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HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

**350C/D**

**ATTENUATOR SET**



OPERATING AND SERVICE MANUAL

MODEL 350C/D

SERIALS PREFIXED: 220-

ATTENUATOR SET

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Box 301, Loveland, Colorado



**TABLE OF CONTENTS**

| Section                                                   | Page       | Section                                         | Page       |
|-----------------------------------------------------------|------------|-------------------------------------------------|------------|
| <b>I GENERAL INFORMATION . . . . .</b>                    | <b>1-1</b> | <b>IV PRINCIPLES OF OPERATION . . . . .</b>     | <b>4-1</b> |
| 1-1. Introduction . . . . .                               | 1-1        | 4-1. General . . . . .                          | 4-1        |
| 1-2. Difference Between Models 350C<br>and 350D . . . . . | 1-1        | 4-3. Attenuation Expressed in Decibels. . . . . | 4-1        |
| 1-4. Description . . . . .                                | 1-1        | 4-4. Power and Voltage Ratios . . . . .         | 4-1        |
| 1-7. Uses . . . . .                                       | 1-1        | 4-7. Reference for DB . . . . .                 | 4-1        |
| 1-9. Differences Between Instruments . . . . .            | 1-1        |                                                 |            |
| <b>II PREPARATION FOR USE . . . . .</b>                   | <b>2-1</b> | <b>V MAINTENANCE . . . . .</b>                  | <b>5-1</b> |
| 2-1. Initial Inspection . . . . .                         | 2-1        | 5-1. Introduction . . . . .                     | 5-1        |
| 2-3. Repackaging for Shipment . . . . .                   | 2-1        | 5-3. Instrument Cover Removal . . . . .         | 5-1        |
| 2-5. Rack/Bench Installation . . . . .                    | 2-1        | 5-5. Component Replacement . . . . .            | 5-1        |
|                                                           |            | 5-6. Removal of Attenuators . . . . .           | 5-1        |
| <b>III OPERATING INSTRUCTIONS . . . . .</b>               | <b>3-1</b> | 5-8. Replacement of Resistors . . . . .         | 5-1        |
| 3-1. Operating Considerations . . . . .                   | 3-1        | 5-10. DC Performance Check . . . . .            | 5-1        |
| 3-2. Impedance . . . . .                                  | 3-1        | 5-11. Test Equipment . . . . .                  | 5-1        |
| 3-4. Leads and Connections . . . . .                      | 3-1        | 5-13. Test Procedure . . . . .                  | 5-1        |
| 3-6. Input Power Limitation . . . . .                     | 3-1        | 5-15. AC Calibration and Accuracy . . . . .     | 5-4        |
| 3-8. Operating Procedures . . . . .                       | 3-3        |                                                 |            |
| 3-9. Matched Impedance . . . . .                          | 3-3        | <b>VI REPLACEABLE PARTS . . . . .</b>           | <b>6-1</b> |
| 3-12. Use of Impedance-Matching<br>Network . . . . .      | 3-3        | 6-1. Introduction . . . . .                     | 6-1        |
|                                                           |            | 6-4. Ordering Information . . . . .             | 6-1        |

**LIST OF ILLUSTRATIONS**

| Number                                           | Title | Page | Number                                                       | Title | Page |
|--------------------------------------------------|-------|------|--------------------------------------------------------------|-------|------|
| 1-1. Model 350D Attenuator Set . . . . .         |       | 1-0  | 5-1. Cabinet Removal . . . . .                               |       | 5-0  |
| 3-1. Model 350C/D Typical Applications . . . . . |       | 3-2  | 5-2. Model 350C/D Rear View (Rear Panel<br>Removed). . . . . |       | 5-1  |
| 3-2. Model 350C Matching Network . . . . .       |       | 3-3  | 5-3. Assembly A1 Component Identification. . . . .           |       | 5-2  |
| 3-3. Model 350D Matching Network . . . . .       |       | 3-4  | 5-4. Assembly A2 Component Identification. . . . .           |       | 5-3  |
| 4-1. Model 350C/D Simplified Circuit . . . . .   |       | 4-1  | 5-5. Test Setup for DC Performance Check. . . . .            |       | 5-4  |
|                                                  |       |      | 5-6. Model 350C/D Schematic Diagram . . . . .                |       | 5-5  |

**LIST OF TABLES**

| Number                                                                          | Title | Page |
|---------------------------------------------------------------------------------|-------|------|
| 1-1. Specifications . . . . .                                                   |       | 1-1  |
| 3-1. Attenuation Factors . . . . .                                              |       | 2-0  |
| 3-2. Model 350C Matching Network Values . . . . .                               |       | 3-3  |
| 3-3. Model 350D Matching Network Values . . . . .                               |       | 3-4  |
| 5-1. Test Equipment Required . . . . .                                          |       | 5-0  |
| 5-2. Model 350C 10 DB Attenuator Check<br>With Input Set to 50 Volts . . . . .  |       | 5-4  |
| 5-3. Model 350C 100 DB Attenuator Check<br>With Input Set to 50 Volts . . . . . |       | 5-4  |
| 5-4. Model 350D 10 DB Attenuator Check<br>With Input Set to 55 Volts . . . . .  |       | 5-4  |
| 5-5. Model 350D 100 DB Attenuator Check<br>With Input Set to 55 Volts . . . . . |       | 5-4  |
| 6-1. Reference Designation Index . . . . .                                      |       | 6-2  |
| 6-2. Replaceable Parts . . . . .                                                |       | 6-5  |



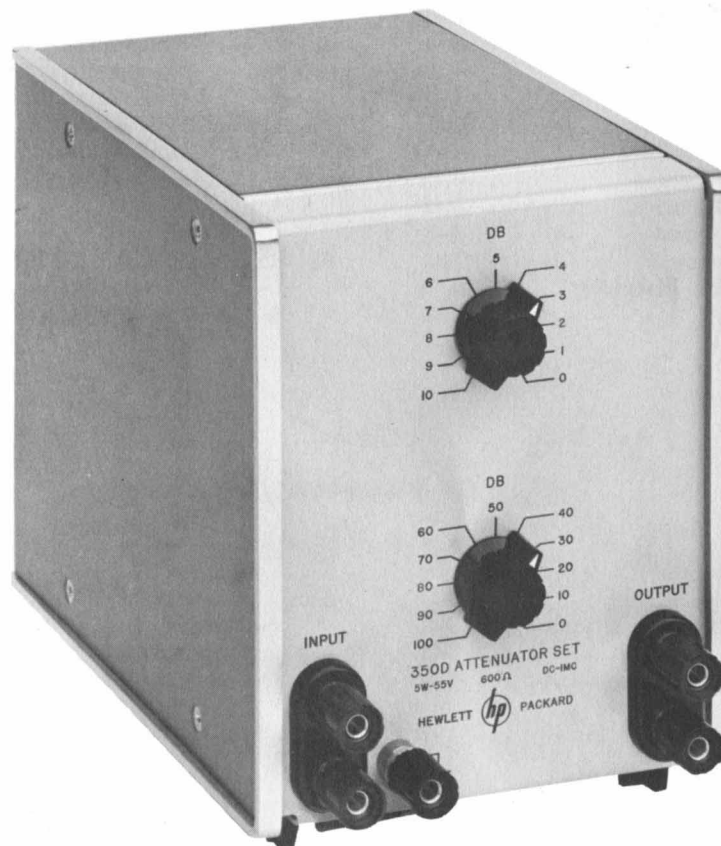


Figure 1-1. Model 350D Attenuator Set

## SECTION I

### GENERAL INFORMATION

#### 1-1. INTRODUCTION.

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

1-3. The basic difference between the  $\odot$  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  $\odot$  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  $\odot$  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  $\pm 0.125$  db at any step; from 100 kc to 1 Mc, error is less than  $\pm 0.25$  db at any step.

#### ACCURACY, 100-DB SECTION:

From dc to 100 kc, error is less than  $\pm 0.25$  db at any step up to 70 db, less than  $\pm 0.5$  db above 70 db; from 100 kc to 1 Mc, error is less than  $\pm 0.5$  db at any step up to 70 db; less than  $\pm 0.75$  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,<br>$A_f$ | db | Attenuation Factor,<br>$A_f$ | db  | Attenuation Factor,<br>$A_f$ |
|----|------------------------------|----|------------------------------|-----|------------------------------|
| 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 re-shipment, 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  $\text{hp}$  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  $\text{hp}$  Customer Service department at the address given on the warranty page.

#### Note

When an instrument is being returned to  $\text{hp}$  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  $\text{hp}$  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  $\text{hp}$  Engineering Representative or  $\text{hp}$  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.

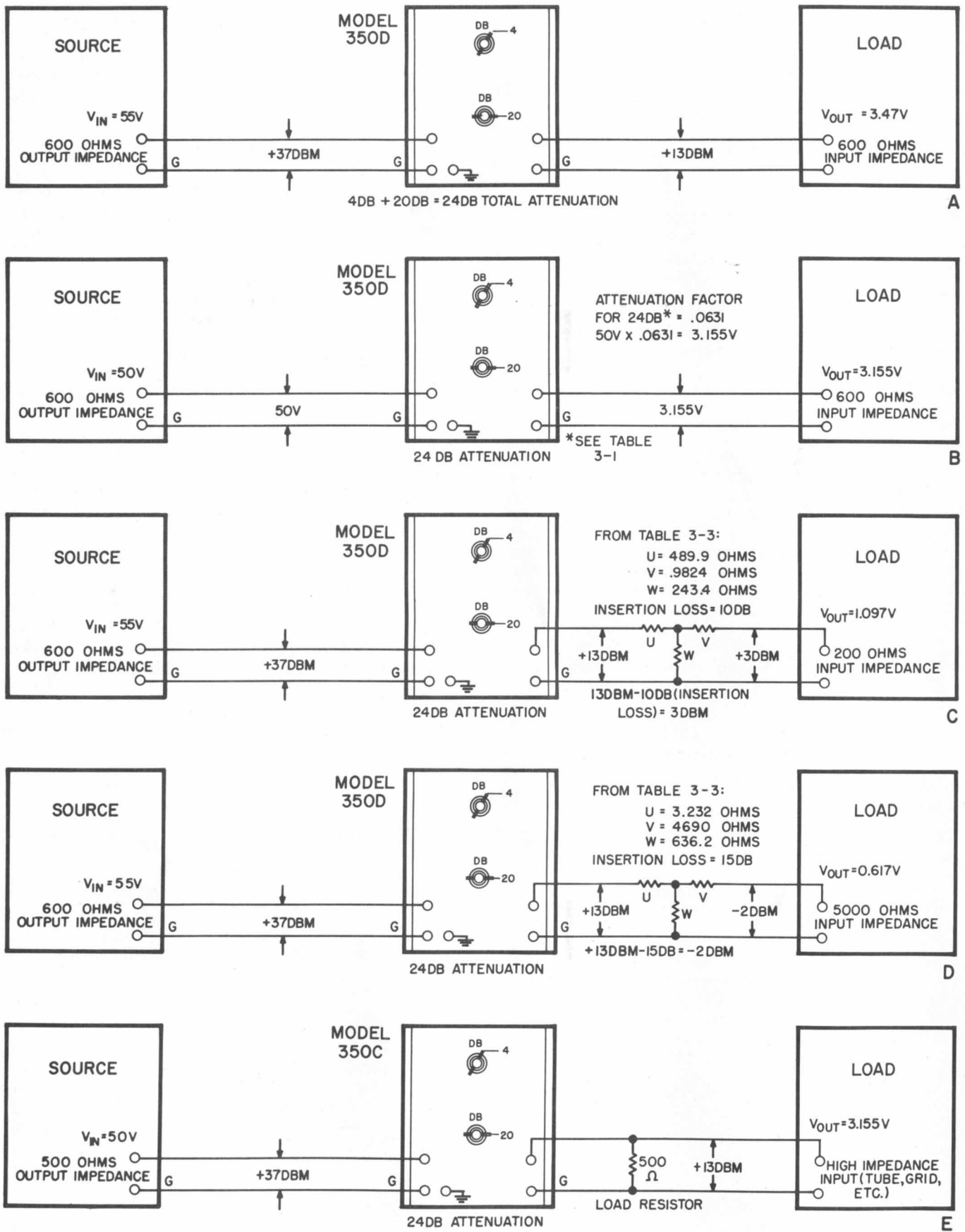
##### 3-4. LEADS AND CONNECTIONS.

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  $\perp$ ) 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 ( $\perp$ ).

##### 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



80-E-86B

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:

- Determine the input voltage to the Model 350C/D and the amount of attenuation set on the Model 350C/D.
- Locate the amount of attenuation in the db column of table 3-1 and read the corresponding attenuation factor.
- 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:

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

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

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

### 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:

- Source frequency is 100 kc or above.
- Model 350C/D is set for less than 20-db attenuation.
- Source output frequency response is affected by mismatched impedance.
- 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.

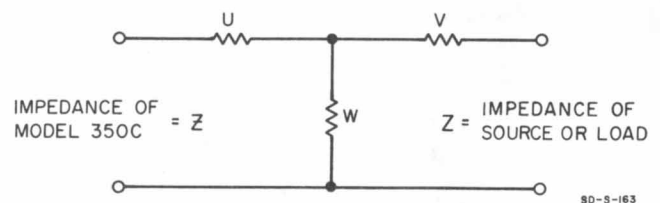


Figure 3-2. Model 350C Matching Network

Table 3-2. Model 350C Matching Network Values

| Z<br>(ohms) | Z<br>(ohms) | U<br>(ohms) | V<br>(ohms) | W<br>(ohms) | Insertion<br>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             |

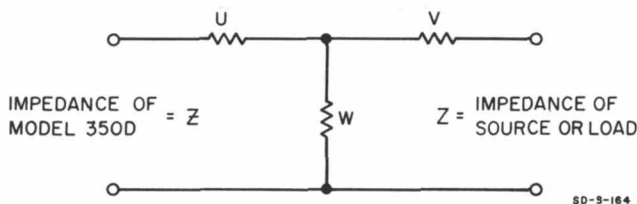


Figure 3-3. Model 350D Matching Network

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<br>(ohms) | Z<br>(ohms) | U<br>(ohms) | V<br>(ohms) | W<br>(ohms) | Insertion<br>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:

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

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

Equation (1) may be rewritten as:

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

and if  $R_1 = R_2$  then,

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

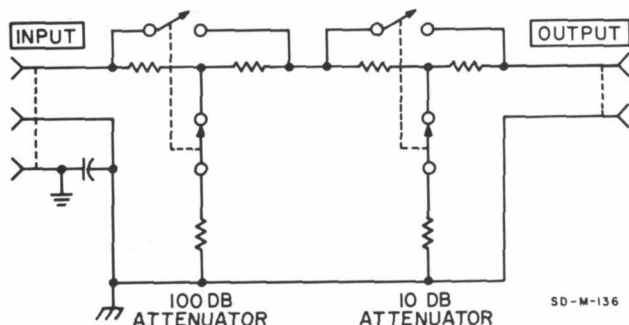


Figure 4-1. Model 350C/D Simplified Circuit

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

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

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  $V_2 = V_{out}$ :

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

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

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

Solving for  $A_f$  gives

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

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

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

From a log table, the  $\text{antilog}_{10}$  of 1.2 is 15.85 and

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

#### 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:

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

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

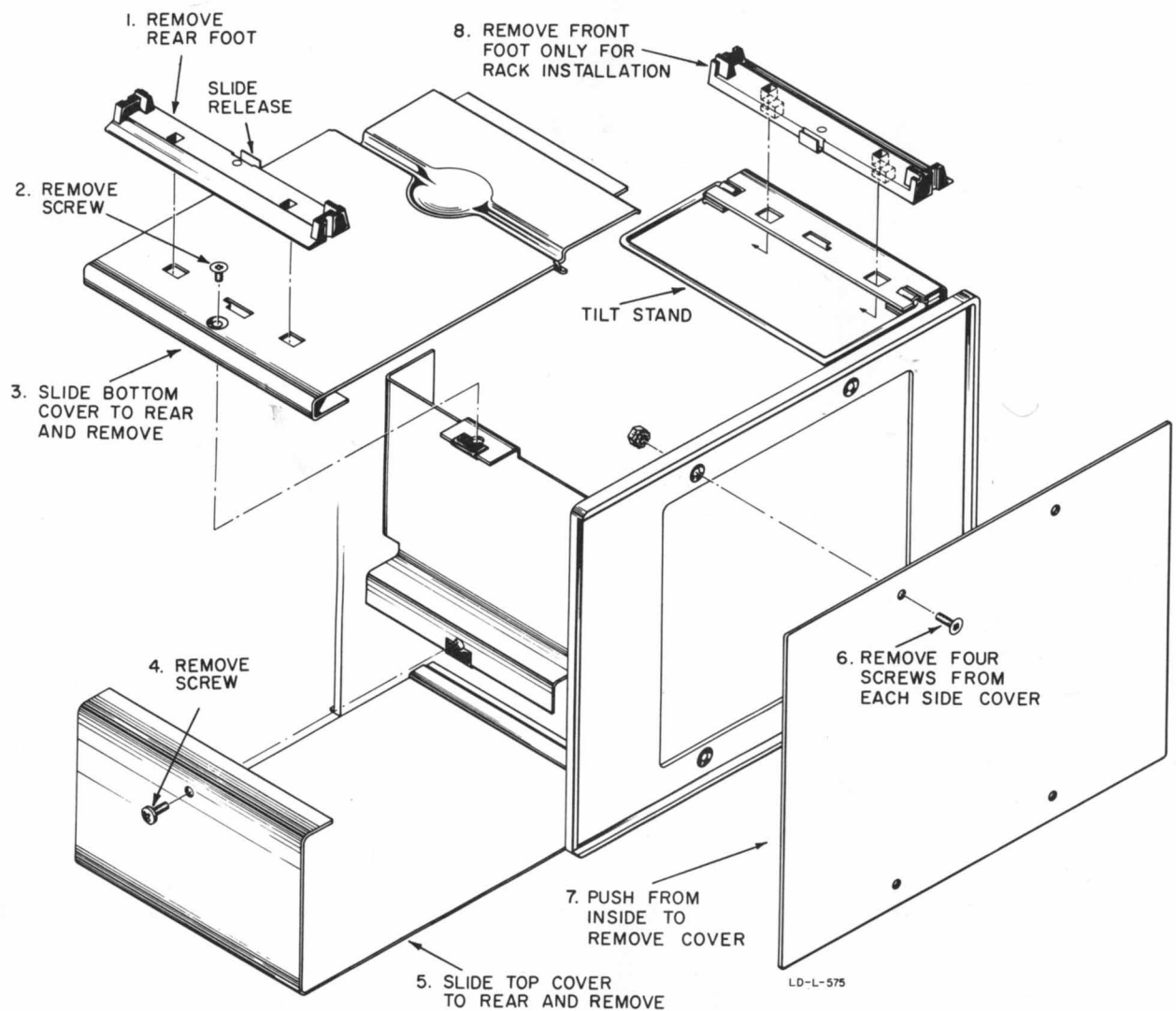


Figure 5-1. Cabinet Removal

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 | hp Model 722AR Power Supply                                       |
| Potentiometer     | Accuracy: 0.01% + 20 $\mu$ v<br>Range: 0.0000 to 1.6110 v                            | Leeds & Northrup<br>Universal Potentiometer<br>Model 7553 Type K3 |
| Voltage Divider   | Accuracy: 0.02%<br>Range: 1.5 volts to 50 volts                                      | Leeds & Northrup<br>Model 7592 DC Volt Box                        |
| Galvanometer      |                                                                                      | Leeds & Northrup<br>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).

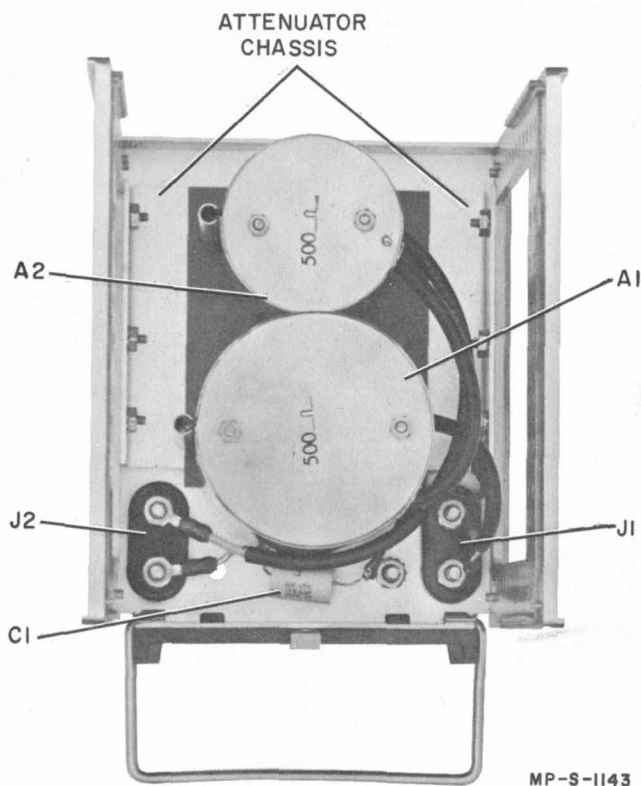


Figure 5-2. Model 350C/D Rear View (Rear Panel Removed)

- 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 Engineering Representative or 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.

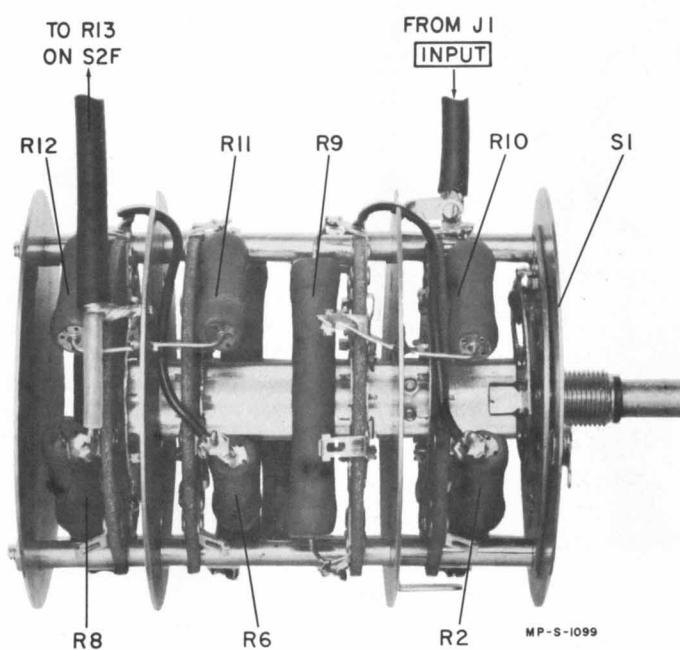
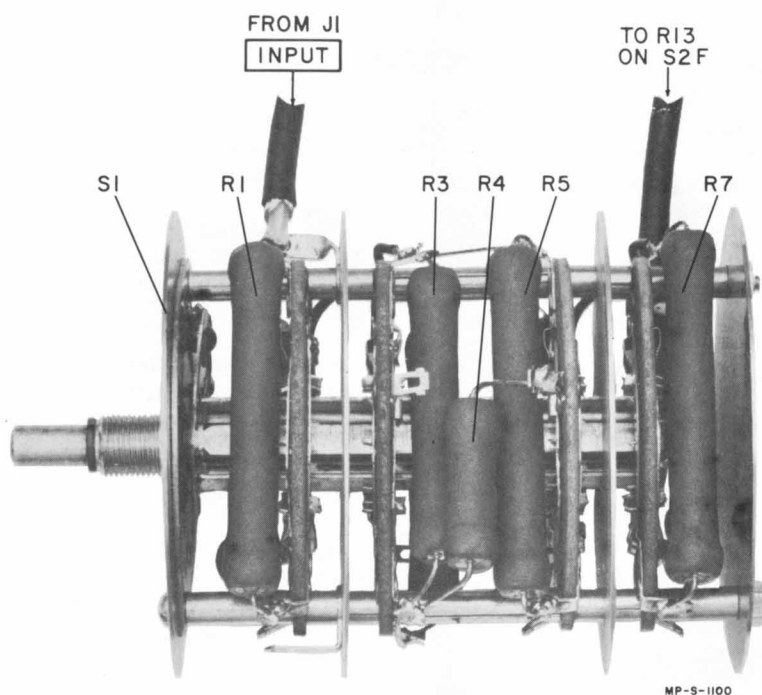


Figure 5-3. Assembly A1 Component Identification.



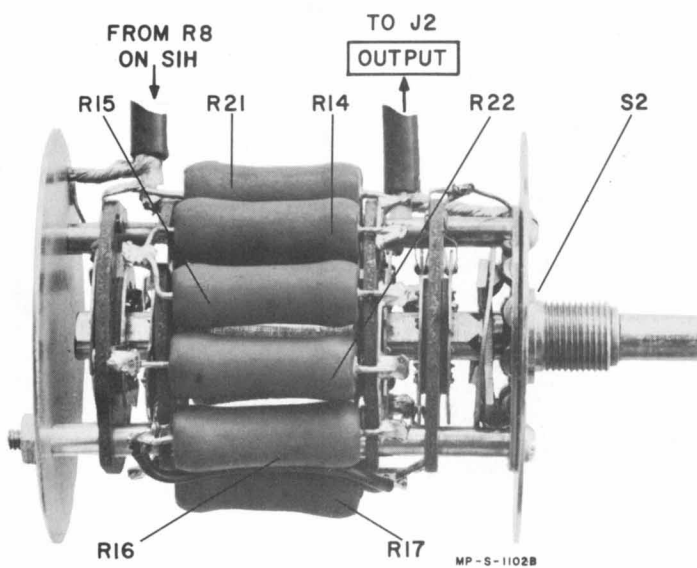
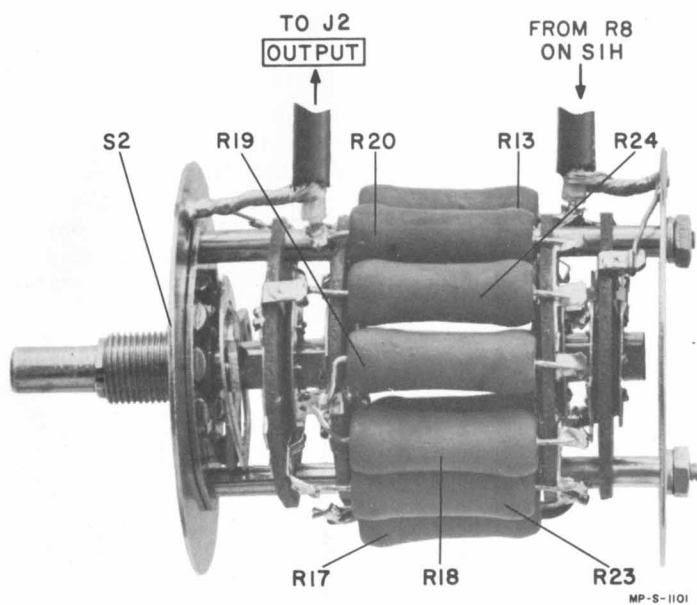


Figure 5-4. Assembly A2 Component Identification

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.

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                | 472 $\mu$ v     | 500 $\mu$ v     | 530 $\mu$ v     |

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  $\phi$  Engineering Representative or return the Model 350C/D to the  $\phi$  Customer Service department.

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                | 519 $\mu$ v     | 550 $\mu$ v     | 583 $\mu$ v     |

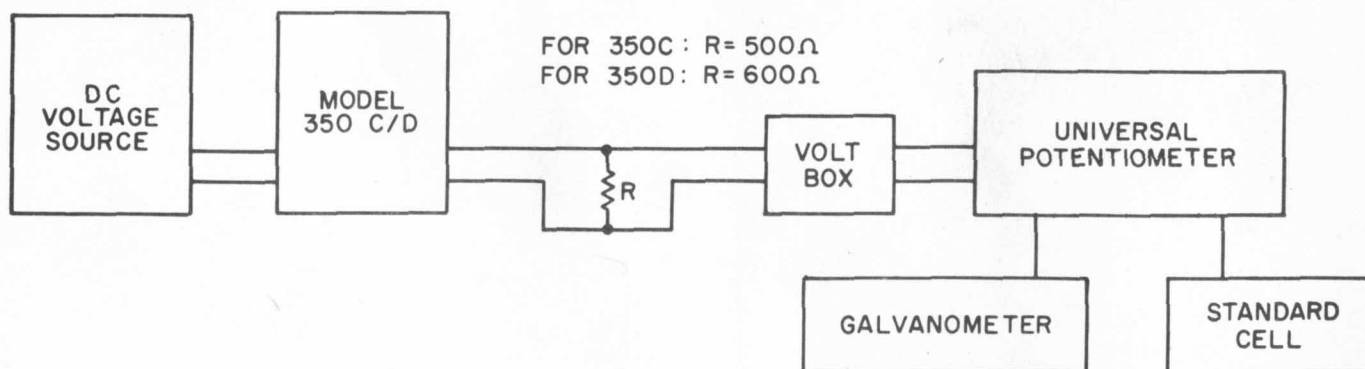
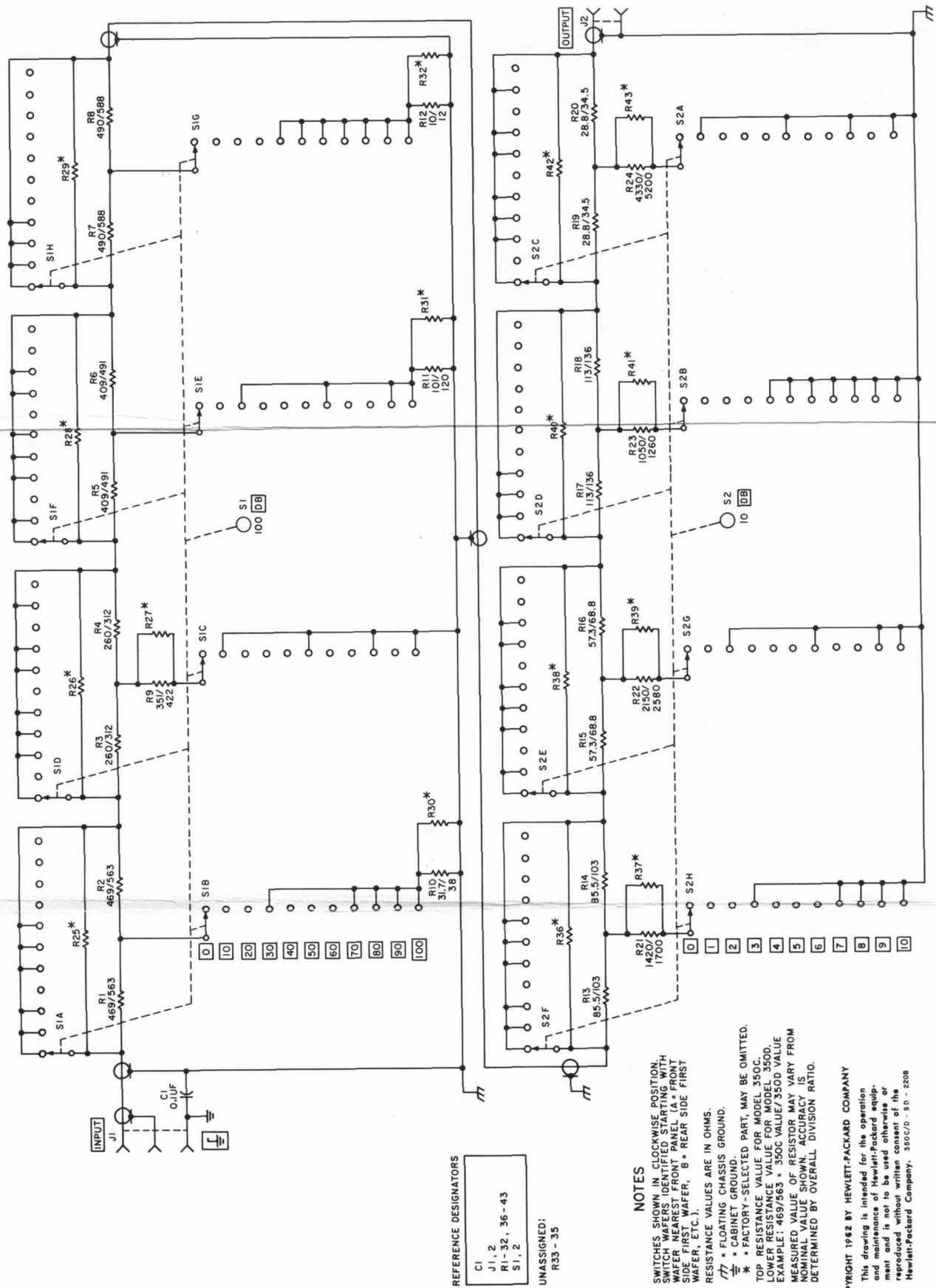


Figure 5-5. Test Setup for DC Performance Check



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 (WAFER 1) SIDE FIRST WAFER, B \* REAR SIDE FIRST WAFER, ETC.).
2. RESISTANCE VALUES ARE IN OHMS.
3. // = FLOATING CHASSIS GROUND.
4. \* = FACTORY-SELECTED PART, MAY BE OMITTED.
5. TOP RESISTANCE VALUE FOR MODEL 350C. LOWER RESISTANCE VALUE FOR MODEL 350D. EXAMPLE: 469/563 = 350C VALUE/350D VALUE. MEASURED VALUE OF RESISTOR MAY VARY FROM NOMINAL VALUE SHOWN. ACTUAL VALUE IS DETERMINED BY OVERALL DIVISION RATIO.

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

## 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  $\phi$  stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their  $\phi$  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                 | F = fuse             | P = plug        | V = vacuum tube, neon bulb, photocell, etc. |
| B = motor                    | FL = filter          | Q = transistor  | W = cable                                   |
| C = capacitor                | J = jack             | R = resistor    | X = socket                                  |
| CR = diode                   | K = relay            | RT = thermistor | XF = fuseholder                             |
| DL = delay line              | L = inductor         | S = switch      | XDS = lampholder                            |
| DS = device signaling (lamp) | M = meter            | T = transformer | Z = network                                 |
| E = misc electronic part     | MP = mechanical part |                 |                                             |

#### ABBREVIATIONS

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

Table 6-1. Reference Designation Index

| Circuit Reference | Ⓢ Stock No.                                      | Description #                                                                                                                                                                                               | Note |
|-------------------|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <u>MODEL 350C</u> |                                                  |                                                                                                                                                                                                             |      |
| A1                | 350C-34B                                         | Assy, attenuator, 0-100db, includes:<br>R1 thru R12, R25 thru R32, S1                                                                                                                                       |      |
| A2                | 350C-34A                                         | Assy, attenuator, 0-10db, includes:<br>R13 thru R24, R36 thru R43, S2                                                                                                                                       |      |
| C1                | 0170-0022                                        | C: fxd, my, 0.1 $\mu$ f $\pm$ 20%, 600 vdcw                                                                                                                                                                 |      |
| J1                | AC-10E<br>AC-10F<br>AC-54A<br>AC-54E<br>120A-47A | Connector: INPUT, includes:<br>Assy, binding post: red<br>Assy, binding post: black<br>Insulator, binding post: 2 hole (outside)<br>Insulator, binding post: 2 hole, keyed (inside)<br>Spacer: binding post |      |
| J2                | AC-10E<br>AC-10F<br>AC-54A<br>AC-54E             | Connector: OUTPUT, includes:<br>Assy, binding post: red<br>Assy, binding post: black<br>Insulator, binding post: 2 hole (outside)<br>Insulator, binding post: 2 hole, keyed (inside)                        |      |
| R1                | 0775-0005                                        | R: fxd, mfgl, 469 ohms $\pm$ 2%, 7W                                                                                                                                                                         |      |
| R2                | 0766-0028                                        | R: fxd, mfgl, 469 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R3                | 0772-0003                                        | R: fxd, mfgl, 260 ohms $\pm$ 2%, 5W                                                                                                                                                                         |      |
| R4                | 0766-0024                                        | R: fxd, mfgl, 260 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R5                | 0775-0004                                        | R: fxd, mfgl, 409 ohms $\pm$ 2%, 7W                                                                                                                                                                         |      |
| R6                | 0766-0026                                        | R: fxd, mfgl, 409 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R7                | 0775-0006                                        | R: fxd, mfgl, 490 ohms $\pm$ 2%, 7W                                                                                                                                                                         |      |
| R8                | 0766-0030                                        | R: fxd, mfgl, 490 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R9                | 0772-0004                                        | R: fxd, mfgl, 351 ohms $\pm$ 2%, 5W                                                                                                                                                                         |      |
| R10               | 0766-0027                                        | R: fxd, mfgl, 31.7 ohms $\pm$ 2%, 3W                                                                                                                                                                        |      |
| R11               | 0766-0025                                        | R: fxd, mfgl, 101 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R12               | 0766-0029                                        | R: fxd, mfgl, 10 ohms $\pm$ 2%, 3W                                                                                                                                                                          |      |
| R13, R14          | 0766-0020                                        | R: fxd, mfgl, 85.5 ohms $\pm$ 2%, 3W                                                                                                                                                                        |      |
| R15, R16          | 0766-0018                                        | R: fxd, mfgl, 57.3 ohms $\pm$ 2%, 3W                                                                                                                                                                        |      |
| R17, R18          | 0766-0022                                        | R: fxd, mfgl, 113 ohms $\pm$ 2%, 3W                                                                                                                                                                         |      |
| R19, R20          | 0766-0016                                        | R: fxd, mfgl, 28.8 ohms $\pm$ 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 $\pm 2\%$ , 3W                                                                                                                                                                      |      |
| R22               | 0766-0019                                        | R: fxd, mfgl, 2150 ohms $\pm 2\%$ , 3W                                                                                                                                                                      |      |
| R23               | 0766-0023                                        | R: fxd, mfgl, 1050 ohms $\pm 2\%$ , 3W                                                                                                                                                                      |      |
| R24               | 0766-0017                                        | R: fxd, mfgl, 4330 ohms $\pm 2\%$ , 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                                                                                                                                                                                             |      |
| <u>MODEL 350D</u> |                                                  |                                                                                                                                                                                                             |      |
| A1                | 350D-34B                                         | Assy, attenuator, 0-100db, includes:<br>R1 thru R12, R25 thru R32, S1                                                                                                                                       |      |
| A2                | 350D-34A                                         | Assy, attenuator, 0-10db, includes:<br>R13 thru R24, R36 thru R43, S2                                                                                                                                       |      |
| C1                | 0170-0022                                        | C: fxd, my, 0.1 $\mu$ f $\pm 20\%$ , 600 vdcw                                                                                                                                                               |      |
| J1                | AC-10E<br>AC-10F<br>AC-54A<br>AC-54E<br>120A-47A | Connector: INPUT, includes:<br>Assy, binding post: red<br>Assy, binding post: black<br>Insulator, binding post: 2 hole (outside)<br>Insulator, binding post: 2 hole, keyed (inside)<br>Spacer: binding post |      |
| J2                | AC-10E<br>AC-10F<br>AC-54A<br>AC-54E             | Connector: OUTPUT, includes:<br>Assy, binding post: red<br>Assy, binding post: black<br>Insulator, binding post: 2 hole (outside)<br>Insulator, binding post: 2 hole, keyed (inside)                        |      |
| R1                | 0775-0002                                        | R: fxd, mfgl, 563 ohms $\pm 2\%$ , 7W                                                                                                                                                                       |      |
| R2                | 0766-0013                                        | R: fxd, mfgl, 563 ohms $\pm 2\%$ , 3W                                                                                                                                                                       |      |
| R3                | 0772-0001                                        | R: fxd, mfgl, 312 ohms $\pm 2\%$ , 5W                                                                                                                                                                       |      |
| R4                | 0766-0009                                        | R: fxd, mfgl, 312 ohms $\pm 2\%$ , 3W                                                                                                                                                                       |      |
| R5                | 0775-0001                                        | R: fxd, mfgl, 491 ohms $\pm 2\%$ , 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 $\pm 2\%$ , 3W  |      |
| R7                | 0775-0003   | R: fxd, mfgl, 588 ohms $\pm 2\%$ , 7W  |      |
| R8                | 0766-0015   | R: fxd, mfgl, 588 ohms $\pm 2\%$ , 3W  |      |
| R9                | 0772-0002   | R: fxd, mfgl, 422 ohms $\pm 2\%$ , 5W  |      |
| R10               | 0766-0012   | R: fxd, mfgl, 38 ohms $\pm 2\%$ , 3W   |      |
| R11               | 0766-0010   | R: fxd, mfgl, 120 ohms $\pm 2\%$ , 3W  |      |
| R12               | 0766-0014   | R: fxd, mfgl, 12 ohms $\pm 2\%$ , 3W   |      |
| R13, R14          | 0766-0005   | R: fxd, mfgl, 103 ohms $\pm 2\%$ , 3W  |      |
| R15, R16          | 0766-0003   | R: fxd, mfgl, 68.8 ohms $\pm 2\%$ , 3W |      |
| R17, R18          | 0766-0007   | R: fxd, mfgl, 136 ohms $\pm 2\%$ , 3W  |      |
| R19, R20          | 0766-0001   | R: fxd, mfgl, 34.5 ohms $\pm 2\%$ , 3W |      |
| R21               | 0766-0006   | R: fxd, mfgl, 1700 ohms $\pm 2\%$ , 3W |      |
| R22               | 0766-0004   | R: fxd, mfgl, 2580 ohms $\pm 2\%$ , 3W |      |
| R23               | 0766-0008   | R: fxd, mfgl, 1260 ohms $\pm 2\%$ , 3W |      |
| R24               | 0766-0002   | R: fxd, mfgl, 5200 ohms $\pm 2\%$ , 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:<br>R13 thru R24, R36 thru R43, S2 | 28480 | 350C-34A      | 1  | 0  |  |  |
| 350C-34B  | Assy, attenuator, 0-100db, includes:<br>R1 thru R12, R25 thru R32, S1 | 28480 | 350C-34B      | 1  | 0  |  |  |
| 350D-34A  | Assy, attenuator, 0-10db, includes:<br>R13 thru R24, R36 thru R43, S2 | 28480 | 350D-34A      | 1  | 0  |  |  |
| 350D-34B  | Assy, attenuator, 0-100db, includes:<br>R1 thru R12, R25 thru R32, S1 | 28480 | 350D-34B      | 1  | 0  |  |  |
| 0170-0022 | C: fxd, my, 0-1 $\mu$ f $\pm$ 20%, 600 vdcw                           | 84411 | HEW 7         | 2  | 1  |  |  |
| 0766-0001 | R: fxd, mfgl, 34.5 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0002 | R: fxd, mfgl, 5200 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0003 | R: fxd, mfgl, 68.8 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0004 | R: fxd, mfgl, 2580 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0005 | R: fxd, mfgl, 103 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0006 | R: fxd, mfgl, 1700 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0007 | R: fxd, mfgl, 136 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0008 | R: fxd, mfgl, 1260 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0009 | R: fxd, mfgl, 312 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0010 | R: fxd, mfgl, 120 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0011 | R: fxd, mfgl, 491 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0012 | R: fxd, mfgl, 38 ohms $\pm$ 2%, 3W                                    | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0013 | R: fxd, mfgl, 563 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0014 | R: fxd, mfgl, 12 ohms $\pm$ 2%, 3W                                    | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0015 | R: fxd, mfgl, 588 ohms $\pm$ 2%, 3W                                   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0016 | R: fxd, mfgl, 28.8 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0017 | R: fxd, mfgl, 4330 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0018 | R: fxd, mfgl, 57.3 ohms $\pm$ 2%, 3W                                  | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0019 | R: fxd, mfgl, 2150 ohms $\pm$ 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 $\pm 2\%$ , 3W | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0021            | R: fxd, mfgl, 1420 ohms $\pm 2\%$ , 3W | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0022            | R: fxd, mfgl, 113 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 2  | 1  |  |  |
| 0766-0023            | R: fxd, mfgl, 1050 ohms $\pm 2\%$ , 3W | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0024            | R: fxd, mfgl, 260 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0025            | R: fxd, mfgl, 101 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0026            | R: fxd, mfgl, 409 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0027            | R: fxd, mfgl, 31.7 ohms $\pm 2\%$ , 3W | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0028            | R: fxd, mfgl, 469 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0029            | R: fxd, mfgl, 10 ohms $\pm 2\%$ , 3W   | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0766-0030            | R: fxd, mfgl, 490 ohms $\pm 2\%$ , 3W  | 07115 | LPI-3, obd#   | 1  | 1  |  |  |
| 0772-0001            | R: fxd, mfgl, 312 ohms $\pm 2\%$ , 5W  | 07115 | LPI-5, obd#   | 1  | 1  |  |  |
| 0772-0002            | R: fxd, mfgl, 422 ohms $\pm 2\%$ , 5W  | 07115 | LPI-5, obd#   | 1  | 1  |  |  |
| 0772-0003            | R: fxd, mfgl, 260 ohms $\pm 2\%$ , 5W  | 07115 | LPI-5, obd#   | 1  | 1  |  |  |
| 0772-0004            | R: fxd, mfgl, 351 ohms $\pm 2\%$ , 5W  | 07115 | LPI-5, obd#   | 1  | 1  |  |  |
| 0775-0001            | R: fxd, mfgl, 491 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| 0775-0002            | R: fxd, mfgl, 563 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| 0775-0003            | R: fxd, mfgl, 588 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| 0775-0004            | R: fxd, mfgl, 409 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| 0775-0005            | R: fxd, mfgl, 469 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| 0775-0006            | R: fxd, mfgl, 490 ohms $\pm 2\%$ , 7W  | 07115 | LPI-7, obd#   | 1  | 1  |  |  |
| <u>MISCELLANEOUS</u> |                                        |       |               |    |    |  |  |
| 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               | CODE NO. | MANUFACTURER                          | ADDRESS                               | CODE NO. | MANUFACTURER                        | ADDRESS                                   |
|----------|-----------------------------------------|-----------------------|----------|---------------------------------------|---------------------------------------|----------|-------------------------------------|-------------------------------------------|
| 00334    | Humidial Co.                            | Colton, Calif.        | 07115    | Corning Glass Works                   | Bradford, Pa.                         | 40920    | Miniature Precision Bearings, Inc.  | Keene, N.H.                               |
| 00335    | Westrex Corp.                           | New York, N.Y.        |          | Electronic Components Dept.           | Pasadena, Calif.                      | 42190    | Muter Co.                           | Chicago, Ill.                             |
| 00373    | Garlock Packing Co.,                    | Camden, N.J.          | 07126    | Digitran Co.                          | Minneapolis, Minn.                    | 43990    | C. A. Norgren Co.                   | Englewood, Colo.                          |
|          | Electronic Products Div.                |                       | 07137    | Transistor Electronics Corp.          | Elmira, N.Y.                          | 44655    | Ohmite Mfg. Co.                     | Skokie, Ill.                              |
| 00656    | Aerovox Corp.                           | New Bedford, Mass.    | 07138    | Westinghouse Electric Corp.           | Los Angeles, Calif.                   | 47904    | Polaroid Corp.                      | Cambridge, Mass.                          |
| 00779    | Amp, Inc.                               | Harrisburg, Pa.       |          | Electronic Tube Div.                  |                                       | 48620    | Precision Thermometer and           | Philadelphia, Pa.                         |
| 00781    | Aircraft Radio Corp.                    | Boonton, N.J.         | 07261    | Avnet Corp.                           | Mountain View, Calif.                 |          | Inst. Co.                           |                                           |
| 00815    | Northern Engineering Laboratories, Inc. | Burlington, Wis.      | 07263    | Fairchild Semiconductor Corp.         | Hawthorne, Calif.                     | 49956    | Raytheon Company                    | Lexington, Mass.                          |
|          |                                         |                       |          |                                       |                                       | 54294    | Shallcross Mfg. Co.                 | Selma, N.C.                               |
| 00853    | Sangamo Electric Company,               | Marion, Ill.          | 07910    | Continental Device Corp.              | Mountain View, Calif.                 | 55026    | Simpson Electric Co.                | Chicago, Ill.                             |
|          | Ordill Division (Capacitors)            |                       | 07933    | Rheem Semiconductor Corp.             |                                       | 55933    | Sonotone Corp.                      | Elmsford, N.Y.                            |
| 00866    | Goe Engineering Co.                     | Los Angeles, Calif.   |          |                                       |                                       | 55938    | Sorenson & Co., Inc.                | So. Norwalk, Conn.                        |
| 00891    | Carl E. Holmes Corp.                    | Los Angeles, Calif.   | 07966    | Shockley Semi-Conductor               | Palo Alto, Calif.                     | 56137    | Spaulding Fibre Co., Inc.           | Tonawanda, N.Y.                           |
| 01121    | Allen Bradley Co.                       | Milwaukee, Wis.       |          | Laboratories                          |                                       | 56289    | Sprague Electric Co.                | North Adams, Mass.                        |
| 01255    | Litton Industries, Inc.                 | Beverly Hills, Calif. | 07980    | Boonton Radio Corp.                   | Boonton, N.J.                         | 59446    | Telex, Inc.                         | St. Paul, Minn.                           |
| 01281    | Pacific Semiconductors, Inc.            | Culver City, Calif.   | 08145    | U.S. Engineering Co.                  | Los Angeles, Calif.                   | 61775    | Union Switch and Signal, Div. of    | Westinghouse Air Brake Co. Swissvale, Pa. |
|          |                                         |                       | 08358    | Burgess Battery Co.                   | Niagara Falls, Ontario, Canada        | 62119    | Universal Electric Co.              | Owosso, Mich.                             |
| 01295    | Texas Instruments, Inc.                 | Dallas, Texas         |          |                                       |                                       | 64959    | Western Electric Co., Inc.          | New York, N.Y.                            |
|          | Transistor Products Div.                |                       | 08717    | Sloan Company                         | Burbank, Calif.                       | 65092    | Weston Inst. Div. of Daystrom, Inc. | Newark, N.J.                              |
| 01349    | The Alliance Mfg. Co.                   | Alliance, Ohio        | 08718    | Cannon Electric Co.                   | Phoenix, Ariz.                        | 66295    | Wittek Manufacturing Co.            | Chicago 23, Ill.                          |
| 01561    | Chassi-Trak Corp.                       | Indianapolis, Ind.    |          | Phoenix Div.                          |                                       | 66346    | Wollensak Optical Co.               | Rochester, N.Y.                           |
| 01589    | Pacific Relays, Inc.                    | Van Nuys, Calif.      | 08792    | CBS Electronics Semiconductor         | Lowell, Mass.                         | 70276    | Allen Mfg. Co.                      | Hartford, Conn.                           |
| 01930    | Amerock Corp.                           | Rockford, Ill.        |          | Operations, Div. of C.B.S. Inc.       |                                       | 70309    | Allied Control Co., Inc.            | New York, N.Y.                            |
| 01961    | Pulse Engineering Co.                   | Santa Clara, Calif.   | 08994    | Mel-Rain                              | Indianapolis, Ind.                    | 70485    | Atlantic India Rubber Works, Inc.   | Chicago, Ill.                             |
| 02114    | Ferroxcube Corp. of America             | Saugerties, N.Y.      | 09026    | Babcock Relays, Inc.                  | Costa Mesa, Calif.                    | 70563    | Amperite Co., Inc.                  | New York, N.Y.                            |
|          |                                         |                       | 09134    | Texas Capacitor Co.                   | Houston, Texas                        | 70903    | Belden Mfg. Co.                     | Chicago, Ill.                             |
| 02286    | Cole Mfg. Co.                           | Palo Alto, Calif.     | 09250    | Electro Assemblies, Inc.              | Chicago, Ill.                         | 70998    | Bird Electronic Corp.               | Cleveland, Ohio                           |
| 02660    | Amphenol-Borg Electronics Corp.         | Chicago, Ill.         | 09569    | Mallory Battery Co. of                | Canada, Ltd. Toronto, Ontario, Canada | 71002    | Birnbach Radio Co.                  | New York, N.Y.                            |
|          |                                         |                       | 10214    | General Transistor Western Corp.      | Los Angeles, Calif.                   | 71041    | Boston Gear Works Div. of           | Quincy, Mass.                             |
| 02735    | Radio Corp. of America                  | Somerville, N.J.      |          |                                       |                                       |          | Murray Co. of Texas                 |                                           |
|          | Semiconductor and Materials Div.        |                       | 10411    | Ti-Tal, Inc.                          | Berkeley, Calif.                      | 71218    | Bud Radio Inc.                      | Cleveland, Ohio                           |
| 02771    | Vocaline Co. of America, Inc.           | Old Saybrook, Conn.   | 10646    | Carborundum Co.                       | Niagara Falls, N.Y.                   | 71286    | Camloc Fastener Corp.               | Paramus, N.J.                             |
|          |                                         |                       | 11236    | CTS of Berne, Inc.                    | Berne, Ind.                           | 71313    | Allen D. Cardwell Electronic        | Plainville, Conn.                         |
| 02777    | Hopkins Engineering Co.                 | San Fernando, Calif.  | 11237    | Chicago Telephone of California, Inc. | So. Pasadena, Calif.                  | 71400    | Bussmann Fuse Div. of McGraw-       | St. Louis, Mo.                            |
|          |                                         |                       |          |                                       |                                       |          | Edison Co.                          | Elkhart, Ind.                             |
| 03508    | G.E. Semiconductor Products Dept.       | Syracuse, N.Y.        | 11312    | Microwave Electronics Corp.           | Palo Alto, Calif.                     | 71450    | CTS Corp.                           | Los Angeles, Calif.                       |
| 03705    | Apex Machine & Tool Co.                 | Dayton, Ohio          | 11534    | Duncan Electronics, Inc.              | Santa Ana, Calif.                     | 71468    | Cannon Electric Co.                 | Burbank, Calif.                           |
| 03797    | Eldema Corp.                            | El Monte, Calif.      | 11711    | General Instrument Corporation        | Newark, N.J.                          | 71471    | Cinema Engineering Co.              | Chicago, Ill.                             |
| 03877    | Transitron Electronic Corp.             | Wakefield, Mass.      |          | Semiconductor Division                |                                       | 71482    | C. P. Clare & Co.                   |                                           |
| 03888    | Pyrofilm Resistor Co.                   | Morristown, N.J.      | 11717    | Imperial Electronics, Inc.            | Buena Park, Calif.                    | 71528    | Standard-Thomson Corp.,             | Waltham, Mass.                            |
| 03954    | Air Marine Motors, Inc.                 | Los Angeles, Calif.   | 11870    | Melabs, Inc.                          | Palo Alto, Calif.                     |          | Clifford Mfg. Co. Div.              |                                           |
| 04009    | Arrow, Hart and Hegeman Elect. Co.      | Hartford, Conn.       | 12697    | Clarostat Mfg. Co.                    | Dover, N.H.                           | 71590    | Centralab Div. of Globe Union Inc.  | Milwaukee, Wis.                           |
|          |                                         |                       | 14655    | Cornell Dubilier Elec. Corp.          | So. Plainfield, N.J.                  | 71700    | The Cornish Wire Co.                | New York, N.Y.                            |
| 04062    | Elmenco Products Co.                    | New York, N.Y.        | 15909    | The Daven Co.                         | Livingston, N.J.                      | 71744    | Chicago Miniature Lamp Works        | Chicago, Ill.                             |
| 04222    | Hi-Q Division of Aerovox                | Myrtle Beach, S.C.    | 16688    | De Jur-Amsco Corporation              | Long Island City 1, N.Y.              | 71753    | A. O. Smith Corp., Crowley Div.     | West Orange, N.J.                         |
| 04298    | Elgin National Watch Co.,               | Burbank, Calif.       | 16758    | Delco Radio Div. of G. M. Corp.       | Kokomo, Ind.                          | 71785    | Cinch Mfg. Corp.                    | Chicago, Ill.                             |
|          | Electronics Division                    |                       | 18873    | E. I. DuPont and Co., Inc.            | Wilmington, Del.                      | 71984    | Dow Corning Corp.                   | Midland, Mich.                            |
| 04404    | Dymec Division of                       | Palo Alto, Calif.     | 19315    | Eclipse Pioneer, Div. of              | Teterboro, N.J.                       | 72136    | Electro Motive Mfg. Co., Inc.       | Willimantic, Conn.                        |
|          | Hewlett-Packard Co.                     |                       | 19500    | Thomas A. Edison Industries,          | West Orange, N.J.                     | 72354    | John E. Fast & Co.                  | Chicago, Ill.                             |
| 04651    | Sylvania Electric Prods., Inc.          | Mountain View, Calif. |          | Div. of McGraw-Edison Co.             |                                       | 72619    | Dialight Corp.                      | Brooklyn, N.Y.                            |
| 04713    | Motorola, Inc., Semiconductor           | Phoenix, Arizona      | 19701    | Electra Manufacturing Co.             | Kansas City, Mo.                      | 72656    | General Ceramics Corp.              | Keasbey, N.J.                             |
|          | Prod. Div.                              |                       | 20183    | Electronic Tube Corp.                 | Philadelphia, Pa.                     | 72758    | Girard-Hopkins                      | Oakland, Calif.                           |
| 04732    | Filtron Co., Inc.                       | Culver City, Calif.   | 21520    | Fansteel Metallurgical Corp.          | No. Chicago, Ill.                     | 72765    | Drake Mfg. Co.                      | Chicago, Ill.                             |
|          | Western Division                        |                       | 21335    | The Fafnir Bearing Co.                | New Britain, Conn.                    | 72825    | Hugh H. Eby Inc.                    | Philadelphia, Pa.                         |
| 04773    | Automatic Electric Co.                  | Northlake, Ill.       | 21964    | Fed. Telephone and Radio Corp.        | Clifton, N.J.                         | 72928    | Gudeman Co.                         | Chicago, Ill.                             |
| 04796    | Sequoia Wire & Cable                    | Redwood City, Calif.  | 24446    | General Electric Co.                  | Schenectady, N.Y.                     | 72964    | Robert M. Hadley Co.                | Los Angeles, Calif.                       |
|          | Company                                 |                       | 24455    | G.E., Lamp Division                   | Nela Park, Cleveland, Ohio            | 72982    | Erie Resistor Corp.                 | Erie, Pa.                                 |
| 04870    | P. M. Motor Co.                         | Chicago 44, Ill.      | 24655    | General Radio Co.                     | West Concord, Mass.                   | 73061    | Hansen Mfg. Co., Inc.               | Princeton, Ind.                           |
| 05006    | Twentieth Century Plastics, Inc.        | Los Angeles, Calif.   | 24662    | Grobet File Co. of America, Inc.      | Carlstadt, N.J.                       | 73138    | Helipot Div. of Beckman             | Fullerton, Calif.                         |
|          |                                         |                       |          |                                       |                                       |          | Instruments, Inc.                   |                                           |
| 05277    | Westinghouse Electric Corp.,            | Youngwood, Pa.        | 26992    | Hamilton Watch Co.                    | Lancaster, Pa.                        | 73293    | Hughes Products Division of         | Newport Beach, Calif.                     |
|          | Semi-Conductor Dept.                    |                       | 28480    | Hewlett-Packard Co.                   | Palo Alto, Calif.                     | 73445    | Amperex Electronic Co., Div. of     | North American Phillips Co., Inc.         |
| 05347    | Ultronix, Inc.                          | San Mateo, Calif.     | 33173    | G.E. Receiving Tube Dept.             | Owensboro, Ky.                        |          |                                     |                                           |
| 05593    | Ilumitronic Engineering Co.             | Sunnyvale, Calif.     | 35434    | Lectrohm Inc.                         | Chicago, Ill.                         | 73506    | Bradley Semiconductor Corp.         | Hamden, Conn.                             |
| 05624    | Barber Colman Co.                       | Rockford, Ill.        | 37942    | P. R. Mallory & Co., Inc.             | Indianapolis, Ind.                    | 73559    | Carling Electric, Inc.              | Hartford, Conn.                           |
| 05729    | Metropolitan Telecommunications Corp.,  | Brooklyn, N.Y.        | 39543    | Mechanical Industries Prod. Co.       | Akron, Ohio                           | 73682    | George K. Garrett Co., Inc.         | Philadelphia, Pa.                         |
|          | Metro Cap. Div.                         |                       |          |                                       |                                       |          |                                     |                                           |
| 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.      |          |                                       |                                       |          |                                     |                                           |

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                | CODE NO. | MANUFACTURER                                                            | ADDRESS                | CODE NO. | MANUFACTURER                                            | ADDRESS               |
|----------|-------------------------------------------------------------------------|------------------------|----------|-------------------------------------------------------------------------|------------------------|----------|---------------------------------------------------------|-----------------------|
| 73734    | Federal Screw Products Co.                                              | Chicago, Ill.          | 82647    | Metals and Controls, Inc., Div. of                                      |                        | 95265    | National Coil Co.                                       | Sheridan, Wyo.        |
| 73743    | Fischer Special Mfg. Co.                                                | Cincinnati, Ohio       |          | Texas Instruments, Inc.,                                                |                        | 95275    | Vitramon, Inc.                                          | Bridgeport, Conn.     |
| 73793    | The General Industries Co.                                              | Elyria, Ohio           |          | Spencer Prods.                                                          | Attleboro, Mass.       | 95354    | Methode Mfg. Co.                                        | Chicago, Ill.         |
| 73905    | Jennings Radio Mfg. Co.                                                 | San Jose, Calif.       | 82866    | Research Products Corp.                                                 | Madison, Wis.          | 95987    | Weckesser Co.                                           | Chicago, Ill.         |
| 74455    | J. H. Winns, and Sons                                                   | Winchester, Mass.      | 82877    | Rotron Manufacturing Co., Inc.                                          | Woodstock, N.Y.        | 96067    | Huggins Laboratories                                    | Sunnyvale, Calif.     |
| 74861    | Industrial Condenser Corp.                                              | Chicago, Ill.          | 82893    | Vector Electronic Co.                                                   | Glendale, Calif.       | 96095    | Hi-Q Division of Aerovox                                | Olean, N.Y.           |
| 74868    | R.F. Products Division of Amphenol-Borg Electronics Corp.               | Danbury, Conn.         | 83053    | Western Washer Mfr. Co.                                                 | Los Angeles, Calif.    | 96256    | Thordarson-Meissner Div. of Maguire Industries, Inc.    | Mt. Carmel, Ill.      |
| 74970    | E. F. Johnson Co.                                                       | Waseca, Minn.          | 83058    | Carr Fastener Co.                                                       | Cambridge, Mass.       | 96296    | Solar Manufacturing Co.                                 | Los Angeles, Calif.   |
| 75042    | International Resistance Co.                                            | Philadelphia, Pa.      | 83086    | New Hampshire Ball Bearing, Inc.                                        | Peterborough, N.H.     | 96330    | Carlton Screw Co.                                       | Chicago, Ill.         |
| 75173    | Jones, Howard B., Division of Cinch Mfg. Corp.                          | Chicago, Ill.          | 83125    | Pyramid Electric Co.                                                    | Darlington, S.C.       | 96341    | Microwave Associates, Inc.                              | Burlington, Mass.     |
| 75378    | James Knights Co.                                                       | Sandwich, Ill.         | 83148    | Electro Cords Co.                                                       | Los Angeles, Calif.    | 96501    | Excel Transformer Co.                                   | Oakland, Calif.       |
| 75382    | Kulka Electric Corporation                                              | Mt. Vernon, N.Y.       | 83186    | Victory Engineering Corp.                                               | Union, N.J.            | 97464    | Industrial Retaining Ring Co.                           | Irvington, N.J.       |
| 75818    | Lenz Electric Mfg. Co.                                                  | Chicago, Ill.          | 83298    | Bendix Corp., Red Bank Div.                                             | Red Bank, N.J.         | 97539    | Automatic and Precision Mfg. Co.                        | Yonkers, N.Y.         |
| 75915    | Littelfuse Inc.                                                         | Des Plaines, Ill.      | 83330    | Smith, Herman H., Inc.                                                  | Brooklyn, N.Y.         | 97966    | CBS Electronics, Div. of C.B.S., Inc.                   | Danvers, Mass.        |
| 76005    | Lord Mfg. Co.                                                           | Erie, Pa.              | 83501    | Gavitt Wire and Cable Co., Div. of Amerace Corp.                        | Brookfield, Mass.      | 98141    | Axel Brothers Inc.                                      | Jamaica, N.Y.         |
| 76210    | C. W. Marwedel                                                          | San Francisco, Calif.  | 83594    | Burroughs Corp., Electronic Tube Div.                                   | Plainfield, N.J.       | 98220    | Francis L. Mosley                                       | Pasadena, Calif.      |
| 76433    | Micamold Electronic Mfg. Corp.                                          | Brooklyn, N.Y.         | 83777    | Model Eng. and Mfg., Inc.                                               | Huntington, Ind.       | 98278    | Microdot, Inc.                                          | So. Pasadena, Calif.  |
| 76487    | James Millen Mfg. Co., Inc.                                             | Malden, Mass.          | 83821    | Loyd Scruggs Co.                                                        | Festus, Mo.            | 98291    | Sealectro Corp.                                         | Mamaroneck, N.Y.      |
| 76493    | J. W. Miller Co.                                                        | Los Angeles, Calif.    | 84171    | Arco Electronics, Inc.                                                  | New York, N.Y.         | 98405    | Carad Corp.                                             | Redwood City, Calif.  |
| 76530    | Monadnock Mills                                                         | San Leandro, Calif.    | 84396    | A. J. Glesener Co., Inc.                                                | San Francisco, Calif.  | 98734    | Palo Alto Engineering Co., Inc.                         | Palo Alto, Calif.     |
| 76545    | Mueller Electric Co.                                                    | Cleveland, Ohio        | 84411    | Good All Electric Mfg. Co.                                              | Ogallala, Neb.         | 98821    | North Hills Electric Co.                                | Mineola, N.Y.         |
| 76854    | Oak Manufacturing Co.                                                   | Crystal Lake, Ill.     | 84970    | Sarkes Tarzian, Inc.                                                    | Bloomington, Ind.      | 98925    | Clevite Transistor Prod. Div. of Clevite Corp.          | Waltham, Mass.        |
| 77068    | Bendix Pacific Division of Bendix Corp.                                 | No. Hollywood, Calif.  | 85454    | Boonton Molding Company                                                 | Boonton, N.J.          | 98978    | International Electronic Research Corp.                 | Burbank, Calif.       |
| 77221    | Phaotron Instrument and Electronic Co.                                  | South Pasadena, Calif. | 85471    | A. B. Boyd Co.                                                          | San Francisco, Calif.  | 99109    | Columbia Technical Corp.                                | New York, N.Y.        |
| 77252    | Philadelphia Steel and Wire Corp.                                       | Philadelphia, Pa.      | 85474    | R. M. Bracamonte & Co.                                                  | San Francisco, Calif.  | 99313    | Varian Associates                                       | Palo Alto, Calif.     |
| 77342    | Potter and Brumfield, Div. of American Machine and Foundry              | Princeton, Ind.        | 85660    | Koiled Kords, Inc.                                                      | New Haven, Conn.       | 99515    | Marshall Industries, Electron Products Division         | Pasadena, Calif.      |
| 77630    | Radio Condenser Co.                                                     | Camden, N.J.           | 85911    | Seamless Rubber Co.                                                     | Chicago, Ill.          | 99707    | Control Switch Division, Controls Co. of America        | El Segundo, Calif.    |
| 77638    | Radio Receptor Co., Inc.                                                | Brooklyn, N.Y.         | 86197    | Clifton Precision Products                                              | Clifton Heights, Pa.   | 99800    | Delevan Electronics Corp.                               | East Aurora, N.Y.     |
| 77764    | Resistance Products Co.                                                 | Harrisburg, Pa.        | 86684    | Radio Corp. of America, RCA Electron Tube Div.                          | Harrison, N.J.         | 99848    | Wilco Corporation                                       | Indianapolis, Ind.    |
| 78189    | Shakeproof Division of Illinois Tool Works                              | Elgin, Ill.            | 87216    | Philco Corp. (Lansdale Division)                                        | Lansdale, Pa.          | 99934    | Renbrandt, Inc.                                         | Boston, Mass.         |
| 78283    | Signal Indicator Corp.                                                  | New York, N.Y.         | 87473    | Western Fibrous Glass Products Co.                                      | San Francisco, Calif.  | 99942    | Hoffman Semiconductor Div. of Hoffman Electronics Corp. | Evanston, Ill.        |
| 78471    | Tilley Mfg. Co.                                                         | San Francisco, Calif.  | 88140    | Cutler-Hammer, Inc.                                                     | Lincoln, Ill.          | 99957    | Technology Instrument Corp. of Calif.                   | Newbury Park, Calif.  |
| 78488    | Stackpole Carbon Co.                                                    | St. Marys, Pa.         | 88220    | Gould-National Batteries, Inc.                                          | St. Paul, Minn.        |          |                                                         |                       |
| 78553    | Tinnerman Products, Inc.                                                | Cleveland, Ohio        | 89473    | General Electric Distributing Corp.                                     | Schenectady, N.Y.      |          |                                                         |                       |
| 78790    | Transformer Engineers                                                   | Newtonville, Mass.     | 89636    | Carter Parts Div. of Economy Baler Co.                                  | Chicago, Ill.          |          |                                                         |                       |
| 78947    | Ucinite Co.                                                             | Hartford, Conn.        | 89665    | United Transformer Co.                                                  | Chicago, Ill.          |          |                                                         |                       |
| 79142    | Veeder Root, Inc.                                                       | Hartford, Conn.        | 90179    | U.S. Rubber Co., Mechanical Goods Div.                                  | Passaic, N.J.          |          |                                                         |                       |
| 79251    | Wenco Mfg. Co.                                                          | Chicago, Ill.          | 90970    | Bearing Engineering Co.                                                 | San Francisco, Calif.  | 0000F    | Malco Tool and Die                                      | Los Angeles, Calif.   |
| 79727    | Continental-Wirt Electronics Corp.                                      | Philadelphia, Pa.      | 91260    | Connor Spring Mfg. Co.                                                  | San Francisco, Calif.  | 0000I    | Telefunken (c/o American Elite)                         | New York, N.Y.        |
| 79963    | Zierick Mfg. Corp.                                                      | New Rochelle, N.Y.     | 91345    | Miller Dial & Nameplate Co.                                             | El Monte, Calif.       | 0000M    | Western Coil Div. of Automatic Ind., Inc.               | Redwood City, Calif.  |
| 80031    | Mepco Division of Sessions Clock Co.                                    | Morristown, N.J.       | 91418    | Radio Materials Co.                                                     | Chicago, Ill.          | 0000N    | Nahm-Bros. Spring Co.                                   | San Leandro, Calif.   |
| 80120    | Schnitzer Alloy Products                                                | Elizabeth, N.J.        | 91506    | Augat Brothers, Inc.                                                    | Attleboro, Mass.       | 0000P    | Ty-Car Mfg. Co., Inc.                                   | Holliston, Mass.      |
| 80130    | Times Facsimile Corp.                                                   | New York, N.Y.         | 91637    | Dale Electronics, Inc.                                                  | Columbus, Nebr.        | 0000T    | Texas Instruments, Inc. Metals and Controls Div.        | Versailles, Ky.       |
| 80131    | Electronic Industries Association Any brand tube meeting EIA standards  | Washington, D.C.       | 91662    | Elco Corp.                                                              | Philadelphia, Pa.      | 0000U    | Tower Mfg. Corp.                                        | Providence, R.I.      |
| 80207    | Unimax Switch, Div. of W. L. Maxson Corp.                               | Wallingford, Conn.     | 91737    | Gremer Mfg. Co., Inc.                                                   | Wakefield, Mass.       | 0000W    | Webster Electronics Co. Inc.                            | New York, N.Y.        |
| 80248    | Oxford Electric Corp.                                                   | Chicago, Ill.          | 91827    | K F Development Co.                                                     | Redwood City, Calif.   | 0000X    | Spruce Pine Mica Co.                                    | Spruce Pine, N.C.     |
| 80294    | Bourns Laboratories, Inc.                                               | Riverside, Calif.      | 91921    | Minneapolis-Honeywell Regulator Co., Micro-Switch Division              | Freeport, Ill.         | 0000Y    | Midland Mfg. Co. Inc.                                   | Kansas City, Kans.    |
| 80411    | Acro Div. of Robertshaw Fulton Controls Co.                             | Columbus 16, Ohio      | 92196    | Universal Metal Products, Inc.                                          | Bassett Puente, Calif. | 0000Z    | Willow Leather Products Corp.                           | Newark, N.J.          |
| 80486    | All Star Products Inc.                                                  | Defiance, Ohio         | 93332    | Sylvania Electric Prod. Inc., Semiconductor Div.                        | Woburn, Mass.          | 000A     | British Radio Electronics Ltd.                          | Washington, D.C.      |
| 80583    | Hammerlund Co., Inc.                                                    | New York, N.Y.         | 93369    | Robbins and Myers, Inc.                                                 | New York, N.Y.         | 000BB    | Precision Instrument Components Co.                     | Van Nuys, Calif.      |
| 80640    | Stevens, Arnold, Co., Inc.                                              | Boston, Mass.          | 93410    | Stevens Mfg. Co., Inc.                                                  | Mansfield, Ohio        | 000CC    | Computer Diode Corp.                                    | Lodi, N.J.            |
| 81030    | International Instruments, Inc.                                         | New Haven, Conn.       | 93983    | Insuline-Van Norman Ind., Inc. Electronic Division                      | Manchester, N.H.       | 000EE    | A. Williams Manufacturing Co.                           | San Jose, Calif.      |
| 81312    | Winchester Electronics Co., Inc.                                        | Norwalk, Conn.         | 94144    | Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation | Quincy, Mass.          | 000FF    | Carmichael Corrugated Specialties                       | Richmond, Calif.      |
| 81415    | Wilkor Products, Inc.                                                   | Cleveland, Ohio        | 94145    | Raytheon Mfg. Co., Semiconductor Div., California Street Plant          | Newton, Mass.          | 000GG    | Goshen Die Cutting Service                              | Goshen, Ind.          |
| 81453    | Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations | Newton, Mass.          | 94148    | Scientific Radio Products, Inc.                                         | Loveland, Colo.        | 000HH    | Rubbercraft Corp.                                       | Torrance, Calif.      |
| 81483    | International Rectifier Corp.                                           | El Segundo, Calif.     | 94154    | Tung-Sol Electric, Inc.                                                 | Newark, N.J.           | 000II    | Birtcher Corporation, Industrial Division               | Monterey Park, Calif. |
| 81860    | Barry Controls, Inc.                                                    | Watertown, Mass.       | 94197    | Curtiss-Wright Corp., Electronics Div.                                  | East Paterson, N.J.    | 000KK    | Amatom                                                  | New Rochelle, N.Y.    |
| 82042    | Carter Parts Co.                                                        | Skokie, Ill.           | 94310    | Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.                    | Chicago, Ill.          | 000LL    | Avery Label                                             | Monrovia, Calif.      |
| 82142    | Jeffers Electronics Division of Speer Carbon Co.                        | Du Bois, Pa.           | 94682    | Worcester Pressed Aluminum Corp.                                        | Worcester, Mass.       | 000MM    | Rubber Eng. & Development                               | Hayward, Calif.       |
| 82170    | Allen B. DuMont Labs., Inc.                                             | Clifton, N.J.          | 95236    | Allies Products Corp.                                                   | Miami, Fla.            | 000NN    | N A "N" D Manufacturing Co.                             | San Jose 27, Calif.   |
| 82209    | Maguire Industries, Inc.                                                | Greenwich, Conn.       | 95238    | Continental Connector Corp.                                             | Woodside, N.Y.         | 000PP    | Atohm Electronics,                                      | Sun Valley, Calif.    |
| 82219    | Sylvania Electric Prod. Inc., Electronic Tube Div.                      | Emporium, Pa.          | 95263    | Leecraft Mfg. Co., Inc.                                                 | New York, N.Y.         | 000QQ    | Cooltron.                                               | Oakland, Calif.       |
| 82376    | Astron Co.                                                              | East Newark, N.J.      | 95264    | Lerco Electronics, Inc.                                                 | Burbank, Calif.        | 000RR    | Radio Industries                                        | Des Plaines, Ill.     |
| 82389    | Switchcraft, Inc.                                                       | Chicago, Ill.          |          |                                                                         |                        | 000SS    | Control of Elgin Watch Co.                              | Burbank, Calif.       |
|          |                                                                         |                        |          |                                                                         |                        | 000TT    | Thomas & Betts Co., The                                 | Elizabeth 1, 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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| 0000F | Malco Tool and Die                               | Los Angeles, Calif.   |
| 0000I | 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.          |
| 000A  | 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.      |
| 000II | Birtcher Corporation, Industrial Division        | Monterey Park, Calif. |
| 000KK | Amatom                                           | New Rochelle, N.Y.    |
| 000LL | Avery Label                                      | Monrovia, Calif.      |
| 000MM | Rubber Eng. & Development                        | Hayward, Calif.       |
| 000NN | N A "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.     |

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