OPERATING AND SERVICE MANUAL

DIGITAL MULTIMETER

3476A

HEWLETT hp PACKARD

-hp- 3476A

MANUAL CHANGES

MODEL 3476A

MULTIMETER

Manual Part No. 03476-90001

► New or Revised Item

CHANGE NO. 1 (PC 14060, 14080, 14110) applies to serial numbers 1619A05841 and greater.

Page 6-3/6-4, Table 6-3. Change the -hp- part numbers and descriptions as shown in Table CS-1.

Table CS-1

Ref. Desig.	From	To
A1R2	0698-8748, 1 K 5%	0811-0006, 5 K 1%
A1R4	0757-0440, 7.5 K	0698-3152, 3480 ohm
A1R13	0698-1055, 1 M 5% 1 W	0757-0059, 1 M 1% ½ W
A1R51	0683-1035, 10 K	0683-1025, 1 K

Page 7-5/7-6, Figure 7-2. Change the value of R2 to 5 K, R4 to 3480 in the ohms current source. Change R21, 10 K to R51, 1 K associated with the MOS Substrate Voltage Adjustment.

CHANGE NO. 2 applies to serial numbers 1646A06291 and greater.

Page 6-3. Change -hp- part number of C4 to 0121-0487, qty 1, Capacitor-V TRMR-AIR 1.0/3.5 pF.

Page 6-4. Change -hp- part number of U1 to 1813-0091.
Add to A1 Mechanical Parts -hp- part number 1251-3379, qty 3, Cont-Conn (25 pin).
Add to Misc. Parts -hp- part number 03476-04701, P.C.B. Hybrid Spacer, qty 4.
Change -hp- part number 03476-00602 in Misc Parts to 03476-00605 and add part number 7120-6297, Label-Caution, qty 1.

Page 7-5/7-6, Figure 7-2. Change the value of C4 to 1.0 — 3.5 pF.

OPERATING AND SERVICE MANUAL

MODEL 3476A

DIGITAL MULTIMETER

For Instrument Serial Numbers 1619A02731 and Greater

Any changes made in instruments manufactured after this printing will be found in a "Manual Changes" supplement s
Any changes made in instruments manufactured after this printing will be found in a "Manual Changes" supplement supplied with this manual. Be sure to examine this supplement, if one exists for this manual, for any changes which apply to your instrument and record these changes in the manual.

If the Serial Number of your instrument is lower than the one on this title page, the manual contains revisions that do not apply to your instrument. Backdating information given in the manual adapts it to earlier instruments.

Where practical, backdating information is integrated into the text, parts list and schematic diagrams. Backdating changes are denoted by a delta sign. An open delta (Δ) or lettered delta (Δ_A) on a given page, refers to the corresponding backdating note on that page. Backdating changes not integrated into the manual are denoted by a numbered delta (Δ_1) which refers to the corresponding change in the Backdating section (Section VIII).

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

Manual Part No. 03476-90001

Microfiche Part No. 03476-90051

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Printed: June 1976

HEWLETT hp PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except that in the case of certain components, if any, listed in Section I of this operating manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the proper preventive maintenance procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

If this product is sold as part of a Hewlett-Packard integrated instrument system, the above warranty shall not be applicable, and this product shall be covered only by the system warranty.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

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

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information concerning the -hp- Model 3476A Multimeter. Included is an instrument description, specifications, information about instrument and manual identification, option and accessory information, and safety considerations.

1-3. DESCRIPTION.

1-4. The -hp- Model 3476A Multimeter is a 3 digit, five function, autoranging instrument which measures ac and dc voltage, ac and dc current, and ohms. A HOLD function is provided to enable the user to make repeated measurements without changing ranges. The sample rate is approximately three readings per second. Throughout the remainder of this manual, the 3476A Multimeter will be referred to as Multimeter.

1-5. SPECIFICATIONS.

1-6. Specifications for the Multimeter are listed in Table 1-1. These specifications are the performance standards or limits to which the Multimeter can be tested. Any changes in these specifications due to manufacturing changes, design or traceability to the National Bureau of Standards will be

Table 1-1. Specifications.

DC VOLTMETER

Ranges: ± 0.11 V, 1.1 V, 11 V, 110 V, 1100 V (1000 V Maximum Input)
Accuracy (20°C to 30°C):

Ranges	Accuracy (90-Day Calibration Cycle)	Accuracy (1-Year Calibration Cycle)
0.11 V	± (0.3% of reading + .2% of range)	± (0.5% of reading + 0.2% of range)
1.1 V, 11 V	± (0.3% of reading + 0.1% of range)	± (0.5% of reading + 0.1% of range)
110 V, 1100 V	± (0.4% of reading + 0.1% of range)	± (0.6% of reading + 0.1% of range)

Common Mode Rejection: > 100 dB at 50 Hz, 60 Hz (1 kΩ unbalanced)
Input Resistance: 10 MΩ ± 5%
Input Protection: < 1000 V (Continuous)
Temperature Coefficient: ± (0.05% of reading + 0.02% of range)/°C

AC VOLTMETER

Ranges: 0.11 V rms, 1.1 V rms, 11 V rms, 110 V rms, 1100 V rms (707 V rms Maximum)
Accuracy (20°C to 30°C):

Ranges*	Accuracy (90-Day Calibration Cycle) 45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
1.1 V rms to 1100 V rms	± (1.5% of reading + 0.4% of range)	± (3% of reading + 0.6% of range)	± (8% of reading + 1.0% of range)
0.11 V rms	± (2% of reading + 0.6% of range)	± (5% of reading + 0.6% of range)	± (18% of reading + 1.0% of range)

	Accuracy (1-Year Calibration Cycle) 45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
1.1 V rms to 1100 V rms	± (1.7% of reading + 0.5% of range)	± (3.2% of reading + 0.7% of range)	± (8.2% of reading + 1.1% of range)
0.11 V rms	± (2.2% of reading + 0.7% of range)	± (5.2% of reading + 0.7% of range)	± (18.2% of reading + 1.1% of range)

*Ranges usable from 0.03 to full scale.
Common Mode Rejection: (1 kΩ balanced) > 80 dB at 50 Hz and 60 Hz
Input Resistance: 10 MΩ ± 5%
Input Capacitance. < 30 pF
Input Protection: < 707 rms continuous
Temperature Coefficient: ± (0.05% of reading + 0.05% of range)/°C

Table 1-1. Specifications (Cont'd).

DC AMMETER

Ranges: ± 0.11 A, 1.1 A (1.1 A maximum input)
Accuracy (20°C to 30°C):

Ranges	Accuracy (90-Day Calibration Cycle)	Accuracy (1-Year Calibration Cycle)
± 0.11 A, 1.1 A	± (0.8% of reading 0.2% of range)	± (1.0% of reading 0.2% of range)

Impedance: 1 – 1.5 ohm constant
Protection: 1.5 A fuse to 250 V (> 250 V will damage the instrument)
Temperature Coefficient: ± (0.05% of reading + 0.02% of range)/°C

AC AMMETER

Ranges: 0.11 A rms, 1.1 A rms (1.1 rms maximum input)
Accuracy (20°C to 30°C):

	Accuracy (90-Day Calibration Cycle)		Accuracy (1-Year Calibration Cycle)	
Ranges*	45 Hz to 2 kHz	2 kHz to 5 kHz	45 Hz to 2 kHz	2 kHz to 5 kHz
1.1 A rms	± (2% of reading + 0.4% of range)	± (3.5% of reading + 0.6% of range)	± (2.2% of reading + 0.5% of range)	± (3.7% of reading + 0.7% of range)
0.11 A rms	± (2.5% of reading + 0.6% of range)	± (5.5% of reading + 0.6% of range)	± (2.7% of reading + 0.7% of range)	± (5.7% of reading + 0.7% of range)

*Ranges usable from 0.03 to full scale.
Impedance: 1 – 1.5 ohm constant
Protection: 1.5 A fuse to 250 V (> 250 V will damage the instrument)
Temperature Coefficient: ± (0.05 of reading + 0.05% of range)/°C

OHMMETER

Ranges: 1.1 kΩ, 11 kΩ, 110 kΩ, 1100 kΩ, 11000 kΩ
Accuracy: (20°C to 30°C)

Ranges	Accuracy (90-Day Calibration Cycle)	Accuracy (1-Year Calibration Cycle)
110 K, 1100 K	± (0.3% of reading + 0.1% of range)	± (0.5% of reading + 0.1% of range)
11000 K, 1.1 K, 11 K	± (0.5% of reading + 0.1% of range	± (0.7% of reading + 0.1% of range)

Open Circuit Voltage: < 4 V
Input Voltage Protection: < 30 V rms continuous, no effect;
30 V to 250 V rms requires replacement of input fuse; > 250 V will damage instrument.
Temperature Coefficient: ± (0.05% of reading + 0.02% of range)/°C

Table 1-2. General Information.

Ranging: Automatic or Hold Mode
Sample Rate: approximately 3 samples per second
Operating Environmental conditions:
Temperature range: 0°C to 40°C
Humidity: < 95% RH
Power:
AC line, < 6 VA at:
Standard, 104–127 V, 54–66 Hz
Option 001, 86–106 V, 54–66 Hz
Option 002, 86–106 V, 48–54 Hz
Option 003, 190–230 V, 48–54 Hz
Option 004, 208–250 V, 48–54 Hz

Weight: 0.71 Kg (1 lb. 9 oz.)
Shipping Weight: 1.14 Kg (2 lb. 8 oz.)
Dimensions: 5.84 cm (2.3 in.) high, 16.8 cm (6.6 in.) wide, 20.6 cm (8.1 in.) deep

covered by an errata or change sheet. These specifications supersede any prior published specifications. Supplemental information in Table 1-2 is provided to describe general operating characteristics.

1-7. INSTRUMENT ANO MANUAL IOENTIFICATION.

1-8. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. A letter between the prefix and the suffix identifies the country in which the instrument was manufactured. The manual is kept up-to-date at all times by means of a change sheet which is supplied with the manual. If the serial number of your instrument differs from the one on the title page of this manual, refer to the change sheet supplied with the manual. All correspondence with Hewlett-Packard should include the complete serial number.

1-9. OPTIONS.

1-10. Table 1-3 lists the options available for the Multimeter.

1-11. The instrument contains a label identifying the line voltage for which the instrument is wired. If the jumper wires are changed to accomodate a different line voltage, the label must also be changed to indicate the new configuration.

NOTE

If the instrument is to be operated at a line frequency other than the one indicated on the label, it will be necessary to perform the Clock Frequency Adjustment in Section V of this manual.

Table 1-3. Options.

Option	Description
Standard	104-127, 54-66 Hz, 6 VA, 60 mA Max.
001	86-106, 54-66 Hz, 6 VA, 70 mA Max.
002	86-106, 48-54 Hz, 6 VA, 70 mA Max.
003	190-230, 48-54 Hz, 6 VA, 30 mA Max.
004	208-150, 48-54 Hz, 6 VA, 30 mA Max.

1-12. ACCESSORIES.

1-13. The accessories available for use with the Multimeter are listed in Table 1-4.

Table 1-4. Accessories.

Accessory Number	Description
Model 11096A	R F Probe, 100 kHz to 500 MHz (down 3 dB at 10 kHz and 700 MHz)
Model 11096A Adapter	1251-4242
Model 11067A	Universal Test Lead Kit
Model 11068A	Soft Carrying Case

1-14. SAFETY CONSIOERATIONS.

1-15. This Operating and Service Manual contains cautions and warnings alerting the user to hazardous operating and maintenance conditions. To ensure the safety of the operating and maintenance personnel and retain the operating condition of the instrument, these instructions must be followed.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions for the installation and shipping of the Multimeter. Included are initial inspection procedures, power and grounding requirements, environmental information, and instructions for repackaging the instrument for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Electrical performance should be tested using the performance tests outlined in Section V. If there is damage or deficiency, see the warranty inside the front of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Multimeter can be operated from any one of the ac power sources listed in Table 1-3. Before connecting the instrument to ac power, verify that the ac power source matches the power requirement of the instrument by refering to the power requirement label attached to the instrument. If the instrument is incompatible with the available power source, refer to Section V for Power Requirement Modification instructions.

2-7. ENVIRONMENTAL REQUIREMENTS.

2-8. The Multimeter will meet the specifications listed in Table 1-1 when the operating temperature is within the range of +20°C to +30°C (+68°F to +86°F). The instrument can be operated where the ambient temperature is within the range of 0°C to 40°C (32°F to 104°F) and the relative humidity is less than 95%.

WARNING

To prevent potential electrical or fire hazard, do not expose equipment to rain or moisture.

2-9. REPACKAGING FOR SHIPMENT.

2-10. The following paragraphs contain a general guide for repackaging the instrument for shipment. Refer to Paragraph 2-11 if the original container is to be used; 2-12 if it is not. If you have any questions, contact your nearest -hp- Sales and Service Office (See Appendix A for office locations).

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

2-11. Place instrument in original container with appropriate packing material and seal well with strong tape or metal bands. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

2-12. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

2-13. POWER CORDS AND RECEPTACLES.

2-14. Figure 2-1 illustrates the plug cap configurations that are available to provide ac power to the Multimeter. The -hp- part number shown directly below each plug cap drawing is the part number for the power cord set equipped with the appropriate mating plug for that receptacle. The appropriate power cord should be provided with each instrument. However, if a different power cord set is required, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided. The instrument ac power input receptacle and cord set appliance coupler meet the safety specifications set by the International Commission on Rules for the Approval of Electrical Equipment (CEE 22).

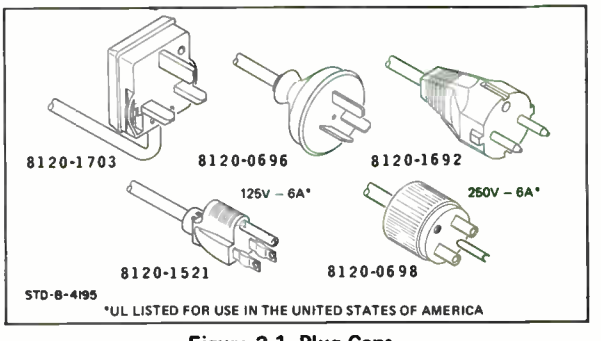


Figure 2-1. Plug Caps.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions for operating the Multimeter. Measurements of ac and dc voltage, ac and dc current, and ohms are discussed. A description of the controls and connectors is given in Figure 3-8.

WARNING

To prevent potential electrical or fire hazard, do not expose the Multimeter or its accessories to rain or moisture.

3-3. TURN-ON.

3-4. Before connecting the Multimeter to ac power, verify that the ac power source matches the power requirements of the Multimeter by referring to the power requirement label located below the ac receptacle. If the instrument is incompatible with the available power source, refer to Section V of this manual for power requirement modification instructions. After this verification, connect the proper ac power to the instrument and press the ON button. The instrument is ready for use.

3-5. OPERATION.

3-6. Overload/Overrange Indication.

3-7. Figure 3-1 shows the display indication during an Overload/Overrange condition.

Figure 3-1. Overload Indication.

3-8. Auto/Hold Switch.

3-9. In the AUTO position (out), the Multimeter is in the Autoranging mode. In this mode the Multimeter will uprange if the display reading increases above 1098 and *downrange* if the display decreases below 100. These numerical autoranging points are irrespective of decimal placement. The difference between the two autoranging points is called the *autoranging hysteresis*. Figure 3-2 shows the autoranging points for dc voltage measurements from 0 to 1000V dc. Autoranging in other Multimeter functions is similar.

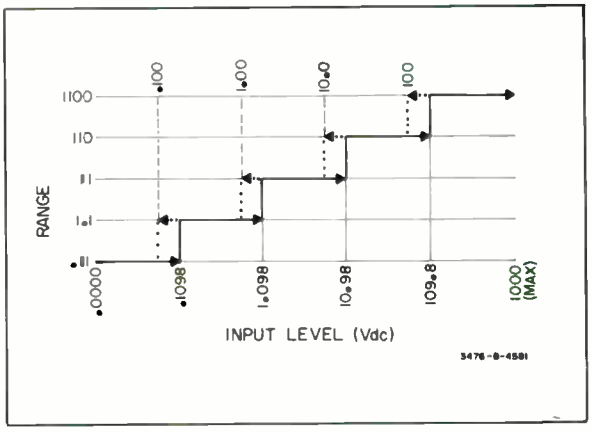


Figure 3-2. Multimeter Autoranging.

3-10. In the HOLD position (IN) the Multimeter will remain in the same range as when the switch was depressed.

NOTE

With the Multimeter in the HOLD position, maximum input levels as described in Table 1-1 can safely be input regardless of the range selected. If the input level exceeds a 1098 display indication, an overload condition will be displayed without damaging the Multimeter.

3-11. AC Voltage Measurements.

CAUTION

To avoid possible damage to the Multimeter circuitry, the ac input voltage must not exceed 707 V rms.

3-12. Set the Multimeter front panel controls as follows:

DC/AC (⎓ ~) . . . . . ~ (IN)
VOLTS (V) . . . . . (IN)
AUTO HOLD . . . . . AUTO (OUT)
AMPS (A) AND kΩ . . . . . (OUT)

3-13. Connect test leads from the Multimeter V Ω (HI) and COM (LOW) connectors to the voltage under test as shown in Figure 3-3.

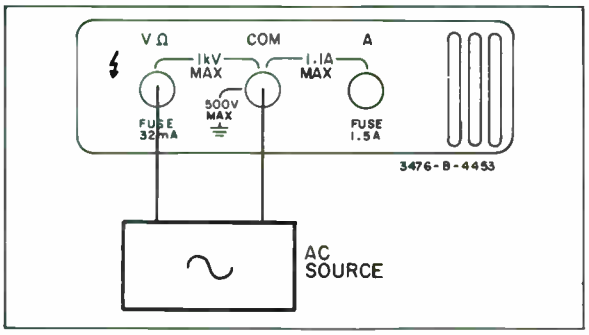


Figure 3-3. AC Voltage Measurement.

3-14. DC Voltage Measurements.

CAUTION

To avoid possible damage to the Multimeter circuitry, the dc input voltage must not exceed 1000 V dc.

3-15. Set the Multimeter front panel controls as follows:

DC/AC (⎓ ~) . . . . . ⎓ (OUT)
VOLTS (V) . . . . . .(IN)
AUTO HOLD. . . . . AUTO (OUT)
AMP (A) AND kΩ. . . . . (OUT)

3-16. Connect test leads from the Multimeter V Ω (HI) and COM (LOW) connectors to the voltage under test as shown in Figure 3-4.

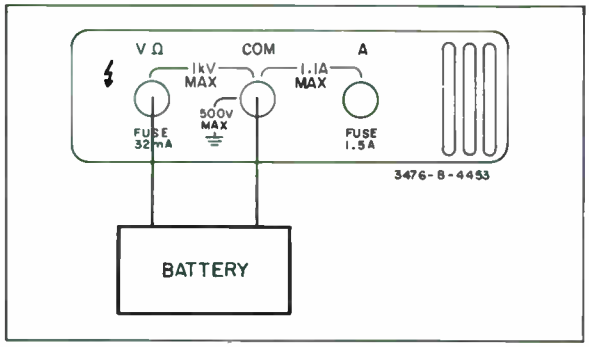


Figure 3-4. DC Voltage Measurement.

3-17. AC Current Measurements.

CAUTION

To avoid possible damage to the Multimeter, do not allow the voltage across the Amps to COM input terminals to exceed 250 V at any time.

3-18. Set the Multimeter front panel controls as follows:

DC/AC (⎓ ~) . . . . . ~ (IN)
AMPS (A) . . . . . .(IN)
AUTO HOLD. . . . . AUTO (OUT)
VOLTS (V) AND kΩ. . . . . (OUT)

3-19. Connect test leads from the Multimeter A and COM connectors to the current under test as shown in Figure 3-5.

3-20. DC Current Measurements.

CAUTION

To avoid possible damage to the Multimeter, do not allow the voltage across the Amps to COM input terminals to exceed 250 V at any time.

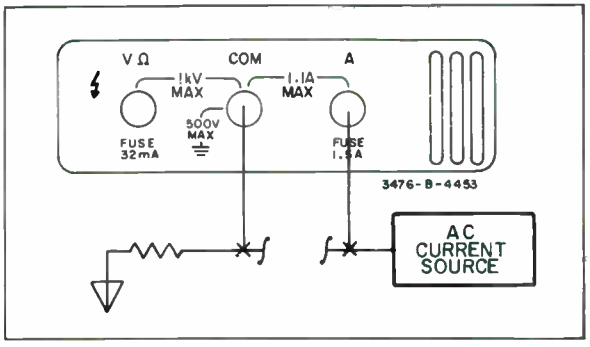


Figure 3-5. AC Current Measurement.

3-21. Set the Multimeter front panel controls as follows:

DC/AC (⎓ ~). . . . . (OUT)
AMPS (A) . . . . . .(IN)
AUTO HOLD. . . . . AUTO (OUT)
VOLTS (V) AND kΩ. . . . . (OUT)

3-22. Connect test leads from the Multimeter A and COM to the current under test as shown in Figure 3-6.

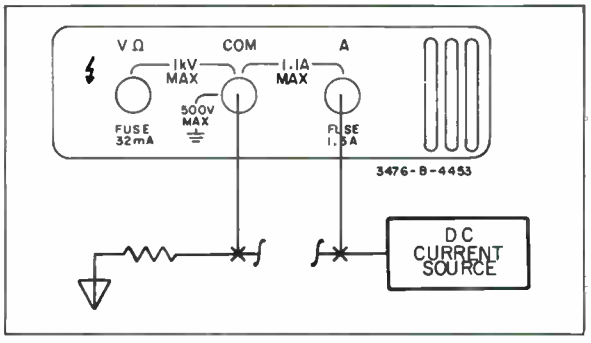


Figure 3-6. DC Current Measurement.

3-23. Resistance Measurements.

3-24. Set the Multimeter front panel controls as follows:

kΩ . . . . . .(IN)
AUTO HOLD. . . . . AUTO (OUT)
VOLTS (V) AND AMP (A) . . . . . (OUT)
DC/AC (⎓ ~). . . . . Either

3-25. Connect test leads from the Multimeter V Ω and COM connectors to the resistance under test as shown in Figure 3-7.

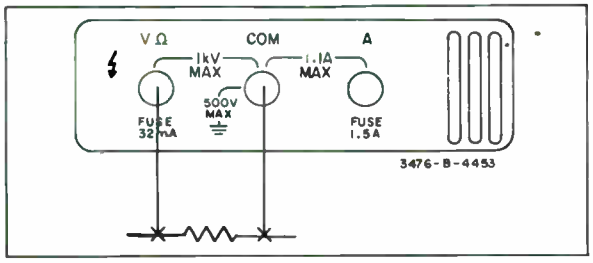
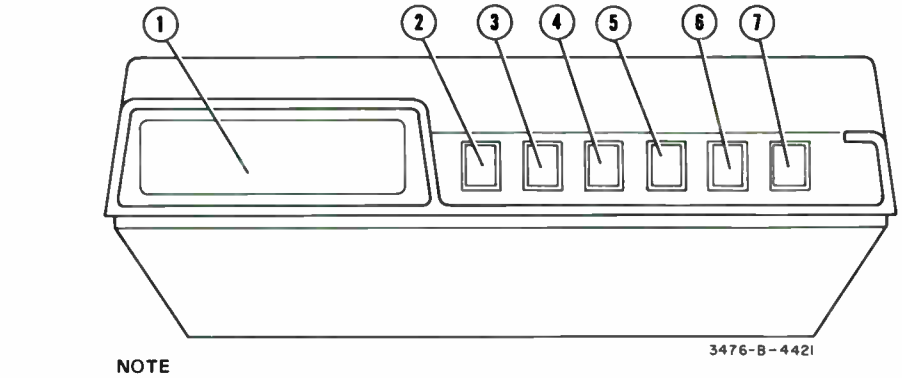


Figure 3-7. Resistance Measurement.

3-26. Input Protection Fuses.

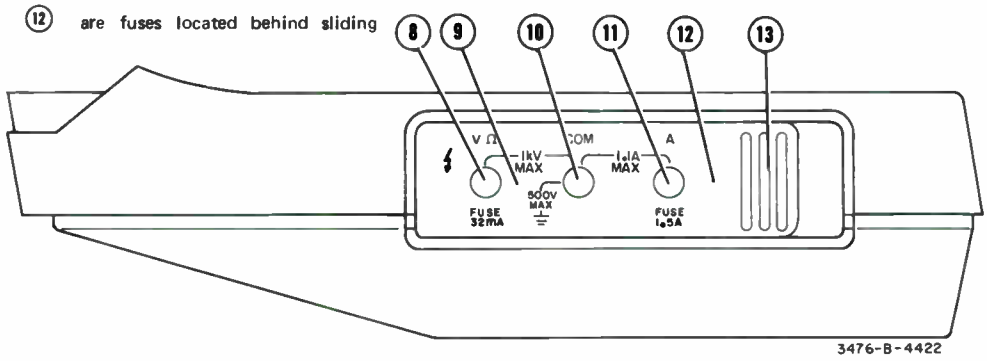
3-27. The AMPS input is protected by a 1.5 A 250 V fuse and the OHMS input is protected by a 32 mA 250 V fuse. These fuses are located behind the sliding Input Panel as shown in Figure 3-8, (9), (12), (13). Replacement of these fuses is accomplished by the following procedure:

a. Slide the Input Panel firmly toward the back of the Multimeter until the fuses protrude.



NOTE

(9) and (12) are fuses located behind sliding panel (13)



(1) DISPLAY: Five section, 7 segment LED readout.

(2) POWER ON Switch: Switches instrument power ON. Power is ON when the pushbutton is depressed.

(3) AC/DC Selector Switch: Selects ac or dc mode for either voltage or current measurements. The instrument is in ac mode when the pushbutton is depressed.

(4) VOLTAGE Selector Switch: Selects voltage function for either ac or dc voltage measurements.

(5) AMPS Selector Switch: Select amps function for either ac or dc current measurements.

(6) kΩ Selector Switch: Selects ohms function for measuring resistance. Display reads in kilohms.

(7) AUTO/HOLD Selector Switch: Select automatic ranging mode or hold mode. Hold mode is set with the switch depressed.

(8) Volts/Ohms Input Terminal: Used in conjunction with the COM terminal (10) for measuring ac voltage, dc voltage, or ohms.

(9) Ohms Input Protection Fuse: 32 mA fuse located behind the sliding input panel (13)

(10) COM Input Terminal: Common terminal for ac/dc volts, ac/dc amps and ohms measurements.

(11) Amps Input Terminal: Used in conjunction with the COM terminal (10) for measuring ac or dc amps.

(12) Amps Input Protection Fuse: 1.5 amp fuse located behind the sliding input panel (13)

(13) Sliding Input Panel: In the front (left) position this panel allows access to the three input terminals (VΩ, COM, A). When in the back (right) position the input protection fuses (9) and (12) can be removed and replaced.

Figure 3-8. Location of Controls and Connectors.

b. Remove and replace faulty fuse.

CAUTION

To avoid possible damage to the Multimeter, insure that the correct fuses are used for replacement in the Input Protection circuit.

c. Push fuses firmly into their receptacles and slide the Input Panel forward to hold fuses in place and align the input jacks.

NOTE

Multimeter test lead banana plugs can be used as a tool to hold the fuses in place while sliding the Input Panel forward.

3-28. AC Line Fuse Replacement.

3-29. Refer to Section V for instruction on the replacement of ac line fuse.

3-30. SEMICONOUCTOR JUNCTION MEASUREMENTS.

3-31. Due to the low output current on the higher ohms ranges, the Multimeter must be downranged to the lowest ohms range in order to measure semiconductor junction (diode) resistance. This can be easily accomplished by the following procedure:

a. To measure the forward resistance, connect the cathode of the diode to the COM terminal and the anode to the ΩV terminal.

b. Press the A pushbutton. This causes the instrument to downrange.

c. Press the kΩ pushbutton and read the forward resistance on the display.

d. To measure the reverse resistance of a diode, reverse the input connections to the diode and repeat Steps b and c.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation for the Model 3476A Multimeter. Included are simplified block diagrams and descriptions of the function of each block.

4-3. Simplified Block Diagram Description (Figure 4-1).

4-4. **Signal Conditioning.** The signal conditioning block consist of the input terminals, overload protection fuses and functional switching. Overload protection fuses provide protection to the Multimeter circuitry during ac or dc amps measurements and during ohms measurements.

4-5. **Ohms Current Source.** The ohms current source provides current for ohms measurements.

4-6. **Input Amplifier.** The input amplifier provides input range switching for all five Multimeter functions. This is accomplished by using FET switches to select different gain levels for the input amplifier. The FET switches are controlled by the Logic Controller.

4-7. **AC Converter.** The AC Converter is an average responding detector used in ac voltage and ac current measurements. The output of the AC Converter is a dc voltage equal to the rms value of the ac input voltage. In the ac current mode, the input voltage to the converter is the ac voltage drop across the 1 ohm current shunt (R45).

4-8. **Integrator, Polarity/Zero Detector, Logic Control and Display.** The Model 3476A uses the dual slope integration technique. The Integrator coupled with the Polarity/Zero Detector and the Logic Controller converts the signal from the conditioning circuits to a digital representation of the input measurement. This digital representation is viewed on the 3476A Display.

4-9. **Power Supply.** The Power Supply is a double regulated dc supply which provides + 6 V dc, - 4 V dc and + 1 V dc.

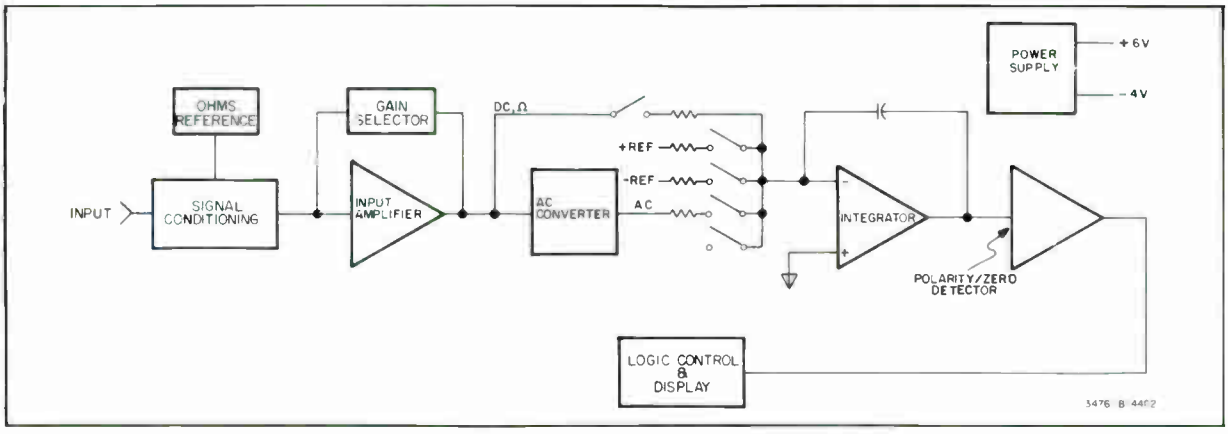


Figure 4-1. Simplified Block Diagram.

WARNING

These servicing instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Table 5-1. Required Test Equipment.

Instrument Type	Characteristics	Recommended Model
Digital Multimeter	DC Volts: 1 V, 10 V, 100 V Accuracy: .05% Input Resistance: ⩾10 MΩ AC Volts: .1 V, 1 V ranges Accuracy: .5% Input Resistance: 10 MΩ	-hp- 3465A
DC Standard	Output: .1 mV to 1000 V Accuracy: .02%	-hp- 740B
AC Calibrator/High Voltage Amplifier	Frequency: 45 Hz to 10 kHz Output: 10 mV to 1000 V Accuracy: 0.1%	-hp- 745A/746A
Meter Calibrator	Output: 1 A Accuracy: 0.1%	-hp- 6920B
Electronic Counter	Frequency: 10 kHz Accuracy: 0.01%	-hp- 5300A/5302A
Power Supply	Output: 5 V, 1 A	-hp- 6294A
Resistive Decade Box	Ranges: 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ and 1 MΩ Steps Accuracy: .05%	General Radio Model GR 1433Z
Resistors	10 MΩ ± 0.1% 1 MΩ ± 0.1% 300 kΩ ± .1% 1 kΩ ± .1% 10 K ± .1%	-hp- Part No. 0698-8194 -hp- Part No. 0698-6369 -hp- Part No. 0698-6332 -hp- Part No. 0698-3491 -hp- Part No. 0698-4157

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section of the manual contains Performance Tests and Adjustment Procedures. The Performance Tests are designed to verify the critical specifications listed in Table 1-1. A Performance Test Card is at the end of this section for recording the results of the performance tests.

5-3. Test Equipment Required.

5-4. Equipment required for the performance tests and adjustment procedures is listed in Table 5-1, Recommended Test Equipment. Equipment that satisfies the critical specifications given in the table may be substituted for a recommended model.

PERFORMANCE TESTS

5-5. PERFORMANCE TESTS.

NOTE

Performance tables are included for both 90 day and 1 year calibration cycles. Be sure to use the appropriate table, depending on the calibration cycle to be used for your instrument.

5-6. DC Voltmeter Accuracy Test.

5-7. A DC Standard is required for this test.

a. Set the Multimeter to measure dc volts. Short the input terminals and check for a display of zero ± 1 count.

b. Connect the DC Standard to the VΩ and COM terminals.

c. Check all the ranges listed in Table 5-2 for the tolerances indicated. Be sure to test for the appropriate calibration cycle.

CAUTION

To avoid possible damage to the Multimeter circuitry, the dc input voltage must not exceed 1000 V dc.

5-8. DC Ammeter Accuracy Test.

5-9. This test requires the use of a Power Supply and a DC Ammeter.

a. Connect the equipment as shown in Figure 5-1.

b. Set the DC Ammeter to the 1000 mA range.

c. Set the Multimeter function to DC A. Adjust the Power Supply output for an indication of 900 mA on the DC Ammeter. The Multimeter should indicate within the limits listed in Table 5-3.

Table 5-2. DC Voltmeter Accuracy Test.

Range	DC Standard Output	Test Limits	
		90 Day Calibration Cycle	1 Year Calibration Cycle
.11 V	- .010 V - .100 V + .100 V	- .0097 to - .0103 - .0995 to - .1005 + .0995 to + .1005	- .0097 to - .0103 - .0994 to - .1006 + .0994 to + .1006
1.1 V	- 1.00 V	- .996 to - 1.004	- .994 to - 1.006
11 V	- 10.00 V + 10.00 V	- 9.96 to - 10.04 + 9.96 to + 10.04	- 9.94 to - 10.06 + 9.94 to + 10.06
1100 V	+ 1000 V	+ 995 to + 1005	+ 993 to + 1007

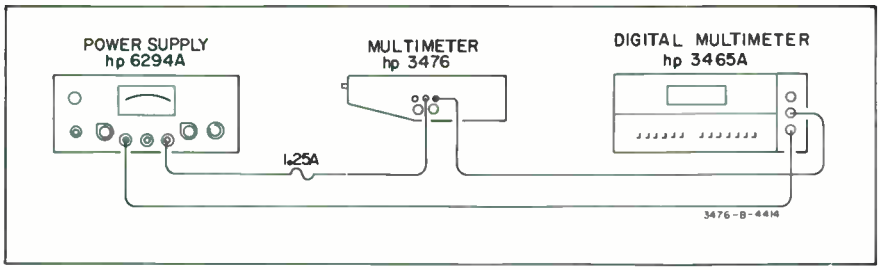


Figure 5-1. DC Ammeter Accuracy Test.

Table 5-3. DC Ammeter Accuracy Test.

Range	Current	90 Day Calibration Limit	1 Year Calibration Limit
1.1 A	900 mA	.891 thru .909	.889 thru .911

5-10. Ohms Accuracy Test.

5-11. A precision resistance decade box will be required for the following test. It should have an accuracy of .05%.

a. Set the FUNCTION switch to kΩ and connect a short between the V/Ω terminal and COM. The Multimeter should indicate zero ± 1 count.

b. Remove the short and connect the equipment as shown in Figure 5-2. Use large wire and connect the decade box as close as possible to the Multimeter. When checking the 11,000 kΩ range, connect the COM terminal to a good earth ground.

c. Check all ranges listed in Table 5-4 for the tolerances indicated. Use the resistance decade box to supply the standard resistances.

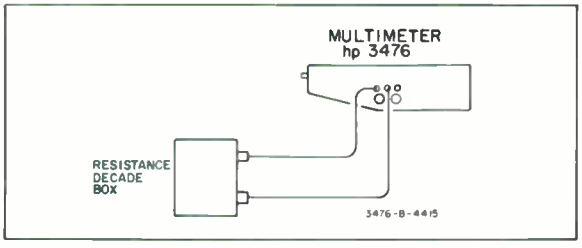


Figure 5-2. Ohms Accuracy Test.

5-12. AC Voltage Accuracy Test.

5-13. An AC Calibrator and High Voltage Amplifier will be required for this test.

CAUTION

To avoid possible damage to the Multimeter circuitry, the ac input voltage must not exceed 707 V rms.

a. Set the Multimeter to AC V. Connect the AC Calibrator between the VΩ and COM terminals. Be sure to connect the Calibrator sense leads.

b. Check the ranges and frequencies listed in Table 5-5 for the tolerances indicated on all ranges through 110 V.

WARNING

Use extreme care when checking the following ranges. Establish all connections before turning on the high voltage source. When the tests are completed, turn off the high voltage before disconnecting any cables or test leads.

c. To check the 1100 V range, connect the AC Calibrator and High Voltage Amplifier to the Multimeter and check the tolerances indicated for the 1100 V range.

Table 5-4. Ohms Accuracy Test.

Range (kΩ)	Standard Resistance	Test Limits (kΩ)	
		90 Day Calibration Cycle	1 Year Calibration Cycle
1.1	100 Ω	.098 thru .102	.098 thru .102
	1 kΩ	.994 thru 1.006	.992 thru 1.008
11	10 kΩ	9.94 thru 10.06	9.92 thru 10.08
110	100 kΩ	99.6 thru 100.4	99.4 thru 100.6
1100	1000 kΩ	996 thru 1004	994 thru 1006
11,000	10,000 kΩ	9940 thru 10,060 kΩ	9920 thru 10,080 kΩ

Table 5-5. AC Voltage Accuracy Test.

Range	AC Standard Output	Test Frequency	Test Limits (V) 90 Day	Test Limits (V) 1 Year
.11 V	.003 V	500 Hz	.0023 to .0037	.0021 to .0038
	.01 V	45 Hz, 2 kHz	.0091 to .0108	.0090 to .0109
	.1 V	45 Hz, 2 kHz	.0978 to .1022	.0975 to .1025
	.01 V	5 kHz	.0088 to .0112	.0087 to .0113
	.1 V	5 kHz	.0943 to .1057	.0940 to .1060
	.01 V	10 kHz	.0071 to .0129	.0069 to .0130
	.09 V	10 kHz	.0727 to .1073	.0724 to .1076
1.1 V	1 V	45 Hz, 2 kHz	.980 to 1.019	.977 to 1.023
	1 V	5 kHz	.963 to 1.037	.960 to 1.040
	1 V	10 kHz	.909 to 1.091	.905 to 1.094
11 V	10 V	45 Hz, 2 kHz	9.80 to 10.19	9.77 to 10.23
	10 V	5 kHz	9.63 to 10.37	9.60 to 10.40
	10 V	10 kHz	9.09 to 10.91	9.05 to 10.94
110 V	100 V	45 Hz, 2 kHz	98.0 to 101.9	97.7 to 102.3
	100 V	5 kHz	96.3 to 103.7	96.0 to 104.0
	100 V	10 kHz	90.9 to 109.1	90.5 to 109.4
1100 V	700 V	45 Hz, 2 kHz	685 to 715	682 to 717
	700 V	5 kHz	672 to 728	669 to 730
	700 V	10 kHz	633 to 767	630 to 770

5-14. AC Ammeter Accuracy Test.

a. Connect the equipment as shown in Figure 5-3.

b. Set the AC Ammeter to the 1000 mA range.

c. Set the Multimeter FUNCTION to AC A. Adjust the Meter Calibrator output for an indication of 900 mA on the AC Ammeter. The Multimeter should indicate within the limits listed in Table 5-6.

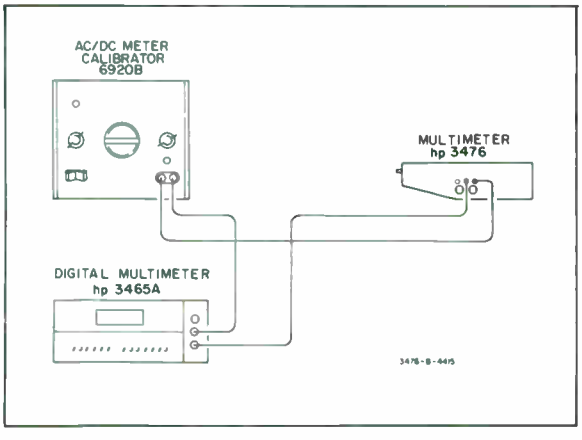


Figure 5-3. AC Ammeter Accuracy Test.

Table 5-6. AC Ammeter Accuracy Test.

Range	Current	90 Day Calibration Limit	1 Year Calibration Limit
1.1 A	900 mA	.878 thru .922	.875 thru .925

5-15. AC Common-Mode Rejection Test.

5-16. An AC Calibrator and a 1 kilohm ± 1% resistor are required for this test.

a. Connect a 1 kilohm resistor between the V/Ω and COM Multimeter terminals.

b. Set the Multimeter FUNCTION to AC V.

c. Connect the AC Calibrator HI output terminal to the Multimeter as shown in Figure 5-4.

d. Set the AC Calibrator frequency to the ac line frequency being used.

e. Set the AC Calibrator output to 100 V rms.

f. The Multimeter should indicate ⩽ 10 mV rms.

5-17. DC Common-Mode Rejection Test.

5-18. An AC Calibrator, an electronic counter, and a 1 kilohm ± 1% resistor are required for this test.

a. Connect a 1 kilohm resistor between the V/Ω and COM Multimeter terminals.

b. Set the Multimeter FUNCTION to DC V.

c. Connect the AC Calibrator HI output terminal to the Multimeter as shown in Figure 5-4.

d. Set the AC Calibrator frequency to the ac line frequency being used (50 Hz or 60 Hz ± .1%).

e. Set the AC Calibrator output to 100 V rms.

f. The Multimeter should indicate ⩽ 1.5 mV peak.

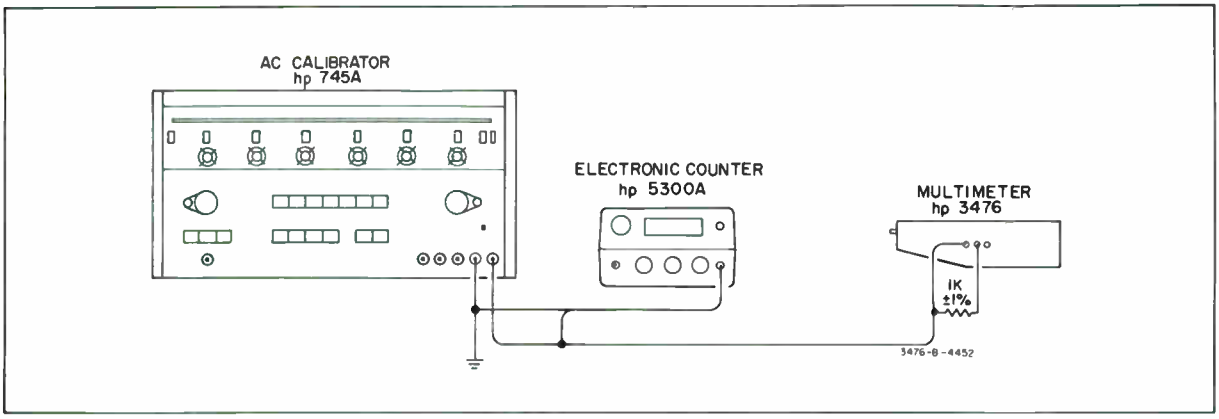


Figure 5-4. Common-Mode Rejection Test.

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

CAUTION

Wear clean cotton gloves when working on the main assembly circuit board or switches. Contamination or fingerprints on high impedance points on the main assembly will degrade the performance of the instrument. Nylon gloves should not be worn due to the possibility of static charge buildup.

CAUTION

The hybrid circuits in the 3476A may be permanently damaged by static discharge from a hand or tool when the 3476A is disassembled. The procedures below must be followed to prevent possible damage.

1. Ground the hand while disassembling and working on the 3476A. Conductive wristbands (-hp- Part No. 00970-67900) are available for this purpose.

2. Attach the 3476A com terminal to earth ground. Touch all tools to earth ground to remove static charges before using them on the 3476A.

3. Use a soldering iron with a grounded tip.

PRE-AOJUSTMENT PROCEOURES.

A. Oisassembly Instructions.

1. Remove the Multimeter Power Cord.

2. With the Multimeter in the inverted position, remove the two screws in the bottom cover.

3. Remove the bottom cover.

4. Remove the internal shield.

5. Remove the Input panel and Input fuses.

6. Connect a jumper across the Amps input protection fuse holder and across the Ohms input protection fuse holder.

B. Turn-On Instructions.

1. Connect the Multimeter TP ⏚ to earth ground.

2. An external 20 V dc power supply can be used to provide instrument power. Connect the power supply across C15 (500 microfarad 50 V dc electrolytic). Connect positive power supply lead to the (+) end of C15 and the negative power supply lead to the other end.

3. If external power supply is not available, use the ac power cord and the appropriate ac line voltage as specified by the option decal attached to the instrument.

5-19. ADJUSTMENT PROCEDURE.

5-20. Refer to Figure 5-5 for the following adjustments.

NOTE

The resistors used in the adjustment procedure must be floating.

5-21. Power Supply Adjustment.

a. Connect a 1 kilohm resistor to the V/Ω and COM terminals. Set the FUNCTION to kΩ and ensure that the HOLD pushbutton is out.

b. Connect a DC Digital Voltmeter between + 6 V test point and ground.

c. Adjust R47 for 5.94 to 6.06 V dc on the Digital Voltmeter.

Δ1 d. If it is not possible to adjust within this limit, change the adjustment range of R47 by replacing or removing JMPR 7. Removing JMPR 7 will allow a more positive adjustment of TP + 6.

5-22. Substrate Adjustment.

a. A 1 kilohm resistor should still be connected between the V/Ω and COM terminals. Connect a jumper between the + 1 test point and TP G.

b. Ensure that the Multimeter downranges to the 1.1 kΩ range and adjust R42 for an indication between .078 and .082 on the display. If these limits cannot be obtained, an indication of 000 to 078 is acceptable if R42 is fully counterclockwise.

5-23. Input Amplifier Zero Adjustment.

5-24. The following adjustment requires that the Multimeter be set to a DC V function, 110 V range with no input applied. Since the Multimeter is autoranging, it is necessary to force it to the 110 V range and then use the HOLD function to keep it there.

a. Remove the jumper connected between + 1 and TP G in the previous step.

b. Set the function to kΩ and connect a 300 kilohm resistor between the Ω/V and COM terminals. When the Multimeter autoranges to the 1.1 megohm range, push the HOLD pushbutton in. This is equivalent to the 110 V range.

c. Change the Multimeter FUNCTION to DC V. Remove the 300 kilohm resistor from the input and replace it with a short.

d. Connect a jumper between U1 pin 12 and analog ground (TP ⏚).

e. Connect a DC Digital Voltmeter to Test Point A. Adjust R38 for an indication between - 1 and + 1 mV dc on the Digital Voltmeter.

NOTE

The following adjustment requires the same test setup. Do not change the setup or FUNCTION settings.

5-25. Integrator Amplifier Zero Adjustment.

5-26. This test requires the same test setup and functions as the previous adjustment.

a. Adjust R10 for a display equal to - 1000 times the value at Test Point A in the previous adjustment, ± 1 count.

Example:

Voltage at A = .2 mV
.2 mV x(- 1000) = - 00.2 V Display

Δ1 b. If R10 does not have sufficient range for this adjustment, remove JMPR 6 and repeat Step a. If JMPR 6 has already been removed, it may be necessary to replace it.

NOTE

If JMPR 6 is open, a more positive voltage can be obtained at TPA by adjusting the Integrator Offset Adj. (R10).

5-27. + DC Volt Gain Adjustment.

a. Remove the DC Digital Voltmeter and jumper between U1 pin 12 and analog ground. Release the HOLD function, and remove the short from the input.

b. Set the Multimeter FUNCTION to DC V. Apply an input of + 1.000 V dc. The Multimeter should autorange to the 1.1 V range for this adjustment.

Δ1 c. Adjust R47 for a display of 1.000. If R47 does not have sufficient range, change the adjustment range of R47 by replacing or removing JMPR 7. Removing JMPR 7 will allow a more positive adjustment of TP + 6.

5-28. – DC Volt Gain Adjustment.

a. Leave the Multimeter FUNCTION set to the DC V and HOLD function out. Change the input from + 1.000 to - 1.000.

b. Adjust R14 for a Multimeter display of - 1.000 V dc.

NOTE

Leave the - 1.00 volt source connected for the following adjustment.

5-29. Clock Frequency Adjustment.

a. Set the Multimeter FUNCTION to DC V, HOLD Function out and - 1.000 volts connected to the input.

b. Connect an electronic counter to test point D. If the Multimeter is to be operated from a 60 Hz line frequency, adjust R43 for an indication of 954 Hz on the counter. For 50 Hz line operation, adjust R43 for 795 Hz.

5-30. Ohms Adjustment.

a. Connect a jumper wire across the fuse that protects the V/Ω terminal (F2).

b. Set the Multimeter FUNCTION to kΩ and connect a 1 megohm ± 0.1% resistor to the input.

c. Adjust R15 for a display of 999 to 1001.

d. Change the input resistor to 10 kilohm, ± 0.1%.

e. Adjust R16 for a display of 10.03 to 10.04.

f. Remove the jumper from the fuse.

NOTE

The resistance of the fuse is a part of the instrument calibration. This is why the display is adjusted high in Step e, with the fuse shorted.

5-31. AC Converter Gain and Zero Adjustment.

a. Disconnect the previous setup and set the Multimeter FUNCTION to ACV.

NOTE

To go to the 1.1 V range and HOLD, set the Multimeter FUNCTION to V AC, and apply 0.3 V to the input. When on the 1.1 V range, push the HOLD pushbutton in.

b. Apply a 1.0 V ac signal at 100 Hz to the input.

c. Adjust R48 for a display between .995 and .997.

d. Change the input level to 0.100 V ac at 100 Hz. Adjust R9 for a display between .099 and .100.

e. Change the input back to 1.00 V ac at 100 Hz. Adjust R48 for a display between .995 and .997.

f. Change the input back to 0.100 V ac at 100 Hz. Adjust R9 for a display between .099 and .100.

5-32. AC High Frequency Adjustment (.11 V range).

a. Set the Multimeter FUNCTION to AC V.

b. Apply a 0.1 V ac signal at 5 kHz to the input. Release the HOLD function and allow the Multimeter to autorange to the .1 V range.

c. Adjust C4 for a display between .1000 and .1010.

5-33. Changing the Power Line Options.

5-34. The Multimeter is capable of operating at any of the line voltages and frequencies listed in Table 1-3, depending upon how the instrument is wired internally. The instrument contains a label identifying the line voltage and frequency for which it is wired. If the instrument is to be operated at a line voltage and frequency other than the one for which it is wired, it is necessary to change the position of jumper wires in the power transformer primary circuit. The clock frequency will have to be readjusted if a different line frequency is used.

NOTE

If the jumper wires are changed, be sure to attach a new label to the instrument, identifying the new configuration.

5-35. Figure 7-2 shows the position of all jumper wires for each line voltage. The component locator drawing of the assembly identifies the position of each numbered jumper.

WARNING

Before changing the power supply jumpers disconnect ac power from the instrument. Power supply jumpers should be changed by qualified service personnel only.

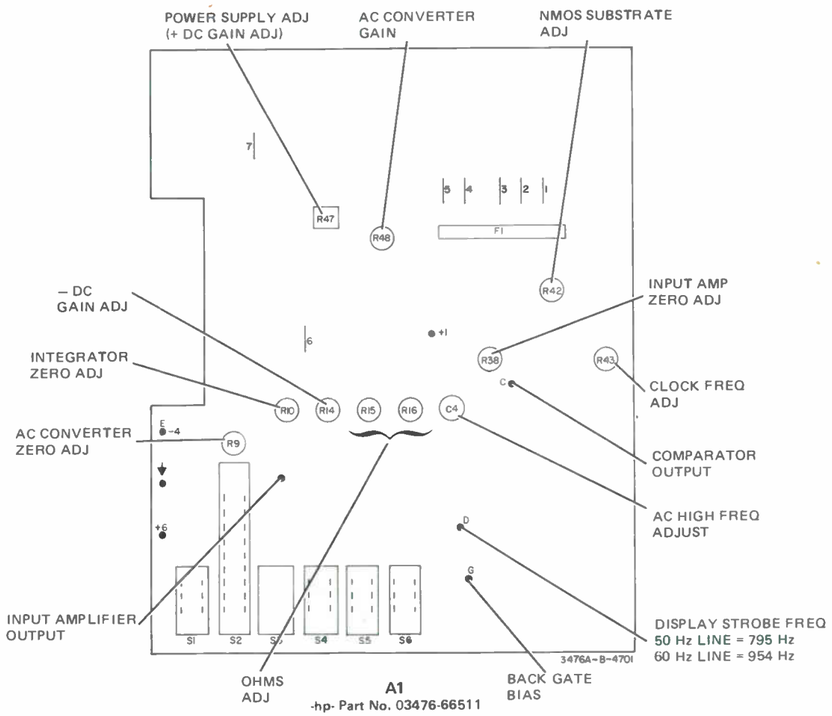


Figure 5-5. Adjustment Locator.

Hewlett-Packard Model 3476A

Multimeter

Serial No. _____

Tests Performed By: _____

Date _____

PERFORMANCE TEST CARD

Paragraph Number	Test		Test Limit		Test Result
			90 Day Calibration Cycle	1 Year Calibration Cycle	
5-6	DC Voltmeter Accuracy				
	.11 V Range				
	- .010 V		- .0097 to - .0103	- .0097 to - .0103	
	- .100 V		- .0995 to - .1005	- .0994 to - .1006	
	+ .100 V		+ .0995 to + .1005	+ .0994 to + .1006	
	1.1 V Range				
	+ 1.0 V		+ .996 to + 1.004	+ .994 to + 1.006	
	11 V Range				
	- 10 V		- 9.96 to - 10.04	- 9.94 to - 10.06	
	+ 10 V		+ 9.96 to + 10.04	+ 9.94 to + 10.06	
	110 V Range				
	- 100 V		- 99.5 to - 100.5	- 99.3 to - 100.7	
	1100 V Range				
	+ 1000 V		+ 995.0 to + 1005.0	+ 993 to + 1007.0	
5-8	DC Ammeter Accuracy				
	900 mA		.891 to .909	.889 thru .911	
5-10	Ohms Accuracy				
	1.1 kΩ Range				
	.1 kΩ		.0980 to .102	.098 thru .102	
	1.0 kΩ		.994 to 1.006	.992 thru 1.008	
	11 kΩ Range				
	10 kΩ		9.94 to 10.06	9.92 thru 10.08	
	110 kΩ Range				
	100 kΩ		99.6 to 100.4	99.4 thru 100.6	
	1100 kΩ Range				
	1000 kΩ		996 to 1004	994 thru 1006	
	11,000 kΩ Range				
	10,000 kΩ		9940 to 10,060	9920 thru 10,080	
5-12	AC Voltmeter Accuracy				
	.11 V Range				
	.003 V	500 Hz	.0023 to .0037	.0021 to .0038	
	.01 V	45 Hz, 2 kHz	.0091 to .0108	.0090 to .0109	
	.1 V	45 Hz, 2 kHz	.0978 to .1022	.0975 to .1025	
	.01 V	5 kHz	.0088 to .0112	.0087 to .0113	
	.1 V	5 kHz	.0943 to .1057	.0040 to .1060	
	.01 V	10 kHz	.0071 to .0129	.0069 to .0130	
	.09 V	10 kHz	.0727 to .1073	.0724 to .1076	
	1.1 V Range				
	1 V	45 Hz, 2 kHz	.980 to 1.019	.977 to 1.023	
	1 V	5 kHz	.963 to 1.037	.960 to 1.040	
	1 V	10 kHz	.909 to 1.091	.905 to 1.094	
	11 V Range				
	10 V	45 Hz, 2 kHz	9.80 to 10.19	9.77 to 10.23	
	10 V	5 kHz	9.63 to 10.37	9.60 to 10.40	
	10 V	10 kHz	9.09 to 10.91	9.05 to 10.94	
	110 V Range				
	100 V	45 Hz, 2 kHz	98.0 to 101.9	97.7 to 102.3	
	100 V	5 kHz	96.3 to 103.7	96.0 to 104.0	
	100 V	10 kHz	90.9 to 109.1	90.5 to 109.4	
	1100 V Range				
	700 V	45 Hz, 2 kHz	685 to 715	682 to 717	
	700 V	5 kHz	672 to 228	669 to 730	
	700 V	10 kHz	633 to 767	630 to 770	

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations in Table 6-1.)

c. Typical manufacturer of the part is a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed in Table 6-3 following their respective assemblies. General miscellaneous parts are listed at the conclusion of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix A for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. 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.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; i.e., Δ, Δ with a letter subscript, e.g., Δ_a, or Δ with a number subscript, e.g., Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section VIII). The number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

6-11. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

Table 6-1. Standard Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPD	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPDT	single-pole double-throw
A	ampere(s)	impg	impregnated	nsr	not separately replaceable	SPST	single-pole single-throw
Au	gold	incd	incandescent	Ω	ohm(s)	Ta	tantalum
C	capacitor	ins	insulation(ed)	obd	order by description	TC	temperature coefficient
cer	ceramic	kΩ	kilohm(s) = 10^{+3} ohms	OD	outside diameter	TiO_2	titanium dioxide
coef	coefficient	kHz	kilohertz = 10^{+3} hertz	p	peak	tog	toggle
com	common	L	inductor	pA	picoampere(s)	tol	tolerance
comp	composition	lin	linear taper	pc	printed circuit	trim	trimmer
conn	connection	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	TSTR	transistor
dep	deposited	mA	milliampere(s) = 10^{-3} amperes	piv	peak inverse voltage	V	volt(s)
DPDT	double-pole double-throw	MHz	megahertz = 10^{+6} hertz	p/o	part of	vacw	alternating current working voltage
DPST	double-pole single-throw	MΩ	megohm(s) = 10^{+6} ohms	pos	position(s)	var	variable
elect	electrolytic	met flm	metal film	poly	polystyrene	vdcw	direct current working voltage
encap	encapsulated	mfr	manufacturer	pot	potentiometer	W	watt(s)
F	farad(s)	ms	millisecond	p-p	peak-to-peak	w/	with
FET	field effect transistor	mtg	mounting	ppm	parts per million	wiv	working inverse voltage
fxd	fixed	mV	millivolt(s) = 10^{-3} volts	prec	precision (temperature coeffient, long term stability and/or tolerance)	w/o	without
GaAs	gallium arsenide	μF	microfarad(s)	R	resistor	ww	wirewound
GHz	gigahertz = 10^{+9} hertz	μs	microsecond(s)	Rh	rhodium		
gd	guard(ed)	μV	microvolt(s) = 10^{-6} volts	rms	root-mean-square	*	optimum value selected at factory, average value shown (part may be omitted)
Ge	germanium	my	Mylar®	rot	rotary	**	no standard type number assigned selected or special type
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes	Se	selenium		
H	henry(ies)	NC	normally closed	sect	section(s)	®	Dupont de Nemours
Hg	mercury	Ne	neon	Si	silicon		
		NO	normally open				

DESIGNATORS

A	assembly	FL	filter	Q	transistor
B	motor	HR	heater	QCR	transistor-diode
BT	battery	IC	integrated circuit	R	resistor
C	capacitor	J	jack	RT	thermistor
CR	diode	K	relay	S	switch
DL	delay line	L	inductor	T	transformer
DS	lamp	M	meter	TB	terminal board
E	misc electronic part	MP	mechanical part	TC	thermocouple
F	fuse	P	plug	TP	test point
				TS	terminal strip
				U	microcircuit
				V	vacuum tube, neon bulb, photocell, etc.
				W	cable
				X	socket
				XDS	lampholder
				XF	fuseholder
				Y	crystal
				Z	network

Table 6-2. Code List of Manufacturers.

Mfr No.	Description	Address	Zip Code
01121	Allen—Bradley Co	Milwaukee, WI	53212
03888	Pyrofilm Corp	Whippany, NJ	07981
04713	Motorola Semiconductor Products	Phoenix, AZ	85008
07088	Kelvin Electric Co	Van Nuys, CA	91401
07263	Fairchild Semiconductor Div	Mountain View, CA	94040
07716	TRW Inc Burlington Div	Burlington, IA	52601
16299	Corning Gl Wk Elec Cmpnt Div	Raleight, NC	27604
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
27014	National Semiconductor Corp	Santa Clara, CA	95051
28480	Hewlett—Packard Co Corporate HQ	Palo Alto, CA	94304
56289	Sprague Electric Co	North Adams, MA	01247
71400	Bussman Mfg Div of McGraw—Edison Co	St. Louis, MO	63017
72136	Electro Motive Mfg Co Inc	Willimantic, CT	06226
74970	Johnson E F Co	Waseca, MN	56093
75915	Littelfuse Inc	Des Plaines, IL	60016

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1 Δ1	03476-66511	1	P.C ASSEMBLY, MAIN BOARD	28480	03476-66511
	03476-69511	1	REBUILT EXCHANGE PC ASSEMBLY	28480	03476-69511
A1C1	0160-3731	1	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	28480	0160-3731
A1C2	0180-0106	2	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A1C3 Δ1	0160-3847	4	CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-3847
A1C4	0121-0452	1	CAPACITOR-V TRMR-AIR 1.3/5.4PF 250V	74970	187-0103-005
A1C5	0180-0291	1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A1C6	0180-0228	2	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X901582
A1C7	0140-0200	1	CAPACITOR-FXD 390PF +-5% 300WVDC MICA	72136	DM15F391J0300WV1CR
A1C8	0160-0577	1	CAPACITOR-FXD 1.8UF +-20% 50WVDC MET	28480	0160-0577
A1C9	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X901582
A1C10 Δ1	0160-3847		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-3847
A1C11	0160-2150	1	CAPACITOR-FXD 33PF +-5% 300WVDC MICA	28480	0160-2150
A1C12	0180-1701	1	CAPACITOR-FXD 6.8UF+-20% 6VDC TA	56289	150D685X0006A2
A1C13	0180-0106		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A1C14	0160-2204	1	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C15	0180-2644	1	CAPACITOR-FXD 470UF+75-10% 10VDC AL	56289	500D447H050FK7
A1C16	0150-0071		CAPACITOR-FXD 400PF +-5% 1000WVDC CER	28480	0150-0071
A1C17, C18 Δ1	0160-3847		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-3847
A1C19	0180-0309		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A1C20	0160-0153		CAPACITOR-FXD 1000PF +/-10% 200WVDC	56289	292P10292
A1C22	0160-3847		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-3847
A1CR1	1902-3054	2	DIODE-ZNR 3.65V 5% DO-7 PD=.4W TC=-.055%	04713	SZ 10939-56
A1CR2	1901-0025	3	DIODE-GEN PRP 100V 200NA DO-7	28480	1901-0025
A1CR3	1901-0025		DIODE-GEN PRP 100V 200NA DO-7	28480	1901-0025
A1CR4	1901-0025		DIODE-GEN PRP 100V 200NA DO-7	28480	1901-0025
A1CR5	1901-0376	2	DIODE-GEN PRP 35V 50NA DO-7	28480	1901-0376
A1CR6	1901-0376		DIODE-GEN PRP 35V 50NA DO-7	28480	1901-0376
A1CR7	1902-3054		DIODE-ZNR 3.65V 5% DO-7 PD=.4W TC=-.055%	04713	SZ 10939-56
A1CR8			NOT ASSIGNED		
A1CR9	1901-0040	3	DIODE-SWITCHING 30V 50NA 2NS DO-35	28480	1901-0040
A1CR10	1901-0040		DIODE-SWITCHING 30V 50NA 2NS DO-35	28480	1901-0040
A1CR11	1901-0040		DIODE-SWITCHING 30V 50NA 2NS DO-35	28480	1901-0040
A1CR12	1902-0041	1	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A1CR13	1902-0025	1	DIODE-ZNR 10V 5% DO-7 PD=.4W TC=+.06%	04713	SZ 10939-182
A1CR14	1906-0069	1	DIODE-FW BRDG 400V 1A	28480	1906-0069
A1DSP1	03476-69502	1	LED DISPLAY WITH 15 PIN PLUG CONNECTOR	28480	03476-69502
A1F1	2110-0311	1	FUSE .063A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.062S
F2	2110-0420	1	FUSE .032A 250V 1.25X.25 UL	75915	312.D31
F3	2110-0043	1	FUSE 1.5A 250V 1.25X.25 UL IEC	71400	AGC 1-1/2
A1Q1	1853-0020	2	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q2	1854-0071	14	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q7	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q9	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q10	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q11	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q14	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q15	1855-0308	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0308
A1Q16			NOT ASSIGNED		
A1Q17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q18	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q19	1853-0394	1	TRANSISTOR PNP SI PD=40W FT=3MHZ	28480	1853-0394
A1R1	0698-7512	1	RESISTOR 10M 1% 2W F TC=0+-100	07716	CCF-993-N330
A1R2	0698-8748	1	RESISTOR 1K 5% 2W MO TC=0+-200	27167	FP42
A1R3	0683-2055	1	RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A1R4	0757-0440	1	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A1R5	0683-2225	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A1R6	0687-3301	1	RESISTOR 33 10% .5W CC TC=0+412	01121	EB3301
A1R7	1810-0244	1	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0244
A1R8	0683-1045	2	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A1R9	2100-3522	2	RESISTOR, VAR 100K OHM 20%	28480	2100-3522
A1R10	2100-3524	2	RESISTOR, VAR 50K OHM 20%	28480	2100-3524
A1R12	0683-2265	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A1R13	0689-1055	1	RESISTOR 1M 5% 1W CC TC=0+1000	01121	GB1055
A1R14	2100-3528	1	RESISTOR, VAR 100 OHM 20%	28480	2100-3528
A1R15	2100-3524		RESISTOR, VAR 50K OHM 20%	28480	2100-3524
A1R16	2100-3529	1	RESISTOR, VAR 1K OHM 20%	28480	2100-3529

See introduction to this section for ordering information

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R17	0683-1065	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A1R18	0683-1035	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R19	0698-4512	1	RESISTOR 88.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8872-F
A1R20	0698-4532	1	RESISTOR 280K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2803-F
A1R22	0698-4539	1	RESISTOR 402K 1% .125W F TC=0+-100	03888	PME55S
A1R23	0698-4453	2	RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A1R24	0757-0472	1	RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A1R25	0698-4479	1	RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A1R26	0757-0283	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A1R27	0757-0442	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R28	0698-4453		RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A1R29	0698-4424	1	RESISTOR 1.4K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1401-F
A1R30 Δ1					
A1R31 Δ1	0683-1025	1	RESISTOR 1K 5% .25W	01121	CB1025
A1R32 Δ1					
A1R34	0698-4474	1	RESISTOR 8.45K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8451-F
A1R35	0757-0465	1	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A1R36	0757-0453	2	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A1R37	0757-0453		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A1R38	2100-3527	1	RESISTOR, VAR 5K OHM 20%	28480	2100-3527
A1R39	0683-4745	1	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A1R40	0698-3557	1	RESISTOR 806 1% .125W F TC=0+-100	16299	C4-1/8-T0-806R-F
A1R41	0698-3262	1	RESISTOR 40.2 1% .125W F TC=0+-100	16299	C4-1/8-T0-4022-F
A1R42	2100-3526	1	RESISTOR, VAR 20K OHM 20%	28480	2100-3526
A1R43	2100-3522		RESISTOR, VAR 100K OHM 20%	28480	2100-3522
A1R44	0683-1005	1	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A1R45	0811-3420	1	RESISTOR 1 .5% 7W PW TC=0+-50	07088	KM-700
A1R46	0698-4020	1	RESISTOR 9.53K 1% .125W F TC=0+-100	16299	C4-1/8-T0-9531-F
A1R47 Δ1	2100-0558	1	RESISTOR, VAR 2.0K OHM 10% C TOP ADJ	28480	2100 0558
A1R48	2100-3525	1	RESISTOR, VAR 200 OHM 20%	28480	2100-3525
A1R49	0698-3450	1	RESISTOR 42.2K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4222-F
A1R50 Δ1	0698-4435		RESISTOR 2K 1% .125W F TC=0+-100	16299	C4-1/8-T0-2491-F F
A1R51	0683-1035	2	RESISTOR 10K 5% .25W	01121	CB1035
A1R52	0683-0365	1	RESISTOR 3.6 5% .25W FC TC=-400/+500	01121	CB36G5
A1R53	0698-4436	1	RESISTOR 2.8K 1% .125W F TC=0+-100	16299	C4-1/8-T0-2801-F
A1R54	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A1R55	0757-0454		RESISTOR 33.2K 1% .125W	24546	C4-1/8-T0-3322-F
A1R117	0757-0283		RESISTOR 2K 1% .125W	24546	C4-1/8-T0-3001-F
A1R118	0698-3161		RESISTOR 38.3K 1% .125W	16299	C4-1/8-T0-3832-F
A1R119	0698-5578		RESISTOR 4K .5% .125W	24546	C4-1/8-T0-4001-D
A1R132	0757-0281		RESISTOR 2.74K 1% .125W	24546	C4-1/8-T0-2741-F
A1R149	0698-3499		RESISTOR 40.2K 1% .125W	16299	C4-1/8-T0-4022-J
A1R153	0698-4439		RESISTOR 3.24K 1% .125W	16299	C4-1/8-T0-3241-F
A1S1 – A1S6	03476-61901	1	SWITCH, PUSHBUTTON	28480	03476-61901
A1T1	9100-3493	1	TRANSFORMER, POWER	28480	9100-3493
A1U1	1813-0068	1	HYBRID (NOT FIELD REPLACEABLE FOR REPAIR USE REBUILT PC ASSY PART NO. 03476-69501)	28480	1813-0068
A1U2, U3	1826-0139		IC MC 1458 OP AMP	04713	MC1458P1
A1U4	1820-0223	1	IC LM 301A OP AMP	27014	LM301AH
A1U5	1826-0317	1	IC, LINEAR	28480	1826-0317
A1U6	1820-0196	1	IC UA 723C V RGLTR	07263	723HC
			A1 MECHANICAL PARTS		
	0340-0060	6	INSULATOR FEDTHRU (LARGE)	98291	FT-E-15
	0340-0092	8	INSULATOR FEEDTHRU (SMALL)	98291	FT-E-12(011-6808)
	1251-4261	1	SOCKET-15 PIN DISPLAY	28480	1251-4261
	1205-0311 Δ1	1	HEAT SINK - O19	28480	1205-0311
	1460-1467	1	SPRING CONTACT-TOP SHIELD	28480	1460-1467
	1460-1469	2	CONTACT SPRING-INPUT	28480	1460-1469
	5040-8013	1	AC POWER RECP	28480	5040-8013
	0370-2913	4	PUSHBUTTON-PLAIN	28480	0370-2913
	0370-2914	2	PUSHBUTTON-MARKED	28480	0370-2914
	2110-0269	2	FUSE CLIP	91506	6008-32CN
			MISCELLANEOUS MECHANICAL PARTS		
	1460-1470	1	BAIL-WIRE	28480	1460-1470
	7120-5107	1	LABEL-POWER INPUT STD	28480	7120-5107
	7120-5108	1	LABEL-POWER INPUT OPTION 001	28480	7120-5108
	7120-5109	1	LABEL-POWER INPUT OPTION 002	28480	7120-5109
	7120-5110	1	LABEL-POWER INPUT OPTION 003	28480	7120-5110
	7120-5111	1	LABEL-POWER INPUT OPTION 004	28480	7120-5111
	7120-5112	1	PLATE-IDENTIFICATION	28480	7120-5112
	2420-0022	2	NUT-ONSERT	28480	2420-0022
	2360-0131	2	SCREW, 6-32 X 1 1/8 PAN	28480	2360-0131
	3050-0066	2	FLAT WASHER	28480	3050-0066
	2190-0918	2	LOCKWASHER, HELICAL	28480	2190-0918
	03476-24701	2	SPACER	28480	03476-24701
	1460-1486	3	SPRING, FUSE CONTACT	28480	1460-1486
	1600-0530	1	SHIELD, UPPER (FOIL)	28480	1600-0530
	03476-00602	1	SHIELD, LOWER (ALUM)	28480	03478-00602
	03476-40201	1	PANEL, FUSE ACCESS	28480	03476-40201
	4114-0649	1	LENS, DISPLAY	28480	4114-0649
	5040-8957	2	FOOT	28480	5040-8957
	8120-1521	1	POWER CORD	28480	8120-1521
	03476-90001		OPERATING AND SERVICE MANUAL	28480	03476-90001
	5040-8069	1	UPPER SHELL	28480	5040-8069
	5040-8070	1	LOWER SHELL	28480	5040-8070
	5040-8038	2	BAIL PLUG	28480	5040-8038
	0624-0333	2	SCREW, 4-20 X 1/4 PAN (PC BOARD RETAINING HARDWARE)	28480	0624-0333
	0624-0289	2	SCREW, 2-28 X 5/16 PAN (PC BOARD RETAINING HARDWARE)	28480	0624-0289

SECTION VII
TROUBLESHOOTING AND CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains preliminary troubleshooting information, printed circuit assembly exchange information, schematic notes and reference designators, and schematic diagrams of the Multimeter and Power Supply circuitry.

WARNING

These servicing instructions are for use by qualified service personnel only. To avoid electrical shock or damage to the instrument, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

7-3. PRELIMINARY TROUBLESHOOTING.

CAUTION

The hybrid circuits in the Multimeter may be permanently damaged by static discharge from a hand or tool when the Multimeter is disassembled. The procedures below must be followed to prevent possible damage.

1. Ground the hand while disassembling and working on the Multimeter. Conductive wristbands (-hp- Part No. 00970-67900) are available for this purpose.

2. Attach the Multimeter COM terminal to earth ground. Touch all tools to earth ground to remove static charges before using them on the Multimeter.

3. Use a soldering iron with a grounded tip.

CAUTION

Wear clean cotton gloves when working on the circuit board. Contamination or fingerprints will reduce the accuracy of the Multimeter. Use low flux content solder (-hp- Part No. 8090-0512) when replacing componenets. Do not permit traces of flux to form on the circuit board. Observe precautions against static discharge. Do not use flux remover.

7-4. Check to ensure the Multimeter is properly powered as indicated by the decal on the side of the instrument.

7-5. If the display illuminates and indicates near zero regardless of the input applied check the appropriate Multimeter input protection fuse.

Volts/Ohms input protection fuse:
1/32 A (250 V) -hp- P/N 2110-0420
Littlefuse P/N 312.031

Amps input protection fuse:
1½ A (250 V) -hp- P/N 2110-0043
Bussman AGC 1 - ½
Littlefuse 312.01.5

7-6. If input fuses are not at fault, proceed to disassemble the Multimeter as follows:

a. Disconnect the power cord.

b. Remove the input protection fuses located behind the sliding input panel.

c. Place the Multimeter upside down on a grounded work surface and remove the two screws from the bottom cover.

d. Remove the bottom cover.

e. Connect a jumper across the amps input protection fuse holder and across the ohms input protection fuse holder.

CAUTION

If it is necessary to handle the printed circuit assembly, hold it by the power transformer and the front panel switch pushbuttons to avoid contamination of the assembly.

WARNING

Disconnect the AC line cord before checking or replacing the AC line fuse.

7-7. If the instrument display did not illuminate, check the ac line fuse.

ac line fuse:
1/16 A (250 V) -hp- Part No. 2110-0311
Littlefuse 313.062
Bussman MDL 1/16

7-8. Connect the 3476A TP ⏚ to earth ground.

7-9. Connect the appropriate ac line voltage as specified by the option decal attached to the instrument.

WARNING

To avoid electrical shock, do not touch the ac line fuse or the line voltage jumpers when the instrument is plugged into ac power.

7-10. Power Supply Troubleshooting.

7-11. Measure the dc power supply voltages referenced to the analog ground test point (TP ⏚). The dc voltmeter indication at TP + 6 should be within the limits of 5.88 to 6.12 V dc. The dc voltmeter indication at TP - 4 should be within the limits of 3.92 to 4.08 V dc. If these voltages are correct, no further power supply checks are necessary.

7-12. If the TP + 6 and TP - 4 voltages are not correct, check the dc voltage at the positive terminal of C15. This voltage should be within the limits of + 15 to + 25 V dc relative to TP ⏚ with less than 2 volts peak-to-peak ripple.

7-13. Verify that the power supply is not in a current limit condition by checking the voltage drop across R52. This voltage should be less than 0.36 V dc.

7-14. Display Troubleshooting.

7-15. Most problems with the display section can be isolated by front panel observations. Note the display failure symptoms prior to troubleshooting this section of the instrument. Display malfunctions can be caused by circuit failures in four main areas. These are:

a. The power supply.
b. The light-emitting diode display (DS1).
c. The associated display drive transistors (Q1–Q14).
d. The logic in the hybrid (U1).

7-16. Power Supply Verification. The power supply tests in Paragraph 7-10 should be performed to verify that the power supplies are functioning properly. Malfunctions in the power supply can result in improper bias of Q1 – Q14 resulting in a defective display.

7-17. Display Verification. A quick check will determine if any segments of the LED display (DS1) are defective. The following procedure should be used:

a. Momentarily connect the emitter of Q2 through Q6 to the - 4 V test point.

b. Verify that the display is completely illuminated as illustrated in Figure 7-1.

c. If this display is realized, the display is working properly. When the display does not indicate properly, proceed with the next paragraph.

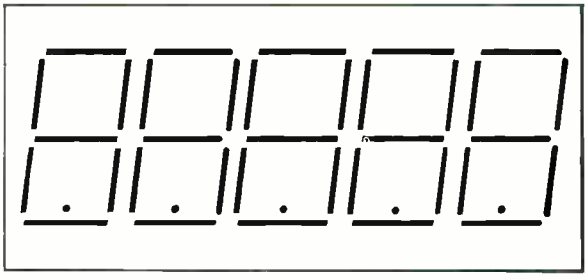


Figure 7-1. Display Verification.

7-18. Display Driver Verification and Troubleshooting. The display drivers are divided into two groups: the digit drivers Q2 – Q6 and the segment drivers Q7 – Q14. Therefore, the first step in troubleshooting the display drivers is to determine if the problem is segment related or digit related. During normal operation if the same segment in all five sections is either "ON" or "OFF" continuously, the associated segment driver and logic should be checked. If one entire digit is either "ON" or "OFF" continuously, the associated digit driver and logic should be checked. A shorted Q1 will cause the entire display to turn "ON".

7-19. Display Logic Problems. The digital information that controls the display is provided by NMOS Hybrid U1 which is not field replaceable. If the Multimeter failure appears to be traceable to U1, refer to Paragraph 7-22 for A1 PC assembly replacement instructions.

7-20. SCHEMATIC DIAGRAMS.

7-21. Figures 7-2 and 7-3 are schematic diagrams of the Multimeter and its power supply.

7-22. PRINTED CIRCUIT ASSEMBLY EXCHANGE.

7-23. To provide maximum instrument performance for minimum cost, the Multimeter is designed around an NMOS Hybrid Integrated Circuit (U1). This Hybrid and its associated discrete electronic circuitry are repairable only at the Hewlett-Packard Manufacturing Division using special equipment. An exchange program has been established to permit field repair of the Multimeter by replacing the entire A1 printed circuit assembly with a factory rebuilt assembly (-hp- Part No. 03476-69510). This assembly is warranted to be fully operational and meet all instrument specifications. For ordering details, contact the Hewlett-Packard Sales and Service Office nearest you.

7-24. Printed Circuit Board Removal.

7-25. Remove the A1 printed circuit board assembly using the following procedure:

a. Disconnect power cord, remove input fuses and bottom shell. Leave the aluminum bottom shield fastened to the PC board.

b. Disconnect positive and negative battery terminals.

c. Remove heat sink from Q100.

d. Remove two polycarbonate spacers.

e. Remove 4 PC board mounting screws – one on each side of the switch assembly and the other two in each corner at the back of the PC board.

f. Pull J4 and J5 free from the top shell.

g. Using transformer T101 as a handle, lift the PC assembly out of the top shell back first until it is above the onsert nuts. The A1 Assembly will now slide back and clear of the top shell.

CAUTION

Handle the PC assembly by the transformer (T101) and the pushbutton switches.

CAUTION

To avoid possible damage to the PC assembly, do not use plastic or bubble pack as a packing material. Use non-static charge producing materials such as conductive foam (-hp- Part No. 9220-1776).

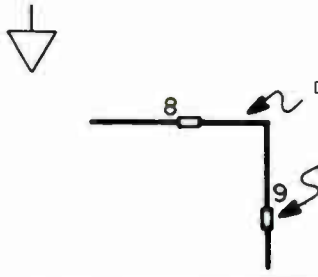
GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3. DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

   DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

4. 

   DENOTES UI HYBRID.
   UI PIN CONNECTOR.

5. DENOTES ASSEMBLY.

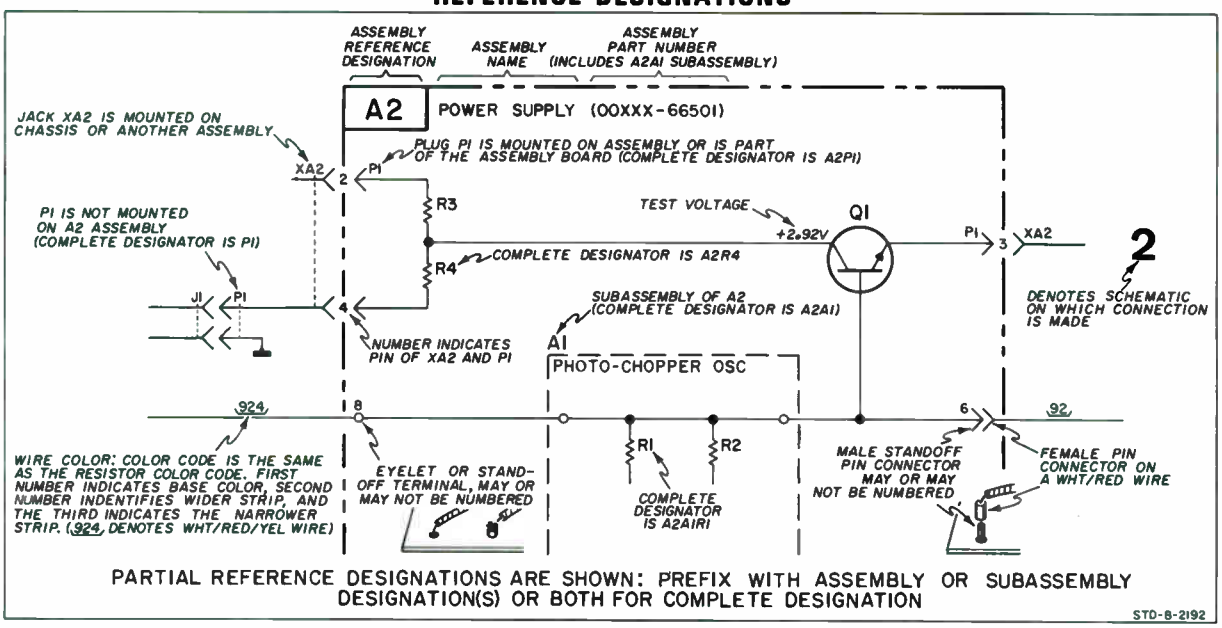
6. DENOTES SCREWDRIVER ADJUST.

7. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

8. (924) DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. (924) = WHITE, RED, YELLOW.)

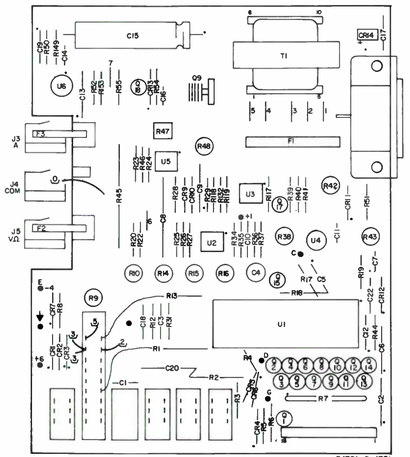
9. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A DVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ± 10% SHOULD BE ALLOWED.

REFERENCE DESIGNATIONS



PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION

STD-B-2192



A1
-hp- Part No. 03476-66501

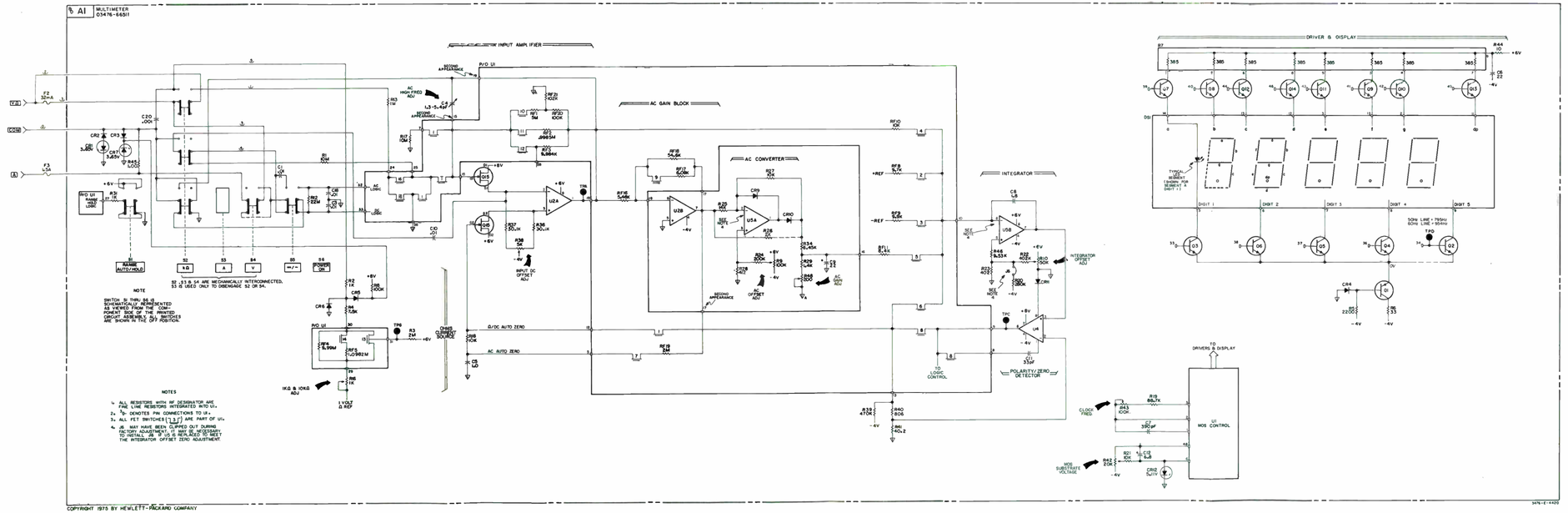
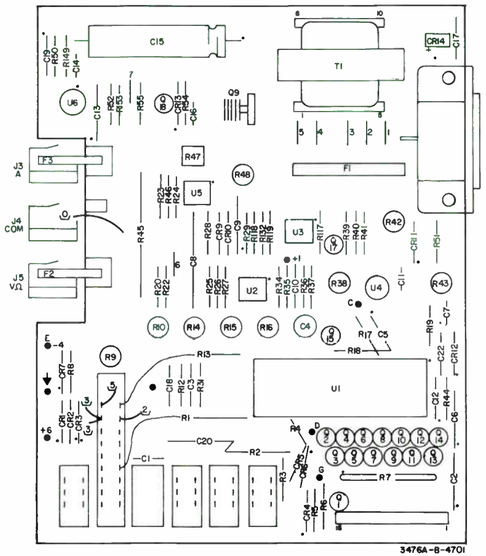


Figure 7-2. Multimeter Schematic Diagram.
7-5/7-6



A1
·hp· Part No. 03476-66501

NOTE 1

R49 MAY HAVE BEEN CLIPPED OUT DURING FACTORY ADJUSTMENT. IT MAY BE NECESSARY TO INSTALL R49 IF U6 IS REPLACED AND THE + 6 POWER SUPPLY VOLTAGE CANNOT BE ADJUSTED LOW ENOUGH.

NOTE 2

BELOW IS A TABLE OF CONNECTIONS FOR OPTIONAL AC LINE VOLTAGES.

LINE VOLTAGE	JUMPER WIRE CONNECTION				
	1	2	3	4	5
86 – 106 volts	IN	OUT	IN	IN	OUT
104 – 127 volts	IN	OUT	OUT	IN	IN
190 – 230 volts	OUT	IN	IN	OUT	OUT
208 – 250 volts	OUT	IN	OUT	OUT	IN

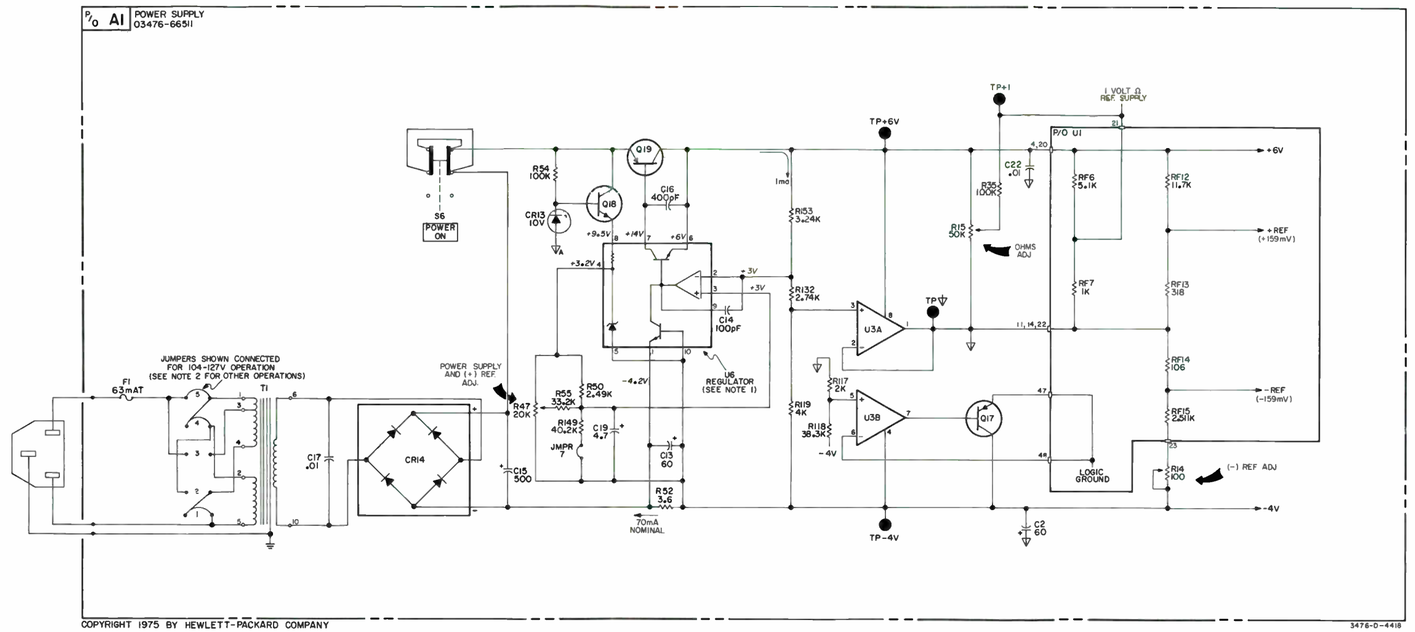


Figure 7-3. Power Supply.

SECTION VIII
BACKDATING

8-1. INTRODUCTION.

8-2. This section contains backdating information which adapts this manual to instruments with serial numbers lower than that shown on the title page.

8-3. CHANGE SEQUENCE.

8-4. Changes are listed in the serial number order that they occurred in the manufacture of the instrument. However, in adapting this manual to an instrument with a particular serial number, apply the changes in reverse order. That is, begin with the latest change and progress to the earliest change applying to that serial number. Table 8-1 lists the serial numbers to which each change applies.

Table 8-1. Manual Backdating Changes.

Instrument Serial Number	Make Manual Changes
1538A00101 thru 1538A02730	1

CHANGE 1.

Section V. Replace Paragraphs 5-21(d), 5-26(b) and 5-27(c) with the following paragraph.

d. If it is not possible to adjust within this limit, remove R49 and repeat Step c. If R49 has already been removed, it may be necessary to replace it.

b. If R10 does not have sufficient range for this adjustment, remove R20 and repeat Step a. If R20 has already been removed, it may be necessary to replace it.

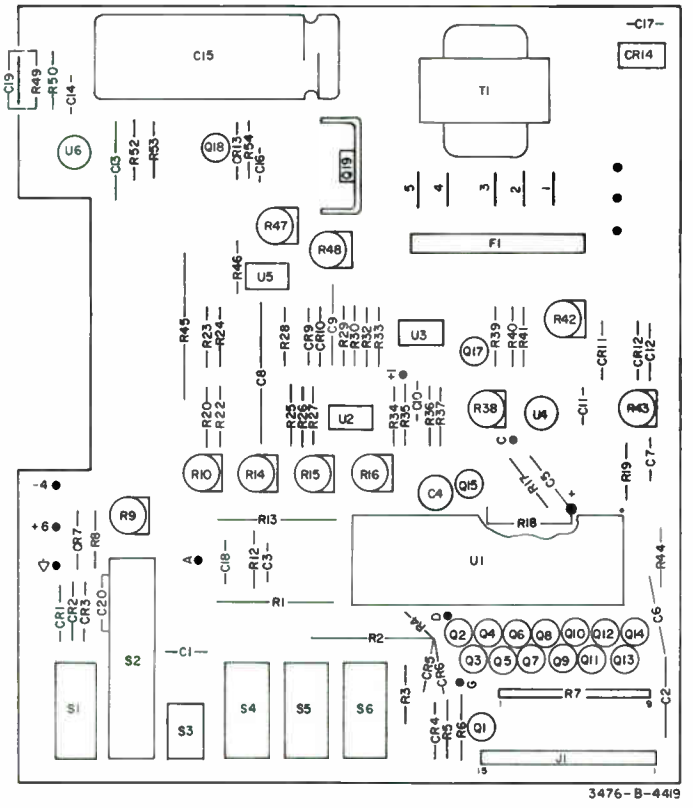
c. Adjust R47 for a display of 1.000. If R45 does not have sufficient range, it may be necessary to remove R49. If R49 has already been removed, it may be necessary to replace it.

Section VI. Change, delete, or add the -hp- part numbers and descriptions of the replaceable parts as listed in Table 8-2.

Table 8-2. Replaceable Parts.

Reference Designator	-hp- Part No.	Description
Change A1	03476-66501	PC Assembly, Main Board
Change A1C3	0160-2605	.02 μF
Change A1C10	0160-2605	.02 μF
Change A1C17	0160-2605	.02 μF
Change A1C18	0160-2605	.02 μF
Delete A1C22		
Add A1R30	0698-3153	3.83 kΩ
Delete A1R31		
Add A1R32	0757-0281	2.74 kΩ
Add A1R33	0757-0407	200 Ω
Change A1R47	2100-0554	500 Ω
Change A1R50	0757-0283	2 kΩ
Delete A1R51		
Delete A1R55—R153		
Change	1205-0298	Heat Sink

Section VII. Change the component locator and schematic diagrams as in Figures 8-1, 8-2 and 8-3.



A1

-hp- Part No. 03476-66501

Figure 8-1. Component Locator.

NOTE 1

R49 MAY HAVE BEEN CLIPPED OUT DURING FACTORY ADJUSTMENT. IT MAY BE NECESSARY TO INSTALL R49 IF U6 IS REPLACED AND THE +6 POWER SUPPLY VOLTAGE CANNOT BE ADJUSTED LOW ENOUGH.

NOTE 2

BELOW IS A TABLE OF CONNECTIONS FOR OPTIONAL AC LINE VOLTAGES.

LINE VOLTAGE	JUMPER WIRE CONNECTION				
	1	2	3	4	5
86 – 106 volts	IN	OUT	IN	IN	OUT
104 – 127 volts	IN	OUT	OUT	IN	IN
190 – 230 volts	OUT	IN	IN	OUT	OUT
208 – 250 volts	OUT	IN	OUT	OUT	IN

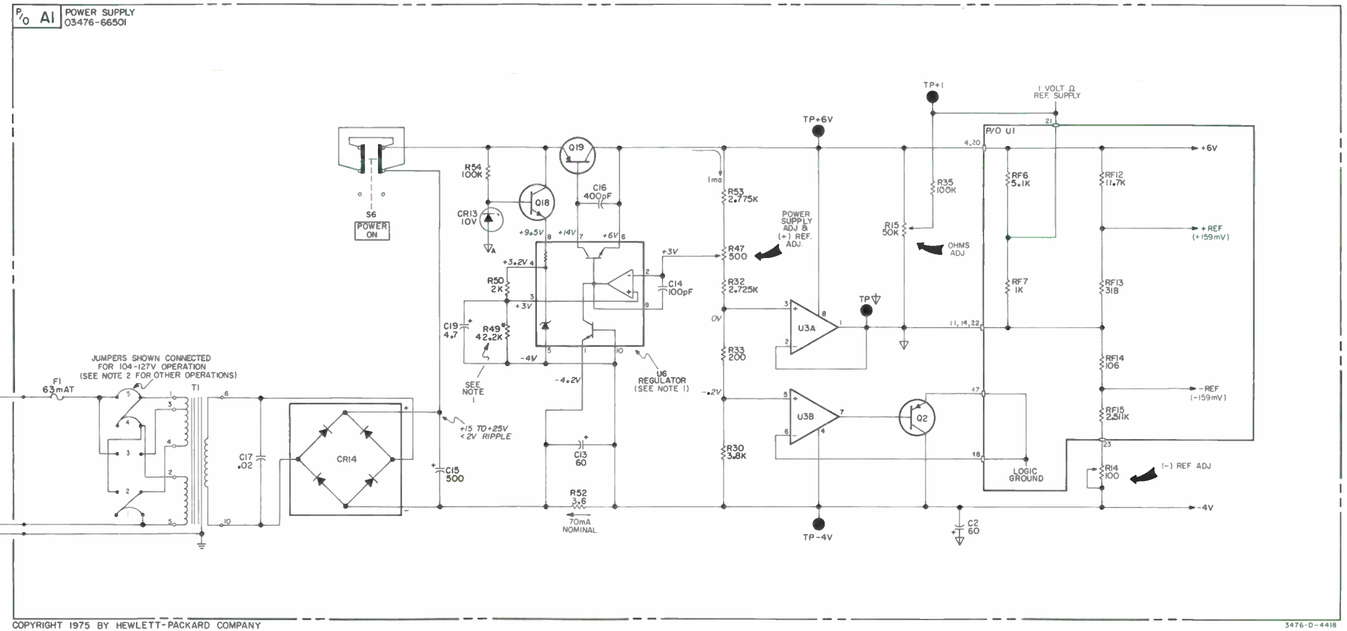


Figure 8-3. Power Supply.

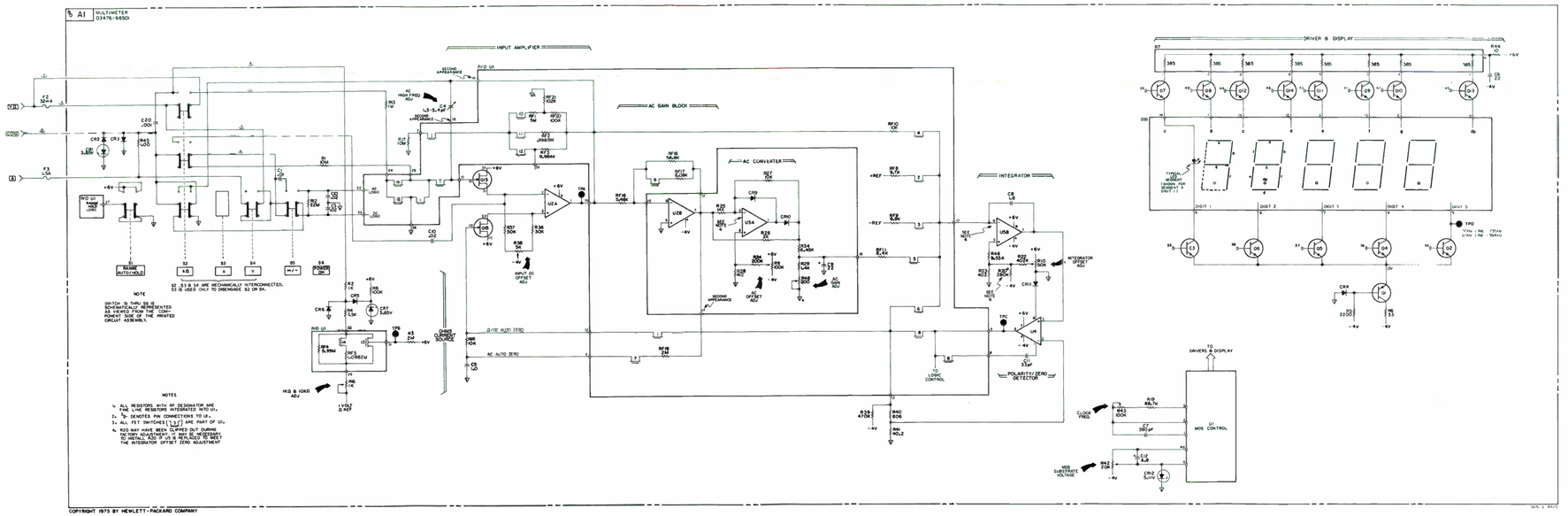


Figure 8-2. Multimeter Schematic Diagram.

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