Errata

Title & Document Type: **3467A Logging Multimeter Operating and Service Manual**

Manual Part Number: **03467-90000**

Revision Date: **March 1978**

About this Manual

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

HP References in this Manual

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

Support for Your Product

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

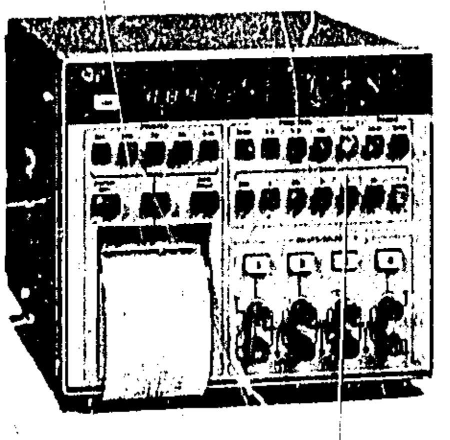
www.agilent.com

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

OPERATING AND SERVICE MANUAL

LOGGING MULTIMETER

3467A



HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

3467A

LOGGING MULTIMETER

Serial Numbers 1821A00101 and Above
Revision A

IMPORTANT NOTICE

This loose leaf manual does not normally require a change sheet. All major change information has been integrated into the manual by page revision. In cases where only minor changes are required, a change sheet may be supplied.

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

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

WARNING

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

Manual Part No. 03467-90000
(Complete Manual Including Binder)
Microfiche Part No. 03467-90050

Printed: March 1978

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I for general safety considerations applicable to this product.

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-. However, warranty service for products installed by -hp- and certain other products designated by -hp- will be performed at Buyer's facility at no charge within the -hp- service travel area. Outside -hp- service travel areas, warranty service will be performed at Buyer's facility only upon -hp's- prior agreement and Buyer shall pay -hp's- round trip travel expenses.

For products returned to -hp- for warranty service, 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.

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.

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.

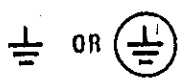
WARNING

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

General Definitions of Safety Symbols Used On Equipment

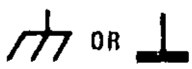
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

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).

WARNING

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

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, 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.

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LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information concerning the Hewlett-Packard Model 3467A Logging Multimeter. Included are an instrument description, specifications, supplemental characteristics, instrument and manual identification, option and accessory descriptions, safety considerations, and some discussion on how to obtain further information on this versatile instrument.

1-3. DESCRIPTION.

1-4. The Hewlett-Packard Model 3467A is a versatile 4 channel, 4½ digit, 4 function, printing multimeter. The 3467A (referred to as *LOGGING MULTIMETER*) can be used for manual and/or automatic measurement logging on any combination of input channels. An internal pacer-timer serves to initiate measurements and is presettable using the instruments' manual entry feature.

1-5. FUNCTIONS.

1-6. The Logging Multimeter functions include DCV, ACV, OHMS, and TEMPERATURE in both independent and math referenced modes. A unique "MIX" mode allows for temperature measurements on Channels 1 and 2, and DCV, ACV, or OHMS measurements on Channels 3 and 4. Temperature measurements utilize an external thermistor of the following type:

a. -hp- 0837-0164

b. YSI 44007

c. Fenwal UUA 35J1

d. OMEGA UUA 35J3

e. or equivalent

1-7. RANGES.

1-8. Ranging is automatic with a STEP pushbutton for up ranging and a HOLD pushbutton for range holding. A μV,Ω pushbutton is provided for DCV and kΩ zeroing of up to 2 mV and 20Ω respectively on any input channel.

1-9. SCANNER.

1-10. A four channel scanner multiplexes inputs one-at-a-time to the Logging Multimeter measurement circuitry. All four input pairs are floating and scanning occurs in a break-before-make sequence.

1-11. PRINTER.

1-12. A 16 character/line thermal printer provides hard-copy of measurement results and elapsed time. Printing can be both manually and timer initiated. A full roll of thermal paper provides approximately 5500 lines of printing (approximately 2½ hours of continuous printing).

1-17. SWITCH-SELECTABLE FEATURES.

1-18. Selectable °C - °F Temperature Units.

1-19. Temperature units are switch selectable between °C or °F. The Logging Multimeter is shipped from the factory with °C units selected. Service trained personnel may refer to Section VIII, "INTERNAL SWITCH SETTINGS" for information required to modify this.

1-20. Selectable "Data" - "Text" Printer Character Orientation.

1-21. Printer character orientation is switch selectable between "DATA" or "TEXT" mode formats. "DATA" mode printing is convenient for reading measurement results from the printer without removing the tape. "TEXT" mode printing is convenient for performing long logging sequences with numerous measurements. The Logging Multimeter is shipped from the factory with "DATA" printer character orientation selected. Refer to Section III, "PRINTER CHARACTER ORIENTATION," for further explanation of the relative merits of "DATA" and "TEXT" character orientations along with a sample of each. Service trained personnel may refer to Section VIII, "INTERNAL SWITCH SETTINGS" for information required to modify the printer character orientation.

1-22. SPECIFICATIONS.

1-23. *Specifications are performance characteristics which are warranted.* The specifications for the -hp- Model 3467A Logging Multimeter are listed in Table 1-1. These specifications provide the standards or limits to which the Logging 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 in a manual change supplement or revised manual pages. These specifications supercede any previously published.

1-24. INSTRUMENT AND MANUAL IDENTIFICATION.

1-25. 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.

1-26. OPTIONS.

1-27. The options available for the Logging Multimeter are:

Option 908	Rack Flange Kit
Option 910	Additional Operating and Service Manual

Table 1-1. Specifications.

DC VOLTMETER

Range	Maximum Reading
20mV	19.999mV
200mV	199.99mV
2 V	1.9999 V
20 V	19.999 V
200 V	199.99 V
350 V	349.9 V

Maximum Input: ± 350 V from any terminal to ground and between any two terminals

Ranging: Automatic or Hold/Step

Sensitivity: 1 μV on 20 mV range

Polarity: Automatically sensed and displayed

Zero Adjustment: Front panel pushbutton compensates for up to ± 2 mV offset for each channel

Accuracy: 6 months, 18°C to 28°C

(Assuming 30 minute warmup and use of zero adjustment)

Range	±(% of Reading + Number of Counts)
20 mV	0.05 + 10
200 mV	0.03 + 2
2V - 20.0V, 350V	0.03 + 1

Temperature Coefficient: (0° to 18°C, 28° to 50°C) ±(0.003% of reading + 0.05 counts)/°C

Input Resistance: 10 MΩ ± 5% on all ranges

Normal Mode Rejection: > 60 dB at 50/60 Hz ± 0.1%

Effective Common Mode Rejection (1 kΩ unbalance): > 120 dB at 50/60 Hz ± 0.1%

Single Channel Response Time (without printing): < 0.7 seconds to within 1 count of final value on one range. Add 0.8 seconds for each range change

OHMMETER

Range	Maximum Reading	Current Through Unknown
200 Ω	199.99 Ω	5mA
2kΩ	1.9999kΩ	1mA
20kΩ	19.999kΩ	100μA
200kΩ	199.99kΩ	10μA
2MΩ	1.9999MΩ	1μA
20MΩ	19.999MΩ	100nA

Input Protection: 250 V RMS or 350 V (DC + peak AC)

Ranging: Automatic or Hold/Step

Sensitivity: 10 mΩ on 200 Ω range

Configuration: 2 wire with front panel pushbutton zero adjustment. Lead resistance of up to 20 Ω can be nulled out for each channel

Accuracy: 6 months, 18°C to 28°C

(Assuming use of zero adjustment on 200 Ω range)

Range	±(% of reading + number of counts)
200 Ω	0.08 + 10
2kΩ	0.03 + 3
20kΩ - 200kΩ	0.03 + 1
2MΩ	0.04 + 1
20MΩ	0.15 + 1

Temperature Coefficient

Range	(0°C to 18°C, 28°C to 50°C)
200 Ω	±(0.002% of reading + 1 count)/°C
2kΩ – 2MΩ	±(0.002% of reading + 0.1 count)/°C
20MΩ	±(0.01% of reading + 0.1 count)/°C

Open Circuit Voltage: < 5 V

Single Channel Response Time (without printing): < 1.1 seconds to within 1 count of final value on one range. Add 0.8 seconds for each range change

DIODE TEST

Function: kΩ ▶

Range: 2kΩ

Current Source: 1mA ± 4%

Diode Voltage Drop Displayed in Volts: 1.9999 volts maximum measurable voltage

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

AC VOLTMETER

AC Converter: True RMS Responding and calibrated in true RMS. AC coupled.

Range	Maximum Reading
200mV	199.99mV
2 V	1.9999 V
20 V	19.999 V
200 V	199.99 V
250 V	249.9 V

Maximum Input: ± 350 V (DC + Peak AC), 10^7 V·Hz from any terminal to ground and between any two terminals.

Ranging: Automatic or Hold/Step

Sensitivity: 10 μV on 200 mV range

Crest Factor: 4:1 at full scale

Accuracy: Accuracy applies with readings of ≥ 9% full scale (≥ 1800 counts on 250 V range), 6 months, 18°C to 28°C, sinusoidal waveform.

Frequency	±(% of reading + number of counts)
45Hz - 100Hz	1 + 40
100Hz - 10kHz	0.2 + 40
10kHz - 20kHz	1 + 40
20kHz - 100kHz	2 + 200

Temperature Coefficient:

Frequency	(0°C to 18°C, 28°C to 50°C)
45Hz - 100Hz	±(0.05% of reading + 2 counts)/°C
100Hz - 10kHz	±(0.03% of reading + 2 counts)/°C
10kHz - 20kHz	±(0.05% of reading + 2 counts)/°C
20kHz - 100kHz	±(0.25% of reading + 15 counts)/°C

Input Impedance: 2 MΩ ± 5% in parallel with < 100 pF

Single Channel Response Time (without printing): < 2 seconds to within 4 counts of final value on one range. Add 1.2 seconds for each range change.

TEMPERATURE MEASUREMENT

Technique: Temperature measurements using thermistors can be made directly in °C or °F (selectable by an internal switch). Thermistor linearization is included for the following thermistors: YSI 44007, OMEGA UUA 35J3, FENWAL UUA 35J1 or equivalent. (One thermistor is furnished with each 3467A)

Accuracy: The accuracy specification includes ohmmeter accuracy, thermistor curve fit accuracy, and thermistor self heating.

-80°C to +80°C ± 0.3°C

+80°C to +110°C ± 0.5°C

+110°C to +150°C ± 1.3°C

Yellow Spring Instrument (YSI), Yellow Springs, Ohio 45387

OMEGA, Box 2917, Stamford, Connecticut 06907

FENWAL, 63 Fountain Street, Framingham, Massachusetts 01701

FOUR-CHANNEL SCANNER

Type: One 2 pole low thermal dry reed relay per channel

Inputs: Floating inputs. Any combination of four channels may be selected to measure one of the following functions: DC volts, true RMS AC volts, resistance or temperature. Measurements of temperature on channels 1 and 2, and either DC volts, AC volts, or resistance on channels 3 and 4 can also be made.

Channel-to-Channel Isolation:

Source Impedance	Up to 1kHz	Up to 100kHz
600Ω	>100 dB	>60 dB
10kΩ	> 80 dB	>40 dB

PRINTER AND TIMER/PACER

Type: Thermal Printer

Print Modes:

Manual: Initiates a printout of selected input channels.

Automatic: Scans, measures and prints selected input channels at preset time intervals.

Time Interval*: 1, 3, 6, 10, 18, 30, 60, or 180 Seconds/Minutes interval selectable via front panel pushbuttons.

Timer: Internal 24 hour crystal controlled interval timer. Timer starts at 00:00:00 (HH:MM:SS). A time offset can be manually entered to synchronize the timer with the time of day.

Timer Accuracy: Within 1 minute in 24 hours

Power Failure Protection: Should a power failure occur for up to 6 seconds, the 3467A will retain the math constant, elapsed time, offsets, and ranges.

* Time intervals < 10 seconds may be shorter than the actual time required to completely measure and print the selected channels. In these cases, the next printout will be initiated upon completion of the present scan sequence.

GENERAL INFORMATION

Reading Rate: Depends on input signal level: 2 to 4½ readings/second

Operating Temperature: 0°C to +50°C

Storage Temperature: -40°C to +65°C without thermal paper

Thermal Paper Storage Temperature: -40°C to +30°C

Humidity: 95% R.H., +15°C to +40°C without thermal paper

60% R.H., +15°C to +30°C with thermal paper

Power: 100/120/220/240 +5%, -10%

48 to 440 Hz line operation, < 25 VA

Dimension: 190.5 mm (7½ in.) high

212.9 mm (8 3/8 in.) wide

304.8 mm (12 in.) deep

Weight:

Net: 4.77 kg (10.5 lb.)

Shipping: 5.44 kg (12 lb.)

1-28. ACCESSORIES SUPPLIED.

1-29. The standard accessories supplied with your Logging Multimeter are:

- Thermal Printer Paper (1 roll)
- Thermistor (1)
- Operating and Service Manual (1)
- Operating Manual (1)
- Extender Boards (2)
- AC Power Cable (1)
- Spare Channel Input Fuses (2)
- Alternate Line Fuses (2)

1-30. ACCESSORIES AVAILABLE.

1-31. The accessories available for use with the Logging Multimeter are:

ACCESSORY	ORDER
Bail Handle Kit	-hp- 5061-2003
Rear Standoff Feet and Power Cord Wrap Kit	-hp- 44416A
Rack Mounting Kit	-hp- 5061-0060
Additional Thermal Printer Paper (6 rolls)	-hp- 82045A
Additional Thermistors (4)	-hp- 44414A
Additional Operating & Service Manual (1)	-hp- 03467-90000
Additional Operating Manual	-hp- 03467-90001
Additional Extender Board (1)	-hp- 5060-0049
Additional AC Power Cable (1)	-hp- 8120-1348
Additional Channel Input Fuse (1)	-hp- 2110-0093

1-32. SAFETY CONSIDERATIONS.

1-33. The Logging Multimeter is a safety class I instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety symbols and instructions before operation.

1-34. SUBJECT INDEX.

1-35. This manual contains an alphabetical subject index located in Appendix A. Refer to this index when information on a particular subject matter is desired.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions for the installation and shipping of the Logging Multimeter. Included are initial inspection procedures, power and grounding requirements, environmental information, instrument mounting information, thermal paper installation instructions, and instruction for repacking 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. The paper well should contain a roll of -hp- thermal paper. Basic operation can be checked using the operator's checks at the end of Section III. If there is damage or deficiency, see the warranty inside the front of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Logging Multimeter requires a power source of 100, 120, 220, or 240 Vac, +5% - 10%, 48 to 440 Hz single phase. Power consumption is less than 25 watts.

2-7. POWER CORDS AND RECEPTACLES.

2-8. Figure 2-1 illustrates the plug cap configurations that are available to provide ac power to the Logging 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.

NOTE

Check local electrical codes for proper plug (attachment cap) selection in your area.

2-9. GROUNDING REQUIREMENT.

2-10. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument cabinet be grounded. The -hp- Model 3467A Logging Multimeter is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

2-11. To preserve the protection feature when operating from a two-contact outlet, use a three-prong adaptor and connect the green pigtail on the adaptor to power line ground.

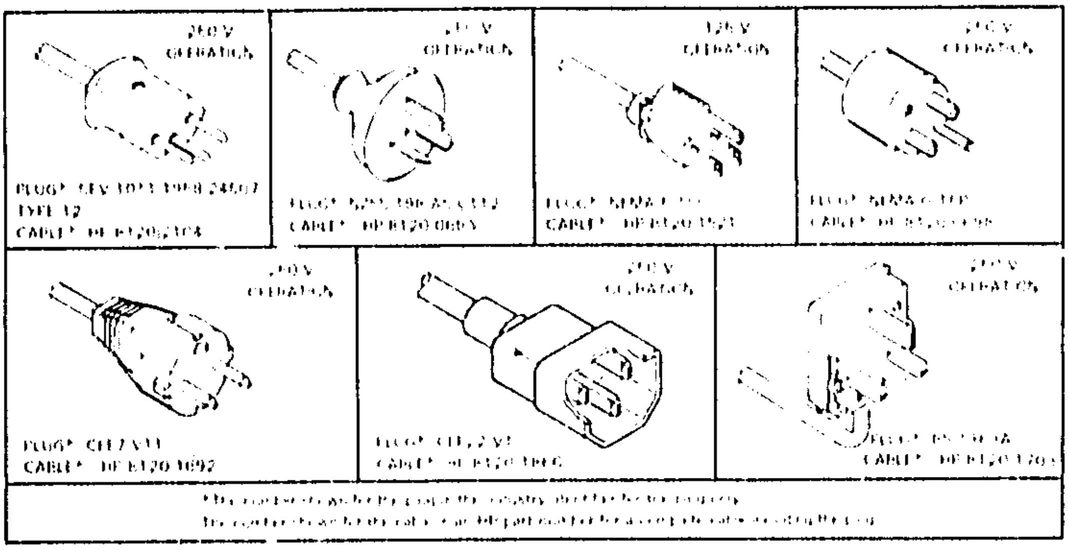


Figure 2-1. Power Receptacles.

2-12. ENVIRONMENTAL REQUIREMENTS.

2-13. Temperature.

Operating Temperature	0°C to +50°C (+32°F to +122°F)
Storage Temperature Without Thermal Paper	-40°C to +55°C (-40°F to +131°F)
Storage Temperature With Thermal Paper	-40°C to +30°C (-40°F to +95°F)
Thermal Paper Storage Temperature	-40°C to +30°C (-40°F to +95°F)

2-14. Humidity.

Humidity Without Thermal Paper	+15°C to +40°C @ 95% RH
Humidity With Thermal Paper	+15°C to +30°C @ 60% RH

WARNING

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

2-15. Thermal Paper. To preserve and prolong your thermal paper, avoid exposure to excessive humidity or heat, to acetone, ammonia or other organic compounds, or to excessive direct sunlight or artificial light sources. Store spare paper in a box or other appropriate container. Printed tapes from the Logging Multimeter will last 30 days or more without fading if properly handled and stored.

CAUTION

Use only Hewlett-Packard thermal paper with Part Number 82045A to avoid damage to the Logging Multimeter printer assembly.

2-16. INSTRUMENT MOUNTING.

2-17. The Logging Multimeter is shipped with plastic feet and tilt stand ready for use as a bench instrument. For additional information regarding mounting accessories, refer to the Hewlett-Packard catalog.

2-18. Rack-Mounting.

2-19. The Logging Multimeter cabinet is an -hp- system II half-rack width module and can be rack-mounted using the rack-mount accessory (5061-0060) provided that sufficient rear support is available. Additional information on rack mounting is provided with the accessory.

2-20. REPLACING PAPER.

To replace the paper roll in your Logging Multimeter proceed as follows:

a. Open the paper well door and remove the empty core.

b. Before inserting the new roll of paper into the Logging Multimeter, discard the first turn to ensure that no glue, tape, or other foreign matter in on the paper.

c. Cut or tear the edge of the paper to provide a clean, smooth edge.

d. Temporarily place the paper roll into the paper well door and guide the leading edge of the paper into the slot at the rear top of the paper well. Refer to Figure 2-2 or the illustration on the inside of the paper well door.

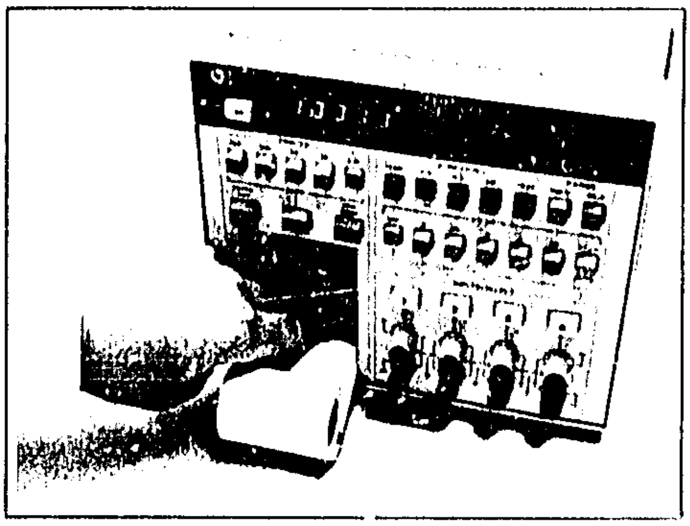


Figure 2-2. Installing Thermal Paper.

e. Depress the LINE switch to turn the Logging Multimeter on, and press the PAPER ADV pushbutton until the leading edge of paper becomes visible beneath the clear plastic tear bar.

f. Insert the roll of paper into the paper well and close the paper well door.

2-21. REPACKAGING FOR SHIPMENT.

2-22. The following paragraphs contain a general guide for repackaging the Logging Multimeter for shipment. If you have any questions, contact your nearest -hp- Sales and Service Office. A list of -hp- Sales and Service Office locations is provided at the rear of this manual for convenience.

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 a sample of the Logging Multimeter "Printer Test" or other sample print if printer service is required. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

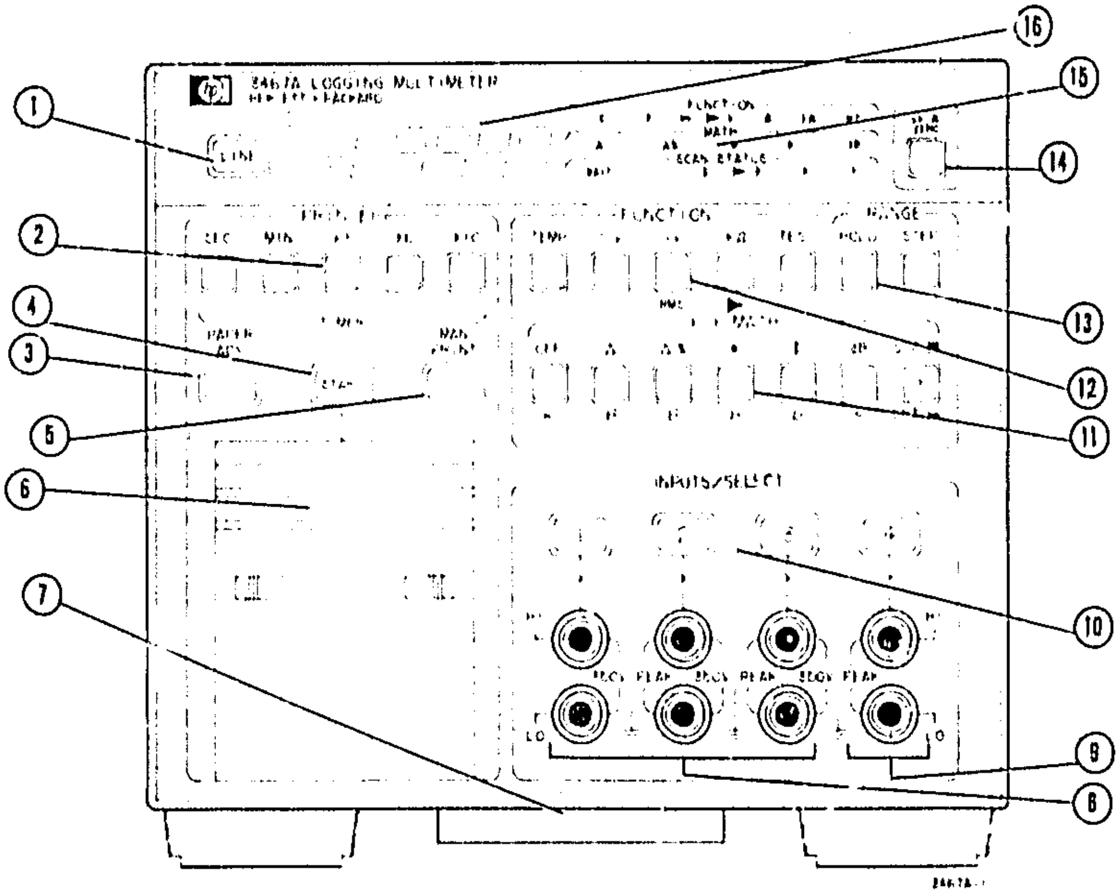
2-23. Place instrument in original container with appropriate packing material and seal with strong tape or metal bands. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

2-24. If original container is not to be used, proceed as follows:

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

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



DESCRIPTION

1 Line On/Off Pushbutton.
Paragraph 3-8.

2 Timer Select Pushbuttons.
Paragraph 3-50.

3 Paper Advance Pushbutton.
Paragraph 2-20.

4 Timer Start Pushbutton.
Paragraph 3-50.

5 Manual Print Pushbutton.
Paragraph 3-49.

6 Thermal Printer.
Paragraph 3-43.

7 User's Information Card.
Paragraph 3-110.

8 Channels 1-3 Input Terminals.
Paragraph 3-27.

9 Channel 4 Math Reference Input
Paragraph 3-29.

10 Inputs/Select Pushbuttons.
Paragraph 3-27.

11 Math Select Pushbuttons.
Paragraph 3-33.

12 Function Select Pushbuttons.
Paragraph 3-17.

13 Range Pushbuttons.
Paragraph 3-20.

14 $\mu V, \Omega$ Pushbutton.
Paragraph 3-25.

15 Multimeter Annunciators.
Paragraph 3-14.

16 Display.
Paragraph 3-14.

Figure 3-1. Front Panel Description.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and hints for operating the Logging Multimeter. Operating procedures are discussed for selecting input channels; making Temperature, DC Voltage, AC Voltage, Ohms, and Mixed Mode measurements; making stored and real time math referenced measurements; and performing timer controlled measurement logging.

3-3. Before reading the remainder of this section, familiarize yourself with the Logging Multimeter front panel controls as they appear in Figure 3-1. The Logging Multimeter is controlled by pushbuttons organized into functional "blocks". The functional blocks are:

Function and Range controls (including X:Y Math)
Inputs/Select controls
Printer controls (including timer)

3-4. A logical approach to operating the Logging Multimeter is to ask the following questions:

"What type of measurement is to be made?"	→	FUNCTION
"What range of values is expected?"	→	RANGE
"Is a direct measurement desired or is a math operation necessary?"	→	X:Y MATH
"How many different measurements are to be made?"	→	INPUTS/SELECT
"Is a record of the results necessary?"	→	PRINTER

Once these questions have been answered within the capabilities of the Logging Multimeter, front panel control settings are defined. The remainder of this section is outlined to increase familiarity with the unique Logging Multimeter features and their application.

3-5. SET UP.

3-6. Power Requirements.

3-7. Before connecting line power to the Logging Multimeter, verify that the AC power source matches the instrument's power requirements. If not, change the rear panel line voltage switches which are located above the line cord receptacle. These switches and their appropriate settings are shown in Figure 3-2.

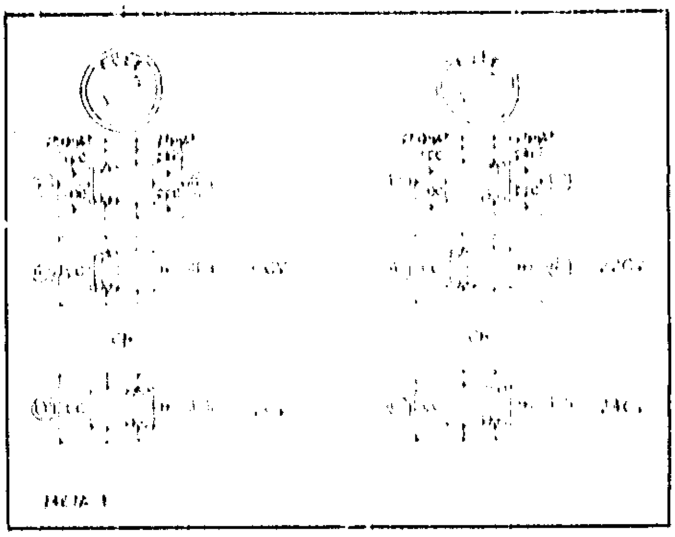


Figure 3-2. Line Voltage Switch Setting.

3-8. After verifying that the available source matches the Logging Multimeter voltage setting, connect the AC power cord and depress the "LINE" switch. The Logging Multimeter is ready for use.

CAUTION

Failure to correctly match the Logging Multimeter's primary voltage setting to the available source may result in damage to the instrument.

3-9. Paper Check.

3-10. If printed results are desired, check to be sure the paper well contains sufficient thermal paper. The paper replacement procedure is described in Section II, "INSTALLATION". One roll of thermal paper provides approximately 5500 lines (approximately 2½ hours of continuous printing).

3-11. **"OP" Display.** Attempting to print when there is no paper will produce an "OP" display as shown in Figure 3-3. This display will occur each time a print is attempted by a Paper Advance, Manual Print, Timed Print, or Self-Test.

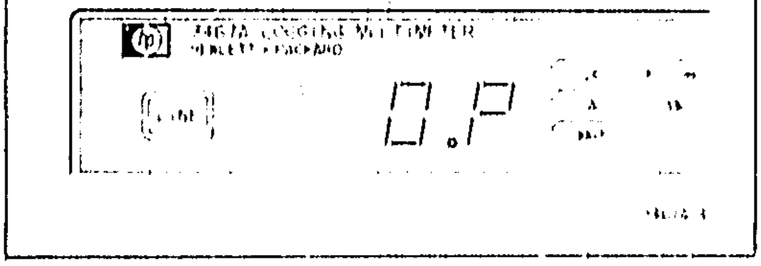


Figure 3-3. "OP" Display.

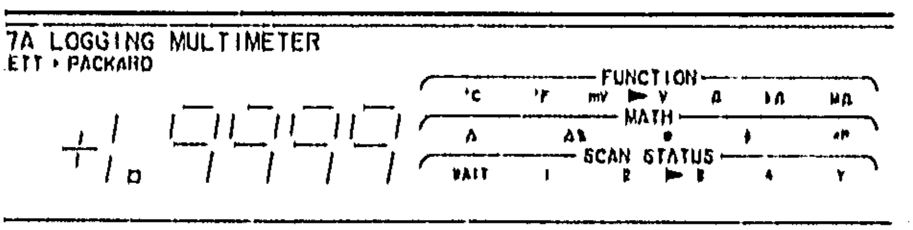
The printer will not run or attempt to print until the thermal paper supply is replenished.

3-12. Turn-On Condition.

3-13. The Logging Multimeter initial Turn-On condition with no pushbuttons selected is in autoranging DCV; up to several seconds may be required for a display to appear. The display is the stored math reference which is set to +1.0000 upon Turn-On, indicated by the Y annunciator. Using and changing the stored math reference is described later in this section as part of "X:Y MATH". The stored reference is always displayed in any function (except TEST) when no channels are selected or the blue Y pushbutton is depressed. Select Channel 1 for the following descriptions.

3-14. DISPLAY FAMILIARIZATION.

3-15. Measurement results are displayed on the five section LED readout while current Instrument Function, Math Operations, and Scanner Status are annunciated on the functionally grouped annunciators. The scanner status annunciators indicate the channel displayed.



3-16. "OL" Display. The "OL" display shown in Figure 3-4 occurs when the Logging Multimeter input is overloaded or overranged. The positioning of the decimal point indicates what range was overloaded. This display will also occur when a math result exceeds ±19999.

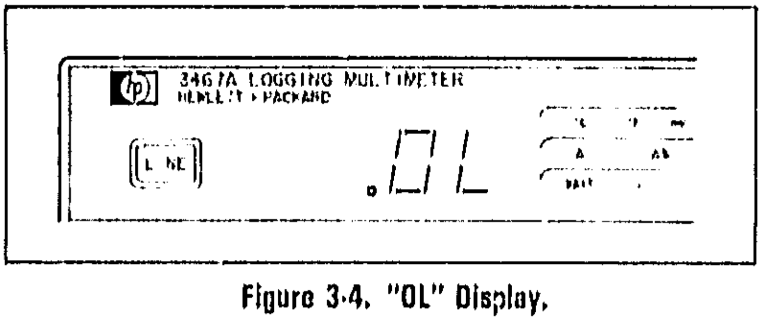
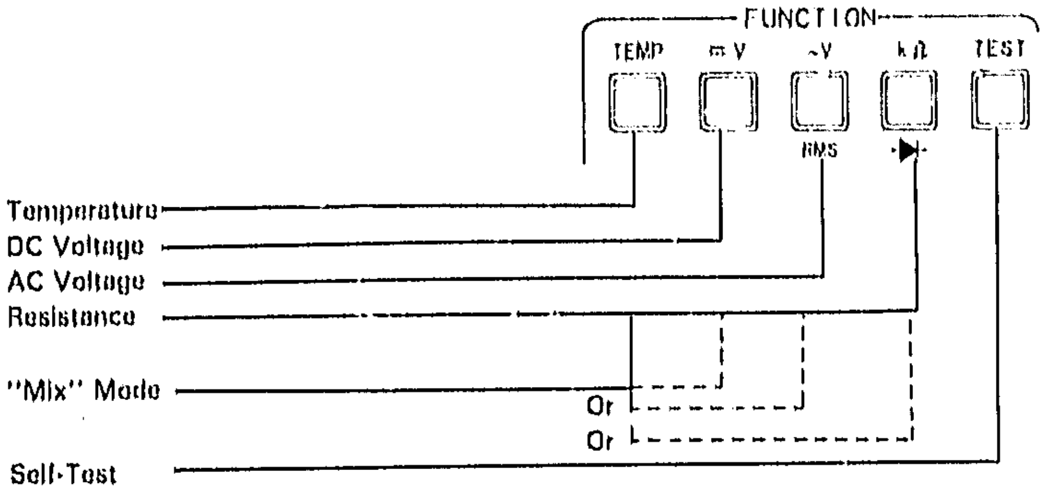


Figure 3-4. "OL" Display.

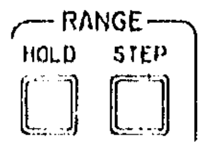
3-17. THE LOGGING MULTIMETER FUNCTIONS.

3-18. The Logging Multimeter has four basic measurement functions. In addition, a combinational or *Mix* mode allows for simultaneous temperature and DCV, ACV, or kΩ measurements. The non-measurement "TEST" function includes a four part operator's check routine and a circuit exercise for use in servicing the Logging Multimeter.

3-19. The front panel function pushbuttons and their use are:



3-20. RANGING.



3-21. The Logging Multimeter can be manually up-ranged or range-held when the HOLD pushbutton is selected (depressed). Pressing the STEP pushbutton will then step all channels selected to the next higher range or turn over to the lowest range if already on the highest range. Manual range control in this manner is *NOT* possible in the following conditions:

a. For X:Y Math Operations.

b. For TEMP function measurements.

c. In the *Mix* mode.

The Logging Multimeter will always autorange for these measurements.

3-22. Autoranging.

3.23. In the autoranging mode, the Logging Multimeter upranges at an absolute count of 1799. This produces an *AUTORANGING HYSTERSIS*. Figure 3-5 shows the autoranging points for DC voltage measurements. Autoranging in other Logging Multimeter functions is similar.

NOTE

The uprange and downrange points may vary in the kΩ and = V functions depending on stored offset zeroes.

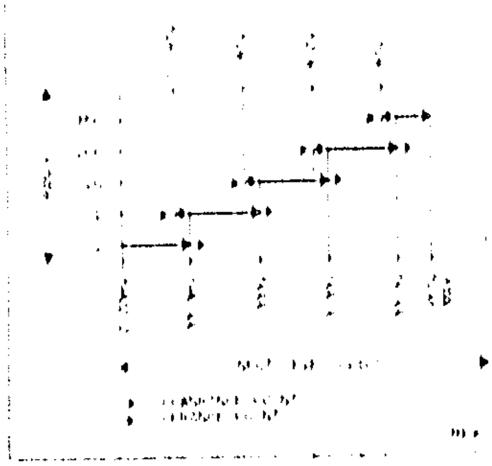
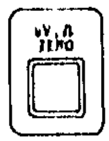


Figure 3-5. Autoranging Hysteresis.

3-24. **Last Range Memory.** The Logging Multimeter remembers the last range on each channel and trys that range first on subsequent measurements. Last range memory occurs even when the channel has been deselected for one or more scan cycles. the Range pushbuttons operate on all currently selected channels. Upranging with all channels selected will uprange all channels. Upranging with only one channel selected will uprange only that channel.

3-25. μV, Ω ZERO.



3.26. The Logging Multimeter μ, Ω pushbutton can be used to zero individual channels with up to 2 mV of DC offset or 20Ω of lead resistance. When in the appropriate ⎓ V or kΩ function, offsets are subtracted directly from (or added to) the measurements (before math) and are retained after changing functions to eliminate the need for zeroing channels again (providing they are not altered in the intermediate function). Instrument turn-on (main reset) sets channel zeroes to 0.

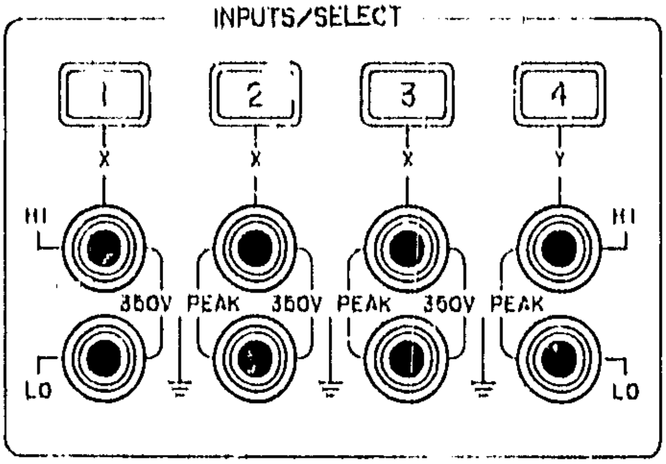
NOTE

There is a separate correction factor which automatically compensates for internal resistances.

3-27. INPUT SELECTION.

3-28. Any combination of the Logging Multimeter's four input channels may be selected via the Inputs/Select pushbuttons. Measurements are made in a step-and-measure sequence and only one channel is closed at a time. All HI/LO lines are fuse protected at 3/8 amperes.

3-29. Channel 4 can be used as the fourth measurement channel with no math selected, or as the X:Y math reference channel with math selected. This means there is a maximum of 3 channels available with math.



CAUTION

To avoid possible damage to the Logging Multimeter circuitry, the input voltage between any two terminals and between any terminal to ground must not exceed ±350 V (DC + peak AC).

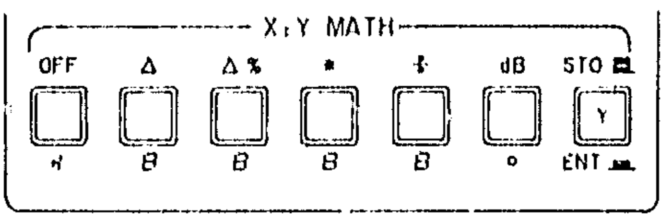
3-30. Scan Sequencing.

3-31. When the timer is off, the Logging Multimeter will scan the selected channels in a 4→1→2→3 sequence and in a free running fashion. The scan will skip channels which are not selected. The scan status annunciators indicate the channel displayed at any instant.

3-32. There is one exception to this. When using Channel 4 as the math reference measurement, the "4" scan status annunciator will remain lit at all times as an indication that this is the math reference. The math reference is always annunciated by the scan status "4" or "Y" annunciators when math is selected.

3-33. X:Y MATH.

3-34. The Logging Multimeter can perform math operations on channel measurements with respect to a measured (4) or stored (Y) reference by selecting the appropriate X:Y Math pushbutton. The Logging Multimeter math operations and symbology are:



Δ $(X_n - Y)$

The DELTA operation produces a mesurement result which is the difference between the channel measurement and the reference.

Example:

⎓ V Function
Channel 2 input: +10.000V
Channel 4 input: + 4.990V

```
Printout:  4: + 4.990    V    ←Reference
           2: + 5.010 Δ  V    ←Result
              00:00:01
```

Δ % $\left[\frac{100(X_n - Y)}{Y}\right]$

The PERCENT DELTA operation produces a measurement result which is the percent difference between the channel measurement and the reference.

Example:

⎓ V Function
Channel 2 input: +10.000V
Channel 4 input: + 4.990V

```
Printout:  4: + 4.990    V    ←Reference
           2: +100.38 Δ%      ←Result
              00:00:01
```

* $[(X_n)(Y)]$

The MULTIPLY operation produces a measurement result which is the multiplication of the channel measurement and the reference.

Example:

⎓ V Function
Channel 2 input: +10.000V
Channel 4 input: + 4.990V

```
Printout:  4: + 4.990    V    ←Reference
           2: + 49.90 *  V    ←Result
              00:00:01
```

÷ $\left[\frac{X_n}{Y}\right]$	The DIVIDE (RATIO) operation produces a measurement result which is the division of the channel measurement by the reference.

Example:

⎓ V Function
Channel 2 Input: + 10.000V
Channel 4 Input: + 4.990V

```
Printout:  4: + 4.990    V    ←Reference
           2: + 2.004 ÷       ←Result
              00:00:01
```

dB $20 \log_{10}\left[\frac{X_n}{Y}\right]$	The DECIBEL operation produces a measurement result which is the decibel level of the channel measurement with respect to the reference.

Example:

⎓ V Function
Channel 2 Input: + 10.000V
Channel 4: + 4.990V

```
Printout:  4: + 4.990    V    ←Reference
           2: + 06.03 dB      ←Result
              00:01:00
```

3-35. All math operations are performed with respect to a stored or measured Channel 4 reference value. There are four distinct methods for obtaining a Y reference value as follows:

3-36. First: Turn-On. Turning on the Logging Multimeter initializes the stored Y4 reference value to + 1.0000.

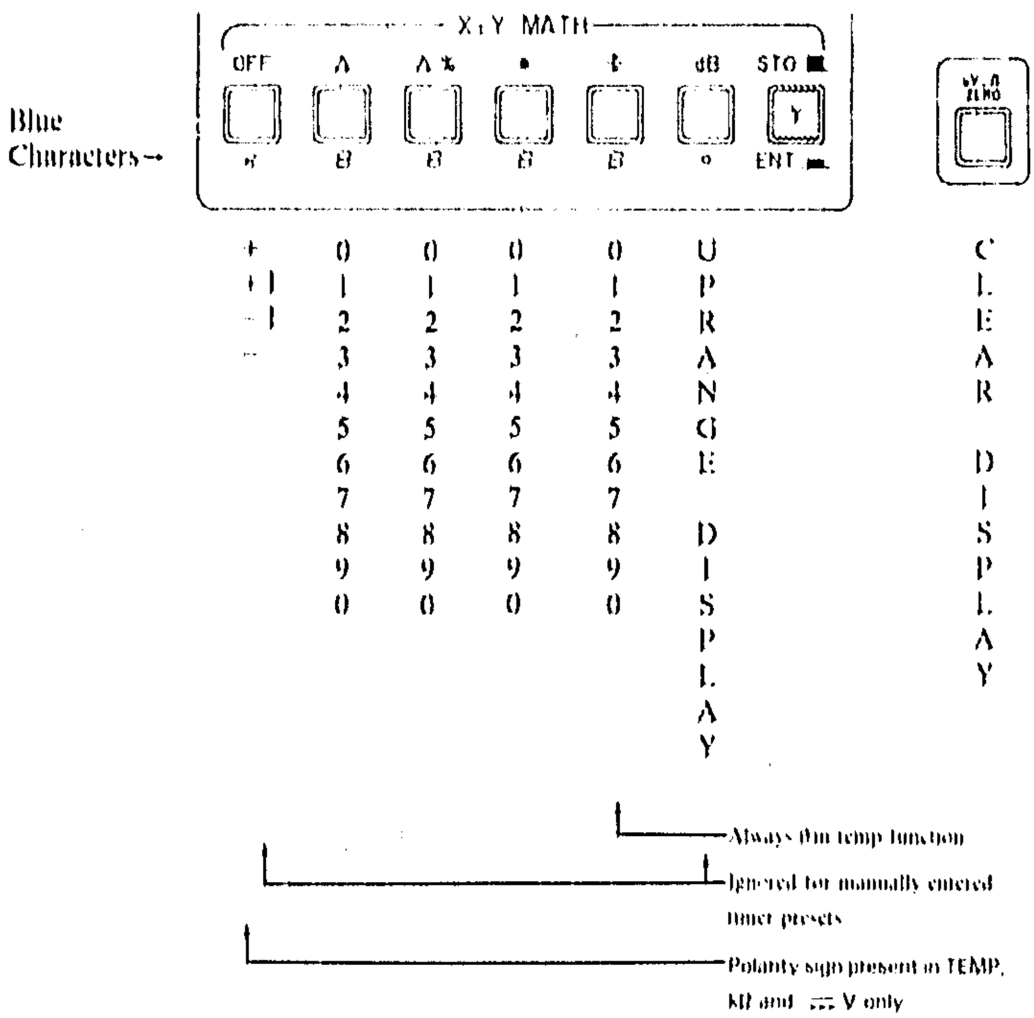
NOTE

Remember that "1" when performing Δ and Δ% math operations. Also, it is useful for dBV measurements.

3-37. Second: Real-Time Referencing. Selecting (depressing) the Channel 4 pushbutton establishes the current Channel 4 measurement as the stored reference value. This value is updated each scan cycle when a new Channel 4 measurement is taken. The "4" scan status annunciator remains lit when real-time referencing. The Y reference measurement is not displayed but is printed along with the measurement results. The X:Y MATH examples show real-time referenced math.

3-38. Third: Measured Reference. Deselecting (releasing) the Channel 4 pushbutton establishes the last Channel 4 measurement as the stored reference value. The "4" scan status annunciator will extinguish and the "Y" scan status annunciator will remain lit, indicating the math reference is now a stored value.

3-39. Fourth: Manually Entered Reference. The stored reference value may be manually entered in an appropriate function and range by depressing the blue Y pushbutton. This displays the previous stored reference value or "CH 4" if Channel 4 is currently selected. (Channel 4 is the reference in this case. It must be deselected to continue with manual entry). This also converts the remaining X:Y Math pushbuttons to momentary contact switches which can be used to step the display digits to the desired value. Pushbuttons are dedicated to digits and the decimal point location according to the blue characters underneath. The sequence followed by each pushbutton is:



3-40. The basic procedure for entering a math reference is to:

a. Enter the manual entry mode ▬ Y. Remember to deselect Channel 4 █ 4

b. Select the appropriate Logging Multimeter function.

c. Step the display to the desired math reference value and range.

d. Store the reference by leaving the manual entry mode █ Y

3-41. Here are a few pointers concerning manually entering math references:

First - "*Mix*" mode math is possible on Channel 3 only, since Channel 4 is the reference and only Channel 3 has the same units.

Second - If Channel 4 is inadvertently selected after manually entering a reference, the entered reference will be lost.

Third - References remain valid until updated by any of the four methods described here.

Fourth - Stored temperature references are not converted when the degrees selection is changed.

Fifth - Keep in mind that math results are normalized to 1°, 1V, or 1 kΩ. Utilize an appropriate range when entering references to avoid loss of resolution on the measurement result. Choose a range which results in > 1°, 1V, or 1 kΩ measurement results.

EXAMPLE: Multiply Channel 2 Measurements by 1.5000

⎓V Function
* X:Y Math
Channel 2 input: 12.345 mV

	DISPLAY	ANNUNCIATOR ON
INCORRECT		
Stored Y Reference	+1.5000	mV

```
Printout:  Y: + 1.500   mV
           2: + .0000 * V   ←
              00:00:01
```

Loss of result due to mV•mV multiplication and 1V normalization

	DISPLAY	ANNUNCIATOR ON
BETTER		
Stored Y Reference	+1.5000	V

```
Printout:  Y: +1.5000    V
           2: + .0125 * V   ←
              00:02:01
```

Loss of resolution in result due to mV•V multiplication and 1V normalization

BEST

Stored Y Reference +1500 V

Printout: Y: +1500.0 V
2: +18.517 V — Correct results to 3 decimal places. mV units inferred.
00:00:00

Sixth - The polarity sign is ignored for manually entered references in the ~V function. Only *magnitudes* are considered.

3-42. PRINTER FAMILIARIZATION.

3-43. The thermal printer may be used to print manually or timer initiated measurement results. The printer format is shipped from the factory with "DATA" orientation as follows:

IR: P X X X X X X U U U
I3: P X X X X X X U U U
I2: P X X X X X X U U U
I1: P X X X X X X U U U
H H: M M: S S

Where HH = Hours elapsed
MM = Minutes elapsed
SS = Seconds elapsed

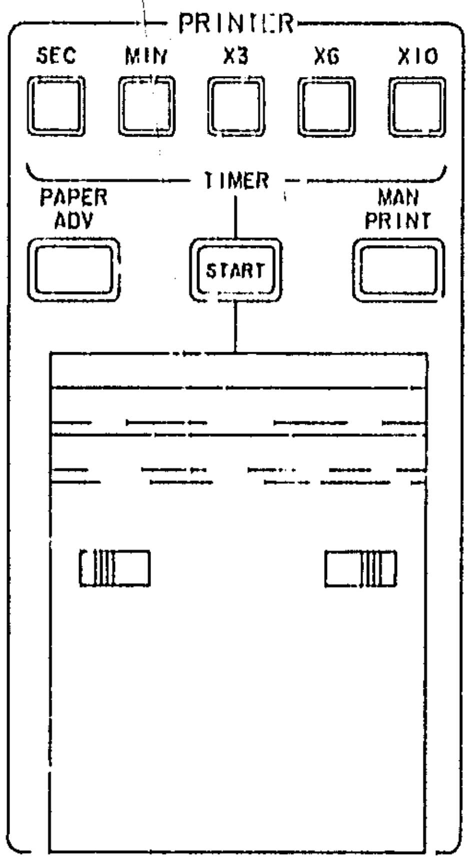
I = ◇ manual print indicator
or blank for timed print

R = 4: Channel 4
or Y: stored reference

P = Blank
or -
or +

XXXXXX = Measurement result with decimal point

UUU = Three character math and units field



3-44. Printer Character Orientation.

3-45. "DATA" orientation is convenient for reading measurement results from the printer without removing the tape since characters are printed right-side-up. This format is assumed throughout all illustrations in this manual unless otherwise specified.

3-46. "TEXT" orientation is an alternate format for the Logging Multimeter printer. This orientation is:

```
     H H:  M M:  S S
I1:  P X X X X X X   U U U
I2:  P X X X X X X   U U U
I3:  P X X X X X X   U U U
IR:  P X X X X X X   U U U
```

where the characters represent the same information as in the "DATA" mode. "TEXT" orientation is convenient for performing long logging sequences with numerous measurements, since the resulting tape is in chronological 1-2-3-4 order once removed from the printer.

3-47. Decide upon a desired format before beginning a logging sequence with the Logging Multimeter. Figure 3-6 shows an actual sample of both "DATA" and "TEXT" mode printing. Service trained personnel may refer to the procedure for changing the printer character orientation in Section VIII, "INTERNAL SWITCH SETTINGS". Notice that Channel 4 measurement results are printed last, although this channel is measured first in the scan sequence.

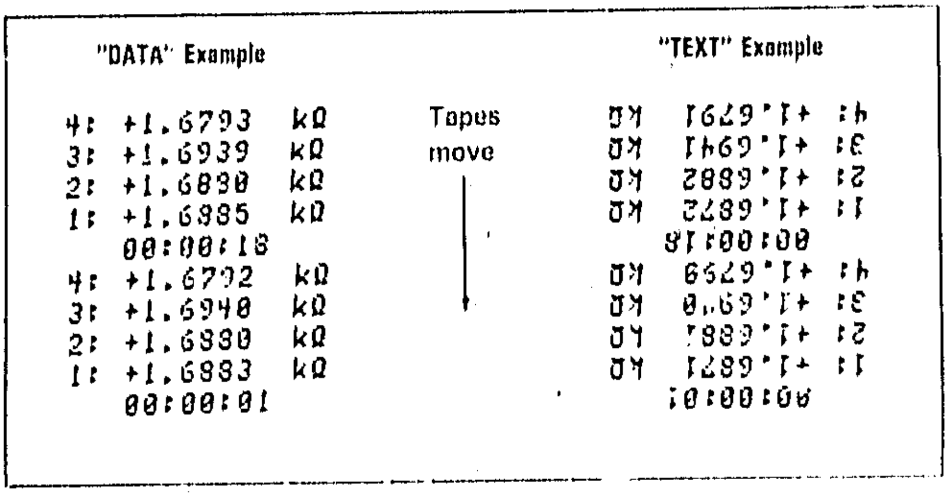


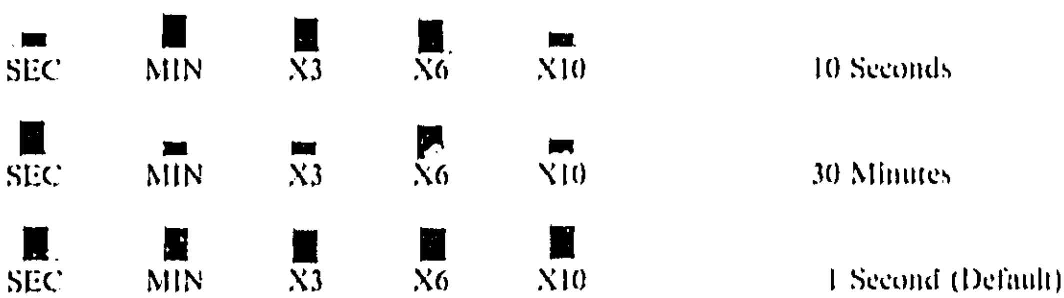
Figure 3-6. "TEXT" vs "DATA" Printer Character Orientation.

3-48. Print Methods.

3-49. Manual Print. Pressing the "MAN PRINT" pushbutton causes the printer to print a blank line followed by measurement results from the currently selected channels. Measurement results printed due to a manual print are indicated by a leading " ◇ " character. A manual print does not affect the timer, but does print elapsed time if the timer is on even when no channels are currently selected.

3-50. Timed Print. Timer intervals of 1 second to 3 hours can be selected via the timer pushbuttons. The actual maximum measurement rate depends on the number of channels, the function, and the amount of ranging to and scale of each measurement. In some cases the selected time interval may be shorter than the time required to completely measure all the selected channels. In this case the Logging Multimeter measures as fast as the above conditions allow. Selecting a new time interval does not modify elapsed time which is printed along with channel measurement results. Between scan cycles the Logging Multimeter enters a "WAIT" state during which the WAIT annunciator is lit. During "WAIT" the Logging Multimeter will monitor the first channel in the scan sequence. Channel 4 is skipped if X:Y math is selected. A timed print with no channels selected only prints elapsed time and the Y stored reference if X:Y math is used.

Example Timer Intervals



3-51. The timer may be preset by using the manual entry feature of the Logging Multimeter. Turning on the timer while in manual entry accepts the displayed value as the timer preset *and starts the timer.* The most significant digit display (±1) and all decimal points are ignored when entering the timer preset. The format is:

X H H M M

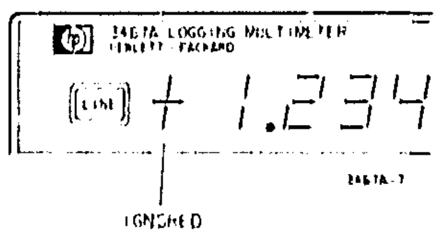
Where X = Ignored overrange digit
HH = Hours digits (MOD 24)
MM = Minutes digits (MOD 60 with carry)

The hours digits are MOD 24 meaning that 24 is subtracted from them upon storage until a number from 0 to 23 is reached and taken as the hours preset. The minutes digits are MOD 60 with a carry into hours (example: 02360 presets the timer to 00:00:00). It is best just to always enter the hours and minutes in a conventional manner. Presetting the timer destroys the previous math reference value, substituting instead the timer preset value. The manually entered reference must be re-entered after presetting the timer.

Example: Log the change in dc voltage of some point or points from a reference voltage (say +25V) and preset the timer to 12:34. The procedure for this is:

a. Y — Enter the manual entry mode.

b. ⎓V — Select the desired function.

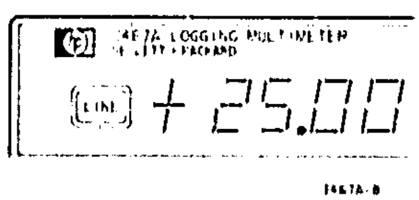
c. 

Step the display to the desired timer preset using the X:Y math pushbuttons.

NOTE

The least significant digit cannot be incremented while in the TEMP function.

d. Start — Turn the timer on to accept the entered preset and start the timer.

e. 

Step the display to the desired math reference using the X:Y Math pushbuttons. This must be done even if the desired reference is 1.0000 since presetting the timer made it 1.234

f. Store the displayed value as the entered reference by releasing the Y pushbutton.

g. Select Δ math, the desired timer interval, and input selections (1, 2, or 3 only).

NOTE

Failure to re-enter the desired math reference after presetting the timer causes it to assume the value entered for the timer preset.

3-52. Notice that math operations can only be performed on Channels 1, 2 and 3 by definition of Channel 4 as the reference. The selected math operation is therefore ignored for Channel 4 measurements and the UUU field on the Channel 4 printout will never contain a math descriptor.

3-53. "OL" Print. the "OL" print occurs when a manual or timed print is initiated for an overload reading.

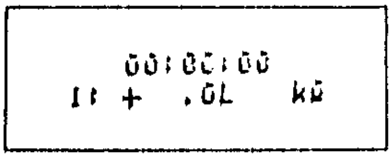


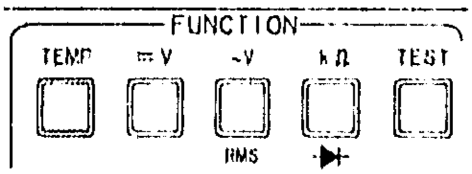
Figure 3-7. "OL" Print (20 kΩ Range).

PUTTING IT ALL TOGETHER

3-54. The following pages contain a function-by-function description of making measurements with the Logging Multimeter and how some of its features can be used.

3-55. TEMPERATURE MEASUREMENTS.

3-56. The Logging Multimeter TEMP function can be used to make autoranging temperature measurements utilizing an external thermistor of the following type;



a. hp 0837-0164
b. YSI 44007
c. Fenwal UUA 35J1
d. Omega UUA 35J3
e. or other equivalent

These thermistors exhibit a 5,000 K ohm resistance at 25°C.

Although variations between thermistor types are small, the Logging Multimeter TEMP function is linearized to the ideal curve of thermistors of this type. Resistance contributions due to channel fusing and high/low lines are automatically eliminated from TEMP measurements. More information on TEMP conversions is available in Section IV, "TEMPERATURE MEASUREMENTS".

CAUTION

Extended usage or cycling above 90°C may change thermistor resistance to exceed specified tolerance. Also, use a heat sink when soldering to a thermistor lead.

3-57. Lead Resistance Effect.

3-58. The effects of lead resistances at several typical temperatures can be calculated from the information in Table 3-1.

Table 3-1. Lead Resistance Effects.

Temperature °C(°F)	Lead Resistance Error
150 °C(302 °F)	-.4666 °C/Ω(-.8397 °F/Ω)
125 °C(257 °F)	-.2261 °C/Ω(-.4070 °F/Ω)
100 °C(212 °F)	-.1008 °C/Ω(-.1814 °F/Ω)
75 °C(167 °F)	-.0407 °C/Ω(-.0733 °F/Ω)
50 °C(122 °F)	-.0146 °C/Ω(-.0263 °F/Ω)
25 °C(77 °F)	-.0046 °C/Ω(-.0081 °F/Ω)

Lead resistance effects diminish at lower temperatures.

3-59. Procedure.

a. Connect the thermistor(s) to the channel(s) to be used as shown in Figure 3-8.

CAUTION

The thermistor leads are extremely fragile. Use extreme care when handling them.

b. Depress the TEMP function pushbutton.

3-60. Temp Measurements With Math.

3-61. Temperature measurements with math include measuring thermal gradients, temperature regulation, thermal response and ambient temperature logging. The least significant display digit is used for TEMP math results and manual entries above ± 1999 degrees, although it remains zero for TEMP manual entries. This means that entered references of up to ± 19990 degrees and math results up to + 19999 degrees are possible with TEMP math.

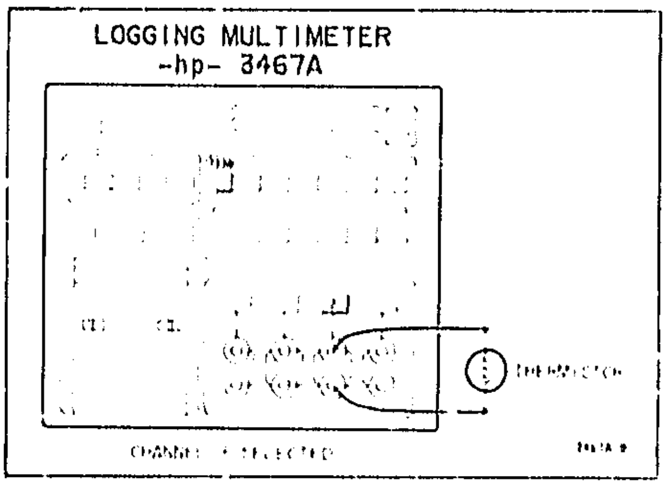
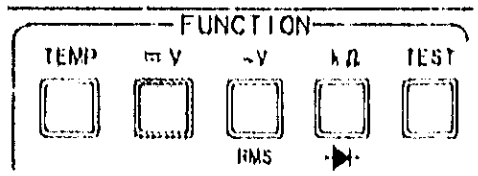


Figure 3-8. Temperature Measurements.

3-62. DC VOLTAGE MEASUREMENTS.

3-63. The Logging Multimeter ⎓V function can be used to make DC voltage measurements.



CAUTION

To avoid possible damage to the Logging Multimeter circuitry, the dc input voltage must not exceed ±350 V (dc + peak ac).

3-64. Procedure (Autoranging).

a. Depress the ⎓V pushbutton.

b. Select the channel(s) to be measured.

c. Connect the measurement leads to be used to the appropriate channel(s) and short the ends together.

d. Zero each channel to be used using the μV, Ω Zero pushbutton.

e. Connect the zeroed measurement leads to the DC voltage(s) to be measured as shown in Figure 3-9.

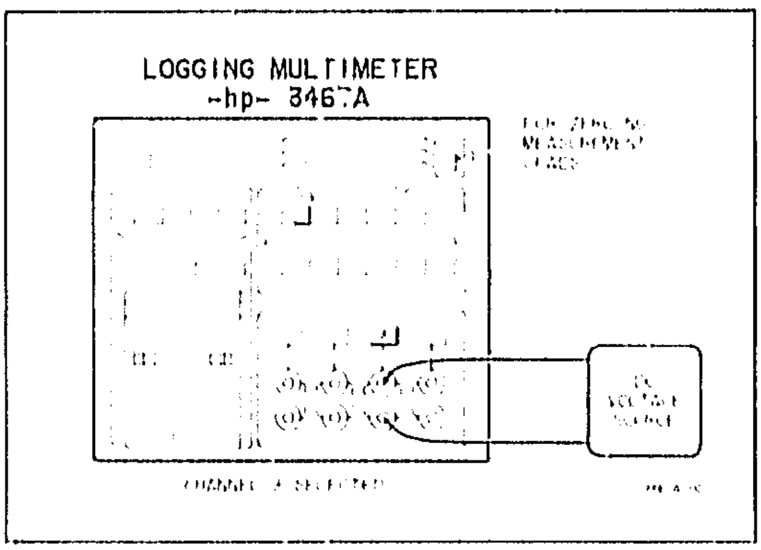


Figure 3-9. DC Voltage Measurements.

3-65. DCV With Math.

3-66. Figure 3-10 illustrates one application utilizing the Logging Multimeter Δ % math capability to calculate power supply load regulation. Other applications include transducer scaling and linear approximation.

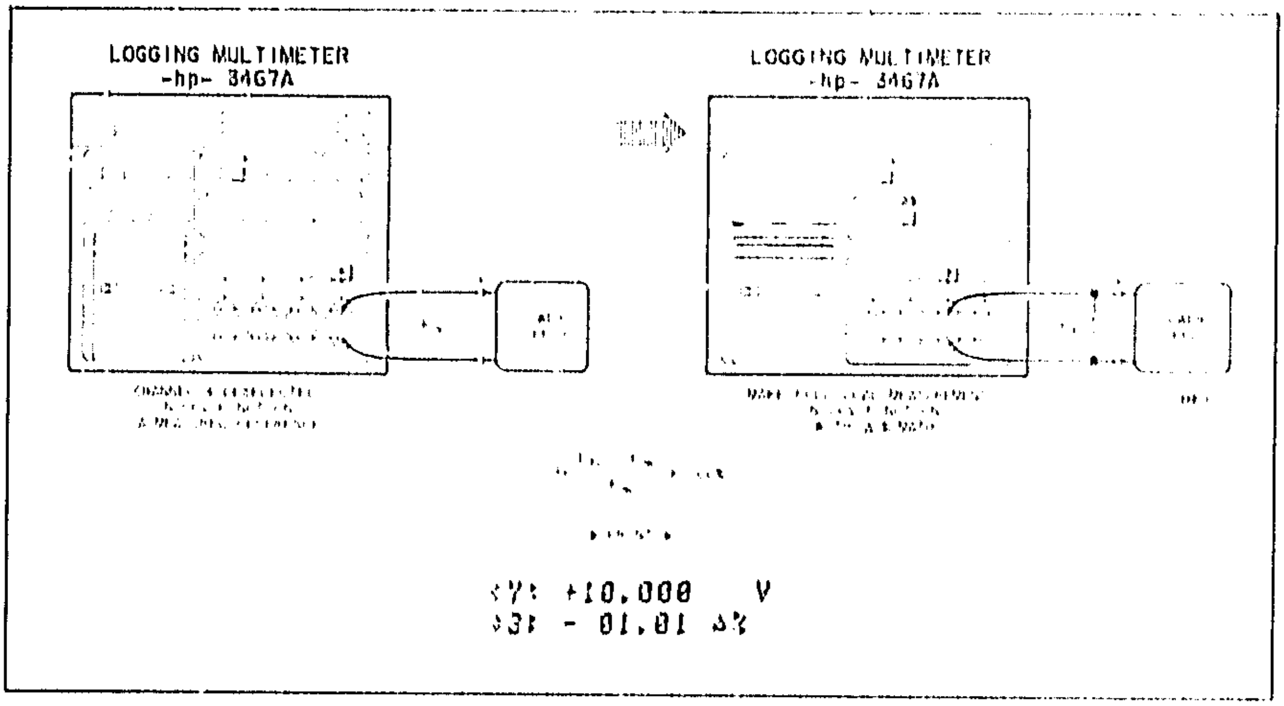
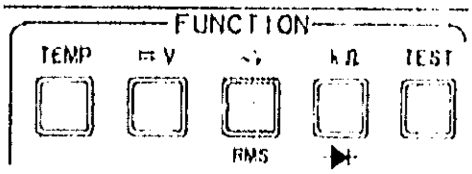


Figure 3-10. Measuring % Regulation.

3-67. AC VOLTAGE MEASUREMENTS.

3-68. The Logging Multimeter ~V function is used to make AC coupled true RMS voltage measurements. Measurements below 10% of full scale or 1800 counts are considered invalid.



CAUTION

To avoid possible damage to the Logging Multimeter, the instantaneous AC input voltage must not exceed 350V (dc + peak ac).

3-69. Procedure (Autoranging).

a. Depress the ~V pushbutton.

b. Select the channel(s) to be measured.

c. Connect the measurement lead(s) to be used to the appropriate channel(s).

d. Connect the measurement leads to the AC voltage(s) to be measured as shown in Figure 3-11.

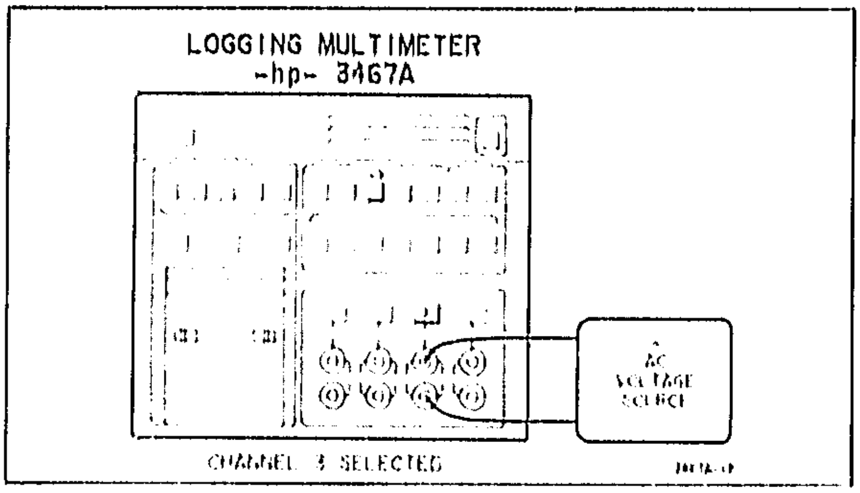
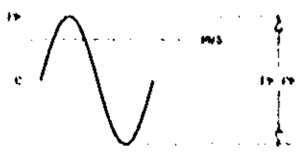
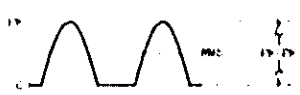


Figure 3-11. AC Voltage Measurements.

3-70. ACV With Math.

3-71. Table 3-2 portrays an application utilizing the Logging Multimeter * math capability to read out directly in units other than RMS. Figure 3-12 illustrates another such application utilizing the ÷ math capability to determine the turns ratio of transformer. dB math is useful for measuring stage gains as shown in Figure 3-13. These are but a few of the many possible applications.

Table 3-2. Units Conversion.

Waveform	Enter This * Reference To Read In		
	Peak	Peak-To-Peak	Average
Sine: 	1.414	2.828	.9003
Fullwave Rectified Sine 	1.551	1.551	1.103
Halfwave Rectified Sine 	2.026	2.026	.7117
Triangle and Sawtooth 	1.732	3.464	.8660

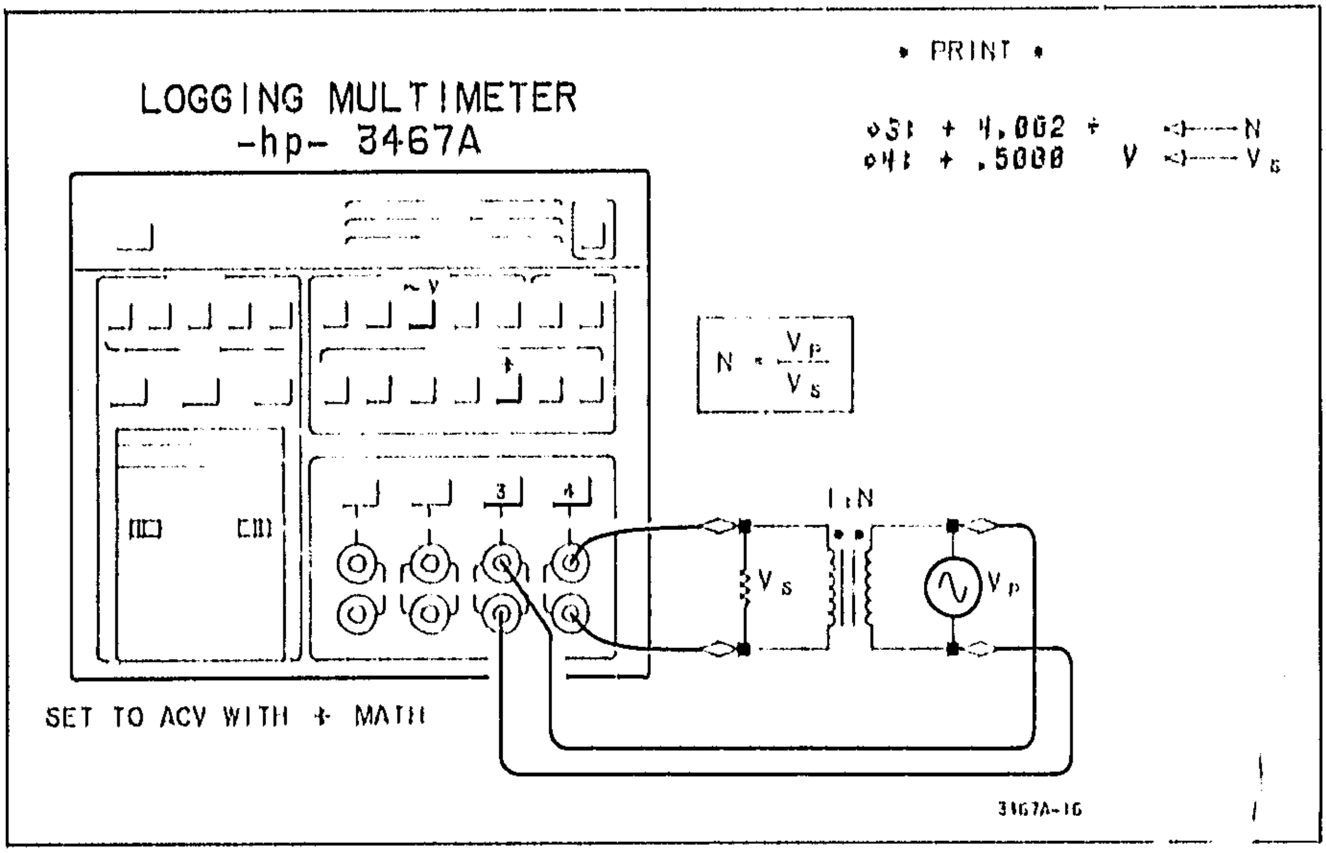


Figure 3-12. Determining A Transformer Turns Ratio.

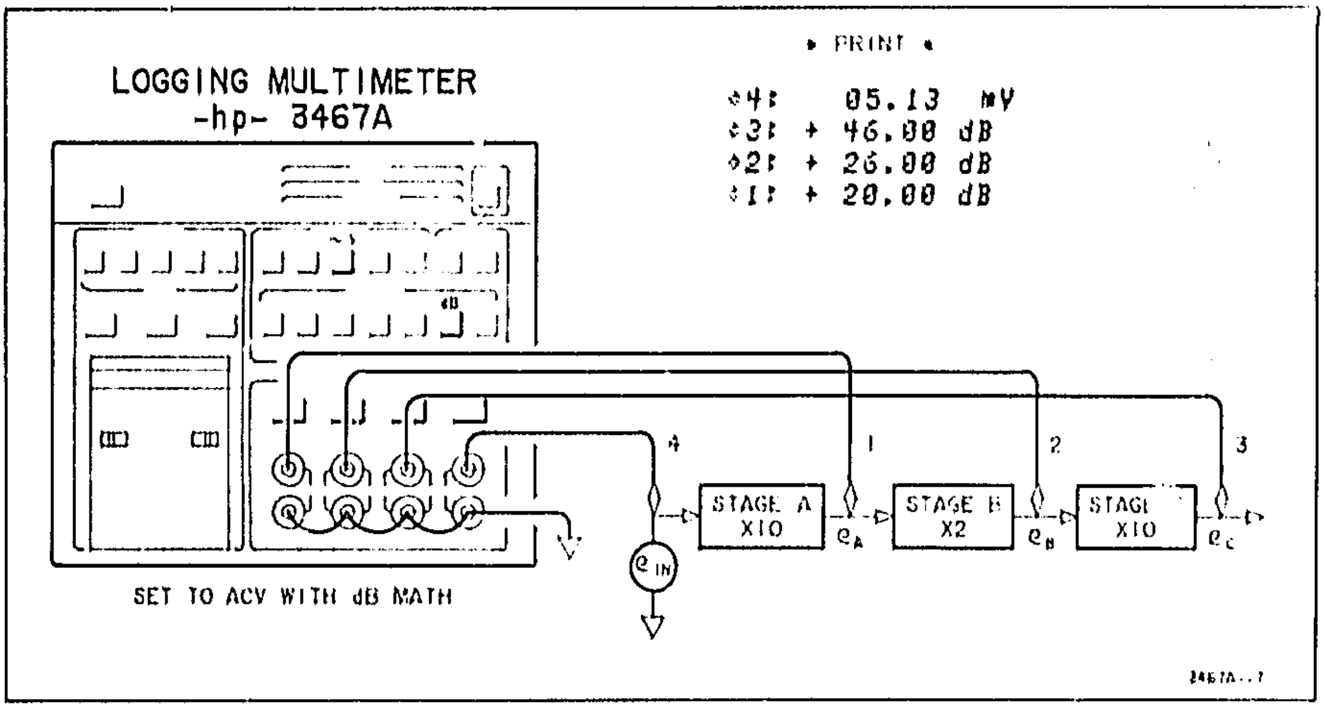


Figure 3-13. Stage Gain Analysis.

3-72. dBm Measurements. The dB math operation can be used in the ACV function to provide dBm measurement results. This requires the use of a stored reference value appropriate for the impedance of the load being utilized. By definition of dBm, the value of Y must be such that:

$$Y^2/Z_L = 1 \text{ mW} \qquad \text{Equation 3-1}$$

where Z_L = Impedance of the load.

Solving this equation for Y we obtain:

$$Y = \sqrt{Z_L/1000} \qquad \text{Equation 3-2}$$

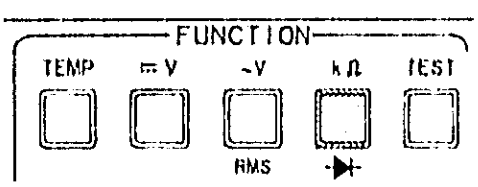
Some commonly used impedances and their corresponding reference values are listed in Table 3-3.

Table 3-3. Commonly Used Impedances and Associated dBm References.

	Impedance, Z_L	Reference Value, Y
	50	.2236
	75	.2739
	135	.3674
	150	.3873
	600	.7746
	900	.9487
dBV	1000	1.0000
	1200	1.0954

3-73. RESISTANCE MEASUREMENTS.

3-74. The Logging Multimeter kΩ function is used to make resistance measurements up to 20 MΩ. The maximum terminal voltage in the kΩ function is approximately 5 Vdc (open circuit.) Resistance contributions due to channel fusing and high/low lines are automatically eliminated from kΩ measurements by a turn-on offset correction. Channel resistances less than the correction or zeroed offsets greater than the actual measurement will produce a negative display.



3-75. Procedure (Autoranging).

a. Depress the kΩ pushbutton.

b. Select the channel(s) to be measured.

c. Connect the measurement leads to be used to the appropriate channel(s) and short the ends together.

d. Zero each channel to be used.

e. Connect the zeroed measurement leads to the resistance to be measured as shown in Figure 3-14.

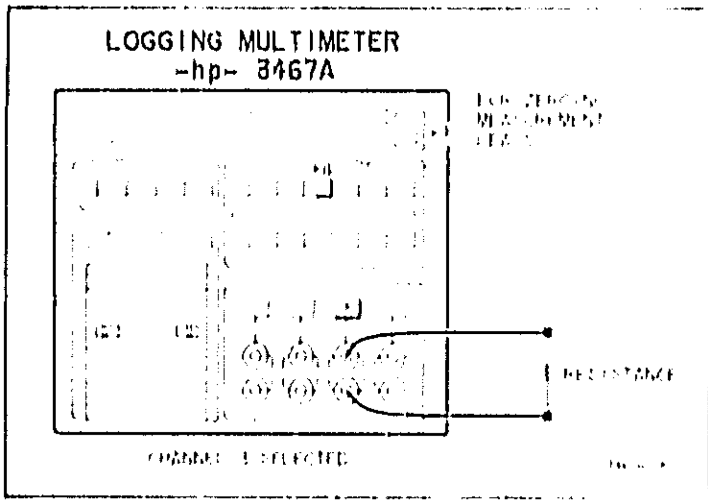


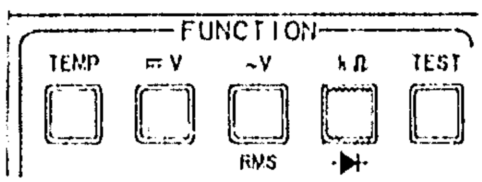
Figure 3-14. Resistance Measurements.

3-76. kΩ With Math.

3-77. There are many applications involving resistance measurements with math operations. These include matching resistors, checking tolerances, and resistive trimming operations.

3-78. DIODE TESTING.

3-79. The Logging Multimeter kΩ function when range-held in the 2 kΩ range can be used to measure PN junction voltage drops. The display indicates the junction potentials in volts. Multiple drops to 1.9999 volts can be measured in this manner.



NOTE

The measurement current in the 2 kΩ range is 1 mA. This test current may be reduced by upranging through the Ohms ranges. Printing the PN junction voltage drop on each range will provide a diode characteristic for 5 decades of current. Refer to Table 3-4.

Table 3-4. PN Junctions Characterization.

Ohms Range	Ohms Current	To Read Display As Volts
		Consider Decimal Point to be here
20 M	.1 μa	X X. X X X
2000 k	1 μa	X X X X. X
200 k	10 μa	X X X. X X
20 k	100 μa	X X. X X X
2 k	1 ma	X X X X X

3-80. Procedure.

a. Depress the kΩ and HOLD pushbuttons.

b. Select the channel(s) to be measured.

c. Connect the measurement leads to be used to the appropriate channel(s) and short the ends together.

d. Step the Logging Multimeter to the 2 kΩ range as indicated by the following decimal point location: X.X X X X

e. Zero each channel to be used.

f. Connect the zeroed measurement leads to the PN junction(s) to be measured. Be sure to observe polarity. Refer to Figure 3-15.

3-81. Typical displays for forward biased junctions are:

Germanium	.3 Volts/Junction
Silicon	.6 Volts/Junction
LED(GaAs)	1.8 Volts/Junction

An "OL" display is typical for reverse biased junctions.

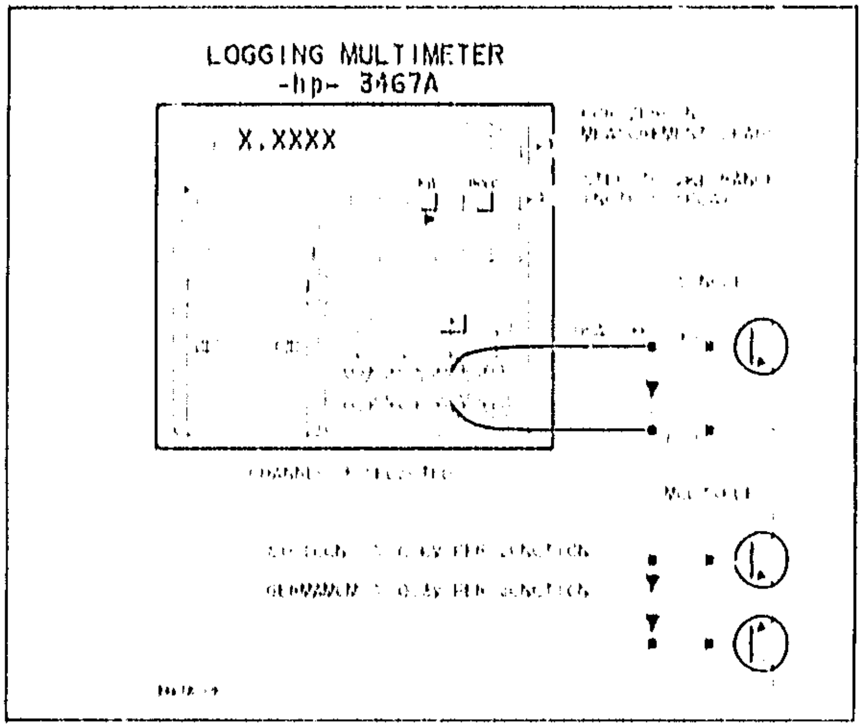


Figure 3-15. Diode Testing.

3-82. MIXED MODE MEASUREMENTS.

3-83. The Logging Multimeter TEMP and ⎓ V, ~ V, or kΩ functions can be used simultaneously to enter the MIX mode. In this mode Channels 1 and 2 are dedicated to autoranging temperature measurements, Chennels 3 and 4 to autoranging DCV, ACV, or kΩ measurements.

3-84. Procedure.

a. Depress the TEMP pushbutton along with the appropriate ⎓ V, ~ V, or kΩ pushbutton.

b. Select the TEMP channel(s) to be measured (1 and/or 2).

c. Connect the thermistor(s) to the TEMP measurement channel(s) as shown in Figure 3-16.

d. Select the remaining channels to be measured (3 and/or 4).

e. Connect the measurement leads to be used to the appropriate remaining channel(s).

f. Zero each DCV or kΩ channel to be used with the μV, Ω Zero pushbutton.

g. Connect the measurement leads to the voltage(s) or resistance(s) to be measured as shown in Figure 3-16.

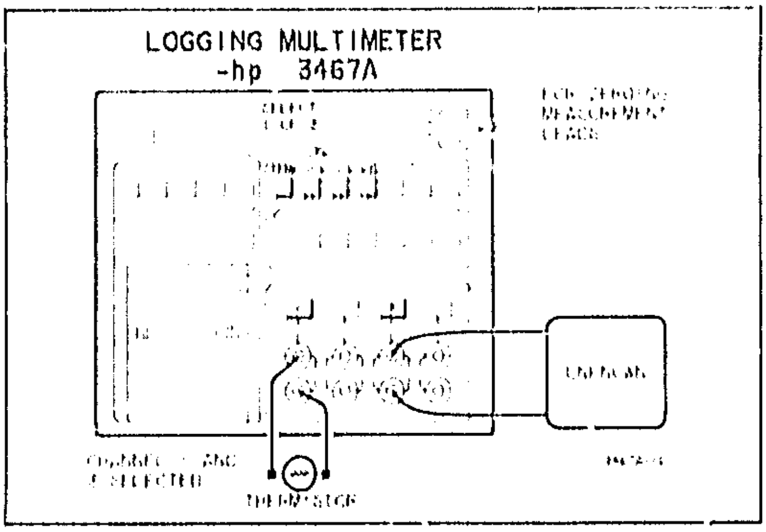


Figure 3-16. MIXED Mode Measurements.

3-85. MIXED Mode Math.

3-86. MIX mode math is possible on Channel 3 only. Figure 3-17 illustrates one application utilizing the Logging Multimeter Δ math capability to log temperature dependency information on a transistor bias network. V_{RE} at the normal ambient temperature is stored as the math reference. Other applications include thermistor characterization, temperature coefficient measurements on resistors, AC controlled temperature source measurements, and other temperature varying relationships.

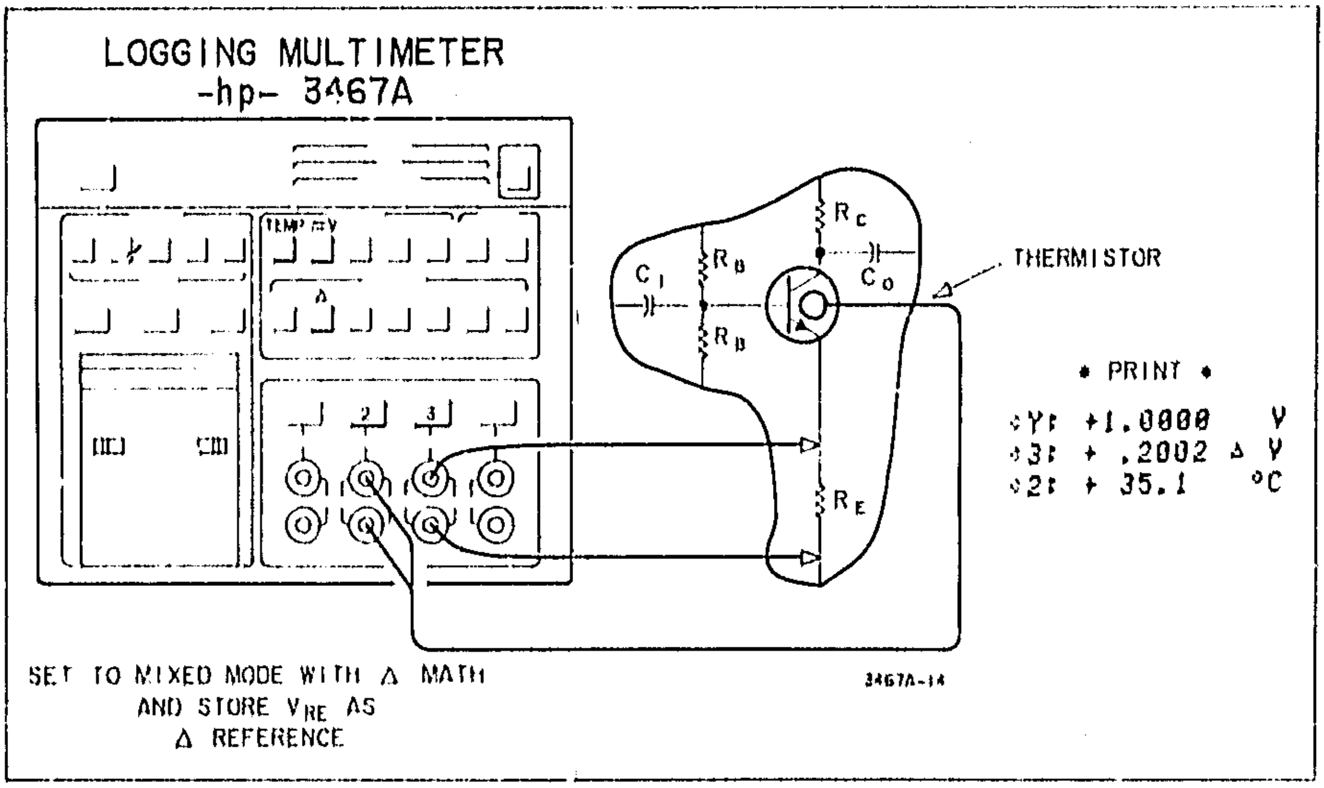


Figure 3-17. Logging Temperature Dependency Information on a Transistor Bias Network.

3-87. HINTS.

3-88. Zeroing Above 20Ω or 2 mV.

3-89. Channel 4 and the Δ math operation can be used to effectively zero measurement lead and offset errors above 20 ohms or 2 millivolts. The procedure is as follows:

a. Connect the shorted measurement leads to the Channel 4 input terminals.

b. Perform a measured reference operation, storing the offset as the reference value. This is illustrated in Figure 3-18.

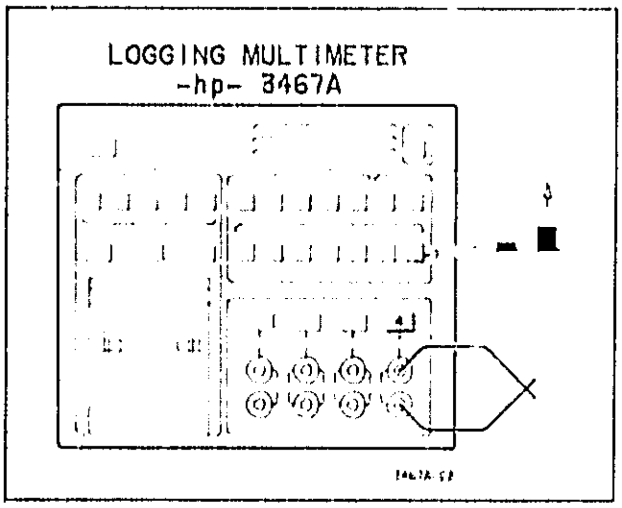


Figure 3-18. Entering Lead Error as Reference.

c. Make the measurement on another channel in the Δ math mode. Lead contributions are automatically eliminated from the measurement results. Figure 3-19 portrays this last step.

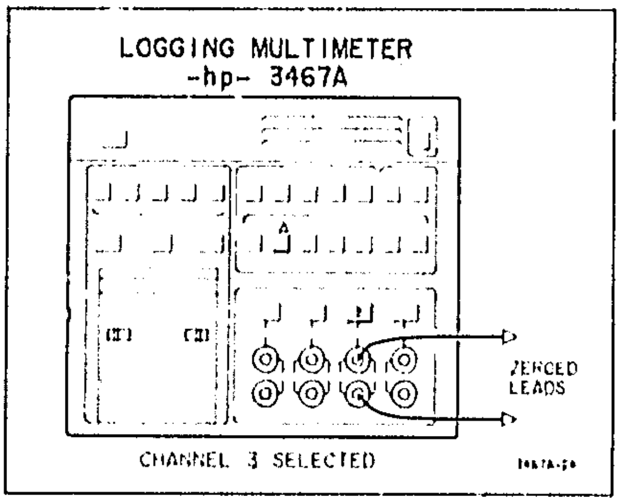


Figure 3-19. Using Δ Math To Eliminate Lead Error.

3-90. WHAT HAPPENS WHEN THE POWER GOES DOWN.

3-91. The Logging Multimeter contains a low-power memory retention circuit which retains math constants, references, and timer preset values during a low line condition A logging sequence may be interrupted by such a condition, but the sequence resumes when line voltage returns to normal. This standby capability is specified at a 5 second minimum value.

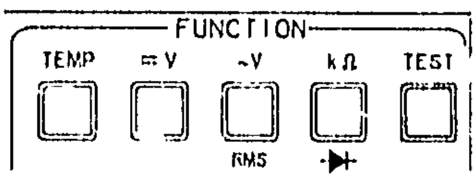
3-92. An interrupted logging sequence is indicated by the manual print which occurs upon power-up. The blank line and manual print character " ◇ " are therefore indicative of a low-line interruption (or a curious passer-by). The time indicated by this manual print indicates the elapsed time when the interruption occured. The Logging Multimeter will then resume logging as before the interruption. Take the following times as an example:

00:01:00		
	>	1 minute intervals (no channels)
00:02:00		
	-	Power line interrupted
00:02:32	-	At this elapsed time
00:03:00	-	Logging continues

3-93. Turning the Logging Multimeter line switch off will discharge the low-power memory retention power supply and upon turn-on reset the stored math constants, references, and timer preset. Removing the line voltage in any other manner (line cord, master switch, etc.) will result in memory retention.

3-94. TEST.

3-95. The Logging Multimeter TEST function can be used to perform any combination of 5 Self-Test routines. The Self-Testing capability is divided into a four-part operator's check and one servicing aid. Selecting the TEST pushbutton places the Logging Multimeter in the test mode defined by the positioning of the "INPUTS/SELECT" pushbutton as in Figure 3-20.



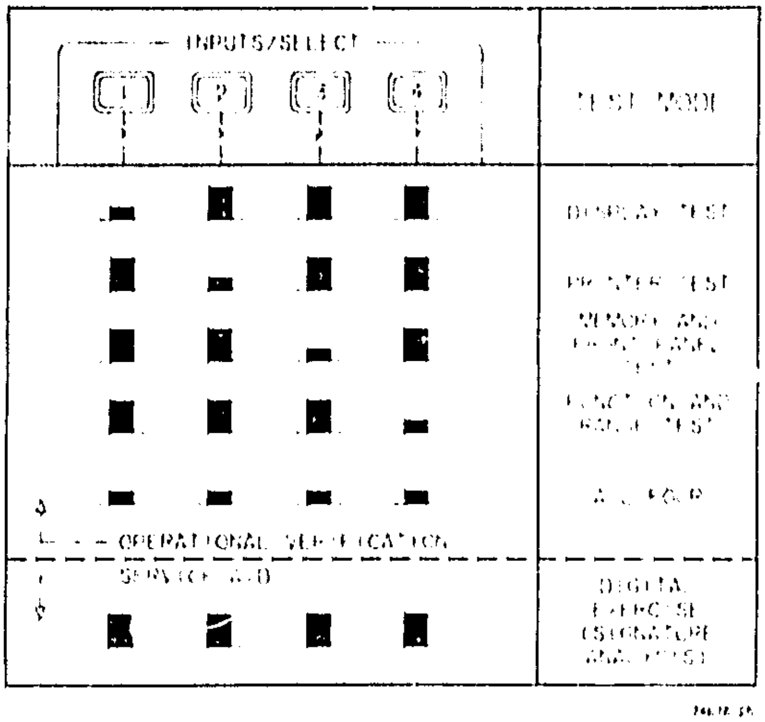


Figure 3-20. Self-Test Selections.

3-96. Operator's Checks.

3-97. The four part operator's check portion of SELF-TEST is a convenient method of verifying the basic operational capability of the Logging Multimeter as part of an incoming inspection or operator's check. Although this check will produce a high confidence level that the Logging Multimeter is basically functioning properly, it should not be used as any indication that the instrument meets published specifications. Users who desire to test the Logging Multimeter against specifications should complete the performance tests given in Section V, "PERFORMANCE TESTS". Interpretation of an operational verification failure is discussed in detail in Section VIII where Self-Test results can provide considerable insights into the nature and causes of Logging Multimeter malfunctions.

3-98. Procedure. Test

3-99. Depress the test pushbutton to enter the Self-Test function. The Inputs/Select pushbuttons can then be set to perform the desired test or tests. The following paragraphs describe each test.

3-100. "Display Test". 1 2 3 4

3-101. This test begins with an initial "dISP" display. The display will then alternate twice from all display segments and annunciators "ON" (4 seconds) to all display segments and annunciators "OFF" (2 seconds). You should scrutinize the display for missing segments or annunciators.

3-102. "Printer Test".

1 2 3 4

3-103. This test will print the Logging Multimeters character set. The print should resemble one of those illustrated in Figure 3-21. Check the print for such things as:

a. Consistent line length.
b. Consistent line spacing.
c. Correct line position.
d. Presence of dots.

NOTE

Make sure the Blue Y pushbutton is not selected for this test or the printer will not print.

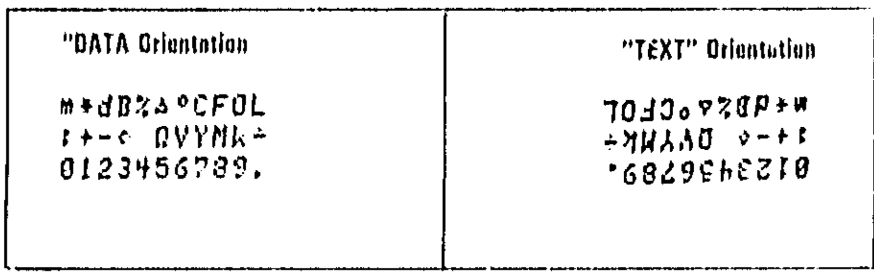


Figure 3-21. Sample "Printer Test" Results.

3-104. "Memory and Front Panel Test".

1 2 3 4

3-105. This test will display an attention-getting "FP" if the low-power memory is operating properly and an "Er" if not. After that, a unique annunciater display will occur for each of the Logging Multimeter pushbuttons that you press. You can compare the display you receive to those shown in Figure 3-22 for each pushbutton.

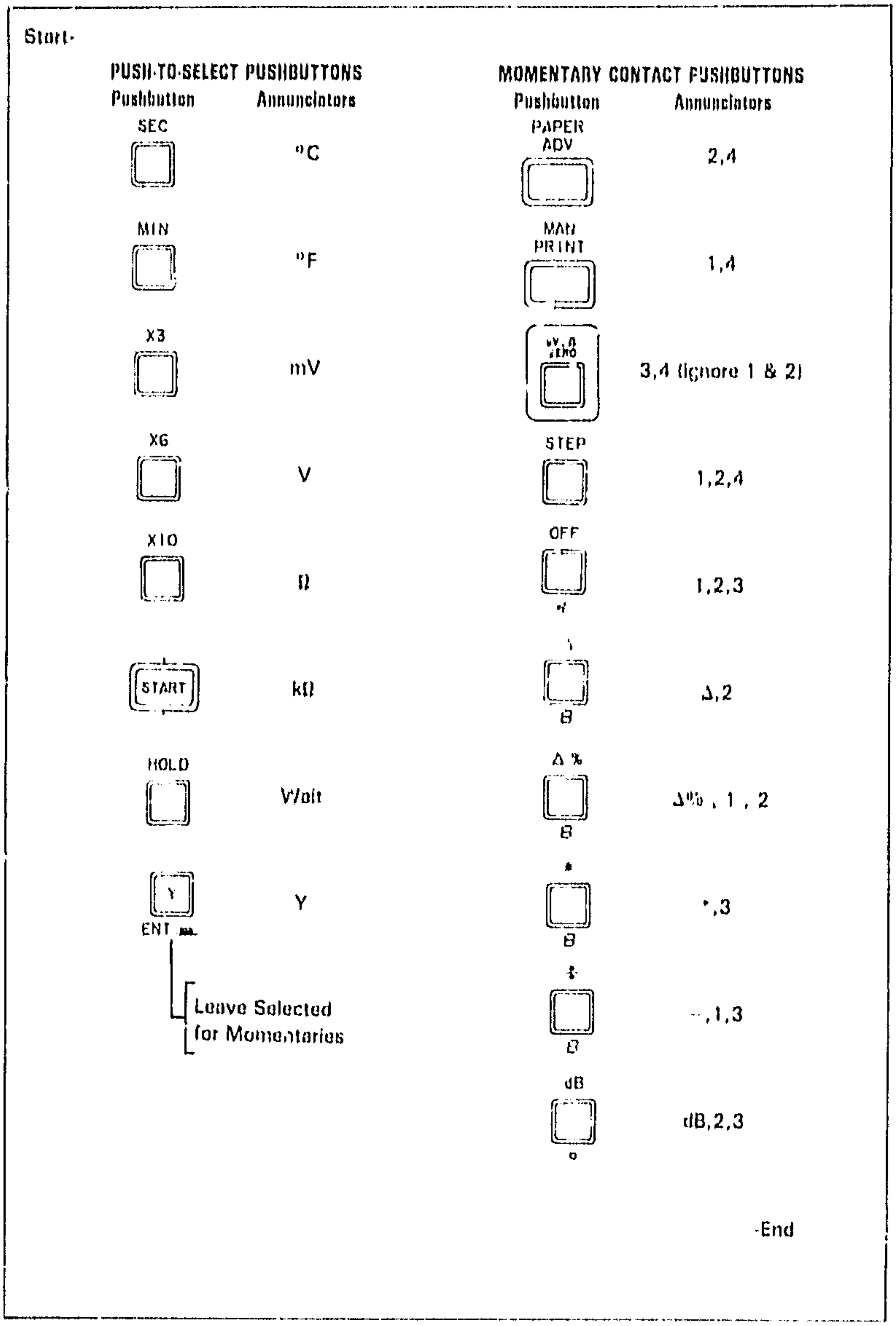


Figure 3-22. Memory and Front Panel Test.

3-106. "Function and Range Test". ■ 1 ■ 2 ■ 3 ▪ 4

3-107. This test will step the digital section of the Logging Multimeter through every valid range in the ⎓V, ~V, and kΩ functions. The printer generates a print similar to one of those in Figure 3-23. Check the print for such things as:

a. The correct functions.
b. The correct ranges.

NOTE

If the Blue Y pushbutton is depressed, ranging is displayed but not printed.

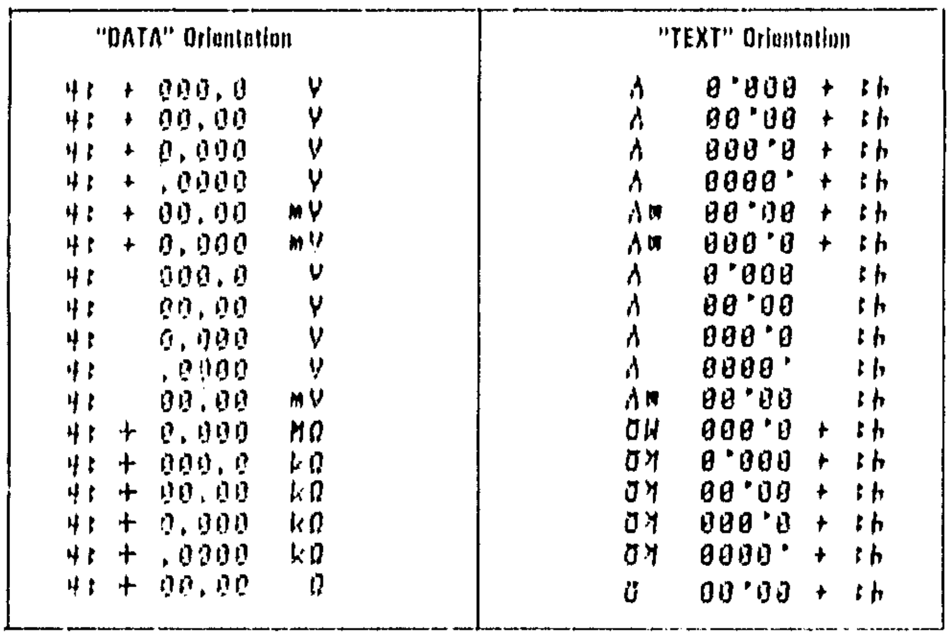


Figure 3-23. Sample "Function and Range Test" Results.

3-108. "Digital Test". ■ 1 ■ 2 ■ 3 ■ 4

3-109. This is the front panel entry method to the *Signature Analysis (SA)* routines. These routines are useful as service aids for the Logging Multimeter. Use of "Digital Test" by service trained personnel is described in detail in Section VIII, "SERVICE", of the 3467A OPERATING AND SERVICE MANUAL.

3-110. USER'S INFORMATION CARD

3-111. A user's information card is provided at the bottom of the Logging Multimeter front panel. This card is easily accessed and contains a summary of operating information and characteristics when quick information is needed.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the Theory of Operation for the Logging Multimeter. A functional description of the Logging Multimeter is followed by Power Supply Theory (by supply), Analog Theory (by function), and Digital Theory (by board). Information on the Input Hybrid (A9U201) and Integrator Hybrid (A9U601) is presented with the Analog Theory. Information on the Voltmeter Control Chip (A4U1) and Microprocessor (A2U1) is presented in the Digital Theory.

4-3. FUNCTIONAL DESCRIPTION.

4-4. The Logging Multimeter utilizes a four channel reed relay scanner to multiplex input signals to the analog portion of the instrument. The analog front end is a signal conversion and processing block that functions as a gain programmable Input-To-DC converter. The analog-to-digital converter employs a Dual-Slope Integration process to convert the DC voltages into digital information. At the heart of the instrument is an 8-bit Microprocessor (MPU), which, through a resident control program, directs the selection of input terminals, Range, and Function; and supervises the display, print, and annunciation outputs. The control ROM also contains the Instrument Self-Test (including *Signature Analysis*, SA) and math routines. A generalized instrument block diagram is shown in Figure 4-1.

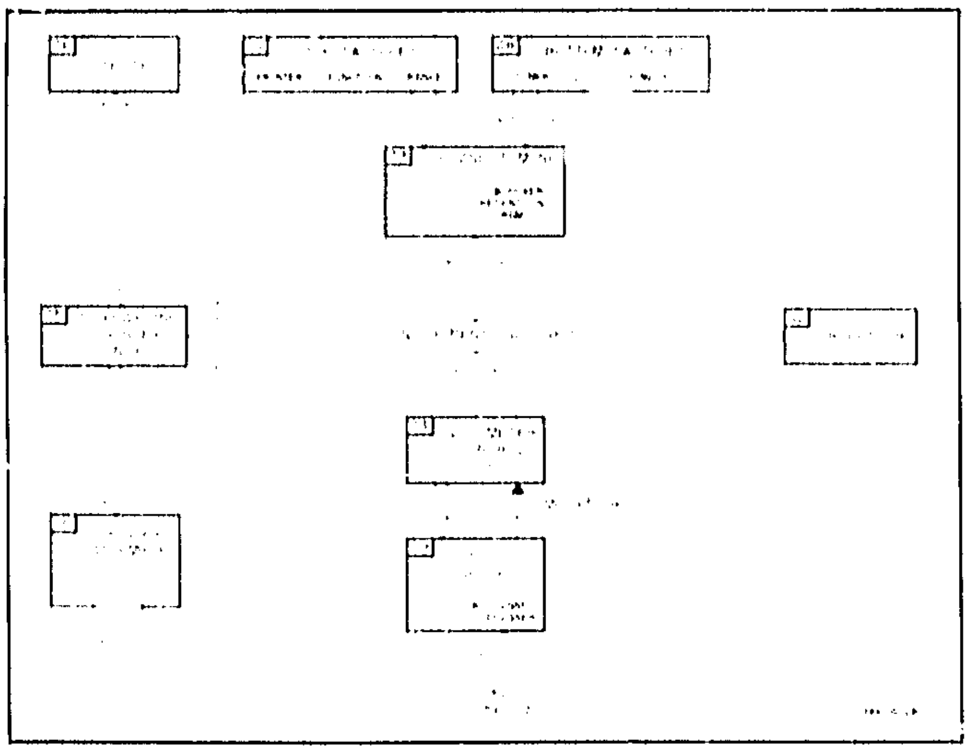


Figure 4-1. 3467A Block Diagram.

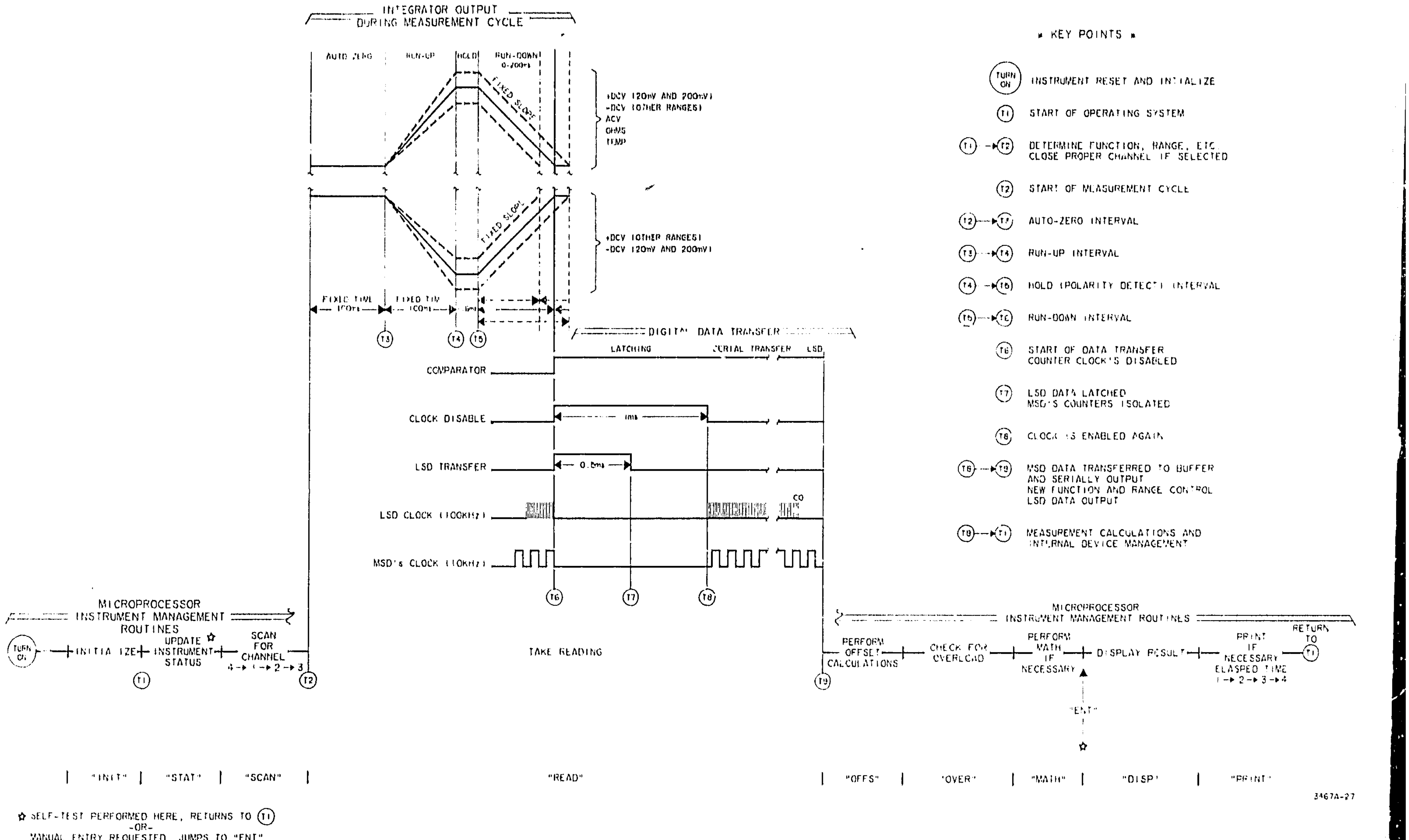


Figure 4-2. Instrument Management.

4-5. Figure 4-2 divides the Logging Multimeter control process into separate Microprocessor directed instrument management routines. Notice that these routines combine to produce the instrument's *Operating System,* which is responsible for all the control processes previously mentioned. Fold-out and refer to this figure as necessary throughout the remainder of this section to relate information on this management routine level.

POWER SUPPLY THEORY

4-6. POWER SUPPLIES.

4-7. The Logging Multimeter power supplies are located on the A9 Analog Board and the A1 Digital Mother Board. We shall refer to the A9 supplies as *Analog Supplies* and the A1 supplies as *Digital Supplies* throughout this manual.

4-8. Analog Supplies.

4-9. Secondary voltage from line transformer T1 is full-wave rectified by CR903-through-CR906 arranged as a bridge. Filtering by C902-through-C905 provides ± 12 volt unregulated supplies at approximately 55 ma.

4-10. **+7 Volt Supply.** The +12 V unregulated voltage is used as a source for the +7 volt precision regulator, U900. The output of U900(6) is adjustable by changing the reference sample via R917. Lowering the resistance of R917 raises the output voltage. R910 provides current limiting at approximately 55 ma. This supply is used by *all other power supplies.*

4-11. **-7 Volt Supply.** The +7 V regulated supply is the reference for this supply and the -12 V unregulated voltage is the source. U901 is configured as a X1 inverting amplifier to derive the -7 volt output from the +7 volt input. Q902 is the current driver which is fed by the -12 V source supply. Figure 4-3 is a simplified illustration of the -7 V supply derivation.

4-12. **-2.65 Volt Supply.** This supply is voltage divided from the -7 V supply by R914 and R915. It supplies the backgate bias voltage to the Input Hybrid (A9U201), the Integrator Hybrid (A9U401, and the Voltmeter Control Chip (A4U1).

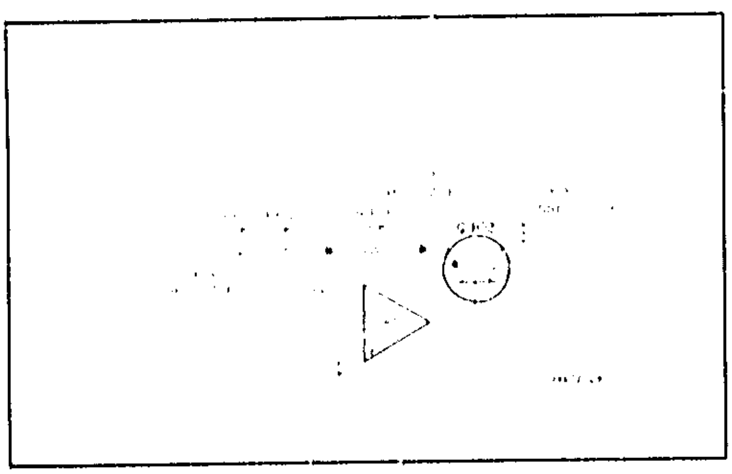


Figure 4-3. Deriving The -7 V Supply.

4-13. **+5 V Reference Supply.** The +5 V reference supply is a precision zener regulated power supply. CR500 is the +6.95 reference zener which is voltage divided by R_{m} and R516 in the feedback path of operational amplifier U500. This is shown in Figure 4-4. The OP AMP is a high open-loop gain, low output impedance amplifier which effectively reduces variations in the voltage divided output due to loading. The result is a highly stable low output impedance reference.

4-14. The course R_{m} adjustment is done at the factory and unless the reference zener (CR500) is replaced, R502 will be sufficient to adjust the reference supply. The +5 V reference supply adjustment is described in detail in Section V, "ADJUSTMENTS".

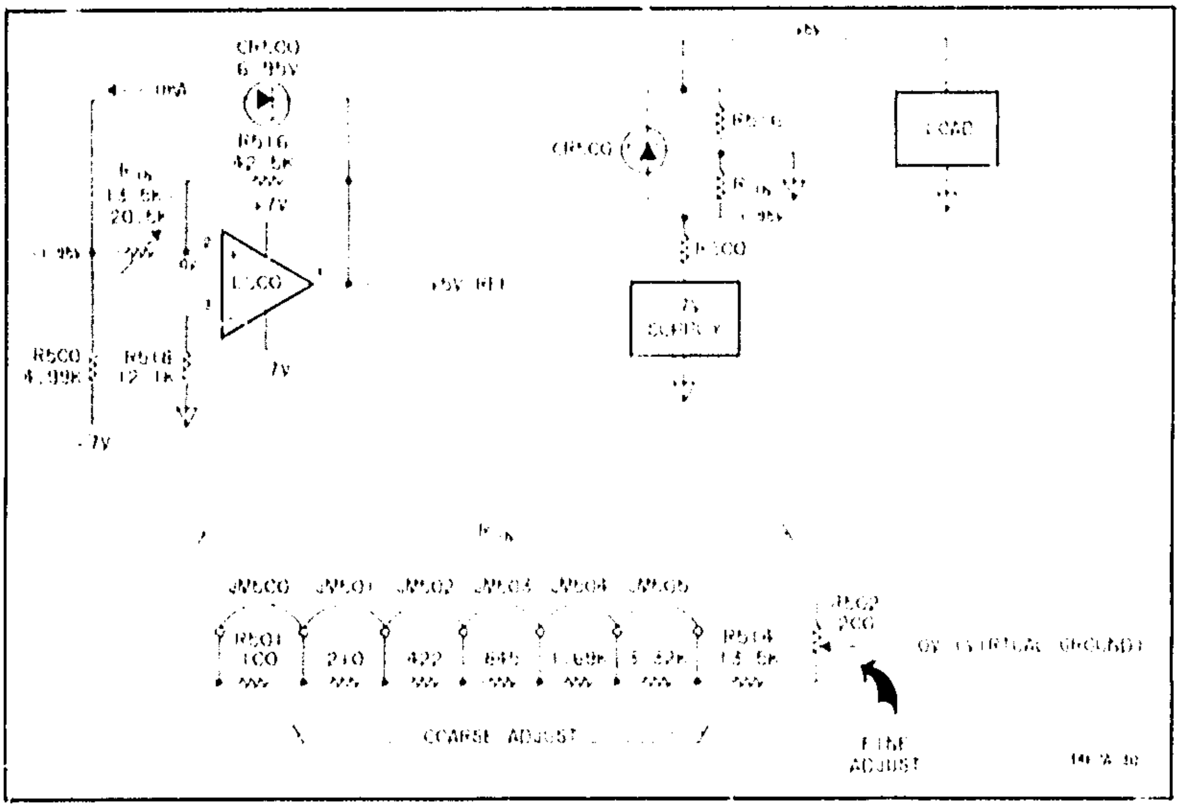


Figure 4-4. 5 V Reference Supply.

4-15. Digital Supplies.

4-16. Secondary voltage from line transformer T1 is full-wave rectified by CR1, CR2, CR5 and CR6. This provides a +8 V unregulated source for the constant current display drivers on A5 and the digital supplies. It also provides a -8 V unregulated supply for A1U1.

4-17. **+5.05 Volt Digital Supply.** Q2 is the series pass element for this supply. R1 is a current sensing resistor which sets the 1.21 ampere current limit value when weighted and fed back to the base of the pass transistor by R2, R4, and U2A. The output current can be calculated by measuring the voltage across R1. Regulation at +5.05 volts is achieved with U1A. The input +5.05 V is voltage divided by R6 and R7 from the +7 V supply.

4-18. **+4.8 Volt Printer Supply.** Q11 is the series pass element in this supply. R10 is a current sensing resistor which sets the 670 ma average current limit value when weighted and damped by R11, R12, and C10, and fed back to the base of the pass transistor by U1B. The damping increases the response time of the current limit loop so that large instaneous printer current demands of 2-3 amperes can be met while limiting the steady-state output current to approximately 670 ma. Regulation at +4.8 V is achieved with U2B. The input +4.8 V is voltage divided by R15 and R16 from the +7 V supply .

ANALOG THEORY

4-19. SCANNER.

4-20. The Logging Multimeter has four separate floating input terminal pairs. Each pair (channel) is switched to the analog function relays through a four channel relay scanner under MPU control. The Scanner and Function relay input arrangement is shown in Figure 4-5.

4-21. Relays K5 through K8 switch the selected input terminals to the appropriate function analog input. K9 reconfigures the input amplifier to place the input terminals in the feedback path of the input amplifier for the kΩ and TEMP functions. K9 also connects the ohms overvoltage and diode protection circuitry into the feedback path of the input amplifier.

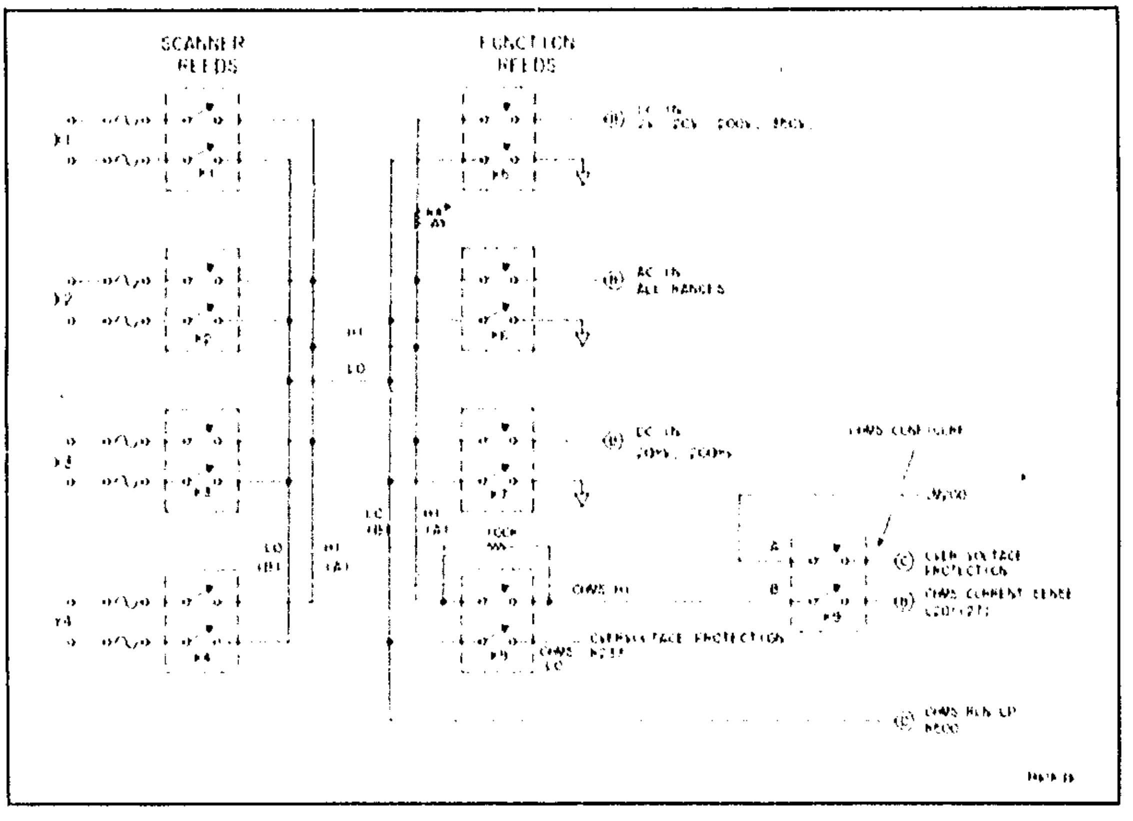


Figure 4-5. Input Scanner And Function Switching.

4-22 Relay decoding and coil drive is provided by A9U1 and A9U2. The truth tables for these 1 of 10 decoders are located in Tables 4-1 and 4-2. Encoded relay closing information is passed to A9U1 and A9U2 from the instrument data bus by the RLY device latch on A4. A9Q1 drives K9 in the kΩ and TEMP functions.

4-23. "Scan" Sequencing.

4-24. Scanner relays are closed prior to function relays to reduce surge currents due to the inherent low to chassis channel capacitances. Scanner relays are scanned in a 4→1→2→3 sequence and Channel 4 is measured first, although this measurement is stored and printed last in the scan sequence.

Table 4-1. Function Relay Drive (U1).

$\overline{FE}$	LODC	C	B	Function	Relay
0	0	0	1	⎓V > 200 mV	K5
0	0	1	0	~V	K6
0	0	1	1	kΩ	K8
0	1	0	1	⎓V ≤ 200 mV	K7
1	X	X	X	None	None

$\overline{FE}$ = Function Enable (Low True).

LODC = 20 mV and 200 mV DCV ranges control line from A1U201.

Table 4-2. Scanner Relay Drive (U2).

$\overline{SE}$	A	B	Relay
0	0	0	K4
0	0	1	K1
0	1	0	K2
0	1	1	K3
1	X	X	None

$\overline{SE}$ = Scanner Enable (Low True).

4-25. THE MEASUREMENT CYCLE.

4-26. A-To-D Conversion Method.

4-27. The Dual-Slope Integration process is the method used by the Logging Multimeter to convert the analog input quantities to digital data. Dual-Slope Integration methods are inherently insensitive to noise at power-line frequencies. The entire conversion is basically a four step process.

4-28. The Four Measurement Intervals.

4-29. The four measurement intervals required for a full conversion are:

a. (T2) — (T3) AUTO-ZERO INTERVAL.

b. (T3) — (T4) RUN-UP INTERVAL.

c. (T4) — (T5) HOLD INTERVAL.

d. (T5) — (T6) RUN-DOWN INTERVAL.

The intervals are timed and controlled by the Voltmeter Control Chip A4U1, which establishes Function, Range and interval configurations with the Input and Integrator Hybrid switching circuits. Refer to Figure 4-6 throughout the following description of the measurement cycle

4-30. Auto-Zero. The concept behind the Auto-Zero Interval is essentially to current balance the summing junction of the Integrator (A9U600) for a zero input condition. The result ensures that zero current flows through the Integrator Capacitor (A9C600) for the beginning of the run-up interval. The current balancing also eliminates Run-Up errors due to Integrator offset currents and Input Amplifier offset voltages.

4-31. Refer to Figure 4-7. The reference current I_R, is switched to the summing junction of the Integrator and a voltage-to-current feedback path is switched to the summing junction from the Slope Amp output. The Auto-Zero Capacitor (A9C700) stores the feedback current as a charge which is the controlling input voltage to JFET A9Q700A, a voltage controlled current source. The resulting feedback current I_{AZ} serves to adjust the balancing current I_R such that the Integrator summing junction is current-nulled, which means no current flows through the Integrator Capacitor. The concept, which is illustrated for the DCV function is similar in other functions, the only differences being in the definition of "a zero input condition". For the voltage functions (DCV & ACV) this is a 0 V input to the Input

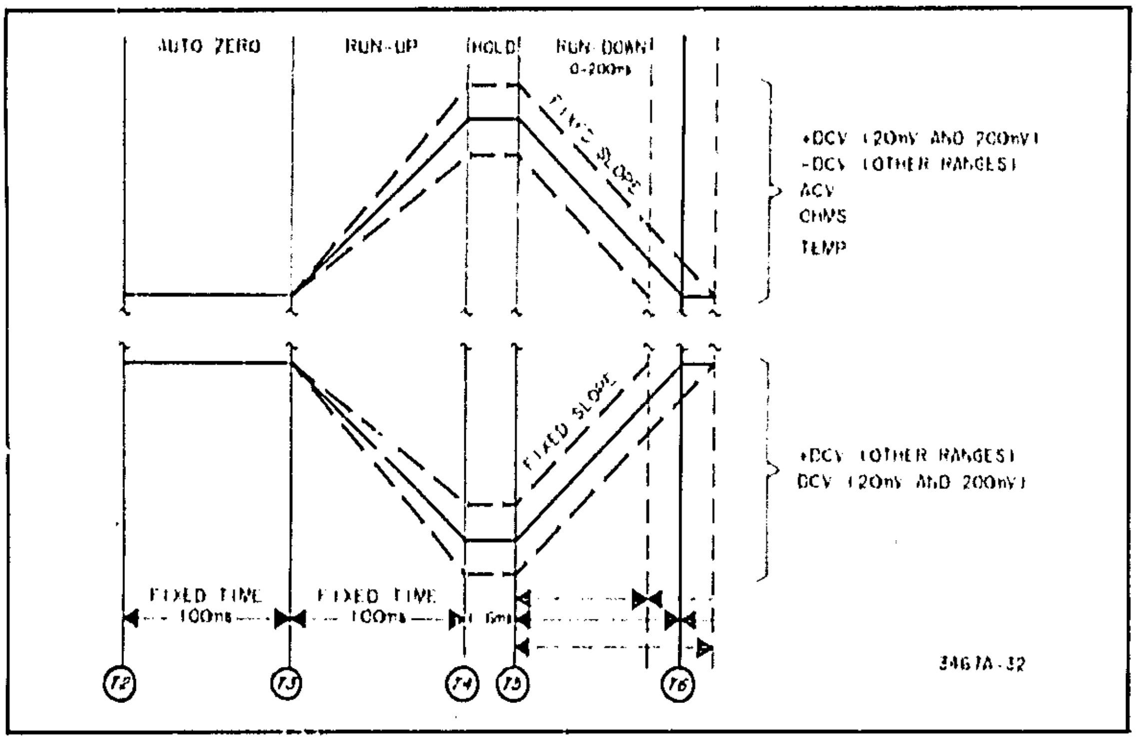


Figure 4-6. The Measurement Cycle.

AMP (inputs switched to ground). For the OHMS and TEMP functions, the Ohms Auto-Zero line is switched in.

4-32. Run-Up (Refer to Figure 4-8). During the Run-Up interval, the input signal charges the Integrator Capacitor for a fixed length of time. This requires that all inputs be processed into a DC voltage which can be used in Run-Up as the charging voltage. The Ohms Converter and true RMS AC Converter achieve this. The proportional DC voltage is applied to a Run-Up resistor in the Integrator Hybrid for approximately 100 ms. The resulting charge on A9C600 is proportional to the input. At the end of Run-Up the processed DC voltage is removed and the measurement cycle begins the Hold interval.

4-33. Hold. The Hold interval is fixed at approximately 1.6 ms. During Hold the Voltmeter Control Chip senses polarity and sets the proper Run-Down configurations.

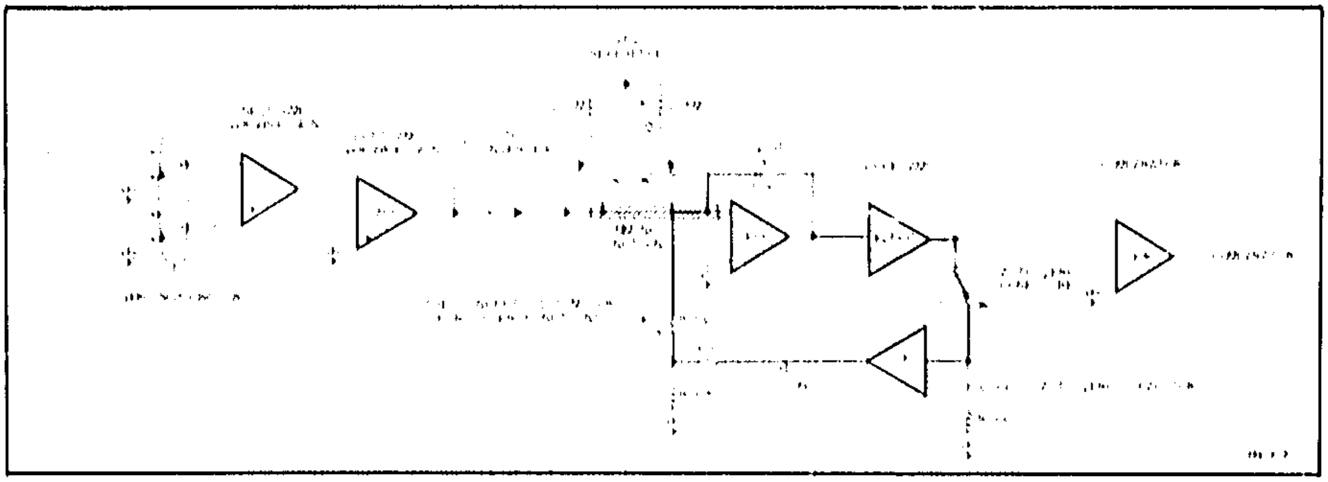


Figure 4-7. Auto-Zero Loop For ==V Function.

4-34. Run-Down. The concept behind Run-Down is essentially to discharge the Integrator Capacitor at a constant rate, counting as it does, until the discharging Integrator output reaches 0V. The amount of time required to reach 0V represents the accumulated charge on the Integrator Capacitor and therefore the input. This technique converts the processed DC voltage into a digital representation. Since the time required to reach 0V is dependent on the initial charge, the length of the Run-Down interval can be anywhere from about 0 seconds for a zero-input to 200 ms for a full-scale input. The Slope-Amp provides gain (X2500) for accurately determining the "Zero-Crossing" point. The Comparator is a high speed ground comparing differential amplifier which changes state when the integrator output passes 0V. The Comparator also provides some additional gain (X90) to improve accuracy. The Comparator transition is negative going for a positively charged Integrator Capacitor (output of Integrator is +) and positive going for a negatively charged Integrator Capacitor (output of Integrator is -).

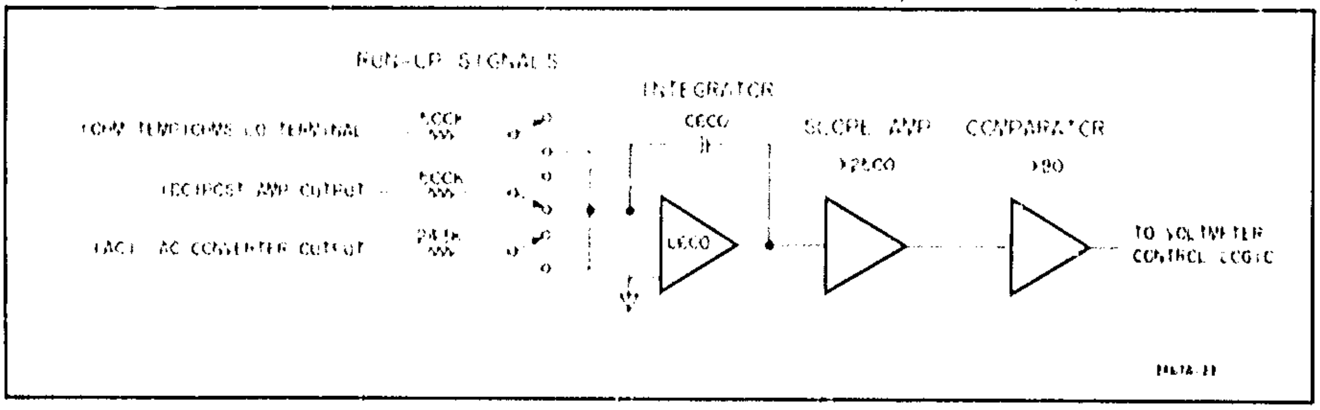


Figure 4-8. The A-To-D Converter Section.

4-35. Multiple Conversions.

4-36. The measurement cycle occurs once for a measurement on a single channel after the first reading. Two measurement cycles occur if the channel is newly closed or if the measurement is to be printed; four measurements cycles if the function is ACV. The multiple conversions are required to allow transients to die after changing channels. After Run-Down, the resulting count is either accepted for the measurement and transferred to the microprocessor or another measurement cycle begins.

4-37. DC VOLTMETER.

4-38. The signal processing on DC voltage inputs conditions the magnitude of the input voltage to within a ±1.9999 volt range at the input of the Integrator. The Input and Post Amplifier gain configurations for all ranges of input voltages are shown in Figure 4-9.

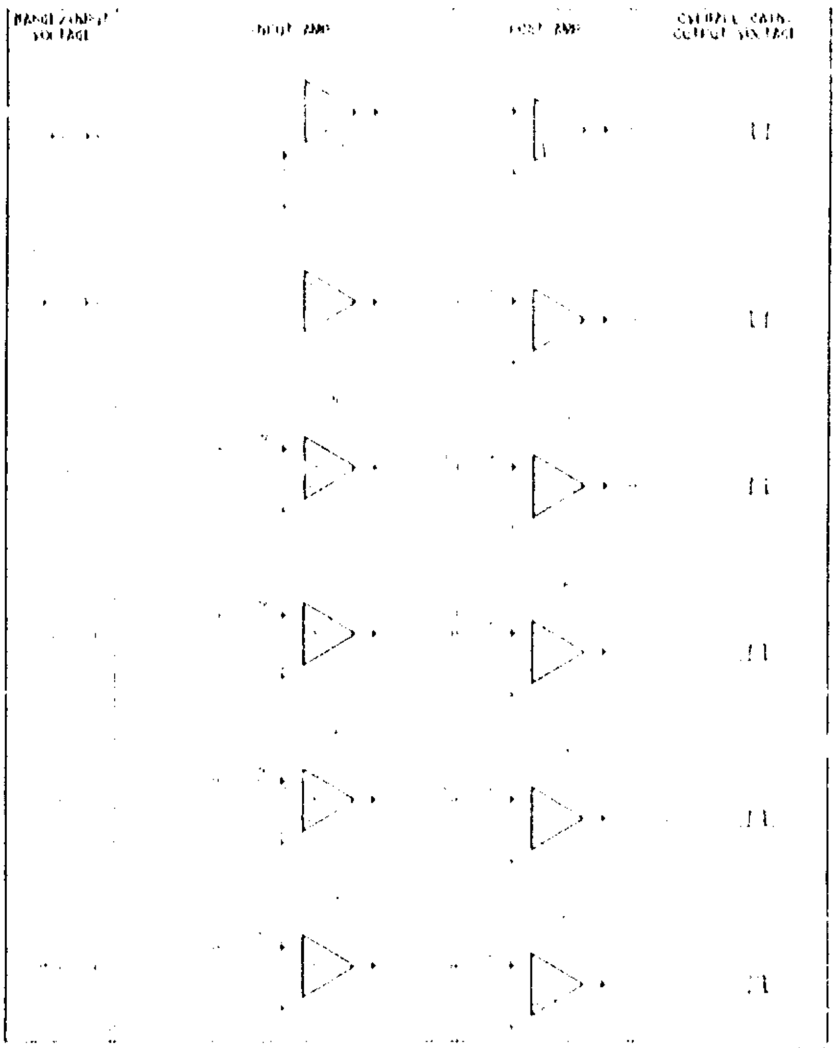


Figure 4-9. DC Gain Configurations.

4-39. Input and Post Amplifiers.

4-40. Gain configurations are set on these amplifiers through MOS-FET switching within the Input Hybrid. The Input Amp is a low noise inverting amplifier which is also operated non-inverting in the 20 mV and 200 mV DC ranges to further reduce noise. The Post Amp provides additional gain to properly scale the integrator input. K7 is closed in the 20 mV and 200 mV ranges and K5 is closed on the 2 V, 20 V, 200 V and 350 V ranges to apply the input to the appropriate Input Amplifier terminal.

4-41. AC VOLTMETER.

4-42. The signal processing on AC voltage inputs conditions the magnitude of the input voltage to within a ±1 volt range at the input of the True-RMS AC converter (A9U400). The AC Converter supplies a DC output voltage mathematically equivalent to the RMS value of the input. True-RMS Converters have the inherent advantage of accurately converting even distorted sinusoidal and non-sinusoidal waveforms into a DC voltage representative of the RMS value of the input waveforms. This DC voltage output is then used for the Run-Up voltage in the Run-Up interval. The True-RMS AC Converter is somewhat non-linear for inputs below 1800 counts and therefore readings below that value should be considered invalid.

4-43. Figure 4-10 illustrates the AC gain and attenuator configurations that condition the input for AC-to-DC conversion by the True-RMS AC Converter. Once the conversion to DC is made, the measurement cycle is the same as the DCV Function.

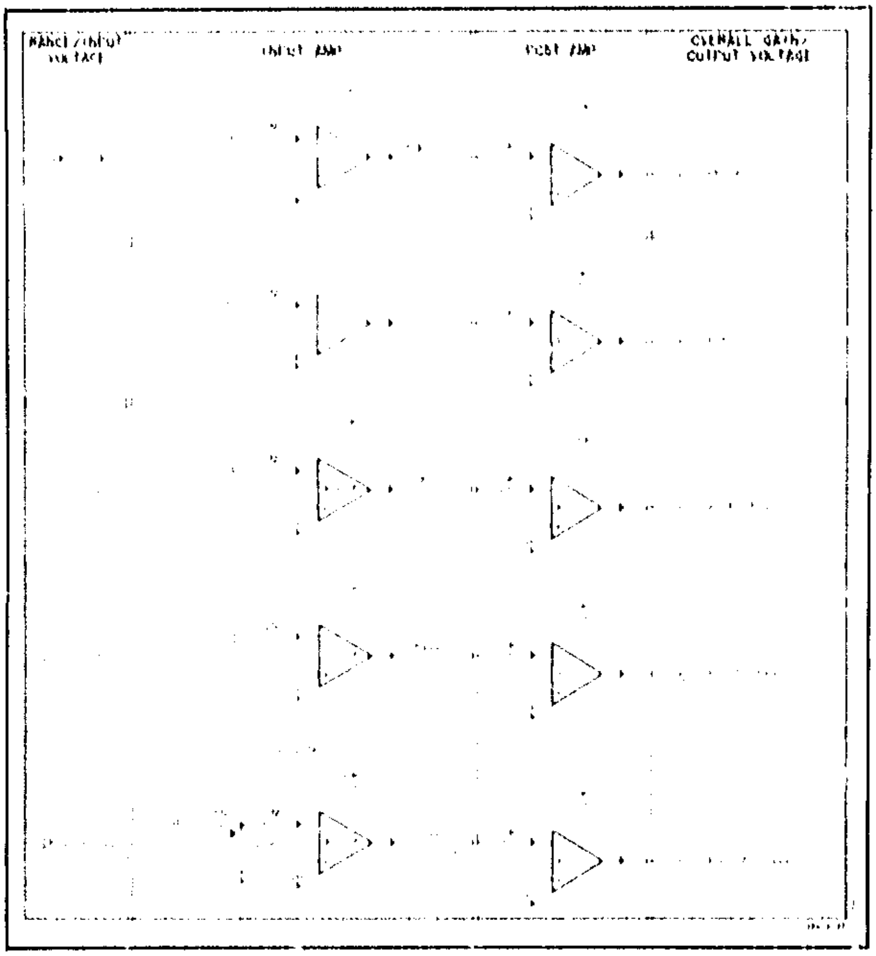


Figure 4-10. AC Gain Configurations.

4-44. OHMMETER.

4-45. Unknown resistances are measured by placing them in the feedback path of the Input Amplifier and sourcing a known current through them. This results in a DC output voltage from the Input Amplifier which is proportional to the unknown resistance. K8 and K9 configure the OHMS Converter for the Ohms-to-voltage conversion. The technique requires an accurate Ohms current source and suitable protection circuitry to prevent accidental damage to the converter due to excessive scanner input voltages.

4-46. Ohms Current Source.

4-47. Figure 4-11 illustrates the function of the Ohms current source in the Ohms configuration. The input voltage to the low output impedance buffer (A9U100) is derived from the +5 volt reference by voltage divider action. The divider produces a .5 V input for the 200Ω range when A9R104 is shorted by A9Q100. In other Ohms ranges, A9Q100 is off and the input is 1 volt. The MOS-FET switching within the Input Hybrid applies the .5 V or 1 V reference (V_{REF}) to an internal laser trimmed reference resistor. The other end of the reference resistor is maintained at virtual ground due to the large open loop gain of the Input Amplifier. The resulting OHMS reference current (I_x) is therefore V_{REF}/R_{REF}. Figure 4-12 illustrates the Ohms current source and reference values for each Ohmmeter range.

4-48. Ohms Conversion.

4-49. During Ohms Auto-Zero, the Ohms Auto-Zero line is switched in, thereby using the potential at the summing junction of the Input Amplifier as a "zero input condition". During Ohms Run-Up, since the input impedance of the Input Amplifier is extremely high, all of the Ohms current (I_x) flows through the scanner input terminals and the unknown resistance (R_x) between them. This action develops an Input Amplifier output voltage which is proportional to the unknown resistance. Equation 4-1 gives the relationship between the resultant DC voltage and the unknown resistance.

$$V_{OUT} = -I_x \bullet R_x \qquad \text{Equation 4-1.}$$

4-50. The resultant DC voltage is within the proper range to be used as a Run-Up voltage during the Run-Up interval. Once the conversion to DC is made, the measurement cycle is the same as the DCV and ACV functions except that the Ohms reference voltage is used for Run-Down in place of the +5 V reference.

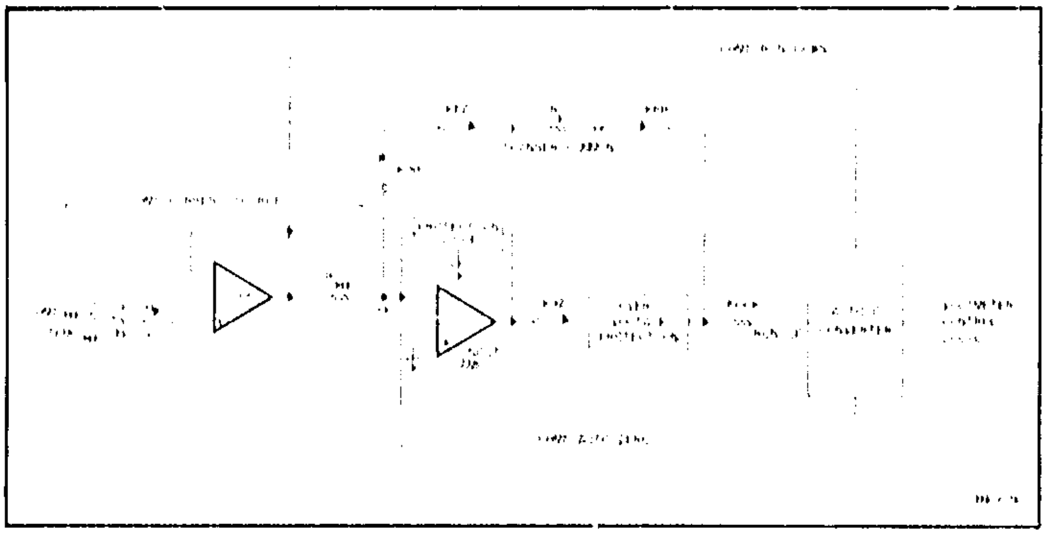
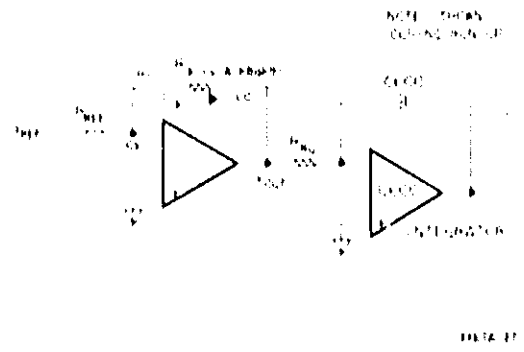


Figure 4-11. Ohms Block Diagram.

4-51. Ohms Protection.

4-52. The OHMS circuitry is protected from the accidental application of large scanner terminal voltages by a diode protection network and an overvoltage protection circuit.

4-53. **Diode Protection.** The diode network protects the Input Amplifier and OHMS current source by limiting the voltage at the inverting input of the Input Amplifier to -.7 V (A9CR200) in the negative direction and +1.2 V (A9CR201 & A9CR202) in the positive direction. Since this limits the "HI" scanner input terminals to near ground potentials, another scheme is needed to isolate the "LOW" scanner input terminals from the OHMS circuitry upon application of an excessive input voltage.



kΩ			R_{REF}	TEMP		
Range	V_{REF}	I_X		Range °C(°F)	V_{REF}	I_x
20M	1V	100na	10M	-80(-112)	.15V	15na
2000k	1V	1μa	1M	-73(-99.3)	.15V	150na
200k	1V	10μa	100k	-42.6(-44.7)	.15V	1.5μa
20k	1V	100μa	10k	-3.9(24.9)	.15V	15μa
2k	1V	1ma	1k	47.2(117)	.15V	150μa
200	.5V	5ma	100	*119(246.2)	.15V	1.5ma

*May actually read 120(248) due to turn on offset.

Figure 4-12. Ohms and Temp Configuration.

4-54. Overvoltage Protection. The overvoltage protection circuit is the second scheme. This circuit acts as a level shifter for the Input Amplifier as well as a high-voltage buffer between the "LOW" scanner input terminal and the output of the Input Amplifier. Essentially, the OHMS overvoltage protection circuit isolates the Input Amplifier from the non-limited "LOW" terminal for "HI"-to-"LOW" voltages exceeding approximately 4.7 volts. Refer to Figure 4-13. Under normal OHMS operation, A9Q205 is saturated and the output of the Input Amp is level shifted from the "LOW" terminal. An excessive positive input voltage will drive the "LOW" terminal negative and the output of the Input Amplifier more negative. The collector of A9Q205 goes to about ground potential which reverse biases A9CR220, the isolation component for excessive positive input voltages. An excessive negative input voltage drives the "LOW" terminal positive and the output of the Input Amplifier more positive. A9Q205 cuts-off and is the isolation component for excessive negative input voltages.

4-55. TEMPERATURE MEASUREMENTS.

4-56. Temperature measurements are made with an external thermistor. Thermistors are temperature varying resistors with a high negative temperature coefficient. The thermistor used by the Logging Multimeter exhibits a 5 kΩ resistance at 25°C. The temperature of this thermistor is calculated from its resistance by a two part logarithmic model. The model is a mathematical description of how the thermistor's resistance varies as a function of temperature. Table 4-3 is a tabular listing of this relationship.

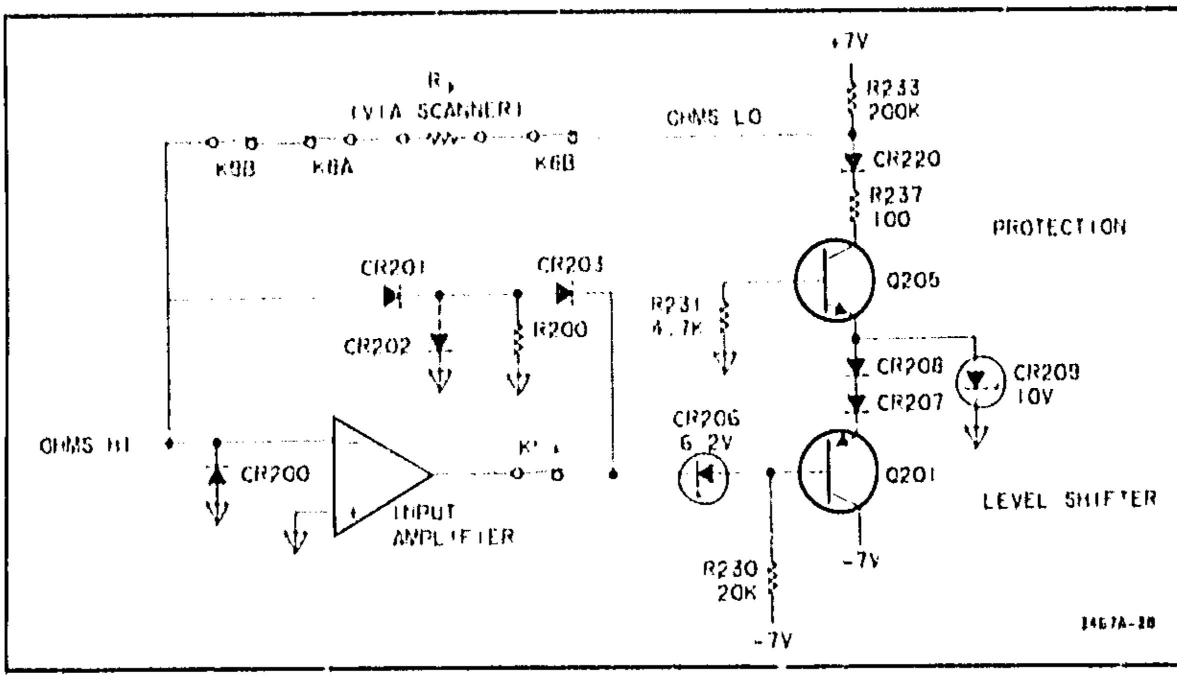


Figure 4-13. Ohms Overvoltage Protection.

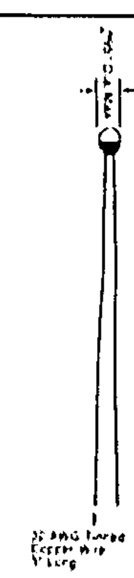
4-57. The TEMP function uses the OHMS function configuration with a lower Ohms reference voltage to measure the thermistor resistance. The lower ohms reference (.15V) is required to reduce the effects of thermistor self-heating which could produce errors. The "TEMP" control line saturates A9Q101 to reduce the voltage divided reference to .15V.

4-58. The resulting Ohms measurement is converted to a Celsius or Fahrenheit temperature by the linearization routine which is performed in "TEMP" as part of the "MATH" instrument management routine.

Table 4-3. Thermistor Resistance Versus Temperature -80° to +150°C.

TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES
-80	3684K	-50	335.3K	-20	48.56K	+10	9951	+40	2663	+70	875.7	+100	339.6	+130	150.2
79	3371K	49	312.5K	19	45.83K	11	9486	41	2559	71	846.4	101	329.8	131	146.5
78	3088K	48	291.0K	18	43.27K	12	9046	42	2459	72	818.3	102	320.4	132	142.9
77	2827K	47	271.2K	17	40.86K	13	8628	43	2363	73	791.2	103	311.3	133	139.4
76	2592K	46	253.0K	16	38.61K	14	8232	44	2272	74	765.1	104	302.6	134	136.0
75	2378K	45	236.2K	15	36.49K	15	7857	45	2184	75	740.0	105	294.0	135	132.6
74	2183K	44	220.5K	14	34.50K	16	7500	46	2101	76	715.9	106	285.7	136	129.4
73	2005K	43	205.9K	13	32.63K	17	7162	47	2021	77	692.7	107	277.8	137	126.3
72	1843K	42	192.5K	12	30.88K	18	6841	48	1944	78	670.3	108	270.1	138	123.2
71	1695K	41	180.0K	11	29.23K	19	6536	49	1871	79	648.8	109	262.6	139	120.3
-70	1560K	-40	168.3K	-10	27.67K	+20	6247	+50	1801	+80	628.1	+110	255.4	+140	117.4
69	1436K	39	157.5K	9	26.21K	21	5972	51	1734	81	608.2	111	248.4	141	114.6
68	1323K	38	147.5K	8	24.83K	22	5710	52	1670	82	588.9	112	241.6	142	111.9
67	1220K	37	138.2K	7	23.54K	23	5462	53	1608	83	570.4	113	235.1	143	109.2
66	1125K	36	129.5K	6	22.32K	24	5226	54	1549	84	552.6	114	228.7	144	106.7
65	1039K	35	121.4K	5	21.17K	25	5000	55	1493	85	535.4	115	222.6	145	104.2
64	959.9K	34	113.9K	4	20.08K	26	4787	56	1439	86	518.8	116	216.7	146	101.8
63	887.2K	33	106.9K	3	19.06K	27	4583	57	1387	87	502.8	117	210.9	147	99.40
62	820.5K	32	100.3K	2	18.10K	28	4389	58	1337	88	487.4	118	205.3	148	97.10
61	759.2K	31	94.22K	-1	17.19K	29	4204	59	1290	89	472.6	119	199.9	149	94.87
-60	702.9K	-30	88.53K	0	16.33K	+30	4029	+60	1244	+90	458.2	+120	194.7	+150	92.70
59	651.1K	29	83.22K	+1	15.52K	31	3861	61	1200	91	444.4	121	189.6		
58	603.5K	28	78.26K	2	14.75K	32	3702	62	1158	92	431.0	122	184.7		
57	559.7K	27	73.62K	3	14.03K	33	3549	63	1117	93	418.2	123	179.9		
56	519.4K	26	69.29K	4	13.34K	34	3404	64	1079	94	405.7	124	175.3		
55	482.2K	25	65.24K	5	12.70K	35	3266	65	1041	95	393.7	125	170.8		
54	447.9K	24	61.45K	6	12.09K	36	3134	66	1006	96	382.1	126	166.4		
53	416.3K	23	57.90K	7	11.51K	37	3008	67	971.1	97	370.9	127	162.2		
52	387.1K	22	54.58K	8	10.96K	38	2888	68	938.0	98	360.1	128	158.1		
51	360.2K	21	51.47K	9	10.44K	39	2773	69	906.3	99	349.7	129	154.1		

$°C = \frac{5}{9}(°F - 32)$ $°F = \frac{9}{5}°C + 32$



4-59. The effects of lead resistance at or above 36°C (96.8°F) can be calculated with the following equation:

$$T_e = \frac{-4751.4\ R_e}{R(\ln(R) + 5.9522)^2} \quad \text{Equation 4-2.}$$

Where T_e = Resultant temperature error in °C.
R_e = Lead resistance.
R = Thermistor resistance at the measurement temperature from Table 4-3.

Worst case sensitivity at 150°C(270°F) is -.4665 °C/Ω (-.8398 °F/Ω).

4-60. HYBRIDS.

4-61. Input Hybrid (A8U201).

4-62. The Input Hybrid contains MOS-FET switches and laser-trimmed resistors. It serves as progammable gain and control switching for the Input Amplifies stage. Function, range, and measurement interval switching and timing are controlled by codes from the Voltmeter Control Chip (A4U1), which controls all measurement cycle functions and autoranging.

4-63. Integrator Hybrid (A8U601).

4-64. The Integrator Hybrid contains MOS-FET switches and laser-trimmed resistors. It serves as programmable gain and control switching for the Post Amplifier stage. The Integrator Hybrid also switches the measurement cycle currents according to function, range, and measurement interval codes from the Voltmeter Control Chip.

DIGITAL THEORY

4-65. INTRODUCTION.

4-66. The digital portion of the Logging Multimeter consists of the following eight boards:

a. Digital Mother Board, A1.
b. Processor Board, A2.
c. I/O and Timing Board, A3.
d. Voltmeter Control Logic Board, A4.
e. Display and Printer Control Board, A5.
f. Display Board, A6.
g. Top Switch Board, A7.
h. Bottom Switch Board, A8.

and all associated interconnection.

4-67. Terms And Abbreviations.

4-68. The following terms appear in the Digital Theory Sub-Section:

ASM — Algorithmic State Machine.

BIT	— A Binary Digit. Positive logic, high true.
BYTE	— 8 Bits. Contents of a memory location.
DEVICE	— Selectable latch or buffer. Devices are treated as memory locations.
HEX	— Abbreviations for hexidecimal (Base 16).
I/O	— Transfer of data to or from memory (ROM, low power memory, or devices).
INTERRUPT	— Input signal to the microprocessor used to request or initiate special program sequence.
LSD	— Least significant digit. The fourth digit of this 4 1/2 digit instrument.
MPU	— Microprocessing unit. The MC6802.
MSD(S)	— Most significant digit(s). The first 3 1/2 digits of this 4 1/2 digit instrument.
NYBBLE	— 1/2 of a BYTE. 4 bits.
RAM	— Random access (READ/WRITE) memory.
ROM	— Read only memory.
V_C	— Low power memory supply voltage.
V_{CC}	— +5.05 volt digital supply voltage.

4-69. DIGITAL MOTHER BOARD.

4-70. This board, A1, contains the digital power supply circuitry, and all connectors and jacks for interconnection between the Logging Multimeter assemblies. Connection to the Analog Board, A9, is via two 16-pin dip cables (W9-1 and W9-2).

4-71. PROCESSOR BOARD.

4-72. The Processor Board, A2, contains the instrument Microprocessor (MPU), ROM-resident Operating System, Master clock source, instrument data bus read/write control and buffers, and various ROM and device address select circuitry. The theory which applies to this board can best be dealt with by describing the instrument Microprocessor and generalizing the Operating System.

4-73. Device latches are "mapped" into locations in memory by the device select lines and are actually treated as memory locations by the MPU. In other words, information is written to them by storing at their location, and information is read from them by loading from their location. This is the inherent method of Input/Output in mapped processors such as the one used in the Logging Multimeter.

4-74. Table 8-1A in Section VIII is a fold-out summary of I/O devices and instrument mnemonics. This table can be unfolded and left for reference throughout the remainder of this section. The complete map of MPU memory places on-board read/write memory (RAM) at HEX addresses 00 thru 7F, the Instrument Data Bus and I/O Devices (for valid data) at 80 thru FF, and ROM (for valid data) at 2000-to-3FFF. The Low Power Retention Memory is a 64 NYBBLE RAM (4 Bits wide) which is read from at device address F5 and written to at device address F6.

4-75. Microprocessor.

4-76. The Microprocessor used in the Logging Multimeter controls the instrument math operations, internal data transfers, and all display and print functions. The specific unit used in this instrument is the Motorola MC6802 MPU.

4-77. The MC6802 is a monolithic 8-Bit parallel microprocessor which is a control oriented version of the popular MC6800. In addition to two 8-Bit accumulators, three 16-Bit dedicated registers (index, stack, and program counter), and one 6-Bit condition code register, the 6802 contains an internal clock generator/driver (externally driven at 4 MHz in the Logging Multimeter) and 128 bytes of on-board RAM at HEX addresses 0000-to-007F. The architecture of the MC6802 is shown in Figure 4-14.

4-78. The Microprocessor is supported by a 6k byte ROM Operating System which establishes the instrument's scan, offset, read, math, display, print, and test routines under both manual and timer control. A brief description of the MPU signal lines and their operating conditions follows.

ADDRESS BUS (A_0-A_{13})

The MPU utilizes 14 address lines (A_0-A_{13}) for addressing memory and devices (timer, printer, display, etc.) A_{14} and A_{15} are used only in the "TEST" routine as Signature Analyzer start and stop control bits used by the -hp- 5004A in a Logging Multimeter service process.

DATA BUS (D_0-D_7)

The MPU data bus consists of 8 bidirectional, tri-state lines used for transferring data to/from devices and from control ROMS.

READ/WRITE (R/$\overline{W}$)

The MPU R/$\overline{W}$ line is used to enable devices when the MPU is reading from them (elapsed time, status, etc.) or writing to them (print data, display data, etc.). The normal standby state of this line is Read (high).

ENABLE (E)

The MPU enable output line is used to control instrument timing. This signal is derived from the MPU internal clock generator and is used as a master clock (MCK), and is a 1 MHz square wave.

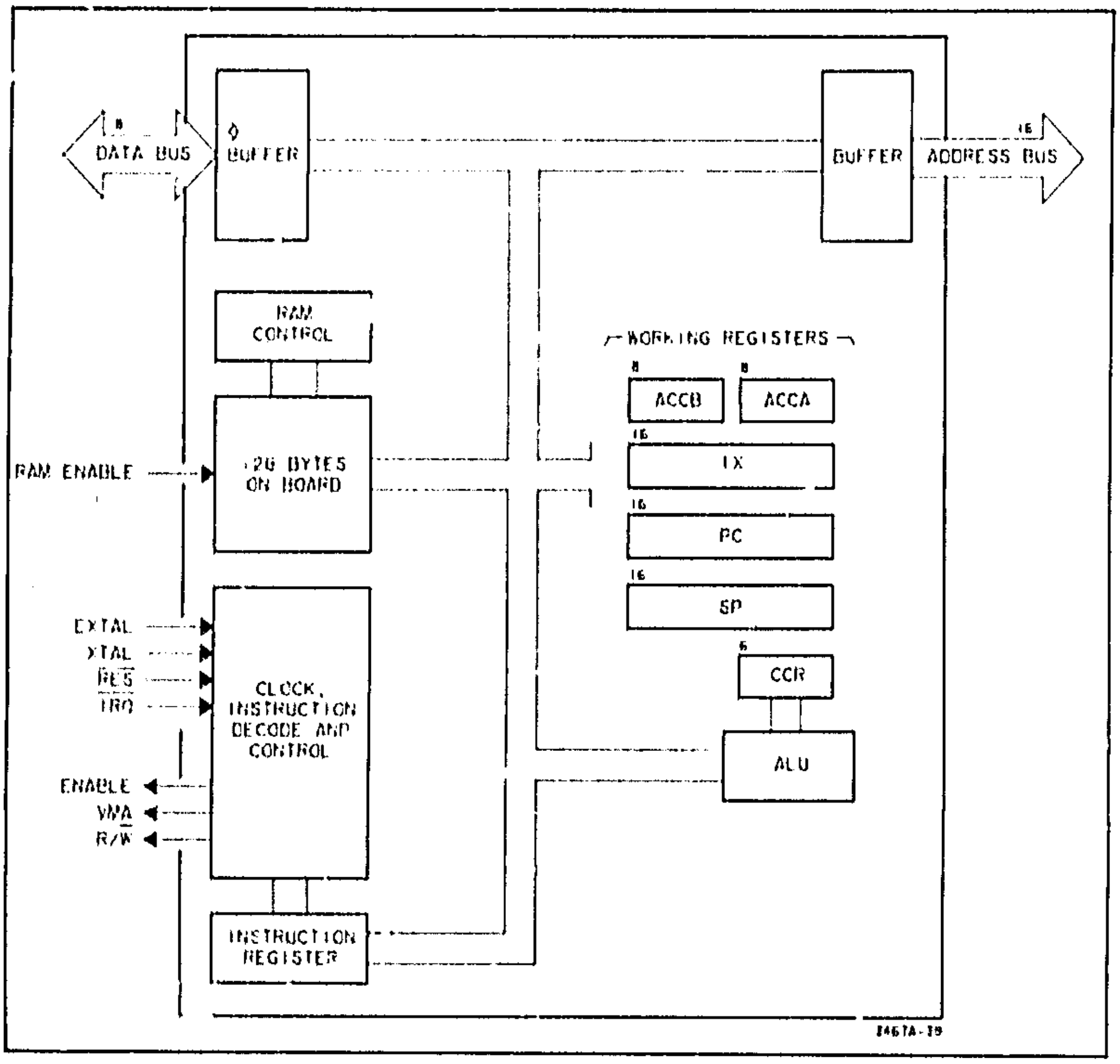


Figure 4-14. MPU Architecture.

RESET ($\overline{RES}$)

The MPU Reset input line is used to reset and start the MPU when it is stuck or a second is lost (refer to theory on A3). The $\overline{RES}$ line is also used to reset the MPU after power-on ($\overline{PON}$).

EXtal and Xtal

The MPU has an internal clock generator which is driven at these two terminals by a 4 MHz crystal-controlled (Y1) oscillator.

VALID MEMORY ADDRESS (VMA)

The MPU Valid Memory Address output line is used to enable devices when there is a valid address on the MPU address bus.

INTERRUPT REQUEST ($\overline{IRQ}$)

The MPU Interrupt Request input line is used by the power drop detection circuitry to signal the MPU when V_{CC} falls below 4.83 volts (adjustable from 4.4V to 5.21V typical). Upon completion of its present task, the $\overline{IRQ}$ line is recognized by the MPU and the low power memory is isolated.

4-79. **Interrupts.** There are three interrupt conditions which will cause the MPU to enter pre-defined service routines. Table 4-4 lists the routines by interrupt condition and provides brief descriptions of each.

Table 4-4. MPU Interrupt Conditions.

Condition	Interrupt Type	Desciption
Turn-On	Reset ($\overline{RES}$)	Restart Initialization Level Sensitive (low clears MPU, positive edge begins restart routine)
Power Down ($V_{CC} \leq 4.83V$)	Interrupt Request ($\overline{IRQ}$)	Interrupt is masked during RAM updating (2 ms maximum) when $V_{CC} > 4.75$ V. Level Sensitive
1 Hz Time Base Lost or Stuck	Reset ($\overline{RES}$)	Two seconds have elapsed without a timer reset (lost) or two timer resets have occured without an elapsed second (stuck).

4-80. ROMs.

4-81. The Logging Multimeter Control ROMs contain the instrument operating system and Self-Test programs. The Logging Multimeter uses 2k Byte ROMS which are arranged as:

ROM 0 (U2)	HEX Locations 2000 to 27FF
ROM 1 (U3)	HEX Locations 3000 to 37FF
ROM 2 (U13)	HEX Locations 3800 to 3FFF

The address decoding enables the control ROMs for valid memory addresses given above when the MPU Enable line is high.

4-82. A flowcharted version of the Logging Multimeter ROM Operating System is given in Figure 4-15. The flowchart is provided as additional insight into the sequences involved with controlling the Logging Multimeter. Notice that one pass through the *Job Control Loop* occurs for each complete measurement or manually incremented digit, also notice that the Self-Test routine does not involve passing through the entire Job Control Loop, and that the "SCAN," "READ," "OFFS" and "PRIN" routines are skipped when a measurement is not required. The following paragraphs desribe the instrument management routines which are portrayed in Figure 4-2 and 4-15:

"INIT"

Initializes the Logging Multimeter hardware and RAM. This routine is performed after in-

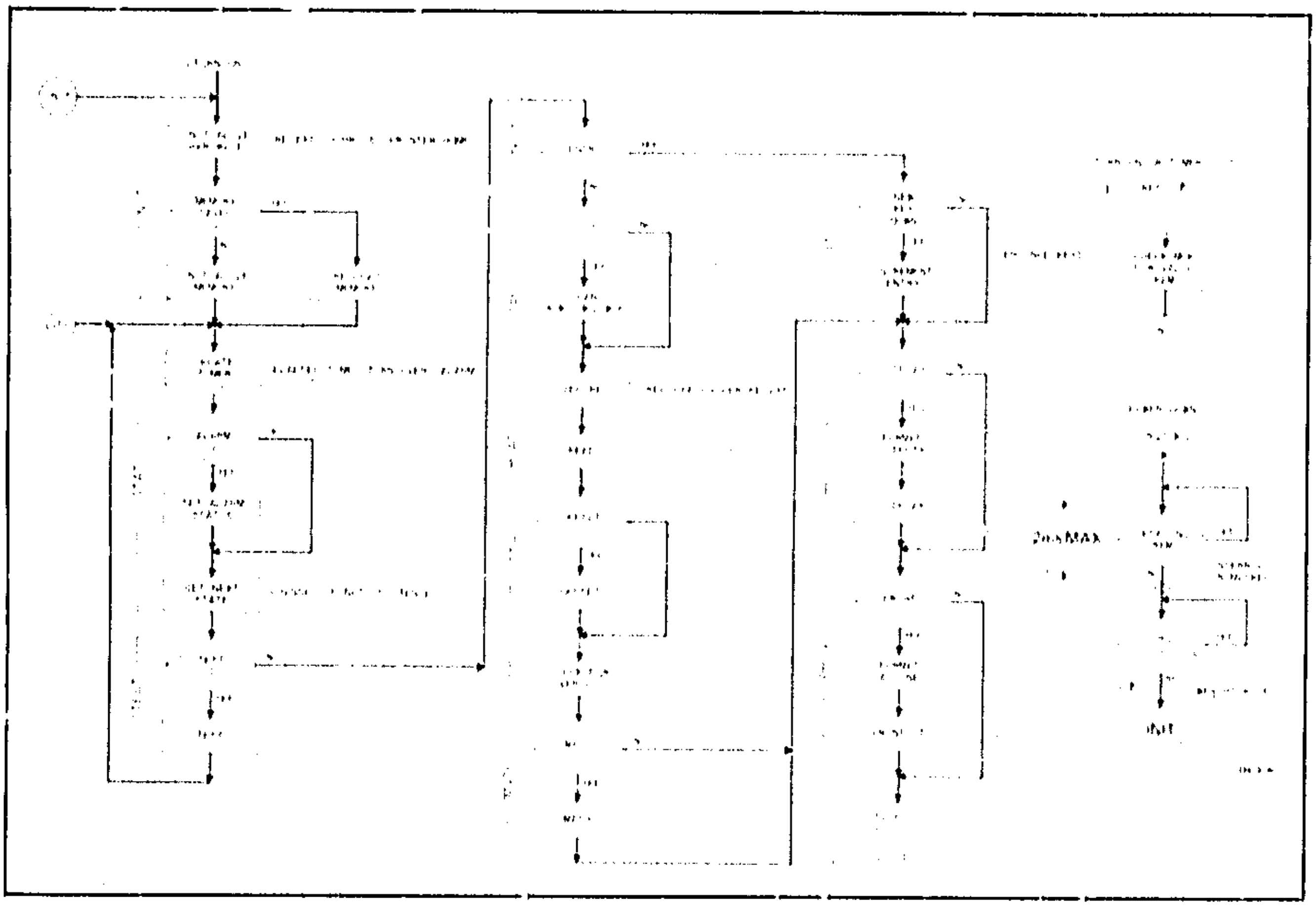


Figure 4-15. Operating System Flowchart.

strument turn-on or upon a stuck or lost microprocessor situation. It is not part of the Job Control Loop of the operating system, meaning that it is not performed except on the above conditions.

"STAT"
(T1)

The status update routine is the beginning of the instruments Job Control Loop. This routine checks for timer conditions such as elapsed second and sets timer status accordingly. It also checks the scanner and voltmeter front panel conditions to determine the next channel, function, and range status to set. The number of analog-to digital conversions required for each measurement is determined here.

"TEST"

This routine checks for a selected front panel "TEST" pushbutton. If selected, the channel pushbutton settings are checked to determine which of five possible Self-Test modes is selected and the appropriate Self-Test routine is then performed. If not selected this routine ends with a check for the manual entry mode. Selection of the "Y" (manual entry) pushbutton will branch the system to the "ENT" routine as will the absence of a selected channel.

Deselection of the TEST front panel pushbutton (selecting another function) returns the processor to the Job Control Loop entry point JCL.

"SCAN"

This routine determines the next scanner and function relays to close, then closes them. If nothing has changed, the same relays are secured. If no channels are selected the routine will open all channels.

"READ"
(T2)

This routine performs the required number of A-to-D measurement cycles and essentially passes control to the Voltmeter control Chip during each conversion. After the last conversion the digital data is transferred into the processors' on board RAM. More information on the transfer is included as part of the Voltmeter Control Logic description later in this section. Channel 4 measurements are stored in the location designated for the X:Y Math reference.

"OFFS"
(T9)

In kΩ and TEMP, this routine subtracts 4 ohms from the measurement to compensate for resistance contributions by the high/low lines and fuses. In the kΩ and ⎓ V functions, it checks if the "μV, Ω ZERO" pushbutton was selected and if so stores the reading obtained in the "READ" routine as an offset if it is less than 20Ω or 20mV. All zeroes are stored for the result itself. This results in the zero display which is observed when the display data RAM is loaded in "DISP". Readings which are too large are not treated as offsets, they are ignored.

"ENT"

This routine is entered when the Y (manual entry) pushbutton is depressed or no channels are selected, since both cases do not require a scan or measurement cycle. The stored reference value is transferred to the display buffer location if the Y manual entry pushbutton is not depressed. A depressed Y manual entry pushbutton will either:

a. Store "CH 4" into the display buffer location if Channel 4 is selected

OR

b. Modify the display buffer location according to momentary codes (i.e. increment a digit).

"DISP"

This routine loads the display data RAM with the contents of the display buffer location and enables the display. During some Self-Test routines the display buffer location is empty at times and no display occurs. Once loaded and enabled the display control circuit will scan the display data RAM on its own.

"OVER"

This routine checks the "OL" bit which is received as part of the serial data transfer from the Voltmeter Control Chip during the "READ" routine. This will result in formating an "OL" display in "DISP" or "OL" print in "PRIN". Readings and results are also compared against their allowable limits and similar formating may result.

"TEMP"
(P/O "Math")

This is the ohms to degree conversion routine based on a two part Logarithmic thermistor model.

"MATH"

This routine will perform the selected X:Y MATH operation which was requested for the measurement. A math result greater than ± 19999 will result in formatting an "OL" display in "DISP".

"PRIN"

This routine checks the timer status and printer control pushbutton settings to determine if a print is required. Printer formatting is done with respect to the selected character orientation, timer status, and type of print (timed or manual). , ı "OL" is then printed. An overload measurement or result formats an "OL" print. Lack of printer paper formats the "OP" display.

4-83. I/O AND TIMING BOARD.

4-84. The I/O and Timing Board, A3, contains the input data buffers, low power memory, power up/down timing, and 1 Hz time base circuitry.

4-85. The Input Data Buffers.

4-86. The device-selectable data buffers are used to selectively load front panel switch information and other signals (timer status, °C-°F selection, etc.) to the Microprocessor. A3U1 is the device select decoder for these tri-state devices.

4-87. The Low Power Memory.

4-88. The Low Power CMOS RAM (A3U12) is a 64 x 4 block of memory used to store the Logging Multimeter constants and instrument status. It is updated once during the control loop by addressing over the instrument data bus $(F6)_{16}$. RAM is preserved in a low power standby state during a power-drop condition. Worst case power supply drain sets the 5 second hold specification.

4-89. Power Up/Down Timing.

4-90. The Power Up/Down Timing Circuit establishes the instrument turn-on, power-return, and power drop sequences. Power drops are defined as a line voltage condition sufficient to drop the +5 volt digital supply to ≤ 4.83 volts. Refer to Figure 4-16 throughout this description.

4-91. **Instrument Turn-On.** Turn-on removes the IRQ condition and provides the RES interrupt required to restart and initialize the Logging Multimeter. The low power memory supply, V_C, is discharged initially due to the shorting action of the "LINE" switch (A6S1) upon turn-off.

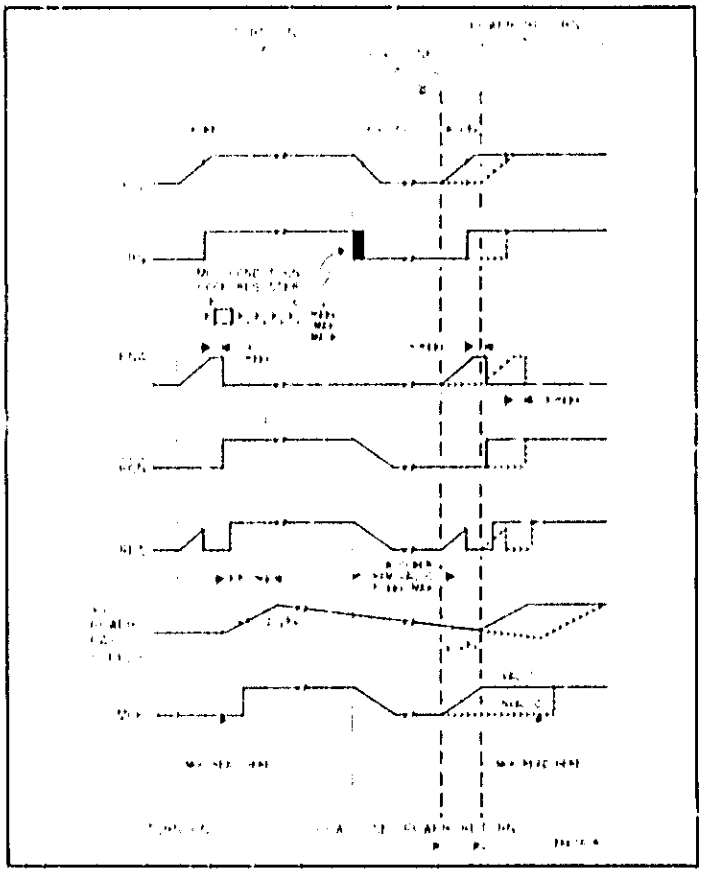


Figure 4-16. Power Up/Down Sequencing.

NOTE

This assumes the "LINE" switch was used to remove line voltage, not an external master switch.

"MOK" is therefore low when checked during turn-on and a full restart occurs rather than a re-load from low power RAM.

4-92. Low Power Retention Supply, V_C. The low power RAM retention supply is developed by a charge on A3C11 when $\overline{ENA}$ goes low (approximately 6 ms after V_{CC} reaches 4.83 volts). The charging circuit for the V_C storage capacitor is shown in Figure 4-17.

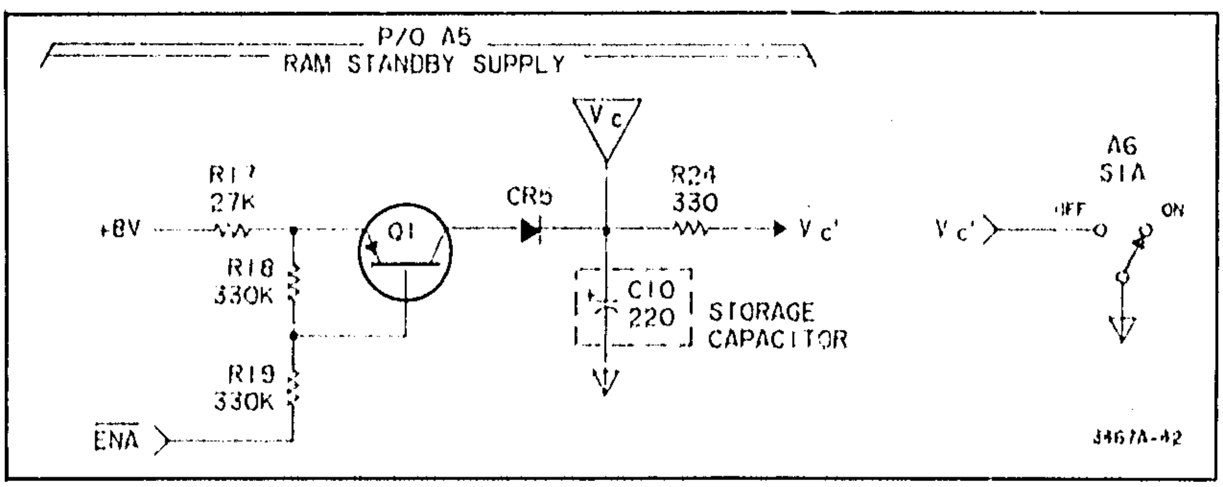


Figure 4-17. Power-Fail Standby Supply.

4-93. **Power-Drop.** Assuming the 4.83 V adjustment was properly made, a line glitch or drop-out below 4.83 V will cause $\overline{IRQ}$ to go low, thus requesting interrupt service from the MPU. This is done at 4.83 V because the MPU may be "Busy" for up to 2 ms before noticing the interrupt. Actually, the interrupt condition is *Masked* for up to 2 ms during some management routines. The MPU must notice the interrupt before V_C drops to 4.75 volts. The $\overline{IRQ}$ interrupt routine begins after RAM updating is complete. It's essentially a wait loop until V_C finds itself the only remaining instrument supply or if power returns ("Glitch").

4-94. **Power-Return.** A return from a power drop will act similarly to a turn-on if V_C fell below 2.25 V during the power-drop condition (V_C is not shorted since the "LINE" switch was not turned off). If V_C remained ≥ 2.25 V throughout the power-drop condition, "MOK" is high when power returns and the still valid low power memory is copied into 6802 memory. The Logging Multimeter performs a Manual Print as an indication of the interruption and loads elapsed time, alarm, offsets, last ranges, and Channel 4 constants from the low-power RAM.

4-95. 1 Hz Time Base.

4-96. The 1 Hz time base circuit is a 6250 Hz clocked MOD 6250 asynchronous counter with partial reset feedback. The output of U10A provides the 1 Hz time base. U10 B is used as a seconds *trap*, being reset upon turn-on ($\overline{PON}$) or after a successful elapsed time update.

The second successive 1 second interval without a timer reset ($\overline{TRE}$) produces a $\overline{RES}$ interrupt, meaning that one second was missed. The second successive timer reset ($\overline{TRE}$) without an elapsed second also produces a $\overline{RES}$ interrupt, meaning that the MPU is lost. the MPU $\overline{RES}$ line is level sensitive but the "INIT" routine begins after this line goes high.

4-97. VOLTMETER CONTROL LOGIC.

4-98. The Voltmeter Control Logic, A4, controls input and Integrator Amplifier switching, measurement cycle timing, Run-Down counters, and serial output transfer timing to the Microprocessor. The least significant digit is generated by a counter external to the voltmeter control chip. This counter operates at ten times the clocking rate to obtain the required resolution. Refer to Figure 4-18 to help clarify the following description.

4-99. Voltmeter Control Chip (A4U1).

4-100. The heart of this poriton of the instrument is the Voltmeter Control Chip, U1. This chip contains the 3½ digit MSD counter, polarity sensing logic, output buffers, and *Algorithmic State Machine* (ASM) logic which controls the autorange, measurement cycle, and serial output timing, a functional block diagram of this chip is shown in Figure 4-19. A state diagram for the Voltmeter Control Chip is also given in this figure.

4-101. Voltmeter - Microprocessor Interface.

4-102. The measurement cycle begins during the "READ" management routine when the Microprocessor writes to device VMC, resetting and enabling the counters and closing the Auto Zero loop. After approximately 100 counts, the MSD counter is reset again and Voltmeter Control Chip sets the Run-Up interval and switching. the Run-Up clock (RUC) is active during Run-Up.

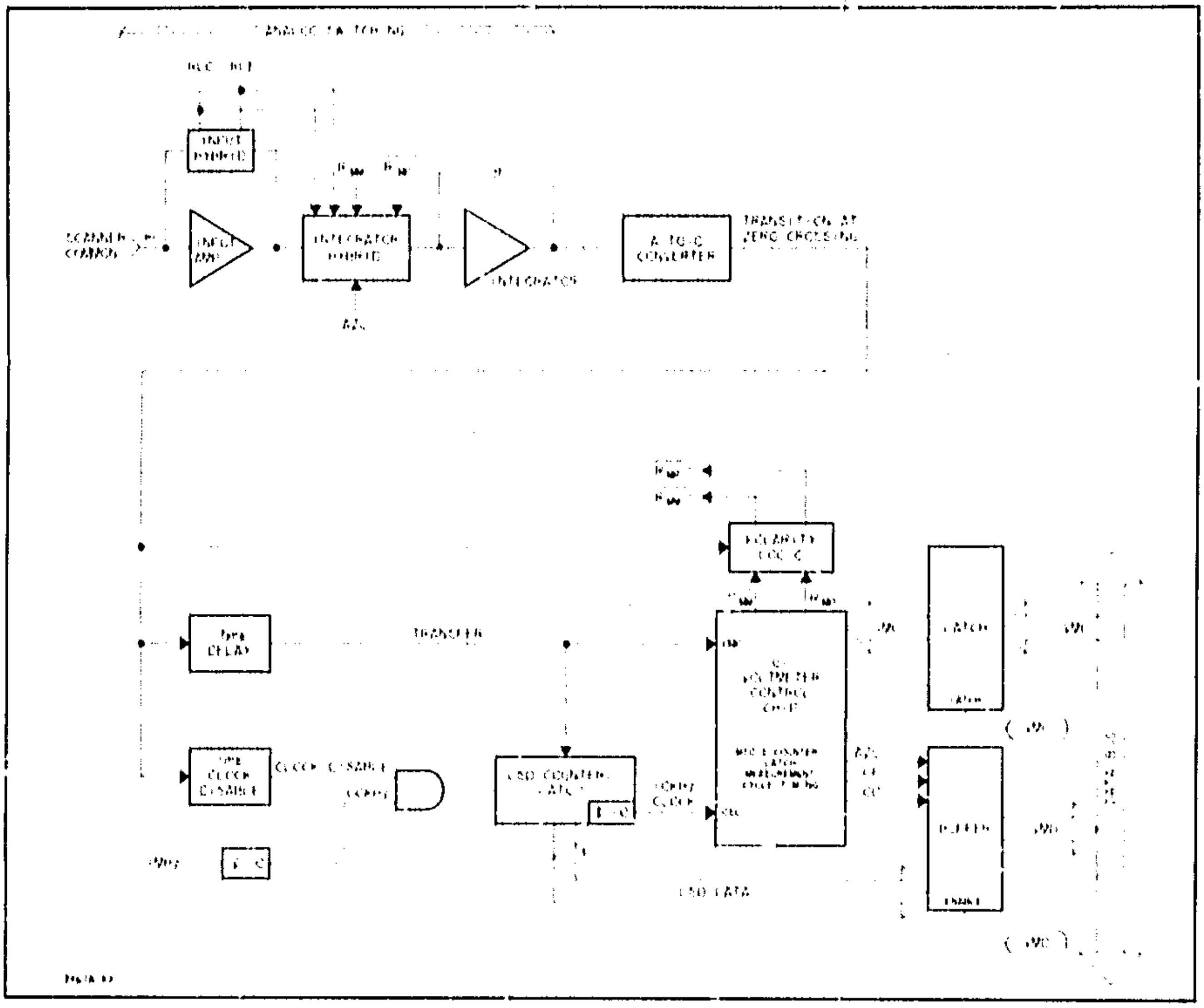


Figure 4-18. Voltmeter Control Logic Block Diagram.

4-103. During the Hold interval, the counters are reset and the polarity of the Run-Up is sensed. Run-Down is then configured, during which the MSD's and LSD counters run until a comparator transition or overload occur. The comparator transition at (T6) on Figure 4-2 stops the counters by disabling the clock source. The LSD transfer signal latches the LSD data into A4U11 and isolates the MSD counter in the Voltmeter Control Chip at (T7). The clock is re-enabled at (T8) and used to shift the MSD data to the output buffer of the Voltmeter Control Chip. The MSD and LSD counter data is finally transferred to the Microprocessor. The MSD data is transferred serially out of "IOD". A timing diagram for a sample measurement is shown in Figure 4-20. The LSD data is transferred as a parallel 4-Bit nybble to complete the data transfer at (T9).

4-104. Codes.

4-105. The function and range codes generated by the Voltmeter Control Chip control the Input and Integrator Hybrid switching throughout the measurement cycle and establish the Input and Post Amp gain configurations to provide an Integrator input within the ±1 V constraints.

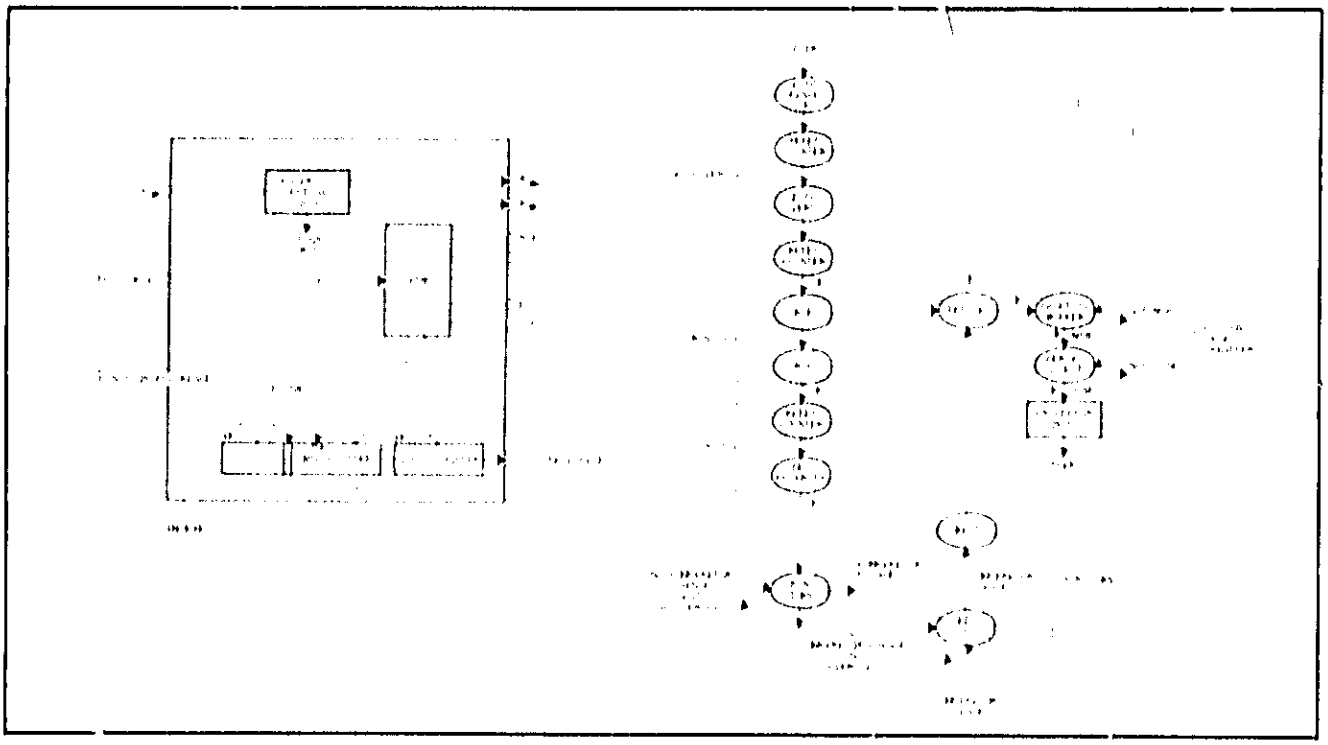
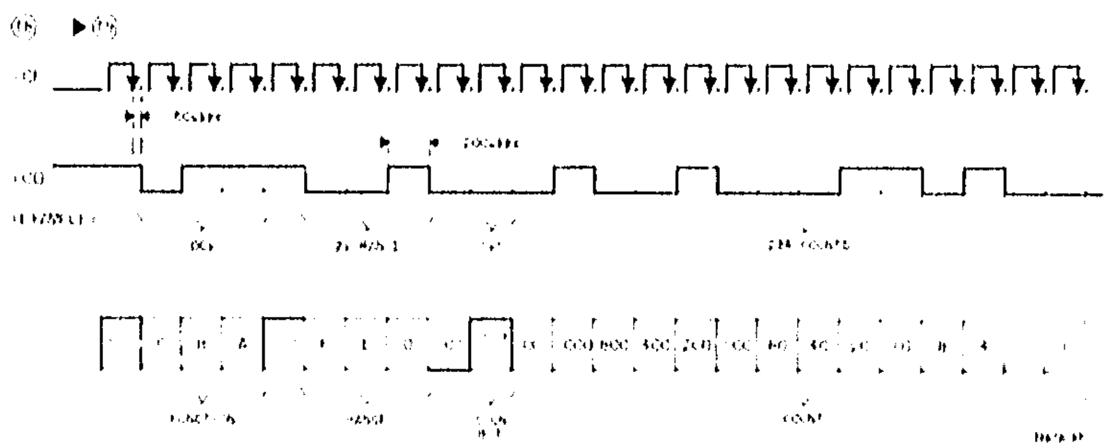


Figure 4-19. 3467A Voltmeter Control Chip.



Range (RG) FE0	Function (FN)**		
	=V C3	~V CB	kΩ* CB
	01	10	11
010	20 mV		
000	200 mV	200 mV	200 Ω
001	2 V	2 V	2 kΩ
01·	20 V	20 V	20 kΩ
111	200 V	200 V	200 kΩ
110	350 V	250 V	2000 kΩ
100	-OL-	-OL-	20 MΩ

*Same for temp.
**FNA is always "1".

Figure 4-20. Voltmeter Control Chip Serial Output Timing.

4-106. DISPLAY AND PRINTER CONTROL.

4-107. Display Control (P/O A5).

4-108. The Display Control circuitry contains 8 characters of display data storage arranged as 16 x 4, a data scanning arrangement, segment and constant current digit drivers, and the necessary clock circuitry.

4-109. **Display Data RAM Loading.** The display data RAM, U16, is loaded with the current 8 BYTES of reading and annunciator data during the "DISP" management routine. This is accomplished by clearing DATA BUS LINE D7 and writing the display data to device "DSP" in 16, 4-Bit nybbles. D7 is then set and written again to device "DSP". This resets the display clock and enables the segment scanner, U12. It also allows the display scanner, U18, to cycle through display data RAM addresses while data is latched out to the digit drivers (as two 4-Bit nybbles).

4-110. **Display Scanning.** Refer to Figure 4-21. The display clock establishes the 625 Hz display cycle and the two latching signals per display cycle. The last old nybble is latched and the display scanner is incremented, thus addressing the first new nybble of RAM through the quad 2-to-1 data selector, U17. This data is latched and the display scanner again incremented to provide the second new nybble (essentially step-latch-step for a new display byte).

4-111. Display data is arranged by segment in the display data RAM. This means that the address contains the segment information and the bit contains the digit information. The result is that segment "A" is lit on all appropriate digits, then segment "B", segment "C", and so forth.

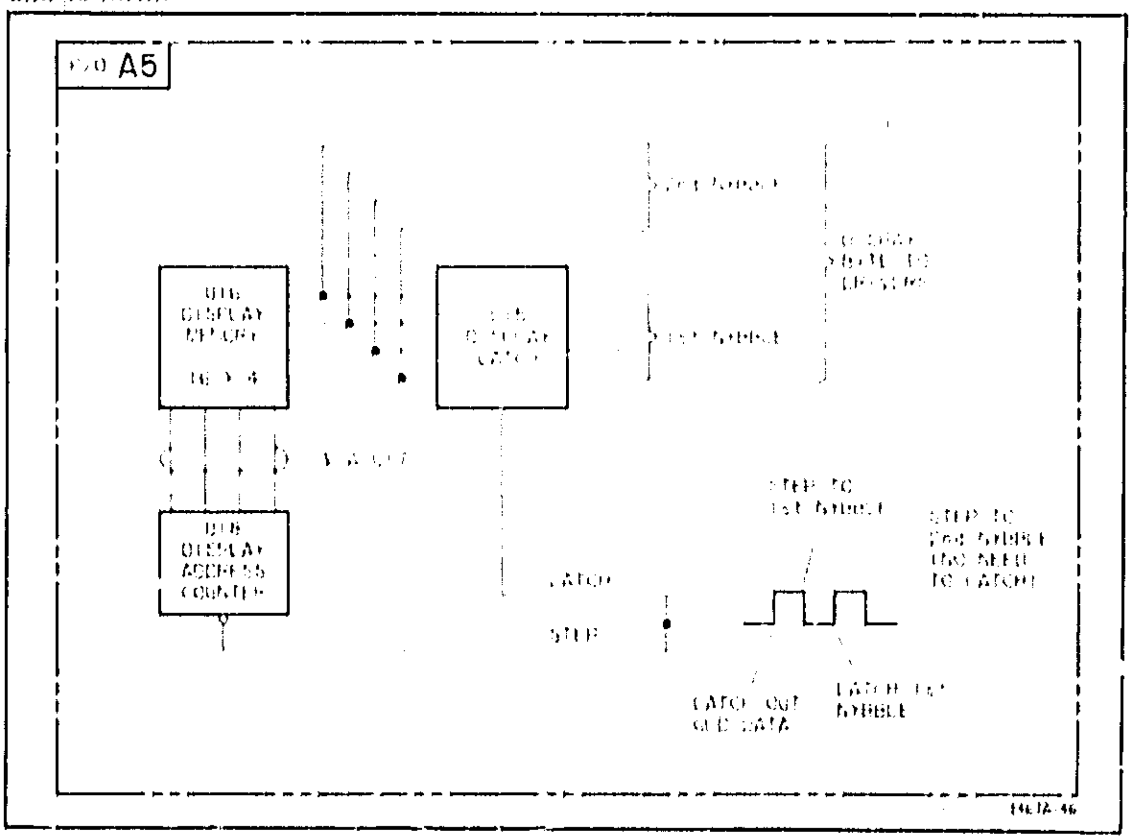


Figure 4-21. Latching Display Data.

4-112. Printer Control (P/O A5).

4-113. The printer control circuitry contains the printer data latch, motor direction decoding, timing counters, and a portion of the motor speed control loop.

4-114. Printer Data. The 7 bits of printer thermal head data and 1 bit of printer direction information is written to the printer control latches (U1, U3 & U8) during the "PRIN" subroutine. This is accomplished by clearing DATA BUS LINE D7 and writing the printer data to device "PRT." The low D7 line gates the sample clock (SCL) to the printer motor speed control circuit, thus establishing a forward motor direction. The printer motor speed control loop serves to regulate the printer's forward speed through a sampled EMF technique.

4-115. Motor Speed Control. During T1 (refer to schematic 6) of "SCL", the motor speed control loop is broken and forward motor drive removed to allow the back EMF transient from the motor to die out. During T2, the printer motor EMF is monitored and compared to a fixed reference to determine if the motor is too fast. If the motor is too fast, the V_m signal from the printer assembly is high, thus removing the FWD motor drive signal whenever the speed rises during T2. If the motor is too slow, the V_m signal from the printer assembly is low, thus applying FWD drive to the printer motor whenever motor speed drops during T2. The natural response of the motor to this intermittent drive/no drive action of the FWD line serves to create a constant motor speed.

4-116. Direction Decoding. There are two methods used to send the printer home and cause a line-feed. Setting the direction bit D7 and writing to device "PRT" establishes a reverse motor direction which sends the thermal print head home where the motor is braked by the "HOME" switch (low at home), setting the "BRK" line (high at home). If the thermal print head is not in the home position (say, after printing a line) and the reverse direction code is not received (perhaps a dropped bit), the U4B protection timer automatically sets a reverse direction code after waiting ≈1.3 ms for another "PRT". This sends the thermal head home, preventing printer damage against the far side of the printer wall upon a subsequent print operation.

4-117. Print Head Data Strobing. The "STB" signal generated by the printer assembly is used to modulate the thermal print head data at a 10 kHz rate. The duty cycle of this signal is varied by the printer assembly such that it is inversely proportional to the printer supply voltage. The result is a uniform print intensity, regardless of slight power supply variations.

4-118. The print intensity resistor, RP*, is factory selected to set the duty cycle (W) of the "STB" signal for the proper print intensity. Selecting a new RP* value is explained in Section VIII, "SERVICE", however, the factory selected value provides the optimum print head life. The "STB" signal duty cycle is approximately 70% for the 4.8 V printer supply.

4-119. DISPLAY BOARD.

4-120. The Display Board, A6, is arranged as an 8 digit, 8 segment array. Five digits are used for displaying measurement results leaving 3 digits for annunciating instrument status.

4-121. The "μV, Ω ZERO" and "LINE" switches are also on this board. The low-power memory supply, V_L, is brought to A6 by W3 and is shorted to ground by the "LINE" switch, S1A, when OFF. The Ohms zero switch line, "OZ", leaves A6 by W3 and is encoded on A8 along with the other instrument momentary contact switches.

4-122. TOP AND BOTTOM SWITCH BOARDS.

4-123. The Top and Bottom Switch Boards, A7 and A8 respectively, contain the front panel pushbuttons used to select the Logging Multimeter function, range, timer interval, math mode, entered reference value, and printer control information.

4-124. All momentary contact switches ("STEP" and "μV, Ω ZERO") are encoded on A8. A7 contains an isolation transformer used to isolate the out of paper switch (OOPS) on the Printer Assembly, AP, from the A7 board. A low-to-chassis spark gap is included on A7 to limit static build up.

4-125. PRINTER ASSEMBLY.

4-126. The Printer Assembly AP, is a proprietary Hewlett-Packard Assembly. Theory on this particular assembly is not presented here.

SECTION V
PERFORMANCE TESTS

5-1. INTRODUCTION.

5-2. This section of the manual contains recommended test procedures for verifying the Logging Multimeter specifications as listed in Section I. A performance test record is provided at the end of this section for your convenience in recording test results. The test record may be reproduced without permission from Hewlett-Packard. All tests can be performed without access to the interior of the instrument.

NOTE

There is sufficient space on the performance test record for taping printed test results. This reduces the amount of recording required throughout the testing process.

5-3. RECOMMENDED TEST EQUIPMENT.

5-4. The recommended equipment for these performance tests is listed in Table 5-1. Equipment that satisfies or exceeds the required characteristics given in the table may be substituted for the recommended models.

Table 5-1. Recommended Performance Test Equipment.

Instrument Type	Required Characteristics	Recommended Model
AC Calibrator/High Voltage Amplifier	Frequency: 20 Hz to 100 kHz. Output: 10mV to 1000V Accuracy (mid band): ± 0.1%	-hp- 745A/746A
DC Standard	Output: 1 mV to 1000 V Accuracy: ± 0.02%	-hp- 740B W/11055B
Electronic Counter	Frequency: 50 and 60 Hz Accuracy: ± 0.01%	-hp- 5300A/5302A
Resistor Decade Box	1Ω, 10Ω, 100Ω, 1kΩ, 100kΩ and 1 MΩ steps Accuracy: ± 0.005%	General Radio Mdl GR 1433-H
Resistors	100.6 ± .1% 600Ω ± 1% 1k ± 1% 10kΩ + 1% 10kΩ ± 0.01% 20 kΩ 10 Turn Potentiometer 10MΩ ± 0.1% 600Ω ± 1%	-hp- 0811-1647 -hp- 0757-1100 -hp- 0727-0761 -hp- 0811-3234 -hp- 0811-1186 -hp- 2100-3484 -hp- 0698-8194 -hp- 0757-1100

5-5. TESTING MULTI-CHANNEL INSTRUMENTS.

5-6. Testing all four channels for each specification is not necessary. After verifying continuity on the four input channels the remaining performance tests need be performed only on the channels indicated (generally channel 3 with 4 as the math reference). Worst-case channels are tested where applicable.

5-7. OPERATIONAL VERIFICATION.

5-8. The Operational Verification is a shortened version of the full performance test. This verification checks the most critical, changeable specifications and is useful for incoming inspections where full testing may not be desired. An operational verification record is provided at the end of this section for your convenience in recording test results. This record may be reproduced without permission from Hewlett-Packard.

5-9. PERFORMANCE TESTS.

5-10. Logging Multimeter performance tests are presented in the following order:

a. Continuity check
b. Temperature measurement accuracy test
c. DC voltmeter accuracy test
d. AC voltmeter accuracy test
e. Ohmmeter accuracy test
f. AC normal mode rejection test
g. AC common mode rejection test
h. Scanner isolation test

5-11. Continuity Check.

5-12. This check is required to verify continuity from the channel input terminals to the scanner common terminals. This allows the Logging Multimeter performance tests to be performed only on a selected channel to reduce testing time.

5-13. Procedure: (Perform also as part of Operational Verification).

a. Set the Logging Multimeter to the kΩ function, autoranging.

b. Select all four channels.

c. Verify that the Logging Multimeter overloads on all four channels. A manual print will obtain a record of this.

d. Short all four channel input HI and LO terminals together.

e. Verify that the magnitude of the readings on all four channels are ≤ ±1.5Ω. A manual print will obtain a record of this.

NOTE

This verifies a channel resistance within 1.5Ω of the turn-on offset of 4Ω. Negative turn-on values are possible.

5-14. Temperature Measurement Accuracy Test.

5-15. The procedure in this test can be used to verify the temperature measurement accuracy as listed below:

5-16. Specification.

	Accuracy
− 80°C to + 80°C (− 112°F to + 176°F)	± .3°C (± .54°F) of theoretical curve
+ 80°C to + 110°C (+ 76°F to + 230°F)	± .5°C (± .9°F) of theoretical curve
+ 110°C to + 150°C (+ 230°F to + 302°F)	± 1.3°C (± 2.34°F) of theoretical curve

5-17. Description. This test consists of simulating the ideal thermistor resistance at specified temperatures with a precision resistor decade box. The temperature reading should correspond to the theoretical curve within specified accuracy.

5-18. Procedure.

Equipment Required:

Resistor Decade Box
(General Radio Model GR 1433-H)

a. Set the Logging Multimeter to the TEMP function.

b. Connect the precision resistor decade box to Channel 3 as shown in Figure 5-1 and adjust the decade box to the test load value, R_L, listed in Table 5-2.

c. Select Channel 3.

d. Verify that the resulting temperature reading is within the test limits for the test load used. The limits are listed in Table 5-2 and on the performance test record.

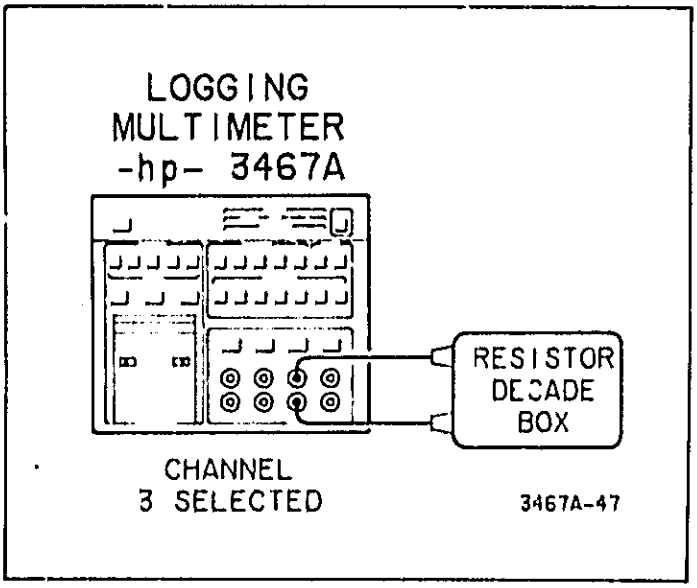


Figure 5-1. Temperature Measurement Accuracy Test.

Table 5.2 Temperature Measurement Accuracy Test Limit.

Test Load, R_T(ohms)	°C Test Limits Low	°C Test Limits High	°F Test Limits Low	°F Test Limits High
97	144.7	147.3	292.6	297.1
255	109.5	110.5	229.1	230.9
628	79.7	80.3	175.5	176.5
16.330k	-00.3	+00.3	31.5	32.5
3371k	−78.7	−79.3	−109.66	−110.74

e. Press the MAN PRINT pushbutton to obtain a printed record of the test results.

f. Repeat Step D for each test load listed in Table 5-2.

g. If a printed record of readings was made, the record can be taped onto the performance test record.

5-19. DC Voltmeter Accuracy Test.

5-20. The procedure in this test can be used to verify the DC voltmeter accuracy as listed below:

CAUTION

To avoid possible damage to the Logging Multimeter circuitry, the voltage between any two terminals and any terminal and ground must not exceed ± 350 volts (DC + peak AC).

5-21. Specification.

Accuracy: (Assuming lead zero adjusted, 23°C ± 5°C, 6 months, 30 min. warm up)

Range	Accuracy
20 mV	.05% reading + 10 counts
200 mV	.04% reading + 2 counts
2 V	.03% reading + 1 count
20 V	.03% reading + 1 count
200 V	.03% reading + 1 count
250 V	.035% reading + 1 count

5-22. Description. This test consists of applying a highly accurate DC source to the Logging Multimeter and verifying that the DC voltage reading is within the specified limits.

NOTE

A 30 minute warm-up time is required prior to beginning this test.

5-23. Procedure.

Equipment Required:

DC Standard (-hp- 740B)
Output Cable (-hp- 11055B)

Divider Resistors:	9.861k ± .01%	(-hp- 0811-9008)
	100.6 ± .1%	(-hp- 0811-1647)
	10k ± 1%	(-hp- 0811-3234)
	20k, 10 turn pot	(-hp- 2100-3484)

a. Set the Logging Multimeter to DC volts and 20 mV range.

b. Allow the Logging Multimeter to warm up for 30 minutes.

c. Connect the measurement leads to Channel 3 and short the ends together.

d. Select Channel 3.

e. Zero the measurement leads with the μV, Ω zero pushbutton.

f. Connect the DC standard to the measurement leads as shown in Figure 5-2. The 20 mV and 200 mV ranges require a precision voltage-divider set-up.

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

h. A printed record of test readings can be made and taped onto the performance test record.

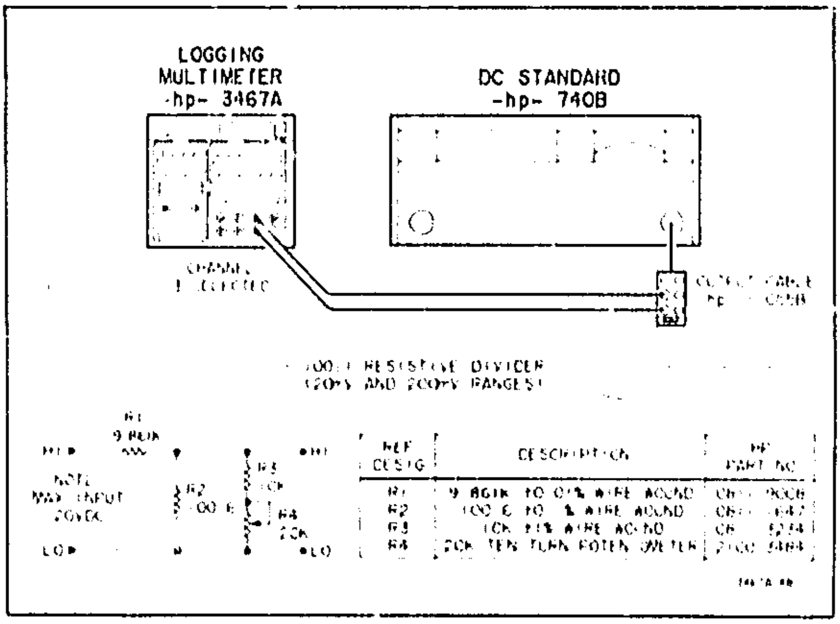


Figure 5-2. DC Voltmeter Accuracy Test.

Table 5-3. DC Voltmeter Accuracy Test Limits.

Range	DC Standard Output	Logging Multimeter Test Limits	
*20 mV	**-1.800 mV** + 10.000 mV **+10.000 mV**	**-1.089 mV** + 9.985 mV **+10.980 mV**	**-1.911 mV** + 10.015 mV **+10.020 mV**
*200 mV	+ 19.00 mV + 100.00 mV **-100.00 mV**	+ 18.97 mV + 99.94 mV **-109.90 mV**	+ 19.03 mV + 100.06 mV **-190.10 mV**
2 V	-.1900 V + 1.0000 V **+1.8000 V**	-.1898 V + .9996 V **+1.0893 V**	+ 1.902 V -10.004 V **-19.007 V**
20 V	+ 1.900 V -10.000 V **-10.000 V**	+ 1.898 V -9.996 V **-18.893 V**	+ 1.902 V -10.005 V **-19.007 V**
200 V	-19.00 V + 100.00 V **+190.00 V**	-18.98 V + 99.06 V **+189.93 V**	-19.02 V + 100.04 V **+190.07 V**
350V	-100.0 V **+300.0 V	-99.9 V **+299.8 V**	-100.1 V **+300.2 V**

NOTE

Operational verification tests are in **BOLD** *type.*

**A 100:1 resistive divider is required to obtain the necessary accuracy on 20 mV and 200 mV ranges.*

***Step the 740B output to this value in 100 V increments.*

5-24. AC Voltmeter Accuracy Test.

5-25. The procedure in this test can be used to verify the AC voltmeter accuracy as listed below:

CAUTION

To avoid possible damage to the Logging Multimeter circuitry, the voltage between any two terminals or any terminal and ground must not exceed ± 350 volts (DC + peak AC).

5-26. Specification.

Sinewave Accuracy: (25°C ± 5°C, 6 months, minimum 1800 count reading).

Frequency	Accuracy
45 Hz - 100 Hz	1% of reading + 40 counts
100 Hz - 10 kHz	0.2% of reading + 40 counts
10 kHz - 20 kHz	1% of reading + 40 counts
20 kHz - 100 kHz	2% of reading + 200 counts

5-27. Description. This test consists of applying a highly accurate AC source (AC calibrator with high voltage amplifier) to the Logging Multimeter and verifying that the AC voltage reading is within the specified limits.

5-28. Procedure.

Equipment Required:

AC Calibrator (-hp- 745A)
High Voltage Amplifier (-hp- 746A)

a. Set the Logging Multimeter function to ACV, 200 mV range. Connect the AC calibrator to Channel 3 as shown in Figure 5-3 and select Channel 3.
b. Verify each range (through the 200 V range) for the test limits listed in Table 5-4 at the given frequencies.

NOTE

You may notice that several samples are required for the AC calibrator output to stabilize. This effect diminishes as you approach full-scale. Allow extra time before initializing a print since more than three samples may be required.

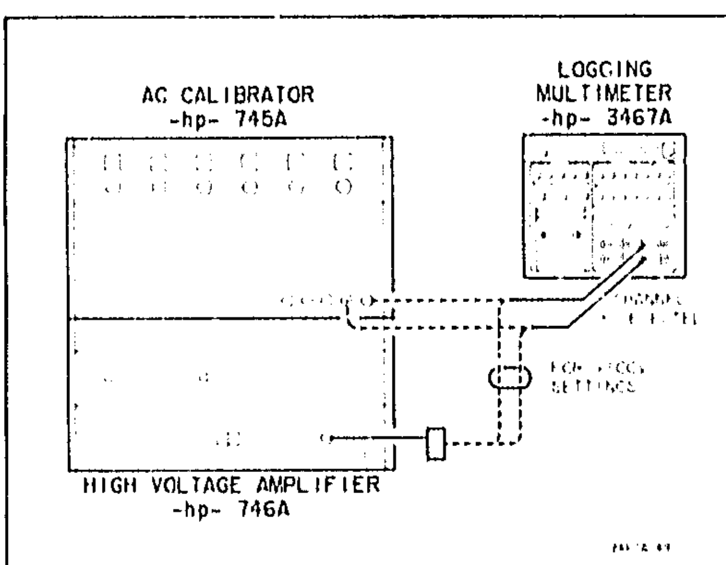


Figure 5-3. AC Voltmeter Accuracy Test.

WARNING

Use extreme care when verifying these last four readings. Make all connections BEFORE turning on the high voltage source. When the test is complete, turn off the high voltage BEFORE disconnecting any cables or test leads.

c. To check the 190 V reading on the 200 V range, and the 250 V range readings, connect the high voltage amplifier to the channel to be tested as shown by the dotted line in Figure 5-3.

d. Verify the last four output/frequency combinations.

e. If a printed record of readings was made, the record can be taped onto the performance test record.

Table 5-4. AC Voltmeter Test Limits.

Range	AC Calibrator Output	Test Frequency	Test Limits	
200 mV	19 mV	100 Hz	18.56 mV	19.44 mV
	19 mV	10 kHz	18.56 mV	19.44 mV
	19 mV	**20 kHz**	**18.41 mV**	**19.59 mV**
	19 mV	**100 kHz**	**16.62 mV**	**21.38 mV**
	190 mV	100 kHz	184.20 mV	195.80 mV
	190 mV	20 kHz	187.70 mV	192.30 mV
	190 mV	**10 kHz**	**189.22 mV**	**190.78 mV**
	190 mV	**100 Hz**	**189.22 mV**	**190.78 mV**
2V	.19V	100 Hz	.1856 V	.1944 V
	.19 V	20 kHz	.1841 V	.1959 V
	1.9 V	100 kHz	1.8420 V	1.9580 V
	1.9 V	**10 kHz**	**1.8922 V**	**1.9078V**
20 V	1.9 V	10 kHz	1.856 V	1.944 V
	1.9 V	100 Hz	1.856 V	1.944 V
	1.9 V	20 kHz	1.841 V	1.959 V
	1.9 V	100 kHz	1.662 V	2.136 V
	19 V	100 kHz	18.420 V	19.580 V
	19 V	20 kHz	18.770 V	19.230 V
	19 V	**10 kHz**	**18.922 V**	**19.078 V**
	19 V	100 Hz	18.922 V	19.078 V
200 V	19 V	100 Hz	18.56 V	19.44 V
	19 V	100 kHz	16.62 V	21.38 V
	190 V	20 kHz	187.70 V	192.30 V
	190 V	**10 kHz**	**189.22 V**	**190.78 V**
250 V	200 V	10 kHz	195.6 V	204.4 V
	***200 V**	**50 kHz**	**176.0 V**	**224.0 V**

NOTE

Operational Verification Tests are in **BOLD** *type.*
**This combination checks AC accuracy at the maximum 10^7 volt-hertz product.*

5-29. Ohmmeter Accuracy Test.

5-30. The procedure in this test can be used to verify the ohmmeter accuracy as listed below:

5-31. Specification.

Range	Accuracy
200Ω	.08% reading + 10 counts
2kΩ	.03% reading + 3 counts
20kΩ	.03% reading + 1 count
200kΩ	.03% reading + 1 count
2000kΩ	.04% reading + 1 count
20 MΩ	.15% reading + 1 count

5-32. Description. This test consists of connecting a precision resistance decade box to the Logging Multimeter and verifying that the ohms reading is within the specified limits.

5-33. Procedure.

Equipment Required:

Resistance Decade Box (General Radio - Model GR 1433-H).

a. Set the Logging Multimeter function to kΩ in the 200Ω range. Connect the resistance decade box to Channel 3 as shown in Figure 5-4.

b. Set the resistance decade box to zero ohms.

c. Zero the Logging Multimeter with the μV, Ω zero pushbutton.

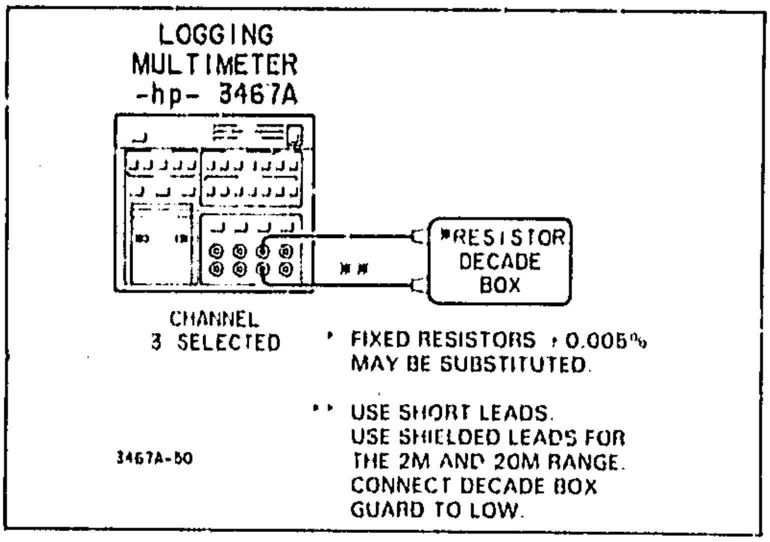


Figure 5-4. Ohmmeter Accuracy Test.

d. Check the ranges listed in Table 5-5 for the indicated tolerances.

e. If a printed record of test readings was made, the record can be taped onto the performance test record.

Table 5-5. Ohmmeter Accuracy Test.

Range	Resistance	Test Limits	
200 Ω	19.0 Ω	18.88 Ω	19.12 Ω
	100.00 Ω	99.82 Ω	100.18 Ω
	190.00 Ω	**189.75 Ω**	**190.25 Ω**
2 kΩ	.1900 kΩ	.1896 kΩ	.1904 kΩ
	1.0000 kΩ	.9994 kΩ	1.0006 kΩ
	1.9000 kΩ	**1.8991 kΩ**	**1.9009 kΩ**
20 kΩ	**1.900 kΩ**	1.898 kΩ	1.902 kΩ
	10.000 kΩ	9.996 kΩ	10.004 kΩ
	19.000 kΩ	**18.993 kΩ**	**19.007 kΩ**
200 kΩ	19.00 kΩ	18.98 kΩ	19.02 kΩ
	100.00 kΩ	99.96 kΩ	100.04 kΩ
	190.00 kΩ	**189.93 kΩ**	**190.07 kΩ**
2000 kΩ	190.0 kΩ	189.8 kΩ	190.2 kΩ
	1000.0 kΩ	999.5 kΩ	1000.5 kΩ
	1900.0 kΩ	**1899.1 kΩ**	**1900.9 kΩ**
20 MΩ	1.900 MΩ	1.896 MΩ	1.904 MΩ
	10.00 MΩ	**9.984 MΩ**	**10.016 MΩ**

NOTE

Operational verification tests are in **BOLD** *type.*

5-34. AC Normal-Mode Rejection Test.

5-35. The procedure in this test can be used to verify the ability of the Logging Multimeter to make accurate DC voltage measurement in the presense of AC normal-mode voltages at power line frequencies. This ability is called *AC Normal Mode Rejection* and is described as the dB ratio of the peak normal-mode voltage to the resultant DC measurement error.

$$NMRR\ (dB) = 20\ LOG_{10} \frac{\text{Peak AC Interfering Voltage}}{\text{Change In DCV Reading}} \qquad \text{Equation 5-1.}$$

5-36. Specification.

Normal Mode Rejection: > 60 dB @ 50/60 Hz ± .1%.

5-37. Description. This test consists of applying a highly accurate normal-mode AC signal to the Logging Multimeter Channel 4 in the DCV function, and verifying that the change in the DC reading on this channel is correct for the specified NMRR.

5-38. Procedure.

Equipment Required:

AC Calibrator (-hp- 745A)
Electronic Counter (-hp- 5300A)

a. Connect the AC calibrator to the electronic counter as shown in Figure 5-5. Do not connect the Logging Multimeter at this time.

b. Adjust the AC calibrator output to 10.0000 V (14 V peak).

c. Using the electronic counter as a monitor, adjust the AC calibrator to the line frequency at your location.

Line Frequency	Period
50 Hz ± .1%	20000 μs ± 20 μsec
60 Hz ± .1%	16667 μs ± 17 μsec

d. Set the Logging Multimeter function to DCV, 20 V range. Short the input terminals of Channel 3 and select Channel 3.

e. Zero Channel 3 using the μV, Ω zero pushbutton.

f. Remove the short and connect the AC Calibrator normal mode to Channel 3. the test set-up is shown in Figure 5-5.

g. The Logging Multimeter reading should not vary more than 0.028V or 28 counts peak-to-peak. This verifies an AC normal mode rejection of ≥ 60 dB.

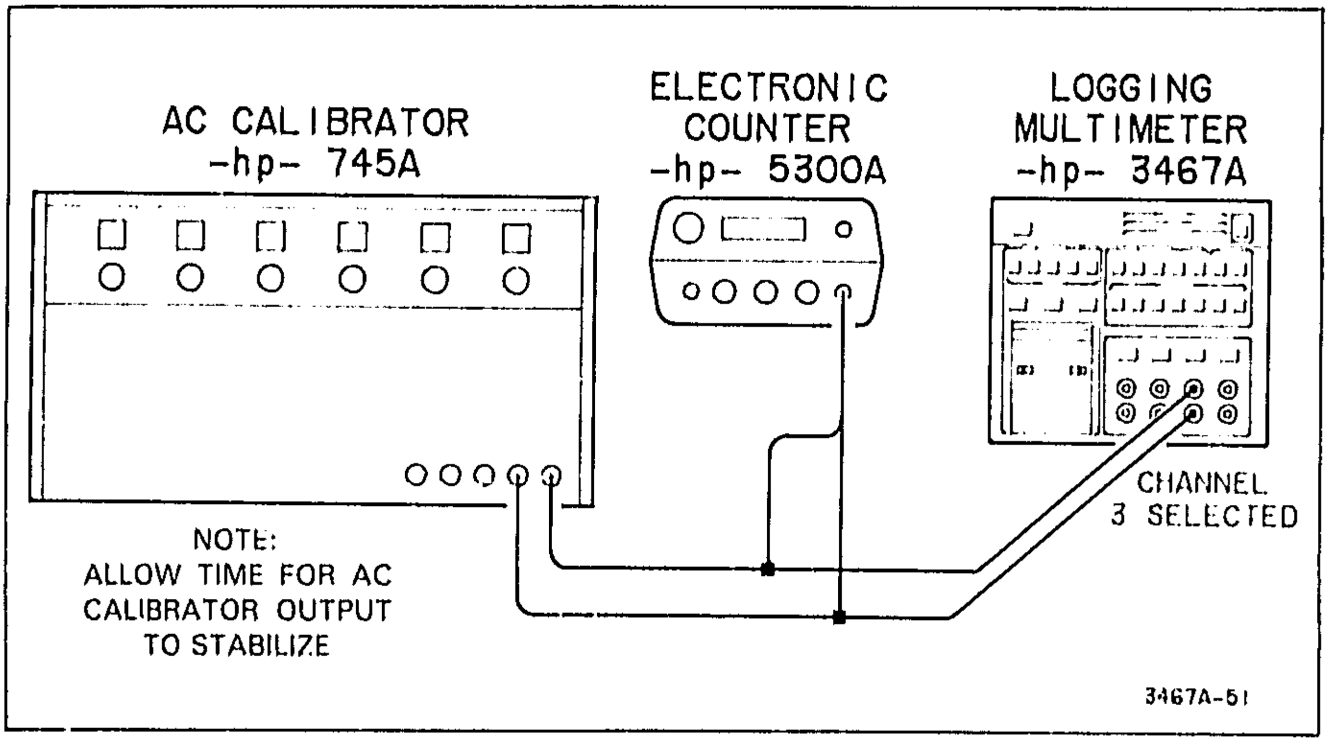


Figure 5-5. AC Normal-Mode Rejection Test.

5-39. AC Common-Mode Rejection Test.

5-40. The procedure in this test can be used to verify the ability of the Logging Multimeter to make accurate AC voltage measurements in the presence of AC common-mode voltages at power line frequencies. This ability is called *AC Common-Mode Rejection* and is described as the dB ratio of the RMS value of the common-mode voltage to the resultant DC measurement error.

$$\text{AC CMRR (dB)} = 20\ \text{LOG}_{10}\ \frac{\text{RMS AC Interfering Voltage}}{\text{Change In DCV Reading}} \qquad \text{Equation 5-2.}$$

NOTE

This specification is derived from the AC effective common-mode rejection specification by:

$$(AC)\ CMRR = (AC)\ ECMRR - NMRR$$

5-41. Specification.

AC Common Mode Rejection: > 60 dB @ 50/60 Hz ± .1%.

5-42. Description. This test consists of applying a highly accurate common-mode AC signal to the Logging Multimeter Channel 3 input terminals in the DCV function.

5-43. Procedure.

Equipment Required:

AC Calibrator (-hp- 745A)
Electronic Counter (-hp- 5300A)
Resistor: 1 kΩ ± 1% (-hp- 0727-0751)
or Resistor Decade Box (General Radio Model GR 1433-H)

a. Connect the AC calibrator to the electronic counter as shown in Figure 5-6. Do not connect the Logging Multimeter at this time.

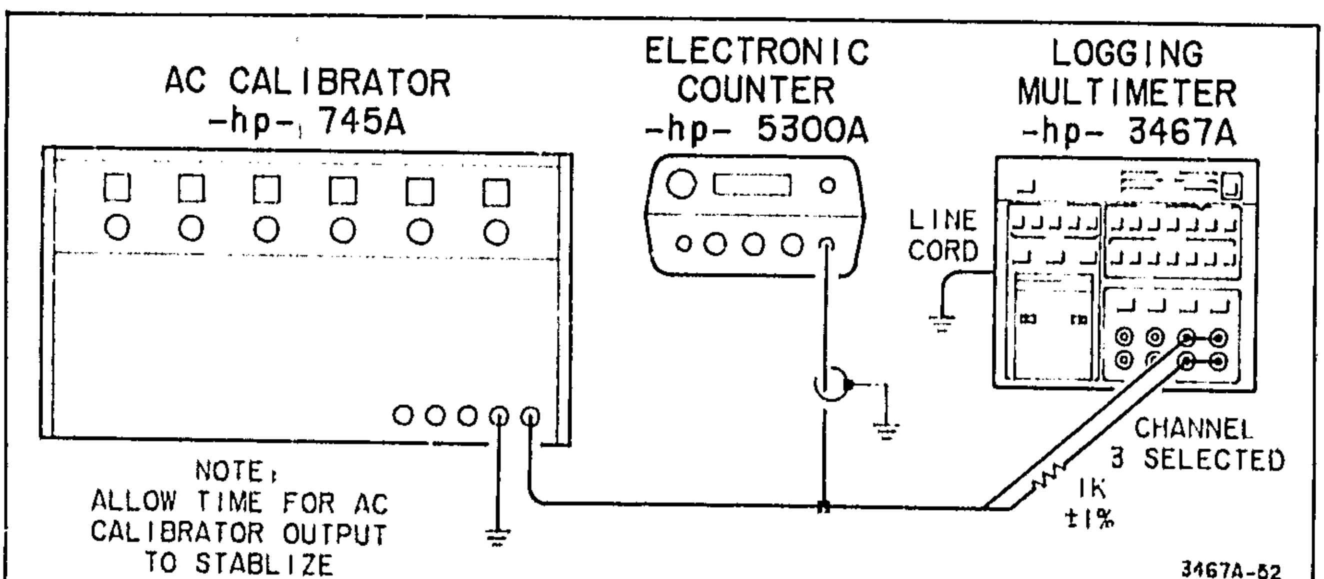


Figure 5-6. AC Common-Mode Rejection Test.

b. Using the electronic counter as a monitor, adjust the AC calibrator to the line frequency at your location.

Line Frequency	Period
50 Hz ± .1%	20000 μs ± μs
60 Hz ± .1%	16667 μs ± μs

c. Set the Logging Multimeter function to DCV, 20 V range. Connect a 1 kΩ ± 1% resistor between the LO and HI input terminals of Channel 3 and select Channel 3. Record the Channel 3 reading or print it _____.

d. Connect the AC calibrator between the HI terminal of Channel 3 (resistor still in place) and power line ground. This is shown in Figure 5-6.

e. Adjust the AC calibrator for an output of 10.00000 Vrms.

f. The Logging Multimeter reading should not vary more than ±0.014V or 14 counts from the reading noted in Step C. This verifies an AC common-mode rejection ratio of ≥ 60 dB.

5-44. Scanner Isolation Test.

5-45. The procedure in this test can be used to verify the isolation between scanner channels in the ACV function.

5-46. Specification.

Source Impedance	Up To 10 kHz	Up To 100 kHz
600 Ω	> 80 dB	> 60 dB
10 kΩ	> 60 dB	> 40 dB

5-47. Description. This test consists of applying an AC signal to Channel 3 and connecting a load across Channel 4 to represent a source impedance. A dB math operation on Channel 3 produces a measurement result equal to the isolation. 10 kHz is used instead of 1 kHz to keep the test readings within the dynamic range of the Logging Multimeter.

5-48. Procedure.

Equipment Required:

AC Calibrator (-hp- 745A)
600 Ω ± 1% (-hp- 0757-1100)
10 kΩ ± .01% (0811-1185)
Resistors above may be substituted by:
Resistor Decade Box (General Radio Model 1433-H)

a. Set the Logging Multimeter to the ACV function, autorange. Connect the AC Calibrator to Channel 3 and the 600 Ω load to Channel 4 as shown in Figure 5-7 and select Channels 3 and 4.

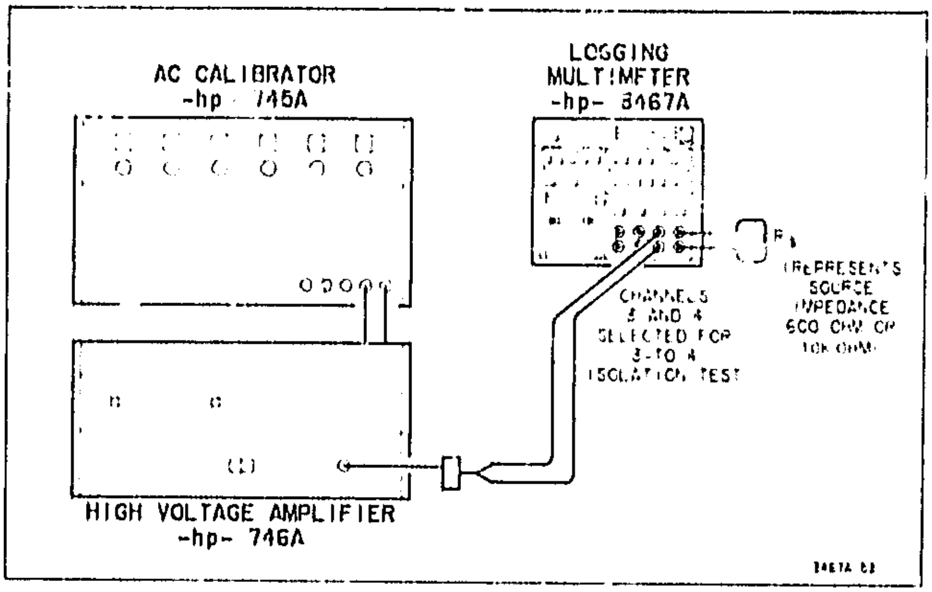


Figure 5-7. Scanner Isolation Test.

b. Set the AC calibrator output to 100.0000 V_{RMS} at 10 kHz.

c. Select the dB math operation. The measurement result should be greater than 80 dB.

d. Verify the scanner isolation at 100 kHz for the same load (60 dB).

e. Repeat the procedure at 10 kHz and 100 kHz with a 10 kΩ load across Channel 4. Verify 60 dB at 10 kHz and 40 dB at 100 kHz.

HEWLETT-PACKARD MODEL 3467A LOGGING MULTIMETER

OPERATIONAL VERIFICATION RECORD

Logging Multimeter

Serial No. ____________

Test Performed By ____________

Date ____________

Test	Test Limit		Test Result
Continuity	Open Circuit "OL" all channels		Open Circuit 1: ______ 2: ______ 3: ______ 4: ______
	Short Circuit ≤ 1.5 Ω all channels		Short Circuit 1: ______ 2: ______ 3: ______ 4: ______
DC Voltmeter Accuracy			
20 mV Range - 1.900 mV + 19.000 mV	- 1.889 mV + 18.980 mV	- 1.911 mV + 190.10 mV	______ ______
200 mV Range - 190.00 mV	- 189.90 mV	+ 190.10 mV	______
2V Range + 1.9000 V	+ 1.8993V	+ 1.9007 V	______
20 V Range - 19.000 V	- 18.993 V	- 19.007 V	______
200V Range + 190.00 V	+ 189.93 V	+ 190.07 V	______
350 V Range + 300.0 V	+ 299.8 V	+ 300.2 V	______

5-14-82

Test	Test Limit		Test Result
AC Voltmeter Accuracy			
200 mV Range			
19 mV 20 kHz	18.41 mV	19.59 mV	
19 mV 100 kHz	16.62 mV	21.38 mV	
190 mV 10 kHz	189.22 mV	190.78 mV	
190 mV 100 Hz	189.22 mV	190.78 mV	
2 V Range			
1.9V 10 kHz	1.8922 V	1.9078 V	
20 V Range			
19 V 10 kHz	18.922 V	19.078 V	
200 V Range			
190 V 10 kHz	189.22 V	190.78 V	
250 V Range			
200 V 50 kHz	176.0 V	224.0 V	
Ohmmeter Accuracy			
200 Ω Range			
19.00 Ω	18.88 Ω	19.12 Ω	
190.00 Ω	189.75 Ω	190.25 Ω	
2 kΩ Range			
1.900 kΩ	1.8991 kΩ	1.9009 kΩ	
20 kΩ Range			
19.000 kΩ	18.993 kΩ	19.007 kΩ	
200 kΩ Range			
190.00 kΩ	189.93 kΩ	190.07 kΩ	
2000 kΩ Range			
1900.0 kΩ	1899.1 kΩ	1900.9 kΩ	
20 MΩ Range			
10.000 MΩ	9.084 MΩ	10.016 MΩ	

Test	Test Limit	Test Result
AC Common Mode Rejection	≤ ± 14 counts difference between readings (peak)	______ ______
Scanner Isolation 600 Ω 10 kHz 600 Ω 100 kHz 10 kΩ 100 kHz 10 kΩ 10 kHz	 > 80 dB > 60 dB > 40 dB > 60 dB	 ______ ______ ______ ______

HEWLETT-PACKARD MODEL 3467A LOGGING MULTIMETER

PERFORMANCE TEST RECORD

Logging Multimeter

Serial No. ____________________

Test Performed By ____________________

Date ____________________

Test	Test Limit	Test Result
Continuity	Open Circuit "OL" all channels Short Circuit ≤ 1.5 Ω all channels	Open Circuit 1: ________ 2: ________ 3: ________ 4: ________ Short Circuit 1: ________ 2: ________ 3: ________ 4: ________
Temperature Measurement Accuracy Test Load, R_T (Ω)	°C °F	
97	144.7 147.3 292.6 297.1	________
255	109.5 110.5 229.1 230.9	________
628	79.7 80.3 175.5 176.5	________
16.330 k	00.3 +00.3 31.5 32.5	________
3371 k	78.7 79.3 109.66 110.74	________

Test		Test Limit		Test Result
AC Voltmeter Accuracy				
200 mV Range				
19 mV	100 Hz	18.56 mV	19.44 mV	
19 mV	10 kHz	18.56 mV	19.44 mV	
19 mV	20 kHz	13.41 mV	19.59 mV	
19 mV	100 kHz	16.62 mV	21.38 mV	
190 mV	100 kHz	184.20 mV	195.80 mV	
190 mV	20 kHz	187.70 mV	192.30 mV	
190 mV	10 kHz	189.22 mV	190.78 mV	
190 mV	100 Hz	189.22 mV	190.78 mV	
2 V Range				
.19 V	100 Hz	.1856 V	.1944 V	
.19 V	20 kHz	.1841 V	.1959 V	
1.9 V	100 kHz	1.8420 V	1.9580 V	
1.9 V	10 kHz	1.8922 V	1.9078 V	
20 V Range				
1.9 V	10 kHz	1.856 V	1.944 V	
1.9 V	100 Hz	1.856 V	1.944 V	
1.9 V	20 kHz	1.841 V	1.959 V	
1.9 V	100 kHz	1.662 V	1.138 V	
19 V	100 kHz	18.370 V	19.630 V	
19 V	20 kHz	18.770 V	19.230 V	
19 V	10 kHz	18.922	19.078 V	
19 V	100 Hz	18.922 V	19.078 V	
200 V Range				
19 V	100 Hz	18.56 V	19.44 V	
19 V	100 kHz	16.62 V	21.38 V	
190 V	20 kHz	187.70 V	192.30 V	
190 V	10 kHz	189.22 V	190.78 V	
250 V Range				
200 V	10 kHz	195.6 V	204.4 V	
*200 V	50 kHz	176.0 V	224.0 V	

*The maximum 10^7 Volt-Hertz Product

Test	Test Limit		Test Result
Ohmmeter Accuracy			
200 Ω Range			
19.00 Ω	18.88 Ω	19.12 Ω	
100.00 Ω	99.82 Ω	100.18 Ω	
190.00 Ω	189.75 Ω	190.25 Ω	
2 kΩ Range			
.1900 kΩ	.1896 kΩ	.1904 kΩ	
1.0000 kΩ	.9994 kΩ	1.0006 kΩ	
1.9000 kΩ	1.8991 kΩ	1.9009 kΩ	
20 kΩ Range			
1.900 kΩ	1.898 kΩ	1.902 kΩ	
10.000 kΩ	9.996 kΩ	10.004 kΩ	
19.000 kΩ	18.993 kΩ	19.007 kΩ	
200 kΩ Range			
19.00 kΩ	18.98 kΩ	19.02 kΩ	
100.00 kΩ	99.96 kΩ	100.04 kΩ	
190.00 kΩ	189.93 kΩ	190.07 kΩ	
2000 kΩ Range			
190.0 kΩ	189.8 kΩ	190.2 kΩ	
1000.0 kΩ	999.5 kΩ	1000.5 kΩ	
1900.0 kΩ	1899.1 kΩ	1900.9 kΩ	
20 MΩ Range			
1.900 MΩ	1.904 MΩ	1.896 MΩ	
10.000 MΩ	9.084 MΩ	10.016 MΩ	
AC Normal Mode Rejection	≤ 28 count peak-to-peak display variance		

Test	Test Limit		Test Result
DC Voltmeter Accuracy			
20 mV Range			
11.900 mV	− 1.889 mV	− 1.911 mV	
+ 10.000 mV	+ 9.985 mV	+ 10.015 mV	
+ 19.000 mV	+ 18.980 mV	+ 19.020 mV	
200 mV Range			
+ 19.00 mV	+ 18.97 mV	+ 19.03 mV	
− 100.00 mV	− 99.94 mV	− 100.06 mV	
− 190.00 mV	− 189.90 mV	− 190.10 mV	
2 V Range			
− .1900 V	− .1898 V	− .1902 V	
+ 1.0000 V	+ .9996 V	+ 1.0004 V	
+ 1.9000 V	+ 1.8993 V	+ 1.9007 V	
20 V Range			
+ 1.900 V	+ 1.898 V	+ 1.902 V	
− 10.000 V	− 9.996 V	− 10.004 V	
− 19.000 V	− 18.993 V	− 19.007 V	
200 V Range			
− 19.00 V	− 18.98 V	− 19.02 V	
+ 100.00 V	+ 99.96 v	+ 100 04 V	
+ 190.00 V	+ 189.93 V	+ 190.07 V	
350 V Range			
− 100.0 V	− 99.9 V	− 100.1 V	
+ 300.0 V	+ 299.8 V	+ 300.2 V	

WARNING

These servicing instructions are for use by trained service personnel only. To avoid electrical shock, do not perform any servicing unless you are trained to do so.

SECTION VI
ADJUSTMENTS

6-1. INTRODUCTION.

6-2. This section presents the adjustment procedures required to bring the Logging Multimeter to peak performance when repairs have been made. These adjustments may be required if performance testing or a service process indicates so. If any difficulties occur, refer to the troubleshooting information in Section VIII. Replacement of factory selected ("padded") components is discussed in Section VIII also.

NOTE

Allow 10 to 15 minutes for the Logging Multimeter to thermally stabilize after using a soldering iron, flux remover, or freon on the A9 Analog Board.

6-3. ADJUSTMENT INTERVAL.

6-4. A complete adjustment is advised every 6 months to ensure proper instrument calibration.

6-5. ADJUSTMENT SEQUENCE.

6-6. The adjustment procedures are presented in a logical sequence that will minimize interaction between adjustments. Although the performance tests might indicate that only one or two adjustments are needed, we recommend that you start at the beginning and do all of the adjustments in the order in which they are given.

6-7. EQUIPMENT REQUIRED.

6-8. Table 6-1 lists the recommended equipment for performing the complete set of adjustments on the Logging Multimeter. Equipment that meets or exceeds the required characteristics given in the table may be substituted for the recommended models.

6-9. ADJUSTMENT AND JUMPER TEST POINT LOCATIONS.

6-10. All of the adjustments and corresponding jumper test points (with the exception of the Power-Drop Voltage adjustment) can be easily located on the adjustment shield. The shield physically covers the A9 Analog Board and is accessed by removing the bottom cover of the Logging Multimeter. The Power-Drop Voltage Adjustment and test points are located on the A3 I/O and Timing Board and are accessed by removing the top cover of the Logging Multimeter.

Table 6-1. Recommended Adjustment Equipment.

Instrument Type	Required Characteristics	Recommended Model
Digital Volt/Ohmmeter	DC Volts: 1V, 10V and 100V range Accuracy: ±0.04% Input Resistance: 10 MΩ Ohms: 20 kΩ Accuracy: ± 0.07%	-hp- 3466A
AC Calibrator	Frequency: 20 Hz to 100 kHz Output: 1 mV to 100 V Accuracy (mid band): ± 0.1%	-hp- 745A
DC Standard	Output: 1 mV to 1000 V Accuracy: ± 0.02%	-hp- 740B
Electronic Counter	Frequency: 50 and 60 Hz Accuracy: ±0.01%	-hp- 5300A/5302A
Resistor Decade Box	1Ω, 10Ω, 100Ω, 1kΩ, 10kΩ, 100kΩ and 1 MΩ steps Accuracy: ±0.005%	General Radio Model GR 1433-H

6-11. SAFETY CONSIDERATIONS.

6-12. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the instrument.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock).

CAUTION

Do not allow the exposed areas of the probes or leads you use to contact the adjustment shield when connected to a jumper test point as it may result in damage to the instrument.

6-13. (1) +7 V SUPPLY ADJUSTMENT.

a. Set the DVM to the DCV function, autorange.

b. Connect the DVM from JM902 (+) to the Channel 3 LOW input terminal (-) and select Channel 3. All other channels should be deselected.

c. Adjust R917 for a DVM reading between +6.990V and +7.010V.

6-14. 2 INPUT ZERO ADJUSTMENT.

NOTE

This adjustment zeroes DC offsets and is not effective for AC offset inherent to the Logging Multimeter.

a. Set the Logging Multimeter to the DCV function, 20 V range.

b. Short the input to Channel 3 and select Channel 3.

c. Set the DVM to the DCV function, autorange.

d. Connect the DVM from JM200 (+) to the Channel 3 LOW input terminal.

e. Adjust R220 for a DVM reading between -0.100 mV and +0.100 mV.

6-15. 3 POST AMP ZERO ADJUSTMENT.

a. Set the Logging Multimeter to the DCV function, 20 V range.

b. Short the input to Channel 3 and select Channel 3.

c. Set the DVM to the DCV function, autorange.

d. Connect the DVM from JM300 (+) to the Channel 3 LOW input terminal.

e. Adjust R304 for a DVM reading between -0.200 mV and +0.200 mV.

6-16. 4 190.00 kΩ ADJUSTMENT.

a. Set the Logging Multimeter to the kΩ function, autorange.

b. Set the Decade Resistor Box to 190 kΩ and connect it to the Channel 3 input.

c. Select Channel 3.

d. Adjust R116 for a Logging Multimeter reading between 189.99 kΩ and 190.01 kΩ.

6-17. 5 10.00 MΩ ADJUSTMENT.

a. Set the Logging Multimeter to the kΩ function, autorange.

b. Set the Decade Resistor box to 10 MΩ and connect it to the Channel 3 input. (Use shielded test leads, with shield connected to the Channel 3 LO input. Keep the shield connected to LOW on the Decade Resistor Box).

c. Select Channel 3.

d. Adjust R602 for a Logging Multimeter reading between 9.998 MΩ and 10.002 MΩ.

6-18. [6] 19.000 V ⎓ ADJUSTMENT.

a. Set the Logging Multimeter to the DCV function, autorange.

b. Set the DC STANDARD to 19.000 V and connect it to the Channel 3 input.

c. Select Channel 3.

d. Adjust R502 for a Logging Multimeter reading of 19.000 V.

19.000 V ⎓ COARSE ADJUSTMENT

If U500, C500, or their associated components have been replaced, adjustment 7 may be beyond the range of R502. If this happens, proceed as follows:

a. Remove the adjustment shield.

b. Set R502 fully counter clockwise.

c. Replace jumpers JM500 thru JM505 if previously clipped out.

d. Set the Logging Multimeter to the DCV function, autorange.

e. Set the DC STANDARD to 19.000 V and connect it to the Channel 3 input.

f. Select Channel 3.

g. Record the Logging Multimeter reading, R = ________ (or press MAN PRINT to print it).

h. Refer to Table 5-2 to decide which combination of jumpers (JM500 thru JM505) should be clipped out. Based on the reading in Step g, clip those JUMPERS.

i. Replace the adjustment shield.

j. Complete adjustment 6 by adjusting R502 for a Logging Multimeter reading of 19.000 V.

6-19. [7] 1/10 SCALE AC ADJUSTMENT 1.900 V 400 Hz.

NOTE

On some earlier instruments this adjustment and those following may be marked [8] through [12] on the adjustment shield. In this case, adjustment [7] should be skipped. Newer instruments have only adjustments [1] through [11] marked on the adjustment shield.

Table 6-2. 18,000 V ⎓ Course Adjustment.

Reading From Step G	JM 50						Reading From Step G	JM 50					
	5	4	3	2	1	0		5	4	3	2	1	0
16 900 < R < 16 955	0	0	0	0	0	0	17 913 < R < 17 946	1	0	0	0	0	0
16 955 < R < 17 010	0	0	0	0	0	1	17 946 < R < 17 977	1	0	0	0	0	1
17 010 < R < 17 038	0	0	0	0	1	0	17 977 < R < 18 009	1	0	0	0	1	0
17 038 < R < 17 066	0	0	0	0	1	1	18 009 < R < 18 041	1	0	0	0	1	1
17 066 < R < 17 095	0	0	0	1	0	0	18 041 < R < 18 073	1	0	0	1	0	0
17 095 < R < 17 124	0	0	0	1	0	1	18 073 < R < 18 105	1	0	0	1	0	1
17 124 < R < 17 153	0	0	0	1	1	0	18 105 < R < 18 139	1	0	0	1	1	0
17 153 < R < 17 182	0	0	0	1	1	1	18 139 < R < 18 172	1	0	0	1	1	1
17 182 < R < 17 211	0	0	1	0	0	0	18 172 < R < 18 206	1	0	1	0	0	0
17 211 < R < 17 240	0	0	1	0	0	1	18 206 < R < 18 236	1	0	1	0	0	1
17 240 < R < 17 266	0	0	1	0	1	0	18 236 < R < 18 270	1	0	1	0	1	0
17 266 < R < 17 292	0	0	1	0	1	1	18 270 < R < 18 303	1	0	1	0	1	1
17 292 < R < 17 326	0	0	1	1	0	0	18 303 < R < 18 337	1	0	1	1	0	0
17 326 < R < 17 360	0	0	1	1	0	1	18 337 < R < 18 370	1	0	1	1	0	1
17 360 < R < 17 390	0	0	1	1	1	0	18 370 < R < 18 403	1	0	1	1	1	0
17 390 < R < 17 419	0	0	1	1	1	1	18 403 < R < 18 437	1	0	1	1	1	1
17 419 < R < 17 449	0	1	0	0	0	0	18 437 < R < 18 470	1	1	0	0	0	0
17 449 < R < 17 479	0	1	0	0	0	1	18 470 < R < 18 503	1	1	0	0	0	1
17 479 < R < 17 509	0	1	0	0	1	0	18 503 < R < 18 538	1	1	0	0	1	0
17 509 < R < 17 539	0	1	0	0	1	1	18 538 < R < 18 572	1	1	0	0	1	1
17 539 < R < 17 569	0	1	0	1	0	0	18 572 < R < 18 606	1	1	0	1	0	0
17 569 < R < 17 600	0	1	0	1	0	1	18 606 < R < 18 640	1	1	0	1	0	1
17 600 < R < 17 631	0	1	0	1	1	0	18 640 < R < 18 675	1	1	0	1	1	0
17 631 < R < 17 663	0	1	0	1	1	1	18 675 < R < 18 709	1	1	0	1	1	1
17 663 < R < 17 694	0	1	1	0	0	0	18 709 < R < 18 744	1	1	1	0	0	0
17 694 < R < 17 724	0	1	1	0	0	1	18 744 < R < 18 779	1	1	1	0	0	1
17 724 < R < 17 756	0	1	1	0	1	0	18 779 < R < 18 810	1	1	1	0	1	0
17 756 < R < 17 787	0	1	1	0	1	1	18 810 < R < 18 840	1	1	1	0	1	1
17 787 < R < 17 819	0	1	1	1	0	0*	18 840 < R < 18 880	1	1	1	1	0	0
17 819 < R < 17 850	0	1	1	1	0	1	18 880 < R < 18 917	1	1	1	1	0	1
17 850 < R < 17 881	0	1	1	1	1	0	18 917 < R < 18 960	1	1	1	1	1	0
17 881 < R < 17 913	0	1	1	1	1	1	18 960 < R < 19 000	1	1	1	1	1	1

1 Jumper in (shorted)
0 Jumper out (open)

*Example

If the reading in Step g was 17 790, the jumper configuration would be

0 1 1 1 0 0

JM50 5 4 3 2 1 0

a. Set the Logging Multimeter to the ACV function, 2 V range.

b. Set the AC Calibrator to 1.90000 V at 400 Hz and connect it to the Channel 3 input.

c. Select Channel 3.

d. Adjust R403 for a Logging Multimeter reading between 1.898 V and 1.902 V.

NOTE

Adjustments 8 thru 11 must be made with the adjustment shield in place.

6-20. [8] FULL-SCALE AC ADJUSTMENT 19.000 V 400 Hz.

a. Change the output voltage of the AC CALIBRATOR to 19.0000 V at 400 Hz.

b. Adjust R407 for a Logging Multimeter reading between 18.998 V and 19.002 V.

c. Return to adjustment [7] and recheck the 1/10 scale gain. Repeat [7] and [8] if necessary.

6-21. [9] FULL SCALE AC ADJUSTMENT 1.9000 V 20 kHz.

a. Set the Logging Multimeter to the ACV function, 2 V range.

b. Set the AC CALIBRATOR to 1.90000 V at 20 kHz and connect it to the Channel 3 input.

c. Select Channel 3.

d. Adjust C209 for a Logging Multimeter reading between 1.8995 V and 1.9005 V.

6-22. [10] AC HIGH FREQUENCY ADJUSTMENT 190.00 mV 100 kHz.

a. Set the Logging Multimeter to the ACV function, 200 mV range.

b. Set the AC CALIBRATOR to .190000 V at 100 kHz and connect it to the Channel 3 input.

c. Select Channel 3.

d. Using a non-metallic tuning tool, adjust C301 for a Logging Multimeter reading between 189.95 mV and 190.05 mV.

6-23. [11] FULL SCALE AC ADJUSTMENT 19.000 V 20 kHz.

a. Set the Logging Multimeter to the ACV function, 20 V range.

b. Set the AC CALIBRATOR to 19.00000 V at 20 kHz and connect it to the Channel 3 input.

c. Select Channel 3.

d. Adjust R203 for a Logging Multimeter reading between 18.995 V and 19.005 V.

6-24. [12] POWER-DROP VOLTAGE ADJUSTMENT 4.83 V.

a. Set the DVM to the DCV function, autorange.

b. Connect the DVM between pin 3 (+ lead, + 5V''' test point) and pin 5 (− lead, V_G test point) of the power supply connector on A3. Refer to Figure 6-1.

c. Adjust A3R6 for a DVM reading between 4.82 V and 4.84 V.

NOTE

An incorrectly adjusted power-drop reference can cause continuous interrupts to the processor, resulting in hang-up and a blank display.

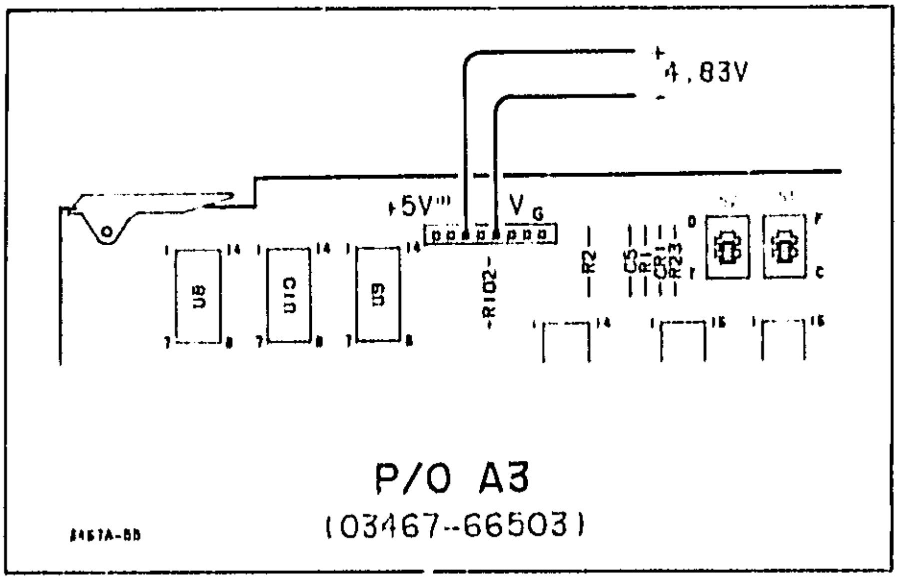


Figure 6-1. Power-Drop Adjustment Test Points.

SECTION VII
REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-3 lists parts in alphanumeric 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 7-1.)

c. Typical manufacturer of the part is a five-digit code. (See Table 7-2 for list of manufacturers.)

d. Manufacturer's part number.

7-3. Miscellaneous parts are listed in Table 7-3 following their respective assemblies. General miscellaneous assemblies and parts are listed at the conclusion of Table 7-3.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packart Sales and Service Office. (Refer to the rear of this manual for a list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

7-6. NON-LISTED PARTS.

7-7. 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.

7-8. PARTS CHANGES.

7-9. Components which have been changed are so marked by one of three symbols. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript (Δ_A) indicates a change which is explained in a note at the bottom of the page or on the appropriate schematic. A Δ with a number subscript (Δ_{10}) indicates the related change is discussed in backdating (Section IX). The number of the subscript refers to the number of the change in backdating.

Table 7-1. Standard Abbreviations.

[illegible]

7-10. EXCHANGE ASSEMBLIES.

7-11. The thermal printer assembly is a non field-repairable item. If a servicing procedure results in a suspected printer assembly malfunction, this strict-exchange package should be removed and sent to the nearest -hp- Sales and Service Office for replacement. Tape a copy of the faulty print onto the assembly and include a full description of printer symptoms. A printer assembly removal procedure is outlined in Section VIII, SERVICE.

AP EXCHANGE ASSEMBLY 03467-69501

7-12. SUBSTITUTE PARTS.

7-13. The zero ohm resistors located on the digital assemblies may be substituted by suitable lengths of AWG 20 wire if replacement becomes necessary and the actual part is not required.

Table 7-2. Code List Of Manufacturers.

Mfr No.	Manufacturer Name	Address
01121	Allen Bradley Co	Milwaukee WI 53204
01295	Texas Instruments Inc Semicond Cmpnt Div	Dallas TX 75222
01928	RCA Corp Solid State Div	Somerville NJ 08876
03888	KDI Pyrofilm Corp	Whippany NJ 07981
04713	Motorola Semiconductor Products	Phoenix AZ 85062
07263	Fairchild Semiconductor Div	Mountain View CA 94042
17856	Siliconix Inc	Santa Clara CA 95054
19701	Mepco/Electra Corp	Mineral Wells TX 76067
22526	Berg Electronics Inc	Cumberland PA 17070
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 92507
56289	Sprague Electric Co	North Adams MA 01247
72136	Electro Motive Corp Sub IEC	Willimantic CT 06226
74970	Johnson E F Co	Waseca MN 56093
75915	Littelfuse Inc	Des Plaines IL 60016

Table 7-3. Replaceable Parts.

Reference Designation	HP Part Number		Qty	Description	Mfr Code	Mfr Part Number
A1 ΔA	03467-66512	9	1	DIGITAL MOTHER BOARD	28480	[illegible]
A1C1	0160-3668	8	1	CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	[illegible]
A1C2	[illegible]		1	CAPACITOR-FXD 4700UF+50-10% 16VDC AL	28480	[illegible]
A1C3	[illegible]		2	CAPACITOR-FXD .01UF +100-0% 500VDC CER	28480	[illegible]
A1C4	[illegible]			CAPACITOR-FXD .01UF +100-0% 500VDC CER	28480	[illegible]
A1C5	[illegible]		1	CAPACITOR-FXD 500UF+75-10% 16VDC AL	56289	[illegible]
A1C6	[illegible]		1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	[illegible]
A1C7 ΔA	0160-0161	4	1	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C8	[illegible]		1	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	[illegible]
A1C10	[illegible]		1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	[illegible]
A1C11	[illegible]			CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	[illegible]
A1C12	[illegible]		1	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	[illegible]
A1C13 ΔA	0180-0197		1	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1CR1	[illegible]		2	DIODE-PWR RECT 100V 6A	04713	MR751
A1CR2	[illegible]			DIODE-PWR RECT 100V 6A	04713	MR751
A1CR3	[illegible]		1	DIODE-ZNR 1N5349B 12V 5% DO-15 PD=5W	04713	1N5349B
A1CR4	[illegible]		4	DIODE-PWR RECT 400V 750MA DO-29	28480	[illegible]
A1CR5	[illegible]			DIODE-PWR RECT 400V 750MA DO-29	28480	[illegible]
A1CR6	[illegible]			DIODE-PWR RECT 400V 750MA DO-29	28480	[illegible]
A1CR7	[illegible]			DIODE-PWR RECT 400V 750MA DO-29	28480	[illegible]
A1CR8	[illegible]		1	DIODE-ZNR 10.0V 5% DO-7 PD=.4W TC=+.06%	28480	[illegible]
A1F1 ΔA	2110-0002			FUSE 2A 250V FAST BLO 1.25X.25 UL IEC	75915	312002
A1J1	[illegible]			CONNECTOR 3-PIN M POST TYPE	28480	[illegible]
A1J2	[illegible]		7	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J3	[illegible]		2	CONNECTOR 3-PIN M POST TYPE	28480	[illegible]
A1J3A	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J3B	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J4	[illegible]		1	CONNECTOR 4-PIN M POST TYPE	28480	[illegible]
A1J4A	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J4B	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J5A	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J5B	[illegible]			CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	[illegible]
A1J6	[illegible]		3	SOCKET-IC 16-CONT DIP-SLDR	28480	[illegible]
A1J7	[illegible]			SOCKET-IC 16-CONT DIP-SLDR	28480	[illegible]
A1J8	[illegible]			SOCKET-IC 16-CONT DIP-SLDR	28480	[illegible]
A1J9	[illegible]		1	CONNECTOR 20 PIN MOLEX	28480	[illegible]
A1Q1	[illegible]		2	TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	04713	2N3055
A1Q2	[illegible]			TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	04713	2N3055
A1R1	[illegible]		2	RESISTOR .1 1% 2W PW TC=0+-800	28480	[illegible]
A1R2	[illegible]		5	RESISTOR 4.99K 1% .125W F TC=0+-100	24546	[illegible]
A1R3	[illegible]			RESISTOR 4.99K 1% .125W F TC=0+-100	24546	[illegible]
A1R4	[illegible]		1	RESISTOR 200K 1% .125W F TC=0+-100	24546	[illegible]
A1R5	[illegible]		2	RESISTOR 10.5K 1% .125W F TC=0+-100	24546	[illegible]
A1R6	[illegible]		1	RESISTOR 19.1K 1% .125W F TC=0+-100	24546	[illegible]
A1R7	[illegible]		2	RESISTOR 40.2K 1% .125W F TC=0+-100	28480	[illegible]
A1R8	[illegible]		1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	[illegible]
A1R9	[illegible]		2	RESISTOR 12K 1% .125W F TC=0+-100	24546	[illegible]
A1R10	[illegible]			RESISTOR .1 5% 2W PW TC=0+-800	28480	[illegible]
A1R11	[illegible]			RESISTOR 4.99K 1% .125W F TC=0+-100	24546	[illegible]
A1R12	[illegible]			RESISTOR 4.99K 1% .125W F TC=0+-100	24546	[illegible]
A1R13	[illegible]		1	RESISTOR 348K 1% .125W F TC=0+-100	28480	[illegible]
A1R14	[illegible]			RESISTOR 14.3K 1% .125W F TC=0+-100	24546	[illegible]
A1R15	[illegible]		1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	[illegible]
A1R16	[illegible]			RESISTOR 69.8K 1% .125W F TC=0+-100	28480	[illegible]
A1R17	[illegible]		1	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	[illegible]
A1R18	[illegible]			RESISTOR 10K 1% .125W F TC=0+-100	24546	[illegible]
A1R20	[illegible]		2	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	[illegible]
A1R21	[illegible]			RESISTOR 4.99K 1% .125W F TC=0+-100	24546	[illegible]
A1R22	[illegible]			RESISTOR 1K 5% .25W FC TC=-400/+600	01121	[illegible]
A1R23	[illegible]		1	RESISTOR 60.4 1% .125W F TC=0+-100	24546	[illegible]
A1S1	[illegible]		4	SWITCH-PB DPDT ALTNG .5A 100VAC	28480	[illegible]
A1S2	[illegible]			SWITCH-PB DPDT ALTNG .5A 100VAC	28480	[illegible]
A1S3	[illegible]			SWITCH-PB DPDT ALTNG .5A 100VAC	28480	[illegible]
A1S4	[illegible]			SWITCH-PB DPDT ALTNG .5A 100VAC	28480	[illegible]
A1U1	[illegible]		2	IC 1458 OP AMP TO-99	04713	MC1458G
A1U2	[illegible]			IC 1458 OP AMP TO-99	04713	MC1458G
A1W1	8120-2770		1	16 PIN DIP CABLE 7 IN	28480	8120-2770
A1W2	8120-2771		1	16 PIN DIP CABLE 9 IN	28480	8120-2771
				A1 MISCELLANEOUS		

ΔA Refer to Schematic 6

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	03467-26512 5A 5	1	PC BOARD, BLANK (26502)	28480	03467-26501
	2110-0269 A	2	FUSEHOLDER CLIP TYPE 250 FUSE	28480	2110-0269

Δ A Refer to Schematic B

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number		Qty	Description	Mfr Code	Mfr Part Number
A2	03467-66502	0	1	PROCESSOR BOARD	28480	03467-66502
A2C1	0180-2376	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A2C2	0160-3847	9	8	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C3	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C4	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C5	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C6	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C7	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C8	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2C9	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A2J1	1251-4824	4	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-4824
A2L1	9140-0137	1	1	COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A2MP1	4040-0750	7	2	EXTRACTOR-PC BOARD RED POLYC	28480	4040-0750
A2R1	0683-4725	2	4	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R2	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R3	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R4	0683-1025	9	2	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R5	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R6	0683-1825	7	2	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A2R7	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A2R8	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R9	1810-0280	3	1	NETWORK-RES 8-PIN-SIP .1-PIN-SPCG 10K	28480	1810-0280
A2R12,16,20,21,60	8160-3376			WIRE 22AWG W/BK PVC 1X22 80C	28480	8160-3376
A2R61 R60	8160-3376			WIRE 22AWG W/BK PVC 1X22 80C	28480	8160-3376
A2S1	3101-1341	3	1	SWITCH-SL SPDT-NS SUBMIN .5A 125VAC/DC	28480	3101-1341
A2U1	1820-2151	7	1	IC MPU MC6802	28480	1820-2151
A2UX1	1200-0654	2	1	SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0654
A2U2	1818-0728	5	1	IC ROM 0	28480	1818-0728
A2UX2	1200-0638	1	3	SOCKET-IC 24-CONT DIP-SLDR	28480	1200-0638
A2U3	1818-0729	6	1	IC ROM 1	28480	1818-0729
A2UX3	1200-0638	1		SOCKET-IC 24-CONT DIP-SLDR	28480	1200-0638
A2U4	1820-1691	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A2U5	1820-1759	5	2	IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A2U6	1820-1759	5		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A2U7	1820-1201	6	3	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A2U8	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A2U9	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A2U10	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A2U11	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A2U12	1818-0730	9	1	IC ROM 2	28480	1818-0730
A2UX12	1200-0638	1		SOCKET-IC 24-CONT DIP-SLDR	28480	1200-0638
A2U14	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A2U15	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A2Y1	0410-0485	2	1	CRYSTAL-QUARTZ XTAL-CTZ, 4.000 MHZ	28480	0410-0485
				A2 MISCELLANEOUS		
	03467-26502	4	1	PC BOARD, BLANK (22206)	28480	03467-26502

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3	03467-66503 1	1	I/O TIMING BOARD	28480	03467-66503
A3C1	0160-3847 9	11	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C2	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C3	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C4	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C5	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C6	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C7	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C8	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C9	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C10	0180-0291 3	1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C11	0180-2208 2	1	CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A3C12	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3C13	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A3CR1	1901-0050 3	4	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR2	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR4	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR5	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR6	1902-1329 3	1	DIODE ZENER 6.06V	28480	1902-1329
A3CR7 CR8	1901-0618		DIODE SCHOTTKY	28480	1901-0618
A3J1	1251-4592 8	1	CONNECTOR 8-PIN M POST TYPE	27264	[illegible]
A3MP1	4040-0751 2	2	EXTRACTOR-PC BOARD GRN POLYC	28480	4040-0751
A3Q1	1853-0089 5	1	TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A3R1	0683-1045 3	3	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A3R4	0757-0443 0	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A3R5	0698-3154 0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A3R6	2100-3273 1	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	28480	2100-3273
A3R7	0683-3325 4	1	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R8	0683-1025 9	2	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R9	0683-4725 2	5	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R11	0683-1025 9	2	RESISTOR 1K 5% .25W FC TC=-400/+600	01607	CB1025
A3R12	0683-1045 3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A3R13	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R14	0683-1045 3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A3R15	0683-4735 4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R16	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R17	0683-2735 0	1	RESISTOR 27K 5% .25W FC TC=-400/+800	01607	CB2735
A3R18	0683-3345 1	3	RESISTOR 330K 5% .25W FC TC=-800/+900	01607	CB3345
A3R19	0683-3345 0	1	RESISTOR 330K 5% .25W FC TC=-800/+900	01607	CB3345
A3R20	0757-0442 9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R21	0757-0441 8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R22	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R23	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R24	0683-3315 4	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A3R25	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R26	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3W1 W2	8160-3376		WIRE 22AWG W/BK PVC 1X22 80C	28480	8160-3376
A3S1	3101-1341 3	2	SWITCH-SL SPDT-NS SUBMIN .5A 125VAC/DC	28480	3101-1341
A3S2	3101-1341 3		SWITCH-SL SPDT-NS SUBMIN .5A 125VAC/DC	28480	3101-1341
A3U1	1820-1216 3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A3U2	1820-1759 9	5	IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U3	1820-1759 9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U4	1820-1759 9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U5	1820-1759 9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U6	1820-1122 0	1	IC CNTR CMOS BCD SYNCHRO DUAL	04713	MC14518BCP
A3U7	1820-1150 4	1	IC CNTR CMOS BIN SYNCHRO DUAL 4-BIT	04713	MC14520BCP
A3U8	1820-1961 5	1	IC GATE CMOS NAND TPL 3-INP	04713	MC14023BCP
A3U9	1820-1144 6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A3U10	1820-1112 8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A3U11	1826-0138 8	1	IC COMPARATOR 14-DIP-P	27014	LM339N
A3U12	1818-0695 5	1	IC MEM 6101 L 1 CMOS	28480	1818-0695
A3U13	1820-1411 0	1	IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A3U14	1820-1759 9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U16	1820-1746		IC BFR CMOS INV HEX	02037	MC14049BCP
A3U16	1820-1112	8	IC FF TTL LS D TYPE POS EDGE TRIG	01295	SN74LS74N
A3U17	1820-1196 8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
			A3 MISCELLANEOUS		

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	03467-26503 7	1	PC BOARD, BLANK	28480	03467-26503

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4	03467-66504 2	1	VOLTMETER CONTROL BOARD	28480	03467-66504
A4C1	0160-3847 9	8	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C2	0160-0157 8	1	CAPACITOR-FXD 4700PF +-10% 200VDC POLYE	28480	0160-0157
A4C3	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C4	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C5	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C6	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C7	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C8	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C10	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4MP1	4040-0752 5	2	EXTRACTOR-PC BOARD YEL POLYC	28480	4040-0752
A4R1	0683-4735 4	2	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A4R2	0683-4735 4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A4R3	0683-8235 9	8	RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R4	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R5	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R6	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R7	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R8	0683-1035 9	8	RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R10	0683-4725 2	2	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R11	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R12	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R13	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R14	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R15	0683-2735 0	3	RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A4R16	0683-2735 0		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A4R17	0683-2735 0		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A4R18	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R19	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R20	0683-1035 9		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A4R22	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R23	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R24	0683-8235 9		RESISTOR 82K 5% .25W FC TC=-400/+800	01121	CB8235
A4R60,70,103,105	8160-3376	6	WIRE 22AWG W BK PVC 1X22 80C	28480	8160-3376
A4R106 ... A	8160-3376	6	WIRE 22AWG W BK PVC 1X22 80C	28480	8160-3376
A4S1	3101-1341 3	1	SWITCH SL SPDT NS SUBMIN 6A 125VAC DC	28480	3101-1341
A4U1	1820-1782 0	1		28480	1820-1782
A4U2	1820-1672 5	1	IC GATE CMOS EXCL-NOR QUAD 2-INP	01928	CD4077BF
A4U3	1820-1465 9	1	IC GATE CMOS NOR TPL 3-INP	04713	MC14025BCP
A4U4	1820-1705 3	1	IC GATE CMOS NOR QUAD 2-INP	04713	MC14001BCP
A4U5	1820-1463 7	3	IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	01928	CD4013BAE
A4U6	1820-1463 7		IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	01928	CD4013BAE
A4U7	1820-1463 7		IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	01928	CD4013BAE
A4U8	1820-1356 2	1	IC MV CMOS MONOSTBL RETRIG/RESET DUAL	04713	MC14528BCP
A4U9	1820-1760 4	1	IC BFR CMOS INV HEX	04713	MC14049UBCP
A4U10	1820-1189 9	1	IC CNTR CMOS BCD UP/DOWN SYNCHRO	04713	MC14510CP
A4U11	1820-1912 6	1	IC LCH CMOS COM CLOCK QUAD	04713	MC14042BCP
A4U13	1820-1417 6	3	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A4U14	1820-1417 6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A4U15	1820-1417 6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A4U16	1820-1195 7	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A4U17	1820-1195 7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A4U18	1820-1195 7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A4U19	1820-1195 7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A4U20	1820-1759 9	1	IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A4U21	1820-1216 3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A4U22	1820-1976 2	2	IC BFR CMOS NON-INV HEX	01928	CD4050BE
A4U24	1820-1976 2		IC BFR CMOS NON-INV HEX	01928	CD4050BE
			A4 MISCELLANEOUS		
A4Z1	03467-26504 8	1	PC BOARD, BLANK (22206)	28480	03467-26504

Δ A Refer to Schematic 4

See Introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number		Qty	Description	Mfr Code	Mfr Part Number
A5	03467-66505	3	1	DSP AND PRT CONTROL	28480	03467-66505
A5C1	0160-3847	9	7	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5C2	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5C3	0180-0374	3	2	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C4	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 5 VDC CER	28480	0160-3847
A5C5	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C6	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5C7	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5C8	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5C9	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A5CR1	1901-0050	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5MP1	4040-0753	0	1	EXTRACTOR-PC BOARD GRN POLYC	28480	4040-0753
A5Q1	1853-0419	5	8	TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q2	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q3	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q4	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q5	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q6	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q7	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5Q8	1853-0419	5		TRANSISTOR PNP SI PD=310MW	01295	2N4403
A5R1	0683-2215	1	8	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R2	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R3	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R4	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R5	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R6	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R7	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R8	0683-1035	1	3	RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A5R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A5R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB1035
A5R11	0683-3315	0	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R12	0683-3315	0		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R13	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R14	0683-3025	3	8	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R15	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R16	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R17	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R18	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R19	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R20	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R21	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R22	0683-2225	3	8	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R23	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R24	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R25	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R26	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R27	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R28	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R29	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A5R30	0683-4705	8	3	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R31	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R32	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R33	0683-6805	3	5	RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A5R34	0683-6805	3		RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A5R35	0683-6805	3		RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A5R36	0683-6805	3		RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A5R37	0683-6805	3		RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A5R60 62	8160 3376			WIRE 22AWG W/BK PVC 1x22 80C	28480	8160 3376
A5U1	1820-1085	2	2	IC RGTR TTL LS D-TYPE QUAD	27014	DM74LS173N
A5U2	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A5U3	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A5U4	1820-1122	0	1	IC CNTR CMOS BCD SYNCHRO DUAL	04713	MC14518BCP
A5U5	1820-1199	1	2	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A5U6	1820-1197	9	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A5U7	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A5U8	1820-1085	2		IC RGTR TTL LS D-TYPE QUAD	27014	DM74LS173N
A5U9	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A5U10	1820-1780	8	1	IC DRVR MOS- DSPL DRVR	27014	DS8863N
A5U11	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A5U12	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A5U13	1820-1417	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A5U14	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A5U15	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5U16	1816-1089 9	1	IC 74LS189 64-BIT RAM TTL	27014	DM74LS189N
A5U17	1820-1428 9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS158N
A5U18	1820-1443 8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS393N
			A5 MISCELLANEOUS		
	03467-26505 9	1	PC BOARD, BLANK (22206)	28480	03467-26505

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number		Qty	Description	Mfr Code	Mfr Part Number
A6	03467-66506	6	1	DISPLAY BOARD	28480	03467-66506
A6DS1	1990-0518	6	18	LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS2	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS3	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS4	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS5	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS6	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS7	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS8	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS9	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS10	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS11	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS12	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS13	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS14	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS15	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS16	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS17	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS18	1990-0518	6		LED-VISIBLE LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A6DS19	1990-0649	3	1	DISPLAY-NUM SEG	28480	5082-7616
A6DS20	1990-0631	2	4	DISPLAY NUM SEG 1-CHAR 3-H GA ABSD FFHD	01542	5082-7610
A6DS21	1990-0631	2		DISPLAY NUM SEG 1-CHAR 3-H GA ABSD FFHD	01542	5082-7610
A6DS22	1990-0631	2		DISPLAY NUM SEG 1-CHAR 3-H GA ABSD FFHD	01542	5082-7610
A6DS23	1990-0631	2		DISPLAY NUM SEG 1-CHAR 3-H GA ABSD FFHD	01542	5082-7610
A6S1	3101-2326	8	1	SWITCH PB 4PST ALTNG 4A 250VAC	28480	3101-2326
A6S2	3101-2344	9	1	PUSHBUTTON µV ZERO	28480	3101-2344
A6W6	8120-2663	0	1	16 PIN DIP CABLE 11 IN	28480	8120-2663
				A6 MISCELLANEOUS		
	03467-26506	0	1	PC BOARD, BLANK (22218)	28480	03467-26506
	0380-0946	3	4	STANDOFF-RVT-ON .625-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A7	03467-66507	5	1	TOP SWITCH BOARD	28480	03467-66507
A7A1	3101-2343	7	1	SWITCH, PUSHBUTTON 5-STATION	28480	3101-2343
A7A2	3101-2344	8	1	SWITCH, PUSHBUTTON 7-STATION	28480	3101-2344
A7C1	0160-3847	9	8	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A7C2	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A7E1	1970-0077	9	1	TUBE-ELECTRON SURGE V PTCTR 350V	28480	1970-0077
A7R1	0683-1045	3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R2	0687-5661	5	1	RESISTOR 56M 10% .5W CC TC=0+1058	01121	EB5661
A7T1	9100-4111	5	1	TRANSFORMER ISOLATION	28480	9100-4111
A7W7	8120-2664	0	1	16 PIN DIP CABLE 8 IN	28480	8120-2664
				A7 MISCELLANEOUS		
	03467-26507	1		PC BOARD, BLANK (22210)	28480	03467-26507
	0380-0698	6		STANDOFF-RVT-ON .438-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	0590-0526	6		THREADED INSERT-NUT 6-32 .085-LG SST	28480	0590-0526
	3101 2129		4	SWITCH FB 4PDT ALTNG 46A 115VAC	28480	3101 2129
	3101 2128		8	SWITCH FB 4PDT INTLK 46A 115VAC	28480	3101 2128
A8	03467-66508	6	1	BOTTOM SWITCH BOARD	28480	03467-66508
A8A1	3101-2336	8	1	SWITCH, PUSHBUTTON 7-STATION	28480	3101-2336
A8C1	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A8C2	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A8C3	0180-0376	5	1	CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A8R1	0683-4725	2	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8S1	3101-1982	8	1	SWITCH-PB DPDT ALTNG .5A 100VAC	28480	3101-1982
A8S2	3101-2347	1	2	PUSHBUTTON PAPER ADV	28480	3101-2347
A8S3	3101-2347	1		PUSHBUTTON MAN PRINT	28480	3101-2347
A8U1	1820-1156	2	1	IC ENCDR CMOS	03406	MM74C922N
A8W8	8120-2772	1	1	16 PIN DIP CABLE 8 IN	28480	8120-2772
				A8 MISCELLANEOUS		
	03467-26508	2		PC BOARD, BLANK (22212)	28480	03467-26508
	3101 2129		1	SWITCH FB 4PDT ALTNG 46A 115VAC	28480	3101 2129
	3103 2128		6	SWITCH FB 4PDT INTLK 46A 115VAC	28480	3101 2128
	3103 2127		3	SWITCH FB 6PDT INTLK 46A 115VAC	28480	3103 2127

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9	03467-66511		ANALOG BOARD (2ND VERSION)	28480	03467-66511
A9C1 Δ7	0160-3847 9	1	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C200	0160-0153 4	1	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A9C201	0160-4559 2	1	CAPACITOR-FXD 39PF +-2% 500VDC PORC	28480	0160-4559
A9C202	0160-4518 1	1	CAPACITOR-FXD 330PF +-1% 300VDC MICA	28480	0160-4518
A9C203	0160-2204 0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A9C204	0180-0374 3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C205	0160-4036 7	2	CAPACITOR-FXD .1UF +-10% 200VDC POLYP	28480	0160-4036
A9C206	0160-3622 8	3	CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A9C207	0160-2248 2	1	CAPACITOR-FXD 4.3PF +-.25PF 500VDC CER	28480	0160-2248
A9C208	0160-4580 5	1	CAPACITOR-FXD 82PF +-2% 500VDC PORC	28480	0160-4580
A9C209	0121-0128 1	1	CAPACITOR-V TRMR-AIR 1.4-9.2PF 350V	74970	189-0503-005
A9C210	0160-4739 0	1		28480	0160-4739
A9C211	0180-1735 2	1	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A9C212 Δ1A	0160-3847 9	1	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C220, 221	0160-3622 8		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A9C300	0160-2265 3	1	CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2265
A9C301	0121-0451 3	1	CAPACITOR-V TRMR-AIR 1.7-11PF 350V	74970	187-0106-005
A9C306	0160-2257 3	1	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A9C400	0160-3183 6	2	CAPACITOR-FXD .47UF +-20% 50VDC	28480	0160-3183
A9C401	0160-3183 6		CAPACITOR-FXD .47UF +-20% 50VDC	28480	0160-3183
A9C402	0160-3601 7	1	CAPACITOR FXD 4UF ±10% 60VDC MET POLYC	28480	0160-3601
A9C403 Δ7	0160-2611	1	CAPACITOR-FXD 1UF +-10% 80VDC MET-POLYC	28480	0160-2611
A9C600	0160-4036 7		CAPACITOR-FXD .1UF +-10% 200VDC POLYP	28480	0160-4036
A9C601	0160-2263 1	1	CAPACITOR-FXD 18PF +-5% 500VDC CER 0+-30	28480	0160-2263
A9C603	0160-3847 9	3	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C700	0160-4785 8	1		28480	0160-4785
A9C701	0180-0210 6	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A9C901 Δ7	0160-3847 9	1	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C902	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C903	0180-2506 7	2	CAPACITOR-FXD 470UF+50-10% 25VDC AL	28480	0180-2506
A9C904	0160-3847 9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A9C905	0180-2506 7		CAPACITOR-FXD 470UF+50-10% 25VDC AL	28480	0180-2506
A9C906	0140-0198 5	1	CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	CM15F201J0300WV1CR
A9C907	0180-0291 3	3	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A9C908	0160-2208 4	1	CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A9C909	0180-0291 3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A9C910	0180-0228 6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A9C911	0180-0291 3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A9CR1	1902-3182 0	4	DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A9CR2	1902-3182 0		DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A9CR3	1902-3182 0		DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A9CR4	1902-3182 0		DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A9CR5	1901-0040 1	13	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR6	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR7	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR8	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR9	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR200	1901-0376 6	6	DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR201	1901-0376 6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR202	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR203	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR204	1906-0100 4	1	DIODE-DUAL 35V 50MA	17856	DPAD 100
A9CR205	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR206	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR207	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR208	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR209	1902-3171 7	1	DIODE-ZNR 11V 5% DO-7 PD=.4W TC=+.062%	28480	1902-3171
A9CR210	1901-0029 6	1	DIODE-PWR RECT 600V 750MA DO-29	28480	1901-0029
A9CR221	1901-0376 6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR222	1901-0376 6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR225	1902-0049 2	1	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A9CR401 Δ2	1902-3002 3	1	DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	28480	1902-3002
A9CR500	1902-1331 7	1	DIODE-ZNR 6.9V 4% DO-07 TC=+.0015%	28480	1902-1331
A9CR600	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR610	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR621	1901-0376 6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR622	1901-0376 6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A9CR903	1901-0028 5	6	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR904	1901-0028 5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR905	1901-0028 5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR906	1901-0028 5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9E1	1970-0029	7	1	TUBE-ELECTRON DIODE SPARK GAP 1KV	28480	1970-0029
A9F1H thru F4H	2110-0003	6	10	FUSE .375A 250V 1X.25 UL IEC	28480	2110-0003
A9F1L thru F4L	2110-0093	8		FUSE .125A 250V 1X.25 UL IEC	28480	2110-0093
A9J1-J2	1200-0678	4		SOCKET-IC 16-CONT W-WRAP	28480	1200-0678
A9J3	1251-4841	0	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-4841
A9K1 thru A9K9	0490-1187	5	9	REED RELAY	28480	0490-1187
A9Q1	1853-0089	6	1	TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A9Q100, Q101	1854-0071	7	3	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A9Q200	1855-0222	2	1	TRANSISTOR JFET DUAL N-CHAN D-MODE SI	28480	1855-0222
A9Q201	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A9Q202, Q203	1855-0270	0	2	TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0270
A9Q204	1853-0086	2	1	TRANSISTOR PNP SI PD=310MW FT=40MHZ	28480	1853-0086
A9Q205	1854-0070	6	1	TRANSISTOR NPN 2N3439 SI TO-5 PD=1W	01928	2N3439
A9Q700	1855-0308	6	1	TRANSISTOR J-FET DUAL N-CHAN D-MODE SI	28480	1855-0308
A9Q900	1853-0012	4	1	TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A
A9R0, A9R1	0683-1045	3	3	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A9R2	0698-3228	0	7	RESISTOR 49.9K 1% .125W F TC=0+-100	28480	0698-3228
A9R3	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A9R4*				*PADDING LIST		
	8150-3376	5		WIRE 22AWG W/BK PVC 1X22 80C	28480	8150-3376
	0698-4127	5		RESISTOR 499 1% .125W F TC=0+-100	03292	C4-1/8-T0-499R-F
	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
	0757-0427	0		RESISTOR 1.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1501-F
	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2001-F
	0698-4435	3		RESISTOR 2.49K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2491-F
	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3011-F
A9R100	0757-0472	5	3	RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A9R102	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A9R104	0698-4469	6	1	RESISTOR 28K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2802-F
A9R105	0698-4480	6	1	RESISTOR 15.8K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1582-F
A9R106	0683-1055	5	3	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A9R107, R108	0683-4735	4	5	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A9R110	0698-3216	4	2	RESISTOR 499K 1% .125W F TC=0+-100	28480	0698-3216
A9R111	0698-8064	8	1	RESISTOR 500K 1% .125W F TC=0+-10	28480	0698-8064
A9R116	2100-3262	6	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	28480	2100-3262
A9R200	0683-1025	9	1	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A9R201	0698-3558	8	1	RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A9R202	0698-8561	6	1	RESISTOR 11.9 5% 1W F TC=0+-25	28480	0698-8561
A9R203	2100-3789	4	2	RESISTOR VAR 20K	28480	2100-3789
A9R206*			4	*PADDING LIST		
	0698-0077	0	2	RESISTOR 93.1K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9312-F
	0698-4526	1	2	RESISTOR 187K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1873-F
A9R207*				*PADDING LIST		
	0698-0077	0		RESISTOR 93.1K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9312-F
	0698-4526	1		RESISTOR 187K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1873-F
A9R208	0683-0275	9	2	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A9R209	0683-1065	7	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A9R210	0757-0472	5		RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A9R211	0698-3216	4		RESISTOR 499K 1% .125W F TC=0+-100	28480	0698-3216
A9R212	0698-3136	8	1	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A9R214	0698-0438	5	2	RESISTOR 374K 1% .125W F TC=0+-100	28480	0698-0438
A9R215	0684-1065	7		RESISTOR 10M 5% .25W FC TC=-900/+1100	01607	CB1065
A9R216	0683-0275	9		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A9R217	0689-1045	5	1	RESISTOR 100K 5% 1W CC TC=0+882	01121	GB1045
A9R218	0683-4735	4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A9R219	0683-4735	4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A9R220	2100-3502	0	1	RESISTOR-TRMR 200 10% C TOP-ADJ 17-TRN	32997	3292W-1-201
A9R230	0757-0449	6	3	RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A9R231	0683-4725	2	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A9R232	0698-8768	2	1	RESISTOR 100K 5% .25W CC TC=-400/+500	28480	0698-8768
A9R233	0698-8767	1	1	RESISTOR 200K 5% .25W FC TC=-800/+900	28480	0698-8767

See introduction to this section for ordering information
*Indicates factory selected value

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	IC [illegible] OP AMP [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	A/D CONVERTER	28480	[illegible]
[illegible]	[illegible]	[illegible]	IC 307 OP AMP [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	IC 741 OP AMP [illegible]	28480	[illegible]
[illegible]	[illegible]	[illegible]	INTEGRATOR HYBRID	28480	[illegible]
[illegible]	[illegible]	[illegible]	TRANSISTOR ARRAY 14-PIN PLSTC DIP	28480	[illegible]
[illegible]	[illegible]	[illegible]	TRANSISTOR ARRAY 16-PIN PLSTC DIP	28480	[illegible]
[illegible]	[illegible]	[illegible]	IC [illegible] COMPARATOR [illegible]	28480	[illegible]
[illegible]	[illegible]	[illegible]	IC [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	IC [illegible] OP AMP [illegible]	[illegible]	[illegible]
			[illegible] MISCELLANEOUS		
	[illegible]	[illegible]	PC BOARD, BLANK	28480	[illegible]
	[illegible]	[illegible]	TERMINAL-STUD [illegible]	28480	[illegible]
	[illegible]	[illegible]	TERMINAL-STUD [illegible]	28480	[illegible]
	[illegible]	[illegible]	SPACER, HYBRID	28480	[illegible]
	[illegible]	[illegible]	STANDOFF [illegible]	00000	ORDER BY DESCRIPTION
	[illegible]	[illegible]	CONNECTOR [illegible]	28480	[illegible]
	[illegible]	[illegible]	CONNECTOR [illegible]	28480	[illegible]
	[illegible]	[illegible]	[illegible]	28480	[illegible]
	[illegible]	[illegible]	[illegible]	28480	[illegible]
	[illegible]	[illegible]	FUSEHOLDER-CLIP TYPE [illegible]	28480	[illegible]
	[illegible]	[illegible]	FUSEHOLDER [illegible]	28480	[illegible]
[illegible]	[illegible]	1	EXCHANGE ASSEMBLY	28480	[illegible]
[illegible]	[illegible]	1	[illegible] CABLE JACK	28480	[illegible]
[illegible]			[illegible] LIST		
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
	[illegible]	1	RESISTOR [illegible]	28480	[illegible]
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
	[illegible]	1	RESISTOR [illegible]	[illegible]	[illegible]
			[illegible] MISCELLANEOUS		
	[illegible]	[illegible]	BRACKET, PAPER ROLL	28480	[illegible]
	[illegible]	[illegible]	SPACER, MODIFIED	28480	[illegible]
	[illegible]	[illegible]	[illegible]	28480	[illegible]
	[illegible]		SCREW, PAN HEAD	28480	[illegible]
	[illegible]		[illegible]	28480	[illegible]
	[illegible]	[illegible]	CONNECTOR [illegible]	28480	[illegible]
	[illegible]	[illegible]	SCREW-MACH [illegible]	00000	ORDER BY DESCRIPTION
			ACCESSORIES SUPPLIED		
	[illegible]	1	[illegible] KIT CONTAINS	28480	[illegible]
	[illegible]	1	THERMISTOR	28480	[illegible]
	[illegible]		FUSE [illegible]	28480	[illegible]
	[illegible]	[illegible]	FUSE [illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	PC ASSEMBLY, EXTENDER	28480	[illegible]
			ENDS KIT		
	[illegible]	1	OPERATING & SERVICE MANUAL	28480	[illegible]
	[illegible]	1	OPERATING MANUAL	28480	[illegible]
	[illegible]	1	CABLE ASSY [illegible]	28480	[illegible]

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MISCELLANEOUS ASSEMBLIES AND PARTS (REFERENCE DESIGNATIONS APPLY TO FIG.7- [illegible] ASSEMBLIES)		
[illegible]	[illegible]	[illegible]	DECK, MAIN	[illegible]	[illegible]
	[illegible]	[illegible]	STANDOFF-HEX [illegible]	[illegible]	ORDER BY DESCRIPTION
	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	SIDE, RIGHT	[illegible]	[illegible]
	[illegible]	[illegible]	GUIDE-PC BOARD RED POLYC [illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	GUIDE-PC BOARD GRN POLYC [illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	GUIDE-PC BOARD YEL POLYC [illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	GUIDE-PC BOARD GRN POLYC [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	SIDE, LEFT	[illegible]	[illegible]
	[illegible]		GUIDE-PC BOARD RED POLYC [illegible]	[illegible]	[illegible]
	[illegible]		GUIDE-PC BOARD GRN POLYC [illegible]	[illegible]	[illegible]
	[illegible]		GUIDE-PC BOARD YEL POLYC [illegible]	[illegible]	[illegible]
	[illegible]		GUIDE-PC BOARD GRN POLYC [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	PANEL, REAR	[illegible]	[illegible]
	[illegible]	[illegible]	TERMINAL-[illegible] LUG [illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	CAPTIVE FASTENER	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR-AC PWR [illegible] MALE FLOATG	[illegible]	[illegible]
	[illegible]	[illegible]	SWITCH-SL [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	BRACKET, TRANSISTOR	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T1	[illegible]	[illegible]	TRANSFORMER, POWER	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR, [illegible]-PIN	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR, CONTACT	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR	[illegible]	[illegible]
	[illegible]	[illegible]	COVER, TRANSFORMER	[illegible]	[illegible]
W1	[illegible]	[illegible]	CABLE ASSEMBLY	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR, CONTACT	[illegible]	[illegible]
	[illegible]	[illegible]	CONNECTOR, [illegible]-PIN FEMALE	[illegible]	[illegible]
W2	03467-61602	1	POWER CABLE ASSEMBLY	28480	03467-61602

See introduction to this section for ordering information

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number		Qty	Description	Mfr Code	Mfr Part Number
			1	[illegible]		
C1	0160-4183	6	2	CAPACITOR-FXD .01UF +-20% 250VAC(RMS)	28480	0160-4183
C2	0160-4183	6		CAPACITOR-FXD .01UF +-20% 250VAC(RMS)	28480	0160-4183
F1	2110-0318			FUSE .125A 250V SLO-BLO 25X.25 UL	04703	313.125
F1	2110-0201	0	1	FUSE .25A 250V SLO-BLO 1.25X.25 UL [illegible]	75915	313.250
MP1	5040-7202	0	1	TRIM TOP	28480	5040-7202
MP2	5020-8817	[illegible]	1	FRAME FRONT	28480	5020-8817
MP3	5001-0440	1	2	TRIM SIDE	28480	5001-0440
MP4	03467-01204	3	1	SHIELD ACTUATOR	28480	03467-01204
MP5	03467-21001	8	1	[illegible]	28480	03467-21001
MP6	1390-0460	4	2	LATCH SLIDE	28480	1390-0460
MP7	03467-20202	1	1	[illegible]	28480	03467-20202
MP8A	1510-0084	4	4	BINDING POST ASSY SGL THD-STUD JCK RED	28480	1510-0084
MP8B	1510-0091	6	4	BINDING POST [illegible]	28480	1510-0091
MP9A	0371-1204	5	1	KEY CAP [illegible]	28480	0371-1204
MP9B	5041-0314	[illegible]	2	PUSHBUTTON [illegible]	28480	5041-0314
MP9C	5041-1003	[illegible]	1	PUSHBUTTON [illegible]	28480	5041-1003
MP9D	5041-0807	9	1	PUSHBUTTON [illegible] GRAY 1/2	28480	5041-0807
MP9E	5041-0808	0	1	PUSHBUTTON [illegible] GRAY 1/2	28480	5041-0808
MP9F	5041-0809	1	1	PUSHBUTTON [illegible] GRAY 1/2	28480	5041-0809
MP9G	5041-0810	4	1	PUSHBUTTON [illegible] GRAY 1/2	28480	5041-0810
MP10	03467-24102	4	2	RETAINER HINGE	28480	03467-24102
MP13A	5041-0800	[illegible]	11	PUSHBUTTON [illegible] GRAY	28480	5041-0800
MP13B	5041-0331	[illegible]	1	PUSHBUTTON SOFT GRAY 1/4	28480	5041-0331
MP13C	5041-1003	4	1	PUSHBUTTON ARROW 1/4	28480	5041-1003
MP13D	5041-1002	[illegible]	1	PUSHBUTTON BLUE 1/4	28480	5041-1002
MP14	5041-0816	4	[illegible]	KNOB [illegible] SMOKE GRAY 1/4	28480	5041-0318
MP15	03467-00201	[illegible]	1	FRONT PANEL	28480	03467-00201
MP16	03467-29101	9	1	LENS DISPLAY	28480	03467-29101
MP16	5040-7863	[illegible]	4	WASHER	28480	5040-7863
MP17	5041-1406	[illegible]	[illegible]	COVER [illegible]	28480	5041-1406
MP18	5040-7222	[illegible]	4	FOOT NON SKID	28480	5040-7222
MP19	1460-1345	[illegible]	2	TILT STAND SST	28480	1460-1345
MP20	03467-21201	2	2	SPACER [illegible]	28480	03467-21201
MP21	5040-7209	[illegible]	1	BUTTON COVER	28480	5040-7209
MP22	1390-0408	0	16	GROMMET	28480	1390-0408
MP23	1390-0457	9	16	PLUNGER	28480	1390-0457
MP24	03467-01203	2	1	SHIELD ANALOG BOARD	28480	03467-01203
MP26	5040-7208	[illegible]	1	TOP COVER	28480	5020-7208
MP27	1400-0611	0	1	CLAMP CABLE	28480	1400-0611
MP28	0470-0940	4	1	ADHESIVE DIE CUT	28480	0470-0940
MP29	7120-3530	0	1	LABEL CAUTION	28480	7120-3530
MP30	0340-0673	3	1	INSULATOR REAR PANEL	28480	0340-0673
MP31	03467-24101	7	2	INSULATOR BRACKET	28480	03467-24101
MP32	7122-0026	6	1	PLATE SERIAL	28480	7122-0026
MP34	3050-0005		1	WASHER SHLDR NO. 10 .14 IN ID .375 IN OD	28480	3050-0005
MP35	2360-0210		4	SCREW MACH 6-32 1.375 IN LG PAN HD POZI	00000	ORDER BY DESCRIPTION
MP36	2110-0565	9	1	FUSEHOLDER CAP BAYONET 12A 250V MAX	28480	2110-0565
MP37	2110-0564	8	1	FUSEHOLDER BODY EXTR POST BAYONET CO	28480	2110-0564
MP38	2110-0569	3	1	NUT FUSEHOLDER	28480	2110-0569
P2	1251-4273	1	1	CONNECTOR	28480	1251-4273
Q2	1854-0063	7	2	TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	28480	1854-0063
Q11	1854-0063	7		TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	28480	1854-0063
W1	8120-2710	4	1	CABLE FRONT 20 PIN	28480	8120-2710
	5001-2219	8	1	INFO TRAY	28480	5001-2219
	4040-1416	3	16	SPACER INSULATOR	28480	4040-1416
	9211-2135	4	1	CARTON CORR	28480	9211-2135
	9320-4000	7	1	CARD 1 INFO	28480	9320-4000
	9320-4001	8	1	CARD 2 INFO	28480	9320-4001
	1480-0333	1	2	PIN TAPE [illegible] .062 IN DIA	28480	1480-0333
	1480-0495	8	2	PIN GRV .062 IN DIA .438 IN LG SST 300	28480	1480-0495

Table 7-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			OTHER HARDWARE		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

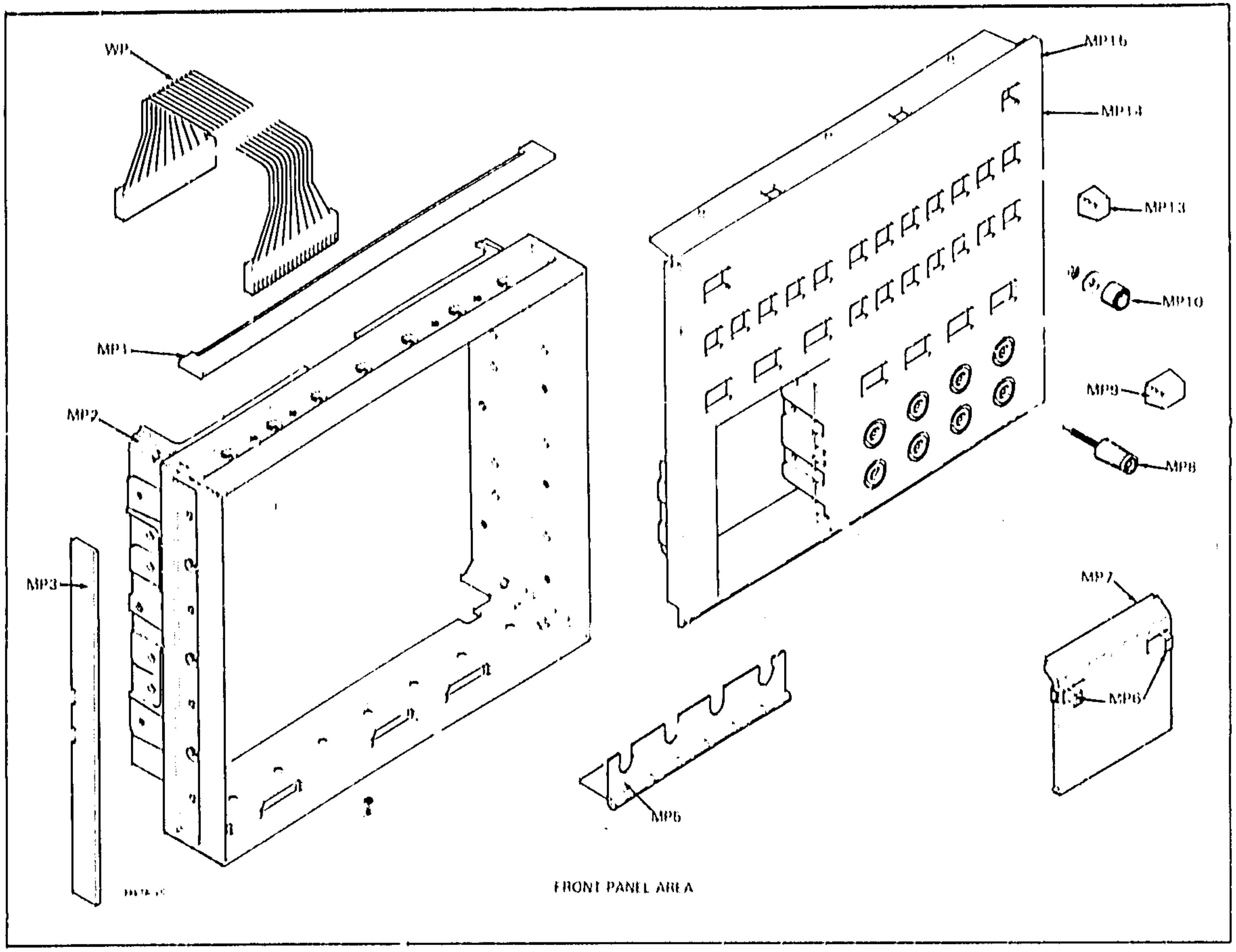


Figure 7-1. Exploded View, Miscellaneous Parts.

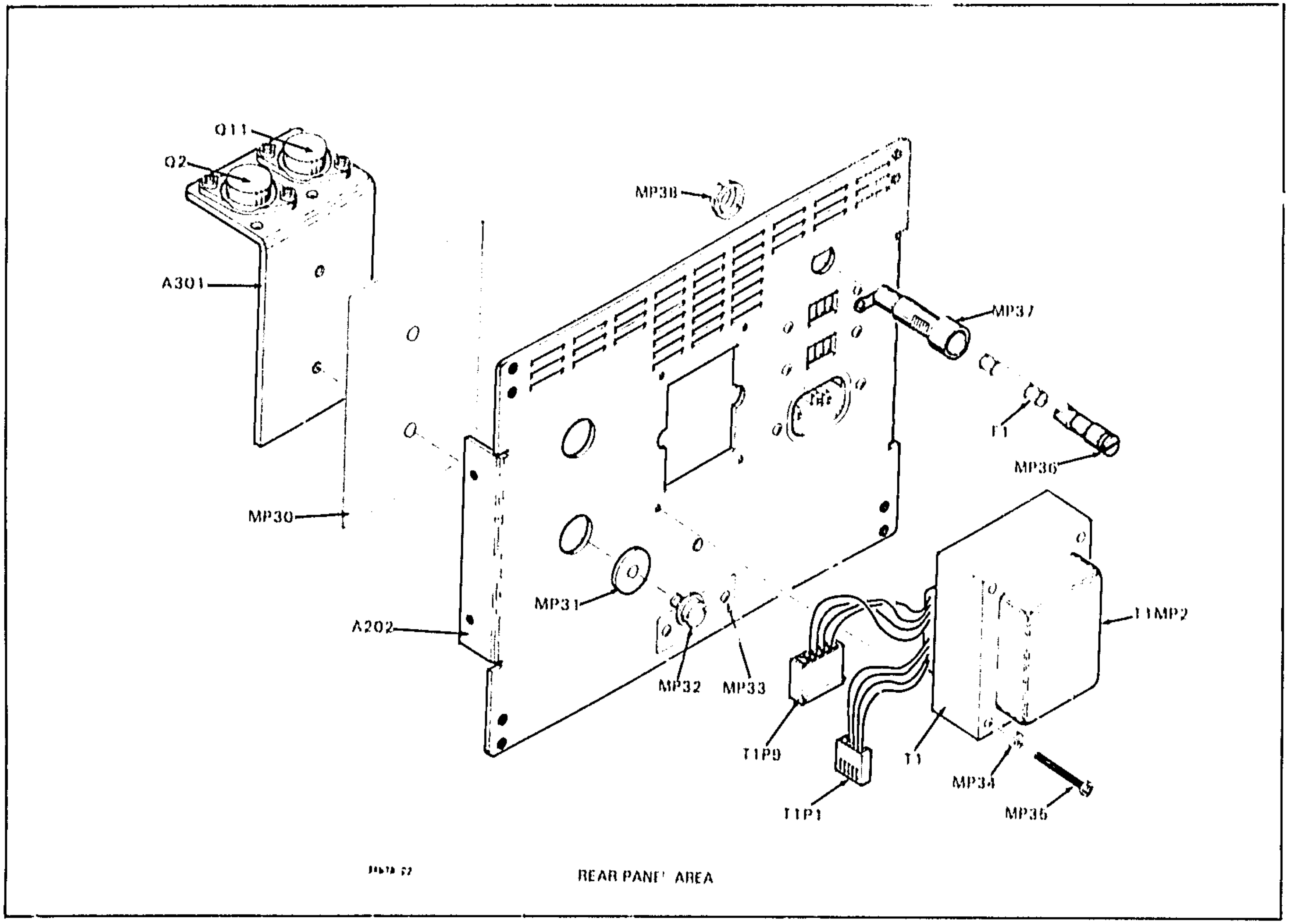


Figure 7-1. Exploded View, Miscellaneous Parts (Cont'd).

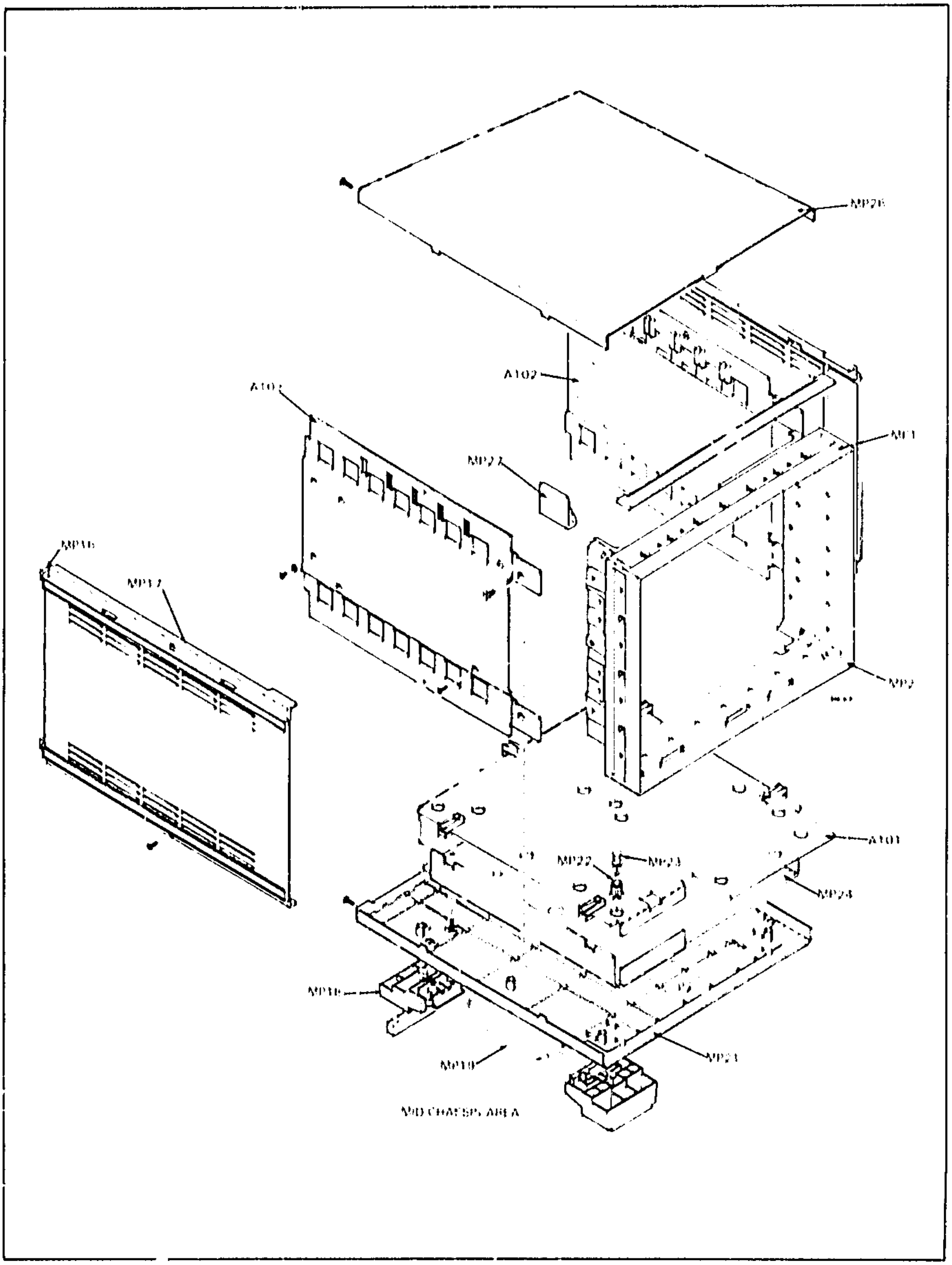


Figure 7-1. Exploded View, Miscellaneous Parts (Cont'd).

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section of the manual contains information on selecting the internally set features of the Logging Multimeter (°C or °F temperature units and "TEXT" or "DATA" character orientation) as well as information and diagrams required for service.

8-3. INTERNAL SWITCH SELECTIONS.

8-4. The following paragraphs describe the switch locations and settings for selecting the TEMP units and printer character orientation of the Logging Multimeter. Access is through the top cover. Refer to Diagram 1 if further illustration is needed for locating A3S1 and S2.

8-5. Selecting °C or °F TEMP Units.

8-6. Temperature measurement units are switch selectable by A3S1. This switch can be set to provide °C or °F units as shown in Figure 8-1.

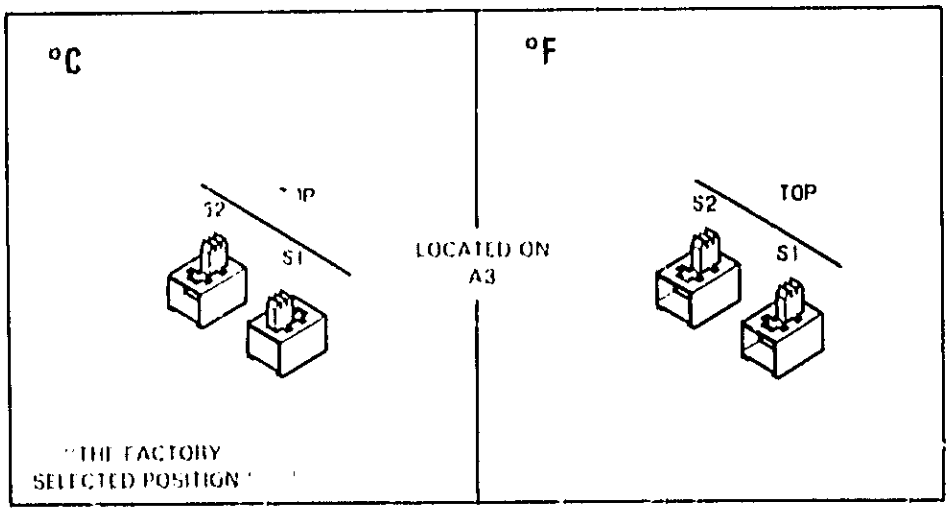


Figure 8-1. Selecting °C or °F TEMP Units.

8-7. Selecting Printer Character Orientation.

8-8. Printer character orientation is switch selectable by A3S2. This switch can be set to provide "DATA" or "TEXT" orientation as shown in Figure 8-2. An explanation of the relative merits of each orientation is given in Section III, "Operating Instructions".

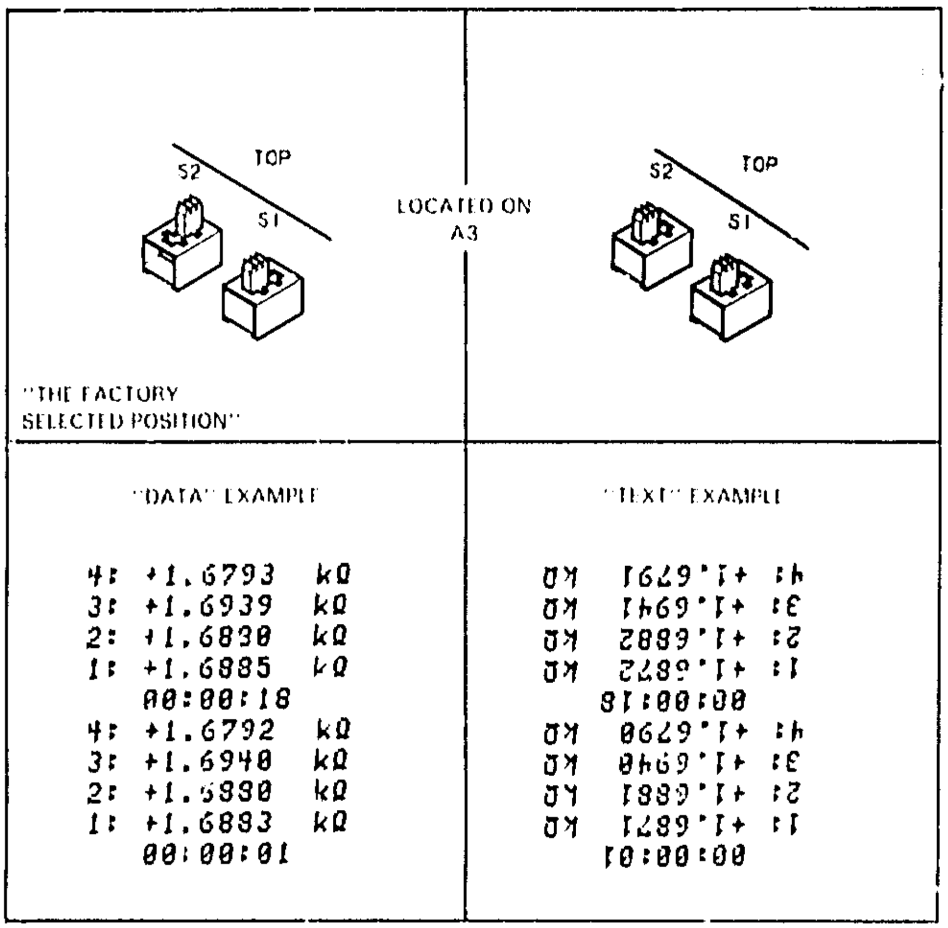


Figure 8-2. Selecting Printer Character Orientation.

Hex Adrs	High Order Select	Select Code(DS) 3	2	1	0	Mnemonic And Name		Contents (D) 7	6	5	4	3	2	1	0
CO	$\overline{DSP}$	0	0	0	0	$\overline{DSP}$	Seg A's Dgt 0 3	$\overline{SD}$				$\overline{b}$	$\overline{b}$	$\overline{b}$	$\overline{b}$
•		•	•	•	•	•		•	•	•	•	•	•	•	•
CF		1	1	1	1	$\overline{DSP}$	Seg B's Dgt 4 7	$\overline{SD}$				$\overline{b}$	$\overline{b}$	$\overline{b}$	$\overline{b}$
FO	$\overline{INT}$	0	0	0	0	$\overline{CHF}$	Chan, Fctn Sel	$\overline{F?}$	$\overline{F4}$	$\overline{F1}$	$\overline{F2}$	$\overline{CH4}$	$\overline{CH3}$	$\overline{CH2}$	$\overline{CH1}$
								MATH				CODE			
F1		0	0	0	1	$\overline{MOM}$	Mom Switch Sel	C	B	A	DAV	D	C	B	A
F2		0	0	1	0	$\overline{SGL}$	Misc Sig Sel	$\overline{HOLD}$	SYNC	$\overline{HOME}$	OOPS	$\overline{ENT}$		S2	S1
F3		0	0	1	1	$\overline{TIM}$	Timer Data Sel		$\overline{TSEC}$	$\overline{START}$	$\overline{X10}$	$\overline{X6}$	X3	$\overline{MIN}$	$\overline{SEC}$
F4		0	1	0	0	$\overline{TRE}$	Timer Reset				SINGLE LINE (FLAG)				
F5		0	1	0	1	$\overline{READ}$	LP RAM Read Sel	$\overline{IFO}$	MOK			RD3	RD2	RD1	RD0
F6		0	1	1	0	WRITE	LP RAM Write Sel					RD3	RD2	RD1	RD0
F7		0	1	1	1	ADDR	LP RAM Adrs Sel			RA5	RA4	RA3	RA2	RA1	RA0
						WRITE LATCHES									
F8	$\overline{INT}$	1	0	0	0	REL	Scnr, Fctn Relays		SE	$\underline{SNB}$	$\underline{SNA}$	FE	TEMP	FNC	FNB
F9		1	0	0	1	VMC	Voltmeter Control	TST		$\overline{CD}$	MAN	RC	RGF	RGF	RFD
FB		1	0	1	1	PRT	Printer Data, Cont	PR	R7	R6	R5	R4	R3	R2	R1
						READ BUFFERS									
F9	$\overline{INT}$	1	0	0	1	$\overline{VMD}$	Voltmeter Data	AZL	IOF	IOD		D4D	D4C	D4B	D4A

MNEMONICS

ADDR	LP Ram Address Select
$\overline{AZL}$	Close Auto Zero Loop
$\overline{b}$	Segment On
BRK	Break Printer Travel
CD	Clock Disable
$\overline{CHF}$	Channel & Function Select
CHX	Channel X Switch Line
CODE A D	Momentary Switch Code
DAV	Momentary Data Valid
D4X	Least Significant Digit Code X
DGD	Digital Ground
DIGX	Display Digit X
$\overline{DSP}$	Display RAM Select
DX	Data Bus Line X
DSX	Device Select Line X
E	MPU Enable Output Line
$\overline{ENA}$	Enable Vc Charge
$\overline{ENT}$	Y Switch Line
EX & X	MPU Clock Inputs
$\overline{FE}$	Function Relay Enable
FKZ	60 kHz Clock
FWD	Forward Printer Travel
$\overline{FX}$	Function Switch Line X
FNX	Function Code Line X
GRD	Switch Guard
G2	Q202 On
G3	Q20. On
HKZ	100 kHz clock
$\overline{HOLD}$	Range Hold Switch Line
$\overline{HOME}$	Print at Home
$\overline{INT}$	Internal Device Select
IOD	A4U1 Serial Output
IOF	Flag for IOD
$\overline{IRQ}$	MPU Interrupt Request
$\overline{KO}$	K Ohms Function Line
LID	Number of Ranges Control
LODC	Input Hybrid + 200 mV Line
MAN	A4U1 Manual Range Control
MATH A C	Math Switch Lines
MCK	1 MHz Clock
$\overline{MIN}$	Minute Switch Line
MOK	LP RAM OK
$\overline{MOM}$	Momentary Switches Select
$\overline{OOPS}$	Out of Paper Switch
OSC	A4U1 Clock
$\overline{O7}$	μV, Ω Zero Switch
PON	Power On
PR	Printer Reverse Control
PRT	Printer Data Select
RAX	LP RAM Address Bit X
R $\overline{W}$	MPU Read Write Line
RC	Range Control On
$\overline{READ}$	LP RAM Read Select
$\overline{RES}$	MPU Reset Interrupt
REV	Reverse Printer Travel
RMM	A4U1 Ramp Minus
$\overline{RMM}$	Hybrid's Ramp Minus
RMP	A4U1 Ramp Postive
$\overline{RMP}$	Hybrid's Ramp Positive
RUC	Run Up Clock
$\overline{RUE}$	Run Up Enable
$\overline{RUN}$	Normal Run Position A4S1
RX	Printer DOT X
RGX	Range Code Line X
SD	Display Scan Disable
SE	Scanner Relay Enable
$\overline{SEC}$	Second Switch Line
$\overline{SEGX}$	Display Segment X
$\overline{SGL}$	Miscellaneous Signals Select
SKZ	6 25 kHz Clock
SNX	Scanner Code Line X
$\overline{START}$	Start Switch Line
STB	Print Head Data Strobe
STE 2	Step Digit Code
SYNC	Display Syncronization
S1	"F"
S2	"DATA"
TEMP	Temperature Reference
$\overline{TIM}$	Timer Data Select
$\overline{X3}$ $\overline{X10}$	Interval Switch Lines
$\overline{TRE}$	Timer Reset Select
$\overline{TSEC}$	Timer Second
TST	8000 Count Test Position A4S1
V BUS	Valid Bus Address
Vc	Low Power Retention Supply
VDAT	Valid Data On Bus
VDEV	Valid I/O Device Address
VM	Printer Motor EMF Sample
VMA	MPU Valid Memory Address Output Line
VMC	Voltmeter Control Select
$\overline{VMD}$	Voltmeter Data Select
VROM	Valid ROM Address & Data
WRITE	LP RAM Write Select

Table 8-1-A. I/O Device Map And Mnemonics.
(Fold-Out Reference For Preceeding Sections)

Hex Adrs	High Order Select	Select Code(DS) 3	2	1	0	Mnemonic And Name		Contents (D) 7	6	5	4	3	2	1	0
C0	DSP	0	0	0	0	DSP	Seg A's Dgt 0 3	SD				b	b	b	b
•		•	•	•	•	•		•	•	•	•	•	•	•	•
CF		1	1	1	1	DSP	Seg B's Dgt 4 7	SD				b	b	b	b
F0	INT	0	0	0	0	CHF	Chan Fctn Sel	F3	F4	F1	F2	CH4	CH3	CH2	CH1
								MATH				CODE			
F1		0	0	0	1	MOM	Main Switch Sel	C	B	A	DAV	D	C	B	A
F2		0	0	1	0	SGL	Misc Sig Sel	HOLD	SYNC	HOME	OOPS	ENT		S2	S1
F3		0	0	1	1	TIM	Timer Data Sel		TSEC	START	X10	X6	X3	MIN	SEC
											SINGLE LINE FLAGS				
F4		0	1	0	0	TRI	Timer Reset								
F5		0	1	0	1	READ	LP RAM Read Sel	IRQ	MOK			RD3	RD2	RD1	RD0
F6		0	1	1	0	WRITE	LP RAM Write Sel					RD3	RD2	RD1	RD0
F7		0	1	1	1	ADDR	LP RAM Adrs Sel			RA5	RA4	RA3	RA2	RA1	RA0
						WRITE LATCHES									
F8	INT	1	0	0	0	RFL	Scnr Fctn Relays		SE	SNB	SNA	FE	TEMP	FNC	FNB
F9		1	0	0	1	VMC	Voltmeter Control	TST		CD	MAN	RC	RGF	RGF	RED
FB		1	0	1	1	PRT	Printer Data, Cont	PR	R7	R6	R5	R4	R3	R2	R1
						READ BUFFERS									
F9	INT	1	0	0	1	VMD	Voltmeter Data	AZL	IOF	IOD		D4D	D4C	D4B	D4A

MNEMONICS

ADDR	LP Ram Address Select
AZL	Close Auto Zero Loop
bx	Segment On
BRK	Break Printer Travel
CD	Clock Disable
CHF	Channel & Function Select
CHX	Channel X Switch Line
CODE A D	Momentary Switch Code
DAV	Momentary Data Valid
DSX	Least Significant Digit Code X
DGD	Digital Ground
DIGX	Display Digit X
DSP	Display RAM Select
DX	Data Bus Line X
DSX	Device Select Line X
E	MPU Enable Output Line
ENA	Enable Vc Charge
ENT	Y Switch Line
EX & X	MPU Clock Inputs
FE	Function Relay Enable
FKZ	60 KHz Clock
FWD	Forward Printer Travel
FX	Function Switch Line X
FNX	Function Code Line X
GRD	Switch Guard
G2	Q202 On
G3	Q203 On
HKZ	100 KHz Clock
HOLD	Range Hold Switch Line
HOME	Printer Home
INT	Internal Device Select
IOD	A4U1 Serial Output
IOF	Flag for IOD
IRQ	MPU Interrupt Request
KO	K Ohms Function Line
LID	Number of Ranges Control
LODC	Input Hybrid > 200 mV Line
MAN	A4U1 Manual Range Control
MATH A C	Math Switch Lines
MCK	1 MHz Clock
MIN	Minute Switch Line
MOK	LP RAM OK
MOM	Momentary Switches Select
OOPS	Out of Paper Switch
OSC	A4U1 Clock
O2	µV, Ω Zero Switch
PON	Power On
PR	Printer Reverse Control
PRT	Printer Data Select
RAX	LP RAM Address Bit X
R W	MPU Read Write Line
RC	Range Control On
READ	LP RAM Read Select
RES	MPU Reset Interrupt
REV	Reverse Printer Travel
RMM	A4U1 Ramp Minus
RMMF	Hybrid's Ramp Minus
RMP	A4U1 Ramp Positive
RMP	Hybrid's Ramp Positive
RUC	Run Up Clock
RUE	Run Up Enable
RUN	Normal Run Position A4S1
RX	Printer DOT X
RGX	Range Code Line X
SD	Display Scan Disable
SE	Scanner Ref Enable
SEC	Second Switch Line
SEGX	Display Segment X
SGL	Miscellaneous Signals Select
SKZ	6.25 KHz Clock
SNX	Scanner Code Line X
START	Start Switch Line
STB	Print Head Data Strobe
STT 2	Step Digit Code
SYNC	Display Synchronization
S1	
S2	DATA
TEMP	Temperature Reference
TIM	Timer Data Select
X3 X10	Interval Switch Lines
TRI	Timer Reset Select
TSEC	Timer Second
TST	8000 Count Test Position A4S1
V BUS	Valid Bus Address
Vc	Low Power Retention Supply
VDAT	Valid Data On Bus
VDEV	Valid I O Device Address
VM	Printer Motor EMF Sample
VMA	MPU Valid Memory Address Output Line
VMC	Voltmeter Control Select
VMD	Voltmeter Data Select
VROM	Valid ROM Address & Data
WRITE	LP RAM Write Select

Table 8-1-B. I/O Device Map And Mnemonics.
(Fold-Out Reference For Remainder Of Service Section)

SERVICE INFORMATION SUMMARY

8-9. THEORY OF OPERATION.

8-10. Should any further understanding of the Logging Multimeter theory of operation be required, refer to Section IV where theory of operation material is presented. Theory pertaining to service is included throughout this section where appropriate.

NOTE

The remaining information in this section is cross-indexed by the "Service Information Summary" near Table 8-1-B and Appendix A, "Subject Index" at the end of this manual.

8-11. RECOMMENDED SERVICE EQUIPMENT.

8-12. The equipment listed in Table 8-2 is recommended for troubleshooting and repairing the Logging Multimeter.

CAUTION

Do not attempt to use a Logging Multimeter to "troubleshoot itself." Damage to the instrument may result.

Table 8-2. Recommended Service Equipment.

Equipment Type	Use	Recommended Model
Digital Voltmeter	Power Supply Troubleshooting	-hp- 3466A
Current Tracer	Power Supply Troubleshooting	-hp- 547A
Oscilloscope	Analog & Digital Troubleshooting Signal Tracing	-hp- 1740A
DC Power Supply	DCV Input Source Signal Tracing	-hp- 740B
Oscillator	ACV Input Source Signal Tracing	-hp- 745A
Resistor Decade Box	Ohms Input Source Signal Tracing	G.R. 1433-H
Signature Analyzer	"Digital Test"	-hp- 5004A
Logic Probe	Digital Troubleshooting	-hp- 545A
Logic Pulser	Digital Troubleshooting	-hp- 546A
Extender Boards (Qty of 2)	Digital Troubleshooting	-hp-5060-0049 (2 supplied with instrument)
Conductive Wrist Bands	Analog Service	-hp- 00970-67900
Cotton Gloves	Analog Service	-hp- 8090-0512

8-13. ACCESS.

8-14. Access to the Logging Multimeter internal circuitry is obtained as described here.

A9 Analog Board	- Remove bottom cover. Board is mounted component side *down.*
A1-thru-A5 Digital Boards	- Remove top cover.
A6-thru-A8 Front Panel Assemblies	- Remove edge trim along front top. The front panel is hinged and will swing down after sufficient force is supplied down and forward on the plastic pins which hold the panel in place. The A8 assembly is mounted component side *down.*

Refer to Schematic I for illustrations showing access to these three areas.

WARNING

"LO" is tied to internal sheet metal. Do not service the Logging Multimeter with voltage applied to the "LO" terminals.

8-15. THE SERVICE PROCESS.

8-16. The Logging Multimeter service process consists of:

Preliminary Troubleshooting
- Visual Checks
- Power Supply Checks

Troubleshooting
- Symptom Analysis with Self-Test
- Fault Isolation and Repair using Signature Analysis (SA) for Digital Based Faults and Conventional Signal tracing for Analog Based Faults.

The *entire* process may not be required if enough symptom information is available on the instrument to proceed to fault isolation and repair. Fault isolation below the board level may not be required if a convenient method of "Board Swapping" exists. Component level repair on the malfunctioning board can then proceed with minimum instrument down time.

8-17. PRELIMINARY TROUBLESHOOTING.

8-18. Inspection.

8-19. Before beginning an in-depth service procedure, check the Logging Multimeter for visual signs of trouble. These include burnt or loose components, loose or broken connectors, and possible shorted or open conductors.

NOTE

Pay particular attention to switches, relays, and other moving parts.

8-20. Input Fusing.

8-21. Both the HI and LOW input lines on each channel are fused to provide added protection to external circuitry and the Logging Multimeter. Loss of measurement ability on a distinct channel is indicative of a blown fuse or faulty relay. Channel fuses and relays can be located on the A9 board component locator and replaced if necessary. Use only Part Number 3110-0093 fuses.

8-22. Interconnection.

8-23. Check the cables! A misplaced or loose cable is a typical cause of improper operation. Schematic 1 will help verify the proper board interconnection.

8-24. Service Switches.

8-25. The "8000 Count" test switch A4S1 and the "Secondary SA" switch A2S1 should both be in the normal operating position ("RUN") or the Logging Multimeter will not operate properly. Use of these two switches is described in this section. Be sure to return them to the "RUN" position after the service process is complete.

Symptoms

A4S1 - No readings above approximately 8000 counts
A2S1 - Display blank

8-26. Supply Splitting.

8-27. A system of power supply jumpers and jumper (0Ω) resistors is used on the Logging Multimeter analog and digital boards as a service aid for identifying low resistive paths to ground (shorted IC's, etc.). A current tracer (-hp- 547A) is a handy piece of equipment for locating the specific component out of those indicated from supply splitting. The schematics distinquish between split supplies with prime (') notations.

8-28. Analog Supply Splitting. The analog power supply jumpers are labeled on the A9 component locator on the apron page of Schematic 8. A figure on the servicing notes page preceeding Schematic 1 shows how the analog supplies are split and distributed to various components. The -2.6V bias supply can be similarily removed from A4U1 by removing cable W9-1 and from A9U601 by removing JM902. When the supply returns to the correct value the component just removed from it is the cause of loading.

8-29. Digital Supply Splitting. The digital power supply jumpers and jumper resistors split the supplies on each digital board. Their locations are given by the component locators on the schematic apron pages. Prime (') notations are used to distinquish between split supplies throughout the schematics.

8-30. Pass Transistors. The digital supply pass transistors (Q2 & Q11) are mounted on a chasis sink shelf at the rear of the Logging Multimeter. The resistance between cases (collectors) on these transistors should be ≅ 0Ω for proper operation. The resistance from shelf-to-chassis should be an open circuit. The shelf may be removed to access the transistor sockets by turning the large white mounting screws located on the rear panel about 1/4 turn counterclockwise.

8-31. USING SELF-TEST TO TROUBLESHOOT.

8-32. The Logging Multimeter self-test feature is a convenient method for diagnosing malfunctions through symptoms. The four parts of the operational verification can be performed individually or in combinations. Combination tests are continually performed (scanned) in a 4-1-2-3 order. We recommend selecting the most appropriate test and cycling the "line" switch. This will continuously perform the test, and also verify the proper "line" switch shorting action on the power-fail supply, V_{L}.

8-33. With a little knowledge of the Logging Multimeter, the results of the self-tests can provide a considerable number of clues to the nature and cause of instrument malfunctions. The fifth self-test, the digital test, is a concentrateable Signature Analysis (SA) test. The test can selectively exercise any one of the four Logging Multimeter digital boards and makes a powerful and convenient service aid. The "8000 count" test is another service aid which is valuable for analog circuitry troubleshooting. Making proper use of these powerful and informative service features, the service process on the Logging Multimeter becomes inherently easier.

8-34. Interpreting Self-Test Failures.

8-35. Some malfunctions may cause failures in more than one self-test. If the first test does not provide enough circuitry - dependent information to indicate a particular board, try other self-tests as necessary. For example, a faulty annunciator causing an incorrect display in the front panel test (3) may not affect the function and range test (4) but will cause the display test (1) to fail, since *all* annunciators are exercised in self-test 1. With no other symptom information, self-test 1 would be required to differentiate between some front-panel and display malfunctions.

8-36. Operating symptoms along the lines of *inoperative* (vs. out of tolerance) channels, ranges, functions, pushbutton operations (X:Y math, man print, etc.) and/or devices (printer, display, groups of pushbuttons, etc) can supply the information required to suspect a particular board or circuit.

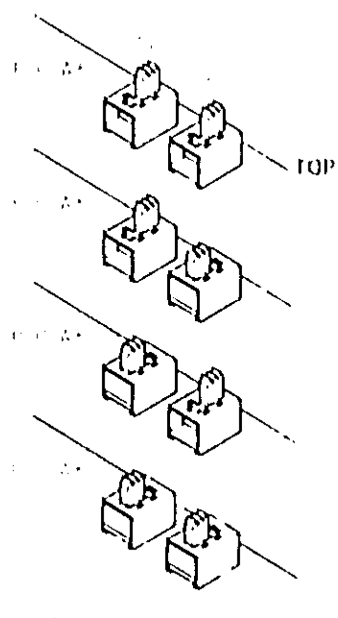
8-37. Table 8-3 lists suspect circuitry for failures in each self-test. Summary information in this table should be considered along with operating symptoms to help identify suspect boards or circuits as quickly as possible. More detailed information is also provided in this section.

Table 8-3. Interpreting Self-Test Failures.

Test Failed	Probable Causes	Service Action	Begins Paragraph
Inability To Enter Test	SOFTWARE HANG UP		
	CMP Stuck in "READ"	"8000 Count" Test thru Comparator	
	SYNC Stuck in "DISP"	Troubleshoot A5 "Display Scanning"	
	HOME Stuck in "PRIN"	Printer Control and Printer	8-46
	HARDWARE		
	4.83 V Adjustment Creating $\overline{IRQ}$	Check Adjustment	
	A2 or A3 Malfunction	Digital Test A2 or A3 Secondary SA if necessary SA2	
1	1 Hz Time Base Display Control Led Segments or Annunciators	Troubleshoot A3 "1 Hz Time Base" Digital Test A5 Part 1 Replace Led(s) or Driver(s) as necessary SA5	8-59
2	Printer Control Printer Assembly	Digital Test A5 Part 2 Exchange AP if necessary SA6	8-64
3	"Er" Low Power RAM circuitry	Digital Test A3 "Low Power Memory" SA3	8-73
	"FP" Switches or Encoder	Replace Switches or Encoder as necessary	
4	Voltmeter Control Chip VMC and VMD Devices or Device Selection	Digital Test A4 (Free Run) Replace A4U1, U16, U17, U20 or U21 as necessary SA4	8-90

8-38. Introduction To The Digital Test 1 2 3 4 TEST

8-39. The Logging Multimeter digital test is a concentrateable signature analysis routine which can be used for identifying faults on any of the four digital boards and digital mother board interconnections. The SA routine operates on a particular board according to the positioning of A3S1 and A3S2 after or before entering digital test. Depressing the "TEST" front panel pushbutton with all four "inputs/select" pushbuttons deselected (released) will initiate digital test. The swich settings for testing each board are:



A2 Processor Board

*A3 I/O and Timing Board

A4 Voltmeter control Logic Board

A5 Display and Printer Control Board

*This is the board tested with the factory selections of S1 and S2 ("DATA" mode and "C).

8-40. Each of these boards has a special SA page preceding its schematic. The front of these pages summarizes the set-ups required and highlights several "key" signatures and/or voltages used to reduce the amount of signature gathering required to locate some malfunctions. The backs contain a complete list of stable signatures for the schematic, followed by a component locator.

8-41. Additional information on control lines, codes, and voltages is summarized into tables on the apron pages of appropriate schematics. Table 8-1-B located earlier in this section is an I/O device map which summarizes the I/O devices (buffers and latches) by select code (address) and contents. This table can be folded out and refered to throughout this section. The mnemonic summary in this table is also useful.

8-42. **Procedure.** The procedure for using signature analysis on a digital board is similar for each one. A few checks on A2 are advised before testing another board, although set-up information is provided with each schematic.

8-43. *General Technique.* Select the appropriate board. Beginning with the signatures on the SA page, check other signatures, working back towards the "source" of the signals. Conceptually this means towards front panel switches and the A-to-D converter for input devices and circuits, and towards the processor data bus for output devices and circuits. The first *correct* "KEY" signature indicates that the cause of the incorrect signatures is that component, another input to that component, or a component conceptually towards the last incorrect signature. This provides a *starting point* for signature tracing close to the malfunctioning component. The complete lists on the back of the SA pages provide the remaining signatures necessary to converge on the malfunctioning component.

8-44. Digital test on A4 is a free run exercise on the board. The Clock, Start, and Stop locations are different and are derived on the A4 board itself.

8-45. Using "KEY" Signatures. Once digital test is operating on the Logging Multimeter, the signatures listed on each SA page can be used to identify the malfunctioning circuit area. The technique of using "KEY" signatures is similar for each schematic.

8-46. Signature Analysis on A2.

8-47. Inability To Enter Test. The ability to enter "Digital Test" requires that a large portion of A2 is functioning properly, as well as portions of A3. The correct +5V signature is a must and verifies that the microprocessor has entered "Digital Test", is correctly performing the SA routine, is properly addressing memory (ROM and Devices), and that the ROM content is correct. A few signal lines can hang-up the processor if stuck in a bad state and should be checked along with the interrupt lines. Refer to Table 8-3.

8-48. Correct +5V Signature. If the +5V signature is correct, "Digital Test" is operative and can be used for troubleshooting. The signatures on SA2 will verify those components that were *not* verified with the +5V signature. This is advisible to avoid the possibility of returning to A2 later in a service process. You're then ready to "Digital Test" other boards.

8-49. Incorrect +5V Signature. If the +5V signature is incorrect, suspect the test set up and/or signature analyzer first, it may save you troubleshooting time. If the set up is correct, the malfunction is directly inhibiting the MPU from entering or performing the SA routine.

NOTE

Ability to enter other self-tests is indicative of a vital channel switch or stuck data bus line.

In this case there is a back-up method for performing signature analysis on the A2 processor board.

8-50. Secondary SA Entry Method. A secondary entry method is provided on the A2 processor board in the form of S1 and the microprocessor data bus pull-up resistors. Setting S1 to the "SA" position tristates the bus read buffer. The pull-up resistors establish logical 1's on all the data bus lines during a "Bus Read" operation which is the proper code for digital test on A2.

8-51. Secondary SA is a convenient method for differentiating between front-panel input circuitry malfunctions and kernel malfunctions (clock, MPU, ROM address decoding, and ROMS). If the +5V signature can still not be obtained through secondary SA, a kernel malfunction exists. If it can be obtained, the malfunction is most likely associated with the circuitry required to read the proper CHF byte from the front panel switches.

8-52. *1 Hz "Glitch".* Signatures obtained through secondary signature analysis will "Glitch" once a second due to the RES pulse from A3. If you prefer, this glitch can be eliminated by jumpering U11 (3) to +5V *after* switching S1 to the "SA" position. If the MPU appears to be "lost" when this is done, remove the jumper momentarily.

NOTE

Jumper this line only after *switching S1 or several signatures may appear incorrect.*

8-53. *Front-Panel Input Malfunction.* Once Secondary SA is operational the remaining A2 components can be checked. The only remaining cause of primary SA failure is in the path from the function and range switches to the data bus (CHF device or stuck node).

8-54. *Kernel Malfunction.* Incorrect Primary and Secondary SA +5V signatures are indicative of a master clock, MPU, ROM address decoding, or ROM malfunction. A continuous interrupt could also cause this. Chip swapping could be tried (MPU & ROMS) or the following pointers may help isolate the problem:

Master Clock	EXtal (U1 (38)) should be a square wave with ≥ 2.0V high and ≤ .8V low at 4 MHz.
Interrupt Lines	IRQ (U1 (4)) should be ≥ 2.0V high and RES should be ≥ 4.0V high.
MPU	Enable (U1 (37)) should be a 1 MHz square wave. High ≥ 2.4V and low ≤ .4V. Each phase should be 500 ns ± 25 ns for symmetry.
	Valid Memory Address (U1 (5)) should be high for falling edge of enable, same voltages.

8-55. If the above conditions are correct, ground HALT, U1 (2), and tie RES, U1 (40) to +5V:

Bus Available, U1 (7), should be ≥ 2.4V high (not used but you can check it).
Valid Memory Address, U1 (5), should be ≤ .4V low.
R/W, U1 (34), should be ≥ 2.4V high.
Data bus, U1 (26-33), should tri-state.
Address bus, U1 (9-20,22-25), should contain next address (indeterminate).

8-56. If these conditions are satisfied, use the VMA, R/$\overline{W}$, and address bus conditions to troubleshoot the ROM I/O device and data bus address decoding circuitry. Lift the HALT jumper as necessary to get a good address for checking the ROM decoding circuitry.

8-57. Display Test 1 2 3 4 TEST

8-58. Pass. The Logging Multimeter has passed this test if it successfully alternates between all LED segments and annunciations on (4 seconds) and no LED segments and annunciators on (2 seconds). Things to check for are:

a. No missing segments or annunciators

b. Consistent Intensity

c. No unusual display flicker

d. Proper alternation times

8-59. Fail. The Logging Multimeter has failed to pass this test if it does not successfully alternate between all led segments and annunciators on, and no LED segments and annunciators on, at 4 and 2 second intervals respectively. Things which indicate this are:

a. No display at all
b. Missing segments or annunciators
c. Inconsistent intensity
d. Exces: display flicker
e. Improper alternation times

8-60. 1 Hz Time-Base Malfunctions, A3. The display test times alternate with the $\overline{TSEC}$ signal generated by the 1 Hz Time Base circuitry on A3. Lack of a display or of proper alternations in the display test may indicate a 1 Hz Time Base malfunction. An electronic counter or scope can be used to troubleshoot this circuit by schematic.

8-61. Signature Analysis on A5 Part 1. A display test failure generally is indicative of a Display Control (P/O A5) or Display (A6) probl. n. Operating symptoms and other self-test results will usually indicate suspect components to begin with. Digital testing on Schematic 5 begins by checking the signatures and voltages on SA5.

8-62. Printer Test. 1 2 3 4 TEST

8-63. Pass. The Logging Multimeter has passed this test if it successfully prints the character set in a manner similar to Figure 8-3 Things to check for are:

a. Consistent Line Length
b. Consistent Line Spacing
c. Consistent Intensity
d. Presence of all dots
e. Correct Home Positioning (left hand wall)

NOTE

The Logging Multimeter makes a slight amount of noise under normal operating conditions. This is natural.

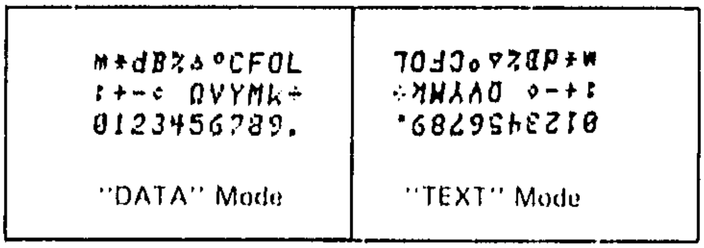


Figure 8-3. Printer Test Passes.

8-64. **Fail.** The Logging Multimeter has failed to pass this test if it does not successfully print the character set. Things which indicate this are:

a. No print at all
b. Inconsistent Line Length
c. Inconsistent Intensity
d. Absence of Dots
e. Incorrect or Missing Characters

8-65. *Signature Analysis On A5 Part II.* A printer test failure is generally indicative of a Printer Control (P/O A5) or Printer (AP) problem. Operating symptoms and other self-test results will usually indicate suspect components to begin with. Digital testing on Schematic 6 begins by checking the signatures and voltages on SA6.

8-66. *Changing The Print Intensity Resistor.* Over a long period of time, the Logging Multimeter printer intensity may decrease slightly. This can be compensated for by increasing the value of the print intensity resistor, R_p, on the printer assembly to obtain an "acceptable" print intensity.

NOTE

If an "acceptable" print intensity cannot be obtained, refer to the following "Exchanging Your Printer Assembly" discussion.

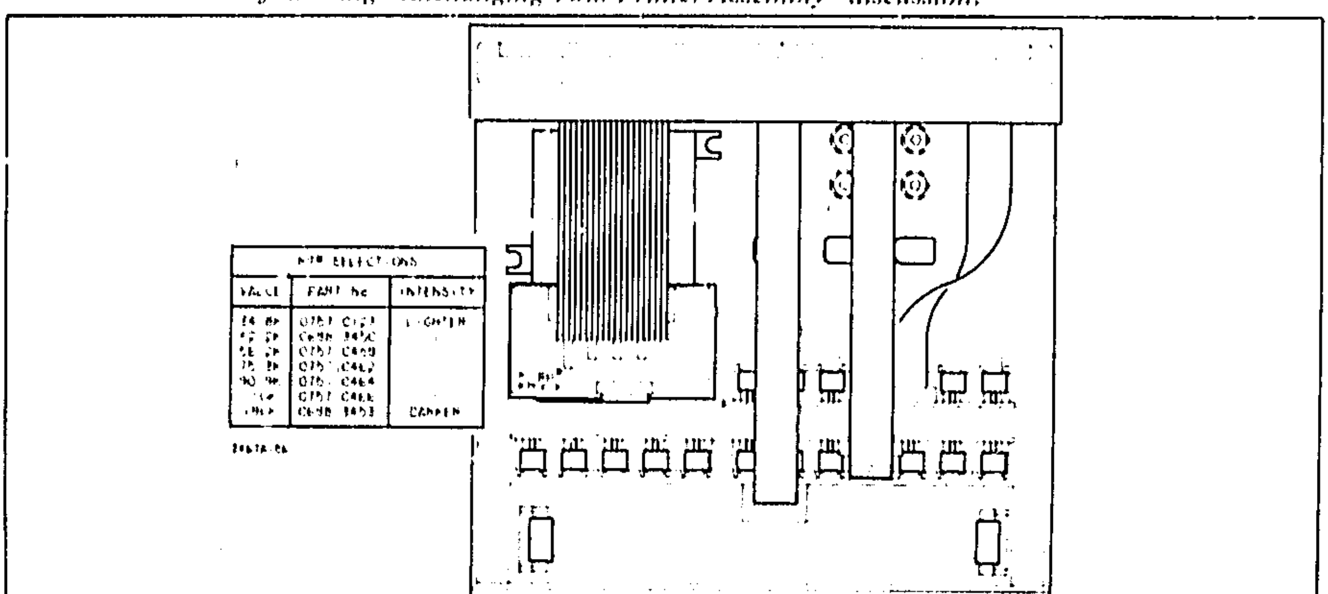


Figure 8-4. Changing The Print Intensity Resistor.

8-67. Exchanging Your Printer Assembly. A malfunctioning thermal printer assembly may be exchanged through your local Hewlett-Packard Sales and Service Office. The repackaging for shipment information in Section II explains how to package your Logging Multimeter or Printer Assembly and what information to include to guarantee the quickest possible turn-around. Be sure to include a copy of the printer test results or another printed sample. The exchange assembly is part number 03467-69501.

8-68. The thermal printer assembly may be removed for exchange without sacrificing the display capabilities of the instrument. In this way you may continue using the Logging Multimeter throughout the exchange process. Figure 8-5 shows the disconnection points and chassis mounting screw locations for removing the printer assembly. Access is through the fold-down front panel. Refer to I for an illustration of front panel access and printer assembly interconnections.

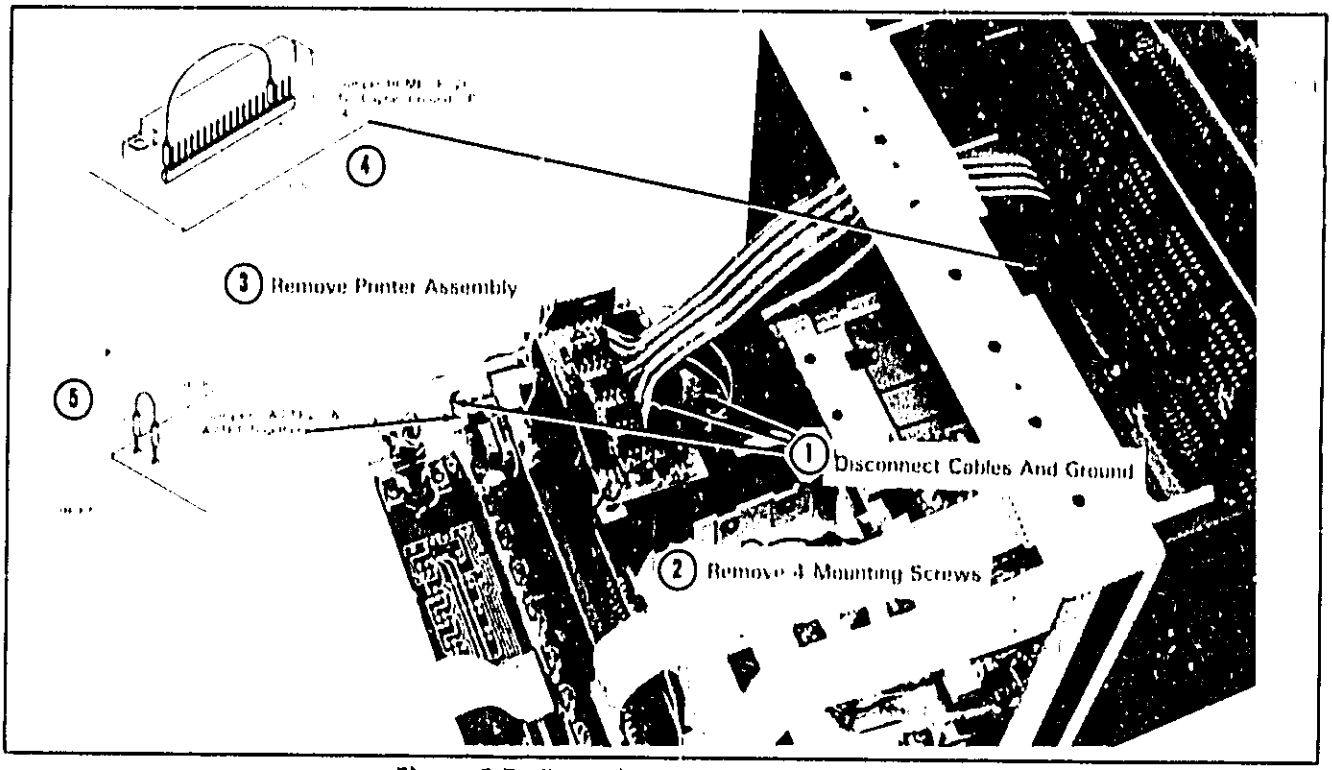


Figure 8-5. Removing The Printer Assembly.

CAUTION Δ^2

Newer printers use plastic mounting studs (vs. captive metal inserts). Do not over tighten (3 inch-pounds maximum torque) or damage may result.

8-69. After removing the printer assembly, short A1JP pin 20 (HOME) to A1JP pin 4 (DGD). This is necessary to allow the Logging Multimeter to operate in the absence of the printer.

8-70. Miscellaneous Printer Replacement Parts. In addition to the print intensity resistor, several other miscellaneous parts are available for the Logging Multimeter printer assembly. The replaceable parts list in Section VII contains the complete list of these.

8-71. Memory And Front Panel Test 1 2 3 4 TEST.

8-72. Pass. The Logging Multimeter has passed this test if the displays resulting from selecting every front panel pushbutton one at a time, and in possible combinations, are correct. Figure 8-6 shows the correct displays for this test without combinations. The display for possible pushbutton combinations should be the logical "OR" of the individual displays. (Does not apply to momentary switch combinations). An "FP" display is indicative of a passed low power memory test.

NOTE

If you are going through individual tests, be sure to do the display test before this one since the display is used here.

8-73. Fail. The Logging Multimeter has failed to pass this test if the displays resulting from selecting the front panel pushbuttons (excluding line switch) are not correct. An "Er" display is also indicative of a test failure.

8-74. 1 Hz Time Base Malfunctions. A faulty timer and some "Display Test" failures are indicative of a 1 Hz time base malfunction.

8-75. Power Up/Down Timing Malfunctions. Improper turn-on or insufficient (lacking) retention are indicative of a power up/down timing malfunction.

8-76. Signature Analysis on A3. A front panel test failure is generally indicative of a switch (A7 or A8), I/O (P/O A3), or low-power RAM problem. An "Er" display in this test is an indication of a low-power RAM addressing or read/write problem. Operating symptoms and other self-test results will usually indicate suspect components to begin with. Complete digital testing on Schematic 3 begins by checking the "KEY" signatures and/or voltages on SA3.

8-77. Function And Range Test 1 2 3 4 TEST.

8-78. Pass. The Logging Multimeter has passed this test if the printed (and displayed) result shows proper ranging on each function as the result in Figure 8-7 does. Things to check for are:

a. All functions are represented in proper order
b. Proper ranges for each function are represented

NOTE

Printing may be suppressed by selecting the blue Y pushbutton.

Start-

PUSH-TO-SELECT PUSHBUTTONS

Pushbutton	Annunciators
SEC	°C
MIN	°F
X3	mV
X6	V
X10	Ω
START	kΩ
HOLD	Wait
Y (ENT)	Y

Leave Selected for Momentaries

MOMENTARY CONTACT PUSHBUTTONS

Pushbutton	Annunciators
PAPER ADV	2,4
MAN PRINT	1,4
sY, Δ ZERO	3,4 (ignore 1 & 2)
STEP	1,2,4
OFF (÷)	1,2,3
Δ (8)	Δ,2
Δ % (8)	Δ%, 1, 2
* (8)	*,3
+ (8)	- 1,3
dB (0)	dB,2,3

-End

Figure 8-6. Memory And Front Panel Test Passes (No Combinations).

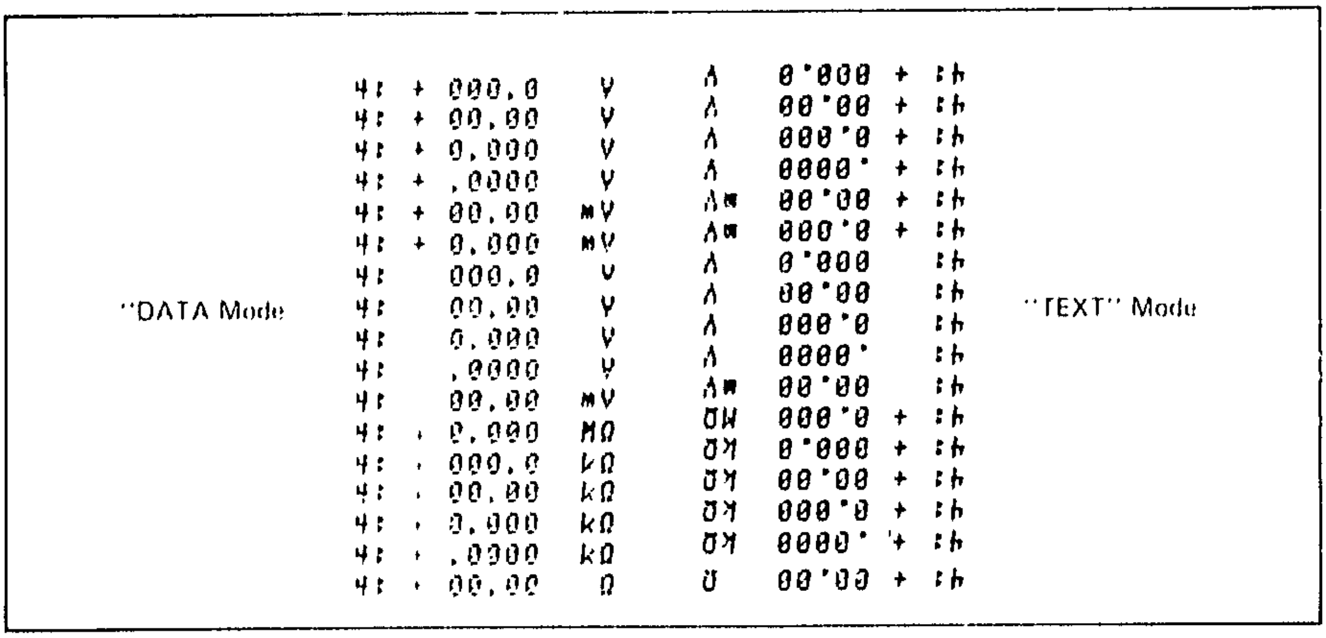


Figure 8-7. Function And Range Test Passes.

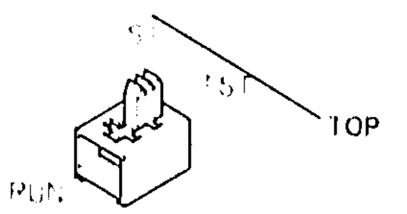
8-79. Analog Service With The "8000 Count" Test. A passed function and range test generally indicates that the voltmeter control chip (A4U1) is accepting function and range information and correctly transferring data to the microprocessor. This means that range, function, or reading operating symptoms most likely result from an Analog Board (A9) problem. The "8000 Count Test" is useful for troubleshooting the analog board.

8-80. "8000 Count" Testing On A9. The "8000 Count Test" uses the run-up clock signal to establish a fixed run-down interval in place of the comparator transition from the analog board. This requires that no comparator transition is received from A9, which can be accomplished by either:

a. Applying an input exceeding 8000 counts
b. Opening (removing) A4 R104, a 0Ω resistor

The fixed 8000 count causes the voltmeter control chip to set consistent measurement intervals independent of range and function. Troubleshooting can then take place by applying an appropriate input and using this to signal trace through the gain processing and A-to-D circuitry. Measurement cycle timing remains constant throughout all ranges and functions tested.

8-81. Selecting the "8000 Count" Test. To select this test, set A4S1 into the "TST" position as shown here:



3467A 58

Ohms function troubleshooting is easiest when the input is left open-circuited to provide the >8000 count input.

NOTE

The "8000 Count" test actually produces a display of ≈ 7600 in the 200 Ω range. This is due to the initial 4 Ω of resistance subtracted from each run-down count to compensate for nominal fuse resistance. Also, stored offsets can affect the value actually displayed up to ±200 counts during the "8000 Count" test. Keep in mind that the exact display is arbitrary as long as the analog circuitry is properly exercised.

NOTE

A saturated amplifier in the signal path can cause the lack of a comparator transition to the Voltmeter Control Logic Section. If the "8000 Count" test passes but a blank display appears when A4S1 is in the "RUN" position, suspect A9U200, U300, U600 or U604. Selecting the ~V function (and clipping JM300 on instruments with serials numbers 1821A-00235 and below) will eliminate A9U200 and U300 from the signal path.

Troubleshooting the DC and AC voltage functions is easiest when A4 R104 is opened, so that input voltages less than 8000 counts can be used.

8-82. Analog Troubleshooting Aids. The A page preceeding Schematic 1 contains several figures and tables useful for signal tracing on A9. The figures and tables summarize stage gains, configurations, relay closures, control lines, and codes, and key test point voltages for the Logging Multimeter functions, ranges, and channel selections.

8-83. Reference designators have been assigned on the analog board according to circuitry functions. Table 8-4 lists the reference designator series used in each major analog board circuit.

Table 8-4. A9 Reference Designator Assignments.

Series	Where Used
000's	Input Scanner and Function Switching Circuitry
100's	Ohms Current Source Circuitry
200's	Input Amplifier Circuitry
300's	Post Amplifier Circuitry
400's	AC Converter Circuitry
500's	+5V Reference Supply Circuitry
600's	Integrator, Slope Amplifier, & Comparator Circuitry
700's	Auto Zero Circuitry
800's	20 mV and 200 mV DCV Switching Circuitry
900's	Analog Supply Circuitry

8-84. Analog Servicing Hints. Here are a few hints pertaining to troubleshooting analog-related malfunctions:

8-85. Power Supplies. The -2.6V supply is dependent on the -7V supply which is dependent on the +7V supply. A malfunction or excessive loading on one will affect the others accordingly.

8-86. ACV Function. Zero input readings up to 50 ±2 counts are possible and normal. This is due to the inherent nonlinearity of the AC converter below 9% of full-scale. If greater, check 20 mV, 20 kHz accuracy. If the accuracy is not within specification a complete adjustment sequence is advised. Inability to adjust back into specification is indicative of a faulty AC converter, U400.

8-87. OHMS Function. Application of excessive input voltages may cause damage to diodes or overvoltage protection components or input amplifier. A general procedure for troubleshooting each area is:

Diode Protection – with 1 kΩ input, 2 kΩ range.

Lift cathode of CR200 and CR203 and anode of CR201 and check for -1V at "Ω LO" test pad. If present, one or more of these protection diodes should be replaced.

Over Voltage Protection - with 1 kΩ input, 2 kΩ range:

Check the DC bias levels of the components. Pay particular attention to R232. The voltages on the schematic apply to this input and range.

Input Amplifier -

Clip JM200 and jumper a 1 kΩ resistor from input HI to JM200 (Input Amp side). Set to 2 KΩ range. The voltage at JM200 (input Amp side) should be -1V. This procedure bypasses K8, K9, and the Overvoltage Protection circuit.

8-88. Noise Isolation (General). Noise problems are among the most difficult to solve when troubleshooting. Some points to remember when searching for noise sources are:

a. It can be generated in early amplifier stages (i.e., input amp) but appear only after amplification.

b. FET's, diodes, zener diodes and other high impedance components can be sources of noise, along with resistors.

c. Defective filter capacitors in power supplies and decoupling capacitors can cause noise problems.

d. Noise can be temperature sensitive.

e. Noise may be external to the instrument (i.e., transinductance in cables, ground loops).

f. Shielding may not be in place.

g. The 60 Hz power line can generate noise.

h. Feedback circuitry may be the source of noise.

i. Cold solder connections on grounds may cause noise.

j. Corroded hardware can cause noise, particularly mechanical ground connections.

k. Relay malfunctions can cause noise.

l. Input protection circuitry can also be a source of noise.

8-89. Noise Isolation (Specific). If more than one function is noisy, the DCV noise should be found first. Many times DC noise will also show up in ACV or kΩ.

a. Check all analog supplies for signs of noise.

b. Check the +5V reference supply at test pad "+5R" for signs of noise.

c. Input amp, U200, may get noisy.

d. Integrator, U600, is a low noise component but may eventually get noisy.

8-90. Fail. the Logging Multimeter has failed to pass test 4 if the printed (and displayed) result does not show proper ranging on each function. Things which indicate this are:

a. No print at all
b. Functions are missing
c. Proper ranges are missing
d. Improper ranges

8-91. Signature Analysis on A4. A function and range test failure is generally indicative of a Voltmeter Control Logic (A4) problem, specifically the Voltmeter Control Chip (A4U1), VMC (A4U16 & U17) and VMD (A4U20) devices, device select decoder (A4U21), or OSC generating circuitry. Operating symptoms and other self-test results will usually indicate suspect components to begin with. Digital testing on Schematic 4 is accomplished with the aid of the Free Run exercise performed by digital test with A4 selected. This exercise connects the OSC signal, a 20kHz clock, to the Voltmeter Control Chip, A4U1. The resulting measurement interval timing establishes changing data throughout the A4 Board. Several stable signatures (particularly on the Voltmeter control Chip) can be obtained by using the HKZ signal as a clock and the AZL line as a start/stop signal. Set-up information and signatures are summarized on the SA4. A4U1 should be thoroughly checked even if the +5V signature on this board is correct.

8-92. Incorrect SA4 +5V Signature. An incorrect +5V signature is indicative of a faulty test set-up or a malfunction in the path between the HKZ clock and the start/stop signal. The most likely component to suspect is the Voltmeter Control Chip, A4U1, if the OSC signal appears correct (10 kHz).

8-93. R206*/R207* PAD CRITERIA.

These resistors zero the Input Amplifier in the 2V DCV range.

NOTE

Replacing R206 and R207* is only required if the Input Hybrid, U201, is replaced.*

a. Cycle the LINE switch ("OFF" and then "ON") to reset any stored offsets.

b. Set the Logging Multimeter to the DCV function, 2V range.

c. Short the input to Channel 3 and select Channel 3.

d. If the reading is .0000V, you're done. If not, remove R206* and R207* and note the reading with them removed, ______.

FOR PRINTED READING

D. Refer to Table 8-5 to select the new pad values for R206* and R207*.

Table 8-5. R206* And R207* Pad Values.

Display Reading	R206*	R207*	-hp- Part Number
≥ + .0002	93.1k	OPEN	0698-4525
+ .0001	187k	OPEN	0698-0077
.0001	OPEN	187k	0698-0077
≥ .0002	OPEN	93.1k	0698-4525

8-94. R4* PAD CRITERIA. Δ2

8-95. This resistor trims the non-inverting mode gain of the input amplifier on the 20 mV and 200 mV dc ranges to within required calibration accuracy. Adding R4* subject to the following pad criteria is recommended on earlier units.

NOTE

Replacing R4 is only required if the Input Hybrid, A9U201, is replaced or after servicing the Input Amplifier section.*

a. Cycle the LINE switch ("OFF" and then "ON") to reset any stored offsets.

b. Set the Logging Multimeter to the dc V function, 200 mV range.

c. Short the input to Channel 3 and select Channel 3.

d. Zero Channel 3 with the μV, Ω zero pushbutton.

e. Set the dc standard (recommend -hp- Model 740B) to .19000 V.

f. Remove the short on Channel 3 and connect the dc standard.

g. Note the Logging Multimeter reading __________.

FOR PRINTED READING

h. Refer to Table 8-6 to select the new pad value for R4*.

Table 8-6. R4* Pad Values.

Display Reading	R4*	-hp- Part Number
+ 190.03	0	8150-3375
+ 190.02	499	0698-4123
+ 190.01	1.00 K	0757-0280
+ 190.00	1.50 K	0757-0427
+ 189.99	2.00 K	0757-0283
+ 189.98	2.49 K	0698-4435
+ 189.97	3.01 K	0757-0273

i. If a new pad value was required for R4*, it will be necessary to perform adjustment [6], the 19.000 V ⎓ adjustment. Refer to Paragraph 6-18 in Section VI.

SERVICE DIAGRAM INDEX

E	Elementary Schematic
I	Interconnection Diagram
A	Analog Troubleshooting Aids
1	Analog Board, A9
SA2	Signature Analysis On The A2 Board
2	Processor Board, A2
SA3	Signature Analysis On The A3 Board
3	I/O And Timing Board, A3
SA4	Signature Analysis On The A4 Board
4	Voltmeter Control Logic, A4
SA5	Signature Analysis On The A5 Board, Part 1
5	Display Control, P/O A5, A6
SA6	Signature Analysis On The A5 Board, Part 2
6	Printer Control, P/O A5, AP
7	Front Panel Switches A7, A8, P/O A1, P/O A6
8	Power Supplies, P/O A9, P/O A1

GENERAL SCHEMATIC NOTES

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

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

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

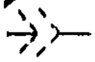
4.  DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5.  DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY.

6. – – – ——— DENOTES ASSEMBLY.

7. ——— or – – – – DENOTES MAIN SIGNAL PATH.

8.  DENOTES SCREWDRIVER ADJUST.

9.  DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

10. \924/ DENOTES WIRE COLOR. COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIPE, THIRD NUMBER IDENTIFIES NARROWER STRIPE, e.g. 924 WHITE, RED, YELLOW.

11. RELAYS WITHIN MAIN SIGNAL PATHS ARE SHOWN ENERGIZED.

12. ▭ DENOTES FRONT PANEL MARKING.

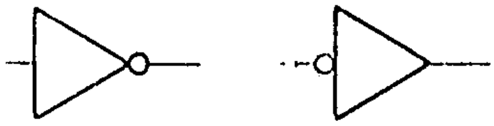
13. EACH GATE IS INDIVIDUALLY DEPICTED BY ITS LOGICALLY EQUIVALENT "OR" "AND" SYMBOL ACCORDING TO ITS USE IN THE CIRCUIT. NOTICE THE LOGICAL EQUIVALENCE OF THE "NOR" GATE AND THE "AND" GATE WITH INVERTED INPUTS, AND OF THE "NAND" GATE AND THE "OR" GATE WITH INVERTED INPUTS.

14. SIGNAL NAMES ON THE SCHEMATICS USE POSITIVE LOGIC AND LOGICAL INVERSION BARS (A, ETC.) TO DENOTE ACTIVE STATES.

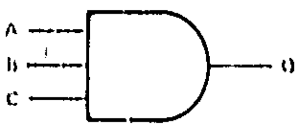
15. INPUT AMP (A9U201) AND INTEGRATOR (A9U501) HYBRIDS' MOS FET SWITCHING AND INTERNAL RESISTORS ARE SHOWN FOR CLARIFICATION ONLY AND ARE NOT SERVICEABLE.

16.  DENOTES A HIGH IMPEDANCE NODE (TEFLON SOLDER CUP).

17.  DENOTES SERVICING MATERIAL ON PAGE A OR SCHEMATIC APRON PAGE.

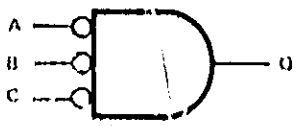


DENOTES INVERTER



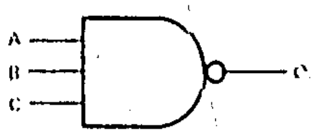
DENOTES "AND" GATE

A	B	C	O
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



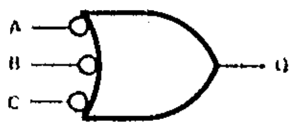
DENOTES "AND" GATE WITH INVERTED INPUTS

A	B	C	O
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0



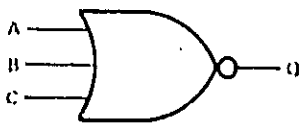
DENOTES "NAND" GATE "AND" WITH INVERTED OUTPUT.

A	B	C	O
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



DENOTES "OR" GATE WITH INVERTED INPUTS.

A	B	C	O
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



DENOTES "NOR" GATE "OR" WITH INVERTED OUTPUT

A	B	C	O
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

E

Figure 8-8. Elementary Schematic.

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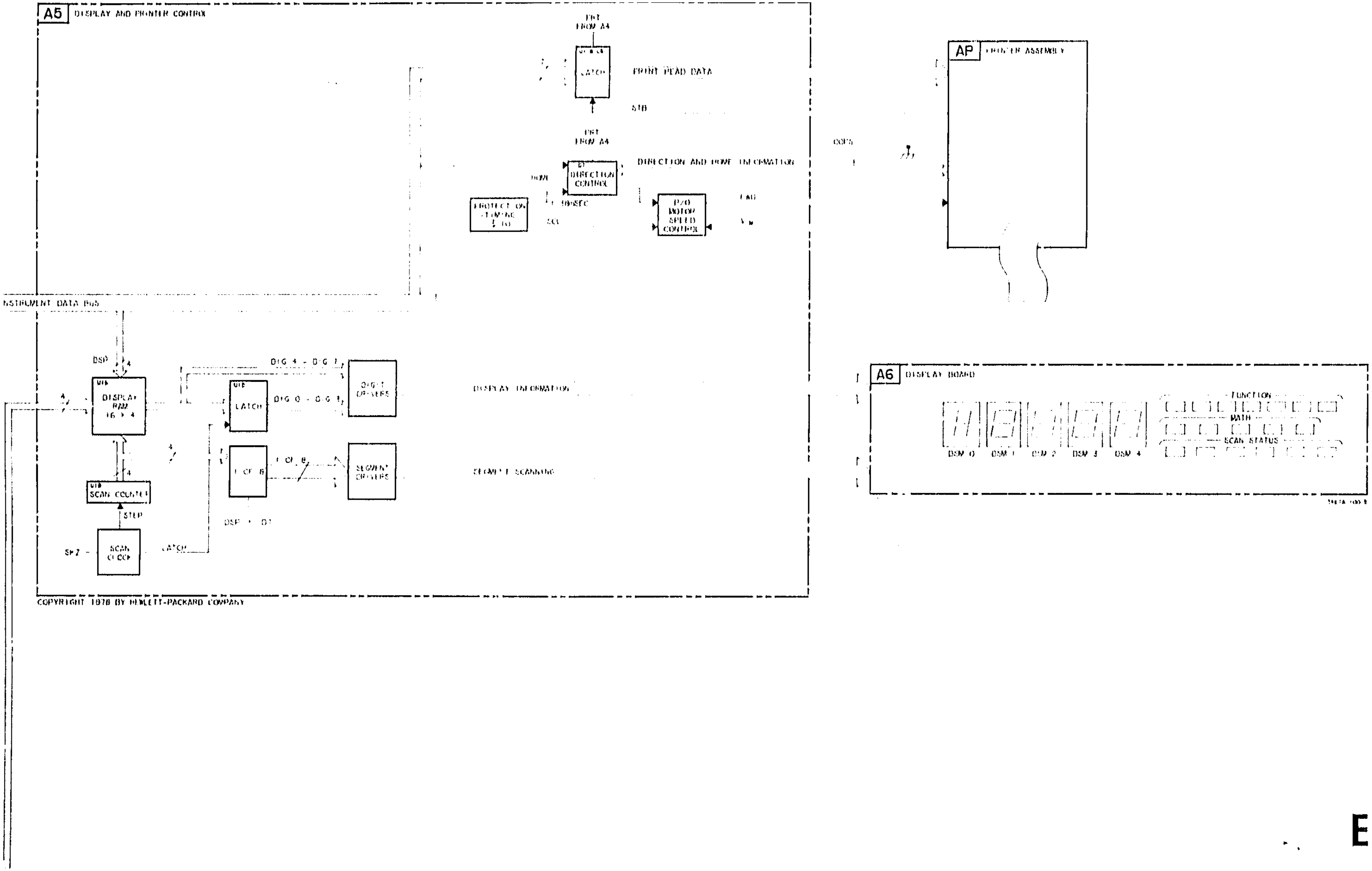
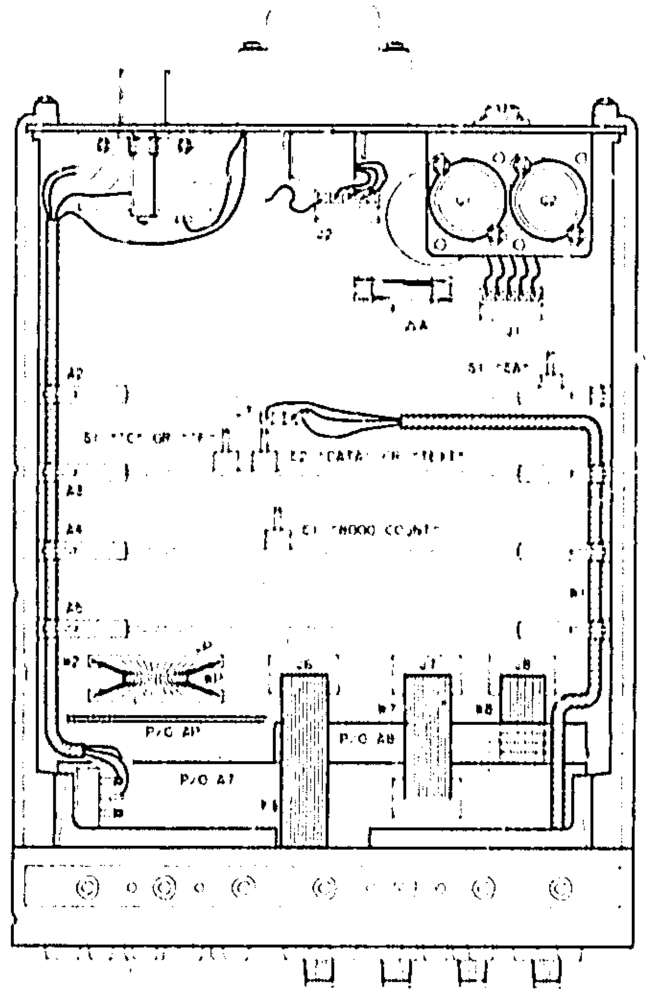
E

Figure 8-8. Elementary Schematic (Cont'd).

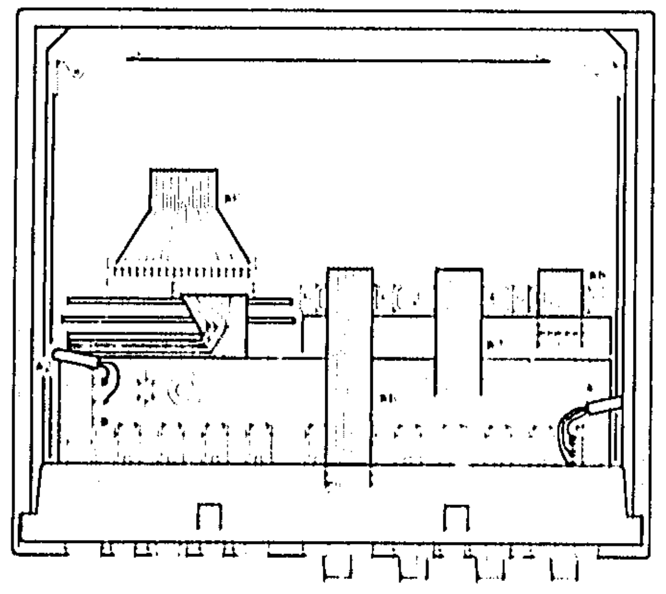


E

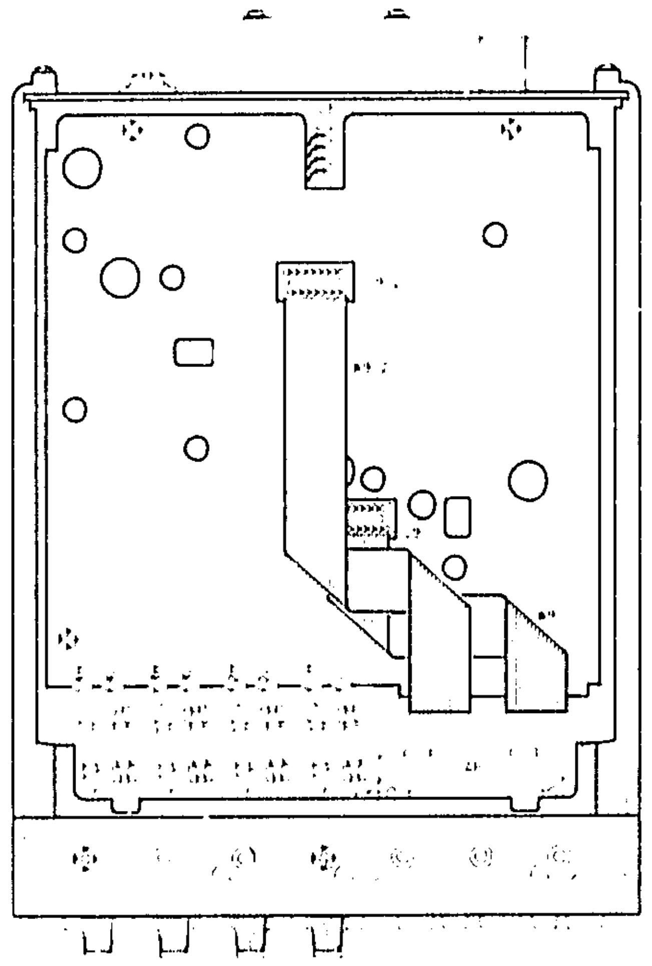
Figure 8-8. Elementary Schematic (Cont'd).



TOP VIEW



FRONT VIEW



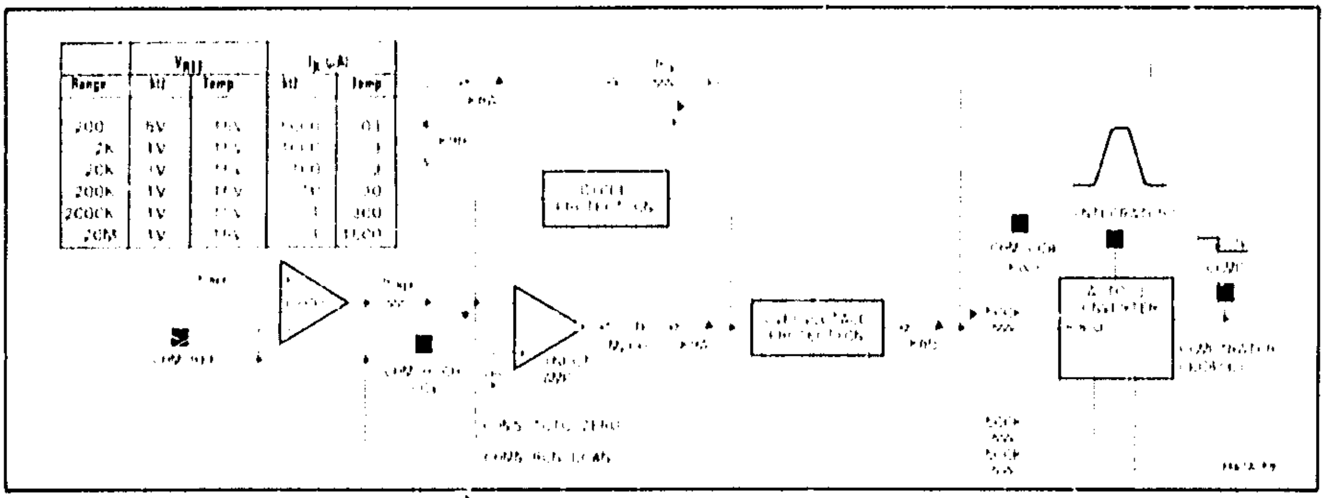
BOTTOM VIEW

igure 8-9. Interconnection Di igram.

ANALOG TROUBLESHOOTING AIDS.

① DC And AC Gain Configurations.

	Range/Input (A)	Function Relay (B)	Input Amp Gain	JM200 (C)	Post Amp Gain	JM300 (D)	Comparator "Comp" U604 (8) DCV / -DCV
DCV	20mV/10mV	K7	10	+100mV	10	1V	
	200mV/100mV		1	+100mV	10	1V	
	2V/1V	K5	.1	.1V	10	+1V	
	20V/10V		1	.1V	1	+1V	
	200V/100V		001	.1V	10	+1V	
	350V/300V		001	.3V	1	+.3V	
ACV	200mV/100mV	K6	.5	50mV	10	.5V	
	2V/1V		.5	.5V	1	.5V	
	20V/10V		.005	.05V	10	.5V	
	200V/100V		.005	.5V	1	.5V	
	250V/200V		.005*	.1V	1	.1V	
			*Includes X.1 Passive Attenuation				



② kΩ And Temp Configuration.

A

Turn this page for more Analog Servicing Aids

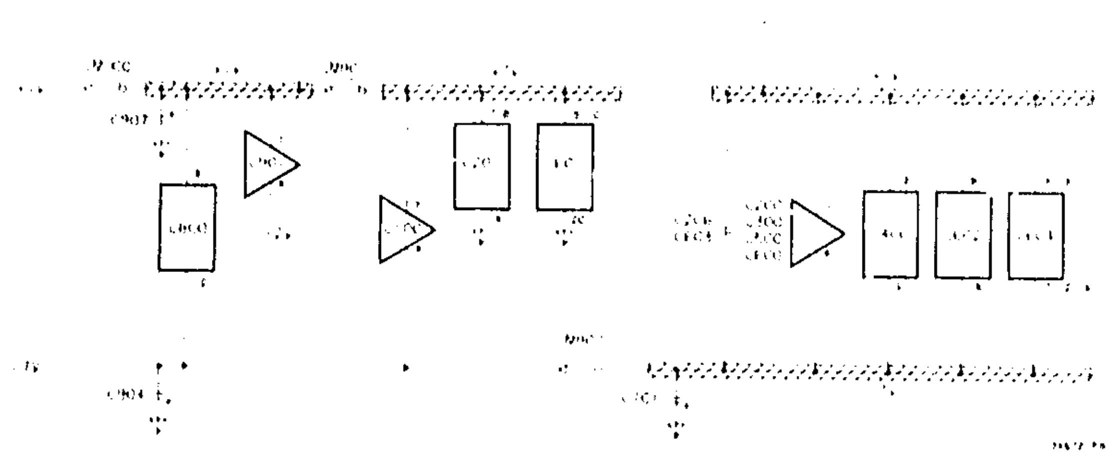
③ Function, Range, And Scanner Control.

Function	Hybrid Code* (FN)	Relay Code** (FN)	Range	Code* (RG)			Function Relay	Other Control Lines (FC = 0 For Each)			
	CB	C'B'		F	E	D		LODC	G2	G3	
⎓V	01	01	20mV	0	1	0	K7	1	1	0	
			200mV	0	0	0	K7	1	1	0	
			2V	0	0	1	K5	0	0	1	
			20V	0	1	1	K5	0	0	1	
			200V	1	1	1	K5	0	0	1	
			350V	1	1	0	K5	0	0	1	
								G2		G3	
~V	10	10									
			200mV	0	0	0	K6	0		1	
			2V	0	0	1	K6	0		1	
			20V	0	1	1	K6	0		1	
			200V	1	1	1	K6	0		1	
			250V	1	1	0	K6	0		1	
								kΩ		Temp	
								200Ω	V_{REF}	Temp	V_{REF}
kΩ/Temp	11	11	200Ω	0	1	0	K8,K9	1	.5V	1	15V
			200Ω	0	0	0	K8,K9	1	.5V	1	15V
			2kΩ	0	0	1	K8,K9	0	1V	1	15V
			20kΩ	0	1	1	K8,K9	0	1V	1	15V
			200kΩ	1	1	1	K8,K9	0	1V	1	15V
			2000kΩ	1	1	0	K8,K9	0	1V	1	15V
			20MΩ	1	0	0	K8,K9	0	1V	1	15V

Channel	Code (SN) A	Code (SN) B	Scanner Relay	SE
4	0	0	K4	0
1	0	1	K1	0
2	1	0	K2	0
3	1	1	K3	0
None	X°	X°	None	1

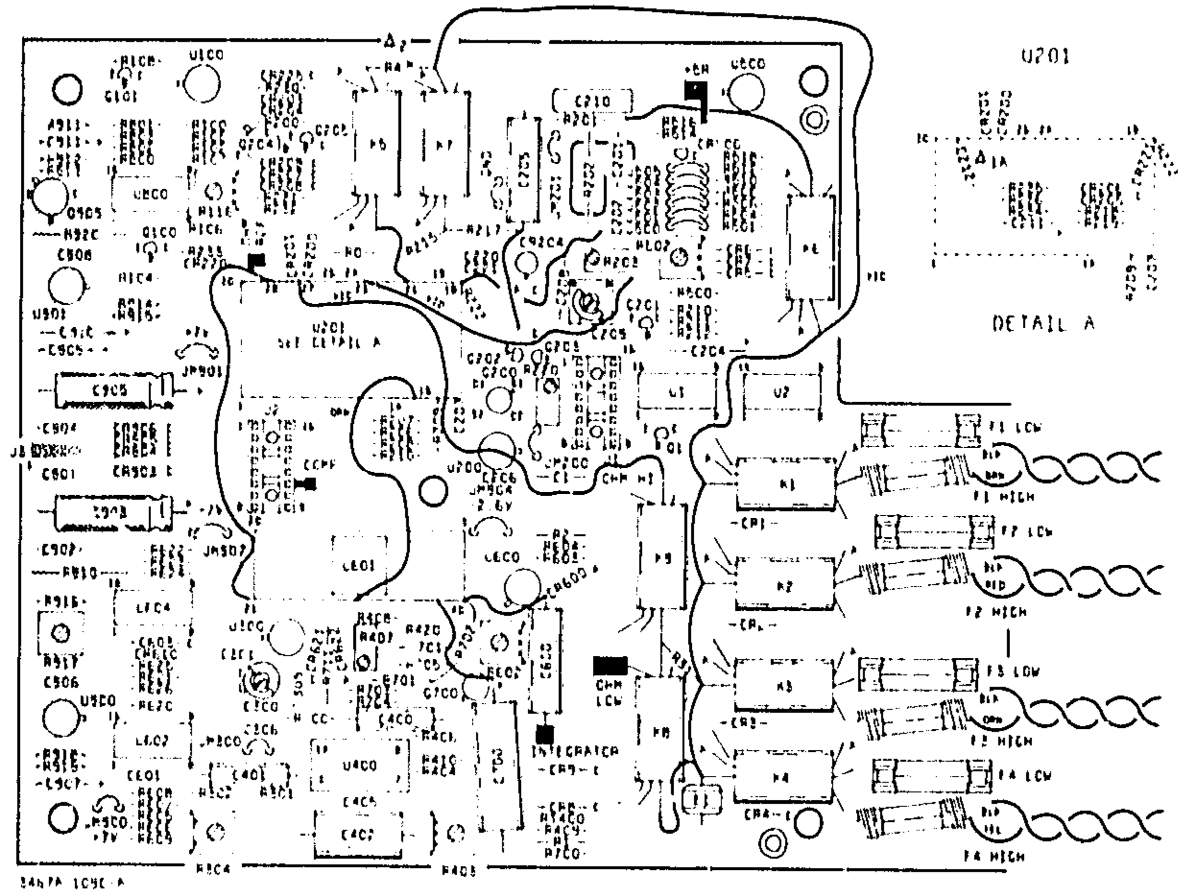
0 = ≤ .8V
1 = ≥ 2.0V
* CMOS Levels
0 = ≤ .5V
1 = ≥ 6.0V

X° = Don't Care State 0 is Expected Value
** Test And Manual Entry Code is 00.



A

④ Analog Supply Splitting.



NOTES

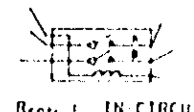
1 SQUARE PADS (WHERE POSSIBLE):

POLAR CAPACITORS	+ TERMINAL
DIODES	CATHODE (C)
IC'S (DIP)	PIN 1
TRANSISTORS	EMITTER
SOCKETS	PIN 1

2 DOTS (WHERE POSSIBLE):

DIODES	CATHODE
IC'S (TO CAN)	PIN 1

3 K1 THRU K9:



		BLACK (PEKO)	CUBE AND SILVER (EAC)
R_{COIL}:	IN-CIRCUIT:	550 OHM	350 OHM
	OUT-OF-CIRCUIT:	700 OHM	400 OHM

4 ALL LEADS ARE BLUE UNLESS OTHERWISE SPECIFIED

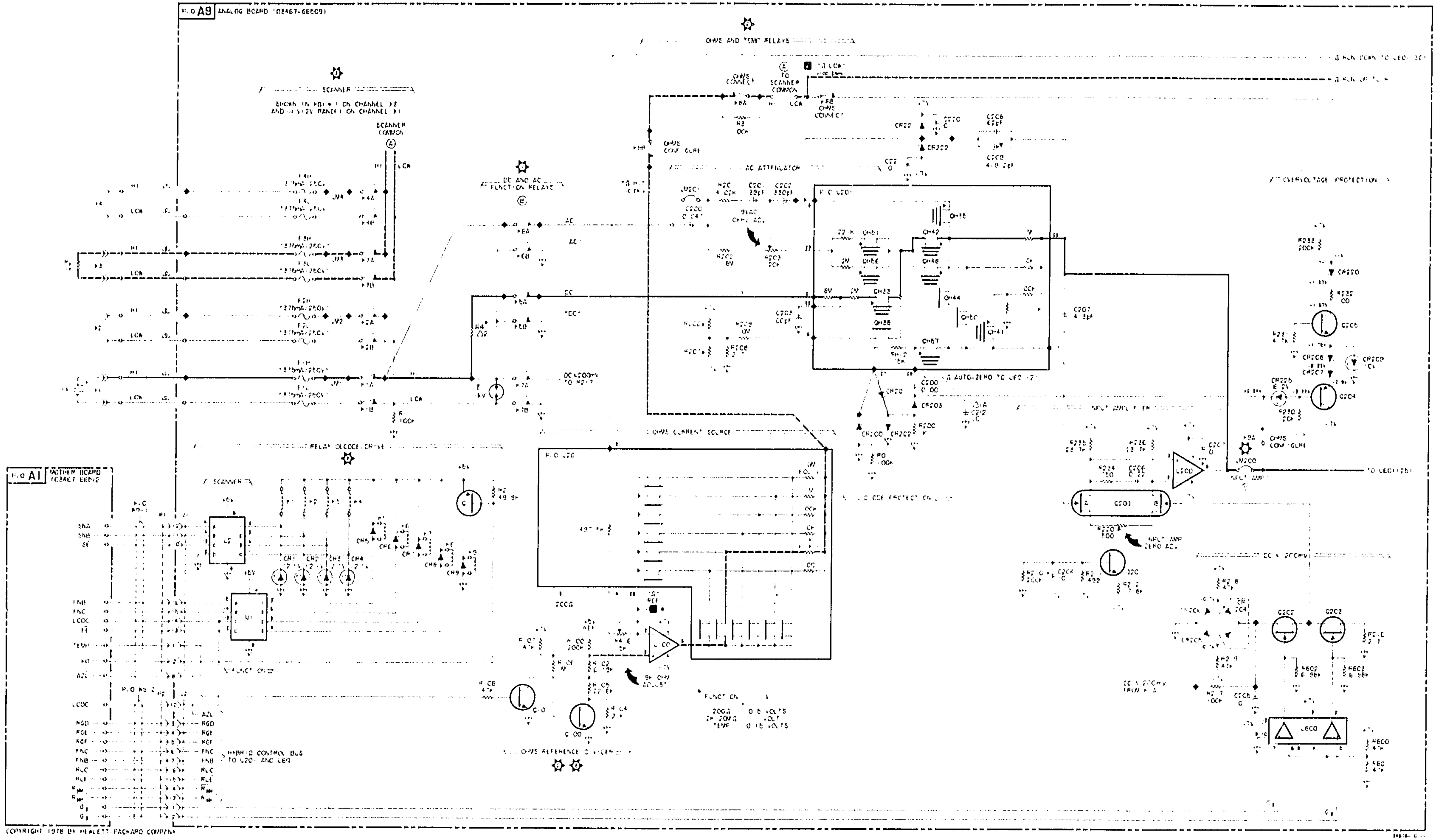
A9
03467-66511
REV A

Δ_A For instrument serial numbers 1821A00160 and below, the following should be noted:

1. C209 should be checked for shorted rotor and stator plates. Mounting should not stress the plates or misalignment and shorting may result. The leads may be preformed to eliminate this stress.

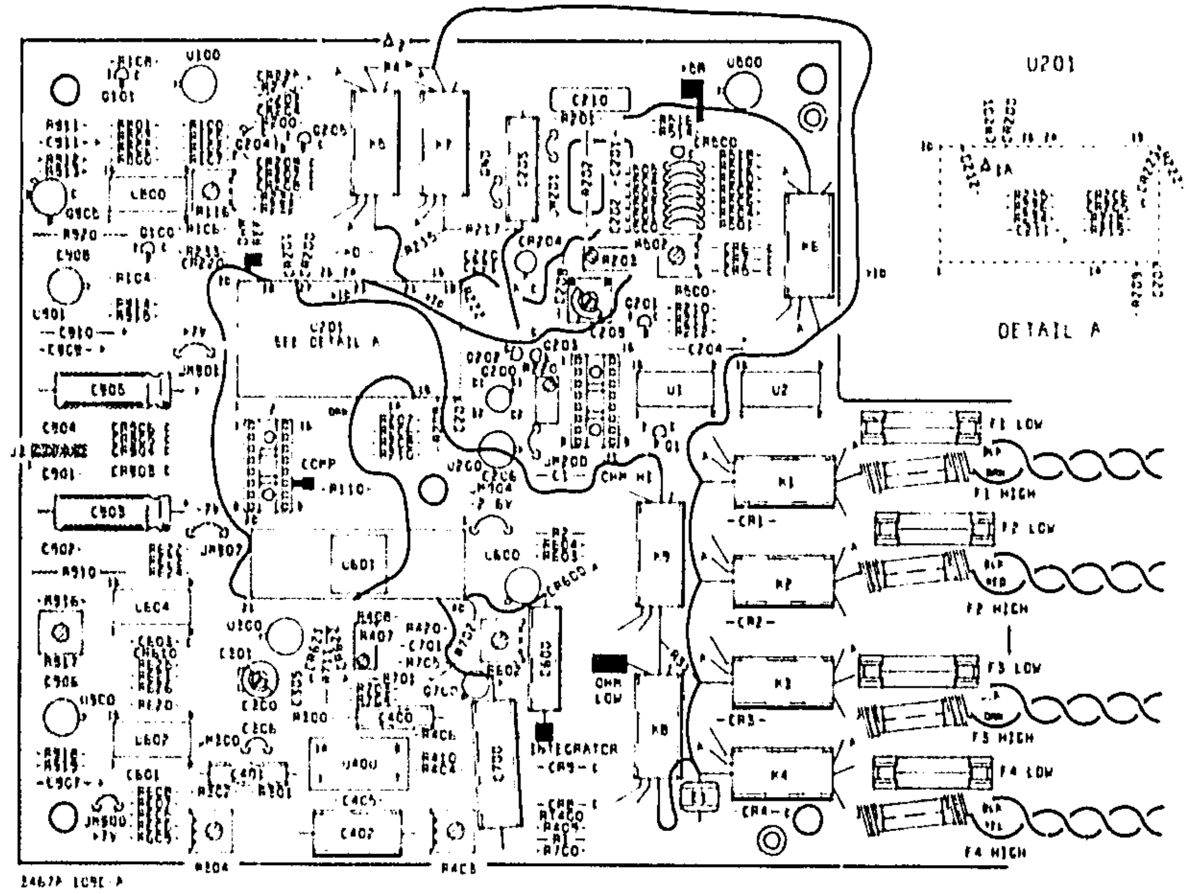
2. C211 should be checked for shorted leads due to soldering on or around this component.

3. The anode of CR3 is somewhat close to a +5 V supply trace. A small amount of solder resist was added between the two to protect against large input voltages. Check between these points to insure adequate isolation.



1

Figure 8-10. Analog Board, A9, Rev. A



NOTES

A9
03467-66511
REV A

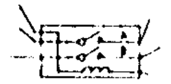
1 SQUARE PADS (WHERE POSSIBLE):

POLAR CAPACITORS	+ TERMINAL
DIODES	CATHODE (C)
IC'S (DIP)	PIN 1
TRANSISTORS	EMITTER
SOCKETS	PIN 1

2 DOTS (WHERE POSSIBLE):

DIODES	CATHODE
IC'S (TO CAN)	PIN 1

3 K1 THRU K9:



		BLACK (MEKO)	CUBE AND SILVER (EAC)
R_{COIL}	IN-CIRCUIT:	550 OHM	350 OHM
	OUT-OF-CIRCUIT:	700 OHM	400 OHM

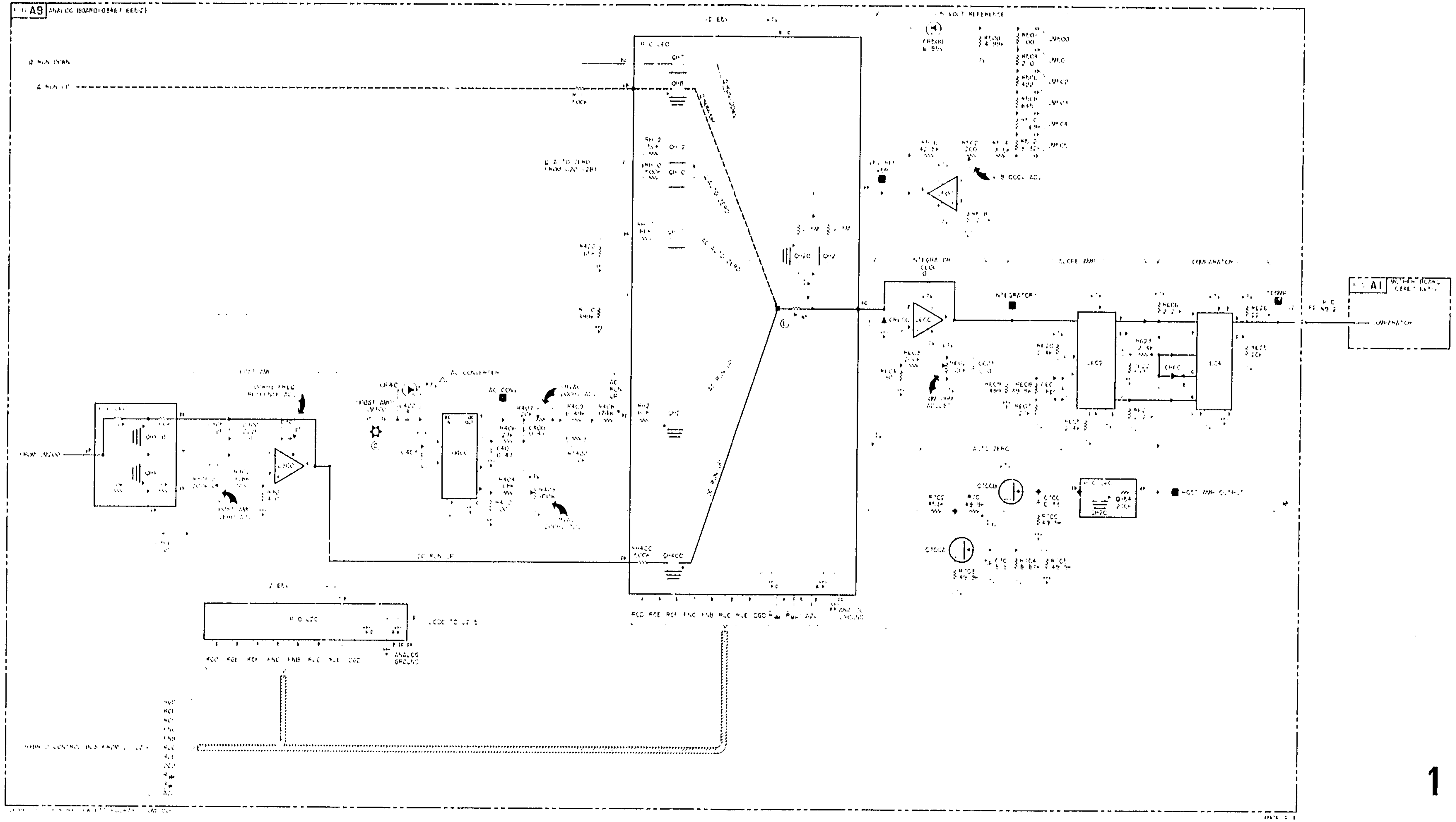
4 ALL LEADS ARE BLUE UNLESS OTHERWISE SPECIFIED

Δ_A For instrument serial numbers 1821A00150 and below, the following should be noted:

1. C209 should be checked for shorted rotor and stator plates. Mounting should not stress the plates or misalignment and shorting may result. The leads may be preformed to eliminate this stress.

2. C211 should be checked for shorted leads due to soldering on or around this component.

3. The anode of CR3 is somewhat close to a +5 V supply trace. A small amount of solder resist was added between the two to protect against large input voltages. Check between these points to insure adequate isolation.



1

Figure 8-10. Analog Board, A9 (Cont'd).

Signature Analysis On The A2 Board.

- Set Up (Primary SA)

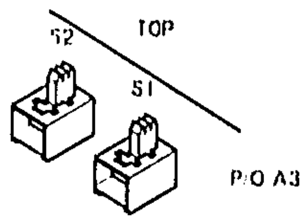
Logging Multimeter

Function: Test

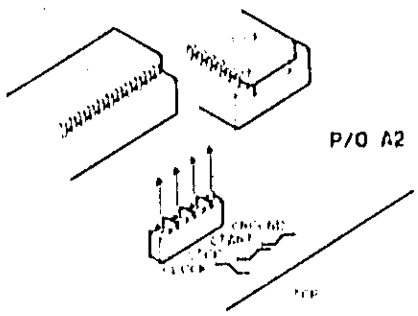
Inputs/Select: 1 2 3 4

All Other Front Panel Pushbuttons: Deselected (Out)

To Select This Board:



Signature Analyzer



- Check The +5V Signature → **SUSP**

Correct	Set up satisfactory, proceed
Incorrect	Check set up and Signature Analyzer Refer to Service Information Summary

- Check **KEY** Signatures And/Or Voltages

Location		Signature	
U4			
	8	A140	$\overline{\text{Int}}$
U7			
	3	HFHF	Device Select Bus
	6	U2HH	
	8	2406	
	11	21HH	

Location		Signature	
U8			
	3	13P7	Read/$\overline{\text{Write}}$
U10			
	8	HPC7	Bus Read/$\overline{\text{Write}}$
	11	A140	

SA2

Turn this page for a complete list of A2 signatures.

Complete List Of A2 Signatures.

NOTES

1. **BOLD** *signatures are key signatures.*
2. *Hyphenated signatures have alternating values.*
3. *Signatures in paranthesis () are obtained in secondary SA.*
4. *To obtain this signature, remove the instrument's paper supply.*
5. *To obtain this signature the "STEP" pushbutton must have been the last momentary contact pushbutton pressed.*

+5V Signature → SUSP

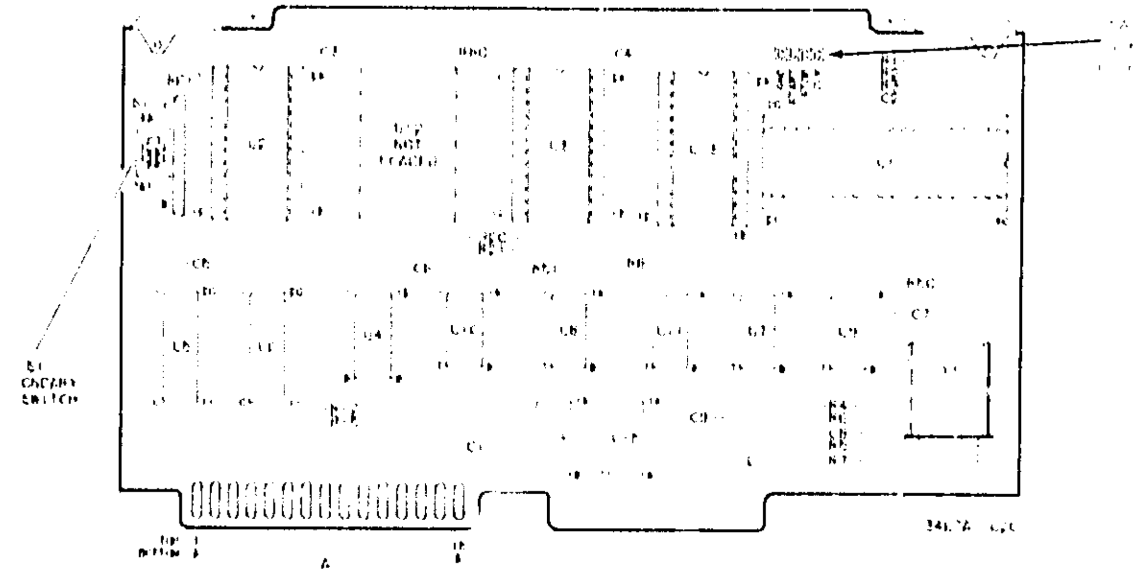
A2 Signature List

Location		Signature
U1		
	9	HFHF
	10	U2HH
	11	2406
	12	21UH
	13	9C1P
	14	53CO
	15	448U
	16	9221
	17	59F5
	18	C314
	19	2C45
	20	204A
	22	2FPC
	23	CP04
	25	UOU1
	34	13P7
U2,U3,U13		
	1	9221
	2	448U
	3	53CO
	4	9C1P
	5	21UH
	6	2406
	7	U2HH
	8	HFHF
	19	2C45
	20	FHC1,53UU for U3, 7U14 for U13
	22	C314
	23	59F5

Location		Signature
U3		See U2
U4		
	1	P15A
	2	204A
	3	2FPC
	4	FHC1
	6	53UU
	7	7U14
	8	**A140**
	11	HPC7
	13	53CO
	14	9CIP
	15	20A9
U5		
	1	A140,(SUSP)
	2	71H6
	4	A22U 3241
	5	UBCF,(OF09)
	8	5FH6
	12	FOH2
	14	5P52,(AAP7)
	16	86H1[5]
	18	UF22,(0897)
	19	A140,(SUSP)
U6		
	1	HPC7
	3	71H6
	5	A22U 3241
	7	UBCF,(OF09)
	9	F5H6
	11	FOH2
	13	5P52,(AAP7)
	15	86H1[5]
	17	UF22,(0897)
	19	HPC7

Location		Signature
U7		
	2	HFHF
	3	**HFHF**
	5	U2HH
	6	**U2HH**
	8	**2406**
	9	2406
	11	**21UH**
	12	21UH
U8		
	2	13P7
	3	**13P7**
	4	9221
	5	P15A
	6	7UU7
U9		
	10	4FC9
	11	13P7
	12	P15A
	13	CP04
U10		
	1	CP04
	3	P15A
	5	7UU7
	6	20A9
	8	**HPC7**
	9	4FC9
	10	7UU7
	11	**A140**
	12	13P7
	13	7UU7
U13		See U2

SA2



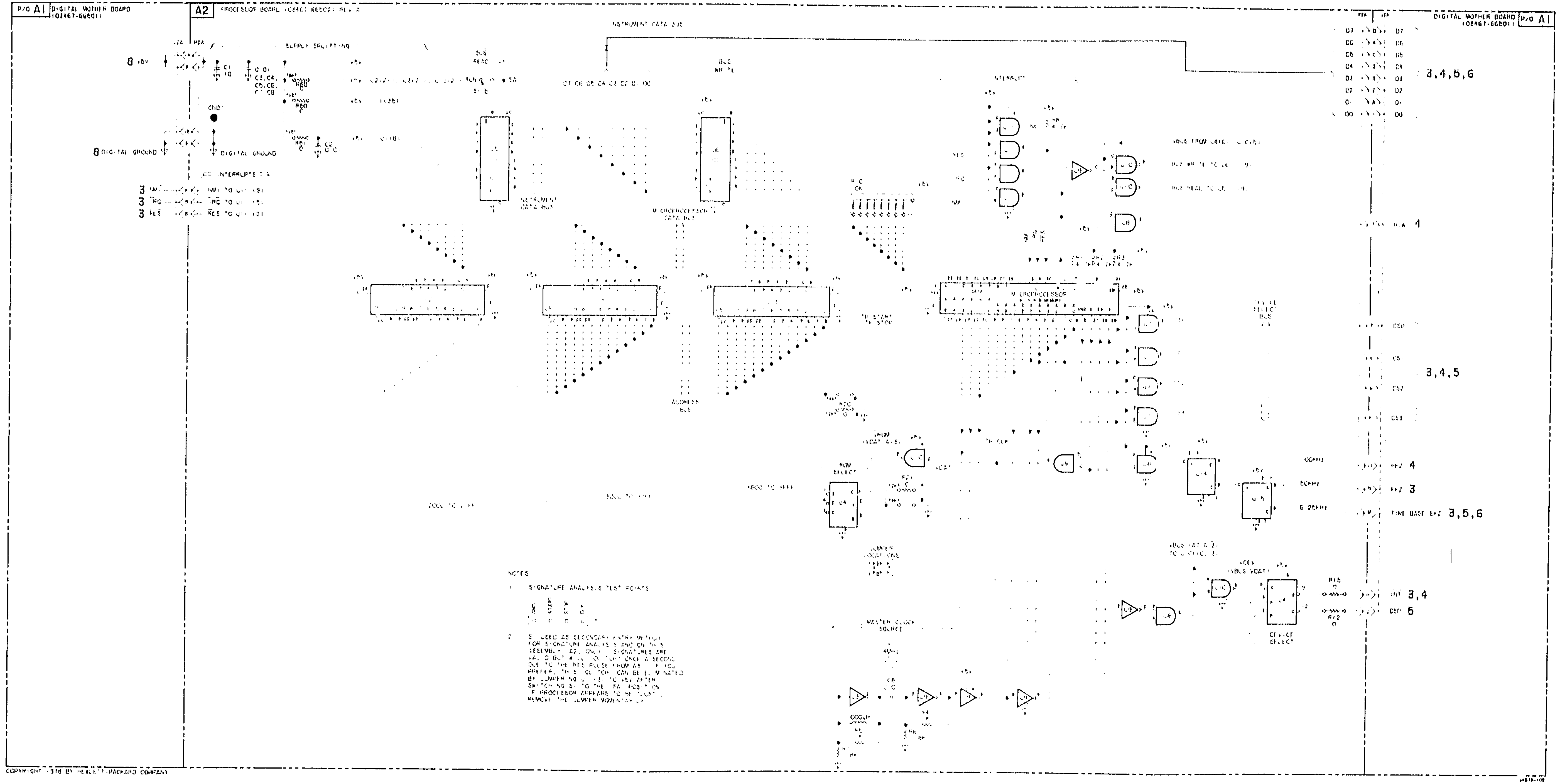
A2

05467-66502

REV A

A Processor & Power Bus

1	D0	A	D1
2	D2	B	D3
3	D4	C	D5
4	D6	D	D7
5	DS0	E	DS1
6	DS2	F	DS3
7	R W	H	INT
8	RES	J	DSP
9	IRQ	K	NMI
10		L	
11	HKZ	M	SKZ
12		N	FKZ
13		P	
14	+5V	R	+5V
15	DGD	S	DGD



2

Figure 8-11. Processor Board, A2.

Signature Analysis On The A3 Board.

- Set Up (Primary SA)

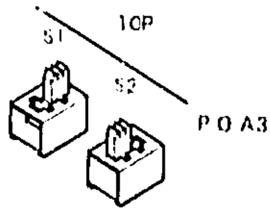
Logging Multimeter

Function: Test

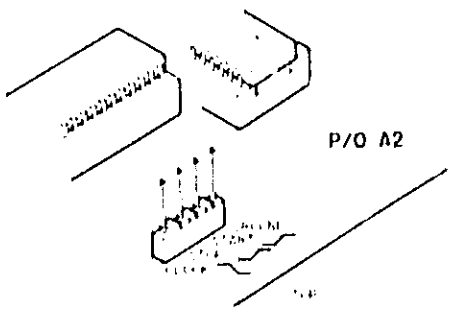
Inputs/Select: 1 2 3 4

All Other Front Panel Pushbuttons: Deselected (Out)

To Select This Board:



Signature Analyzer



- Check The +5V Signature → **UUPA**

Correct Set up satisfactory, proceed

Incorrect Check set up and Signature Analyzer
Refer to Service Information Summary

- Check **KEY** Signatures And/Or Voltages

Location		Signature	
U12			
	10	09U5	Low Power Ram
	12	7A14	Low Power Ram
	14	6686	Low Power Ram
	16	GFCP	Low Power Ram

Location		Signature	
U14			
	3	1C43	Data Bus
	6	U417[6]	Data Bus
	7	6603	Data Bus
	8	H943	Data Bus
	11	6171, 6867[4]	Data Bus
	13	23F3	Data Bus
	16	F11P F938[7]	Data Bus
	17	AB31	Data Bus

SA3

Turn this page for a complete list of A3 signatures.

Complete List Of A3 Signatures.

NOTES

1. **BOLD** *signatures are key signatures.*
2. *Hyphenated signatures have alternating values.*
3. *Signatures in paranthesis () are obtained in secondary SA.*
4. *To obtain this signature, remove the instrument's paper supply.*
5. *To obtain this signature the "STEP" pushbutton must have been the last momentary contact pushbutton pressed.*

+5V Signature → UUPA

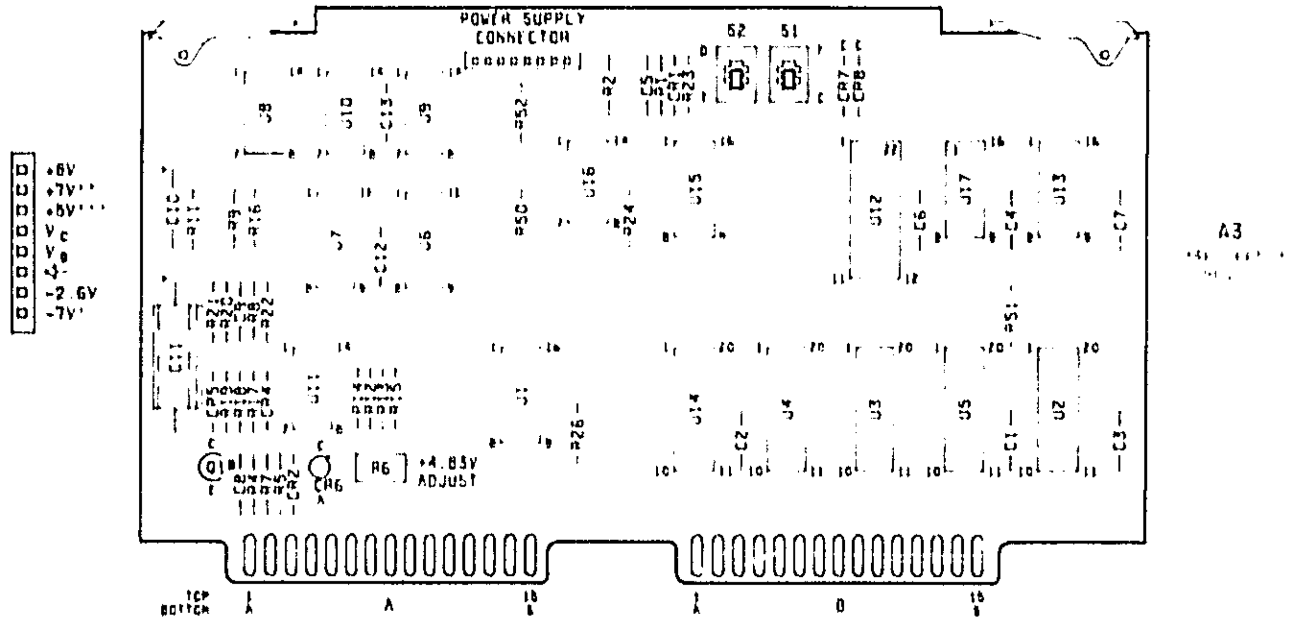
A3 Signature List.

Location	Signature
U1	
1	7211
2	F2FA
3	FUCC
4	84PH
5	16BH
7	P6FA
8	UFAP
13	OUP9
U2,U3	
3	1CU3
6	U417[5]
7	6503[5]
8	H943
11	6171,6957[4]
13	23F3
15	F11P F938
17	A831
U4	
1	OUP9
3	1CU3
6	U417[5]
7	6503
9	H943
11	6171,6957[4]
13	23F3
15	F11P F938
17	A831
19	OUP9
U5	
3	1CU3
6	U417[5]
7	6503
9	H943
11	6171,6957[4]
13	23F3
15	F11P F938
17	A831

Location	Signature
U12	
1	6FCP
2	6686
3	7A14
4	09U6
5	95PH
9	026H
10	**09U6**
11	1P95
12	**7A14**
13	19C1
14	**6686**
15	5C3U
16	**6FCP**
20	UFAP
21	64CU
U13	
1	UH87
2	1CU3
3	U417[5]
4	0344
6	6503
7	H943
8	A4H6
9	5C3U
10	19C1
11	P65C
13	0344
14	P17U
15	1P95
16	026H

Location	Signature
U14	
2	09U6
3	**1CU3**
4	7A14
5	**U417[5]**
6	6686
7	**6503**
8	6FCP
9	**H943**
11	**6171,6957[4]**
13	**23F3**
15	**F11P F938**
17	**A831**
U15	
4	UFAP
5	0344
11	UFAP
12	0344
14	UFAP
15	0344
U17	
2	09U6
3	1CU3
4	U417[5]
5	7A14
6	6503
7	6686
9	P6FA
10	6FCP
11	H943
12	64CU
13	6171,6957[4]
14	23F3
15	95PH

SA3



A - Processor & Power Bus

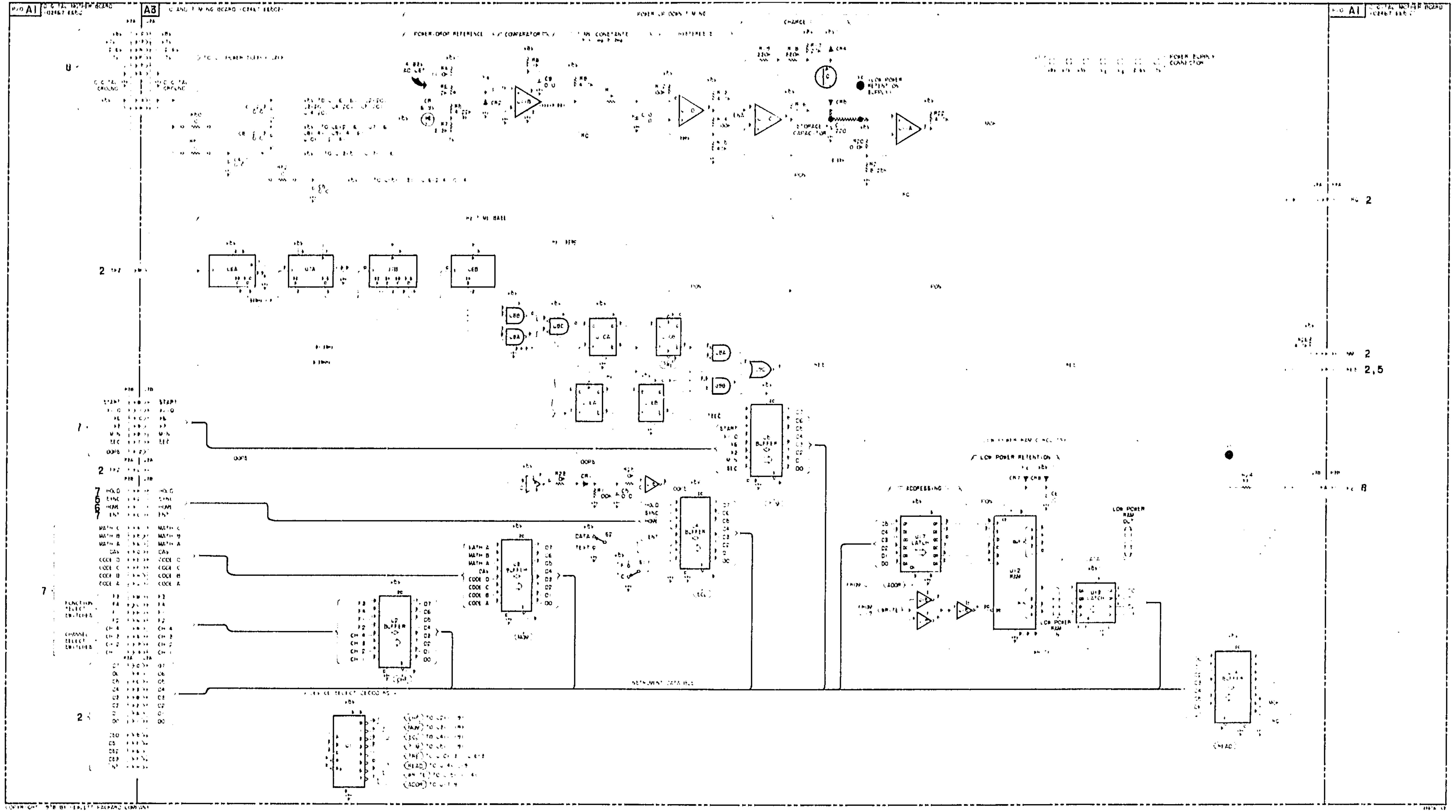
1.	D0	A	D1
2.	D2	B.	D3
3	D4	C	D5
4	D6	D	D7
5	DS0	E	DS1
6.	DS2	F	DS3
7	R/$\overline{W}$	H	$\overline{INT}$
8	$\overline{RES}$	J.	
9	$\overline{IRQ}$	K.	$\overline{NMI}$
10	$\overline{TRE}$	L	FKZ
11.	HKZ	M	SKZ
12.	+8V	N.	
13	+7V''	P	7V'
14.	+5V	R	+5V
15.	DGD	S	DGD

B - I/O & Control Bus

1	HOME	A	Vc
2	SYNC	B	$\overline{START}$
3.	$\overline{OZ}$	C	$\overline{ENT}$
4	MATH C	D	DAV
5	MATH B	E.	CODE D
6	MATH A	F	CODE C
7	$\overline{SEC}$	H	CODE B
8	$\overline{MIN}$	J	CODE A
9	$\overline{X3}$	K	$\overline{HOLD}$
10	$\overline{X6}$	L	$\overline{F4}$
11	$\overline{X10}$	M	$\overline{F3}$
12	$\overline{OUPS}$	N	$\overline{F2}$
13		P	$\overline{F1}$
14	$\overline{CH1}$	R	$\overline{CH4}$
15	$\overline{CH2}$	S	$\overline{CH3}$

Function	Pushbutton Code (F)	Channel	Pushbutton Code (CH)	Math	Pushbutton Code (MATH)	Momentary	Momentary Code (CODE)
	4 3 2 1		4 3 2 1		C B A		D C B A
TEMP	1 1 1 0	4	0 1 1 1	(0)	1 1 1	+/ (OFF)	0 1 1 1
...V	1 1 0 1	3	1 0 1 1	Δ	0 1 0	(Δ)	0 0 1 0
MIX	1 1 0 1	2	1 1 0 1	Δ%	0 1 1	(Δ%)	0 0 1 1
V	1 0 1 1	1	1 1 1 0	%	1 0 0	(%)	0 1 0 0
FB	0 1 1 1	NONE	1 1 1 1		1 0 1	( )	0 1 0 1
TEST	1 1 1 1			dB	1 1 0	(dB)	0 1 1 0
NONE	1 1 0 1			Y ENT —	ENT 0	PAPER ADV	1 0 1 0
						MAN PRINT	1 0 0 1
						STEP	1 0 1 1
						ΔV 0 ZERO	1 1 X X

0 = +.8V
1 = +2.0V
X = Don't Care



3

Figure 8-12. I/O And Timing Board, A3.
Rev. A 8-43/8-44

Signature Analysis On The A4 Board.

- Set Up (Primary SA)

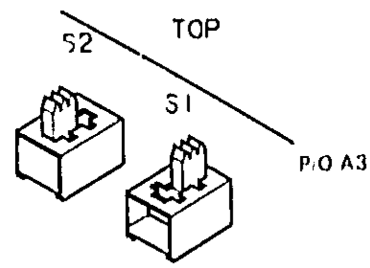
Logging Multimeter

Function: Test

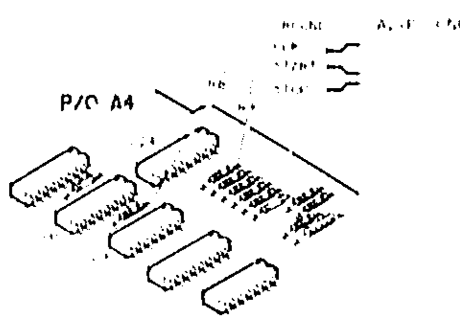
Inputs/Select: 1 2 3 4

All Other Front Panel Pushbuttons: Deselected (Out)

To Select This Board:



Signature Analyzer



- Check The +5V Signature — F746

Correct	Set up satisfactory, proceed
Incorrect	Check set up and signature analyzer Refer to service information summary

- Check KEY Signatures And/Or Voltages

Location		Signature	
U1			
	32	3420	OSC
U10			
	2	3420	LSD COUNTER
	6	7A7C	LSD COUNTER
	11	H869	LSD COUNTER
	14	9262	LSD COUNTER

Location		Signature	
U22			
	16	PF03	IOF
U24			
	12	F01F	RUC

SA4

Turn this page for a complete list of A4 signatures.

Complete List Of A4 Signatures.

NOTES

1. **BOLD** *signatures are key signatures.*

2. *Hyphenated signatures have alternating values.*

3. *Signatures in paranthesis () are obtained in secondary SA.*

4. *To obtain this signature, remove the instrument's paper supply.*

5. *To obtain this signature the "STEP" pushbutton must have been the last momentary contact pushbutton pressed.*

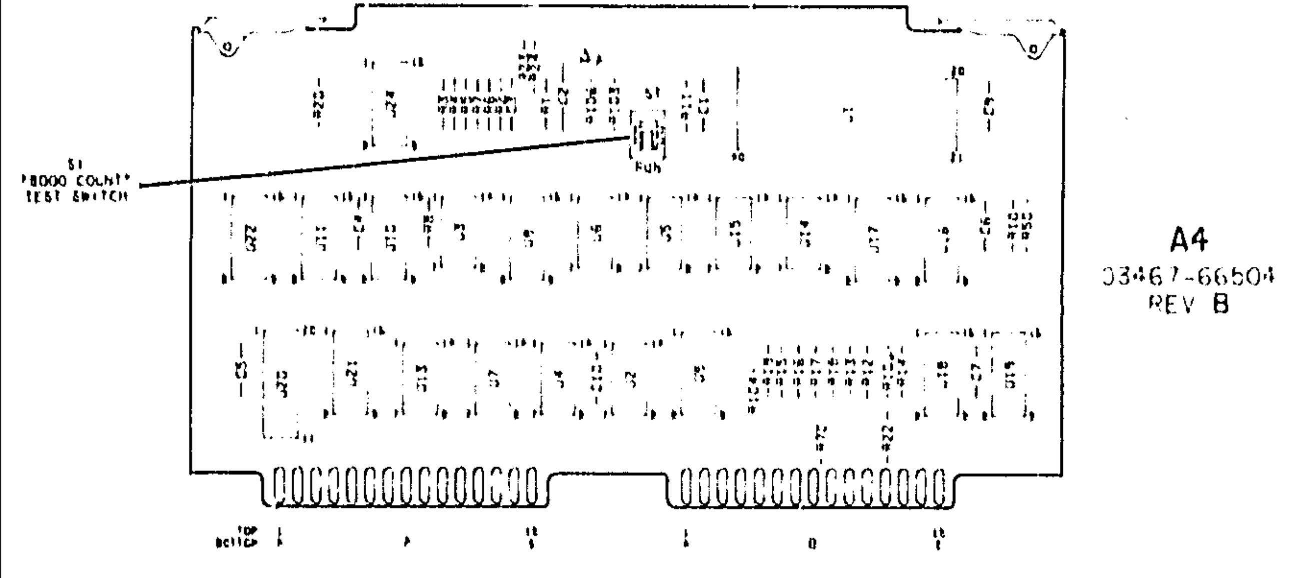
+5V Signature → F746

A4 Signature List.

Location		Signature
U1		
	9	F01F
	10	C3CA
	11	9339
	12	4173
	20	49U3
	21	49U3
	27	PF03
	28	0U06
	29	386A
	30	FUC6
	31	8147
	32	**3420**
U6		
	3	F01F
	11	076A
U8		
	14	AC7F
U9		
	4	076A
	6	F01F

Location		Signature
U10		
	2	**3420**
	6	**7A7C**
	7	**H4A6**
	11	**H889**
	14	**0282**
U11		
	4	7A7C
	7	H889
	13	0282
	14	3420
U20		
	16	PF03
U22		
	14	PF03
	15	**PF03**
U24		
	11	F01F
	12	**F01F**

SA4



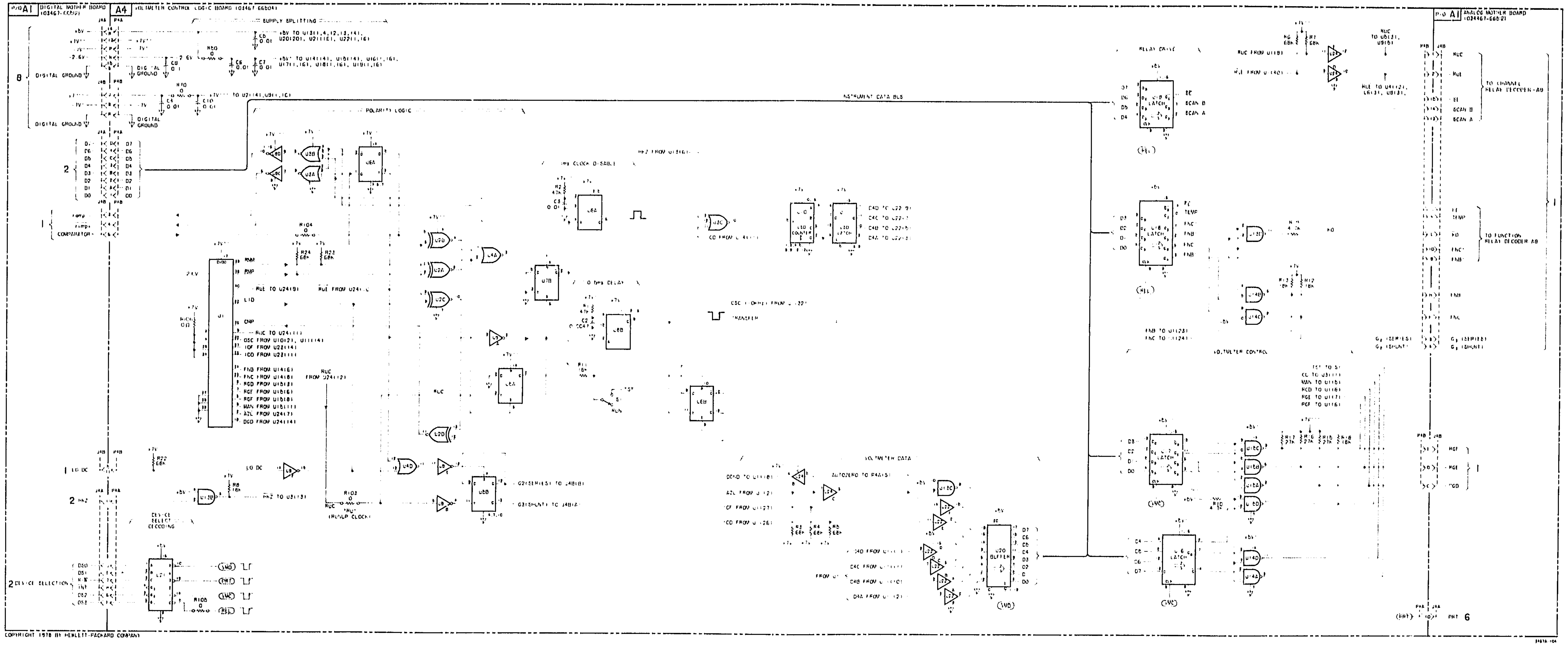
A4
03467-66504
REV B

A - Processor & Power Bus				B - I/O & Control Bus			
1	D0	A	D1	1	PGC	A	G3
2	D2	B	D3	2	RGE	B	G2
3	D4	C	D5	3	RMM	C	RGD
4	D6	D	D7	4	RMP	D	RGE
5	DS0	E	DS1	5	LO DC	E	RGI
6	DS2	F	DS3	6	COMPARATOR	F	FNC
7	R/W	H	INT	7		H	FNB
8	RES	J	TRE	8	-7V	J	+7V
9	IRQ	K		9	FNB	K	TEMP
10	PRT	L		10	FNC	L	KO
11	HKZ	M	SKZ	11	LO DC	M	
12		N	-2.6V	12	FE	N	
13	+7V	P	-7V	13	SNA	P	-2.6V
14	+5V	R	+5V	14	SNB	R	DGD
15	DGD	S	DGD	15	SE	S	AZL

Voltmeter Control Codes

[illegible]

ΔA For serial numbers 1821A00271 and above, A4R106 was added as a trouble shooting aid for splitting the +7 V supply.



4

Figure 8-13. Voltmeter Control Logic, A4, Rev. A

Signature Analysis On The A5 Board, Part 1.

- Set Up (Primary SA)

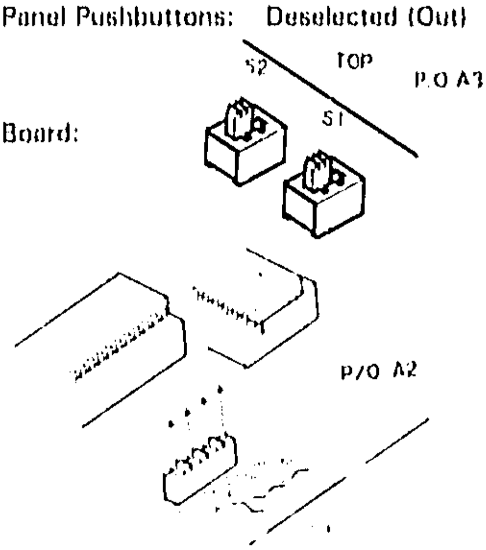
Logging Multimeter

Function: Test

Inputs/Select: 1 2 3 4

All Other Front Panel Pushbuttons: Deselected (Out)

To Select This Board:



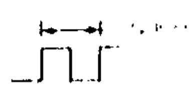
Signature Analyzer

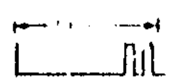
- Check The +5V Signature → AHP6

Correct	Set up satisfactory, proceed
Incorrect	Check set up and signature analyzer Refer to service information summary

- Check KEY Signatures And/Or Voltages

Location	Signature		Voltages
U14			
3	2236	Display Ram Data	(SYNC) U17 (3)
6	FOHU		
8	C723		
11	HOP3		
U16			
3	4P31	$\overline{DSP}$	
U17			
4	04U6	Display Ram Addressing	Latch and Step
7	8H67		
9	AHC8		
12	82PF		





SA5

Turn this page for a complete list of A5, Part 1 signatures.

Complete List Of A5, Part 1 Signatures.

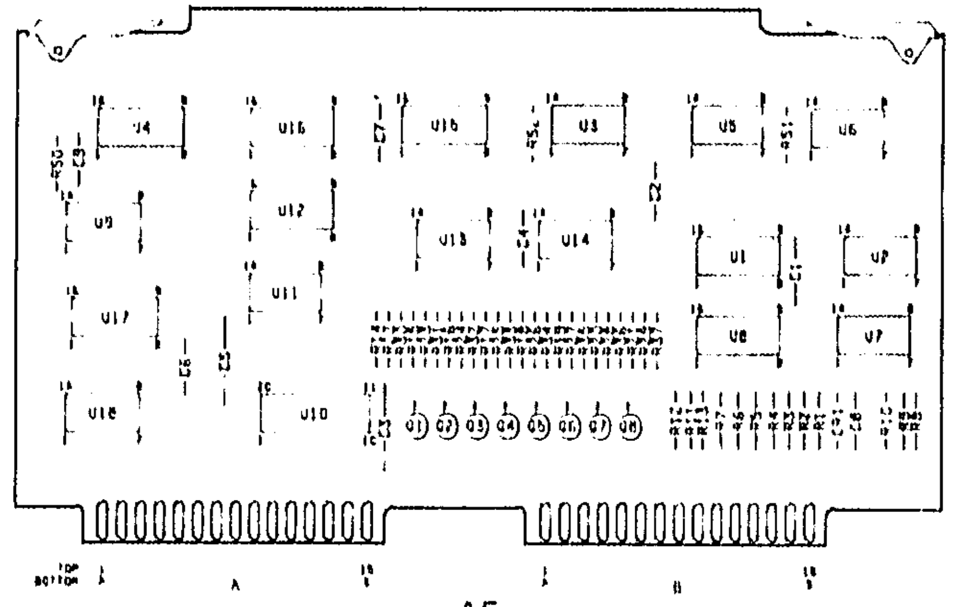
NOTES

1. **BOLD** *signatures are key signatures.*
2. *Hyphenated signatures have alternating values.*
3. *Signatures in paranthesis () are obtained in secondary SA.*
4. *To obtain this signature, remove the instrument's paper supply*
5. *To obtain this signature the "STEP" pushbutton must have been the last momentary contact pushbutton pressed.*

+5V Signature → AHPG

Location	Signature
U3	
11	4P31
12	7H2C
U14	
2	UF5H
3	**7235**
5	C3FF
6	**F0HU**
8	**C723**
9	1AF6
11	**H0P3**
12	7H05
U15	
1	4P31
4	UF68
5	C3FF
12	1AF5
13	7H06

Location	Signature
U16	
1	04U6
3	**4P31**
4	709P
5	UF5B
6	9P20
7	C3FF
8	1AF6
10	P88H
11	7H05
12	094B
13	82PF
14	AHC8
15	9H67
U17	
3	A910
4	**04U6**
6	3031
7	**9H67**
9	**AHC8**
10	005P
12	**82PF**
13	2U0A



A5

03467-66505

REV A

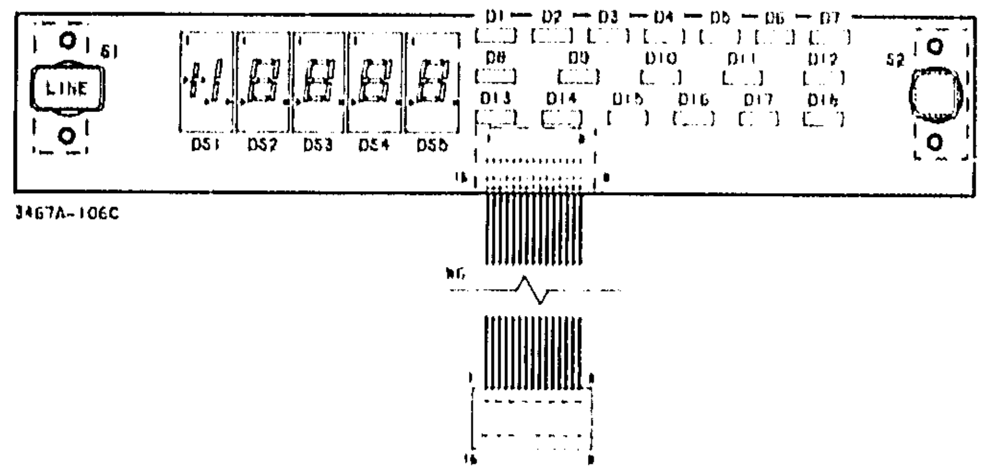
3467A-105C

	A · Processor & Power Bus				B · I/O & Control Bus		
1	D0	A	D1	1	DIG0	A	$\overline{SEG A}$
2	D2	B	D3	2	DIG1	B	$\overline{SEG B}$
3	D4	C	D5	3	DIG2	C	$\overline{SEG C}$
4	D6	D	D7	4	DIG3	D	$\overline{SEG D}$
5	DS0	E	DS1	5	DIG4	E	$\overline{SEG E}$
6	DS2	F	DS3	6	DIG5	F	$\overline{SEG F}$
7	R/$\overline{W}$	H	$\overline{DSP}$	7	DIG6	H	$\overline{SEG G}$
8	$\overline{RTS}$	J		8	DIG7	J	$\overline{SEG H}$
9		K	$\overline{HOMI}$	9	FWD	K	REV
10	PRT	L	SYNC	10	BRK	L	R7
11	HK7	M	SK7	11	R6	M	R5
12	+8V	N	+8V	12	R4	N	R3
13	+7V	P		13	R2	P	R1
14	+5V	R	+5V	14	VM	R	VSS
15	DGD	S	DGD	15	STB	S	$\overline{HOMI}$

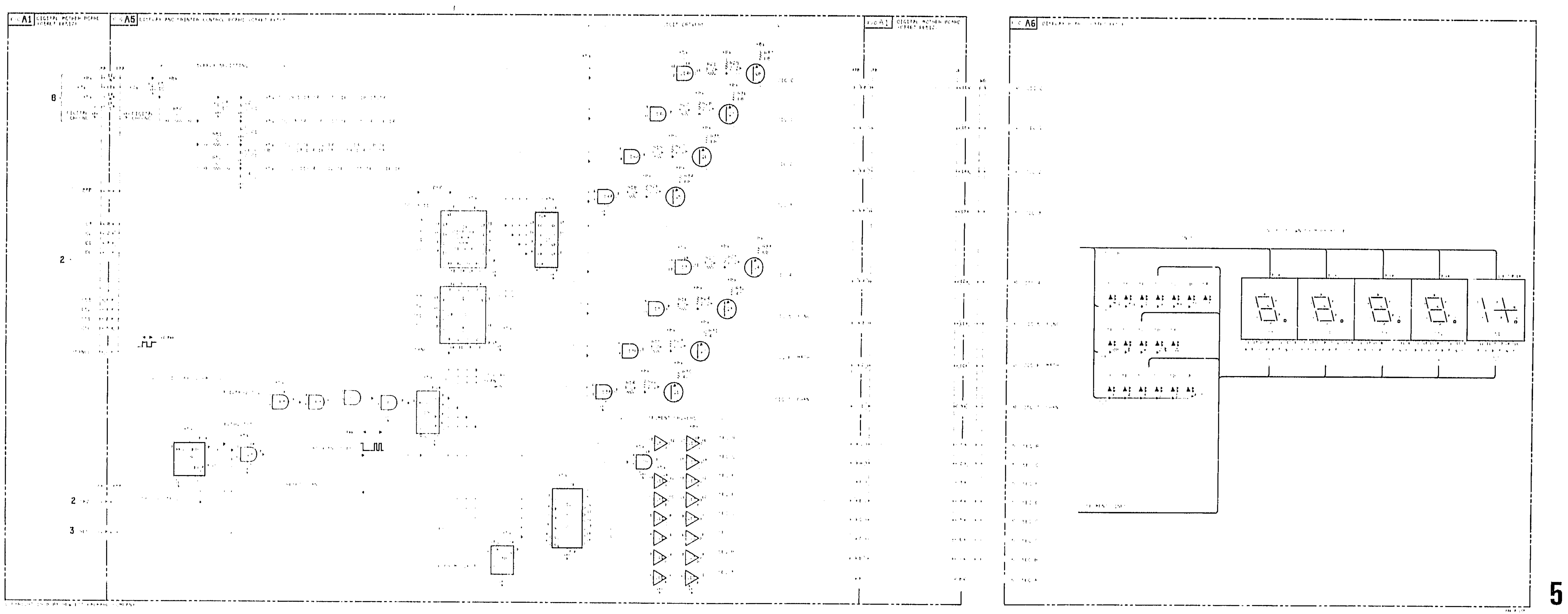
A6

03467-66506

REV A



3467A-106C



5

Figure 8-14. Display Control, P/O A5, A6.

Rev. A 8-51/8-52

Signature Analysis On The A5 Board, Part 2.

- Set Up (Primary SA)

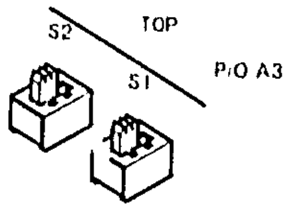
Logging Multimeter

Function: Test

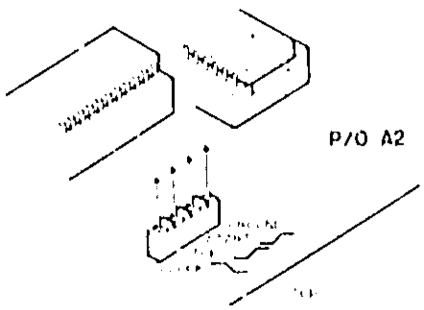
Inputs/Select: 1 2 3 4

All Other Front Panel Pushbuttons: Deselected (Out)

To Select This Board:



Signature Analyzer



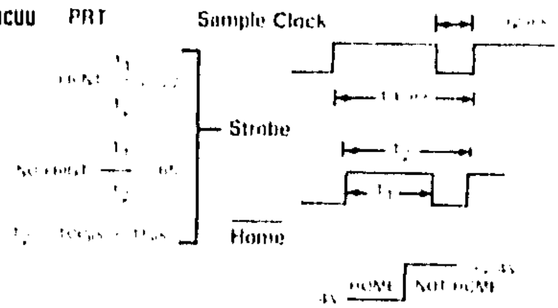
- Check The +5V Signature → AHP6

Correct Set up satisfactory, proceed

Incorrect Check set up and signature analyzer
Refer to service information summary

- Check KEY Signatures And/Or Voltages

Location		Signature		Voltages
U4				
	1	OCUU	PRT	



SA6

Turn this page for a complete list of A5, Part 2 signatures.

Complete List Of A6, Part 2 Signatures.

NOTES

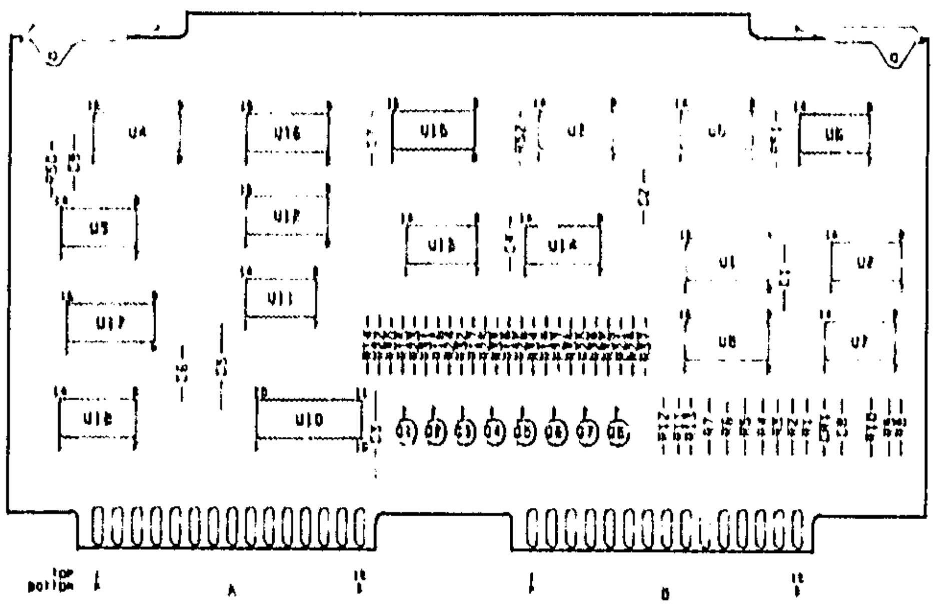
1. **BOLD** *signatures are key signatures.*
2. *Hyphenated signatures have alternating values.*
3. *Signatures in paranthesis () are obtained in secondary SA.*
4. *To obtain this signature, remove the instrument's paper supply.*
5. *To obtain this signature the "STEP" pushbutton must have been the last momentary contact pushbutton pressed.*

+5V Signature — AHP6

Location		Signature
U1		
	7	A619
	11	0948
	12	P88H
	13	9P20
	14	709P
U3		
	2	7H26
	3	A619
U4		
	15	**0CUU**

Location		Signature
U5		
	1	A619
	2	0CUU
U8		
	7	A619
	12	AH27 F06U
	13	830H
	14	4CU7

SA6



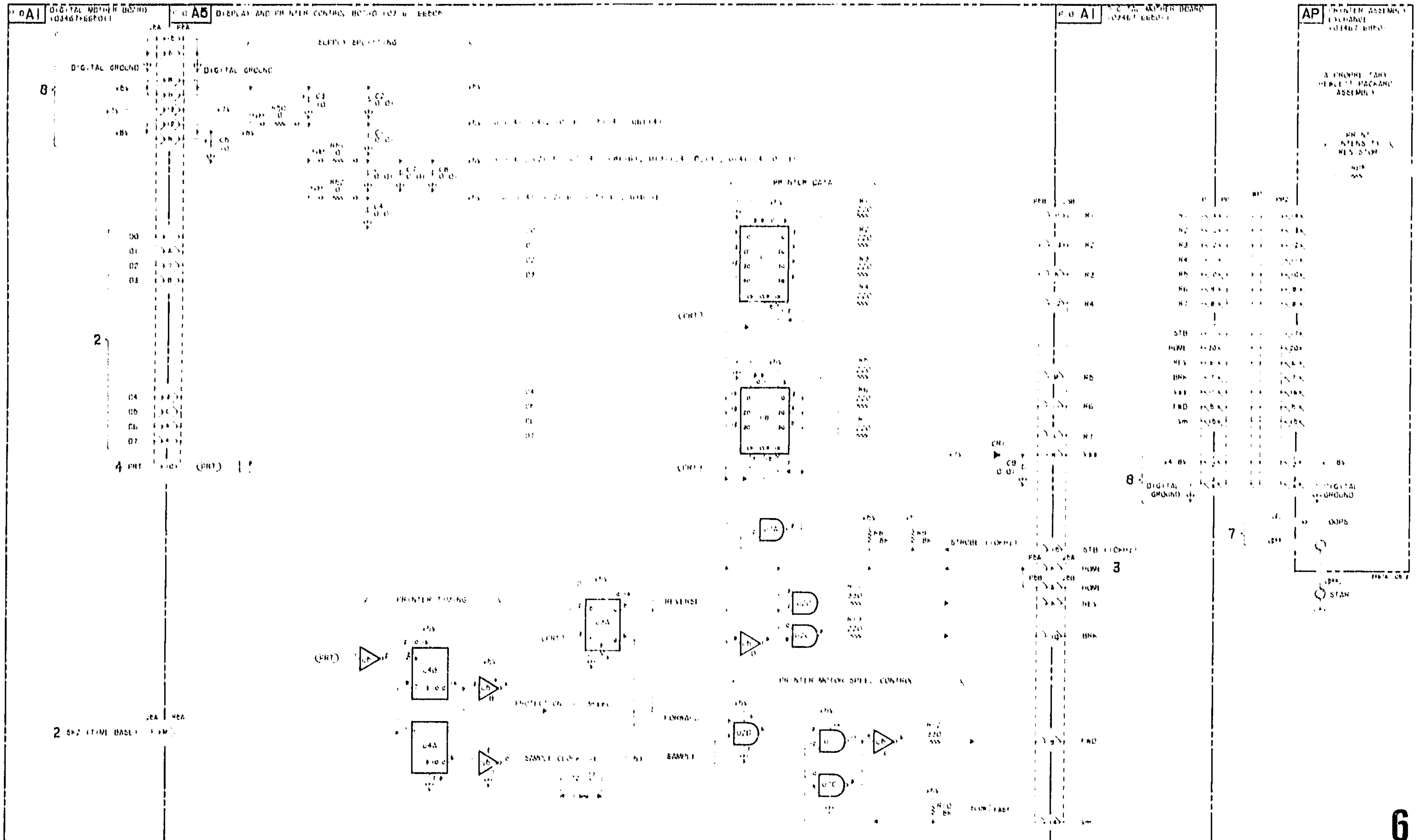
A5

03467-66505

REV A

3467A 105C

A - Processor & Power Bus				B - I/O & Control Bus			
1	D0	A	D1	1	DIG0	A	$\overline{SEG\ A}$
2	D2	B	D3	2	DIG1	B	$\overline{SEG\ B}$
3	D4	C	D5	3	DIG2	C	$\overline{SEG\ C}$
4	D6	D	D7	4	DIG3	D	$\overline{SEG\ D}$
5	DS0	E	DS1	5	DIG4	E	$\overline{SEG\ E}$
6	DS2	F	DS3	6	DIG5	F	$\overline{SEG\ F}$
7	R/$\overline{W}$	H	$\overline{DSP}$	7	DIG6	H	$\overline{SEG\ G}$
8	$\overline{REG}$	J		8	DIG7	J	$\overline{SEG\ H}$
9		K	$\overline{HOME}$	9	FWD	K	REV
10	PRT	L	SYNC	10	BRK	L	R7
11	RK2	M	SK2	11	R6	M	R5
12	+8V	N	+8V	12	R4	N	R3
13	+7V	P		13	R2	P	R1
14	+5V	R	+5V	14	VM	R	VSS
15	DGD	S	DGD	15	STB	S	$\overline{HOME}$



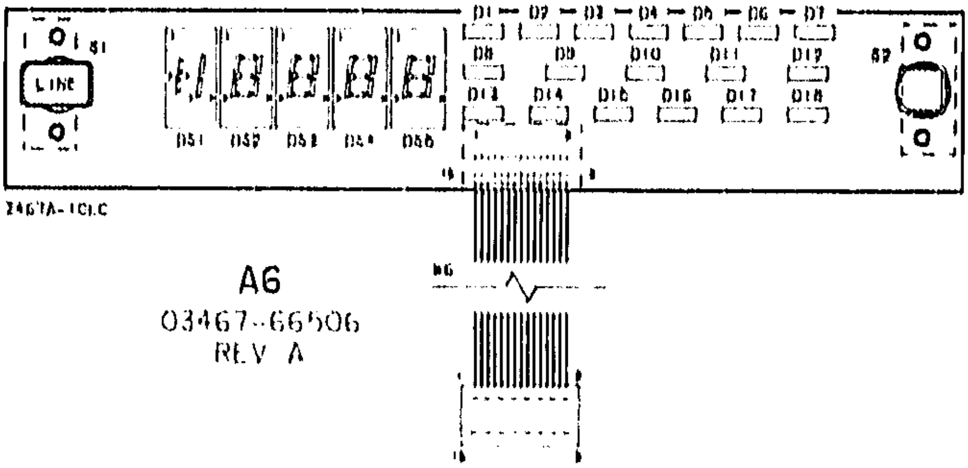
6

Figure 8-15. Printer Control, P/O A5, AP.
Rev. A 8-55/8-56

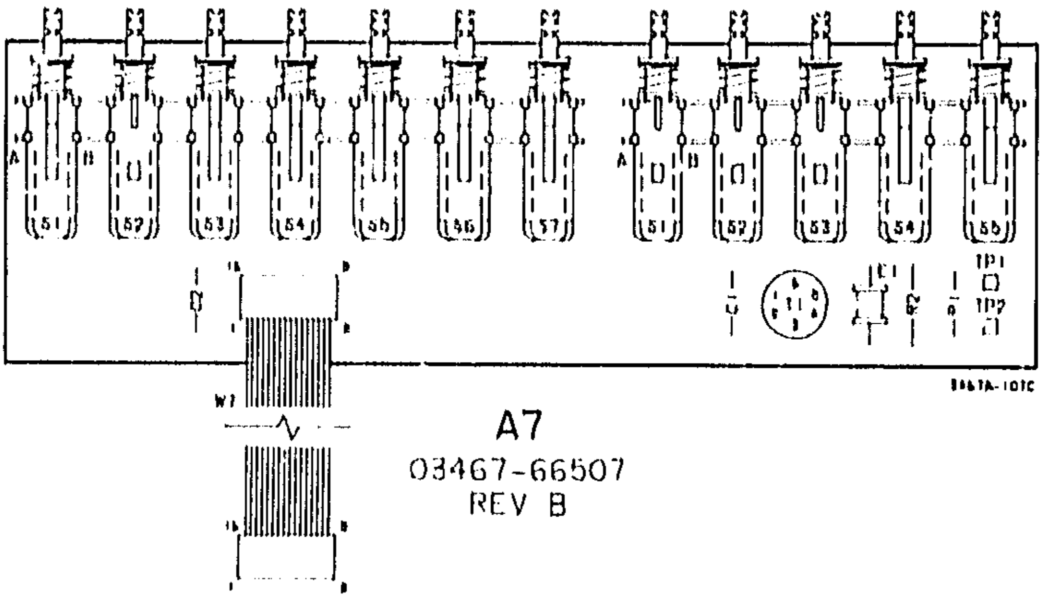
Function	Pushbutton Code (F)	Channel	Pushbutton Code (CH)
	4 3 2 1		4 3 2 1
TEMP	1 1 1 0	4	0 1 1 1
DC V	1 1 0 1	3	1 0 1 1
AC V	1 0 1 1	2	1 1 0 1
kΩ	0 1 1 1	1	1 1 1 0
TEST	1 1 1 1	NONE	1 1 1 1
NONE	1 1 0 1		

Math	Pushbutton Code (MATH)	Momentary	Momentary Code (CODE)
	C B A		D C B A
OFF	1 1 1	(OFF)	0 1 1 1
Δ	0 1 0	(Δ)	0 0 1 0
Δ%	0 1 1	(Δ%)	0 0 1 1
*	1 0 0	(*)	0 1 0 0
	1 0 1	( )	0 1 0 1
dB	1 1 0	• (dB)	0 1 1 0
Y ENT	$\overline{ENT}$ 0	PAPER ADV	1 0 1 0
		MAN PRINT	1 0 0 1
		STEP	1 0 1 1
		μV/Ω ZERO	1 1 X X

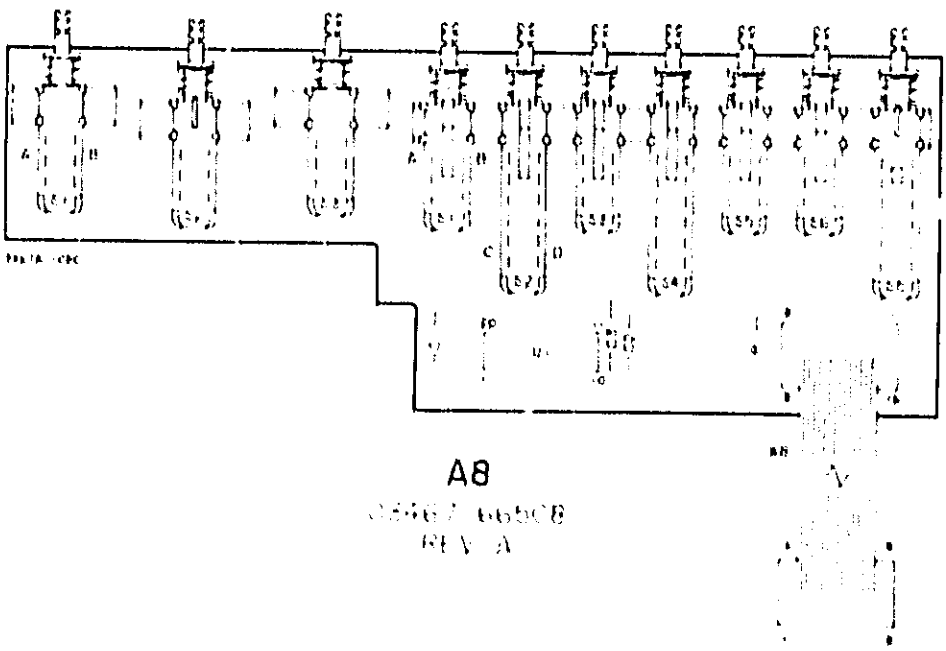
0 = < .8V
1 = > 2.0V
X = Don't Care



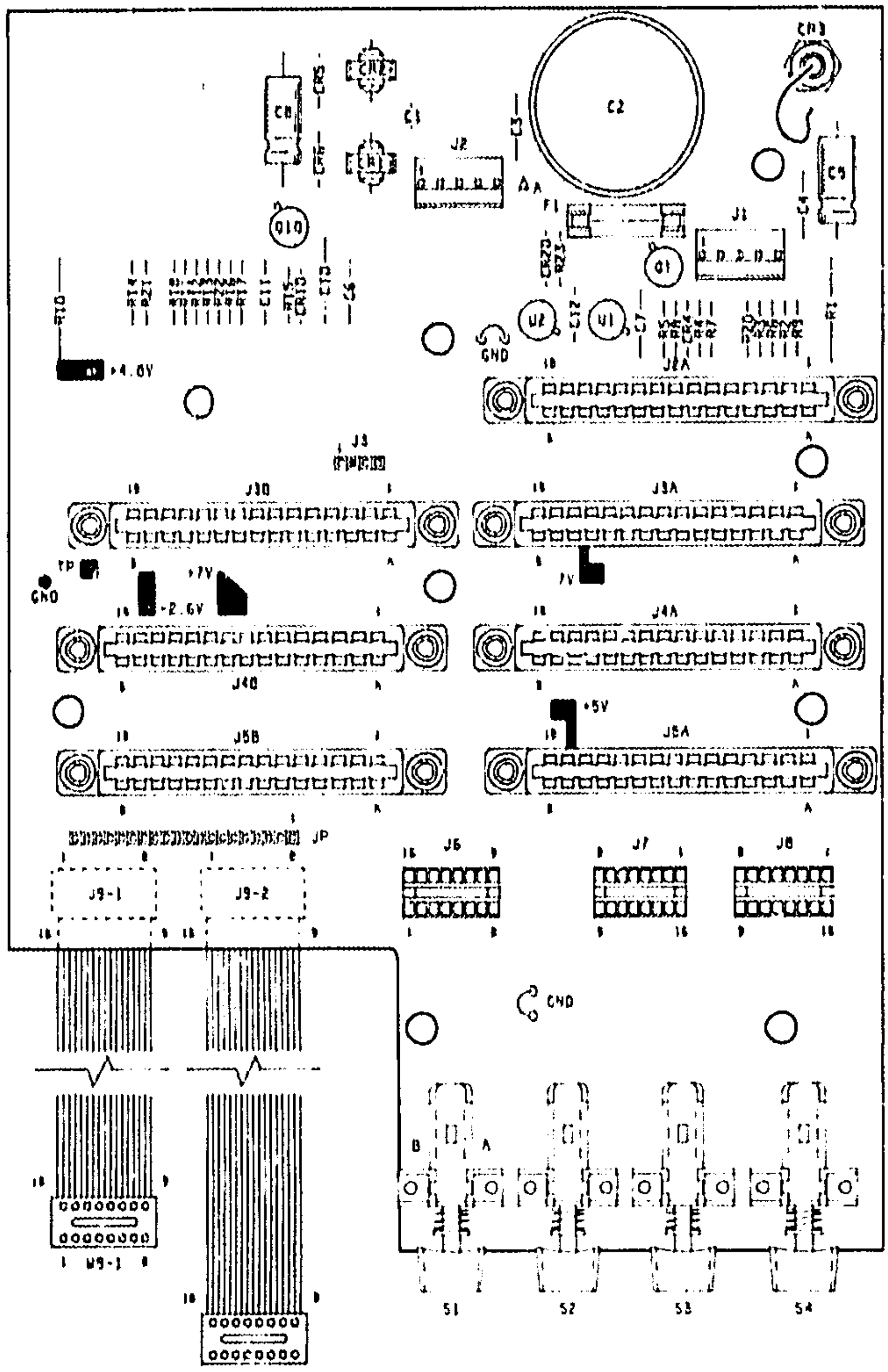
A6
03467-66506
REV A



A7
03467-66507
REV B

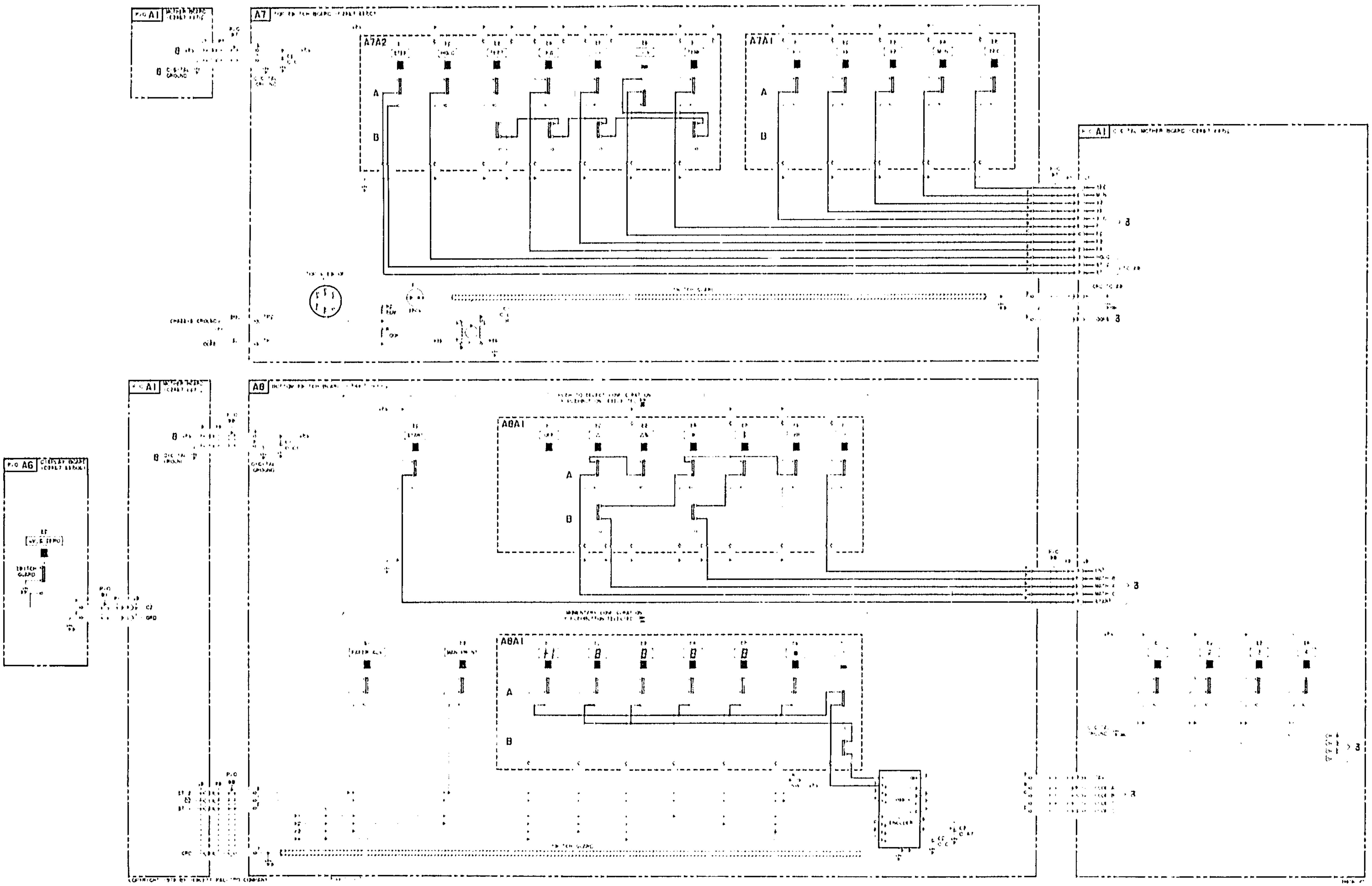


A8
03467-66508
REV A



A1
03467-66512
REV A

3467A-101C

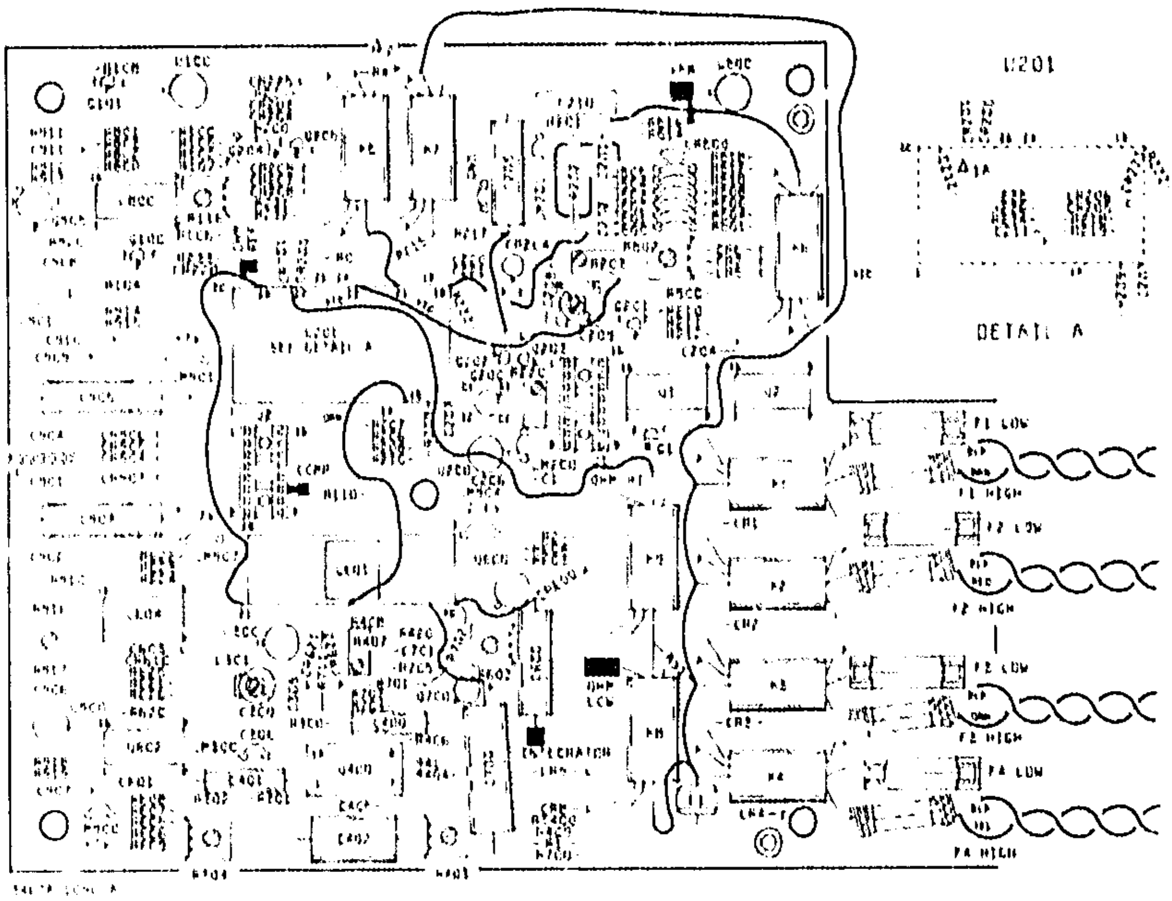


7

Figure 8-16. Front Panel Switches P/O A1, P/O A6, A7, A8.

Power Supply Tolerances.

Supply		Correct Range		
7V		6.970V	to	7.030V
2.65V		2.55V	to	2.75V
+7V		+6.990V	to	+7.010V
+5V		+4.85V	to	+5.25V
+4.8V	Print	+4.6V	to	+4.9V
+4.8V	No Print	+4.75V	to	+4.95V



A9
[illegible]
REV A

NOTES

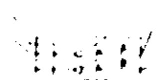
1. SQUARE PADS (WHERE POSSIBLE):

POLAR CAPACITORS	+ TERMINAL
DIODES	CATHODE
IC'S (DIP)	PIN 1
TRANSISTORS	EMITTER
SOCKETS	PIN 1

2. DOTS (WHERE POSSIBLE):

DIODES	CATHODE
IC'S (TO CAN)	PIN 1

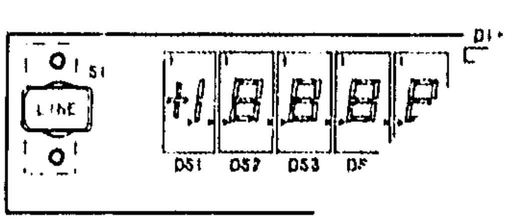
3. K1 THRU K8

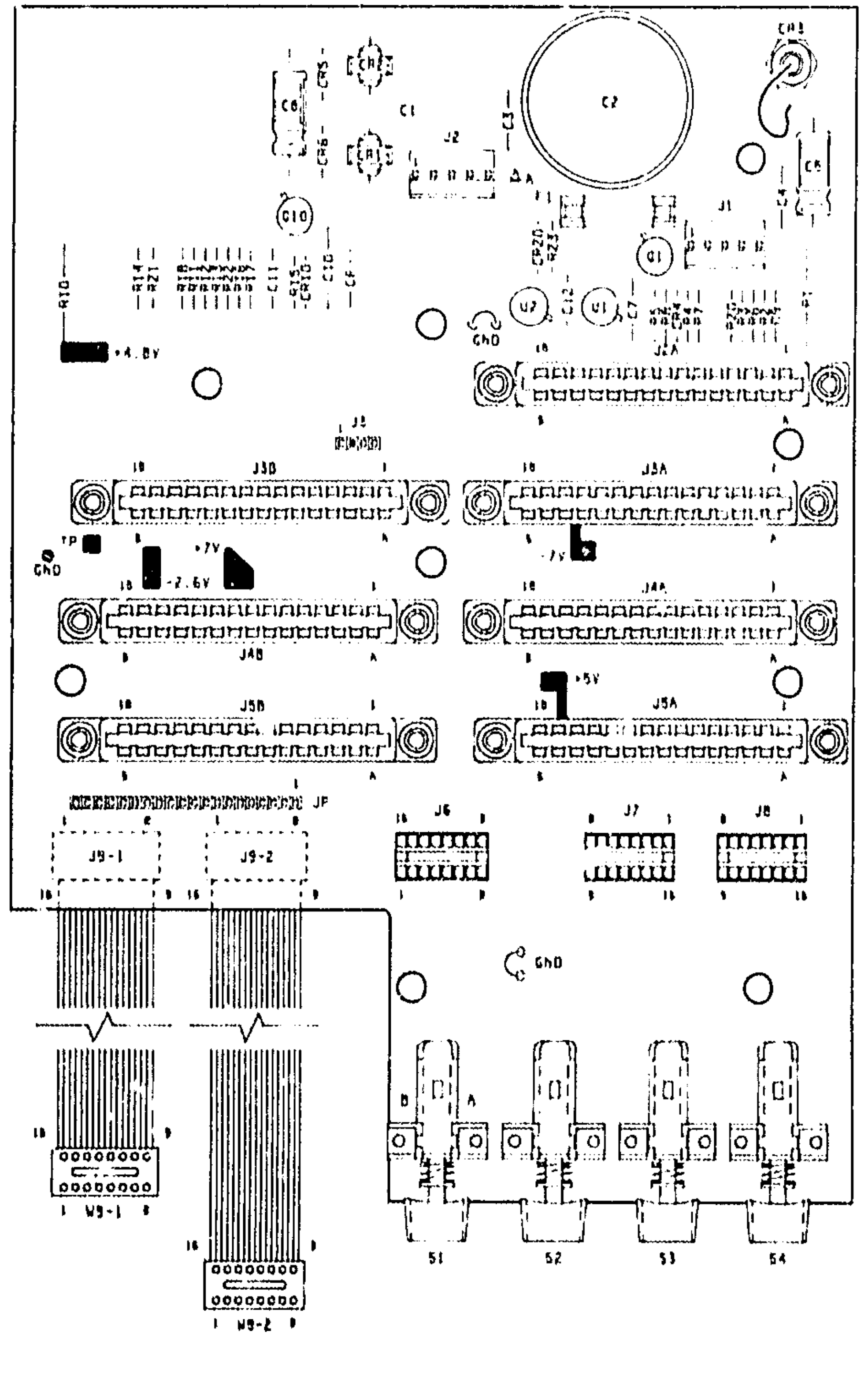


		BLACK (MERIT)	CUBE AND SILVER (LEACH)
R_{COIL}	IN CIRCUIT	550 OHM	350 OHM
	OUT OF CIRCUIT	700 OHM	400 OHM

4. ALL LEADS ARE BLUE UNLESS OTHERWISE SPECIFIED

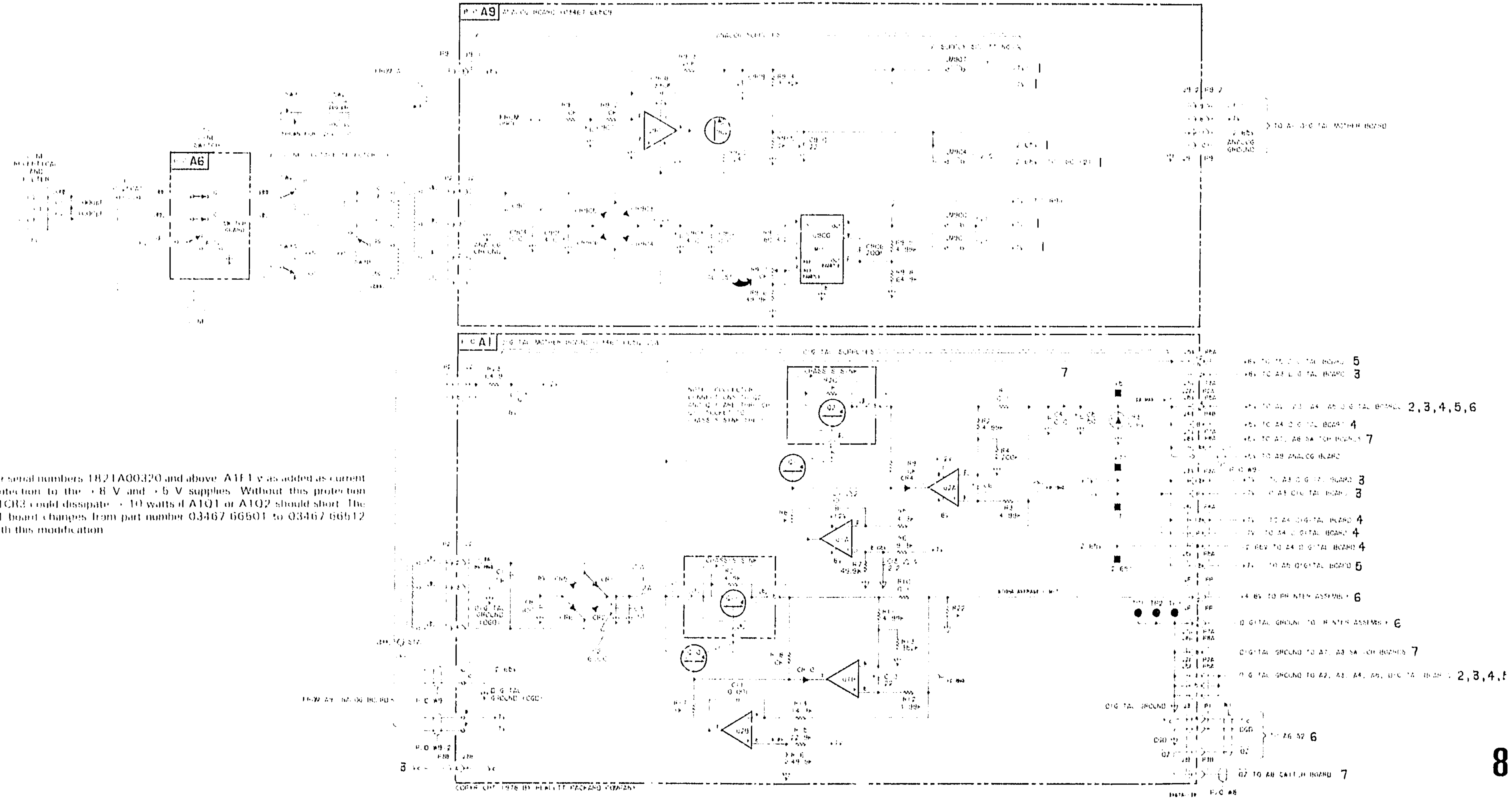
A6
03467-66506
REV A





A1
03467-66512
REV A

346.A-101C



△A For serial numbers 1821A00320 and above A1F1 was added as current protection to the +8 V and +5 V supplies. Without this protection A1CR3 could dissipate >10 watts if A1Q1 or A1Q2 should short. The A1 board changes from part number 03467-66501 to 03467-66512 with this modification.

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Figure 8-17. Power Supplies P/O A1, P/O A9.

SECTION IX
MANUAL CHANGES

9-1. INTRODUCTION.

9-2. This section contains information required to adapt this manual to instruments manufactured before the printing date indicated on the title page. This manual applies to all instruments manufactured to this date.

9-3. Backdating information has been identified in thi   anual using the Δ symbols. This symbology conforms to the following convention:

Δ_N Where N   A Number

This symbol denotes a change which *is not* described on the page where the symbol is. It is used for changes such as added, deleted, or modified parts which could affect servicing procedures on the instrument and therefore requires information broken down by instrument serial numbers, including any servicing concerns. The description appears in this section.

Δ_A Where A   A Letter

This symbol denotes a change which *is* described on the page where the symbol is. It is used for changes such as part number or vendor number changes that will not generally affect a service procedure and need not be broken down by instrument serial number. these change are not described in this section.

9-4. To use the information in this section, begin with the latest change and progress to the earliest change that applies to the serial number of your instrumen . Incorporate those changes which apply.

Δ_1 **Change Number 1.** For instrument serial numbers **1821A-00150** and below.

Page 6-4, Paragraph 6-19, Adjustment 7 . The adjustment shield indentifies this adjustment as 8 and has an extraneous (not-used) adjustment number 7 . Ignore the markings on the shield and jump to the adjustment marked 8 .

Page 8-41, Figure 8-12, A3 Component Locator. A3 is a REVISION B assembly. The only difference is that CR7 and CR8 are mounted off-the-board on testpoints.

Δ_{1A} **Change Number 1A.** For instruments with serial numbers **1821A00215** and below. A1C7 was increased in value to further filter line glitches. A1C13 was added to delay the 5 V supply turn on to allow A3U11 to turn-on properly. A9C212 was added to help prevent kΩ function oscillations which can cause 20 M range errors (several counts high).

Page 7-3, Table 7-3. Add to parts list:

Designator	-hp- Part No.	Description	Quantity
A1C7	0160 0153	.001 μ 200 V	1

Delete from parts list:

Designator	-hp- Part No.	Description	Quantity
A1C7	0160 0161	.01 μ 200 V	1
A1C13	0180 0197	2.2 μ 20 V	1
A9C212	0160 3847	.01 μ 50 V	1

Page 8-33, Figure 8-10, Schematic 1. Modify this schematic by deleting A9C212.

Page 8-63, Figure 8-17, Schematic 8. Modify this schematic by deleting A9C13 and changing A9C7 from .01 μ to .001 μ.

Δ2 **Change Number 2.** For instrument serial numbers **1821A-00236** and below.

Page 7-3, Table 7-3. Add to parts list:

Designator	-hp- Part No.	Description	Quantity
A9	03467-66509	Analog Board (1st Version)	1
A9C1	0160-2055	.01 μ 100 V	1
A9C901	0160 2055	.01 μ 100 V	1
A9J10	1200 0C07	SKT 16 Pin	1
A9R214	0698 4638	Resistor F 374k .01	1
A9R400	2100 0580	Resistor Var 500k	
A9R401	0698 4486	Resistor F 24.9k .01	1
A9R402	0683 1055	Resistor F 1M .05 1 4W	1
A9R404	0683 1055	Resistor F 1M .05 1 4W	1
A9R406	0698 4486	Resistor F 24.9k .01	1
A9R410	0698 4486	Resistor F 24.9k .01	1
A9R415	0698 0442	Resistor F 10k .01	1
A9R416	0698 0442	Resistor F 10k .01	1
	03467-26509	PC Board	1
A10	03467 66510	AC Converter Board	1
A10C1	0160 2611	1μf	1
A10P1	1200 0578	Socket	1
A10R1	0757 0280	1k .125W	1
A10U400	1826 0421	AC Converter	1
A10U600	1826 0561	IC 741 OP Amp	1

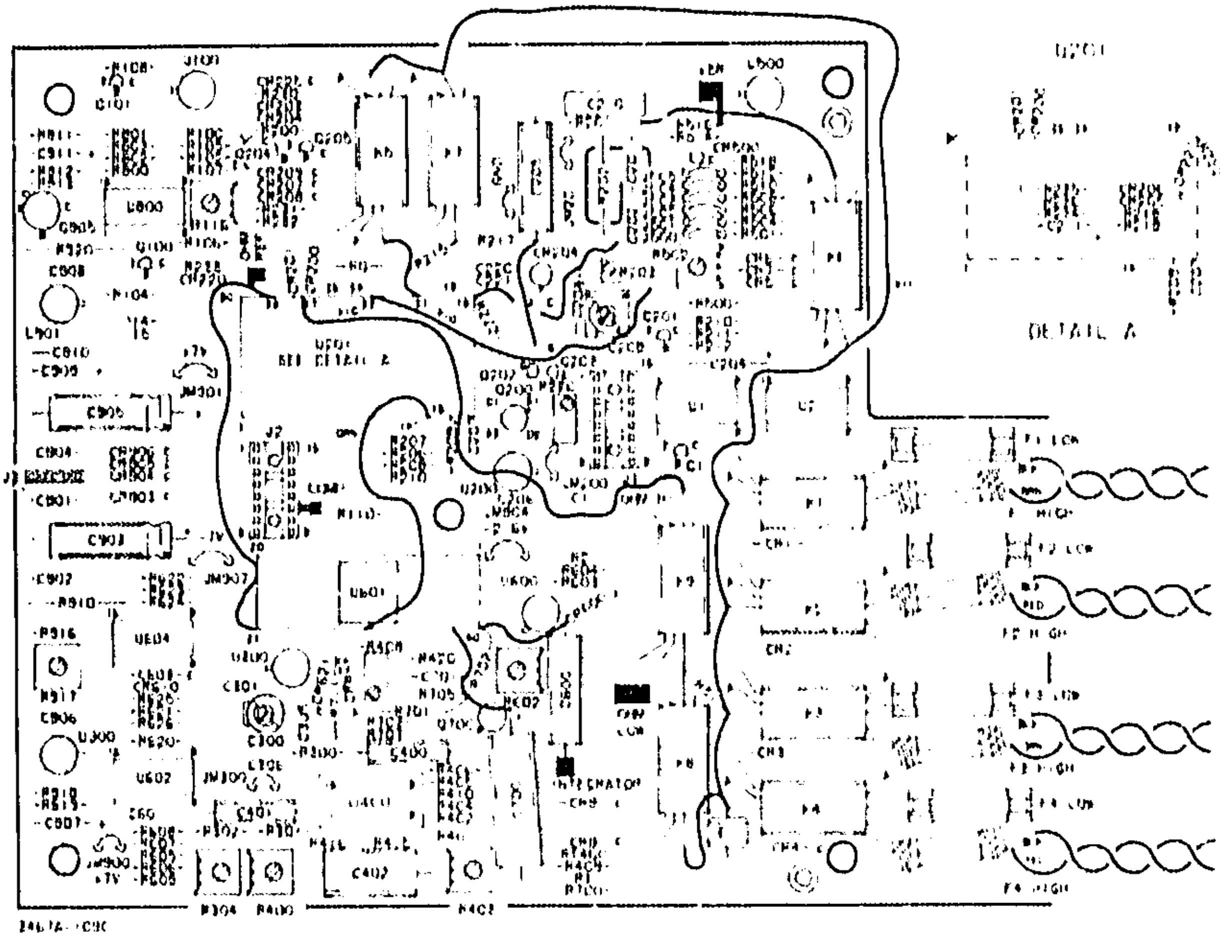
Delete from parts list:

Designator	hp Part No.	Description	Quantity
A1C7	0180 0197	1.1μ 10 V	1
A1C13	0160 0161	.01μ 200V	1
A9C1	0160 3847	.01μ 50V	1
A9C403	0160 2611	1μ [illegible] V	1
A9C901	0160 3847	.01μ 50V	
A9CR401	1902 3002	Diode Zener 2.37 V	1
A9R4*		Padding List	
	8150 3375	0	
	0698 4123	499 .01	
	0757 0280	1000 .01	
	0757 0427	1500 .01	
	0757 0283	2000 .01	
	0698 4435	2490 .01	
	0757 0273	3010 .01	
A9R404	0757 0461	68k .01	1
A9R410	0757 0401	Resistor F 100 .01	1
A9U400	1826 0421	AC Converter	1
A9U600	1826 0013	IC 741 OP AMP	1

Page 8-23/8-24, Paragraph 8-94. R4* is not loaded on these units, a jumper is used. Adding R4* to earlier units subject to the pad criteria on these pages is recommended to equalize calibration accuracy on the 20 mV and 200 mV ranges with respect to the other ranges (Input Amplifier is operated non-inverting on the lowest two dc V ranges).

Page 8-35, Figure 8-10, A9 Component Locator & Schematic I. The AC converter is mounted on a separate board on these instruments. The Ac Converter Board plugs into a DIP jack which replaces A9U400. The part number for this board is 03467-66510. To backdate the manual:

1. Revise the A9 component locator to reflect the 03467-66509 component layout:



A9
03467-66509
REV. A

NOTES

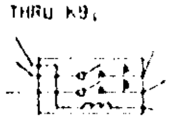
1. SQUARE PADS (WHERE POSSIBLE),

POLAR CAPACITORS	-	+ TERMINAL
DIODES	-	CATHODE (C)
IC'S (DIP)		PIN 1
TRANSISTORS	-	EMITTER
SOCKETS	-	PIN 1

2. DOTS (WHERE POSSIBLE),

DIODES	-	CATHODE
IC'S (TO CAN)	-	PIN 1

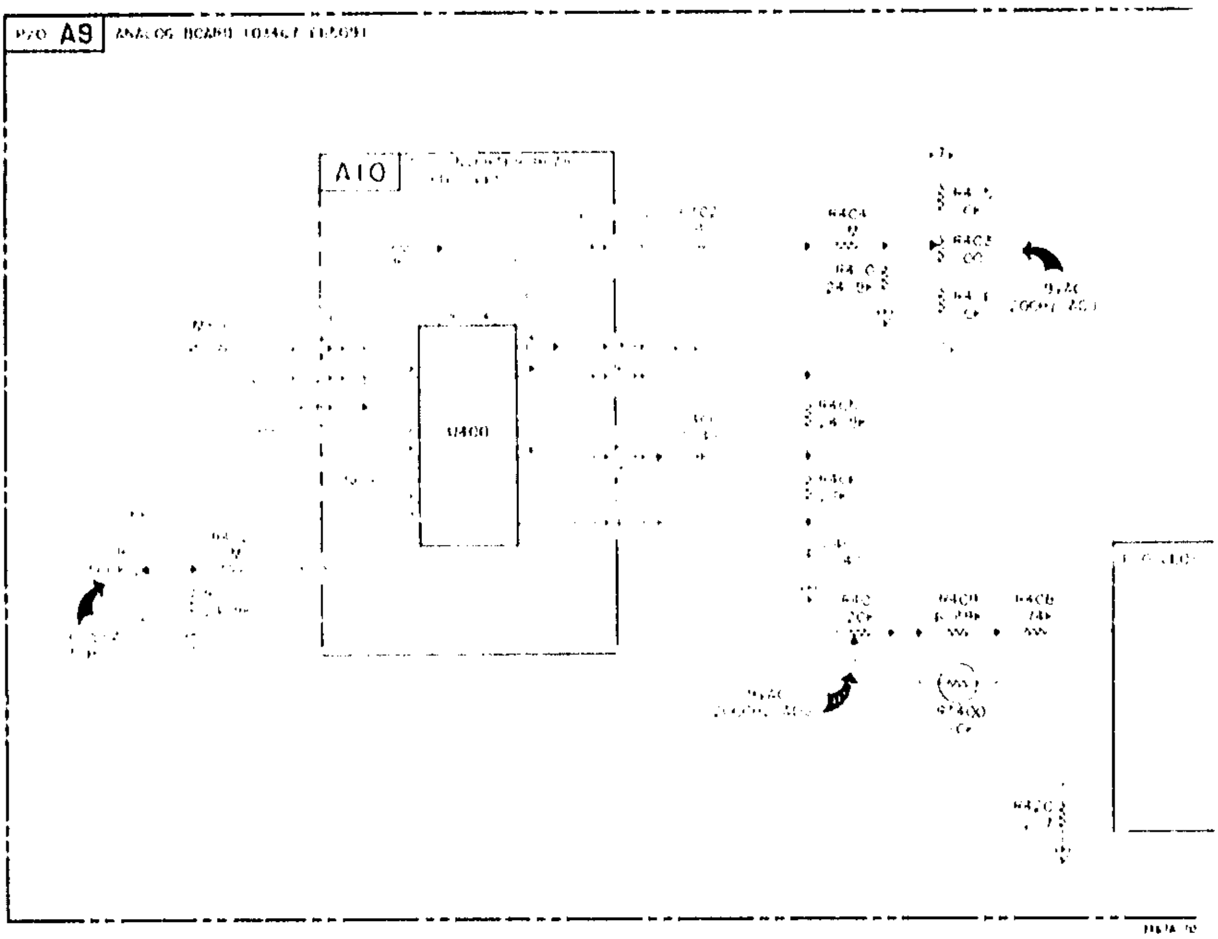
3. K1 THRU K9,



		BLACK (WEKO)	SILVER (EAC)
R_{COIL}:	IN-CIRCUIT,	550 OHM	350 OHM
	OUT-OF-CIRCUIT	700 OHM	400 OHM

4. ALL LEADS ARE BLUE UNLESS OTHERWISE SPECIFIED

2. Revise A9 on Schematic 1 and refer to this schematic for A10, the AC Converter Board, as necessary:



NOTE

The zero-input-condition reading on these units may be up to 100 counts (approximate) rather than the 50 counts (approximate) in later units. Here, again, this is an invalid reading (< 9% of full-scale) and should be ignored.

NOTE

If an older A9 board (03467-66509) needs replacement, the newer version may be used (03467-66511) to substitute both the A9 and the A10 boards.

APPENDIX A
SUBJECT INDEX

Note: Paragraph numbers are given unless otherwise specified.

Subject Index (Cont'd).

MANUAL CHANGES

-hp- MODEL 3467A

LOGGING MULTIMETER

Manual Part Number 03467-90000

▌ New or Revised Item

CHANGE NO. 1 applies to all serial numbers.

Page 5-4, Table 5.2. Change Table 5-2 to the following:

Table 5.2 Temperature Measurement Accuracy Test Limit.

Test Lead R_s (ohms)	°C Test Limits Low	°C Test Limits High	°F Test Limits Low	°F Test Limits High
97	146.7	149.3	296.1	300.7
255	109.5	110.5	229.1	230.9
628	79.7	80.3	175.5	176.5
16,330k	−00.3	+00.3	31.5	32.5
3371k	−78.7	−79.3	−109.66	−110.74

Page 5-14, Figure 5-7. Replace figure with the following (deleting the -hp- 746A voltage amplifier).

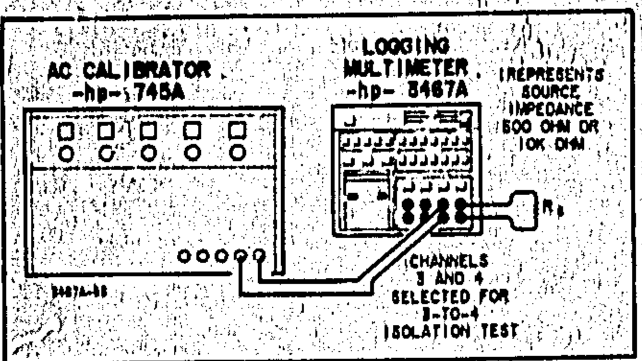


Figure 5-7. Scanner Isolation Test.

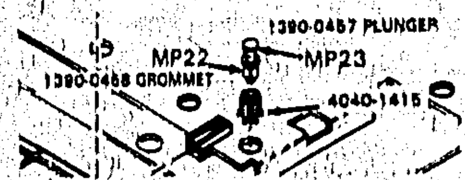
Page 1-3, Table 1-1. Change the Ohmmeter listing to the following:

Table 1-1. Specifications.

Range	Maximum Reading	Current Through Unknown
200Ω	195.990*.	5mA
2kΩ	1.9959kΩ*	1mA
20kΩ	19.995kΩ*	100μA
200kΩ	199.99kΩ	10μA
2MΩ	1.9999MΩ	1μA
20MΩ	19.999MΩ	100nA

*Values are true when instrument is first turned on. When zeroing button is used the maximum readings will vary slightly, plus or minus, depending on the particular instrument and measurement lead lengths.

Page 7-21/7-22, Figure 7-1. Exploded View, miscellaneous parts, MP22 is erroneously pointing to the insulator spacer, MP22 is suppose to point toward the grommet as shown below:



Page 6-3, Paragraph 6-14, Step a. Change "Set the Logging Multimeter to the DCV function" to "Set the Logging Multimeter to the ACV function".

Page 6-3, Paragraph 6-15, Step a. Change "Set the Logging Multimeter to the DCV function" to "Set the Logging Multimeter to the ACV function".

Page 4-22, Figure 4-17, Storage Capacitor. Change C10 to C11 (numbering was wrong).

Page 8-43/8-44, Figure 8-12, I/O and Timing Board, A3. Change CR1 in the Power-Drop Reference area to CR6, CR6 is a 6.9V zener diode.

Page 8-33/8-34, Analog Board, A9, Schematic. Connected to U100, negative input, is shown R415, 5k, 19k ohm adjust. Change this to R116, 5k, 190.0k ohm adjust.

Page 6-2, Paragraph 6-13, +7V Supply Adjustment. Paragraph 6-13 is incomplete as printed in manual. Replace with the following:

a. Set the 3467A to ACV, autorange.

b. Short the inputs of Channel 3 and select only Channel 3.

c. Set the external DVM to the DCV function, autorange.

d. Connect the external DVM from JM902(+) to the Channel 3 LOW input terminal (−).

e. Adjust R917 for a DVM reading between +6.990V and +7.010V.

Page 6-3, Paragraphs 6-14 and 6-15, Steps c and Steps d. Change "Set the DVM" and "connect the DVM" to "Set the external DVM" and "connect the external DVM".

Page 6-4, Paragraph 6-19, 1/10 Scale AC Adjustment 1.900C 400Hz. Change paragraph number to 6-20.

Page 6-5, Paragraph 6-19, Step a. Change "2V range" to "20V range".

Page 6-5, Paragraph 6-20, Full-Scale AC Adjustment 19.000V 400 Hz. Change paragraph number to 6-19.

Page 8-8, Paragraph 8-20. Add the following note:

Note

The Full-Scale AC Adjustment 19,000V 400Hz *and* 1/10 Scale AC Adjustment 1.9V 400Hz *are two adjustments which are interrelated. Adjusting one will change the other. Since the Full-Scale adjustment is the most sensitive, time can be saved by adjusting this first. That is, on the adjustment procedure (printed on shield) do step 8 before step 7.*

Pages 8-33, 8-35, 8-52, 8-4, Component Locator for A9 Board. Change jumper reference JM900 to JM902 (lower lefthand corner).

Page 8-54, Power Supply Schematic. Change JM900 to JM302 (upper righthand corner).

Page 7-17, Table 7-3. Change Table 7-3 to the following:

For MP7

Delete:	03467-20202	Door Printer
	1480-0333	Pin-Dowel
Add:	03467-67901	Door Printer
	1480-0557	Pin-Dowel
	7121-1231	Label Information

Page 7-13, Table 7-3. Change Table to the following:

For A9Q200

Delete: P/N 1855-0222

Add: P/N 1855-0469

CHANGE NO. 2. Applies to Serial Prefix 2513 and Above

Title Page. Add the following caution to the title page.

CAUTION

Your instrument may have either metric or English hardware. **DO NOT** *intermix the different hardware or damage to the instrument may result. Follow the cautions in the manual that pertain to the different hardware. Contact your local HP Office if more information is needed.*

Section I, Paragraph 1-31. Do the following changes in the paragraph.

Change the "Rack Mounting Kit" part numbers in the table in paragraph 1-31 to the following.

Rack Mounting Kit
(For Serial Prefix 1821 and below, use HP P/N 5061-0060
For Serial Prefix 2513 and above, use HP P/N 5061-9660)

Add the following caution to paragraph 1-31.

CAUTION

Your instrument may have either metric or English hardware. **DO NOT** *intermix the different hardware or damage to the instrument's frame and cabinet may result. For instruments with with serial prefix 2513 and above, use metric rack mounting hardware, as listed above. For instruments with serial prefix 1821 and below, use English rack mounting hardware also as listed above. Contact your local HP Office if more information is needed.*

Section II, Paragraph 2-19. Change the paragraph to the following.

2-19. The Logging Multimeter cabinet is an -hp- system II half-rack width module and can be rack-mounted using the rack-mount accessory, provided that sufficient rear support is available. For instruments with serial prefix 2513 and above, use the metric accessory (P/N 5061-9660). For serial prefix 1821 and below, use the English accessory (P/N 5061-0060). Additional information on rack mounting is provided with the accessory.

CAUTION

DO NOT *intermix the different hardware or damage to the instrument's cabinet parts and hardware can result.*

Section VII, Table 7-3 (Replaceable Parts). Do the following changes in the table.

Reference Designation	HP Part Number	Qty	Description
			Under PARTS
Change: MP2	5020-8817	1	Frame, Front (For Serial Prefix 1821 and Below)
			Under OTHER HARDWARE
	2510-0192	4	Screw (Front Frame Screws) (For Serial Prefix 1821 and Below)
			Under PARTS
Add: MP2	5021-5817	1	Frame, Front (For Serial Prefix 2513 and Above)
			Under OTHER HARDWARE
	0515-1331	4	Screw (Front Frame Screws) (For Serial Prefix 2513 and Above)