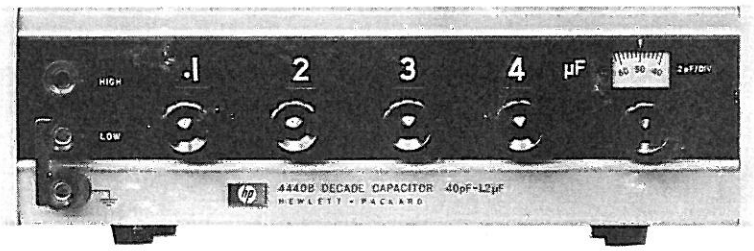
OPERATING AND SERVICE MANUAL

DECADE CAPACITOR

4440B



HEWLETT-PACKARD

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.

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OPERATING AND SERVICE MANUAL

MODEL 4440B
DECADE CAPACITOR

SERIALS PREFIXED: 1224 J and above

See Section VI for Other Serial Prefixes.

Part No. 04440-90003

Printed: MAR. 1980

HEWLETT PACKARD

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Table 1-1. Specifications

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.

Dielectric:
Silvered mica for decade steps.

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).

Temperature Coefficient:
-0 to +70 ppm/° C

Dissipation Factor:
0.001 max at 1kHz above 1040pF.
*0.005 max at 1kHz below 1040pF.

* For lowest decade only.

Resonant Frequency:
Typical values of the resonant frequency are: 450kHz at 1μF, 4MHz at 0.01μF, and 40 MHz at 100pF.

Insulation Resistance:
5×10^9 ohms minimum, after 5 minutes at 500Vdc.

Maximum Voltage:
500V peak

Operating Temperature:
0° C - 65° C

Weight:
Approximately 5.5 lb. (2.5kg)

Dimensions:

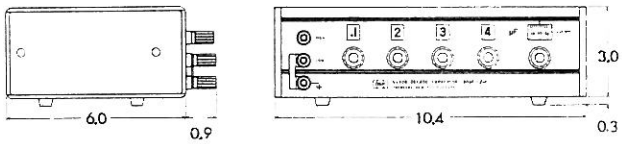


Figure 1-1. Model 4440B Decade Capacitor

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 1.2μF. 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 (350lb/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 temparature, -40° F (-40° C).

c. Maximum temparature, 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.

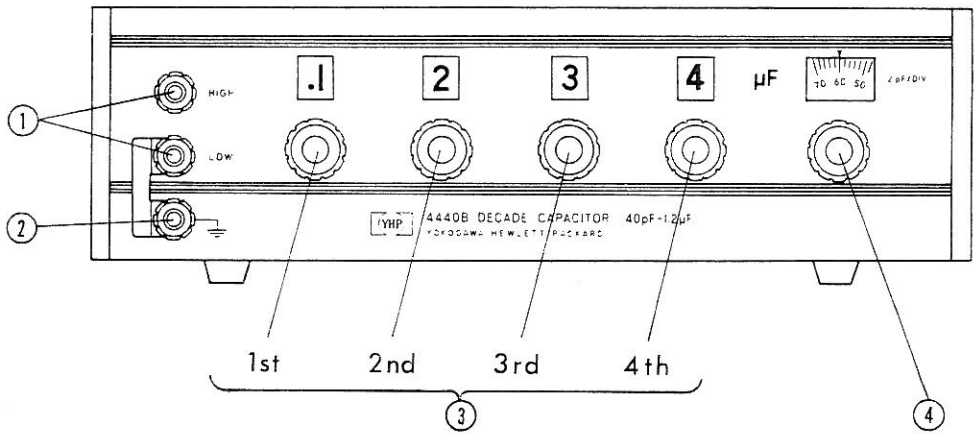
SECTION III
OPERATION

3-1. INTRODUCTION

3-2. The Model 4440B Decade Capacitor provides capacitance from 40pF to 1.2μF 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.



1. HIGH, LOW terminals: Provide capacitance value set by decade switches and vernier control. Low terminal is at floating ground potential, and should be tied to Ground terminal (⏚) with grounding strap in a two-terminal connection.

2. Ground terminal (⏚): Connected to the cabinet internally. When grounding strap is disconnected from the LOW terminal, the instrument may be used as a three-terminal connection capacitor.

3. Decade switches: Provide capacitance up to 1.1999μF between HIGH and LOW terminals in steps of 0.0001μF (100pF). The value of capacitance is displayed in the windows just above the control knobs ganged with the switches in in-line form.

   1st decade switch: provides capacitance of 0 to 1.1μF in 0.1μF steps.

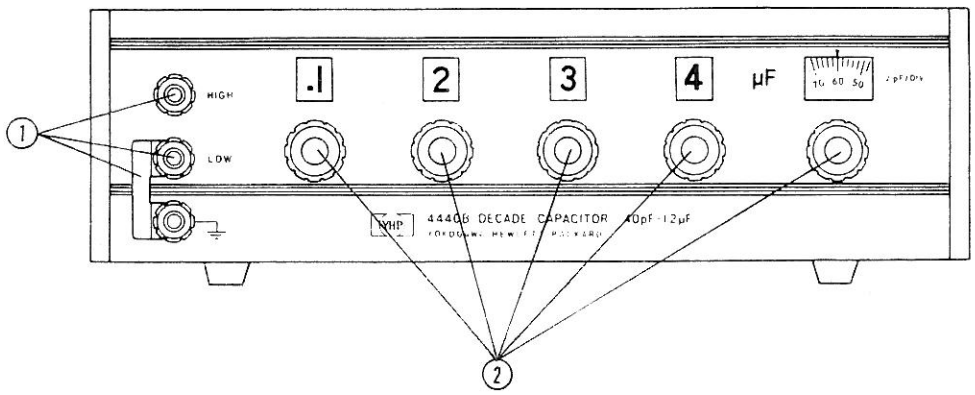
   2nd decade switch: provides capacitance of 0 to 0.09μF in 0.01μF steps.

   3rd decade switch: provides capacitance of 0 to 0.009μF (9000pF) in 0.001μF (1000pF) steps.

   4th decade switch: provides capacitance of 0 to 0.0009μF (900pF) in 0.0001μF (100pF) steps.

4. Vernier control: Provides 40pF to 140pF of continuously adjustable capacitance between the 100pF steps of the smallest decade. Resolution is 2pF and dial scale is linear. Letters in 100pF to 140pF range are in red.

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 μF position. This setting keeps all (four) contacts that contact stess 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.

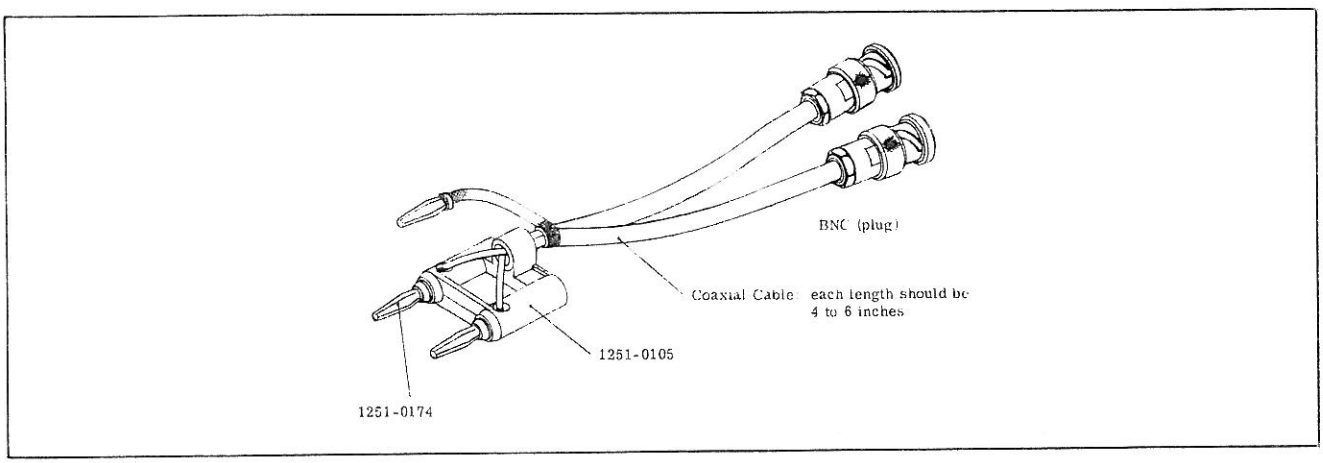


Figure 4-1 Measuring Cable

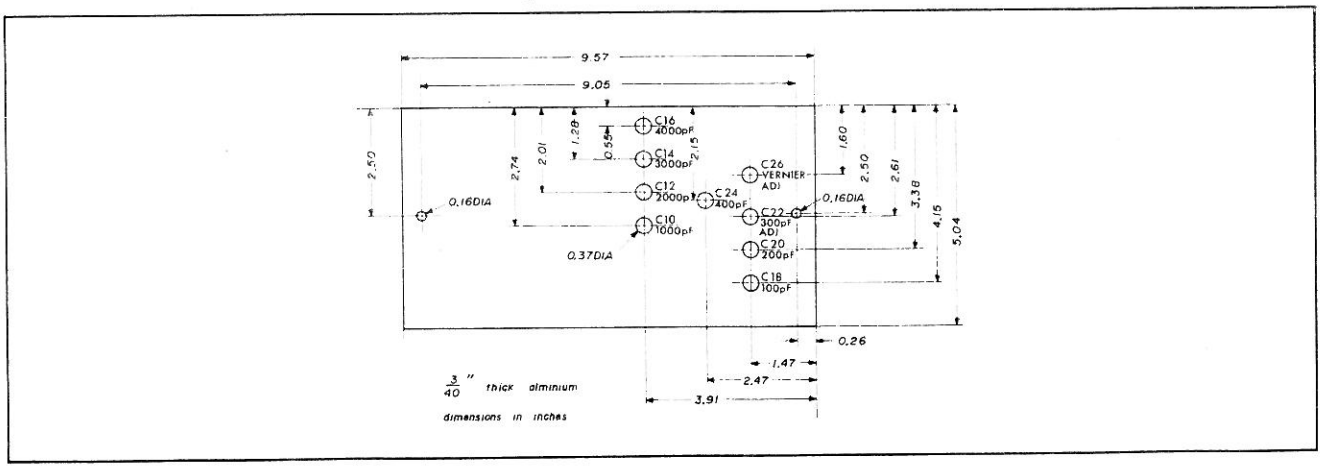


Figure 4-2 Testing Plate

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.

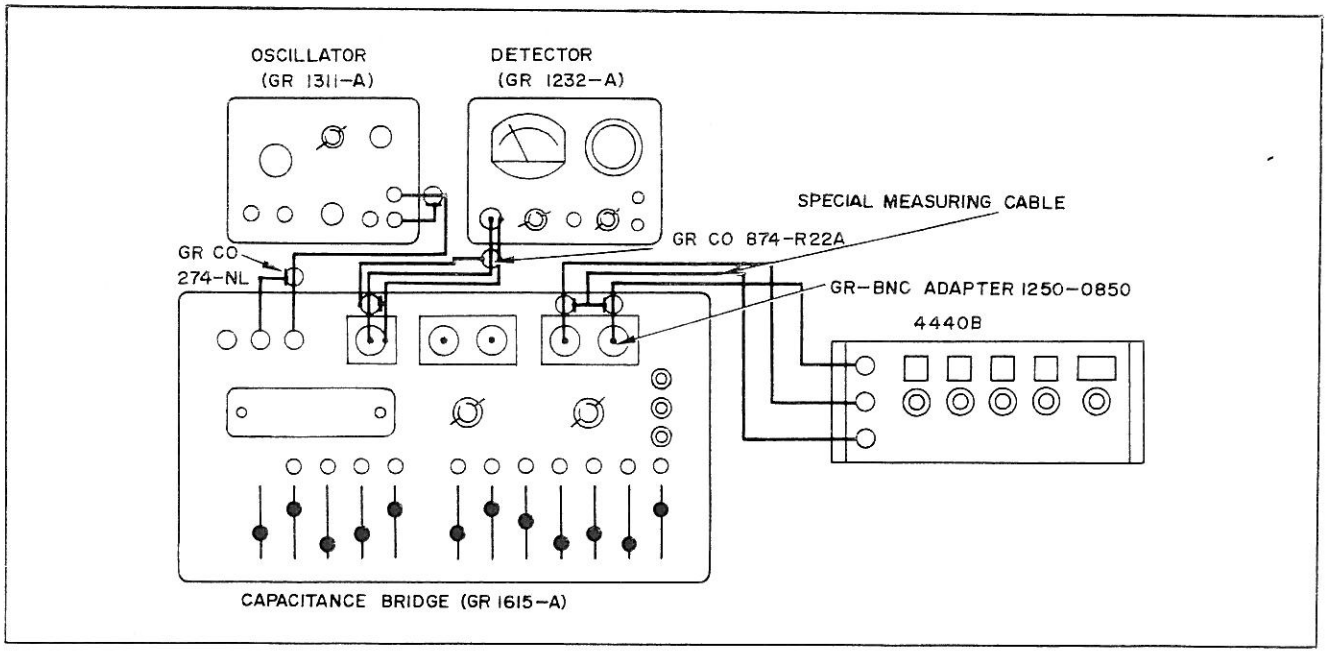


Figure 4-3. Performance Test Setup

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 0.1μF), 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).

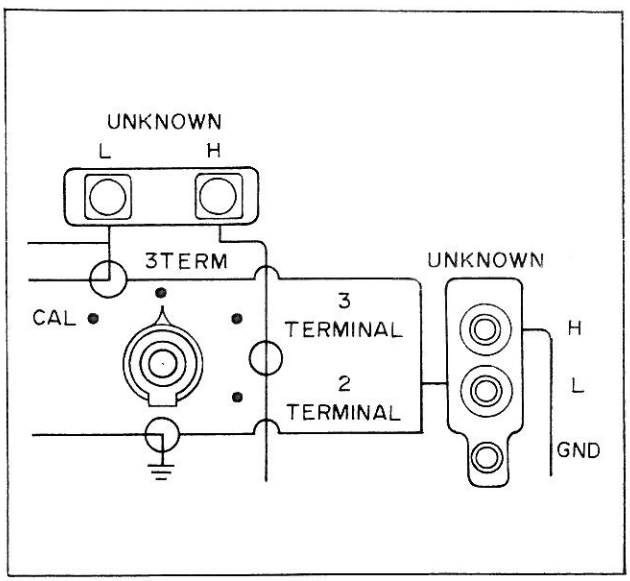


Figure 4-4. 1615-A Capacitance Bridge Setting

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)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)pF and (143.35 + x)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)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)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% of reading + (10 + Cs/Cx) 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.

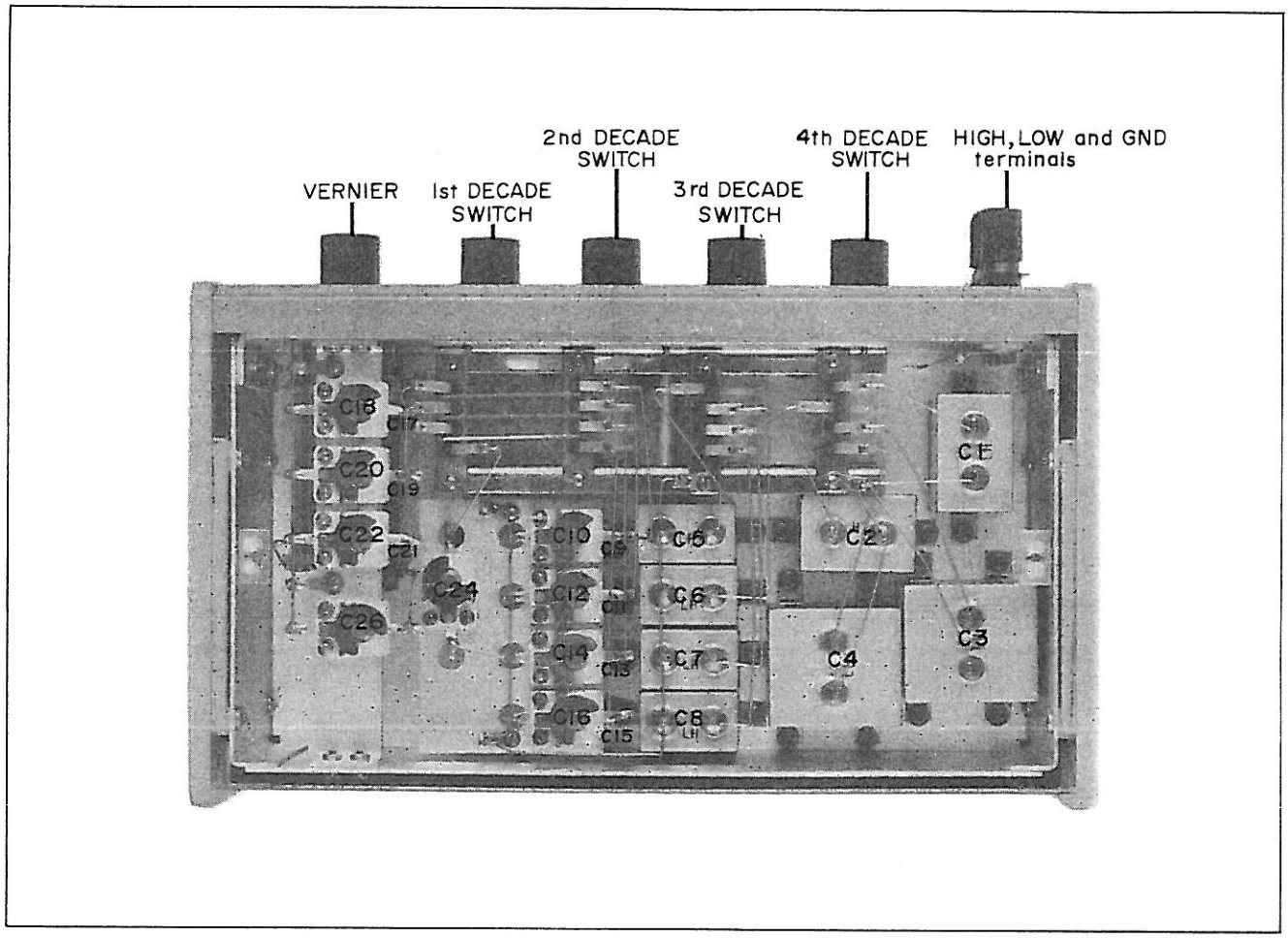


Figure 4-5. Parts Location

Table 4-3. Composition of the 1st Decade

Component / Dial Setting	0.1 μF C1	0.2 μF C2	0.4 μF C3	0.4 μF 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 μF C5	0.02 μF C6	0.03 μF C7	0.03 μF 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 μF 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 alpha-numerical 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

A	= assembly	E	= misc electronic part	MP	= mechanical part	TP	= test point
B	= motor	F	= fuse	P	= plug	V	= vacuum, tube, neon bulb, photocell, etc.
BT	= battery	FL	= filter	Q	= transistor		
C	= capacitor	IC	= integrated circuit	R	= resistor	VR	= voltage regulator
CP	= coupler	J	= jack	RT	= thermistor	W	= cable
CR	= diode	K	= relay	S	= switch	X	= socket
DL	= delay line	L	= inductor	T	= transformer	Y	= crystal
DS	= device signaling (lamp)	M	= meter	TB	= terminal board		

ABBREVIATIONS

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

0001-9700

Table 5-2. Reference Designation Index

Reference Designation	HP Part No.	Description	Note
C1	0160-1571	C:FXD S. MICA 0.1μF 0.2% 500VDCW	
C2	0160-1570	C:FXD S. MICA 0.2μF 0.2% 500VDCW	
C3	0160-1569	C:FXD S. MICA 0.4μF 0.2% 500VDCW	
C4	0160-1569	C:FXD S. MICA 0.4μF 0.2% 500VDCW	
C5	0160-1574	C:FXD S. MICA 0.01μF 0.2% 500VDCW	
C6	0160-1573	C:FXD S. MICA 0.02μF 0.2% 500VDCW	
C7	0160-1572	C:FXD S. MICA 0.03μF 0.2% 500VDCW	
C8	0160-1572	C:FXD S. MICA 0.03μF 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		TERMINAL:HIGH	
	04440-7048	BINDING POST ASS'Y:RED	
	04440-5021	INSULATOR:FRONT	
	04440-3021	INSULATOR:REAR	
J2		TERMINAL:LOW	
	1510-0006	BINDING POST:BLACK	
	04440-5021	INSULATOR:FRONT	
J3		TERMINA:GROUND (⏚)	
	04440-3028	BINDING POST ASS'Y:BLACK	
	0340-0223	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		SWITCH ASS'Y:DECADE	
	3100-0909	CONTACT:BAR 4 REQ'D	
	04440-7047	CONTACT:ASS'Y 4 REQ'D	
	04440-5022	CAM:10 POSITION FOR S2-S4 3 REQ'D	
	04440-5023	CAM:12 POSITION FOR S1	
	1460-0307	SPRING:COIL 2 REQ'D	
	04260-1067	ARM:CLICK 4 REQ'D	
	04260-3056	ROLLER:CLICK 4 REQ'D	
	04260-3057	SHAFT:CLICK 2 REQ'D	
	04440-1028	ANGLE:L REAR	
	04440-1029	ANGLE:L FRONT	
	04440-1040	PLATE:SHIELD 3 REQ'D	
	04440-1044	CHASSIS:SWITCH ASS'Y	
	04440-3022	INSULATOR:BAR CONTACT 8 REQ'D	
	04440-3023	STUD 4 REQ'D	
	04440-3025	SPACER	
		MISCELLANEOUS	
	5040-3316	FRAME:SIDE 2 REQ'D	
	04440-1139	PANEL:FRONT	
	04440-1125	PANEL:FLONT	
	04440-1134	COVER:TOP	
	04440-1135	COVER:BOTTOM	
	5000-4197	COVER:SIDE 2 REQ'D	
	0370-0025	KNOB:ROUND 3/4" DIA BLACK 5 REQ'D	
	1520-0115	CUSHION:FOOT 4 REQ'D	
	04440-5124	DIAL:DECADE SWITCH FOR S2 - S4 3 REQ'D	
	04440-5125	DIAL:DECADE SWITCH FOR S1	
	04440-5127	DIAL:VERNIER	
	04440-5126	TRIM:FRONT PANEL 2 REQ'D	
	04440-1026	CASE:SHIELD	
	04440-1036	PLATE:SHIELD CASE	
	04440-1032	PLATE:CAPACITOR ASS'Y	
	04440-1033	ANGLE:L 2 REQ'D	
	04440-1038	SPRING:L ANGLE 2 REQ'D	
	04440-1043	ANGLE:CAPACITOR ASS'Y	
	04440-3023	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 mainframe 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.

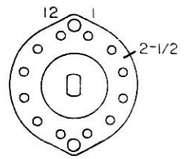
SYMBOLS

- FRONT PANEL
- REAR PANEL
- KNOB CONTROL
- SCREWDRIVER ADJUST
- MAIN SIGNAL PATH
- FEEDBACK PATH
- CONDUCTING ELEMENT
- WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE
- POWER LINE GROUND
- CIRCUIT COMMON GROUND
- TEST POINT
- "AND" GATE
- INHIBIT GATE
- "OR" GATE

WAVEFORMS SHOWN ARE TYPICAL

SWITCH DESIGNATIONS

A3S1BR(2-1/2)

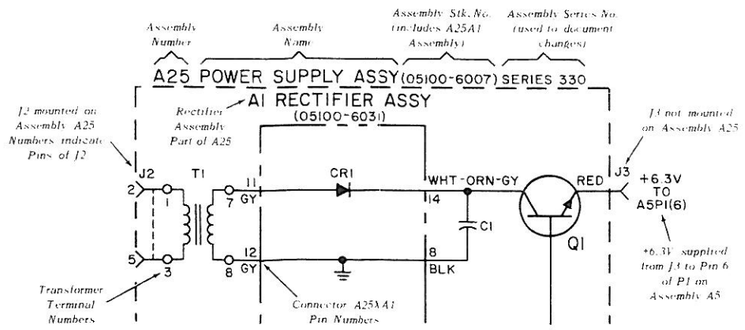


A3S1	SWITCH S1 WITHIN ASSEMBLY A3
B	2ND WAFER FROM FRONT (A=1ST, ETC)
R	REAR OF WAFER (F=FRONT)
(2-1/2)	TERMINAL LOCATION (2½) (VIEWED FROM FRONT)

REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3



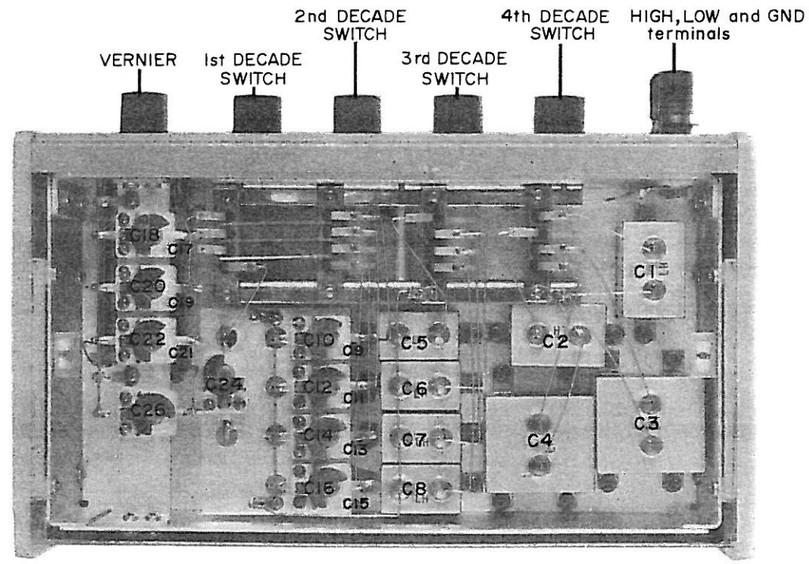
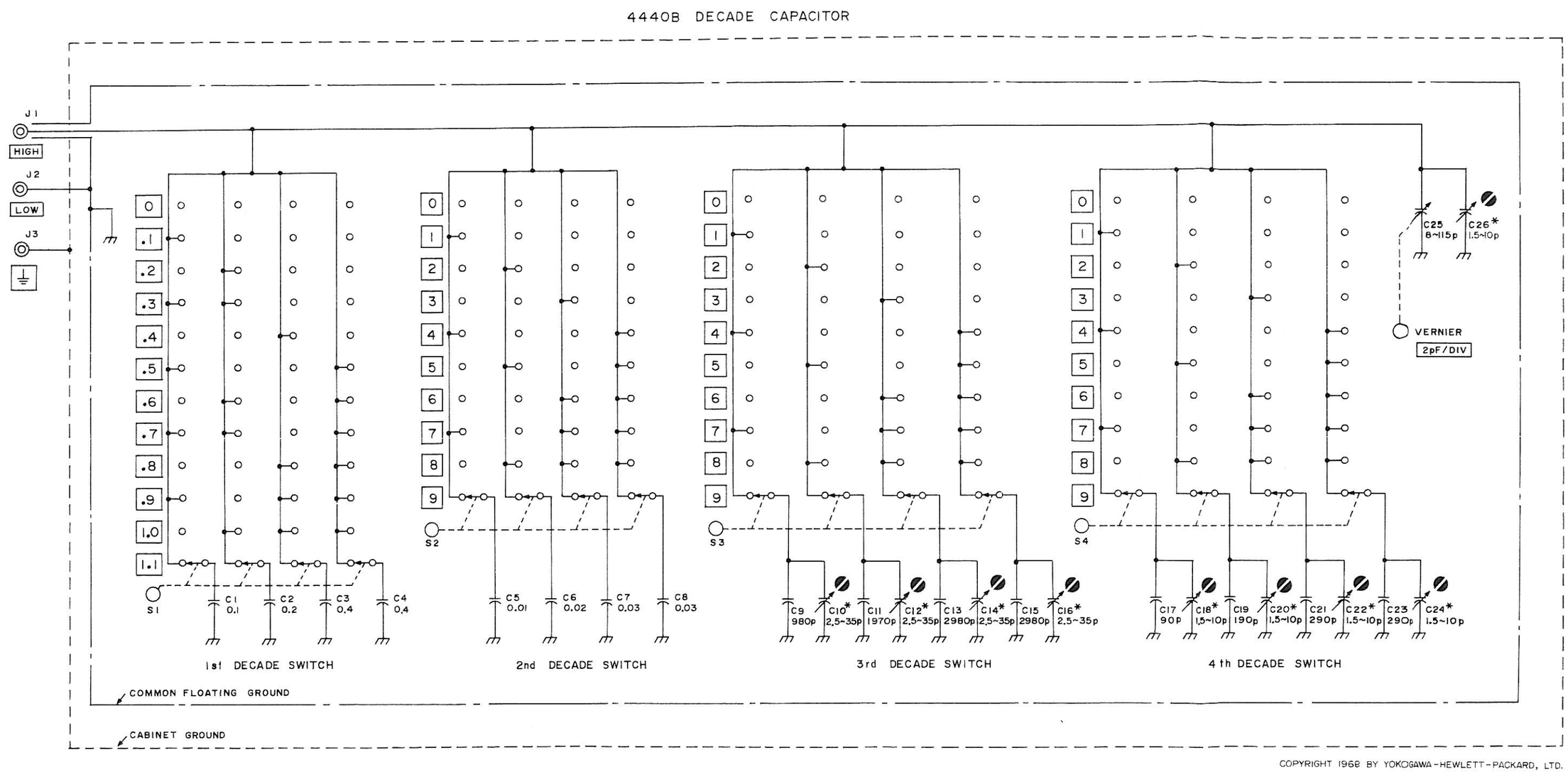


Figure 7-1. Schematic Diagram Notes



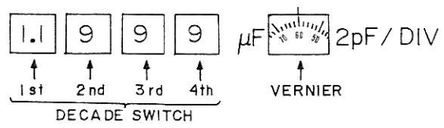


Figure 7-2. Model 4440B Schematic Diagram

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Cable BLUESTAR

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Cable BLUESTAR

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Tel 32069 32161 32282
Telex 0885-514
Cable BLUESTAR

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Cable BLUESTAR

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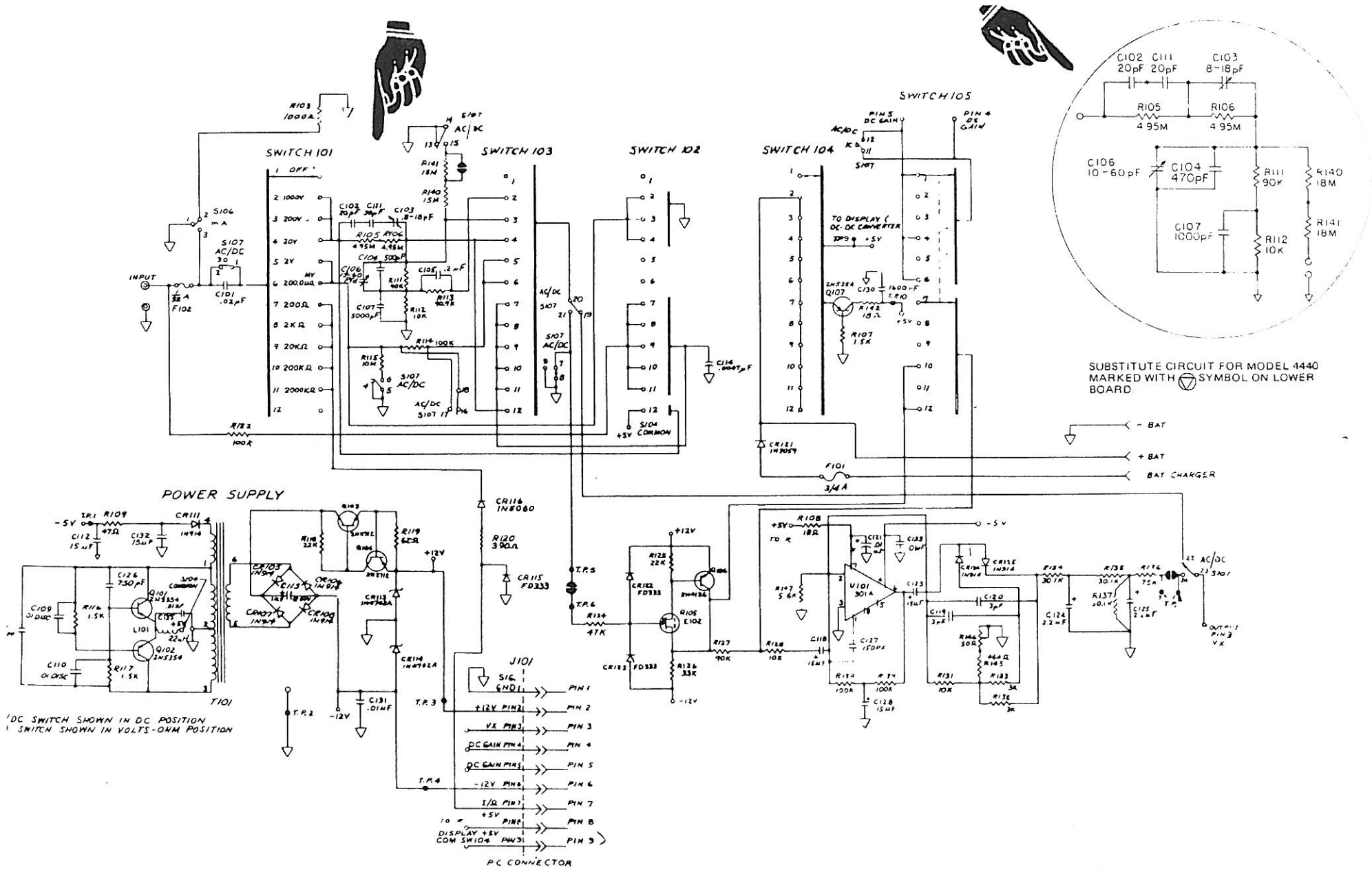

Figure 7-3. Schematic Diagram, Lower Board