

## Errata

**Title & Document Type:** 3476A Digital Multimeter Operating and Service Manual

**Manual Part Number:** 03476-90001

**Revision Date:** June 1976

### About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

### HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

### Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

[www.agilent.com](http://www.agilent.com)

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.



**Agilent Technologies**

OPERATING AND SERVICE MANUAL

hp-3476A

# DIGITAL MULTIMETER

## 3476A



HEWLETT  PACKARD

hp-3476A



## 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.  
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 ( $\Delta$ ) or lettered delta ( $\Delta_A$ ) 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 ( $\Delta_1$ ) 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. 03476-900J1

Microfiche Part No. 03476-90051

Copyright Hewlett-Packard Company 1975  
P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Printed: June 1976

HEWLETT  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.

TABLE OF CONTENTS

Section	Page	Section	Page
I. GENERAL INFORMATION . . . . .	1-1	5-8. DC Ammeter Accuracy Test . . . . .	5-1
1-1. Introduction . . . . .	1-1	5-10. Ohms Accuracy Test . . . . .	5-2
1-3. Description . . . . .	1-1	5-12. AC Voltage Accuracy Test . . . . .	5-2
1-5. Specifications . . . . .	1-1	5-14. AC Ammeter Accuracy Test . . . . .	5-3
1-7. Instrument and Manual Identification . . . . .	1-3/1-4	5-15. AC Common-Mode Rejection Test . . . . .	5-3
1-9. Options . . . . .	1-3/1-4	5-17. DC Common-Mode Rejection Test . . . . .	5-3
1-12. Accessories . . . . .	1-3/1-4	5-19. Adjustment Procedure . . . . .	5-6
1-14. Safety Considerations . . . . .	1-3/1-4	5-21. Power Supply Adjustment . . . . .	5-6
II. INSTALLATION . . . . .	2-1/2-2	5-22. Substrate Adjustment . . . . .	5-6
2-1. Introduction . . . . .	2-1/2-2	5-23. Input Amplifier Zero Adjustment . . . . .	5-6
2-3. Initial Inspection . . . . .	2-1/2-2	5-25. Integrator Amplifier Zero Adjustment . . . . .	5-6
2-5. Power Requirements . . . . .	2-1/2-2	5-27. + DC Volt Gain Adjustment . . . . .	5-6
2-7. Environmental Requirements . . . . .	2-1/2-2	5-28. - DC Volt Gain Adjustment . . . . .	5-6
2-9. Repackaging for Shipment . . . . .	2-1/2-2	5-29. Clock Frequency Adjustment . . . . .	5-6
2-13. Power Cords and Receptacles . . . . .	2-1/2-2	5-30. Ohms Adjustment . . . . .	5-7
III. OPERATING INSTRUCTIONS . . . . .	3-1	5-31. AC Converter Gain and Zero Adjustment . . . . .	5-7
3-1. Introduction . . . . .	3-1	5-32. AC High Frequency Adjustment (11 V range) . . . . .	5-7
3-3. Turn-On . . . . .	3-1	5-33. Changing the Power Line Options . . . . .	5-7
3-5. Operation . . . . .	3-1	VI. REPLACEABLE PARTS . . . . .	6-1
3-6. Overload/Overrange Indication . . . . .	3-1	6-1. Introduction . . . . .	6-1
3-8. Auto/Hold Switch . . . . .	3-1	6-4. Ordering Information . . . . .	6-1
3-11. AC Voltage Measurements . . . . .	3-1	6-6. Non-Listed Parts . . . . .	6-1
3-14. DC Voltage Measurements . . . . .	3-2	6-8. Parts Changes . . . . .	6-1
3-17. AC Current Measurements . . . . .	3-2	6-10. Proprietary Parts . . . . .	6-1
3-20. DC Current Measurements . . . . .	3-2	VII. TROUBLESHOOTING AND CIRCUIT DIAGRAMS . . . . .	7-1
3-23. Resistance Measurements . . . . .	3-2	7-1. Introduction . . . . .	7-1
3-26. Input Protection Fuses . . . . .	3-3	7-3. Preliminary Troubleshooting . . . . .	7-1
3-28. AC Line Fuse Replacement . . . . .	3-4	7-10. Power Supply Troubleshooting . . . . .	7-2
3-30. Semiconductor Junction Measurements . . . . .	3-4	7-14. Display Troubleshooting . . . . .	7-2
IV. THEORY OF OPERATION . . . . .	4-1/4-2	7-20. Schematic Diagrams . . . . .	7-2
4-1. Introduction . . . . .	4-1/4-2	7-22. Printed Circuit Assembly Exchange . . . . .	7-2
4-3. Simplified Block Diagram Description . . . . .	4-1/4-2	7-24. Printed Circuit Board Removal . . . . .	7-3
V. MAINTENANCE . . . . .	5-1	VIII. BACKDATING . . . . .	8-1
5-1. Introduction . . . . .	5-1	8-1. Introduction . . . . .	8-1
5-3. Test Equipment Required . . . . .	5-1	8-3. Change Sequence . . . . .	8-1
5-5. Performance Tests . . . . .	5-1		
5-6. DC Voltmeter Accuracy Test . . . . .	5-1		

**LIST OF TABLES**

Table	Page	Table	Page
1-1. Specifications . . . . .	1-1	5-4. Ohms Accuracy Test . . . . .	5-2
1-2. General Information . . . . .	1-2	5-5. AC Voltage Accuracy Test . . . . .	5-3
1-3. Options . . . . .	1-3/1-4	5-6. AC Ammeter Accuracy Test . . . . .	5-3
1-4. Accessories . . . . .	1-3/1-4	6-1. Standard Abbreviations . . . . .	6-1
5-1. Required Test Equipment . . . . .	5-0	6-2. Code List of Manufacturers . . . . .	6-2
5-2. DC Voltmeter Accuracy Test . . . . .	5-1	6-3. Replaceable Parts . . . . .	6-3
5-3. DC Ammeter Accuracy Test . . . . .	5-2	8-1. Manual Backdating Changes . . . . .	8-1
		8-2. Replaceable Parts . . . . .	8-1

**LIST OF ILLUSTRATIONS**

Figure	Page	Figure	Page
2-1. Plug Caps . . . . .	2-1/2-2	4-1. Simplified Block Diagram . . . . .	4-1/4-2
3-1. Overload Indication . . . . .	3-1	5-1. DC Ammeter Accuracy Test . . . . .	5-2
3-2. Multimeter Autoranging . . . . .	3-1	5-2. Ohms Accuracy Test . . . . .	5-2
3-3. AC Voltage Measurement . . . . .	3-2	5-3. AC Ammeter Accuracy Test . . . . .	5-3
3-4. DC Voltage Measurement . . . . .	3-2	5-4. Common-Mode Rejection Test . . . . .	5-4
3-5. AC Current Measurement . . . . .	3-2	7-1. Display Verification . . . . .	7-2
3-6. DC Current Measurement . . . . .	3-2	8-1. Component Locator . . . . .	8-2
3-7. Resistance Measurement . . . . .	3-3	8-2. Multimeter Schematic Diagram . . . . .	8-3/8-4
3-8. Location of Controls and Connectors . . . . .	3-3	8-3. Power Supply . . . . .	8-5/8-6

## 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.

<b>DC VOLTMETER</b>			
Ranges: $\pm 0.11$ 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	$\pm 10.3\%$ of reading + .2% of range)	$\pm 10.5\%$ of reading + 0.2% of range)	
1.1 V, 11 V	$\pm 10.3\%$ of reading + 0.1% of range)	$\pm 10.5\%$ of reading + 0.1% of range)	
110 V, 1100 V	$\pm 10.4\%$ of reading + 0.1% of range)	$\pm 10.6\%$ of reading + 0.1% of range)	
Common Mode Rejection: > 100 dB at 60 Hz, 60 Hz (1 k $\Omega$ unbalanced)			
Input Resistance: 10 M $\Omega$ $\pm$ 5%			
Input Protection: < 1000 V (Continuous)			
Temperature Coefficient: $\pm 0.05\%$ of reading + 0.02% of range/°C			
<b>AC VOLTMETER:</b>			
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):			
Accuracy (90-Day Calibration Cycle)			
Ranges*	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
1.1 V rms to 1100 V rms	$\pm 11.6\%$ of reading + 0.4% of range)	$\pm 13\%$ of reading + 0.6% of range)	$\pm 18\%$ of reading + 1.0% of range)
0.11 V rms	$\pm 12\%$ of reading + 0.6% of range)	$\pm 15\%$ of reading + 0.6% of range)	$\pm 18\%$ of reading + 1.0% of range)
Accuracy (1-Year Calibration Cycle)			
Ranges*	45 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
1.1 V rms to 1100 V rms	$\pm 11.7\%$ of reading + 0.5% of range)	$\pm 13.2\%$ of reading + 0.7% of range)	$\pm 18.2\%$ of reading + 1.1% of range)
0.11 V rms	$\pm 12.2\%$ of reading + 0.7% of range)	$\pm 15.2\%$ of reading + 0.7% of range)	$\pm 18.2\%$ of reading + 1.1% of range)
*Ranges usable from 0.03 to full scale.			
Common Mode Rejection: (1 k $\Omega$ balanced) > 80 dB at 50 Hz and 60 Hz			
Input Resistance: 10 M $\Omega$ $\pm$ 5%			
Input Capacitance: < 30 pF			
Input Protection: < 707 rms continuous			
Temperature Coefficient: $\pm 0.05\%$ of reading + 0.05% of range/°C			

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

**DC AMMETER**

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

Ranges	Accuracy	
	(90-Day Calibration Cycle)	(1-Year Calibration Cycle)
$\pm 0.11$ A, 1.1 A	$\pm$ (0.8% of reading + 0.2% of range)	$\pm$ (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:  $\pm$  (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):

Ranges*	Accuracy		Accuracy	
	(90-Day Calibration Cycle)		(1-Year Calibration Cycle)	
	45 Hz to 2 kHz	2 kHz to 5 kHz	45 Hz to 2 kHz	2 kHz to 5 kHz
1.1 A rms	$\pm$ (2% of reading + 0.4% of range)	$\pm$ (3.5% of reading + 0.6% of range)	$\pm$ (2.2% of reading + 0.5% of range)	$\pm$ (3.7% of reading + 0.7% of range)
0.11 A rms	$\pm$ (2.5% of reading + 0.6% of range)	$\pm$ (5.5% of reading + 0.6% of range)	$\pm$ (2.7% of reading + 0.7% of range)	$\pm$ (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:  $\pm$  (0.05% of reading + 0.05% of range)/°C

**OHMMETER**

Ranges: 1.1 k $\Omega$ , 11 k $\Omega$ , 110 k $\Omega$ , 1100 k $\Omega$ , 11000 k $\Omega$   
 Accuracy: (20°C to 30°C)

Ranges	Accuracy	
	(90-Day Calibration Cycle)	(1-Year Calibration Cycle)
110 K, 1100 K	$\pm$ (0.3% of reading + 0.1% of range)	$\pm$ (0.5% of reading + 0.1% of range)
11000 K, 1.1 K, 11 K	$\pm$ (0.5% of reading + 0.1% of range)	$\pm$ (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:  $\pm$  (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, 100-230 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 AND MANUAL IDENTIFICATION.

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 accommodate 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.

Options	Description
Standard	104-127, 54-66 Hz, 6 VA, 60 mA Max.
001	56-106, 54-66 Hz, 6 VA, 70 mA Max.
002	86-106, 45-64 Hz, 6 VA, 70 mA Max.
003	100-230, 48-64 Hz, 6 VA, 30 mA Max.
004	208-110, 48-64 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 CONSIDERATIONS.

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 marks 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 referring 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 (+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:

- Wrap instrument in heavy paper or plastic before placing in an inner container.
- Place packing material around all sides of instrument and protect panel face with cardboard strips.
- 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).

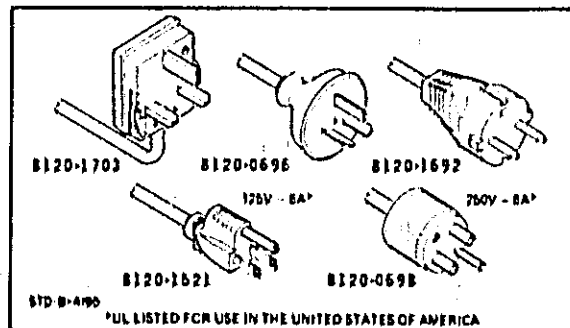


Figure 2-1. Plug Caps.

## 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.

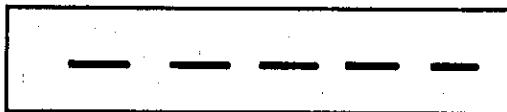


Figure 3-1. Overload Indication.

#### 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 up-range if the display reading increases above **11098** and downrange if the display decreases below **11109**. 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.

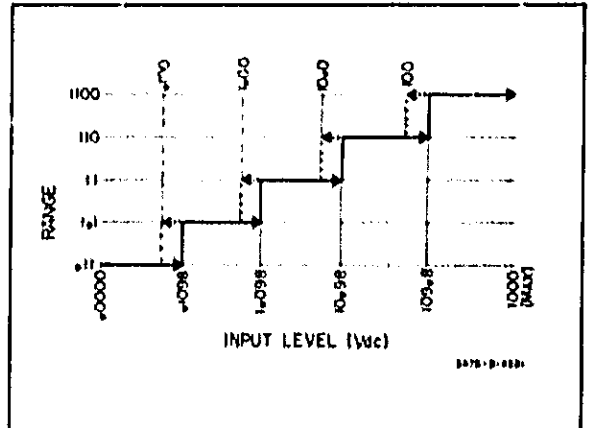


Figure 3-2. Multimeter Autoranging.

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 **11098** 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.

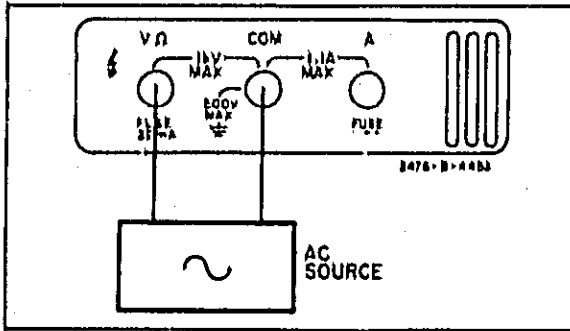


Figure 3-3. AC Voltage Measurement.

3-14. DC Voltage Measurements.



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.

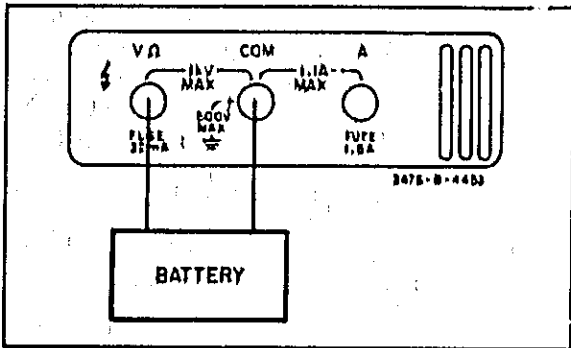


Figure 3-4. DC Voltage Measurement.

3-17. AC Current Measurements.



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.



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.

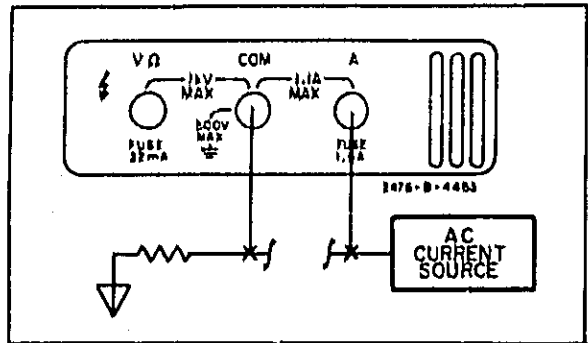


Figure 3-5. AC Current Measurement.

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.

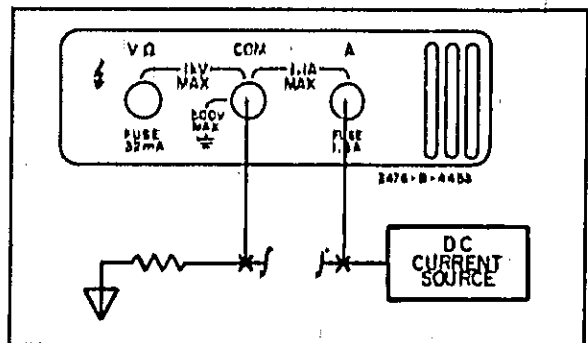


Figure 3-6. DC Current Measurement.

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  $V \Omega$  and

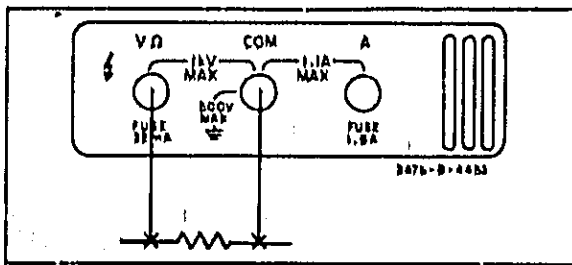


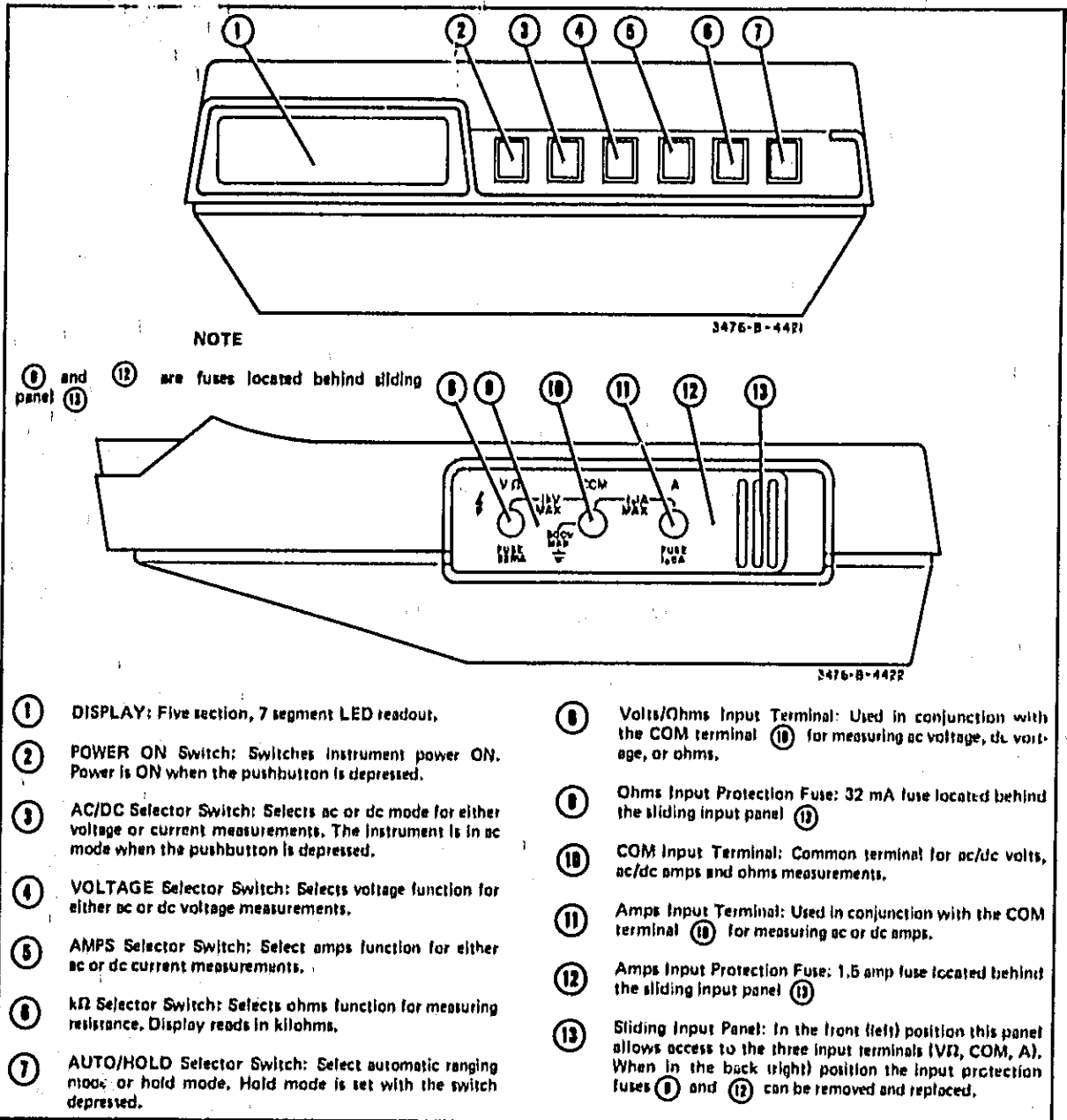
Figure 3-7. Resistance Measurement.

COM connectors to the resistance under test as shown in Figure 3-7.

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, ⑧, 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.



- 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. SEMICONDUCTOR 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  $\Omega V$  terminal.
- b. Press the A pushbutton. This causes the instrument to downrange.
- c. Press the  $k\Omega$  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.

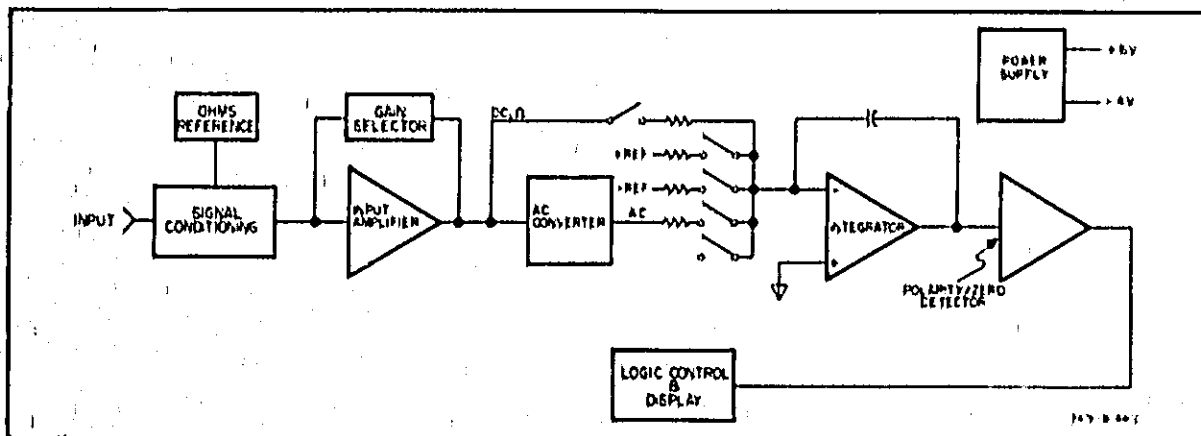


Figure 4-1. Simplified Block Diagram.

**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 B-1. Required Test Equipment.

Instrument Type	Characteristics	Recommended Model
Digital Multimeter	DC Volts: 1 V, 10 V, 100 V Accuracy: .05% Input Resistance: $\geq 10\text{ M}\Omega$  AC Volts: .1 V, 1 V ranges Accuracy: .5% Input Resistance: 10 M $\Omega$	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-6200A/6302A
Power Supply	Output: 5 V, 1 A	hp-6294A
Resistive Decade Box	Ranges: 10 $\Omega$ , 100 $\Omega$ , 1 k $\Omega$ , 10 k $\Omega$ , 100 k $\Omega$ and 1 M $\Omega$ Steps Accuracy: .05%	General Radio Model GR 14332
Resistors	10 M $\Omega$ $\pm$ 0.1% 1 M $\Omega$ $\pm$ 0.1%  300 k $\Omega$ $\pm$ .1% 1 k $\Omega$ $\pm$ .1% 10 K $\pm$ .1%	hp- Part No. 0698-8104 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

### 5-6. 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.

- Set the Multimeter to measure dc volts. Short the input terminals and check for a display of zero  $\pm 1$  count.
- Connect the DC Standard to the V $\Omega$  and COM terminals.
- Check all the ranges listed in Table 5-2 for the tolerances indicated. Be sure to test for the appropriate calibration cycle.



*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.

- Connect the equipment as shown in Figure 5-1.
- Set the DC Ammeter to the 1000 mA range.
- 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	$\pm .010$ V	$\pm .0007$ to $\pm .0103$	$\pm .0007$ to $\pm .0103$
	$\pm .100$ V	$\pm .0095$ to $\pm .1005$	$\pm .0094$ to $\pm .1006$
	$\pm .100$ V	$\pm .0095$ to $\pm .1005$	$\pm .0094$ to $\pm .1006$
1.1 V	$\pm 1.00$ V	$\pm .096$ to $\pm 1.004$	$\pm .094$ to $\pm 1.006$
11 V	$\pm 10.00$ V	$\pm 0.06$ to $\pm 10.04$	$\pm 0.04$ to $\pm 10.06$
	$\pm 10.00$ V	$\pm 0.06$ to $\pm 10.04$	$\pm 0.04$ to $\pm 10.06$
1100 V	$\pm 1000$ V	$\pm 0.95$ to $\pm 1005$	$\pm 0.93$ to $\pm 1007$

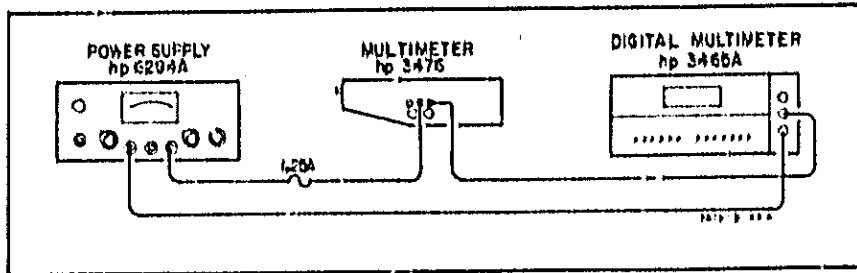


Figure 5-1. DC Ammeter Accuracy Test.

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	.880 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  $k\Omega$  and connect a short between the  $V/\Omega$  terminal and COM. The Multimeter should indicate zero  $\pm 1$  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  $k\Omega$  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.

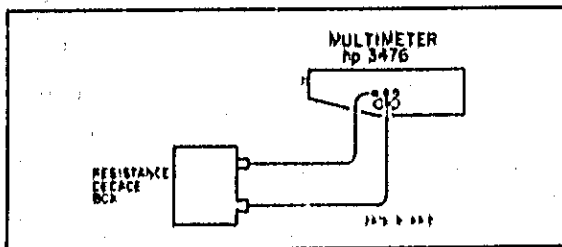


Figure 5-2. Ohms Accuracy Test.

Table 5-4. Ohms Accuracy Test.

Range ( $k\Omega$ )	Standard Resistance	Test Limits ( $k\Omega$ )	
		90 Day Calibration Cycle	1 Year Calibration Cycle
1.1	100 $\Omega$ 1 $k\Omega$	.098 thru .102 .994 thru 1.006	.092 thru .108 .992 thru 1.008
11	10 $k\Omega$	9.94 thru 10.06	9.92 thru 10.08
110	100 $k\Omega$	99.6 thru 100.4	99.4 thru 100.6
1100	1000 $k\Omega$	996 thru 1004	994 thru 1006
11,000	10,000 $k\Omega$	9940 thru 10,060 $k\Omega$	9920 thru 10,080 $k\Omega$

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 Vrms.

a. Set the Multimeter to AC V. Connect the AC Calibrator between the  $V/\Omega$  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 5-5. AC Voltage Accuracy Test.

Range	AC Standard Output	Test Frequency	Test Limits (V)	
			90 Day	1 Year
.11 V	.003 V	600 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 .1067	.0940 to .1060
	.01 V	10 kHz	.0071 to .0120	.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.

- Connect the equipment as shown in Figure 5-3.
- Set the AC Ammeter to the 1000 mA range.
- 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.

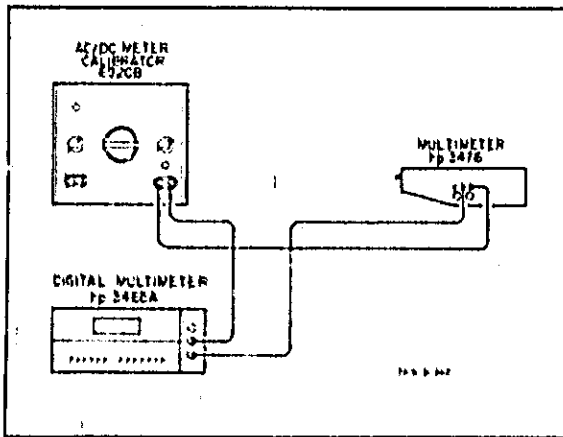


Figure 5-3. AC Ammeter Accuracy Test.

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  $\pm 1\%$  resistor are required for this test.

- Connect a 1 kilohm resistor between the V/ $\Omega$  and COM Multimeter terminals.
- Set the Multimeter FUNCTION to AC V.
- Connect the AC Calibrator III output terminal to the Multimeter as shown in Figure 5-4.
- Set the AC Calibrator frequency to the ac line frequency being used.
- Set the AC Calibrator output to 100 V rms.
- The Multimeter should indicate  $\leq 10$  mV rms.

5-17. DC Common-Mode Rejection Test.

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

- Connect a 1 kilohm resistor between the V/ $\Omega$  and COM Multimeter terminals.
- Set the Multimeter FUNCTION to DC V.
- Connect the AC Calibrator III output terminal to the Multimeter as shown in Figure 5-4.
- Set the AC Calibrator frequency to the ac line frequency being used (50 Hz or 60 Hz  $\pm 1\%$ ).
- Set the AC Calibrator output to 100 V rms.
- The Multimeter should indicate  $\leq 1.5$  mV peak.

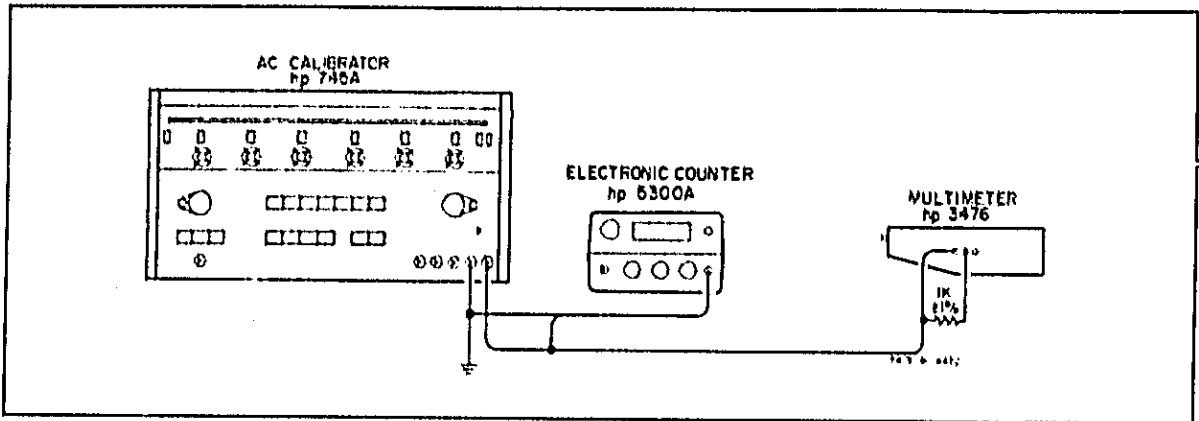


Figure 5-4. Common-Mode Rejection Test.

**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-ADJUSTMENT PROCEDURES.****A. Disassembly 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  $\downarrow$  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.

**5-10. 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/ $\Omega$  and COM terminals. Set the FUNCTION to k $\Omega$  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.

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/ $\Omega$  and COM terminals. Connect a jumper between the + 1 test point and TP G.

b. Ensure that the Multimeter downranges to the 1.1 k $\Omega$  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 k $\Omega$  and connect a 300 kilohm resistor between the  $\Omega$ /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  $\nabla$  ).

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,  $\pm 1$  count.

Example:

Voltage at A = .2 mV

.2 mV  $\times$  (- 1000) = - 00.2 V Display

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.

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/ $\Omega$  terminal (F2).

b. Set the Multimeter FUNCTION to k $\Omega$  and connect a 1 megohm  $\pm$  0.1% resistor to the input.

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

d. Change the input resistor to 10 kilohm,  $\pm$  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 (1.1 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 auto-range 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.*



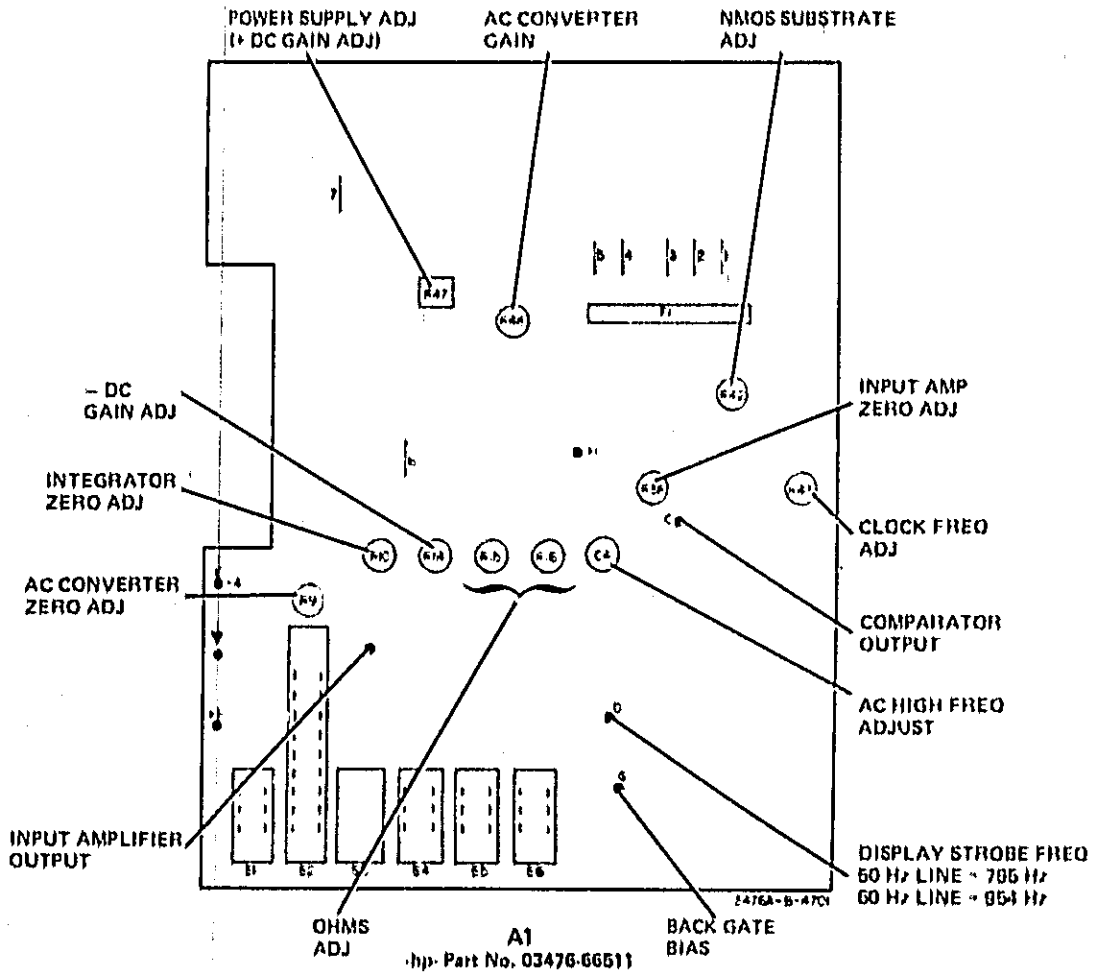


Figure 5-5. Adjustment Locator.  
5-9/5-10

**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	.0930 to .102	.098 thru .102	_____	
	1.0 kΩ	.894 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	99.5 to 100.5	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 .0109	.0090 to .0109	_____
	.1 V	45 Hz, 2 kHz	.0978 to .1022	.0976 to .1026	_____
	.01 V	5 kHz	.0088 to .0112	.0087 to .0113	_____
	.1 V	5 kHz	.0843 to .1057	.0840 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 728	669 to 730	_____	
700 V	10 kHz	633 to 767	630 to 770	_____	



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	Mojmala Semiconductor Products	Phoenix, AZ	85008
07088	Kelvin Electric Co	Van Nuys, CA	91401
07263	Fairchild Semiconductor Div	Mountain View, CA	94040
07716	TIW Inc Burlington Div	Burlington, IA	52601
16208	Corning Gl Wk Elec Compnt Div	Raleigh, NC	27604
24648	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
66289	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
74370	Johnson E F Co	Waseca, MN	56083
76015	Littelfuse Inc	Des Plaines, IL	60016





## 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 w/ the disassembling and working on the Multimeter. Conductive wristbands (hip- 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 (hip- Part No. 8090-0512) when replacing components. 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)    hip- P/N 2110-0420  
Littlefuse P/N 312.031

Amps input protection fuse:  
1/8 A (250 V)    hip- P/N 2110-0043  
Bussman AGC 1 - 1/8  
Littlefuse 312.015

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 pushbutton to avoid dislodgement 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) Chip Part No. 2110-0311  
Littleline 313,062  
Rusman MDL 1/16

7-8. Connect the 3476A TP  $\nabla$  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 fuses 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  $\nabla$ ). The dc voltmeter indication at TP + 6 should be within the limits of 5.88 to 6.22 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  $\nabla$  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 (DS1) 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:

- The power supply.
- The light-emitting diode display (DS1).
- The associated display driver transistors (Q1 - Q14).
- 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.

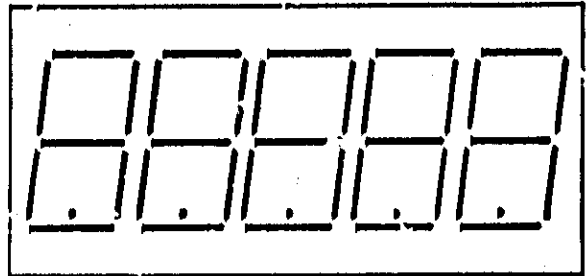


Figure 7-1. Display Verification.

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 replaceable 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 (Chip 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 lines 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 open 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 (shp. Part No. 9220-1776).

**GENERAL SCHEMATIC NOTES**

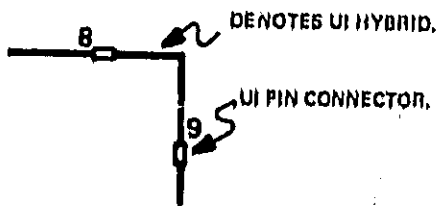
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

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).



5.  DENOTES ASSEMBLY.

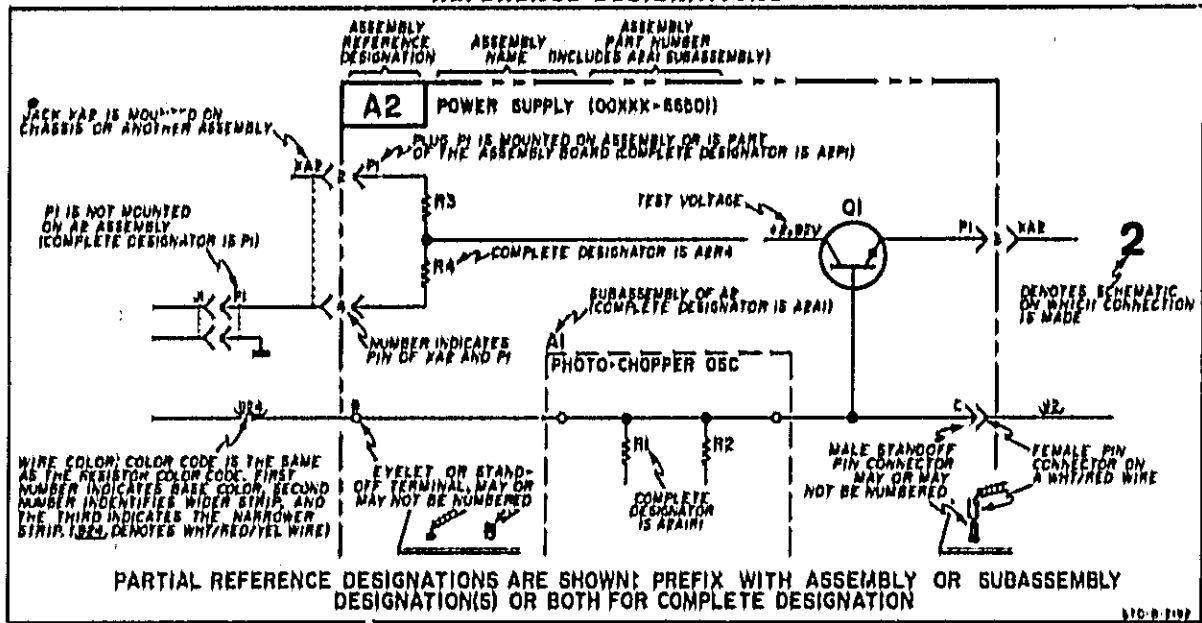
6.  DENOTES SCREWDRIVER ADJUST.

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. 02A 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. 022 - 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**



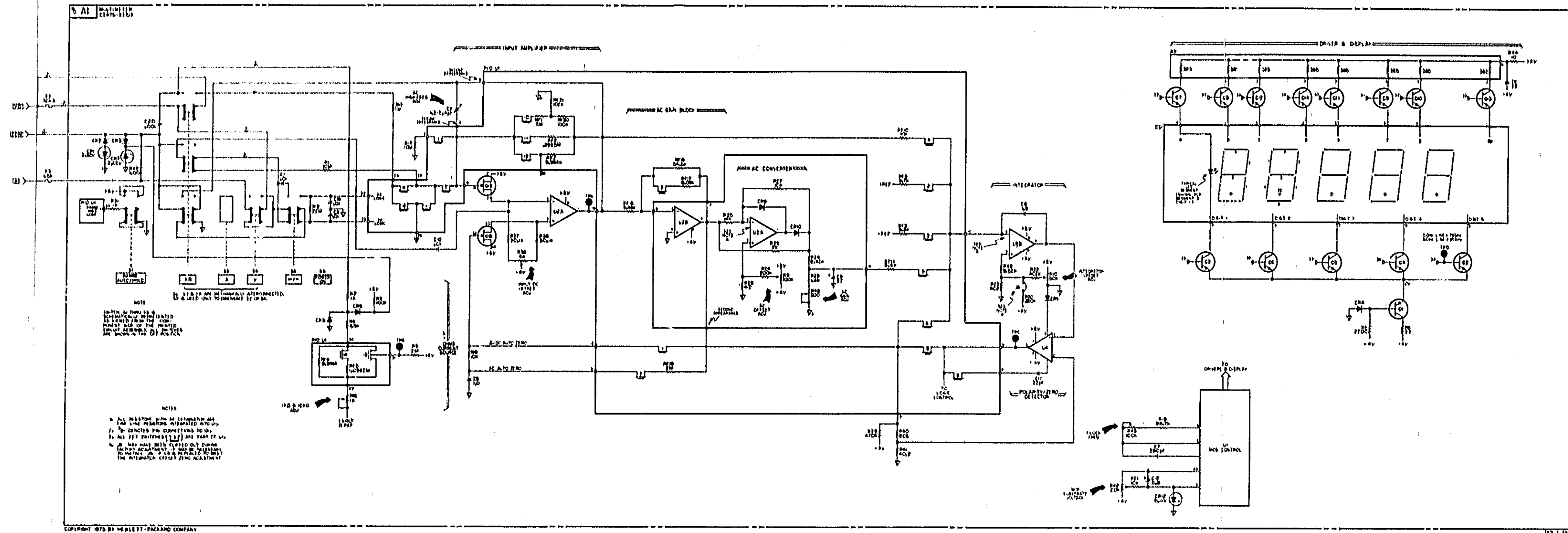
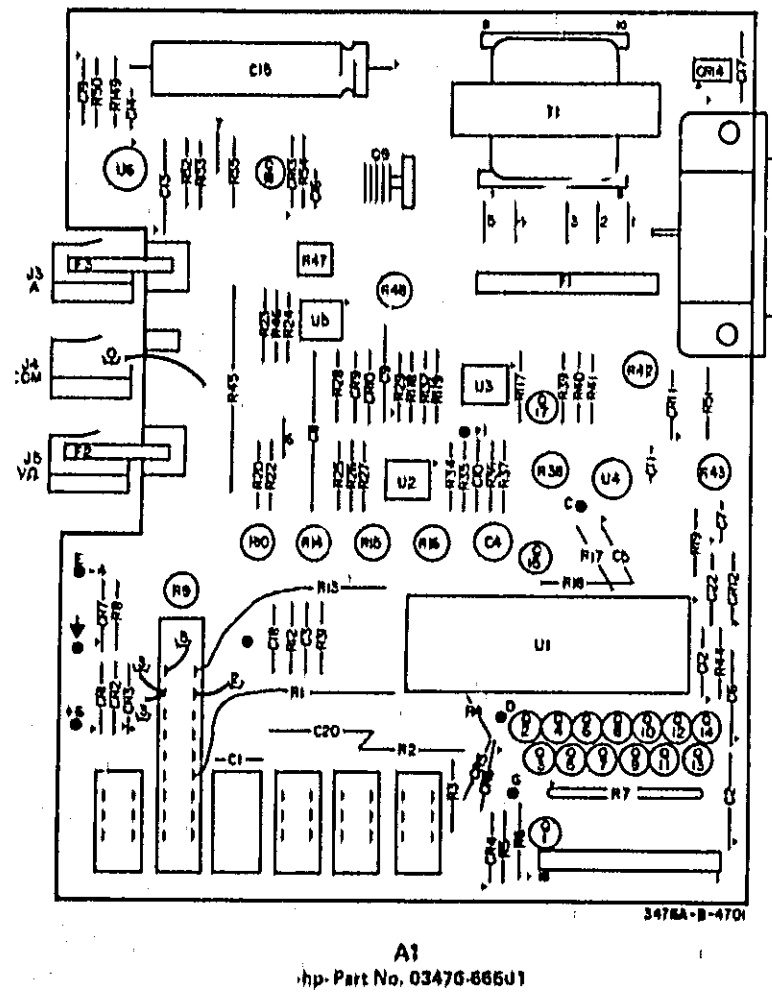
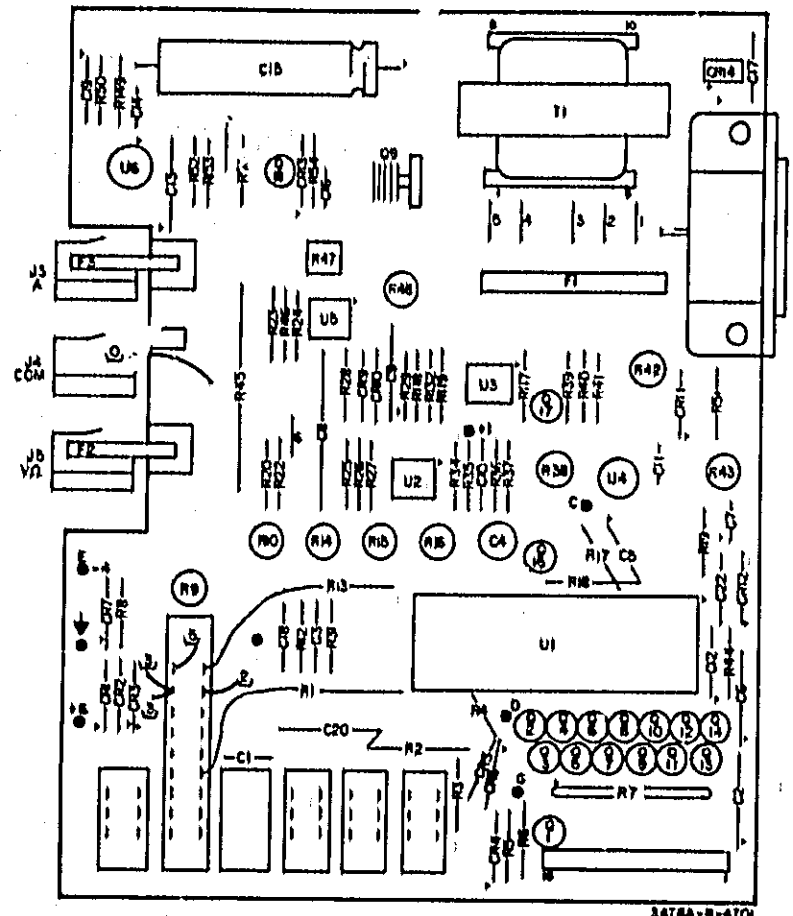


Figure 7-2. Multimeter Schematic Diagram.  
7-5/7-6



A1  
hp Part No. 03476-66601

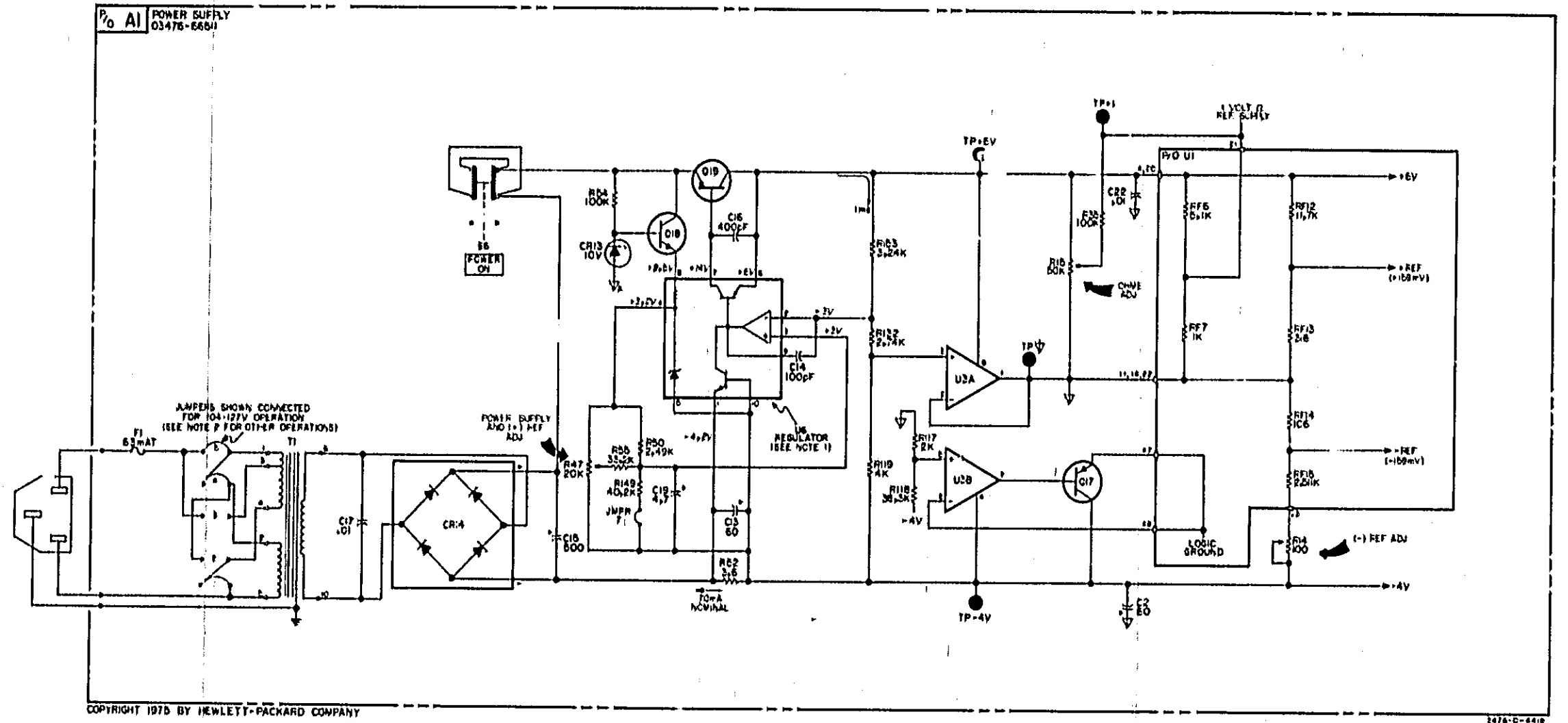
NOTE 1

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



POWER SUPPLY  
03476-66601

Figure 7-3. Power Supply.  
7-717-8

## 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 in which 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
1638A00101 thru 1638A02730	1

#### CHANGE I.

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

a. 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.

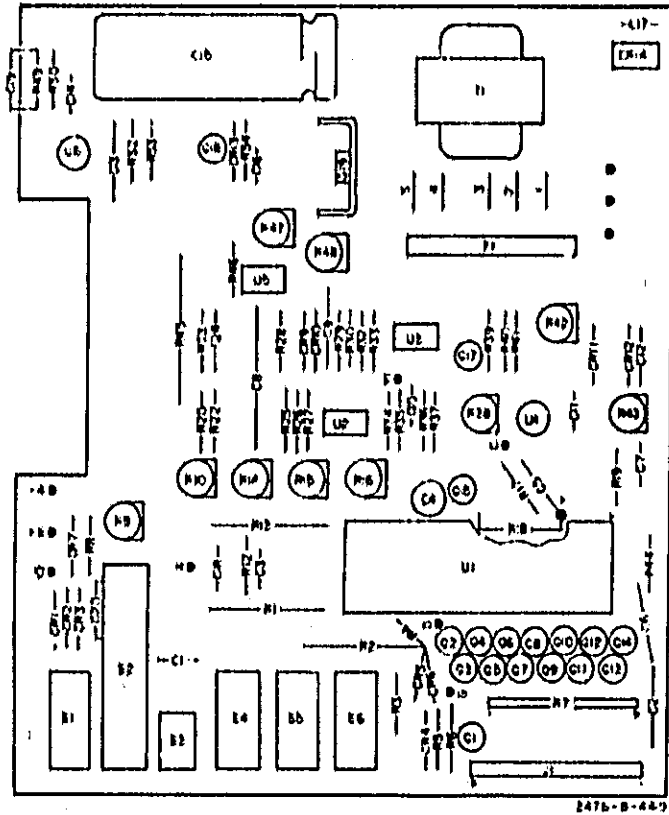
c. Adjust R47 for a display of 1.000. If R45 does not have sufficient range, it may be necessary to remove R49. If R49 has already been removed, it may be necessary to replace it.

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	03476-6601	PC Assembly, Main Board
Change A1C3	0160-2606	.02 $\mu$ F
Change A1C10	0160-2706	.02 $\mu$ F
Change A1C17	0160-2606	.02 $\mu$ F
Change A1C18	0160-2606	.02 $\mu$ F
Change A1C22		
Add A1R30	0098-3163	3.83 k $\Omega$
Delete A1R31		
Add A1R32	3707-0281	2.74 k $\Omega$
Add A1R33	0757-0407	200 $\Omega$
Change A1R47	2100-0554	600 $\Omega$
Change A1R50	0757-0283	2 $\Omega$
Delete A1R51		
Delete A1R55-R163		
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 66601

Figure B-1, Component Locator.

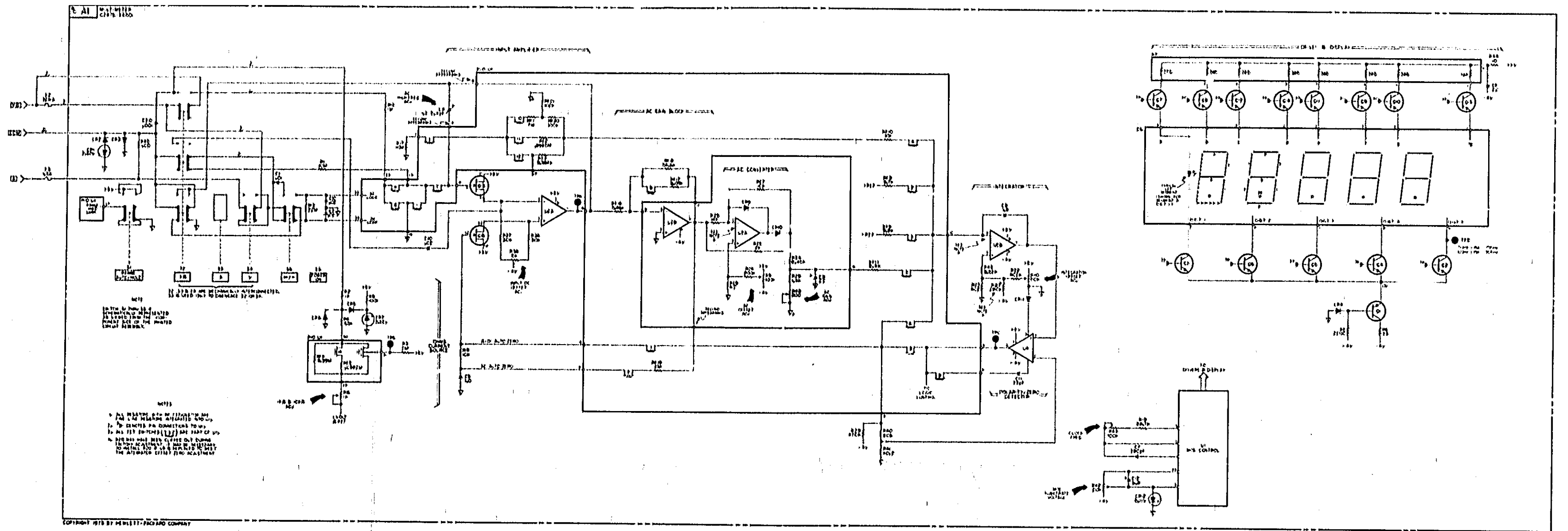


Figure 8-2. Multimeter Schematic Diagram.  
8-3/8-4





# hp 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 1619A06841 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	0608-8748, 1 K 5%	0B11-0006, 5 K 1%
A1R4	0767-0440, 7.5 K	0698-3162, 3480 ohm
A1R13	0698-1066, 1 M 5% 1 W	0767-0060, 1 M 1% 1/2 W
A1R51	0683-1036, 10 K	0683-1026, 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 MOF Substrate Voltage Adjustment.

**CHANGE NO. 2** applies to serial numbers 1848A08281 and greater.

Page 6-3. Change -hp- part number of C4 to 0121-0487, qty 1, Capacitor-V TRMR-AIR 1.03, 5 pF.

Page 8-4. Change -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 7-6/7-8, Figure 7-2. Change the value of C4 to 1.0-3.5 nF.

**CHANGE NO. 3** applies to serial numbers 1848A11263 and greater.

Page 1-2/1-3. Add to Tables 1-2 and 1-3 the following option:

Option 006, 208-260, 54-86Hz, 6VA, 30 mA Max.