HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

350C/D

ATTENUATOR SET

350C/D

OPERATING AND SERVICE MANUAL

MODEL 350C/D

SERIALS PREFIXED: 220-

ATTENUATOR SET

Box 301, Loveland, Colorado

01307-1

Printed: OCT 1962

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

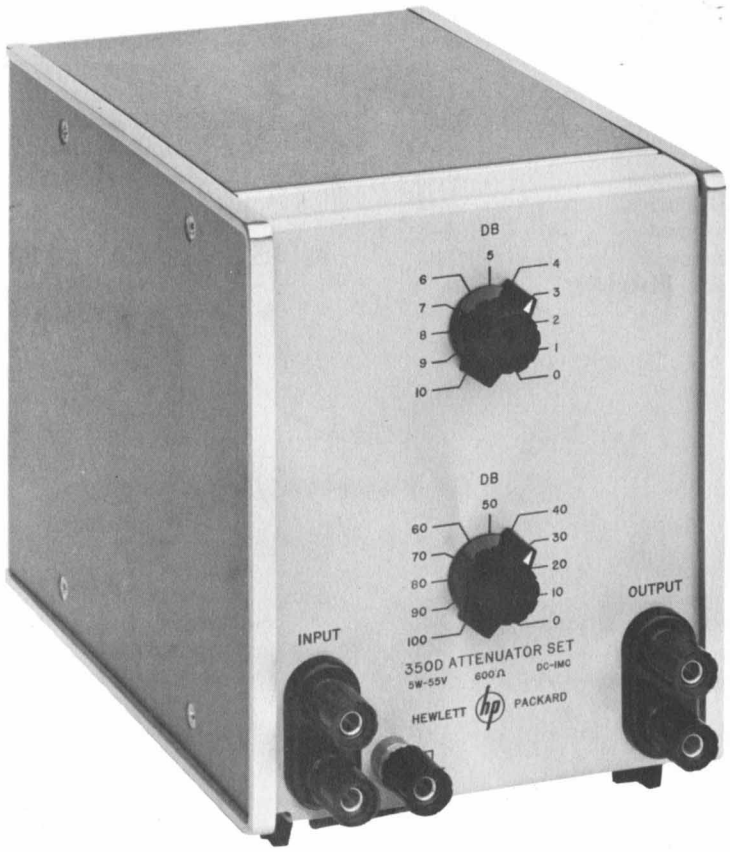


Figure 1-1. Model 350D Attenuator Set

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. DIFFERENCE BETWEEN MODELS 350C AND 350D.

1-3. The basic difference between the hp Model 350C and Model 350D Attenuator Set is the input-output impedance value. The Model 350C has an input-output impedance of 500 ohms, and the Model 350D an input-output impedance of 600 ohms. Because of the similarity in design, use, circuitry and specifications, the two instruments are referred to as the Model 350C/D in this manual.

1-4. DESCRIPTION.

1-5. The Model 350C/D (Model 350D shown in figure 1-1) is an accurate, wide frequency range attenuator which provides attenuation from 0 db to a maximum of 110 db. Specifications for both instruments are given in table 1-1. The Model 350C/D will dissipate a maximum of 5 watts in continuous use with good accuracy from dc to 1 Mc. Each Model 350C/D consists of two sections: (1) 100 db adjustable in 10 db-steps, and (2) 10 db, adjustable in 1-db steps. The two sections are additive, allowing attenuation in 1-db or 10-db increments over the full 110-db range. A floating input is included which isolates the attenuator circuit ground from cabinet ground, allowing an ac input to be at a dc level.

1-6. The hp modular enclosure design allows convenient conversion from a bench model to a model which mounts in a standard 19-inch rack (see paragraph 2-5). The modular design provides the mechanical stability necessary for stacking instruments on a flat surface.

1-7. USES.

1-8. Wide frequency range, high power dissipation capability, and accuracy make the Model 350C/D useful in such applications as attenuating an oscillator output, checking gain and frequency response of an amplifier, and determining transmission loss. Use of the Model 350C/D is possible with a mismatched load or source impedance. Information on impedance matching networks and the attenuation losses involved are given in section III.

1-9. DIFFERENCES BETWEEN INSTRUMENTS.

1-10. The Hewlett-Packard Company uses a two-section, eight-digit serial number to identify instruments (e.g., 000-00000). The serial number is on a plate attached to the rear panel of the instrument. The first three digits are a serial prefix number, also appearing on the title page of this manual, and the last five digits refer to a specific instrument. If the first three digits of the instrument serial number are not the same as those on the title page, change sheets included with this manual will define any differences between other instruments and the Model 350C/D described herein. If the change sheets are missing, your hp Engineering Representative can supply the information.

Table 1-1. Specifications

ATTENUATION:
110 db in 1-db steps

ACCURACY, 10-DB SECTION:
From dc to 100 kc, error is less than ±0.125 db at any step; from 100 kc to 1 Mc, error is less than ±0.25 db at any step.

ACCURACY, 100-DB SECTION:
From dc to 100 kc, error is less than ±0.25 db at any step up to 70 db, less than ±0.5 db above 70 db; from 100 kc to 1 Mc, error is less than ±0.5 db at any step up to 70 db; less than ±0.75 db above 70 db.

POWER CAPACITY:
350C, 500 ohms: 5 watts (50 vdc or rms) maximum, continuous duty
350D, 600 ohms: 5 watts (55 vdc or rms) maximum, continuous duty

DIMENSIONS:
Module 6-3/32 in. high, 5-1/8 in. wide, 8 in. deep

WEIGHT:
Net 5 lb, shipping 7 lb

Table 3-1. Attenuation Factors

db	Attenuation Factor, A_f	db	Attenuation Factor, A_f	db	Attenuation Factor, A_f
0	1.0000	37	.01413	74	.0001995
1	.8913	38	.012590	75	.0001778
2	.7943	39	.011220	76	.00015850
3	.7079	40	.010000	77	.00014130
4	.6310	41	.008913	78	.00012590
5	.5623	42	.007943	79	.00011220
6	.5012	43	.007079	80	.00010000
7	.4467	44	.006310	81	.00008913
8	.3981	45	.005623	82	.00007943
9	.3548	46	.005012	83	.00007079
10	.3162	47	.004467	84	.00006310
11	.2818	48	.003981	85	.00005623
12	.2512	49	.003548	86	.00005012
13	.2239	50	.003162	87	.00004467
14	.1995	51	.002818	88	.00003981
15	.1778	52	.002512	89	.00003548
16	.1585	53	.002239	90	.00003162
17	.1413	54	.001995	91	.00002818
18	.1259	55	.001778	92	.00002512
19	.1122	56	.001585	93	.00002239
20	.1000	57	.001413	94	.00001995
21	.08913	58	.001259	95	.00001778
22	.07943	59	.001122	96	.00001585
23	.07079	60	.001000	97	.00001413
24	.06310	61	.0008913	98	.00001259
25	.05623	62	.0007943	99	.00001122
26	.05012	63	.0007079	100	.00001000
27	.04467	64	.0006310	101	.000008913
28	.03981	65	.0005623	102	.000007943
29	.03548	66	.0005012	103	.000007079
30	.03162	67	.0004467	104	.000006310
31	.02818	68	.0003981	105	.000005623
32	.02512	69	.0003548	106	.000005012
33	.02239	70	.003162	107	.000004467
34	.01995	71	.0002818	108	.000003981
35	.01778	72	.0002512	109	.000003548
36	.01585	73	.0002239	110	.000003162

SECTION II
PREPARATION FOR USE

2-1. INITIAL INSPECTION.

2-2. Upon receipt of the Model 350C/D, verify that package contents are complete and as ordered. Inspect the instrument for any physical damage, such as a scratched panel surface, broken knob or connector, etc., incurred in shipping. To facilitate possible reshipment, keep the original packing material (if foam) until the instrument is operated satisfactorily (see paragraph 5-10 for a dc performance check). If damage is found, file a claim with the freight carrier; refer to the warranty page in this manual.

2-3. REPACKAGING FOR SHIPMENT.

2-4. When returning an instrument to the Hewlett-Packard Company, use the original packing materials (if foam) or contact your authorized hp Engineering Representative for assistance. Original packing materials which are cardboard "accordion-like" filler are not recommended for reshipment packing since the useful cushioning qualities are usually gone after one use. If the foam-type packing material is not available, first protect the instrument surfaces with heavy paper or with sheets of cardboard placed flat against the instrument. Then protect the instrument on all sides (use approximately 4 inches of new packing material designed specifically for packaging cushioning), pack in a durable carton marked clearly for proper handling, and insure adequately before shipping. Ship the instrument to the hp Customer Service department at the address given on the warranty page.

Note

When an instrument is being returned to hp for service or repair, attach a tag to the instrument specifying owner, desired action, model number, and full serial number. All correspondence should identify the instrument by model number and the full (eight-digit) serial number.

2-5. RACK/BENCH INSTALLATION.

2-6. The Model 350C/D is initially shipped with the plastic feet and tilt stand attached, ready for use as a bench-type instrument (unless ordered specifically as a rack-type model). The instrument may be adapted to mount in a standard 19-inch rack, alone or alongside other hp modular instruments. Refer to figure 5-1 to see how the feet (and covers) are removed from the instrument. Complete information on rack-mounting the Model 350C/D is available from your hp Engineering Representative or hp Customer Service. Specify the instrument and complete serial number.

SECTION III
OPERATING INSTRUCTIONS

3-1. OPERATING CONSIDERATIONS.

3-2. IMPEDANCE.

3-3. For full accuracy and ease of application, the source and load impedances should match the impedance at the INPUT and OUTPUT terminals of the Model 350C/D. When source and load impedances are the same as the impedance of the Model 350C/D, the amount of attenuation in the circuit is the sum of the two attenuator-knob settings. If an impedance-matching network is used (see paragraph 3-12), the amount of insertion loss must be added to the Model 350C/D setting to obtain the amount of attenuation between source and load.

3-4. LEADS AND CONNECTIONS.

3-5. When making connections to the Model 350C/D and the other instruments in the test or measurement setup, use shielded (coaxial) leads as short in length as possible. Failure to use shielded leads may result in attenuation of a different value from that set on the Model 350C/D controls, especially at high attenuator settings and at frequencies above 100 kc. The shunting effect of stray capacitance (leads, terminals, etc.) is a factor at high frequencies unless shielded connections and short lead lengths are used. Three connectors at the INPUT terminals allow an ac input to be at a dc potential. Connect all inputs to the top and lower left INPUT terminals. If both input leads are shielded, connect the shield to the lower right terminal (marked $\doteq$) which is at cabinet ground potential. If an input is ac, but at some dc level, the load on the Model 350C/D must also be floating, i.e. not connected to cabinet ground potential ($\doteq$).

3-6. INPUT POWER LIMITATION.

3-7. Do not apply more than 5 watts maximum to the Model 350C/D INPUT terminals. For the Model 350C (input impedance, 500 ohms), 5 watts corresponds to

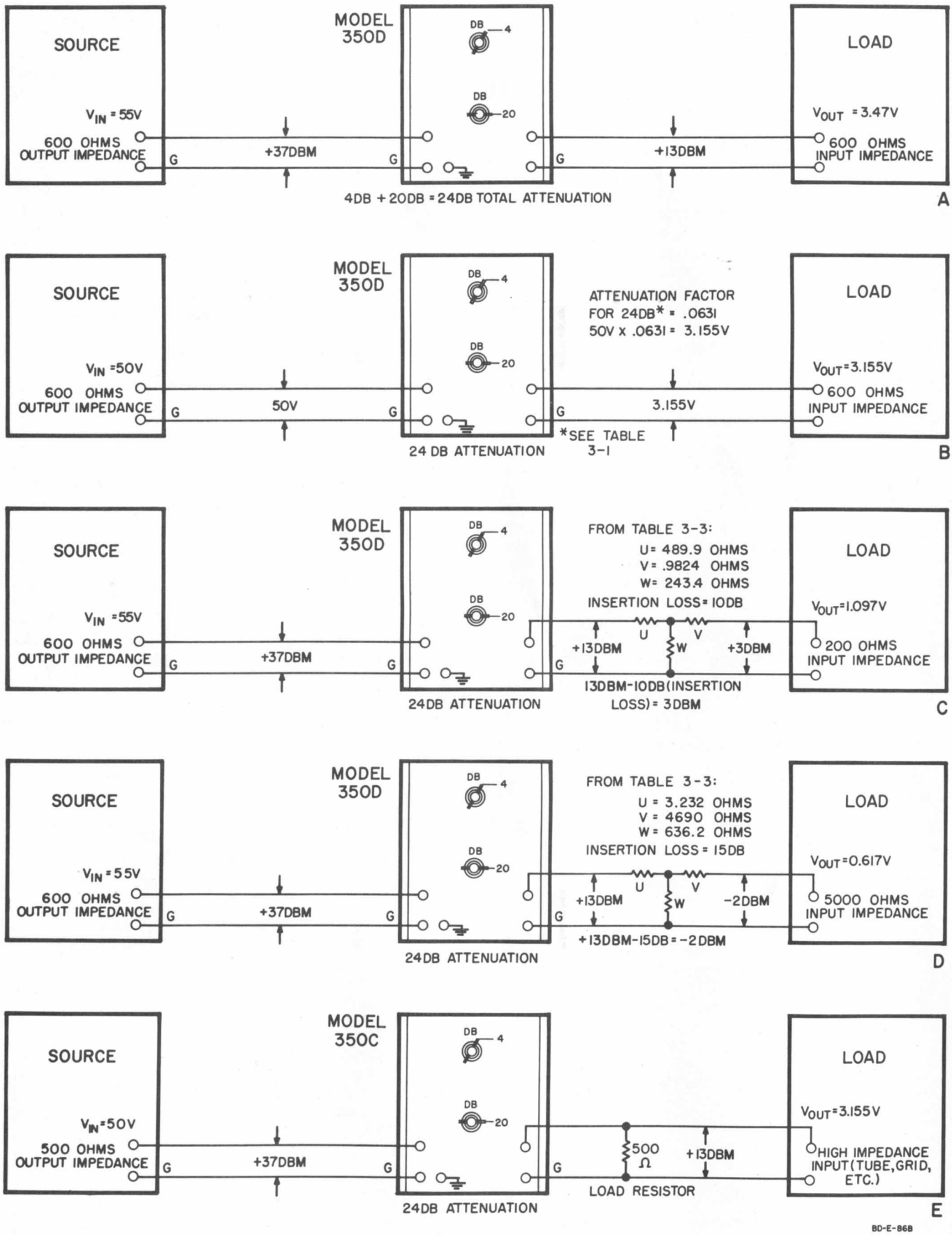


Figure 3-1. Model 350C/D Typical Applications

50 volts (dc or rms): for the Model 350D (input impedance, 600 ohms), 5 watts corresponds to approximately 55 volts (dc or rms).

CAUTION

The Model 350C/D may be damaged by applying power to the OUTPUT terminals or by applying more than 5 watts to the INPUT terminals.

3-8. OPERATING PROCEDURES.

3-9. MATCHED IMPEDANCE.

3-10. When the Model 350C/D INPUT and OUTPUT terminals are terminated properly, attenuation is the sum of the 10 DB and the 100 DB control settings. The voltage at the output of the Model 350C/D may be determined if input voltage (or input db level) and the amount of attenuation inserted by the Model 350C/D are known. Table 3-1 shows the attenuation factor (A_f) over the attenuation range of the Model 350C/D. The method for finding the input level in dbm, is explained in section IV. To find the voltage at the output terminals proceed as follows:

a. Determine the input voltage to the Model 350C/D and the amount of attenuation set on the Model 350C/D.

b. Locate the amount of attenuation in the db column of table 3-1 and read the corresponding attenuation factor.

c. To calculate the output voltage, multiply the input voltage by the attenuation factor. See paragraph 3-11 for an example.

3-11. In figure 3-1 A and B the Model 350D is shown connected to a matching source and load. In both cases the Model 350D is set to attenuate the signal by 24 db. The attenuation factor for 24 db from table 3-1 is 0.0631 and the output voltage, for the conditions shown in figure 3-1A, is then:

$$V_{out} = (55v)\ (0.0631) = 3.47 \text{ volts}$$

For figure 3-1B the attenuation factor is the same as for figure 3-1A and the output voltage is:

$$V_{out} = (50v)\ (0.0631) = 3.155 \text{ volts}$$

3-12. USE OF IMPEDANCE-MATCHING NETWORK.

3-13. NEED FOR INPUT MATCH. An impedance-matching network is necessary between source and Model 350C/D attenuator under the following conditions:

a. Source frequency is 100 kc or above.

b. Model 350C/D is set for less than 20-db attenuation.

c. Source output frequency response is affected by mismatched impedance.

d. Source output is monitored by meter which is accurate only when source operates into matched load.

3-14. MATCHING AT THE INPUT.

a. When the source is not affected by mismatch and source impedance is lower than that of Model 350C/D, a series resistor may be used between source and attenuator. The resistor value should be the difference between Model 350C/D impedance and source impedance. For example, to match the Model 350C to a 200-ohm source requires a series resistance of 300 ohms.

b. Except for the condition stated in a., a resistive impedance-matching network should be used. Resistors should be deposited film or carbon type. Also, better accuracy is obtained if the network is enclosed in a shielded container and connecting leads are kept short. Data on impedance-matching networks for the Model 350C are given in figure 3-2 and table 3-2; data for the Model 350D are given in figure 3-3 and table 3-3. The amount of insertion loss is included in tables 3-2 and 3-3.

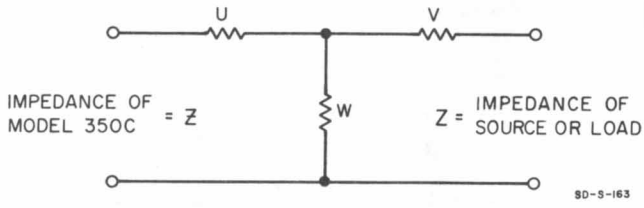


Figure 3-2. Model 350C Matching Network

Table 3-2. Model 350C Matching Network Values

Z (ohms)	Z (ohms)	U (ohms)	V (ohms)	W (ohms)	Insertion Loss
500	50	474.3	1.166	51.40	16 db
500	200	387.3	.8843	256.7	9 db
500	600	13.22	245.2	1148.0	4 db
500	2000	31.3	1733.0	536.2	12 db
500	5000	11.66	4743.0	514.1	16 db

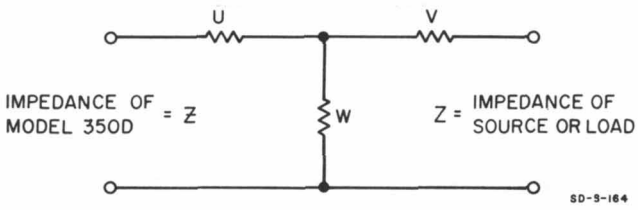


Figure 3-3. Model 350D Matching Network

3-15. NEED FOR OUTPUT MATCH. To maintain the rated attenuation accuracy of the Model 350C/D, the impedance of the load must match the output impedance of the Model 350C/D. When the load also must be terminated in its matching impedance, a resistive matching network must be used. When mismatch does not affect the load, under some conditions the required impedance match for the Model 350C/D can be obtained by use of a single resistor. Conditions under which a resistor can be used, and use of matching networks, are discussed below.

3-16. MATCHING AT THE OUTPUT.

a. When the impedance of the load is lower than that of the Model 350C/D and the load is not affected by a mismatch, impedance match for the Model 350C/D output can be obtained by inserting a series resistor between 350C/D output and load. Resistor value should be the difference between the Model 350C/D output impedance and the load impedance.

b. When the impedance of the load is much higher than that of the Model 350C/D, on the order of 50,000 ohms or more, impedance match for the Model 350C/D can be obtained by using a shunting resistor across the Model 350C/D output. For the Model 350C, the shunting resistor should be 500 ohms (see figure 3-1E), and for the Model 350D, 600 ohms.

c. Networks may be used which provide the Model 350C/D and its load with an impedance match. Network data and connections are given in figures 3-2 and 3-3 and tables 3-2 and 3-3. Figure 3-1C shows a network for matching a 200-ohm load and the 600-ohm Model 350D; figure 3-1D shows a network for matching a 500-ohm load and the 600-ohm Model 350D.

Table 3-3. Model 350D Matching Network Values

Z (ohms)	Z (ohms)	U (ohms)	V (ohms)	W (ohms)	Insertion Loss
600	50	574.5	2.111	49.92	17 db
600	200	489.9	.9824	243.4	10 db
600	500	245.2	13.22	1148.0	4 db
600	2000	33.06	1674.0	670.8	11 db
600	5000	3.232	4690.0	636.2	15 db

SECTION IV
PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. The Model 350C/D is shown in simplified schematic form in figure 4-1. In the complete schematic (figure 5-6) note that each attenuator section, 10 db and 100 db, is composed of four segments, each basically the same configuration as shown in figure 4-1. The attenuator circuit ground is isolated from the cabinet ground by capacitor C1, to allow a floating input, i.e. an ac signal at a dc level.

4-3. ATTENUATION EXPRESSED IN DECIBELS.

4-4. POWER AND VOLTAGE RATIOS.

4-5. The basic equation for computing attenuation in decibels is based on a power ratio where P = power, V = voltage, and R = resistance:

$$\text{no. of decibels} = 10 \log_{10}\left(\frac{P_1}{P_2}\right) \qquad (1)$$

Since power is expressed as: $P = \frac{V^2}{R}$ (2)

Equation (1) may be rewritten as:

$$\text{no. of db} = 10 \log_{10} \left(\frac{\frac{V_1^2}{R_1}}{\frac{V_2^2}{R_2}}\right) \qquad (3)$$

and if $R_1 = R_2$ then,

$$\text{no. of db} = 10 \log_{10} \left(\frac{V_1}{V_2}\right)^2 \qquad (4)$$

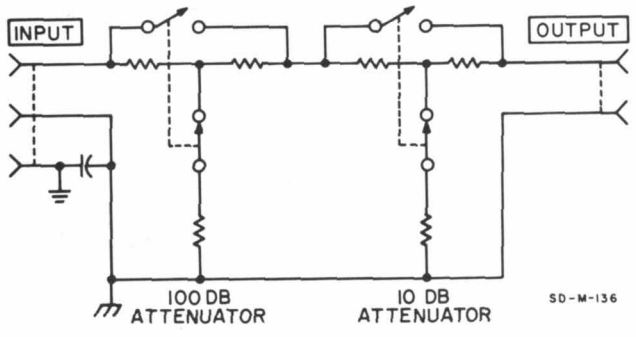


Figure 4-1. Model 350C/D Simplified Circuit

The basic rules for exponents of logarithms then allow equation (4) to be written as:

$$\text{no. of db} = 20 \log_{10} \left(\frac{V_1}{V_2}\right) \qquad (5)$$

4-6. The values of attenuation factor given in table 3-1 are based on a voltage ratio assuming the resistance at the input and output is the same. Values for A_f are computed using equation (5) where $V_1 = V_{in}$ and $V_2 = V_{out}$:

$$V_{out} = V_{in} A_f \quad \text{or} \quad \frac{V_{in}}{V_{out}} = \frac{1}{A_f} \qquad (6)$$

Then substituting equation (6) in equation (5) gives

$$\text{no. of db} = 20 \log_{10} \left(\frac{1}{A_f}\right) \qquad (7)$$

Solving for A_f gives

$$A_f = \frac{1}{\text{antilog}_{10} \frac{\text{no. of db}}{20}} \qquad (8)$$

An example will check the value for A_f given in table 3-1 to 24 db.

$$A_f = \frac{1}{\text{antilog}_{10}\left(\frac{24}{20}\right)} = \frac{1}{\text{antilog}_{10}(1.2)} \qquad (9)$$

From a log table, the antilog_{10} of 1.2 is 15.85 and

$$A_f = \frac{1}{15.85} = 0.0631 \qquad (10)$$

4-7. REFERENCE FOR DB.

4-8. The db levels given in figure 3-1 are referenced to a milliwatt of power, hence the term dbm. This indicates that the logarithm is taken of a power ratio where 1 milliwatt is the reference. For the 37 dbm shown in figure 3-1E, equations (1) and (2) show that:

$$\text{dbm} = 10 \log_{10} \frac{\left(\frac{50^2}{500}\right)}{1 \text{ milliwatt}}$$

$$\text{dbm} = 10 \log_{10} (5000) = 10 (3.7) = 37$$

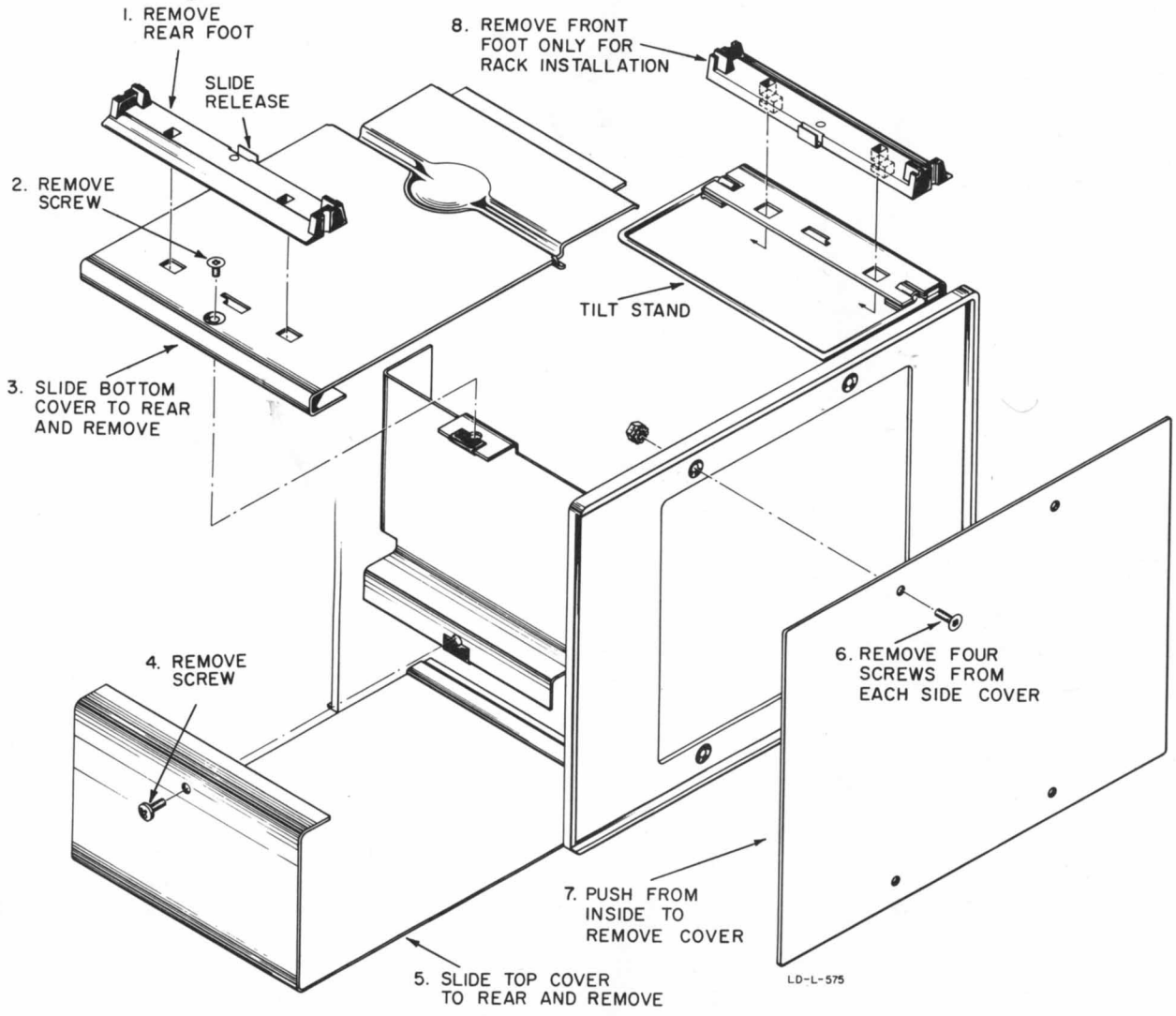


Figure 5-1. Cabinet Removal

Table 5-1. Test Equipment Required

Description	Minimum Required Specifications	Recommended Equipment
DC Voltage Source	Load Regulation: Less than 5 mv change at output terminals for 0 to 2 amperes change	℗ Model 722AR Power Supply
Potentiometer	Accuracy: 0.01% +20 μv Range: 0.0000 to 1.6110 v	Leeds & Northrup Universal Potentiometer Model 7553 Type K3
Voltage Divider	Accuracy: 0.02% Range: 1.5 volts to 50 volts	Leeds & Northrup Model 7592 DC Volt Box
Galvanometer		Leeds & Northrup Model 2430 Galvanometer
Standard Cell		Eppley, Catalog No. 100

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. Maintenance of the Model 350C/D should be minimal unless an overload voltage or physical damage requires replacement of a part. To prevent possible leakage across terminals at high frequencies, keep the instrument free of dust. The attenuator shaft bushings under the front panel DB knobs should be lubricated annually with one drop of light machine oil. Figure 5-6 is a schematic diagram for the Model 350C/D.

5-3. INSTRUMENT COVER REMOVAL.

5-4. Figure 5-1 illustrates the removal of all instrument covers. This should be necessary only when replacing an attenuator section or a switch component (see paragraphs 5-5 and 5-7).

5-5. COMPONENT REPLACEMENT.

5-6. REMOVAL OF ATTENUATORS.

5-7. Figure 5-2 illustrates the Model 350C/D with rear panel removed and identifies the components and assemblies. To remove the attenuator assemblies, proceed as follows:

a. Remove all instrument covers (see figure 5-1).

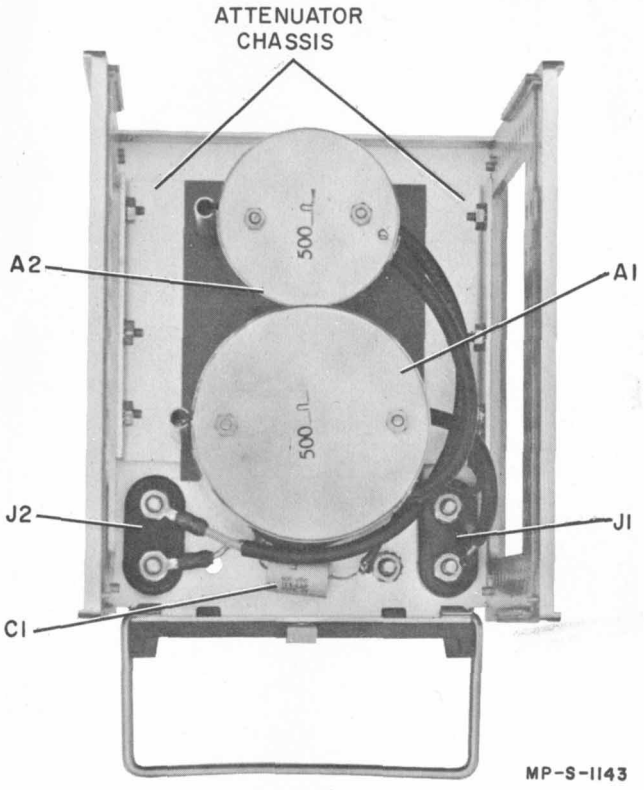


Figure 5-2. Model 350C/D Rear View (Rear Panel Removed)

b. Loosen screws in both attenuator knobs and remove knobs.

c. Disconnect coaxial cables from connectors J1 and J2 (see figure 5-2). Mark cables for proper reinstallation. Remove capacitor C1 lead from ground lug.

d. Remove flathead screws which fasten attenuator chassis (see figure 5-2) to instrument side castings. Remove attenuator chassis from instrument frame.

e. Remove switch shaft nuts holding assemblies to attenuator chassis.

f. Remove the slotted metal sleeve which clamps each shield around the attenuator assembly. To completely remove shield, unsolder the coaxial lead between the two attenuators; use care to avoid damage to cable insulation. This frees each attenuator for individual repair or replacement.

g. Reassembly is essentially the reverse of the above procedure.

5-8. REPLACEMENT OF RESISTORS.

5-9. Figure 5-3 identifies the resistors on the 100 db attenuator, A1, and figure 5-4 on the 10 db attenuator, A2. Replacement resistors may be ordered from the parts information in section VI. When a resistor is replaced, a padding resistor may be necessary to restore calibration accuracy. Contact your hp Engineering Representative or hp Customer Service for additional help or information.

5-10. DC PERFORMANCE CHECK.

5-11. TEST EQUIPMENT.

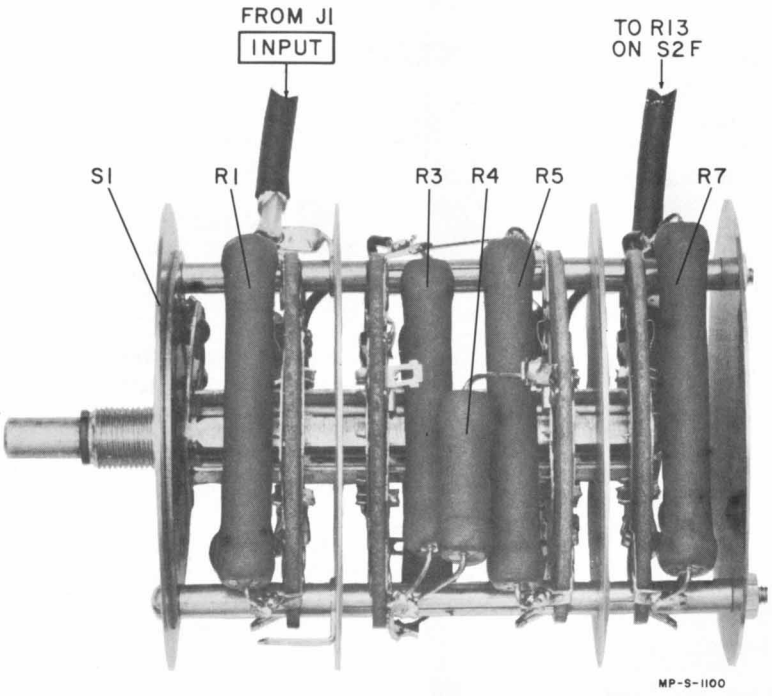
5-12. A dc performance check of the Model 350C/D may be made without removing any of the instrument covers, using only external connections for the test equipment. Figure 5-5 shows a test setup using the equipment listed in table 5-1. Any substitute test equipment should provide the minimum required specifications in table 5-1.

5-13. TEST PROCEDURE.

5-14. The following procedure should be used for a dc performance check of the Model 350C/D:

a. Connect test equipment as shown in figure 5-5. The input from the dc voltage source is connected to the top and the lower left of the Model 350C/D INPUT terminals.

b. Set both Model 350C/D attenuator DB knobs to the "0" position.



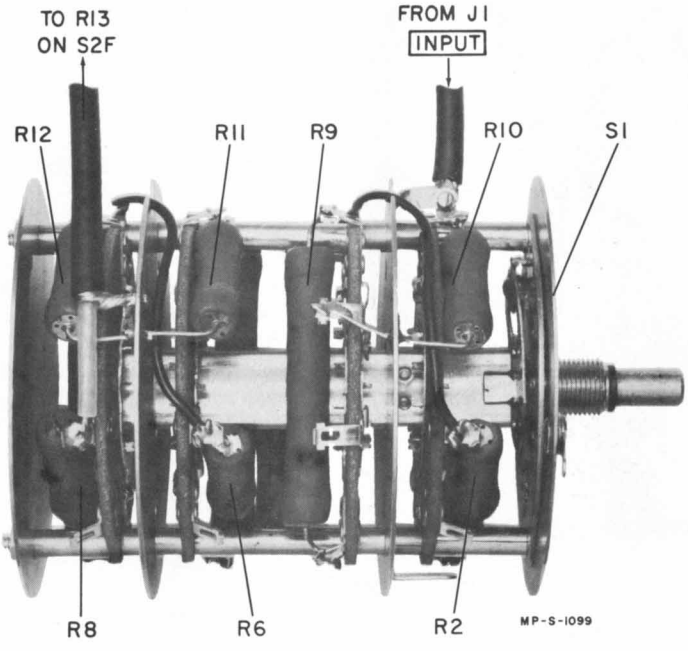
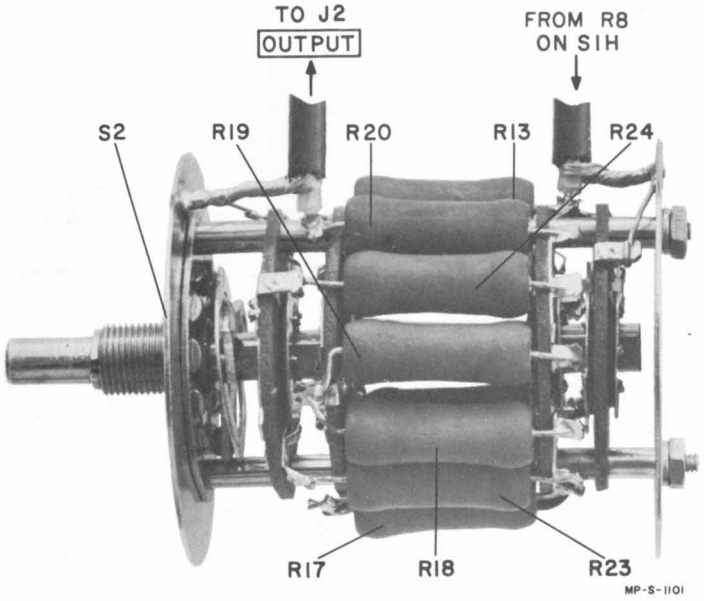


Figure 5-3. Assembly A1 Component Identification.



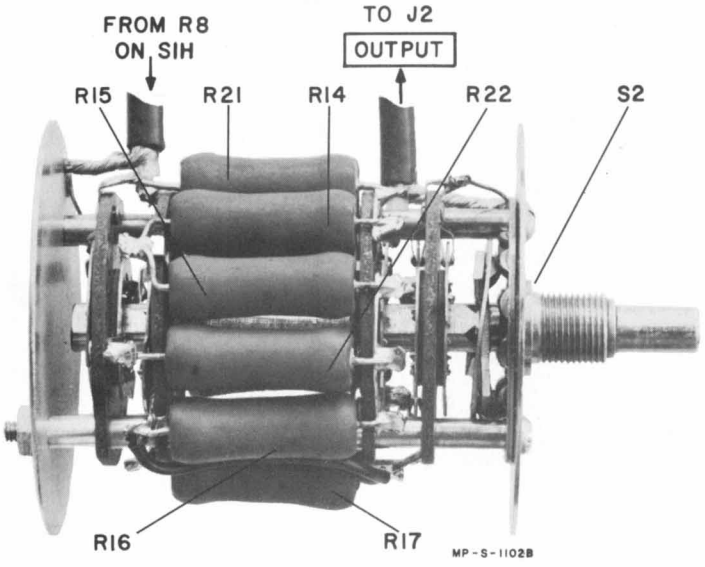


Figure 5-4. Assembly A2 Component Identification

c. Adjust the output of the dc voltage source to 50 volts if checking a Model 350C or to 55 volts if checking a Model 350D. All voltage readings are as indicated by the voltage divider and potentiometer setup.

d. Change the 10 DB attenuator in 1 db steps and compare the readings with those given in table 5-2 or 5-4. Return the 10 DB knob to the "0" setting.

e. Change the 100 DB section in 10 db steps and compare the readings with those given in table 5-3 or 5-5.

Note: Do not use the 15 volts range or lower on the Leeds and Northrup Model 7592. These ranges will cause an impedance mismatch between the volt box and Model 350C/D, degrading the attenuator accuracy.

5-15. AC CALIBRATION AND ACCURACY.

5-16. The ac accuracy of the Model 350C/D may be verified using a substitution technique with a ratio transformer or another attenuator, accurately calibrated. If a complete calibration check is desired which covers the entire frequency range, contact your hp Engineering Representative or return the Model 350C/D to the hp Customer Service department.

Table 5-2. Model 350C 10 DB Attenuator Check With Input Set to 50 Volts

Attenuator Setting	Minimum Reading	Nominal Reading	Maximum Reading
1	43.925v	44.565v	45.207v
2	39.154v	39.715v	40.290v
3	34.892v	35.390v	35.912v
4	31.095v	31.550v	32.008v
5	27.716v	28.115v	28.523v
6	24.704v	25.060v	25.419v
7	22.017v	22.335v	22.655v
8	19.623v	19.905v	20.194v
9	17.489v	17.740v	17.999v
10	15.586v	15.810v	16.041v

Table 5-3. Model 350C 100 DB Attenuator Check With Input Set to 50 Volts

Attenuator Setting	Minimum Reading	Nominal Reading	Maximum Reading
10	15.367v	15.810v	16.291v
20	4.863v	5.000v	5.151v
30	1.537v	1.581v	1.629v
40	.4863v	.500v	.5151v
50	.1537v	.1581v	.1629v
60	.0486v	.050v	.0515v
70	15.37mv	15.8mv	16.29mv
80	4.72mv	5.0mv	5.29mv
90	1.49mv	1.58mv	1.68mv
100	472μv	500μv	530μv

Table 5-4. Model 350D 10 DB Attenuator Check With Input Set to 55 Volts

Attenuator Setting	Minimum Reading	Nominal Reading	Maximum Reading
1	48.330v	49.019v	49.729v
2	43.070v	43.686v	44.319v
3	38.381v	38.924v	39.511v
4	34.204v	34.705v	35.209v
5	30.488v	30.926v	31.375v
6	27.174v	27.566v	27.961v
7	24.218v	24.568v	24.921v
8	21.583v	21.895v	22.213v
9	19.243v	19.514v	19.798v
10	17.145v	17.391v	17.645v

Table 5-5. Model 350D 100 DB Attenuator Check With Input Set to 55 Volts

Attenuator Setting	Minimum Reading	Nominal Reading	Maximum Reading
10	16.897v	17.391v	17.901v
20	5.350v	5.50v	5.666v
30	1.691v	1.739v	1.792v
40	0.535v	0.550v	0.566v
50	0.1691v	0.1739v	0.1792v
60	0.0535v	0.055v	0.0566v
70	169.1mv	173.9mv	179.2mv
80	5.19mv	5.5mv	5.82mv
90	1.64mv	1.74mv	1.84mv
100	519μv	550μv	583μv

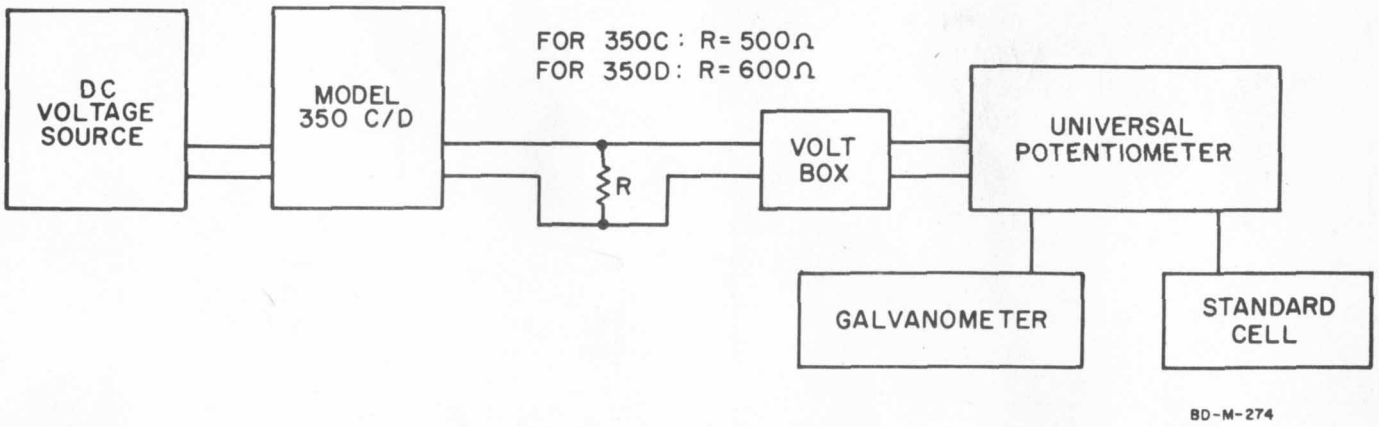
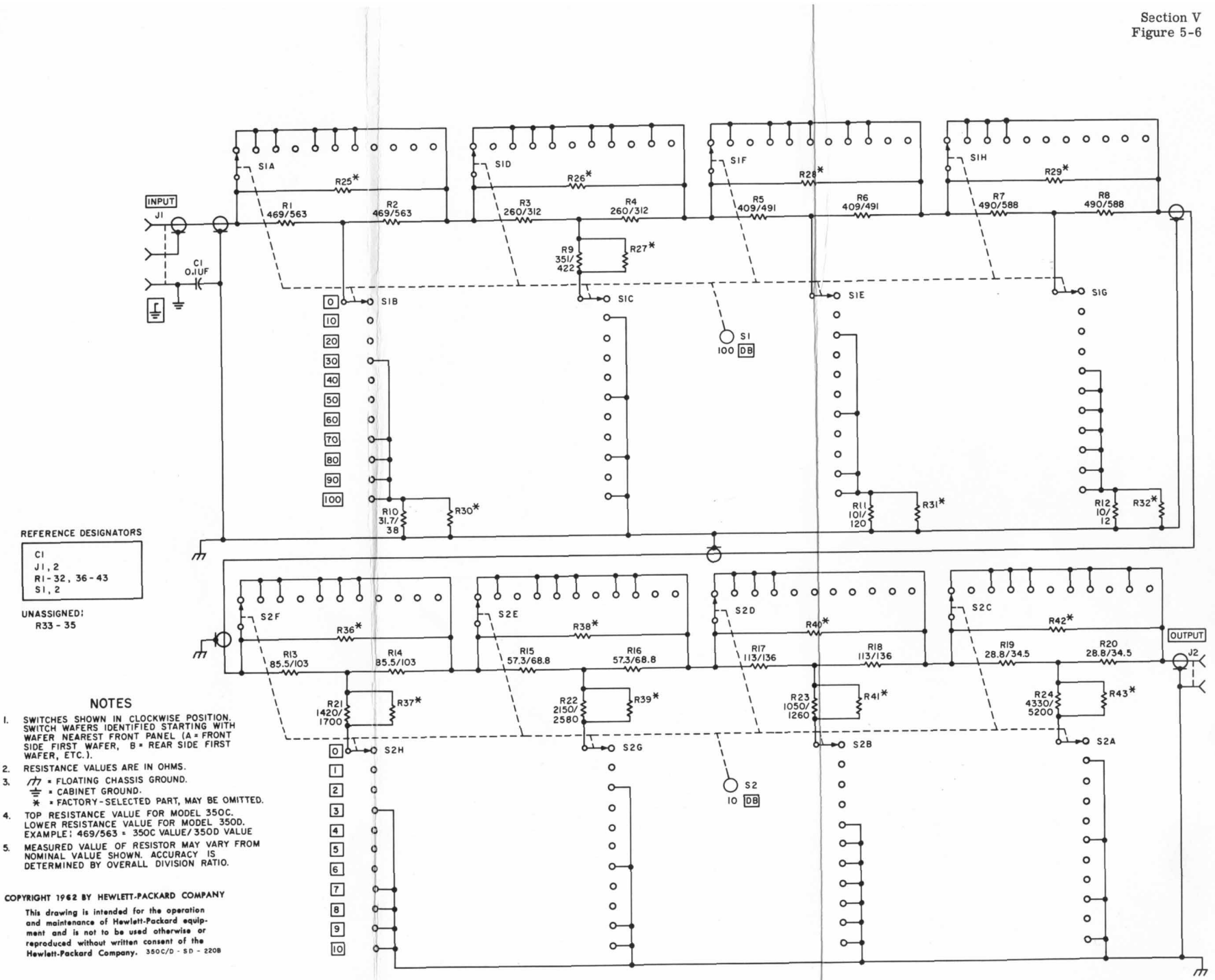


Figure 5-5. Test Setup for DC Performance Check



REFERENCE DESIGNATORS

C1
J1, 2
R1-32, 36-43
S1, 2

UNASSIGNED:
R33-35

NOTES

1. SWITCHES SHOWN IN CLOCKWISE POSITION. SWITCH WAFERS IDENTIFIED STARTING WITH WAFER NEAREST FRONT PANEL (A = FRONT SIDE FIRST WAFER, B = REAR SIDE FIRST WAFER, ETC.).
2. RESISTANCE VALUES ARE IN OHMS.
3. ⏚ = FLOATING CHASSIS GROUND.
   ⏚ = CABINET GROUND.
   * = FACTORY-SELECTED PART, MAY BE OMITTED.
4. TOP RESISTANCE VALUE FOR MODEL 350C. LOWER RESISTANCE VALUE FOR MODEL 350D. EXAMPLE: 469/563 = 350C VALUE/350D VALUE
5. MEASURED VALUE OF RESISTOR MAY VARY FROM NOMINAL VALUE SHOWN. ACCURACY IS DETERMINED BY OVERALL DIVISION RATIO.

Figure 5-6. Model 350C/D Schematic Diagram

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and hp stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their hp stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

6-4. ORDERING INFORMATION.

6-5. 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.
54-54bis Route des Acacias
Geneva, Switzerland

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A = assembly
B = motor
C = capacitor
CR = diode
DL = delay line
DS = device signaling (lamp)
E = misc electronic part
F = fuse
FL = filter
J = jack
K = relay
L = inductor
M = meter
MP = mechanical part
P = plug
Q = transistor
R = resistor
RT = thermistor
S = switch
T = transformer
V = vacuum tube, neon bulb, photocell, etc.
W = cable
X = socket
XF = fuseholder
XDS = lampholder
Z = network

ABBREVIATIONS

A = amperes
BP = bandpass
BWO = backward wave oscillator
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
CONN = connection
CRT = cathode-ray tube
DEPC = deposited carbon
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by hp stock numbers.
ELECT = electrolytic
ENCAP = encapsulated
F = farads
FXD = fixed
GE = germanium
GL = glass
GRD = ground(ed)
H = henries
HG = mercury
HR = hour(s)
IMPG = impregnated
INCD = incandescent
INS = insulation (ed)
K = kilo = 1000
LIN = linear taper
LOG = logarithmic taper
M = meg = 10^6
MA = milliamperes
MINAT = miniature
METFLM = metal film
MFR = manufacturer
MTG = mounting
MY = mylar
NC = normally closed
NE = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
NSR = not separately replaceable
OBD = order by description
P = peak
PC = printed circuit board
PF = picofarads = 10^{-12} farads
PP = peak-to-peak
PIV = peak inverse voltage
POR = porcelain
POS = position(s)
POLY = polystyrene
POT = potentiometer
RECT = rectifier
ROT = rotary
RMS = root-mean-square
RMO = rack mount only
S-B = slow-blow
SE = selenium
SECT = section(s)
SI = silicon
SIL = silver
SL = slide
TA = tantalum
TD = time delay
TI = titanium dioxide
TOG = toggle
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube
U = micro = 10^{-6}
VAC = vacuum
VAR = variable
W/ = with
W = watts
WW = wirewound
W/O = without
* = optimum value selected at factory, average value shown (part may be omitted)
# = number

01194-5

Table 6-1. Reference Designation Index

Circuit Reference	℗ Stock No.	Description #	Note
		MODEL 350C	
A1	350C-34B	Assy, attenuator, 0-100db, includes: R1 thru R12, R25 thru R32, S1	
A2	350C-34A	Assy, attenuator, 0-10db, includes: R13 thru R24, R36 thru R43, S2	
C1	0170-0022	C: fxd, my, 0.1μf ±20%, 600 vdcw	
J1		Connector: INPUT, includes:	
	AC-10E	Assy, binding post: red	
	AC-10F	Assy, binding post: black	
	AC-54A	Insulator, binding post: 2 hole (outside)	
	AC-54E	Insulator, binding post: 2 hole, keyed (inside)	
	120A-47A	Spacer: binding post	
J2		Connector: OUTPUT, includes:	
	AC-10E	Assy, binding post: red	
	AC-10F	Assy, binding post: black	
	AC-54A	Insulator, binding post: 2 hole (outside)	
	AC-54E	Insulator, binding post: 2 hole, keyed (inside)	
R1	0775-0005	R: fxd, mfgl, 469 ohms ±2%, 7W	
R2	0766-0028	R: fxd, mfgl, 469 ohms ±2%, 3W	
R3	0772-0003	R: fxd, mfgl, 260 ohms ±2%, 5W	
R4	0766-0024	R: fxd, mfgl, 260 ohms ±2%, 3W	
R5	0775-0004	R: fxd, mfgl, 409 ohms ±2%, 7W	
R6	0766-0026	R: fxd, mfgl, 409 ohms ±2%, 3W	
R7	0775-0006	R: fxd, mfgl, 490 ohms ±2%, 7W	
R8	0766-0030	R: fxd, mfgl, 490 ohms ±2%, 3W	
R9	0772-0004	R: fxd, mfgl, 351 ohms ±2%, 5W	
R10	0766-0027	R: fxd, mfgl, 31.7 ohms ±2%, 3W	
R11	0766-0025	R: fxd, mfgl, 101 ohms ±2%, 3W	
R12	0766-0029	R: fxd, mfgl, 10 ohms ±2%, 3W	
R13, R14	0766-0020	R: fxd, mfgl, 85.5 ohms ±2%, 3W	
R15, R16	0766-0018	R: fxd, mfgl, 57.3 ohms ±2%, 3W	
R17, R18	0766-0022	R: fxd, mfgl, 113 ohms ±2%, 3W	
R19, R20	0766-0016	R: fxd, mfgl, 28.8 ohms ±2%, 3W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	℗ Stock No.	Description #	Note
R21	0766-0021	R: fxd, mfgl, 1420 ohms ±2%, 3W	
R22	0766-0019	R: fxd, mfgl, 2150 ohms ±2%, 3W	
R23	0766-0023	R: fxd, mfgl, 1050 ohms ±2%, 3W	
R24	0766-0017	R: fxd, mfgl, 4330 ohms ±2%, 3W	
R25 thru R32		Factory selected part, may be omitted	
R33 thru R35		Not assigned	
R36 thru R43		Factory selected part, may be omitted	
S1		Nsr; part of A1	
S2		Nsr; part of A2	
		MODEL 350D	
A1	350D-34B	Assy, attenuator, 0-100db, includes: R1 thru R12, R25 thru R32, S1	
A2	350D-34A	Assy, attenuator, 0-10db, includes: R13 thru R24, R36 thru R43, S2	
C1	0170-0022	C: fxd, my, 0.1μf ±20%, 600 vdcw	
J1		Connector: INPUT, includes:	
	AC-10E	Assy, binding post: red	
	AC-10F	Assy, binding post: black	
	AC-54A	Insulator, binding post: 2 hole (outside)	
	AC-54E	Insulator, binding post: 2 hole, keyed (inside)	
	120A-47A	Spacer: binding post	
J2		Connector: OUTPUT, includes:	
	AC-10E	Assy, binding post: red	
	AC-10F	Assy, binding post: black	
	AC-54A	Insulator, binding post: 2 hole (outside)	
	AC-54E	Insulator, binding post: 2 hole, keyed (inside)	
R1	0775-0002	R: fxd, mfgl, 563 ohms ±2%, 7W	
R2	0766-0013	R: fxd, mfgl, 563 ohms ±2%, 3W	
R3	0772-0001	R: fxd, mfgl, 312 ohms ±2%, 5W	
R4	0766-0009	R: fxd, mfgl, 312 ohms ±2%, 3W	
R5	0775-0001	R: fxd, mfgl, 491 ohms ±2%, 7W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	℗ Stock No.	Description #	Note
R6	0766-0011	R: fxd, mfgl, 491 ohms ±2%, 3W	
R7	0775-0003	R: fxd, mfgl, 588 ohms ±2%, 7W	
R8	0766-0015	R: fxd, mfgl, 588 ohms ±2%, 3W	
R9	0772-0002	R: fxd, mfgl, 422 ohms ±2%, 5W	
R10	0766-0012	R: fxd, mfgl, 38 ohms ±2%, 3W	
R11	0766-0010	R: fxd, mfgl, 120 ohms ±2%, 3W	
R12	0766-0014	R: fxd, mfgl, 12 ohms ±2%, 3W	
R13, R14	0766-0005	R: fxd, mfgl, 103 ohms ±2%, 3W	
R15, R16	0766-0003	R: fxd, mfgl, 68.8 ohms ±2%, 3W	
R17, R18	0766-0007	R: fxd, mfgl, 136 ohms ±2%, 3W	
R19, R20	0766-0001	R: fxd, mfgl, 34.5 ohms ±2%, 3W	
R21	0766-0006	R: fxd, mfgl, 1700 ohms ±2%, 3W	
R22	0766-0004	R: fxd, mfgl, 2580 ohms ±2%, 3W	
R23	0766-0008	R: fxd, mfgl, 1260 ohms ±2%, 3W	
R24	0766-0002	R: fxd, mfgl, 5200 ohms ±2%, 3W	
R25 thru R32		Factory selected part, may be omitted	
R33 thru R35		Not assigned	
R36 thru R42		Factory selected part, may be omitted	
S1		Nsr; part of A1	
S2		Nsr; part of A2	

See introduction to this section

Table 6-2. Replaceable Parts

℗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS		
AC-10E	Assy, binding post: red	28480	AC-10E	2	1		
AC-10F	Assy, binding post: black	28480	AC-10F	3	1		
AC-54A	Insulator, binding post: 2 hole (outside)	28480	AC-54A	2	1		
AC-54E	Insulator, binding post: 2 hole, keyed (inside)	28480	AC-54E	2	1		
120A-47A	Spacer: binding post	28480	120A-47A	1	0		
350C-34A	Assy, attenuator, 0-10db, includes: R13 thru R24, R36 thru R43, S2	28480	350C-34A	1	0		
350C-34B	Assy, attenuator, 0-100db, includes: R1 thru R12, R25 thru R32, S1	28480	350C-34B	1	0		
350D-34A	Assy, attenuator, 0-10db, includes: R13 thru R24, R36 thru R43, S2	28480	350D-34A	1	0		
350D-34B	Assy, attenuator, 0-100db, includes: R1 thru R12, R25 thru R32, S1	28480	350D-34B	1	0		
0170-0022	C: fxd, my, 0-1μf ±20%, 600 vdcw	84411	HEW 7	2	1		
0766-0001	R: fxd, mfgl, 34.5 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0002	R: fxd, mfgl, 5200 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0003	R: fxd, mfgl, 68.8 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0004	R: fxd, mfgl, 2580 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0005	R: fxd, mfgl, 103 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0006	R: fxd, mfgl, 1700 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0007	R: fxd, mfgl, 136 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0008	R: fxd, mfgl, 1260 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0009	R: fxd, mfgl, 312 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0010	R: fxd, mfgl, 120 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0011	R: fxd, mfgl, 491 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0012	R: fxd, mfgl, 38 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0013	R: fxd, mfgl, 563 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0014	R: fxd, mfgl, 12 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0015	R: fxd, mfgl, 588 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0016	R: fxd, mfgl, 28.8 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0017	R: fxd, mfgl, 4330 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0018	R: fxd, mfgl, 57.3 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0019	R: fxd, mfgl, 2150 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		

#See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

℗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS		
0766-0020	R: fxd, mfgl, 85.5 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0021	R: fxd, mfgl, 1420 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0022	R: fxd, mfgl, 113 ohms ±2%, 3W	07115	LPI-3, obd#	2	1		
0766-0023	R: fxd, mfgl, 1050 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0024	R: fxd, mfgl, 260 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0025	R: fxd, mfgl, 101 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0026	R: fxd, mfgl, 409 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0027	R: fxd, mfgl, 31.7 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0028	R: fxd, mfgl, 469 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0029	R: fxd, mfgl, 10 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0766-0030	R: fxd, mfgl, 490 ohms ±2%, 3W	07115	LPI-3, obd#	1	1		
0772-0001	R: fxd, mfgl, 312 ohms ±2%, 5W	07115	LPI-5, obd#	1	1		
0772-0002	R: fxd, mfgl, 422 ohms ±2%, 5W	07115	LPI-5, obd#	1	1		
0772-0003	R: fxd, mfgl, 260 ohms ±2%, 5W	07115	LPI-5, obd#	1	1		
0772-0004	R: fxd, mfgl, 351 ohms ±2%, 5W	07115	LPI-5, obd#	1	1		
0775-0001	R: fxd, mfgl, 491 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
0775-0002	R: fxd, mfgl, 563 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
0775-0003	R: fxd, mfgl, 588 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
0775-0004	R: fxd, mfgl, 409 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
0775-0005	R: fxd, mfgl, 469 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
0775-0006	R: fxd, mfgl, 490 ohms ±2%, 7W	07115	LPI-7, obd#	1	1		
	MISCELLANEOUS						
C144B-42A-1	Cover: 6 x 8 (side)	28480	C144B-42A-1	2	0		
C144B-52A-1	Assy, cover: half recess (top)	28480	C144B-52A-1	1	0		
C144E-52C-1	Cover (bottom)	28480	C144E-52C-1	1	0		
C144H-04	Assy, foot	28480	C144H-04	2	1		
G-74DH	Knob: bar w/arrow, black	28480	G-74DH	2	1		
300C-900	Manual, instruction	28480	350C-900	1	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
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire & Cable Company	Redwood City, Calif.
04870	P. M. Motor Co.	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Metro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
08994	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.

From: F.S.C. Handbook Supplements
H4-1 Dated: June 1962
H4-2 Dated: March 1962

00015-27
Revised: 20 August 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
73734	Federal Screw Products Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J. H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	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.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Calif.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers,'Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91921	Minneapolis-Honeywell Regulator Co., Micro-Switch Division	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

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

0000F	Malco Tool and Die	Los Angeles, Calif.
00001	Telefunken (c/o American Elite)	New York, N.Y.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000FF	Carmichael Corrugated Specialties	Richmond, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
00011	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NNA	"N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics,	Sun Valley, Calif.
000QQ	Cooltron.	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000TT	Thomas & Betts Co., The	Elizabeth 1, N.J.

From: F.S.C. Handbook Supplements
H4-1 Dated: June 1962
H4-2 Dated: March 1962

00015-27
Revised: 20 August 1962

350C/D-900

PRINTED IN U.S.A.