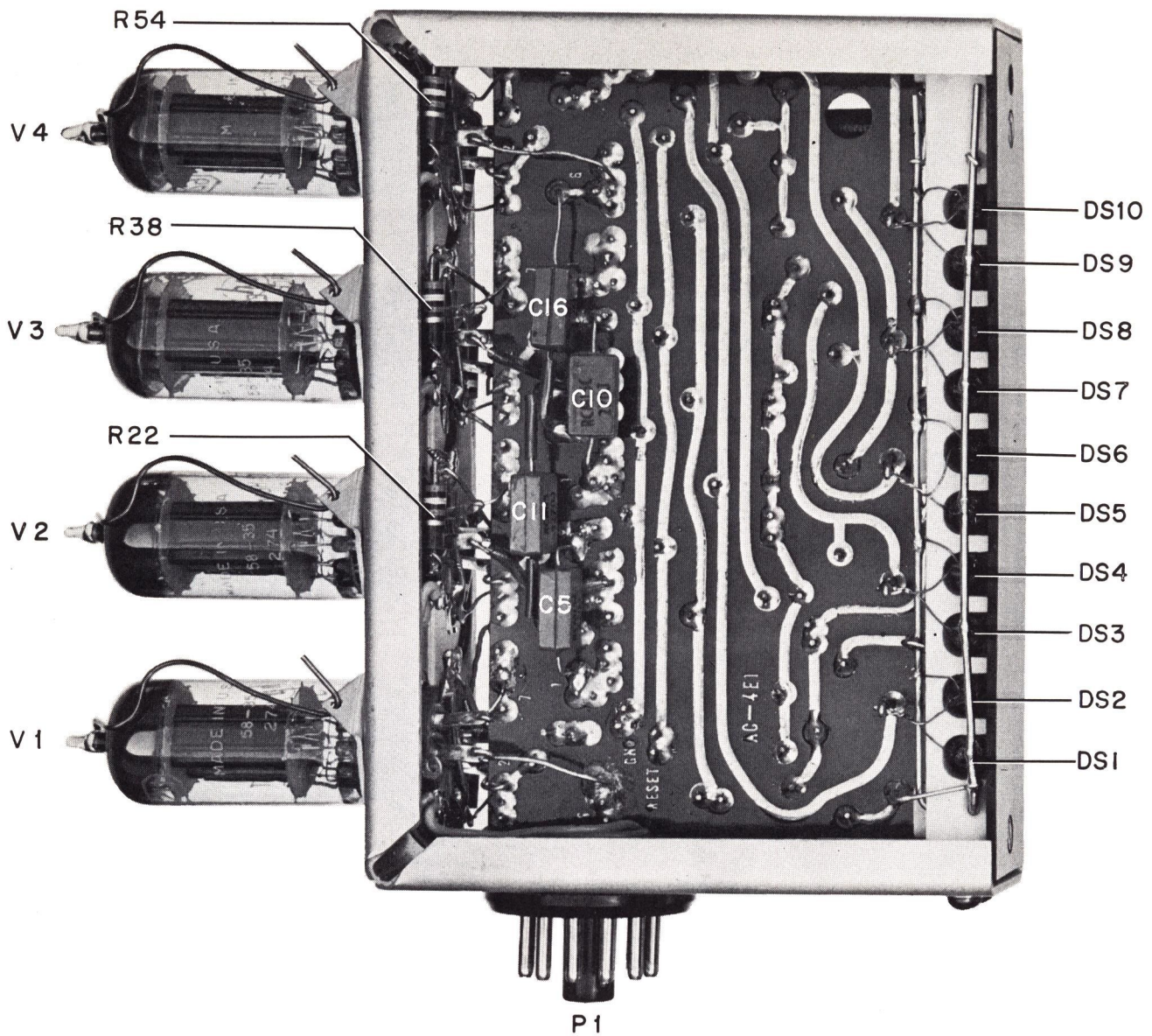
01106-2



MP-S-395

Figure 4-6. Right Side View, AC-4C/G

01106-2



MP-S-390

Figure 4-7. Left Side View, AC-4E.

01106-2

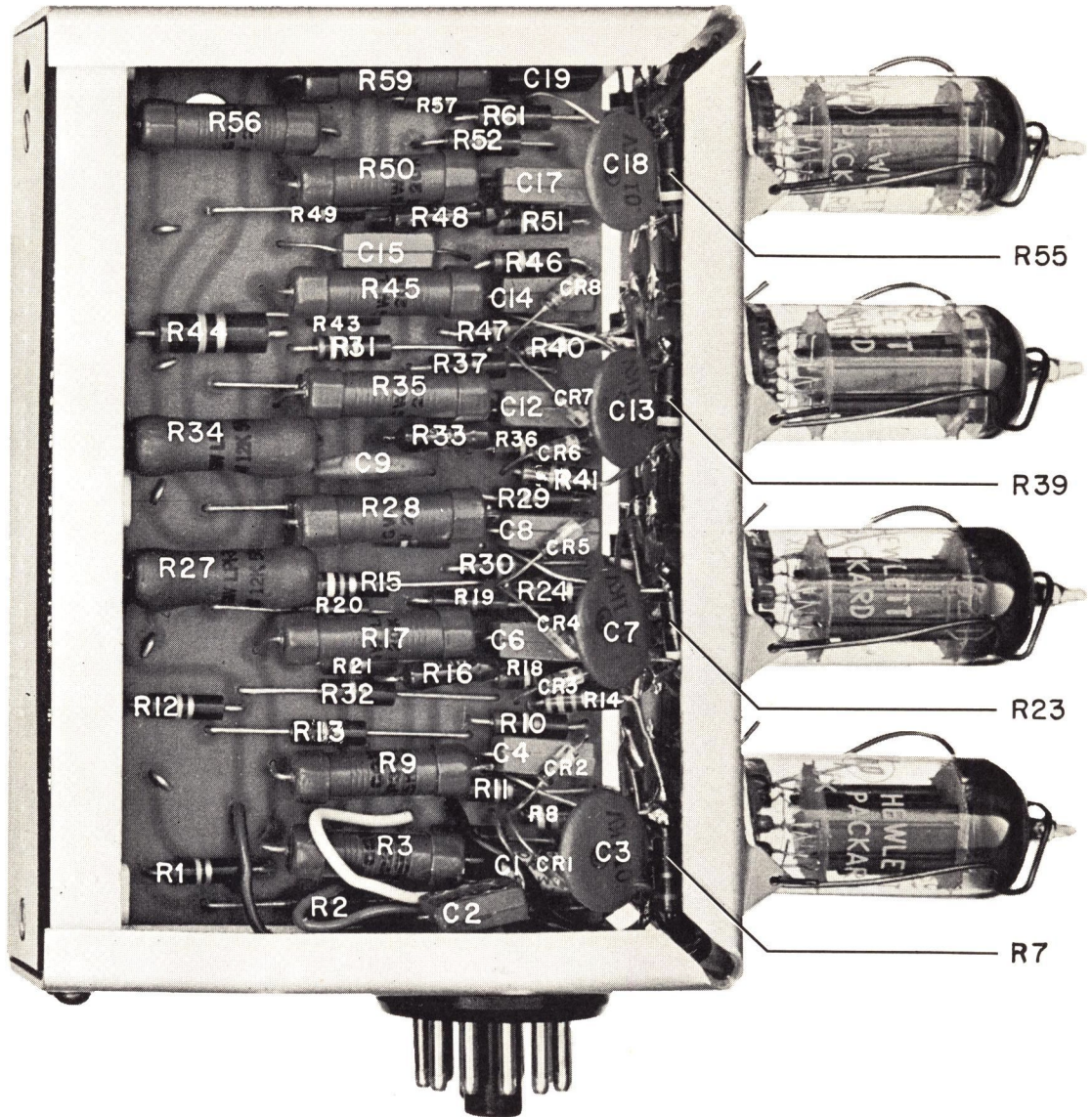
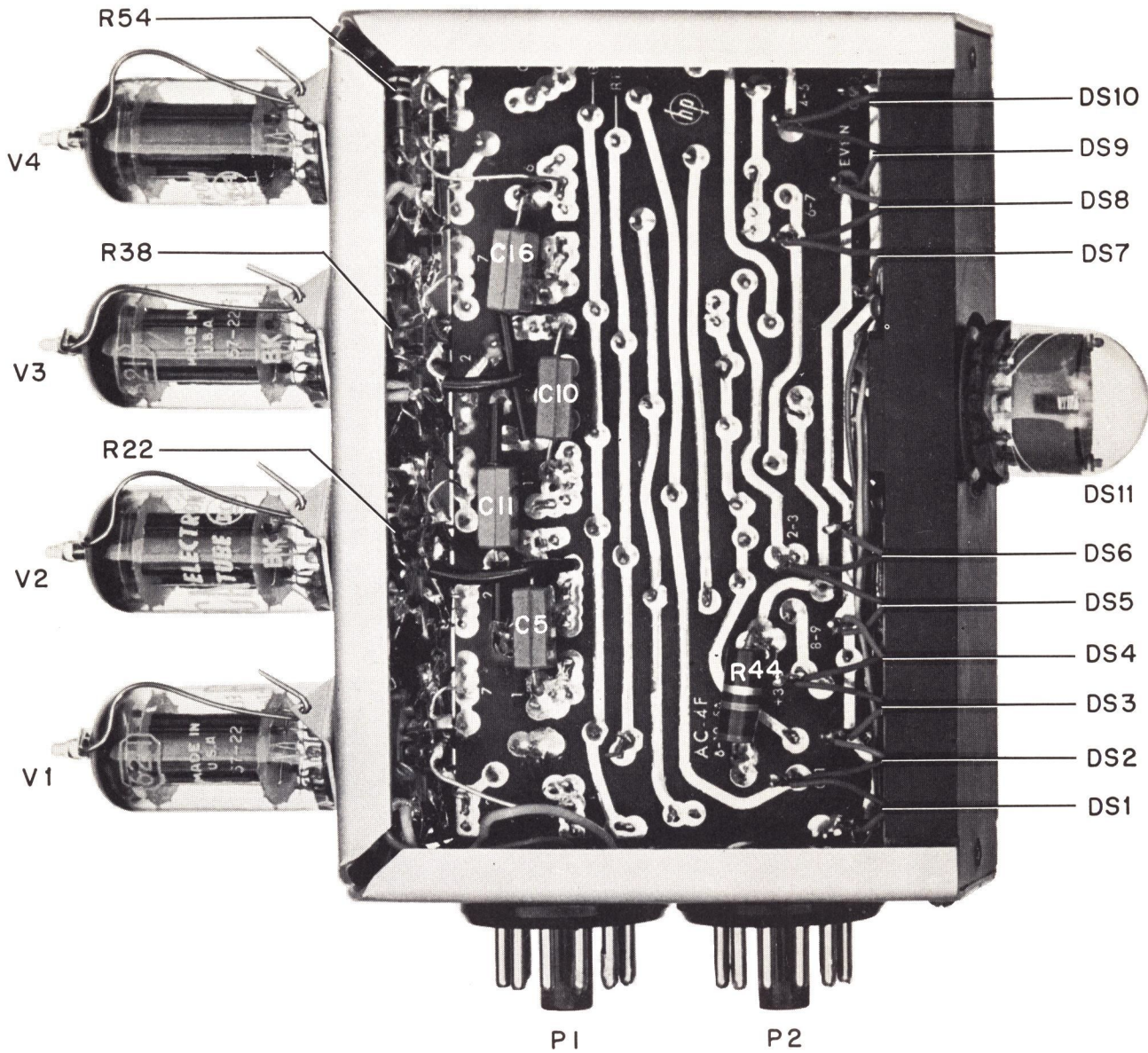


Figure 4-8. Right Side View, AC-4E.

Mp-S-391

01106-2



MP-S-393

Figure 4-9. Left Side View, AC-4J.

01106-2

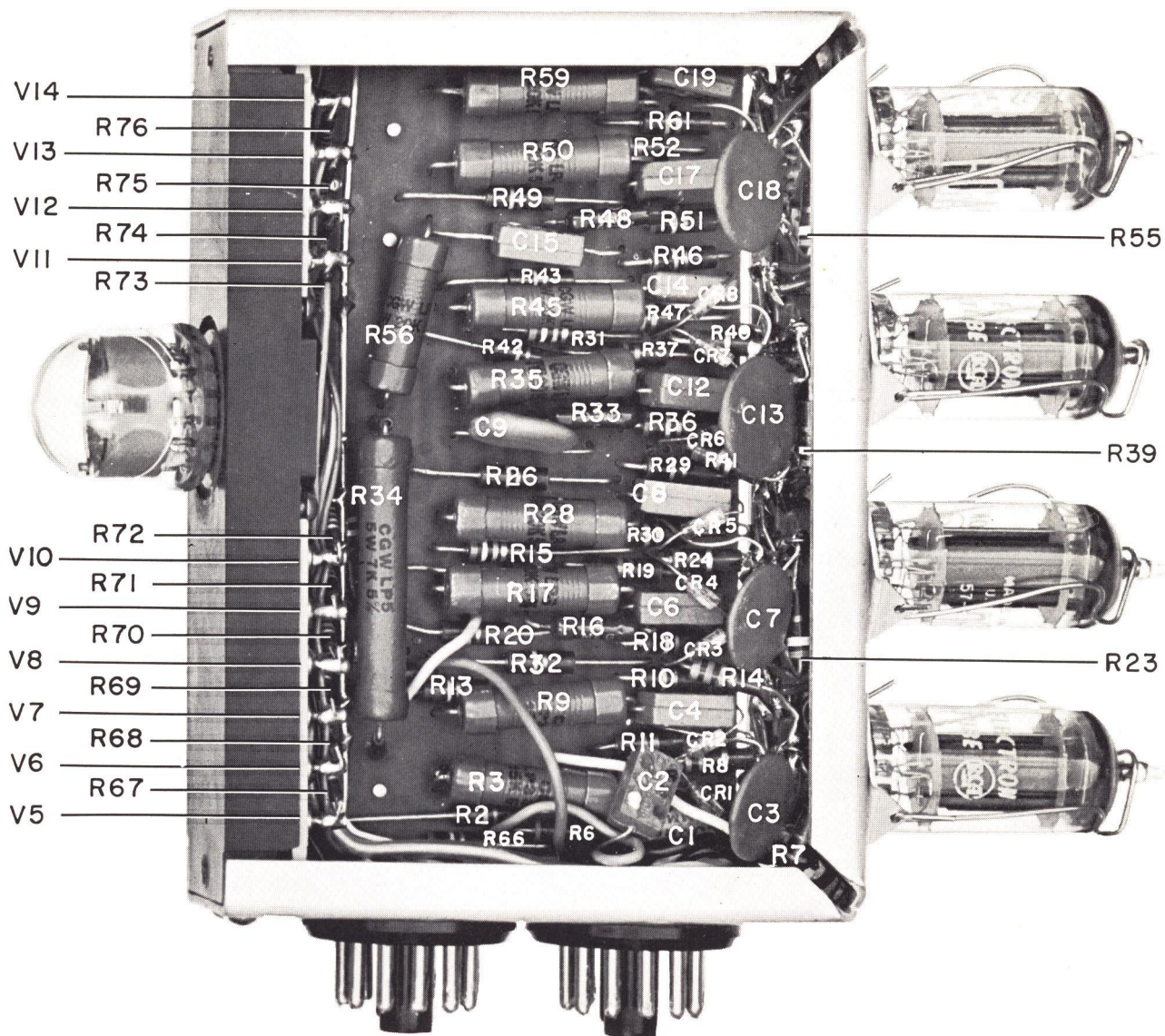


Figure 4-10. Right Side View, AC-4J.

MP-S 392

01106-2

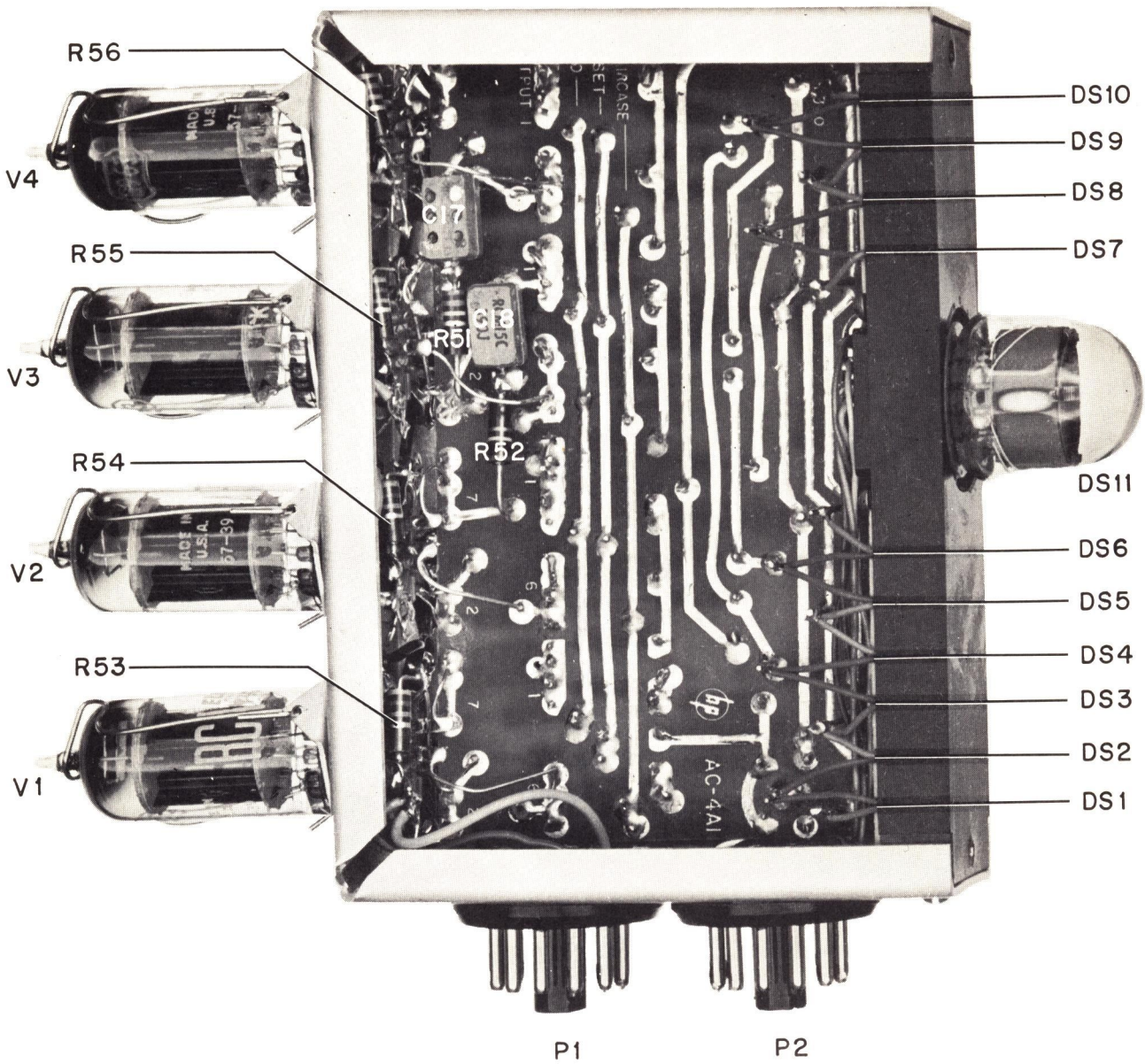
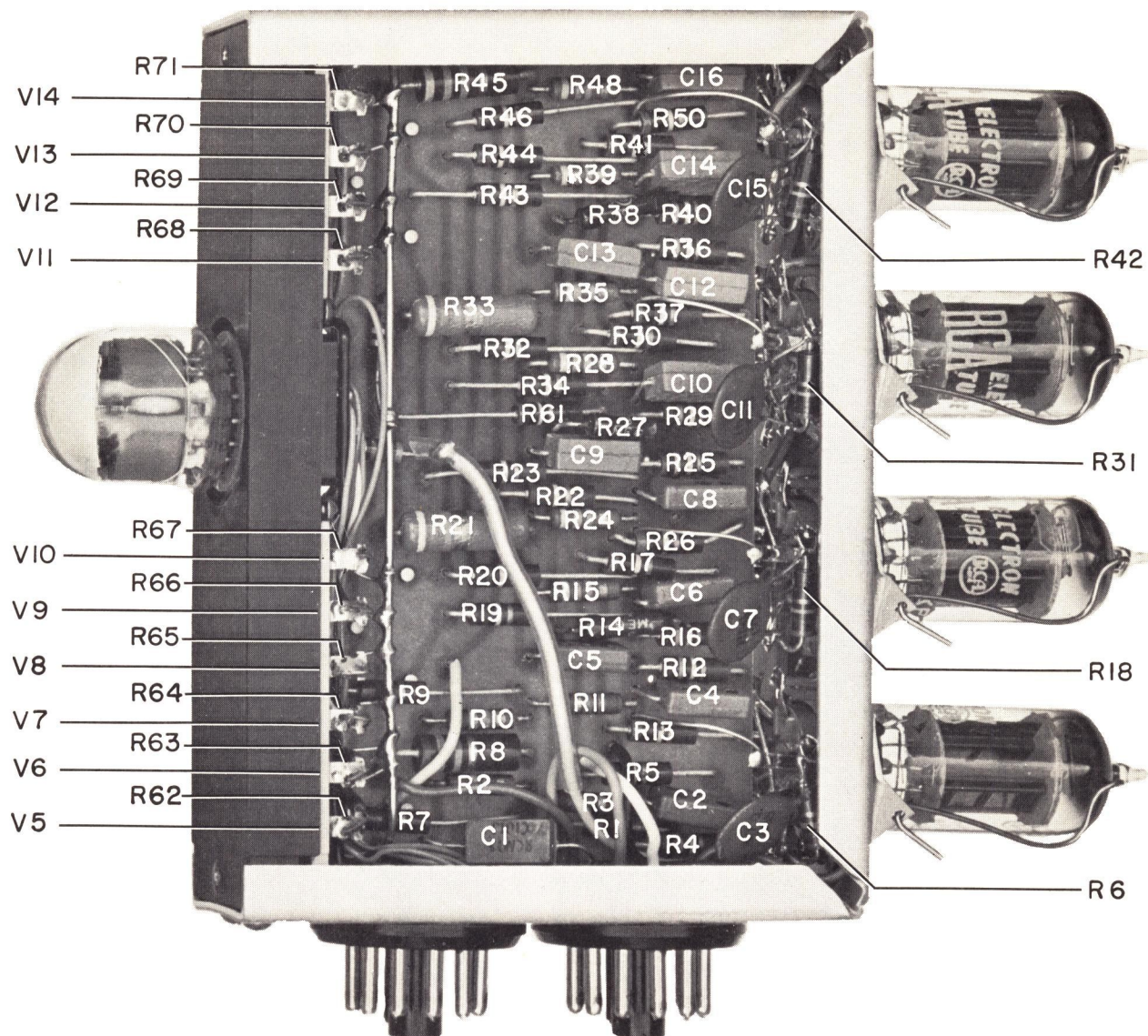


Figure 4-11. Left Side View, AC-4K

MP-S-396

01106-2



MP-S-397

Figure 4-12. Right Side View, AC-4K

01106-2

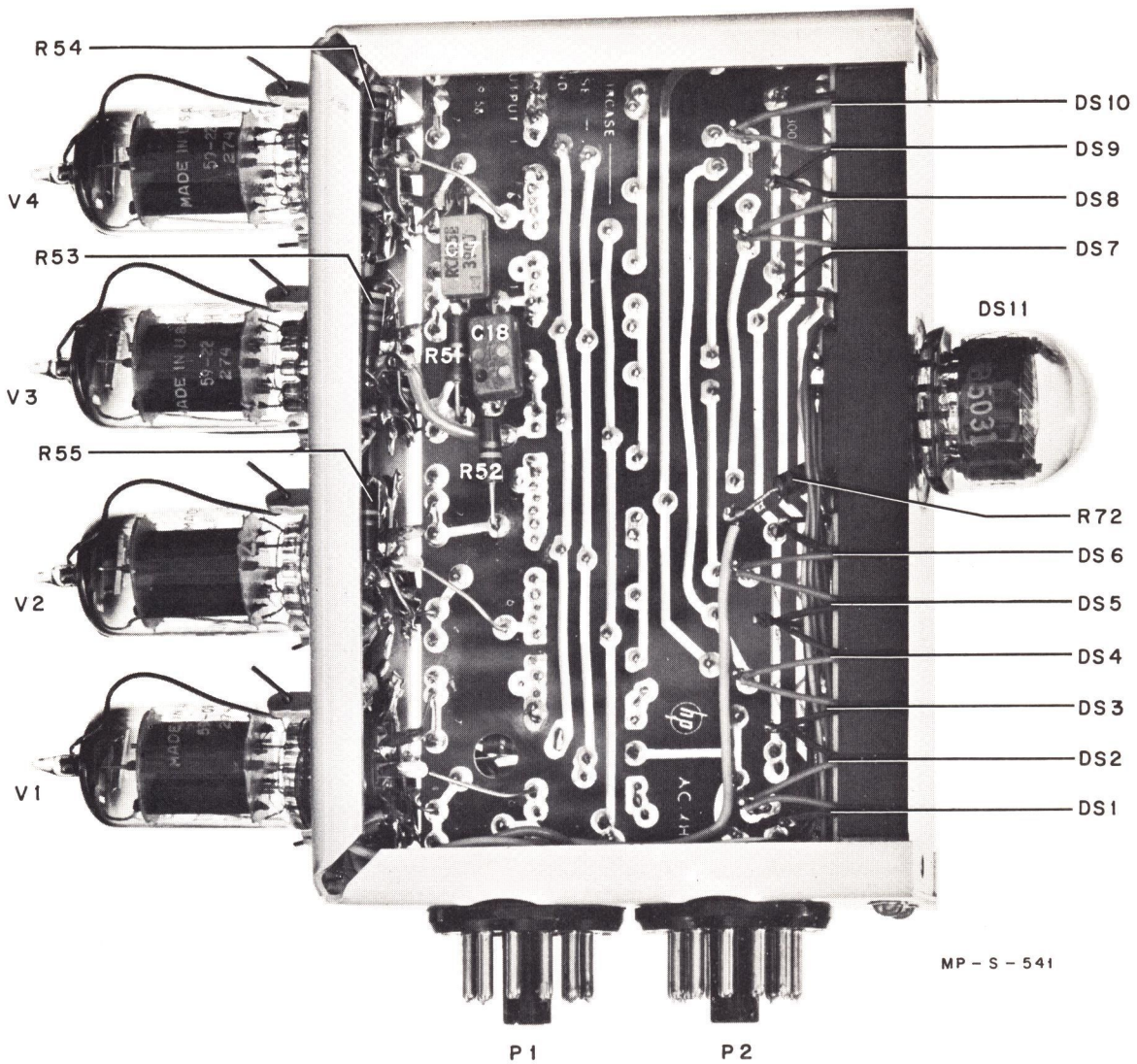
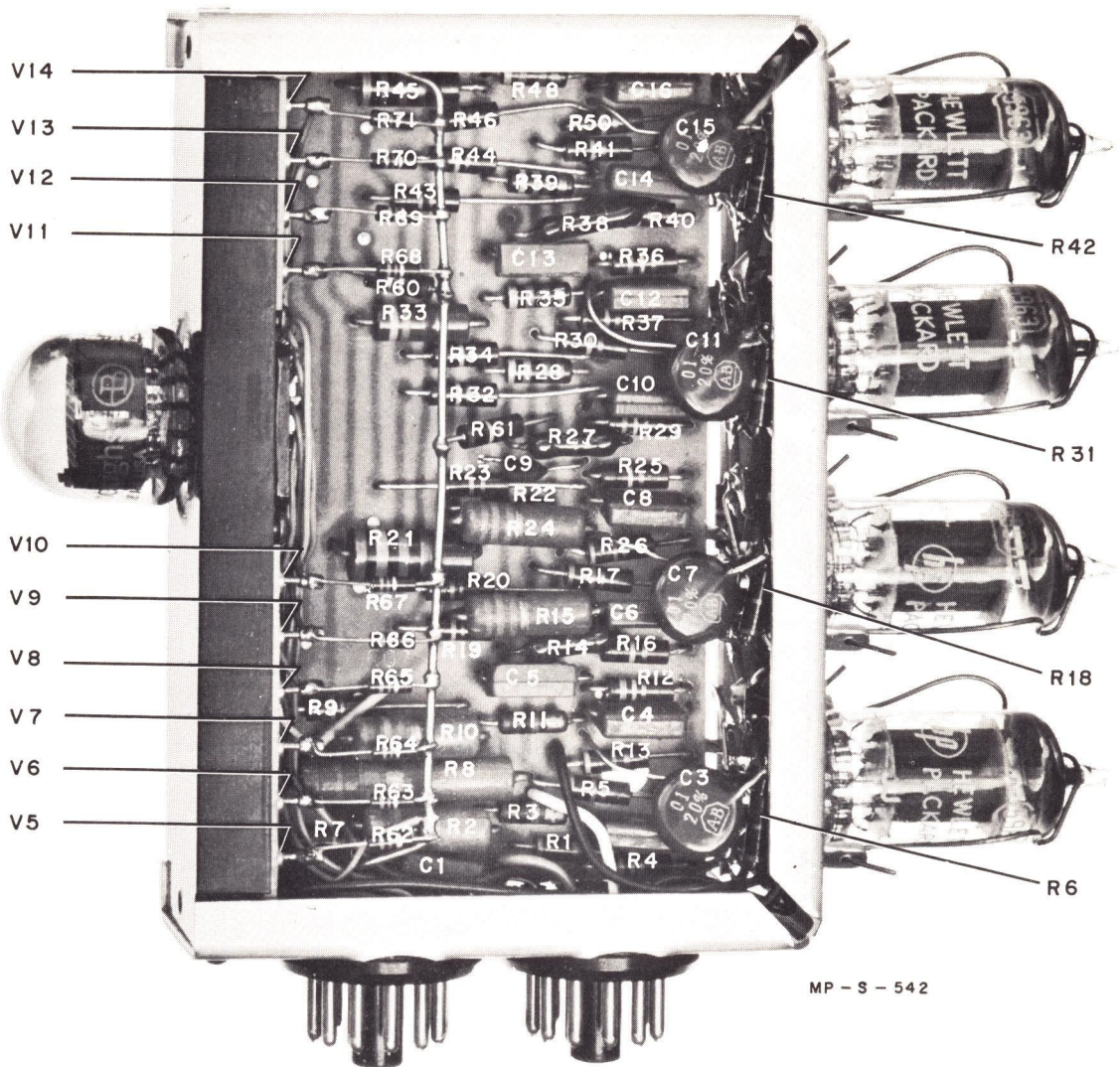


Figure 4-13. Left Side View, AC-4L

MP-S-541

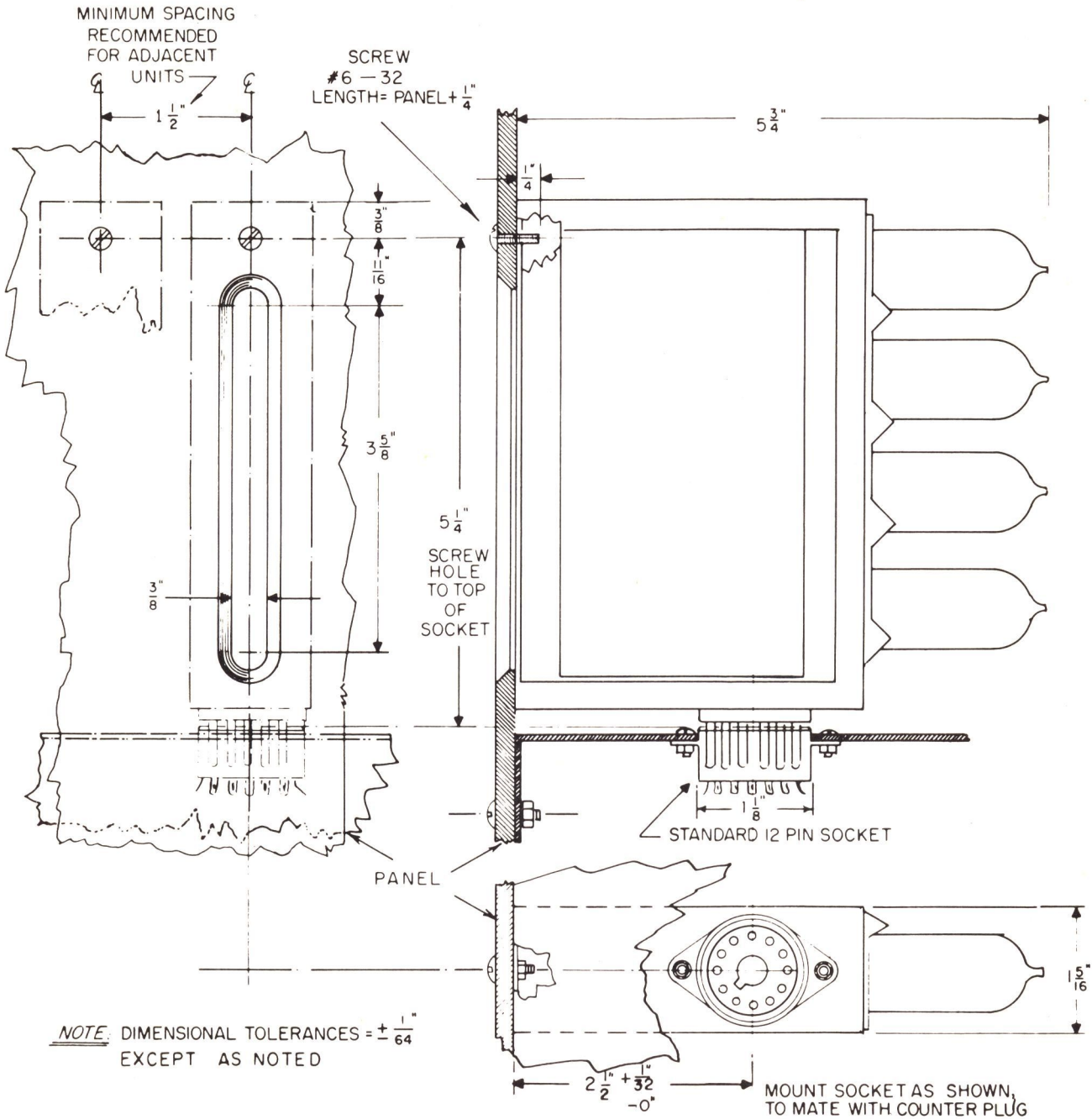
01106-2



MP-S-542

Figure 4-14. Right Side View, AC-4L.

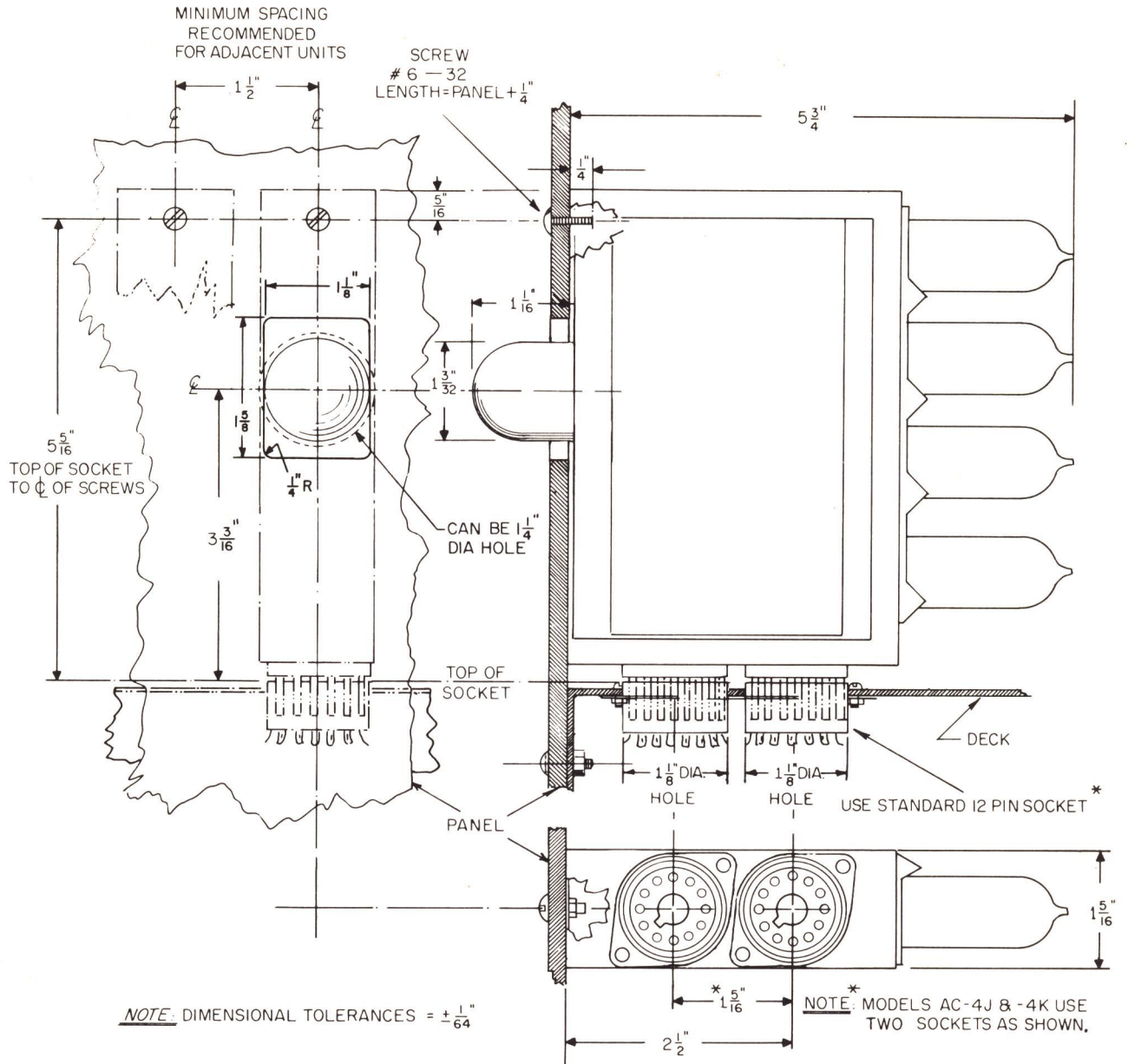
01106-2



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Figure 4-15. Mounting Dimensions: AC-4C, AC-4E, AC-4G.

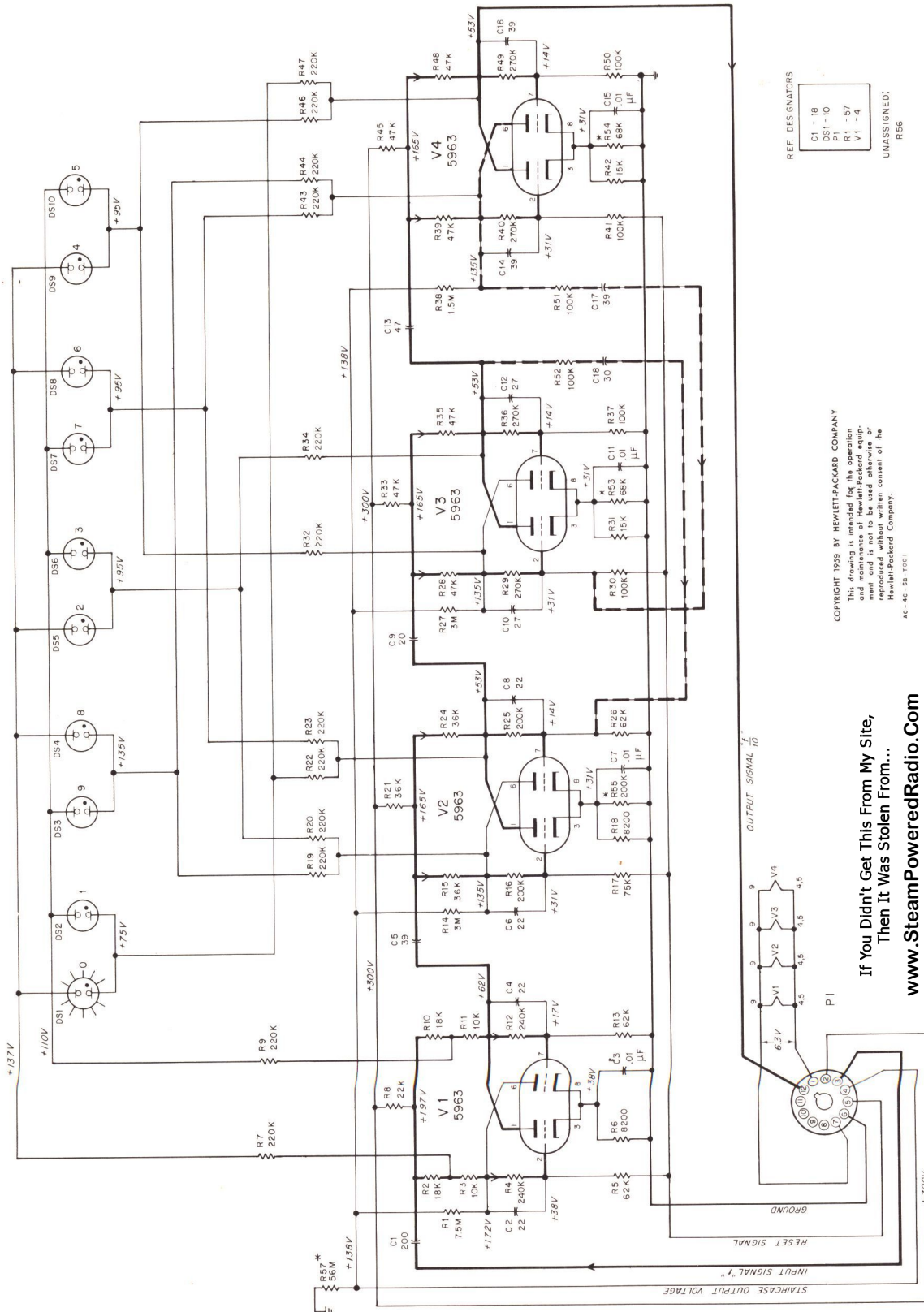
01106-2



5080-C-4

Figure 4-16. Mounting Dimensions, AC-4K, AC-4J, AC-4L

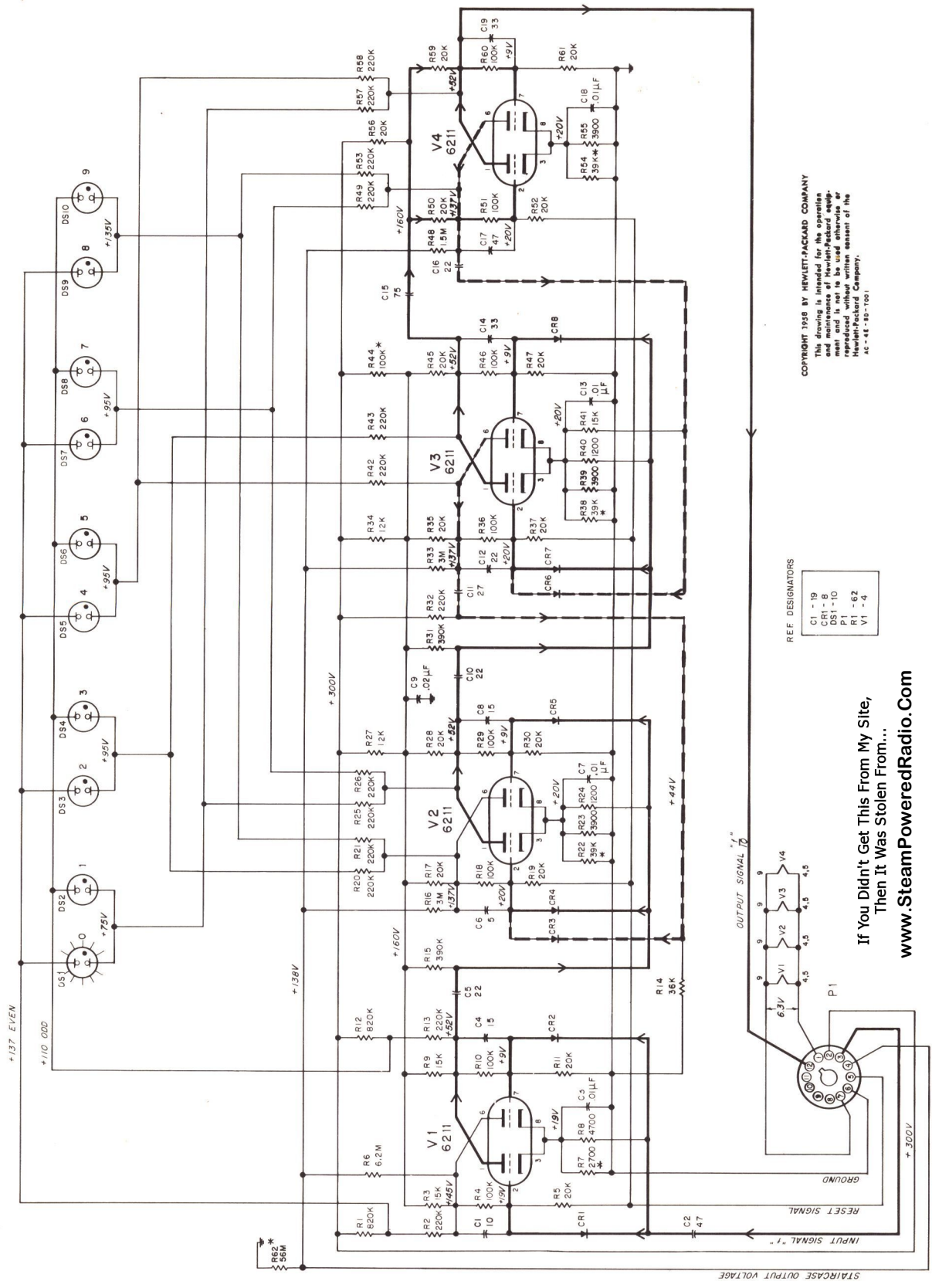
01106-3



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 ment. It is not to be used for other pur-
 poses without the written consent of the
 Hewlett-Packard Company.
 AC-4C-5B-12001

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Figure 4-17. Decade Counter AC-4C



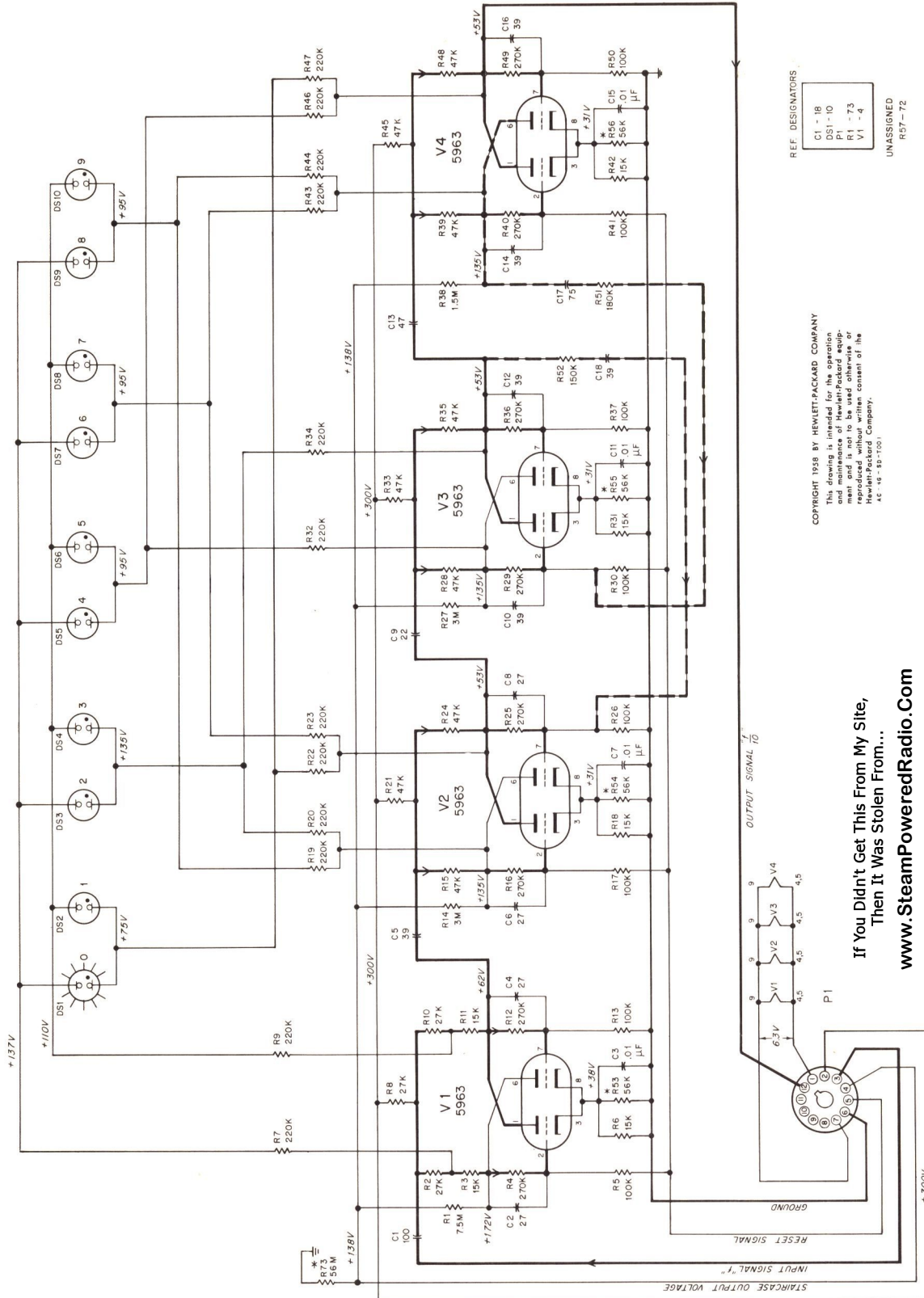
REF. DESIGNATORS
 C1 - 19
 CR1 - 8
 DS1 - 10
 P1 - 1
 R1 - 62
 V1 - 4

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 AC-4E-10-1001

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Figure 4-18. Decade Counter AC-4E

01106-2



REF. DESIGNATORS

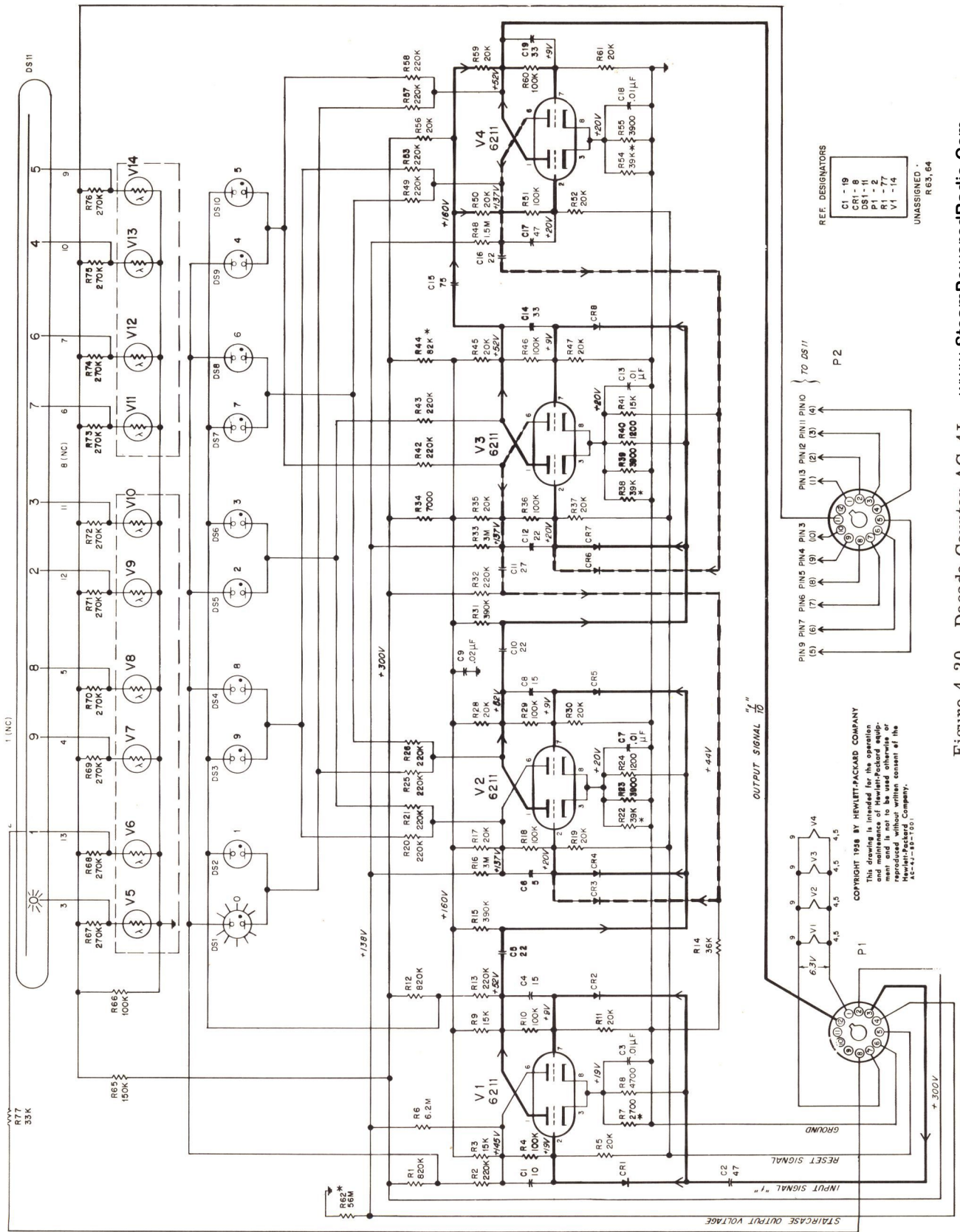
C1 - 10
DS1 - 10
P1 - 73
V1 - 4

UNASSIGNED
R57 - 72

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44-146-80-1001

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Figure 4-19. Decade Counter AC-4G

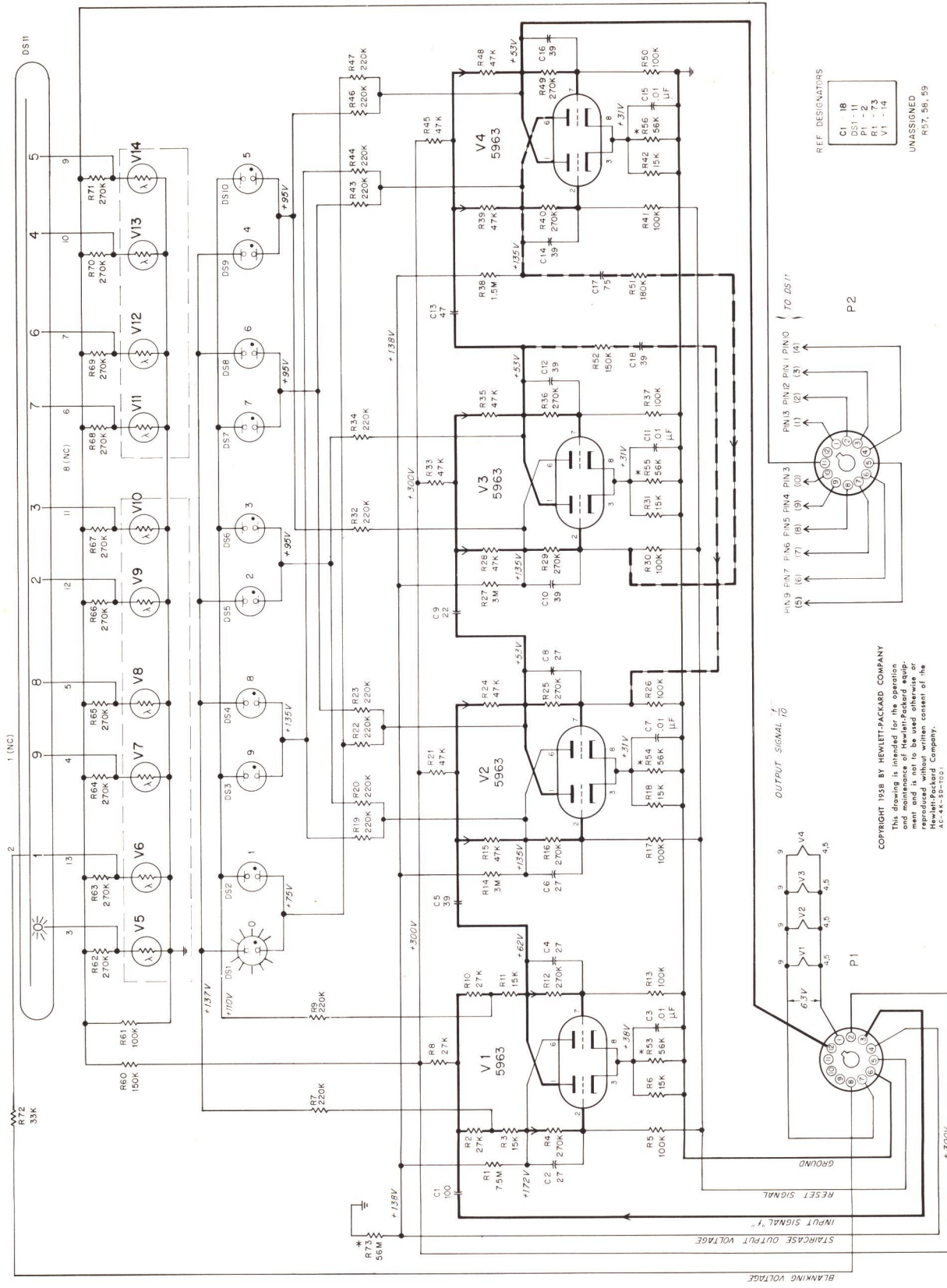


REF. DESIGNATORS

C1 - 19
DS1 - 10
P1 - 2
V1 - 14
UNASSIGNED - R 63, 64

Figure 4-20. Decade Counter AC-4J www.SteamPoweredRadio.Com

01106-2



REF DESIGNATORS

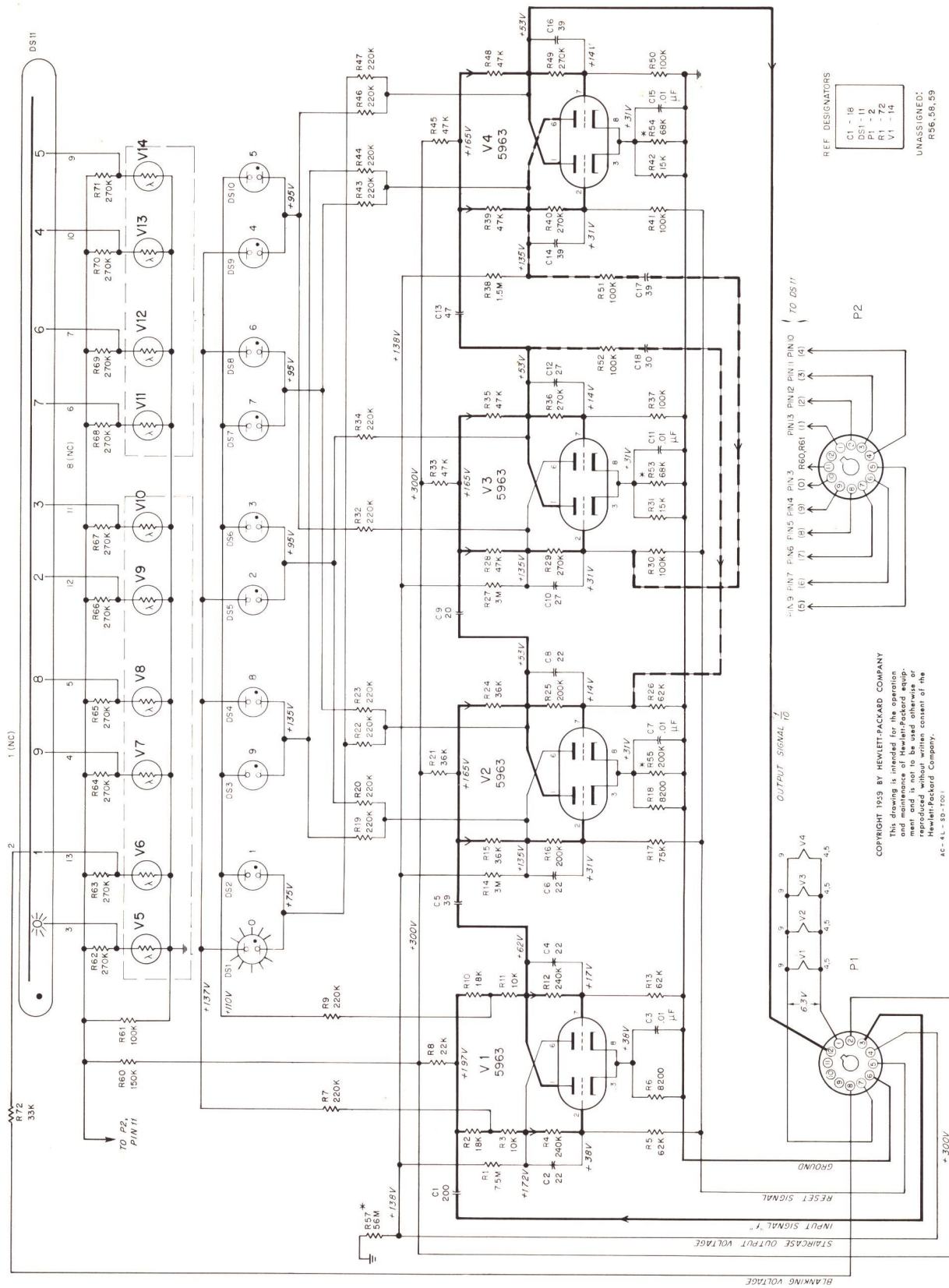
C1 - 18
DS1 - 11
P1 - 2
V1 - 3
V1 - 14

UNASSIGNED
R27, 36, 39

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Figure 4-21. Decade Counter AC-4K

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AC-4K-5D-1001



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Figure 4-22. Decade Counter AC-4L

SECTION V REPLACEABLE PARTS

5-1 INTRODUCTION

This section contains information for ordering replacement parts for the AC-4 series Decade Counter plug-in units.

Tables 5-1 through 5-3 list replaceable parts in alpha-numerical order of their reference designators. Detailed information on a part used more than once in the plug-in unit is listed opposite the first reference designator applying to the part. Parts descriptions are arranged as follows:

- Table 5-1. Models AC-4C and AC-4L
- Table 5-2. Models AC-4E and AC-4J
- Table 5-3. Models AC-4G and AC-4K

Each table includes the following information:

- 1) Reference designator.
- 2) Full description of the part.
- 3) Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.
- 4) Hewlett-Packard stock number.
- 5) Total quantity used in the plug-in unit (TQ col).
- 6) Recommended spare quantity of one plug-in unit for complete maintenance during one year of isolated service (RS col).

5-2 ORDERING INFORMATION

To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
Rue du Vieux Billard No. 1
Geneva, Switzerland

Specify the following information for each part:

- 1) Model and complete serial number of instrument.
- 2) Hewlett-Packard stock number.
- 3) Circuit reference designator.
- 4) Description.

To order a part not listed in the tables, give a complete description of the part and include its function and location.

Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 1 of 6)

Ckt Ref	Description	Mfr	Ⓜ Stock No.	TQ	RS		
C1	Capacitor: fixed, mica, 200 pf ±5%, 500 vdcw	00853	0140-0090	1	1		
C2	Capacitor: fixed, mica, 22 pf ±5%, 500 vdcw	00853	0140-0034	4	1		
C3	Capacitor: fixed, ceramic, 0.01 μf ±20%, 1000 vdcw	56289	0150-0012	4	1		
C4	Same as C2						
C5	Capacitor: fixed, mica, 39 pf ±5%, 500 vdcw	76433	0140-0035	4	1		

01106-2

Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 2 of 6)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
C6	Same as C2						
C7	Same as C3						
C8	Same as C2						
C9	Capacitor: fixed, ceramic, 20 pf $\pm 10\%$, 600 vdcw	84411	0150-0035	1	1		
C10	Capacitor: fixed, mica, 27 pf $\pm 5\%$, 500 vdcw	76433	0140-0042	2	1		
C11	Same as C3						
C12	Same as C10						
C13	Capacitor: fixed, mica, 47 pf $\pm 5\%$, 500 vdcw	76433	0140-0039	1	1		
C14	Same as C5						
C15	Same as C3						
C16, 17	Same as C5						
C18	Capacitor: fixed, mica, 30 pf $\pm 5\%$, 500 vdcw	00853	0140-0105	1	1		
DS1 thru DS10	Lamp, neon: NE2, paired, aged, (Model AC-4C only)	28480	AC-4A-8	5	5		
	Lamp, neon, NE23, single, aged, (Model AC-4L only)	28480	AC-4A-10	10	10		
DS11	Tube, digital indicator (Model AC-4L only)	83594	1970-0002	1	1		
P1, 2	Connector, male: 12-pin AC-4C AC-4L	02660	1251-0077	1 2	0 0		
R1	Resistor: fixed, composition, 7.5 megohms $\pm 5\%$, 1/2 W	01121	0686-7555	1	1		
R2	Resistor: fixed, composition, 18,000 ohms $\pm 5\%$, 1 W	75042	0698-0007	2	1		
R3	Resistor: fixed, composition, 10,000 ohms $\pm 5\%$, 1/2 W	75042	0698-0002	2	1		

* See introduction to this section

01106-2

Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 3 of 6)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
R4	Resistor: fixed, composition, 240,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2445	2	1		
R5	Resistor: fixed, composition, 62,000 ohms $\pm 5\%$, 1/2 W	01121	0686-6235	3	1		
R6	Resistor: fixed, composition, 8200 ohms $\pm 5\%$, 1/2 W	01121	0686-8225	2	1		
R7	Resistor: fixed, composition, 220,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2245	12	3		
R8	Resistor: fixed, composition, 22,000 ohms $\pm 5\%$, 1/2 W	75042	0698-0010	1	1		
R9	Same as R7						
R10	Same as R2						
R11	Same as R3						
R12	Same as R4						
R13	Same as R5						
R14	Resistor: fixed, composition, 3 megohms $\pm 1\%$, 1/2 W	19701	0727-0292	2	1		
R15	Resistor: fixed, composition, 36,000 ohms $\pm 5\%$, 1 W	75042	0698-0008	2	1		
R16	Resistor: fixed, composition, 200,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2045	3	1		
R17	Resistor: fixed, composition, 75,000 ohms $\pm 5\%$, 1/2 W	01121	0686-7535	1	1		
R18	Same as R6						
R19, 20	Same as R7						
R21	Resistor: fixed, composition, 36,000 ohms $\pm 5\%$, 1/2 W	01121	0686-3635	1	1		
R22, 23	Same as R7						
R24	Same as R15						
R25	Same as R16						

* See introduction to this section

01106-2

Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 4 of 6)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
R26	Same as R5						
R27	Same as R14						
R28	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1/2 W	75042	0698-0005	4	1		
R29	Resistor: fixed, composition, 270,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2745	4	1		
R30	Resistor: fixed, composition, 100,000 ohms $\pm 5\%$, 1/2 W	01121	0686-1045	6	2		
R31	Resistor: fixed, composition, 15,000 ohms $\pm 5\%$, 1/2 W	01121	0686-1535	2	1		
R32	Same as R7						
R33	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1 W	75042	0698-0009	1	1		
R34	Same as R7						
R35	Same as R28						
R36	Same as R29						
R37	Same as R30						
R38	Resistor: fixed, deposited carbon, 1.5 megohms $\pm 1\%$, 1/2 W	19701	0727-0282	1	1		
R39	Same as R28						
R40	Same as R29						
R41	Same as R30						
R42	Same as R31						
R43, 44	Same as R7						
R45	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1 W	01121	0689-4735	1	1		
R46, 47	Same as R7						
R48	Same as R28						

* See introduction to this section

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Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 5 of 6)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
R49	Same as R29						
R50 thru R52	Same as R30						
R53, 54	Resistor: fixed, composition, 68,000 ohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-6831	2	1		
R55	Same as R16 Optimum value selected at factory Average value shown						
R56	Not assigned						
R57	Resistor: fixed, composition, 56 megohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-5661	1	1		
R58, 59	Not assigned						
R60	Resistor: fixed, composition, 150,000 ohms $\pm 10\%$, 1/2 W (Model AC-4L only)	01121	0687-1541	1	1		
R61	Resistor: fixed, composition, 100,000 ohms $\pm 10\%$, 1/2 W (Model AC-4L only)	01121	0687-1041	1	1		
R62 thru R71	Resistor: fixed, composition, 470,000 ohms $\pm 10\%$, 1/4 W (Model AC-4L only)	01121	0684-4741	10	3		
R72	Resistor: fixed, composition, 33,000 ohms $\pm 10\%$, 1/2 W (Model AC-4L only)	01121	0687-3331	1	1		
R73	Resistor: fixed, composition, 56 megohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-5661	1	1		
V1 thru V4	Tube, electron: 5963	80131	1932-0008	4	4		
V5 thru V10	Photoconductor plate, 6 units (Model AC-4L only)	28480	AC-4H-3	1	0		

* See introduction to this section

Table 5-1. Replaceable Parts, Models AC-4C and AC-4L (Sheet 6 of 6)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
V11 thru V14	Photoconductor plate, 4 units (Model AC-4L only)	28480	AC-4H-2	1	0		
	<u>MISCELLANEOUS</u>						
	Lamp block, neon (Model AC-4C only)	28480	AC-4E-2	1	0		
	Lamp block, neon (Model AC-4L only)	28480	AC-4J-3	1	0		
	Numeral panel, plastic (Model AC-4C only)	28480	AC-4A-6	1	0		
	Socket, tube: 9 pin	91662	1200-0008	4	0		

Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 1 of 6)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
C1	Capacitor: fixed, ceramic, 10 pf \pm 0.5 pf, 500 vdcw	96095	0150-0009	1	1		
C2	Capacitor: fixed, mica, 47 pf \pm 5%, 500 vdcw	76433	0140-0039	2	1		
C3	Capacitor: fixed, ceramic, 0.01 μ f \pm 20%, 1000 vdcw	56289	0150-0012	4	1		
C4	Capacitor: fixed, mica, 15 pf \pm 10%, 500 vdcw	00853	0140-0004	2	1		
C5	Capacitor: fixed, mica, 22 pf \pm 5%, 500 vdcw	00853	0140-0034	4	1		
C6	Capacitor: fixed, mica, 5 pf \pm 20%, 500 vdcw	76433	0140-0033	1	1		
C7	Same as C3						
C8	Same as C4						
C9	Capacitor: fixed, ceramic, 0.02 μ f \pm 10%, 600 vdcw	91418	0150-0024	1	1		
C10	Same as C5						

* See introduction to this section

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Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 2 of 6)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
C11	Capacitor: fixed, mica, 27 pf $\pm 5\%$, 500 vdcw	76433	0140-0042	1	1		
C12	Same as C5						
C13	Same as C3						
C14	Capacitor: fixed, mica, 33 pf $\pm 5\%$, 500 vdcw	76433	0140-0100	2	1		
C15	Capacitor: fixed, mica, 75 pf $\pm 5\%$, 500 vdcw	00853	0140-0040	1	1		
C16	Same as C5						
C17	Same as C2						
C18	Same as C3						
C19	Same as C14						
CR1 thru CR8	Diode, germanium: type HD-2135A	73293	1910-0011	8	8		
DS1 thru DS10	Lamp, neon: NE2, paired, aged, (Model AC-4E only)	28480	AC-4A-8	5	5		
	Lamp, neon: NE23, single, aged, (Model AC-4J only)	28480	AC-4A-10	10	10		
DS11	Tube, digital indicator (Model AC-4J only)	83594	1970-0002	1	1		
P1,2	Connector, male: 12-pin AC-4E AC-4J	02660	1251-0077	1 2	0 0		
R1	Resistor: fixed, composition, 820,000 ohms $\pm 10\%$, 1/2 W	01121	0687-8241	2	1		
R2	Resistor: fixed, composition, 220,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2245	13	3		
R3	Resistor: fixed, metal film, 15,000 ohms $\pm 5\%$, 3 W	07115	0767-0010	2	1		

* See introduction to this section

Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 3 of 6)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
R4	Resistor: fixed, composition, 100,000 ohms $\pm 5\%$, 1/2 W	01121	0686-1045	9	2		
R5	Resistor: fixed, composition, 20,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2035	8	2		
R6	Resistor: fixed, composition, 6.2 megohms $\pm 5\%$, 1/2 W	01121	0686-6255	1	1		
R7	Resistor: fixed, composition, 2700 ohms $\pm 5\%$, 1/2 W Optimum value selected at factory. Average value shown.	01121	0686-2725	1	1		
R8	Resistor: fixed, composition, 4700 ohms $\pm 10\%$, 1/2 W	01121	0687-4721	1	1		
R9	Same as R3						
R10	Same as R4						
R11	Same as R5						
R12	Same as R1						
R13	Same as R2						
R14	Resistor: fixed, composition, 36,000 ohms $\pm 5\%$, 1/2 W	01121	0686-3635	1	1		
R15	Resistor: fixed, composition, 390,000 ohms $\pm 10\%$, 1/2 W	01121	0687-3941	2	1		
R16	Resistor: fixed, deposited carbon, 3 megohms $\pm 1\%$, 1/2 W	19701	0727-0292	2	1		
R17	Resistor: fixed, metal film, 20,000 ohms $\pm 5\%$, 3 W	07115	0767-0011	7	2		
R18	Same as R4						
R19	Same as R5						
R20,21	Same as R2						
R22	Resistor: fixed, composition, 39,000 ohms $\pm 10\%$, 1/2 W Optimum value selected at factory. Average value shown.	01121	0687-3931	3	1		
R23	Resistor: fixed, composition, 3900 ohms $\pm 5\%$, 1/2 W	01121	0686-3925	3	1		

* See introduction to this section

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Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 4 of 6)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
R24	Resistor: fixed, composition, 1200 ohms $\pm 10\%$, 1/2 W	01121	0687-1221	2	1		
R25, 26	Same as R2						
R27	Resistor: fixed, metal film, 12,000 ohms $\pm 5\%$, 3 W (Model AC-4E only)	07115	0767-0009	2	1		
R28	Same as R17						
R29	Same as R4						
R30	Same as R5						
R31	Same as R15						
R32	Same as R2						
R33	Same as R16						
R34	Same as R27 (Model AC-4E only) Resistor: fixed, metal film, 7000 ohms $\pm 5\%$, 5 W (Model AC-4J only)	07115	0773-0003	1	1		
R35	Same as R17						
R36	Same as R4						
R37	Same as R5						
R38	Same as R22 - Optimum value selected at factory. Average value shown.						
R39	Same as R23						
R40	Same as R24						
R41	Resistor: fixed, composition, 15,000 ohms $\pm 10\%$, 1/2 W	01121	0687-1531	1	1		
R42, 43	Same as R2						
R44	Same as R4 (Model AC-4E only) Optimum value selected at factory Average value shown Resistor: fixed, composition, 82,000 ohms $\pm 10\%$, 1 W Optimum value selected at factory Average value shown (Model AC-4J only)	01121	0690-8231	1	1		

* See introduction to this section

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Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 5 of 6)

Ckt Ref	Description	Mfr *	Stock No.	TQ*	RS*		
R45	Same as R17						
R46	Same as R4						
R47	Same as R5						
R48	Resistor: fixed, deposited carbon, 1.5 megohms $\pm 1\%$, 1/2 W	19701	0727-0282	1	1		
R49	Same as R2						
R50	Same as R17						
R51	Same as R4						
R52	Same as R5						
R53	Same as R2						
R54	Same as R22 - Optimum value selected at factory. Average value shown.						
R55	Same as R23						
R56	Same as R17						
R57, 58	Same as R2						
R59	Same as R17						
R60	Same as R4						
R61	Same as R5						
R62	Resistor: fixed, composition, 56 megohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-5661	1	1		
R63, 64	Not assigned						
R65	Resistor: fixed, composition, 150,000 ohms $\pm 10\%$, 1/2 W (Model AC-4J only)	01121	0687-1541	1	1		
R66	Same as R4 (Model AC-4J only)						
R67 thru R76	Resistor: fixed, composition, 270,000 ohms $\pm 10\%$, 1/4 W (Model AC-4J only)	01121	0684-2741	10	3		

* See introduction to this section

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Table 5-2. Replaceable Parts, Models AC-4E and AC-4J (Sheet 6 of 6)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
R77	Resistor: fixed, composition, 33,000 ohms $\pm 10\%$, 1/2 W	01121	0687-3331	1	1		
V1 thru V4	Tube, electron: 6211	80131	1932-0012	4	4		
V5 thru V10	Photoconductor plate, 6 units (Model AC-4J only)	28480	AC-4H-3	1	0		
V11 thru V14	Photoconductor plate, 4 units (Model AC-4J only)	28480	AC-4H-2	1	0		
<u>MISCELLANEOUS</u>							
	Lamp block, neon (Model AC-4E only)	28480	AC-4E-2	1	0		
	Lamp block, neon (Model AC-4J only)	28480	AC-4J-3	1	0		
	Numeral plate, plastic (Model AC-4E only)	28480	AC-4A-6	1	0		
	Socket, tube: 9 pin	91662	1200-0018	4	0		

Table 5-3. Replaceable Parts, Models AC-4G and AC-4K (Sheet 1 of 5)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
C1	Capacitor: fixed, mica, 100 pf $\pm 5\%$, 500 vdcw	00853	0140-0041	1	1		
C2	Capacitor: fixed, mica, 27 pf $\pm 5\%$, 500 vdcw	76433	0140-0042	4	1		
C3	Capacitor: fixed, ceramic, 0.01 μ f $\pm 20\%$, 1000 vdcw	56289	0150-0012	4	1		
C4	Same as C2						
C5	Capacitor: fixed, mica, 39 pf $\pm 5\%$, 500 vdcw	76433	0140-0035	6	2		
C6	Same as C2						

* See introduction to this section

Table 5-3. Replaceable Parts, Models AC-4G and AC-4K (Sheet 2 of 5)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
C7	Same as C3						
C8	Same as C2						
C9	Capacitor: fixed, mica, 22 pf ±5%, 500 vdcw	00853	0140-0034	1	1		
C10	Same as C5						
C11	Same as C3						
C12	Same as C5						
C13	Capacitor: fixed, mica, 47 pf ±5%, 500 vdcw	76433	0140-0039	1	1		
C14	Same as C5						
C15	Same as C3						
C16	Same as C5						
C17	Capacitor: fixed, mica, 75 pf ±5%, 500 vdcw	00853	0140-0040	1	1		
C18	Same as C5						
DS1 thru DS10	Lamp, neon: NE2, paired, aged (Model AC-4G only)	28480	AC-4A-8	5	5		
	Lamp, neon: NE23, single, aged (Model AC-4K only)	28480	AC-4A-10	10	10		
DS11	Tube, digital indicator (Model AC-4K only)	83594	1970-0002	1	1		
P1,2	Connector, male: 12-pin AC-4G AC-4K	02660	1251-0077	1 2	0 0		
R1	Resistor: fixed, composition, 7.5 megohms ±5%, 1/2 W	01121	0686-7555	1	1		
R2	Resistor: fixed, composition, 27,000 ohms ±5%, 1/2 W	75042	0698-0004	2	1		
R3	Resistor: fixed, composition, 15,000 ohms ±5%, 1/2 W	75042	0698-0003	2	1		

* See introduction to this section

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Table 5-3. Replaceable Parts, Models AC-4G and AC-4K (Sheet 3 of 5)

Ckt Ref	Description	Mfr *	Ⓟ Stock No.	TQ*	RS*		
R4	Resistor: fixed, composition, 270,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2745	8	2		
R5	Resistor: fixed, composition, 100,000 ohms $\pm 5\%$, 1/2 W	01121	0686-1045	8	2		
R6	Resistor: fixed, composition, 15,000 ohms $\pm 5\%$, 1/2 W	01121	0686-1535	4	1		
R7	Resistor: fixed, composition, 220,000 ohms $\pm 5\%$, 1/2 W	01121	0686-2245	12	3		
R8	Resistor: fixed, composition, 27,000 ohms $\pm 5\%$, 1 W	01121	0689-2735	1	1		
R9	Same as R7						
R10	Same as R2						
R11	Same as R3						
R12	Same as R4						
R13	Same as R5						
R14	Resistor: fixed, deposited carbon, 3 megohms $\pm 1\%$, 1/2 W	19701	0727-0292	2	1		
R15	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1/2 W	75042	0698-0005	6	2		
R16	Same as R4						
R17	Same as R5						
R18	Same as R6						
R19, 20	Same as R7						
R21	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1 W	75042	0698-0009	2	1		
R22, 23	Same as R7						
R24	Same as R15						
R25	Same as R4						
R26	Same as R5						

* See introduction to this section

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Table 5-3. Replaceable Parts, Models AC-4G and AC-4K (Sheet 4 of 5)

Ckt Ref	Description	Mfr *	Stock No.	TQ*	RS*		
R27	Same as R14						
R28	Same as R15						
R29	Same as R4						
R30	Same as R5						
R31	Same as R6						
R32	Same as R7						
R33	Same as R21						
R34	Same as R7						
R35	Same as R15						
R36	Same as R4						
R37	Same as R5						
R38	Resistor: fixed, composition, 1.5 megohms $\pm 1\%$, 1/2 W	19701	0727-0282	1	1		
R39	Same as R15						
R40	Same as R4						
R41	Same as R5						
R42	Same as R6						
R43, 44	Same as R7						
R45	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1 W	01121	0689-4735	1	1		
R46, 47	Same as R7						
R48	Same as R15						
R49	Same as R4						
R50	Same as R5						
R51	Resistor: fixed, composition, 180,000 ohms $\pm 10\%$, 1/2 W	01121	0687-1841	1	1		
R52	Resistor: fixed, composition, 150,000 ohms $\pm 10\%$, 1/2 W	01121	0687-1541	1	1		

* See introduction to this section

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Table 5-3. Replaceable Parts, Models AC-4G and AC-4K (Sheet 5 of 5)

Ckt Ref	Description	Mfr *	Ⓢ Stock No.	TQ*	RS*		
R53 thru R55	Resistor: fixed, composition, 68,000 ohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-5631	3	1		
R56	Resistor: fixed, composition, 47,000 ohms $\pm 5\%$, 1/2 W (Model AC-4G only) Optimum value selected at factory Average value shown	01121	0686-4735	1	1		
	Resistor: fixed, composition, 27,000 ohms $\pm 5\%$, 1/2 W (Model AC-4K only) Optimum value selected at factory Average value shown	01121	0686-2735	1	1		
R57 thru R59	Not assigned						
R60	Same as R52 (Model AC-4K only)						
R61	Resistor: fixed, composition, 100,000 ohms $\pm 10\%$, 1/2 W (Model AC-4K only)	01121	0687-1041	1	1		
R62 thru R71	Resistor: fixed, composition, 270,000 ohms $\pm 10\%$, 1/4 W (Model AC-4K only)	01121	0684-2741	10	3		
R72	Resistor: fixed, composition, 33,000 ohms $\pm 10\%$, 1/2 W (Model AC-4K only)	01121	0687-3331	1	1		
R73	Resistor: fixed, composition, 56 megohms $\pm 10\%$, 1/2 W Optimum value selected at factory Average value shown	01121	0687-5661	1	1		
V1 thru V4	Tube, electron: 5963	80131	1932-0008	4	4		
V5 thru V10	Photoconductor plate: 6 units (Model AC-4K only)	28480	AC-4H-3	1	0		
V11 thru V14	Photoconductor plate: 4 units (Model AC-4K only)	28480	AC-4H-2	1	0		
	<u>MISCELLANEOUS</u>						
	Lamp block, neon (Model AC-4G only)	28480	AC-4E-2	1	0		
	Lamp block, neon (Model AC-4K only)	28480	AC-4J-3	1	0		
	Numeral plate, plastic (Model AC-4G only)	28480	AC-4A-6	1	0		
	Socket, tube: 9 pin	91662	1200-0008	4	0		

* See introduction to this section

APPENDIX

CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
00334	Humidial Co.	Colton, Calif.	08717	Sloan Company	Burbank, Calif.	66346	Wollensak Optical Co.	Rochester, N.Y.
00335	Westrex Corp.	New York, N.Y.	08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.	70119	Advance Electric and Relay Co.	Burbank, Calif.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.	08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.	70276	Allen Mfg. Co.	Hartford, Conn.
00656	Aerovox Corp.	New Bedford, Mass.	09134	Texas Capacitor Co.	Houston, Texas	70309	Allied Control Co., Inc.	New York, N.Y.
00779	Amp, Inc.	Harrisburg, Pa.	09250	Electro Assemblies, Inc.	Chicago, Ill.	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
00781	Aircraft Radio Corp.	Boonton, N.J.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	70563	Amperite Co., Inc.	New York, N.Y.
00853	Sangamo Electric Co., Cap. Div.	Marion, Ill.	10411	Ti-Tal, Inc.	Berkeley, Calif.	70903	Belden Mfg. Co.	Chicago, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.	10646	Carborundum Co.	Niagara Falls, N.Y.	70998	Bird Electronic Corp.	Cleveland, Ohio
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	11236	CTS of Berne, Inc.	Berne, Ind.	71002	Birnbach Radio Co.	New York, N.Y.
01121	Allen Bradley Co.	Milwaukee, Wis.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	71218	Bud Radio Inc.	Cleveland, Ohio
01255	Litton Industries, Inc.	Beverly Hills, Calif.	11264	Dymec, Inc.	Palo Alto, Calif.	71286	Camloc Fastener Corp.	Paramus, N.J.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.	12697	Clarostat Mfg. Co.	Dover, N.H.	71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
01295	Texas Instruments, Inc. Semiconductor Components Div.	Dallas, Texas	14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.	71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
01349	The Alliance Mfg. Co.	Alliance, Ohio	15909	The Daven Co.	Livingston, N.J.	71450	CTS Corp.	Elkhart, Ind.
01561	Chassi-Trak Corp.	Indianapolis, Ind.	16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.	71468	Cannon Electric Co.	Los Angeles, Calif.
01961	Pulse Engineering Co.	Santa Clara, Calif.	18873	E. I. DuPont and Co., Inc.	Wilmington, Del.	71471	Cinema Engineering Co.	Burbank, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.	19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.	71482	C. P. Clare & Co.	Chicago, Ill.
02286	Cole Mfg. Co.	Palo Alto, Calif.	19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
02660	Amphenol Electronics Corp.	Chicago, Ill.	19701	Electra Manufacturing Co.	Kansas City, Mo.	71700	The Cornish Wire Co.	New York, N.Y.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.	20183	Electronic Tube Corp.	Philadelphia, Pa.	71744	Chicago Miniature Lamp Works	Chicago, Ill.
02777	Hopkins Engineering Co.	San Fernando, Calif.	21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.	71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.	21335	The Fafnir Bearing Co.	New Britain, Conn.	71785	Cinch Mfg. Corp.	Chicago, Ill.
03705	Apex Machine & Tool Co.	Dayton, Ohio	21964	Fed. Telephone and Radio Corp.	Clifton, N.J.	71984	Dow Corning Corp.	Midland, Mich.
03797	Eldema Corp.	El Monte, Calif.	24446	General Electric Co. G. E. Lamp Division	Schenectady, N.Y.	72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
03877	Transitron Electronic Corp.	Wakefield, Mass.	24455	General Electric Co. G. E. Lamp Division	Nela Park, Cleveland, Ohio	72354	John E. Fast & Co.	Chicago, Ill.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.	24655	General Radio Co.	West Concord, Mass.	72619	Dialight Corp.	Brooklyn, N.Y.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.	72656	General Ceramics Corp.	Keasbey, N.J.
04062	Elmenco Products Co.	New York, N.Y.	26992	Hamilton Watch Co.	Lancaster, Pa.	72758	Girard-Hopkins	Oakland, Calif.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.	28480	Hewlett-Packard Co.	Palo Alto, Calif.	72765	Drake Mfg. Co.	Chicago, Ill.
04651	Special Tube Operations of Sylvania Electronic Systems	Mountain View, Calif.	33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	35434	Pectrohm Inc.	Chicago, Ill.	72928	Gudeman Co.	Chicago, Ill.
04732	Filtron Co., Inc. Western Division	Culver City, Calif.	37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.	72982	Erie Resistor Corp.	Erie, Pa.
04777	Automatic Electric Sales Corp.	Northlake, Ill.	39543	Mechanical Industries Prod. Co.	Akron, Ohio	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.	40920	Miniature Precision Bearings, Inc.	Keene, N.H.	73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.	42190	Muter Co.	Chicago, Ill.	73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
05624	Barber Colman Co.	Rockford, Ill.	43990	C. A. Norgren Co.	Englewood, Colo.	73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
05783	Stewart Engineering Co.	Soquel, Calif.	44655	Ohmite Mfg. Co.	Skokie, Ill.	73506	Bradley Semiconductor Corp.	New Haven, Conn.
06004	The Bassick Co.	Bridgport, Conn.	47904	Polaroid Corp.	Cambridge, Mass.	73559	Carling Electric, Inc.	Hartford, Conn.
06812	Torrington Mfg. Co., West. Div.	Van Nuys, Calif.	48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.	73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.	49956	Raytheon Mfg. Co.	Waltham, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
07126	Digitran Co.	Pasadena, Calif.	54294	Shallcross Mfg. Co.	Selma, N.C.	73793	The General Industries Co.	Elyria, Ohio
07137	Transistor Electronics Corp.	Minneapolis, Minn.	55026	Simpson Electric Co.	Chicago, Ill.	73905	Jennings Radio Mfg. Co.	San Jose, Calif.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.	55933	Sonotone Corp.	Elmsford, N.Y.	74455	J. H. Winns, and Sons	Winchester, Mass.
07261	Avnet Corp.	Los Angeles, Calif.	55938	Sorenson & Co., Inc.	So. Norwalk, Conn.	74861	Industrial Condenser Corp.	Chicago, Ill.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.	56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.	74868	Industrial Products Co.	Danbury, Conn.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.	56289	Sprague Electric Co.	North Adams, Mass.	74970	E. F. Johnson Co.	Waseca, Minn.
07980	Boonton Radio Corp.	Boonton, N.J.	61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	75042	International Resistance Co.	Philadelphia, Pa.
08145	U.S. Engineering Co.	Los Angeles, Calif.	62119	Universal Electric Co.	Owosso, Mich.	75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	64959	Western Electric Co., Inc.	New York, N.Y.	75378	James Knights Co.	Sandwich, Ill.
			65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.	75382	Kulka Electric Mfg. Co., Inc.	Mt. Vernon, N.Y.
						75818	Lenz Electric Mfg. Co.	Chicago, Ill.
						75915	Littelfuse Inc.	Des Plaines, Ill.
						76005	Lord Mfg. Co.	Erie, Pa.
						76210	C. W. Marwedel	San Francisco, Calif.

APPENDIX CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.	83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.	96341	Microwave Associates, Inc.	Burlington, Mass.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.	83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	96501	Excel Transformer Co.	Oakland, Calif.
76530	Monadnock Mills	San Leandro, Calif.	83821	Loyd Scruggs Co.	Festus, Mo.	97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
76545	Mueller Electric Co.	Cleveland, Ohio	84171	Arco Electronics, Inc.	New York, N.Y.	97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
76854	Oak Manufacturing Co.	Chicago, Ill.	84396	A. J. Glesener Co., Inc.	San Francisco, Calif.	98141	Axel Brothers Inc.	Jamaica, N.Y.
77068	Bendix Corp., Bendix Pacific Div.	No. Hollywood, Calif.	84411	Good All Electric Mfg. Co.	Ogallala, Neb.	98220	Francis L. Mosley	Pasadena, Calif.
77221	Phaotron Instrument and Electronic Co.	South Pasadena, Calif.	84970	Sarkes Tarzian, Inc.	Bloomington, Ind.	98278	Microdot, Inc.	So. Pasadena, Calif.
77342	Potter and Brumfield, Inc.	Princeton, Ind.	85474	R. M. Bracamonte & Co.	San Francisco, Calif.	98291	Sealectro Corp.	New Rochelle, N.Y.
77630	Radio Condenser Co.	Camden, N.J.	85660	Koiled Kords, Inc.	New Haven, Conn.	98405	Carad Corp.	Redwood City, Calif.
77634	Radio Essentials Inc.	Mt. Vernon, N.Y.	85911	Seamless Rubber Co.	Chicago, Ill.	98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.	86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.	98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
77764	Resistance Products Co.	Harrisburg, Pa.	87473	Western Fibrous Glass Products Co.	San Francisco, Calif.	98978	International Electronic Research Corp.	Burbank, Calif.
78283	Signal Indicator Corp.	New York, N.Y.	88140	Cutler-Hammer, Inc.	Lincoln, Ill.	99109	Columbia Technical Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.	89473	General Electric Distributing Corp.	Schenectady, N.Y.	99313	Varian Associates	Palo Alto, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.	90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.	99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
78790	Transformer Engineers	Pasadena, Calif.	90970	Bearing Engineering Co.	San Francisco, Calif.	99707	Control Switch Division, of America	Controls Co. El Segundo, Calif.
78947	Ucinite Co.	Newtonville, Mass.	91418	Radio Materials Co.	Chicago, Ill.	99800	Delevan Electronics Corp.	East Aurora, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.	91506	Augat Brothers, Inc.	Attleboro, Mass.	99821	North Hills Electric Co.	Great Neck, L.I., N.Y.
79251	Wenco Mfg. Co.	Chicago, Ill.	91637	Dale Products, Inc.	Columbus, Neb.	99848	Wilco Corporation	Indianapolis, Ind.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.	91662	Elco Corp.	Philadelphia, Pa.	99934	Renbrandt, Inc.	Boston, Mass.
80031	Meppo Division of Sessions Clock Co.	Morristown, N.J.	91737	Gremer Mfg. Co., Inc.	Wakefield, Mass.	99942	Hoffman Semiconductor Div. of Hoffman Electronics, Corp.	Evanston, Ill.
80130	Times Facsimile Corp.	New York, N.Y.	91827	K F Development Co.	Redwood City, Calif.	99957	Technology Instruments Corp. of Calif.	No. Hollywood, Calif.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.	91929	Micro-Switch Div. of Minneapolis Honeywell Regulator Co.	Freeport, Ill.			
80248	Oxford Electric Corp.	Chicago, Ill.	92196	Universal Metal Products, Inc.	Bassett Puente, Calif.			
80411	Acro Manufacturing Co.	Columbus, Ohio	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.			
80486	All Star Products Inc.	Defiance, Ohio	93369	Robbins and Myers, Inc.	New York, N.Y.			
80583	Hammerlund Co., Inc.	New York, N.Y.	93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio			
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.	93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.			
81030	International Instruments, Inc.	New Haven, Conn.	94144	Raytheon Mfg. Co., Receiving Tube Div.	Quincy, Mass.	0000C	Connor Spring Mfg. Co.	San Francisco, Calif.
81415	Wilkor Products, Inc.	Cleveland, Ohio	94145	Raytheon Mfg. Co., Semi- conductor Div.	Newton, Mass.	0000D	Connex Corp.	Oakland, Calif.
81453	Raytheon Mfg. Co., Industrial Tube Division	Quincy, Mass.	94148	Scientific Radio Products, Inc.	Loveland, Colo.	0000E	Fisher Switches, Inc.	San Francisco, Calif.
81483	International Rectifier Corp.	El Segundo, Calif.	94154	Tung-Sol Electric, Inc.	Newark, N.J.	0000F	Malco Tool and Die	Los Angeles, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.	94197	Curtiss-Wright Corp., Electronics Div.	Carlstadt, N.J.	0000G	Microwave Engineering Co.	Palo Alto, Calif.
82042	Carter Parts Co.	Skokie, Ill.	94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.	0000H	Philco Corp. (Lansdale Division)	Lansdale, Pa.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.	95236	Allies Products Corp.	Miami, Fla.	0000I	Telefunken (c/o American Elite)	New York, N.Y.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.	95238	Continental Connector Corp.	Woodside, N.Y.	0000L	Winchester Electronics, Inc.	Santa Monica, Calif.
82209	Maguire Industries, Inc.	Greenwich, Conn.	95263	Leecraft Mfg. Co., Inc.	New York, N.Y.	0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.	95265	National Coil Co.	Sheridan, Wyo.	0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
82376	Astron Co.	East Newark, N.J.	95354	Methode Mfg. Co.	Chicago, Ill.	0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
82389	Switchcraft, Inc.	Chicago, Ill.	95987	Weckesser Co.	Chicago, Ill.	0000R	Metro Cap. Div., Metropolitan Telecommunications Corp.	Brooklyn, N.Y.
82647	Texas Instruments, Inc., Metals and Controls Div., Spencer Products	Attleboro, Mass.	96067	Huggins Laboratories	Sunnyvale, Calif.	0000S	Moulton Electronics	San Carlos, Calif.
82866	Research Products Corp.	Madison, Wis.	96095	Hi-Q Division of Aerovox	Olean, N.Y.	0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
82893	Vector Electronic Co.	Glendale, Calif.	96296	Solar Manufacturing Co.	Los Angeles, Calif.	0000U	Tower Mfg. Corp.	Providence, R.I.
83148	Electro Cords Co.	Los Angeles, Calif.	96330	Carlton Screw Co.	Chicago, Ill.	0000V	Imperial Electronics, Inc.	Buena Park, Calif.
83186	Victory Engineering Corp.	Union, N.J.						
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.						

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.


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H4-1 Dated Oct. 1960
H4-2 Dated Oct. 1960



WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your authorized  Sales Representative for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.


CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your authorized  Sales Representative is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, U.S.A.
Telephone: (415) 326-3950
TWX No. PAL AL 117-U
Cable: "HEWPACK"

OR (In Western Europe)

Hewlett-Packard S.A.
54 Route Des Acacias
Geneva, Switzerland
Telephone: (022) 42. 81. 50
Cable: "HEWPACKSA"



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