Errata

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. To reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648 is now model number Agilent 8648.

Ce manuel peut contenir des références à <<HP>> ou <<Hewlett-Packard.>> Veuillez noter que les produits de test et mesure, de semi-conducteur et d'analyse chimique qui avaient fait partie de la société Hewlett-Packard sont maintenent une partie de la société Agilent Technologies. Pour reduire la confusion potentielle, le seul changement aux noms de reference a été dans le préfixe de nom de société : là où un nom de référence était HP XXXX, le nouveau nom de référence est maintenant Agilent XXXX. Par example, le HP 8648 s'appelle maintenent Agilent 8648.

Diese Gebrauchsanweiseung kann Bezug nehmen auf die Namen HP oder Hewlett-Packard. Bitte beachten Sie, dass ehemalige Betriebsbereiche von Hewlett-Packard wie HP-Halbleiterprodukte, HP-chemische Analysen oder HP-Test- und Messwesen nun zu der Firma Agilent Technology gehören. Um Verwirrung zu vermeiden wurde lediglich bei Produktname und - Nummer der vo laufende Firmenname geändert: Produkte mit dem Namen/Nummer HP XXXX lauten nun mehr Agilent XXXX. Z.B, das Modell HP 8648 heißt nun Agilent 8648.

Questo manuale potrebbe contenere riferimenti ad HP o Hewlett-Packard. Si noti che le attività precedentemente gestite da Hewlett-Packard nel campo di Test & Misura, Semiconduttori, ed Analisi Chimica sono ora diventate parte di Agilent Technologies. Al fine di ridurre il rischio di confusione, l'unica modifica effettuata sui numeri di prodotto e sui nomi ha riguardato il prefisso con il nome dell'azienda : dove precedentemente compariva "HP XXXX" compare ora "Agilent XXXX". Ad esempio: il modello HP8648 è ora indicato come Agilent 8648.

Este manual puede hacer referencias a HP o Hewlett Packard. Las organizaciones de Prueba y Medición (Test and Measurement), Semiconductores (Semiconductor Products) y Análisis Químico (Chemical Analysis) que pertenecían a Hewlett Packard, ahora forman parte de Agilent Technologies. Para reducir una potencial confusión, el único cambio en el número de producto y nombre, es el prefijo de la compañía: Si el producto solía ser HP XXXX, ahora pasa a ser Agilent XXXX. Por ejemplo, el modelo HP8648 es ahora Agilent 8648.

这个手册里面可能含有惠普公司的资料。请注意惠普公司以前的测试，半导体产品，化学分析部门现在属于安捷伦公司。为了减少可能的误解，产品号码和名字只改变最前面的公司名字。如果一个产品的号码 / 名字以前是HP XXXX，现在的号码 / 名字是安捷伦 XXXX。例如模型号码是惠普 8 6 4 8 。现在是模型号码安捷伦 8 6 4 8 。

Document Part Number 5185-8447

Agilent Technologies

這個手冊裡面可能含有惠普公司的資料。請注意惠普公司以前的測試，半導體產品，化學分析部門現在屬于安捷倫公司。爲了減少可能的誤解，產品號碼和名字只改變最前面的公司名字。如果一個產品的號碼／名字以前是HP XXXX，現在的號碼／名字是安捷倫 XXXX。例如模型號碼是惠普８６４８。現在是模型號碼安捷倫８６４８。

マニュアル・チェンジ

変更

本文中の「HP(YHP)」、または「(横河)ヒューレット･パッカード株式会社」という語句を、「Agilent」、または「アジレント・テクノロジー株式会社」と変更してください。

ヒューレット・パッカード社の電子計測、半導体製品、化学分析ビジネス部門は分離独立し、アジレント・テクノロジー社となりました。

社名変更に伴うお客様の混乱を避けるため、製品番号の接頭部のみ変更しております。

（例: 旧製品名　HP 4294A　は、現在　Agilent 4294A　として販売いたしております。）

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3435A

DIGITAL MULTIMETER

Serial Numbers 1606A00101 and Greater

IMPORTANT NOTICE

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.

Backdating changes not integrated into the manual are denoted by a numbered delta (Δ_1) which refers to the change in the Backdating Information.

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. 03435-90002

Microfiche Part No. 03435-90052

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

Printed: January 1980

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard 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

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other 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.

10/1/79

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS.

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

DANGER

The DANGER sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which could result in injury or death to personnel even during normal operation.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information concerning the -hp- Model 3435A 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 3435A is a 3½ digit, five function, autoranging multimeter. The functions are AC and DC Voltage, AC and DC Current and Ohms. All five functions have manually selectable ranges. AC and DC Voltage and Ohms functions may also be automatically ranged by depressing the AUTO pushbutton. Throughout the remainder of this manual, the -hp- Model 3435A 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 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.

Table 1-1. Specifications.

AC VOLTMETER

AC Converter: Avg. Responding rms calibrated.

Ranges	Max Display
200 mV	199.9 mV
2 V	1.999 V
20 V	19.99 V
200 V	199.9 V
1200 V	1199 V

Maximum Input: 1700 V (dc + peak ac), 10^7 volt - Hz max.

Ranging: Automatic or manual.

Sensitivity: 100 µV on 200 mV range.

Accuracy: 1 year, 15° to 30°C @ 95% RH.

Minimum Reading: 20 digits.

30 Hz - 50 Hz	± 1.5% of reading ± 3 digits
50 Hz - 20 kHz	± 0.3% of reading ± 3 digits
20 kHz - 100 kHz	± 1.5% of reading ± 10 digits

Temperature Coefficient: 0° - 15°C and 30° - 55°C ± (0.04% of reading + 0.2 digits) /°C.

Input Impedance: Resistance: 5 meg Ω. Shunt Capacitance: < 50 pF.

Input Type: Floating.

Response Time: 1.6 seconds to within 3 digits of final value on one range. Add 1.2 seconds for each range change.

DC VOLTMETER

Ranges	Max Display
± 200 mV	± 199.9 mV
± 2 V	± 1.999 V
± 20 V	± 19.99 V
± 200 V	± 199.9 V
± 1200 V	± 1199 V

Maximum Input: 1200 V (dc + peak ac).

Ranging: Automatic or manual.

Sensitivity: 100 µV on 200 mV range.

Polarity: Automatically sensed and displayed.

Accuracy: 1 Year 15° to 30°C @ 95% RH.

Range	Specifications
200 mV	± (0.1% of reading + 2 digits)
2 V to 1200 V	± (0.1% of reading + 1 digit)

Temperature Coefficient: 0° - 15°C and 30° - 55°C ± (.018% reading + 0.1 digit) /°C

Input Resistance: 10 meg Ω ± 1%.

Input Type: Floating.

Normal Mode Rejection: 40 dB at 50 Hz and 60 Hz ± .1 Hz.

Effective Common Mode Rejection: With 1 kΩ unbalance is > 120 dB at 50/60 Hz ± 0.1%.

Response Time: < 0.7 seconds to within 1 digit on one range. Add 1 second for each range change.

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

AC CURRENT

Ranges	Max Display
200 µA	199.9 µA
2 mA	1.999 mA
20 mA	19.99 mA
200 mA	199.9 mA
2000 mA	1999 mA

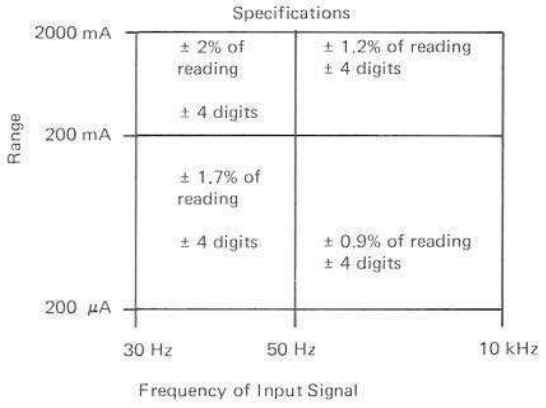
Maximum Input: 2A from < 250 V source.

Protection: 2A/250 V fuse (normal blow).

Ranging: Manual only.

Sensitivity: 100 nA on 200 µA range.

Accuracy: With display of ≥20 digits.
1 year 15 to 30°C 95% RH.



Temperature Coefficient: 0 - 15°C and 30 - 55°C
± (0.05% of reading + 0.2 digits) /°C.

Voltage Burden:

200 µA to 20 mA	< 220 mV rms
200 mA range	< 240 mV rms
2000 mA range	< 400 mV rms

Input Type: Floating.

Response Time: 1.6 seconds on any range to within 3 digits.

DC CURRENT

Ranges	Max Display
± 200 µA	± 199.9 µA
± 2 mA	± 1.999 mA
± 20 mA	± 19.99 mA
± 200 mA	± 199.9 mA
± 2000 mA	± 1999 mA

Maximum Input: 2A from < 250 V source.

Protection: 2A/250 V fuse (normal blow).

Ranging: Manual only.

Sensitivity: 10 nA on 200 µA range.

Polarity: Automatically sensed and displayed.

Accuracy: 1 year, 15 to 30°C @ 95% RH.

Range	Specifications
200 µA to 200 mA	± (0.3% of reading + 2 digits)
2000 mA	± (0.6% of reading + 2 digits)

Temperature Coefficient: 0 - 15°C and 30 - 55°C
± (.028% of reading + 0.1 digits) /°C.

Voltage Burden:

Range	Max Burden at Full Scale
200 µA to 20 mA	< 220 mV
200 mA	< 240 mV
2000 mA	< 400 mV

Input Type: Floating.

Response Time: 0.7 seconds on one range to within 1 digit.

OHMMETER

Ranges	Max Display
20 Ω	19.99 Ω
200 Ω	199.9 Ω
2 kΩ	1.999 kΩ
20 kΩ	19.99 kΩ
200 kΩ	199.9 kΩ
2 MΩ	1.999 MΩ
20 MΩ	19.99 MΩ

Input Protection: 250 V rms.

Ranging: Automatic, or manual.

Sensitivity: 10 milliohm on 20 Ω range.

Accuracy: 1 year 15 to 30°C at 95% RH.

Range	Specification
20 Ω	± (0.5% of reading + 10 digits)
200 Ω to 2 MΩ	± (0.2% of reading + 2 digits)
20 MΩ	± (0.8% of reading + 2 digits)

Temperature Coefficient: 0 - 15°C and 30 - 55°C.

Range	Specifications
20 Ω to 2MΩ	± (0.04% of reading + 0.2 digits) /°C
20 MΩ	± (.18% of reading + 0.2 digits) /°C

Configuration: 2 wire.

Open Circuit Voltage: < 5 V max.

Current through unknown:

Range	20Ω 200Ω	2kΩ	20kΩ	200kΩ	2MΩ	20MΩ
Current	5mA 5mA	500µA	50µA	5µA	500nA	50nA

Response Time: 0.8 seconds to within 1 digit. Add 0.8 seconds for each range change.

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.

Table 1-2. General Information.

GENERAL:

Display: 7 segment RED 0.3 inch high LED's. Function and range annunciation.

Reading rate: 2.4 - 4.7/sec. depending on input level.

A-D Conversion: Dual slope.

Integration time: 100 msec.

Ranging: Automatic or manual in acV, dcV, and Manual only in ac and dc current.

Storage Temperature: (- 40 to + 75)°C; (- 40 to + 65)°C with batteries.

Operating Temperature: (0 to 55)°C.

Humidity: 0 - 95% RH at 40°C.

Power: AC line; 48 - 440 Hz
86-106 V Opt. 100
104-127 V Opt. 115
190-233 V Opt. 210
208-250 V Opt. 230

Rechargeable batteries included with 3435A only.

Battery: 10 hours minimum continuous operation. Recharge Time: 16 hours operating, 12 hours non-operating. 4 hour recharge provides 8 hours of continuous use.

Total Instrument Power Dissipated: AC only; 3 watts. With charger; 8 watts

Configuration: 3435A Std, Streamlined portable case with handle, ac line power. Rechargeable batteries, and recharger included.

3435A Opt 001, Streamlined portable case, ac line power only.

3435A Opt 002, Rack and Stack case, ac line power only. Rack mount kit not included.

Dimensions: 3435A: 23.81 cm (9 3/8") wide x 9.84 cm (3 7/8") high x 27.62 cm (10 7/8") long.

3435A Option 002: 20.96 cm (8 1/4") wide x 8.57 cm (3 3/8") high x 26.67 cm (10 1/2") long.

Weights: 3435A: 2.41 kg (5 lbs. 5 oz.)

3435A Option 001: 1.84 kg (4 lbs. 1 oz.)

3435A Option 002: 1.81 kg (4 lbs.)

1-9. OPTIONS.

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

1-11. The option label affixed to the rear of the Multimeter identifies the line voltage for which the instrument is wired. This operating voltage can be changed by following the procedure outlined in Section V (Power Requirement Modification Instructions). If the line voltage option is changed, the option label should also be corrected to reflect the new configuration.

NOTE

Option 001 Multimeters can be converted to standards by adding the battery and charge circuits. The Battery/Charger kit is -hp- Part Number 03435-80001.

1-12. ACCESSORIES.

1-13. The accessories available for use with the Multimeter are listed in Table 1-4. A test lead set, -hp- part number 8120-2521, is included.

Table 1-3. Options.

Standard	Streamlined portable case with handle. AC line or rechargeable battery operation with battery charger included.
Option 001	Streamlined portable case with handle. AC line operation only.
Option 002	Rack mount case. AC line operation only.
Option 100	86 - 106 Vac 48 - 440 Hz 3 Watts
Option 115	104 - 127 Vac 48 - 440 Hz 3 Watts
Option 210	190 - 233 Vac 48 - 440 Hz 3 Watts
Option 230	208 - 250 Vac 48 - 440 Hz 3 Watts
Option 908	Rack Mount Kit (for Option 002 case only). -hp- Part Number 5061-0054.
Option 910	An additional Operating and Service Manual.

Table 1-4. Accessories.

11002A	Test leads (dual banana to dual alligator).
11003A	Test leads dual banana to probe and alligator.
11096B	RF Probe 10 kHz to 700 MHz, use only 10 V and 100 V dc ranges.
5061-0054	Rack adapter kit including ½ module filler panel. Use with Opt. 02 only.
34110A	Soft vinyl carrying/operating case.
34111A	High voltage probe, 40 kV dc
34112A	Touch - Hold, input probe.
11067A	Test lead kit.

1-14. SAFETY CONSIDERATIONS.

1-15. This Operating and Service Manual contains cautions and warnings alerting the user to hazardous operating and maintenance conditions. This information is flagged by a caution or warning heading and/or the symbol ⚠. The ⚠ symbol appears on the front panel and is an international symbol meaning "refer to the Operating and Service Manual". This symbol flags important operating instructions located in Section III. To ensure the safety of the operating and maintenance personnel and retain the operating condition of the instrument, these instructions must be adhered to.

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 test 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 1-2. Before connecting the instrument to ac power, verify that the ac power source matches the power requirement of the instrument as marked on the option label affixed to the rear of 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 + 15°C to + 30°C. The instrument can be operated where the ambient temperature is within the range of 0°C to + 40°C 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 of plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect front panel 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).

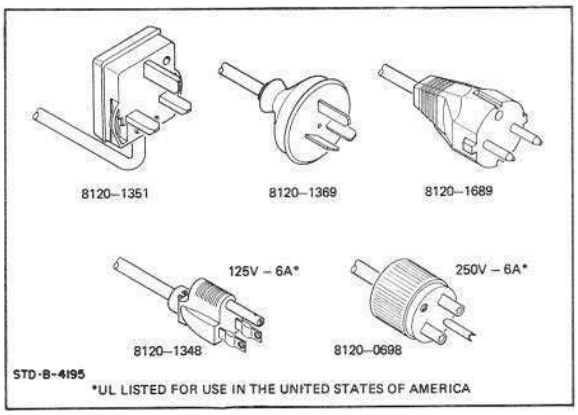
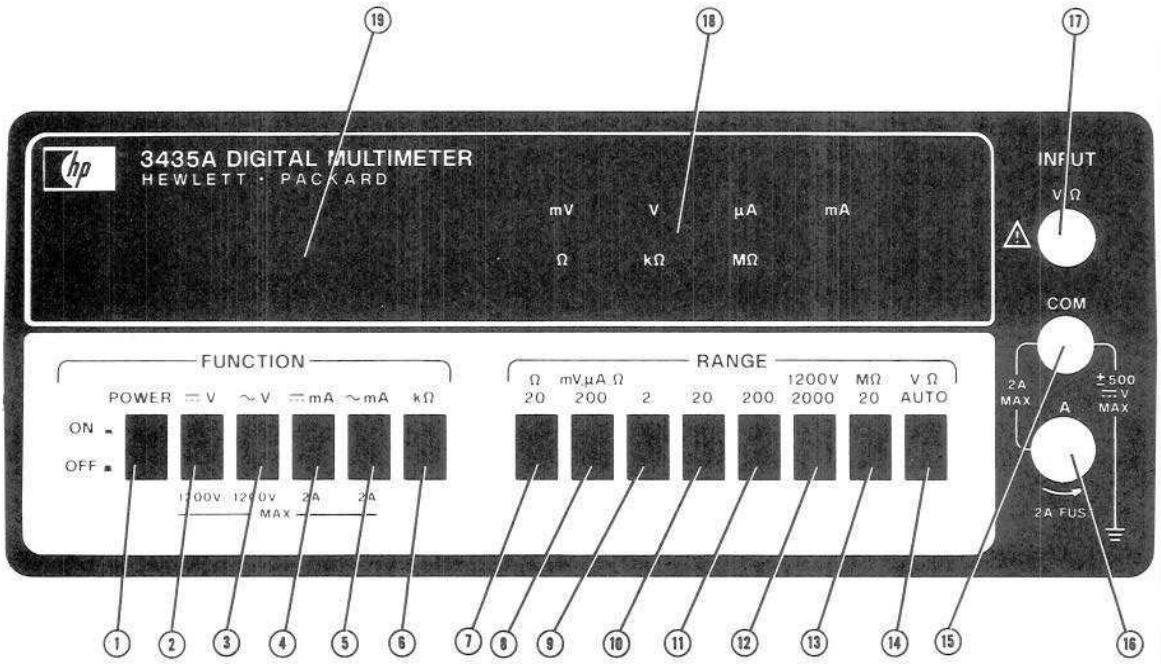


Figure 2-1. Power Receptacles.



DESCRIPTION

① POWER ON/OFF SWITCH. SWITCHES MULTIMETER POWER ON OR OFF. BATTERIES ARE BEING RECHARGED WHENEVER AC LINE VOLTAGE IS CONNECTED REGARDLESS OF THE POWER SWITCH POSITION. THE CHARGE RATE, HOWEVER, IS MUCH FASTER WITH THE POWER SWITCH IN THE OFF POSITION.

FUNCTION SWITCHES: USED TO SELECT THE FIVE MULTIMETER FUNCTIONS.

② DC VOLTAGE FUNCTION SWITCH.

③ AC VOLTAGE FUNCTION SWITCH.

④ DC MILLIAMPERES FUNCTION SWITCH.

⑤ AC MILLIAMPERES FUNCTION SWITCH.

⑥ KILOHMS FUNCTION SWITCH.

MANUAL RANGE SWITCHES: USED TO SELECT INPUT MEASUREMENT RANGES.

⑦ 20 OHMS RANGE SWITCH (OHMS ONLY).

⑧ 200 MILLIVOLT, MICROAMP AND OHMS RANGE SWITCH.

⑨ 2 VOLT, MILLIAMP AND KILOHM RANGE SWITCH.

⑩ 20 VOLT, MILLIAMP AND KILOHM RANGE SWITCH.

⑪ 200 VOLT, MILLIAMP AND KILOHM RANGE SWITCH.

⑫ 1200 VOLT, 2000 MILLIAMP AND KILOHM RANGE SWITCH.

⑬ 20 MEGOHM RANGE SWITCH (OHMS ONLY).

⑭ AUTO RANGE SWITCH. AUTOMATICALLY SELECTS RANGE FOR BEST RESOLUTION WHEN AC VOLTS, DC VOLTS, OR OHMS FUNCTIONS ARE SELECTED.

INPUT TERMINALS.

⑮ COM INPUT TERMINAL: COMMON TERMINAL FOR AC/DC VOLTS, AC/DC AMPS AND OHMS MEASUREMENTS..

⑯ AMPS INPUT TERMINAL: USED IN CONJUNCTION WITH THE COM TERMINAL FOR MEASURING AC AND DC CURRENT.

⑰ VOLTS/OHMS INPUT TERMINAL: USED IN CONJUNCTION WITH THE COM TERMINAL FOR MEASURING AC/DC VOLTAGE AND OHMS.

⑱ FUNCTION/RANGE ANNUNCIATORS.

⑲ DISPLAY: FOUR SECTION LED READOUT. LEFT SECTION DISPLAYS ± 1. RIGHT THREE SECTIONS ARE 7 SEGMENT.

Figure 3-1. Description on Controls and Connectors.

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 3-1.

WARNING

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

3-3. AC Operation.

3-4. Before connecting the Multimeter to ac power, verify that the ac power source matches the power requirements of the Multimeter as marked on the option label affixed to the rear of the instrument. 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. Battery Operation.

3-6. Recharging the Battery. Before operating the Multimeter in the Battery Mode, ensure that the battery is charged. Connect the Multimeter to the proper ac line voltage and allow 12 hours for a full recharge with the POWER switch off (out). This provides a minimum operating time of 10 hours. A 4 hour recharge will allow an operating time of 8 hours. Operating the instrument with the proper ac line voltage connected and the POWER switch on, provides a full battery recharge in 16 hours.

NOTE

Repeated partial charge cycles may result in a temporary loss of battery capacity. Normal capacity can be restored by fully charging the battery.

3-7. Low Battery Voltage. The Multimeter will operate in Battery Mode when the battery voltage is greater than 5.6 V. This voltage is measured through the access hole on the bottom of the Multimeter. To accomplish this perform the following procedure:

a. Disconnect ac line voltage.

b. Select dcV function and 20 V range.

c. Insert the V - Ω test probe into the access hole as shown in Figure 3-2.

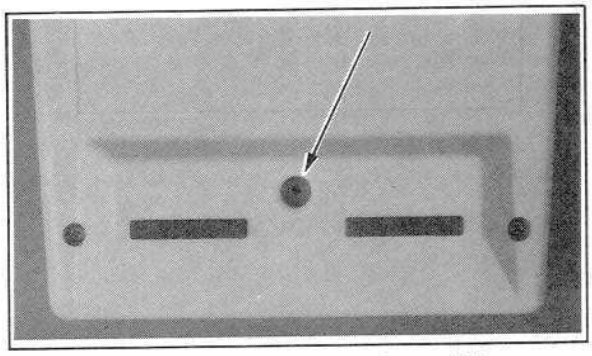


Figure 3-2. Battery Voltage Access Hole.

3-8. If the battery voltage drops below 5.6 volts, the Multimeter will automatically stop operating (blank display) to prevent damage to the battery. If this occurs, set the POWER switch to OFF and recharge the battery.

3-9. If the display has blanked due to low battery voltage, and there is a requirement to make one or two more measurements before recharging the battery, set the POWER switch to OFF for approximately 15 minutes and then make the measurement. This allows the battery to partially rejuvenate.

3-10. Overload/Overrange/Improper Function Indication.

3-11. Figure 3-3 shows the display indication during overload, overrange, or an improper switch setting.

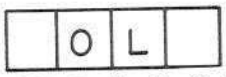


Figure 3-3. Overload Indication.

3-12. Table 3-1 lists improper switch combinations.

Table 3-1. Improper Switch Combinations.

Function	Range	
⎓ mA	Ω 20	MΩ 20
~ mA	Ω 20	MΩ 20
⎓ V	Ω 20	MΩ 20
~ V	Ω 20	MΩ 20
⎓ mA	Auto	
~ mA	Auto	

3-13. Auto.

3-14. Depressing the AUTO switch with acV, dcV or kΩ function selected sets the Multimeter in an automatic ranging mode. In this mode the Multimeter will *uprange* if the display reading increases above (+) or (-) 1999 and *downrange* if the display decreases below (+) or (-) 180. These numerical autoranging points are irrespective of decimal placement. The difference between the two autoranging points is called autoranging hysteresis. Figure 3-4 shows the autoranging points for dc voltage measurements from 0 to 1200 Vdc. Autoranging in other Multimeter functions is similar.

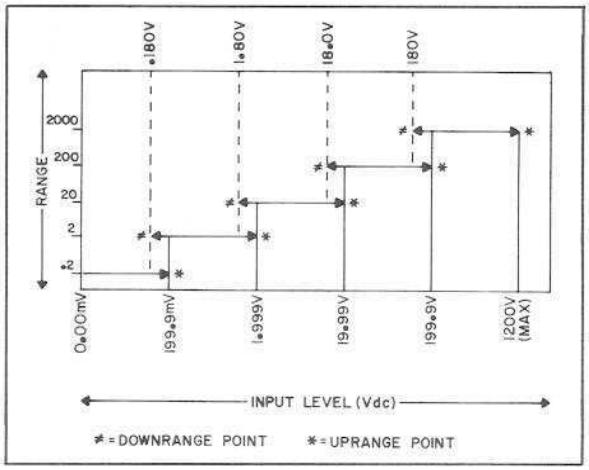


Figure 3-4. Multimeter Autoranging.

3-15. To release the AUTO switch depress one of the MANUAL RANGE switches.

3-16. Input Terminals.

3-17. VΩ (Volts/Ohms). The VΩ terminal is the *high* terminal for ac and dc voltage measurements. For ohms measurements, it is the positive (+) terminal.

3-18. COM (Common). The COM terminal is used for all five Multimeter functions. It is the negative (-) terminal for ohms measurements and it is the *low* terminal for ac and dc voltage and current measurements.

⚠ CAUTION

To avoid possible damage to the Multimeter circuitry, the voltage between COM and ⏚ (earth ground) must not exceed ± 500 Vdc.

3-19. A (Amps). The A terminal is the *high* terminal for ac and dc amps measurements. There is a 2 amp input protection fuse in series with this terminal.

⚠ CAUTION

The current function is protected by a fuse of 250 V rating. To avoid damage to the Multimeter, current sources having open circuit voltages greater than 250 V (dc + peak ac) must not be connected to the A (amps) input terminal.

3-20. AC Voltage Measurements.

⚠ CAUTION

To avoid possible damage to the Multimeter circuitry, the ac input voltage must not exceed 1700 V (dc + peak ac).

3-21. Procedure:

a. Depress ~ V (ac volts).

b. Depress proper manual range (200 mV to 1200 V) or depress AUTO for automatic range selection.

c. Connect test leads from the Multimeter VΩ (high) and COM (low) terminals to the voltage under test as shown in Figure 3-5.

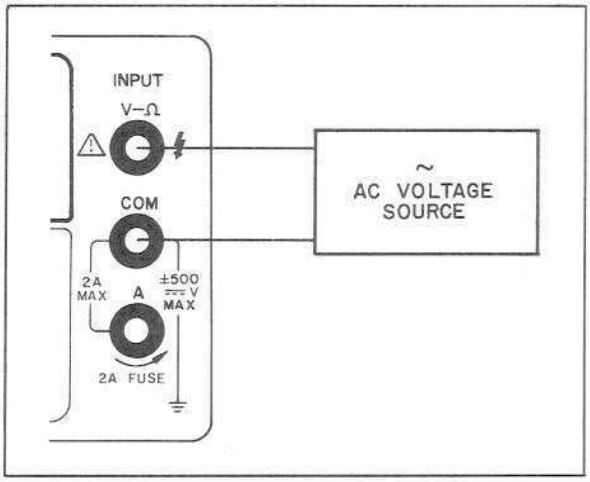


Figure 3-5. AC Voltage Measurement.

3-22. DC Voltage Measurements.

⚠ CAUTION

To avoid possible damage to the Multimeter circuitry, the dc input voltage must not exceed 1200 V (dc + peak ac).

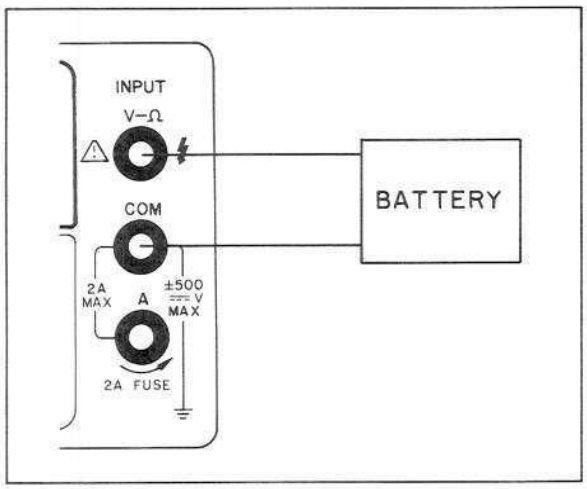


Figure 3-6. DC Voltage Measurements.

3-23. Procedure:

a. Depress ⎓ V (dc volts).

b. Depress proper manual range (200 mV to 1200 V) or depress AUTO for automatic range selection.

c. Connect test leads from the Multimeter VΩ (high) and COM (low) terminals to the voltage under test as shown in Figure 3-6.

3-24. AC Current Measurements.

⚠ CAUTION

The current function is protected by a fuse of 250 V rating. To avoid damage to the Multimeter, current sources having open circuit voltages greater than 250 V (dc + peak ac) must not be connected to the A (amps) input terminal.

3-25. Procedure:

a. Depress ~ mA (ac milliamperes).

b. Depress proper manual range (200 μA to 2000 mA).

c. Connect test leads from the Multmeter A and COM terminals in series with the current under test as shown in Figure 3-7.

3-26. DC Current Measurement.

⚠ CAUTION

The current function is protected by a fuse of 250 V rating. To avoid damage to the Multimeter, current sources having open circuit voltages greater than 250 V (dc + peak ac) must not be connected to the A (amps) input terminal.

3-27. Procedure:

a. Depress ⎓ mA (dc milliamperes).

b. Depress proper manual range (200 μA to 2000 mA).

c. Connect test leads from the Multimeter A and COM terminals in series with the current under test as shown in Figure 3-8.

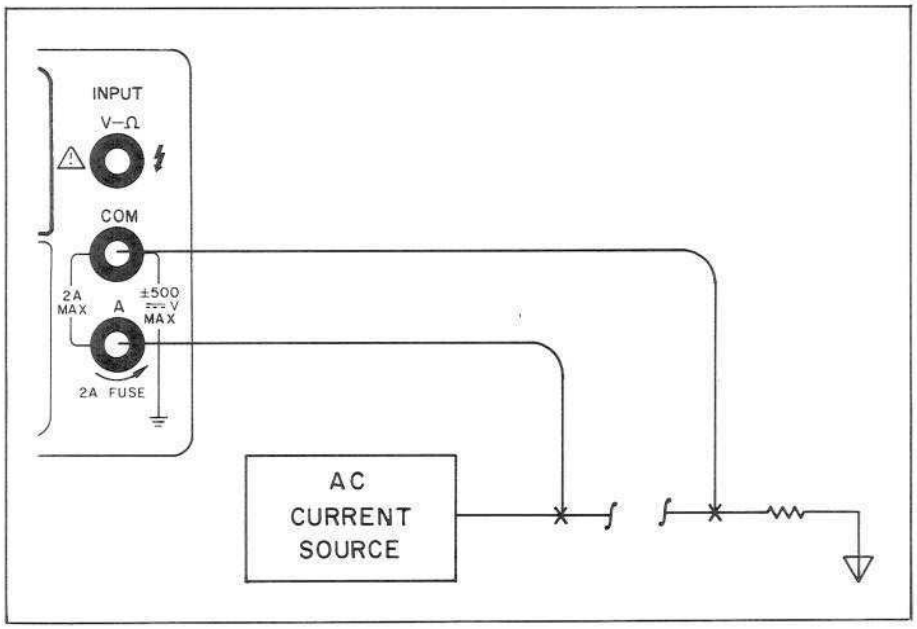


Figure 3-7. AC Current Measurement.

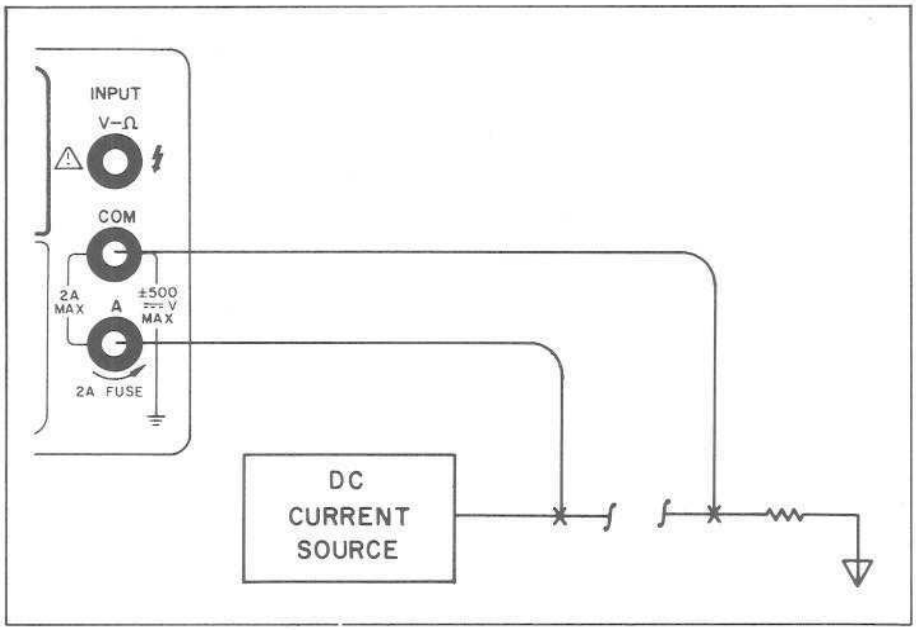


Figure 3-8. DC Current Measurements.

3-28. Resistance Measurements.

3-29. Procedure:

a. Depress kΩ (kilohms).

b. Depress proper manual range (20 Ω to 20 MΩ).

c. Connect test leads from the Multimeter VΩ (+) and COM (-) terminals to the resistance under test as shown in Figure 3-9.

NOTE

When making resistance measurements using the lower ohms ranges, consideration should be given to the resistance of the test leads. This potential measurement error can be eliminated by measuring the lead resistance and subtracting it from the combined resistance value of the test leads and the resistance under test.

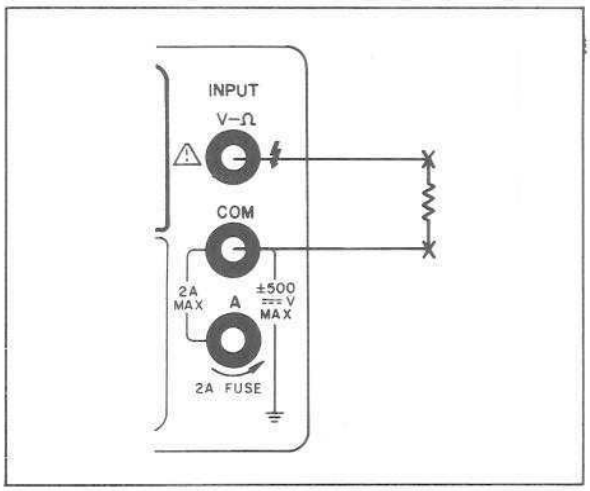


Figure 3-9. Resistance Measurement.

3-30. Handle/Bail.

3-31. The Multimeter display viewing angle is adjusted by rotating the Handle/Bail to a convenient position as shown in Figure 3-10.

3-32. Option Decal.

3-33. The option decal is affixed to the rear of the Multimeter. An example is shown in Figure 3-11.

3-34. Information Decal.

3-35. The information decal shown in Figure 3-12 is affixed to the underside of the Multimeter.

3-36. Amps Input Fuse Replacement.

3-37. The amps input is protected by a 2A 250 V fuse, -hp- Part Number 2110-0002. This fuse is easily replaced using the following procedure:

a. Insert a coin or wide bladed screwdriver into the slots of the A input terminal.

b. Press the color ring in and rotate it counterclockwise 1/3 turn.

c. Remove and replace the blown fuse.

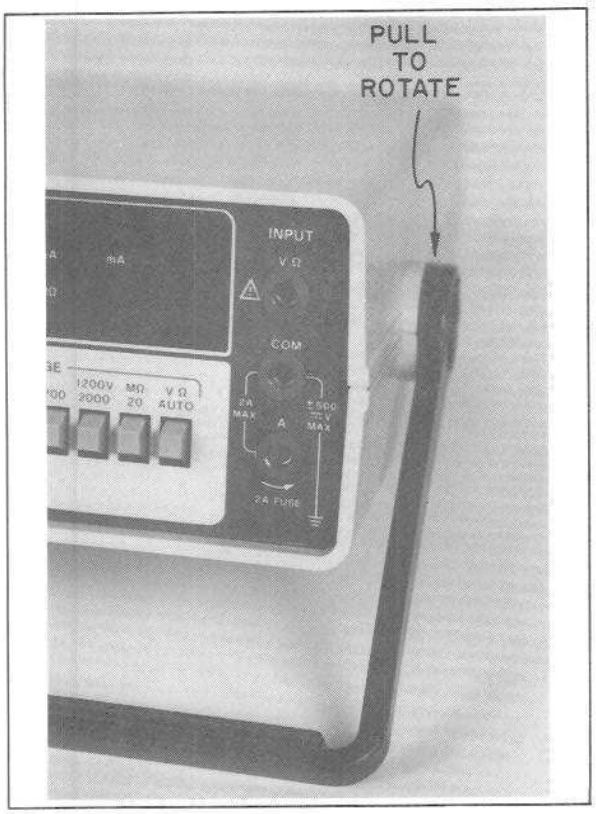


Figure 3-10. Handle/Bail Positioning.

3-38. Multimeter Cleaning.

CAUTION

Do not allow cleaning solvents, flux remover, or alcohol to come in contact with the Multimeter.

3-39. The Multimeter case and front panel should only be cleaned with a mild solution of soap and water and a soft cloth.

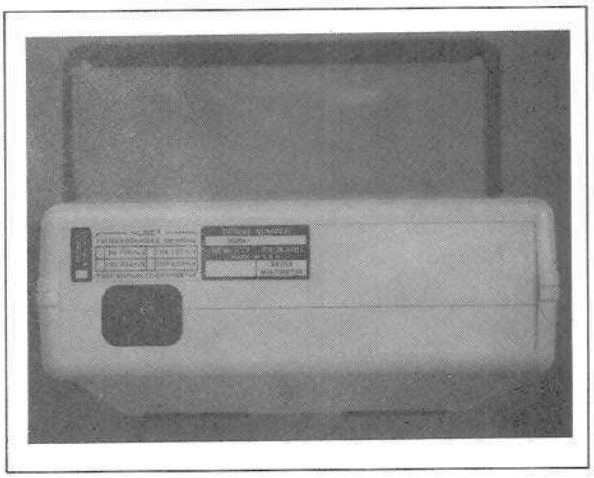
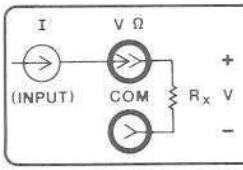


Figure 3-11. Option Decal.

3435A DIGITAL MULTIMETER
HEWLETT-PACKARD

WARNING: NO OPERATOR SERVICEABLE PARTS INSIDE. REFER TO QUALIFIED PERSONNEL ONLY.

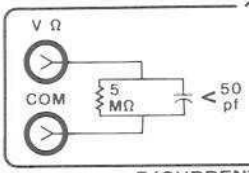
Ω (OHMS)



- V⎓ 5 V⎓ OPEN CIRCUIT.
- PROTECTION: ± 350 V⎓ OR 250 VRMS.
- FOR BEST ACCURACY ON LOW RESISTANCE RANGES SUBTRACT LEAD RESISTANCE.

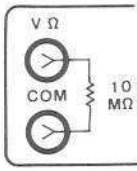
RANGE	I	V 1K COUNTS
20 Ω	5 mA	50 mV
200 Ω	5 mA	500 mV
2 kΩ	500 μA	500 mV
20 kΩ	50 μA	500 mV
200 kΩ	5 μA	500 mV
2 MΩ	500 nA	500 mV
20 MΩ	50 nA	500 mV

~V (AC VOLTS)



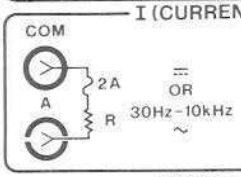
- MAXIMUM VOLTAGE: 1199 VRMS.
- MAXIMUM INPUTS: 500 V⎓ 1700 V(⎓ & P ~), 10^7 V - Hz.
- FREQ RANGE: 30 Hz - 100 k Hz.
- CONVERTER: AVERAGE RESPONDING, CALIBRATED IN RMS.

⎓V (DC VOLTS)



MAXIMUM VOLTAGE: 1199 V⎓

I (CURRENT) (MANUAL RANGE ONLY)



I MAX: 1.999A (<250 V SOURCE).

RANGE	R
200 μA	1 kΩ
2 mA	100 Ω
20 mA	10 Ω
200 mA	1 Ω
2 A	0.1 Ω

BATTERY

CHARGE TIME		RUN TIME
INST ON	INST OFF	@25°C
2.5 HR.	1.5 HR	4 HR
16 HRS	12 HR.	10 HR

CONT CHG WILL NOT HARM BAT.
5.6 - 6.4V BAT CONTACT BETWEEN RUBBER FEET.

FUSES

FUNCTION	VALUE	LOCATION
~LINE	125 mA/ 250 V	MAIN BD
I	2A/250 V	A INPUT
BATTERY	2A/250V	BAT BD

AUTO RANGE

UP RANGE
2000 COUNTS

DOWN RANGE
179 COUNTS

SAMPLE RATE

5/SEC AT 000

2/SEC AT 1999

"OL" DISPLAY

OFF SCALE INPUT OR IMPROPER SELECTION OF FUNCTION AND RANGE

NOTE: SHORTING COM TO A STOPS SAMPLING IN ⎓ V (DC VOLTS) & ~ V (AC VOLTS).

Figure 3-12. Information Decal.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation for the 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. Input Switching. The input switching block consists of the Function switches and the Range switches. These switches program the controller using a 3 line function code (FNA, FNB, FNC) and a 4 line range code (MRD, MRE, MRF, Auto).

4-5. Input Amplifier. The input amplifier is a multi-gain operational amplifier. It is used for all five input functions. The gain is selected by MOS FET switches which are controlled by the controller (U13) or by the manual range switches.

4-6. Post Amplifier. Ac and dc voltages are amplified by the post amplifier. The gain is x1 or x10 and is selected by MOS FET switches. The switching is controlled by the manual range switches or by the controller (U13).

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 function, the input voltage to the converter is the ac voltage drop across the current shunts, times the gain of the input and post amplifiers.

4-8. Ohms Current Source. The ohms current source provides ohms reference voltage for the analog to digital converter and it provides sense current to the "unknown resistance" for each of the 7 ohms ranges.

4-9. Current Shunts. The current shunts are used for ac and dc current measurements. The voltage drop across the shunt resistors is the input voltage to the input amplifier in the ac or dc milliamps function.

4-10. Analog to Digital Converter. The analog to digital converter use the *dual slope integration technique* to translate analog input signals into digital timing pulses.

4-11. Controller. The controller processes range and function information and provides digital control to MOS FET switches in the input and post amplifiers and the analog to digital converter. The controller also converts the comparator output (run down time) into appropriate digit and segment drive voltages to operate the display.

4-12. Display. The display provides an annunciated digital readout of the input signal using light emitting diodes.

4-13. Battery Charger. The battery charger consists of a three cell rechargeable battery, a current limited charger circuit and a digitally controlled ac to dc converter. The battery charger circuitry operates whenever ac line voltage is connected.

4-14. Power Supply. The power supply provides dc voltages of +7, -7, -2, and V_{Disp} to the Multimeter circuitry. V_{Disp} will be equal to the battery voltage (5.6 V to 6.5 V) for standard configuration instruments. V_{Disp} will be 6.4 ± .2 for Option 001 and 002 instruments.

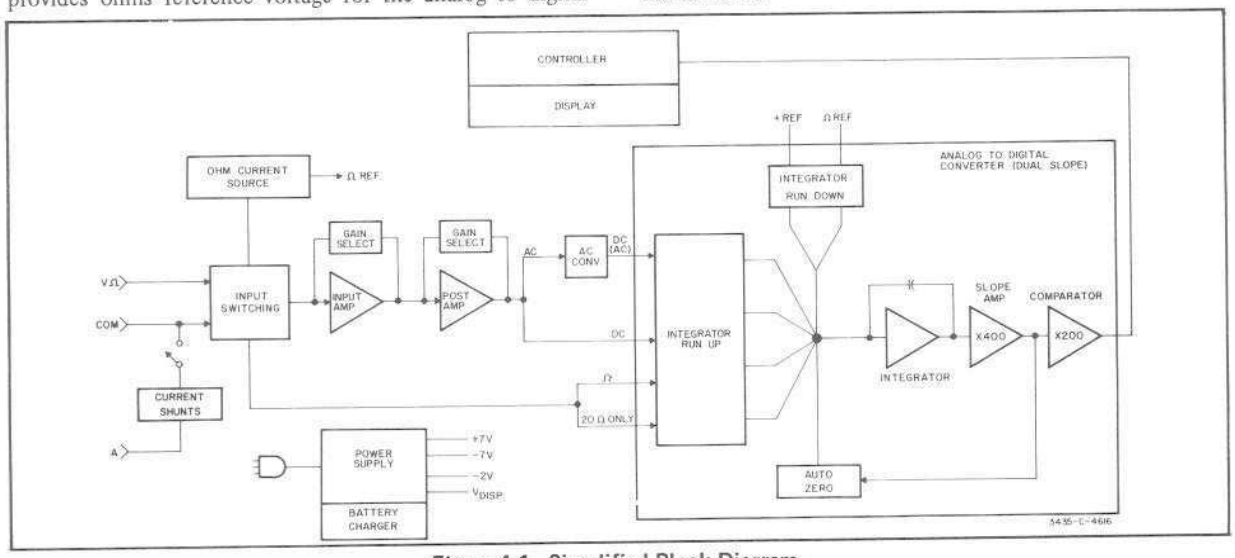


Figure 4-1. Simplified Block Diagram.

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.

Table 5-1. Test Equipment Required.

Instrument Type	Required Characteristics	Recommended Model
Digital Volt/Ohmmeter	DC Volts: 1 V, 10 V and 100 V range Accuracy: ± 0.04% Input Resistance: 10 MΩ Ohms: 20 k Ω Accuracy: ± 0.07%	-hp- 3470 System; -hp- 34702A Multimeter
Digital Voltmeter	DC Volts: 5 digit resolution to 1 μV on 100 mV dc range Accuracy: ± 0.007% AC Volts: 1 V and 10 V range Frequency: 40 Hz to 20 kHz Accuracy: 0.25%	-hp- 3450B
AC Calibrator/High Voltage Amplifier	Frequency: 20 Hz to 100 kHz Output: 1 mV to 1000 V Accuracy (mid band): ± 0.1%	-hp- 745A/746A
DC Standard	Output: 1 mV to 1000 V Accuracy: ± 0.02%	-hp- 740B
Meter Calibrator	Output: 1 A Accuracy: ± 0.1%	-hp- 6920B
Electronic Counter	Frequency: 50 and 60 Hz Accuracy: ± 0.01%	-hp- 5300A/5302A
Power Supply	Output: 20 V, 1 A	-hp- 6294A
Resistor Decade Box	10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ and 1 MΩ steps Accuracy: ± 0.005%	General Radio Mdl GR 1433-Z
Resistors	1 Ω ± 0.02% 10 Ω ± 0.01% 1 kΩ ± 0.01% 10 kΩ ± 0.01% 100 kΩ ± 0.01% 1 MΩ ± 0.01% 10 MΩ ± 0.1% 22 kΩ ± 1%	G.R. 1440-9601 G.R. 1440-9611 G.R. 1440-9631 G.R. 1440-9641 G.R. 1440-9651 G.R. 1440-9661 0698-8194 0757-1087

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.

5-5. PERFORMANCE TESTS.

5-6. AC Voltage Accuracy Test.

5-7. 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 1700 V (dc + peak ac).

a. Set the Multimeter to ac V.

b. Connect the AC Calibrator as shown in Figure 5-1.

c. Check the ranges and frequencies listed in Table 5-2 for the tolerances indicated on all ranges through 200 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.

d. To check the 1200 V range, connect the AC Calibrator and High Voltage Amplifier to the Multimeter and check the tolerances indicated for the 1200 V range.

5-8. DC Voltmeter Accuracy Test.

5-9. A DC Standard is required for this test.

a. Set the Multimeter to measure dc volts.

b. Connect the DC Standard to the VΩ and COM terminals as shown in Figure 5-2.

c. Check all the ranges listed in Table 5-3 for the tolerances indicated.

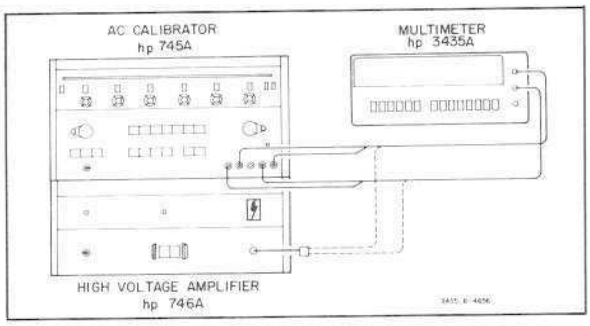


Figure 5-1. AC Voltage Accuracy Test.

Table 5-2. AC Voltage Accuracy Test.

Range	AC Standard Output	Test Frequency	Multimeter Display Limits
200 mV	10 mV	30 Hz	9.5 to 10.5 mV
	10 mV	50 Hz	9.7 to 10.3 mV
	10 mV	1 kHz	9.7 to 10.3 mV
	10 mV	10 kHz	9.7 to 10.3 mV
	10 mV	20 kHz	9.7 to 10.3 mV
	10 mV	50 kHz	8.8 to 11.2 mV
	10 mV	100 kHz	8.8 to 11.2 mV
	50 mV	30 Hz	49.0 to 51.1 mV
	50 mV	50 Hz	49.5 to 50.5 mV
	50 mV	20 kHz	49.5 to 50.5 mV
	50 mV	100 kHz	48.2 to 51.7 mV
	100 mV	30 Hz	98.2 to 101.8 mV
	100 mV	50 Hz, 500 Hz	99.4 to 100.6 mV
	100 mV	20 kHz	99.4 to 100.6 mV
	100 mV	100 kHz	97.5 to 102.5 mV
2 V	1 V	30 Hz	.982 to 1.018 V
	1 V	50 Hz, 1 kHz	.994 to 1.006 V
	1 V	20 kHz	.994 to 1.006 V
	1 V	100 kHz	.975 to 1.025 V
20 V	10 V	30 Hz	9.82 to 10.18 V
	10 V	50 Hz, 10 kHz	9.94 to 10.06 V
	10 V	20 kHz	9.94 to 10.06 V
	10 V	100 kHz	9.75 to 10.25 V
200 V	100 V	30 Hz	98.2 to 101.8 V
	100 V	50 Hz, 15 kHz	99.4 to 100.6 V
	100 V	20 kHz	99.4 to 100.6 V
	100 V	100 kHz	97.5 to 102.5 V
1200 V	1000 V	30 Hz	982 to 1018 V
	1000 V	50 Hz, 1 kHz	994 to 1006 V
	1000 V	10 kHz	994 to 1006 V

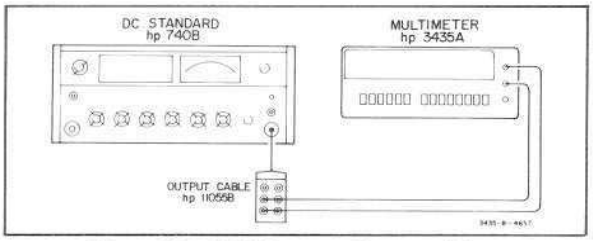


Figure 5-2. DC Voltmeter Accuracy Test.

CAUTION

To avoid possible damage to the Multimeter circuitry, the dc input voltage must not exceed 1200 V (dc + peak ac).

Table 5-3. DC Voltage Accuracy Test.

Range	DC Standard Output	Multimeter Display Limits
200 mV	+ 10 mV + 50 mV - 100 mV	+ 9.8 to + 10.2 mV + 49.7 to + 50.25 mV - 99.7 to - 100.3 mV
2 V	- .1 V + .5 V + 1 V	- .099 to - .101 V + .498 to + .502 V + .998 to + 1.002 V
20 V	- 2 V - 5 V + 10 V	- 1.99 to - 2.01 V - 4.98 to - 5.02 V + 9.98 to + 10.02 V
200 V	+ 20 V - 50 V - 100 V	+ 19.9 to + 20.1 V - 49.8 to - 50.2 V - 99.8 to - 100.2 V
1200 V	+ 200 V - 500 V + 1000 V	+ 198 to + 201 V - 498 to - 502 V + 998 to + 1002 V

5-10. AC Ammeter Accuracy Test.

a. Connect the equipment as shown in Figure 5-3 using the decade resistor box to select the value of R_A. Set the Multimeter function to ac A (~ A). Using the values of R_A and AC Calibrator outputs shown in Table 5-4, check the 200 μA, 2 mA and 20 mA Multimeter ranges at the frequencies listed.

b. To check the 200 mA and 2000 mA ranges, it will be necessary to use an ac current source such as the Model 6920B Meter Calibrator. Disconnect the AC Calibrator and connect the 6920B in its place. Set 6920B OUTPUT SWITCH to OFF.

c. Set the 6920B function to AC and OUTPUT SWITCH to ON HOLD. Check the Multimeter 200 mA range at 20 mA, 50 mA, and 100 mA for the tolerances listed in Table 5-5. Return the OUTPUT SWITCH on the 6290B to OFF before changing any ranges.

d. Change the 6920B and Multimeter ranges to 2000 mA (2A). Set the calibrator OUTPUT switch to ON HOLD and check the Multimeter 2000 mA range at levels of 100 mA, 500 mA and 1000 mA for the tolerances listed in Table 5-5.

5-11. DC Ammeter Accuracy Test.

5-12. This test requires the use of a power supply, a DC Standard and a precision resistor listed in Table 5-6 (part numbers are given in Table 5-1) or a resistor decade box.

a. Connect the Multimeter and test equipment as shown in Figure 5-4.

b. Connect the 100 kilohm ± 0.01% resistor in the R_A position as shown.

c. Set the Multimeter function to DCA (⎓ A) and range to 200 μA. Adjust the power supply output for a differential voltmeter reading of 1.000 V. The Multimeter should indicate 9.8 to 10.2 μA.

d. Check all the Multimeter ranges, using the values of R_A and differential voltmeter readings shown in Table 5-6. The Multimeter display should indicate within the limits provided.

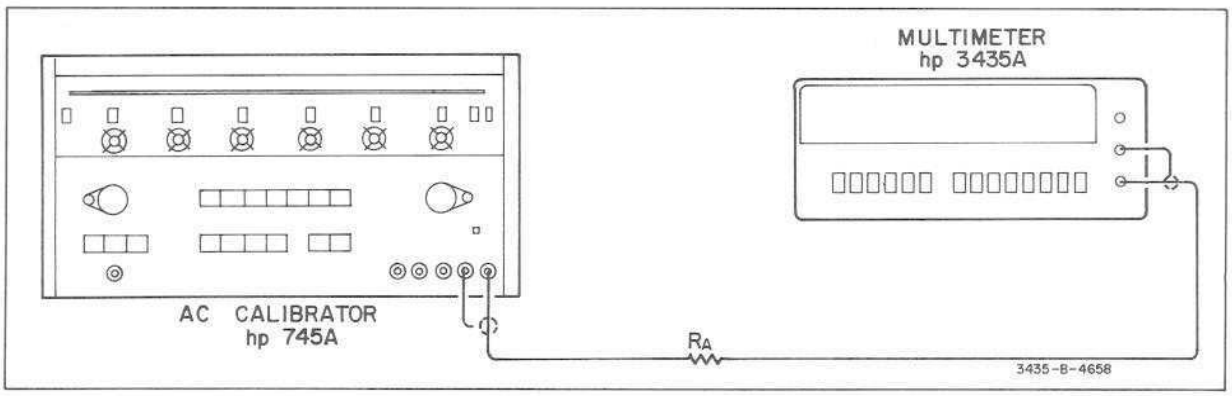


Figure 5-3. AC Ammeter Accuracy Test 200 μA thru 20 mA Range.

Table 5-4. AC Ammeter Accuracy Test, 200 μA thru 20 mA Ranges.

Range	AC Calibrator Output Level	AC Calibrator Frequency	R_A Value	Current Level	Multimeter Display Limits
200 μA	1 V	30 Hz 50 Hz, 10 kHz	100 kΩ ± .1%	10 μA	9.4 to 10.6 μA 9.5 to 10.5 μA
2 mA	10 V	30 Hz 50 Hz, 10 kHz	100 kΩ ± .1%	.1 mA	.094 to .106 mA .095 to .105 mA
20 mA	10 V	30 Hz 50 Hz, 10 kHz	10 kΩ ± 0.1%	1 mA	.94 to 1.06 mA .95 to 1.05 mA

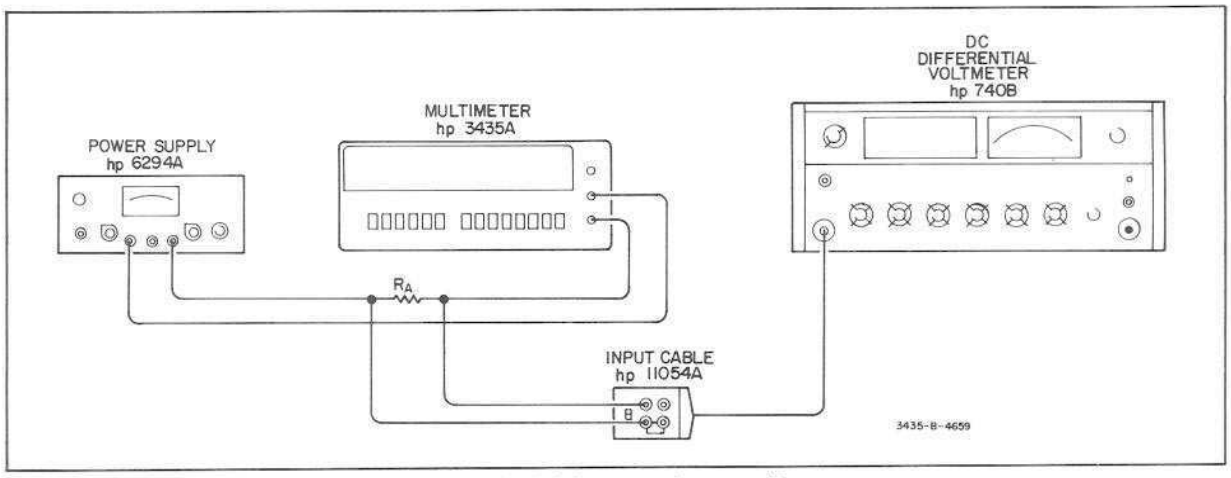


Figure 5-4. DC Ammeter Accuracy Test.

Table 5-5.

AC Ammeter Accuracy Test, 200 mA and 2000 mA Ranges.

Range	Output Meter Calibration	Multimeter Display Limits
200 mA	20 mA	19.4 to 20.6 mA
	50 mA	49.1 to 50.9 mA
	100 mA	98.7 to 101.3 mA
2000 mA	100 mA	95 to 105 mA
	500 mA	490 to 510 mA
	1000 mA	984 to 1016 mA

5-13. Ohms Accuracy Test.

5-14. A precision resistive decade box will be required for this test. It should be calibrated and have a known accuracy of .005%.

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

b. Set the Multimeter function to OHMS (Ω) and check all the ranges in Table 5-7 using the decade box to supply the indicated resistances. The Multimeter display should indicate within the limits provided.

5-15. AC Normal-Mode Rejection Test.

5-16. AC normal-mode rejection is the ratio of the peak normal-mode voltage to the resultant error in reading.

$$NMR_{(db)} = 20 \log_{10} \frac{\text{Peak ac superimposed voltage}}{\text{Effect on reading (peak volts)}}$$

An AC Calibrator and Electronic Counter are required for this test.

a. Connect the test equipment as shown in Figure 5-6. Do not connect the Multimeter at this time.

b. Using the Electronic Counter as a monitor, adjust the AC Calibrator frequency to 60 Hz ± 0.1% (Period = 16650 to 16683 μs).

c. Set the Multimeter function to dcV (⎓V) and range to 20 V. Short the Multimeter input and note the indication.

d. Disconnect the short and connect the AC Calibrator to the Multimeter input. Adjust the Calibrator output to 7.07 V rms (10 V peak).

e. The Multimeter indication should not vary more than 100 mV from the indication noted in Step C. This verifies a normal-mode rejection of greater than 40 dB.

f. Repeat Steps c, d and e for an AC Calibrator output frequency of 50 Hz ± 0.1% as monitored by the Electronic Counter (Period = 1998 to 20020 μs).

Table 5-6. DC Ammeter Accuracy Test.

Range	Current Level	R_A	Differential VM Reading	Multimeter Display Limits
200 μA	10 μA 50 μA 100 μA	100 kΩ ± 0.01%	1.0000 V 5.0000 V 10.000 V	9.8 to 10.2 μA 49.6 to 50.4 μA 99.5 to 100.5 μA
2 mA	.1 mA .5 mA 1 mA	1 kΩ ± 0.01%	.10000 V .50000 V 1.0000 V	.098 to .102 mA .496 to .503 mA .995 to 1.005 mA
20 mA	1 mA 5 mA 10 mA	1 kΩ ± 0.01%	1.0000 V 5.0000 V 10.000 V	.98 to 1.02 mA 4.96 to 5.04 mA 9.95 to 10.05 mA
200 mA	10 mA 50 mA 100 mA	10 Ω ± 0.01%	.10000 V .5000 V 1.0000 V	9.8 to 10.2 mA 49.6 to 50.4 mA 99.5 to 100.5 mA
2000 mA	100 mA 500 mA 1000 mA	1 Ω ± 0.02%	.10000 V .50000 V 1.0000 V	97 to 103 mA 495 to 505 mA 992 to 1008 mA

Table 5-7. Ohms Accuracy Test.

Range	Standard Resistance	Multimeter Display Limits
20 Ω	1 Ω 5 Ω 10 Ω	.89 to 1.11 Ω 4.87 to 5.13 Ω 9.85 to 10.15 Ω
200 Ω	10 Ω 50 Ω 100 Ω	9.8 to 10.2 Ω 49.7 to 50.3 Ω 99.6 to 100.4 Ω
2 kΩ	200 Ω (.2 k) 500 Ω (.5 k) 1 kΩ	.198 to .202 kΩ .497 to .503 kΩ .996 to 1.004 kΩ
20 kΩ	2 kΩ 5 kΩ 10 kΩ	1.98 to 2.02 kΩ 4.97 to 5.03 kΩ 9.96 to 10.04 kΩ
200 kΩ	20 kΩ 50 kΩ 100 kΩ	19.8 to 20.2 kΩ 49.7 to 50.3 kΩ 99.6 to 100.4 kΩ
2000 kΩ (2 MΩ)	200 kΩ 500 kΩ 1000 kΩ	198 to 202 kΩ 497 to 503 kΩ 996 to 1004 kΩ
20 MΩ	1 MΩ 5 MΩ 10 MΩ	.97 to 1.03 MΩ 4.94 to 5.06 MΩ 9.90 to 10.10 MΩ

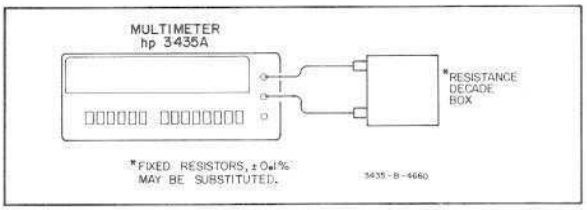


Figure 5-5. Ohms Accuracy Test.

5-17. Effective Common-Mode Rejection Test.

5-18. Effective Common-Mode Rejection (ECMR) is a measure of the ability of the Multimeter to reject dc voltages of equal amplitude applied simultaneously to both voltage input terminals. ECMR is normally measured in decibels and can be calculated by the following formula:

$$\text{ECMR (dB)} = 20 \log_{10} \frac{\text{Peak common-mode voltage}}{\text{Effect on reading (peak volts)}}$$

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

b. Set the Multimeter function to dcV (⎓V) and range to 200 mV. Note the Multimeter indication.

c. Connect an AC Calibrator as shown in Figure 5-7 and set the output amplitude to 100 V at 60 Hz ± 1 Hz. (Period = 16650 to 16683 μs.)

d. Note the Multimeter indication. The indication should not vary more than 0.1 mV from the reading noted in Step b. This verifies an ECMR of greater than 120 dB.

e. Repeat Steps c and d with the AC Calibrator frequency set to 50 Hz ± 1%. (Period = 1998 to 20020 μs.)

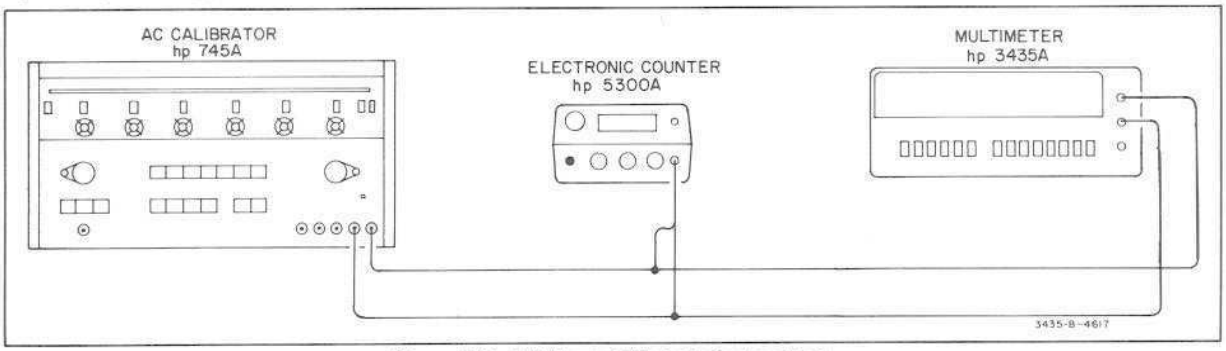


Figure 5-6. AC Normal-Mode Rejection Test.

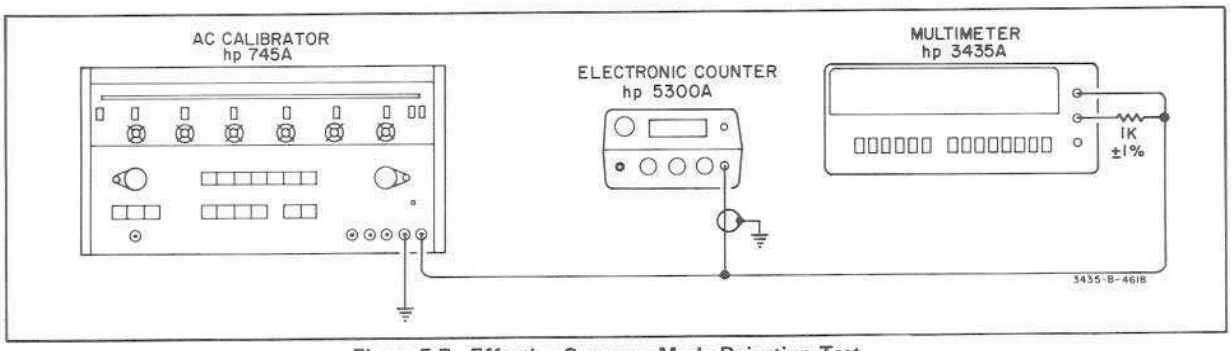


Figure 5-7. Effective Common-Mode Rejection Test.

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 of 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 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.

PRE-ADJUSTMENT PROCEDURES.

A. Disassembly Instructions.

1. Remove the Multimeter Power Cord.

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

3. Carefully return the Multimeter to the upright position with the front panel facing you.

NOTE

Battery and charger circuitry are located in the top shell and are connected to the main PC assembly by an 8 lead cable. To avoid possible damage to the cable or connectors, remove top cover slowly.

4. Remove the top shell vertically and place it at the right side of the lower shell in an inverted position. This will allow access to all internal adjustments while still being able to observe the display and change the switch settings.

B. Turn-On Instructions.

1. Connect the Multimeter ground jumper to earth ground.

2. Use ac line voltage to power the Multimeter while making adjustments.

5-19. ADJUSTMENT PROCEDURE.

5-20. Refer to foldout Figure 5-11 for the following adjustments. Ground is the reference for all measurements (COM test jumpers).

NOTE

Do not deviate from the adjustment sequence of this procedure.

5-21. ① + 7 V Power Supply Adjustment (R417).

a. Connect a dc Digital Voltmeter (DVM) to the + end of C407.

b. Adjust R417 for a dc DVM reading of +7.0 volts.

5-22. Battery Charge Voltage Adjustment (R818).

a. Disconnect ac line voltage.

b. Lift one end of battery fuse F801 to open the battery circuit.

c. Connect dc DVM to positive battery terminal.

d. Connect ac line voltage and set the POWER switch to ON.

e. Adjust R818 for a dc DVM reading of 7.2 volts.

f. Replace fust F801.

5-23. ② Clock Frequency Adjustment (R9).

a. Connect a 10 MΩ (10:1 divider) oscilloscope probe from the 5300A/5302A frequency counter input to JM2 on the Multimeter A1 PC assembly.

b. Adjust R9 for a frequency counter reading of 9980 Hz to 10020 Hz (10 kHz ± .2%).

5-24. ③ AC Zero Adjustment (R203).

a. Set the Multimeter to acV, 20 V range.

b. Connect a short across the V/Ω to COM terminals.

c. Adjust R203 for a Multimeter display reading of 00.0 V.

5-25. ④ 20 Ohms Zero Adjustment (R111).

a. Set the Multimeter to kΩ, 20 Ω range.

b. Connect a short across the V/Ω to COM terminals.

NOTE

Use a low resistance short comprised of heavy copper wire soldered across a double banana connector.

c. Adjust R111 for a Multimeter display reading of 0.00 ohms.

5-26. ⑤ DC Gain Adjustment (R403).

a. Set the Multimeter to dcV, 20 V range.

b. Set the 740B dc standard as follows:

Function	Std
Range	100 V
Output voltage	19.000 (V)

c. Connect the 740B output to the Multimeter input as shown in Figure 5-8.

d. Adjust R403 for a Multimeter display reading of 19.00 V.

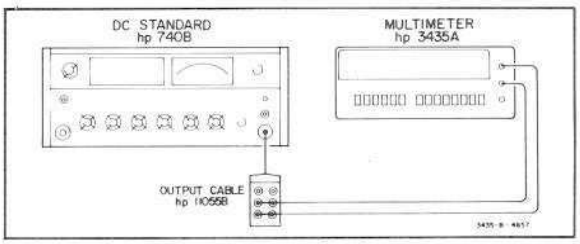


Figure 5-8. DC Gain Adjustment.

5-27. ⑥ Ohms Gain Adjustment (R119).

a. Set the Multimeter to kΩ, 20 kΩ range.

b. Set the GR 1433Z Decade Resistor to 19 kΩ and connect it across the V/Ω to COM terminals.

c. Adjust R119 for a Multimeter display reading of 19.00 kΩ.

5-28. ⑦ AC Gain Adjustment (R123).

a. Set the Multimeter to acV, 20 V range.

b. Set the 745A AC Calibrator as follows:

Frequency	200 Hz
Voltage range	100 V
Output voltage	19.0000 V (ac)

c. Connect the 745A to the Multimeter as shown in Figure 5-9.

d. Adjust R123 for a Multimeter display reading of 19.00 V.

5-29. ⑧ 2 V Range, 20 kHz Adjustment (R110).

a. Set the Multimeter to acV, 2 V range.

b. Set the 745A AC Calibrator as follows:

Frequency	20 kHz
Voltage Range	10 V
Output Voltage	1.90000 V (ac)

c. Connect the 745A to the Multimeter as shown in Figure 5-9.

d. Adjust R110 for a Multimeter display reading of 1.900 V.

5-30. ⑨ 20 V Range, 20 kHz Adjustment (R102).

a. Set the Multimeter to acV, 20 V range.

b. Set the 745A AC Calibrator as follows:

Frequency	20 kHz
Voltage Range	100 V
Output Voltage	19.0000 V (ac)

c. Connect the 745A to the Multimeter as shown in Figure 5-9.

d. Adjust R102 for a Multimeter display reading of 19.00 V.

5-31. ⑩ 20 V Range, 100 kHz Adjustment (C109).

a. Set the Multimeter to acV, 20 V range.

b. Set the 745A AC Calibrator as follows:

Frequency	100 kHz
Voltage Range	100 V
Output Voltage	19.0000 V (ac)

c. Connect the 745A to the Multimeter as shown in Figure 5-9.

d. Adjust C109 for a Multimeter display reading of 19.00 V.

5-32. POWER REQUIREMENT MODIFICATION INSTRUCTIONS.

5-33. There are four different line voltage configurations available for the Multimeter. To change line voltage requirements, arrange resistors R421 through R425 to accomodate the desired line voltage as shown in Figure 5-10.

NOTE

A jumper (short) may be substituted for the 2.7 ohm resistors (R421-R425).

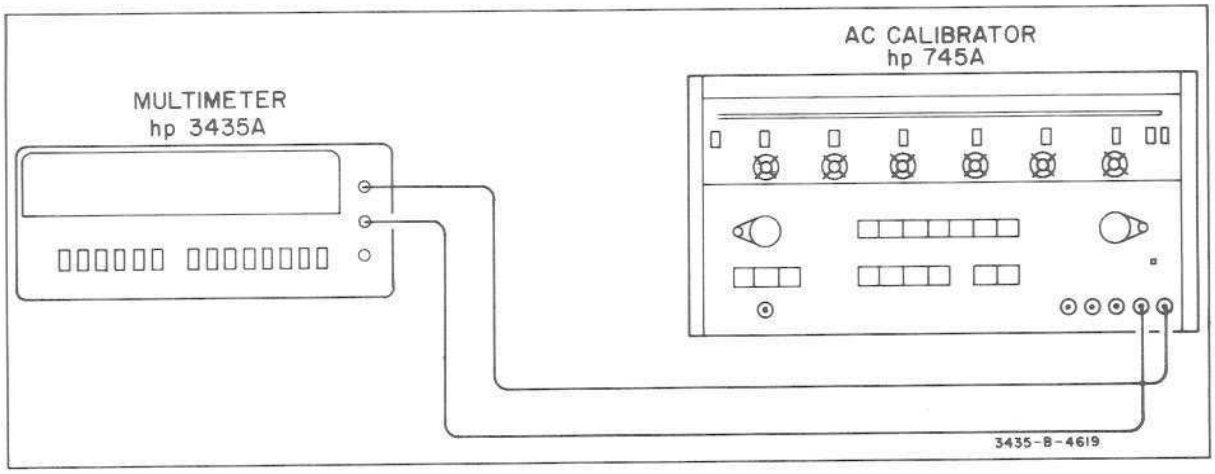


Figure 5-9. AC Gain Adjustment.

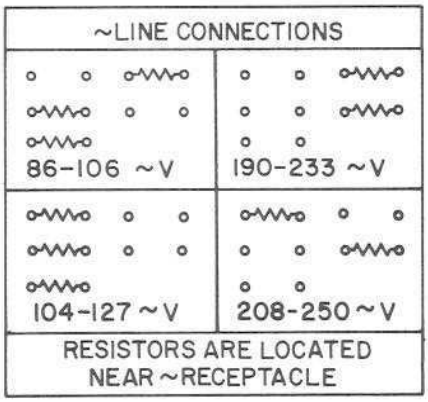


Figure 5-10. Line Voltage Configurations.

Hewlett-Packard Model 3435A

Multimeter

Serial No. _____

Test Performed By: _____

Date _____

PERFORMANCE TEST CARD

Paragraph Number	Test	Test Limit	Test Result
5-6	AC Voltage Accuracy		
	200 mV Range		
	10 mV | 30 Hz	9.5 to 10.5 mV	_____
	10 mV | 50 Hz	9.7 to 10.3 mV	_____
	10 mV | 1 kHz	9.7 to 10.3 mV	_____
	10 mV | 10 kHz	9.7 to 10.3 mV	_____
	10 mV | 20 kHz	9.7 to 10.3 mV	_____
	10 mV | 50 kHz	8.8 to 11.2 mV	_____
	10 mV | 100 kHz	8.8 to 11.2 mV	_____
	50 mV | 30 Hz	49.0 to 51.1 mV	_____
	50 mV | 50 Hz	49.5 to 50.5 mV	_____
	50 mV | 20 kHz	49.5 to 50.5 mV	_____
	50 mV | 100 kHz	48.2 to 51.7 mV	_____
	100 mV | 30 Hz	98.2 to 101.8 mV	_____
	100 mV | 50 Hz, 500 Hz	99.4 to 100.6 mV	_____
	100 mV | 20 kHz	99.4 to 100.6 mV	_____
	100 mV | 100 kHz	97.5 to 102.5 mV	_____
	2 V Range		
	1 V | 30 Hz	.982 to 1.018 V	_____
	1 V | 50 Hz, 1 kHz	.994 to 1.006 V	_____
	1 V | 20 kHz	.994 to 1.006 V	_____
	1 V | 100 kHz	.975 to 1.025 V	_____
	20 V Range		
	10 V | 30 Hz	9.82 to 10.18 V	_____
	10 V | 50 Hz, 10 kHz	9.94 to 10.06 V	_____
	10 V | 20 kHz	9.94 to 10.06 V	_____
	10 V | 100 kHz	9.75 to 10.25 V	_____
	200 V Range		
	100 V | 30 Hz	98.2 to 101.8 V	_____
	100 V | 50 Hz, 15 kHz	99.4 to 100.6 V	_____
	100 V | 20 kHz	99.4 to 100.6 V	_____
	100 V | 100 kHz	97.5 to 102.5 V	_____
	1200 V Range		
	1000 V | 30 Hz	982 to 1018 V	_____
	1000 V | 50 Hz, 1 kHz	994 to 1006 V	_____
	1000 V | 20 kHz	994 to 1006 V	_____
5-8	DC Voltage Accuracy		
	200 mV Range		
	+ 10 mV	+ 9.8 to + 10.2 mV	_____
	+ 50 mV	+ 49.7 to + 50.25 mV	_____
	- 100 mV	- 99.7 to - 100.3 mV	_____
	2 V Range		
	- .1 V	- .099 to - .101 V	_____
	+ .5 V	+ .498 to + .502 V	_____
	+ 1 V	+ .998 to + 1.002 V	_____
	20 V Range		
	- 2 V	- 1.99 to - 2.01 V	_____
	- 5 V	- 4.98 to - 5.02 V	_____
	+ 10 V	+ 9.98 to + 10.02 V	_____
	200 V Range		
	+ 20 V	+19.9 to + 20.1 V	_____
	- 50 V	- 49.8 to - 50.2 V	_____
	- 100 V	- 99.8 to - 100.2 V	_____
	1200 V Range		
	+ 200 V	+ 198 to + 201 V	_____
	- 500 V	- 498 to - 502 V	_____
	+ 1000 V	+ 998 to + 1002 V	_____

PERFORMANCE TEST CARD (CONT'd)

Paragraph Number	Test		Test Limit	Test Result
5-10	AC Ammeter Accuracy			
	200 μA			
	10 μA	30 Hz	9.4 to 10.6 μA	_____
		50 Hz, 10 kHz	9.5 to 10.5 μA	_____
	2 mA			
	.1 mA	30 Hz	.094 to .106 mA	_____
		50 Hz, 10 kHz	.095 to .105 mA	_____
	20 mA			
	1 mA	30 Hz	.94 to 1.06 mA	_____
		50 Hz, 10 kHz	.95 to 1.05 mA	_____
	200 mA			
	20 mA	60 Hz	19.4 to 20.6 mA	_____
	50 mA	60 Hz	49.1 to 50.9 mA	_____
	100 mA	60 Hz	98.7 to 101.3 mA	_____
	2000 mA			
	100 mA	60 Hz	95 to 105 mA	_____
	500 mA	60 Hz	490 to 510 mA	_____
	1000 mA	60 Hz	984 to 1016 mA	_____
5-11	DC Ammeter Accuracy			
	200 μA Range			
	10 μA		9.8 to 10.2 μA	_____
	50 μA		49.6 to 50.4 μA	_____
	100 μA		99.5 to 100.5 μA	_____
	2 mA Range			
	.1 mA		.098 to .102 mA	_____
	.5 mA		.496 to .503 mA	_____
	1 mA		.995 to 1.005 mA	_____
	20 mA Range			
	1 mA		.98 to 1.02 mA	_____
	5 mA		4.96 to 5.04 mA	_____
	10 mA		9.95 to 10.05 mA	_____
	200 mA Range			
	10 mA		9.8 to 10.2 mA	_____
	50 mA		49.6 to 50.4 mA	_____
	100 mA		99.5 to 100.5 mA	_____
	2000 mA Range			
	100 mA		97 to 103 mA	_____
	500 mA		495 to 505 mA	_____
	1000 mA		992 to 1008 mA	_____
5-13	Ohms Accuracy			
	20 Ω Range			
	1 Ω		.89 to 1.11 Ω	_____
	5 Ω		4.87 to 5.13 Ω	_____
	10 Ω		9.85 to 10.15 Ω	_____
	200 Ω Range			
	10 Ω		9.8 to 10.2 Ω	_____
	50 Ω		49.7 to 50.3 Ω	_____
	100 Ω		99.6 to 100.4 Ω	_____
	2 kΩ Range			
	200 Ω (.2 k)		.198 to .202 kΩ	_____
	500 Ω (.5 k)		.497 to .503 kΩ	_____
	1 kΩ		.996 to 1.004 kΩ	_____
	20 kΩ Range			
	2 kΩ		1.98 to 2.02 kΩ	_____
	5 kΩ		4.97 to 5.03 kΩ	_____
	10 kΩ		9.96 to 10.04 kΩ	_____

PERFORMANCE TEST CARD (CONT'd)

Paragraph Number	Test	Test Limit	Test Result
5-13 (Cont'd)	200 kΩ Range		
	20 kΩ	19.8 to 20.2 kΩ	_____
	50 kΩ	49.7 to 50.3 kΩ	_____
	100 kΩ	99.6 to 100.4 kΩ	_____
	2000 kΩ Range		
	200 kΩ	198 to 202 kΩ	_____
	500 kΩ	497 to 503 kΩ	_____
	1000 kΩ	996 to 1004 kΩ	_____
	20 MΩ Range		
	1 MΩ	.97 to 1.03 MΩ	_____
	5 MΩ	4.94 to 5.06 MΩ	_____
	10 MΩ	9.90 to 10.10 MΩ	_____
5-15	AC Normal Mode Rejection at 50 and 60 Hz	< 100 mV (40 dB)	_____
5-17	Effective Common Mode Rejection at 50 and 60 Hz	< .1 mV (120 dB)	_____

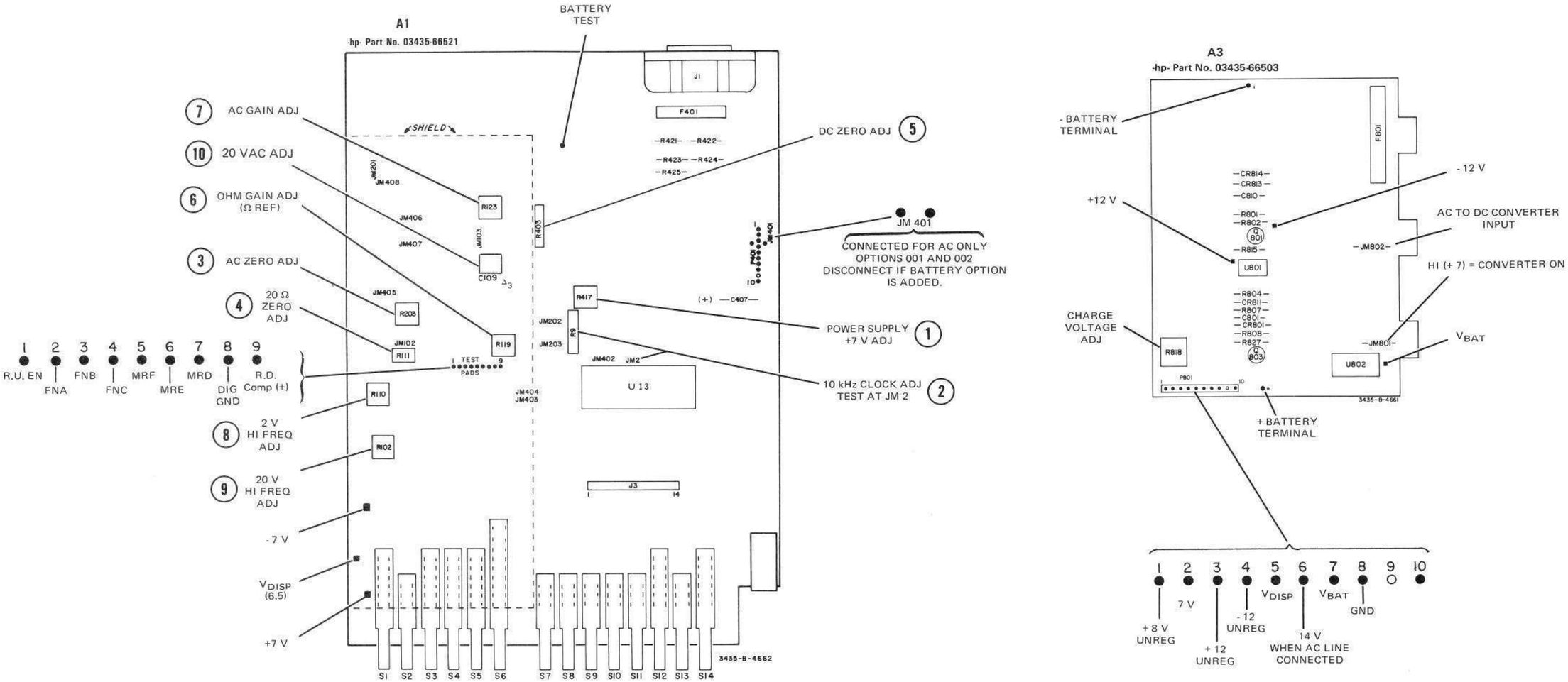


Figure 5-11. Adjustment Locator.

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

DESIGNATORS

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

Table 6-2. Code List of Manufacturers.

MFR NO.	MANUFACTURER'S CODE LIST	ADDRESS	
00000	U.S.A. COMMON	ANY SUPPLIER OF USA	
00160	OHARA METAL PRODUCTS	SAN FRANCISCO CAL	94107
01121	ALLEN BRADLEY CO.	MILWAUKEE WI	53212
01295	TEXAS INSTRUMENT INC. SEMICONDUCTOR CMPNT DIV.	DALLAS TX	75231
01686	RCL ELECTRONICS INC.	MANCHESTER NH	03102
02735	RCA CORP. SOLID STATE DIV.	SOMMERVILLE NJ	08876
03888	PYROFILM CORP.	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
12954	DICKSON ELECTRONICS CORP.	SCOTTSDALE AZ	85252
14140	EDISON ELEK DIV MCGRAW-EDISON	MANCHESTER NH	03130
16299	CORNING GLASS WORKS ELEC CMPNT DIV.	RALEIGH NC	27604
17856	SILICONIX INC.	SANTA CLARA CA	95050
19701	MEPCO/ELECTRA CORP.	MINERAL WELLS TX	76067
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
32997	BOURNS INC TRIMPOT PROD DIV.	RIVERSIDE CA	92707
56289	SPRAGUE ELECTRIC CO.	NORTH ADAMS NA	01247
71400	BUSSMAN MFG DIV OF MCGRAW-EDISON CO.	ST LOUIS MO	63017
72136	ELECTRO MOTIVE MFG CO., INC.	WILLIMANTIC CT	06226
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV.	FULLERTON CA	92634
74970	JOHNSON E. F. CO.	WASECA MN	56093
84411	TRW CAPACITOR DIV	OGALLALA NE	69153
91506	AUGAT INC	ATTLEBORO MA	02703
95121	QUALITY COMPONENTS INC	ST MARYS PA	15857
98291	SEALECTRO CORP.	MAMARONECK NY	10544

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1 Δ	03435-66521	1	MAIN PC ASSEMBLY	28480	03435-66521
A1C1	0150-0012	4	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	56289	C023A102J103MS38
A1C2	0160-2384	1	CAPACITOR-FXD 120PF +-5% 500 WVDC MICA	28480	0160-2384
A1C3 *	0160-0378		CAPACITOR-FXD 27PF +-5% 500WVDC MICA	28480	0160-0378
A1C99	0150-0014	1	CAPACITOR-FXD 5000PF +100 -0% 500WVDC CER	28480	0150-0014
A1C100	0150-0012	4	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	56289	C023A102J103MS38
A1C101	0150-0012	4	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	56289	C023A102J103MS38
A1C102	0160-4418	1	CAPACITOR-FXD 22 PF +-5% 500WVDC	28480	0160-4418
A1C103	0160-0336	2	CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A1C104 *	0140-0234	1	CAPACITOR-FXD 500PF +-1% 300WVDC MICA	72136	DM15F501F0300WV1C
A1C105 *	0160-0336	2	CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A1C106	0160-2197	2	CAPACITOR-FXD 10PF +-5% 300WVDC MICA	28480	0160-2197
A1C107	0160-0153	1	CAPACITOR-FXD 1000PF +-10% 200WVDC	56289	292P10292
A1C108	0160-3847	6	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A1C109 Δ3	0121-0451	1	CAPACITOR-V TRMR-AIR 1.7 - 11 PF 250V	04670	187-0106-005
A1C110	0160-2197	2	CAPACITOR-FXD 10PF +-5% 300WVDC MICA	28480	0160-2197
A1C111	0140-0145	1	CAPACITOR-FXD 22PF +-5% 500WVDC MICA	72136	DM15C220J0500WV1CR
A1C112 Δ2	0180-0309	6	CAPACITOR-FXD 4.7UF +-20% 10VDC TA	04200	150D475X0010A2
A1C113 Δ2	0180-0309	1	CAPACITOR-FXD 4.7UF +-20% 10VDC TA	04200	150D475X0010A2
A1C114	0180-0291	6	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C115	0150-0044	4	CAPACITOR-FXD 5.6PF +-5% 500WVDC TI	95121	TYPE QC
A1C116	0150-0044	4	CAPACITOR-FXD 5.6PF +-5% 500WVDC TI	95121	TYPE QC
A1C117	0160-3847	6	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A1C118	0160-3847	6	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A1C119	0180-0291	6	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C120	0180-0116	1	CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A1C121	0150-0012	4	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	56289	C023A102J103MS38
A1C202	0160-0168	1	CAPACITOR-FXD .1UF +-10% 200WVDC	56289	292P10492
A1C203	0150-0044	4	CAPACITOR-FXD 5.6PF +-5% 500WVDC TI	95121	TYPE QC
A1C204	0150-0044	4	CAPACITOR-FXD 5.6PF +-5% 500WVDC TI	95121	TYPE QC
A1C205	0170-0038	1	CAPACITOR-FXD .22UF +-10% 200WVDC	28480	0170-0038
A1C400	0160-2055	1	CAPACITOR-FXD .01UF +80 -20% 100WVDC CER	28480	0160-2055
A1C401	0180-2651	1	CAPACITOR-FXD 470UF +75 -10% 16VDC AL	56289	500D447H016DF7
A1C402	0160-3847	5	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A1C403	0180-2638	2	CAPACITOR-FXD 220UF +75 -10% 35VDC AL	56289	500D227H035DF7
A1C404	0180-3847	5	CAPACITOR-FXD .01UF 25V	28480	0180-3847
A1C405	0180-2638	2	CAPACITOR-FXD 220UF +75 -10% 35VDC AL	56289	500D227H035DF7
A1C406	0140-0198	1	CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A1C407	0180-0291	6	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C408	0160-0362	2	CAPACITOR-FXD 510PF +-5% 300WVDC MICA	28480	0160-0362
A1C409	0180-0291	6	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C410	0180-0228	1	CAPACITOR-FXD 22UF +-10% 15VDC TA	56289	150D226X9015B2
A1CR1	1901-0040	8	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR100 Δ1	1906-0096	1	DIODE-FW BRDG 200V 2A	02037	MDA202
A1CR101	1901-0376	2	DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A1CR102	1901-0376	2	DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A1CR103	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR104	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR105	1901-0029	3	DIODE-PRW RECT 600V 750MA DO-29	28480	1901-0029
A1CR107	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR108	1902-0554	1	DIODE-ZNR 10V 5% DO-15 PD=IN TC= +.06%	28480	1902-0554
A1CR110	1901-0535	2	DIODE-SCHOTTKY	28480	1901-0535
A1CR111	1901-0535	2	DIODE-SCHOTTKY	28480	1901-0535
A1CR200	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR201	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR202	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR203	1901-0040	8	DIODE-SWITCHING 50V 500MA 30NS DO-7	28480	1901-0040
A1CR400	1902-1329	1	DIODE-ZENER 6.95V	28480	1902-1329
A1CR401	1901-0029	3	DIODE-PRW RECT 600V 750MA DO-29	28480	1901-0029
A1CR402	1901-0029	3	DIODE-PRW RECT 600V 750MA DO-29	28480	1901-0029
A1CR403 - 406 Δ	1901-0029	6	DIODE-PRW RECT 600 V 750MA DO-29	28480	1901-0029
A1CR407 - 408	1901-0050	6	DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A1F401	2110-0318	1	FUSE-.125A 250V SLOW-BLO 1.25 x .25	08806	A1H
A1J1 Δ	1251-4743	1	CONNECTOR-AC PWR HP-9 MALE REC-FLG THRMP	28480	1251-4743
A1J3	1251-4390	2	14 PIN DISPLAY CONNECTOR, FEMALE	28480	1251-4390
A1J401	03435-61601	2	CABLE ASSEMBLY W/CONNECTORS. P/O A1W2	28480	03435-61601
A1P401	1251-4401	3	10 PIN BATTERY CHARGER CONNECTOR, M (PIN 9 CLIPPED OUT)	27264	22-04-2101
A1Q1, Q2	1854-0071	5	TRANSISTOR-NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q3 - Q6	1853-0016	4	TRANSISTOR-PNP SI TO-92 PD=300MW	28480	1853-0016
A1Q17, Q18	1854-0071	5	TRANSISTOR-NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q101	1854-0079	1	TRANSISTOR-NPN 2N3439 SI	02735	2N3439
A1Q401	1854-0071	5	TRANSISTOR-NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q402	1854-0039	1	TRANSISTOR-NPN 2N3053 SI	04713	2N3053
A1Q403	1853-0012	1	TRANSISTOR-PNP 2N2904A SI	01295	2N2904A

Table 6-3 Replaceable Parts(Cont'd)

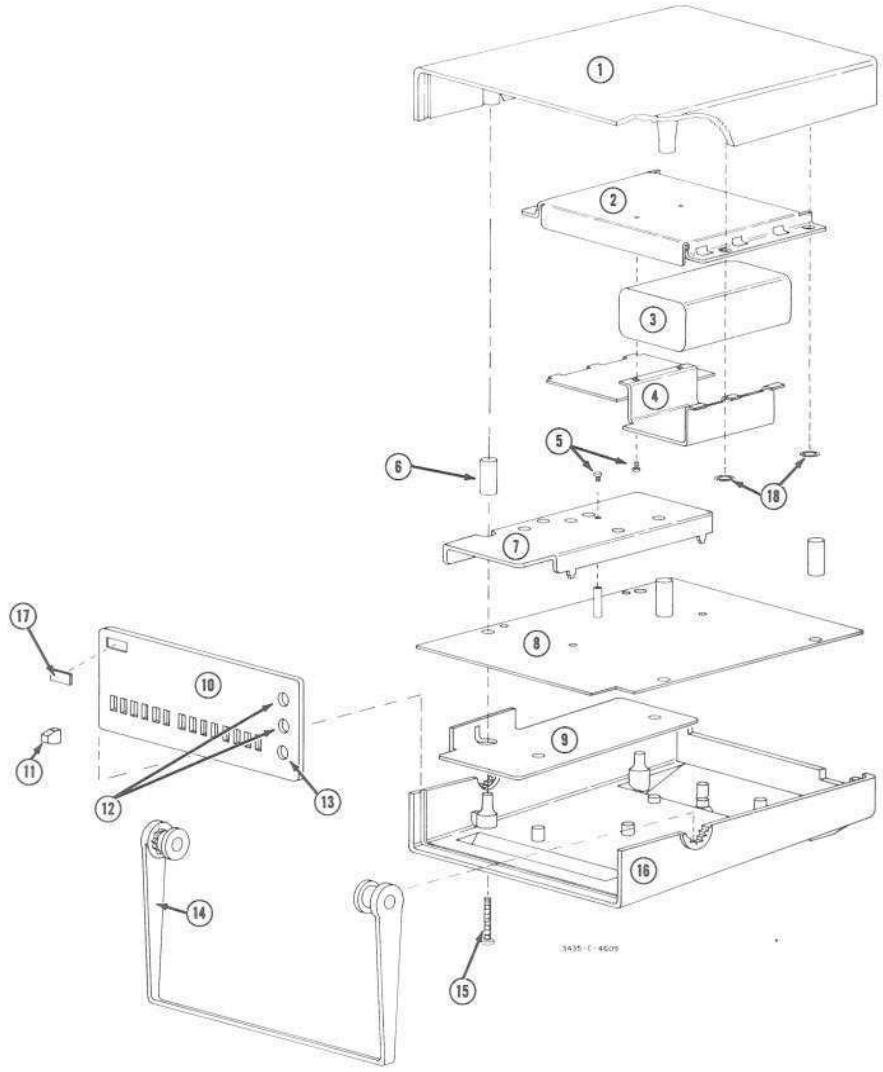
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R1, R2	0698-8767	3	RESISTOR-FXD 200K OHM .5	28480	0698-8767
A1R3, R4	0683-4735	2	RESISTOR-FXD 47K 5% .25W	01121	CB4735
A1R5 - R7	0683-1025	4	RESISTOR- 1K 5% .25W	01121	CB1025
A1R8	0698-4519	1	RESISTOR- 140K 1% .125W	24546	C4-1/8-TO-1403-F
A1R9	2100-3094	1	RESISTOR-TRMR 100K 10%	32997	3006P-1-104
A1R10 - R13	0683-5115	4	RESISTOR- 510 5% .25W	01121	CB5115
A1R14 - R17	0683-2035	4	RESISTOR- 20K 5% .25W	01121	CB2035
A1R20	0757-0437	4	RESISTOR-4.75K 1% .125W	24546	C4-1/8-TO-4751-F
A1R100	0698-8717	1	RESISTOR- 4.78M 1% 1W	07716	CEC-993-N330
A1R101	0757-0437	3	RESISTOR- 4.75K 1% .125W	24546	C4-1/8-TO-4751-F
A1R102	2100-0558	1	RESISTOR-TRMR 20K 10%	32997	3386P-Y46-203
A1R103	0698-8716	1	RESISTOR- 8M .5% 2W	07716	CCF-993-N330
A1R106	0683-1065	1	RESISTOR- 10M 5% .25W	01121	CB 1065
A1R107	0683-0275	6	RESISTOR- 2.7 5% .25W	01121	CB27G5
A1R108	0698-4123	2	RESISTOR-FXD 499 OHM 1% .125W	16299	C4-1/8-TO-499R-F
A1R109	0698-4202	1	RESISTOR- 8.87K 1% .125W	16299	C4-1/8-TO-8871-F
A1R110	2100-3211	1	RESISTOR-TRMR 1K 10%	32997	3386P-Y46-102
A1R111	2100-3566	1	RESISTOR-V 100K	28480	2100-3566
A1R112	0757-0472	4	RESISTOR- 200K 1% .125W	24546	C4-1/8-TO-2003-F
A1R113	0757-0410	2	RESISTOR- 301 1% .125W	24546	C4-1/8-TO-301R-F
A1R114	0757-0473	2	RESISTOR- 221K 1% .125W	24546	C4-1/8-TO-2213-F
A1R115	0698-3159	2	RESISTOR- 26.1K 1% .125W	16299	C4-1/8-TO-2612-F
A1R116	0698-8767	3	RESISTOR-FXD 200K OHM .5	28480	0698-8767
A1R117	0757-0437	3	RESISTOR- 4.75K 1% .125W	24546	C4-1/8-TO-4751-F
A1R118	0698-8768	3	RESISTOR-FXD 100 OHM .5	28480	0698-8768
A1R119	2100-3210	3	RESISTOR-TRMR 10K 10%	32997	3386P-Y46-103
A1R120	0698-4485	1	RESISTOR- 23.2K 1% .125W	24546	C4-1/8-TO-2322-F
A1R121	0757-0449	4	RESISTOR- 20K 1% .125W	24546	C4-1/8-TO-2002-F
A1R122	0698-3160	1	RESISTOR- 31.6K 1% .125W	16299	C4-1/8-TO-3162-F
A1R123 Δ2	2100-3211	3	RESISTOR-TRMR 1K 10% C TOP-ADJ 1 TRN	28480	2100-3211
A1R124 Δ2	0698-4479	1	RESISTOR 14K 1% .125W F TC = +-100	03292	C4-1/8-TO-1402-F
A1R125	0757-0473	2	RESISTOR- 221K 1% .125W	24546	C4-1/8-TO-2213-F
A1R126	0683-1055	1	RESISTOR- 1M 5% .25W	01121	CB1055
A1R127, R128 Δ2	0757-0449	2	RESISTOR 20K 1% .125W F TC = 0+-100	03292	C4-1/8-TO-2002-F
A1R129, R130 Δ2	0757-0283	4	RESISTOR 2K 1% .125W F TC = 0+-100	03292	C4-1/8-TO-2001-F
A1R131	0698-8768	3	RESISTOR-FXD 100 OHM .5	28480	0698-8768
A1R132	0757-0442	4	RESISTOR- 10K 1% .125W	24546	C4-1/8-TO-1002-F
A1R201	0757-0410	2	RESISTOR- 301 1% .125W	24546	C4-1/8-TO-301R-F
A1R202	0757-0472	4	RESISTOR- 200K 1% .125W	24546	C4-1/8-TO-2003-F
A1R203	2100-3214	1	RESISTOR-TRMR 100K 10%	32997	3386P-Y46-104
A1R204	0698-4123	2	RESISTOR- 499 1% .125W	16299	C4-1/8-TO-499R-F
A1R205	0757-0472	4	RESISTOR- 200K 1% .125W	24546	C4-1/8-TO-2003-F
A1R206	0683-1025	4	RESISTOR- 1K 5% .25W	01121	CB1025
A1R207	0757-0472	4	RESISTOR- 200K 1% .125W	24546	C4-1/8-TO-2003-F
A1R208	0757-0449	4	RESISTOR- 20K 1% .125W	24546	C4-1/8-TO-2002-F
A1R209	0757-0270	1	RESISTOR- 249K 1% .125W	24546	C4-1/8-TO-2493-F
A1R210	0698-8769	1	RESISTOR-FXD 49.7K .1%	28480	0698-8769
A1R211	0698-8396	1	RESISTOR- 500K .1% .25W	19701	MF52C1/4-T2-5003-B
A1R401	0698-4472	1	RESISTOR- 7.68K 1% .125W	24546	C4-1/8-TO-7681-F
A1R402	0698-6481	1	RESISTOR- 16.2K 1% .125W	24546	NE55
A1R403	2100-3056	1	RESISTOR-TRMR 5K 10%	32997	3006P-1-502
A1R404	0698-7646	1	RESISTOR- 31.6K 1% .125W	19701	MF4C1/8-T9-3162-F
A1R405	0698-3540	1	RESISTOR- 15.4K 1% .125W	16299	C4-1/8-TO-1542-F
A1R406	0757-0459	1	RESISTOR- 56.2K 1% .125W	24546	C4-1/8-TO-5622-F
A1R407	0698-3159	2	RESISTOR- 26.1K 1% .125W	16299	C4-1/8-TO-2612-F
A1R408	0698-8768	3	RESISTOR-FXD 100 OHM .5	28480	0698-8768
A1R409	0757-0442	4	RESISTOR- 10K 1% .125W	24546	C4-1/8-TO-1002-F
A1R410	0698-3332	1	RESISTOR- 80.6 1% .5W	24546	NA6
A1R411, R412	0757-0449	4	RESISTOR- 20K 1% .125W	24546	C4-1/8-TO-2002-F
A1R413	0698-4842	1	RESISTOR- 124 1% .5W	24546	NA6
A1R414	0757-0437	3	RESISTOR- 4.75K 1% .125W	24546	C4-1/8-TO-4751-F
A1R415	0757-0283	1	RESISTOR- 2K 1% .125W	24546	C4-1/8-TO-2001-F
A1R416	0757-0458	1	RESISTOR- 51.1K 1% .125W	24546	C4-1/8-TO-5112-F
A1R417	2100-3210	3	RESISTOR-TRMR 10K 10%	32997	3386P-Y46-103
A1R418	0698-4502	1	RESISTOR- 64.9K 1% .125W	24546	C4-1/8-TO-6492-F
A1R419	0698-3279	1	RESISTOR- 4.99K 1% .125W	16299	C4-1/8-TO-4991-F
A1R421 - R425 *	0683-0275	6	RESISTOR- 2.7 5% .25W	01121	CB27G5
A1R501	0698-5453	1	RESISTOR- 900 OHM .1% .125W	03888	PME55-1/8-T2-900R-B
A1R502	0698-5456	1	RESISTOR- 90 OHM .1% .125W	24546	NC55
A1R503	0811-3433	1	RESISTOR- 9 OHM .1% 3W	01686	T28-79
A1R504	0811-3455	1	RESISTOR- FXD .9 OHM .1% 4W	28480	0811-3455
A1R505	0811-3435	1	RESISTOR- .1 OHM .1%	01686	T28-79
A1S1	3101-2129	1	PUSHBUTTON SWITCH, (PUSH-PUSH)		
A1S2	3101-2130	7	PUSHBUTTON SWITCH		
A1S3 - S5	3101-2128	5	PUSHBUTTON SWITCH		
A1S6	3101-2127	1	PUSHBUTTON SWITCH		
A1S7-S11	3101-2130	7	PUSHBUTTON SWITCH		
A1S12, S14	3101-2128	5	PUSHBUTTON SWITCH		
A1S13	3101-2130	7	PUSHBUTTON SWITCH		

* A jumper (short) may be substituted for R421 through R425.

Table 6-3 Replaceable Parts(Cont'd)

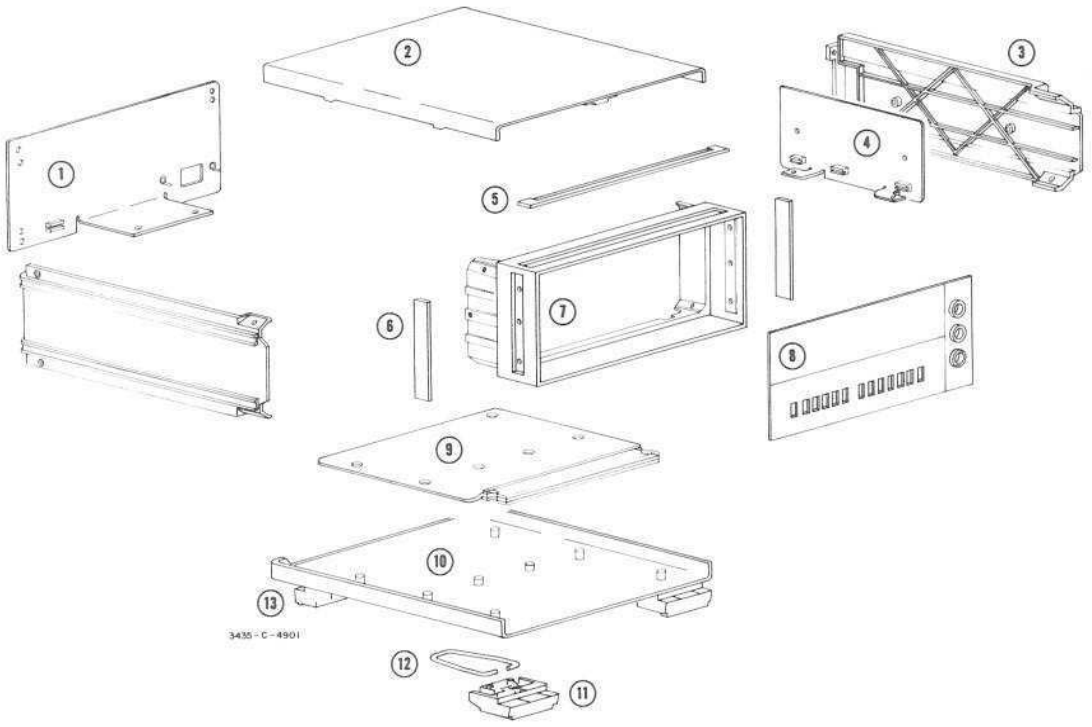
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1T401	9100-3494	1	TRANSFORMER	28480	9100-3494
A1U1	1826-0340	1	OPERATIONAL AMPLIFIER LF356	28480	1826-0340
A1U2	1826-0043	4	IC LM 307 OP AMP	27014	LM307H
A1U3 - U6	1820-0223	4	IC LM 301A OP AMP	27014	LM301AH
A1U7 - U9	1826-0043	4	IC LM 307 OP AMP	27014	LM307H
A1U10	1826-0010	1	IC UA 723 V RGL TR	07263	723HM
A1U11	1813-0070	1	INPUT HYBRID	28480	1813-0070
A1U12	1813-0071	1	INTEGR HYBRID	28480	1813-0071
A1U13	1820-1742	1	CONTROL CHIP	28480	1820-1742
A1U14, U15 Δ	1820-2254	2	IC - DIGITAL SN75492N	01295	SN75492N
	7120-3530	1	LABEL - CAUTION 6 - IN - WD 1.5 - IN - LG	28480	7120-3530
A1W2	03435-66522	1	BATTERY CABLE W/CONNECTORS	28480	03435-66522
A1W3	8120-3455	1	RIBBON CABLE, 14 LEAD	28480	8120-3455
A2	03435-66502		DISPLAY PC ASSEMBLY	28480	03435-66502
A2DS1 - DS7	1990-0404	7	LED VISIBLE - ANNUNCIATORS	28480	1990-0404
A2DSM1	1990-0532	1	DISPLAY-NUM SEG .5- (+ - 1)	28480	1990-0532
A2DSM2 - DSM4	1990-0531	3	DISPLAY-NUM SEG 1	28480	1990-0531
A2J1	1251-4390	2	14 PIN CONNECTOR, FEMALE	28480	1251-4390
A2R1, R2	0683-1115	14	RESISTOR- 110 5% .25W	01121	CB1115
A2R3	0683-2215	3	RESISTOR- 220 5% .25W	01121	CB2215
A2R4 - R8	0683-1115	14	RESISTOR- 110 5% .25W	01121	CB1115
A2R9, R10	0683-2215	3	RESISTOR- 220 5% .25W	01121	CB2215
A2R19 - R25	0683-1115	14	RESISTOR- 110 5% .25W	01121	CB1115
W3	8120-2279	1	CABLE-UNSHLD 26 AWG 14-CNDCT	28480	8120-2279
A3	03435-66503		BATTERY CHARGER PC ASSEMBLY	28480	03435-66503
BT801	1420-0233	1	6 VOLT BATTERY PACK	28480	1420-0233
A3C801, C802	0160-3847	4	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A3C803	0180-1743	1	CAPACITOR-FXD .1UF +-10% 35VDC TA	56289	150D104X9035A2
A3C805	0150-0084	1	CAPACITOR-FXD .1UF +80 -20% 100WVDC CER	28480	0150-0084
A3C806	0160-2204	1	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	09023	RDM15F101J3C
A3C807	0140-0195	1	CAPACITOR-FXD 130PF +-5% 300WVDC MICA	72136	DM15F131J0300WV1CR
A3C808	0180-0309	1	CAPACITOR-FXD 4.7UF +-20% 10VDC TA	56289	150D475X0010A2
A3C809, C810	0160-3847	4	CAPACITOR-FXD .01UF +100 -0% 25WVDC CER	28480	0160-3847
A3CR801	1901-0040	9	DIODE-SWITCHING 30V 50MA 2NS	28480	1901-0040
A3CR802	1902-3182	1	DIODE-ZNR 12.1V 5%	04713	SZ 10939-206
A3CR804 - CR811	1901-0040	9	DIODE-SWITCHING 30V 50MA 2NS	28480	1901-0040
A3CR812 - CR815	1910-0034	4	DIODE-GE 30V 80MA 8NS	28480	1910-0034
A3CR816, CR817	1901-0535	2	DIODE- HOT CARRIER	28480	1901-0535
A3F801	2110-0002	1	FUSE 2A 250V FAST-BLO	71400	AGC-2
A3J801	03435-61601	1	BATTERY CABLE W/CONNECTOR, P/O W2	28480	03435-61601
A3P801	1251-4401	1	10 PIN MALE CONNECTOR (PIN 9 CLIPPED OUT)	27264	22-04-2101
A3Q801	1853-0010	1	TRANSISTOR-PNP SI TO-18	28480	1853-0010
A3Q802	1854-0063	1	TRANSISTOR-NPN 2N3055 SI TO-3	28480	1854-0063
A3Q803 - Q805	1854-0087	3	TRANSISTOR-NPN SI PD=360MW	28480	1854-0087
A3R801	0683-3335	3	RESISTOR- 33K 5% .25W	01121	CB3335
A3R802	0683-1515	1	RESISTOR- 150 5% .25W	01121	CB1515
A3R803	0683-3325	3	RESISTOR- 3.3K 5% .25W	01121	CB3325
A3R804	0757-0465	1	RESISTOR- 100K 1% .125W	24546	C4-1/8-TO-1003-F
A3R805	0698-4508	1	RESISTOR- 78.7K 1% .125W	24546	C4-1/8-TO-7872-F
A3R806	0698-3148	1	RESISTOR- 102K 1% .125W	16299	C4-1/8-TO-1023-F
A3R807	0698-4518	1	RESISTOR- 137K 1% .125W	24546	C4-1/8-TO-1373-F
A3R808	0698-1045	3	RESISTOR-FXD 100K .05 1/4	28480	0698-1045
A3R809	0757-0479	2	RESISTOR- 392K 1% .125W	19701	MF4C1/8-TO-3923-F
A3R810	0698-4431	1	RESISTOR- 2.05K 1% .125W	16299	C4-1/8-TO-2051-F
A3R811	0812-0040	1	RESISTOR- .27 5% 5W	75042	BW20-1/2-27/100-J
A3R812	0683-1045	3	RESISTOR- 100K 5% .25W	01121	CB1045
A3R813	0698-3279	1	RESISTOR- 4.99K 1% .125W	16299	C4-1/8-TO-4991-F
A3R814	0698-3149	1	RESISTOR- 255K 1% .125W	16299	C4-1/8-TO-2553-F
A3R815	0698-4531	1	RESISTOR- 267K 1% .125W	24546	C4-1/8-TO-2673-F
A3R816, R817	0683-1055	2	RESISTOR- 1M 5% .25W	01121	CB1055
A3R818	2100-0558	1	RESISTOR-TRMR 20K 10%	32997	3386P-Y46-203
A3R819	0683-4755	1	RESISTOR- 4.7M 5% .25W	01121	CB4755
A3R820	0757-0479	2	RESISTOR- 392K 1% .125W	19701	MF4C1/8-TO-3923-F
A3R821, R822	0683-3335	3	RESISTOR- 33K 5% .25W	01121	CB3335
A3R823	0683-1045	3	RESISTOR- 100K 5% .25W	01121	CB1045
A3R824, R825	0683-3325	3	RESISTOR- 3.3K 5% .25W	01121	CB3325
A3R826	0683-1005	1	RESISTOR- 10 5% .25W	01121	CB1005
A3R827	0698-3268	1	RESISTOR- 11.5K 1% .125W	16299	C4-1/8-TO-1152-F
A3T801	9100-3920	1	PULSE TRANSFORMER	28480	9100-0681
A3U801	1826-0139	1	IC MC 1458 OP AMP	04713	MC1458P1
A3U802	1820-0944	1	IC-DIGITAL CD4025AE CMOS	02735	CD4025AY
A3U803	1820-0938	1	IC-DIGITAL CD4027AE CMOS	02735	CD4027AY
A3U804	1820-0949	1	IC-DIGITAL CD4011AE CMOS	02735	CD4011AY

Table 6-4. Miscellaneous Parts.



INDEX NO.	-hp- PART NO.	DESCRIPTION	TQ
1	5040-8085	TOP SHELL	1
2	03435-00101	BATTERY DECK	1
3	1420-0233	6 VOLT BATTERY PAC	1
4	03435-01201	BATTERY CLAMP	1
5	2360-0117	6 - 32 X 3/8	3
	2360-0116	6 - 32 X 1/4	1
6	5040-8044	POLYCARBONATE SPACER	4
7	03435-00601	A1 PC SHIELD (TOP)	1
8	03435-66501	A1 PC ASSEMBLY	1
9	03435-00602	BOTTOM SHIELD	1
10	03435-00201	FRONT PANEL	1
11	0370-2486	PUSHBUTTON KNOB (LIGHT GREY)	7
11	0370-2625	PUSHBUTTON KNOB (WHITE)	1
11	0370-2873	PUSHBUTTON KNOB (DARK GREY)	5
11	0370-2917	PUSHBUTTON KNOB (LIGHT BLUE)	1
12	5040-7456	BANANA JACK ASSY (J1, J2)	2
13	5060-7455	AMPS INPUT FUSE HOLDER	1
	5040-8068	FUSE SPRING HOLDER (NOT SHOWN)	1
	1460-1485	FUSE SPRING (NOT SHOWN)	1
	2110-0002	AMPS INPUT FUSE (NOT SHOWN)	1
14	5040-8058	HANDLE/BAIL	1
15	2360-0137	6 - 32 X 1 3/4	4
16	03435-64401	BOTTOM SHELL W/BOTTOM SHIELD	1
17	7120-6188	-hp- LOGO PLATE	2
18	0510-0585	PUSH-ON RETAINER	4

Table 6-5. Option 002 Miscellaneous Parts.



INDEX NO.	HP PART NO.	DESCRIPTION	TQ
1	03435-00202	REAR PANEL	1
2	5040-7208	TOP COVER	1
3	5040-8210	SIDE COVER	2
4	03435-00604	SIDE SHIELD	2
5	5040-7203	TOP TRIM	1
6	5001-0438	SIDE TRIM	2
7	5020-8813	FRONT FRAME	1
8	03435-00201	FRONT PANEL	1
9	03435-00603	BOTTOM SHIELD	1
10	5040-7209	BOTTOM COVER	1
11	5040-7201	FRONT FOOT	2
12	1460-1345	TILT STAND	2
13	5040-7222	REAR FOOT	2

FASTENING HARDWARE

DESCRIPTION	HP PART NO.	TQ
SIDE SHIELD SCREWS	2360-0113	8
GROUNDING SCREWS	2680-0128	1
GROUNDING LUG	0360-0053	1
BACK PANEL SCREWS	2360-0199	6
FRONT PANEL SCREWS	2510-0099	4
TRANSFORMER SCREWS	2360-0121	2
CENTER SCREW (A1 PC BOARD)	2360-0119	1
BOTTOM SHIELD SCREWS	2360-0113	8
TOP COVER SCREWS	2360-0199	6
BOTTOM COVER SCREWS	2360-0330	2
SQUARE PLASTIC WASHER	5040-7853	4

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the manual contains troubleshooting information, simplified and complete schematic diagrams, and component locators.

7-3. SCHEMATIC DIAGRAMS.

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.

7-4. The schematic diagrams, Figure 7-5 through 7-8 are a schematic representation of the Multimeter circuitry and its power supply. Figure 7-4 is a simplified schematic representation of the analog portion of the Multimeter.

7-5. TROUBLESHOOTING.

7-6. Troubleshooting procedures are performed after it is established that there is a failure in the Multimeter circuitry. Unless a failure is obvious, such as a blank display, refer to the Adjustment Procedures and Performance Checks in Section V before attempting to troubleshoot the Multimeter.

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 components. Do not permit traces of flux to form on the circuit board. Observe precautions against static discharge. Do not use flux remover.

7-7. Preliminary Troubleshooting.

7-8. Front Panel Observations. Without disassembling the Multimeter, failures can often be isolated by a simplified performance test and careful observance of display indications. This is especially true if the failure is a measurement error. Table 7-1 is a simplified performance test.

7-9. Record the results of the simplified performance test. Refer to Table 7-2 AC Gain and 7-3 DC Gain and Figure 7-1 Functional Block Diagram.

NOTE

Circled letters (A) through (E) are reference points to aid in correlating between block, simplified, and complete schematic diagrams.

7-10. Failure isolation between Input Amp and Post Amp can be evaluated by observing which particular ranges are in or out of specification.

Example 1:

	200 mV	IN
	2 V	IN
acV	20 V	OUT
	200 V	OUT
	1200 V	IN

The failure is probably associated with the input amp x .002 gain.

Example 2:

	200 mV	OUT
	2 V	IN
dcV	20 V	IN
	200 V	OUT
	1200 V	IN

The problem is probably associated with the post amp x 10 gain.

Table 7-1. Simplified Performance Test.

Function	Range	Input	Multimeter Display Limits	
dcV	200 mV	100 mVdc	99.7 to 100.3 mV	
	2 V	1 Vdc	.998 to 1.002 V	
	20 V	10 Vdc	9.98 to 10.02 V	
	200 V	100 Vdc	99.8 to 100.2 V	
			100 Hz	100 kHz
acV	200 mV	*100 mVac	99.4 to 100.6 mV	97.5 to 102.5 mV
	2 V	*1 Vac	.994 to 1.006 V	.975 to 1.025 V
	20 V	*10 Vac	9.94 to 10.06 V	9.94 to 10.06 V
	200 V	*100 Vac	99.4 to 100.6 V	97.5 to 102.5 V
	1200 V	1000 Vac	994 to 1006 V	
kΩ	20 Ω	10 Ω	9.85 to 10.15 Ω	
	2 kΩ	1 kΩ	.996 to 1.004 kΩ	

*Test at 100 Hz and 100 kHz.

Table 7-2. AC Gain.

	Ⓐ			Ⓓ
Range	Input Voltage	Input Amp (Gain)	Post Amp (Gain)	Post Amp Output
200 mV	.1 V	.2	x 10	200 mV
2 V	1 V	.2	x 1	200 mV
20 V	10 V	.002	x 10	200 mV
200 V	100 V	.002	x 1	200 mV
1200 V	1 kV	.0002	x 1	200 mV

Table 7-3. DC Gain.

	Ⓑ			Ⓓ
Range	Input Voltage Ⓐ	Input Amp (Gain)	Post Amp (Gain)	Post Amp Output Ⓒ
200 mV	100 mV	X 1	X 10	1 V
2 V	1 V	X 1	X 1	1 V
20 V	10 V	X .1	X 1	1 V
200 V	100 V	X .001	X 10	1 V
1200 V	1000 V	X .001	X 1	1 V

7-11. 100 kHz frequency response failures are most often associated with the ac to dc converter or the post amp x 10 gain. This failure can also be isolated by recording and evaluating the ranges that are in or out of specification.

Example1:

200 mV	OUT
2 V	OUT
20 V	OUT
200 V	OUT
1200 V	OUT

The failure is probably associated with the ac to dc converter.

Example 2:

200 mV	OUT
2 V	IN
20 V	OUT
200 V	IN
1200 V	IN

The failure is probably associated with the post amp x 10 gain.

7-12. The functional block diagram can be used to isolate failures as follows:

Example 1:

acV	OUT
dcV	OUT
Ohms	OUT

The failure is probably associated with the input amp of the a to d converter.

Example 2:

acV	OUT
dcV	IN
Ohms	IN

The failure is probably associated with the ac to dc converter.

7-13. Disassembly Procedure.

a. Remove the Multimeter Power Cord.

b. With the Multimeter in the inverted position, remove the four screws from the bottom cover.

c. Carefully return the Multimeter to the upright position with the front panel facing you.

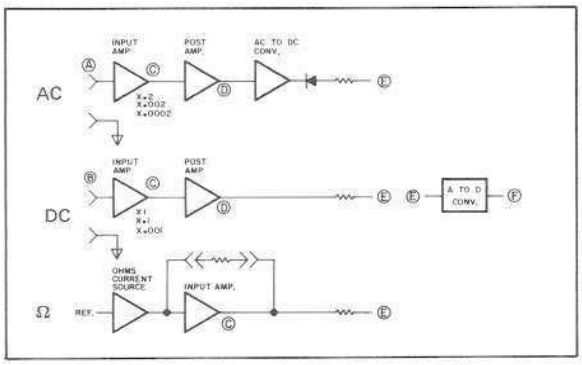


Figure 7-1. Functional Block Diagram.

NOTE

Battery and charger circuitry are located in the top shell and are connected to the main PC assembly by an 8 lead cable. To avoid possible damage to the cable or connectors, remove top cover slowly.

d. Remove the top shell vertically and place it at the right side of the lower shell in an inverted position. This will allow access to all internal adjustments while still being able to observe the display and change the switch settings.

7-14. Visual Inspection. Visually inspect the Multimeter for cracked or burned components, pinched or broken cables or corrosion contamination.

7-15. Troubleshooting Information.

7-16. Test Jumpers. Test jumpers (JM) are strategically located on the A1 and A3 PC assemblies to aid in troubleshooting. In some locations JM's can be clipped open for circuit isolation. Table 7-4 lists the JM's and their function.

NOTE

The letter J etched on the A1 PC assembly denotes the JM designator on the schematics.

7-17. Test Pads. Logic control states (Hi = + 7 V, Low = 0 V) can be evaluated using the test pads. Table 7-5 lists the test pad by number and its associated function.

Table 7-5. Test Pads.

No.	Usage	No.	Usage
1	Run Up Enable	6	MRE Manual Range Switch Code
2	FNA } Function	7	MRD Manual Range Switch Code
3	FNB } Switch	8	Digital Ground
4	FNC } Code	9	Run Down Compensation (+)
5	MRF Manual Range Switch Code	10	No Connection

7-18. Power Supply and Battery Charger. Troubleshooting the 3435A should start with a check of all supply voltages.

7-19. The +7 V supply is adjustable and provides a reference voltage to the −7 V supply. The reference for V_{DISP} is also supplied by the +7 V supply when the battery charger is not present and JM401 is connected.

7-20. Jumpers are available to isolate defective components which may be loading the supplies down. A diagram opposite the power supply schematic shows the circuit location of jumpers in the +7, −7, and −2 volt supplies. A loading problem may be initially identified by measuring the load current of a supply. The power switch is the best place to measure these currents. Typical current loads are shown on the schematic.

Table 7-4. Test Jumpers.

JM Number	Voltage/Signal	Usage
JM 1	External Hold	Holds Display
JM 2	10 kHz Test	Test Only
JM 102	Input Amp Output	
JM 103	Post Amp Output	
JM 201	Slope Amp Output	
JM 202	Comparator Output	
JM 203	Run up Clock	Test Only
JM 401	V_{disp} Supply	When Opened
JM 402	V_{sub} -2 V Supply	disconnects V_{sub} from U11, U12, U13
JM 403	V_{sub} -2 V Supply	disconnects V_{sub} from U11
JM 404	V_{sub} -2 V Supply	disconnects V_{sub} from U12
JM 405	+ 7 V Supply	disconnects +7 V from U2, U3, U4, U5, U6, U7, U12
JM 406	+ 7 V Supply	disconnects +7 V from U5, U6, U7
JM 407	- 7 V Supply	disconnects - 7 V from U2, U3, U4, U5, U6, U7, U12
JM 408	- 7 V Supply	disconnects - 7 V from U5, U6, U7
JM 801	Converter Control Output	test point only - DO NOT CUT
JM 802	AC to DC Converter Input	test point only - DO NOT CUT

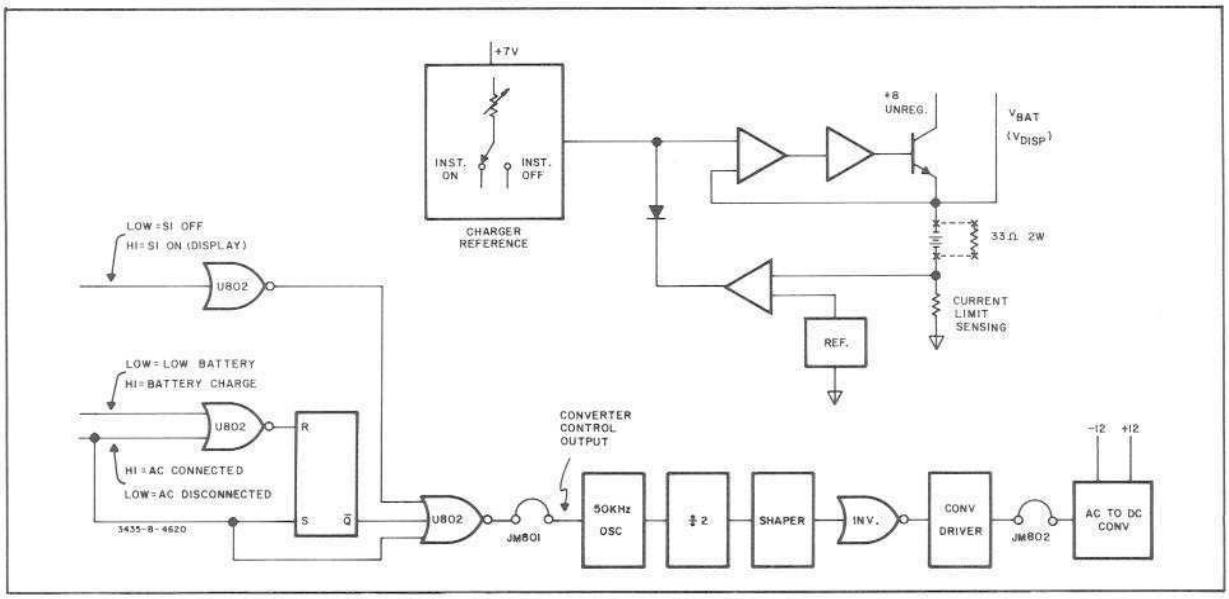


Figure 7-2. Battery Charger Block Diagram.

Table 7-6. Digital Troubleshooting.

Function	Range	R.U. EN	FNA	FNB	FNC	MRF	MRE	MRD	GND	R.D. Comp (+)
dc V	200 mV	⎍	1	1	0	0	0	0	0	1
	2 V		1	1	0	0	0	1	0	1
	20 V		1	1	0	0	1	1	0	1
	200 V		1	1	0	1	1	1	0	1
	1200 V		1	1	0	1	1	0	0	1
ac V	200 mV		1	0	1	0	0	0	0	1
	2 V		1	0	1	0	0	1	0	1
	20 V		1	0	1	0	1	1	0	1
	200 V		1	0	1	1	1	1	0	1
	1200 V		1	0	1	1	1	0	0	1
dc mA	200 μA		1	0	0	0	0	0	0	1
	2 mA		1	0	0	0	0	1	0	1
	20 mA		1	0	0	0	1	1	0	1
	200 mA		1	0	0	1	1	1	0	1
	2000 mA		1	0	0	1	1	0	0	1
ac mA	200 μA		0	0	0	0	0	0	0	1
	2 mA		0	0	0	0	0	1	0	1
	20 mA		0	0	0	0	1	1	0	1
	200 mA		0	0	0	1	1	1	0	1
	2000 mA		0	0	0	1	1	0	0	1
k Ω	20 Ω		1	1	1	0	1	0	0	1
	200 Ω		0	1	1	0	0	0	0	1
	2 kΩ		1	1	1	0	0	1	0	1
	20 kΩ		1	1	1	0	1	1	0	1
	200 kΩ		1	1	1	1	1	1	0	1
	2000 kΩ		1	1	1	1	1	0	0	1
	20 MΩ		1	1	1	1	0	0	0	1

Measurements taken with V/Ω to COM shorted.
1 = 7 V
0 = 0 V
⎍ = Clock

7-21. If the −2 V supply is loaded down by U11, U12, or U13, first isolated the problem to a single IC. Before replacing the IC, check associated circuitry-especially operational amplifiers.

7-22. If a problem exists in the supply itself, disconnect the cable between the A1 and A3 assemblies. Connect JM401 by shorting the emitter of Q402 to pin 7 of P401. If the problem still exists, troubleshoot the power supply circuitry on A1. Waveforms, voltage levels, and typical ripple values are indicated on the schematic.

7-23. Proper operation of the A1 circuitry indicates that the power supply problem is on A3. Disconnect JM401 and reconnect A3 to the main assembly. Begin troubleshooting A3 by checking the fuse and measuring the battery voltage. Verify the adjustment of R818 as described in paragraph 5-22. If the correct charging voltage cannot be obtained, try lifting CR801. If this resolves the problem, troubleshoot the current limiting circuitry.

7-24. Figure 7-2 is a block diagram of the battery charger circuitry. Figure 7-3 shows the relationship of charge voltage and current with the Multimeter off (fast charge) and on (slow charge). Waveforms and voltage levels are shown on the schematic.

7-25. The charger current limiting circuit is composed of a limiter operational amplifier circuit which controls the voltage regulator. A sensing resistor (R811) provides a voltage proportional to the current through the battery; the limiter compares this voltage to a reference voltage. To check the current limiting action of the circuit, monitor the charging voltage at the positive terminal of the battery. This voltage should be approximately 7.2 volts for a fully charged battery. Shorting pin 5 of U801 to ground should reduce the voltage to roughly 6.5 volts (V_{BAT}).

7-26. The voltage regulator circuit performs two functions. With the AC power on, the regulator maintains a constant charging voltage on the battery. In the event that the charging current begins to exceed 550 mA, the limiter circuit acts upon the regulator to decrease the charging voltage. When the instrument is operating on battery power, the voltage regulator circuit monitors the battery voltage and compares it with a reference voltage. When the battery voltage drops below 5.7 volts, U801 pin 1 goes low and shuts down the DC to DC converter. This action prevents a damaging complete discharge of the battery.

7-27. The converter control logic turns off the converter oscillator whenever the AC line is connected. Low battery voltage also shuts down the oscillator. For troubleshooting purposes, a variable power supply can be used in place of the battery to simulate various battery voltages; this should be done only with the AC line disconnected.

7-28. When the AC power is disconnected and the power switch is turned on, the converter oscillator is turned on momentarily to provide power for the voltage regulator circuit; this circuit must determine if the battery voltage is sufficient to continue providing power. If the battery voltage is sufficient, the control logic will dictate continued operation of the oscillator and the instrument will continue to function. Insufficient battery voltage will not allow continued operation of the oscillator.

7-29. The momentary turn-on circuit consists of C805. The sudden application of V_{DISP} to C805 causes an exponentially decreasing voltage at pin 7 of U803. This voltage turns the converter on for about 0.4 seconds to check battery voltage.

7-30. A problem in the converter control logic or the converter oscillator can be difficult to troubleshoot since they are turned on only momentarily when the instrument is turned on; if they are not functioning properly, the instrument will not remain on. The momentary turn-on may be defeated by connecting a 1 meg ohm resistor across C805. This will set U803 pin 2 to a constant low (when S1 is on) and keep the control logic in a steady "ON" state. Troubleshooting of the oscillator circuitry can proceed using the waveforms and voltage levels shown on the schematic.

7-31. Jumpers JM801 and JM802 are test points only; they should not be cut. Cutting them may cause damage to T801, Q804, and Q805.

7-32. Digital Troubleshooting. Controller U13 provides logic signals for the display circuitry, integrator hybrid, and input hybrid. The controller also accepts range and function information from the front panel switches; it determines and provides range information when in the autorange mode.

7-33 A logic check of the controller may be accomplished by connecting the run-up clock in place of the comparator output at U13 pin 36. To institute this test mode, turn the instrument off and cut JM202. Connect the side of JM202 that is nearest R9 to JM203. Turn the instrument on. The display should read all zeros in all functions and ranges except for illegal switch combinations. The display will indicate OL for invalid switch settings. The annunciator LED's should reflect the function and range information as set by the front panel switches. Autoranging may be checked by setting a function in its highest possible range and then switching to autorange. The display should indicate sequential ranging down to the lowest possible range.

7-34. Table 7-6 lists test pad logic levels for the various functions and ranges. Table 7-7 shows display waveforms for a display of −0.00. These waveforms are taken in the test mode. DCV function, and 20 V range.

7-35. JM202 should be replaced with -hp- part number 1460-1489 when testing has been completed.

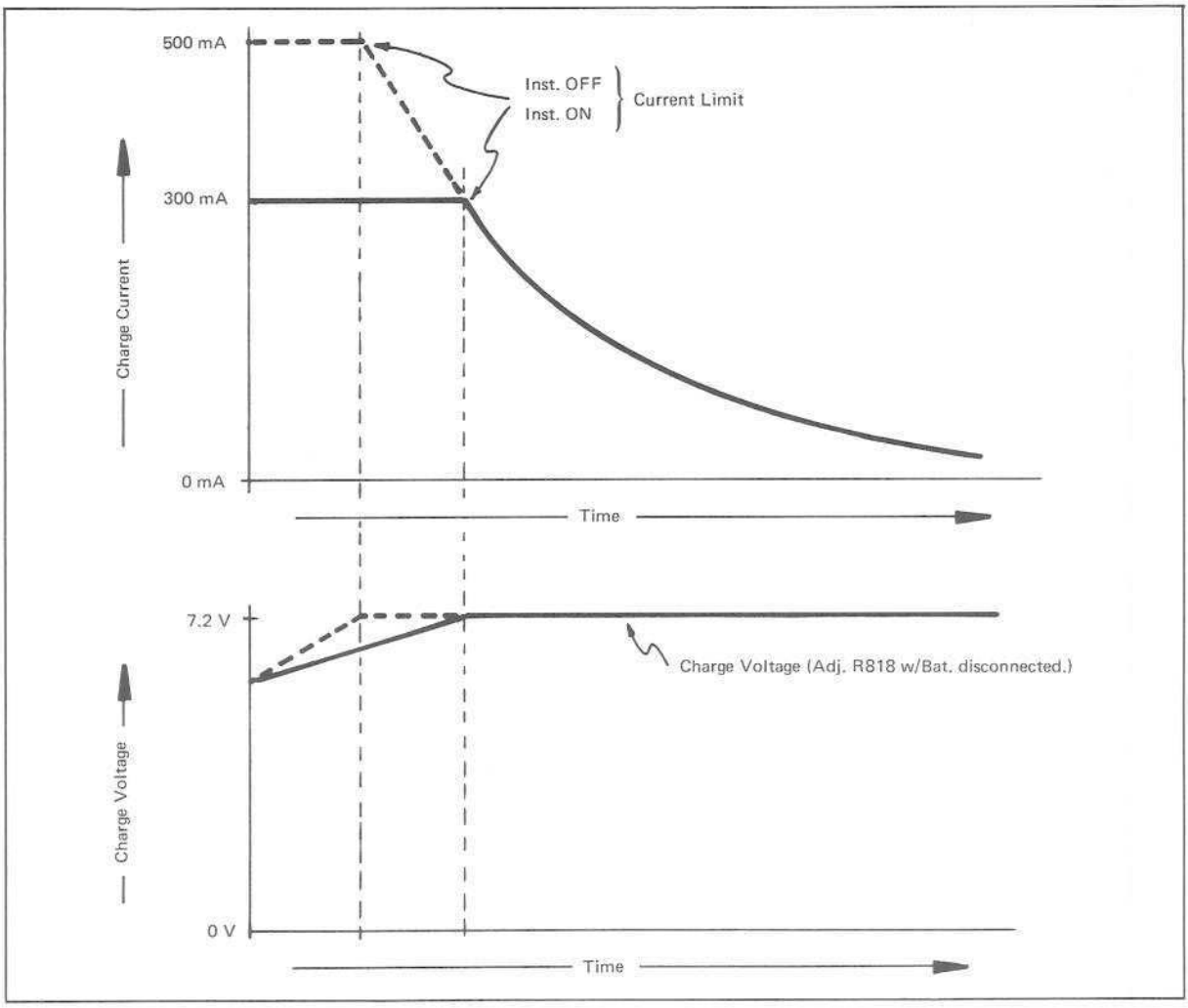


Figure 7-3. Charge Current/Voltage.

7-36. Voltage and Current Signal Conditioning. In the current functions, currents are transformed into voltage using precision current shunts. The input amplifier and post amplifier convert all DC voltage input signals to a level of −2.0 to +2.0 volts; this level – which is seen at the output of the post amplifier – is the input to the A to D converter. All AC input signals are converted to a level of −400 to +400 millivolts AC. This AC level is the input to the AC to DC converter. If the display shows a constant OL in all functions and ranges, start troubleshooting by checking the level at JM103 (post amp output). Table 7-2 and 7-3 should be used to verify the gains of the input amp and post amp. Waveforms and voltage levels are shown on the schematic.

7-37. Ohms Converter. Most problems in the ohms circuitry are a result of damaged protection components. These components can suffer damage when excess voltages are applied to the input terminals while in the ohms function. Troubleshooting should begin by lifitng one end of diodes CR101, CR102, CR202, and CR203. The absence of these protection diodes will not inhibit normal operation of the circuit.

7-38. To check the ohms current source and bypass the remaining protection circuitry, lift the anode of CR107. Connect the cathode of CR107 to one terminal of a milliameter. The other milliameter terminal should be connected to the V/Ω terminal of the 3455A. Table 7-8 lists the various currents that the ohms current source should deliver for different ramps in the kΩ function. If the current source is not functioning properly, check the ohms reference op amp (U8) and the input amp; replace U11 as a last resort. Normal operation of the current source suggests that the problem is in the protection circuitry; check CR105, CR107, CR108, and Q101.

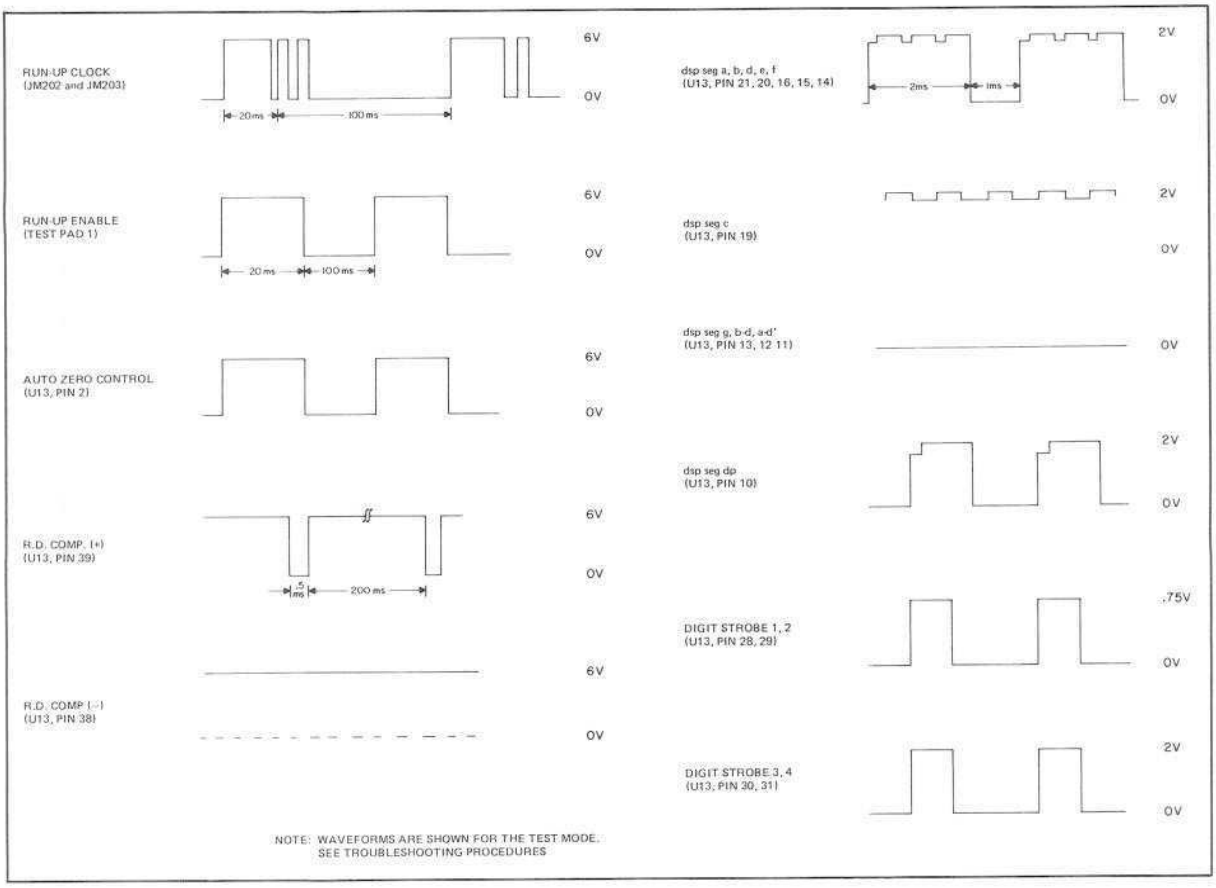


Table 7-7. Control and Logic Waveforms.

Table 7-8. Ohms Current Source.

Range	I_X, Ohms Current Source
20 Ω	5 mA
200 Ω	5 mA
2 kΩ	500 μA
20 kΩ	50 μA
200 kΩ	5 μA
2000 kΩ	500 nA
20 MΩ	50 nA

7-39. Low readings on the 20 MΩ range may be caused by defects in C103, C107, or C108. If the 3435A cannot be zeroed on ohms, C106, CR202, and CR203 should be checked.

7-40. Protection diodes should be replaced in the circuit when troubleshooting has been completed.

7-41. AC to DC Converter. The AC to DC converter changes AC signals to an equivalent DC signal that may be measured by the A to D converter. The AC to DC converter should operate properly over the specified frequency range of the 3435A. It should be noted that frequency response problems can be caused by the AC to DC converter, the post amp, or the input amp.

7-42. Any half-scale AC input should produce about –85 mV DC on C120. To verify that the AC portion of the integrater hybrid is functioning properly, connect a DC standard set to –85 mV DC across C120. The display should show approximately 1000 counts.

7-43. Isolation of frequency response problems should begin with a check of the AC to DC converter. To check the frequency response, cut JM103. Switch the 3435A to the ACV function. Connect 200 mV AC between ground (common) and the end of JM103 nearest the back of the 3435A. A 745A AC Calibrator should be used as the AC standard. The 3435A display should show 1000 counts for a 200 mV input at JM103. Vary the frequency of the 745A to check the flatness of the converter. When replacing JM103 with -hp- part number 1460-1489, cut the ends of the jumper short to prevent shorting to the shield beneath the PC board.

7-44. To check frequency response of the post amp, cut JM102. With the 3435A in the AC function and 2 V range, connect a 745A set to 200 mV AC between ground and the side of JM102 farthest from R111. The display should show 1000 counts. Vary the frequency to check the flatness of the post amp in the X1 gain configuration. To check the X10 gain configuration, set the 745A to 20 mV AC and change the 3435A to the 20 V range. As in 7-43, replace the jumper JM102.

7-45. Verification of flatness in the AC to DC converter and post amp would isolate frequency response problems to the input stage.

7-46. Typically, low AC readings can be a result of defects in many different components. U5, U6, C110, C105, and C106 are some possibilities. Non-linear AC readings can usually be corrected by replacing CR110 and CR111. Abnormalities in C120 can cause noisy AC readings.

7-47. Auto-Zero Circuit. To verify proper operation of the auto-zero circuit, set the 3435A in the 20 K range and ohms function. With the input shorted, sweep R203 from stop to stop. The reading on the display should vary less than 4 counts. Then, switch to the 20 Ω range. Varying R203 should not change the display more than 12 counts. Re-adjust R203; see the adjustment procedures.

7-48. A to D Converter. Analog to digital conversion is performed using dual slope integration. Check the 4.6 volt reference supply to begin troubleshooting. Waveforms and voltage levels are shown on the schematic.

7-49. A simple check can verify basic operation of the three operational amplifiers in the circuit. With the instrument off, put a short across the integrator capacitor C202. Short the input and turn the instrument on (range and function are not important in this test). As R203 is varied from stop to stop, the outputs of the amplifiers should vary as shown in Table 7-9. Remove the short on C202 and re-adjust R203 when troubleshooting has been completed.

Table 7-9. A to D Converter Op Amp Troubleshooting.

Amplifier	Approximate Output Variance
U2	+10 mV to −10 mV
U3	+4 V to −4 V
U4	+6 V to −400 mV

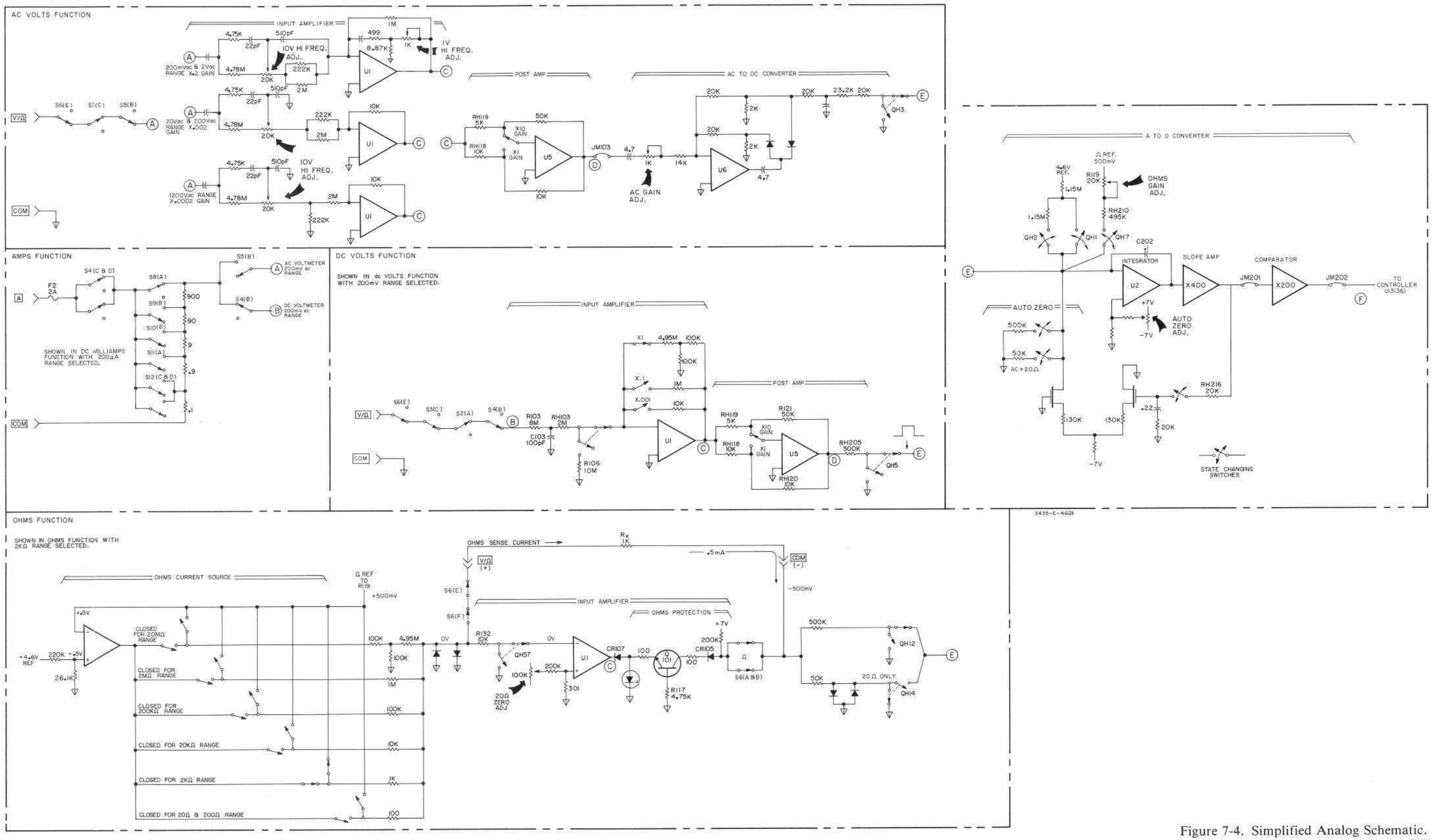
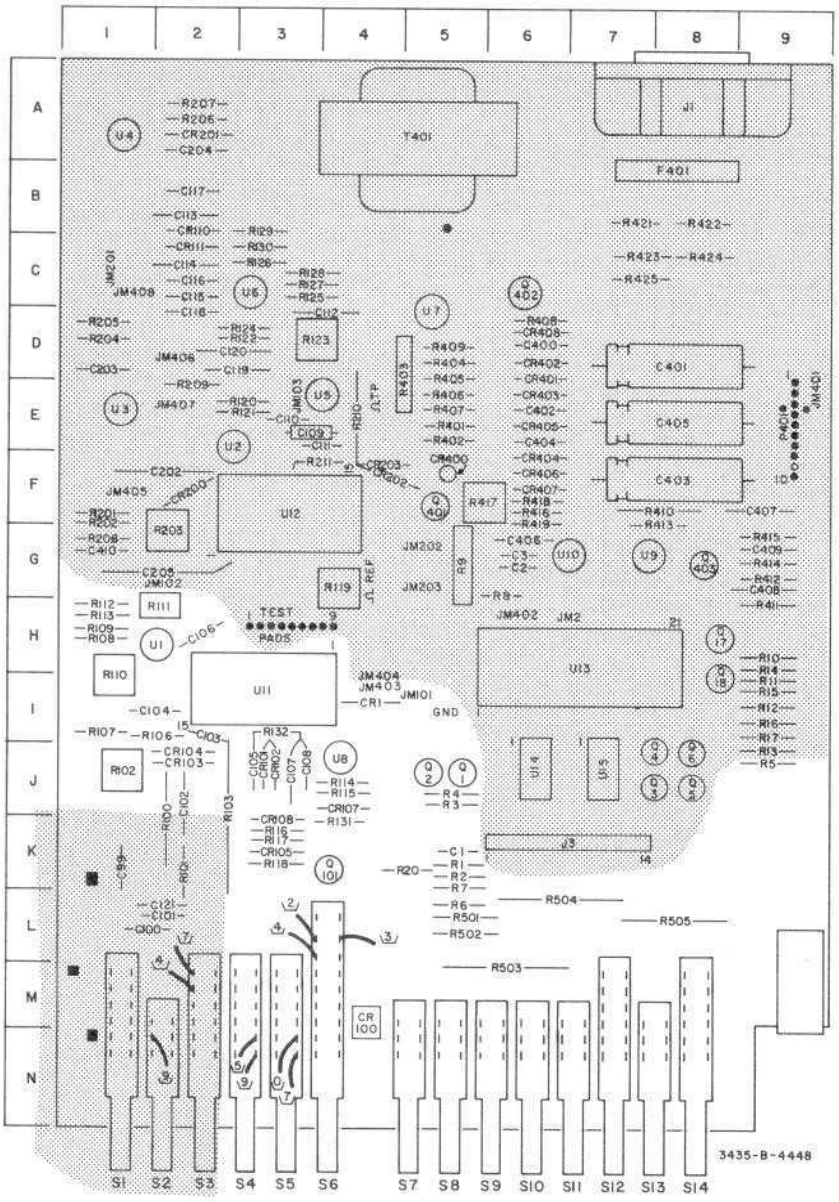


Figure 7-4. Simplified Analog Schematic.

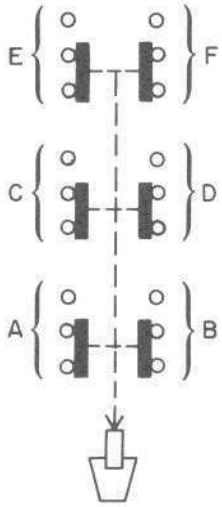


A1
-hp- Part No. 03435-66521

UNSHADED AREAS
FOR THIS SCHEMATIC

A1 COMPONENT LOCATIONS

	C	CR	R
1	K5	I4	K5
2			K5
3			J5
4			J5
5			J9
6			L5
7			K5
20			K4
99	K1		
100	L2	M4	K2
101	L2	J3	K2
102	J2	J3	J1
103	I2	J2	J3
104	I2	J2	
105	J3	K3	
106	H2		I2
107	J3	J4	I1
108	J3	K3	H1
109			H1
110			I1
111			H2
112			H1
113			H1
114			J4
115			J4
116			K3
117			K3
118			K3
121	L2		
131			K4
132			I3
501			L5
502			L5
503			M6
504			L7
505			L8



NOTE 1

THE SCHEMATIC IS SHOWN WITH DCV (FUNCTION) AND .2 V (RANGE) SELECTED. PROMINANT SCHEMATIC LINES SHOW THE SIGNAL PATH FOR THIS SWITCH SETTING.

NOTE 2

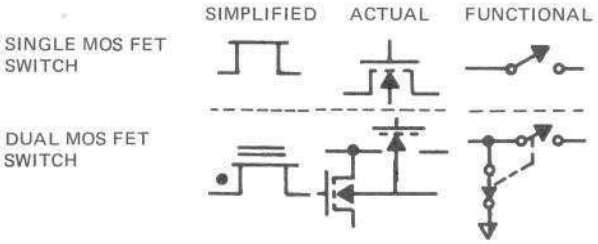
SWITCHES S2 THROUGH S14 ARE SCHEMATICALLY ORIENTED IN ASCENDING NUMERICAL ORDER FROM LEFT TO RIGHT. THIS ORIENTATION IS THE SAME AS THE PHYSICAL ORIENTATION OF THE ACTUAL SWITCH AS THEY ARE VIEWED ON THE COMPONENT LOCATOR FIGURE 7-5. SWITCH SECTIONS ARE LABELED A THROUGH F ON THE SCHEMATIC AS SHOWN ON THE ADJACENT DIAGRAM.

NOTE 3

U11, U12, AND U13 ARE HYBRID INTEGRATED CIRCUITS. FINE LINE RESISTORS AND MOS FET SWITCHES WHICH ARE PART OF THE HYBRIDS ARE SHOWN ON THE SCHEMATIC FOR OPERATIONAL CLARIFICATION ONLY. THESE COMPONENTS ARE NOT INDIVIDUALLY SERVICEABLE.

NOTE 4

SIMPLIFIED SCHEMATIC REPRESENTATIONS OF MOS FET SWITCHES ARE USED FOR SCHEMATIC CLARITY. COMPARISONS OF THE SIMPLIFIED, ACTUAL AND FUNCTIONAL SCHEMATIC REPRESENTATIONS ARE AS FOLLOWS:



NOTE 5

TYPICAL VOLTAGES ARE SHOWN FOR A 10 V INPUT ON THE 20 V RANGE. (AC) OR (DC) INDICATES THE APPROPRIATE VOLTAGE FUNCTION.

RANGE	CODE			
	MRD	MRE	MRF	AUTO
20 Ω (S7)	0	1	0	1
200 (S8)	0	0	0	1
2 (S9)	1	0	0	1
20 (S10)	1	1	0	1
200 (S11)	1	1	1	1
2000 (S12)	0	1	1	1
20 MΩ (S13)	0	0	1	1
AUTO/MANUAL (S14)	OPEN	OPEN	OPEN	0

FUNCTION	CODE		
	FNA	FNB	FNC
DCV (S2)	1	1	0
ACV (S3)	1	0	1
DCI (S4)	1	0	0
ACI (S5)	0	0	0
Ω (S6)	1	1	1

1 = +7 V
0 = 0 V ( )
MRD = MANUAL RANGE LINE "D"
FNA = FUNCTION LINE "A"

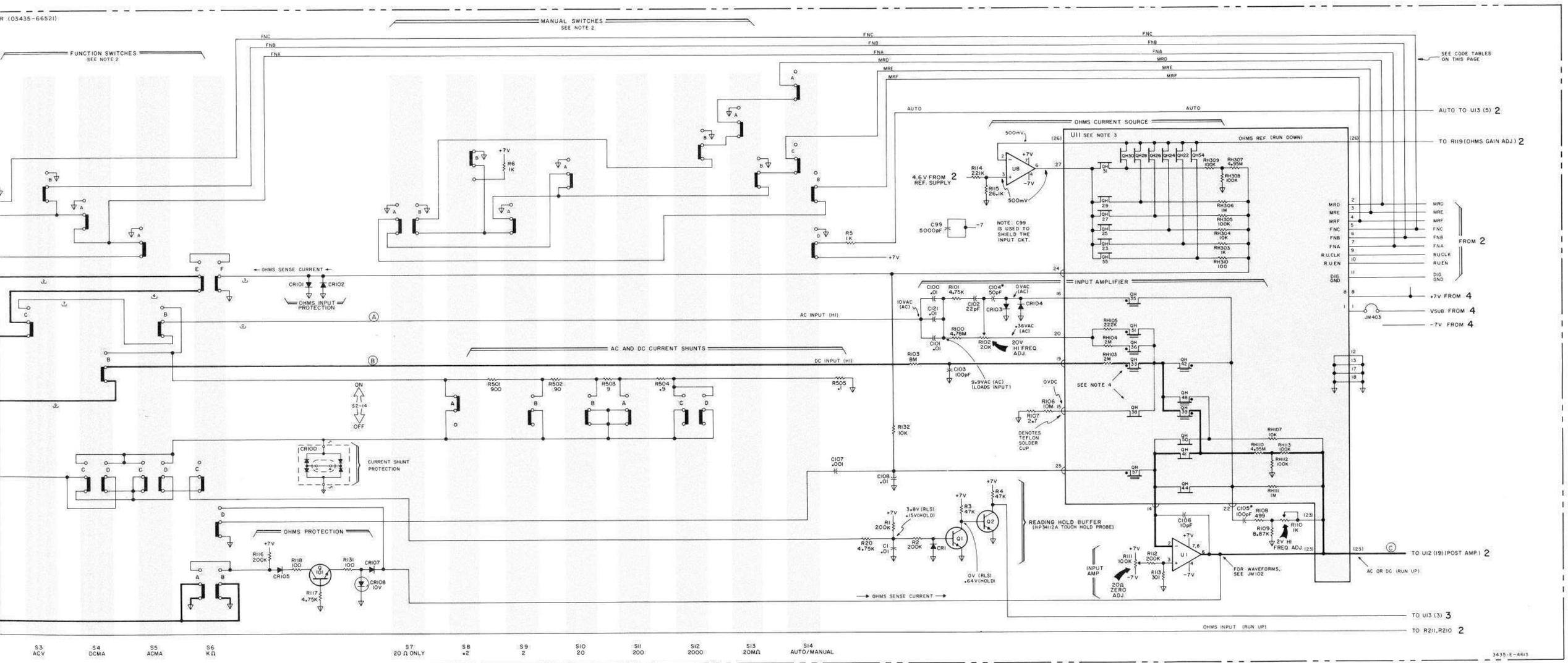
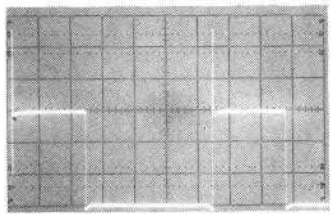


Figure 7-5. 3435A Input Switching, Input Amplifier and Ohms Current Source Schematic.

SLOPE AMP/COMP/AUTO ZERO/CLOCK

HALF-SCALE INPUT

0V

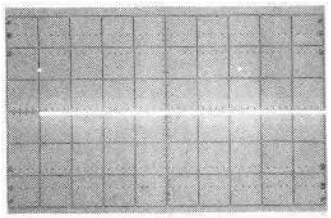


10

JM201

VERT: 2 V/div
HORIZ: 50 msec/div

0V

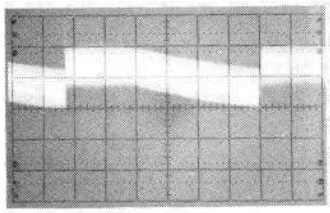


11

JM 202

VERT: 2 V/div
HORIZ: 50 msec/div

0V

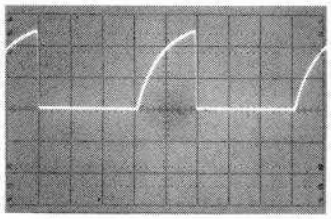


9

U12 PIN2

VERT: .02 V/div
HORIZ: 50 msec/div

0V



12

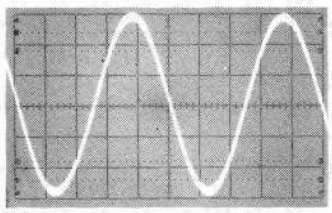
JM 2 (CLOCK)

VERT: 2 V/div
HORIZ: 50 msec/div

AC CONVERTER

1 VRMS @ 1 KHZ

0V

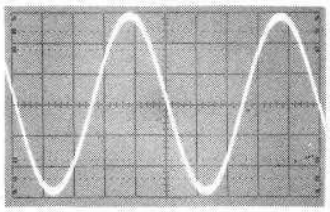


4

JM 102

VERT: .1 V/div
HORIZ: .2 msec/div

0V

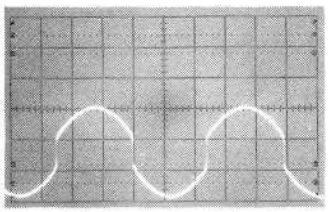


5

JM 103

VERT: .1 V/div
HORIZ: .2 msec/div

0V

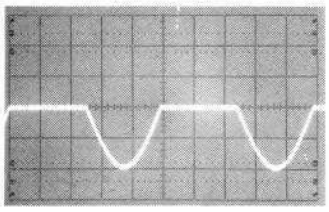


6

U6 PIN 6

VERT: .5 V/div
HORIZ: .2 msec/div

0V

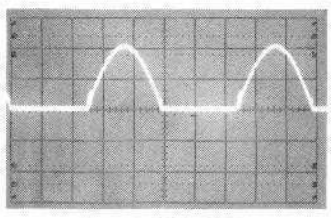


7

CR111 ANODE

VERT: .2 V/div
HORIZ: .2 msec/div

0V

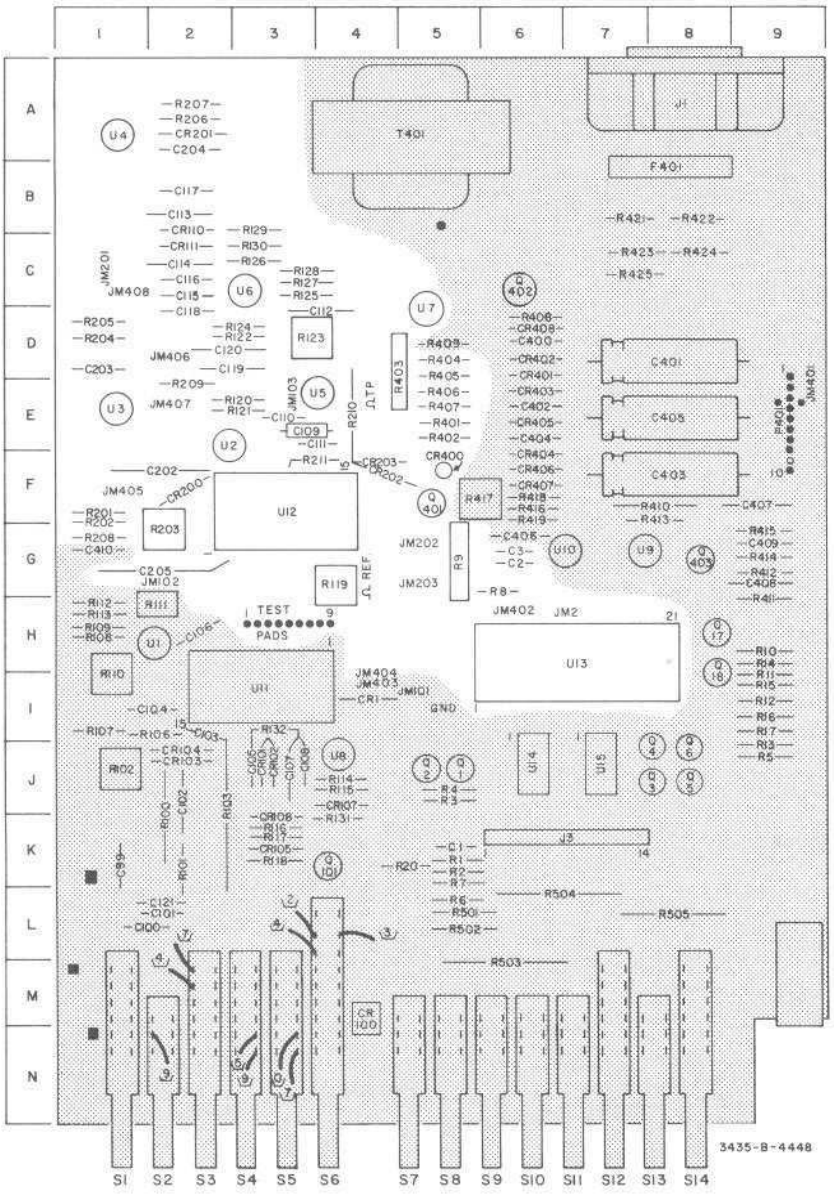


8

CR110 CATHODE

VERT: .2 V/div
HORIZ: .2 msec/div

UNSHADED AREAS
FOR THIS SCHEMATIC



A1
-hp- Part No. 03435-66521

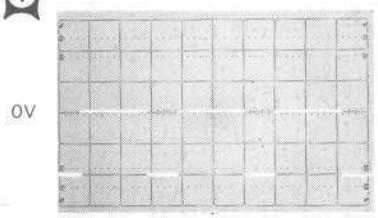
A1 COMPONENT LOCATIONS

	C	CR	R	U
2	G6			E2
3	G6			E1
4				A1
5				E3
6				C3
8			G6	
9			G5	
12				F3
13				H7
109	E3			
110	E3	B2		
111	E3	C2		
112	D2			
113	B2			
114	C2			
115	C2			
116	C2			
117	B2			
118	D2			
119	D2		G4	
120	D2		E3	
121			E3	
122			D3	
123			D3	
124			D3	
125			C3	
126			C3	
127			C3	
128			C3	
129			B3	
130			C3	
200		F2		
201		A2	F1	
202	F2	F4	G1	
203	D1	F4	G2	
204	A2		D1	
205	G2		D1	
206			A2	
207			A2	
208			G1	
209			E2	
210			E4	
211			F3	
400		F5		
401			E5	
402			E5	
403			E4	
404			D5	
405			D5	
406			E5	
407			E5	

IMPUT AMP/POST AMP/INTEGRATOR

+ 1 VDC

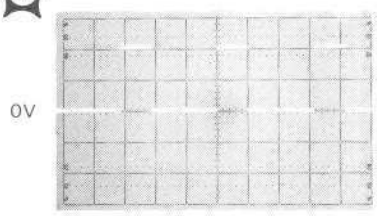
1



JM102

VERT: .5 V/div
HORIZ: .1 sec/div

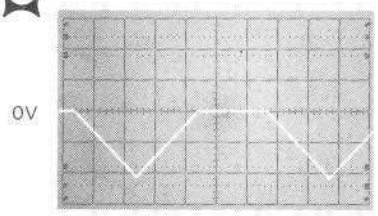
2



JM103

VERT: .5 V/div
HORIZ: .1 sec/div

3



INTEGRATOR OUTPUT
(U2 PIN 6)

VERT: 1 V/div
HORIZ: 50 msec/div

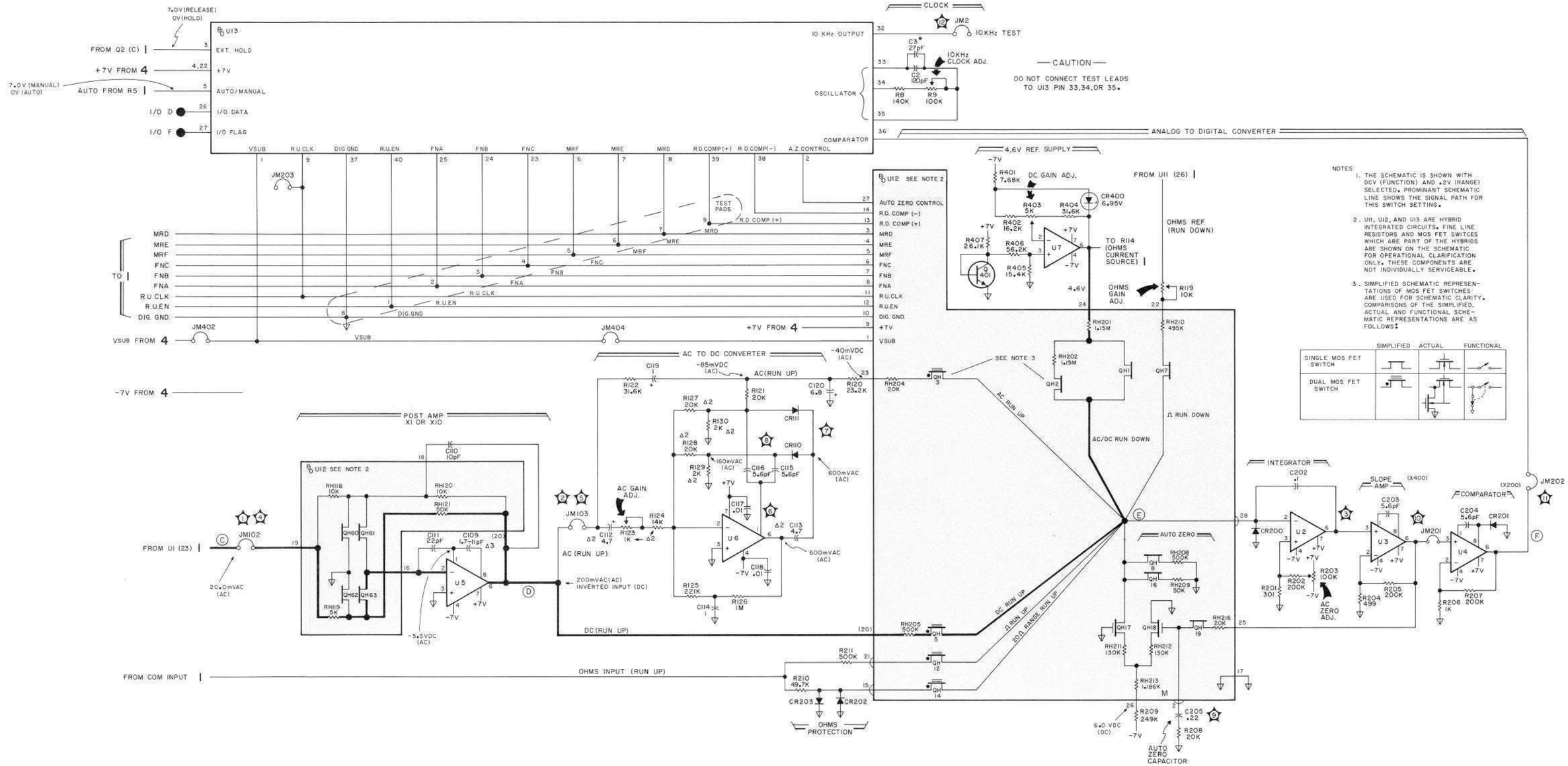
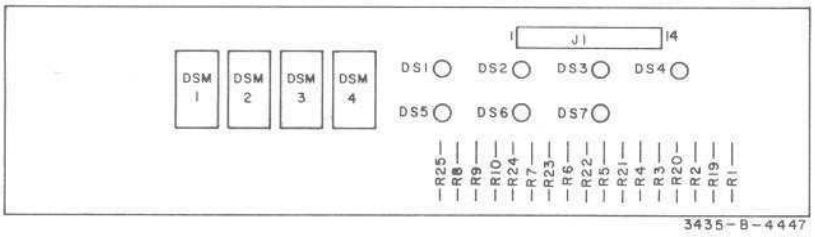
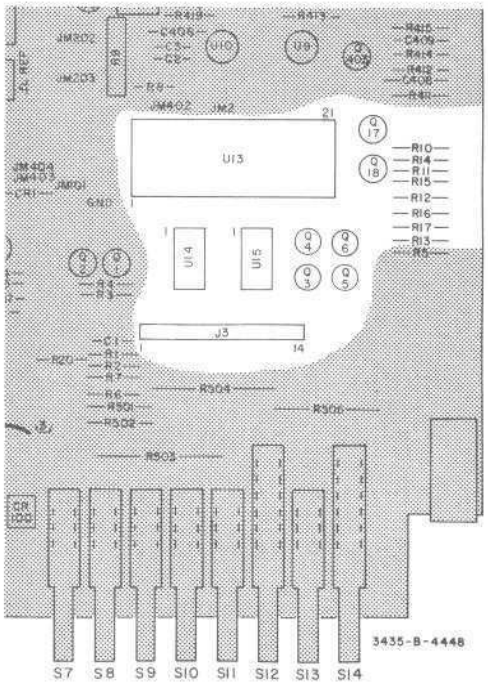


Figure 7-6. 3435A Post Amplifier, AC to DC Converter and Analog to Digital Converter to Schematic.



A2
-hp- Part No. 03435-66522



A1
-hp- Part No. 03435-66521

UNSHADED AREAS
FOR THIS SCHEMATIC

NOTE: DISPLAY WAVEFORMS ARE SHOWN IN TABLE 7-7.
SEE TROUBLESHOOTING INFORMATION.

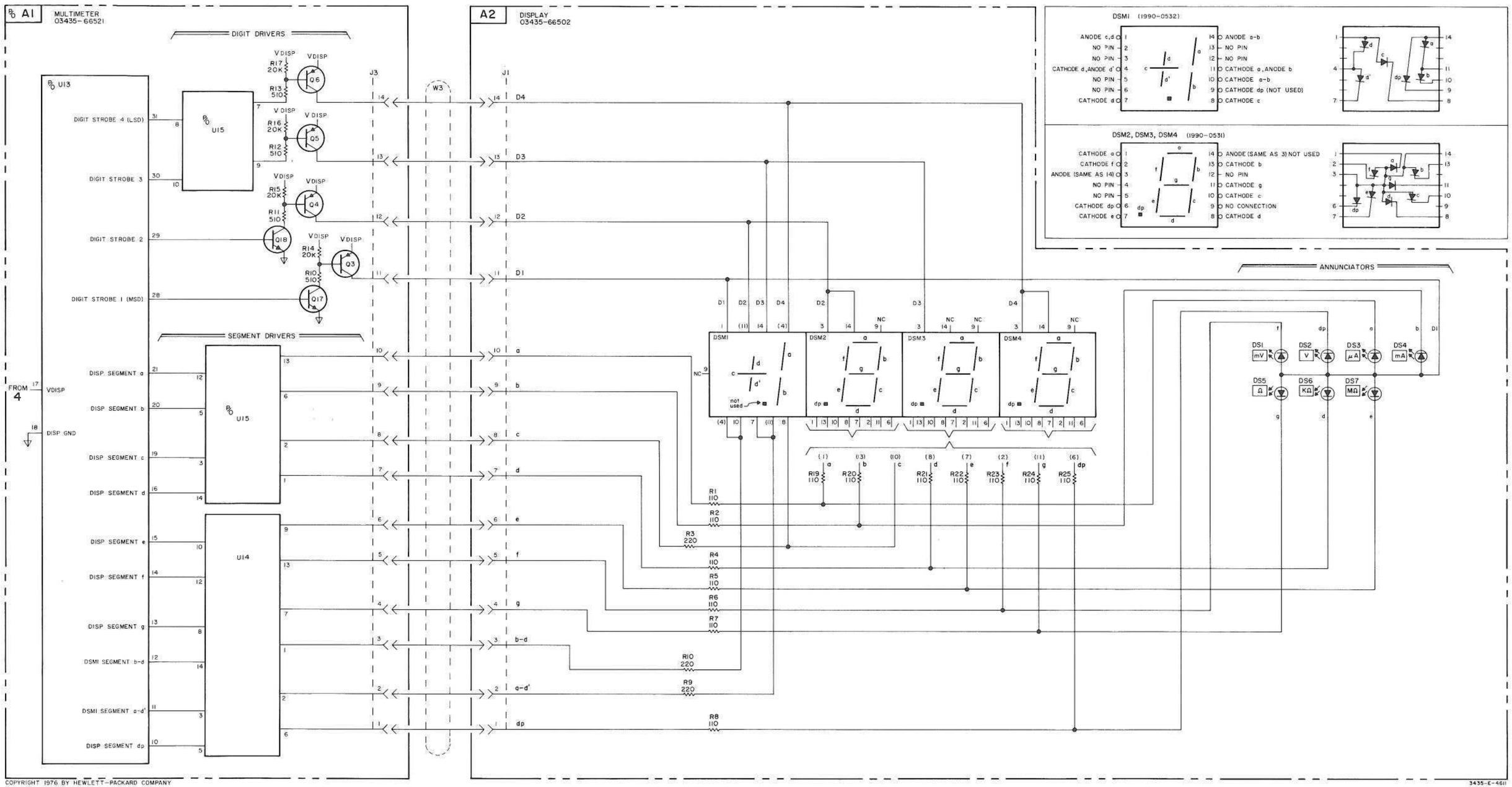
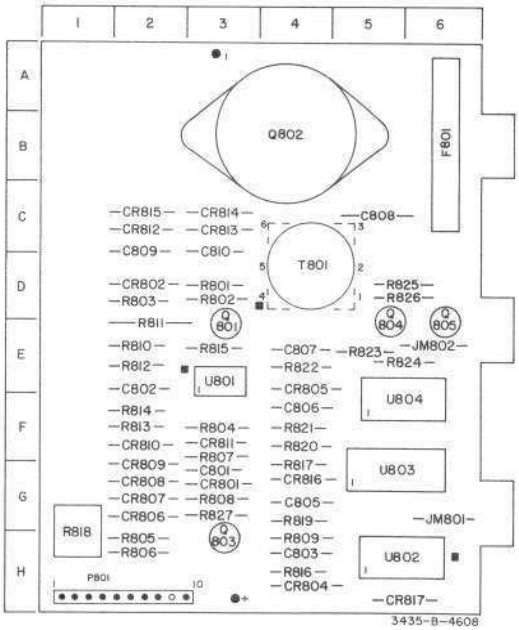


Figure 7-7. Display Schematic.



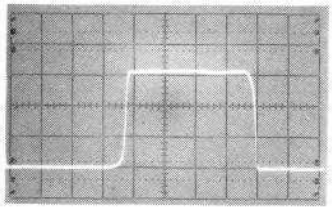
A3
-hp- Part No. 03435-66503

POWER SUPPLY BOARD

COMPONENT LOCATIONS

	C	CR	R
801	G3	G3	D3
802	E2	D2	D3
803	H4		D2
804		H4	F3
805	G4	E4	H2
806	F4	G2	H2
807	E4	G2	F3
808	C5	G2	G3
809	C2	G2	H4
810	C3	F2	E2
811		F3	E2
812		C2	E2
813		C3	F2
814		C3	F2
815		C2	E3
816		G4	H4
817		H5	G4
818			H1
819			G4
820			F4
821			F4
822			E4
823			E5
824			E5
825			D5
826			D5
827			G3

0V

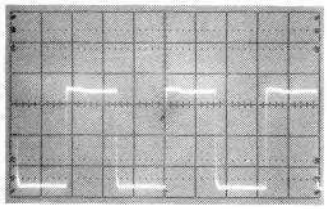


1

U803 PIN 13

VERT: 2 V/div
HORIZ: 5 μsec/div

0V

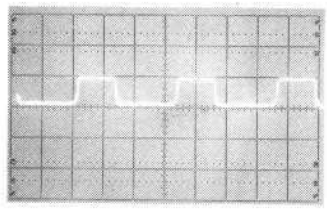


2

CR805 CATHODE

VERT: 2V/div
HORIZ: 10 μsec/div

0V

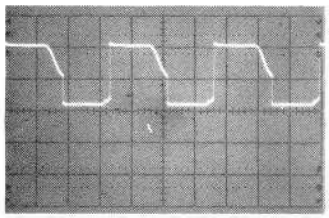


3

JM802

VERT: 2 V/div
HORIZ: 10 μsec/div

0V

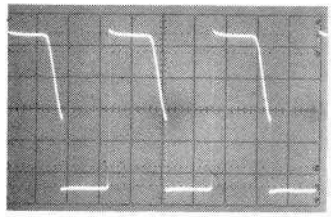


4

Q805 COLLECTOR

VERT: 5 V/div
HORIZ: 10 msec/div

0V

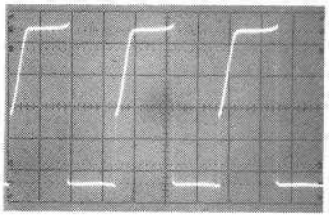


5

CR814 CATHODE

VERT: 5 V/div
HORIZ: 5 msec/div

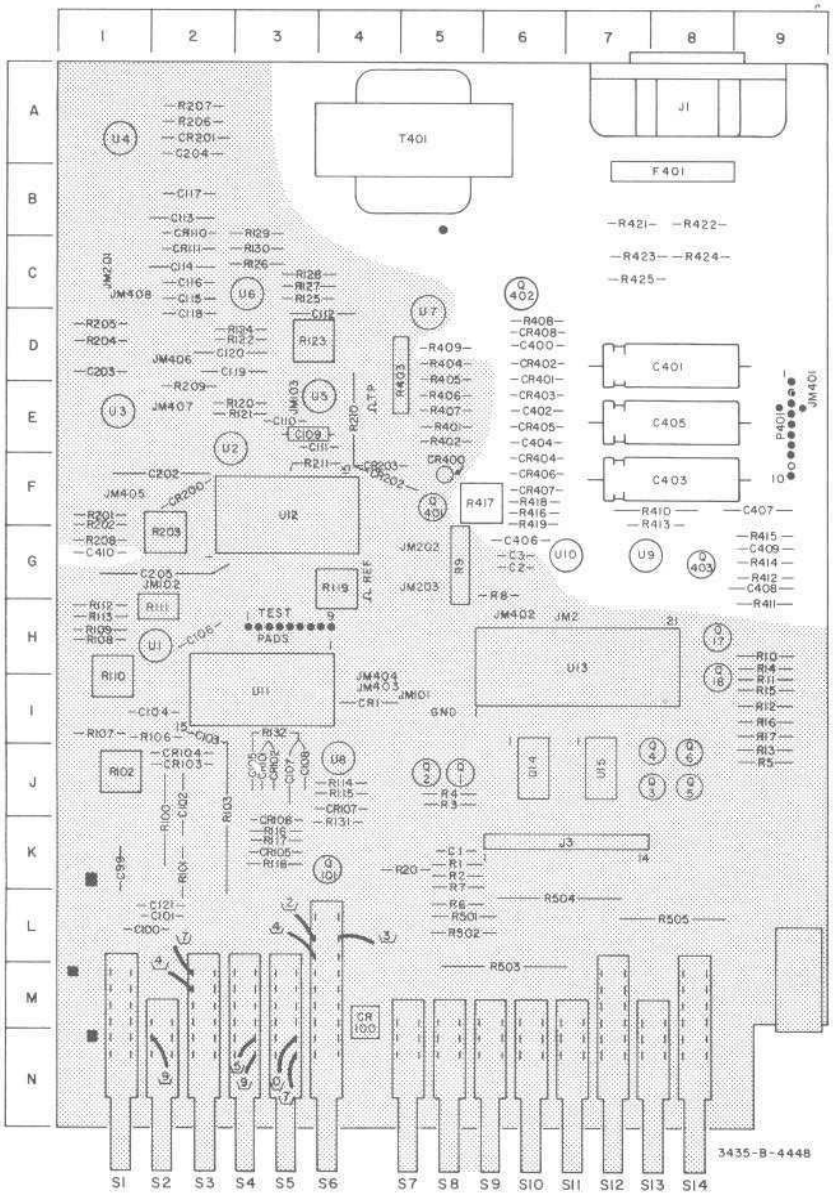
0V



6

CR813 CATHODE

VERT: 5 V/div
HORIZ: 5 ms/div

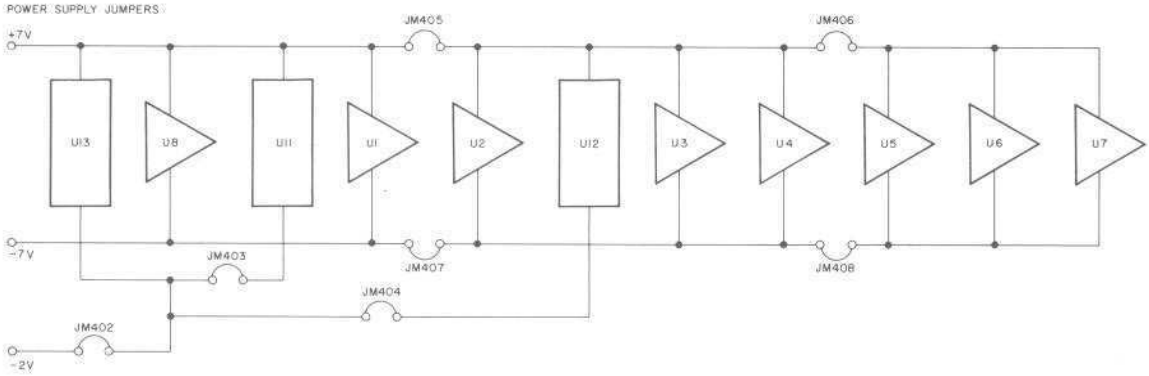


A1
-hp- Part No. 03435-66521

UNSHADED AREAS
FOR THIS SCHEMATIC

A1 COMPONENT LOCATIONS

	C	CR	R
400	D6		
401		E6	
402	E6	D6	
403		E6	
404	E6	F6	
405		E6	
406	G6	F6	
407	F9	F6	
408	G9	D6	D6
409	G9		D5
410	G1		F8
411			H9
412			G9
413			F8
414			G9
415			G9
416			F6
417			F5
418			F6
419			F6
421			B7
422			B8
423			C7
424			C8
425			C7



NOTE

JM 405 THROUGH JM 408 ARE NOT SHOWN ON THE SCHEMATIC DIAGRAMS.

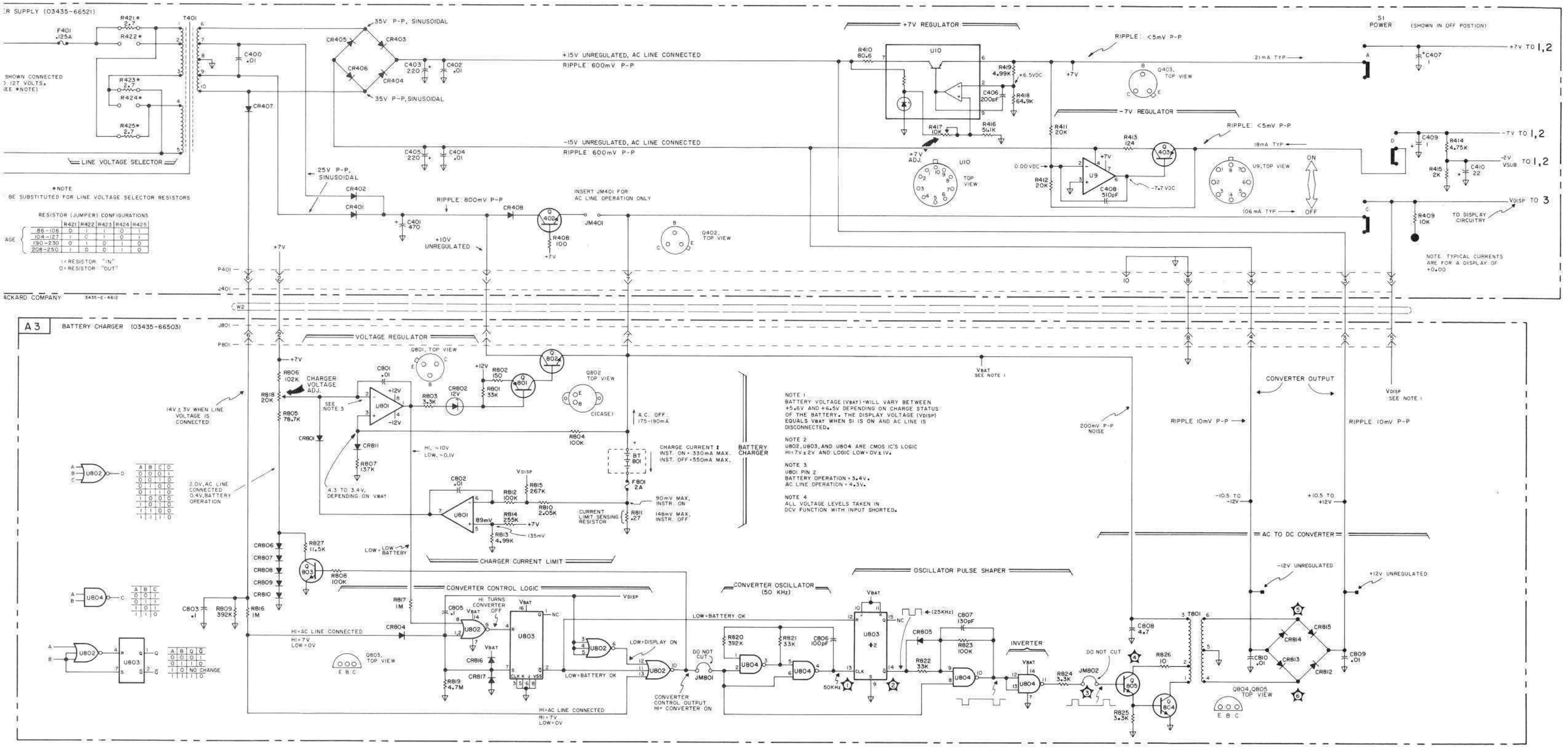


Figure 7-8. Power Supply and Battery Charger Schematic.
7-17/7-18

SECTION VIII
BACKDATING INFORMATION

$\Delta 1$ For serial numbers 1606A03100 and below, use part number 1906-0023 if replacement is necessary.

$\Delta 2$ For serial numbers 1606A02850 and below, replace all parts marked with $\Delta 2$ if replacement of any is necessary. All $\Delta 2$ parts are found in the AC to DC converter circuit.

$\Delta 3$ For serial numbers 1606A02850 and below, A1C109 is a fixed 3.3 pF capacitor, -hp- part number 0150-0059. Omit adjustment number (10).

MANUAL CHANGES

MODEL 3435A

DIGITAL MULTIMETER

Manual Part No. 03435-90002

■New or Revised Item

ERRATA

CHANGE NO. 1

On Table 6-3 of page 6-5, A1U1 is HP Part No. 5180-0218.

Page 6-5, Table 6-3. The part number for A1W3 should be 8120-2279, not 8120-3455.

CHANGE NO. 2. Applies to Serial Numbers 1606A07701 and greater.

On Table 6-3, page 6-3, delete C109 (P/N 0121-0451), C110 (P/N 0160-2197), and C111 (P/N 0140-0145).

Page 6-4. Add part R133, P/N 0698-4435 R-F 2.49K .01%.

5-7. Delete paragraph 5-31 (10) 20V Range 100kHz Adjustment (C109).

Figure 5-11, page 5-9/5-10. Delete (10) 20VAC ADJ and C109.

Correct all component locators as shown in Figure 2.

Page 6-5. Delete U5 (P/N 1820-0223) and add U5 P/N 1826-0357 IC LM301AH OP AMP.

Table 6-4, page 6-6. Delete Index No. 7 (P/N 03435-00601) and add P/N 03435-00616.

Figure 7-6, page 7-13/7-14. Correct schematic as shown in Figure 1.

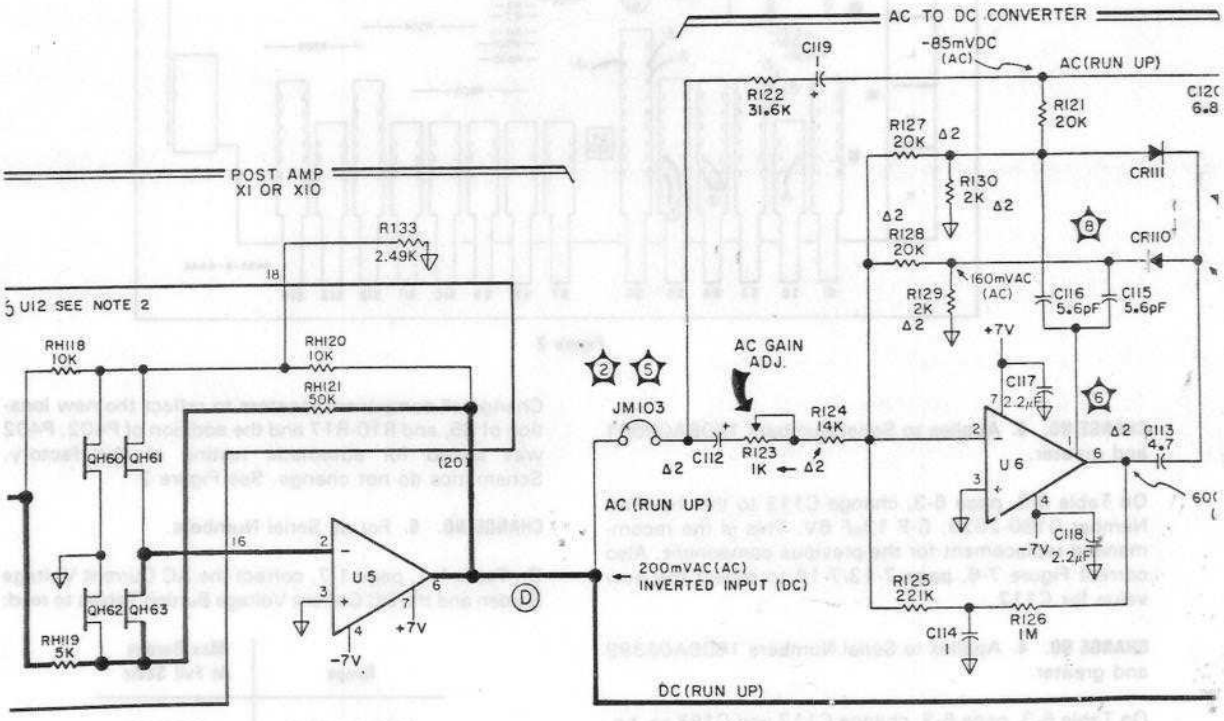


Figure 1

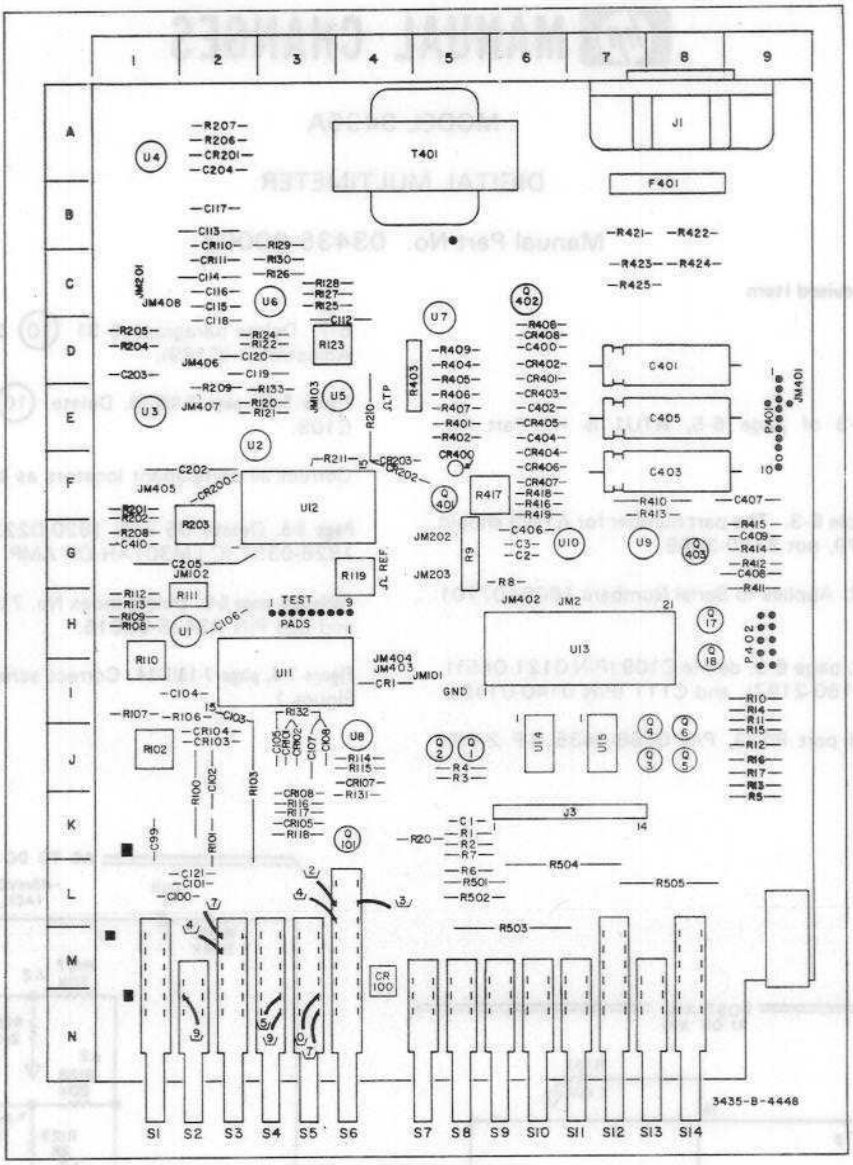


Figure 2

CHANGE NO. 3. Applies to Serial Numbers 1606A08091 and greater.

On Table 6-3, page 6-3, change C112 to the -hp- Part Number 0180-2623, C-F 12μF 6V. This is the recommended replacement for the previous component. Also correct Figure 7-6, page 7-13/7-14 to reflect the new value for C112.

CHANGE NO. 4. Applies to Serial Numbers 1606A08399 and greater.

On Table 6-3, page 6-3, change C117 and C188 to -hp- Part Number 0160-0128, C-F 2.2μF. This is the recommended replacement for the previous component. Also correct Figure 7-6, page 7-13/7-14 to reflect the new value for C117 and C118.

CHANGE No. 5. Applies to Serial Numbers 1606A13891 and greater.

Change all component locators to reflect the new location of R5, and R10-R17 and the addition of P402. P402 was added for automatic testing at the factory. Schematics do not change. See Figure 2.

CHANGE NO. 6. For all Serial Numbers.

On Table 1-1, page 1-7, correct the AC Current Voltage Burden and the DC Current Voltage Burden Tables to read:

Range	Max Burden At Full Scale
200μA-10mA	<220mV
200mA	<240mV
2000mA	<650mV

CHANGE NO. 7. For all serial numbers.

On Table 6-4, page 6-6, the -hp- part number for the Bottom Shell w/Shield (Mechanical part 16) should be: 4040-1463. The new part number replaces the old part number in all 3435A applications.

CHANGE NO. 8

Page 1-3. Delete the second sentence of paragraph 1-13.