OPERATING AND SERVICE MANUAL

1700 SERIES
OPTION 034/035

DIGITAL MULTIMETER

SCANNED with the Permission of Agilent Technologies

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HEWLETT PACKARD

HP 1700
OPT. 034/035

Watchguard

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 and the Safety Summary 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.

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This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. 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.

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OPERATING AND SERVICE MANUAL

1700 SERIES OPTION 034/035 DIGITAL MULTIMETER

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed **1712A**.

For additional information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

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SAFETY SUMMARY

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

GROUND THE INSTRUMENT.

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

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

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

KEEP AWAY FROM LIVE CIRCUITS.

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

DO NOT SERVICE OR ADJUST ALONE.

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of 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.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information to operate, test and service the Hewlett-Packard 1700 series Option 034/035 Digital Multimeter (hereinafter called Option 034/035). Instrument specifications are contained in table 1-1.

1-3. DESCRIPTION.

1-4. The Option 034/035 is a digital multimeter installed on top of an HP 1700 series oscilloscope. It is a five-function, autoranging instrument with a 3-1/2 digit LED display. The instrument is designed to receive a dc voltage proportional to the position of measurement markers on an oscilloscope screen and provide digital readouts in terms of time from one selected marker to another.

1-5. The Option 034/035 can also be used for conventional measurements of ac and dc voltage, ac and dc current, and resistance. A hold function is provided to lock out the auto range function. The multimeter receives input data at a rate of approximately three samples per second.

1-6. INSTRUMENTS COVERED BY MANUAL.

1-7. Attached to assembly A1 inside the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-8. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-9. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-10. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

Table 1-1. Specifications

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

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

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

Table 1-1. Specifications (Cont'd)

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

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

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

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

DC AMMETER
Ranges: ± 0.11 A, 1.1 A
Accuracy (20°C to 30°C):

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

Impedance: 1 — 1.5 ohm constant
Current Protected: 1.5 A fuse

AC AMMETER
Ranges: 0.11 A rms, 1.1 A rms
Accuracy (20°C to 30°C):

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

*Ranges usable from 0.03 to full scale.
Impedance: 1 — 1.5 ohm constant.
Current Protected: 1.5 A fuse.

Table 1-1. Specifications (Cont'd)

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

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

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

GENERAL
Ranging: Automatic or Hold Mode.
Sample Rate: approximately 3 samples per second.
Operating Environmental conditions:
Temperature range: 0°C to 40°C.
Humidity: < 95% RH.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides installation information and descriptions of the operating power and signal interconnections.

2-3. INSTALLATION INFORMATION.

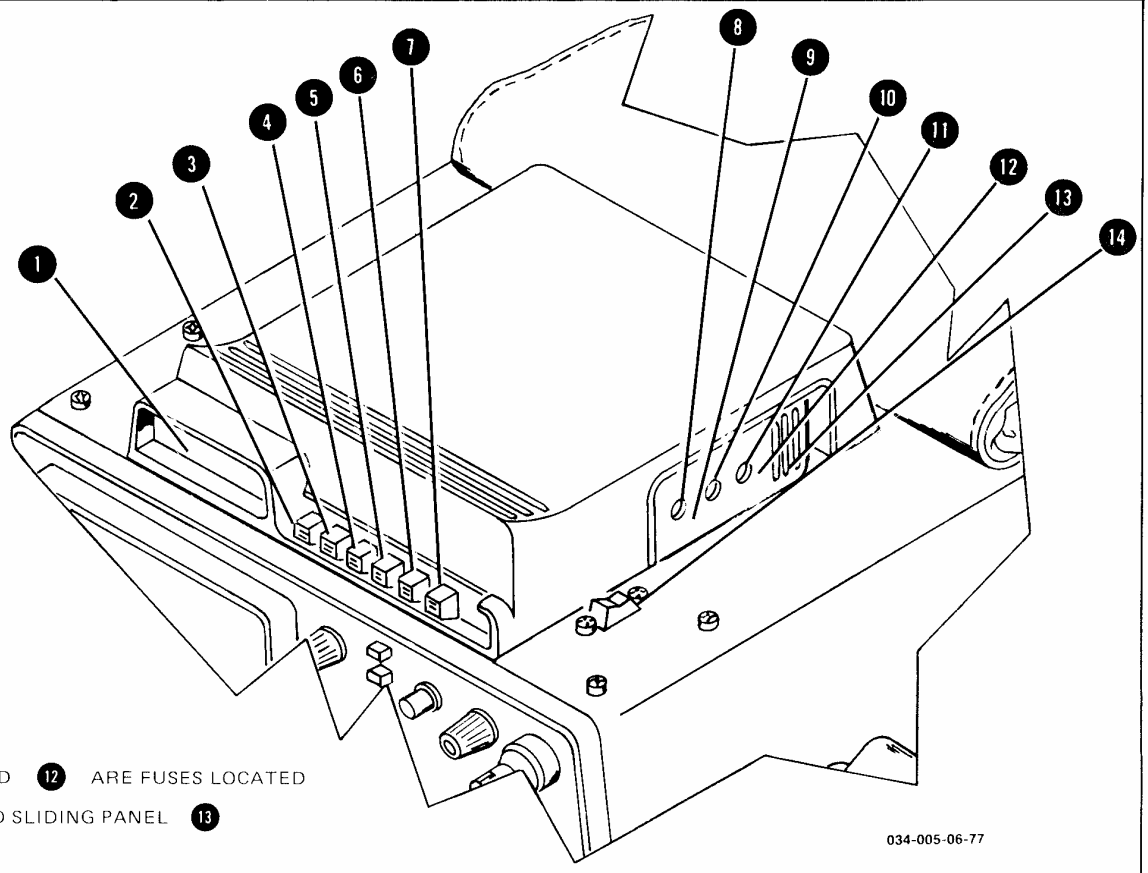
2-4. Option 034/035 is designed to be installed directly on top of most 1700-series Oscilloscopes. A special instrument top cover and pouch are used in place of the standard top cover and pouch when Option 034/035 is installed. Refer to Section VI for HP Part Numbers of these components.

2-5. OPERATING POWER INTERCONNECTIONS.

2-6. Operating power is obtained from the oscilloscope low voltage power supply transformer. It is coupled through a cable assembly and separate transformer to the digital multimeter. No separate adjustments are required when changing operating power sources for the oscilloscope.

2-7. SIGNAL INTERCONNECTIONS.

2-8. The only signal interconnection to the host oscilloscope is the ΔT voltage used in time interval measurements.



1. **Display:** Five section, 7 segment LED readout.
2. **LINE Switch:** Switches instrument power ON or OFF. Power is ON when the pushbutton is depressed.
3. **AC/DC Selector Switch:** Selects ac or dc mode for either voltage or current measurements. The instrument is in ac mode when the pushbutton is depressed.
4. **Voltage Selector Switch:** Selects voltage function for either ac or dc voltage measurements.
5. **Amps Selector Switch:** Selects amps function for either ac or dc current measurements.
6. **kΩ Selector Switch:** Selects ohms function for measuring resistance. Display reads in kilohms.
7. **RANGE Selector Switch:** Selects AUTO ranging mode or HOLD mode. HOLD mode is set with the switch depressed. Refer to paragraph 3-5.
8. **Volts/Ohms Input Terminal:** Used in conjunction with the COM terminal 10 for measuring ac voltage, dc voltage, or ohms.
9. **Ohms Input Protection Fuse:** 32 mA fuse located behind the sliding input panel 13.
10. **COM Input Terminal:** Common terminal for ac/dc volts, ac/dc amps and ohms measurements.
11. **Amps Input Terminal:** Used in conjunction with the COM terminal 10 for measuring ac or dc amps.
12. **Amps Input Protection Fuse:** 1.5 amp fuse located behind the sliding input panel 13.
13. **Sliding Input Panel:** In the front (left) position this panel allows access to the three input terminals (VΩ, COM, A). When in the back (right) position the input protection fuses 9 and 12 can be removed and replaced.
14. **MULTIMETER/TIME INTERVAL Switch:** Selects either direct readouts in units of time for oscilloscope ΔT measurements, or conventional multimeter measurements.

Figure 3-1. Controls and Connectors

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section presents information on the operation of Option 034/035. Figure 3-1 illustrates and describes instrument controls and connectors. The following paragraphs provide descriptions of the overload/overrange indication and use of the RANGE switch.

3-3. OVERLOAD/OVERRANGE INDICATION.

3-4. Figure 3-2 shows the display indication during an overload/overrange condition.

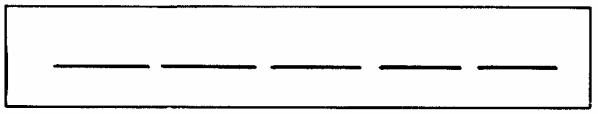


Figure 3-2. Overload Indication

3-5. RANGE SWITCH.

3-6. In the AUTO position (out), the instrument is in the automatic ranging mode. In this mode any measurements taken within the range of the instrument as shown in table 1-1 will be displayed with maximum resolution. In the HOLD position (in), the instrument will remain in the same range.

3-7. If the RANGE switch is pressed into the HOLD position with the display indicating 1.000 V dc, the instrument will remain in the 1.1 V dc range until the switch is released. In the 1.1 V dc HOLD range, the display will track input voltages from zero V dc to full scale. If the input voltage exceeds full scale, an overload/overrange indication will be displayed.

3-8. ΔT MEASUREMENTS.

a. Press LINE switch to ON.

b. Set MULTIMETER/TIME INTERVAL switch (on oscilloscope top cover) to TIME INTERVAL (forward) position. (This disables the conventional multimeter controls.) LED's will display direct readouts of time intervals measured on the oscilloscope.

3-9. AC VOLTAGE MEASUREMENTS.

CAUTION

To avoid damage to Option 034/035 circuitry, the ac input voltage must not exceed 707 V rms.

a. Set front panel controls as follows:

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

b. Connect test leads from V Ω and COM (low) connectors to voltage under test as shown in figure 3-3.

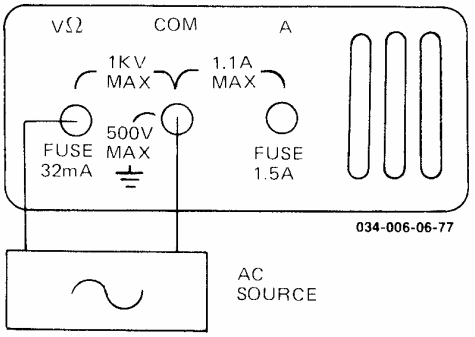


Figure 3-3. AC Voltage Measurement

3-10. DC VOLTAGE MEASUREMENTS.

CAUTION

To avoid damage to Option 034/035 circuitry, the dc input voltage must not exceed 1000 V dc.

a. Set front panel controls as follows:

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

b. Connect test leads from V Ω (hi) and COM (low) connectors to voltage under test as shown in figure 3-4.

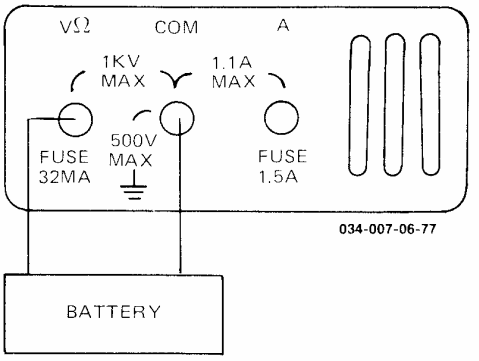


Figure 3-4. DC Voltage Measurement

3-11. AC CURRENT MEASUREMENTS.

CAUTION

To avoid damage to Option 034/035 circuitry, the ac input current must not exceed 1.1 amp rms.

a. Set front panel controls as follows:

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

b. Connect test leads from A and COM connectors to current under test as shown in figure 3-5.

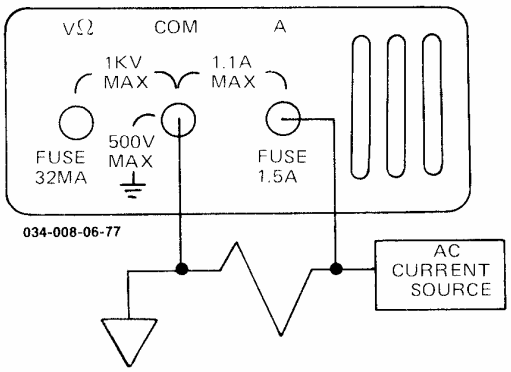


Figure 3-5. AC Current Measurement

3-12. DC CURRENT MEASUREMENTS.

CAUTION

To avoid damage to Option 034/035 circuitry, the dc input current must not exceed 1.1 amp dc.

a. Set front panel controls as follows:

DC/AC ..... (OUT)
AMPS (A) ..... (IN)
RANGE ..... AUTO (OUT)
VOLTS (V) AND KΩ ..... (OUT)

b. Connect test leads from A and COM to current under test as shown in figure 3-6.

3-13. RESISTANCE MEASUREMENTS.

a. Set front panel controls as follows:

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

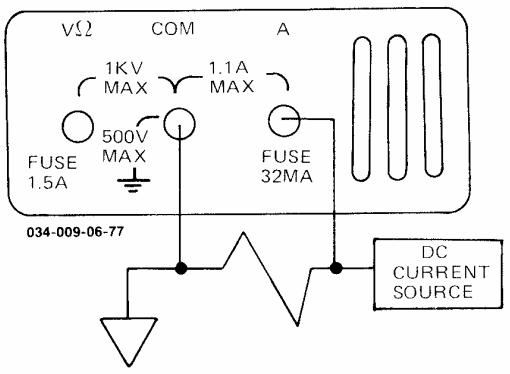


Figure 3-6. DC Current Measurement

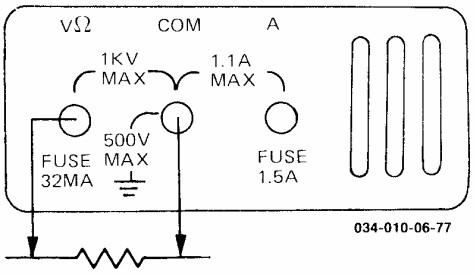


Figure 3-7. Resistance Measurement

b. Connect test leads from V Ω and COM connectors to resistance under test as shown in figure 3-7.

3-14. SEMICONDUCTOR JUNCTION MEASUREMENTS.

3-15. Due to the low output current on the higher ohm ranges, Option 034/035 must be downranged to the lowest ohm range in order to measure semiconductor junction (diode) resistance. This can be easily accomplished by the following procedure:

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

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

c. Press RANGE pushbutton in (HOLD).

d. Press kΩ pushbutton.

e. Release RANGE pushbutton (AUTO). The instrument will automatically uprange.

f. Take reading and then press RANGE pushbutton in (HOLD).

g. To measure reverse resistance of diode, switch input connections to diode, release RANGE pushbutton, and allow instrument to autorange.

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation for the Option 034/035 Digital Multimeter. Included is a discussion keyed to a simplified block diagram of the instrument, and additional discussions of the circuits shown on the schematics.

4-3. SIMPLIFIED BLOCK DIAGRAM. (See figure 4-1.)

4-4. SIGNAL CONDITIONING. The signal conditioning block consists of the input terminals, overload protection fuses, and functional switching. The fuses protect the multimeter circuitry during ac and dc current measurements and during resistance measurements.

4-5. OHMS CURRENT SOURCE. The ohms current source provides a constant current for use in making resistance measurements.

4-6. INPUT AMPLIFIER. The input amplifier provides range selection for all five multimeter functions. This is accomplished by selecting different gain factors for the input amplifier. The gain factor is selected by the hybrid MOS control.

4-7. AC CONVERTER. The ac converter is an average responding detector used in ac voltage and ac current measurements. During ac voltage measurements, the output of the ac converter is a dc voltage equal to the rms value of the ac input. During ac current measurements, the input voltage to the converter is derived from a 1-ohm current shunt.

4-8. INTEGRATOR. The integrator receives a dc charging voltage from either the input amplifier (during dc and resistance measurements) or from the ac converter (during ac measurements). The charge (a dc voltage proportional to the signal being measured) builds on the integrator capacitance for a predetermined period of time. This is the ramp-up period. At the end of the ramp-up period, the test signal is disconnected and a reference voltage is connected to the integrator input. Polarity of the reference voltage is selected to remove charge from the integrator capacitance. This is the ramp-down period. With a known value of reference voltage, and a linear integrator discharge rate, the value of the charge built during the ramp-up period is determined by measuring the length of the ramp-down period.

4-9. POLARITY/ZERO DETECTOR. The polarity/zero detector provides a voltage to the hybrid MOS control that has the same polarity as the charge on the integrator capacitance. This polarity is used by the hybrid MOS control to determine which reference source to select during the integrator ramp-down period. Output of the polarity/zero detector reverses

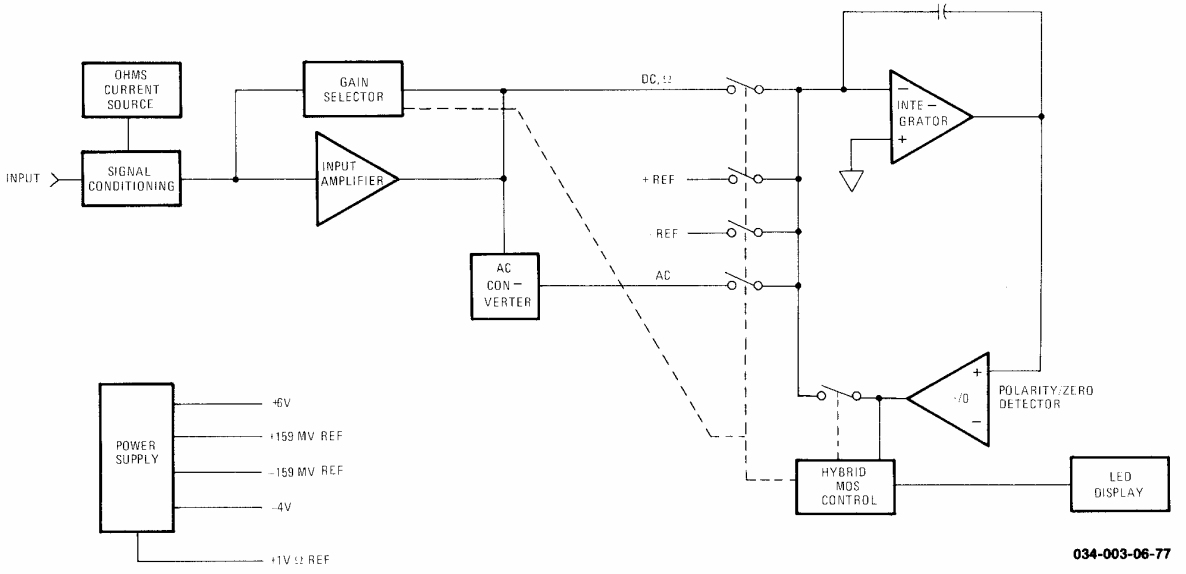


Figure 4-1. Simplified Block Diagram

polarity when the integrator charge passes through 0 volt. This polarity reversal is supplied to the hybrid MOS control where it signals the end of the ramp-down period. After the ramp-down period, the hybrid MOS control closes a FET switch that connects the polarity/zero detector output to the input of the integrator. This circuit allows both amplifiers to stabilize at 0 volt before beginning the next ramp-up period.

4-10. HYBRID MOS CONTROL. The hybrid MOS control opens and closes FET switches in the circuitry according to the mode and sequence of the measurement being taken. The hybrid MOS control contains an internal clock and counter circuits. These circuits control duration of the integrator ramp-up period and count clock pulses during the ramp-down period. The hybrid MOS control actually selects between two ramp-up periods during dc measurements (one ten times longer than the other). The two ramp-up periods offer multimeter sensitivities of X1 and X10 in the integrator stage. The hybrid MOS control translates clock count from the ramp-down period into a digital value and drives the LED display to indicate the measurement value.

4-11. POWER SUPPLY. The power supply provides regulated dc voltages of +6 V dc, —4 V dc, +1 V dc, and reference voltages of +159 and —159 mV dc.

4-12. MULTIMETER SCHEMATIC DESCRIPTION. (See schematic 2.)

4-13. SIGNAL CONDITIONING. Signal conditioning circuitry consists of switches S1 through S5 and associated circuits. Positioning of the switches selects the mode of measurement.

4-14. OHMS CURRENT SOURCE. The ohms current source provides current for resistance measurements. A1R16 is adjusted to calibrate the current output.

4-15. INPUT AMPLIFIER. The input amplifier consists of operational amplifier U2A and dual J-FET Q15 connected in a source follower configuration along with associated feedback resistances. Gain (or attenuation) of the stage is governed by the particular arrangement of feedback resistances selected by MOS FET switches 10, 11, and 12, and input resistance R1 or R13. R38 is adjusted for a 0-volt dc indication when a jumper is connected across the multimeter input terminals. The gains in the input amplifier stage, selected by the MOS FET switches, are 1, 0.1, and 0.001. These gains, along with the two different ramp-up periods used in the integrator stage, provide the five ranges in dc. In ac, only the longest ramp-up period is used in the integrator. The ac converter stage offers X1 and X10 attenuation factors to provide the five ranges for ac measurements.

4-16. AC GAIN STAGE. The ac gain stage consists of operational amplifier U2B and associated input and feedback resistances. MOS FET switch 9 selects a gain of either X1 or X0.1 for this stage.

4-17. AC CONVERTER. The ac converter is a low-distortion, full-wave rectifier followed by an RC filter. When the output of U2B is negative (one-half of an ac sine wave), the output of U5A is positive. CR10 is forward biased, and a positive charge develops at the top of R34. When the output of U2B is positive, the output of U5A is negative. CR10 is back biased and CR9 prevents saturation in U5B. Positive charge is added through R26 to the top of R34. R48 is adjusted to maintain a positive dc charge on R34 that is proportional to the rms value of the ac voltage sine wave applied to the multimeter. The pulsating dc voltage across R34 is filtered by the RC network consisting of C9 and associated resistors. R9 is adjusted to derive a 0-volt charge on C9 with a 0-volt ac input.

4-18. INTEGRATOR. The integrator consists of operational amplifier U5B, C8, and U1RF10 or 11. Upon application of a signal through U1RF10 or 11, capacitor C8 charges. The charge period is determined by power line frequency and is internally adjusted so that the integration period minimizes the effects of common-mode pickup. The output of U5B is a ramp whose final value depends on the input being measured. This is the ramp-up period.

4-19. At the end of the ramp-up period, the hybrid MOS control opens the conducting MOS FET switch (U1S4 or 5) and closes the MOS FET switch that supplies the appropriate reference voltage. The reference voltage has the opposite polarity of the test voltage so the integrator capacitor begins to discharge. As the capacitor discharges, the integrator output becomes a ramp in the opposite direction. When zero ramp voltage is detected, the ramp-down period ends. Duration of the ramp-down period is directly proportional to the charge stored during ramp-up. The hybrid MOS control measures this duration and translates it into the value of the voltage applied during ramp-up.

4-20. The values of both reference voltages are the same. Values of their associated input resistances are slightly different to compensate for offset of the integrator stage. Two ramp-up periods are used in the integrator during dc and resistance measurements to obtain X1 and X10 gain factors in the circuit. Only the longest ramp-up period is used during ac measurements; this period provides additional filtering for the pulsating dc from the ac converter.

4-21. POLARITY/ZERO DETECTOR. Operational amplifier U4 performs two functions: it detects polarity of the integrator voltage developed during the ramp-up phase, and it supplies a trigger when the integrator output crosses 0 volt during the ramp-down phase. Polarity of the output voltage from U4 is the same as integrator output polarity, and is supplied to the hybrid MOS control. As the integrator output crosses through 0 volt, the high gain of U4 provides a very fast transition from one polarity to the other. This

polarity switch is detected in the hybrid MOS control and interpreted as the 0-volt integrator voltage.

4-22. AUTO ZERO PHASE. The previous discussions assumed that all circuitry had zero offset voltages. The auto-zero loops compensate for inherent circuit offsets to obtain this condition prior to the ramp-up phase. In resistance and dc measurements, after the end of the ramp-down period, the output from the polarity/zero detector is connected to the input amplifier. The polarity and amplitude of this signal reduces dc offsets in the input amplifier and integrator circuits. The input signal under test is disconnected from the amplifier during the auto-zero phase. During ac measurements, the auto-zero loop performs the same function, but involves only the input amplifier and ac gain stage.

4-23. IDLE PHASE. The purpose of the idle phase is to ensure that the dual-slope ramp starts and ends at the same voltage level. The idle loop is closed after auto zero, just before the start of ramp-up. During the idle phase, output from the polarity/zero detector is supplied to the input of the integrator. A charge is placed on the integrator capacitor that is exactly the same as the charge which will be detected as 0 volt at the end of the ramp-down period. Also, the input signal is reconnected to the input amplifier during the idle phase so the circuitry can charge to the applied voltage before the beginning of the ramp-up phase.

4-24. RESISTANCE MEASUREMENTS. During resistance measurements, the multimeter circuitry functions the same as during dc measurements, except that the input amplifier is reconfigured. The reconfiguration places a calibrated dc voltage across the input resistance selected for U2A. The resistance to be measured is made a part of the amplifier feedback loop for U2A. Since gain of the input amplifier is established by feedback resistance, the output voltage from U2A is proportional to the unknown resistance. CR1 through CR3 and CR7 protect the input circuit against any overload voltages that occur during resistance measurements.

4-25. HYBRID MOS CONTROL A1U1. The MOS control portion of U1 contains an astable multivibrator clock circuit. R19, R43, and C7 control the clock frequency.

4-26. The clock signal is supplied to a counter in U1. The number in the counter is transferred to a buffer storage.

4-27. LED DISPLAY. The remaining portion of U1 logic circuitry controls the display. It strobes one digit at a time and selects the minus sign, decimal point location, and overload indication. The display is scanned from left to right. As each digit is scanned, the cathodes of all seven diodes in the digit are pulled low by the associated digit driver. Anodes of the appropriate segments are pulled high by the selected segment drivers. For a segment in a digit to light, both its segment and digit drivers must be on.

4-28. POWER SUPPLY. The power supply circuitry is shown on Schematic 1. Transformer T1 couples the ac operating power to the power supply. CR14 provides full-wave rectification of the applied voltage. S6 controls application of the pulsating dc voltage.

4-29. Transistor Q19, bootstrapped with a transistor in U6, is the voltage pass transistor. Transistor Q18 supplies constant voltage to regulator U6. A1U6 has a temperature compensated voltage source that supplies the network consisting of A1R47, A1R55, A1R50, A1R49, and A1C19. This network supplies one input to the amplifier in U6. The other input to this amplifier is derived from a voltage divider connected from +6 V to ground. Output from the amplifier controls the pass transistor.

4-30. Another transistor in U6 obtains a voltage proportional to power supply current across R52. This circuit limits current flow through the pass transistor. If excessive current is drawn from the supply, such as an external short circuit, the voltage developed across R52 will drive the U6 transistor to conduct and reduce the pass transistor output.

4-31. U3A controls the analog ground circuit in the instrument. U3B, with Q17, controls the logic ground circuit in MOS U1.

4-32. R47 is adjusted for +6 V at the +6 V test point and —4 V at the —4 V test point. R14 adjusts the negative reference voltage inside the MOS control chip for balance with the position reference voltage. R15 is adjusted for +1 V in the ohms measurement reference supply (+1 V test point).

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides a performance test and adjustment procedures for the Option 034/035. Adjustment locations are shown at the end of this section in figure 5-5.

5-3. TEST EQUIPMENT.

5-4. Table 5-1 lists test equipment recommended for performance checks and adjustments. Test equipment having equivalent characteristics may be substituted.

5-5. PERFORMANCE CHECKS.

NOTE

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

5-6. DC VOLTMETER ACCURACY TEST.

5-7. A dc standard is required for this test.

Table 5-1. Recommended Test Equipment

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

Table 5-2. DC Voltmeter Accuracy Test

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

a. Set Option 034/035 to measure dc volts. Short input terminals and check for display of 0 ±1 count.

b. Connect dc standard to V Ω and COM terminals.

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

CAUTION

Do not apply more than 1000 V; instrument may be damaged.

5-8. DC AMMETER ACCURACY TEST.

5-9. This test requires the use of a power supply and the dc ammeter function of a digital multimeter (DMM).

a. Connect equipment as shown in figure 5-1.

b. Set DMM to 1000-mA range.

c. Set Option 034/035 function to DC A. Adjust power supply output for indication of 1000 mA on DMM. Option 034/035 should indicate within limits listed in table 5-3.

5-10. OHMS ACCURACY TEST.

5-11. A resistance decade box is required for the following test.

a. Set FUNCTION switch to kΩ and connect short between V Ω and COM terminals. Option 034/035 should indicate 0 ±1 count.

b. Remove short and connect equipment as shown in figure 5-2. Use large wire and connect resistance decade box as close as possible to Option 034/035. When checking 11,000 kΩ range, connect COM terminal to good earth ground.

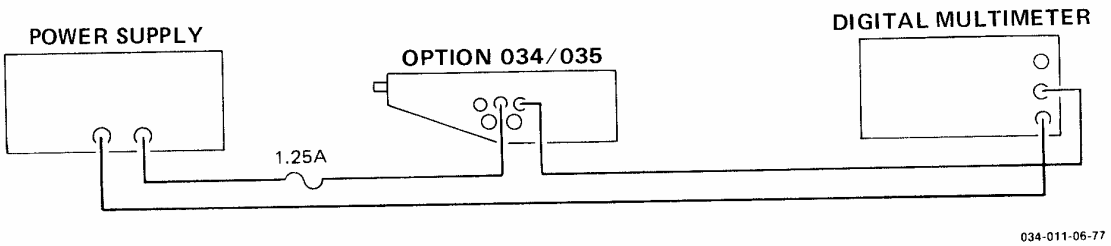


Figure 5-1. DC Ammeter Accuracy Test

Table 5-3. DC Ammeter Accuracy Test

Range	Current	90-Day Calibration Limit	1-Year Calibration Limit
1.1 A	1.000 A	.990 thru 1.010	.988 thru 1.012

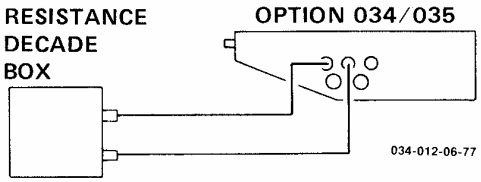


Figure 5-2. Ohms Accuracy Test

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

5-12. AC VOLTAGE ACCURACY TEST.

5-13. An ac calibrator and high voltage amplifier are required for this test.

CAUTION

To avoid damage, the ac input voltage must not exceed 707 V rms (1000 V peak).

a. Set Option 034/035 to AC V. Connect ac calibrator between V Ω and COM terminals. Be sure to connect calibrator sense leads.

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

Table 5-4. Ohms Accuracy Test

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

Table 5-5. AC Voltage Accuracy Test

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

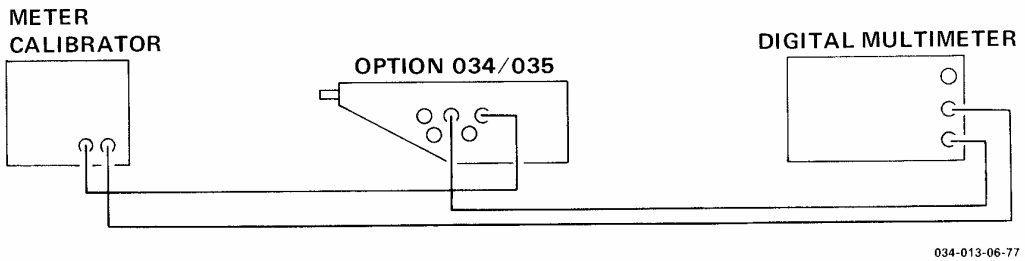


Figure 5-3. AC Ammeter Accuracy Test

WARNING

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

c. To check 1100 V range, connect ac calibrator and high voltage amplifier to Option 034/035. Check tolerances indicated for 1100 V range.

5-14. AC AMMETER ACCURACY TEST.

a. Connect equipment as shown in figure 5-3.

b. Set DMM to 1000-mA range.

c. Set Option 034/035 FUNCTION to AC A. Adjust meter calibrator output for indication of 1000 mA on DMM. Option 034/035 should indicate within limits listed in table 5-6.

5-15. AC COMMON-MODE REJECTION TEST.

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

a. Connect 1-kilohm resistor between V Ω and COM terminals on Option 034/035.

b. Set Option 034/035 function to AC V.

c. Connect ac calibrator HI output terminal to Option 034/035 as shown in figure 5-4.

d. Set ac calibrator frequency to ac line frequency being used.

e. Set ac calibrator output to 100 V rms. Option 034/035 should indicate ≤10 mV rms.

5-17. DC COMMON-MODE REJECTION TEST.

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

a. Connect 1-kilohm resistor between V Ω and COM terminals on Option 034/035.

b. Set Option 034/035 function to DC V.

c. Connect ac calibrator HI output terminal to Option 034/035 as shown in figure 5-4.

d. Set ac calibrator frequency to 60 Hz for Option 034 or 50 Hz for Option 035.

e. Set ac calibrator output to 100 V rms. Option 034/035 should indicate ≤1.5 mV peak.

Table 5-6. AC Ammeter Accuracy Test

Range	Current	90-Day Calibration Limit	1-Year Calibration Limit
1.1 A	1.000 A	.976 thru 1.024	.973 thru 1.027

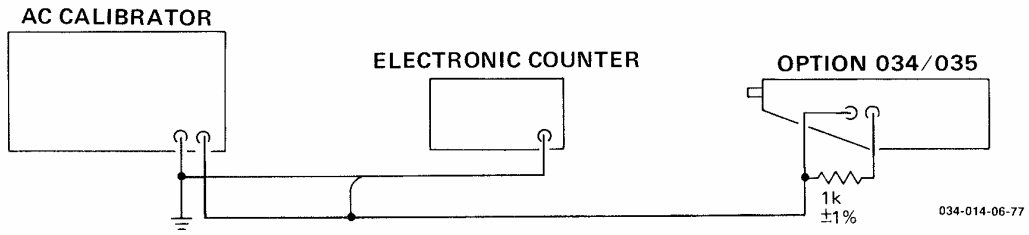


Figure 5-4. Common-mode Rejection Test

WARNING

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

CAUTION

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

CAUTION

Hybrid circuits in the Option 034/035 may be damaged by static discharge from a hand or tool. The following precautions must be observed to prevent damage.

1. Ground the hand while disassembling and working on Option 034/035. Conductive wristbands (HP Part No. 00970-67900) are available for this purpose.

2. Attach Option 034/035 COM terminal to earth ground. Touch all tools to earth ground to remove static charges before using them on Option 034/035.

3. Use a soldering iron with a grounded tip.

5-19. PREADJUSTMENT PROCEDURES.

5-20. DISASSEMBLY INSTRUCTIONS.

a. Remove instrument top cover from oscilloscope and disconnect internal cable assembly.

b. With Option 034/035 inverted, remove two screws in cover.

c. Remove cover.

d. Remove internal shield.

e. Remove input panel and input fuses.

f. Connect jumpers across amps input protection fuse holder and across ohms input protection fuse holder.

5-21. TURN-ON INSTRUCTIONS.

a. Connect Option 034/035 TP ⏚ to earth ground.

b. Connect 20 V dc power supply to provide instrument power. If using an external 20 V dc source, connect power supply across C15. Connect positive power supply lead to (+) end of C15 and negative power supply lead to other end. If an external power supply is not available, use the transformer power cord from the oscilloscope.

5-22. ADJUSTMENT PROCEDURE.

5-23. See figure 5-5 for the following adjustment locations.

NOTE

The resistors used in the adjustment procedure must be floating.

5-24. POWER SUPPLY ADJUSTMENT.

a. Connect 1-kilohm resistor to V Ω and COM terminals. Set function to kΩ and ensure that RANGE pushbutton is out.

b. Connect digital voltmeter between +6 V test point and ground.

c. Adjust R47 for 5.94 to 6.06 V dc on digital voltmeter. If it is not possible to adjust within this limit, change the adjustment range of R47 by replacing or removing JMPR 7. Removing JMPR 7 will allow a more positive adjustment of TP +6.

5-25. SUBSTRATE ADJUSTMENT.

a. Connect 1-kilohm resistor between V Ω and COM terminals. Connect jumper between +1 test point and TPG.

b. Verify that Option 034/035 downranges to 1.1 kΩ range and adjust R42 for indication between .078 and .082 on display. If these limits cannot be obtained, indication of 000 to 078 is acceptable if R43 is fully clockwise (counterclockwise if A1U1 substrate is soldered in).

5-26. INPUT AMPLIFIER ZERO ADJUSTMENT.

5-27. The following adjustment requires that Option 034/035 be set to a DC V function, 110 V range with no input applied. Since Option 034/035 is autoranging, it is necessary to force it to the 110 V range and use the RANGE-HOLD function to keep it there.

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

b. Set function to kΩ and connect 300-kilohm resistor between V Ω and COM terminals. When

Option 034/035 autoranges to 1.1 megohm range, push RANGE pushbutton in (HOLD). This is equivalent to 110 V range.

c. Change function to DC V. Remove 300-kilohm resistor from input and replace it with a short.

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

e. Connect digital voltmeter to Test Point A. Adjust R38 for indication between —1 and +1 mV dc on digital voltmeter.

NOTE

The next adjustment requires the same test setup. Do not change the setup or function settings.

5-28. INTEGRATOR AMPLIFIER ZERO ADJUSTMENT.

5-29. This test requires the same test setup and functions as the previous adjustment.

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

Example:
Voltage at A = .2 mV
.2 mV x(—1000) = —00.2 V Display

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

NOTE

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

5-30. +DC VOLT GAIN ADJUSTMENT.

a. Remove digital voltmeter and jumper between U1 pin 12 and analog ground. Release RANGE pushbutton and remove short from input.

b. Set function to DC V. Apply input of +1.000 V dc. Option 034/035 should autorange to 1.1 V range for this adjustment.

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

5-31. —DC VOLT GAIN ADJUSTMENT.

a. Leave function set to DC V and RANGE switch out. Change input from +1.000 to —1.000.

b. Adjust R14 for Option 034/035 display of —1.000 V dc.

NOTE

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

5-32. CLOCK FREQUENCY ADJUSTMENT.

a. Set function to DC V, RANGE switch out, and —1.000 volts connected to input.

b. Connect electronic counter to test point D. If adjusting Option 034 (60-Hz line frequency), adjust R43 for indication of 954 Hz on counter. If adjusting Option 035 (50-Hz line frequency), adjust R43 for 795 Hz.

5-33. OHMS ADJUSTMENT.

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

b. Set function to kΩ and connect 1 megohm ±0.1% resistor to input.

c. Adjust R15 for display of 999 to 1001.

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

e. Adjust R16 for display of 10.03 to 10.04.

f. Remove jumper from fuse.

NOTE

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

5-34. AC CONVERTER GAIN AND ZERO ADJUSTMENT.

a. Disconnect previous setup and set Option 034/035 function to AC V.

NOTE

To go to the 1.1 V range and HOLD, set the Option 034/035 function to V AC, and apply 0.3 V to the input. When on the 1.1 V range, push the RANGE pushbutton in (HOLD).

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

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

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

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

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

5-35. AC HIGH FREQUENCY ADJUSTMENT (.11 V RANGE).

a. Set function to AC V.

b. Apply 0.1 V ac signal at 5 kHz to input. Release RANGE switch and allow Option 034/035 to autorange to .1 V range.

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

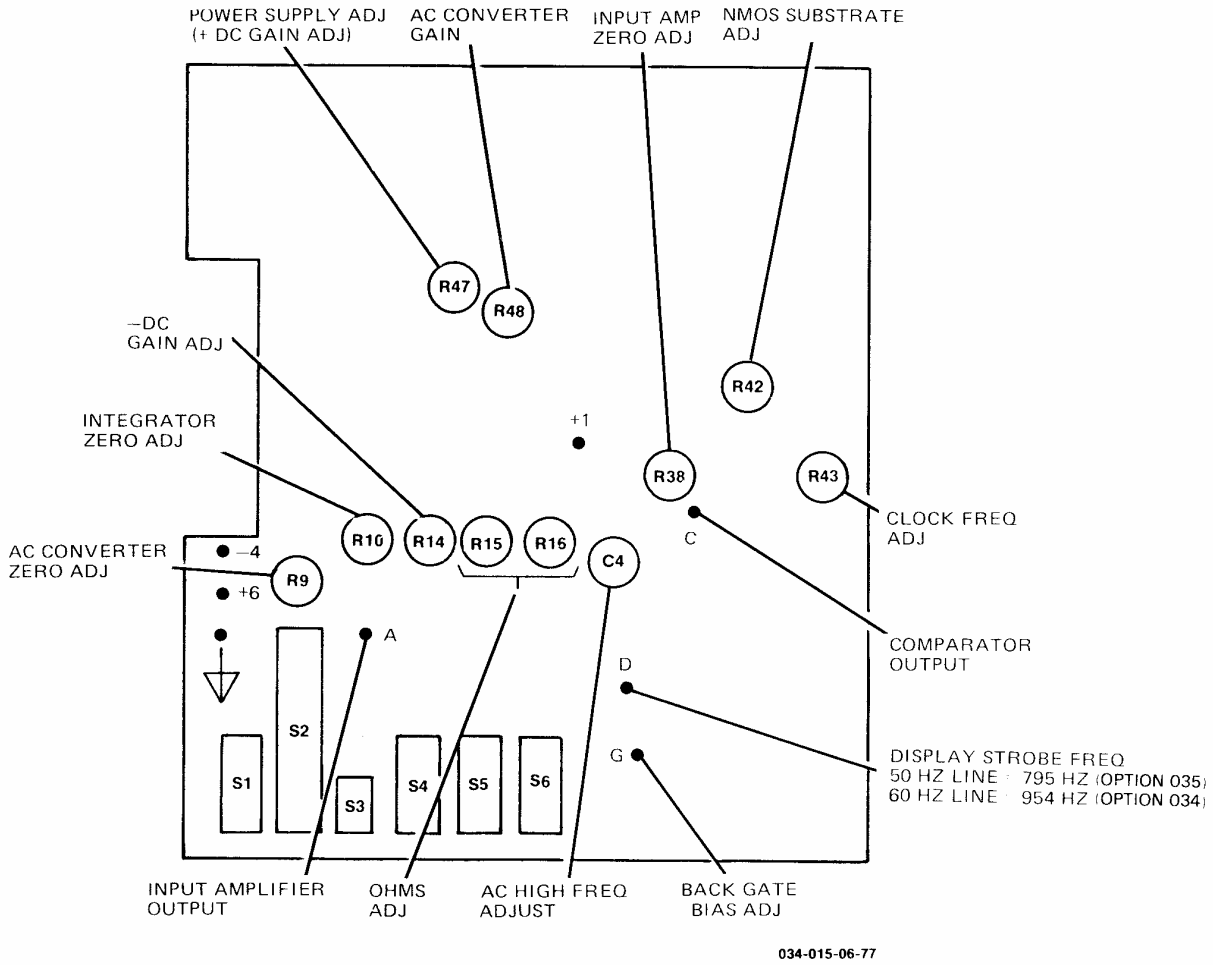


Figure 5-5. Adjustment Locations

Table 6-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

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

ABBREVIATIONS

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

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains the names and addresses that correspond to the manufacturer's code numbers.

6-3. REPLACEABLE PARTS LIST.

6-4. Table 6-2 is the list of replaceable parts and is organized as follows:

a. Chassis-mounted parts and assemblies in alpha-numerical order by reference designation.

b. The electrical assembly and its components in alpha-numerical order by reference designation.

c. Miscellaneous parts.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. The total quantity (Qty) in the instrument.

c. The description of the part.

d. A typical manufacturer of the part in a five-digit code.

e. The manufacturers' number for the part.

The total quantity for each part is given only once—at the first appearance of the part number in the list.

6-5. ORDERING INFORMATION.

6-6. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-7. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

6-8. SPARE PARTS KIT.

6-9. Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares list are based on failure reports and repair data, and parts support for one year. A Recommended Spares list for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

6-10. DIRECT MAIL ORDER SYSTEM.

6-11. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices—to provide these advantages, a check or money order must accompany each order.

6-12. Mail order forms and specific ordering information is available through your local HP office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	3476A/H01	1	DIGITAL MULTIMETER	28480	3476A/H01
F2	2110-0420	1	FUSE .032A 250V 1.25X .25 UL	75915	312.031
F3	2110-0043	1	FUSE 1.5A 250V 1.25X .25 UL IEC	71400	AGC 1-1/2
	01710-04106	1	COVER, TOP, OSCILLOSCOPE	28480	01710-04106
	1540-0446	1	POUCH, TOP COVER	28480	1540-0446
	5040-8302	1	ADAPTER, 3476A/H01	28480	5040-8302
	01710-24705	2	SPACER	28480	01710-24705
	2200-0103	2	SCREW, MACH 4-40 0.250 LG	28480	2200-0103
	2200-0111	2	SCREW, MACH 4-40 0.500 LG	28480	2200-0111
	2200-0762	2	SCREW, MACH 4-40 0.250 LG	28480	2200-0762
	2360-0115	2	SCREW, MACH 6-32 0.312 LG	28480	2360-0115
S4	03476-61601	1	SWITCH ASSY, ROCKER DPDT NONSHORTING	28480	03476-61601
T2	9100-3956	1	TRANSFORMER, LINE	28480	9100-3956
W13	01710-61638	1	CABLE ASSEMBLY, POWER	28480	01710-61638
A1	03476-66534	1	P.C. ASSEMBLY, MAIN BOARD	28480	03476-66534
A1C1	0160-3731	1	CAPACITOR-FXD .01UF +-20% 1000WVDC CER	28480	0160-3731
A1C2	0180-0106	2	CAPACITOR-FXD 60UF +-20% 6VDC TA	56289	150D606X0006B2
A1C3	0160-3847	4	CAPACITOR-FXD .01UF +100-0% 25WVDC CER	28480	0160-3847
A1C4	0121-0452	1	CAPACITOR-V TRMR-AIR 1.3/5.4PF 250V	74970	187-0103-005
A1C5	0180-0291	1	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A1C6	0180-0228	2	CAPACITOR-FXD 22UF +-10% 15VDC TA	56289	150D226X9015B2
A1C7	0140-0200	1	CAPACITOR-FXD 390PF +-5% 300WVDC MICA	72136	DM15F391J0300WV1CR
A1C8	0160-0577	1	CAPACITOR-FXD 1.8UF +-20% 50WVDC MET	28480	0160-0577
A1C9	0180-0228		CAPACITOR-FXD 22UF +-10% 15VDC TA	56289	150D226X9015B2
A1C10	0160-3847		CAPACITOR-FXD .01UF +100-0% 25WVDC CER	28480	0160-3847
A1C11	0160-2150	1	CAPACITOR-FXD 33PF +-5% 300WVDC MICA	28480	0160-2150
A1C12	0180-1701	1	CAPACITOR-FXD 6.8UF +-20% 6VDC TA	56289	150D685X0006A2
A1C13	0180-0106		CAPACITOR-FXD 60UF +-20% 6VDC TA	56289	150D606X0006B2
A1C14	0160-2204	1	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C15	0180-2644	1	CAPACITOR-FXD 470UF +100--10% 50VDC AL	56289	500D447H050FK7
A1C16	0150-0071	1	CAPACITOR-FXD 400PF +-5% 1000WVDC CER	28480	0150-0071
A1C17			NOT ASSIGNED		
A1C18	0160-3847		CAPACITOR-FXD .01UF +100-0% 25WVDC CER	28480	0160-3847
A1C19	0180-0309	1	CAPACITOR-FXD 4.7UF +-20% 10VDC TA	56289	150D475X0010A2
A1C20	0160-0153	1	CAPACITOR-FXD 1000PF +/-10% 200WVDC	56289	292P10292
A1C21			NOT ASSIGNED		
A1C22	0160-3847		CAPACITOR-FXD .01UF +100-0% 25WVDC CER	28480	0160-3847
A1CR1	1902-3054	2	DIODE-ZNR 3.65V 5% D0-7 PD=.4W TC=-.055%	04713	SZ 10939-56
A1CR2	1901-0025	3	DIODE-GEN PRP 100V 200NA D0-7	28480	1901-0025
A1CR3	1901-0025		DIODE-GEN PRP 100V 200NA D0-7	28480	1901-0025
A1CR4	1901-0025		DIODE-GEN PRP 100V 200NA D0-7	28480	1901-0025
A1CR5	1901-0376	2	DIODE-GEN PRP 35V 50NA D0-7	28480	1901-0376
A1CR6	1901-0376		DIODE-GEN PRP 35V 50NA D0-7	28480	1901-0376
A1CR7	1902-3054		DIODE-ZNR 3.65V 5% D0-7 PD=.4W TC=-.055%	04713	SZ 10939-56
A1CR8			NOT ASSIGNED		
A1CR9	1901-0040	3	DIODE-SWITCHING 30V 50NA 2NS D0-35	28480	1901-0040
A1CR10	1901-0040		DIODE-SWITCHING 30V 50NA 2NS D0-35	28480	1901-0040
A1CR11	1901-0040		DIODE-SWITCHING 30V 50NA 2NS D0-35	28480	1901-0040
A1CR12	1902-0041	1	DIODE-ZNR 5.11V 5% D0-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A1CR13	1902-0025	1	DIODE-ZNR 10V 5% D0-7 PD=.4W TC=+.06%	04713	SZ 10939-182
A1CR14	1906-0069	1	DIODE-FW BRDG 400V 1A	28480	1906-0069
A1DS1	03476-69502	1	LED DISPLAY W/15-PIN CONNECTOR	28480	03476-69502
A1Q1	1853-0020	2	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q2	1854-0071	14	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q7	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q9	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q10	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q11	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q14	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q15	1855-0308	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0308
A1Q16			NOT ASSIGNED		
A1Q17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q18	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q19	1853-0394	1	TRANSITOR PNP SI PD=40W FT=3MHZ	28480	1853-0394
A1R1	0698-7512	1	RESISTOR 10M 1% 2W F TC=0+-100	07716	CCF-993-N330
A1R2	0811-0006	1	RESISTOR 5K 1% 5W PW TC=0+-20	07088	KM-500
A1R3	0683-2055	1	RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A1R4	0698-3152	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A1R5	0683-2225	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A1R6	0687-3301	1	RESISTOR 33 10% .5W CC TC=0+412	01121	EB3301
A1R7	1810-0244	1	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0244
A1R8	0683-1045	2	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A1R9	2100-3522	2	RESISTOR, VAR 100K OHM 20%	28480	2100-3522

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R10	2100-3524	2	RESISTOR, VAR 50K OHM 20%	28480	2100-3524
A1R11			NOT ASSIGNED		
A1R12	0683-2265	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A1R13	0757-0059	1	RESISTOR 1M 1% .5W F TC=0+100	19701	MF7C1/2-T0-1004-F
A1R14	2100-3528	1	RESISTOR, VAR 100 OHM 20%	28480	2100-3528
A1R15	2100-3524				
A1R16	2100-3529	1	RESISTOR, VAR 50K OHM 20%	28480	2100-3524
A1R17	0683-1065	1	RESISTOR, VAR 1K OHM 20%	28480	2100-3529
A1R18	0683-1035	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A1R19	0698-4512	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
			RESISTOR 88.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8872-F
A1R20	0698-4532	1	RESISTOR 280K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2803-F
A1R21			NOT ASSIGNED		
A1R22	0698-4539	1	RESISTOR 402K 1% .125W F TC=0+-100	03888	PME55S
A1R23	0698-4453	2	RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A1R24	0757-0472	1	RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A1R25	0698-4479	1	RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A1R26	0757-0283	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A1R27	0757-0442	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R28	0698-4453		RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A1R29	0698-4424	1	RESISTOR 1.4K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1401-F
A1R30			NOT ASSIGNED		
A1R31	0683-1025	2	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R33			NOT ASSIGNED		
A1R34	0698-4474	1	RESISTOR 8.45K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8451-F
A1R35	0757-0465	1	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A1R36	0757-0453	2	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A1R37	0757-0453		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A1R38	2100-3527	1	RESISTOR, VAR 5K OHM 20%	28480	2100-3527
A1R39	0683-4745	1	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A1R40	0698-3557	1	RESISTOR 806 1% .125W F TC=0+-100	16299	C4-1/8-T0-806R-F
A1R41	0698-3262	1	RESISTOR 40.2 1% .125W F TC=0+-100	16299	C4-1/8-T0-4022-F
A1R42	2100-3526	1	RESISTOR, VAR 20K OHM 20%	28480	2100-3526
A1R43	2100-3522		RESISTOR, VAR 100K OHM 20%	28480	2100-3522
A1R44	0683-1005	1	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A1R45	0811-3420	1	RESISTOR 1 .5% 7W PW TC=0+-50	07088	KM-700
A1R46	0698-4020	1	RESISTOR 9.53K 1% .125W F TC=0+-100	16299	C4-1/8-T0-9531-F
A1R47	2100-0558	1	RESISTOR, VAR 20K OHM 10% C TOP ADJ	73138	72PR20K
A1R48	2100-3525	1	RESISTOR, VAR 200 OHM 20%	28480	2100-3525
A1R49			NOT ASSIGNED		
A1R50	0698-4435	1	RESISTOR 2.49K 1% .125W F TC=0+-100	16299	C4-1/8-T0-2491-F
A1R51	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R52	0683-0365	1	RESISTOR 3.6 5% .25W FC TC=-400/+500	01121	CB36G5
A1R53			NOT ASSIGNED		
A1R54	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A1R55	0757-0454	1	RESISTOR 33.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3322-F
A1R56-116			NOT ASSIGNED		
A1R117	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A1R118	0698-3161	1	RESISTOR 38.3K 1% .125W F TC=0+-100	16299	C4-1/8-T0-3832-F
A1R119	0698-5578	1	RESISTOR 4K 5% .125W F TC=0+-100	24546	C4-1/8-T0-4001-0
A1R120-131			NOT ASSIGNED		
A1R132	0757-0281	1	RESISTOR 2.74K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2471-F
A1R133-148			NOT ASSIGNED		
A1R149	0698-3499	1	RESISTOR 40.2K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4022-F
A1R150-152			NOT ASSIGNED		
A1R153	0698-4439	1	RESISTOR 3.24K 1% .125W F TC=0+-100	16299	C4-1/8-T0-3241-F
A1S1 A1S6	03476-61901	1	SWITCH, PUSHBUTTON	28480	03476-61901
A1U1	1813-0068	1	HYBRID (NOT FIELD REPLACEABLE FOR REPAIR USE REBUILT PC ASSY PART NO. 03476-69511)	28480	1813-0068
A1U2, U3	1826-0139	2	IC MC 1458 OP AMP	04713	MC1458P1
A1U4	1820-0223	1	IC LM 301A OP AMP	27014	LM301AH
A1U5	1826-0317	1	IC, LINEAR	28480	1826-0317
A1U6	1820-0196	1	IC UA 723C V RGLTR	07263	723HC
			A1 MECHANICAL PARTS		
	0340-0060	6	INSULATOR FEEDTHRU (LARGE)	98291	FT-E-15
	0340-0092	8	INSULATOR FEEDTHRU (SMALL)	98291	FT-E-12(011-6808)
	1251-4261	1	SOCKET-15 PIN DISPLAY	28480	1251-4261
	1205-0311	1	HEAT SINK - Q19	28480	1205-0311
	1460-1467	1	SPRING CONTACT-TOP SHIELD	28480	1460-1467
	1460-1469	2	CONTACT SPRING-INPUT	28480	1460-1469
	0370-2913	4	PUSHBUTTON-PLAIN	28480	0370-2913
	0370-2914	2	PUSHBUTTON-MARKED	28480	0370-2914
	2110-0269	2	FUSE CLIP	91506	6008-32CN
	7120-5112	1	PLATE-IDENTIFICATION	28480	7120-5112
	2420-0022	2	NUT-SPECIALTY 6-32-THD	28480	2420-0022
	2360-0131	2	SCREW, 6-32 X 1-1/8 PAN	28480	2360-0131
	3050-0066	2	FLAT WASHER	28480	3050-0066
	2190-0918	2	LOCKWASHER, HELICAL	28480	2190-0918
	1460-1486	3	SPRING, FUSE CONTACT	28480	1460-1486
	1600-0530	1	SHIELD, UPPER (FOIL)	28480	1600-0530
	03476-00602	1	SHIELD, LOWER (ALUM)	28480	03476-00602

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			A1 MECHANICAL PARTS (CONT'D)		
	03476-40201	1	PANEL, FUSE ACCESS	28480	03476-40201
	4114-0649	1	LENS, DISPLAY	28480	4114-0649
	5040-8291	1	UPPER SHELL	28480	5040-8291
	5040-8038	2	BAIL PLUG	28480	5040-8038
	7120-6286	1	LABEL, PUSHBUTTON	28480	7120-6286

Table 6-3. List of Manufacturers' Codes

Mfr Code	Manufacturer Name	Address	Zip Code
01121	ALLEN-BRADLEY CO	MILWAUKEE, WI	53212
03888	PYROFILM CORP	WHIPPANY, NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX, AZ	85008
07088	KELVIN ELECTRIC CO	VAN NUYS, CA	91401
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW, CA	94040
07716	TRW INC BURLINGTON DIV	BURLINGTON, IA	52601
16299	CORNING GL WK ELEC CMPNT DIV	RALEIGH, NC	27604
19701	MEPCO ELECTRA CORP	MINERAL WELLS, TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD, PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA, CA	95051
28480	HEWLETT PACKARD CO CORPORATE HQ	PALO ALTO, CA	94304
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MA	01247
71400	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST. LOUIS, MO	63017
72136	ELECTRO MOTIVE MFG CO INC	WILLIMANTIC, CT	06226
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON, CA	92634
74970	JOHNSON E F CO	WASECA, MN	56093
75915	LITTLEFUSE INC	DES PLAINES, IL	60016
91506	AUGAT INC	ATTELBORO, MA	02703
98291	SEALECTRO CORP	MAMARONECK, NY	10544

See introduction to this section for ordering information

SECTION VII

MANUAL CHANGES

This section normally contains information for adapting this manual to instruments for which the content does not apply directly. Since this manual does apply directly to instruments having serial numbers listed on the title page, no change information is given here. Refer to INSTRUMENTS COVERED BY MANUAL in Section I for additional information about serial number coverage.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. To provide maximum instrument performance for minimum cost, the Option 034/035 is designed around an NMOS Hybrid Integrated Circuit (U1). This hybrid and its associated discrete electronic circuitry are repairable only at the Hewlett-Packard Manufacturing Division using special equipment. An exchange program has been established to permit field repair by replacing the entire A1 printed circuit assembly with a factory rebuilt assembly. This assembly is warranted to be fully operational and meet all instrument specifications. For ordering details, contact the Hewlett-Packard Sales and Service Office nearest you.

8-3. The following troubleshooting information is provided for use by qualified service personnel in locating specific failures that can be repaired at the component level. Troubleshooting beyond these recommended areas will void the instrument warranty.

WARNING

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

8-4. SCHEMATICS.

8-5. Schematic diagrams (figures 8-3 and 8-4) illustrate the circuits of the Option 034/035. Components marked with an asterisk are those that are part of an adjustment procedure. A method for selecting the correct value is outlined in the adjustment procedures of Section V.

8-6. TROUBLESHOOTING.

CAUTION

The hybrid circuits in Option 034/035 may be damaged by static discharge from a hand or tool. The following precautions must be observed to prevent damage.

a. Ground the hand while disassembling and working on Option 034/035. Conductive wristbands (HP Part No. 00970-67900) are available for this purpose.

b. Attach Option 034/035 COM terminal to earth ground. Touch all tools to earth ground to remove static charges before using them.

c. Use a soldering iron with a grounded tip.

CAUTION

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

8-7. If the display illuminates and indicates near zero regardless of the input applied, check the appropriate input protection fuse.

Volts/Ohms input protection fuse:
.032A (250 V) HP P/N 2110-0420
Littlefuse P/N 312.031

Amps input protection fuse:
1-1/2 A (250 V) HP P/N 2110-0043
Bussman AGC 1-1/2
Littlefuse 312.01.5

8-8. If input fuses are not at fault, proceed to disassembly Option 034/035 as follows:

a. Remove instrument top cover from oscilloscope and disconnect internal cable assembly from transformer.

b. Place Option 034/035 upside down on grounded work surface. Remove two screws holding cover.

c. Remove cover.

d. Remove input panel and input fuses.

e. Connect jumpers across amps input protection fuse holder and across ohms input protection fuse holder.

CAUTION

If it is necessary to handle the printed circuit assembly, hold it by capacitor C15 and the front panel switch pushbuttons to avoid contamination of the assembly.

f. Connect Option 034/035 TP ⏚ to earth ground.

g. Connect 20 volts dc across C15; +voltage to positive end, —voltage to negative end.

NOTE

If 20 volts dc is not readily available, it can be obtained by reconnecting Option 034/035 to the oscilloscope power supply through cable W13.

8-9. POWER SUPPLY TROUBLESHOOTING. Measure the dc power supply voltages referenced to the analog ground test point (TP ⏚). The dc voltmeter indication at TP +6 should be within the limits of 5.94 to 6.06 V dc. The dc voltmeter indication at TP —4 should be within the limits of 3.96 to 4.04 V dc. If these voltages are correct, no further power supply checks are necessary.

8-10. If TP +6 and TP —4 voltages are not correct, check dc voltage at the positive terminal of C15. This voltage should be within the limits of +15 to +25 V dc relative to TP ⏚ with less than 2 volts peak-to-peak ripple.

8-11. Verify that the power supply is not in a current limit condition by checking the voltage drop across R52. This voltage should be less than 0.36 V dc.

8-12. DISPLAY TROUBLESHOOTING. Most problems with the display section can be isolated by front panel observations. Note the display failure symptoms prior to troubleshooting this section of the instrument. Display malfunctions can be caused by circuit failures in four main areas. These are:

a. The power supply.

b. The light-emitting diode display (DS1).

c. The associated display drive transistors (Q1-Q14).

d. The logic in the hybrid (U1).

8-13. POWER SUPPLY VERIFICATION. The power supply tests in paragraph 8-9 should be performed to verify that the power supplies are functioning properly. Malfunctions in the power supply can result in improper bias of Q1 through Q14, resulting in a defective display.

8-14. DISPLAY VERIFICATION. A quick check will determine if any segments of the LED display (DS1) are defective. The following procedure should be used:

a. Momentarily connect emitter of Q3, Q4 or Q6 to —4 V test point.

b. Verify that display is completely illuminated as shown in figure 8-1. If display does not indicate as shown, proceed to paragraph 8-15.

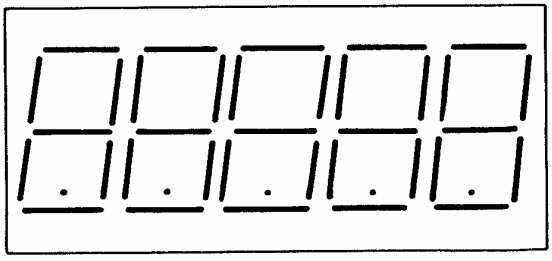


Figure 8-1. Display Verification

8-15. DISPLAY DRIVER VERIFICATION AND TROUBLESHOOTING. The display drivers are divided into two groups: the digit drivers Q2 through Q6 and the segment drivers Q7 through Q14. Therefore, the first step in troubleshooting the display drivers is to determine if the problem is segment related or digit related. During normal operation, if the same segment in all five sections is either on or off continuously, the associated segment driver and logic should be checked. If one entire digit is either on or off continuously, the associated digit driver and logic should be checked. A shorted Q1 will cause the entire display to turn on.

8-16. DISPLAY LOGIC PROBLEMS. The digital information that controls the display is provided by NMOS Hybrid U1 which is not field replaceable. If the Option 034/035 failure appears to be traceable to U1, refer to paragraph 8-2 for A1 pc assembly replacement instructions.

8-17. OHMS PROTECTION CIRCUIT TROUBLESHOOTING. If the ohms protection diodes (CR5 and

CR6) are leaky, an error will be present in the higher ohms range resistance readings.

8-18. A leaky condition of CR5 and CR6 may be caused by applying voltage across the VΩ to COM terminal while the ohms function is selected. This may also cause R2 to show signs of overheating and discoloration. In either case, replace CR5 and CR6.

Table 8-1. General Schematic Notes

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

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

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

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

4. DENOTES UI HYBRID.

   UI PIN CONNECTOR.

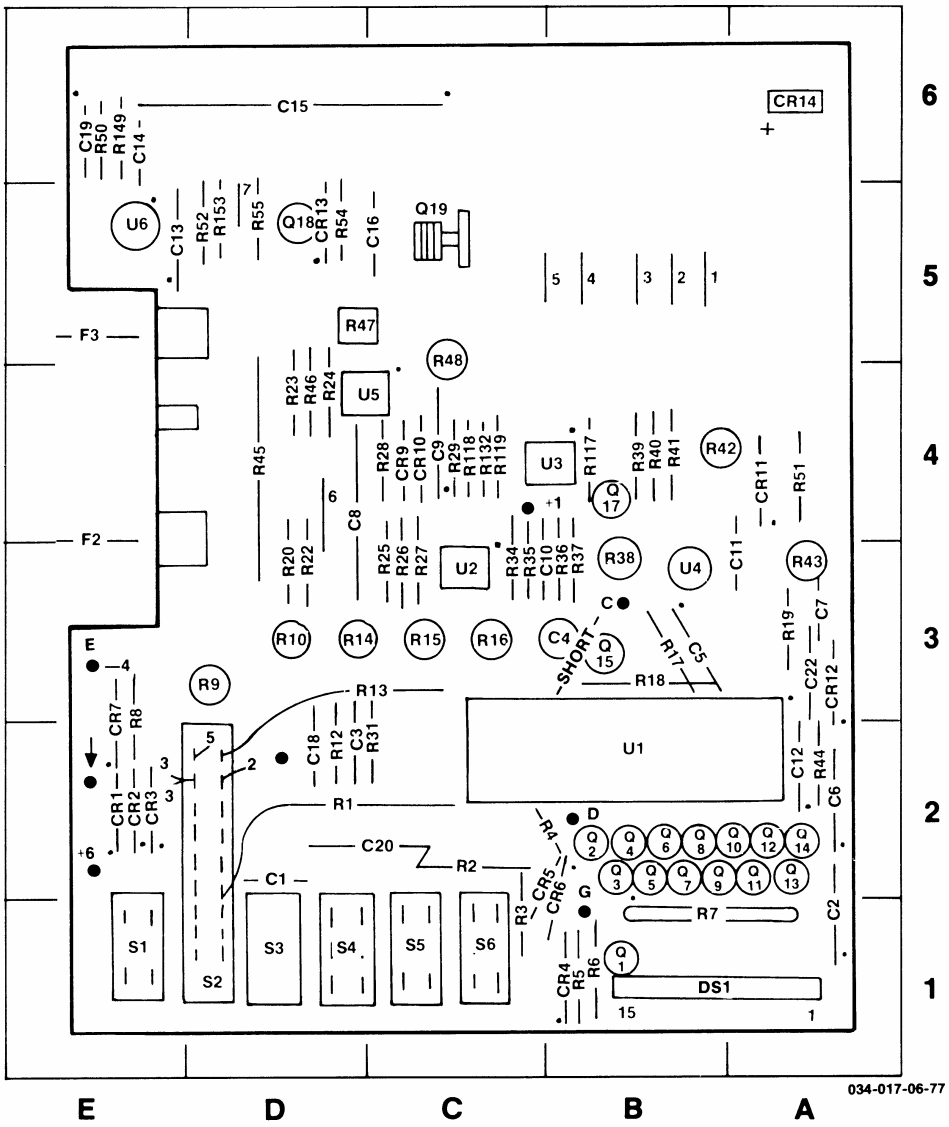
5. ——— — — ——— DENOTES ASSEMBLY.

6. DENOTES SCREWDRIVER ADJUST.

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

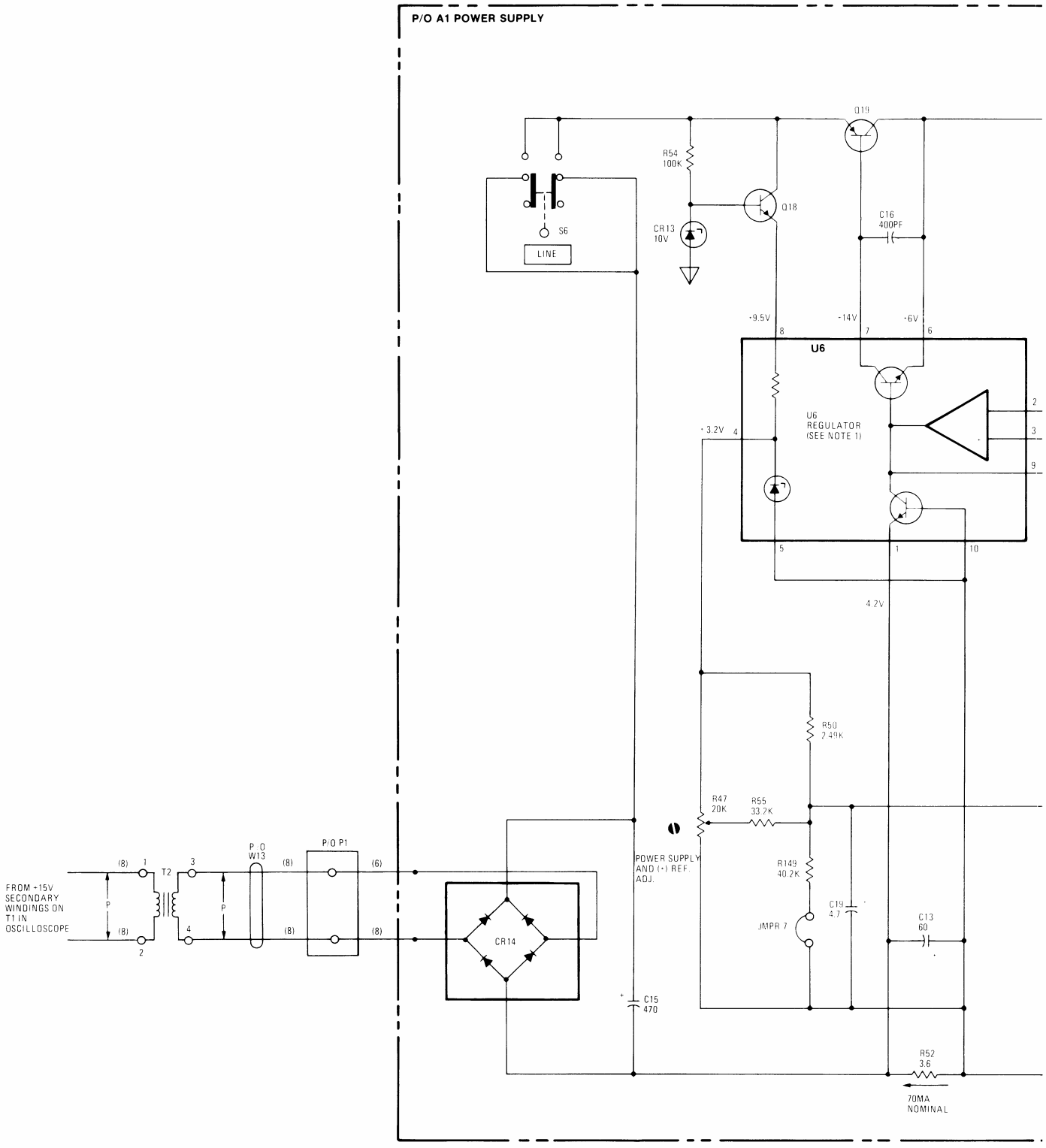
8. (924) DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. (924) = WHITE, RED, YELLOW.)

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



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-2	C18	D-2	CR14	A-6	Q11	A-2	R8	E-3	R25	C-3	R43	A-3	R149	E-6
C2	A-1	C19	E-6	DS1	B-1	Q12	A-2	R9	D-3	R26	C-3	R44	A-2	R153	D-5
C3	D-2	C20	C-2	F2	E-4	Q13	A-2	R10	D-3	R27	C-3	R45	D-4	S1	E-1
C4	B-3	C22	A-3	F3	E-5	Q14	A-2	R12	D-2	R28	C-4	R46	D-4	S2	D-1
C5	B-3	CR1	E-2	JMPR6	D-4	Q15	B-3	R13	C-3	R29	C-4	R47	D-5	S3	D-1
C6	A-2	CR2	E-2	JMPR7	D-5	Q17	B-4	R14	D-3	R31	C-2	R48	C-5	S4	D-1
C7	A-3	CR3	E-2	Q1	B-1	Q18	D-5	R15	C-3	R34	C-3	R50	E-6	S5	C-1
C8	D-4	CR4	B-1	Q2	B-2	Q19	C-5	R16	C-3	R35	C-3	R51	A-4	S6	C-1
C9	C-4	CR5	B-2	Q3	B-2	R1	D-2	R17	B-3	R36	B-3	R52	D-5	U1	B-2
C10	C-3	CR6	B-2	Q4	B-2	R2	C-2	R18	B-3	R37	B-3	R54	D-5	U2	C-3
C11	A-3	CR7	E-3	Q5	B-2	R3	C-1	R19	A-3	R38	B-3	R55	D-5	U3	B-4
C12	A-2	CR9	C-4	Q6	B-2	R4	B-2	R20	D-3	R39	B-4	R117	B-4	U4	B-3
C13	E-5	CR10	C-4	Q7	B-2	R5	B-1	R22	D-3	R40	B-4	R118	C-4	U5	D-4
C14	E-6	CR11	A-4	Q8	B-2	R6	B-1	R23	D-4	R41	B-4	R119	C-4	U6	E-5
C15	D-6	CR12	A-3	Q9	B-2	R7	B-1	R24	D-4	R42	B-4	R132	C-4		
C16	C-5	CR13	D-5	Q10	A-2										

Figure 8-2. Assembly A1 Component Locations


P/O A1 POWER SUPPLY
Q19
R54
100K
Q18
C16
400PF
CR13
10V
S6
LINE
+9.5V
-14V
-6V
8
7
6
U6
U6
REGULATOR
(SEE NOTE 1)
+3.2V
4
2
3
9
5
1
10
4.2V
R50
2.49K
R47
20K
R55
33.2K
R149
40.2K
C19
4.7
JMPR 7
C13
60
POWER SUPPLY
AND (+) REF.
ADJ.
C15
470
R52
3.6
70MA
NOMINAL
FROM +15V
SECONDARY
WINDINGS ON
T1 IN
OSCILLOSCOPE
(8)
1
T2
3
4
2
P
P
P/O
W13
P/O P1
(6)
CR14

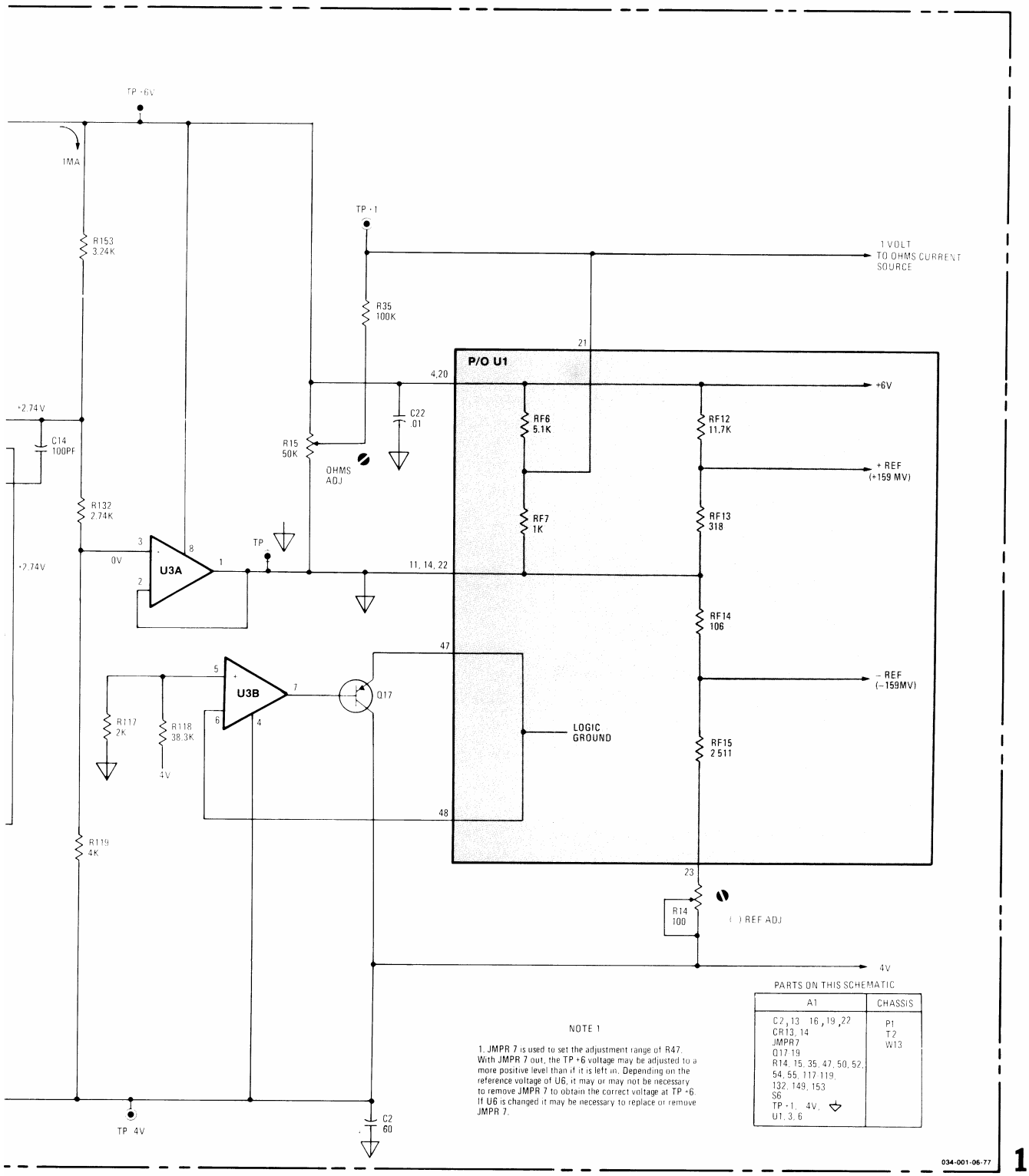
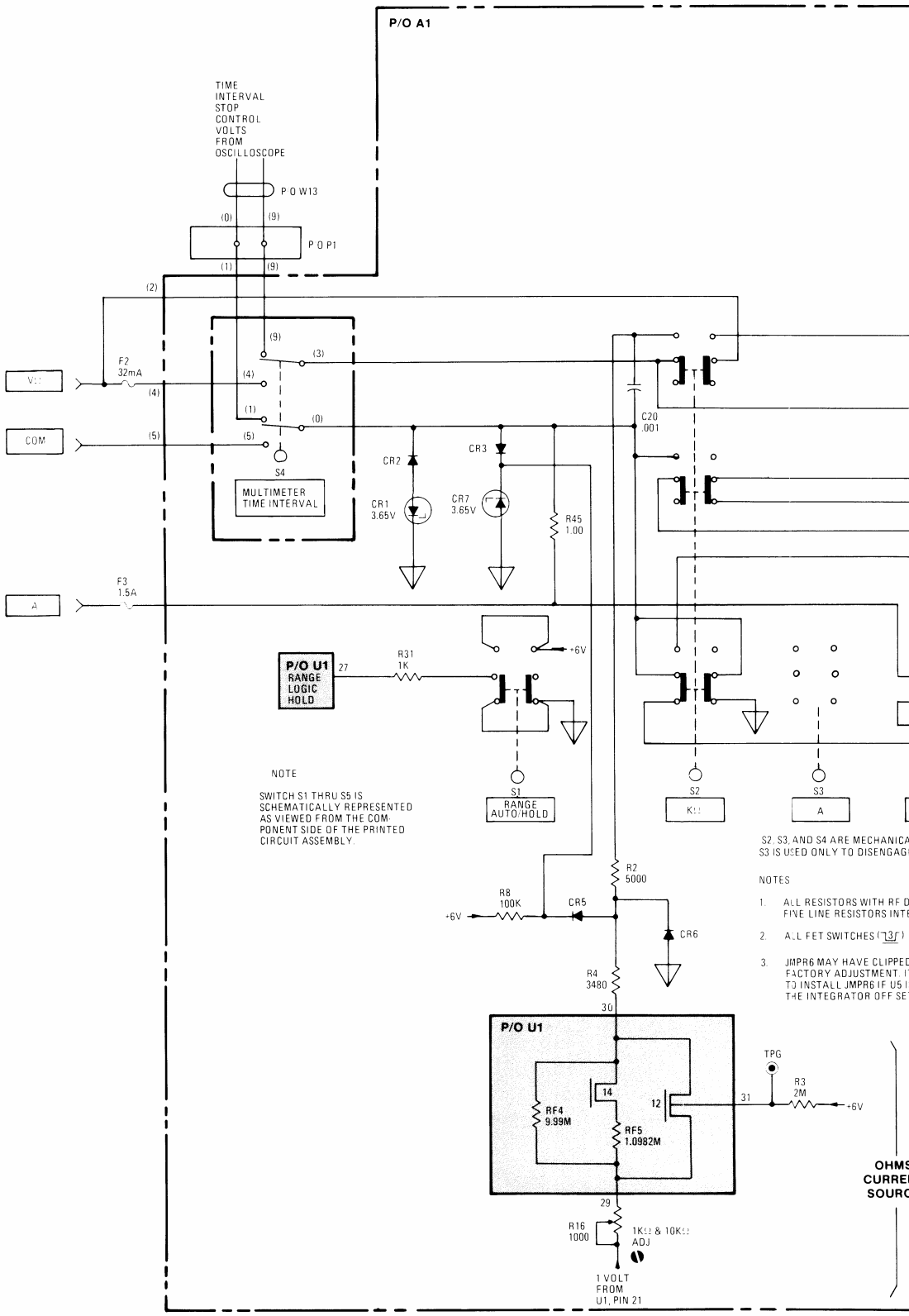
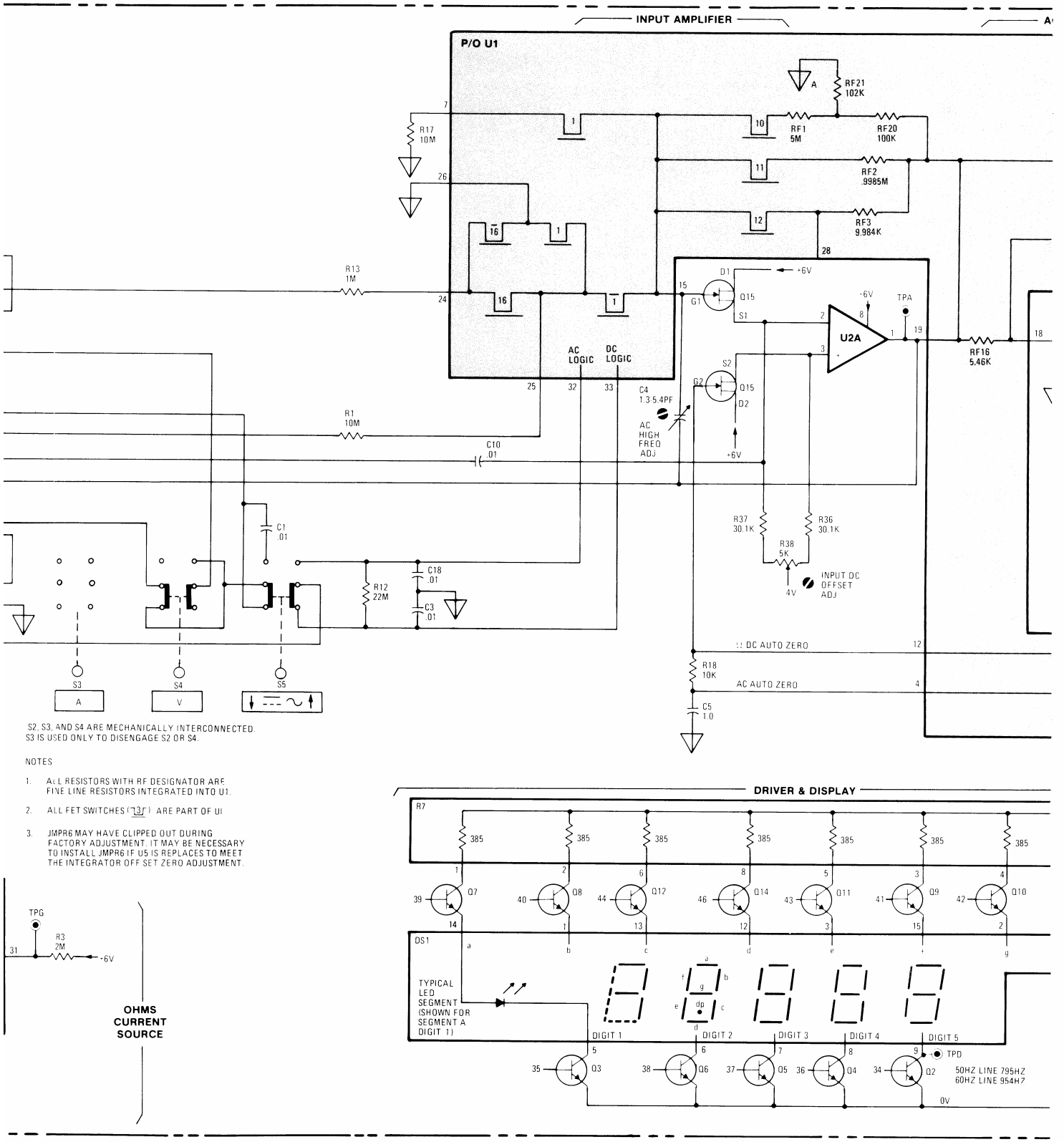


Figure 8-3.
Power Supply Schematic
8-5/(8-6 blank)


P/O A1
TIME INTERVAL STOP CONTROL VOLTS FROM OSCILLOSCOPE
P/O W13
P/O P1
F2 32mA
COM
F3 1.5A
S4
MULTIMETER TIME INTERVAL
CR1 3.65V
CR2
CR3
CR7 3.65V
C20 .001
R45 1.00
P/O U1 RANGE LOGIC HOLD
R31 1K
+6V
S1 RANGE AUTO/HOLD
S2
S3
A
NOTE
SWITCH S1 THRU S5 IS SCHEMATICALLY REPRESENTED AS VIEWED FROM THE COMPONENT SIDE OF THE PRINTED CIRCUIT ASSEMBLY.
R2 5000
R8 100K
CR5
CR6
R4 3480
P/O U1
RF4 9.99M
RF5 1.0982M
TPG
R3 2M
R16 1000
1KΩ & 10KΩ ADJ
1 VOLT FROM U1, PIN 21
NOTES
1. ALL RESISTORS WITH RF D FINE LINE RESISTORS INTE
2. ALL FET SWITCHES (TJ)
3. JMPR6 MAY HAVE CLIPPED FACTORY ADJUSTMENT. I TO INSTALL JMPR6 IF U5 I THE INTEGRATOR OFF SE
OHMS CURRE SOURC


INPUT AMPLIFIER
P/O U1
RF21 102K
RF1 5M
RF20 100K
RF2 .9985M
RF3 9.984K
R17 10M
R13 1M
R1 10M
C10 .01
C1 .01
R12 22M
C18 .01
C3 .01
AC LOGIC
DC LOGIC
C4 1.3-5.4PF
AC HIGH FREQ ADJ
+6V
TPA
U2A
RF16 5.46K
R37 30.1K
R36 30.1K
R38 5K
4V
INPUT DC OFFSET ADJ
DC AUTO ZERO
R18 10K
AC AUTO ZERO
C5 1.0
S3
S4
S5
A
V
S2, S3, AND S4 ARE MECHANICALLY INTERCONNECTED.
S3 IS USED ONLY TO DISENGAGE S2 OR S4.
NOTES
1. ALL RESISTORS WITH RF DESIGNATOR ARE FINE LINE RESISTORS INTEGRATED INTO U1.
2. ALL FET SWITCHES ARE PART OF U1
3. JMPR6 MAY HAVE CLIPPED OUT DURING FACTORY ADJUSTMENT. IT MAY BE NECESSARY TO INSTALL JMPR6 IF U5 IS REPLACES TO MEET THE INTEGRATOR OFF SET ZERO ADJUSTMENT.
TPG
R3 2M
OHMS CURRENT SOURCE
DRIVER & DISPLAY
R7
385
Q7
Q8
Q12
Q14
Q11
Q9
Q10
DS1
TYPICAL LED SEGMENT (SHOWN FOR SEGMENT A DIGIT 1)
DIGIT 1
DIGIT 2
DIGIT 3
DIGIT 4
DIGIT 5
Q3
Q6
Q5
Q4
Q2
TPD
50HZ LINE 795HZ
60HZ LINE 954HZ
0V

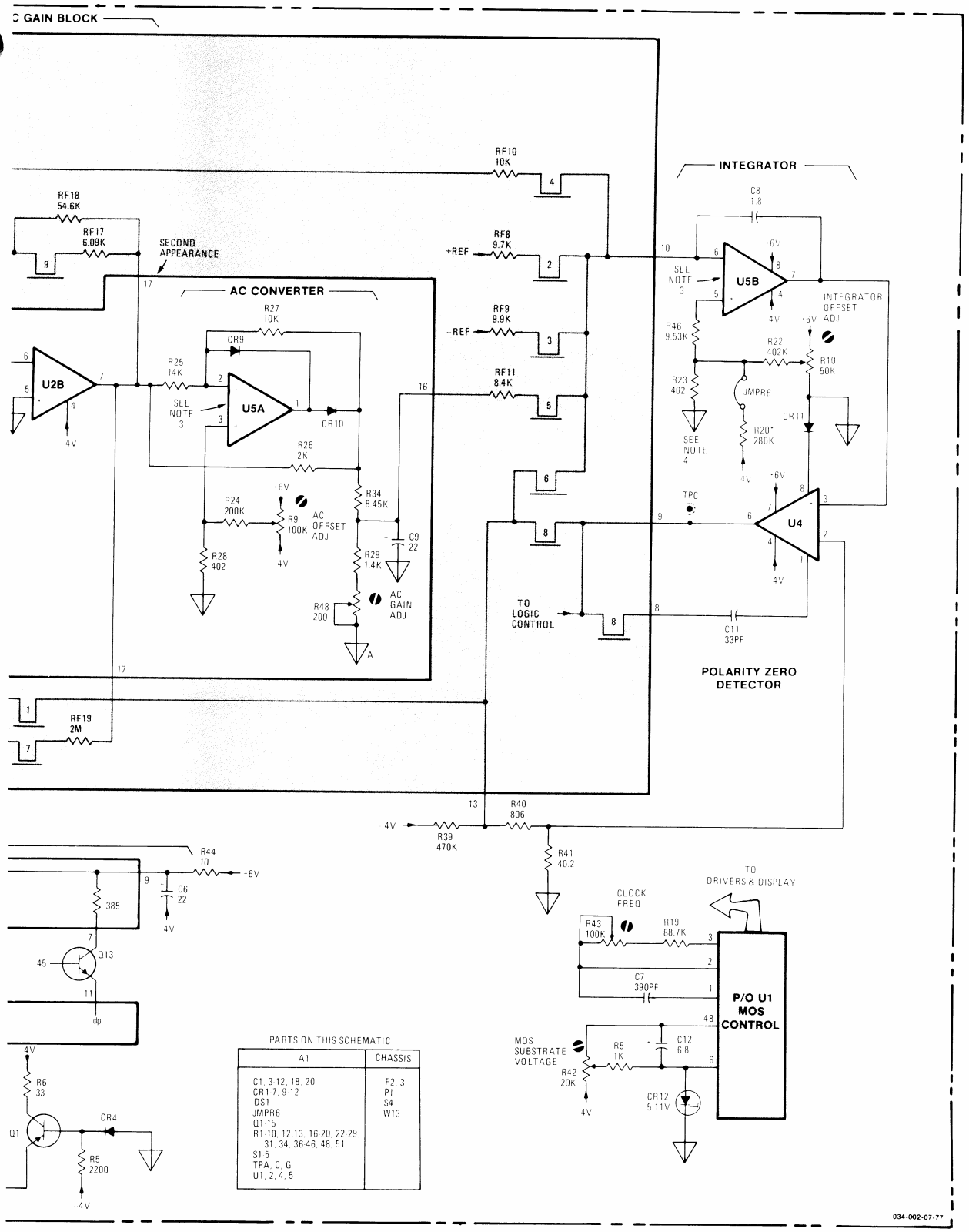


Figure 8-4.
Multimeter Schematic
8-7/(8-8 blank)

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number:	1742A
Date Printed:	July, 1978
Part Number:	01742-90903

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
1840A	1		
1919A	1,2		
2021A	1,2,3		
2305A	1,2,3,4		

▲ NEW ITEM

CHANGE 1

Page 3-0,

Change NOTE for controls 26 and 27 as follows:

NOTE: In TRIG'D, the 1742A provides conventional delayed sweep with a single marker controlled by the 10 turn stop control 18. Output from ΔTIME OUT connectors (or DMM on Option 034) in TRIG'D will indicate the position of the STOP control 18, not the time interval being displayed.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

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Printed in U.S.A.

CHANGE 1 (CONT'D)

Table 6-2,
Change: A10 HP Part No. and Mfr Part No. to 01740-66555 (2 places).
Add: A10CR9 HP Part No. 1901-0040, DIODE-SWITCHING 30V 50MA 2NS DO-35, Mfr Code 28480, Mfr Part No. 1901-0040.

Figure 8-30,
Change Schematic 9 as shown below:

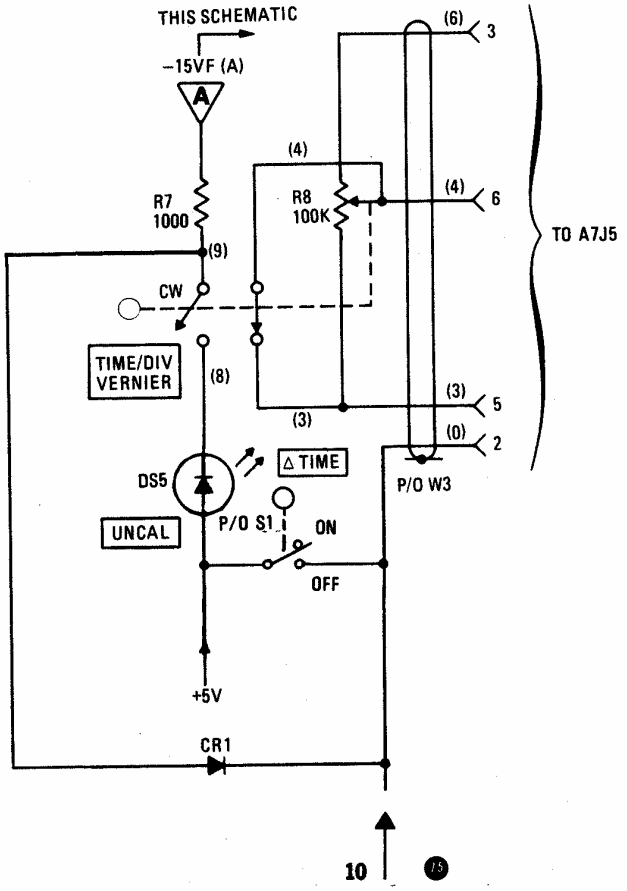
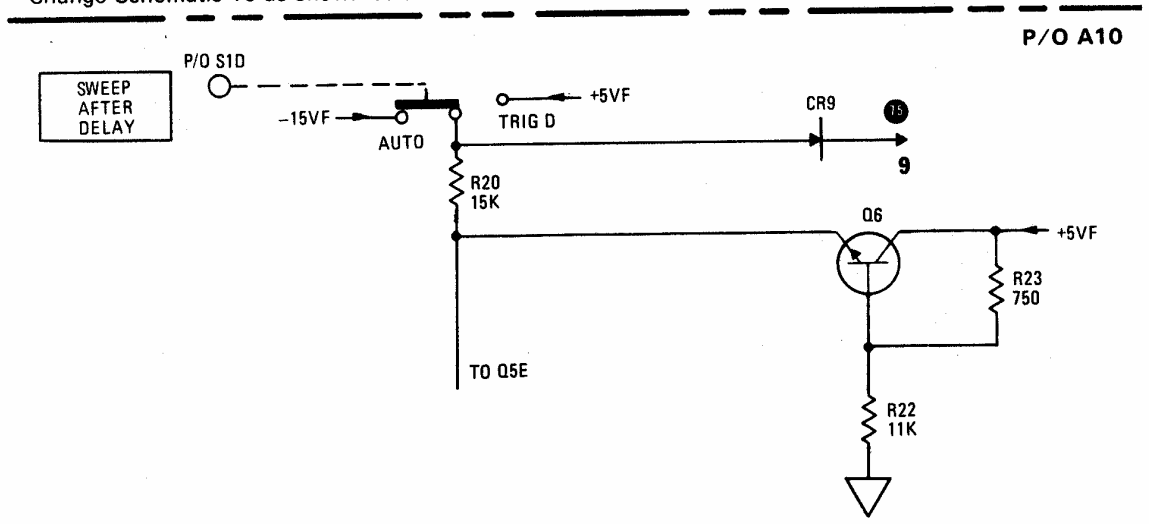


Figure 8-32,
Change Schematic 10 as shown below:



CHANGE 2

Figure 6-1. (Sheet 1 of 2),
Add: to H4 Where Used entry; CRT SHIELD (2).
Add: to H24 Where Used entry; CRT SHIELD (2).
Add: H45, SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI, HP PART NO. 2360-0195, CRT SHIELD (2).
Table 6-2,
Change: L2, HP and Mfr Part Nos. to 01336-66002.
Change: MP65, HP and Mfr Part Nos. to 01740-60602.

CHANGE 3

Change: A3, HP Part No. and Mfr Part No. to 01740-66567.
Change: A3(OPTION 101), HP Part No. and Mfr Part No. to 01740-66579.
Change: A5, HP Part No. and Mfr Part No. to 01740-66572.
Change: A7, HP Part No. and Mfr Part No. to 01743-66518.
Change: A7(OPTION 101), HP Part No. and Mfr Part No. to 01743-66519.
Change: A8, HP Part No. and Mfr Part No. to 01740-66568.
Change: A9, HP Part No. and Mfr Part No. to 01740-66565.
Change: A11, HP Part No. and Mfr Part No. to 01740-66569.
Change: A12, HP Part No. and Mfr Part No. to 01740-66582.
Change: A13, HP Part No. and Mfr Part No. to 01740-66564.
Change: A15, HP Part No. and Mfr Part No. to 01740-66570.
Change: A16, HP Part No. and Mfr Part No. to 01740-66563.
Change: A17, HP Part No. and Mfr Part No. to 01742-66502.
Change: T1, HP Part No. and Mfr Part No. to 9100-2619.
Change: W3, HP Part No. and Mfr Part No. to 01742-61602.
Change: W7, HP Part No. and Mfr Part No. to 01743-61611.
Change: W8, HP Part No. and Mfr Part No. to 01743-61609.

Change: A3P2, HP Part No. and Mfr Part No. to 1251-5346.
Change: A3P3, HP Part No. and Mfr Part No. to 1251-6149.
Change: A3P4, HP Part No. and Mfr Part No. to 1251-6149.

Change: A5XA3, HP Part No. and Mfr Part No. to 1251-6137.

Change: A7P2, HP Part No. and Mfr Part No. to 1251-6009.
Change: A7P3, HP Part No. and Mfr Part No. to 1251-5346.
Change: A7P4, HP Part No. and Mfr Part No. to 1251-6144.
Change: A7P5, HP Part No. and Mfr Part No. to 1251-6012.
Change: A7P6, HP Part No. and Mfr Part No. to 1251-6009.
Change: A7P7, HP Part No. and Mfr Part No. to 1251-6146.
Add: A7XA9, HP Part No. 1251-6006, CONNECTOR 12-PIN F POST TYPE, Mfr Code 28480, Mfr Part No. 1251-6006.

Change: A8XA7, HP Part No. and Mfr Part No. to 1251-6136.

Change: A9P1, HP Part No. and Mfr Part No. to 1251-6105.

Change: A11XA7, HP Part No. and Mfr Part No. to 1251-6001.

Change: A12P1, HP Part No. and Mfr Part No. to 1251-3898.
Change: A12XA16, HP Part No. and Mfr Part No. to 1251-6007.

Change: A13XA3P3, HP Part No. and Mfr Part No. to 1251-6014.
Change: A13XA3P4, HP Part No. and Mfr Part No. to 1251-6014.

Change: A15XA12, HP Part No. and Mfr Part No. to 1251-6136.

CHANGE 3 (CONT'D)

Add: A16C21, HP Part No. 0160-5028, 1, CAPACITOR-FXD .1 UF 500 VDC CER, Mfr Code 72982, Mfr Part No. 8141-500-X7R0-101K.
Add: A16C22, HP Part No. 0160-3670, 5, CAPACITOR-FXD .1 UF 200 VDC CER, Mfr Code 72982, Mfr Part No. 8131-M212-651-104M.
Add: A16C23, HP Part No. 0160-3670, CAPACITOR-FXD .1 UF 200 VDC CER, Mfr Code 72982, Mfr Part No. 8131-M212-651-104M.
Add: A16C24, HP Part No. 0160-3670, CAPACITOR-FXD .1 UF 200 VDC CER, Mfr Code 72982, Mfr Part No. 8131-M212-651-104M.
Add: A16C25, HP Part No. 0160-3670, CAPACITOR-FXD .1 UF 200 VDC CER, Mfr Code 72982, Mfr Part No. 8131-M212-651-104M.
Add: A16C26, HP Part No. 0160-3670, CAPACITOR-FXD .1 UF 200 VDC Cer, Mfr Code 72982, Mfr Part No. 8131-M212-651-104M.
Change: A16P1, HP Part No. and Mfr Part No. to 1251-6008.
Change: A16P3, HP Part No. and Mfr Part No. to 1251-6009.
Change: A16P4, HP Part No. and Mfr Part No. to 1251-5346.

Section VIII. Schematic 2,
Add: C21 to T1 across pins 1 and 2.
Add: C22 to T1 across pins 3 and 4.
Add: C23 to T1 across pins 11 and 12.
Add: C24 to T1 across pins 9 and 10.
Add: C25 to T1 across pins 7 and 8.
Add: C26 to T1 across pins 5 and 6.

▲ CHANGE 4

Page 6-5, Table 6-2. Replaceable Parts.
Change: A4 HP and Mfr Part No. to 01740-61633.
Change: A8 HP and Mfr Part No. to 01740-66593.
Change: A9 HP and Mfr Part No. to 01740-66592.

Page 6-12, Table 6-2. Replaceable Parts.
Change: A5 HP and Mfr Part No. to 01740-61633.

Page 6-17, Table 6-2. Replaceable Parts.
Change: A8 HP and Mfr Part No. to 01740-66593.

Page 6-18, Table 6-2. Replaceable Parts.
Change: A9 HP and Mfr Part No. to 01740-66592.
Change: A9R5 to HP and Mfr Part No. 0761-0011, RESISTOR 3.3K 5% 1W MO TC=0±200. Mfr Code 28480.

Page 6-19, Table 6-2. Replaceable Parts.
Change: A9U1 to HP Part No. 1826-0311, IC OP AMP GP 8-DIP-P PKG, Mfr Code 04713, Mfr Part No. MLM201AP1.
Delete: A9XU1.

Page 8-25, Schematic 11.
Change: A9R5 to 3300 ohms.