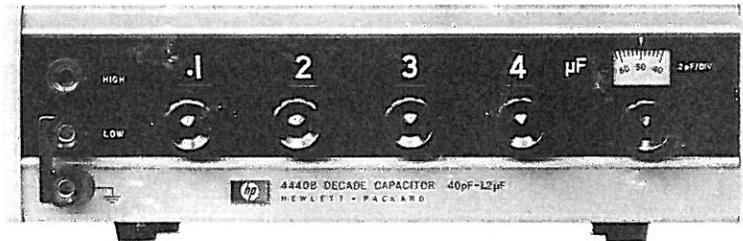


DECADE CAPACITOR

4440B

GENERAL ELECTRIC
INSTRUMENTATION SERVICE
(602) 278-8515
CAL
DUE



Electronic Services, Los Angeles
M15752X

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

O P E R A T I N G A N D S E R V I C E M A N U A L

MODEL 4440B
DECADE CAPACITOR

SERIALS PREFIXED: 1224 J and above
See Section VI for Other Serial Prefixes.

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9-1, TAKAKURA-CHO, HACHIOJI-SHI, TOKYO, JAPAN

Part No. 04440-90003

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Table 1-1. Specifications

| | |
|---|---|
| <p>Capacitance: 40pF to 1.2μF in steps of 100pF with a 40pF to 140pF variable air capacitor providing continuous adjustment to better than 2pF between steps.</p> <p>Dielectric: Silvered mica for decade steps.</p> <p>Direct Reading Accuracy: ±(0.25% + 3pF) at 1kHz for three-terminal connection; capacitance increase for two-terminal connection is less than 1pF (nominal 0.5pF).</p> <p>Temperature Coefficient: -0 to +70 ppm/°C</p> <p>Dissipation Factor: 0.001 max at 1kHz above 1040pF. *0.005 max at 1kHz below 1040pF. * For lowest decade only.</p> <p>Resonant Frequency: Typical values of the resonant frequency are: 450kHz at 1μF, 4MHz at 0.01μF, and 40 MHz at 100pF.</p> | <p>Insulation Resistance: 5 x 10⁹ ohms minimum, after 5 minutes at 500Vdc.</p> <p>Maximum Voltage: 500V peak</p> <p>Operating Temperature: 0° C - 65° C</p> <p>Weight: Approximately 5.5 lb. (2.5kg)</p> <p>Dimensions:</p> |
|---|---|

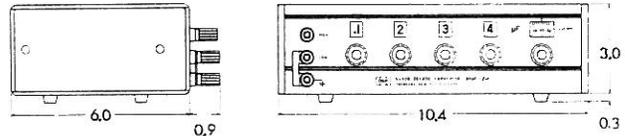


Figure 1-1. Model 4440B Decade Capacitor

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. The HP 4440B Decade Capacitor is a high-accuracy instrument providing usable capacitances from 40pF to 1.2 μ F. Its 0.25% accuracy makes it an ideal aid in circuit design, ac bridge measurements, and any application where accuracy is critical, such as a working standard. The 4440B is also ideally suited for production line testing.

1-3. The 4440B offers simplicity of operation combining four easy-to-read decade ranges in a lightweight, compact package designed for operator convenience and speed. The use of silvered-mica capacitors in all decade steps provides for high accuracy, low dissipation factor, and good temperature coefficient. An air capacitor vernier provides 100pF of additional capacitance with 2pF resolution between the 100pF steps of the smallest decade. The capacitors are housed in a double shield, such that the increased capacitance from three-terminal connection to two-terminal connection is held to 1pF.

1-4. SPECIFICATIONS

1-5. A complete list of specifications is found in Table 1-1.

1-6. INSTRUMENT IDENTIFICATION

1-7. Hewlett-Packard uses a two-section eight-digit serial number to identify instrument. The first three digits (preceding the dash) are the serial prefix which identifies a series of instruments; the last five digits identify a particular instrument in the series. The serial number appears on a plate located on the rear panel. All correspondence with Hewlett-Packard Sales/Service Offices with regard to an instrument should reference the complete serial number.

1-8. MANUAL CHANGES

1-9. This manual provides operating and service information for the HP Model 4440B Decade Capacitor. Information in this manual applies directly to instruments (as manufactured) with serial numbers prefixed by the three digits indicated on the title page. If the serial prefix of the instrument is different from that on the title page, a "Manual Changes" sheet supplied will describe changes which will adapt this manual to provide correct coverage. Technical correction (if any) to this manual, due to known errors in print, are called Errata and are shown on the change sheet. For information on manual coverage of any HP instrument, contact the nearest HP Sales/Service Office (addresses are listed at the back of this manual).

SECTION II INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information for unpacking, inspection, repacking, storage, and installation of the Model 4440B.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for damage (scratches, dents, broken knobs, etc.). If the instrument is damaged or fails to meet specifications, notify the carrier and the nearest Hewlett-Packard Field Office (see list at back of this manual). Retain the shipping carton and the padding material for the carrier's inspection. The field office will arrange for the repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. STORAGE AND SHIPMENT

2-6. PACKAGING. To protect valuable electronic equipment during storage or shipment always use the best packaging methods available. Your Hewlett-Packard field office can provide packing material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Here are a few recommended packaging methods:

- a. RUBBERIZED HAIR. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument securely in strong corrugated container (350 lb/sq in. bursting test) with 2-

inch rubberized hair pads placed along all surfaces of the instrument. Insert fillers between pads and container to ensure a snug fit.

- b. EXCELSIOR. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument in strong corrugated container (350 lb/sq in. bursting test) with a layer of excelsior about 6 inches thick packed firmly against all surfaces of the instrument.

2-7. ENVIRONMENT. Conditions during storage and shipment should normally be limited as follows:

- a. Maximum altitude, 20,000 feet.
- b. Minimum temperature, -40° F (-40° C).
- c. Maximum temperature, 167° F (75° C).

2-8. INSTALLATION

2-9. The Model 4440B is a submodular unit, equipped with rubber feet for bench operation as shipped from the factory. However, when used in combination with other submodular units it can be rack mounted. The HP adapter frame is designed for this purpose and is available through your Hewlett-Packard Sales/Service Office.

2-10. ADAPTER FRAME (HP Part No. 5060-0808)

2-11. The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only.

SECTION III OPERATION

3-1. INTRODUCTION

3-2. The Model 4440B Decade Capacitor provides capacitance from 40pF to 1.2 μ F in steps of 100pF. Between steps a variable air capacitor provides continuous adjustment to better than 2pF. Capacitance

setting can be directly read out from in-line display.

3-3. CONTROLS AND CONNECTORS

3-4. The front panel controls and connectors are explained in Figure 3-1.

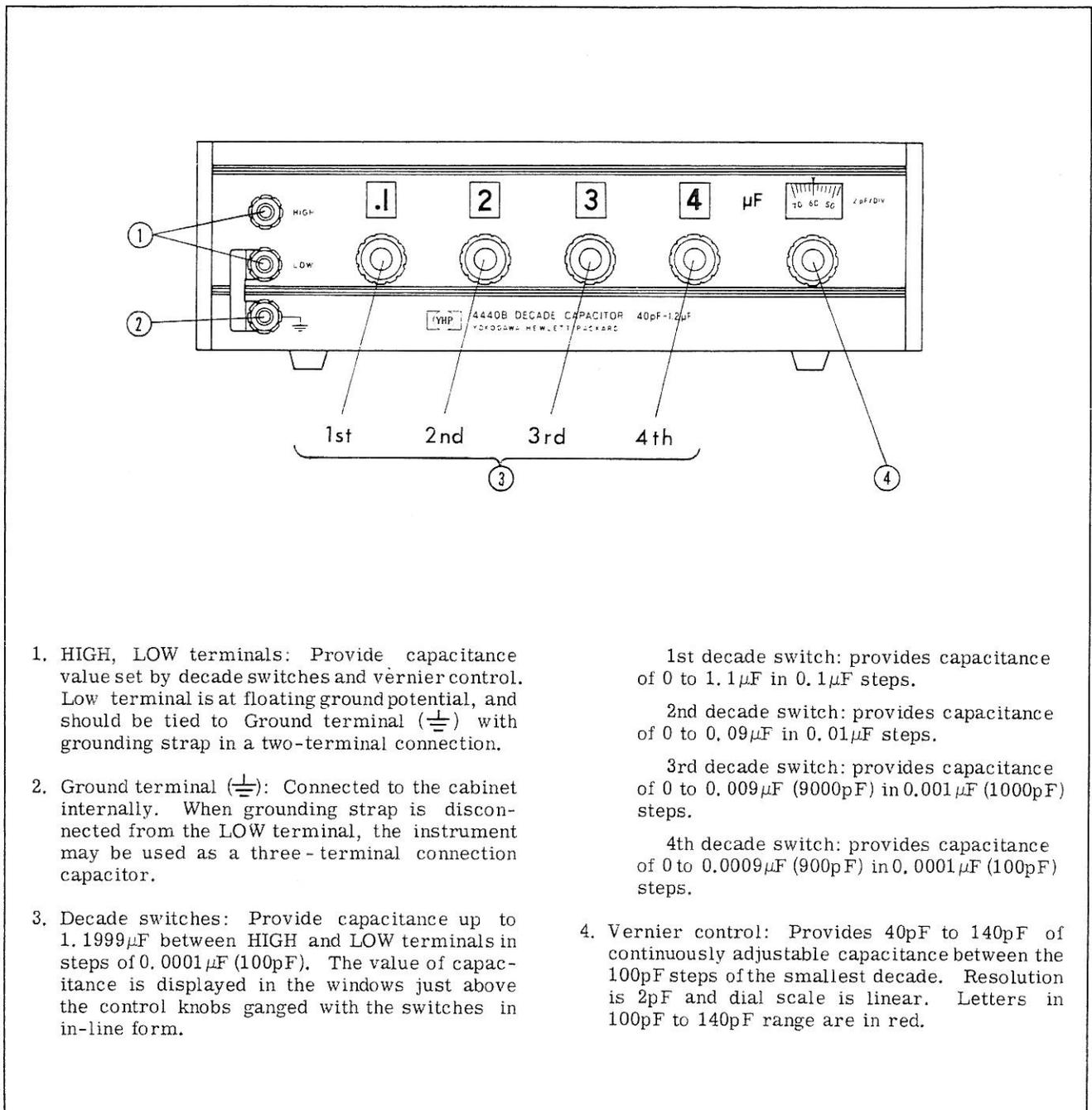
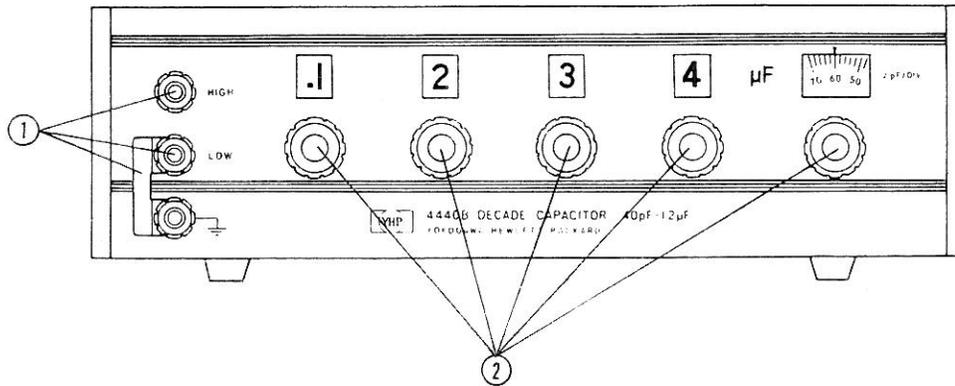


Figure 3-1. Front Panel Controls and Connectors



1. Connect the terminals to desired external circuit. Being used as a two-terminal connection, LOW terminal should be tied to Ground terminal with grounding strap. For three-terminal connection use, grounding strap must be removed from the LOW terminal.
2. Set decade switches and vernier control to desired capacitance value. Capacitance value is displayed by the sum of the decade switches and vernier control settings. Refer to the following Table.

CAUTION

Do not apply more than 500V (peak maximum) to the terminals. Damage to the capacitor will occur if higher voltages are applied.

| Capacitance Value | Control Settings | Examples |
|--|--|---|
| 40pF - 140pF 0.000DEG μF | . 0 0 0 0 μF DEG 2pF/DIV | 52pF . 0 0 0 0 μF 52 2pF/DIV 134pF . 0 0 0 0 μF 134 2pF/DIV |
| more than 140pF, 10pF decade is 0-3 0. ABCD E=0-3 G μF | 0. A B C D-1 μF 100+EG 2pF/DIV range in red letters | 234pF . 0 0 0 1 μF 134 2pF/DIV 1220pF . 0 0 1 1 μF 120 2pF/DIV |
| more than 140pF, 10pF decade is 4-9 0. ABCD E=4-9 G μF | 0. A B C D μF EG 2pF/DIV | 152pF . 0 0 0 1 μF 52 2pF/DIV 1340pF . 0 0 1 3 μF 40 2pF/DIV |

Figure 3-2. Operating Procedure

Note

After using and/or for storage, set decade switches to 1.1999 μ F position. This setting keeps all (four) contacts that contact stress and corrosion is minimized.

Table 4-1. Test Equipment Required

| Instrument Type | Required Characteristics | Use | Recommended Model |
|------------------------|---|--|--|
| Capacitance* Bridge | Measuring Frequency: 1kHz Range: 10pF to 1.1μF Resolution: 0.01pF Capacitance Accuracy: 0.01% Dissipation Factor Resolution: better than 10 ⁻⁴ Dissipation Factor Accuracy: 10 ⁻⁴ | Performance Test and Calibration | GR Type 1615-A Capacitance Bridge |
| Oscillator** | Frequency Range Covering: 1kHz Maximum Output: 30V rms into 600Ω load | Performance Test and Calibration | GR Type 1311-A Audio Oscillator |
| Detector*** | Frequency Range Covering: 1kHz Sensitivity: 0.1μV Gain: 120dB | Performance Test and Calibration | GR Type 1232-A Tuned Amplifier and Null Detector |
| Measuring Cable | | Performance Test and Calibration | Shown in Figure 4-1 |
| Testing Plate | | Calibration | Shown in Figure 4-2 |

*, **, ***: These three instruments work together as a capacitance bridge and are substituted by HP Model 4270A Automatic Capacitance Bridge. See paragraph 4-16.

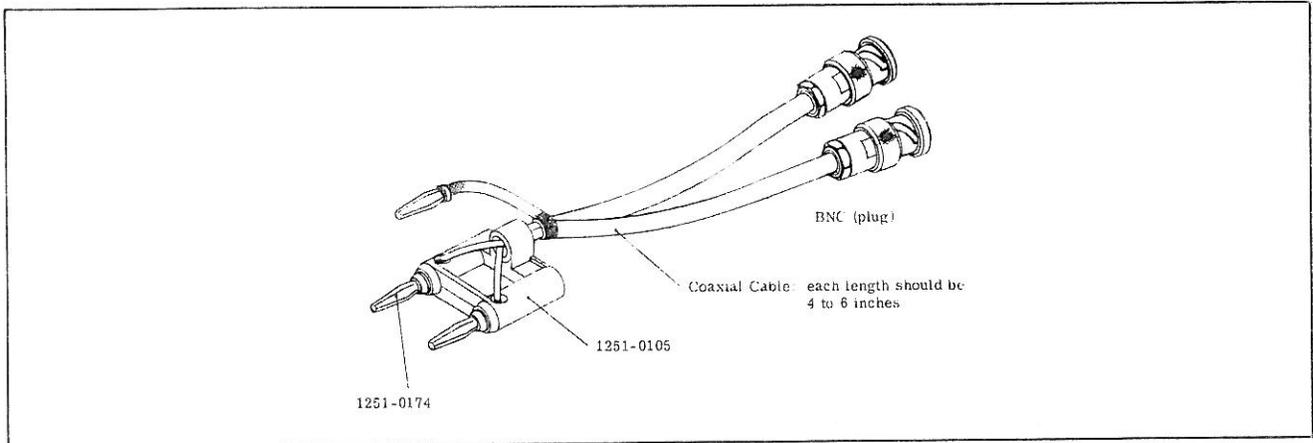


Figure 4-1 Measuring Cable

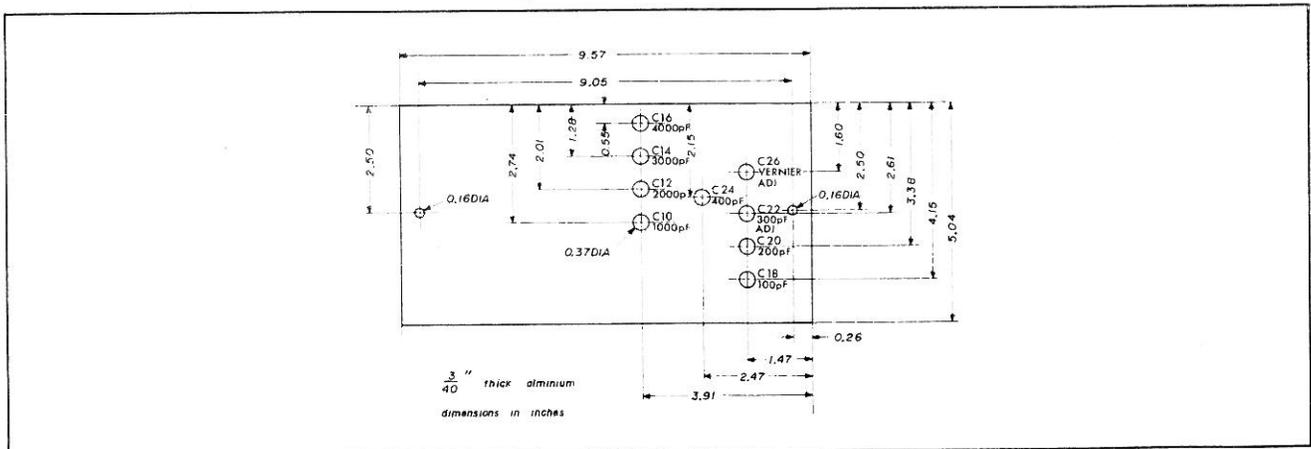


Figure 4-2 Testing Plate

SECTION IV MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the Model 4440B should be minimal unless an overload voltage or physical damages require replacement of a part. This section gives maintenance and service information. Included is a table of recommended test equipment, repair procedures, an in-cabinet performance check.

4-3. TEST EQUIPMENT

4-4. Table 4-1 lists recommended test equipment for maintaining and checking performance of the instrument. Test equipment having equivalent characteristics may be substituted for equipment listed.

4-5. IN-CABINET PERFORMANCE CHECK

4-6. The performance check can be used to verify proper operation of the instrument and also may be used:

- a. As part of an incoming inspection check of instrument specifications.
- b. Periodically, for instruments used in systems where maximum reliability is important.
- c. As part of a procedure to locate defective components.
- d. After any repair or adjustment, before returning instrument to regular service.

- e. As a permanent record of the instrument maintenance performed.

4-7. The performance test setup is illustrated in Figure 4-3. An Oscillator (GR Type 1311-A), a Capacitance Bridge (GR Type 1615-A), and a Detector (GR Type 1232-A) are required for this test. In addition, a special measuring cable assembly as shown in Figure 4-1 is required.

4-8. To perform the performance test, proceed as follows:

- a. Make test setup as illustrated in Figure 4-3.
- b. Set the 1311-A Audio Oscillator controls as follows:
 FREQUENCY dial 1 kHz
 MAXIMUM OUTPUT
 switch . . . 30V, 130mA
 OUTPUT LEVEL 12 o'clock position
 Δ F Dial 0
- c. Set the 1232-A Tuned Amplifier and Null Detector controls as follows:
 GAIN dial 12 o'clock position
 METER switch LOG
 FILTER FREQUENCY
 switch . . . 200Hz - 2kHz
 FILTER TUNING dial . . Set around the scale
 10 to maximize the
 meter deflection.

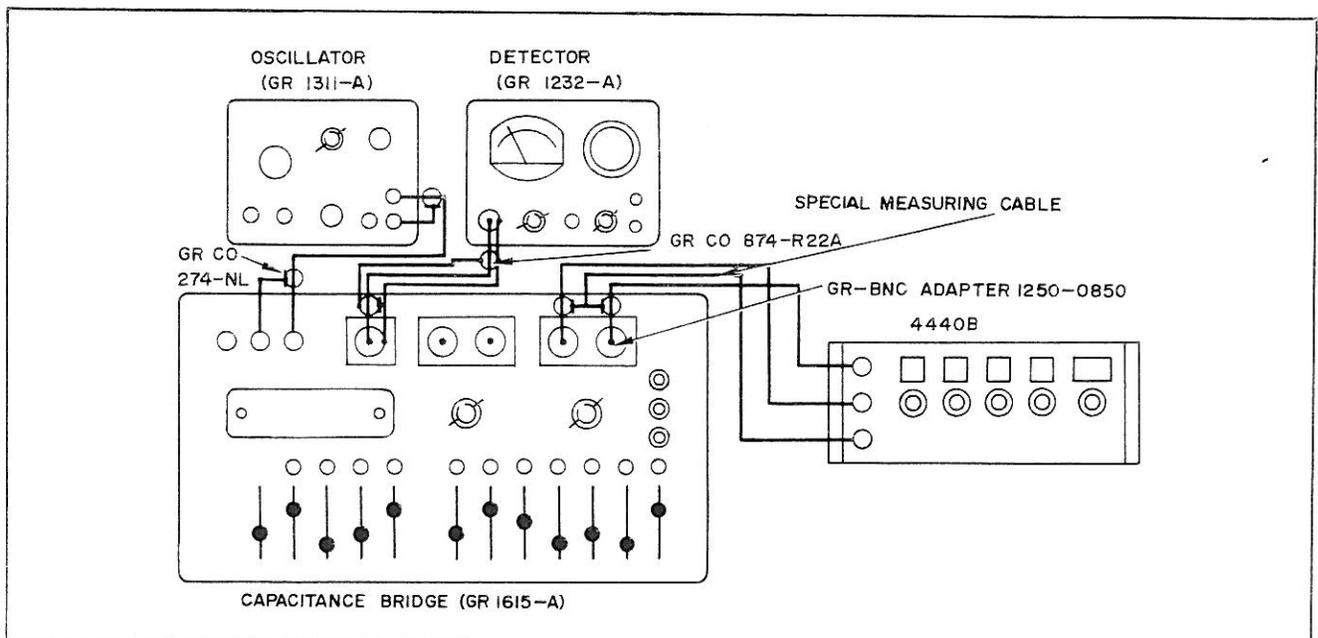


Figure 4-3. Performance Test Setup

- d. Set the 1615-A Capacitance Bridge controls as illustrated in Figure 4-4.
- e. Connect the 1311-A Audio Oscillator OUTPUT and the 1615-A Capacitance Bridge GENERATOR terminals with input cable GR CO 274 - NL. Connect the 1615-A's DETECTOR connector and the 1232-A Tuned Amplifier and Null Detector with cable GR CO 874-R22A.
- f. Turn on the power switches of the 1311-A Audio Oscillator and 1232-A Tuned Amplifier and Null Detector.
- g. Connect the measuring cable to the 1615-A UNKNOWN terminal with GR - BNC (receptacle) adapter, HP Part No. 1250-0850 and measure the residual capacitance of the measuring cable by manipulating 1615-A capacitance controls.

Let the obtained value x .
 x is usually 0.7pF to 1.2pF.

4-9. Set the 4440B as shown in Table 4-2, measure the capacitance between the 4440B terminals. Check that the 1615-A capacitance reading is within the upper and lower limits shown in Table 4-2 and that the dissipation factor reading is less than .001.

NOTE

When measuring higher values of the 4440B (greater than $0.1\mu\text{F}$), the resistance of the measuring cable increases the series loss resulting in an incorrect Dissipation Factor reading of the 1615-A. In this case, use 3 TERMINAL (binding post) position of the 1615-A Terminal Selector and connect the 4440B to these terminals with three pieces of wire with resistance as small as possible (thicker than AWG #20, shorter than 4 inches).

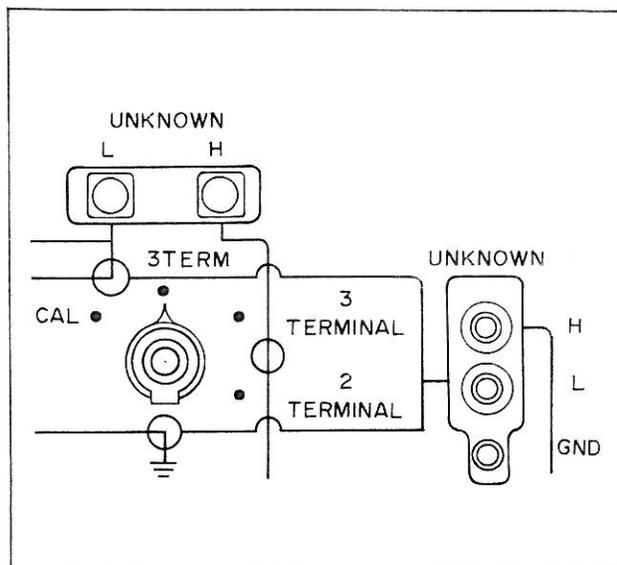


Figure 4-4. 1615-A Capacitance Bridge Setting

4-10. ADJUSTMENT

4-11. When the adjustment of the variable capacitor is necessary, the testing plate (Figure 4-2) should be installed according to the following steps, and an adjusting screw driver with long insulator rod should be used. The Capacitance Bridge reading while adjustment is being made should be equal to the reading after the adjustment is completed.

- a. Remove the top cover by taking out two screws on the rear.
- b. Remove the inside cover plate by taking out two screws at the center of the right and left sides of the plate.
- c. Install the testing plate (Figure 4-2) in place of the inside cover. Fasten it with the two screws taken out in step b.

4-12. Set the Capacitance Bridge same as indicated in paragraph 4-8.

4-13. VERNIER ADJUSTMENT

- a. Set all the dials of four decades to zero, and the vernier scale to 40pF.
- b. Set 1615-A capacitance controls $(40 + x)\text{pF}$, and adjust C26 to minimize the meter deflection of the 1232-A "Tuned Amplifier and Null Detector" using the adjusting driver. Rotate the vernier dial, and set vernier scale to 140pF . Make the 1615-A Capacitance Bridge balance by manipulating capacitance and dissipation factor - conductance controls, with D MAX knob set at 0.01, and read the capacitance and dissipation factor. The reading should be between $(135.65 + x)\text{pF}$ and $(143.35 + x)\text{pF}$. Dissipation factor should be less than .001.
- c. Set vernier scale to 120pF, 100pF, 80pF and 60pF, make the 1615-A Capacitance Bridge balance at each setting and make sure that the reading is within the limits listed in Table 4-2.
- d. Set vernier scale to 40pF again.

4-14. FOURTH DECADE ADJUSTMENT

- a. Without moving vernier scale, set the fourth decade dial of 4440B to 1 (equivalent to 100pF).
- b. Set capacitance control of 1615-A to $(140 + x)\text{pF}$. Adjust C18 and manipulate the dissipation factor control for the minimum deflection on the 1232A meter. Dissipation factor readout should be less than .001.
- c. Set the fourth decade dial to 2 (equivalent to 200pF), set capacitance control of 1615-A to $(240 + x)\text{pF}$ and balance the 1615-A by following the same steps as indicated in step b. with the adjustment of C20.

Table 4-2. Capacitance Check

| 4440B Setting | | 1615-A Reading | | 4270A Reading | |
|---------------|-----------------|----------------|-------------|---------------|-------------|
| Decade Switch | Vernier Control | Lower Limit | Upper Limit | Lower Limit | Upper Limit |
| 0000 | 40 pF | 36.90 + x | 43.10 + x | 36.95 + x | 43.05 + x |
| 0000 | 60 pF | 56.85 + x | 63.15 + x | 56.92 + x | 63.08 + x |
| 0000 | 80 pF | 76.80 + x | 83.20 + x | 76.89 + x | 83.11 + x |
| 0000 | 100 pF | 96.75 + x | 103.25 + x | 96.86 + x | 103.14 + x |
| 0000 | 120 pF | 116.70 + x | 123.30 + x | 116.83 + x | 123.17 + x |
| 0000 | 140 pF | 136.65 + x | 143.35 + x | 136.80 + x | 143.20 + x |
| 0001 | | 136.65 + x | 143.35 + x | 136.80 + x | 143.20 + x |
| 0002 | | 236.40 + x | 243.60 + x | 236.65 + x | 243.35 + x |
| 0003 | | 336.15 + x | 343.85 + x | 336.50 + x | 343.50 + x |
| 0004 | | 435.90 + x | 444.10 + x | 436.35 + x | 443.65 + x |
| 0005 | 40 pF | 535.65 + x | 544.35 + x | 536.20 + x | 543.80 + x |
| 0006 | | 635.40 + x | 644.60 + x | 636.05 + x | 643.95 + x |
| 0007 | | 735.15 + x | 744.85 + x | 735.90 + x | 744.10 + x |
| 0008 | | 834.90 + x | 845.10 + x | 835.75 + x | 844.25 + x |
| 0009 | | 934.65 + x | 945.35 + x | 935.60 + x | 944.65 + x |
| 0010 | | 1034.5 + x | 1045.5 + x | 1035.6 + x | 1044.4 + x |
| 0020 | | 2032.0 + x | 2048.0 + x | 2034.1 + x | 2045.9 + x |
| 0030 | | 3029.5 + x | 3050.5 + x | 3032.6 + x | 3047.4 + x |
| 0040 | | 4027.0 + x | 4053.0 + x | 4031.1 + x | 4048.9 + x |
| 0050 | 40 pF | 5024.5 + x | 5055.5 + x | 5029.6 + x | 5050.4 + x |
| 0060 | | 6022.0 + x | 6058.0 + x | 6028.1 + x | 6051.9 + x |
| 0070 | | 7019.5 + x | 7060.5 + x | 7026.6 + x | 7053.4 + x |
| 0080 | | 8017.0 + x | 8063.0 + x | 8025.1 + x | 8054.9 + x |
| 0090 | | 9014.5 + x | 9065.5 + x | 9023.6 + x | 9056.4 + x |
| 0100 | | 10014 + x | 10068 + x | 10024 + x | 10058 + x |
| 0200 | | 19987 + x | 20093 + x | 20007 + x | 20073 + x |
| 0300 | | 29962 + x | 30118 + x | 29992 + x | 30088 + x |
| 0400 | | 39937 + x | 40143 + x | 39977 + x | 40103 + x |
| 0500 | 40 pF | 49912 + x | 50168 + x | 49962 + x | 50118 + x |
| 0600 | | 59887 + x | 60193 + x | 59947 + x | 60133 + x |
| 0700 | | 69862 + x | 70218 + x | 69932 + x | 70148 + x |
| 0800 | | 79837 + x | 80243 + x | 79917 + x | 80163 + x |
| 0900 | | 89812 + x | 90268 + x | 89902 + x | 90178 + x |
| .1000 | | 99787 | 100293 | 99.89 nF | 100.19 nF |
| .2000 | | 199537 | 200543 | 199.8 nF | 200.3 nF |
| .3000 | | 299287 | 300793 | 299.6 nF | 300.5 nF |
| .4000 | | 399037 | 401043 | 399.5 nF | 400.6 nF |
| .5000 | | 498787 | 501293 | 499.3 nF | 500.8 nF |
| .6000 | 40 pF | 598537 | 601543 | 599.2 nF | 600.9 nF |
| .7000 | | 698287 | 701793 | 699.0 nF | 701.1 nF |
| .8000 | | 798037 | 802043 | 798.9 nF | 801.2 nF |
| .9000 | | 897787 | 902293 | 898.7 nF | 901.4 nF |
| 1.0000 | | 997537 | 1002543 | 998.6 nF | 1.0015 μF |
| 1.1000 | | 1097287 | 1102793 | 1.0984 μF | 1.1017 μF |

- d. Set the fourth decade dial to 3 (equivalent to 300 pF), set capacitance control of 1615-A to $(340 + x)$ pF and balance the 1615-A by following the same steps as indicated in step b. with the adjustment of C22.
- e. Set the fourth decade dial to 4 (equivalent to 400 pF), set capacitance control of 1615-A to $(440 + x)$ pF and balance the 1615-A by following the same steps as indicated in step b. with the adjustment of C24.
- f. Set the fourth decade dial to 5, 6, 7, 8, 9, and balance the 1615-A by manipulating the Capacitance and Dissipation Factor - Conductance controls. Capacitance readout should be within the limits indicated in Table 4-2. Dissipation Factor readout should be less than .001.

4-15. THIRD DECADE ADJUSTMENT

- a. Without moving vernier scale, set the third decade dial of 4440B to 1 (equivalent to 1000pF) and set the fourth decade to 0.
- b. Set capacitance control of 1615-A to $(1040 + x)$ pF, adjust C10 and manipulate the dissipation factor control for the minimum deflection on the 1232 - A meter. Dissipation factor readout should be less than .001.
- c. Set the third decade dial of 4440B to 2 (equivalent to 2000pF), set capacitance control of 1615-A to $(2040 + x)$ pF, and balance the 1615-A as indicated in step b. with the adjustment of C12.
- d. Set the third decade dial of 4440B to 3 (equivalent to 3000pF), set capacitance control of 1615-A to $(3040 + x)$ pF, and balance the 1615-A as indicated in step b. with the adjustment of C14.
- e. Set the third decade dial to 4 (equivalent to 4000pF), set capacitance control of 1615-A to $(4040 + x)$ pF and balance the 1615-A as indicated in step b. with the adjustment of C16.
- f. Set the third decade dial to 5, 6, 7, 8, 9, and balance the 1615-A. Capacitance readout should be within the limits indicated in Table 4-2. Dissipation Factor readout should be less than .001.

4-16. This paragraph describes how to calibrate the capacitance of the 4440B when it is not necessary to confirm the dissipation factor less than .001. This easier and simpler way of capacitance calibration is performed by HP Model 4270A. Automatic Capacitance Bridge. (No oscillator and null detector are necessary). Dissipation factor accuracy of 4270A is:

$$1\% \text{ of reading} + (10 + C_s/C_x) \text{ counts}$$

so the dissipation factor of 4440B can not be confirmed. Performance Check and Adjustment can be done according to paragraphs 4-7 through 4-15 with Table 4-2 and the following change.

Adjustment with C18(4-14, b), C20(4-14, c), C22(4-14, d), C24(4-14, e), C10(4-15, b), C12 (4-15, c), C14(4-15, d), C16(4-15, e), should be changed as: (for example)

4-14, a. b. should be as follows:

Without moving vernier scale, set the fourth decade dial of 4440B to 1 (equivalent to 100pF). Adjust C18 for the 4270A reading of $(140 + x)$ pF.

4-17. TROUBLESHOOTING

4-18. LOCAL TROUBLE: When wrong capacitance or dissipation factor values are found at a certain setting or at a certain series of settings, check the associated components shown in Table 4-3 through 4-6, or the associated decade switch and connections between the components. Parts location is illustrated in Figure 4-5.

4-19. TROUBLE IN VARIABLE CAPACITOR: If dissipation factor is greater than .001, at a certain setting, see if there is not any specks of dirt between the plates of the associated variable capacitor. Sometimes these tend to increase the dissipation factor readings. Blowing or wiping off these specks will improve the reading.

4-20. OVERALL TROUBLE: When a wrong value of capacitance or dissipation factor is presented at all the settings, the trouble should be allocated to one of six portions of the 4440B, terminal portion, 1st decade, 2nd decade, 3rd decade 4th decade and vernier portion. These six portions are connected by a wire which runs below the four decade switches and is terminated at the solder lug of the HIGH terminal. The possible causes of troubles are:

- a. Terminal portion: wrong insulator between HIGH terminal and LOW terminal (Common Floating Ground), wrong binding post.
- b. Decade switch portion: wrong insulator between the common of the switch connected to HIGH terminal and Common Floating Ground, dirty rotor of the switch, wrong wiring configuration.
- c. Vernier portion: trouble in vernier capacitor C25 or variable capacitor C26, specks of dirt on these components.

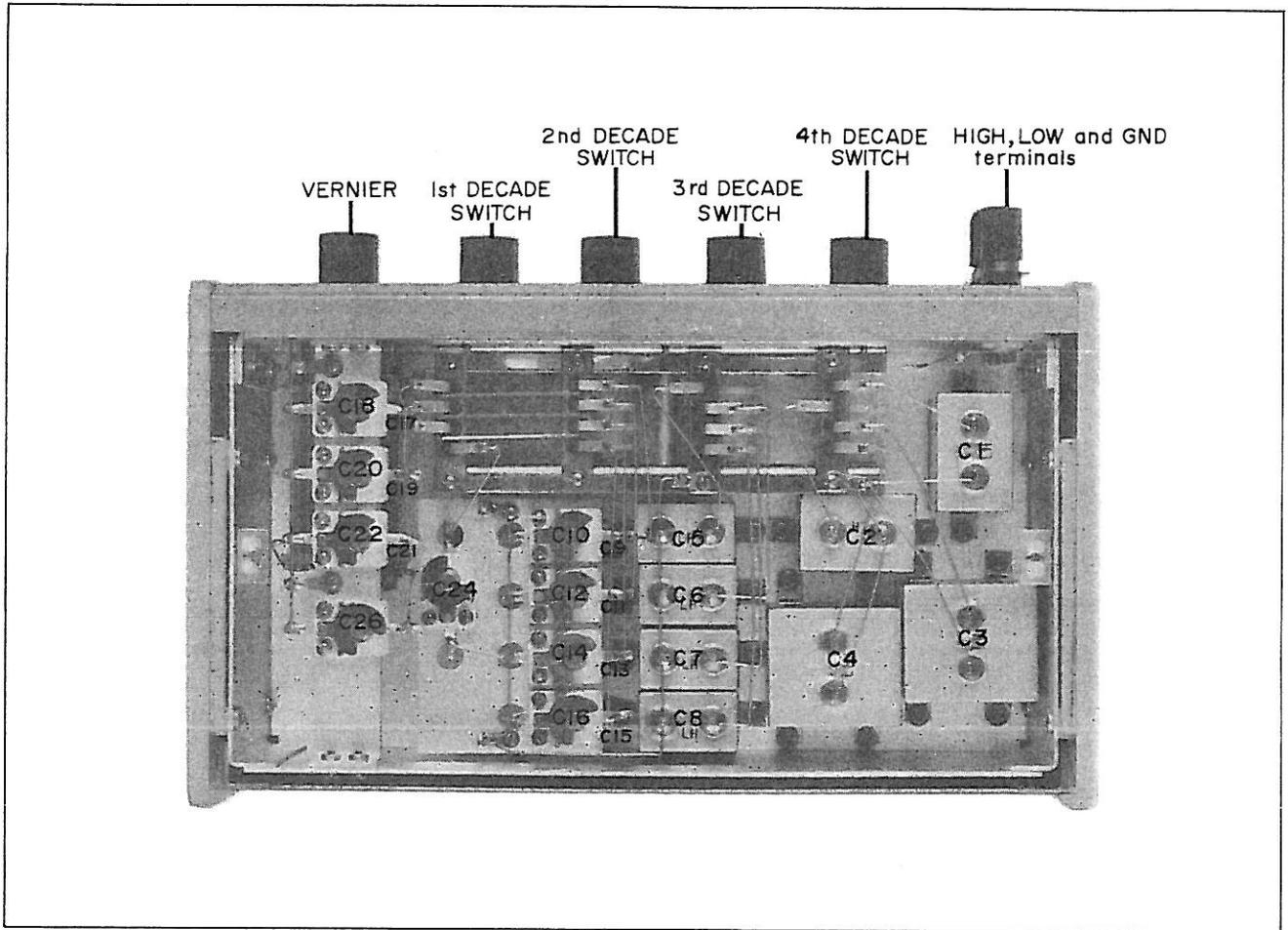


Figure 4-5. Parts Location

Table 4-3. Composition of the 1st Decade

| Component Dial Setting | 0.1 μ F C1 | 0.2 μ F C2 | 0.4 μ F C3 | 0.4 μ F C4 |
|------------------------|----------------|----------------|----------------|----------------|
| .0 | - | - | - | - |
| .1 | ○ | - | - | - |
| .2 | - | ○ | - | - |
| .3 | ○ | ○ | - | - |
| .4 | - | - | ○ | - |
| .5 | ○ | - | - | ○ |
| .6 | - | ○ | - | ○ |
| .7 | ○ | ○ | - | ○ |
| .8 | - | - | ○ | ○ |
| .9 | ○ | - | ○ | ○ |
| 1.0 | - | ○ | ○ | ○ |
| 1.1 | ○ | ○ | ○ | ○ |

Table 4-4. Composition of the 2nd Decade

| Component Dial Setting | 0.01 μ F C5 | 0.02 μ F C6 | 0.03 μ F C7 | 0.03 μ F C8 |
|------------------------|-----------------|-----------------|-----------------|-----------------|
| 0 | - | - | - | - |
| 1 | ○ | - | - | - |
| 2 | - | ○ | - | - |
| 3 | - | - | ○ | - |
| 4 | ○ | - | - | ○ |
| 5 | - | ○ | - | ○ |
| 6 | - | - | ○ | ○ |
| 7 | ○ | - | ○ | ○ |
| 8 | - | ○ | ○ | ○ |
| 9 | ○ | ○ | ○ | ○ |

Table 4-5. Composition of the 3rd Decade

| Component Dial Setting | 1000pF C9+C10 | 2000pF C11+C12 | 3000pF C13+C14 | 3000pF C15+C16 |
|------------------------------|------------------|-------------------|-------------------|-------------------|
| 0 | - | - | - | - |
| 1 | ○ | - | - | - |
| 2 | - | ○ | - | - |
| 3 | - | - | ○ | - |
| 4 | ○ | - | - | ○ |
| 5 | - | ○ | - | ○ |
| 6 | - | - | ○ | ○ |
| 7 | ○ | - | ○ | ○ |
| 8 | - | ○ | ○ | ○ |
| 9 | ○ | ○ | ○ | ○ |

Table 4-6. Composition of the 4th Decade

| Component Dial Setting | 100pF C17+C18 | 200pF C19+C20 | 300pF C21+C22 | 300pF C23+C24 |
|------------------------------|------------------|------------------|------------------|------------------|
| 0 | - | - | - | - |
| 1 | ○ | - | - | - |
| 2 | - | ○ | - | - |
| 3 | - | - | ○ | - |
| 4 | ○ | - | - | ○ |
| 5 | - | ○ | - | ○ |
| 6 | - | - | ○ | ○ |
| 7 | ○ | - | ○ | ○ |
| 8 | - | ○ | ○ | ○ |
| 9 | ○ | ○ | ○ | ○ |

Note

After using and/or for storage, set decade switches to 1.1999 μ F position. This setting keeps all (four) contacts of the four decade switches closed so that contact stress and corrosion is minimized.

SECTION V REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information for ordering replacement parts. Table 5-2 lists parts in alphabetical order of their reference designators and indicates the description (see Table 5-1 for abbreviations used) and HP Part number of each part, together with any applicable notes.

5-3. Miscellaneous parts associated with each assembly are listed at the end of each assembly listing. Others are listed at the end of Table 5-2.

5-4. ORDERING INFORMATION

5-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

5-6. To obtain a part that is not listed, include:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

Table 5-1. List of Reference Designators and Abbreviations

| REFERENCE DESIGNATORS | | | | | |
|---|---|---|--|--|--|
| <p>A = assembly B = motor BT = battery C = capacitor CP = coupler CR = diode DL = delay line DS = device signaling (lamp)</p> | <p>E = misc electronic part F = fuse FL = filter IC = integrated circuit J = jack K = relay L = inductor M = meter</p> | <p>MP = mechanical part P = plug Q = transistor R = resistor RT = thermistor S = switch T = transformer TB = terminal board</p> | <p>TP = test point V = vacuum tube, neon bulb, photocell, etc. VR = voltage regulator W = cable X = socket Y = crystal</p> | | |
| ABBREVIATIONS | | | | | |
| <p>A = amperes A. F. C. = automatic frequency control AMPL = amplifier B. F. O. = beat frequency oscillator BE CU = beryllium copper BH = binder head BP = bandpass BRS = brass BWO = backward wave oscillator CCW = counter-clockwise CER = ceramic CMO = cabinet mount only COEF = coefficient COM = common COMP = composition COMPL = complete CONN = connector CP = cadmium plate CRT = cathode-ray tube CW = clockwise DEPC = deposited carbon DR = drive ELECT = electrolytic ENCAP = encapsulated EXT = external F = farads f = femto = 10⁻¹⁵ FH = flat head FIL H = filhster head FXD = fixed G = giga = 10⁹ GE = germanium GL = glass GRD = grounded</p> | <p>H = henries HEX = hexagonal HG = mercury HR = hour(s) Hz = hertz IF = intermediate freq. IMPG = impregnated INCD = incandescent INCL = include(s) INS = insulation(ed) INT = internal k = kilo = 1000 LH = left hand LIN = linear taper LK WASH = lock washer LOG = logarithmic taper LPF = low pass filter m = milli = 10⁻³ M = meg = 10⁶ MET FLM = metal film MET OX = metallic oxide MFR = manufacturer MINAT = miniature MOM = momentary MTG = mounting MY = "mylar" n = nano = 10⁻⁹ N C = normally closed NE = neon NI PL = nickel plate N O = normally open NPO = negative positive zero (zero temperature coefficient)</p> | <p>NPN = negative-positive-negative NRFR = not recommended for field replacement NSR = not separately replaceable OBD = order by description OH = oval head OX = oxide P = peak PC = printed circuit p = pico = 10⁻¹² PH BRZ = phosphor bronze PHL = Phillips PIV = peak inverse voltage PNP = positive-negative-positive P/O = part of POLY = polystyrene PORC = porcelain POS = position(s) POT = potentiometer PP = peak-to-peak PT = point PWV = peak working voltage RECT = rectifier RF = radio frequency RH = round head or right hand RMO = rack mount only RMS = root-mean square</p> | <p>RWV = reverse working voltage S-B = slow-blow SCR = screw SE = selenium SECT = section(s) SEMICON = semiconductor SI = silicon SIL = silver SL = slide SPG = spring SPL = special SST = stainless steel SR = split ring STL = steel TA = tantalum TD = time delay TGL = toggle THD = thread TI = titanium TOL = tolerance TRIM = trimmer TWT = traveling wave tube μ = micro = 10⁻⁶ VAR = variable VDCW = dc working volts W = with W = watts WIV = working inverse voltage WW = wirewound W/O = without</p> | | |

0001-9700

Table 5-2. Reference Designation Index

| Reference Designation | HP Part No. | Description | Note |
|-----------------------|--|--|------|
| C1 | 0160-1571 | C:FXD S. MICA 0.1 μ F 0.2% 500VDCW | |
| C2 | 0160-1570 | C:FXD S. MICA 0.2 μ F 0.2% 500VDCW | |
| C3 | 0160-1569 | C:FXD S. MICA 0.4 μ F 0.2% 500VDCW | |
| C4 | 0160-1569 | C:FXD S. MICA 0.4 μ F 0.2% 500VDCW | |
| C5 | 0160-1574 | C:FXD S. MICA 0.01 μ F 0.2% 500VDCW | |
| C6 | 0160-1573 | C:FXD S. MICA 0.02 μ F 0.2% 500VDCW | |
| C7 | 0160-1572 | C:FXD S. MICA 0.03 μ F 0.2% 500VDCW | |
| C8 | 0160-1572 | C:FXD S. MICA 0.03 μ F 0.2% 500VDCW | |
| C9 | 0160-1577 | C:FXD S. MICA 980pF 1% 500VDCW | |
| C10 | 0121-0229 | C:VAR AIR 2.5-35pF 500VDCW | |
| C11 | 0160-1576 | C:FXD S. MICA 1970pF 0.5% 500VDCW | |
| C12 | 0121-0229 | C:VAR AIR 2.5-35pF 500VDCW | |
| C13 | 0160-1575 | C:FXD S. MICA 2980pF 0.5% 500VDCW | |
| C14 | 0121-0229 | C:VAR AIR 2.5-35pF 500VDCW | |
| C15 | 0160-1575 | C:FXD S. MICA 2980pF 0.5% 500VDCW | |
| C16 | 0121-0229 | C:VAR AIR 2.5-35pF 500VDCW | |
| C17 | 0160-1580 | C:FXD S. MICA 90pF 1% 500VDCW | |
| C18 | 0121-0227 | C:VAR AIR 1.5-10pF 500VDCW | |
| C19 | 0160-1579 | C:FXD S. MICA 190pF 1% 500VDCW | |
| C20 | 0121-0227 | C:VAR AIR 1.5-10pF 500VDCW | |
| C21 | 0160-1578 | C:FXD S. MICA 290pF 1% 500VDCW | |
| C22 | 0121-0227 | C:VAR AIR 1.5-10pF 500VDCW | |
| C23 | 0160-1578 | C:FXD S. MICA 290pF 1% 500VDCW | |
| C24 | 0121-0227 | C:VAR AIR 1.5-10pF 500VDCW | |
| C25 | 0121-0226 | C:VAR AIR 8-115pF 500VDCW | |
| C26 | 0121-0227 | C:VAR AIR 1.5-10pF 500VDCW | |
| J1 | 04440-7048 04440-5021 04440-3021 | TERMINAL:HIGH BINDING POST ASS'Y:RED INSULATOR:FRONT INSULATOR:REAR | |
| J2 | 1510-0006 04440-5021 | TERMINAL:LOW BINDING POST:BLACK INSULATOR:FRONT | |
| J3 | 04440-3028 0340-0223 | TERMINAL:GROUND (\perp) BINDING POST ASS'Y:BLACK INSULATOR:FRONT | |

See list of abbreviations in introduction to this section

Table 5-2. Reference Designation Index (Cont'd)

| Reference Designation | HP Part No. | Description | Note |
|-----------------------|--|--|------|
| S1-S4 | 3100-0909 04440-7047 04440-5022 04440-5023 | SWITCH ASS'Y:DECADE CONTACT:BAR 4 REQ'D CONTACT:ASS'Y 4 REQ'D CAM:10 POSITION FOR S2-S4 3 REQ'D CAM:12 POSITION FOR S1 | |
| | 1460-0307 04260-1067 04260-3056 04260-3057 04440-1028 | SPRING:COIL 2 REQ'D ARM:CLICK 4 REQ'D ROLLER:CLICK 4 REQ'D SHAFT:CLICK 2 REQ'D ANGLE:L REAR | |
| | 04440-1029 04440-1040 04440-1044 04440-3022 04440-3023 | ANGLE:L FRONT PLATE:SHIELD 3 REQ'D CHASSIS:SWITCH ASS'Y INSULATOR:BAR CONTACT 8 REQ'D STUD 4 REQ'D | |
| | 04440-3025 | SPACER | |
| | | MISCELLANEOUS | |
| | 5040-3316 04440-1139 04440-1125 04440-1134 04440-1135 5000-4197 | FRAME:SIDE 2 REQ'D PANEL:FRONT PANEL:FLONT COVER:TOP COVER:BOTTOM COVER:SIDE 2 REQ'D | |
| | 0370-0025 1520-0115 04440-5124 04440-5125 04440-5127 | KNOB:ROUND 3/4" DIA BLACK 5 REQ'D CUSHION:FOOT 4 REQ'D DIAL:DECADE SWITCH FOR S2 - S4 3 REQ'D DIAL:DECADE SWITCH FOR S1 DIAL:VERNIER | |
| | 04440-5126 04440-1026 04440-1036 04440-1032 04440-1033 | TRIM:FRONT PANEL 2 REQ'D CASE:SHIELD PLATE:SHIELD CASE PLATE:CAPACITOR ASS'Y ANGLE:L 2 REQ'D | |
| | 04440-1038 04440-1043 04440-3023 | SPRING:L ANGLE 2 REQ'D ANGLE:CAPACITOR ASS'Y STUD 2 REQ'D | |

See list of abbreviations in introduction to this section

SECTION VI MANUAL CHANGES AND OPTIONS

6-1. OPTIONS

6-2. Options are standard modifications performed on HP instruments at the factory. No options for the Model 4440B are offered at the present time.

6-3. SPECIAL INSTRUMENTS

6-4. "Specials" are standard HP instrument that are modified according to customer specifications. A separate insert sheet is included with the manual for special instruments having electrical changes. Make the changes specified in addition to any other changes that are necessary.

6-5. MANUAL CHANGES

6-6. This manual applies directly to the Model 4440B with serials 935/936-00631 and above. The following paragraphs explain how to adapt this manual to apply to later instruments with higher serial prefix, or earlier instruments with lower serial prefix. Technical corrections to this manual (if any) are called errata and are listed on a separate "Manual Changes" sheet supplied with this manual.

6-7. LATER INSTRUMENTS: If the serial prefix of your Model 4440B is above 935/936, refer to a separate "Manual Changes" sheet supplied with this manual. Locate the serial prefix of your instrument and make the indicated changes.

6-8. EARLIER INSTRUMENTS(Backdating Changes): If the serial prefix of your Model 4440B is 935/936-00630 and below, refer to Table 6-1 for the changes necessary to adapt this manual to your particular

instrument. Locate the serial prefix of your instrument in the table and make the indicated changes. Note that instrument-component values that differ from those in this manual, yet are not listed in this backdating changes, should be replaced using the part number given in this manual.

Table 6-1. Backdating Changes

| Instrument Serial Prefix or Number | Make Changes |
|--|---------------------|
| 813/814 | 1, 2, 3, 4, 5, 6, 7 |
| 815/816-00250 and below | 2, 3, 4, 5, 6, 7 |
| 815/816-00370 and below | 3, 4, 5, 6, 7 |
| 919/920-00400 and below | 4, 5, 6, 7 |
| 935/936-00520 and below | 5, 6, 7 |
| 935/936-00630 and below | 6, 7 |
| 935/936 and below | 7 |

CHANGE 1

Page 5-2, Table 5-2, Reference Designation Index
Delete C18*, C20*, C22* and C24*

Page 7-3, Figure 7-2, Schematic Diagram
Delete C18*, C20*, C22* and C24* from circuit.

CHANGE 2

Page 5-2, Table 5-2, Reference Designation Index
Delete P/O J1 HP Part No. 04440-7048, BINDING POST ASS'Y:RED
Add P/O J1 HP Part No. 1510-0007, BINDING POST:RED

CHANGE 3

Page 5-3, Table 5-2, Reference Designation Index, Miscellaneous
Change HP Part No. of ANGLE:CAPACITOR ASS'Y to 04440-1041.

CHANGE 4

- Page 5-2, Table 5-2, Reference Designation Index
Change HP Part No. of 0340-0223 (P/O J3) INSULATOR:FRONT to 04260-5021
- Page 5-3, Table 5-2, Reference Designation Index
Change HP Part No. of 04440-1044(P/O S1-S4), CHASSIS:SWITCH ASS'Y to 04440-1027

CHANGE 5

- Page 5-2, Table 5-2, Reference Designation Index
Change C26* to HP Part No. 0121-0228, C:VAR AIR 2-15pF 500VDCW.
- Page 7-3, Figure 7-2, Schematic Diagram
Change value of C26* to 2-15pF.

CHANGE 6

- Page 5-3, Table 5-2, Reference Designation Index, Miscellaneous
Change HP Part No. of DIAL:VERNIER to 04440-1037.

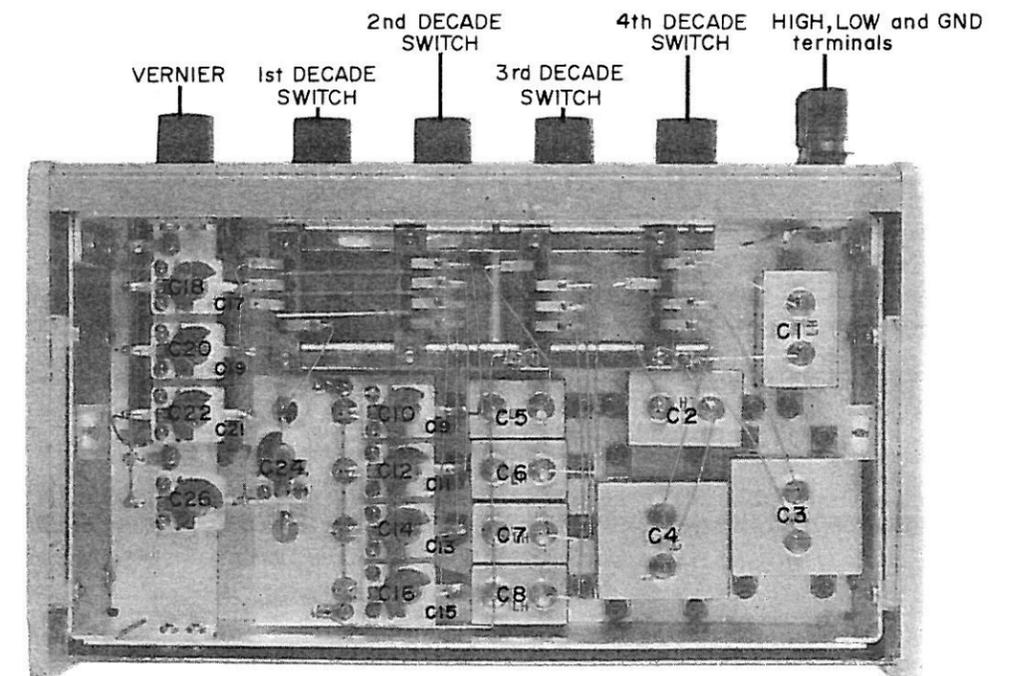
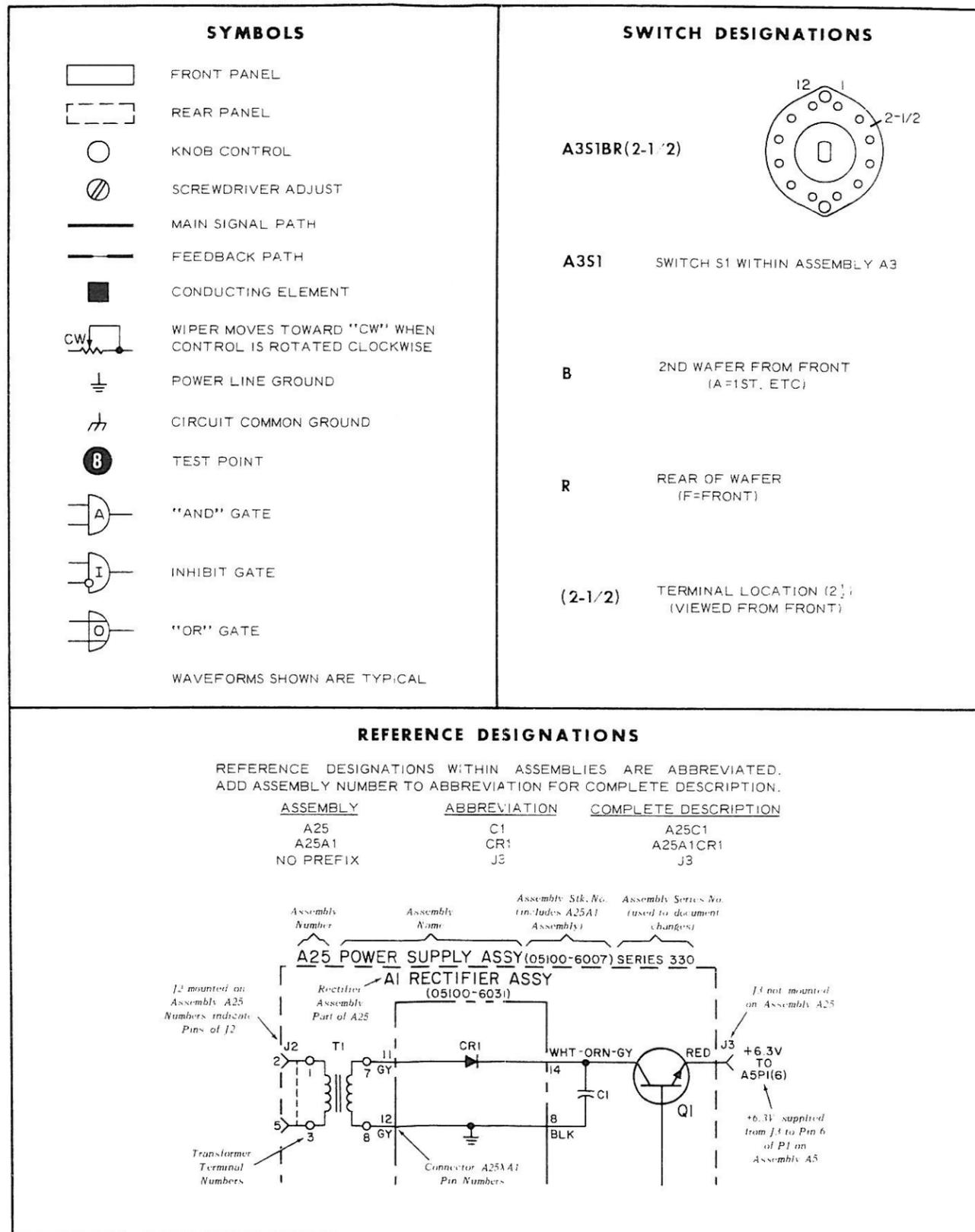
CHANGE 7

- Page 5-2, Table 5-2, Reference Designation Index
Change HP Part No. of MISCELLANEOUS parts as follows:

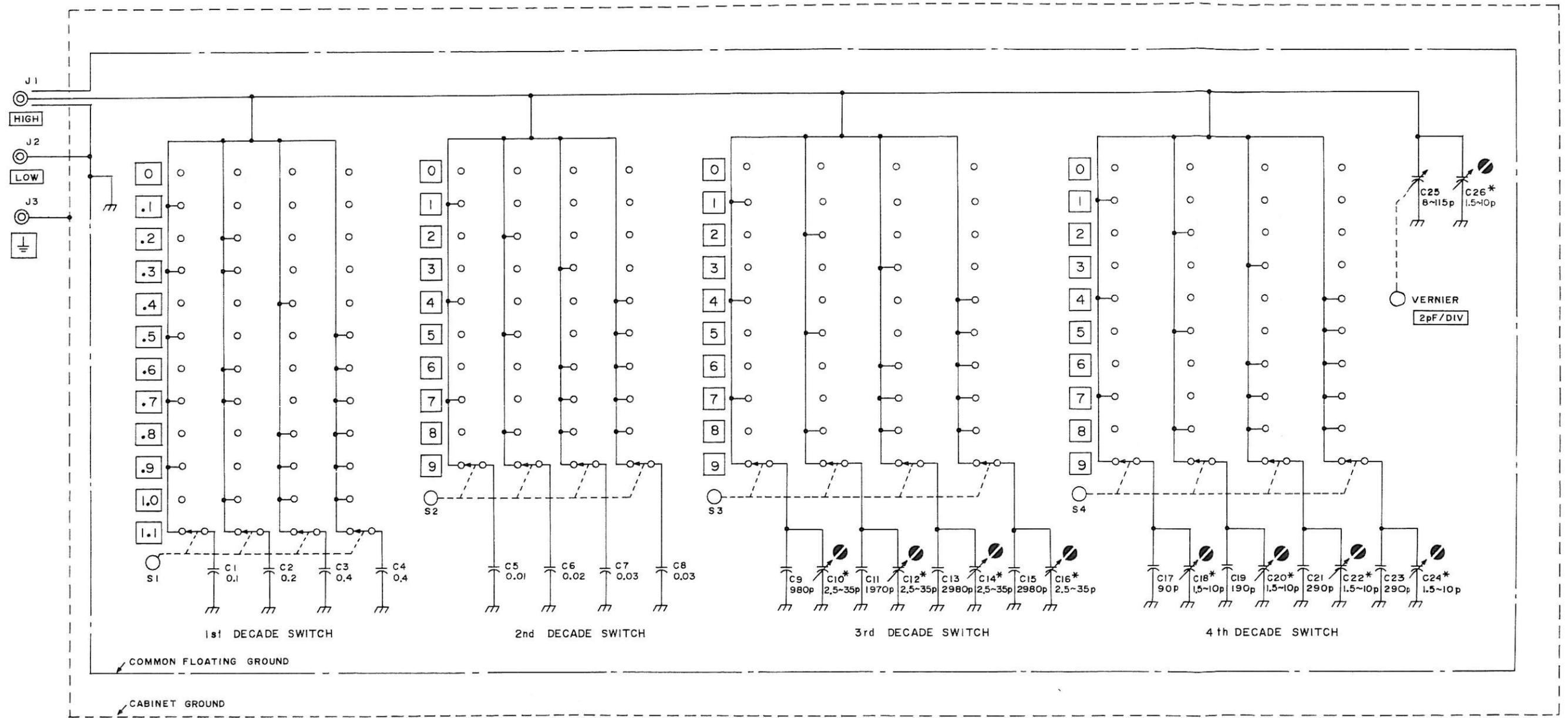
5040-3316 (FRAME:SIDE) to 5040-3310.
04440-1139 (PANEL:FLONT) to 04440-1039.
04440-1125 (PANEL:FLONT) to 04440-1025.
04440-1134 (COVER:TOP) to 04440-1034.
04440-1135 (COVER:BOTTOM) to 04440-1035.
5000-4197 (COVER:SIDE) to 04440-1031.
04440-5124 (DIAL:DECADE) to 04440-5024.
04440-5125 (DIAL:DECADE) to 04440-5025.
04440-5127 (DIAL:VERNIER) to 04440-5027.
04440-5126 (TRIM:FRONT) to 04440-5026.

SECTION VII
CIRCUIT DIAGRAM

- 7-1. INTRODUCTION
- 7-2. This section includes the following:
- a. General Notes for schematic diagram.
 - b. Schematic Diagram and Parts Location Illustration.
- 7-3. GENERAL NOTES
- a. Unless other wise indicated, resistance is in ohms, capacitance is in microfarads, and inductance is in microhenries.
 - b. Components assigned an asterisk(*) are factory selected, average values shown.
- c. The components mounted on chassis or main-frame parts are not assigned an assembly designation (i. e. R1, Q1, etc.).
 - d. Reference designations (R1, Q1, etc.) within assembly (A1, A2, etc.) use assembly designation as prefix to form complete designation (i. e. R1 in A1 assembly is A1R1).
 - e. (9. 4. 7) indicates wire color code. Wire color code (MIL-STD-681) same as resistor color code. First number identifies ground color, second number identifies wide stripe, and third number identifies narrow stripe, i. e. (9. 4. 7) denotes white ground, yellow wide stripe, violet narrow stripe.
- 7-4. Additional notes are shown in Figure 7-1.



4440B DECADE CAPACITOR



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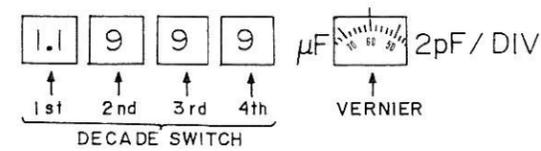
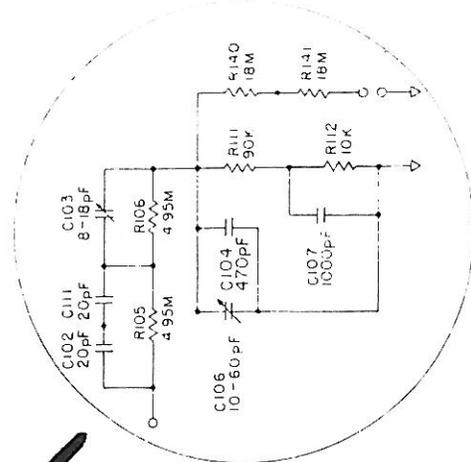


Figure 7-2. Model 4440B Schematic Diagram



SUBSTITUTE CIRCUIT FOR MODEL 4440
 MARKED WITH SYMBOL ON LOWER
 BOARD.

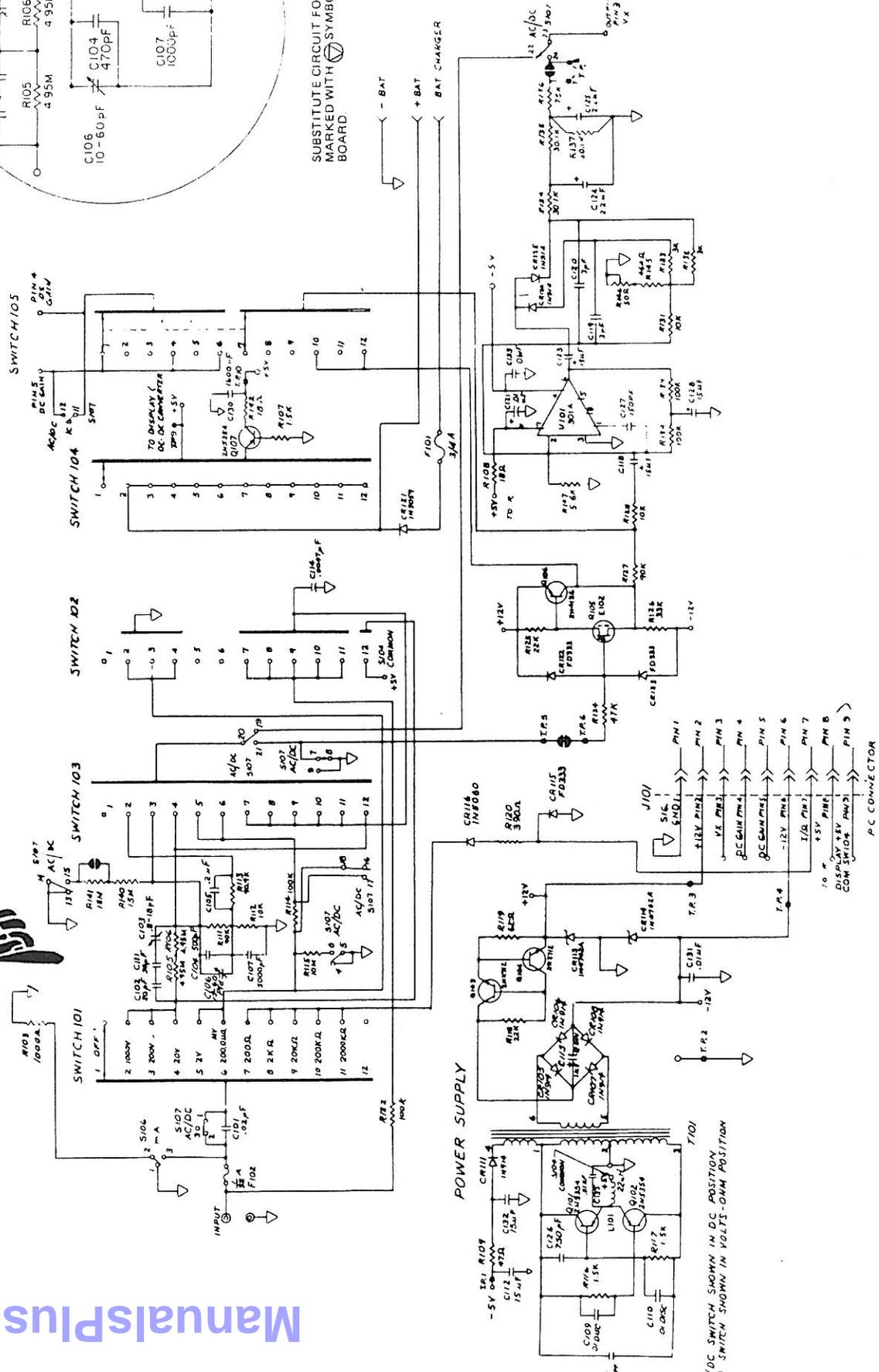


Figure 7-3. Schematic Diagram, Lower Board

