OPERATING AND SERVICE MANUAL

MEASUREMENT SYSTEM

3470

HEWLETT hp PACKARD

-hp- 3470

OPERATING AND SERVICE MANUAL

Binder Part No. 34740-90011
(Includes cover insert)
Manual Part No. 34740-90012 or 34750-90012
(Binder, System Introduction and Display Manual)

MODEL 3470
MEASUREMENT SYSTEM

IMPORTANT NOTICE

This instruction manual requires no change sheet. Any change information has already been integrated into the manual by page revisions. Revised pages have a revision letter which can be found on the lower corner of the page. Reference may also be made to Section VIII of each manual where backdating information for earlier instruments can be found.

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

Printed: JUNE 1973

HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

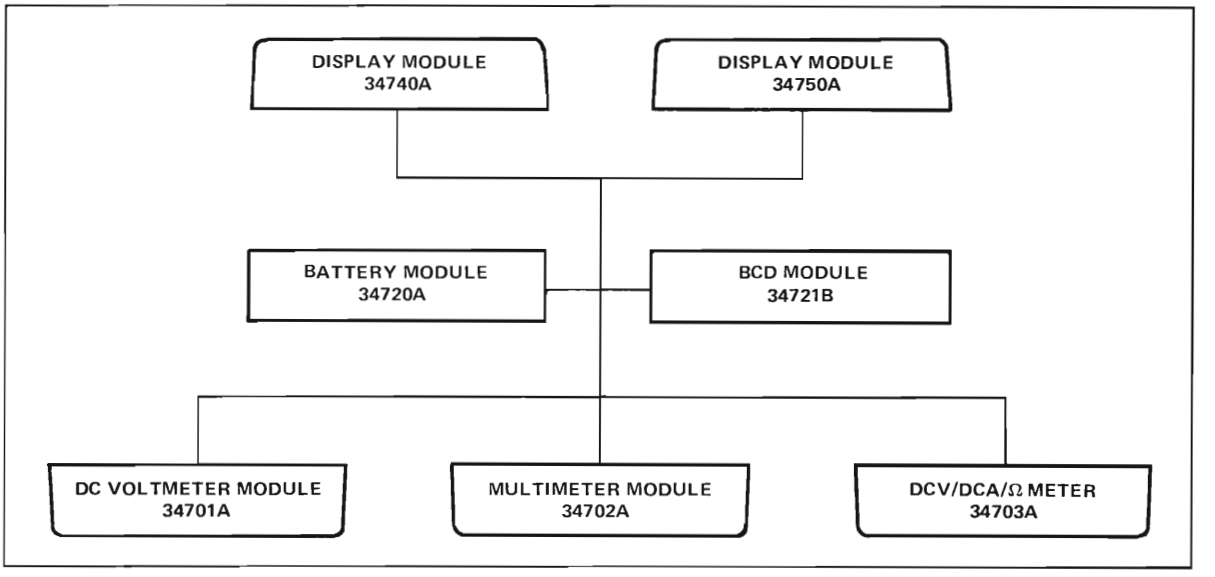
For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

INTRODUCTION

The 3470 Measurement System is a series of modules that may be plugged together to form several different measuring instruments, including both line powered and battery powered versions.

A mainframe display module is connected to a bottom plug-on function module to form a complete instrument. The BCD and/or Battery plug-on module may be added between the display and function modules as desired.

Refer to the Operating and Service Manual of the plug-on module to be used with the display module for the operating instructions, incoming inspection, and adjustment procedures of the instrument as a whole.



Possible Instrument Configurations

NAME _____ COMPANY _____

JOB TITLE _____ ADDRESS _____

ADDITIONAL COMMENT

FIRST FOLD

SECOND FOLD

FIRST CLASS
PERMIT NO. 37
LOVELAND, COLORADO

BUSINESS REPLY MAIL

NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

HEWLETT-PACKARD COMPANY
LOVELAND DIVISION, Dept. 4169
P.O. BOX 301
LOVELAND, COLORADO 80537
U.S.A.

To further improve the Hewlett-Packard instrument documentation, we would appreciate your comments on this manual. Please check yes or no to the following questions. Add any comments you wish. If more room is desired, additional comments may be added on the back of this questionnaire. When completed, tear on perforated line, fold, staple and mail.

1. Would you like to see more applications information in the manual? YES ____ NO ____
   COMMENT _____

2. Is a detailed theory of operation necessary? YES ____ NO ____
   COMMENT _____

3. Are the performance checks and adjustment procedures clear as to the procedure and to the specification they are to verify? YES ____ NO ____
   COMMENT _____

4. Would you like to see a condensed adjustment procedure included? YES ____ NO ____
   COMMENT _____

5. Would you like to see the performance checks and adjustment procedures combined? YES ____ NO ____
   COMMENT _____

6. Would a more complete list of hardware be beneficial? YES ____ NO ____
   COMMENT _____

7. Are exploded views useful? YES ____ NO ____
   COMMENT _____

8. Is the troubleshooting section of this manual adequate? YES ____ NO ____
   COMMENT _____

9. Do you like and use the troubleshooting trees? YES ____ NO ____
   COMMENT _____

10. Are the schematic diagrams clearly illustrated and easy to follow? YES ____ NO ____
    COMMENT _____

11. Would you prefer the assembly outlines on the schematics in color? YES ____ NO ____
    COMMENT _____

12. Would you prefer drawings of waveforms and component locators as opposed to photographs; YES ____ NO ____
    COMMENT _____

13. Would you prefer to have a separate operating manual and service manual? YES ____ NO ____
    COMMENT _____

14. Do you use the red stripe and blue stripe board exchange program? YES ____ NO ____
    COMMENT _____

15. Would you use the red stripe and blue stripe board exchange program? YES ____ NO ____
    COMMENT _____

16. Does the operating and service manual remain with the instrument? YES ____ NO ____
    If not, where does it go? _____

17. In what way do you feel we can most improve this manual? _____

18. Do you prefer the loose leaf binder for manuals as opposed to the bound manuals? YES ____ NO ____
    _____

19. Do you use change sheets? YES ____ NO ____
    _____

OPERATING AND SERVICE MANUAL

DISPLAY
34740A

HEWLETT hp PACKARD

34740A
DISPLAY

34740A

OPERATING AND SERVICE MANUAL

Manual Part No. 34740-90001
Microfiche Part No. 34740-90051

MODEL 34740A
DISPLAY

Serials Prefixed: 1213

IMPORTANT NOTICE

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

Printed: NOVEMBER 1972

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SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 34740A Display Module is a four-digit 1 V range dc voltmeter with 100 % overrange capability that functions with a plug-on module such as the 34702A Multimeter or 34701 DC Voltmeter. This modular construction feature makes the 3470 measurement system versatile. New plug-on models are under development to expand the range of applications of the instrument. A 34720A Battery Module or 34721A BCD Module may be connected between the 34740A and the plug-on module for more versatility.

1-3. A dual slope integrating measurement technique is employed to give 60 dB noise rejection at the power line frequency. Five readings per second are attained on Option 060 (60 Hz line), and eight readings per second on Option 050 (50 Hz line).

1-4. The display of four full digits plus an overrange digit is composed of light emitting diodes that give a clear bright readout indication. The fifth overrange digit is provided to complete the readout on measurements above full scale up to the 100 % overrange point. A display blanking feature indicates the overload point at 100 % overrange.

1-5. The 34740A may be fully adjusted from the rear panel, and is easily removed from its case for repair. An internal jumper wire may be positioned to give a self test of the logic and display circuitry. The 11456A Readout Test Card aids troubleshooting.

1-6. OPTIONS.

1-7. The 34740A may be ordered as either Option 050 or 060 for optimum operation at 50 Hz or 60 Hz line voltages respectively.

1-8. SPECIFICATIONS.

1-9. The specifications for the 34740A are not stated separately, but rather included in the specifications for the function module. See the Operating and Service Manual for the function module to be used with the 34740A.

1-10. ACCESSORIES AVAILABLE.

11456A - Read-Out Test Card for testing and trouble-shooting the 34740A Display module.

18019A - Carrying case accomodates the 34740A Display, a center module and a bottom module plus power cord and input cables.

11457A - Rack Mount Kit for 34740A Display, 34721A BCD module and a bottom module.

10576A - Rack Mount Kit for 34740A Display and a bottom module.

562A-16C - Printer Cable for operation with the 5055A Digital Recorder.

1-11. INSTRUMENT AND MANUAL IDENTIFICATION.

1-12. Hewlett-Packard uses a two-section serial number. The first section concerns instrument modifications; the second section numbers the individual instruments. Some serial numbers may have a letter separating the two sections of the number. This letter indicates the country in which the instrument was manufactured.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains installation and shipping information for the Model 34740A.

2-3. INITIAL INSPECTION.

2-4. Each 34740A has been carefully inspected prior to shipment and should be in perfect electrical order and free of mars or scratches. To confirm this, the instrument should be inspected upon receipt for damage that might have occurred in transit, or for deficiencies otherwise. If there is damage due to shipping, file a claim with the carrier; if there are electrical or mechanical deficiencies not attributable to shipping, then refer to the statement of Warranty on the back of the title page. Use the procedures of Section V to check the instrument performance.

2-5. POWER REQUIREMENTS.

2-6. The Model 34740A may be operated from the four line voltages 100 V, 120 V, 220 V and 240 V rms + 5 % - 10 %, of 48 Hz to 440 Hz frequency. The two switches on the rear panel are positioned to select one of the four voltages. Power dissipation is 8.7 VA maximum.

CAUTION

TO AVOID INSTRUMENT DAMAGE, THE REAR PANEL LINE VOLTAGE SWITCH MUST BE IN THE CORRECT POSITION BEFORE THE POWER CORD IS PLUGGED IN.

2-7. GROUNDING REQUIREMENTS.

2-8. For the safety of operating personnel, a provision for grounding the instrument case has been provided as recommended by the National Electrical Manufacturer's Association (NEMA). The offset pin of the power cable grounds the instrument when plugged into the appropriate receptacle. If only a two-contact receptacle is available, then use a three-prong-to-two-prong adapter and connect the green pigtail of the adapter to earth ground.

2-9. INSTRUMENT MOUNTING.

2-10. Bench Use.

2-11. The front of the 34740A may be elevated for operating convenience by lowering the tilt stand on the bottom module.

2-12. Rack Use.

2-13. The 11457A Rack Mount Kit allows the 34740A and the 34721A BCD Module plus a bottom module to be rack mounted.

2-14. REPACKAGING FOR SHIPMENT.

2-15. If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument describing the work to be accomplished and identifying the owner and instrument. Identify the instrument by serial number, model number, and name in any correspondence. If you have any questions, contact your local Hewlett-Packard Sales and Service Office. See Appendix B for office locations.

2-16. If the original shipping container is to be used, place the instrument in the container with appropriate packing material and seal the container well with strong tape or metal bands. A new container may be purchased from your nearest -hp- Sales and Service Office.

2-17. If an -hp- container is not to be used, then use a heavy carton or wooden box with an inner container. Wrap the instrument with heavy paper or plastic and place cardboard strips across the face for protection before placing the instrument in the inner container. Use packing material around all sides of the inner container, and seal the outer container well with strong tape or metal bands. Mark the container with "DELICATE INSTRUMENT." or "FRAGILE".

2-18. POWER CORDS AND RECEPTACLES.

2-19. Figure 2-1 illustrates the standard power receptacle (wall outlet) configurations that are used throughout the United States and in other countries. The -hp- part number shown directly above each receptacle drawing is the part number for a 34740A power cord equipped with the appropriate mating plug for that receptacle. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.

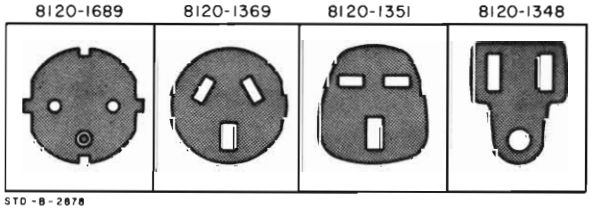


Figure 2-1. Power Receptacles.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. Refer to Figure 3-1 regarding power connection to the 34740A.

CAUTION

DO NOT PLUG IN THE POWER CORD WITHOUT FIRST SELECTING THE PROPER LINE VOLTAGE AT THE LINE SELECTOR SWITCHES.

3-3. Refer to the Operating and Service Manual of the plug-on module to be used with the 34740A for operating instructions of the instrument as a whole.

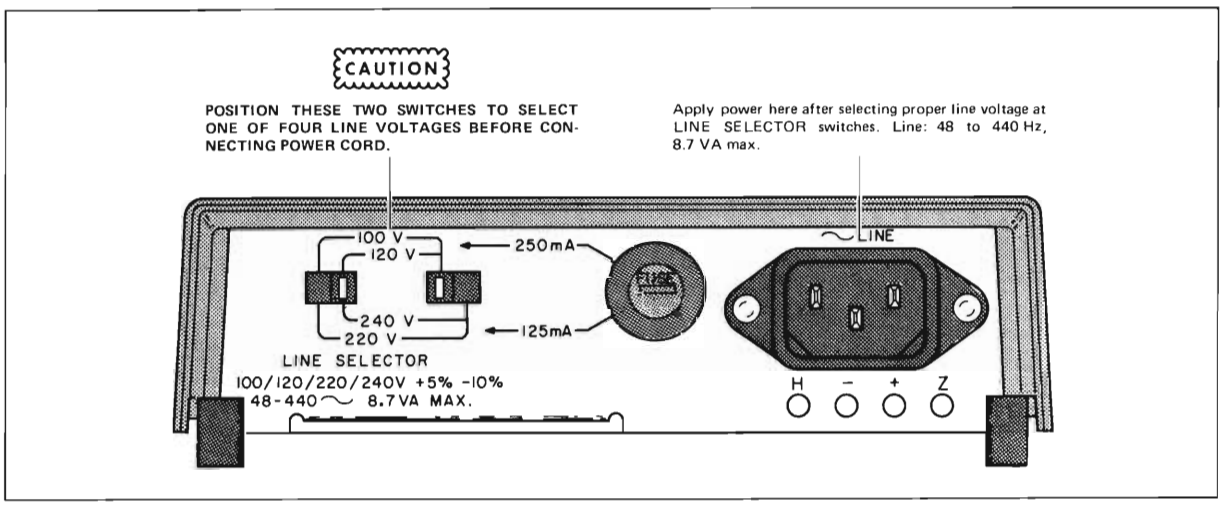


Figure 3-1. Power Connections.

SECTION IV
THEORY OF OPERATION

4-1. BASIC MEASUREMENT TECHNIQUE.

4-2. A dual-slope integrating measurement technique is employed by the 34740A. An Integrator is charged by the dc Input Voltage for a fixed precise 1/30 sec timing interval, and then discharged to zero by a fixed Reference Voltage. Since the charge slope is proportional to the Input Voltage, and the discharge slope fixed, the time taken for discharge is proportional to the Input Voltage. Thus a voltage-to-time conversion is achieved. A readout of the voltage is then obtained by counting pulses from a Crystal Oscillator during the discharge time. (10,000 counts equals full scale, 20,000 counts overload.)

4-3. TIMING SYSTEM.

4-4. Basic.

4-5. The measurement period is divided into six timing intervals 0T1, 1T2, 2T3, 3T4, 4T5 and 5T0 of 1/30 sec duration each. This gives a measurement period of 1/5 sec, or 5 measurements per second. Period 0T1 allows the Input Voltage to settle before it charges the Integrator during 1T2. 2T3 allows the Reference Voltage to settle before it discharges the Integrator. 3T4 plus 4T5 is the Integrator discharging interval, with full scale occuring at t4 and overload at t5. 5T0 is the auto-zeroing period.

4-6. The Data and Timing Clock generates 3 MHz crystal controlled pulses that are divided down to 30 Hz by the Data and Timing Counter within the Data Accumulator to drive the Timing Generator, Counter Reset and Input Polarity circuits. The 30 Hz Timing One-shot provides the proper duration pulses to the latter two circuits.

4-7. Timing Generator.

4-8. The Timing Generator develops a code of three signals A, B and C that jointly define the six timing intervals that comprise the measurement period. It is a three bit counter driven by 30 Hz pulses from the Data Accumulator. Signal A is the 0T3 interval and divides the measurement period in half, B signal is the 1T4 interval and coincides with the integration waveform for a full scale Input Voltage, and C represents the Reference Voltage enable period 2T5.

4-9. DATA SYSTEM.

4-10. Basic.

4-11. The Voltage-to-Time Converter effectively creates a time interval proportional to the Input Voltage by generating a Zero Detect pulse at an interval after timing point t3. The Data Counter is reset to zero at t3, and then counts 3 MHz pulses until Zero Detect. This count is displayed on the front panel as the Input Voltage.

4-12. Voltage-to-Time Converter.

4-13. Integrator. The heart of the Voltage-to-Time Converter is the Integrator, which charges or discharges at a linear rate proportional to its input voltage. The Integrator is charged by the dc Input Voltage from the Input Attenuator through the Input Voltage FET Switch, Buffer Amplifier and Integrator FET Switch during the fixed time interval 1T2. Since the charge time is fixed, the voltage reached on the Integrator Capacitor is proportional to the Input Voltage.

4-14. The Integrator is discharged by the fixed Reference Voltage through the Reference Voltage FET Switch, Buffer Amplifier and Integrator FET Switch beginning at timing point t3. Since the charge level is proportional to the Input Voltage and the discharge rate fixed, the time taken for discharge is proportional to the Input Voltage.

4-15. Zero Detect. The point in time when the Integrator reaches zero voltage is detected by the Zero Detect differential amplifier. This high-gain amplifier is operated open loop so that it remains saturated at one output polarity until its input from the Integrator goes thru zero. Its other input is held near zero, so the amplifier suddenly switches output polarity to give a Zero Detect pulse at the Integrator discharge point.

4-16. The level at which Zero Detect actually occurs is adjusted to a slight voltage of the opposite polarity to the Integrator charge to inhibit oscillation of the Zero Detect Amplifier during Auto-Zero time. The voltage used as the Zero Detect level is divided down from the Buffer Amplifier which has the Reference Voltage output while discharging the Integrator. The Zero Detect output is held high by C (L) signal while it is not being used during 0T2 and 5T0.

4-17. Slope Amp. The Slope Amplifier has a gain of 20 (at low levels), and increases the discharge slope (and also the charge slope) to enable the Zero Detect Amplifier to more precisely detect the exact point at which the Integrator charge reaches the Zero Detect level.

4-18. Auto Zero. An automatic zeroing of the Buffer, Integrator and Slope amplifiers takes place during 5T0 of each measurement period. The three Auto-Zero FET switches Q4, Q10 and Q11 close to apply a zero voltage to

the Buffer Amplifier, reduce the Integrator input resistance and time constant, and feed back the output of the Slope Amplifier to the Auto-Zero Capacitor respectively. This small feedback voltage is stored on the Auto Zero Capacitor at the Integrator differential input to counteract the offsets of the amplifiers during the next measurement period.

4-19. Data Logic.

4-20. Zero-Detect Steering. The Zero-Detect signal from the Voltage-to-Time Converter is a negative-to-positive or positive-to-negative level change depending on whether the Input Voltage polarity is positive or negative respectively. The Zero-Detect Steering circuit converts these level changes into a positive-to-ground level change on either input polarity. Gates U14 pins 3 and 6 are used on a negative input polarity, and gates U14 pins 11, 8 and 6 are used on a positive polarity.

4-21. Zero-Detect Catcher. An oscillation occurs on the Zero-Detect line from the Voltage-to-Time Converter after Zero-Detect. The Zero-Detect Catcher flip-flop allows only the first level change from the Zero-Detect Steering circuit to fire the Transfer one-shot. The flip-flop is reset at t0 by the A (L) signal.

4-22. Transfer. The purpose of the Transfer one-shot is to transfer the count accumulated on the Data Counter within the Data Accumulator into the Storage registers at Zero-Detect. Transfer also turns off the Data Clock for 30 μsec to provide the correct input to the Data Accumulator for Transfer.

4-23. Reset. A Reset pulse is developed by the 30 Hz Timing One-Shop and the gates U11 pin 8 and U7 pin 6 when Reset Enable signal goes high at t3. The Reset pulse returns the Data Counter to zero so that the Data count of the 3 MHz pulses may begin. The 30 μsec duration of the Reset pulse delays the beginning of the Data count past t3 to compensate for the Zero Detect level being set slightly different than zero in the Voltage-to-Time Converter.

4-24. Input Polarity. The polarity of the Input Voltage is determined at t2 when the Polarity Enable signal goes high at U10 pin 1. The polarity of the Zero-Detect line from the Voltage-to-Time Converter at t2 is opposite to that of the Input Voltage. This polarity is applied to the D input of the Input Polarity flip-flop and causes the Q output to go high or low according to the Input Voltage polarity when the C input goes low with a pulse from the 30 Hz Timing One-Shot. The Input Polarity flip-flop then controls the Zero-Detect Steering and Polarity Display circuits.

4-25. Reference Polarity. Gates U17 pins 1 and 5 monitor the Input Voltage polarity on the Zero-Detect line from the Voltage-to-Time Converter during 2T5 when Reference Enable is high. This determines which polarity of the Reference Voltage is needed to discharge the Integrator.

4-26. SCANNING SYSTEM.

4-27. Basic.

4-28. To transfer the data stored in the Data Accumulator out to the front panel for display, a system scans the five storage decades at a 6 kHz rate so that the digit of each storage decade is supplied to all five Display decades simultaneously. It then scans the Display decades in synchronization with the storage decade scanning to illuminate each Display decade individually while the digit for that decade is being supplied to the Display.

4-29. A "half-character" sub-system within the basic scanning system modifies the basic 6 kHz scanning scheme. The data characters are actually divided into right and left halves and supplied a half-character at a time to the Display at 12 kHz, twice the basic scanning frequency. At the same time, the Display decades are also scanned a half-character at a time at 12 kHz to illuminate them at the appropriate time.

4-30. Scanner.

4-31. The heart of the scanning system is the Scanner which scans the data in the Data Accumulator at 6 kHz with the x, y and z lines; scans the Display, a half-character at a time at 12 kHz with the nine half-character scan lines; and switches the Character Generator between the right and left half characters at 12 kHz.

4-32. Data Accumulator.

4-33. The five decades of BCD data stored in the Data Accumulator are fed out at 6 kHz with each decade in its four-line binary code. This time-multiplexing is accomplished by the x, y and z lines from the Scanner.

4-34. Character Generator.

4-35. The Character Generator develops a decimal character from each data decade arriving in binary form from the Data Accumulator. These characters are divided in half vertically and supplied a half-character at a time at 12 kHz to the five Display decades. A line from the Scanner develops the 12 kHz alternation between the right and left half characters. The BCD data decades arrive at the Character Generator at 6 kHz, the "whole" character scan frequency.

4-36. Overrange Digit Scan Monitor.

4-37. The x, y and z scan lines are monitored to determine when the overrange digit (the 10,000's or most significant digit) is being scanned. This information is needed by the Overload, Overrange and Display Blank circuits.

4-38. Overload.

4-39. Flip-flop U8-A is set to the true state when the BCD-2 bit of the overrange digit is high at the D input. This

corresponds to a data count of 20,000, the overload point. The flip-flop is set false the next time the overrange digit is scanned if the overrange digit is not 2.

4-40. Overrange.

4-41. Flip-flop U8-B is set true when the BCD-1 or BCD-2 bit of the overrange digit is high at the D input. This corresponds to a data count of 10,000 or greater, the overrange region. The flip-flop is set false the next time the overrange digit is scanned if the overrange digit is zero.

4-42. Display Blank.

4-43. The Display Blank circuit interrupts the BCD data to the Character Generator and develops a display blank code (111) on the BCD8 thru BCD2 lines to blank out the overrange digit while it is being scanned on an Input Voltage below full scale (10,000 counts). It also blanks out the 1,000's thru 1's digits while they are being scanned on an overload Input Voltage (20,000 counts).

4-44. Gate U5 pin 3 blanks the Overrange Digit by giving a high logic level to OR gates U3 pins 12, 10 and 2 on the Display Assembly when its input pins are high on Not Overrange while the Overrange Digit is being scanned. Gate U5 pin 11 blanks the 1000's thru 1's digits when its inputs are high on Overload while the four digits are being scanned. Gate U5 pin 8 negates the BCD2 data bit on Overload so that only "1" is displayed in the 10,000's digit at Overload.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information for maintenance of the 34740A. Included are performance checks for incoming inspection and adjustment procedures. A Model 740B Voltage Standard is required. Troubleshooting is given in Section VII.

5-3. PERFORMANCE CHECK.

5-4. The performance of the 34740A is normally checked with it connected to a function plug-on module as described in the Operating and Service Manual for that module. However, the performance of the 34740A alone may be checked with the aid of the 11456A Test Card.

a. Connect the INPUT pin on the 11456A to the + REF and - REF pins alternately. The display should be + 10000 (± 2 counts) and - 10000 (± 2 counts) respectively.

b. Connect DP1, DP2, DP3 and DP4 pins alternately to GND 3 pin to test the decimal point display.

5-5. ADJUSTMENTS.

5-6. The 34740A is normally adjusted as a unit with a function plug-on module as explained in the Operating and Service Manual for that plug-on. However, the 34740A may be adjusted alone with the aid of the 11456A Readout Test Card as follows.

a. Apply 1 mV dc from the 740B Voltage Standard to the INPUT and GND 1 pins of the 11456A. Turn the Z adjustment on the rear panel to give the same readout on both polarities of the 1 mV. The readout does not have to be exactly 1 mV (10 counts) now.

b. Now turn the rear panel H adjustment to give a 10 count readout on both polarities of the 1 mV input. It may be necessary to reaccomplish step a. because the Z and H adjustments interact somewhat.

c. Change the 740B to 1 V dc output, and turn the + R and - R adjustments on the rear panel to give a display of 10000 on both polarities.

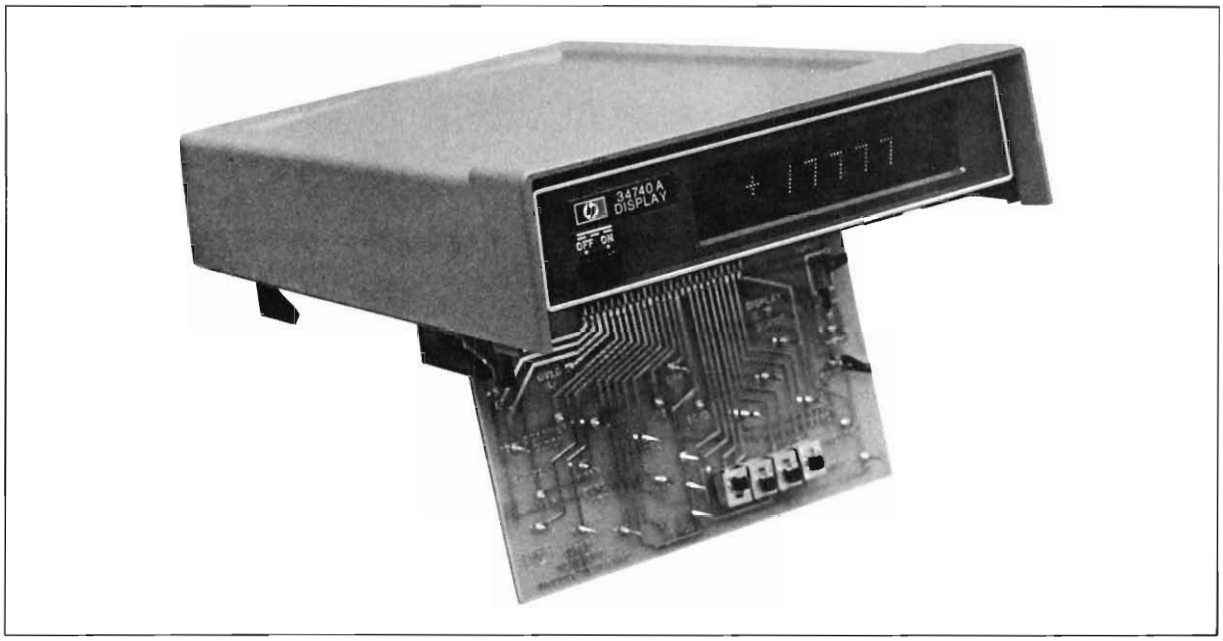


Figure 5-1. 11456A Read Out Test Card.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes and provides the following:

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

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

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

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

6-8. PROPRIETARY PARTS.

6-9. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

ABBREVIATIONS

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

* optimum value selected at factory, average value shown (part may be omitted)

** no standard type number assigned selected or special type

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

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

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	34740-66511	1	BOARD ASSY:MAIN	14493	34740-66511
A1C6	0160-2204	2	C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A1C7	0160-2204		C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A1C8	0160-0362	1	C:FXD MICA 510PF 5%	28480	0160-0362
A1C9*	0160-2205	2	C:FXD MICA 120 PF 5%	28480	0160-2205
A1C10	0180-1701	2	C:FXD ELECT 6.8 UF 20% 6VDCW	28480	0180-1701
A1C11	0150-0093	6	C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A1C12	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A1C13	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A1C14	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A1C15	0160-0207	2	C:FXD MYLAR 0.01UF 5% 200VDCW	28480	0160-0207
A1C16	0160-0207		C:FXD MYLAR 0.01UF 5% 200VDCW	28480	0160-0207
A1C17	0150-0084	1	C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C20	0180-2501	2	C:FXD AL ELECT 680 UF +50-10% 25VDCW	73445	ET681X025A02
A1C21	0180-2501		C:FXD AL ELECT 680 UF +50-10% 25VDCW	73445	ET681X025A02
A1C22	0180-2530	2	C:FXD AL ELECT 1600 UF +50-10% 16VDCW	73445	ET152X016A03
A1C23	0180-2530		C:FXD AL ELECT 1600 UF +50-10% 16VDCW	73445	ET152X016A03
A1C24	0180-0228	2	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X901582-DYS
A1C25	0180-0228		C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X901532-DYS
A1C26	01 00-0182	1	C:FXD 47PF 5% 300V	00853	OBD
A1CR2	1901-0040	16	DIODE: SILICON 30MA 30WV	07263	FDG1088
A1CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR7	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR8	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR9	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR10	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR11	1902-3043	2	DIODE:BREAKDOWN 5.81V 5%	04713	SZ10939-134
A1CR12	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR13	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR14	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR15	1902-3048		DIODE:BREAKDOWN 5.81V 5%	04713	SZ10939-134
A1CR16, CR17	1901-0028	7	DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR18	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR19	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR20	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR21	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR22	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR23	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR24	1901-0040		DIODE: SILICON 30 MA 30 WV	07263	FDG1088
A1CR25	1902-3191	2	DIODE: BREAKDOWN 13.0 V 2 % 400 MW	28480	1901-3190
A1CR26, CR27	1901-0040		DIODE: SILICON 30 MA 30 WV	07263	FDG1088
A1CR28	1902-3191		DIODE:BREAKDOWN:13.0V 2 % 400 MW	28480	1902-3190
A1CR29	1902-3049	2	DIODE:BREAKDOWN 6.19V 5%	04713	SZ10939-122
A1CR30	1902-3073	2	DIODE BREAKDOWN:4.32V 5%	04713	SZ 10939-77
A1CR31	1902-0680	2	DIODE:T.C.REFERENCE JEDEC TYPE IN827	04713	Obd
A1CR32	1902-3049		DIODE:BREAKDOWN 6.19V 5%	04713	SZ10939-122
A1CR33	1902-3073		DIODE BREAKDOWN:4.32V 5%	04713	SZ 10939-77
A1CR34	1902-0680		DIODE:T.C.REFERENCE JEDEC TYPE IN827	04713	Obd
A1J1	1251-2564		CONN: R & P, 50 CONTACT PLUG	74868	57-10500-27
A1Q12	1853-0020	7	TSTR:SI PNP (SELECTED FROM 2N3702)	28480	1853-0020
A1Q13	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q14	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q15	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q16	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q17, Q18, Q19	1854-0071	5	TSTR: SI NPN (SELECTED FROM 2N3704)	28480	1854-0071
A1Q30	1853-0020		TSTR: SI PNP (SELECTED FROM 2N3702)	28480	1853-0020
A1Q31	1854-0022	1	TSTR:SI NPN	07263	S17843
A1Q32	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q33	1853-0051	1	TSTR:SI PNP	80131	2N4037
A1Q34	1855-0062	2	TSTR:SI FET 30V	01295	2N1595
A1Q35	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q36	1855-0062		TSTR:SI FET 30V	01295	2N1595
A1Q37	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1R12	2100-2522	1	R:VAR CERMET 10K OHM 10% LIN 1/2W	28480	2100-2522
A1R13	1810-0134		RESISTOR PACK: 5 FXD 56 K OHM 5 %	56289	200 C OBD
A1R14	0684-5631	2	R:FXD COMP 56K OHM 10% 1/4W	01121	CB 5631
A1R15	1810-0135		RESISTOR PACK: 5 FXD 10 K OHM 5 %	56289	200 C OBD
A1R16	1810-0135		RESISTOR PACK: 5 FXD 10 K OHM 5 %	56289	200 C OBD
A1R17	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R18	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R19	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R20	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R21	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R22	0757-0280	3	R:FXD MET FLM 1.00K OHM 1% 1/8W	28480	0757-0280
A1R23	2100-2413	1	R:VAR FLM 200 OHM 10% LIN 1/2W	28480	2100-2413
A1R24	0757-0442	2	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
ΔA1R25	0683-6815	1	R:FXD COMP 680 OHM 5% 1/4W	01121	CB 6815
A1R26	0698-4539	1	R:FXD MET FLM 402 K OHM 1% 1/8W	28480	0698-4539
A1R27	0684-1011	1	R:FXD COMP 100 OHM 10% 1/4W	01121	CB 1011
A1R28	0684-5621	1	R:FXD COMP 5.6K OHM 10% 1/4W	01121	CB 5621
A1R29	J684-2231	1	R:FXD COMP 22 K OHM 10% 1/4W	01121	CB 2231
A1R30	0698-4479	1	R:FXD FLM 14 K OHM 1% 1/8W (OPT. 060)	28480	0698-4479
A1R30	0698-0064		R:FXD MET FLM 9.31 K OHM 1% 1/8W (OPT 050)	28480	0698-0064
A1R31	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R32	1810-0143		RESISTOR PACK 5 FXD 3.3 K OHM 10%	56289	200 C OBD
A1R33	0698-4479		R:FXD FLM 14K OHM 1% 1/8W	28480	0698-4479
A1R34	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R35	0684-3321	1	R:FXD COMP 3300 OHM 10% 1/4W	01121	CB 3321
A1R36	1810-0139		RESISTOR PACK 4 FXD 22 K OHM 5%	56289	200 C OBD
A1R37	1810-0139		RESISTOR PACK 4 FXD 22 K OHM 5%	56289	200 C OBD
A1R38	1810-0140		RESISTOR PACK 3 FXD 22 K OHM 5%	56289	200 C OBD
A1R39	0684-3311	4	R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R40	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R41	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R42	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R43	1810-0139		RESISTOR PACK 4 FXD 22 K OHM 5%	56289	200 C OBD
A1R47	0684-1021	1	R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021
A1R48	0684-4721	2	R:FXD COMP 4700 OHM 10% 1/4W	01121	CB 4721
A1R49	0698-4443	2	R:FXD FLM 4.53K OHM 1% 1/8W	28480	0698-4443
A1R50	0698-4391	2	R:FXD FLM 69.8 OHM 1% 1/8W	28480	0698-4391
A1R51	0684-4721		R:FXD COMP 4700 OHM 10% 1/4W	01121	CB 4721
A1R52	0698-4443		R:FXD FLM 4.53K OHM 1% 1/8W	28480	0698-4443
A1R53	0698-4391		R:FXD FLM 69.8 OHM 1% 1/8W	28480	0698-4391
Δ A1R54	0757-0280		R:FXD MET FLM 1.00K OHM 1% 1/8W	28480	0757-0280
A1R55	0698-3178	2	R:FXD MET FLM 487 OHM 1% 1/8W	28480	0698-3178
Δ A1R56	0757-0280		R:FXD MET FLM 1.00K OHM 1% 1/8W	28480	0757-0280
A1R57	0698-3178		R:FXD MET FLM 487 OHM 1% 1/8W	28480	0698-3178
A1R58	2100-3154	2	R:VAR CERMET 1000 OHM 10% TYPE P 3/4W	28480	2100-3154
A1R59	2100-3154		R:VAR CERMET 1000 OHM 10% TYPE P 3/4W	28480	2100-3154
A1R60	1810-0130	1	CIRCUIT-PASSIVE:8 RES. 14 PIN	28480	1810-0130
A1R61	0684-3321	1	R: FXD COMP 3300 OHM 10% 1/4 W	01121	CB 3321
A1S1	3101-1723	1	SWITCH:PUSHBUTTON 4PDT SINGLE STA.	71590	A-3101-1723-1
A1U4	1820-0586	1	IC:TTL LP HEX INVERTER	12040	DM74L04N
A1U5	1820-0511	1	IC:TTL QUAD 2-INPT AND GATE	01295	SN7408N
A1U6	1820-0661	2	IC:TTL QUAD 2-INPT OR GATE	01295	SN7432N
A1U7	1820-0583	5	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U8	1820-0596	3	IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
†A1U9	1820-0798	1	IC:TTL SIX DECADE	28480	1820-0798
A1U10	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U11	1820-0585	2	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L03N
A1U12	1820-0668	1	IC:TTL HEX DRIVER W/OPEN COLL(30V)	01295	SN7407N
A1U13	1820-0567	1	IC: TTL DUAL VOLTAGE-CONTROLLED FLIP-FLOP	04713	MC4024P
A1U14	1820-0583		IC: TTL LP QUAD 2-INPUT NAND GATE	12040	DM74L00N
A1U15	1820-0585		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L03N
A1U16	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
A1U17	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U18	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U19	1820-0584	1	IC:TTL LP QUAD 2-INPT NOR GATE	12040	DM74L02N
A1U20	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
A1U23	1820-0203	3	IC:OPERATIONAL AMPLIFIER	07263	SL8940
A1U24	1820-0321	1	INTEGRATED CIRCUIT:HI-SPEED COMPARATOR	01295	SN72 710L
A1U25	1820-0430	1	IC:LINEAR, VOLTAGE REGULATOR 5V	28480	1820-0430
A1Y1	0410-0467	1	CRYSTAL: QUARTZ OPTION 060	28480	0410-0467
	0410-0468		CRYSTAL: QUARTZ OPTION 050	28480	0410-0468
A2	34740-66512	1	DISPLAY ASSY	14493	34740-66512
A2C18	0180-1701		C:FXD ELECT 5.8 UF 20% 6VDCW	28480	0180-1701
A2C19	0160-0156	1	C:FXD MY 0.0039 UF 10% 200VDCW	56289	192P39292-PTS
A2Q20	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q21	1854-0215	9	TSTR:SI NPN	80131	2N3904
A2Q22	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q23	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q24	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q25	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q26	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q27	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q28	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q29	1854-0215		TSTR:SI NPN	80131	2N3904
A2R44	0684-4721	1	R: FXD 4700 OHM 10% 1/4 W	01121	CB 4721
A2R45	0684-8201	2	R:FXD COMP 82 OHM 10% 1/4W	01121	CB 8201
A2R46	0684-8201		R:FXD COMP 82 OHM 10% 1/4W	01121	CB 8201
†A2U1	1820-0635	1	IC:DIGITAL	28480	1820-0635
†A2U2	1820-0571	1	IC:TTL DIGITAL	28480	1820-0571
A2U3	1820-0661		IC:TTL QUAD 2-INPT OR GATE	01295	SN7432N

ΔUSE FOR ALL REPLACEMENT

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2U26	1990-0405	1	DISPLAY PLUS MINUS		
A2U27	1990-0408	1	DISPLAY MODIFIED		
A3	34740-66503	1	AMPLIFIER ASSY	14493	34740-66503
A3C1	0180-0291	1	C:FXD ELECT 1.0 UF 10% 35VDCW	56289	1500105X9035A2-DYS
A3C2	0160-3183	1	C:FXD MY 0.47 UF 20% 50VDCW	84411	HEW 101
A3C3	0160-2641	1	C:FXD POLY 0.1 UF 10% 50VDCW	56289	1049R5-PDP 275 SPEC
A3C4	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A3C5	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
A3CR1	1902-3041	1	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A3Q1	1855-0412	6	TSTR:FET SI N-CHANNEL	17856	FN 2960
A3Q2	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN 2960
A3Q3	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN 2960
A3Q4	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN 2960
A3Q5	1855-0308	2	TSTR:SI DUAL N-CHANNEL	28480	1855-0308
A3Q6	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q7	1855-0093	1	TSTR:FET N-CHANNEL	28480	1855-0093
A3Q8	1855-0308		TSTR:SI DUAL N-CHANNEL	28480	1855-0308
A3Q10	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN 2960
A3Q11	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN 2960
A3R1	0698-4485	2	R:FXD FLM 23.2K OHM 1% 1/8W	28480	0698-4485
A3R2	0684-4711	1	R:FXD COMP 470 OHM 10% 1/4W	01121	CB 4711
A3R3	0698-4485		R:FXD FLM 23.2K OHM 1% 1/8W	28480	0698-4485
A3R4	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R5	0684-2731	1	R:FXD COMP 27K OHM 10% 1/4W	01121	CB 2731
A3R6	0698-4501	1	R:FXD FLM 59K OHM 1% 1/8W OPTION 060	28480	0698-4501
A3R6	0698-4495		R: FXD FLM 37.4 K OHM 1% 1/8 W OPTION 050	75042	CEA T-0 080
A3R7	0698-3157	1	R:FXD MET FLM 19.6K OHM 1% 1/8W (OPT 060)	28480	0698-3157
A3R7	0698-3519		R:FXD MET FLM 12.4K OHM 1% 1/8W (OPT 050)	28480	0698-3519
A3R8, R9	0698-4494	2	R:FXD FLM 35.7K OHM 1% 1/8W	28480	0698-4494
A3R10	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A3R11	0684-5631		R:FXD COMP 56K OHM 10% 1/4W	01121	CB 5631
A3U21	1820-0203		IC:OPERATIONAL AMPLIFIER	07263	SL8940
A3U22	1820-0203		IC:OPERATIONAL AMPLIFIER	07263	SL8940

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MISCELLANEOUS		
	5040-7001		CATCH RIGHT SLIDE		
	5040-6000		CATCH LEFT SIDE		
	0340-0782	1	INSULATOR:TRANSISTOR	28480	0340-0782
	0340-0783	2	INSULATOR:SPRING	00000	08D
	0370-2159	3	KNOB:PUSHBUTTON	28480	0370-2159
	05300-20010	1	CASE	28480	05300-20010
	05300-40003	4	SUPPORT:BOARD	28480	05300-40003
	05300-40004	4	GUIDE:SLIDE	28480	05300-40004
	1400-0383	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	341001
	2110-0304	1	FUSE:CARTRIDGE 1/4 AMP 250V	75915	3AG/CAT. 312.250
	2110-0027	1	FUSE:0.125A 250V	75915	312.125
	34740-60201	1	PANEL ASSY:REAR	14493	34740-60201
	4040-0920	1	PANEL:FRONT	28480	4040-0920
	7120-2931	1	NAMEPLATE	28480	7120-2931
	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
	0380-0333	1	STANDOFF:CAPTIVE 4-40 X 0.312" LG	00000	08D
	0380-0775	1	STANDOFF:SWAGE TYPE 1.000" LG 0.250"OD	00000	08D
	1251-0291	1	CONNECTOR:14 PIN	02660	57-10140
	1251-2357	1	SOCKET:3-PIN MALE POWER RECEPTACLE	82389	EAC-301
	3101-1639	1	SWITCH:SLIDE 2-DPDT	82389	11E-1036
	9170-0894	2	BEAD – SHIELDING	28480	9170-0894
Δ	9100-3413	1	TRANSFORMER (T1)	28480	9100-3413

ΔUSE FOR ALL REPLACEMENT

SECTION VII
CIRCUIT DIAGRAMS
TROUBLESHOOTING

7-1. INTRODUCTION.

7-2. This section contains the diagrams and troubleshooting information necessary to maintain the Model 34740A. Both schematic diagrams and pictorial views of the circuit boards are included.

7-3. NOTES.

7-4. The following notes apply in general to all schematic diagrams:

a. Partial reference designators are shown. Prefix with assembly or subassembly designation(s) or both for complete designation.

b. Component values are shown as follows unless otherwise noted:

Capacitance in microfarads
Resistance in ohms

c. *Average value shown. Optimum value selected at factory.

d. ⏚ Denotes earth ground.

e. ⏚ Denotes chassis or frame ground.

f. ▽ Denotes floatable circuit ground.

g. ▽ Denotes printed circuit assembly ground.

h. ——— — — ——— Denotes assembly outline.

i. — — — — — — — Denotes subassembly outline.

j. ——————— Denotes main signal path.

k. — — — — — — — Denotes feedback path.

l. ▭ Denotes front panel markings.

m. Denotes screwdriver adjust.

n. \924/ Denotes wire color. Color code is the same as the resistor color code. First number identifies the base color; second identifies the wider strip; and third number identifies the narrower strip (e.g.\924/ = white, red, yellow).

o. An (L) suffix indicates low-true logic signals; otherwise signals are high true.

7-5. TROUBLESHOOTING.

7-6. The philosophy in troubleshooting the 34740A is that when a signal is found to be incorrect, but all of the signals that develop this signal are determined to be correct, then the components directly associated with the incorrect signal are the only ones that may possibly be faulty. The components include those that directly develop the signal, as well as some that are driven by the signal and may load down the signal.

7-7. It is implicit in this technique that there be no feedback loops. There are feedback loops in the 34740A, but a simple method exists to break each of these so that the technique is valid.

7-8. Table 7-1 and Signal Development Diagram Figure 7-2 show which of the 27 major signals directly develop each of the 27 signals. Each signal is described in Figure 7-3 or 7-4 so that it may be determined to be correct or incorrect. Table 7-1 lists the components that may be faulty when a signal is found to be incorrect but its developing signals correct.

7-9. Troubleshooting Steps.

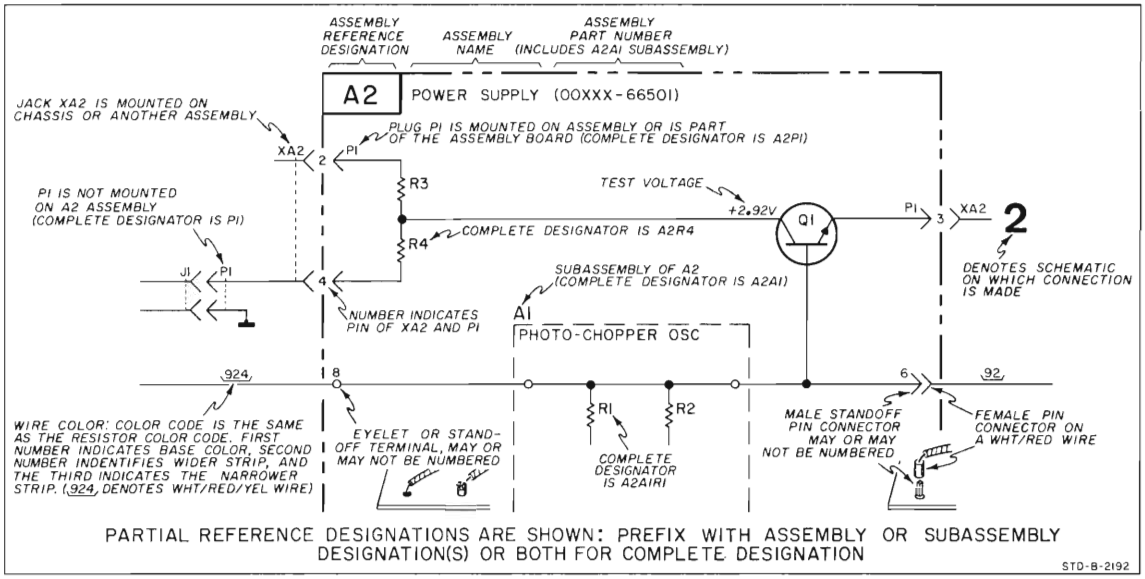
1. Check power supply voltages (± 12 V, + 5 V, ± 6 V). These are found on the 11456A Test Card and vertical amplifier assembly A3.

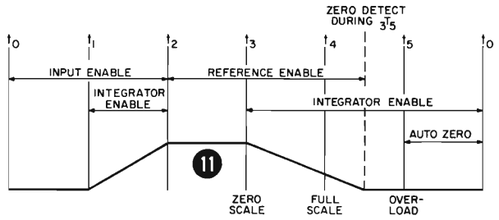
2. Determine if the malfuction is in the 34740A or function plug-on module. Separate the 34740A from the plug-on module and connect the 11456A Readout Test Card to the 34740A. Check the readout by applying dc voltages up to ± 2 V to the INPUT pin and GND 1. The display should blank out at ± 2 V. Check the decimal point display by connecting DP1, DP2, DP3 and DP4 to GND 3.

3. Check the display with the four test switches on the 11456A.

4. Refer to the Signal Development diagram Figure 7-2 and Table 7-1, and begin checking signals according to Figures 7-3 and 7-4. Good starting points are signal (11) and timing signals A, B and C at (4) .

REFERENCE DESIGNATIONS





TIMING GENERATOR (4)

Generates the A, B and C signals that jointly define the six timing intervals $_0T_1$ thru $_5T_0$ of the measurement period. Driven by 30 Hz from the Data Accumulator.

TIMING A, B, C

30 Hz

TIMING A, B

COUNTER RESET (5)

Resets the Data Counter to zero at t_3 so that the data count may begin.

30 HZ TIMING ONE-SHOT (3)

Provides pulses to operate the Input Polarity and Counter Reset circuits when they are enabled by the Timing Generator.

30 Hz RESET DRIVE

30 Hz

TRANS

2

FET-SWITCH DRIVE (9)

Drives the FET switches that operate the analog voltage-to-time converter.

TIMING A, B, C

30 Hz POLARITY DRIVE

VOLTAGE-TO-TIME CONVERTER
(ANALOG)
(Time interval t_3 - Zero Detect proportional to DC Input Voltage)

6 7 7 8

INPUT SWITCH

Input Voltage — Q1

+ Ref Voltage — Q2

- Ref Voltage — Q3

AUTO ZERO — Q4

10 **BUFFER AMP** 10

High-to-low impedance converter.

INTEGRATOR SWITCH — Q7

AUTO ZERO — Q10

11 **INTEGRATOR** 11

Produces a dual slope waveform with the $t_1 \cdot t_2$ slope and $t_2 \cdot t_3$ plateau voltage proportional to the DC Input Voltage, and the $t_3 \cdot$ to $\cdot$ ZD slope fixed. Thus the *time* from t_3 to ZD is proportional to the DC Input Voltage

AUTO ZERO — Q11

Auto-Zero Capacitor

12 **SLOPE AMP**

Increases the Integrator slopes to achieve a precise Zero Detect point.

13 **ZERO DETECT**

Develops a pulse at Zero Detect during $t_3 \cdot t_5$ to Transfer the Data Count into Storage. ZD level is actually adjusted to a voltage slightly different than zero.

Zero-Detect Level Set

TIMING A, C

INPUT POLARITY (14)

Determines the polarity of the Input voltage from the Zero Detect line at t_2 to operate the Zero Detect Steering circuit and supply the polarity to the Display.

ZERO-DETECT STEERING (15)

The polarity of the Zero-Detect pulse is dependent upon the Input polarity. Zero-Detect Steering converts it into a positive-to-ground level change on either input polarity.

B
Z
TROUBLESHOOT JUMPER

ZERO DETECT LEVEL CHANGE

POLARIZED ZERO DETECT

ZERO-DETECT CATCHER

The Zero Detect line from the V-to-T Conv. oscillates after the first crossing of zero voltage (Zero Detect). Zero-Detect Catcher allows only this first crossing to fire the Transfer one-shot.

TIMING A, C

16

ZERO DETECT HELD

17

TRANSFER

Transfers the Data out of Data Storage into the front panel Display via the scanning system at Zero Detect.

TRANSFER

DATA & TIMING CLOCK

Generates 3 MHz pulses t
are counted by the Data
Timing Counter to generate
BCD data and a 30 Hz tim
signal. Is turned off momen
ily at Reset and Transfer.

3470A-0-2802

NOTES
- Timing System - free running; does not depend on Input Voltage.
- Data System - (Analog and Logic) conditions Input Voltage; controlled by Timing.
- Scanning System - basically free running, but Input Voltage determines BCD code in (19) and (24), and decimal code in (26)

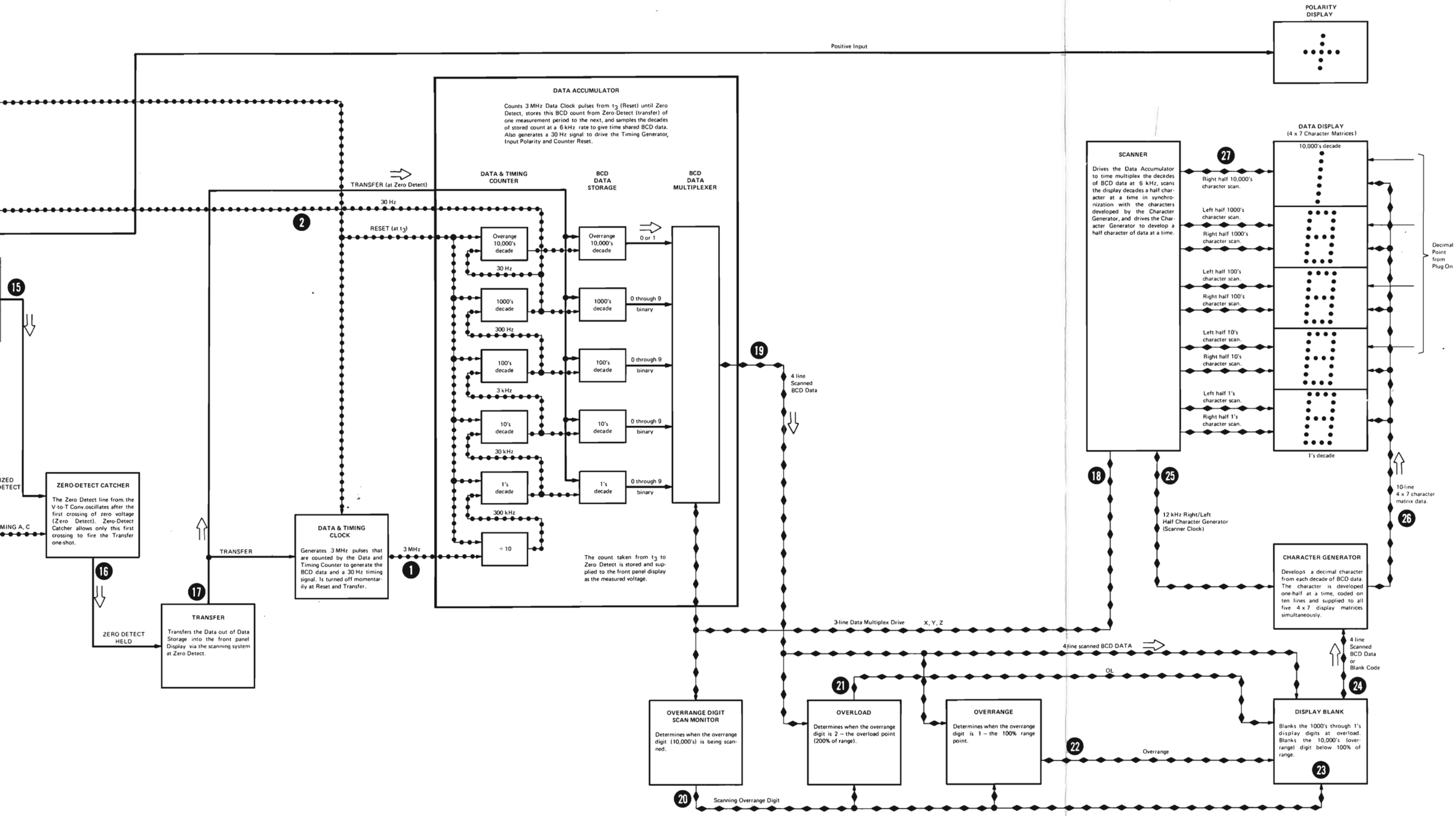


Figure 7-1. Block Diagram.

34740A SIGNAL DEVELOPMENT

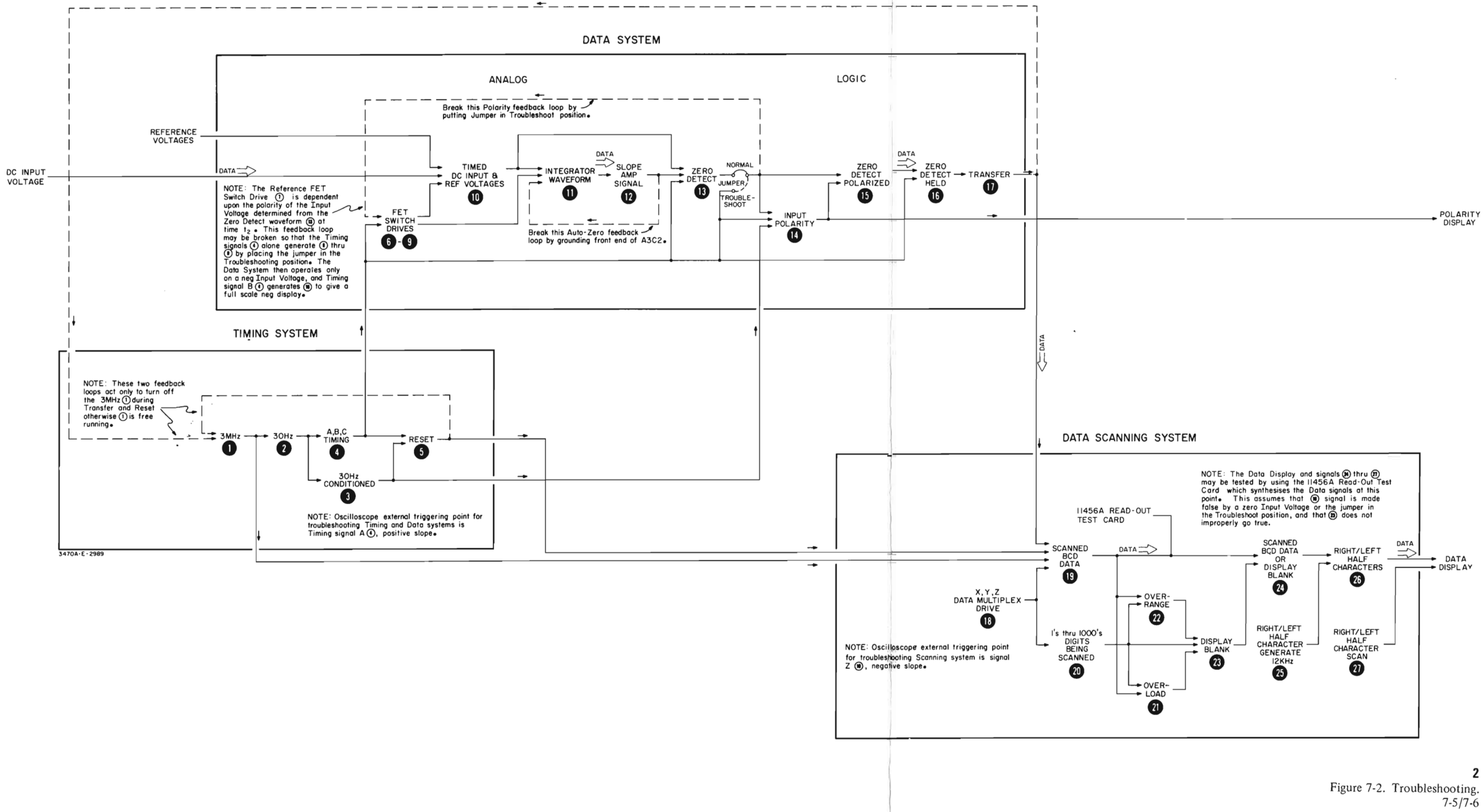


Figure 7-2. Troubleshooting.

Table 7-1. Faulty Components.

Signals that Develop The 27 Major Signals	Major Signals	Faulty Components**
(5)* (17)*	(1)	U7, U13, Y1/U9
(1)	(2)	U9, Q18, CR13, CR15/U11, U7
(2)	(3)	U11/U10, U11
(2)	(4)	U7, U16, U18, U20, U17/U10, U19, Q17, CR12 (U14, U16, U17 if Jumper in troubleshoot (B) position)
(3) (4)	(5)	U11, U19/U7
(4)	(6)	Q12, CR2
(4) (13)*	(7)	Q13, Q14, CR3, CR4, U17, U14
(4)	(8)	Q15, CR5, CR6, CR8, U17/U10
(4)	(9)	Q16, CR7, U19
(6) (7) (8) (9)	(10)	Q1 thru Q6, CR1 thru CR7, U21/Q7
(10) (12)*	(11)	Q7, Q8, U22, CR7
Recommended starting point for "half-split" troubleshooting. → (11)	(12)	U23, Q11, CR8 thru CR10
(4) (10) (12)	(13)	U24, CR11, Q17, CR12
(3) (4) (13)	(14)	U16, U10/U14, Q20
(13) (14)	(15)	U14/U10
(4) (15)	(16)	U10, U4, U17/U15
(16)	(17)	U15
	(18)	U1/U9, U5
(1) (5) (17) (18)	(19)	U7, U9, U12/U8, U6
(18)	(20)	U4, U5/U8, U5
(19) (20)	(21)	U4, U6, U8/U4, U5
(19) (20)	(22)	U8, U6/U5
(20) (21) (22)	(23)	U6, U5/U3
(19) (23)	(24)	U3, U5, U4/U2
	(25)	U1/U2
(24) (25)	(26)	U2/U27
	(27)	U1/Q21 thru Q29

* These are feedback signals. (5) and (17) act only to cut off (1) momentarily; check that they are not permanently in the disabling state. (13) may be broken by putting the troubleshooting jumper in the troubleshoot position. (12) may be broken by grounding the front end of A3C2.

** Components to left of diagonal generate the signal; those to right may load down signal.

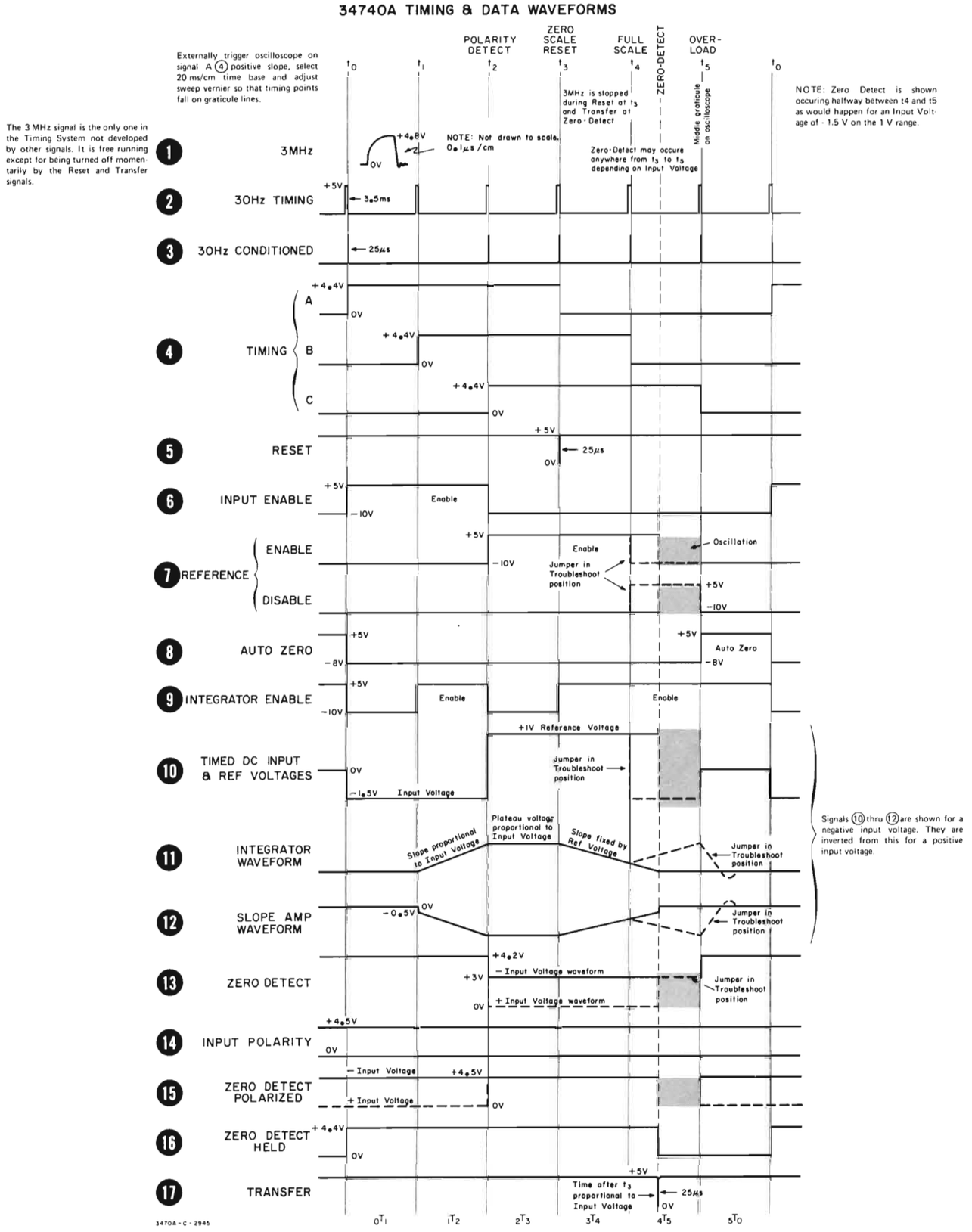


Figure 7-3. Timing Diagram.

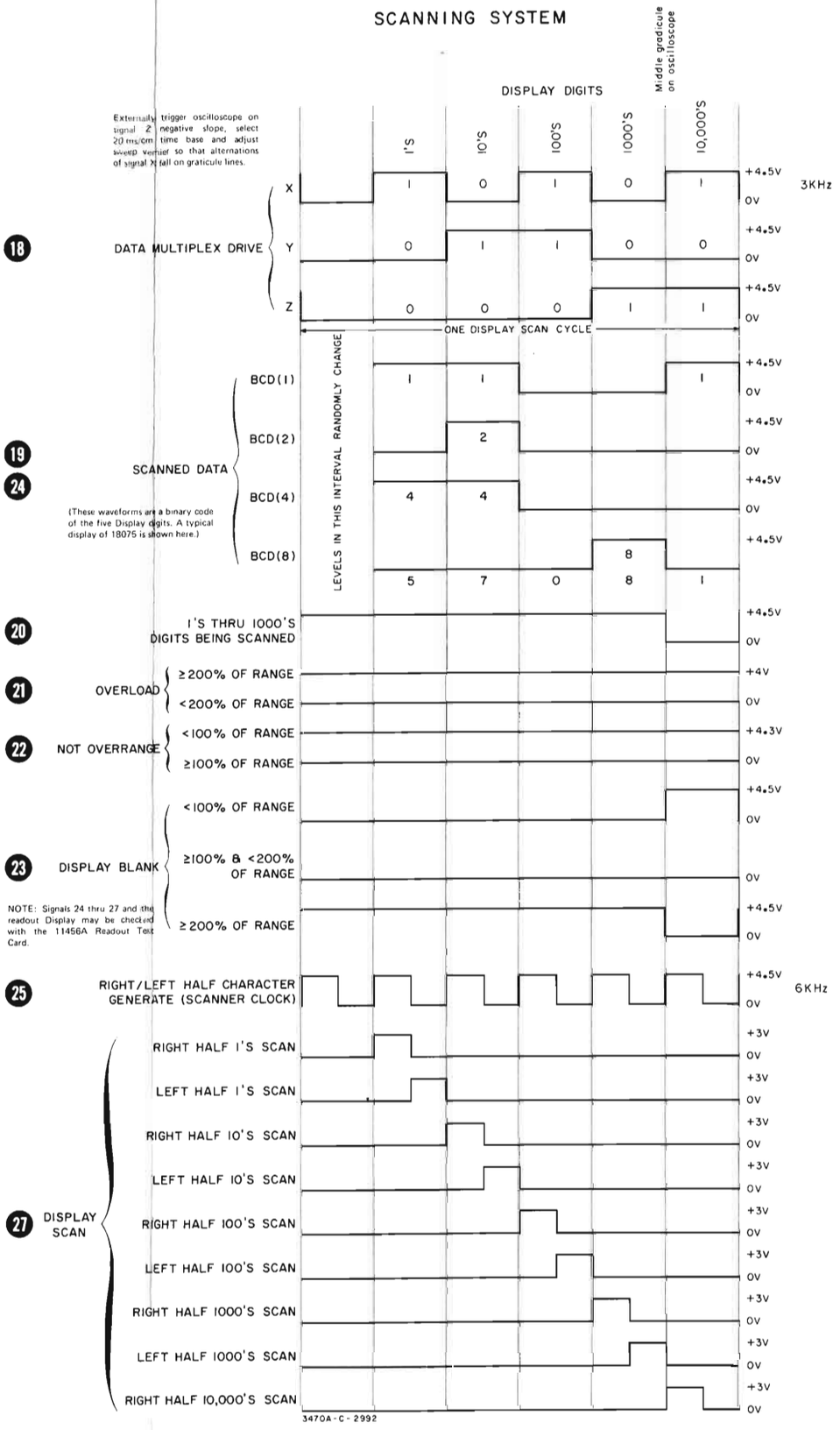


Figure 7-4. Scanning Diagram.

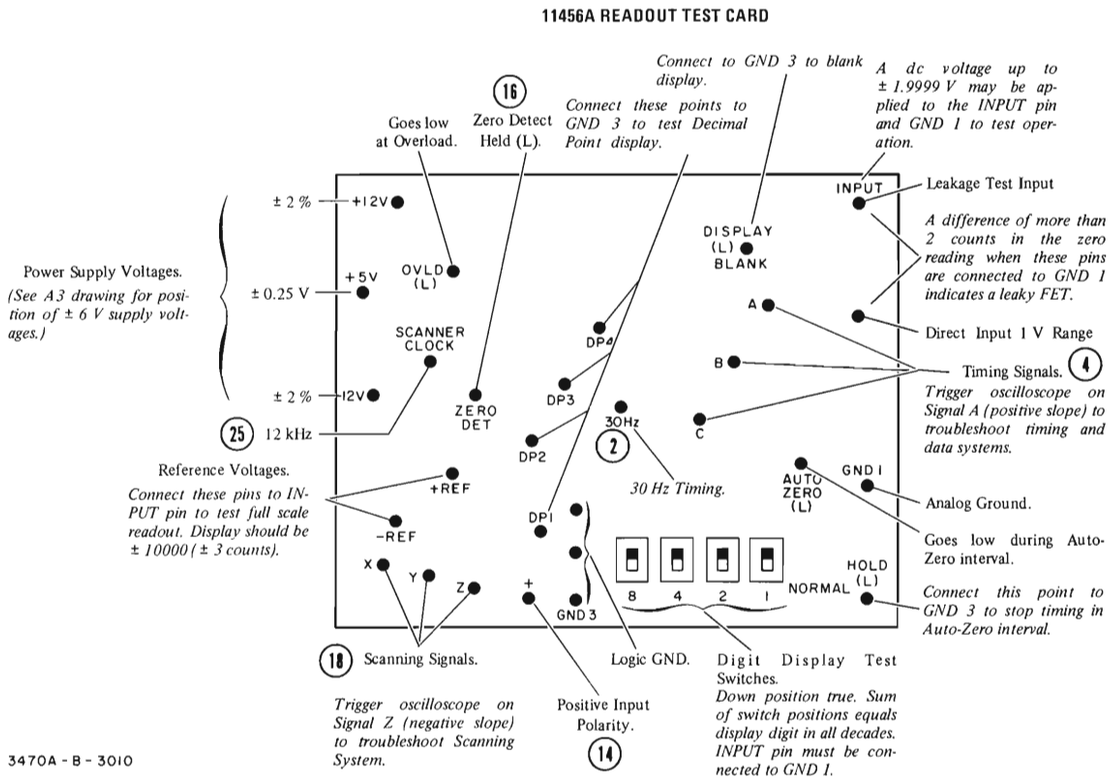


Figure 7-5. 11456A Readout Test Card.

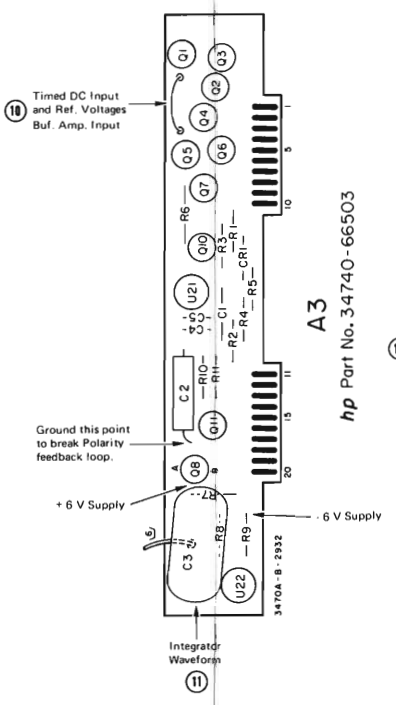


Figure 7-6. A3.

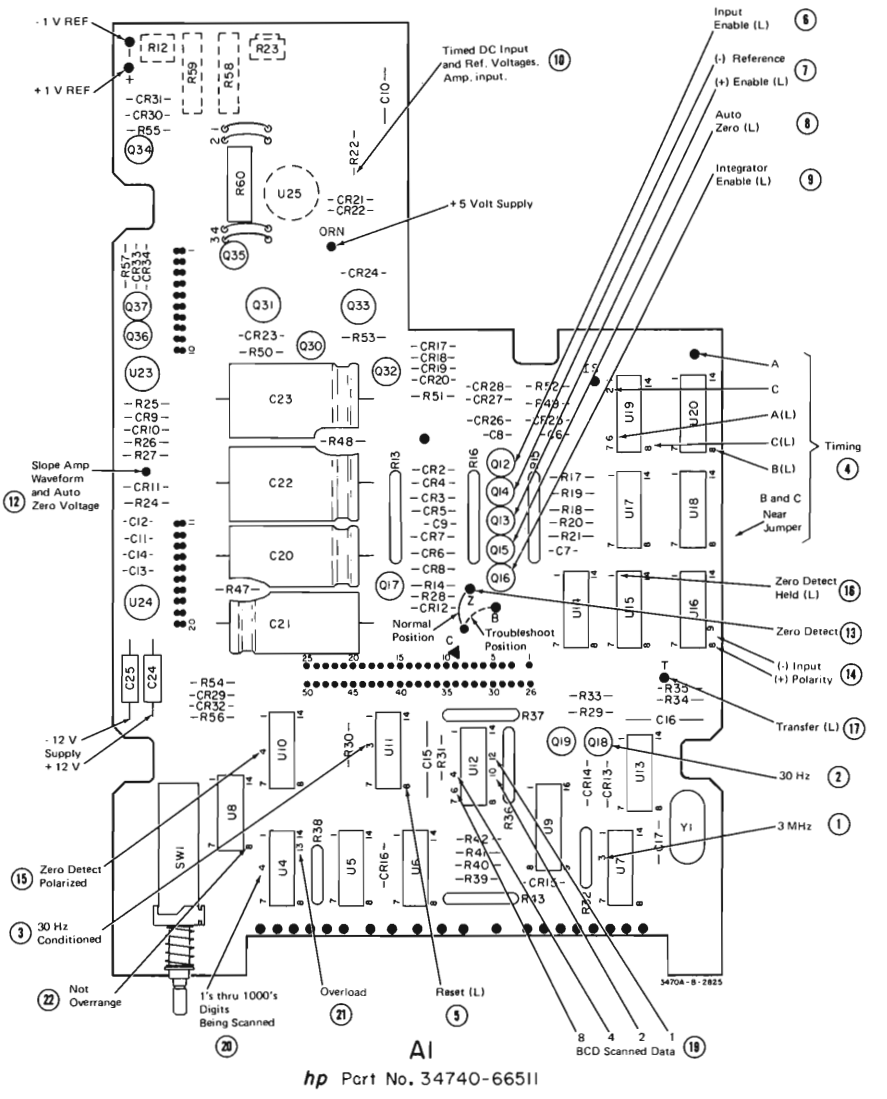


Figure 7-7. A1.

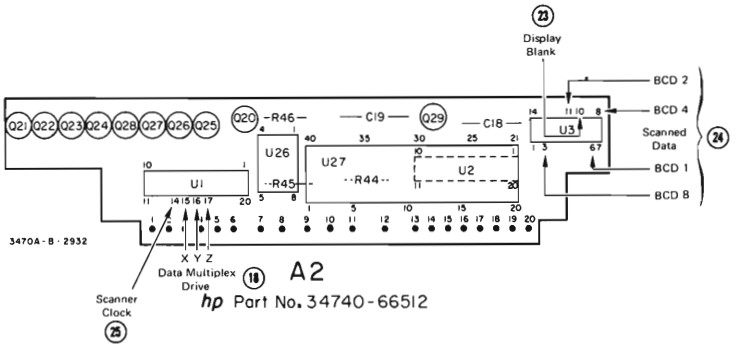
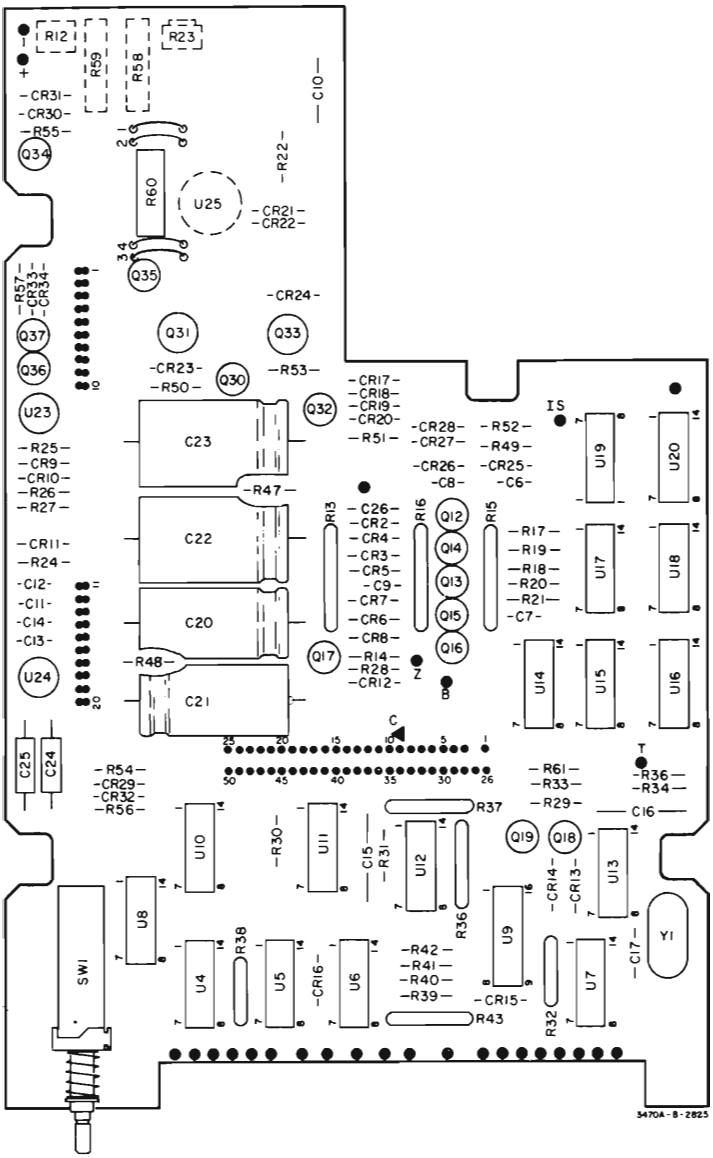
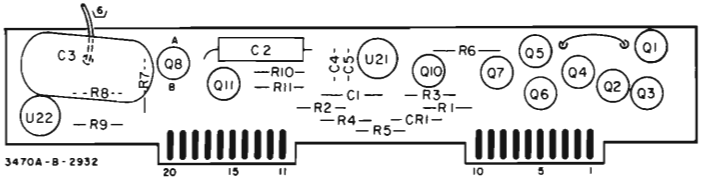


Figure 7-8. A2.



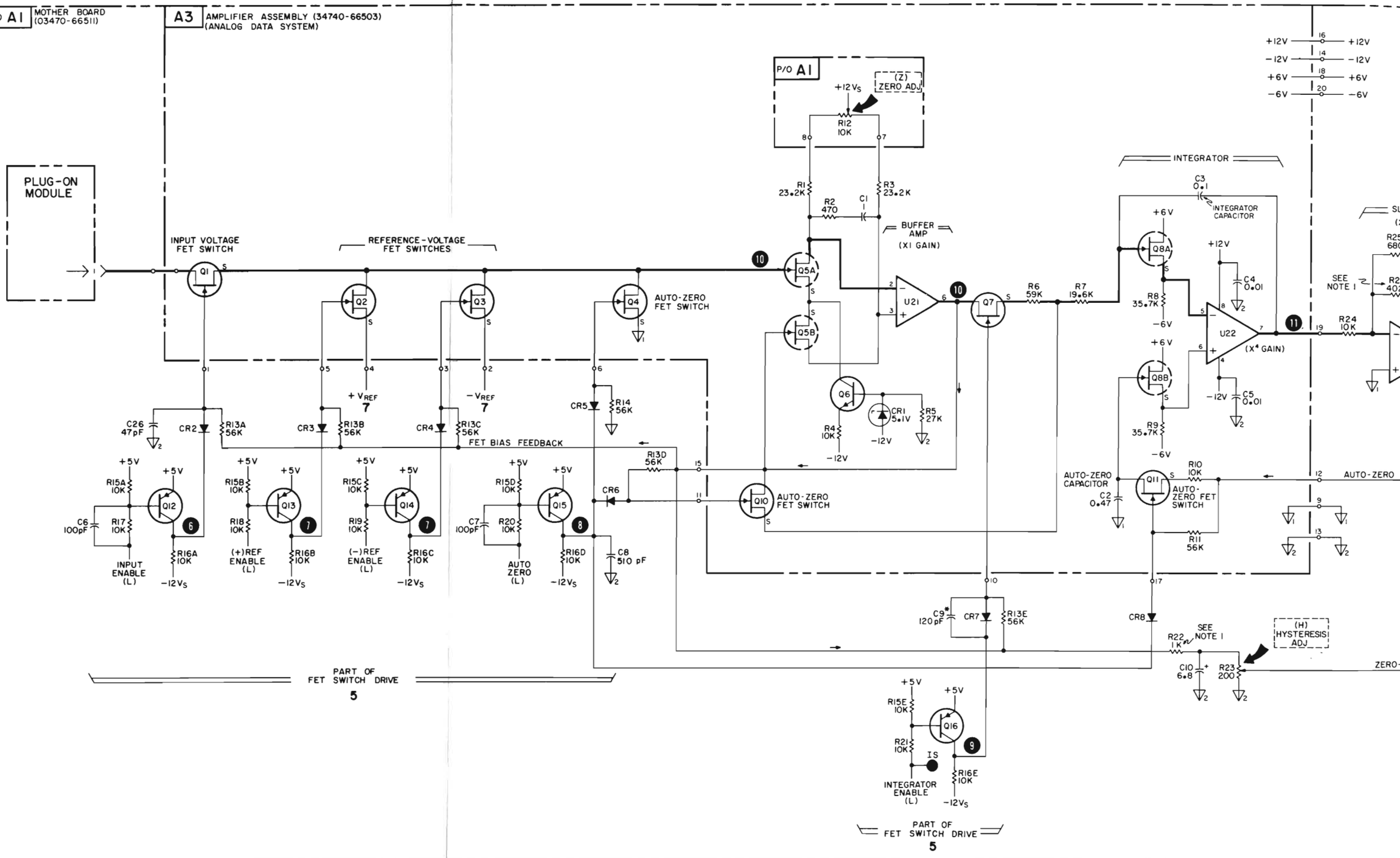


A3

hp Part No. 34740-66503

P/O A1 MOTHER BOARD (03470-66511)

A3 AMPLIFIER ASSEMBLY (34740-66503) (ANALOG DATA SYSTEM)



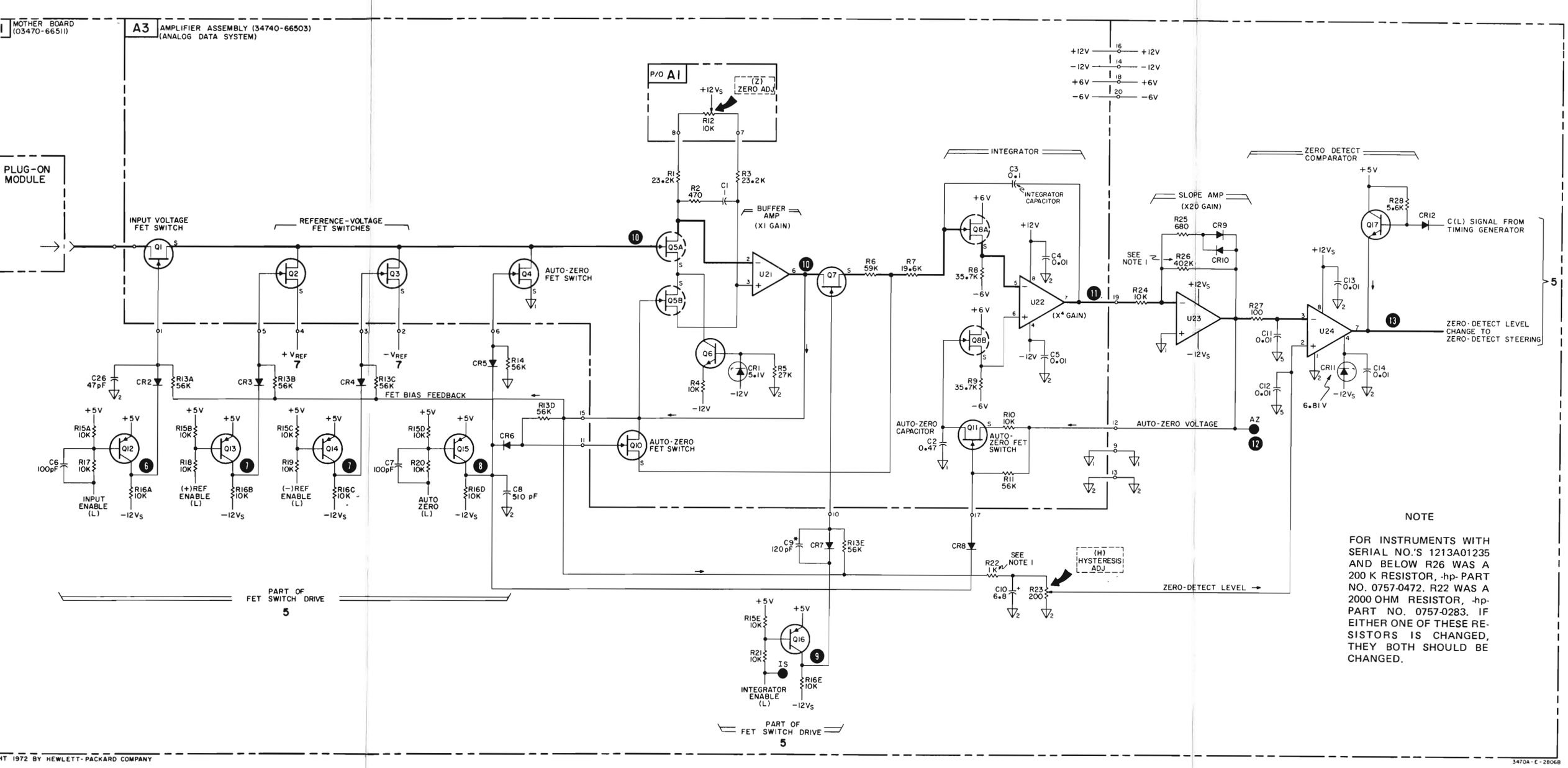
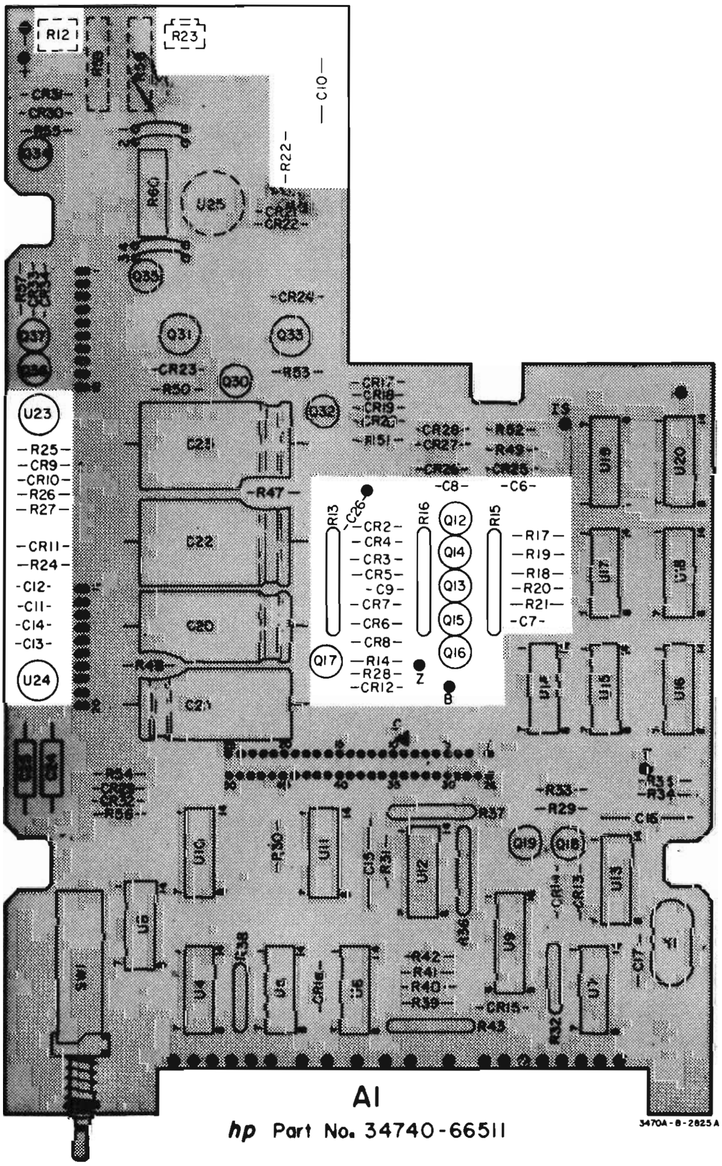


Figure 7-9. Amplifiers.



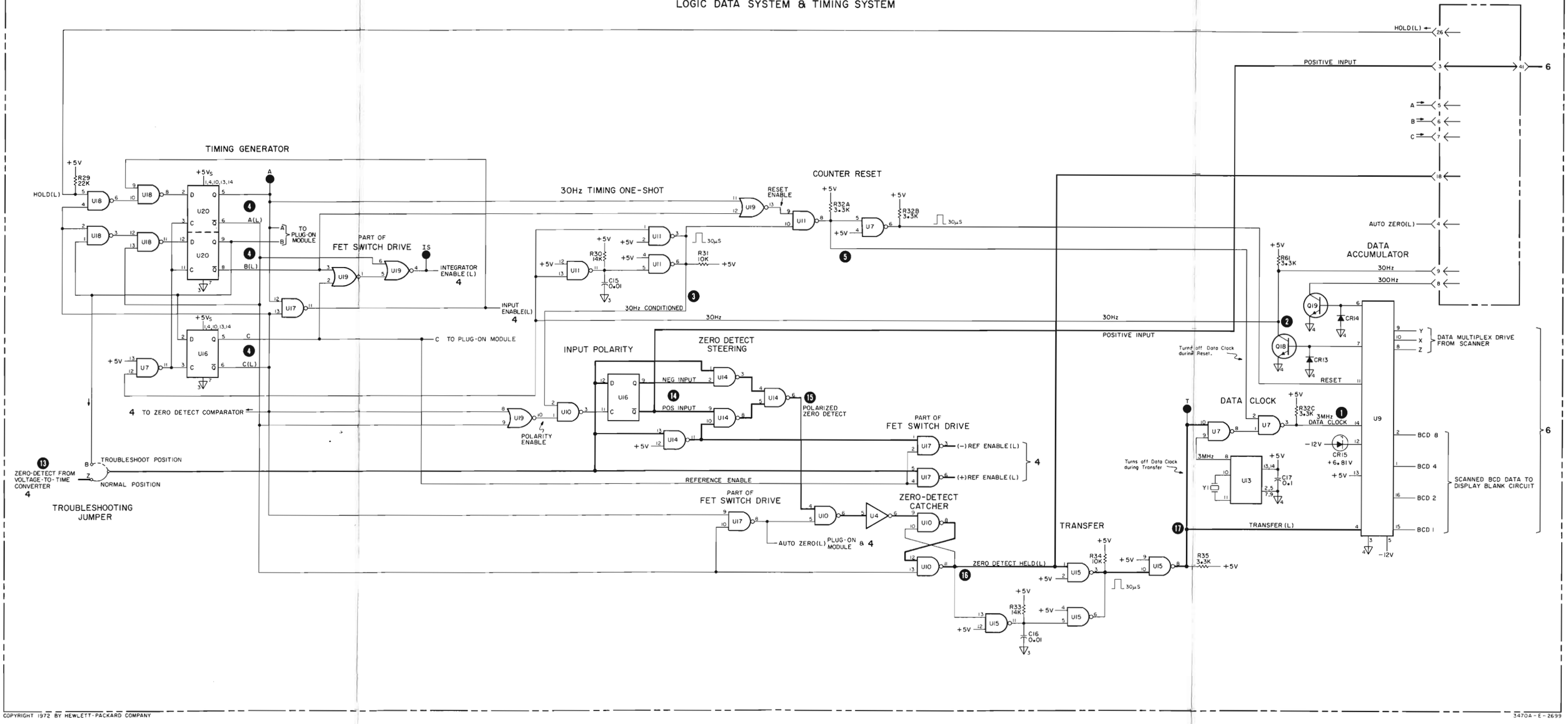
A1

hp Part No. 34740-66511

3470A-B-2825A

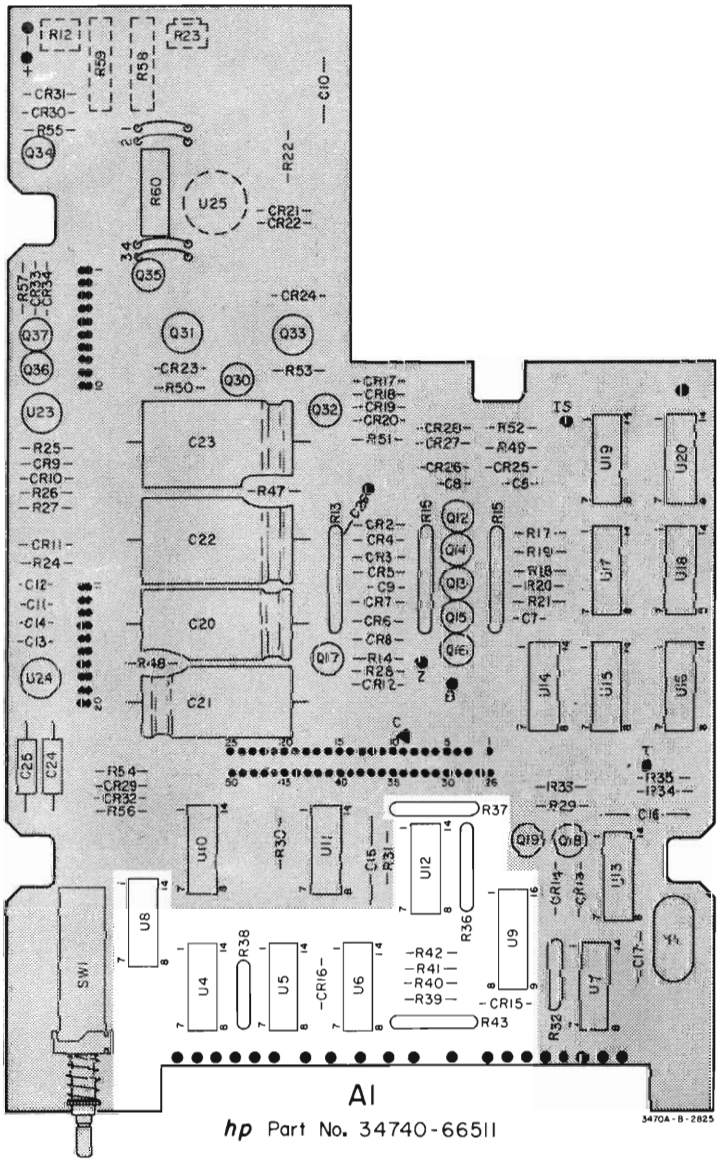
P/O A1 MOTHER BOARD (03470-66511)

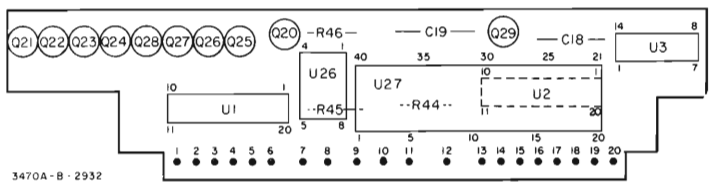
LOGIC DATA SYSTEM & TIMING SYSTEM



3470A-E-2699

Figure 7-10. Timing Logic.
7-11/7-12
Rev. A


R12
R59
R58
R23
C10
CR31
CR30
R55
Q34
R22
R60
U25
CR21
CR22
Q35
CR24
R57
CR33
CR34
Q37
Q31
Q33
Q36
CR23
R50
Q30
R53
Q32
U23
CR17
CR18
CR19
CR20
R51
CR28
CR27
R52
R49
CR26
CR25
C8
C23
R47
C22
R13
R16
R15
CR2
CR4
CR3
CR5
C9
CR7
CR6
CR8
Q12
Q14
Q13
Q15
Q16
Q17
R14
R28
CR12
R17
R19
R18
R20
R21
C7
C20
R48
C21
U24
U19
U20
U17
U18
U14
U15
U16
C25
C24
R54
CR29
CR32
R56
R33
R29
C16
R35
R34
R37
U10
R30
U11
C15
R31
U12
Q19
Q18
U13
CR14
CR13
C17
U8
R38
U4
U5
CR16
U6
R42
R41
R40
R39
R36
U9
CR15
R43
R32
U7
SW1
A1
hp Part No. 34740-66511
3470A-B-2825


Q21
Q22
Q23
Q24
Q28
Q27
Q26
Q25
Q20
R46
C19
Q29
C18
U3
U26
U27
U2
U1
R45
R44
3470A-B-2932
A2
hp Part No. 34740-66512

P/O A1 MOTHER BOARD (34740-66511)

SCANNING SYSTEM & DISPLAY

A2 DISPLAY ASSEMBLY (34740-66512)

PLUG-ON MODULE

5 POSITIVE INPUT

POLARITY ENABLE (L)

POLARITY DISPLAY

R45 82

R44 4.7K

Q20

R46 82

U26

27 RIGHT/LEFT HALF CHARACTER SCAN

SCANNER

V_{LED}

CR16

+5V

C18 6.8

C19 0.0039

U1

1's

10's

100's

1000's

Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29

10,000's

U27

DP4(L) DP3(L) DP2(L) DP1(L)

DISPLAY TROUBLESHOOTING

Symptom:	Probable Fault:
Blanking (left or right) of one decade out.	Faulty Q21-Q29 follower or Scanner.
More or less than one digit lit in one decade out.	Display.
Same glowing digit in all five decades.	Character Generator or Data Multiplexer.

DATA ACCUMULATOR

300Hz

30Hz

5 RESET

1 3MHz DATA CLOCK

−12V

CR15 6.81V

+5V

17 TRANSFER

U9

DATA MULTIPLEX DRIVE

18

Y X Z

R38A R38B R38C R38D 22K

R36A R36B R36C R36D 22K

R37A R37B R37C R37D 22K

U12

R39 R40 R41 R42 330

DP4(L) DP3(L) DP2(L) DP1(L)

R43A R43B R43C R43D 22K

DECIMAL POINT

25 12KHz

CHARACTER GENERATOR

RIGHT/LEFT HALF CHARACTERS 26

U2

SCANNER CLOCK

RIGHT/LEFT HALF CHARACTER GENERATE

DATA DISPLAY

19 SCANNED BCD DATA

BCD 8 BCD 4 BCD 2 BCD 1

DISPLAY BLANK

OVERLOAD (L)

EXTERNAL DISPLAY BLANK

Holds BCD 2 low at Overload so that "2" will not be displayed in 10,000's digit.

OVERLOAD

U8A FLIP-FLOP

U8B FLIP-FLOP

OVERRANGE DIGIT SCAN DETECT 20

OVERRANGE 21

NOT OVERRANGE 22

Gives a "1" display in the 10,000's digit at Overload.

Blanks the Overrange (10,000's) digit below 100% of range.

23

OVERRANGE DIGIT BEING SCANNED

1's THRU 1000's DIGITS BEING SCANNED

Blanks the 1's thru 1000's digits on Overload.

24 SCANNED BCD DATA OR DISPLAY BLANK CODE

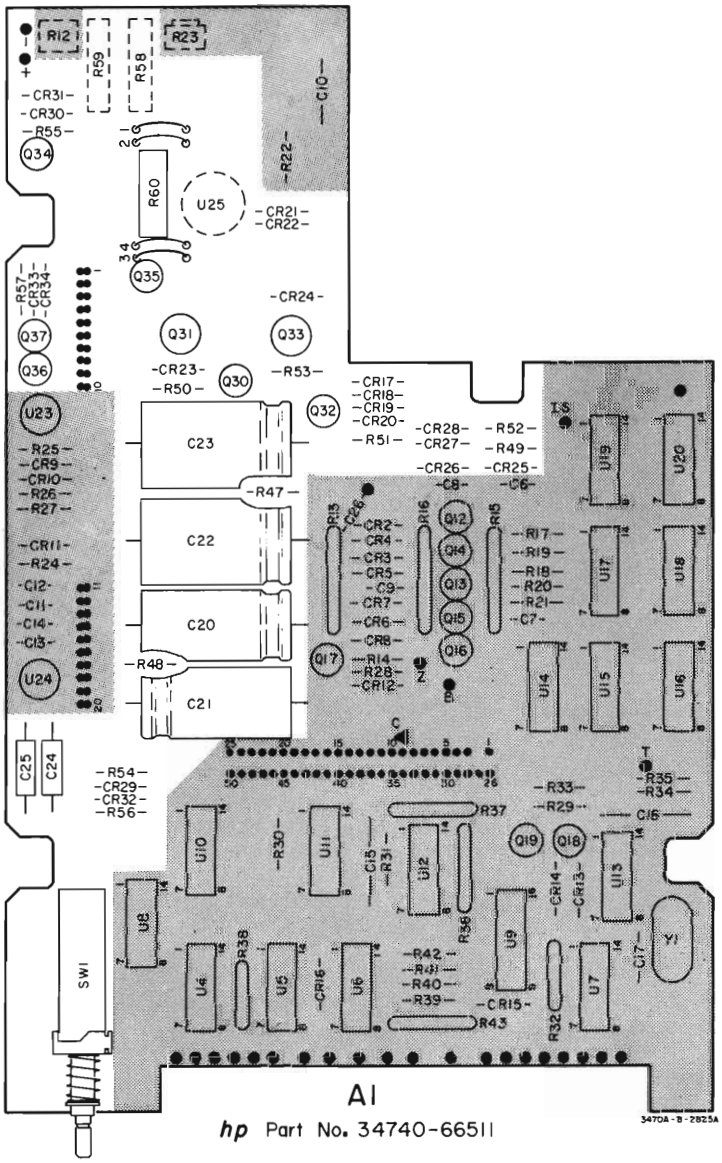
U3

NOTE:
The Overload and Overrange flip-flops are clocked on the positive-going edge of signal 20. Q output then goes to the same high or low level as D input.

NOTE:
Display Blank Code (1111) on BCD 8 thru BCD 2 lines is developed by Display Blank signal 23 when the Overrange digit is being scanned below full scale (<100% of range) or when the 1's thru 1000's digits are being scanned on Overload (≥200% of range).

3470A-E-2803

Figure 7-11. Scanning Logic.
7-13/7-14
Rev. A


R12
R23
R59
R58
C10
CR31
CR30
R55
Q34
R22
R60
U25
CR21
CR22
Q35
CR24
R57
CR33
CR34
Q37
Q31
Q33
Q36
CR23
R50
Q30
R53
CR17
CR18
CR19
CR20
R51
Q32
U23
R25
CR9
CR10
R26
R27
C23
R47
CR28
CR27
CR26
R52
R49
CR25
C8
C6
IS
U19
U20
U17
U18
U14
U15
U16
C22
C20
R48
C21
R13
R28
CR2
CR4
CR3
CR5
C9
CR7
CR6
CR8
CR14
CR12
R16
R15
Q12
Q14
Q13
Q15
Q16
Q17
R17
R19
R18
R20
R21
C7
U24
CR11
R24
C12
C11
C14
C13
C25
C24
R54
CR29
CR32
R56
R33
R29
R35
R34
C16
R37
Q19
Q18
U10
U11
U12
U13
R30
C15
R31
CR14
CR13
U8
R38
U4
U5
U6
CR16
R42
R41
R40
R39
R36
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R43
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hp Part No. 34740-66511
3470A-B-2825A

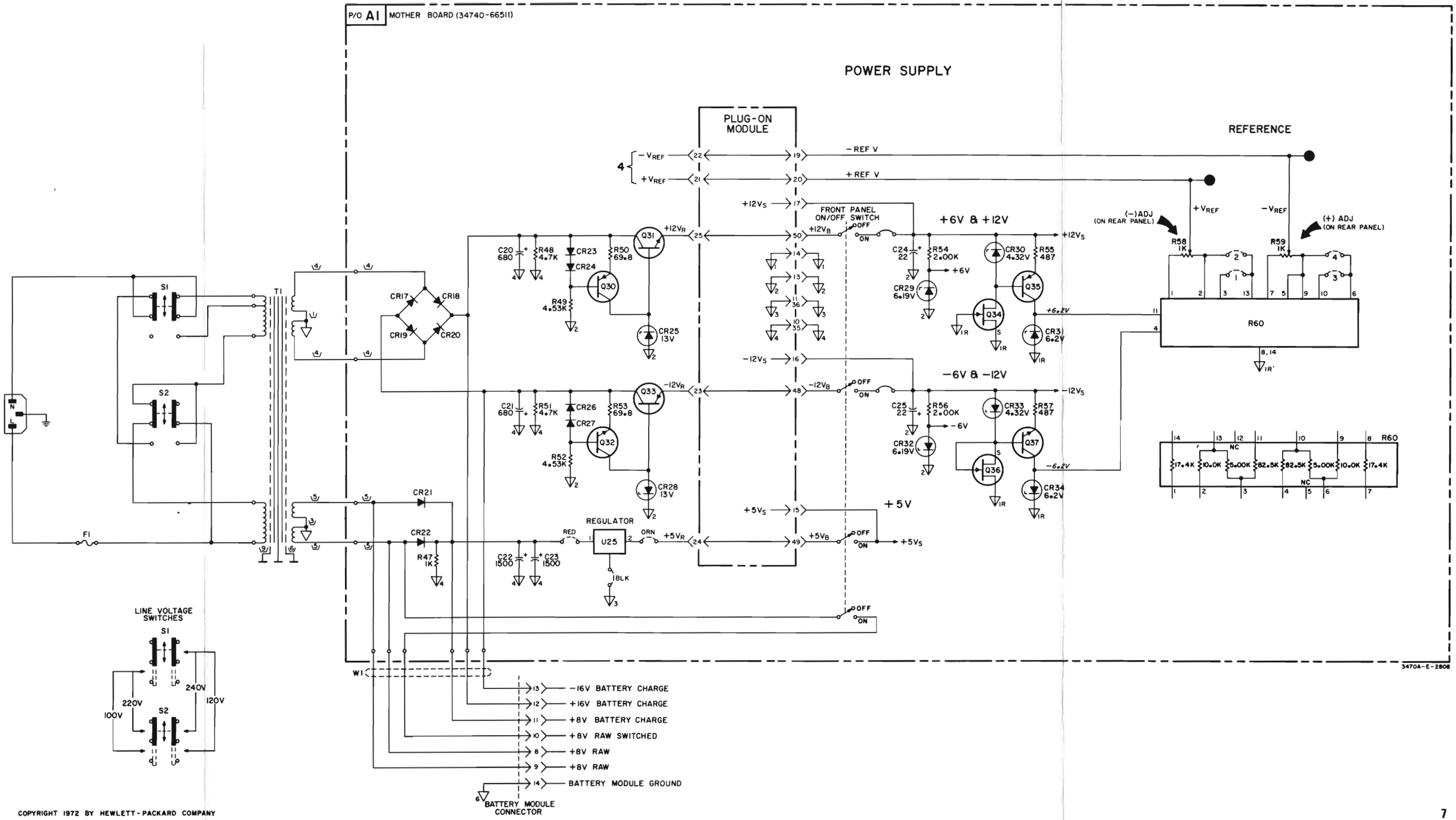

Figure 7-12. Power Supply.

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins EngineeringCo.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N. J.
03296	Nylon Molding Corp.	Springfield, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon.	Clifton Heights, Penn.
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N. Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N. J.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N. J.
16554	Electroid Co.	Union, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N. J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	H P Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark.	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
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94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
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95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
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95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
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95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
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97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
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99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

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0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
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OPERATING AND SERVICE MANUAL

MODEL 34750A
DISPLAY

The main body of this instruction manual applies to

Serial Number 1304A00101

and higher. Any changes made in instruments having serial numbers higher than the above number are, or will be, integrated into the manual by page revision as they occur. Revised pages are identified by a revision letter in the lower corner of the page. You may receive subsequent revised pages by returning the questionaire in the front of the manual with the appropriate square marked. If a change is made that does not apply to all previously manufactured instruments, backdating information in Section VIII adapts the manual to the earlier instruments.

Manual Part No. 34750-90001

Microfiche Part No. 34750-90051

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

PRINTED IN U.S.A.

Revised: March 1975

Printed: JUNE 1973

HEWLETT hp PACKARD

CERTIFICATION

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

WARRANTY AND ASSISTANCE

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

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

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

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

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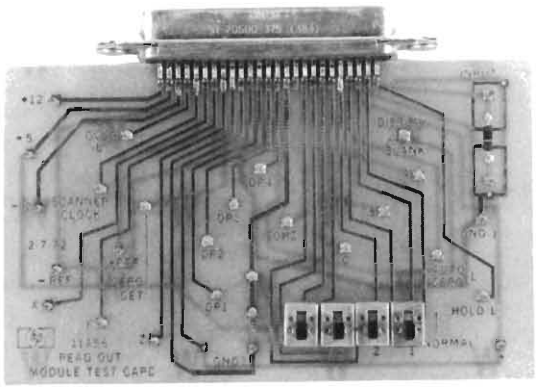
SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

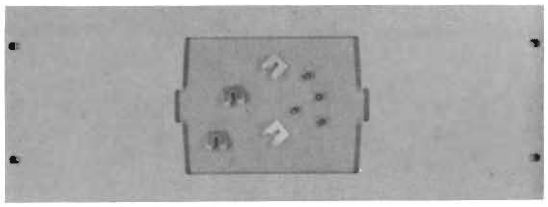
1-2. The Hewlett-Packard Model 34750A Display Module is part of the low cost 3470 Measurement System designed to measure AC volts, DC volts, current and resistance. It can be combined with the Model 34701A, Model 34702A or Model 34703A Plug-On Module, shown in Figure 1-1, to make these measurements. Table 1-1 lists the various plug-on modules which condition the input to the Model 34750A, and indicates the functions of each.

Figure 1-1. Plug-On Modules which can be used with the 34750A Display Module.

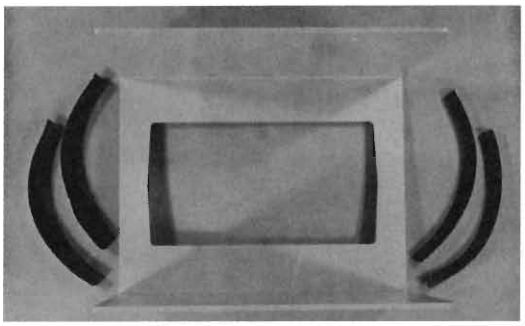


11456A
READ OUT TEST CARD

18019A
CARRYING CASE



11457A
RACK MOUNT KIT



10576A
RACK MOUNT KIT

562A-16C
PRINTER CABLE

Figure 1-2. Accessories Available for use with 34750A.

Table 1-1. 3470A Series Signal Conditioning Modules.

Plug-On (Signal Conditioning) Module	Function				
	DCV	Ω	ACV	DCA	Auto-Ranging
34701A DC Voltmeter	X				
34702A Multimeter	X	X	X		
34703A DCV/DCA/Ω Meter	X	X		X	X

1-3. Two center (sandwich) modules are also available for use with the Model 34750A and a signal conditioning module. These modules (Model 34720A and Model 34721A) add the capabilities of battery operation and BCD output to the 3470A measurement system. These modules are also shown in Figure I-1.

1-4. The digital readout of the 34750A consists of five full digits plus an overrange "1". The LED (Light Emitting Diode) display provides a bright clear readout with a maximum display of 199999.

1-5. The Model 34750A has an internal jumper wire which may be positioned to test the logic and display circuits.

1-6. SPECIFICATIONS.

1-7. Specifications for the 34750A are included in Section I of the Operating and Service manuals for the "plug-on" modules.

1-8. OPTIONS.

1-9. Options available for the 34750A are listed in Table 1-2.

Table 1-2. Available Options.

Option	Purpose	Measurement Rate
060	Operation with 60 Hz line.	5/sec
050	Operation with 50 Hz line.	8/sec

1-10. ACCESSORIES AVAILABLE (See Figure 1-2).

a. 11456A - Read Out Test Card - Facilitates testing and troubleshooting the Model 34750A Display Module.

b. 18019A - Carrying Case - Accomodates the 34750A Display Module, a center module, and a "plug-on" module plus the power cord and input cables.

c. 11457A - Rack Mount Kit - Permits rack mounting of a 34750A Display Module, a 34721B Center Module, and a "plug-on" module.

d. 10576A - Rack Mount Kit - Permits rack mounting of a 34750A Display Module and a "plug-on" module.

e. 562A-16C - Printer Cable - Connects the output of the Model 34721B BCD Module to a Model 5055A Digital Recorder.

1-11. INSTRUMENT AND MANUAL IDENTIFICATION.

1-12. A three-section serial number is used to identify your Model 34750A. Figure 1-3 illustrates the meaning of the three parts of the number.

1-13. This manual is kept up-to-date with revised pages. If the serial number ou your instrument is lower than the one on the title page of this manual refer to the backdating information in Section VIII which adapts this manual to your instrument. All correspondence with Hewlett-Packard Company should include the complete serial number.

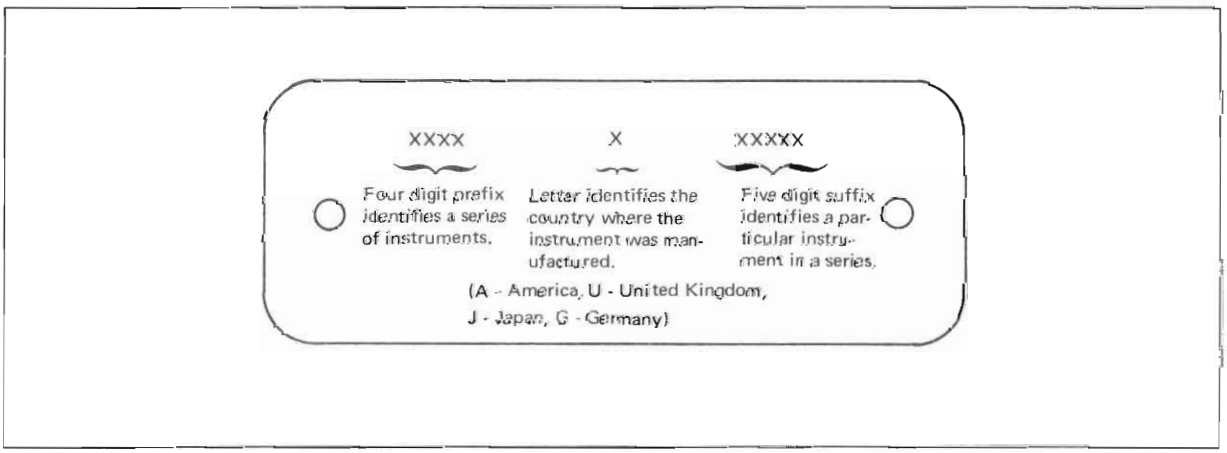


Figure 1-3. Instrument Serial Number (on rear panel).

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions for the installation and shipping of the 34750A. Included are initial inspection procedures, power and grounding requirements, environmental information and repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check to ensure you have received a power cord with the instrument. Using the performance test procedures referred to in Section V, test the electrical performance of the instrument. If there is damage or deficiency see the warranty on the reverse side of the title page of this manual.

2-5. POWER REQUIREMENTS.

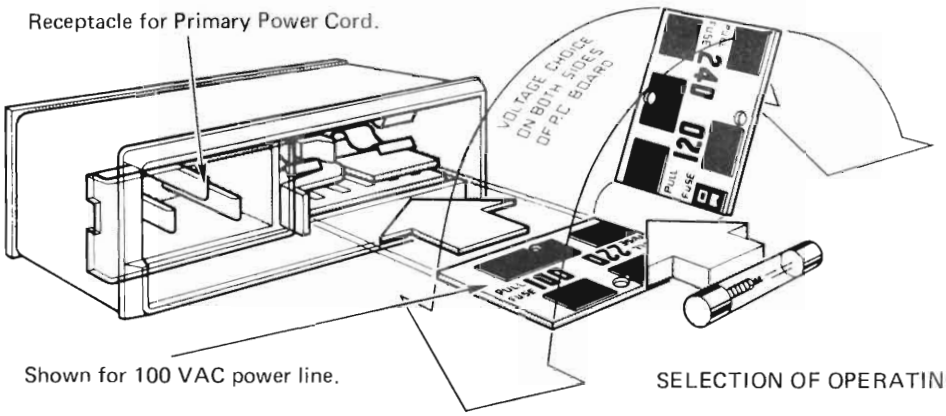
2-6. The 34750A can be operated from the following nominal primary power sources:

Line Voltage	Tolerances	Frequency Range
100 V	+ 5 % to - 10 %	48 to 440 Hz
120 V	+ 5 % to - 10 %	48 to 440 Hz
220 V	+ 5 % to - 10 %	48 to 440 Hz
240 V	+ 5 % to - 10 %	48 to 440 Hz

The 34750A is set for 120 volt operation at the factory. Refer to Figure 2-1 for the procedure to change your unit for operation on a different voltage.

CAUTION

IF THE INSTRUMENT IS NOT SET FOR THE CORRECT PRIMARY POWER VOLTAGE IT MAY BE SERIOUSLY DAMAGED.



SELECTION OF OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position.
4. Check to ensure you are using the proper size fuse. A 0.5 amp fuse is required for 100/120 VAC line operation, a 0.25 amp fuse should be used for 220/240 VAC operation.
5. Re-insert the fuse in the fuseholder.

Operating voltage is shown in module window.

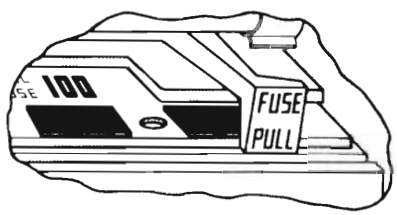


Figure 2-1. Voltage Selection.

The primary power voltage that is currently selected to operate your 34750A can be observed in the power module window. (See Figure 2-1).

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 34750A is equipped with a three-conductor power cable that grounds the instrument when it is plugged into the appropriate receptacle. The offset pin on the power cable is the ground wire.

2-9. To preserve this protection feature when operating from a two-contact outlet, use a three-prong to two-prong adapter and connect the pigtail on the adapter to power line ground.

2-10. ENVIRONMENTAL REQUIREMENTS.

2-11. The 34750A should not be operated where the ambient temperature exceeds 0^{o} C to 50^{o} C (32^{o} F to 122^{o} F) or stored where the ambient temperature exceeds - 40^{o} C to 75^{o} C (- 40^{o} F to 167^{o} F).

2-12. INSTRUMENT MOUNTING.

2-13. Bench Use.

2-14. The front of the 34750A may be elevated for operating convenience by lowering the tilt stand on the bottom module.

2-15. Rack Use.

2-16. Figure 2-2 shows the available kits for rack mounting the various module combinations of the 3470 series of instruments.

2-17. REPACKAGING FOR SHIPMENT.

2-18. The following paragraphs contain a general guide for repackaging the instrument for shipment. Refer to Paragraph 2-19 if the original container is to be used; 2-20 if it is not. If you have any questions, contact your nearest -hp- Sales and Service Office (See Appendix B for office locations).

NOTE

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

2-19. Place the instrument in the original container with appropriate packing material and seal well with strong tape or metal bands.

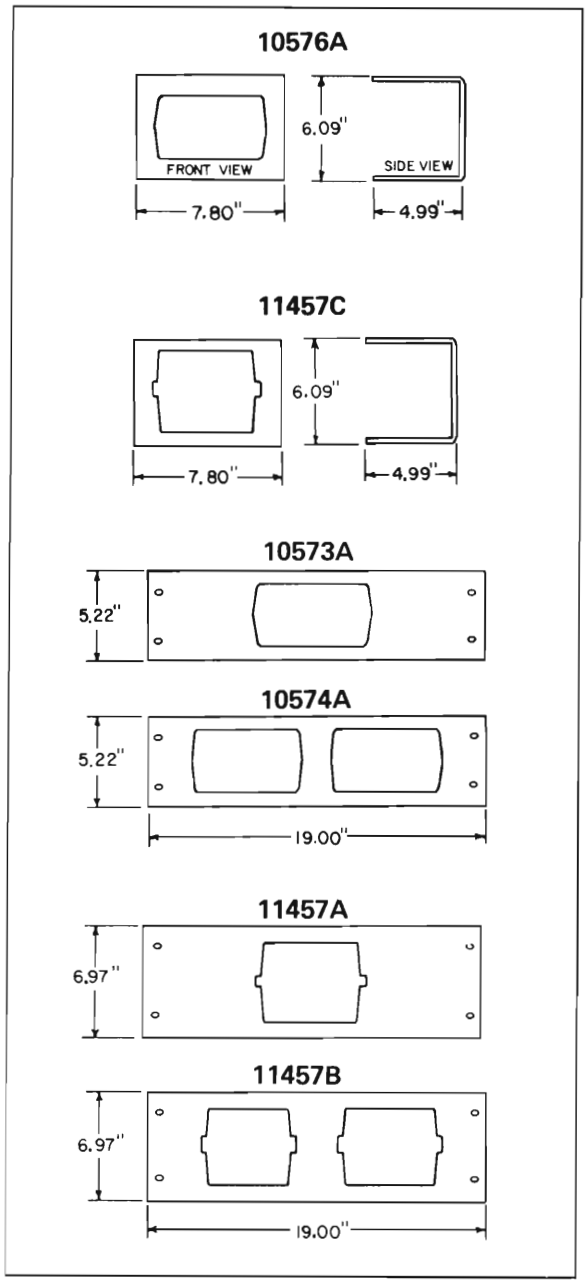


Figure 2-2. Rack Mount Kits.

2-20. If the original container is not to be used, proceed as follows:

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

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

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

2-21. POWER CORDS AND RECEPTACLES.

2-22. Figure 2-3 illustrates power receptacle (wall outlet) configurations that are used throughout the United States and in other countries. The -hp- part number shown directly below each receptacle drawing is the part number for a 34750A power cord equipped with the appropriate mating plug for that receptacle. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided. The 34750A power cord, power input receptacle and mating connectors meet the safety standards set forth by the International Electrotechnical Commission (IEC).

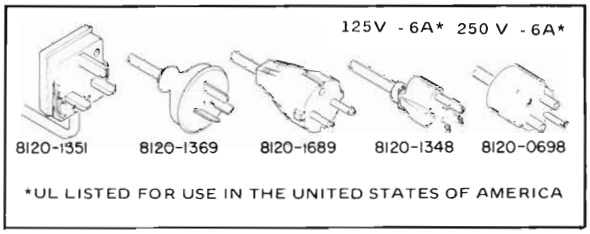


Figure 2-3. Power Receptacles.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and information which will assist you in proper operation of your Model 34750A Display Module. A signal conditioning module (Model 34701A, 34702A or 34703A) is required for proper operation of the display module.

3-3. REAR PANEL FEATURES.

3-4. The rear panel of the Model 34750A is shown in Figure 3-1.

CAUTION

DO NOT PLUG IN THE POWER CORD WITHOUT FIRST SELECTING THE PROPER LINE VOLTAGE.

3-5. WARM-UP.

3-6. A warm-up period of 1 hour is normally required for the instrument to achieve specified accuracy. The instrument should be calibrated with the bottom and center modules to be used with the instrument.

NOTE

Due to temperature change inside the instrument between line and battery operation, the + and - references must be readjusted when changing modes to achieve specified accuracy. The nominal temperature change between line and battery operation is - 15° C.

3-7. OPERATION WITH PLUG-ON MODULES.

3-8. Information regarding operation of the instrument with a plug-on module can be found in the Operating and Service Manual for the plug-on.

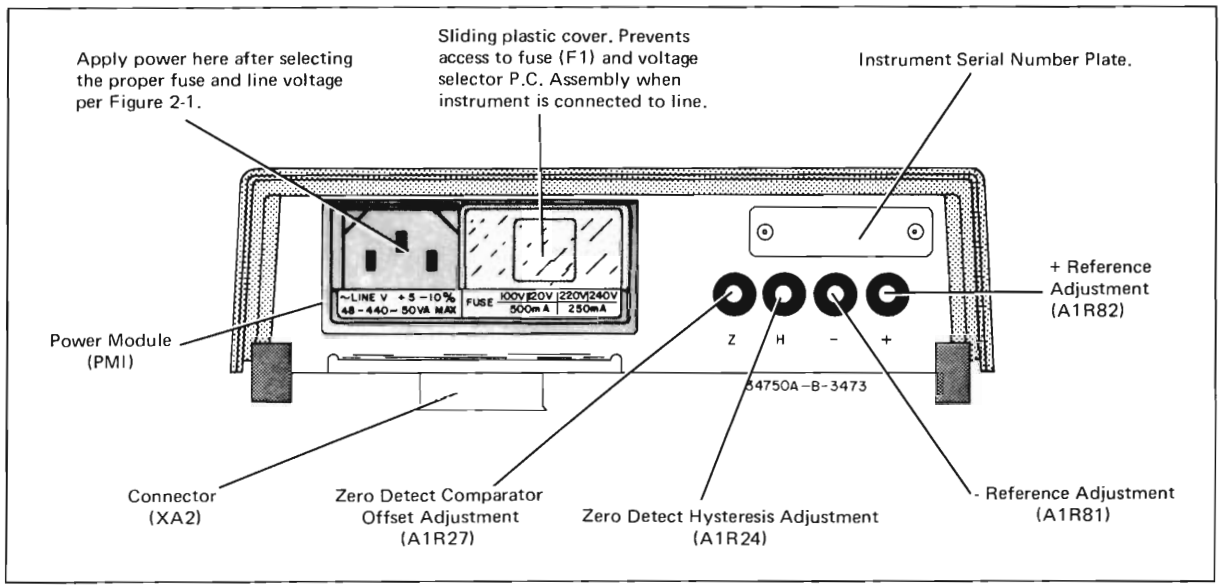


Figure 3-1. 34750A Rear Panel.

CAUTION

INSTALLATION OR REMOVAL OF PLUG-ON MODULES IS TO BE MADE BY QUALIFIED PERSONNEL ONLY.

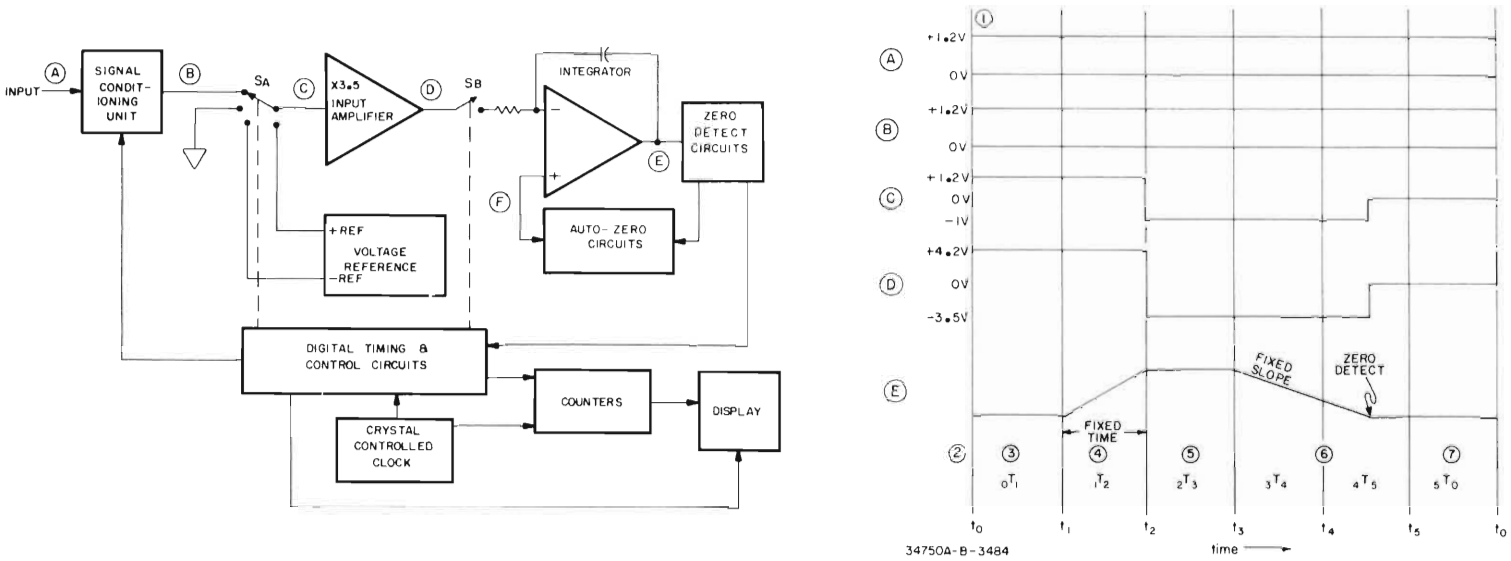


Figure 4-1. Basic Block Diagram of 34750A.

1. This measurement example is for a dc voltage of + 1.2 volts measured on the 1 volt range of an -hp- Model 34701A. For this measurement the voltage at A and B is + 1.2 volts for the entire measurement sequence.

2. Prior to t_0 (during $_5T_0$ of the previous measurement) S_A was connected to ground and S_B was closed. The Auto-Zero circuit was enabled and a voltage applied to the + input of the Integrator Amplifier (point F) that causes the voltage at E to be 0 volts. This voltage will stay at F until the Auto-Zero circuit is again enabled after the value of the input voltage has been determined.

3. At t_0, S_A is switched to the output of the signal conditioning unit and the Input Amplifier is given time to respond to its new value during $_0T_1$. S_B is open during this time interval so the output of the Integrator remains at 0 volts.

4. S_B is closed at t_1 and the Integrator output ramps to a level proportional to the input voltage during $_1T_2$.

5. The output level of the Integrator remains constant during $_2T_3$ because S_B opens at t_2. S_A is switched to one of the reference voltage positions (- Ref. for a + voltage at B) and the Input Amplifier is given time to achieve its new output level.

6. During $_3T_4$ and $_4T_5$, S_B is closed and the Integrator output ramps toward 0 volts. When zero detect occurs S_A is switched to ground and the Auto-Zero circuits are enabled. During the time interval from t_3 until zero detect occurs the output of a fixed frequency oscillator is counted. The counts accumulated during this time interval are transferred to storage buffers and displayed as measured result on the front panel.

7. The auto-zero cycle begins at zero detect. Zero detect can occur as late as t_5. The time interval $_5T_0$ provides adequate time for the Auto-Zero circuits to complete the auto-zero cycle.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The 34750A Display is a five-digit analog-to-digital converter that utilizes the dual slope integrating technique and a LED (light-emitting diode) display. The 34750A is designed to operate with a signal-conditioning "Plug-On Module". The signal-conditioning unit converts the input signal to a dc voltage between ± 2 volts (± 1 volt full scale + 100 % overrange) which is measured and displayed by the 34750A. A Basic Block Diagram of the 34750A (Figure 4-1) will be discussed in this section followed by a more detailed description of these blocks and the circuits involved.

4-3. Basic Measurement Sequence.

4-4. The dual slope integrating measurement technique employed by the 34750A is described with waveforms and a timing sequence in Figure 4-1. Each measurement sequence is divided into six time intervals of equal length. Figure 4-1 shows the designations that will be used to identify the beginning of each time interval, the time intervals and a description of the measurement cycle.

4-5. ANALOG CIRCUITS.

4-6. Input Amplifier.

4-7. A stable gain of +3.5 is provided by the Input Amplifier (see Figure 4-2). Only one of the FET switches Q1 through Q4 is conducting at a time to provide an input to the amplifier. Bias current is minimized by the FET input stage of the amplifier. Adjustment R8 sets the output at TP1 to 0 V with point 1 grounded. The FET Bias Network is discussed in Note 1 of Figure 4-2.

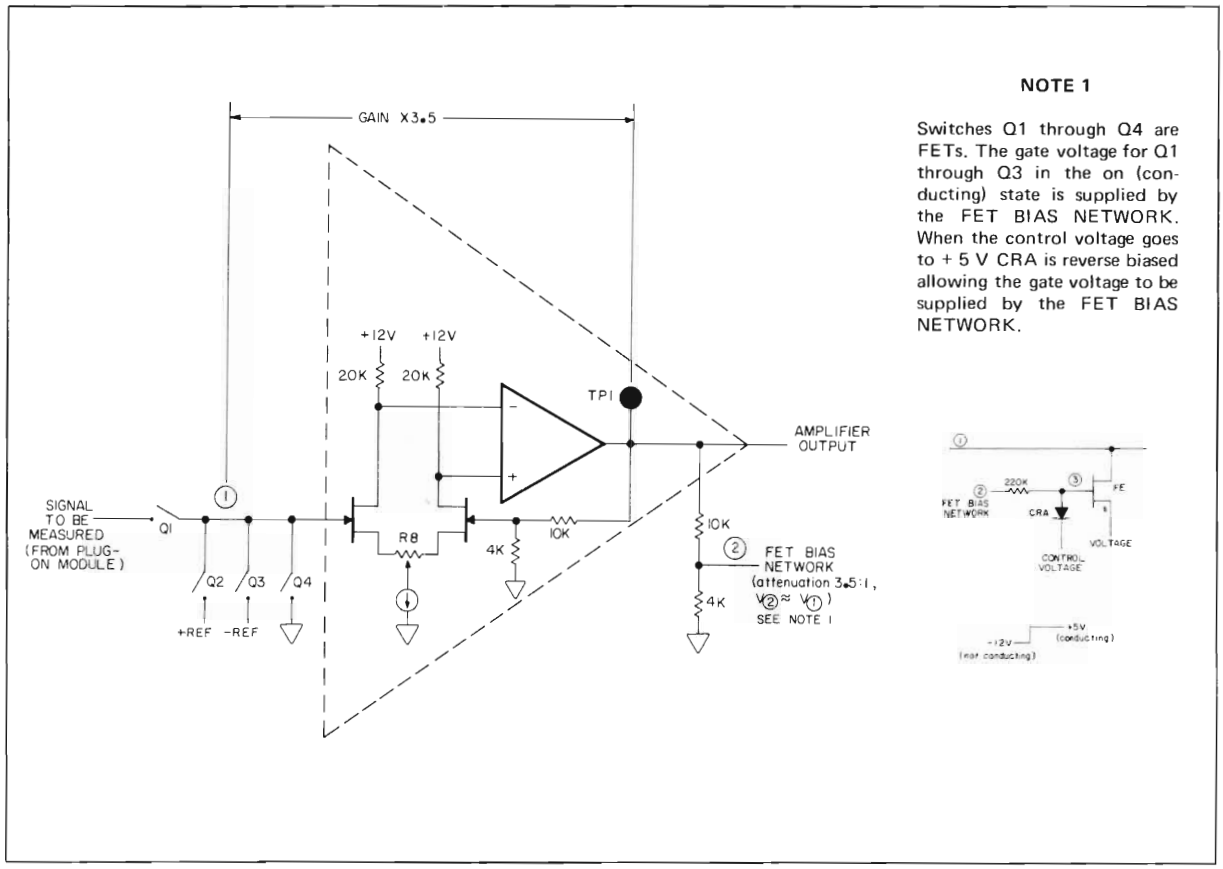


Figure 4-2. Simplified Diagram of the Input Amplifier.

4-8. Integrator.

4-9. The Integrator utilizes a high gain amplifier and a FET input stage to minimize the input current required by the amplifier. A simplified diagram of the Integrator is shown in Figure 4-3. Switch Q6 enables the Integrator during a measurement cycle. FET switch Q13 conducts during the auto-zero cycle to speed up the circuit response during auto-zero. This rapid response is required to quickly recover from overload conditions. The Auto-Zero feedback voltage for the Integrator and the Slope Amplifiers is stored on the Auto-Zero Capacitor. This voltage is applied to the gate of Q7B during the measurement cycle. The auto-zero cycle is discussed in more detail in Paragraph 4-12.

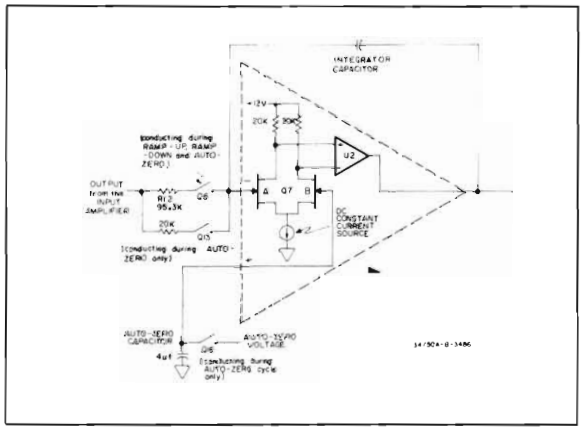


Figure 4-3. Simplified Diagram of the Integrator Circuit.

4-10. Zero Detect Circuits.

4-11. The Zero Detect circuits consist of two amplifiers, each with a gain of 10, and a high gain comparator shown in Figure 4-4. The second amplifier has diode clamps between its output and the inverting input to prevent amplifier saturation. Depending on the polarity of the input at point 1 with respect to point 2 the Comparator output is either + 3 V or 0 V*. The polarity of the voltage at point 2 is determined by the output of the Input Amplifier. At zero detect the Integrator output passes through 0 V. This causes the signal at point 1 to momentarily swing to the polarity opposite that at point 2. Accordingly, the Comparator Amplifier output switches to the level opposite the one that it previously held (i.e. + 3 V to 0 V or 0 V to + 3 V). Adjustments R24 and R27 are used to calibrate the instrument for small input voltages.

4-12. Auto-Zero Cycle.

4-13. Figure 4-5 shows the 34750A circuits in the auto-zero mode. FET switch Q13 is conducting, which speeds up the recovery of the Integrator to a 0 volt output level (this is important when recovery from overload is required). When Q16 conducts the voltage on the Auto-Zero Capacitor becomes equal to the offset at point 2 with point 1 grounded. After the auto-zero cycle, Q13 and Q16 do not conduct until the next auto-zero cycle. The voltage acquired on the Auto-Zero Capacitor during the auto-zero cycle remains as offset compensation for the rest of the measurement cycle.

4-14. DIGITAL PROCESSING CIRCUITS.

4-15. The Model 34750A Digital Processing Circuits comprise an Algorithmic State Machine (ASM). Figure 4-6 shows a typical simplified block diagram of an ASM. The ASM is a sequential logic circuit that can be described completely with a flow chart. The "Next State Function" and "Output Function" blocks are combinational logic networks. A combinational network is a

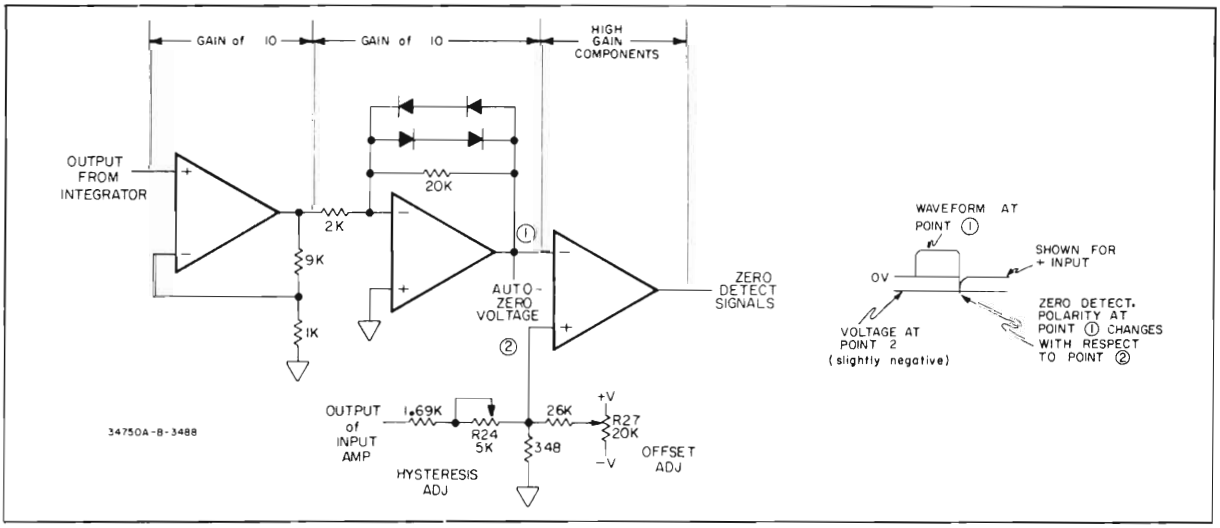


Figure 4-4. Simplified Diagram of Zero Detect Circuits.

* The Comparator Amplifier is clamped internally to prevent it from swinging to the + and - power supply voltages.

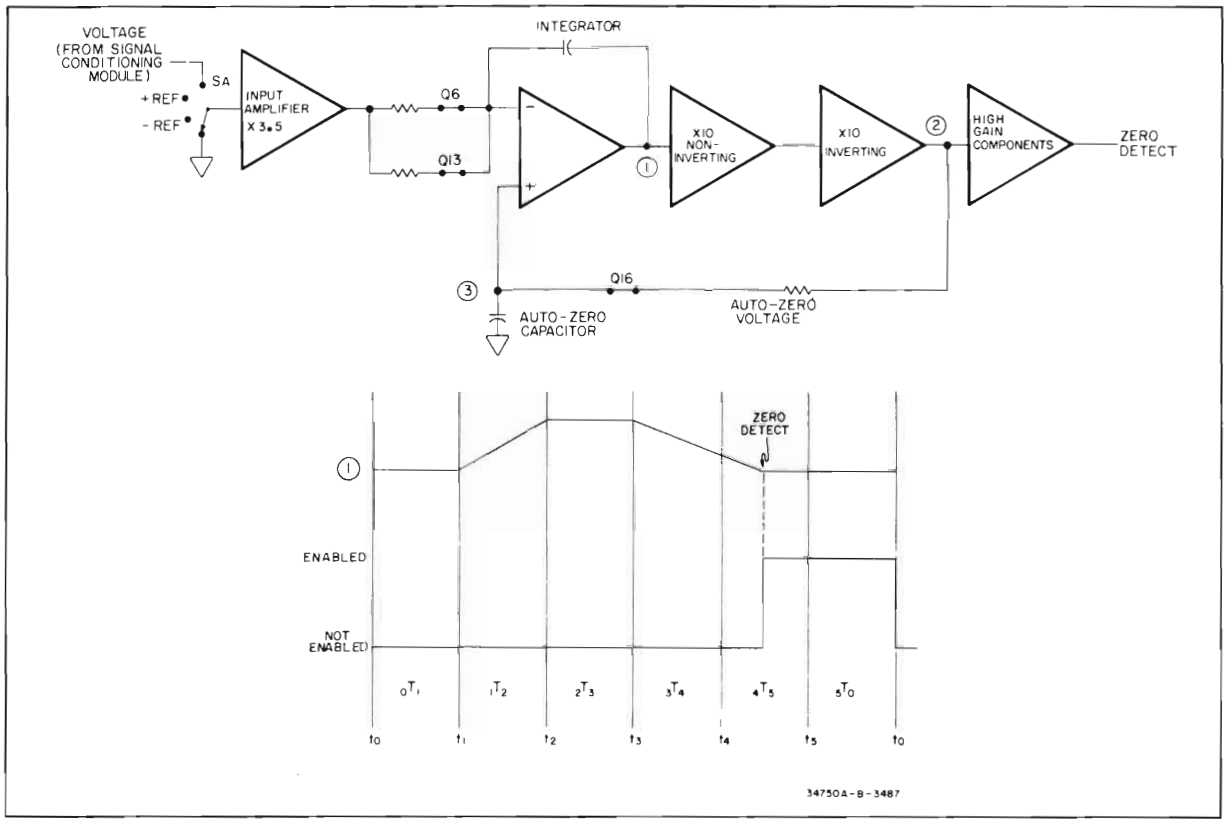


Figure 4-5. 34750A Circuits shown in Auto-Zero Mode.

logical network whose output is completely determined by its present input states. Sequential logic circuits contain memory or storage elements such as flip-flops. As the circuits operate the state of the memory changes. The memory elements may have one state at first and later take on another state. The "Next State" that the memory goes to is dependent on the "Present State", the Clock and the external inputs that are supplied to the logic circuit. The output is dependent on the external inputs and the "Present State" of the memory. The "Present State" of the memory is dependent on the past sequence of inputs that have been applied.

4-16. The Algorithmic State Machine (ASM). The State Machine in the Model 34750A is shown in Figure 4-7 in block form. The inputs to the State Machine come from the Analog Circuits and the plug-on modules. The output consists of the Data Display of the instrument and logic signals which are applied to the various plug-on modules.

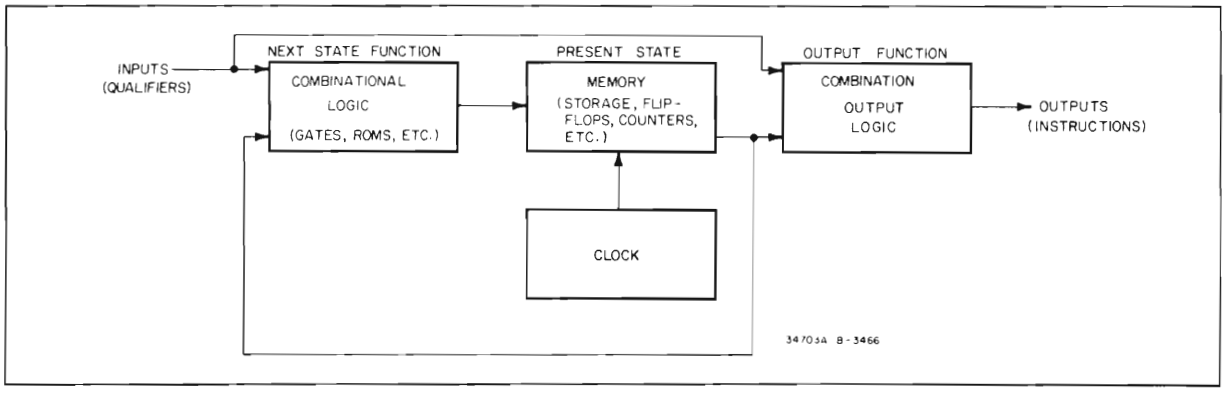


Figure 4-6. Block Diagram of Typical ASM.

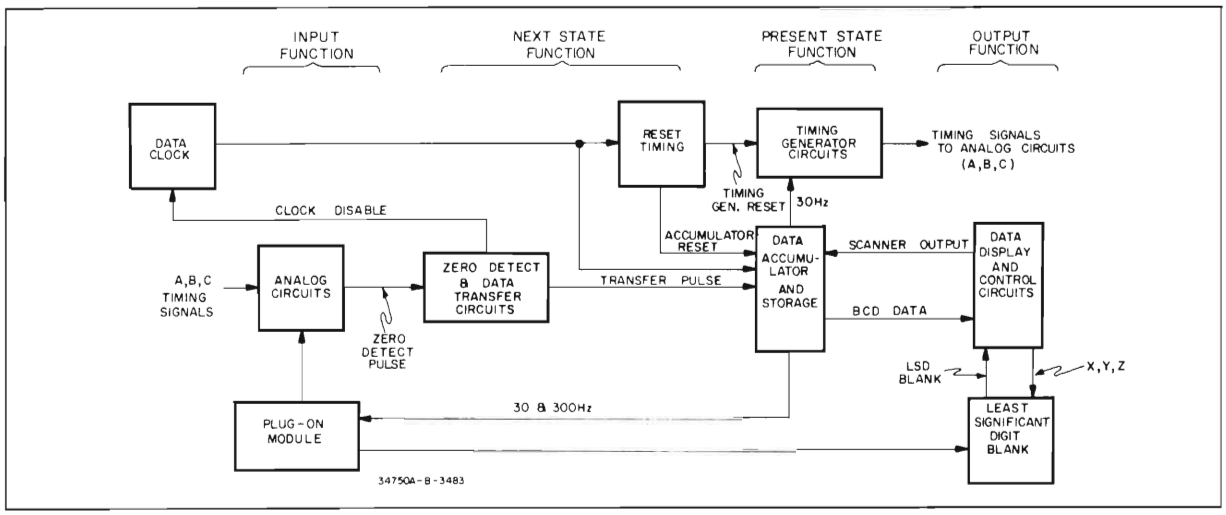


Figure 4-7. ASM Simplified Block Diagram.

4-17. Data Clock (Refer to Figure 4-8).

4-18. The Data Clock generates controlled pulses to which the timing of the analog to digital converter of the Model 34750A is synchronized.* Its frequency is determined by Crystal Y1. The crystal output is amplified by two inverting amplifiers (U6). The output of these amplifiers is then applied to the crystal to sustain oscillations. Buffer U7 is a unity gain amplifier which isolates the clock circuit and prevents loading of the clock by the external circuitry.

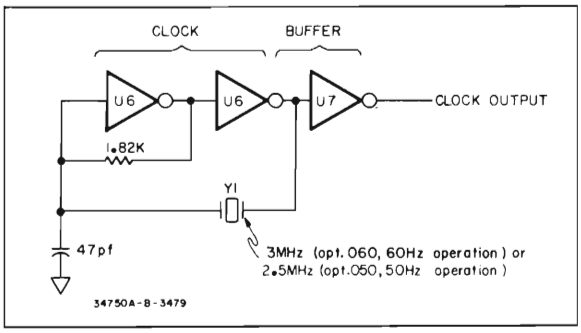


Figure 4-8. Data Clock.

4-19. Timing Generator Circuit (See Figure 7-8).

4-20. The Timing Generator consists of three D flip-flops which generate signals A, B and C. Signal A is used to generate signal B, and signal B is used to generate signal C. The inverse of signal C (i.e., $\overline{C}$) is then used to produce signal A (via gates U16 and U8). The various combinations of signals A, B and C determine the "State Codes" of the instrument timing. Figure 4-9 shows the timing relationships for the Timing Generator and provides a flow chart indicating the sequence in which events occur within the instrument. State Codes 101 and 010 are illegal and will be entered only if caused to do so by transient pulses generated when the instrument is turned on. If an illegal state is entered, the Timing Generator flip-flops will be cleared on the next reset pulse. This sets the instrument to state 000, at which time an auto-zero cycle occurs. The timing sequence then continues in its normal fashion.

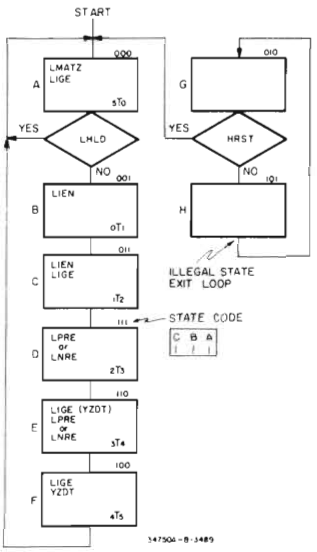
4-21. Zero Detect and Data Transfer Circuits (Refer to Figure 4-10).

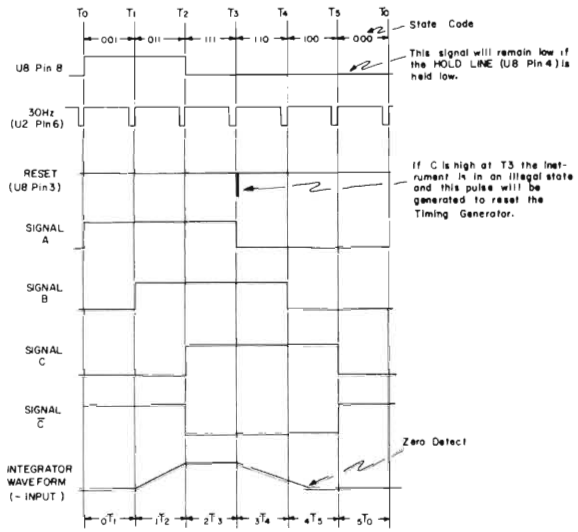
4-22. The Zero Detect circuits generate a voltage transistion when the integrator waveform reaches approximately 0 V. The polarity of the transistion is determined by the polarity of the input. This pulse is then used by the Data Transfer circuits to initiate the following sequence of events:

> The polarity of voltage on the D input of Flip-Flop U18 during input enable determines whether the flip-flop is set or reset. If a negative voltage is connected to the 34750A input, the Q output of the flip-flop is high (>3 V). The zero detect pulse, in this instance, is a negative transistion. For a positive input the $\overline{Q}$ output of the flip-flop is high and the zero detect pulse is a positive transistion. If the Q output is high the + Reference Gate is enabled. If $\overline{Q}$ is high the - Reference Gate is enabled. The zero detect pulse is applied to the Zero Detect Gates. These gates generate a positive going transistion regardless of the polarity of the Zero Detect Pulse. Normally, oscillations occur on the Zero Detect waveform after the initial transistion at zero detect. The Zero Detect Catcher is a flip-flop which responds to only

* This does not include the scanning system which has its own clock.

the first transistion of the positive pulse from the zero detect gates. It provides a negative going pulse to the Data Transfer Timing circuits. The Data Transfer Timing circuits inhibit the main clock during the period of data transfer within the Data Accumulator. The Transfer Timing Waveforms in Figure 4-10 show the relationship between the Data Clock Disable pulse and the Transfer Pulse. The length of the Data Clock Disable pulse is set by the time constant of C23 and R52. The length of the Transfer pulse is set by the time constant of C26 and R53. Since the time constant of C23 and R52 is larger than that for C26 and R53 the Data Clock Disable pulse remains low for a longer period than the Transfer Pulse. This prevents the Data Clock from altering the count in the Data Accumulator during a transfer cycle.





A. State 000
   1. Mainframe auto-zero cycle occurs (LMATZ).
   2. Integrator enabled.
   3. Cycle in auto-zero if "Hold" line is low.

B. State 001
   1. Input enabled (LIEN).
   2. Integrator disabled.

C. State 011
   1. Input enabled (LIEN).
   2. Integrator enabled (LIGE) starts run-up.
   3. Polarity of input determined.

D. State 111
   1. Input disabled.
   2. Integrator disabled.
   3. Proper reference voltage selected (LNRE or LPRE).
      a. - reference selected for + input.
      b. + reference selected for - input.

E. State 110
   1. Input disabled.
   2. Reset for about 128 counts ($\approx$40 μs).
   3. Integrator enabled and run-down begins.
   4. Proper reference voltage enabled (LNRE or LPRE).
   5. Zero Detect Catcher enabled. Zero detect during this interval causes the following events to occur:
      a. Data Clock Disable pulse generated.
      b. Transfer pulse occurs.
      c. Reference voltage disabled.
      d. Auto-Zero Cycle begins.

F. State 100
   1. Input disabled.
   2. Integrator enabled and run-down continues.
   3. Proper reference voltage enabled.
   4. Overrange "1" illuminated.
   5. Zero Detect Catcher enabled. Zero detect during this interval causes the following events to occur:
      a. Data Clock Disable pulse generated.
      b. Transfer pulse occurs.
      c. Reference voltage disabled.
      d. Auto-Zero Cycle begins.

G&H. States 010 and 101
These are illegal states and are not normally entered. If the instrument enters an illegal state, it cycles through states 010 and 101 until the reset pulse occurs. At reset, the Timing Generator is cleared to state 000 and a normal measurement cycle begins.

Figure 4-9. 34750A Flow Chart.

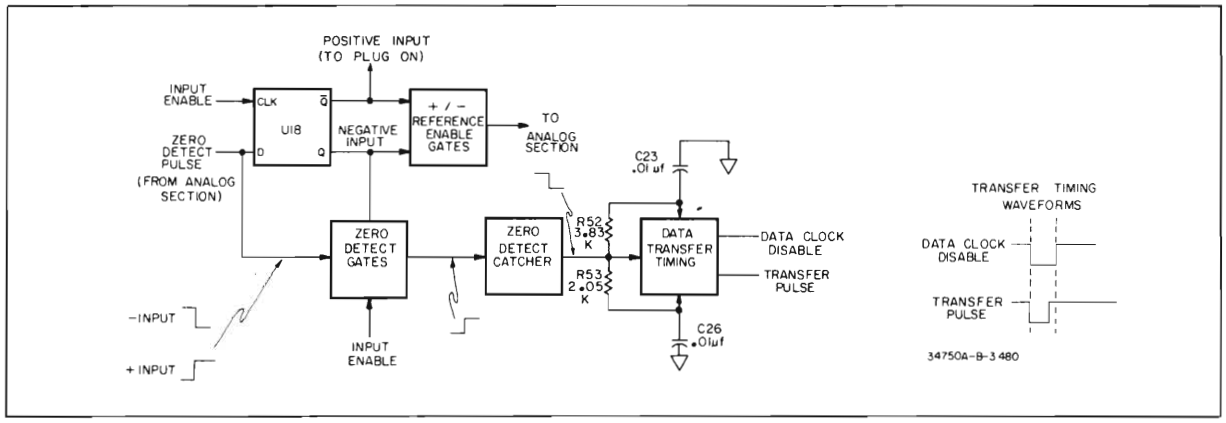


Figure 4-10. Zero Detect and Data Transfer Timing.

4-23. Data Accumulator and Storage (Refer to Figure 7-7).

4-24. The Data Accumulator counts pulses from the Data Clock starting at the beginning of run-down (T3 on Figure 4-9) and continuing until zero detect. The Data Accumulator reset pulse is generated at the beginning of run-down. This pulse resets the 5 decades of the Data Accumulator Counter. At zero detect the Transfer Pulse goes low and the Data Clock is inhibited. Each decade of the accumulated count is then transferred in 8421 parallel BCD form to storage elements within the Data Accumulator. This data is then scanned a decade at a time by signals X, Y and Z, and applied to the BCD output lines.

4-25. Data Display and Control Circuits (Refer to Figure 4-11).

4-26. The Data Scanner controls the timing of the Display circuits. Signal X occurs at a 3 kHz rate. Signals Y and Z occur at a 1.5 kHz rate. Scanner clock and

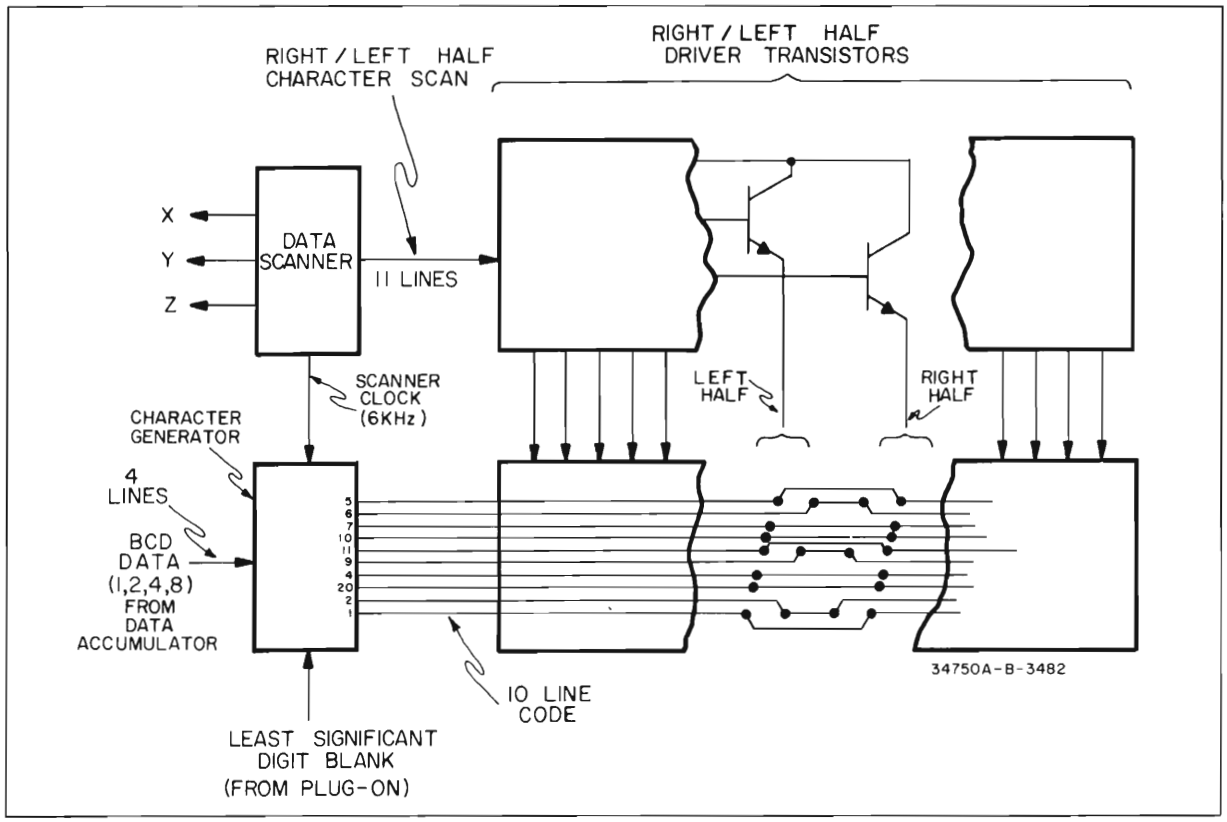


Figure 4-11. Data Display Circuits.

Right Half/Left Half character scan occur at a 6 kHz rate. The BCD data from the Data Accumulator is converted to a 10 line code. The desired lines go low (ground) when selected, providing a ground path for current through the Right Half/Left Half Driver Transistors and the LED chips connected to the lines. Each character is individually scanned beginning with the least significant and proceeding to the most significant (right to left as you face the instrument). Each character is also divided into a left and right half. The selected LED's of the right half are illuminated first followed by those of the left half.

4-27. Reset Timing (See Figure 4-12).

4-28. The Reset Timing circuits generate a reset pulse at the beginning of run-down (T3) in the measurement cycle. When signal "A" goes low the ÷ 32 counter (U12) is reset causing Pin 2 of U8 to go low and pin 1 to go high. This initiates the Reset Pulse and enables the flip-flops in the ÷ 4 counter (U11). Figure 4-12 shows the timing relationship of the reset pulse to signal A of the Timing Generator. The Data Clock is divided by a factor of 128 (4 x 32). Pin 2 of U8 goes high after approximately 128 counts of the Data Clock causing Pin 1 of U8 to go low. This completes the reset sequence for one measurement cycle.

4-29. Least Significant Digit Blank (Refer to Figure 7-7).

4-30. Depending upon the signal conditioning module used it is sometimes necessary to blank the last digit of the Model 34750A. This is accomplished by grounding Pin 12 of the character generator during the time the least significant digit is scanned. Two "Nor" Gates (U13) and one "Nand" Gate (U14) are used to do this. As indicated on the schematic diagram, all inputs to the Nor Gates (Pins 5, 6, 9 and 8) must be low in order to obtain a low at Pin 11 of U14. A low at Pin 11 of U14 will blank the digit.

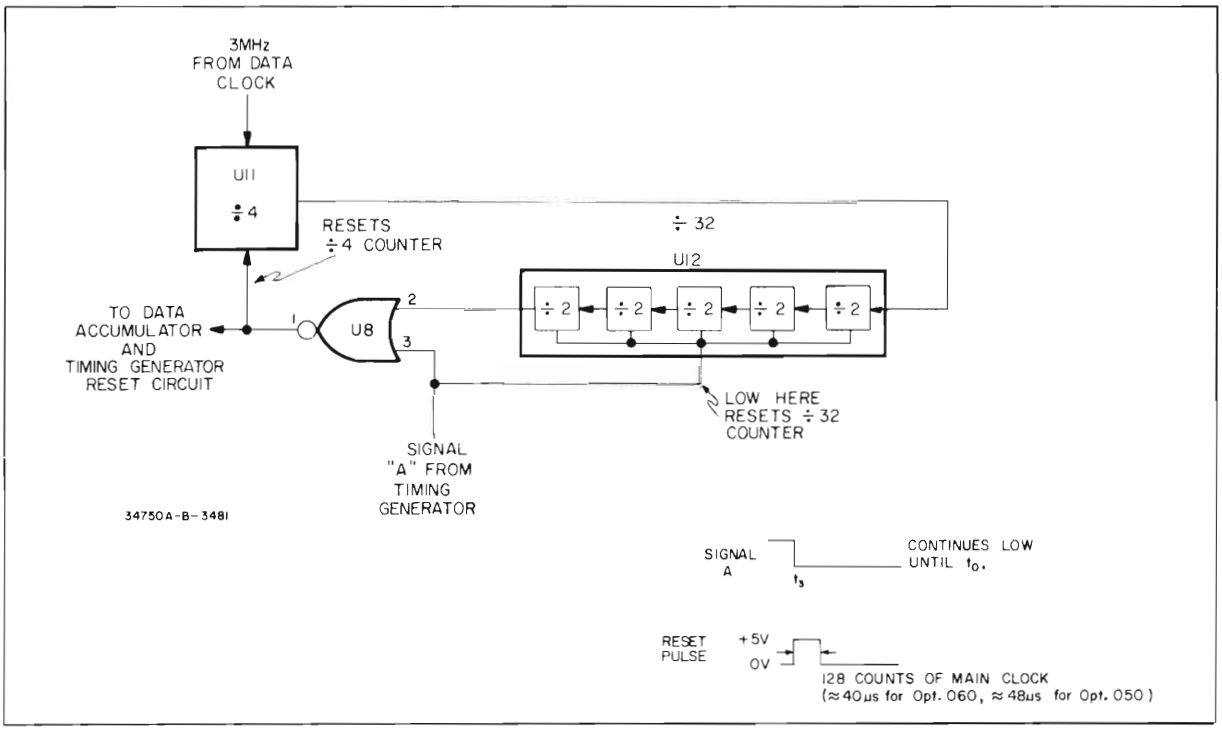


Figure 4-12. Reset Timing.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. Operational checks and Adjustment Procedures for the Model 34750A are contained in this section of the manual. Performance tests relating to the operation of a 34750A and a plug-on module are contained in the manual for the plug-on module (34701A, 34702A or 34703A).

CAUTION

INSTALLATION OR REMOVAL OF PLUG-ON MODULES IS TO BE MADE BY QUALIFIED PERSONNEL ONLY.

5-3. OPERATIONAL CHECKS.

5-4. The following checks will assist in determining if your instrument is functioning correctly. These tests are not intended to check instrument specifications.

Figure 5-1. 11456A Readout Test Card.

5-5. Connect an 11456A Readout Test Card to the model 34750A as shown in Figure 5-1. Use a short clip lead to make the required connections listed in Table 5-2. and compare the test results with those indicated.

5-6. ADJUSTMENT PROCEDURE.

5-7. Paragraphs 5-12 through 5-16 are adjustment procedures for the Model 34750A Display. These procedures require the use of a 34701A, 34702A or 34703A plug-on module. We recommend that these procedures be performed only if the performance checks show that the instrument does not meet its specifications. If the instrument cannot be adjusted to meet its specifications, refer to Troubleshooting (Paragraph 7-3) in Section VII. Table 5-1 lists test equipment recommended for the adjustment procedures and troubleshooting.

WARNING

DISCONNECT THE POWER CORD BEFORE REMOVING THE COVERS.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Specifications	Recommended Model
DC Digital Voltmeter	4 digit resolution Accuracy: ± (.03 % of reading + 0.01 % of range)	-hp- Model 34740A
DC Standard	1 V Range Accuracy: ± (0.002 % of setting + 0.0004 % of range)	-hp- Model 740B

Table 5-2. Operational Checks.

Connections on 11456A Assembly	Display Expected	Refer to the following Areas of the Manual if the Correct Display is not Obtained.
Input Pin to + Ref.	+ 1.00000 (± 2 counts)	Paragraph 5-16, Figure 7-3
Input Pin to - Ref.	- 1.00000 (± 2 counts)	Paragraph 5-16, Figure 7-3
DP1 to GND3	XXX.XX	Figure 7-3
DP2 to GND3	XX.XXX	Figure 7-3
DP3 to GND3	X.XXXX	Figure 7-3
DP4 to GND3	.XXXXX	Figure 7-3
	NOTE X represents any digit between 0 and 9.	

5-8. Cover Removal.

5-9. In order to perform two of the adjustments in this section, it will be necessary to obtain access to the interior of the instrument. If your Display Module is connected to a plug-on module separate the two modules by pulling the slide lock levers, shown in Figure 3-1, to the rear and lifting the Display Module from the plug-on module. The 34750A Cover can then be removed by unscrewing a mounting bolt near the transformer (see Figure 5-2) and spreading apart two sets of plastic fingers which hold the Display printed circuit assembly in place. The printed circuit (p.c.) assembly is covered by a black metal shield which must also be removed. This is accomplished by unscrewing the four bolts holding it in place and lifting it off the p.c. assembly. Connect a plug-on module to the 34750A and apply power.

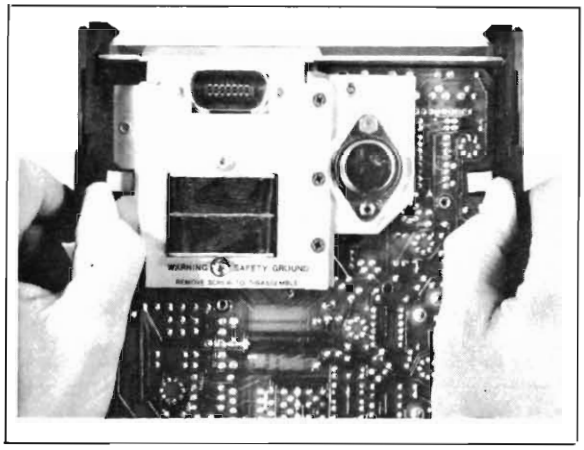


Figure 5-2. Cover Removal.

WARNING

A NUMBER OF BRASS TERMINALS EXTEND FROM THE POWER MODULE (PMI) INTO THE INSTRUMENT. (SEE FIGURE 5-4). A PLASTIC COVER HAS BEEN PLACED OVER THE TERMINALS TO PREVENT ELECTRICAL SHOCK WHEN WORKING IN THE AREA OF THE POWER MODULE. EXTREME CARE SHOULD BE EXERCISED, PARTICULARLY IF THIS COVER IS REMOVED, TO AVOID CONTACT WITH THE TERMINALS. THIS WARNING APPLIES WHENEVER THE INSTRUMENT IS CONNECTED TO THE POWER LINE.

5-10. Adjustment Locator.

5-11. Figure 5-4. shows the location of all adjustments within the Model 34750A.

NOTE

The following procedures require a properly functioning plug-on module. Refer to the Operating and Service manual of the associated plug-on module if it appears to be malfunctioning.

5-12. Power Supply Adjustment.

a. Connect a dc voltmeter (-hp- Model 34740A/34701A or equivalent) between A1GND1 and the cathode of A1CR25.

b. Observe the voltmeter and adjust A1R69 for +12 V ± 10 mV.

5-13. INPUT AMP. OFFSET ADJUSTMENT.

a. Connect TP4 of the A1 assembly to GND1.

b. Connect a digital voltmeter (-hp- Model 34740A/34701A or equivalent) to TP1, using GND1 as reference, and adjust A1R8 for 0 V ± 1 mV.

NOTE

Before proceeding, all covers removed in Paragraph 5-8 should be reinstalled. The instrument should then be allowed to warm up for approximately 2 hours. See Paragraph 3-5 for information on instrument warm-up time.

5-14. ZERO DETECT COMPARATOR OFFSET.

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

b. Set the plug-on module to the 1000 V range and the DC STANDARD for a .20000 V output. (If a Model 34703A plug-on is used, set it for "MANUAL" operation.) Note the indication of the voltmeter display.

c. Invert the input and again observe the display. If the indications in steps b and c do not agree, adjust the "Z" (ZERO) control on the rear panel until the display indication for both polarities is the same.

5-15. ZERO DETECT HYSTERESIS ADJUSTMENT.

a. With the instruments connected and set as in Paragraph 5-14, adjust the "H" Hysteresis on the rear panel to give a display indication of 20 counts.

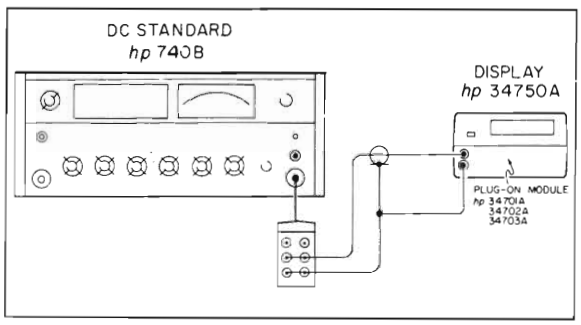


Figure 5-3. Zero Detect Comparator Offset Adjustment.

5-16. REFERENCE VOLTAGE ADJUSTMENTS.

a. Apply + 1.00000 V to the plug-on module input from the DC STANDARD. The plug-on module should be set to the 1 V range.

b. Adjust the "+" control on the rear panel of the instrument for + 1 V ± 1 count.

c. Apply - 1.00000 V to the Model 34750A input from the DC STANDARD.

d. Adjust the "-" control on the rear panel of the instrument for - 1 V + 1 count.

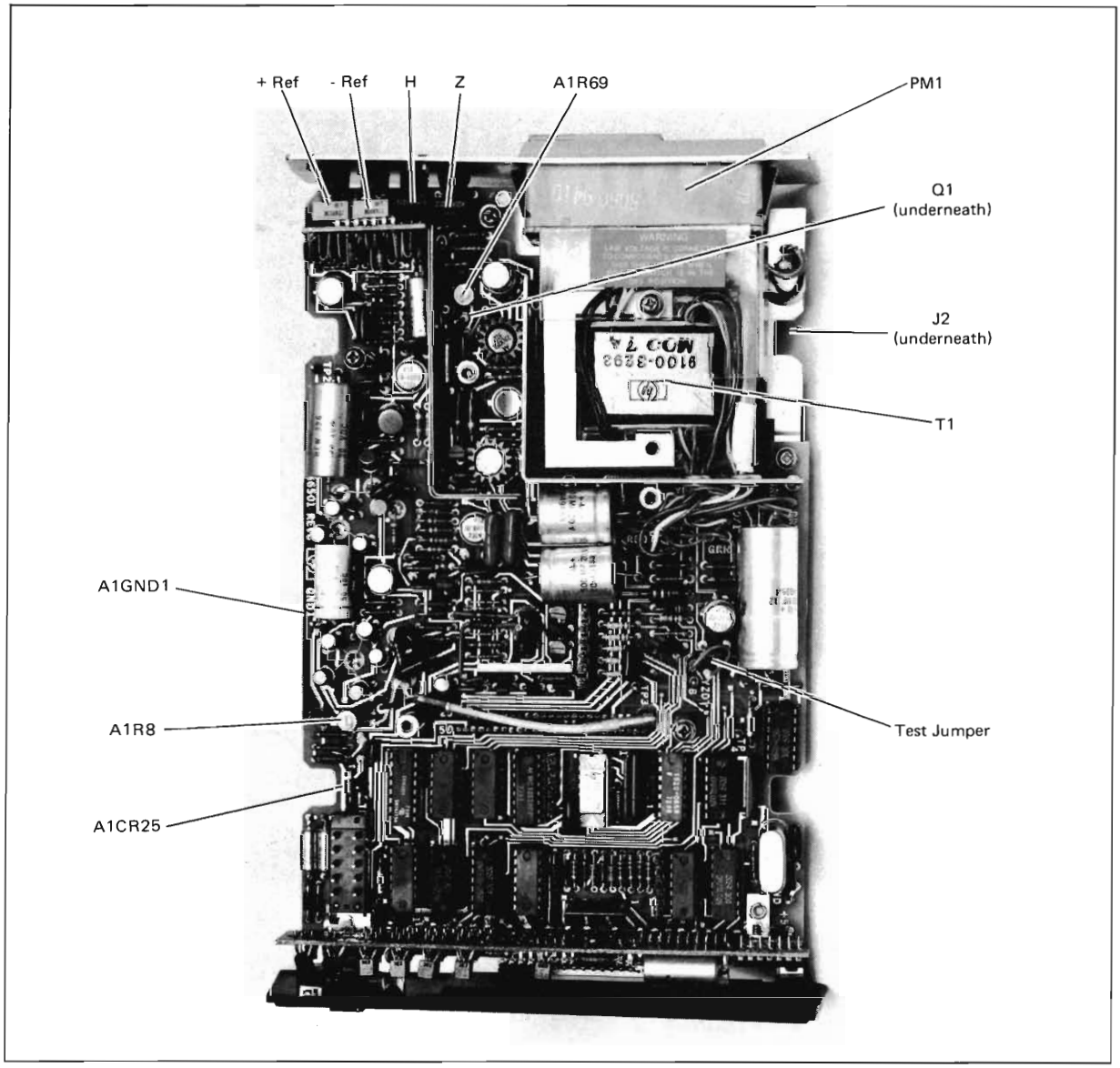


Figure 5-4. Chassis Mounted Component and Adjustment Locator.

ABBREVIATIONS

Ag . . . silver
Al . . . aluminum
A . . . ampere(s)
Au . . . gold

C . . . capacitor
cer . . . ceramic
coef . . . coefficient
com . . . common
comp . . . composition
conn . . . connection

dep . . . deposited
DPDT . . . double-pole double-throw
DPST . . . double-pole single-throw

elect . . . electrolytic
encap . . . encapsulated

F . . . farad(s)
FET . . . field effect transistor
fxd . . . fixed

GaAs . . . gallium arsenide
GHz . . . gigahertz = 10^{+9} hertz
gd . . . guard(ed)
Ge . . . germanium
gnd . . . ground(ed)

H . . . henry(ies)
Hg . . . mercury

Hz . . . hertz (cycle(s) per second)

ID . . . inside diameter
impg . . . impregnated
incd . . . incandescent
ins . . . insulation(ed)

kΩ . . . kilohm(s) = 10^{+3} ohms
kHz . . . kilohertz = 10^{+3} hertz

L . . . inductor
lin . . . linear taper
log . . . logarithmic taper

mA . . . milliampere(s) = 10^{-3} amperes
MHz . . . megahertz = 10^{+6} hertz
MΩ . . . megohm(s) = 10^{+6} ohms
met flm . . . metal film
mfr . . . manufacturer
ms . . . millisecond
mtg . . . mounting
mV . . . millivolt(s) = 10^{-3} volts
μF . . . microfarad(s)
μs . . . microsecond(s)
μV . . . microvolt(s) = 10^{-6} volts
my . . . Mylar®

nA . . . nanoampere(s) = 10^{-9} amperes
NC . . . normally closed
Ne . . . neon
NO . . . normally open

NPO . . . negative positive zero (zero temperature coefficient)
ns . . . nanosecond(s) = 10^{-9} seconds
nsr . . . not separately replaceable

Ω . . . ohm(s)
obd . . . order by description
OD . . . outside diameter

p . . . peak
pA . . . picoampere(s)
pc . . . printed circuit
pF . . . picofarad(s) 10^{-12} farads
piv . . . peak inverse voltage
p/o . . . part of
pos . . . position(s)
poly . . . polystyrene
pot . . . potentiometer
p-p . . . peak-to-peak
ppm . . . parts per million
prec . . . precision (temperature coeffient, long term stability and/or tolerance)

R . . . resistor
Rh . . . rhodium
rms . . . root-mean-square
rot . . . rotary

Se . . . selenium
sect . . . section(s)
Si . . . silicon

sl . . . slide
SPDT . . . single-pole double-throw
SPST . . . single-pole single-throw

Ta . . . tantalum
TC . . . temperature coefficient
TiO_2 . . . titanium dioxide
tog . . . toggle
tol . . . tolerance
trim . . . trimmer
TSTR . . . transistor

V . . . volt(s)
vacw . . . alternating current working voltage
var . . . variable
vdcw . . . direct current working voltage

W . . . watt(s)
w/ . . . with
wiv . . . working inverse voltage
w/o . . . without
ww . . . wirewound

* . . . optimum value selected at factory, average value shown (part may be omitted)
** . . . no standard type number assigned selected or special type

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

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

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

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

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

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

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; i.e. Δ, Δ with a letter subscript, e.g. Δ_a, or Δ with a number subscript e.g. Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section 8). The number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

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

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	34750-66501	1	BOARD ASSY:MAIN (INCLUDES A2)	28480	34750-66501
A1C1	0140-0204	3	C:FXD MICA 47PF 500V	72136	DM15E470J0500WV1CR
A1C2	0160-2207	2	C:FXD MICA 300 PF 5%	28480	0160-2207
A1C3	0160-2204		C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A1C4	0160-3622	10	C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C5	0140-0204	2	C:FXD MICA 47 PF 5% NPO 500VDCW	14655	RDM15E470J5C
A1C6	0160-2199	2	C:FXD MICA 30 PF 5% 300VDCW	28480	0160-2199
A1C7	0150-0045	1	C:FXD TI 8.2 PF 5% 500VDCW	78488	TYPE GA
A1C8	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C9	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C10	0160-4025	1	C:FXD 0.33 UF 10%	28480	0160-4025
A1C11	0160-2207		C:FXD MICA 300 PF 5%	28480	0160-2207
A1C12	0160-3501	1	C:FXD POLY 4 UF 10% 50VDCW	84411	HEW 138
A1C13	0160-0820	1	C:FXD CER 0.05 UF +80-20% 25VDCW	72982	5855 Y5U 5G3Z
A1C14	0150-0050	2	C:FXD CER 1000 PF +80-20% 1000VDCW	56289	CG67B102E102ZS26-CDH
A1C15	0180-1794	1	C:FXD ELECT 22 UF 10% 35VDCW	56289	150D226X9035R2-DYS
A1C16	0160-2199		C:FXD MICA 30 PF 5% 300VDCW	28480	0160-2199
A1C17	0160-3077	2	C:FXD MY 0.027 UF 10% 100VDCW	56289	225P2739WB1-PWM
A1C18	0160-3077		C:FXD MY 0.027 UF 10% 100VDCW	56289	225P2739WB1-PWM
A1C19	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C21	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C22	0140-0204		C:FXD MICA 47 PF 5% NPO 500VDCW	14655	RDM15E470J5C
A1C23	0160-3847	2	C:FXD CER 0.01 UF +100-10% 25VDCW	72982	8005-Q1ACB-W5R-1C3P
A1C24	0180-1701	2	C:FXD ELECT 6.8 UF 20% 6VDCW	28480	0180-1701
A1C25	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C26	0160-3847		C:FXD CER 0.01 UF +100-10% 25VDCW	72982	8005-Q1ACB-W5R-1C3P
A1C27	0140-0200	1	C:FXD MICA 390 PF 5%	72136	RDM15F391-J3C
A1C28	0180-0229	1	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A1C29	0160-0362		C:FXD MICA 510 PF 5%	28480	0160-0362
A1C31	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C32	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C33	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C34	0180-0228	2	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1C35	0180-0465	2	C:FXD 500 UF 30VDCW	28480	0160-4080
A1C36	0180-0465		C:FXD 500 UF 30VDCW	28480	0160-4080
A1C37	0180-0228		C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1C38	0160-3622		C:FXD CER 0.1 UF +80-20% 100VDCW	72982	8131-100-651-104Z
A1C39	0180-0466	1	C:FXD 2200 UF 15VDCW	28480	0160-4081
A1C41	0150-0050		C:FXD CER 1000 PF +80-20% 1000VDCW	56289	CC67B102E102ZS26-CDH
A1C42	0180-1701		C:FXD ELECT 6.8 UF 20% 6VDCW	28480	0180-1701
Δ_b A1C43	0160-4095		C:FXD .5 PF 500V	95275	VY13COR5B
A1CR1, 2	1901-0040	10	DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR3	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR4	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR5	1901-0376	3	DIODE:SILICON 35V	28480	1901-0376
A1CR6	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR7	1902-0041	2	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A1CR8	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR9	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR10	1901-0586	1	DIODE:SI 30 WV 10 PA LEAKAGE	28480	1901-0586
A1CR11	1901-0376		DIODE:SILICON 35V	28480	1901-0376
A1CR12	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR13	1901-0376		DIODE:SILICON 35V	28480	1901-0376
A1CR14	1902-0048	3	DIODE:BREAKDOWN 6.81V 5%	04713	SZ10939-134
A1CR15	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR16	1901-0040		DIODE:SILICON 50 MA 30 WV	07263	FDG1088
A1CR17	1901-0518	1	DIODE:HOT CARRIER	28480	1901-0518
A1CR18	1902-0048		DIODE:BREAKDOWN 6.81V 5%	04713	SZ10939-134
A1CR19	1901-0028	7	DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR21	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR22	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR23	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR24	1902-0048		DIODE:BREAKDOWN 6.81V 5%	04713	SZ10939-134
A1CR25, CR26	1902-0202	2	DIODE BREAKDOWN:15.0V 5% 1W	28480	1902-0202
A1CR27, CR28			DIODE BREAKDOWN:6.43V (MATCHED WITH A1U25 AS A SET, SEE A1U25 FOR PART NUMBER TO ORDER)		
A1CR29, CR31	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR32	1902-0551	1	DIODE BREAKDOWN:6.19V 5%	28480	1902-0551
A1CR33	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1CR34	1902-0041		DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A1L1	9100-3223	2	COIL:FXD 220 UH	28480	9100-3223
A1L2	9100-3223		COIL:FXD 220 UH	28480	9100-3223
A1L3	9170-0894		BEAD:SHIELDING	02114	56-59-65/4A6

See introduction to this section for ordering information

Δ_b This component did not exist on instrument Serial No's. 1304A00275 and below.

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1L4	9170-0894		BEAD:SHIELDING	28480	9170-0894
A1L5	9170-0894		BEAD:SHIELDING	28480	9170-0894
A1L6	9170-0894		BEAD:SHIELDING	28480	9170-0894
A1L7	9170-0894		BEAD:SHIELDING	28480	9170-0894
A1Q1	1855-0208	6	TSTR: SI	17856	2N4117
A1Q2	1855-0305		TSTR:SI	80131	2N4117A
A1Q3	1855-0305		TSTR:SI	80131	2N4117A
A1Q4	1855-0305		TSTR:SI	80131	2N4117A
A1Q5	1855-0418	1	TRANSISTOR:FET	28480	1855-0418
A1Q6	1855-0093	1	TSTR:FET N-CHANNEL	28480	1855-0093
A1Q7	1855-0308	1	TSTR:SI NPN DUAL	28480	1855-0308
A1Q8	1853-0020	5	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q9	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q11	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q12	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q13	1855-0412		TSTR:FET	28480	1855-0412
A1Q14	1854-0071	5	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q15	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q16	1855-0412		TSTR:FET	28480	1855-0412
A1Q17	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q18	1853-0089	1	TSTR:SI PNP	80131	2N4917
A1Q19	1854-0094	1	TSTR: SI NPN	80131	2N3646
A1Q21	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q22	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q23	1854-0039	1	TSTR:SI NPN	80131	2N3053
A1Q24	1853-0016	1	TSTR:SI PNP	80131	2N3638
A1Q25	1853-0051	1	TSTR:SI PNP	80131	2N4037
A1R1	0684-5641	1	R:FXD COMP 560K OHM 10% 1/4W	01121	CB 5641
A1R2	0684-2241	3	R:FXD COMP 220K OHM 10% 1/4W	01121	CB 2241
A1R3	0684-2241		R:FXD COMP 220K OHM 10% 1/4W	01121	CB 2241
A1R4	0684-2241		R:FXD COMP 220K OHM 10% 1/4W	01121	CB 2241
A1R5	0684-3331	2	R:FXD COMP 33K OHM 10% 1/4W	01121	CB 3331
Δa A1R6	0757-0446	6	R:FXD FLM 15K OHM 1% 1/8W	28480	0757-0449
Δa A1R7	0757-0446		R:FXD FLM 15K OHM 1% 1/8W	28480	0757-0449
A1R8	2100-2061	1	R:VAR FLM 200 OHM 10% LIN 1/2W	28480	2100-2061
A1R9	0757-0442	5	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R11	0698-3558	3	R:FXD MET FLM 4.02K OHM 1% 1/8W	28480	0698-3558
A1R12	0757-0978	1	R:FXD FLM 95.3K OHM 1% 1/8W	28480	0757-0978
				28480	0698-3271
A1R13	0757-0449		R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A1R14	0757-0449		R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A1R15	0684-2701	1	R:FXD COMP 27 OHM 10% 1/4W	01121	CB 27C1
A1R16	0684-2711	1	R:FXD COMP 270 OHM 10% 1/4W	01121	CB 2711
A1R17	0757-0283	1	R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A1R18	0757-0449		R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A1R19	0698-3443	1	R:FXD MET FLM 287 OHM 1% 1/8W	28480	0698-3443
A1R21	0757-0280	1	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R22	0757-0288	1	R:FXD MET FLM 9.09K OHM 1% 1/8W	28480	0757-0288
A1R23	0698-4428	1	R:FXD FLM 1.69K OHM 1% 1/8W	28480	0698-4428
A1R24	2100-3207	1	R:VAR CERMET 5K OHM 10% LIN 1/2W	28480	2100-3207
A1R25	0698-3445	1	R:FXD MET FLM 348 OHM 1% 1/8W	28480	0698-3445
A1R26	0698-3159	1	R:FXD MET FLM 26.1K OHM 1% 1/8W	28480	0698-3159
A1R27	2100-3353	1	R:VAR CERMET 20K OHM 10% 1/2W	28480	2100-3353
A1R28	1810-0171	1	RES. NETWORK 5 X 2.7K OHM	28480	1810-0171
A1R29	0684-1031	5	R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R31	1810-0151	1	RESISTIVE NETWORK	28480	1810-0151
A1R32	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R33	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R34	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R35	0757-0449		R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A1R36	0684-5631	2	R:FXD COMP 56K OHM 10% 1/4W	01121	CB 5631
Δa A1R37	0698-3268		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R38	0757-0430	1	R:FXD MET FLM 2.21K OHM 1% 1/8W	28480	0757-0430
A1R39	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R41	0698-3558		R:FXD MET FLM 4.02K OHM 1% 1/8W	28480	0698-3558
A1R42	0698-3268	1	R:FXD FLM 11.5K OHM 1% 1/8W	28480	0698-3268
A1R43	0684-5631		R:FXD COMP 56K OHM 10% 1/4W	01121	CB 5631
A1R44	0698-3499	1	R:FXD FLM 40.2K OHM 1% 1/8W	28480	0698-3499
A1R45	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R46	0684-3321	3	R:FXD COMP 3300 OHM 10% 1/4W	01121	CB 3321
A1R47	0684-3321		R:FXD COMP 3300 OHM 10% 1/4W	01121	CB 3321
A1R48	1810-0139	4	RES. NETWORK 4 X 22K OHM 5% 0.125W EA.	28480	1810-0139
A1R49	1810-0172	1	RES. NETWORK	28480	1810-0172
A1R51	0684-3321		R:FXD COMP 3300 OHM 10% 1/4W	01121	CB 3321
A1R52	0698-3153		R:FXD MET FLM 3.83 K OHM 1% 1/8W	28480	0698-3153

See introduction to this section for ordering information

Δa Use for all replacement. Replace all components marked Δa if any one is replaced.

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R53	0698-4431	2	R:FXD MET FLM 2.05 K OHM 1% 1/8W	28480	0698-4431
A1R54	1810-0173	1	RES. NETWORK	28480	1810-0173
A1R55	0684-3331		R:FXD COMP 33K OHM 10% 1/4W	01121	CB 3331
A1R56	1810-0139		RES. NETWORK 4 X 22K OHM 5% 0.125W EA.	28480	1810-0139
A1R57	1810-0139		RES. NETWORK 4 X 22K OHM 5% 0.125W EA.	28480	1810-0139
A1R58	1810-0139		RES. NETWORK 4 X 22K OHM 5% 0.125W EA.	28480	1810-0139
A1R59	0684-3311	4	R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R61	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R62	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R63	0684-3311		R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
A1R64	0757-0429	1	R:FXD MET FLM 1.82K OHM 1% 1/8W	28480	0757-0429
A1R65	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A1R66	0687-2701	1	R:FXD COMP 27 OHM 10% 1/2W	01121	EB 2701
A1R67	0683-0365	1	R:FXD COMP 3.6 OHM 5% 1/4W	01121	CB-36G5
A1R68	0698-4441	1	R:FXD MET FLM 3.74K OHM 1% 1/8W	28480	0698-4441
A1R69	2100-2497	1	R:VAR FLM 2000 OHM 10% LIN 1/2W	28480	2100-2497
A1R71	0757-0290	1	R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A1R72	0812-0040	1	R:FXD WW 0.27 OHM 5% 1/2W	28480	0812-0040
A1R73	0683-1025	1	R:FXD COMP 1C00 OHM 5% 1/4W	01121	CB 1025
A1R74	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R75	0698-4470	1	R:FXD FLM 6.98K OHM 1% 1/8W	28480	0698-4470
A1R76	0698-3279	1	R:FXD MET FLM 4990 OHM 1% 1/8W	28480	0698-3279
A1R77	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R78	0684-0271	1	R:FXD COMP 2.7 OHM 10% 1/4W	01121	CB 27G1
A1R79	0687-1201	1	R:FXD COMP 12 OHM 10% 1/2W	01121	EB 12G1
A1R80	0683-1525		R:FXD 1.5K OHM 5% 1/4 W	01121	CB1525
A1R81	2100-3274	2	R:VAR CER 10K OHM 10% LIN 1/2W	28480	2100-3274
A1R82	2100-3274		R:VAR CER 10K OHM 10% LIN 1/2W	28480	2100-3274
Δ_b A1R83, 84	0811-0639		R:FXD 51 OHM 5% 1½W	75042	BW-20
Δ_b A1R85	0684-2721		R:FXD 2700 OHM 10% 1/4W	01121	CB2721
A1S1	3101-1723	1	SWITCH:PUSHBUTTON 4PDT SINGLE STA.	71590	A-3101-1723-1
A1U1	1820-0223	3	INTEGRATED CIRCUIT:OPERATIONAL AMPL.	28480	1820-0223
A1U2	1820-0223		INTEGRATED CIRCUIT:OPERATIONAL AMPL.	28480	1820-0223
A1U3	1826-0009	1	IC:LINEAR OP. AMPL.	28480	1826-0009
A1U4	1820-0223		INTEGRATED CIRCUIT:OPERATIONAL AMPL.	28480	1820-0223
A1U5	1820-0321	1	INTEGRATED CIRCUIT:HI-SPEED COMPARATOR	01295	SN72 71CL
A1U6	1820-0586	1	IC:TTL LP HEX INVERTER	12040	DM74L04N
A1U7	1820-0668	1	IC:TTL HEX DRIVER W/OPEN COLL(30V)	01295	SN74C7N
A1U8	1820-0583	4	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U9	1820-0839	1	IC:TTL QUAD D-TYPE F/F	01295	SN74175N
A1U11	1820-0596	2	IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
A1U12	1820-1150	1	IC:RESET COUNTER	28480	1820-1150
A1U13	1820-0584	1	IC:TTL LP QUAD 2-INPT NOR GATE	12040	DM74L02N
A1U14	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U15	1820-0598	1	IC:TTL LP QUAD 2-INPT EXCL. OR GATE	12040	DM74L86N
A1U16	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
A1U17	1820-0587	1	IC:TTL LP TRIPLE 3-INPT NAND GATE	12040	DM74L10N
A1U18	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
A1U19	1820-0585	1	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L03N
A1U21†	1820-0798	1	IC:TTL SIX DECADE	28480	1820-0798
A1U22	1820-0196	2	IC:LINEAR VOLTAGE REGULATOR(INPUT)	28480	1820-0196
A1U23	1826-0043	1	IC:LINEAR OPERATIONAL AMPLIFIER	28480	1826-0043
A1U24	1820-0196		IC:LINEAR VOLTAGE REGULATOR(INPUT)	28480	1820-0196
A1U25†	1813-0032	1	REFERENCE:HYBRID	28480	1813-0032
A1XA1	1251-2564	1	CONNECTOR:R & P, 50 CONTACT PLUG	74868	57-10500-27
A1Y1	0410-0467	1	CRYSTAL (FOR 60 HZ OPERATION)	28480	0410-0467
A1Y1	0410-0490	1	CRYSTAL:QUARTZ (FOR 50 HZ OPERATION)	28480	0410-0490
A2	34750-66502	1	BOARD ASSY: HPA (PART OF A1 ASSY)	28480	34750-66502
A2C1	0180-1714	1	C:FXD ELECT 330 UF 10% 6VDCW	28480	0180-1714
A2C2	0160-3156	1	C:FXD MY 0.0039 UF 10% 200VDCW	56289	152P39292-PTS
A2Q1	1854-0215	11	TSTR:SI NPN	80131	2N3904
A2Q2	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q3	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q4	1854-0215		TSTR:SI NPN	80131	2N3904

See introduction to this section for ordering information

Δ_b These components did not exist on instrument Serial No's. 1304A00275 and below.

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2Q5	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q6	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q7	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q8	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q9	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q11	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q12	1854-0215		TSTR:SI NPN	80131	2N3904
A2Q13	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2R1	0684-4721	1	R:FXD COMP 4700 OHM 10% 1/4W	C1121	CB 4721
A2R2	0684-8201	2	R:FXD COMP 82 OHM 10% 1/4W	01121	CB 8201
A2R3	0684-8201		R:FXD COMP 82 OHM 10% 1/4W	01121	CB 8201
A2U1 †	1820-0635	1	IC:DIGITAL	28480	1820-0635
A2U2 †	1990-0413	1	NUMERIC DISPLAY:LED	28480	1990-0413
A2U3	1990-0405	1	NUMERIC DISPLAY:LED(PLUS-MINUS)	28480	1990-0405
A2U4	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74LC00N
A2U5 †	1820-0571	1	IC:TTL NUMERIC DISPLAY CHARACTER GEN.	28480	1820-0571
			CHASSIS MOUNTED COMPONENTS		
F1	2110-0012	1	FUSE:0.5 AMP 250V	75915	312.500
F1	2110-0004	1	FUSE:CARTRIDGE 1/4 AMP 250V	75915	3AG/CAT. 312.250
XA2	1251-0291	1	CONNECTOR:14 PIN	C2660	57-10140
PM1	34750-28801	1	POWER MODULE	28480	34750-28801
Q1	1854-0245	1	TRANSISTOR:SI NPN	80131	2N3771
T1	9100-3293	1	TRANSFORMER:POWER	28480	9100-3293
W1	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
			MISCELLANEOUS		
	05300-20010	1	CASE	28480	05300-20010
	34750-00601	1	SHIELD:POWER INPUT PROTECTION	28480	34750-00601
	34750-61601	1	CABLE(FROM XA2TO MOTHER BOARD)	28480	34750-61601
	4040-0920	1	PANEL:FRONT	28480	4040-0920
	7120-3265	1	NAMEPLATE	28480	7120-3265
	7120-3534	1	DECAL	28480	7120-3534
	7122-0058	1	PLATE:SERIAL	28480	7122-0058
	7124-2308	1	LABEL:INFORMATION	28480	7124-2308
	0370-2159	1	KNOB: PUSHBUTTON	28480	0370-2159
	1600-0421	1	SHIELD: ANALOG (L - SHAPED)	28480	1600-0421
	0340-0787	1	INSULATOR: POWER SWITCH	28480	0340-0787
	1200-0423	1	SOCKET: IC BLK 16 CONTACT	23880	CSA2900 - 16B
	1205-0002	2	HEAT SINK: TRANSISTOR	07387	3AL-635-2R
	34750-60601	1	SHIELD ASSY: TRANSFORMER	28480	34750-60601
	34750-61602	1	CABLE: INPUT	28480	34750-61602
	1200-0462	48	SOCKET: IC CONTACT (FOR DISPLAY)	00779	3-116141-2
	9170-0894		BEAD: SHIELDING (USED ON A2 ASSEMBLY)	28480	9170-0894
	0340-0782	1	INSULATOR:TRANSISTOR } FOR Q1	28480	0340-0782
	0340-0783	2	INSULATOR:SPRING } FOR Q1	28480	0340-0783
	5040-7001	1	SLIDE LOCK, BLACK, RIGHT	28480	5040-7001
	5040-6000	1	SLIDE LOCK, BALCK, LEFT	28480	5040-6000

See introduction to this section for ordering information

Δ Use for all replacement.

SECTION VII
CIRCUIT DIAGRAMS TROUBLESHOOTING

7-1. INTRODUCTION.

7-2. This section of the Operating and Service Manual contains troubleshooting information and circuit diagrams for the Model 34750A Display Module. Included are troubleshooting trees, a functional block diagram, schematic and component location diagrams and timing diagrams.

7-3. TROUBLESHOOTING.

7-4. Troubleshooting Trees.

7-5. Figures 7-1 through 7-3 are troubleshooting trees designed to assist in the isolation of malfunctions. Table 7-1 lists the troubleshooting trees and their respective figure numbers.

Table 7-1. Troubleshooting Trees.

Figure	Troubleshooting Tree
7-1	Power Supply Troubleshooting Tree
7-2	Analog Troubleshooting Tree
7-3	Digital Troubleshooting Tree

7-6. Troubleshooting Procedures.

7-7. The following procedure is recommended for troubleshooting the Model 34750A.

a. Ensure the signal conditioning plug-on is functioning properly. Normally, if the Model 34750A passes the operational checks given in Paragraph 5-3, the Display Module is functioning properly and the signal conditioning module is malfunctioning. If you have checked the signal conditioning module and found it to be good proceed to step b.

b. Determine the exact symptoms of the failure. This can usually be accomplished by attempting the performance tests for the instrument. These procedures are found in the Operating and Service Manual for the signal conditioning plug-on module. Often this method will isolate the trouble to a particular circuit which affects the parameter under test.

c. Once the problem has been characterized, assuming the instrument is not completely dead, attempt the Adjustment Procedures outlined in Section V. Some apparent malfunctions can be corrected by these adjustments. Inability to obtain a correct adjustment can also help in localizing the problem.

d. Check for burned or loose components, or other conditions which might be the source of trouble.

e. Begin with the Power Supply Troubleshooting Tree (No. 1). If the power supplies are functioning properly the tree will quickly lead to the troubleshooting tree for either the analog or the digital portion of the instrument.

f. If the end of a tree is reached without finding the trouble, carefully recheck the symptoms to ensure you have interpreted them properly. Using the schematics, voltages and timing waveforms in Section VII (Figures 7-5 through 7-8) attempt to localize the malfunction. The problem can usually be isolated to the analog or digital section by connecting the test jumper shown in Figure 5-4 to "B". A + 1.00000 should be displayed. If it is not, the digital section is malfunctioning.

7-8. FUNCTIONAL BLOCK DIAGRAM (Figure 7-4).

7-9. The Functional Block Diagram is a detailed block diagram showing the overall relationship between circuit elements of the Model 34750A. The diagram shows all adjustments within the Model 34750A and provides waveforms that should be helpful in troubleshooting.

7-10. TIMING DIAGRAM (Figure 7-5).

7-11. Figure 7-5 shows the timing relationships between the major signals generated within the Model 34750A. Each signal has been assigned a number within a circle, e.g. ③ , which corresponds to an identical number on one of the schematic diagrams. Illustrations of the 34750-66501 and 34750-66502 printed circuit assemblies, showing the physical location of each signal is also provided.

7-12. SCHEMATIC DIAGRAMS (Figures 7-6, 7-7 and 7-8).

7-13. The circuits contained within the Model 34750A are shown in the schematic diagrams. These diagrams are provided to assist in troubleshooting the instrument.

7-14. COMPONENT LOCATION DIAGRAMS.

7-15. Component Location Diagrams are provided with each schematic to show the location of the various components mounted on the printed circuit assemblies. Each component is identified by a reference designator.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUB-ASSEMBLY 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. (PERMANENTLY CONNECTED TO FRAME GROUND).

6.  ANY LETTER OR NUMBER IN TRIANGLE DENOTES A SPECIAL GROUND.

7. DENOTES ASSEMBLY.

8. DENOTES MAIN SIGNAL PATH.

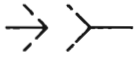
9. DENOTES FEEDBACK PATH.

10.  DENOTES FRONT PANEL MARKING.

11.  DENOTES REAR PANEL MARKING.

12.  DENOTES SCREWDRIVER ADJUST.

13. * AVERAGE VALUE SHOWN. OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER.

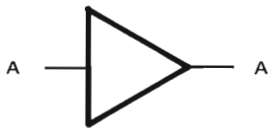
14.  DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15.  DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES STRIP.

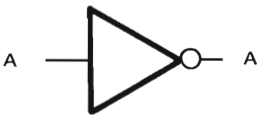
16. ALL RELAYS ARE SHOWN DEENERGIZED.

17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 DIVIDER PROBE (10 MEGOHM, 10 pF). THE VOLTAGE LEVELS SHOWN ON THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ± 10 % IN MEASUREMENTS SHOULD BE ALLOWED.

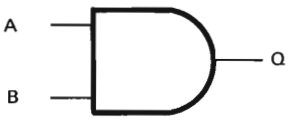
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ± 10 % SHOULD BE ALLOWED.



DENOTES BUFFER

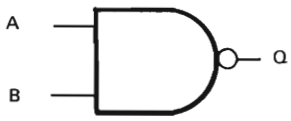


DENOTES INVERTER



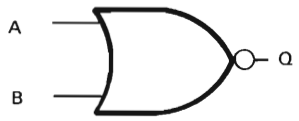
A	B	Q
1	1	1
1	0	0
0	1	0
0	0	0

DENOTES AND GATE



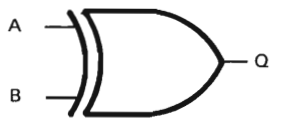
A	B	Q
1	1	0
1	0	1
0	1	1
0	0	1

DENOTES NAND GATE



A	B	Q
1	1	0
1	0	0
0	1	0
0	0	1

DENOTES NOR GATE



A	B	Q
1	1	0
1	0	1
0	1	1
0	0	0

DENOTES "EXCLUSIVE" OR GATE

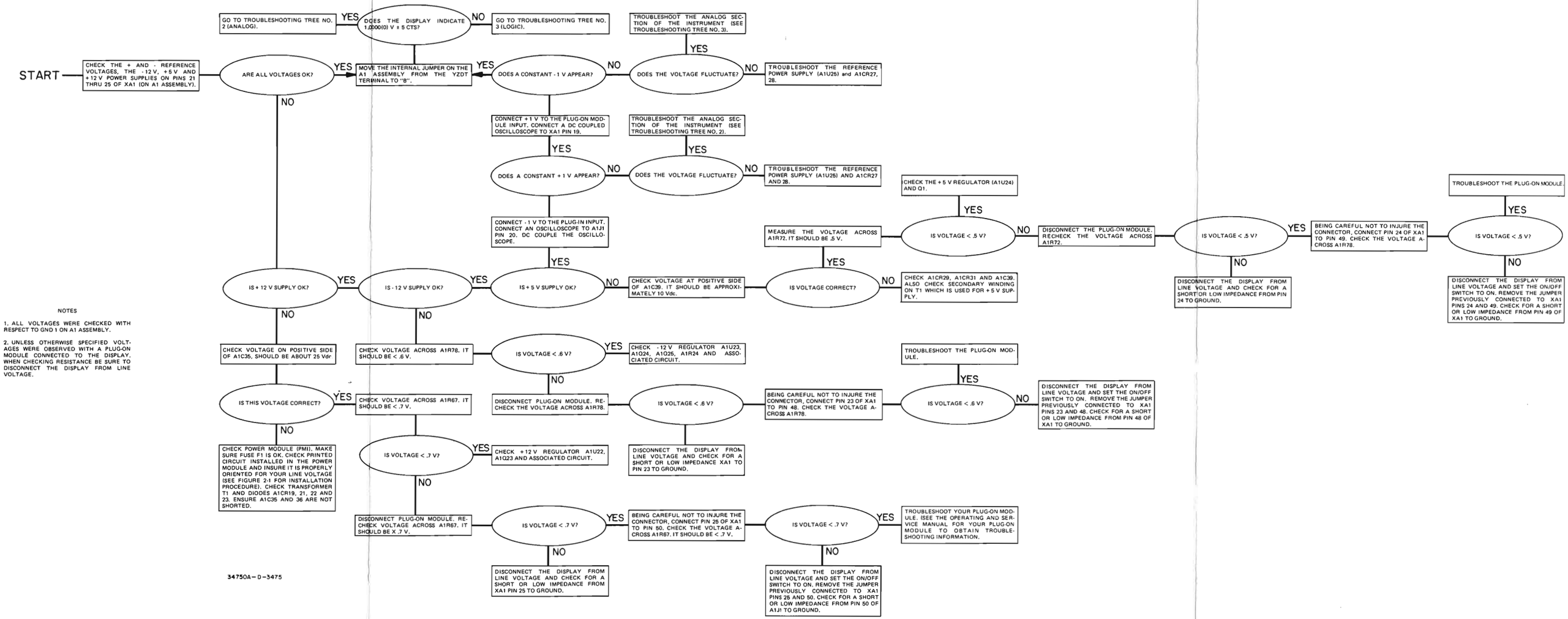
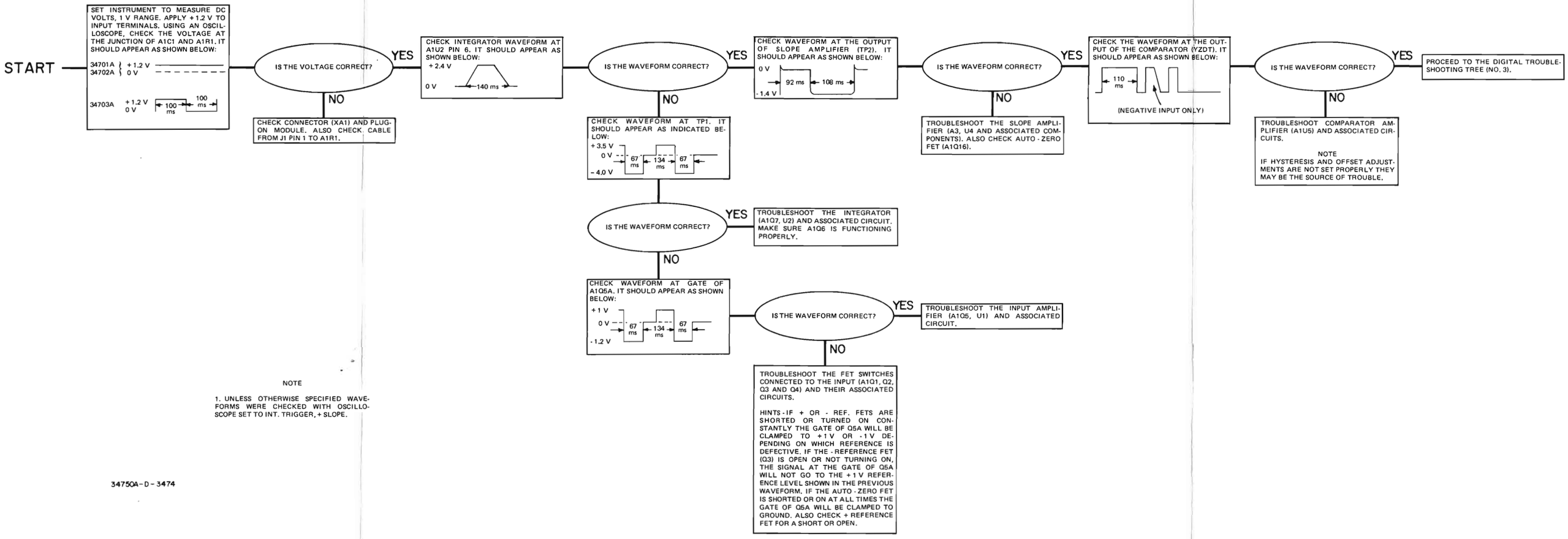


Figure 7-1. Power Supply Troubleshooting Tree.



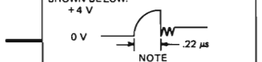
NOTE

1. UNLESS OTHERWISE SPECIFIED WAVEFORMS WERE CHECKED WITH OSCILLOSCOPE SET TO INT. TRIGGER, + SLOPE.

34750A-D-3474

Figure 7-2. Analog Troubleshooting Tree.

CHECK 3 MHz CLOCK WAVEFORM AT U21 PIN 14. IT SHOULD APPEAR AS SHOWN BELOW:



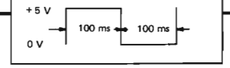
NOTE
FOR OPTION 050 THIS PERIOD IS .264 µs.

IS THE WAVEFORM CORRECT?

YES → CHECK WAVEFORM ON COLLECTOR OF A1Q21. IT SHOULD APPEAR AS SHOWN BELOW:

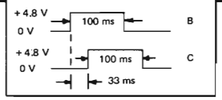
IS THE WAVEFORM CORRECT?

YES → CHECK WAVEFORM AT TP3. IT SHOULD APPEAR AS SHOWN BELOW:



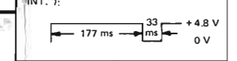
IS WAVEFORM CORRECT?

YES → TRIGGER OSCILLOSCOPE ON EXT. AT TP3. CHECK TIMING WAVEFORMS B AND C. SHOULD APPEAR AS SHOWN:



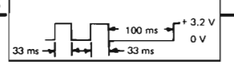
ARE WAVEFORMS CORRECT?

YES → CHECK WAVEFORM ON PIN 6 OF A1U16. IT SHOULD APPEAR AS SHOWN. (TRIGGER OSCILLOSCOPE ON "+", "INT."):



IS WAVEFORM CORRECT?

YES → CHECK WAVEFORM ON PIN 11 OF A1U15. IT SHOULD BE:



IS WAVEFORM CORRECT?

YES → A

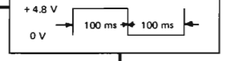
NO → CHECK A1U15 AND U8 FOR PROPER OPERATION.

NO → A1U16 PROBABLY DEFECTIVE.

NO → A1U9 PROBABLY DEFECTIVE.

IS WAVEFORM CORRECT?

YES → CHECK WAVEFORM AT PIN 13 OF A1U9. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

YES → CHECK VOLTAGE AT PIN 1 A1U9. IT SHOULD BE ABOUT +4.8 V.

IS VOLTAGE CORRECT?

YES → A1U9 PROBABLY DEFECTIVE.

NO → CHECK A1U8 (PINS 1, 2, 3) AND RESET CIRCUIT FOR PROPER OPERATION.

NO → CHECK VOLTAGE AT A1TP4. IT SHOULD BE HIGH (APPROXIMATELY +5 V).

IS VOLTAGE CORRECT?

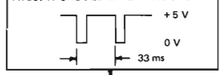
YES → CHECK A1U8 AND U16 FOR PROPER OPERATION.

NO → CHECK FOR PIN 26 OF A1XA1 (CONNECTOR) OR PIN 4 OF U8 SHORTED TO GROUND.

NO → A1U6 PROBABLY DEFECTIVE.

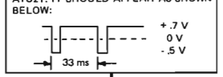
IS WAVEFORM CORRECT?

YES → CHECK FOR 30 Hz CLOCK ON PIN 9 OF A1U9. IT SHOULD APPEAR AS SHOWN:



IS THE WAVEFORM CORRECT?

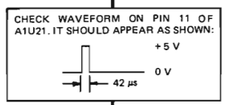
YES → CHECK WAVEFORM AT PIN 7 OF A1U21. IT SHOULD APPEAR AS SHOWN BELOW:



IS THE WAVEFORM CORRECT?

YES → CHECK A1Q21 AND A1U6 (PINS 1 AND 2) FOR PROPER OPERATION. CHECK CONNECTOR XA1 PIN 9 AND PLUG-ON.

NO → CHECK WAVEFORM ON PIN 11 OF A1U21. IT SHOULD APPEAR AS SHOWN:



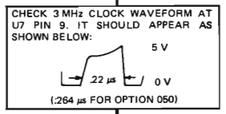
IS WAVEFORM CORRECT?

YES → A1Q21 PROBABLY DEFECTIVE.

NO → CHECK RESET CIRCUIT (U11, 12 AND 13). IF OK, CHECK RESET LINE FOR SHORT TO GROUND VIA U8 PIN 2 OR U21 PIN 11.

NO → TROUBLESHOOT THE MAIN CLOCK (U6, Y1) AND ASSOCIATED CIRCUIT. ENSURE INPUT TO U7 (9) IS NOT SHORTED.

CHECK 3 MHz CLOCK WAVEFORM AT U7 PIN 9. IT SHOULD APPEAR AS SHOWN BELOW:



(.264 µs FOR OPTION 050)

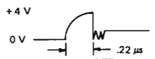
IS THE WAVEFORM CORRECT?

YES → TURN OFF THE INSTRUMENT AND REMOVE A1U21 FROM ITS SOCKET.

CAUTION

A1U21 IS AN MOS DEVICE. IT CAN BE DESTROYED BY CONTACT WITH A STATIC CHARGE.

CHECK THE WAVEFORM AT PIN 14 OF THE CONNECTOR FOR U21. IT SHOULD APPEAR AS SHOWN BELOW:



NOTE
FOR OPTION 050 THIS PERIOD IS .264 µs.

IS THE WAVEFORM CORRECT?

YES → A1U21 DEFECTIVE.

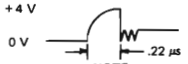
NO → CHECK A1U7 (PINS 8 AND 9) AND A1U19 (PINS 11, 12 AND 13) FOR PROPER OPERATION.

34750A-D-3491

p/o Figure 7-3. Digital Troubleshooting Tree.

START

CHECK 3 MHz CLOCK WAVEFORM AT U21 PIN 14. IT SHOULD APPEAR AS SHOWN BELOW:

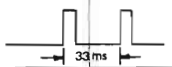


NOTE
FOR OPTION 050 THIS PERIOD IS .264 µs.

IS THE WAVEFORM CORRECT?

YES

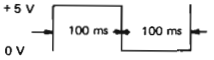
CHECK WAVEFORM ON COLLECTOR OF A1Q21. IT SHOULD APPEAR AS SHOWN BELOW:



IS THE WAVEFORM CORRECT?

YES

CHECK WAVEFORM AT TP3. IT SHOULD APPEAR AS SHOWN BELOW:

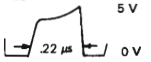


IS WAVEFORM CORRECT?

YES

NO

CHECK 3 MHz CLOCK WAVEFORM AT U7 PIN 9. IT SHOULD APPEAR AS SHOWN BELOW:



(.264 µs FOR OPTION 050)

IS THE WAVEFORM CORRECT?

NO

TROUBLESHOOT THE MAIN CLOCK (U6, Y1) AND ASSOCIATED CIRCUIT. ENSURE INPUT TO U7 (9) IS NOT SHORTED.

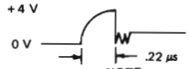
YES

TURN OFF THE INSTRUMENT AND REMOVE A1U21 FROM ITS SOCKET.

CAUTION

A1U21 IS AN MOS DEVICE. IT CAN BE DESTROYED BY CONTACT WITH A STATIC CHARGE.

CHECK THE WAVEFORM AT PIN 14 OF THE CONNECTOR FOR U21. IT SHOULD APPEAR AS SHOWN BELOW:



NOTE
FOR OPTION 050 THIS PERIOD IS .264 µs.

IS THE WAVEFORM CORRECT?

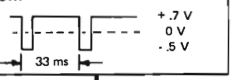
YES

A1U21 DEFECTIVE.

NO

CHECK A1U7 (PINS 8 AND 9) AND A1U19 (PINS 11, 12 AND 13) FOR PROPER OPERATION.

CHECK WAVEFORM AT PIN 7 OF A1U21. IT SHOULD APPEAR AS SHOWN BELOW:



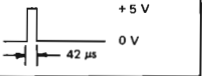
IS THE WAVEFORM CORRECT?

YES

CHECK A1Q21 AND A1U6 (PINS 1 AND 2) FOR PROPER OPERATION. CHECK CONNECTOR XA1 PIN 9 AND PLUG-ON.

NO

CHECK WAVEFORM ON PIN 11 OF A1U21. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

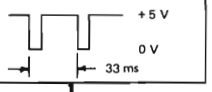
YES

A1Q21 PROBABLY DEFECTIVE.

NO

CHECK RESET CIRCUIT (U11, 12 AND 13). IF OK, CHECK RESET LINE FOR SHORT TO GROUND VIA U8 PIN 2 OR U21 PIN 11.

CHECK FOR 30 Hz CLOCK ON PIN 9 OF A1U9. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

YES

NO

A1U6 PROBABLY DEFECTIVE.

34750A-D-3491

A

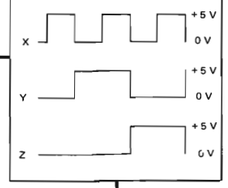
CHECK WAVEFORM ON PIN 12 OF A1U17. IT SHOULD APPEAR AS SHOWN:

IS WAVEFORM CORRECT?

YES → CHECK A1U17 PIN 6 FOR CONSTANT HIGH (+4.8 V).

IS VOLTAGE CORRECT?

YES → CHECK WAVEFORMS X, Y AND Z ON PINS 10, 9 AND 8 OF A1U21. EXTERNALLY TRIGGER OSCILLOSCOPE ON SIGNAL Z. WAVEFORMS SHOULD APPEAR AS SHOWN:

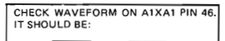


ARE WAVEFORMS CORRECT?

YES → RETURN JUMPER TO YZDT APPLY .87 VOLTS TO THE 34750A INPUT. CHECK VOLTAGE AT PINS 1, 2, 15 AND 16. OF A1U21 WITH AN OSCILLOSCOPE. THE VOLTAGE AT EACH PIN SHOULD BE SWITCHING BETWEEN ≈0 V AND +4.8 V.

ARE VOLTAGES SWITCHING AS INDICATED?

YES → CHECK WAVEFORM ON A1XA1 PIN 46. IT SHOULD BE:

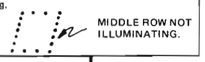


NOTE
SIGNAL MAY VARY ≈10 % FROM NOMINAL.

IS WAVEFORM CORRECT?

YES → OBSERVE DISPLAY. CHECK TO SEE IF A HORIZONTAL ROW OF LED'S IS NOT ILLUMINATING.

e.g.



DO ALL HORIZONTAL ROWS ILLUMINATE?

YES → OBSERVE DISPLAY. CHECK TO SEE IF VERTICAL 1/2 OF ANY DIGIT IS MISSING.

e.g.

ARE ALL DIGITS DISPLAYED CORRECTLY?

YES → APPLY +1.2 V TO 34750A INPUT AND OBSERVE DISPLAY. THE OVERRANGE "1" SHOULD ILLUMINATE.

YES

TROUBLESHOOT A2U5 AND BCD1 GATE OF A1U4.

NO → PROBABLE CAUSE IS A2U1 OR TRANSISTORS (Q2-12) WHICH SELECT MISSING 1/2 DIGIT.

e.g. A2Q9 SELECTS RIGHT HALF OF IO's DIGIT.

NO → PROBABLE CAUSE IS EITHER DISPLAY IC (A2U3) OR A2U5.

NO → ENSURE SCANNER CLOCK IS NOT SHORTED TO GROUND BY THE PLUG-ON. CHECK A2U1 (SCANNER) AND A2C2.

NO → A1U21 PROBABLY DEFECTIVE.

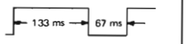
NO → A2U1 IS PROBABLY DEFECTIVE.

NO → A1U17 PROBABLY DEFECTIVE.

NO → CHECK VOLTAGE ON PIN 5 OF A1U18. IT SHOULD BE ≈+4.8 V.

IS VOLTAGE CORRECT?

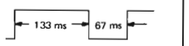
YES → CHECK WAVEFORM ON PIN 13 OF A1U17. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

YES → A1U17 PROBABLY DEFECTIVE.

NO → CHECK WAVEFORM ON PIN 11 OF A1U16. IT SHOULD APPEAR AS SHOWN:

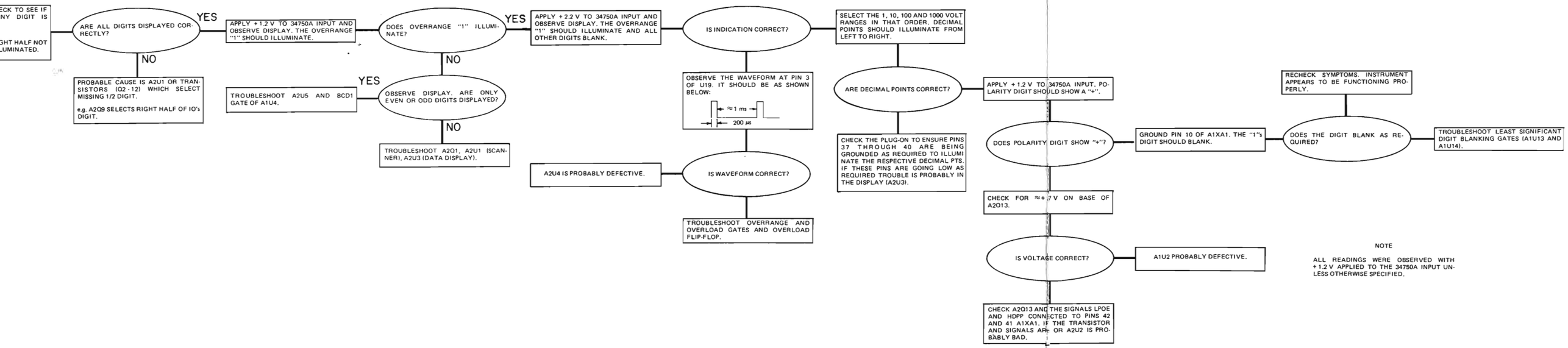


IS WAVEFORM CORRECT?

YES → TROUBLESHOOT ZERO DETECT CATCHER (A1U16 PINS 8, 9, 10 AND A1U17 PINS 8, 9, 10, AND 11).

NO → CHECK A1U15 (PINS 1, 2, 3) AND A1U16 (PINS 11, 12, 13) FOR PROPER OPERATION.

NO → A1U18 PROBABLY DEFECTIVE.



p/o Figure 7-3. Digital Troubleshooting Tree.

A1

INPUT VOLTAGE

INPUT SWITCHING

+1.0V
-1.2V
7 ms
(AIQ2 DRAIN)

+ REF VOLTAGE (+V_{REF})

- REF VOLTAGE (-V_{REF})

AUTO-ZERO

+REF ENABLE (LPRE)

-REF ENABLE (LNRE)

ZERO DETECT HELD (LZDH)

INPUT ENABLE (LIEN)

FET SWITCH DRIVE CIRCUITS

+/- REF ENABLE

ZERO DETECT HELD (LZDH)

INTEGRATOR ENABLE

AUTO-ZERO (LMATZ)

ZERO DETECT HELD (LZDH)

INPUT AMP

INPUT AMP OFFSET

R8

+3.5V
-4.2V
7 ms

TP1

(X3.5)

R9

R11

R12

R35

INTEGRATOR

C10

INTEGRATOR CAPACITOR

AUTO-ZERO

AUTO ZERO CAPACITOR

C12

SLOPE AMP

PIN6, AIU2

4.8V
0V

R22

R21

R17

R18

TP2 0V -1.5V

ZERO DETECT COMPARATOR

R19

C17

HYSTERESIS (H)

R24

R26

R25

+12V

R27

-12V

COMPARATOR OFFSET (Z)

TIMING BIT B

INTEGRATOR ENABLE (LIEN)
AUTO-ZERO (LMATZ)
INPUT ENABLE (LIEN)

30Hz

MEASUREMENT TIMING CIRCUITS

TIMING GENERATOR SIGNALS (A,B,C)

- V_{REF}

+ V_{REF}

R81

R82

+/- REFERENCE SOURCES

+12Vs

-12Vs

PIN8, AIU7

+5V
0V
.22 µs

RESET PULSE GENERATOR

DATA CLOCK

3MHz

÷ 4

RESET COUNTER

POSITIVE INPUT

INPUT POLARITY FLIP-FLOP

TO FET DRIVE CIRCUITS

+/- REFERENCE ENABLE

TIMING GENERATOR

30Hz

A,B,C

40 µs

RESET PULSE PIN 11, AIU21

ZERO DETECT PROCESSOR

ZERO DETECT HELD (LZDH)

DATA CLK DISABLE & TRANSFER PULSE GENERATOR

TRANSFER (AIU21 PIN4) PULSE

+4.6V
0V
50 µs

DATA ACCUMULATOR

(X,Y,Z) FROM SCANNER

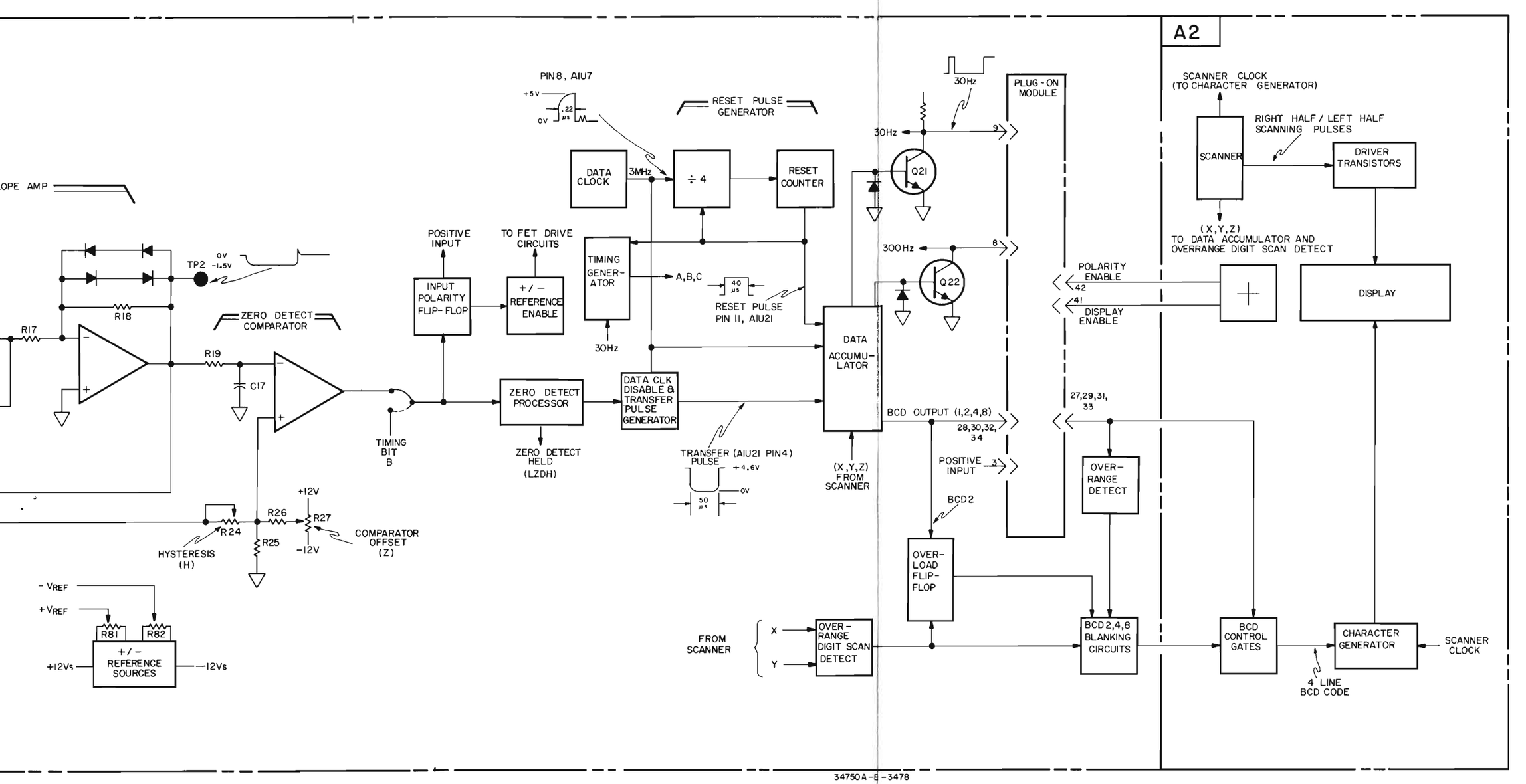
FROM SCANNER

X

Y

OVER-RANGE DIGIT SCAN DETECT

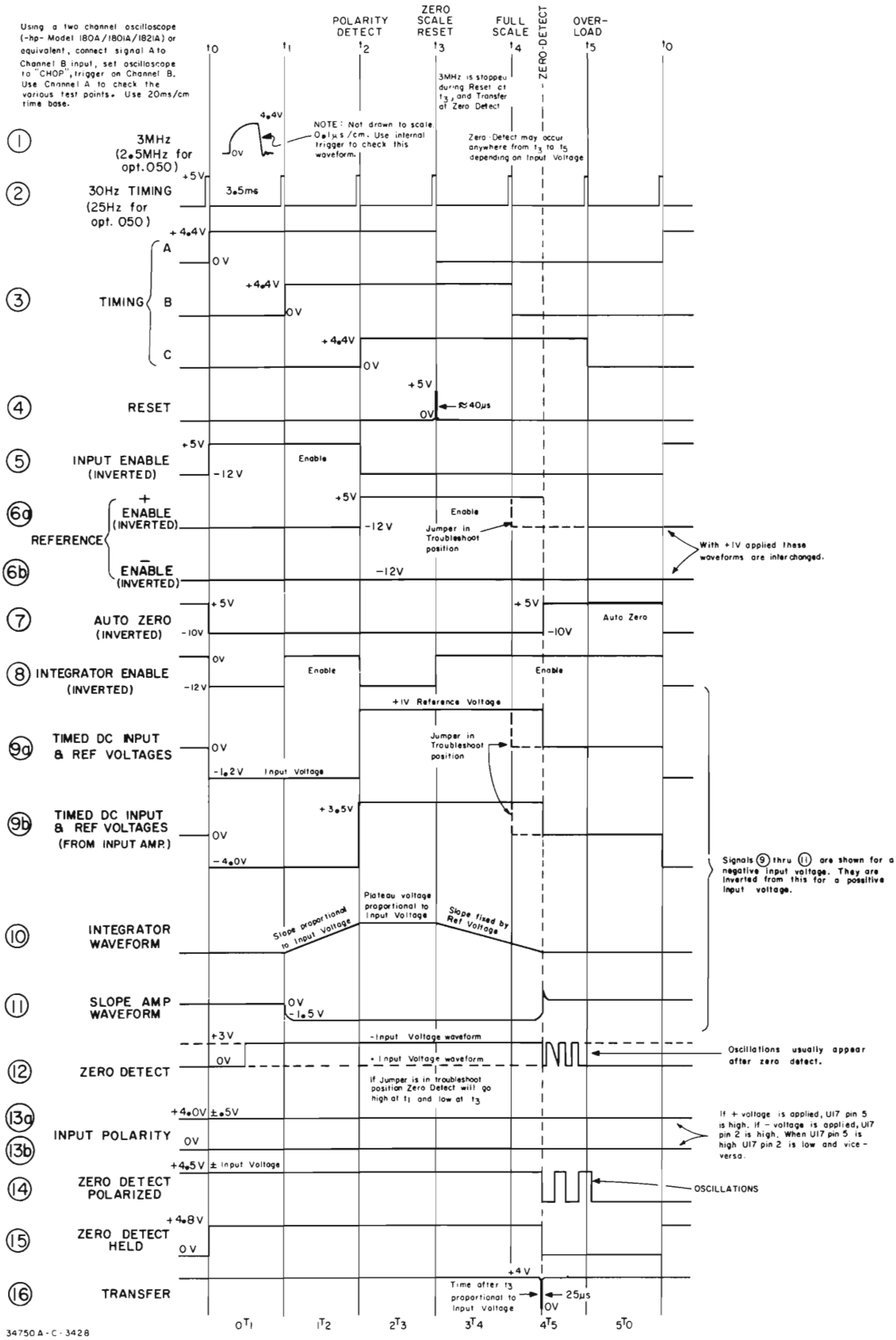
— NOTE —
ALL WAVEFORMS WERE OBTAINED WITH -1.2V APPLIED TO THE INPUT.



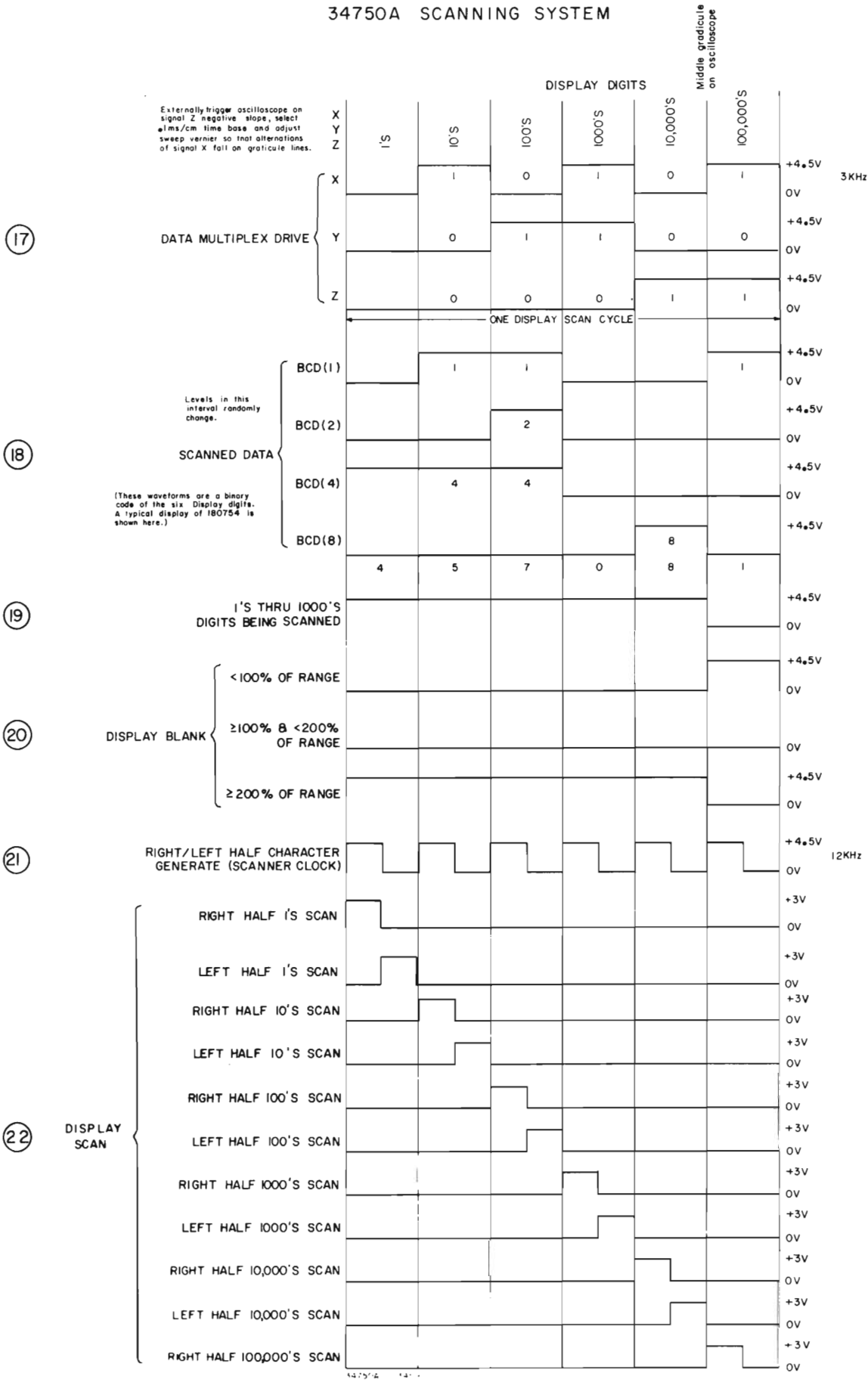
34750A-E-3478

Figure 7-4. Functional Block Diagram.

34750A TIMING & DATA WAVEFORMS



34750A SCANNING SYSTEM



34750 MNEMONIC DICTIONARY

LHLD **(Low HoLD)** - When low, this signal inhibits the instrument from taking additional readings.

LMATZ **(Low Mainframe Auto - Zero)** - This signal goes low during mainframe auto - zero period.

LZDH **(Low Zero Detect Hold)** - This signal goes low at zero detect.

L5DB **(Low 5th Digit Blank)** - When low, this signal blanks the 5th digit of the mainframe.

LPOE **(Low POlarity Enable)** - When low, this signal enables the polarity display digit.

HDPP **(High Display Positive Polarity)** - When high, this signal causes the polarity indicator to show a +.

LDP4 **(Low Decimal Point 4)** - When low, this signal illuminates decimal point 4.

LDP3 **(Low Decimal Point 3)** - When low, this signal illuminates decimal point 3.

LDP2 **(Low Decimal Point 2)** - When low, this signal illuminates decimal point 2.

LDP1 **(Low Decimal Point 1)** - When low, this signal illuminates decimal point 1.

LOVL **(Low OVerLoad)** - When low, this signal indicates the instrument is in overload.

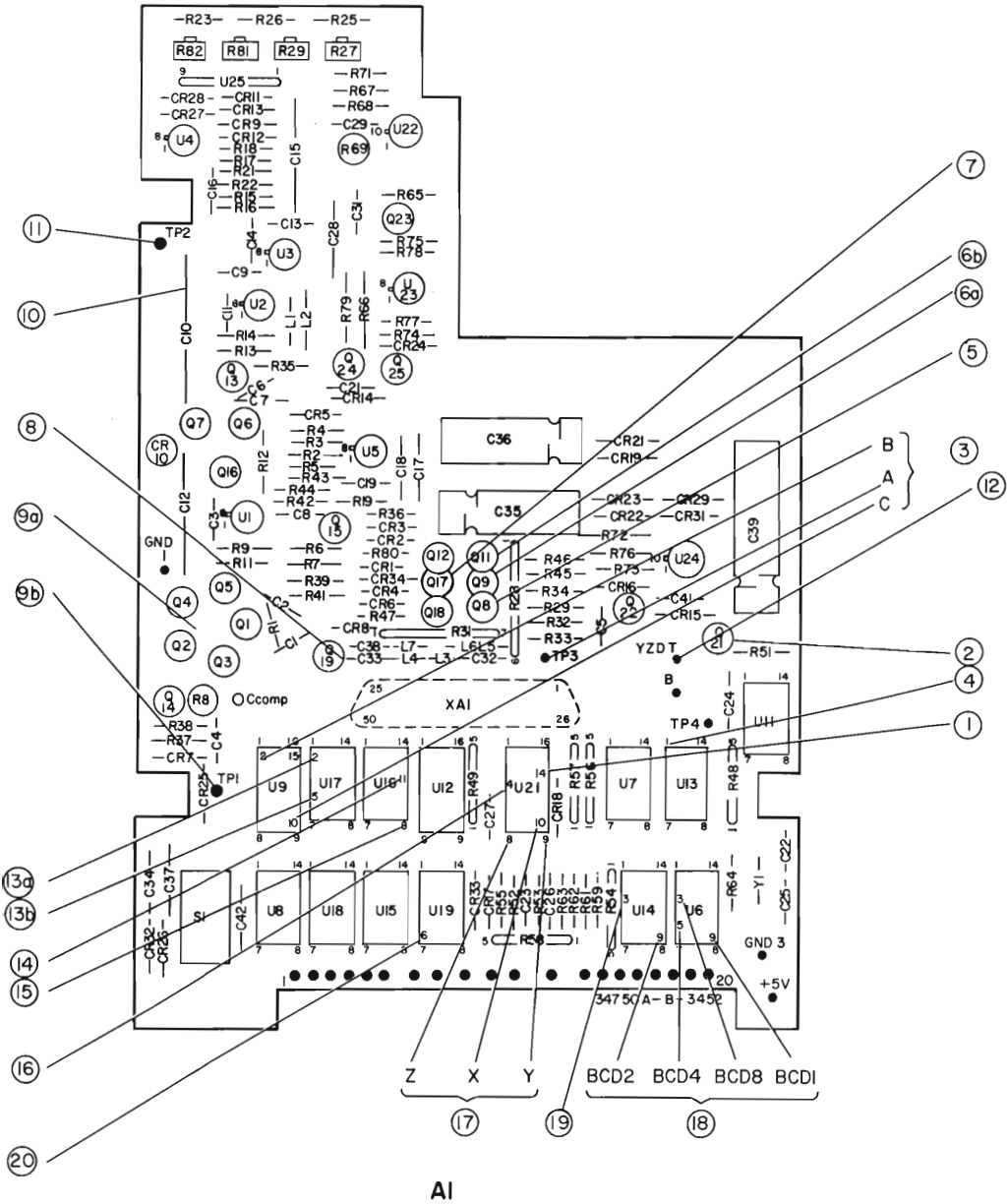
LBLK **(Low BLanK)** - The display is blanked when this signal is low.

LIGE **(Low InteGrator Enable)** - When low, this signal enables the integrator.

LIEN **(Low Input ENable)** - When low, this signal enables the 34750A input circuits.

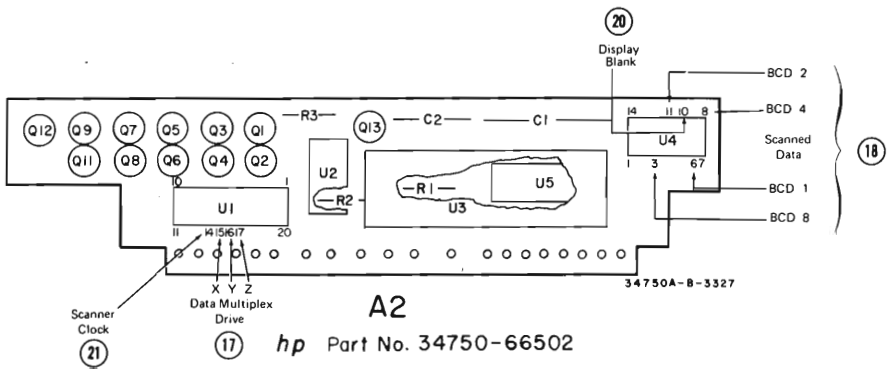
LNRE **(Low Negative Reference Enable)** - When low, this signal enables the negative reference supply.

LPRE **(Low Positive Reference Enable)** - When low, this signal enables the positive reference supply.



A1

hp Part No. 034750-66501
Rev C



A2

hp Part No. 34750-66502

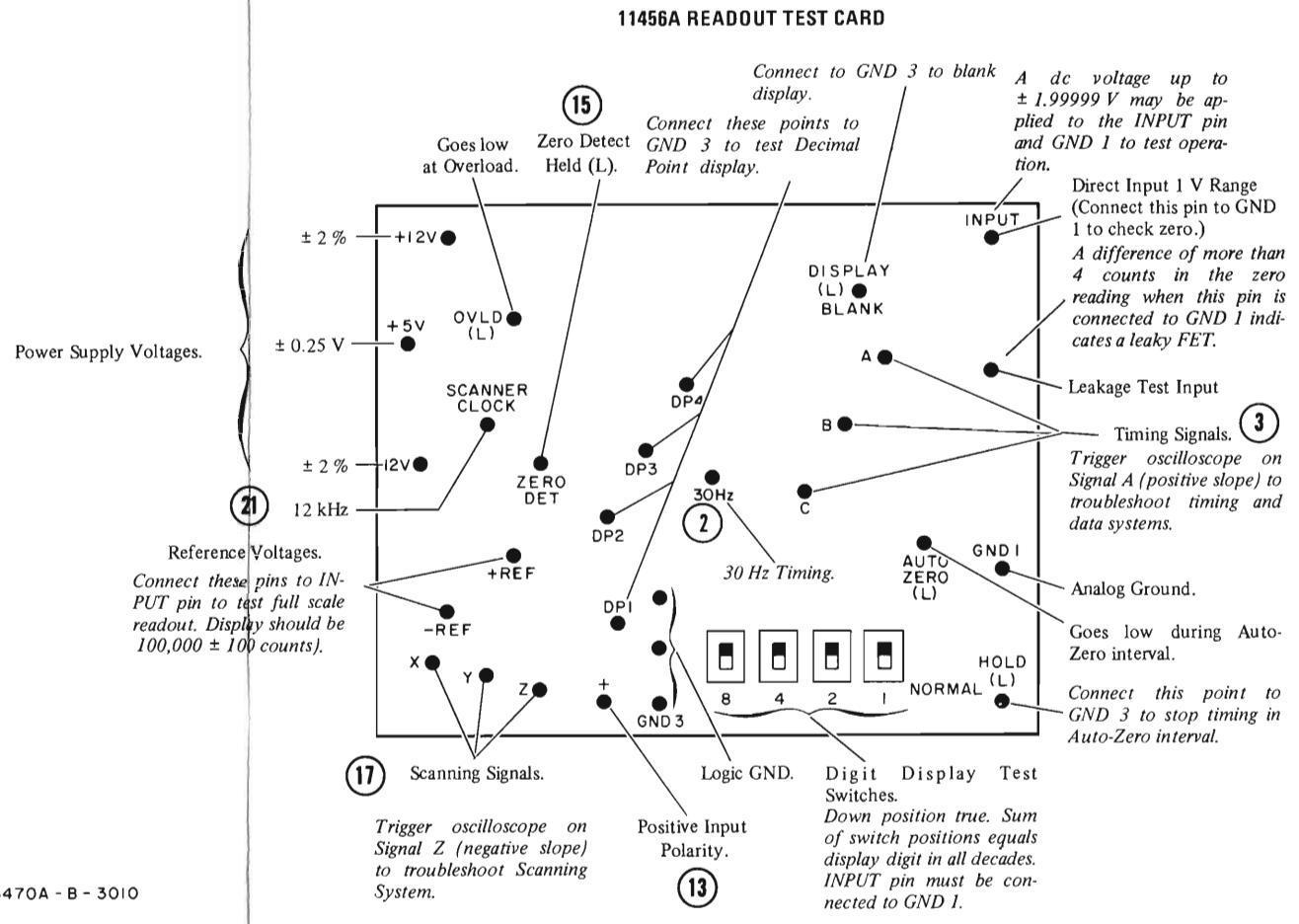
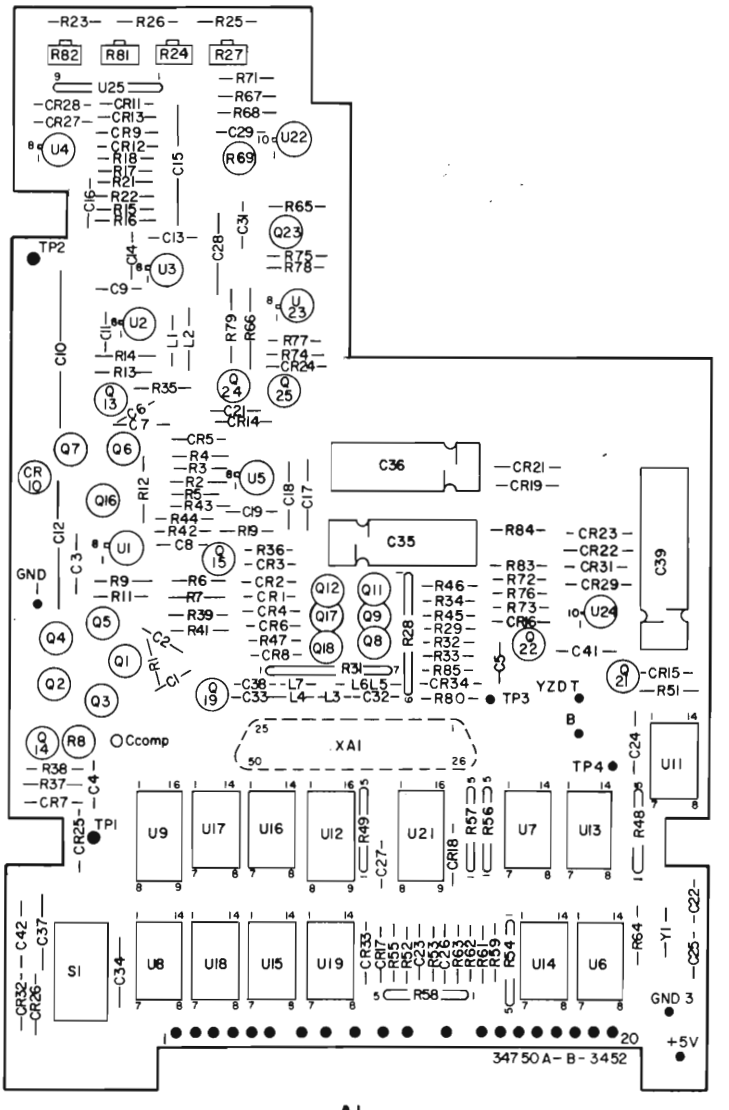


Figure 7-5. Timing Waveforms.
Rev. A 7-11/7-12



A1

hp Part No. 034750-66501

Rev D

NOTES

1. | DENOTES SCHEMATIC ON WHICH SIGNAL CONNECTION IS MADE.

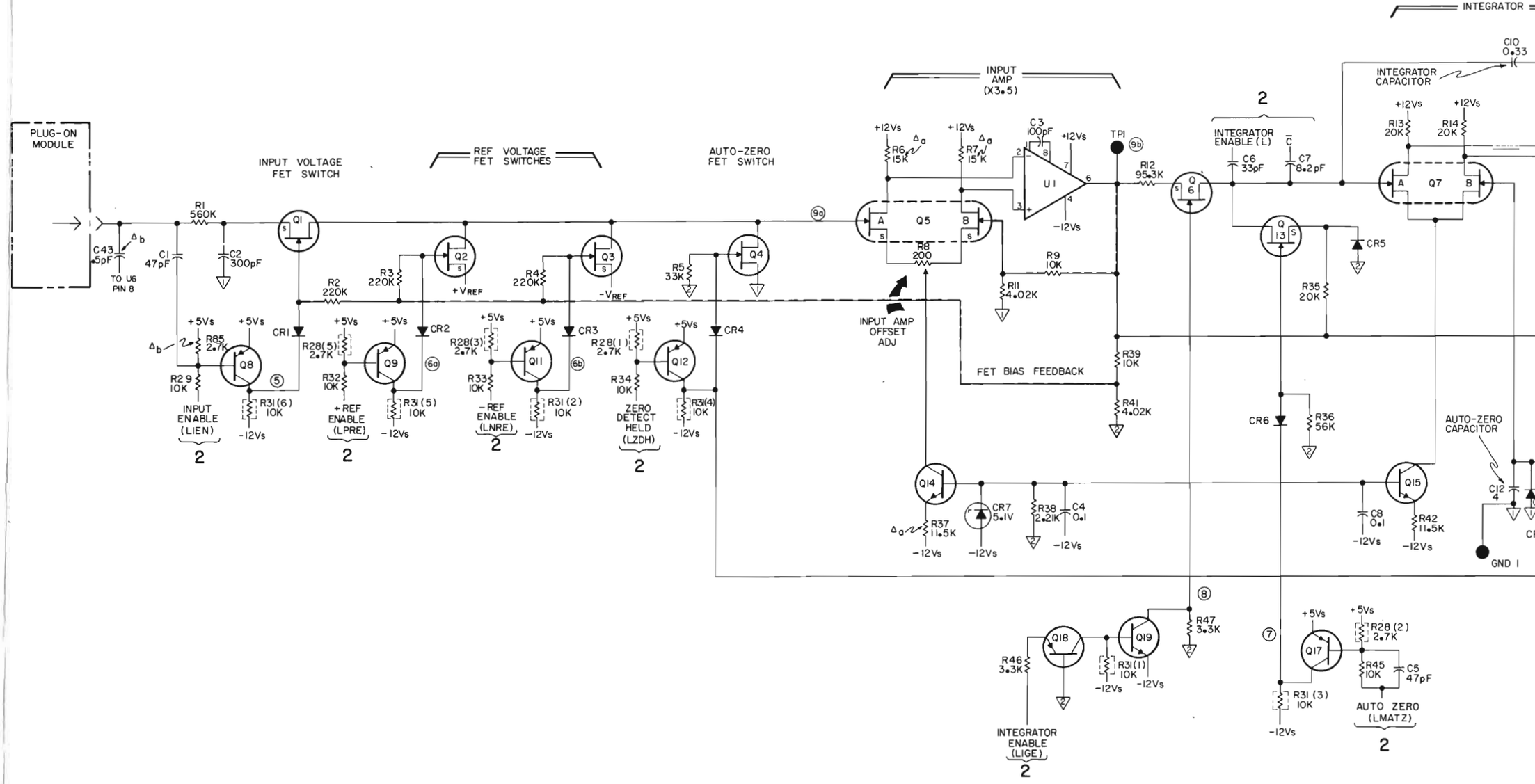
2. (3) NUMBERS IN CIRCLES REFER TO WAVEFORMS ON FIGURE 7-5.

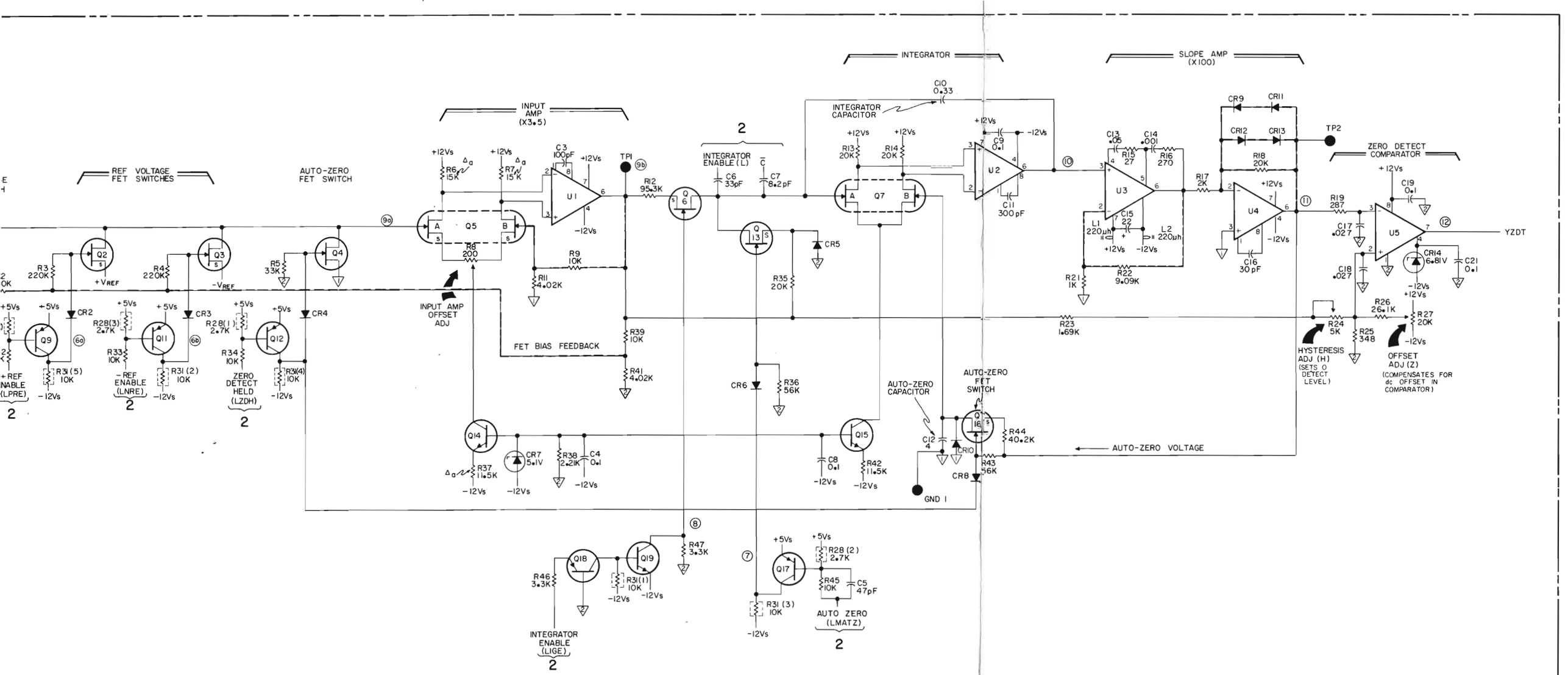
Δ_a USE FOR ALL REPLACEMENT. IF EITHER R6, R7, OR R37 IS REPLACED, ALL SHOULD BE REPLACED.

Δ_b INSTRUMENT SERIAL NO's. 1304A00275 AND BELOW DID NOT CONTAIN R85. IT WAS PART OF RESISTOR PACK R28.

Δ_1 REFER TO CHANGE NO.1 IN SECTION 8 FOR INSTRUMENT SERIAL NO.'s 1304A00275 AND BELOW.

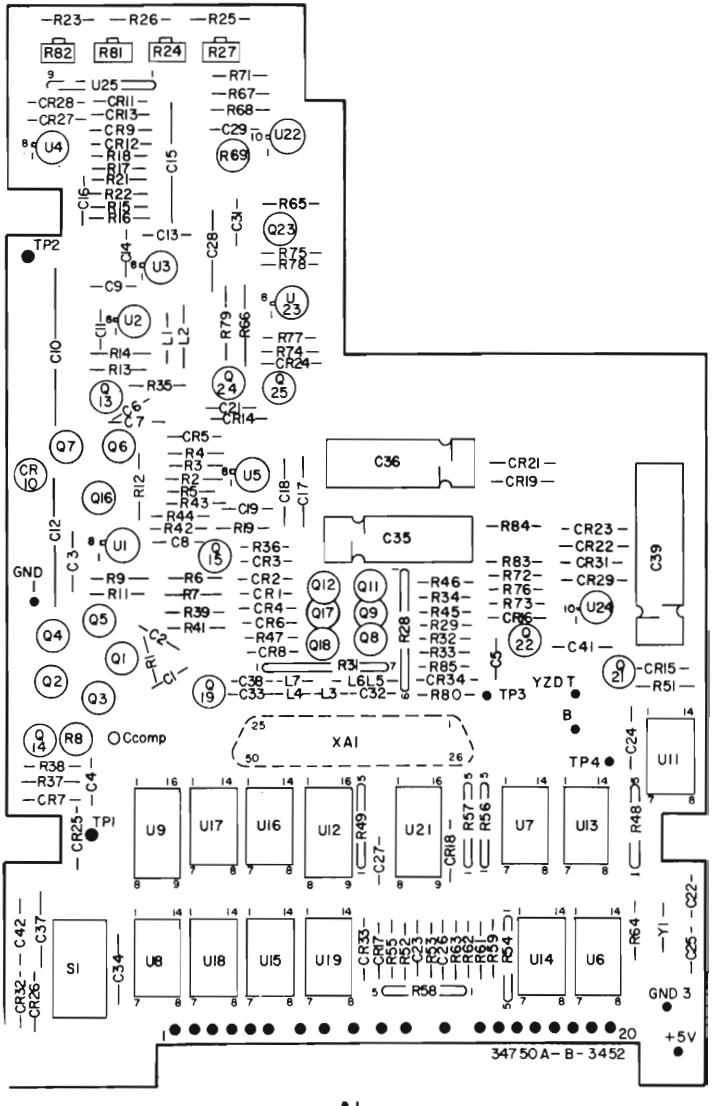
P/O A1 MOTHER BOARD 034750-66501
(ANALOG SIGNAL PROCESSOR SECTION)





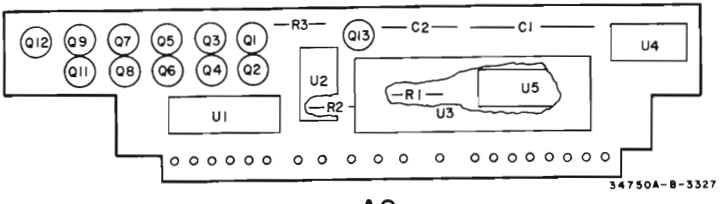
34750A-J-3456

Figure 7-6. Analog Signal Processor.
Rev. B 7-13/7-14



A1

hp Part No. 034750-66501
Rev D



A2

hp Part No. 34750-66502

P/O A1 MOTHER BOARD 034750-6650I (DIGITAL PROCESSOR)

A2 DISPLAY MODULE 034750-

DATA CLOCK

BUFFER

÷4

+5Vs

R64 1.82K

C22 47pF

Y1

TP3

TP4

HOLD (LHLD)

R48 22K

U8

U9 TIMING GENERATOR

30Hz

R49 2.2K

U12 RESET COUNTER

R49 22K

U13

RESET PULSE

U15

INTEGRATOR ENABLE (LINGE)

U16

AUTO ZERO (LMATZ) (TO PLUG ON)

INPUT ENABLE (LIEN)

U17

POSITIVE INPUT (TO PLUG ON)

NEGATIVE INPUT

-REF ENABLE (LNRE)

+REF ENABLE (LPRE)

U18

ZERO DETECT HELD (LZDH)

ZERO DETECT CATCHER

YZDT

NORMAL

TEST

B TIMING BIT

ZERO DETECT GATES

DATA TRANSFER TIMING

DATA CLOCK DISABLE

C23 .01

R52 3.83K

R53 2.05K

C26 .01

U19

R54 1.8K

CR17

TRANSFER PULSE

R55 33K

C27 390pF

CR18 6.81V

-12Vs

U21 DATA ACCUMULATOR

R57 22K

+5V

R51 3.3K

Q21

CR15

Q22

CR16

R54 22K

R56 22K

U7

BCD8

BCD4

BCD2

BCD1

PLUG-ON MODULE

XA1

SEE NOTE 3

X

Y

Z

ZERO DETECT HELD (LZDH)

POSITIVE INPUT

AUTO ZERO (LMATZ)

HOLD (LHLD)

LSD BLANK (LSDB)

LEAST SIGNIFICANT DIGIT BLANK

U13

U14

CR33

C1 330

RIGHT/LEFT H CHARACTER SC

U1 SCANNER

C2 .0039

100,000'S

POLARITY ENABLE (LPOE)

DISPLAY POLARITY (HDPP)

R1 4.7K

Q13

R2 82

R3 82

POLARITY DISPLAY U2

VLED

R58 22K

R59 330

R61 330

R62 330

R63 330

DP 4 (LDP4)

DP 3 (LDP3)

DP 2 (LDP2)

DP 1 (LDP1)

SCANNER CLOCK

SCANNER CLK 12KH

BCD 8

BCD 4

BCD 2

BCD1

(LOVL)

HOLDS BCD2 LOW AT OVERLOAD SO THAT 2 WILL NOT BE DISPLAYED IN 100,000'S DIGIT

GIVES A "1" DISPLAY IN THE 100,000'S DIGIT AT OVERLOAD

OVERRANGE DETECT

EXTERNAL DISPLAY BLANK LINE (LBLK)

OVERLOAD

BLANKS OVERRANGE DIGIT BELOW 100% OF RANGE

OVERRANGE DIGIT SCAN DETECT

OVERRANGE DIGIT BEING SCANNED (H)

BLANKS 1'S THRU 10,000'S DIGITS ON OVERLOAD

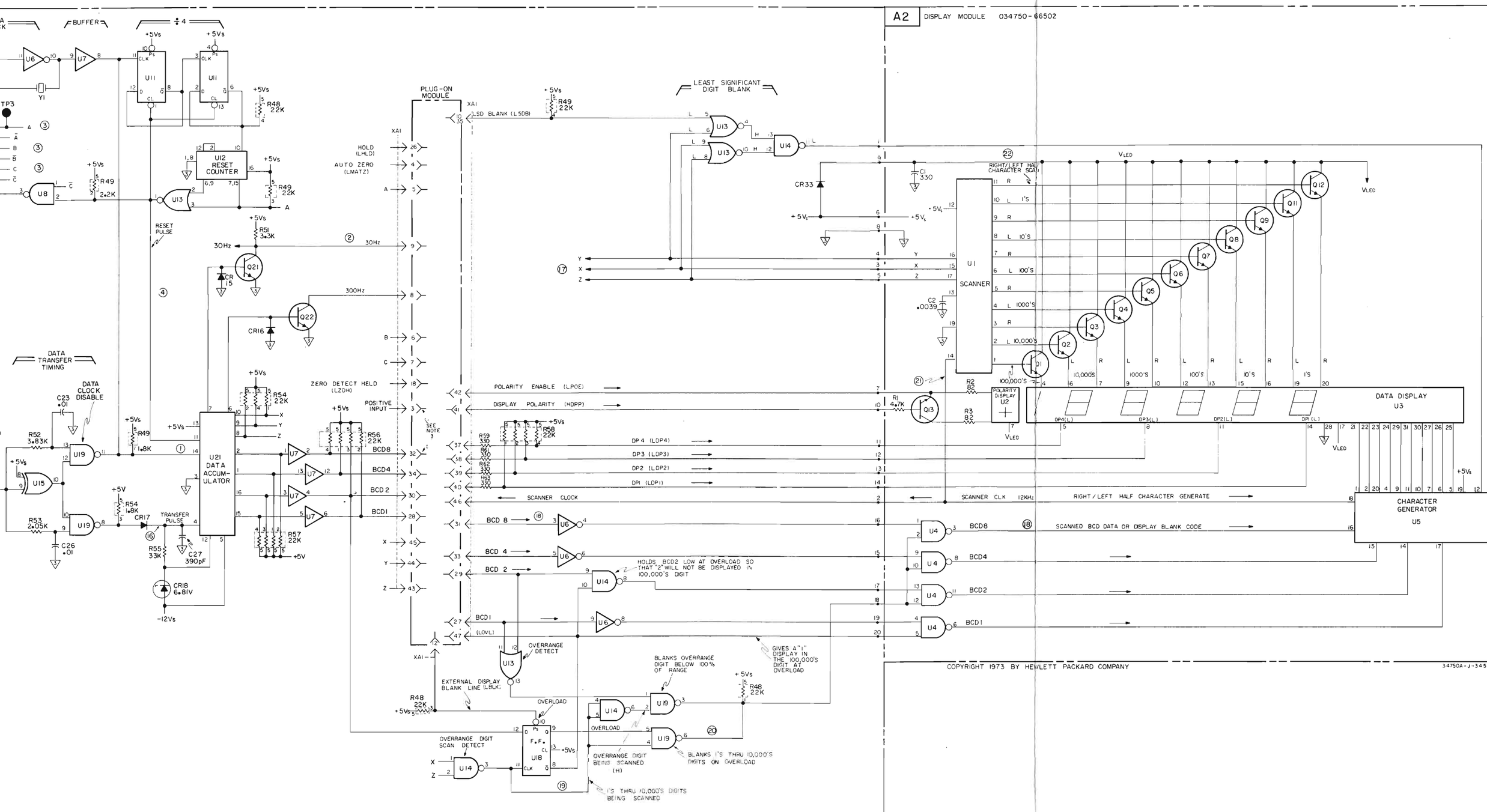
1'S THRU 10,000'S DIGITS BEING SCANNED

+5Vs IS FILTERED HERE, NEAR THE LOGIC CIRCUITS WHERE IT IS USED. THIS REDUCES RIPPLE AND HIGH FREQUENCY NOISE.

C24 6.8

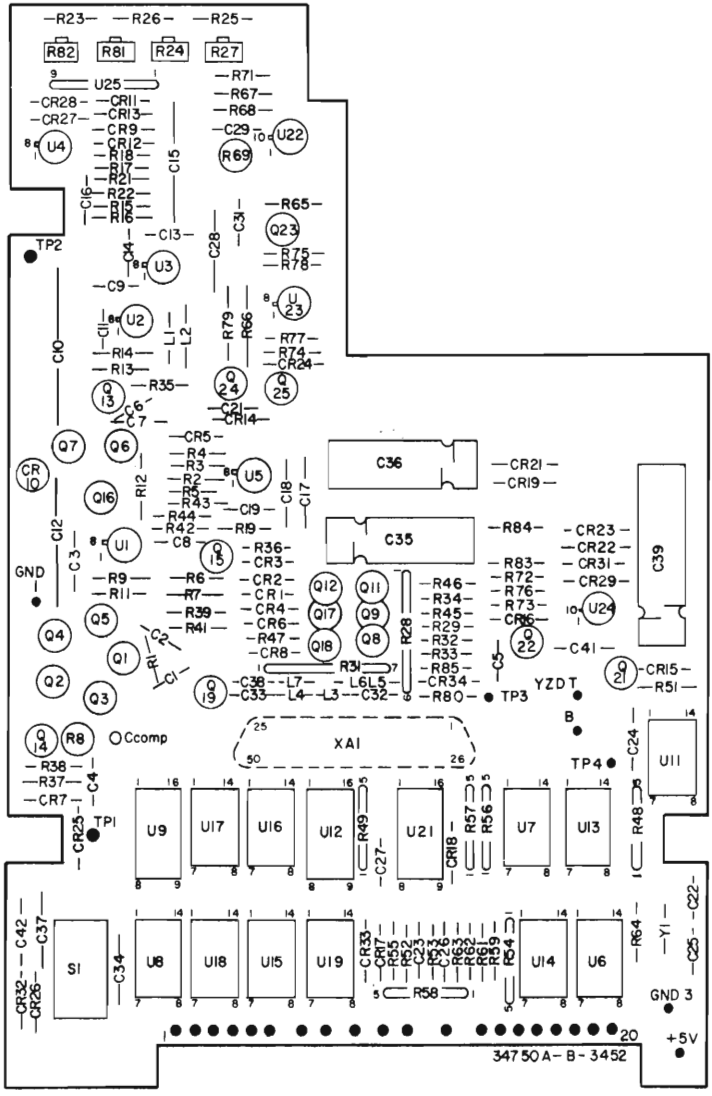
C25 0.1

GND 3



34750A-J-3457

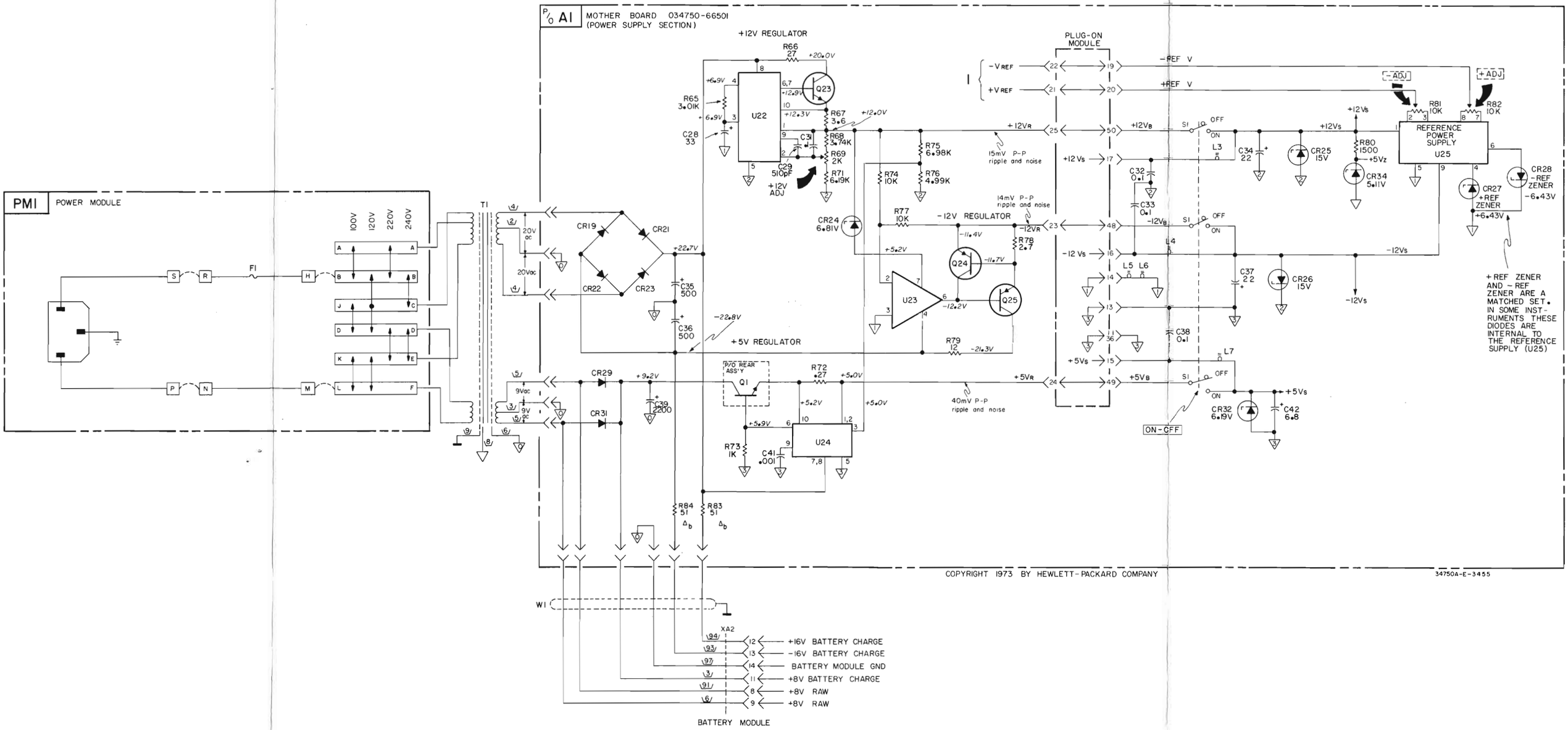
Figure 7-7. Digital Signal Processor.
Rev. B 7-15/7-16



A1

hp Part No. 034750-66501

Rev D



3

Figure 7-8. Power Supply.
Rev. B 7-17/7-18

SECTION VIII
BACKDATING

8-1. INTRODUCTION.

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

8-3. CHANGE SEQUENCE.

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

8-5. PARTS NOT INCLUDED IN BACKDATING.

8-6. When replacing a part whose value or part number differs from the schematic diagram or parts list in this manual, yet is not listed in the following changes, use the replacement part number shown in Section VI. These parts are identified by the symbol Δ.

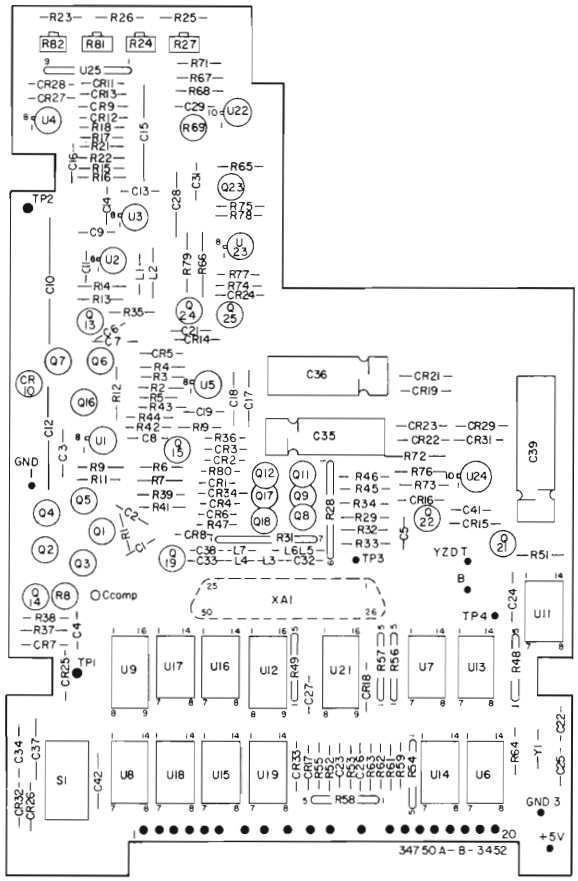
Table 8-1. Manual Backdating Changes.

Instrument Serial Prefix	Make Manual Changes
1304A00275 and below	1

CHANGE NO. 1

Applies to instrument Serial No's 1304A00275 & below.

Change the 34750-90001 Component Locator as shown below:



A1
hp Part No. 034750-66501
Rev C

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon	Clifton Heights, Penn.
09922	Burndy Corp	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co, Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark.	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G. E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U. S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
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91827	K F Development Co.	Redwood City, Cal.
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91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
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94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
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96341	Microwave Associates, Inc.	Burlington, Mass.
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99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

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0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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OPERATING AND SERVICE MANUAL

BATTERY MODULE
34720A

HEWLETT hp PACKARD

-hp- 34720A

OPERATING AND SERVICE MANUAL

Manual Part No. 34720-90002
Microfiche Part No. 34720-90052

MODEL 34720A
BATTERY MODULE

The main body of this instruction manual applies to

Serial Number 1224A00101

and higher. Any changes made in instruments having serial numbers higher than the above number are, or will be, integrated into the manual by page revision as they occur. Revised pages are identified by a revision letter in the lower corner of the page. You may receive subsequent revised pages by returning the questionnaire in the front of the manual with the appropriate square marked. If a change is made that does not apply to all previously manufactured instruments, backdating information in Section VIII adapts the manual to the earlier instruments.

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

Printed in U.S.A.

Printed: FEBRUARY 1974

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This publication represents our latest effort in improving the quality of our instruction manuals. We would like to know what you think of it and how you feel we can better serve your needs. Will you give us a few minutes of your time by completing the questionnaire on the reverse side?

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Model 34720A

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1-3. WARRANTY.

1-4. The Model 34720A Battery Module is covered by a one-year warranty on all parts except the batteries. *The batteries are warranted for six months against failure due to manufacturing defect.*

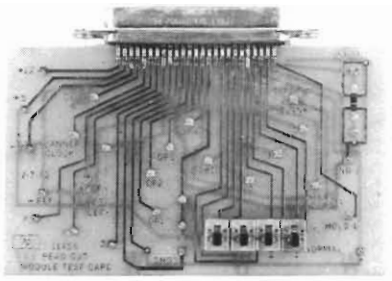
1-5. SPECIFICATIONS.

1-6. Specifications for the 3470 Measurement System are unchanged from those stated in the Operating and Service Manuals for the separate instruments when operating in a temperature range of 0° C to + 50° C.

1-7. ACCESSORIES AVAILABLE (See Figure 1-1).

a. 11456A–Readout Test Card–facilitates testing and troubleshooting the Display Module with the 34720A connected.

b. 18019A–Carrying Case–accommodates a Display Module, a "signal conditioning" module, and the 34720A Battery Module plus the power cord and input cables. A



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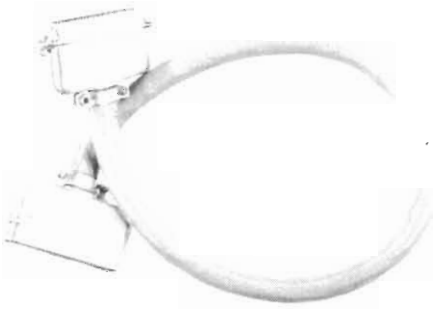


11148A
PLUG-ON EXTENDER CABLE

Figure 1-1. Accessories Available.

shoulder strap consisting of a web strap, -hp- Part No. 1440-0075, and a shoulder pad, -hp- Part No. 1440-0097, is available.

c. 11148A–Plug-on Extender Cable–allows the instrument to be operated with the bottom module separated from the battery module.

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. A three-section serial number is used to identify your Model 34720A. Figure 1-2 illustrates the meaning of the three parts of the number.

1-10. This manual is kept up to date with revised pages. If the serial number of your instrument is lower than the one on the title page of this manual, refer to the backdating information in Section VIII which adapts this manual to your instrument. All correspondence with Hewlett-Packard Company should include the complete serial number.

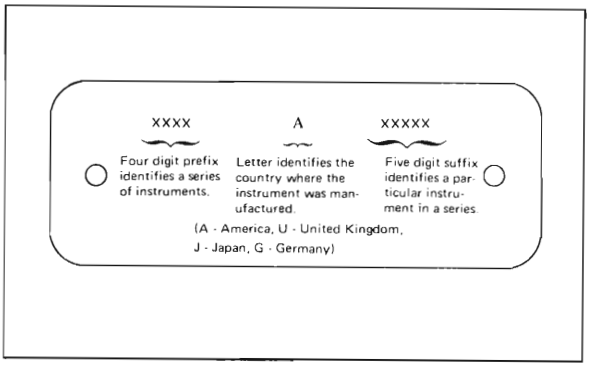


Figure 1-2. Instrument Serial Number (on rear panel).

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions for the installation and shipping of the Model 34720A. Included are initial inspection procedures, battery information, environmental information, and repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit file a claim with the carrier. If there is damage or deficiency not due to shipping, see the warranty on the reverse side of the title page of this manual.

2-5. BATTERIES.

2-6. Three sets of nickel-cadmium batteries are used in the 34720A Battery Module. They supply nominal voltages of + 5 V, + 12 V, and - 12 V. A fully charged pack will operate the instrument for up to 6 hours.

2-7. ENVIRONMENTAL REQUIREMENTS.

2-8. The following temperature limits should be observed:

Operating (discharge):	0°C to + 50°C
Charge:	+ 5°C to + 40°C
Storage:	- 40°C to + 75°C

2-9. INSTALLATION OF THE MODEL 34720A.

2-10. Referring to Figure 2-1, install the Model 34720A between the display module and the bottom module using the following procedure:

a. Separate the display module from the bottom module if they are connected together. This is done by pulling the two side locks on the back of the display module to the rear and lifting the display module from the bottom module.

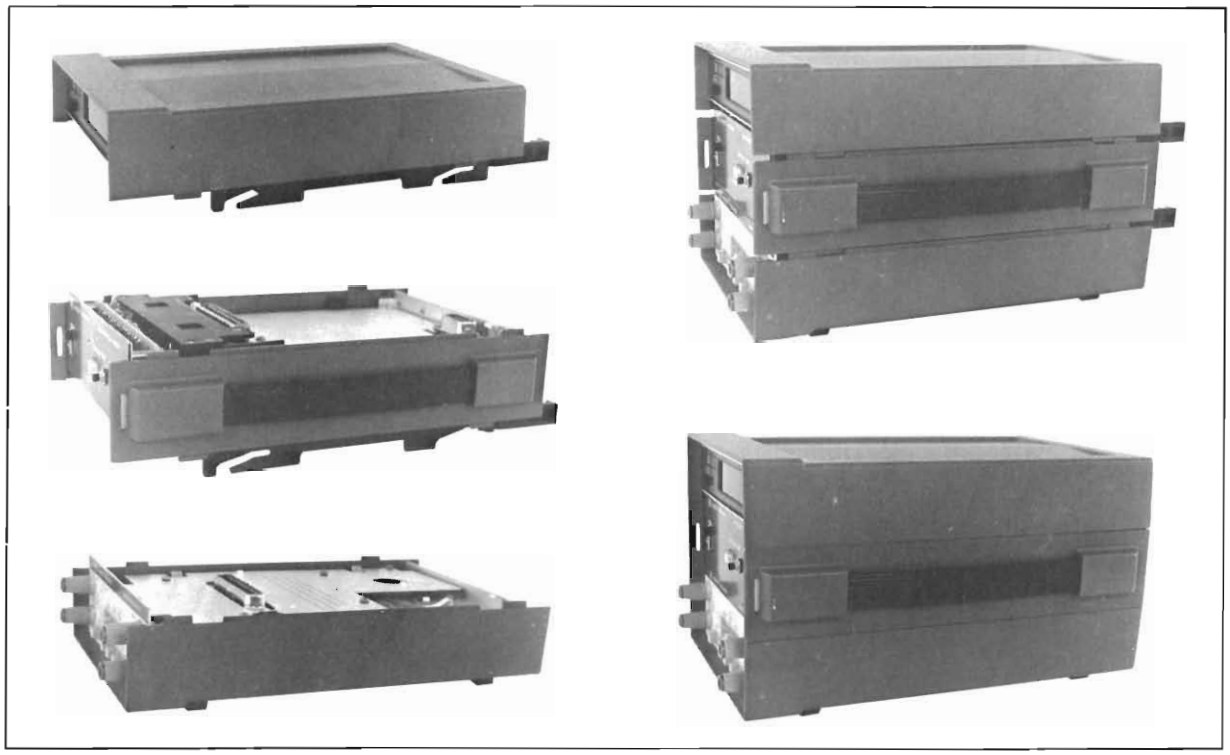


Figure 2-1. Installation of the Model 34720A.

b. Position the display module over the Model 34720A so that the plastic keys on the sides of the two modules interlock.

c. Push the side locks toward the display module. This fastens the two modules together.

d. Pull the side locks on the Model 34720A rearward and connect the bottom module to the 34720A. This can be accomplished in a manner similar to that previously described.

2-11. REPACKING FOR SHIPMENT.

2-12. If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument describing the work to be accomplished and identifying the owner of the instrument. Identify the instrument by serial, number, model number, and name in any correspondence. If you have any questions, contact your local Hewlett-Packard Sales and Service Office.

2-13. If the original shipping container is to be used, place the instrument in the container with appropriate packing material and seal the container well with strong tape or metal bands.

2-14. If an -hp- container is not to be used, use a heavy carton or wooden box with an inner container. Wrap the instrument with heavy paper or plastic and place cardboard strips across the face for protection before placing the instrument in the inner container. Use packing material around all sides of the inner container and seal the outer container well with strong tape or metal bands. Mark the container with "DELICATE INSTRUMENT" or "FRAGILE."

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains operating instructions for the Model 34720A. A display module (Model 34740A or Model 34750A) and a signal-conditioning module such as the Model 34702A are normally connected to the Model 34720A. Also included in this section is identification of controls, indicators, and connectors. The measurement procedure for the 3470 System using a battery module is identical to the procedure without a battery pack.

3-3. PANEL FEATURES.

3-4. Panel features of the instrument are described in Figure 3-1.

3-5. OPERATION.

3-6. Line Mode.

3-7. When the MODE switch is in LINE position (see Figure 3-1), the batteries are not used to power the instrument. However, a trickle charge is applied to the batteries whenever the line cord is connected, whether the power switch on the display module is ON or OFF. This trickle charge is not sufficient to charge the batteries when the instrument is on.

3-8. Battery.

NOTE

The nickel-cadmium batteries used in the 34720A are warranted for six months against failure due to manufacturing defect.

WARNING

Connect the solder lug terminal on the rear of the battery module to earth ground when operating in the battery mode. Otherwise a high voltage breakdown between the input circuit and instrument chassis could be dangerous to the operator.

3-9. Set the MODE switch to the BATTERY position, turn the instrument ON, and press the BATTERY TEST pushbutton to check the condition of the batteries. Always test the batteries under normal operating load; i.e., with the display and signal-conditioning modules connected, the instrument on, and operating in BATTERY mode. If the BATTERY TEST indicator needle is in the red area, the batteries should be recharged. Refer to Paragraph 3-11 for information regarding charging the batteries. When the batteries are fully charged at normal temperature (25°C), they are capable of supplying up to 6 hours of operation.

CAUTION

Do not discharge the batteries to the point where the battery test indication is to the left of the red area. To do so may cause permanent damage to the batteries.

3-10. The instrument may be operated in the battery mode where the temperature within the battery module is between 0°C and 50°C (32°F to 122°F). The operating temperature within the battery module is normally 5°C (9°F) higher than ambient temperature.

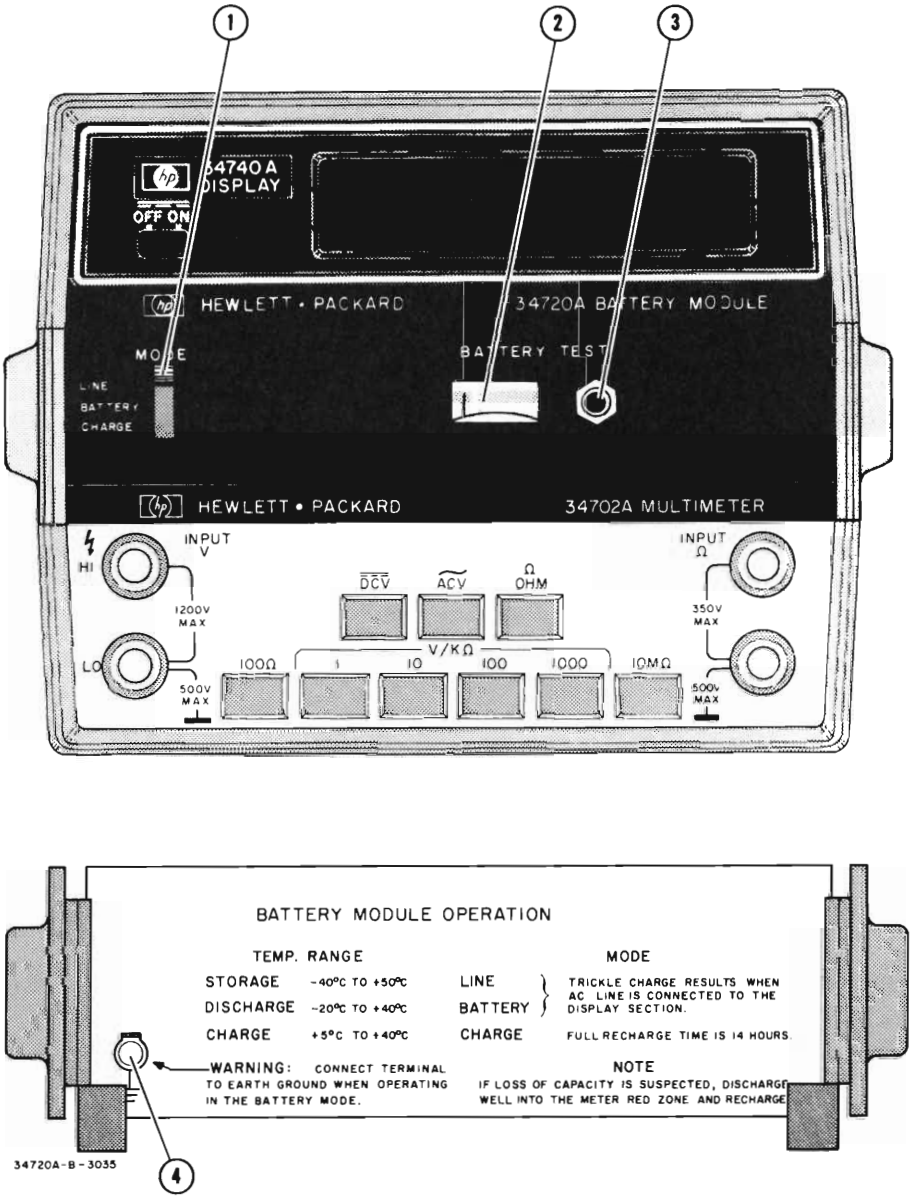
3-11. Charge Mode (fast charge).

NOTE

A trickle charge is maintained on the batteries whenever the line cord is connected to the display module. While this small charging current will help to prevent the batteries from completely discharging, it should not be relied upon to fully charge the batteries.

CAUTION

The nickel-cadmium batteries are hermetically sealed and can be damaged if charged at a fast rate at temperatures above 104°F (40°C). Do not charge at the fast rate for more than 15 hours.



1. Mode Switch. Selects Line or Battery operation, or charge.
2. Battery Test Indicator. Batteries must be recharged when indication is in red area.
3. Battery Test Pushbutton.
4. Safety Ground Terminal (See Paragraph 3-6).

Figure 3-1. Front and Rear Panels.

3-12. When the BATTERY TEST indicator needle is in the red area, recharge the batteries using CHARGE MODE. Recharge time for completely discharged batteries is approximately 14 hours. Proceed as follows:

> Connect the line cord to primary power and set the MODE switch to CHARGE. The display module power switch may be either ON or OFF, since the instrument will not operate while in CHARGE mode. Although the batteries will probably not be damaged by allowing them to fast charge more than 14 hours, repeated overcharging may shorten battery life.

3-13. The battery pack may be charged at temperatures between 5° C and 40° C (41° F to 104° F), but will accept a greater charge if the temperature is between 5° C and 25° C. Figure 3-2 shows the decrease in charge acceptance at temperatures up to 40° C. Charging at temperatures outside the specified range may cause the batteries to vent, with a resulting decrease in capacity.

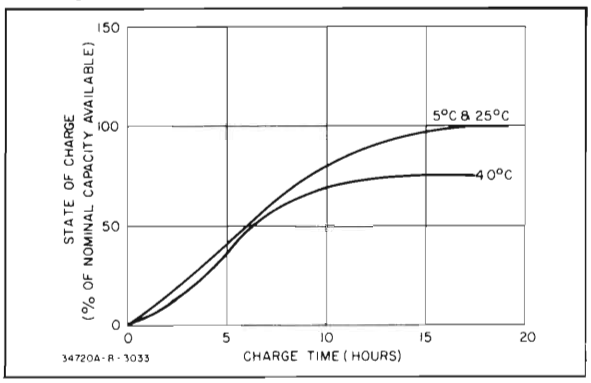


Figure 3-2. Battery Charge Acceptance vs. Temperature.

3-14. BATTERY STORAGE.

3-15. When shipped from the factory the nickel-cadmium batteries are in the discharged state (≥ 1 V/battery for the 3/5 D size cells and ≥ 2.0 V/battery for the batteries in the 5 V supply). When possible the batteries should be stored in this state. If the batteries are stored in the charged state they should be recharged for a period of 14 to 15 hours every 3 months. If this is not done significant loss of battery capacity will occur. To minimize self-discharge during storage the batteries should be stored at a temperature of 20° C or lower. Although a nickel-cadmium battery will eventually lose all of its charge through self discharge it can be returned to service with a normal recharge.

CAUTION

Permanent battery damage may result if the batteries are stored at high temperatures for a prolonged period.

3-16. CYCLE-LIFE OF NICKEL-CADMIUM BATTERIES.

3-17. The cycle-life of the batteries is based, by the manufacturer, on an end point of 80% of the rated 225 milliampere-hour capacity. This is with a ten hour charge and discharge current of 22.5 milliamperes with discharge carried to the normal ten-hour end voltage (1.10 volts/battery) of every cycle. Under these conditions a cycle-life in excess of 100 cycles can be expected.

SECTION IV
THEORY OF OPERATION

4-1. BATTERY SUPPLIES.

4-2. Three voltages are supplied by the battery module; i.e., + 12 V, - 12 V, and + 5 V. Figure 4-1 represents a typical battery supply. Power for the various plug-on modules is provided by the display module power supplies when the MODE switch is in LINE position. In the BATTERY position, power is supplied by the battery module. When the MODE switch is in either LINE or BATTERY position, charging current is applied to the battery through the diode and R_{LO} in series with R_{HI}. This provides a trickle charge.

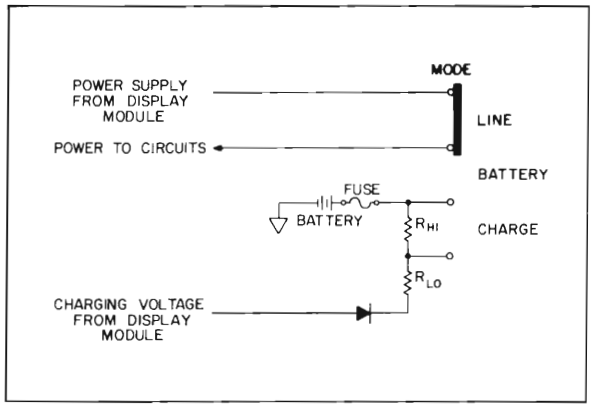


Figure 4-1. Typical Battery Supply.

When the switch is set to the CHARGE position, only the diode and R_{LO} are in the charge path. This increases the charging current by a factor of 10. The diode prevents the battery from discharging back through the charge circuit when the line cord is disconnected.

4-3. The nickel-cadmium batteries used in the Model 34720A are able to supply relatively high discharge currents. Because of this, a fuse is inserted in each battery supply line to prevent damage to wiring or circuits due to an accidental short circuit or component failures.

4-4. BATTERY TEST CIRCUIT (See Figure 4-2).

4-5. The BATTERY TEST switch connects the meter circuit to the + 5 V battery to monitor its state of charge. The + 5 V battery is monitored because its rate of discharge is normally greater than for the other supplies. Current through the meter is limited by a resistor and a zener diode. A 50 Ω potentiometer is connected in shunt with the meter. This potentiometer is adjusted to give a full scale meter reading when the batteries are fully charged and operating under normal load conditions.

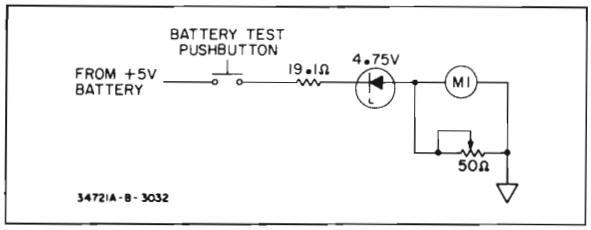


Figure 4-2. Battery Test Circuit.

4-6. NICKEL-CADMIUM BATTERIES.

4-7. The 34720A Battery Module uses resealable vented nickel-cadmium batteries. These cells are normally in a sealed condition, but will vent under excessive internal pressure, then reseal as the pressure is relieved. Charging at temperatures outside the specified range (+ 5° C to + 40° C) may cause the batteries to vent, and repeated venting will result in a decrease in battery capacity because of loss of electrolyte.

4-8. The nickel-cadmium batteries in the separate supply packs are connected in series. Since the batteries do not all have exactly the same charge capacity, some will reach the complete discharge state before others. If discharge is continued beyond this point (below the meter red zone), the batteries with lower capacity may reverse polarity causing venting and resulting loss of capacity.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for proper maintenance of the Model 34720A. The 34720A requires no performance tests.

NOTE

The nickel-cadmium batteries in this instrument are warranted for six months against failure due to manufacturing defect.

5-3. RECOMMENDED TEST EQUIPMENT.

5-4. A dc voltmeter with at least 10 MΩ input resistance and an ohmmeter are needed to maintain the 34720A Battery Module. An -hp- Model 427A Multi-Function Meter is recommended. Also an -hp- 11148A Plug-on Extender Cable is required to perform the procedures outlined in this section.

WARNING

The following precautions should be observed when working with nickel-cadmium batteries.

a. Be very careful with uninsulated tools when working with charged batteries. Severe arcing may result from an accidental short circuit because nickel-cadmium batteries are capable of high discharge current.

b. Do not wear rings without wearing gloves when handling charged cells. Metal watch bands, identification bracelets, and other such jewelry are also dangerous. Severe burns can be realized from shorting a charged cell.

c. Do not attempt to solder directly to a sealed cell. Too much heat can damage the seal. Solder only to the metal tab.

d. Do not place uninsulated batteries on a metal bench or metal surface. This may place a direct short across the cells.

e. Do not dispose of batteries in a fire.

f. In case you get electrolyte on your hands, wash quickly and neutralize with a mild acid such as vinegar.

NOTE

Individual batteries cannot be replaced in this instrument because the individual battery capacities are matched in each pack. For information regarding charging and care of the nickel-cadmium batteries refer to Section III of this manual.

5-5. ADJUSTING THE BATTERY TEST METER.

5-6. The meter circuit should not require adjustment unless one or both batteries in the + 5 V supply have been replaced or unless the meter itself has been replaced. Use the following procedure to adjust the meter:

NOTE

The battery module must be connected to a display module. Also, an 11456A Readout Test Card or an 11148A Extender Cable is required in this procedure.

a. Remove the signal-conditioning (bottom) module from the instrument.

b. Connect an 11148A Extender Cable between the signal-conditioning module and the 34720A or connect the -hp- 11456A Read-Out Test Card in place of the signal-conditioning module.

c. Connect the line cord to primary power and set the MODE switch to CHARGE. Allow the batteries to charge for approximately 14 hours.

d. After the batteries have been charged, set the MODE switch to BATTERY and turn the instrument on. Allow the instrument to operate for 5 minutes.

e. Turn A1R8 fully counterclockwise. (Figure 5-1 shows the location of A1R8.) The meter needle should move against the right-hand stop when the pushbutton is pressed.

f. Hold the BATTERY TEST pushbutton in and adjust A1R8 until the meter needle just begins to move away from the right-hand edge of the meter. This completes the meter adjustment.

5-7. GENERAL MAINTENANCE INFORMATION.

5-8. The following paragraphs provide servicing and repair information for your Model 34720A.

5-9. Access to Components.

5-10. To gain access to the components on the A1 printed circuit (P.C.) assembly, use the following procedure:

a. Remove the covers from both battery compartments and take out the batteries.

CAUTION

Do not place the batteries on a metal surface. Also be careful when using uninsulated tools.

b. Remove the screws securing the rear battery compartment to the side frames. Remove the compartment from the module.

c. Remove the screws holding the 50 pin connector to the battery compartment.

d. Remove the four No. 4 allen screws securing the front compartment to the side frames. Remove the compartment.

e. Remove the four screws holding the A1 P.C. assembly to the front panel. The P.C. assembly can now be removed for troubleshooting or repair.

5-11. Meter Replacement.

5-12. In order to remove the BATTERY TEST meter, first perform steps a through e of Paragraph 5-9. After this has been accomplished, remove the nut from the pushbutton on the front panel. Take out the screws holding the front panel to the side frames and separate the front panel from the sub-panel. Unsolder the two wires which connect to the meter and remove the two screws which hold it to the sub-panel. Install the new meter and reassemble the instrument.

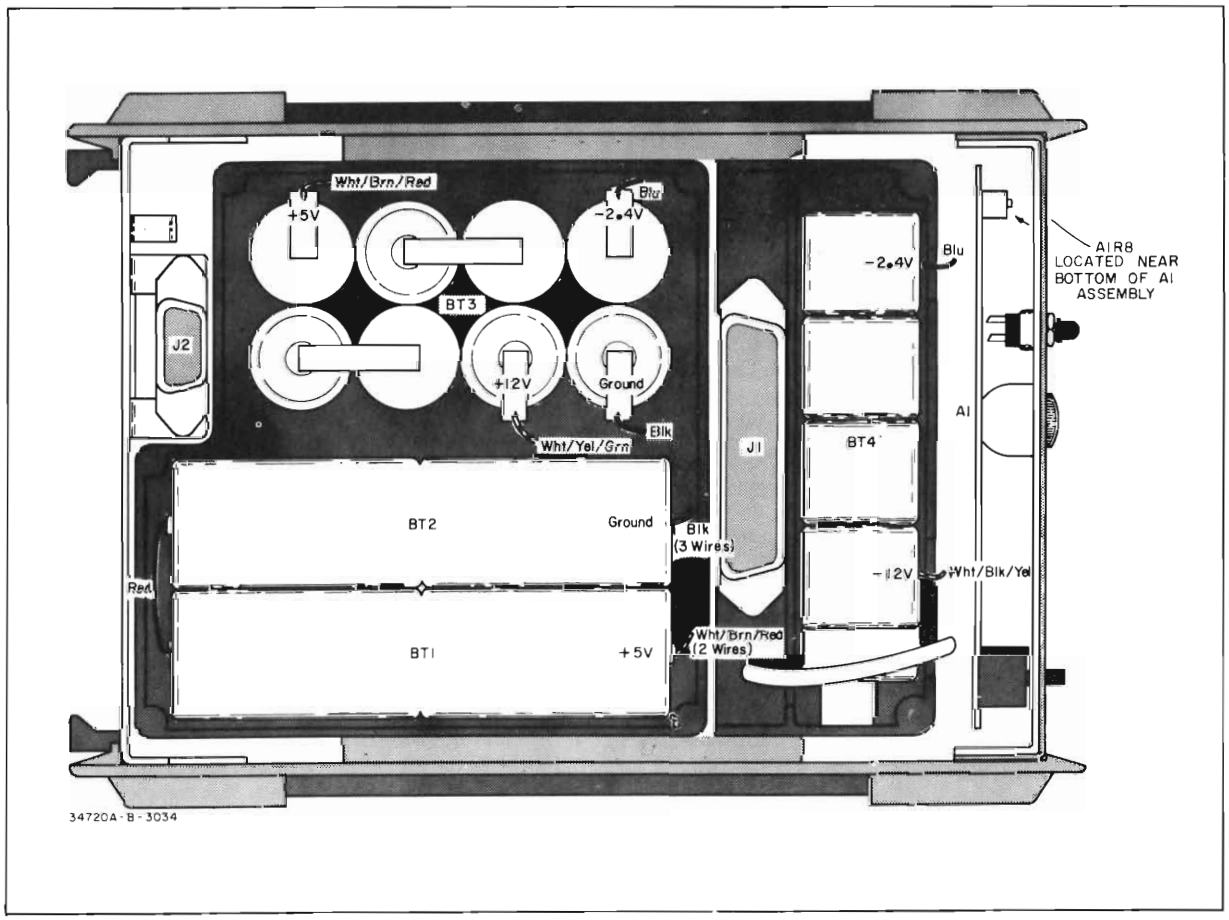


Figure 5-1. Battery Location.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes and provides the following:

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

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

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

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

ABBREVIATIONS

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

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

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

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	**34720-66501**	**1**	**Main Circuit Assembly**	**-hp-**	
CR1 thru CR4	1901-0028	4	Diode: Si 400 piv	04713	SR 1358-9
CR5	1902-3086	1	Diode: breakdown 4.75 V ± 2 %	04713	SZ 11213-48
F1	2110-0003	1	Fuse: 3 A 250 V normal blow	71400	AGC-3
F2, F3	2110-0002	2	Fuse: 2 A 250 V normal blow	71400	AGC-2
R1	0698-3605	1	R: fxd flm 15.0 Ω ± 5 % 2 W	75042	RG-42 obd
R2, R3	0698-5019	2	R: fxd flm 32.4 Ω ± 1 % 1/2 W	75042	CEC T-0 obd
R4	0698-3333	1	R: fxd flm 137 Ω ± 1 % 1/8 W	75042	CEA T-0 obd
R5, R6	0698-3443	2	R: fxd flm 287 Ω ± 1 % 1/8 W	75042	CEA T-0 obd
R7	0698-4366	1	R: fxd flm 19.1 Ω ± 1 % 1/8 W	75042	CEA T-0 obd
R8	2100-2520	1	R: var cermet 50 Ω ± 20 % 1/2 W	73138	62-220-1
S1	3101-1717	1	Switch: slide, 3 pole, 3 pos.	79727	G-1685
XF1	2110-0269	6	Fuse clip	91506	6008-32CN
A2	**34720-66502**	**1**	**Plug-On Connector Assembly**	**-hp-**	
P1	1251-0099	1	Connector: 50-pin male	02660	57-10500-375
J1	34720-27601	1	Connector: 50-pin female	-hp-	
A3	**34720-66503**	**1**	**Battery Connector Assembly**	**-hp-**	
J2	1251-0290	1	Connector: 14-pin female	02660	57-20140
P2	1251-0291	1	Connector: 14-pin male	02660	57-10140
			CHASSIS MOUNTED COMPONENTS		
BT1, BT2	1420-0097	2	Battery pack	-hp-	
BT3	1420-0094	1	Battery pack	-hp-	
BT4	1420-0095	1	Battery pack	-hp-	
M1	1120-0537	1	Meter	-hp-	
S2	3101-1747	1	Switch: pushbutton SPST	09353	8532
W1	34720-61601		Assembly: cable	-hp-	
			MISCELLANEOUS		
	34720-00201	1	Panel: front	-hp-	
	34720-00203	1	Panel: sub	-hp-	
	5020-6894	2	Frame: side	-hp-	
	5040-6000	1	Catch: left, slide	-hp-	
	1440-0096	2	Handle: strap	12136	7835-Y12561
	5040-7036	4	Support: slide catch	-hp-	
	2200-0778	12	Screw: 4-40 x 0.312 in. long, flat head	02615	obd
	34720-60204	1	Panel assy: rear	-hp-	
	1460-1312	2	Spring clip	-hp-	
	34720-04101	1	Cover: rear battery case	-hp-	
	5040-7384	1	Cover: front battery case	-hp-	
	5040-7001	1	Catch: right slide	-hp-	
	5040-7381	1	Battery case: rear	-hp-	
	34720-66401	1	Battery case: front	-hp-	
	9220-1762	2	Dust cover	-hp-	
	34720-90002	1	Manual: Operating and Service	-hp-	

SECTION VII
TROUBLESHOOTING AND CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the Operating and Service Manual contains troubleshooting information and a circuit diagram for the Model 34720A Battery Module.

7-3. TROUBLESHOOTING.

7-4. If the instrument operates correctly with the MODE switch set to LINE, but will not operate correctly on BATTERY, the trouble is in the battery module or in the connections between modules. The battery test circuit monitors only the voltage across the + 5 V supply. Therefore, it is possible to have a "good" indication and still have a bad battery in either the + 12 V or - 12 V supply. Each battery supply is fused. The fuses are accessible by separating the bottom module and the battery module. The end of the fuse which is connected to the battery is indicated by a "B" (See Figure 7-1).

7-5. Battery Circuit Checks.

7-6. The best method of troubleshooting the battery module is to trace voltages through the suspected circuit. Table 7-1 shows typical voltages for each supply under charged and discharged conditions. Voltages should be measured with the power cord disconnected and the instrument operating in BATTERY MODE.

7-7. To check the voltage of the batteries, first separate the display module from the battery module. Remove the covers in the battery compartment and connect the battery module to the display module using an 11148A Extender Cable. This procedure is outlined in steps a - c of Paragraph 5-6 in the Maintenance Section of this manual.

7-8. If a single battery in a battery pack has failed, the overall voltage of the pack should be about 1.2 V less than normal (2.2 V in the 5 V supply). The voltage drops approximately 1.2 V for each battery that has failed. If the + 5 V and + 12 V supplies both indicate the same voltage error, the trouble is probably in the + 5 V battery pack. The + 5 V supply is also part of the + 12 V supply. To isolate the batteries from the rest of the circuit, remove the fuse in the circuit of interest. Two batteries in the - 12 V supply are part of battery pack BT3. The remainder of the batteries in the - 12 V supply are part of BT4.

Table 7-1. Typical Battery Voltages.

Supply	Fully Charged Voltage	Discharged* Voltage
+ 5 V	+ 5.2 V to + 5.4 V	+ 4.6 V to + 4.8 V
+ 12 V	+ 13.5 V to + 14 V	+ 11.5 V to + 12 V
- 12 V	- 13.5 V to - 14 V	- 11.5 V to - 12 V

* Test conditions: Charge for at least 14 hours, then operate on battery (power cord disconnected) for 6 hours.

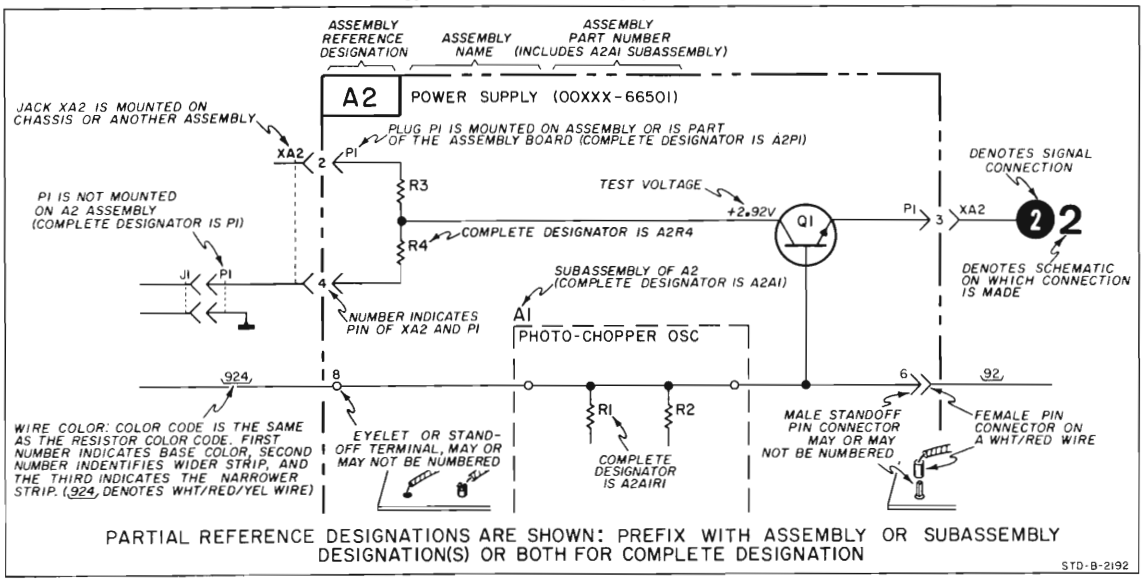
7-9. SCHEMATIC DIAGRAM.

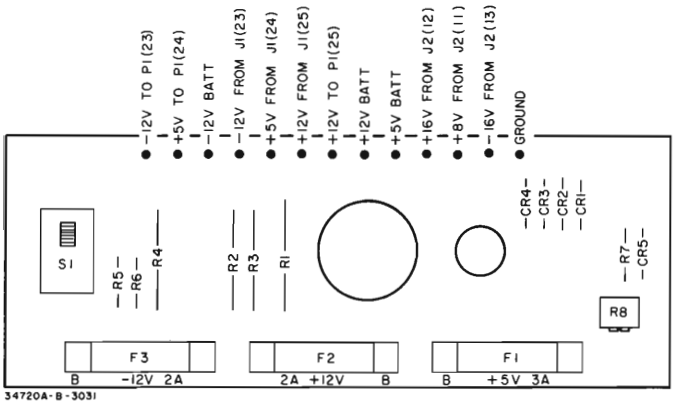
7-10. Figure 7-1 is the schematic diagram of the Model 34720A. This diagram is provided to assist in troubleshooting the instrument.

7-11. COMPONENT LOCATION DIAGRAM.

7-12. A Component Location Diagram of the 34720-66501 printed circuit assembly is provided on the schematic diagram. The Component Location Diagram shows location of all components mounted on the assembly. Each component is identified by a reference designator which corresponds to the same component on the schematic diagram.

REFERENCE DESIGNATIONS





A1

hp Part No. 34721-66501

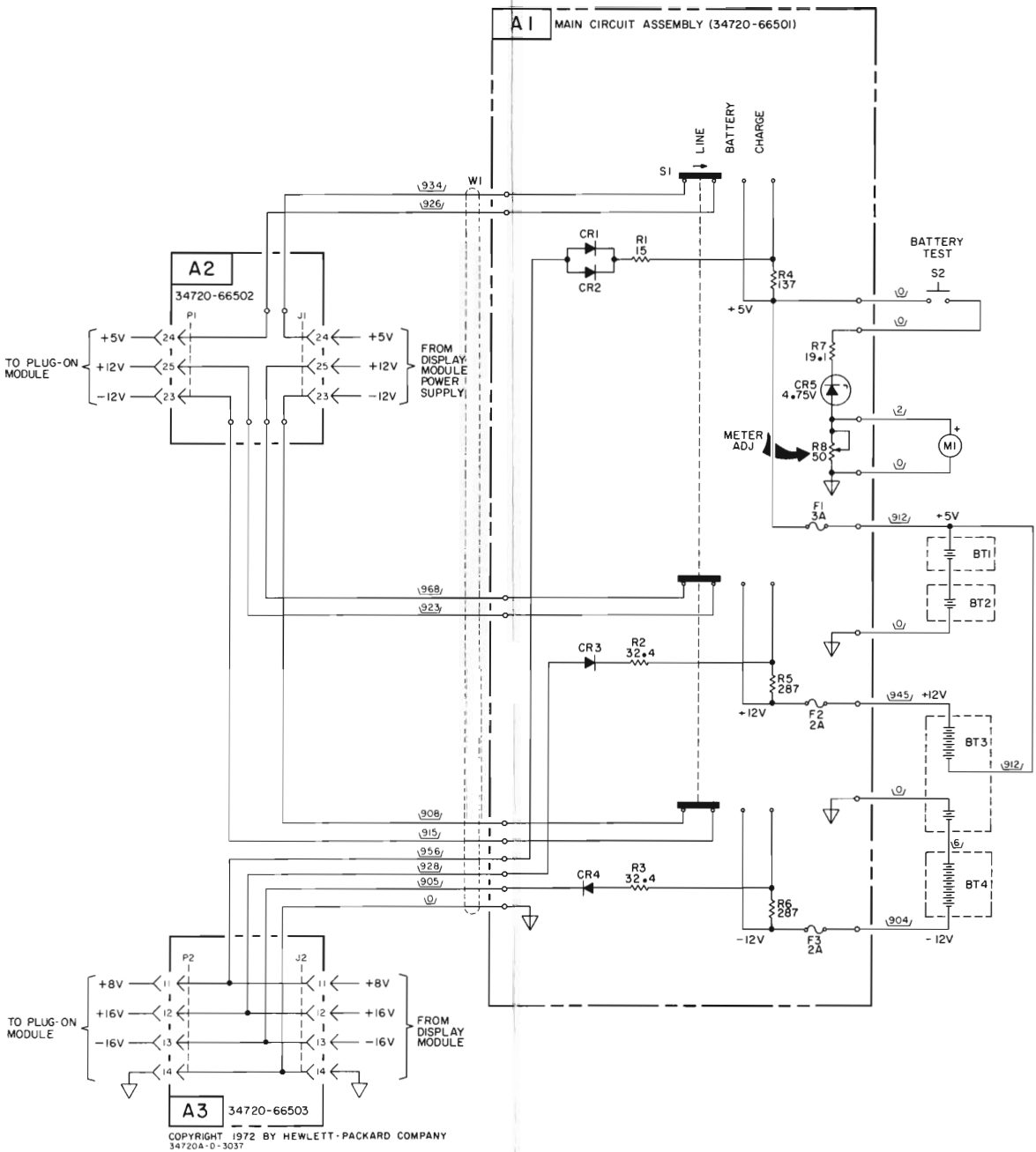


Figure 7-1. Schematic Diagram, Battery Module.

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A Common	Any supplier of U. S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N. J.
03296	Nylon Molding Corp.	Springfield, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox.	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon Clifton Heights, Penn.	
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N. Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company.	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N. J.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N. J.
16554	Electroid Co.	Union, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N. J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
919€1	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
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98278	Microdot, Inc.	So. Pasadena, Cal.
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98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

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0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
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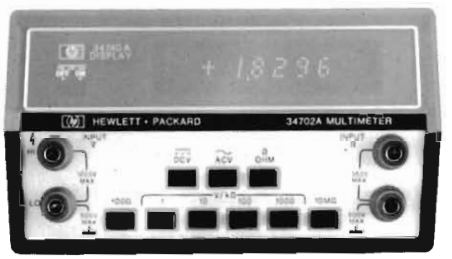
OPERATING AND SERVICE MANUAL

MULTIMETER
34702A



HEWLETT hp PACKARD

-hp- 34702A

OPERATING AND SERVICE MANUAL

Manual Part No. 34702-90002
Microfiche Part No. 34702-90052

MODEL 34702A
MULTIMETER

The main body of this instruction manual applies to

Serial Number 1212A0336

and higher. Any changes made in instruments having serial numbers higher than the above number are, or will be, integrated into the manual by page revision as they occur. Revised pages are identified by a revision letter in the lower corner of the page. If a change is made that does not apply to all previously manufactured instruments, backdating information in Section VIII adapts the manual to the earlier instruments.

WARNING

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

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

PRINTED IN U.S.A.

Revised: January 1975

Printed: October 1976

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual contains installation and operating instructions as well as maintenance information which includes performance checks for the Model 34702A. A schematic diagram, theory of operation, and troubleshooting information are provided for use in maintaining the 34702A Multimeter Module.

1-3. DESCRIPTION.

1-4. The Hewlett-Packard Model 34702A Multimeter is a signal conditioning module that may be connected to a Model 34740A or 34750A Display Module, to measure AC Voltage, DC Voltage, or resistance. The AC and DC volts functions provide four decade ranges from 1 V to 1000 V. Six resistance ranges from 100 Ω full scale to 10 MΩ full scale are provided by the "OHM (Ω)" function. Each available range of the Model 34702A has 100% overranging capability except the 1000 V range which has 20%.

CAUTION

Overload protection circuits allow up to 1200 V peak to be applied to the INPUT V terminals without damaging the instrument. Up to 350 V can be applied to the INPUT Ω terminals without damaging the instrument. No more than 500 V should be applied between LO and Chassis (⏚). Do not apply voltage between LO and Chassis when using the 34721A or 34721B BCD Module. These modules connect LO to Chassis when attached to the Model 34702A.

1-5. SPECIFICATIONS AND GENERAL INFORMATION.

1-6. Table 1-1 lists specifications for the Model 34702A Multimeter. This table supercedes all other previously printed specifications. Procedures are provided in Section V to verify performance of the instrument to its specifications and to readjust the instrument if required. The accuracy specifications apply for ambient temperatures of 23°C ± 5°C. For temperatures outside this range, a temperature coefficient factor (listed in Table 1-1) must be used.

1-7. Table 1-2 lists general information relating to the instrument.

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. A three-section serial number (xxxxAxxxxx) is used to identify your Model 34702A. Figure 1-1 illustrates the meaning of the three parts of the number.

1-10. This manual is kept up-to-date with revised pages. If the serial number of your instrument is lower than the one on the title page of this manual, refer to the backdating information in Section VIII which adapts this manual to your instrument. All correspondence with Hewlett-Packard Company should include the complete serial number.

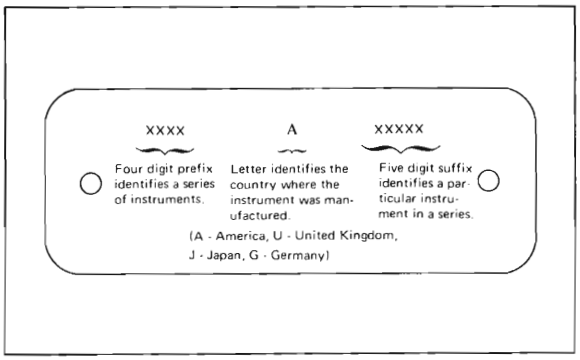


Figure 1-1. Instrument Serial Number.

Table 1-1. Specifications. (Measured using 34740A or 34750A Display Unit)

DC VOLTAGE
34740A

Performance:

Accuracy (+ 23°C ± 5°C), ≤ 95% RH)
- 30 days ± (0.03% of reading + .01% of range)
- 90 days ± (0.04% of reading + .01% of range)
- 6 mo. ± (0.05% of reading + .02% of range)
- 1 yr. ± (0.06% of reading + .02% of range)

Stability (24 hours, + 23°C ± 1°C)
± (0.01% of reading + 0.005% of range)

Temperature Coefficient (0°C to + 50°C)
DC voltage: ± (0.0035% of reading + 0.001% of range)/°C.

Input Characteristics:

Input resistance
- 1 and 10 V ranges: 11.11 MΩ ± 0.2%
- 100 V range: 10.1 MΩ ± 0.2%
- 1000 V range: 10 MΩ ± 0.2%

Effective Common Mode Rejection (1 kΩ unbalance)
DC: > 80 dB. *

Normal Mode Rejection
- 50 Hz (Option 050): >60 dB (50 Hz ± 0.1%)
- 60 Hz (Option 060): >60 dB (60 Hz ± 0.1%)

* Does not apply when BCD Module is used.

AC VOLTAGE
34740A

Performance:

Accuracy (+ 23°C ± 5°C, ≤95% RH)

30 days
- 45 Hz to 20 kHz ± (0.25% of reading + .05% of range)
- 20 kHz to 100 kHz ± (0.75% of reading + .05% of range)

90 days
- 45 Hz to 20 kHz ± (0.30% of reading + .05% of range)
- 20 kHz to 100 kHz ± (0.80% of reading + .05% of range)

6 mo.
- 45 Hz to 20 kHz ± (0.35% of reading + .05% of range)
- 20 kHz to 100 kHz ± (0.85% of reading + .05% of range)

1 yr.
- 45 Hz to 20 kHz ± (0.50% of reading + 0.05% of range)
- 20 kHz to 100 kHz ± (1.0% of reading + 0.05% of range)

Temperature Coefficient (0°C to + 50°C)
AC voltage: ± (0.03% of reading + 0.001% of range) / °C.

Stability (24 hours, + 23°C ± 1°C)
AC voltage: 45 Hz to 20 kHz: ± (0.15% of reading + 0.05% of range)
20 kHz to 100 kHz: ± (0.4% of reading + 0.05% of range)

Response Time: < 2 s within ± 0.3% of final value or 20 counts, whichever is greater.

Input Characteristics:

Input impedance
- 1 and 10 V ranges: 11.11 MΩ ± 0.2%/ /80 pF max.
- 100 V range: 10.1 MΩ ± 0.2%/ /80 pF max.
- 1000 V range: 10 MΩ ± 0.2%/ /80 pF max.

OHMS
34740A

Performance:

Accuracy (+ 23°C ± 5°C, ≤ 95% RH)

30 days
- 10 MΩ range ± (0.25% of reading + 0.02% of range)
- All other ranges ± (0.05% of reading + 0.02% of range)

90 days
- 10 MΩ range ± (0.30% of reading + 0.02% of range)
- All other ranges ± (0.06% of reading + 0.02% of range)

6 mo.
- 10 MΩ range ± (0.35% of reading + 0.03% of range)
- All other ranges ± (0.07% of reading + 0.03% of range)

1 yr.
- 10 MΩ range ± (0.50% of reading + 0.03% of range)
- All other ranges ± (0.11% of reading + 0.03% of range)

Stability (24 hours, 23°C ± 1°C)
- 10 MΩ range ± (0.1% of reading + 0.01% of range)
- All other ranges ± (0.02% of reading + 0.02% of range)

Temperature Coefficient (0°C to + 50°C)
Ohms
- 10 MΩ range: ± (0.035% of reading + 0.001% of range) / °C.
- All other ranges: ± (0.006% of reading + 0.001% of range) / °C.

DC VOLTAGE
34750A

Performance:

Accuracy (+ 23°C ± 5°C), ≤ 95% RH)
- 30 days ± (0.025% of reading + .005% of range)
- 90 days ± (0.035% of reading + .005% of range)
- 6 mo. ± (0.045% of reading + .007% of range)
- 1 yr. ± (0.06% of reading + .01% of range)

NOTE: Due to temperature change inside the instrument between line and battery operation, the references must be adjusted when changing modes to achieve these specifications.

Stability (24 hours, + 23°C ± 1°C)
DC voltage: ± (.008% of reading ± .004% of range)

Temperature Coefficient (0°C to + 50°C)
DC voltage: ± (0.0025% of reading + 0.0002% of range) / °C

Input Characteristics

Input resistance
- 1 and 10 V ranges: 11.11 MΩ ± 0.2%
- 100 V range: 10.1 MΩ ± 0.2%
- 1000 V range: 10 MΩ ± 0.2%

Effective Common Mode Rejection (1 kΩ unbalance)
DC: >80 dB. *

* Does not apply when BCD Module is used.

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

Normal Mode Rejection
50 Hz (Option 050): >60 dB (50 Hz ± 0.1%)
60 Hz (Option 060): >60 dB (60 Hz ± 0.1%)

AC VOLTAGE

34750A

Performance:

Accuracy (+ 23° ± 5°C, ≤ 95% RH)

30 days	
45 Hz to 20 kHz	± (0.25% of reading + .05% of range)
20 kHz to 100 kHz	± (.75% of reading + .05% of range)
90 days	
45 Hz to 20 kHz	± (.3% of reading + .05% of range)
20 kHz to 100 kHz	± (.8% of reading + .05% of range)
6 mo.	
45 Hz to 20 kHz	± (.35% of reading + .05% of range)
20 kHz to 100 kHz	± (.85% of reading + .05% of range)
1 yr.	
45 Hz to 20 kHz	± (0.50% of reading + 0.05% of range)
20 kHz to 100 kHz	± (1.0% of reading + 0.05% of range)

Stability (24 hours, + 23°C ± 1°C)
AC voltage: 45 Hz to 20 kHz: ± (0.15% of reading + 0.05% of range)
20 kHz to 100 kHz: ± (0.4% of reading + 0.05% of range)

Temperature Coefficient (0°C to + 50°C)
AC voltage: + (0.03% of reading + 0.001% of range) / °C

Response Time: < 2 s within ± 0.3% of final value or 200 counts, whichever is greater.

Input Characteristics:
Input impedance
1 and 10 V ranges: 11.11 MΩ ± 0.2%/ /80 pF max.
100 V range: 10.1 MΩ ± 0.2%/ /80 pF max.
1000 V range: 10 MΩ ± 0.2%/ /80 pF max.

OHMS

34750A

Performance:

Accuracy (+ 23°C ± 5°C, ≤ 95% RH)

30 days	
10 MΩ range	± (0.25% of reading + 0.015% of range)
All other ranges	± (0.045% of reading + 0.015% of range)
90 days	
10 MΩ range	± (0.3% of reading + 0.015% of range)
All other ranges	± (0.055% of reading + 0.015% of range)
6 mo.	
10 MΩ range	± (0.35% of reading + 0.02% of range)
All other ranges	± (0.065% of reading + 0.02% of range)
1 yr.	
10 MΩ range	± (0.50% of reading + 0.02% of range)
All other ranges	± (0.11% of reading + 0.02% of range)

NOTE: Due to temperature change inside the instrument between line and battery operation, the references must be adjusted when changing modes to achieve these specifications.

Stability (24 hours, 23°C ± 1°C)
10 MΩ range ± (0.1% of reading + 0.009% of range)
All other ranges ± (0.2% of reading + 0.015% of range)

Temperature Coefficient (0°C to + 50°C)
10 MΩ range: ± (0.035% of reading + 0.001% of range) / °C
All other ranges: ± (0.006% of reading + 0.001% of range) / °C

Table 1-2. General Information.

DC VOLTAGE

34740A

Ranges:

Range	Full Scale Reading	Maximum Reading
1 V	± 1.0000 V	± 1.9999 V
10 V	± 10.000 V	± 19.999 V
100 V	± 100.00 V	± 199.99 V
1000 V	± 1000.0 V	± 1200.0 V

Overrange
1000 V range: 20%.
All other ranges: 100% (19999 max reading)

Range Selection: manual pushbuttons

Performance:

Reading Rate
Option 050 (50 Hz): 8/s fixed
Option 060 (60 Hz): 5/s fixed

Input Characteristics:

Input terminals: floating pair *

Maximum input voltage
High to Low: ± 1200 V
Low to Chassis: ± 500 V *
* Does not apply when BCD Module is used.

AC VOLTAGE

34740A

Ranges:

Range	Full Scale Reading	Maximum Reading
1 V	1.0000 V	1.9999 V
10 V	10.000 V	19.999 V
100 V	100.00 V	199.99 V
1000 V	1000.0 V	1200.0 V

Table 1-2. General Information (Cont'd).

Overrange
1000 V range: 20%
All other ranges: 100% (19999 max reading)

Range selection: manual pushbuttons

Performance:

Frequency range: 45 Hz to 100 kHz

Input Characteristics:

Input terminals: floating pair. *
Maximum input voltage
High to low: 1200 V rms. Except 1 V range.
1 V Range:
1200 V rms maximum 45 Hz – 200 Hz
300 V rms maximum 200 Hz – 100 kHz
Low to Chassis: ± 500 V *
* Does not apply when BCD Module is used.

OHMS
34740A

Ranges:

Range	Full Scale Reading	Maximum Reading
100 Ω	100.00 Ω	199.99 Ω
1 kΩ	1.0000 kΩ	1.9999 kΩ
10 kΩ	10.000 kΩ	19.999 kΩ
100 kΩ	100.00 kΩ	199.99 kΩ
1000 kΩ	1000.0 kΩ	1999.9 kΩ
10 MΩ	10.000 MΩ	19.999 MΩ

Overrange: 100% on all ranges

Range selection: manual pushbuttons

Input Characteristics:

Input terminals: floating pair (different from voltage input terminals).

Current through measured resistor: 10 mA on 100 Ω range decreasing one decade per successively higher range.

Effective Common Mode Rejection: same as dc specifications.

Overload protection: ± 350 V peak (248 V rms sine wave).

Other:

Operating temperature: 0°C to + 50°C.

Storage temperature: - 40°C to + 75°C.

Line requirements: 100/120/220/240 V
- 10%, + 5% switchable:
48 Hz to 440 Hz; ≤ 8.7 VA.

DC VOLTAGE
34750A

Ranges:

Range	Full Scale Reading	Maximum Reading
1 V	± 1.00000 V	± 1.99999 V
10 V	± 10.0000 V	± 19.9999 V
100 V	± 100.000 V	± 199.999 V
1000 V	± 1000.00 V	± 1200.00 V

Overrange
1000 V range: 20%
All other ranges: 100% (199999 max reading)

Range selection: manual pushbuttons

Reading rate
Option 050 (50 Hz): 4/s fixed
Option 060 (60 Hz): 5/s fixed

Input terminals: floating pair *

Maximum input voltage
High to Low: ± 1200 V
Low to Chassis: ± 500 V *
* Does not apply when BCD Module is used.

AC VOLTAGE
34750A

Ranges:

Range	Full Scale Reading	Maximum Reading
1 V	1.00000 V	1.99999 V
10 V	10.0000 V	19.9999 V
100 V	100.000 V	199.999 V
1000 V	1000.00 V	1200.00 V

Overrange
1000 V range: 20%
All other ranges: 100% (199999 max reading)

Range selection: manual pushbuttons

Frequency range: 45 Hz to 100 kHz

Input terminals: floating pair

Maximum input voltage
High to Low: 1200 V rms except on 1 V range. On 1 V range 2.5×10^5 V Hz limit with minimum protection of 300 V rms.
Low Chassis: ± 500 V

OHMS
34750A

Ranges:

100 Ω	100.000 Ω	199.99 Ω
1 kΩ	1.00000 kΩ	1.99999 kΩ
10 kΩ	10.0000 kΩ	19.9999 kΩ
100 kΩ	100.000 kΩ	199.999 kΩ
1000 kΩ	1000.00 kΩ	1999.99 kΩ
10 MΩ	10.0000 MΩ	19.9999 MΩ

Overrange: 100% on all ranges

Range selection: manual pushbuttons

Input terminals: floating pair (different from voltage input terminals).

Current through measured resistor: 10 mA on 100 Ω range decreasing one decade per successively higher range.

Effective Common Mode Rejection: same as dc specifications.

Overload protection: ± 350 V peak (248 V rms sine wave).

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains installation and shipping information for the Model 34702A.

2-3. INITIAL INSPECTION.

2-4. The Model 34702A should be inspected upon receipt for damage that might have occurred in transit. If there is damage due to shipping, file a claim with the carrier. If there are other electrical or mechanical deficiencies refer to the warranty statement on the back of the title page. Use the procedures provided in Section V to check instrument performance.

2-5. CONNECTION TO THE DISPLAY MODULE.

2-6. Referring to Figure 2-1, connect the Model 34702A to the Display Module using the following procedure:

a. Pull the side locks on the Display Module to the rear.

b. Position the Display Module and 34702A together so that the tabs and slots on the sides of the two units interlock.

c. Push the side locks toward the Display Module. This pulls the two units together and locks them.

2-7. If a 34720A Battery Module or a 34721B BCD Module is to be used between the display module and the 34702A then the side locks on this middle module hold the 34702A.

2-8. REPACKAGING FOR SHIPMENT.

2-9. If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument describing the work to be accomplished and identifying the owner of the instrument. Identify the instrument by serial number, model number and name in any correspondence. If you have any questions, contact your local Hewlett-Packard Sales and Service Office.

2-10. If the original shipping container is to be used, place the instrument in the container with appropriate packing material and seal the container well with strong tape or metal bands.

2-11. If an -hp- container is not to be used, use a heavy carton or wooden box with an inner container. Wrap the instrument with heavy paper or plastic and place cardboard strips across the face for protection before placing the instrument in the inner container. Use packing material around all sides of the inner container, and seal the outer container well with strong tape or metal bands. Mark the container with "DELICATE INSTRUMENT" or "FRAGILE."

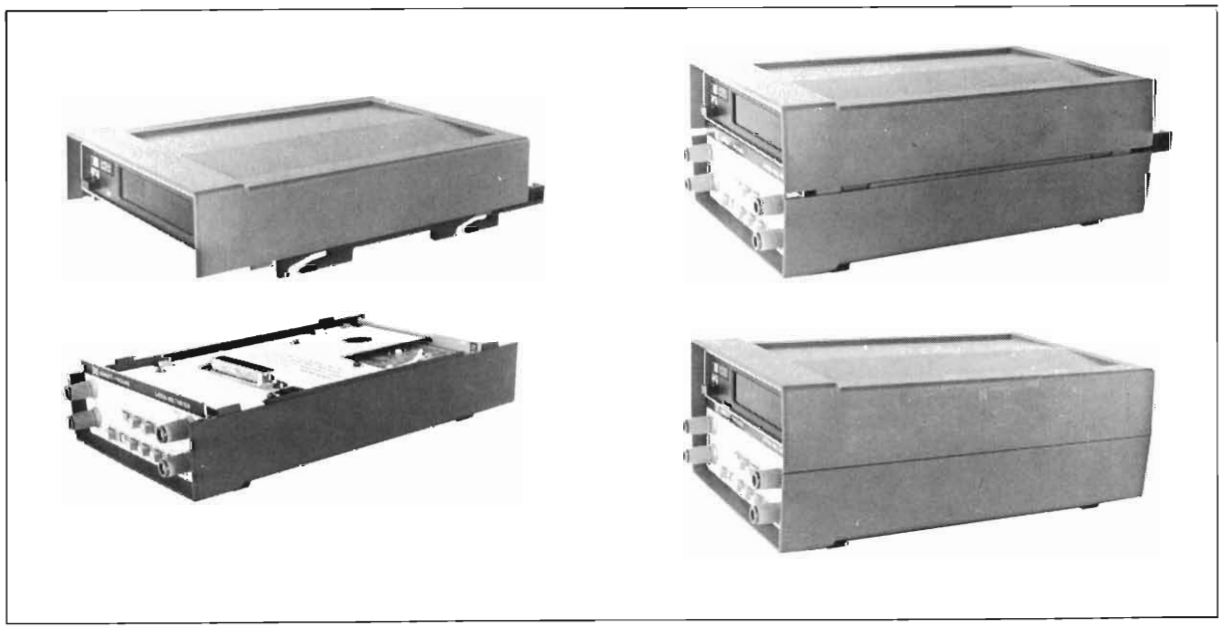


Figure 2-1. Installation of the Model 34702A.

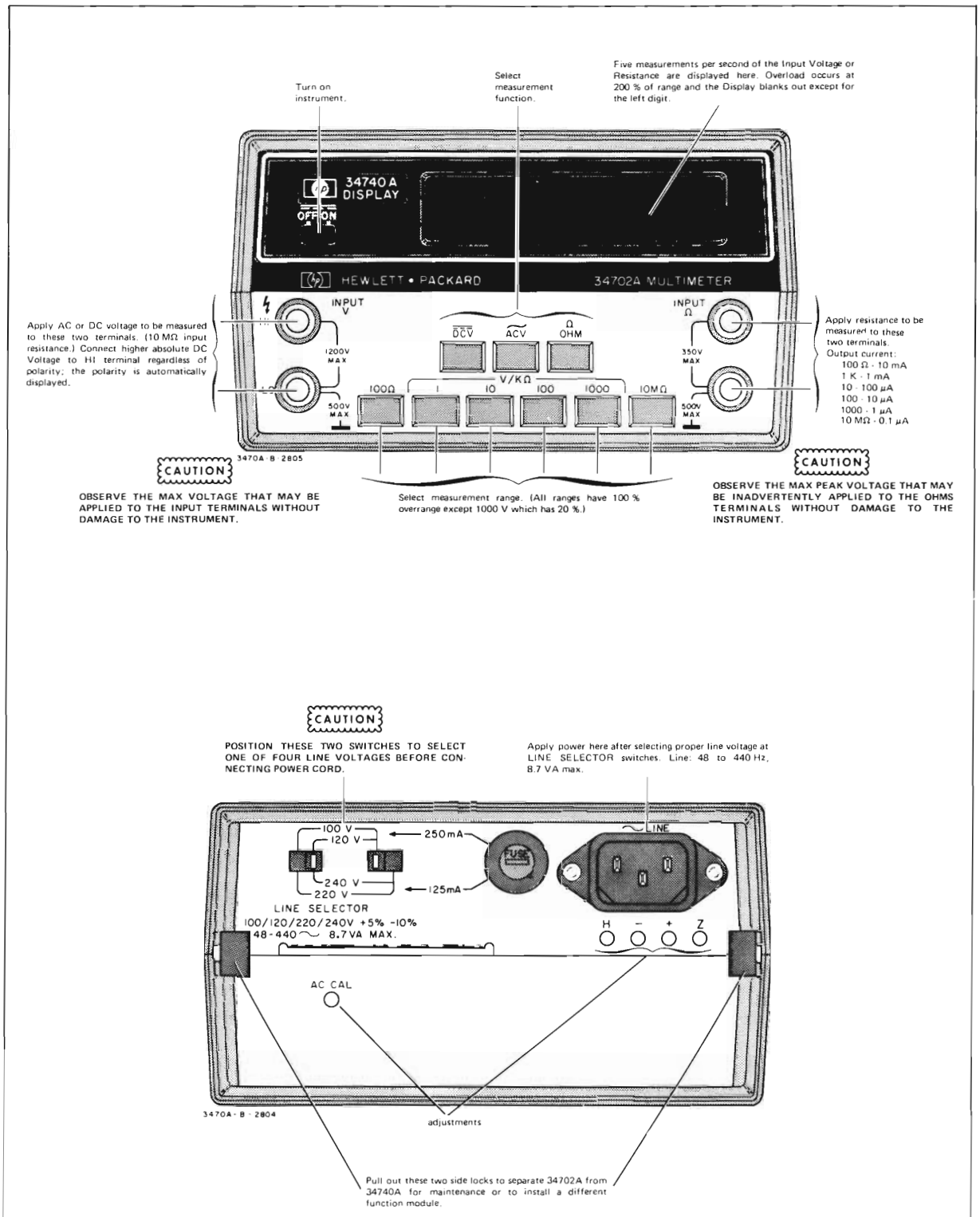


Figure 3-1. Front and Rear Panel Features.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and information which will assist you in proper operation of the Model 34702A Multimeter Module. A Model 34740A or 34750A Display Module is required to operate the Model 34702A. Included in this section is identification of controls, indicators and connectors; operating procedures; and BCD output code information (for use in conjunction with the 34721B BCD Module).

3-3. PANEL FEATURES.

3-4. The panel features of the instrument are described in Figure 3-1.

3-5. FRONT PANEL OPERATION.

3-6. There are two manual controls; the function switch and the range switch (See Figure 3-1). Each range, except the 1000 V range, has 100% overranging capability; e.g. using a four digit display module 1.9999 V can be measured on the 1 V range. The display blanks at 200% of range, indicating an overload.

CAUTION

Overload protection circuits allow up to 1200 V peak to be applied to the INPUT V terminals without damaging the instrument. Up to 350 V can be applied to the INPUT Ω terminals without damaging the instrument. No more than 500 V should be applied between LO and Chassis (⏚). Do not apply voltage between LO and Chassis when using the 34721A or 34721B BCD Module. These modules connect LO to Chassis when attached to the Model 34702A.

3-7. DC Voltage Measurement.

3-8. Set the Function switch to DCV, select the required voltage range, and apply the voltage to be measured to the INPUT V terminals.

3-9. AC Voltage Measurement.

3-10. Set the function switch to ACV, select the required voltage range, and apply the voltage to be measured to the INPUT V terminals.

3-11. Resistance Measurement.

3-12. Set the function switch to OHM (Ω), select the required resistance range, and connect the device to be measured to the INPUT Ω terminals.

3-13. 34721B/5055A OUTPUT CODES.

3-14. Output codes obtained from a 34721B BCD Module when used in conjunction with the Model 34702A and a display module are listed in Table 3-1. Refer to the 34721B Operating and Service Manual for further information regarding the BCD Module.

Table 3-1. 34721B/5055A Output Codes.

Number Printed	Polarity Overload Column 9	Range Column 8		Function Column 7	Overrange Column 6	Digits Columns 1 through 5
		kΩ	Volts			
0				DCV	underrange	0
1	+	10000		ACV	overrange	1
2		1000	1000	kΩ		2
3		100	100			3
4		10	10			4
5		1	1			5
6		.1				6
7						7
8						8
9						9

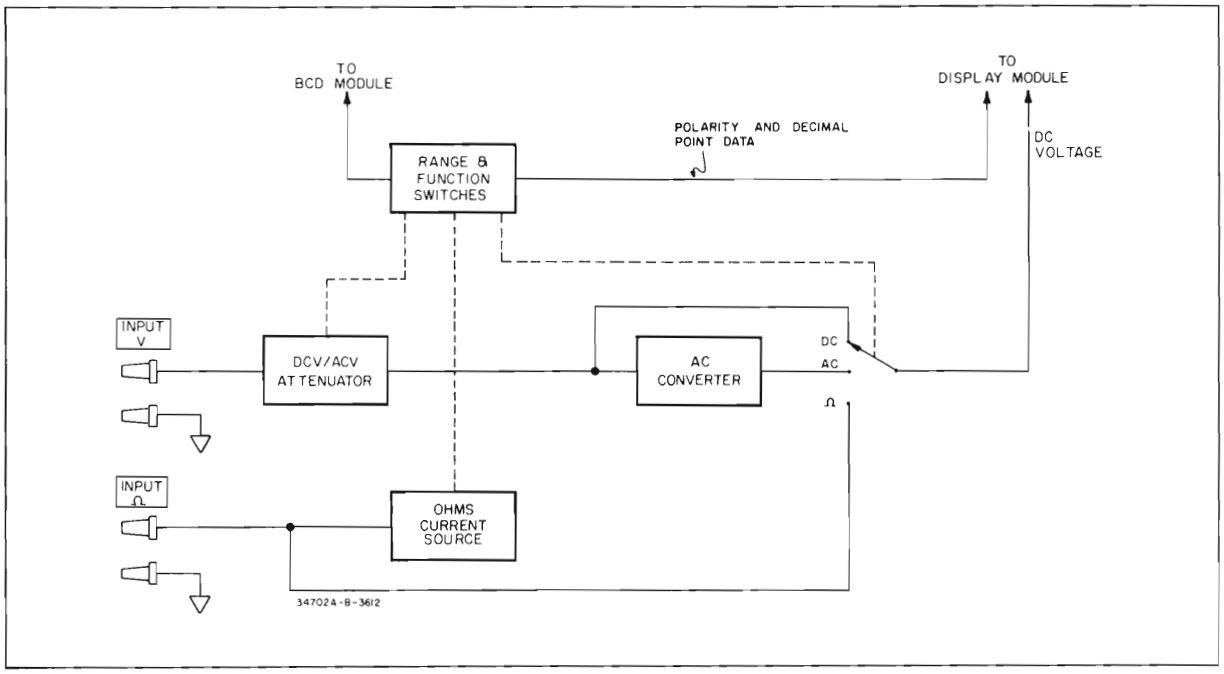


Figure 4-1. Block Diagram.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the Model 34702 Multimeter in simplified form followed by a more detailed functional description. A detailed circuit schematic is shown in Figure 7-3.

4-3. BLOCK DIAGRAM DESCRIPTION.

4-4. The circuits of the Model 34702A can be divided into four major blocks shown in Figure 4-1.

4-5. ACV And DCV Attenuator.

4-6. The ACV/DCV Attenuator reduces the level of the signal applied to the input so that it can be measured by the 34740A or 34750A Display Module. The signal can be attenuated by a factor of 1, 10, 100 or 1000.

4-7. Current Source.

4-8. Resistance measurements are made by passing a known current through the resistor being measured and then measuring the voltage developed across the resistor. The current source supplies five different currents used by the six available ohmmeter ranges. Resistance of an unknown is measured by connecting it across the OHMS terminals and selecting OHM (Ω) function.

4-9. Range/Function Switches.

4-10. Range and Function switching is accomplished by manual selection. Data from the Range and Function switches is supplied to the Display Module, and to the BCD Module when it is connected.

4-11. AC Converter.

4-12. The AC Converter accepts ac voltage from the attenuator and changes it to a dc voltage proportional to the level of the applied signal.

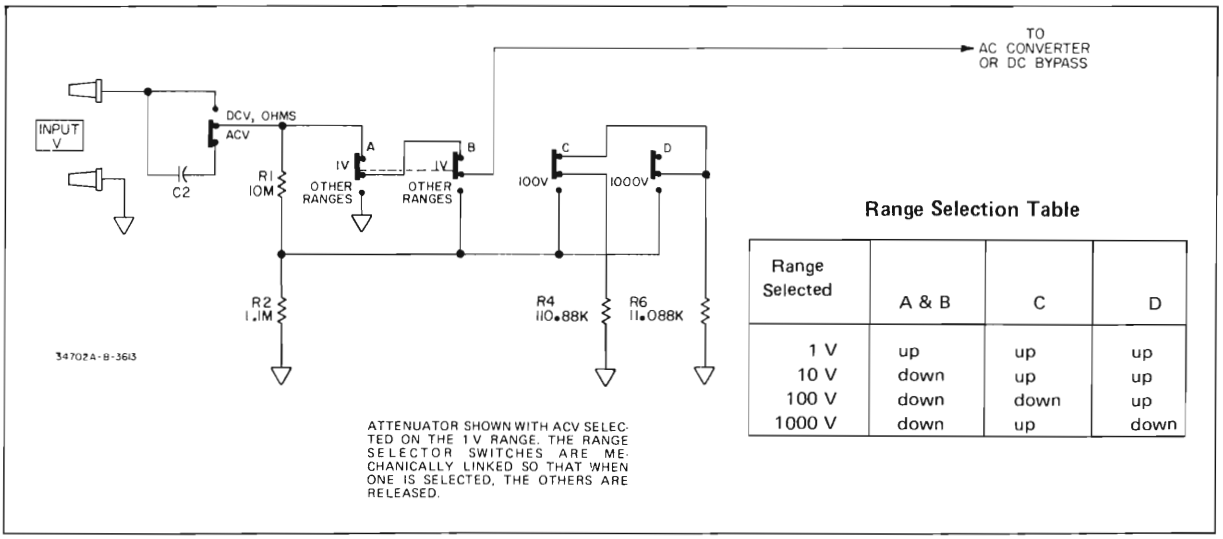
4-13. DETAILED THEORY OF OPERATION.

4-14. ACV/DCV Attenuator.

4-15. Figure 4-2 shows the ACV/DCV Attenuator with its AC and DC voltage accuracy adjustments deleted. Resistors R3, R5, and R7, shown in Figure 7-5 are dc adjustments. Capacitors C3 through C11, also shown in Figure 7-5, provide ac compensation for the attenuator.

4-16. Ohms Converter.

4-17. Current Source. A simplified diagram of the Ohmmeter current source is shown in Figure 4-3a. Zener diode CR16 is the voltage reference for the current source.



Range Selection Table

Range Selected	A & B	C	D
1 V	up	up	up
10 V	down	up	up
100 V	down	down	up
1000 V	down	up	down

Figure 4-2. ACV/DCV Attenuator.

Amplifier A is connected in a non-inverting configuration and R_b is adjusted such that 1 V (.1 V for the 10 MΩ range) is developed across R_a and R_b. Amplifier B has its + input connected to a stable dc voltage of -6.2 V. The - input is connected to the output of Amplifier A through the range reference resistors R52 - R56. The 1 V across R_a and R_b causes the output of Amplifier B to become more positive. This allows the current through Q_X to vary such that the - input of Amplifier B becomes approximately - 6.2 V. The input current to Amplifier B is very small. Consequently the current that flows through the range reference resistors is the same as the current supplied by the source of Q_X. The drain current of Q_X is almost identical to its source current because the gate current is extremely small. The drain current flows through R_X and develops a dc voltage which is applied to the Display Module input. The output current, I_X, is changed for different resistance ranges by changing the value of R_a. On the 10 MΩ range Switch S_b is in the 10 MΩ position which reduces the voltage between points 4 and 5 to .1 V.

4-18. Ohms Protection Circuit. The actual circuit represented by Q_X in Figure 4-3a is shown in Figure 4-3b. The ohmmeter circuits are protected for voltages applied to the "OHM (Ω)" input up to 350 V peak. Large negative voltages are blocked by CR12. Large positive voltages are blocked by the high collector to base breakdown voltages of Q13 and Q14. CR13 conducts for positive voltages greater than approximately 2 V, causing CR14 to conduct,

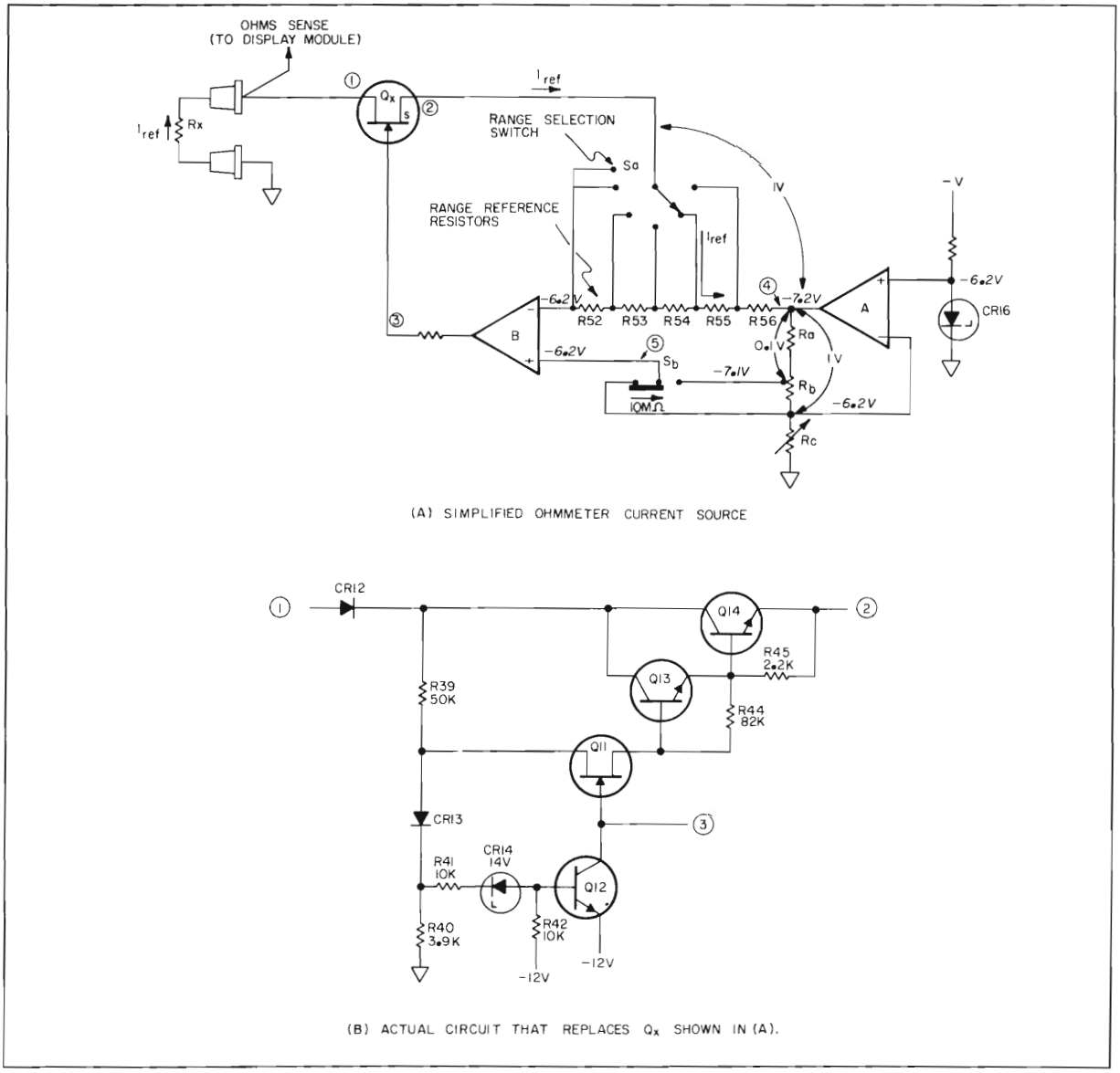


Figure 4-3. Ohms Converter.

turning on Q12. This places - 12 V at the collector of Q12 which turns off transistors Q11, Q13, and Q14.

4-19. AC Measuring Circuits.

4-20. A simplified diagram of the circuits used to measure ac voltage is shown in Figure 4-4.

The attenuation of the input signal by the Attenuator for the four ac voltage ranges is:

Range	Attenuation Factor
1 V	X 1
10 V	X 0.1
100 V	X 0.01
1000 V	X 0.001

The output voltage of the attenuator is buffered by the Impedance Converter. The voltage gain of the Impedance Converter is adjustable and is approximately one. Its input impedance is very high to minimize loading of the Attenuator and its output resistance is low to drive the Converter Amplifier. The AC Converter yields a dc output voltage that is porportional to the average value of the negative half-wave rectified input signal. The resulting voltage is filtered and measured by the Display Module.

4-21. Impedance Converter. A simplified diagram of the Impedance Converter is shown in Figure 4-5. The input transistor Q1 is a source follower. Transistors Q2 and Q3 constitute an amplifier that provides bias current to Q1 and a high input resistance (load resistance) for Q1. A positive going voltage at point 1 causes the voltage at point 2 to increase. This increased voltage at point 2 increases the

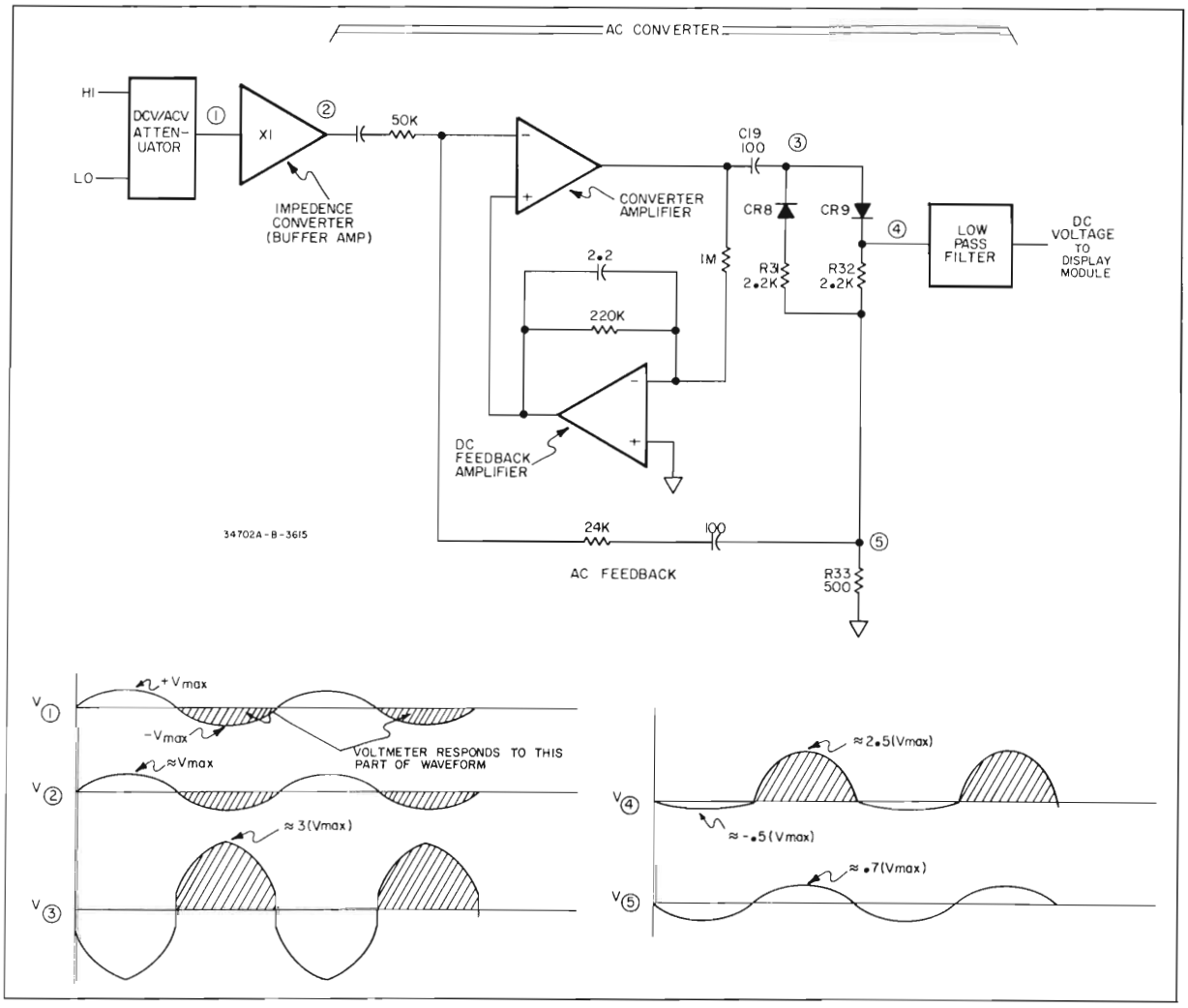


Figure 4-4. AC/DC Converter.

current through Q2. The increased current causes the voltage at point 4 to increase. Since Q3 is an emitter follower, point 3 will also increase and follow very closely the voltage at point 2. Since the output voltage is taken at the emitter of Q3, R13 may be increased to make the gain of the amplifier greater than unity.

4-22. AC Converter. Refer to Figure 4-4 for the following discussion. Overall ac feedback is supplied from point 5 back to the inverting input. The voltage at point 5 is similar in shape to the voltage at point 2, inverted and about one-half the amplitude. Current for the negative half of the waveform at point 5 flows through CR8, R31 and R33. Current for the positive half of this waveform flows through CR9, R32 and R33. The output voltage is taken at the cathode of CR9, filtered by the Low Pass Filter and measured by the Display Module. The DC Feedback Amplifier provides a low frequency feedback path around the Converter Amplifier to keep the Converter Amplifier biased properly.

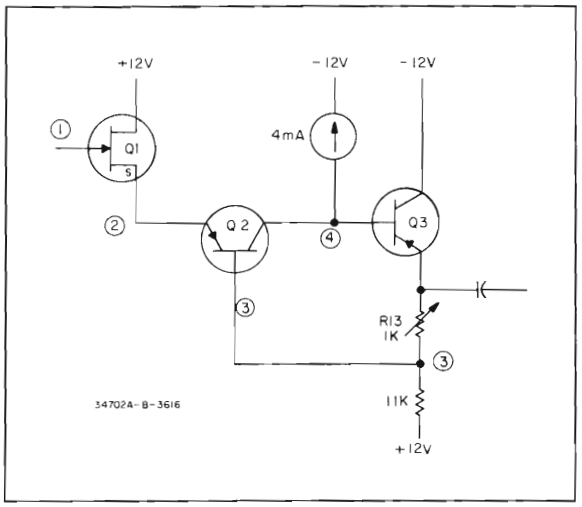


Figure 4-5. Impedance Converter.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for maintenance of the -hp- Model 34702A Multimeter. Included are Performance Tests and Adjustment Procedures for the 30 day, 90 day, 6 month, and 1 year intervals referred to in Table 1-1. To determine the optimum calibration interval for your instrument, refer to MIL Specification MIL-C-45662A. If, after completing the Performance Checks, you find that the instrument does not meet its required specifications, refer to the Adjustment Procedure (Paragraph 5-16). Attempt to readjust the instrument to bring it into specification. If, after adjusting the instrument, it is still out of specification, refer to troubleshooting in Section VII.

5-3. RECOMMENDED TEST EQUIPMENT.

5-4. The test equipment that is recommended for maintaining the Model 34702A is listed in Table 5-1. If the recommended model is not available, use equipment that has specifications equal to or better than those listed.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Recommended Model
AC Calibrator	1 V, 10 V, 100 V 1000 V, 45 Hz to 100 kHz Accuracy: ± 0.04% of setting (45 Hz to 20 kHz) ± 0.15% of setting (100 kHz)	-hp- Model 745A/746A
100 Ω, 1 kΩ 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ standard resistors	Accuracy: ± 0.01%	General Radio Model GR 1433-Z Decade Resistor
DC Standard	1 V, 10 V, 100 V, 1000 V Ranges Accuracy: ± 0.008%	-hp- 740B
Electronic Counter	Capable of measuring the period of 50 Hz or 60 Hz to within ± .01%	-hp- Model 5300A/ 5302A

5-5. PERFORMANCE TESTS.

5-6. The following tests verify that the Model 34702A is operating properly and meets the specifications listed in Table 1-1 of this manual. These tests should be completed before any attempt is made to adjust the instrument.

5-7. A Performance Test Record is provided at the end of this section for recording the results of the Performance Tests.

5-8. All of the following tests have been written to include the use of either a 34740A or 34750A Display Module.

5-9. DC Accuracy Test (DCV Function).

DESCRIPTION:
This test verifies the ability of the Model 34702A to measure dc voltage accurately within the specification limits.

SPECIFICATION:

34740A

Accuracy (+ 23°C ± 5°C), ≤95% RH):

30 days	±(0.03% of reading + .01% of range)
90 days	±(0.04% of reading + .01% of range)
6 mo.	±(0.05% of reading + .02% of range)
1 yr.	±(0.06% of reading + .02% of range)

34750A

Accuracy (+ 23°C ± 5°C), ≤95% RH):

30 days	± (0.025% of reading + .005% of range)
90 days	±(0.035% of reading + .005% of range)
6 mo.	±(0.045% of reading + .007% of range)
1 yr.	±(0.06% of reading + .01% of range)

RECOMMENDED TEST EQUIPMENT:

DC Standard, -hp- Model 740B

TEST PROCEDURE:

a. Select the DCV function of the Model 34702A and connect a dc standard (-hp- Model 740B or equivalent) to the 34702A INPUT V terminals.

b. Check dc accuracy for both polarities of input according to Table 5-2. Apply short to 34702A input to check 0 V reading on all ranges.

NOTE

With 1000 V applied only the positive polarity is checked due to the possibility of arcing within the Model 740B.

Table 5-2. DC Accuracy.

DC Standard	34702A Range	34740A Display				DC Standard	34702A Range	34750A Display			
		30 Day	90 Day	6 Months	1 Year			30 Day	90 Day	6 Months	1 Year
0 V	1 V	- .0001 to + .0001	- .0001 to + .0001	- .0002 to + .0002	- .0002 to + .0002	0 V	1 V	- .00004 to + .00004	- .00005 to + .00005	- .00007 to + .00007	- .00010 to + .00010
± 1 V	1 V	± .9996 to ± 1.0004	± .9995 to ± 1.0005	± .9993 to ± 1.0007	± .9992 to ± 1.0008	± 1 V	1 V	± .99971 to ± 1.00029	± .99960 to ± 1.00040	± .99948 to ± 1.00052	± .99930 to ± 1.00070
± 1.9 V	1 V	± 1.8993 to ± 1.9007	± 1.8991 to ± 1.9009	± 1.8989 to ± 1.9012	± 1.8987 to ± 1.9013	± 1.9 V	1 V	± 1.89948 to ± 1.90052	± 1.89929 to ± 1.90072	± 1.89908 to ± 1.90093	± 1.89876 to ± 1.90124
± 1.998 V	1 V	± 1.9973 to ± 1.9987	± 1.9971 to ± 1.9989	± 1.9968 to ± 1.9962	± 1.9965 to ± 1.9995	± 1.998 V	1 V	± 1.99746 to ± 1.99854	± 1.99725 to ± 1.99875	± 1.99703 to ± 1.99897	± 1.99660 to ± 1.99940
0 V	10 V	- 0.001 to + 0.001	- 0.001 to + 0.001	- 0.002 to + 0.002	- 0.002 to + 0.002	0 V	10 V	- 0.0004 to + 0.0004	- 0.0005 to + 0.0005	- 0.0007 to + 0.0007	- 0.0010 to + 0.0010
± 10 V	10 V	± 9.996 to ± 10.004	± 9.995 to ± 10.005	± 9.993 to ± 10.007	± 9.992 to ± 10.008	± 10 V	10 V	± 9.9971 to ± 10.0029	± 9.9960 to ± 10.0040	± 9.9948 to ± 10.0052	± 9.9939 to ± 10.0070
± 19 V	10 V	± 18.993 to ± 19.007	± 18.991 to ± 19.009	± 18.989 to ± 19.012	± 18.987 to ± 19.013	± 19 V	10 V	± 18.9948 to ± 19.0052	± 18.9929 to ± 19.0072	± 18.9903 to ± 19.0093	± 18.9876 to ± 19.0124
0 V	100 V	- 00.01 to + 00.01	- 00.01 to + 00.01	- 00.02 to + 00.02	- 00.02 to + 00.02	0 V	100 V	- 00.004 to + 00.004	- 00.005 to + 00.005	- 00.007 to + 00.007	- 00.010 to + 00.010
± 100 V	100 V	±99.96 to ± 100.04	± 99.95 to ± 100.05	± 99.93 to ± 100.07	± 99.92 to ± 100.08	± 100 V	100 V	± 99.971 to ± 100.029	± 99.960 to ± 100.040	± 99.948 to ± 100.052	± 99.930 to ± 100.070
± 190 V	100 V	± 189.93 to ± 190.07	± 189.91 to ± 190.09	± 189.89 to ± 190.12	± 189.87 to ± 190.13	± 190 V	100 V	± 189.948 to ± 190.052	± 189.929 to ± 190.072	± 189.908 to ± 190.093	± 189.876 to ± 190.124
0 V	1000 V	- 000.1 to + 000.1	- 000.1 to + 000.1	- 000.2 to + 000.2	- 000.2 to + 000.2	0 V	1000 V	- 000.04 to + 000.04	- 000.05 to + 000.05	- 000.07 to + 000.07	- 000.10 to + 000.10
+ 1000 V	1000 V	+ 999.6 to + 1000.4	+ 999.5 to + 1000.5	+ 999.3 to + 1000.7	+ 999.2 to + 1000.8	+ 1000 V	1000 V	+ 999.71 to + 1000.29	+ 999.60 to + 1000.40	+ 999.48 to + 1000.52	± 999.30 to ± 1000.70

5-10. Input Impedance Test (DCV and ACV Function).

DESCRIPTION:

Input impedance affects the ability of a voltmeter to accurately measure a given voltage because of loading effects caused by the impedance. Normally, it is desirable to achieve as high an input impedance as possible. This check ensures that the input impedance of the Model 34702A meets the specifications listed below.

SPECIFICATION:

Input Resistance

1 and 10 V ranges:	11.11 MΩ ± 0.2% ⩽80 pF
100 V range:	10.1 MΩ ± 0.2% ⩽80 pF
1000 V range:	10 MΩ ± 0.2% ⩽80 pF

RECOMMENDED TEST EQUIPMENT:

AC Calibrator, -hp- Model 745A
DC Standard, -hp- Model 740B
Resistance Decade, GR Model 1433-Z

TEST PROCEDURE:

a. Connect the equipment as shown in Figure 5-1. The Model 34702A should be set to DCV on the 1 V range.

b. Set the resistance decade to 10 MΩ and then shunt it with a jumper lead. Set the DC standard for + 1.0000 V (34740A Display) or + 1.00000 V (34750A Display) as observed on the Display Module.

c. Remove the jumper lead and again observe the display. It should read between .5258 V and .5268 V (34740A) or between .52582 and .52681 (34750A).

NOTE

The 34702A is not checked on the 10 V range since the input circuit is equivalent for both the 1 V and the 10 V ranges.

d. Set the Model 34702A to the 100 V range and short the resistance box with a jumper lead.

e. Set the dc standard for + 100.00 V (34740A) or + 100.000 V (34750A) as observed on the Display Module.

WARNING

Use extreme caution when removing or replacing the jumper in Steps f, g and i to avoid electrical shock when performing the input impedance test on the 100 V and 1000 V ranges.

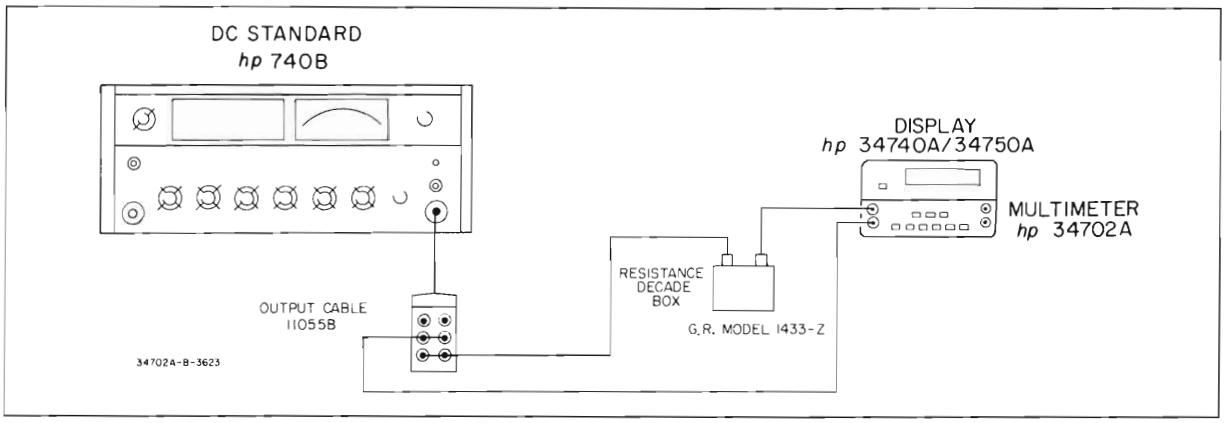


Figure 5-1. Input Impedance Test.

f. Turn the dc standard OUTPUT to OFF. Remove the jumper from the resistance box. Set dc standard OUTPUT to ON and again observe the display. It should read 50.20 to 50.30 (34740A) or 50.201 to 50.301 (34750A).

g. Turn the dc standard OUTPUT to OFF. Set the Model 34702A to the 1000 V range and short the resistance box with a jumper lead.

h. Turn the dc standard OUTPUT to ON. Set the dc standard for + 1000.0 V (34740A) or + 1000.00 V (34750A) as observed on the Display Module.

i. Turn the dc standard OUTPUT to OFF. Remove the jumper from the resistance box. Turn the dc standard OUTPUT to ON and again observe the display. It should read 499.7 to 500.7 (34740A) or 499.75 to 500.75 (34750A).

j. Set the dc standard OUTPUT to zero. Replace dc standard with the ac standard.

k. Set the Model 34702A to the 1 V range. Replace the resistance box with a 100 kilohm resistor (-hp- Part Number 0757-0465). Connect one end of the resistor directly to the HI terminal. Set the ac standard frequency to 1 kHz. Adjust the ac standard amplitude for + 1.0000 V ± 1 count (34740A) or + 1.00000 V ± 1 count (34750A) as observed on the Display Module.

l. Change the ac standard frequency to 20 kHz. The 34702A display should indicate ⩾ .7059 (34740A) or ⩾ .70594 (34750A). This verifies the 34702A input capacity specification.

5-11. DC Effective Common Mode Rejection.

DESCRIPTION:

Effective Common Mode Rejection (ECMR) is a measure of the effect of a common mode source on the measured value or readout of the instrument with a 1 kΩ unbalance. Typically ECMR is measured in decibels (dB) and can be calculated by the following formula:

$$\text{ECMR (dB)} = 20 \log_{10} \left(\frac{\text{Common Mode Voltage Applied}}{\text{Change in Display Indication}} \right)$$

SPECIFICATION:

Effective Common Mode Rejection (1 kΩ unbalance): > 80 dB.

RECOMMENDED TEST EQUIPMENT:

DC Standard, -hp- Model 740B
Resistor, 1 kΩ ± 1% (resistance decade may be used for this)

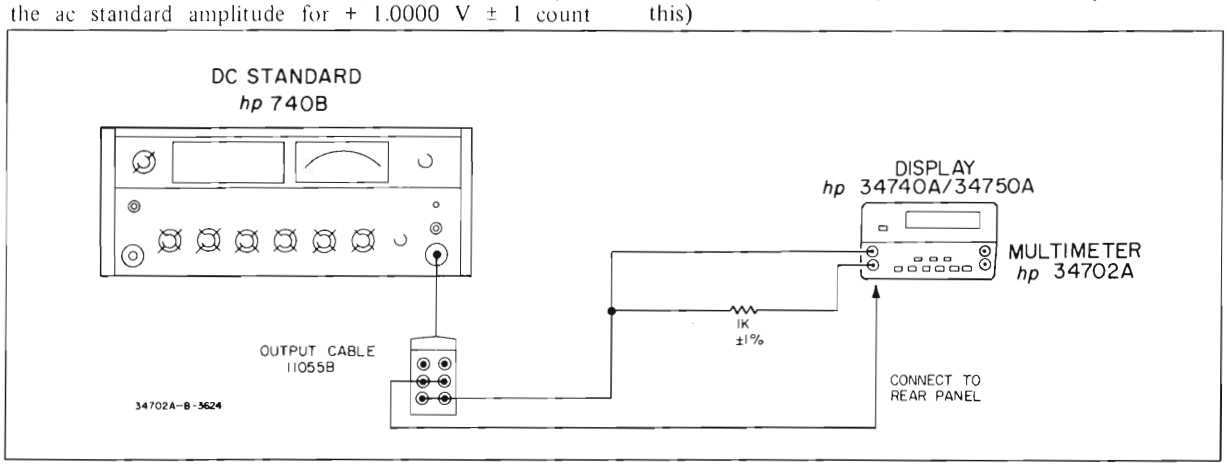


Figure 5-2. Effective Common Mode Rejection.

TEST PROCEDURE:

a. Disconnect all previous connections to the Model 34702A input and connect the equipment as shown in Figure 5-2. Set the dc standard for a +10 V output. Set the 34702A to the 1 V range.

b. Observe the voltmeter display. It should read less than 10 counts (34740A Display) or 100 counts (34750A Display). This verifies an effective common mode rejection at dc of > 80 dB.

5-12. Normal Mode Rejection.

DESCRIPTION:

Normal Mode Rejection (NMR) is a measure of the ability of the Model 34702A to reject ac signals applied to the INPUT V terminals while the instrument is operating in DCV function. NMR is measured in decibels (dB) and can be calculated by the following formula:

$$NMR\ (dB) = 20 \log_{10} \left(\frac{\text{Peak Normal Mode Voltage}}{\text{Peak Display Indication}}\right)$$

SPECIFICATION:

Normal Mode Rejection: Greater than 60 dB (at 50 Hz ± 0.1% or 60 Hz ± 0.1%).

RECOMMENDED TEST EQUIPMENT:

AC Calibrator, -hp- Model 745A
Electronic Counter, -hp- Model 5300A/5302A

TEST PROCEDURE:

a. Disconnect all previous connections to the 34702A input and connect the equipment as shown in Figure 5-3. Set the Model 34702A to DCV and the 1 V range.

b. Adjust the ac calibrator output for .707 V rms (1 V peak).

c. Set the counter controls to measure period and adjust the ac calibrator frequency for a counter indication between 16.650 ms and 16.683 ms (19.980 ms to 20.020 ms for Option 050). The Display Module should read <10 counts (34740A Display) or <100 counts (34750A Display).

5-13. AC Accuracy.

DESCRIPTION:

This test verifies the ability of the Model 34702A to measure ac voltage accurately to within the specification tolerances.

SPECIFICATION:

34740A

Accuracy (+ 23°C ± 5°C, ≤ 95% RH):

30 days		
	45 Hz to 20 kHz	±(0.25% of reading + .05% of range)
	20 kHz to 100 kHz	±(0.75% of reading + .05% of range)
90 days		
	45 Hz to 20 kHz	±(0.30% of reading + .05% of range)
	20 kHz to 100 kHz	±(0.80% of reading + .05% of range)
6 mo.		
	45 Hz to 20 kHz	±(0.35% of reading + .05% of range)
	20 kHz to 100 kHz	±(0.85% of reading + .05% of range)
1 yr.		
	45 Hz to 20 kHz	±(0.50% of reading + 0.05% of range)
	20 kHz to 100 kHz	±(1.0% of reading + 0.05% of range)

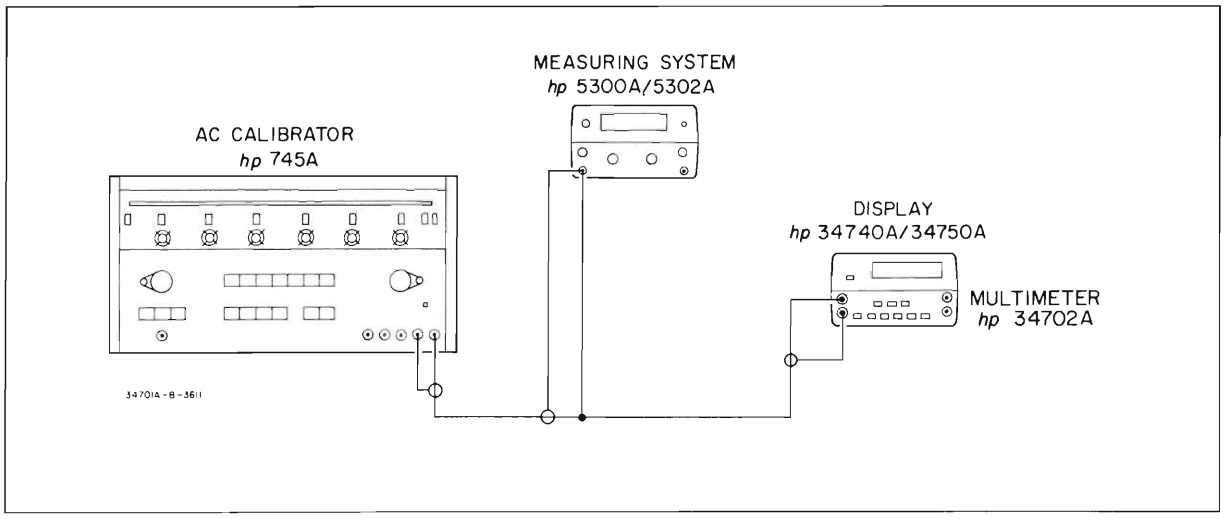


Figure 5-3. Normal Mode Rejection.

34750A

Accuracy (+ 23°C ± 5°C, ≤95% RH):

30 days
45 Hz to 20 kHz ±(0.25% of reading + .05% of range)
20 kHz to 100 kHz ±(.75% of reading + .05% of range)

90 days
45 Hz to 20 kHz ±(.3% of reading + .05% of range)
20 kHz to 100 kHz ±(.8% of reading + .05% of range)

6 mo.
45 Hz to 20 kHz ±(.35% of reading + .05% of range)
20 kHz to 100 kHz ±(.85% of reading + .05% of range)

1 yr.
45 Hz to 20 kHz ±(0.50% of reading + 0.05% of range)
20 kHz to 100 kHz ±(1.0% of reading + 0.05% of range)

RECOMMENDED TEST EQUIPMENT:

AC Calibrator/High Voltage Amplifier, -hp- Model 745A/746A or equivalent.

TEST PROCEDURE:

a. Set the Model 34702A function switch to ACV and select the 1 V range. Apply short to 34702A input and check 0 V reading on all ranges.

b. Using an ac calibrator and a high voltage amplifier (-hp- Model 745A/746A recommended), check the accuracy of the Model 34702A for inputs other than 0 V at 45 Hz and 20 kHz using Table 5-3(a). Also check the accuracy for these inputs at 100 kHz using Table 5-3(b). All readings should be within the limits specified by the tables.

5-14. Response Time.

DESCRIPTION:

This test verifies the ability of the Model 34702A to respond quickly to changes in input voltage.

SPECIFICATION:

34740A

Response time: <2 s to within ± 0.3% of final value or 20 counts, whichever is greater.

Table 5-3(a). AC Accuracy (45 Hz and 20 kHz).

AC Standard	34702A Range	34740A Display 30 Day	90 Day	6 Months	1 Year	AC Standard	34702A Range	34750A Display 30 Day	90 Day	6 Months	1 Year
0 V	1 V	.0005	.0005	.0005	.0005	0 V	1 V	.00040	.00050	.00050	.00050
1 V	1 V	.9970 to 1.0030	.9965 to 1.0035	.9960 to 1.0040	.9945 to 1.0055	1 V	1 V	.99710 to 1.00290	.99650 to 1.00350	.99600 to 1.00400	.99550 to 1.00550
1.9 V	1 V	1.8948 to 1.9053	1.8938 to 1.9062	1.8929 to 1.9072	1.8900 to 1.9100	1.9 V	1 V	1.89485 to 1.90515	1.89380 to 1.90620	1.89285 to 1.90715	1.89000 to 1.91000
1.990 V	1 V	1.9845 to 1.9955	1.9835 to 1.9965	1.9825 to 1.9975	———	1.990 V	1 V	1.98463 to 1.99538	1.98353 to 1.99647	1.98254 to 1.99747	———
0 V	10 V	0.005	0.005	0.005	0.005	0 V	10 V	0.0040	0.0050	0.0050	0.0050
10 V	10 V	9.970 to 10.030	9.965 to 10.035	9.960 to 10.040	9.945 to 10.055	10 V	10 V	9.9710 to 10.0290	9.9650 to 10.0350	9.9600 to 10.0400	9.9550 to 10.0550
19 V	10 V	18.948 to 19.053	18.938 to 19.062	18.929 to 19.072	18.900 to 19.100	19 V	10 V	18.9485 to 19.0515	18.9380 to 19.0620	18.9285 to 19.0715	18.9000 to 19.1000
0 V	100 V	00.05	00.05	00.05	00.05	0 V	100 V	00.040	00.050	00.050	00.050
100 V	100 V	99.70 to 100.30	99.65 to 100.35	99.60 to 100.40	99.45 to 100.55	100 V	100 V	99.710 to 100.290	99.650 to 100.350	99.600 to 100.400	99.550 to 100.550
190 V	100 V	189.48 to 190.53	189.38 to 190.62	189.29 to 190.72	189.00 to 191.00	190 V	100 V	189.485 to 190.515	189.380 to 190.620	189.285 to 190.715	189.000 to 191.000
0 V	1000 V	000.5	000.5	000.5	000.5	0 V	1000 V	000.40	000.50	000.50	000.50
1000 V	1000 V	997.0 to 1003.0	996.5 to 1003.5	996.0 to 1004.0	994.5 to 1005.5	1000 V	1000 V	997.10 to 1002.90	996.50 to 1003.50	996.00 to 1004.00	995.50 to 1005.50

Table 5-3(b). AC Accuracy (100 kHz).

AC Standard	34702A Range	34740A Display 30 Day	90 Day	6 Months	1 Year	AC Standard	34702A Range	34750A Display 30 Day	90 Day	6 Months	1 Year
0 V	1 V	.0005	.0005	.0005	.0005	0 V	1 V	.00050	.00050	.00050	.00050
1 V	1 V	.9920 to 1.0080	.9915 to 1.0085	.9910 to 1.0090	.9895 to 1.0105	1 V	1V	.99200 to 1.00800	.99150 to 1.00850	.99100 to 1.00900	.98950 to 1.01050
1.9 V	1 V	1.8853 to 1.9148	1.8839 to 1.9162	1.8829 to 1.9171	1.8801 to 1.9200	1.9 V	1 V	1.88525 to 1.91475	1.88430 to 1.91570	1.88335 to 1.91665	1.88050 to 1.91950
0 V	10 V	0.005	0.005	0.005	0.005	0 V	10 V	0.0050	0.0050	0.0050	0.0050
10 V	10 V	9.920 to 10.080	9.915 to 10.085	9.910 to 10.090	9.895 to 10.105	10 V	10 V	9.9200 to 10.0800	9.9150 to 10.0850	9.9100 to 10.0900	9.8950 to 10.1050
19 V	10 V	18.853 to 19.148	18.839 to 19.016	18.829 to 19.171	18.801 to 19.200	19 V	10 V	18.8525 to 19.1475	18.8430 to 19.1570	18.8335 to 19.1665	18.8050 to 19.1950
0 V	100 V	00.05	00.05	00.05	00.05	0 V	100 V	00.050	00.050	00.050	00.050
100 V	100 V	99.20 to 100.80	99.15 to 100.85	99.10 to 100.90	98.95 to 101.05	100 V	100 V	99.200 to 100.800	99.150 to 100.850	99.100 to 100.900	98.950 to 101.050
190 V	100 V	188.53 to 191.48	188.39 to 190.16	188.29 to 191.71	188.01 to 192.00	190 V	100 V	188.525 to 191.475	188.430 to 191.570	188.335 to 191.665	188.050 to 191.950
0 V	1000 V	000.5	000.5	000.5	000.5	0 V	1000 V	000.50	000.50	000.50	000.50
1000 V	1000 V	992.0 to 1008.0	991.5 to 1008.5	991.0 to 1009.0	989.5 to 1010.5	1000 V	1000 V	992.00 to 1008.00	991.50 to 1008.50	991.00 to 1009.00	989.50 to 1010.50

34750A

Response time: < 2 s to within ± 0.3% of final value or 200 counts, whichever is greater.

RECOMMENDED TEST EQUIPMENT:

AC Calibrator, -hp- Model 745A or equivalent

TEST PROCEDURE:

a. Set the ac calibrator output to 10 V at 1 kHz. Set the 34702A to ACV on the 10 V range.

b. Connect the output of the ac calibrator to the 34702A INPUT V terminals while observing the 34740A/34750A Display Module. The display indication should read within 30 counts (34740A) or 300 counts (34750A) of its final value within two seconds after the 34702A is connected to the ac calibrator.

5-15. Ohms Accuracy.

DESCRIPTION:

This test verifies the ability of the Model 34702A to accurately measure resistance to within the limits of the specification given below.

SPECIFICATION:

34740A

Accuracy (+ 23°C ± 5°C, ≤ 95% RH):

30 days
- 10 MΩ range: ±(0.25% of reading + 0.02% of range)
- All other ranges: ±(0.05% of reading + 0.02% of range)

90 days
- 10 MΩ range: ±(0.30% of reading + 0.02% of range)
- All other ranges: ±(0.06% of reading + 0.02% of range)

6 mo.
- 10 MΩ range: ±(0.35% of reading + 0.03% of range)
- All other ranges: ±(0.07% of reading + 0.03% of range)

1 yr.
- 10 MΩ range: ±(0.50% of reading + 0.03% of range)
- All other ranges: ±(0.11% of reading + 0.03% of range)

34750A

Accuracy (+ 23°C ± 5°C, ≤ 95% RH):

30 days
- 10 MΩ range: ±(0.25% of reading + 0.015% of range)
- All other ranges: ±(0.045% of reading + 0.015% of range)

90 days
- 10 MΩ range: ±(0.3% of reading + 0.015% of range)
- All other ranges: ±(0.055% of reading + 0.015% of range)

6 mo.
- 10 MΩ range: ±(0.35% of reading + 0.02% of range)
- All other ranges: ±(0.065% of reading + 0.02% of range)

1 yr.
- 10 MΩ range: ±(0.50% of reading + 0.02% of range)
- All other ranges: ±(0.11% of reading + 0.02% of range)

RECOMMENDED TEST EQUIPMENT:

Resistance Decade, GR Model 1433-Z or equivalent.

NOTE

Due to temperature change inside the instrument between line and battery operation, the voltage references in the Display Module must be adjusted when changing modes to achieve these specifications.

TEST PROCEDURE:

a. Connect a resistance decade with 100 Ω through 1 MΩ steps to the INPUT Ω terminals of the Model 34702A.

b. Refer to Table 5-4 and check the accuracy of the 34702A on the 100 Ω through 10 MΩ ranges.

Table 5-4. Ohms Accuracy Test.

Resistance Standard	34702A Range	34740A Display				DC Standard	34702A Range	34750A Display			
		30 Day	90 Day	6 Months	1 Year			30 Day	90 Day	6 Months	1 Year
0 Ω	100 Ω	00.02	00.02	00.03	00.03	0 Ω	100 Ω	00.015	00.015	00.020	00.020
100 Ω	100 Ω	99.93 to 100.07	99.92 to 100.08	99.90 to 100.10	99.86 to 100.14	100 Ω	100 Ω	99.940 to 100.060	99.930 to 100.070	99.915 to 100.085	99.870 to 100.130
190 Ω	100 Ω	189.89 to 190.12	189.87 to 190.13	189.84 to 190.16	189.76 to 190.24	190 Ω	100 Ω	189.900 to 190.101	189.881 to 190.120	189.877 to 190.124	189.771 to 190.229
0 Ω	1 kΩ	.0002	.0002	.0003	.0003	0 Ω	1 kΩ	.00015	.00015	.00020	.00020
1000 Ω	1 kΩ	.9993 to 1.0007	.9992 to 1.0008	.9990 to 1.0010	.9986 to 1.0014	1000 Ω	1 kΩ	.99940 to 1.00060	.99930 to 1.00070	.99915 to 1.00085	.99870 to 1.00130
1900 Ω	1 kΩ	1.8989 to 1.9012	1.8987 to 1.9013	1.8984 to 1.9016	1.8976 to 1.9024	1900 Ω	1 kΩ	1.89900 to 1.90101	1.89881 to 1.90120	1.89877 to 1.90124	1.89771 to 1.90229
1990 Ω	1 kΩ	1.9888 to 1.9912	1.9886 to 1.9914	1.9883 to 1.9917	1.9875 to 1.9925	1990 Ω	1 kΩ	1.98895 to 1.99105	1.98891 to 1.99109	1.98871 to 1.99129	1.98761 to 1.99239
0 Ω	10 kΩ	0.002	0.002	0.003	0.003	0 Ω	10 kΩ	0.0015	0.0015	0.0020	0.0020
10 kΩ	10 kΩ	9.993 to 10.007	9.992 to 10.008	9.990 to 10.010	9.986 to 10.014	10 kΩ	10 kΩ	9.9940 to 10.0060	9.9930 to 10.0070	9.9915 to 10.0085	9.9870 to 10.0130
19 kΩ	10 kΩ	18.989 to 19.012	18.987 to 19.013	18.984 to 19.016	18.976 to 19.024	19 kΩ	10 kΩ	18.9900 to 19.0101	18.9881 to 19.0120	18.9877 to 19.0124	18.9771 to 19.0229
0 Ω	100 kΩ	00.02	00.02	00.03	00.03	0 Ω	100 kΩ	00.015	00.015	00.020	00.020
100 kΩ	100 kΩ	99.93 to 100.07	99.92 to 100.08	99.90 to 100.10	99.86 to 100.14	100 kΩ	100 kΩ	99.940 to 190.060	99.930 to 100.070	99.915 to 100.085	99.870 to 100.130
190 kΩ	100 kΩ	189.89 to 190.12	189.87 to 190.13	189.84 to 190.16	189.76 to 190.24	190 kΩ	100 kΩ	189.900 to 190.101	189.881 to 190.120	189.877 to 190.124	189.771 to 190.229
0 Ω	1000 kΩ	000.2	000.2	000.3	000.3	0 Ω	1000 kΩ	000.15	000.15	000.20	000.20
1 MΩ	1000 kΩ	999.3 to 1000.7	999.2 to 1000.8	999.0 to 1001.0	998.86 to 1001.4	1 MΩ	1000 kΩ	999.40 to 1900.60	999.30 to 1000.70	999.15 to 1000.85	998.70 to 1001.30
1.9 MΩ	1000 kΩ	1898.9 to 1991.2	1898.7 to 1901.3	1898.4 to 1901.6	1897.6 to 1902.4	1.9 MΩ	1000 kΩ	1899.00 to 1901.01	1898.81 to 1901.20	1898.77 to 1901.24	1897.71 to 1902.29
0 Ω	10 MΩ	0.002	0.002	0.003	0.003	0 Ω	10 MΩ	0.0015	0.0015	0.0020	0.0020
10 MΩ	10 MΩ	9.973 to 10.027	9.968 to 10.032	9.961 to 10.038	9.947 to 10.053	10 MΩ	10 MΩ	.99745 to 1.00265	.99685 to 1.00315	.99630 to 1.00370	.99480 to 1.00520

5-16. ADJUSTMENT PROCEDURE.

5-17. The following is a complete adjustment procedure for the Model 34702A.

NOTE

Before proceeding, it should be ascertained that the display module is operating properly and is calibrated.

5-18. Cover Removal.

5-19. Disconnect the power cord. Separate the 34702A from the display module by pulling the two side locks at the back of the instrument rearward and lifting the mainframe from the 34702A. Separate the 34702A main assembly from its cover by spreading apart two sets of plastic fingers, as shown in Figure 5-4, and removing the cover. After removing the cover reconnect the 34702A to the mainframe and attach the power cord.

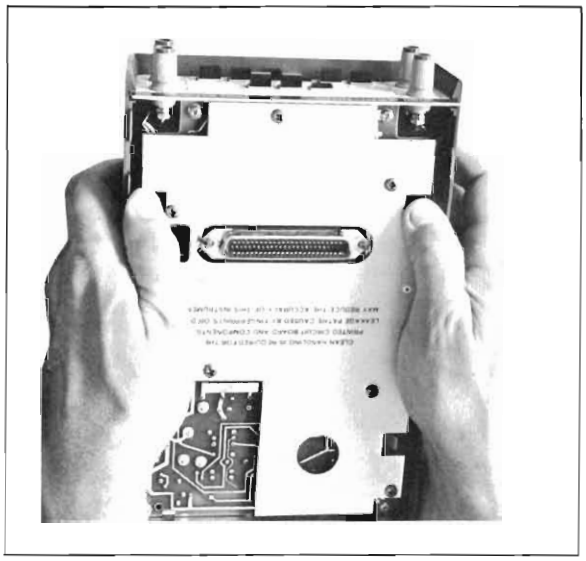


Figure 5-4. Removal From Case.

NOTE

It will be necessary to turn the instrument upside down to obtain access to the 34702A adjustments. Figure 5-5 shows the location of all adjustments in the Model 34702A.

5-20. DC Adjustments.

DESCRIPTION:

These adjustments affect dc accuracy of the Model 34702A.

RECOMMENDED TEST EQUIPMENT:

DC Standard, -hp- Model 740B or equivalent

CALIBRATION PROCEDURE:

WARNING

1000 V is used in the following procedure. Contact with this voltage can cause death or serious injury.

a. Select the 10 V range of the 34702A and connect a dc standard to the INPUT V terminals.

b. Set the output of the dc standard to 10 V and adjust A1R3 for a 10.000 V readout (34740A), or a 10.0000 V readout (34750A).

c. Select the 100 V range of the 34702A and set the dc standard to 100 V output. Adjust R5 to obtain a 100.00 V readout (34740A) or a 100.000 V readout (34750A).

d. Select the 1000 V range of the 34702A and set the dc standard to 1000 V output. Adjust R7 to give a 1000.0 V readout (34740A), or a 1000.00 V readout (34750A).

5-21. 34702A AC Adjustments.

DESCRIPTION:

These adjustments affect ac accuracy of the Model 34702A.

RECOMMENDED TEST EQUIPMENT:

AC Calibrator, -hp- Model 745A
High Voltage Amplifier, -hp- Model 746A

CALIBRATION PROCEDURE:

WARNING

1000 V ac is used in the following procedure. Contact with this voltage can cause death or serious injury.

a. Select the ACV function of the Model 34702A and set it to the 1 V range.

b. Apply 1 V at 10 kHz from the ac calibrator to the 34702A INPUT V terminals and adjust A1R13 for a 1.0000 V readout (34740A), or a 1.00000 readout (34750A).

c. Select the 1000 V range of the Model 34702A and apply 1000 V from the ac calibrator/high voltage amplifier to the 34702A.

d. Adjust A1C5 (coarse adj.) for a 1000.0 V readout (34740A), or a 1000.00 V readout (34750A).

e. Select the 10 V range of the Model 34702A and set the ac calibrator to the 10 V range.

f. Adjust A1C6 for a 10.000 V readout (34740A), or a 10.0000 V readout (34750A).

g. Select the 100 V range of the Model 34702A and set the ac calibrator for 100 V output.

h. Adjust A1C9 for a 100.00 V readout (34740A), or a 100.000 V readout (34750A).

i. Select the 1000 V range of the Model 34702A and apply 1000 V from the ac calibrator/high voltage amplifier.

j. Adjust A1C11 (fine adj.) for a 1000.0 V readout (34740A), or a 1000.00 V readout (34750A).

WARNING

To avoid possible electrical shock, turn off the high voltage amplifier before disconnecting it from the Model 34702A.

5-22. 34702A Ohms Adjustments.

DESCRIPTION:

These adjustments affect the Ohms Accuracy of the Model 34702A.

RECOMMENDED TEST EQUIPMENT:

Decade Resistor, General Radio Model 1433-Z or equivalent.

CALIBRATION PROCEDURE:

a. Connect the resistance decade to the 34702A INPUT Ω terminals using two short lengths of copper wire. Set the resistance decade to 10 kΩ.

b. Select the OHM function of the Model 34702A and set it to the 10 kΩ range. Adjust A1R64 to give a 10.000 kΩ readout (34740A), or a 10.0000 kΩ readout (34750A).

c. Set the resistance decade to 10 MΩ. Select the 10 MΩ range of the 34702A and turn A1R59 to give a 10.000 MΩ readout (34740A) or a 10.0000 MΩ readout (34750A).

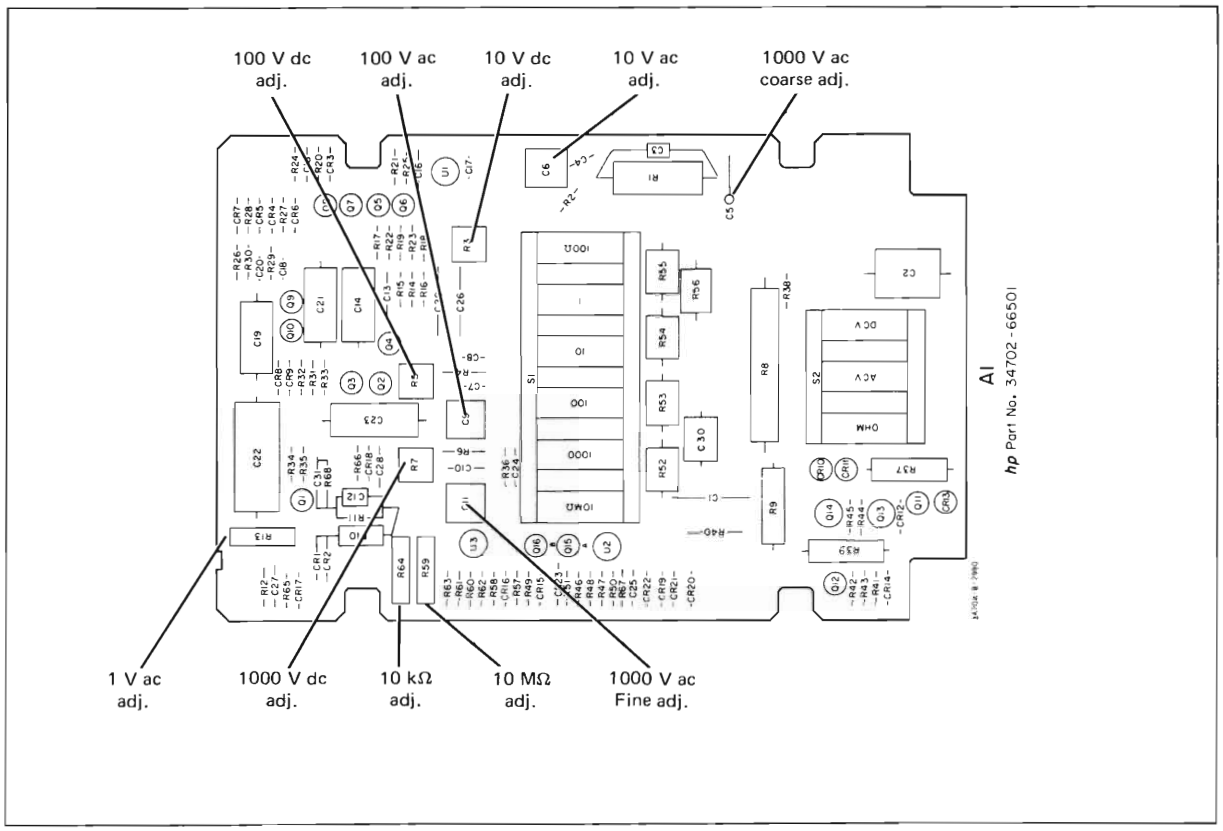


Figure 5-5. Adjustment Locator.

PERFORMANCE TEST CARD

Hewlett-Packard Model 34740A/34702A
Multimeter
Serial Number _____

Tests Performed By _____

Date _____

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-9	DC Accuracy (30 Days)			
	1 V Range	- .0001	_____	+ .0001
		± .9996	_____	± 1.0004
		± 1.8993	_____	± 1.9007
		± 1.9973	_____	± 1.9987
	10 V Range	- 0.001	_____	+ 0.001
		± 9.996	_____	± 10.004
		± 18.993	_____	± 19.007
	100 V Range	- 00.01	_____	+ 00.01
		± 99.96	_____	± 100.04
		± 189.93	_____	± 190.07
	1000 V Range	- 000.1	_____	+ 000.1
		+ 999.6	_____	+ 1000.4
	(90 Days)			
	1 V Range	- .0001	_____	+ .0001
		± .9995	_____	± 1.0005
		± 1.8991	_____	± 1.9009
		± 1.9971	_____	± 1.9989
	10 V Range	- 0.001	_____	+ 0.001
		± 9.996	_____	± 10.004
		± 18.993	_____	± 19.007
	100 V Range	- 00.01	_____	+ 00.01
		± 99.96	_____	± 100.04
		± 189.93	_____	± 190.07
	1000 V Range	- 000.1	_____	+ 000.1
		+ 999.5	_____	+ 1000.5
	(6 Months)			
	1 V Range	- .0002	_____	+ .0002
		± .9993	_____	± 1.0007
		± 1.8989	_____	± 1.9012
		± 1.9968	_____	± 1.9992
	10 V Range	- 0.002	_____	+ 0.002
		± 9.993	_____	± 10.007
		± 18.989	_____	± 19.012
	100 V Range	- 00.02	_____	+ 00.02
		± 99.93	_____	± 100.07
		± 189.89	_____	± 190.12
	1000 V Range	- 000.2	_____	+ 000.2
		+ 999.3	_____	+ 1000.7

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-9 (Cont'd)	(1 Year)			
	1 V Range	- .0002	_____	+ .0002
		± .9992	_____	± 1.0008
		± 1.8987	_____	± 1.9013
		± 1.9966	_____	± 1.9994
	10 V Range	- 0.002	_____	+ 0.002
		± 9.992	_____	± 10.008
		± 18.987	_____	± 19.013
	100 V Range	- 00.02	_____	+ 00.02
		± 99.92	_____	± 100.08
		± 189.87	_____	± 190.13
	1000 V Range	- 000.2	_____	+ 000.2
		+ 999.2	_____	+ 1000.8
5-10	Input Impedance: Resistance			
	1 V and 10 V Ranges	.5258	_____	.5268
	100 V Range	50.20	_____	50.30
	1000 V Range	499.7	_____	500.7
	Capacitance		_____	⩽ 80 pF
5-11	DC Effective Common Mode Rejection		_____	< 10 counts
5-12	Normal Mode Rejection		_____	< 10 counts
5-13	AC Accuracy 45 Hz to 20 kHz (30 Days)			
			_____	.0005
	1 V Range	.9970	_____	1.0030
		1.8948	_____	1.9053
		1.9845	_____	1.9955
			_____	0.005
	10 V Range	9.970	_____	10.030
		18.948	_____	19.053
			_____	00.05
	100 V Range	99.70	_____	100.30
		189.48	_____	190.53
	1000 V Range	000.5	_____	000.5
		997.0	_____	1003.0
	(90 Days)			
			_____	.0005
	1 V Range	.9965	_____	10.035
		1.8938	_____	1.9062
		1.9835	_____	1.9965
			_____	0.005
	10 V Range	9.965	_____	10.035
		18.938	_____	19.062
			_____	00.05
	100 V Range	99.65	_____	100.35
		189.38	_____	190.62

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-13 (Cont'd)				
	1000 V Range	996.5	_____	000.5
			_____	1003.5
	(6 Months)			
	1 V Range	.9960	_____	.0005
		1.8929	_____	1.0040
		1.9825	_____	1.9072
			_____	1.9975
	10 V Range	9.960	_____	0.005
		18.929	_____	10.040
			_____	19.072
	100 V Range	99.60	_____	00.05
		189.29	_____	100.40
			_____	190.72
	1000 V Range	994.5	_____	000.5
			_____	1005.5
	(1 Year)			
	1 V Range	.9945	_____	.0005
		1.8900	_____	1.0055
			_____	1.9100
	10 V Range	9.945	_____	0.005
		18.900	_____	10.055
			_____	19.100
	100 V Range	99.45	_____	00.05
		189.00	_____	100.55
			_____	191.00
	1000 V Range	994.5	_____	000.5
			_____	1005.5
	AC Accuracy 100 kHz (30 Days)			
	1 V Range	.9920	_____	.0005
		1.8853	_____	1.0080
			_____	1.9148
	10 V Range	9.920	_____	0.005
		18.853	_____	10.080
			_____	19.148
	100 V Range	99.20	_____	00.05
		188.53	_____	100.80
			_____	191.48
	1000 V Range	992.0	_____	000.5
			_____	1008.0
	(90 Days)			
	1 V Range	.9915	_____	.0005
		1.8839	_____	1.0085
			_____	1.9162

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-13 (Cont'd)			_____	0.005
	10 V	9.915	_____	10.085
	Range	18.839	_____	19.162
			_____	00.05
	100 V	99.15	_____	100.85
	Range	188.39	_____	190.16
			_____	000.5
	1000 V	991.5	_____	1008.5
	Range			
	(6 Months)			
			_____	.0005
	1 V	.9910	_____	1.0090
	Range	1.8819	_____	1.9171
			_____	0.005
	10 V	9.910	_____	10.090
	Range	18.829	_____	19.171
			_____	00.05
	100 V	99.10	_____	100.90
	Range	188.29	_____	191.71
			_____	000.5
	1000 V	991.0	_____	1009.0
	Range			
	(1 Year)			
			_____	.0005
	1 V	.9895	_____	1.0105
	Range	1.8801	_____	1.9200
			_____	0.005
	10 V	9.895	_____	10.105
	Range	18.801	_____	19.200
			_____	00.05
	100 V	98.95	_____	101.05
	Range	188.01	_____	192.00
			_____	000.5
	1000 V	989.5	_____	1010.5
	Range			
5-14	Response Time		_____	⩽ 30 counts
5-15	Ohms Accuracy (30 Day)			
			_____	00.02
	100 Ω	99.93	_____	100.07
	Range	189.89	_____	190.12
			_____	.0002
	1 kΩ	.9993	_____	1.0007
	Range	1.8989	_____	1.9012
		1.9888	_____	1.9912
			_____	0.002
	10 kΩ	9.993	_____	10.007
	Range	18.989	_____	19.912

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-15 (Cont'd)			_____	00.02
	100 kΩ	99.93	_____	100.07
	Range	189.89	_____	199.12
			_____	000.2
	1000 kΩ	999.3	_____	1000.7
	Range	1898.9	_____	1991.2
			_____	0.002
	10 MΩ	9.973	_____	10.027
	Range			
	(90 Day)			
			_____	00.02
	100 Ω	99.92	_____	100.08
	Range	189.87	_____	190.13
			_____	.0002
		.9992	_____	1.0008
	1 kΩ	1.8987	_____	1.9013
	Range	1.9886	_____	1.9914
			_____	0.002
	10 kΩ	9.992	_____	10.008
	Range	18.987	_____	19.013
			_____	00.02
	100 kΩ	99.92	_____	100.08
	Range	189.87	_____	190.13
			_____	000.2
	1000 kΩ	999.2	_____	1000.8
	Range	1898.7	_____	1901.3
			_____	0.002
	10 MΩ	9.973	_____	10.027
	Range			
	(6 Months)			
			_____	00.03
	100 Ω	99.90	_____	100.10
	Range	189.84	_____	190.16
			_____	.0003
		.9990	_____	1.0010
	1 kΩ	1.8984	_____	1.9016
	Range	1.9883	_____	1.9917
			_____	0.002
	10 kΩ	9.990	_____	10.010
	Range	19.883	_____	19.917
			_____	00.03
	100 kΩ	99.90	_____	100.10
	Range	198.83	_____	199.17
			_____	000.3
	1000 kΩ	999.0	_____	1001.0
	Range	1988.3	_____	1991.7
			_____	0.003
	10 MΩ	9.961	_____	10.038
	Range			

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-15 (Cont'd)	(1 Year)			
	100 Ω Range	99.86	_____	00.03
		189.76	_____	100.14
			_____	190.24
	1 kΩ Range	.9986	_____	.0003
		1.8976	_____	1.0014
		1.9875	_____	1.9024
			_____	1.9925
	10 kΩ Range	9.986	_____	0.003
		18.976	_____	10.014
			_____	19.024
	100 kΩ Range	99.86	_____	00.03
		189.76	_____	100.14
			_____	190.24
	1000 kΩ Range	998.86	_____	000.3
		1897.6	_____	1001.4
			_____	1902.4
	10 MΩ Range	9.947	_____	0.003
			_____	10.053

PERFORMANCE TEST CARD

Hewlett-Packard Model 34750A/34702A
Multimeter

Tests Performed by _____

Serial No. _____

Date _____

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-9	DC Accuracy (30 Days)			
	1 V Range	- .00004	_____	+ .00004
		± .99971	_____	± 1.00029
		± 1.89948	_____	± 1.90052
		± 1.99746	_____	± 1.99854
	10 V Range	- 0.0004	_____	+ 0.0004
		± 9.9971	_____	± 10.0029
		± 18.9948	_____	± 19.0052
	100 V Range	- 00.004	_____	+ 00.004
		± 99.971	_____	± 100.029
		± 189.948	_____	± 190.052
	1000 V Range	- 000.04	_____	+ 000.04
		+ 999.71	_____	+ 1000.29
	(90 Days)			
	1 V Range	- .00005	_____	+ .00005
		± .99960	_____	± 1.00040
		± 1.89929	_____	± 1.90072
		± 1.99725	_____	± 1.99875
	10 V Range	- 0.0005	_____	+ 0.0005
		± 9.9960	_____	± 10.0040
		± 18.9929	_____	± 19.0072
	100 V Range	- 00.005	_____	+ 00.005
		± 99.960	_____	± 100.040
		± 189.929	_____	± 190.072
	1000 V Range	- 000.05	_____	+ 000.05
		+ 999.60	_____	+ 1000.40
	(6 Months)			
	1 V Range	- .00007	_____	+ .00007
		± .99948	_____	± 1.00052
		± 1.89908	_____	± 1.90093
		± 1.99703	_____	± 1.99897
	10 V Range	- 0.0007	_____	+ 0.0007
		± 9.9948	_____	± 10.0052
		± 18.9908	_____	± 19.0093
	100 V Range	- 00.007	_____	+ 00.007
		± 99.948	_____	± 100.052
		± 189.908	_____	± 190.093
	1000 V Range	- 000.07	_____	+ 000.07
		+ 999.48	_____	+ 1000.52

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-9 (Cont'd)	(1 Year)			
	1 V Range	- .00010	_____	+ .00010
		± .99930	_____	± 1.00070
		± 1.89876	_____	± 1.90124
		± 1.99660	_____	± 1.99940
	10 V Range	- 0.0010	_____	+ 0.0010
		± 9.9930	_____	± 10.0070
		± 18.9876	_____	± 19.0124
	100 V Range	- 00.010	_____	+ 00.010
		± 99.930	_____	± 100.070
		± 189.876	_____	± 190.124
	1000 V Range	- 000.10	_____	+ 000.10
		± 999.30	_____	± 1000.70
5-10	Input Impedance: Resistance			
	1 V and 10 V Ranges	.52582	_____	.52682
	100 V Ranges	50.201	_____	50.301
	1000 V Ranges	499.75	_____	500.75
	Capacitance		_____	⩽ 80 pF
5-11	DC Effective Common Mode Rejection		_____	< 100 counts
5-12	Normal Mode Rejection		_____	< 100 counts
5-13	AC Accuracy 45 Hz to 20 kHz (30 Day)			
			_____	.00040
	1 V Range	.99710	_____	1.00290
		1.89485	_____	1.90515
		1.98463	_____	1.99538
			_____	0.0040
	10 V Range	9.9710	_____	10.0290
		18.9485	_____	19.0515
			_____	00.040
	100 V Range	99.710	_____	100.290
		189.485	_____	190.515
	1000 V Range		_____	000.40
		997.10	_____	1002.90
	(90 Day)			
			_____	.00050
	1 V Range	.99650	_____	1.00350
		1.89380	_____	1.90620
		1.98353	_____	1.99647
			_____	0.0050
	10 V Range	9.9650	_____	10.0350
		18.9380	_____	19.0620
			_____	00.050
	100 V Range	99.650	_____	100.350
		189.380	_____	190.620

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-13 (Cont'd)				
	1000 V Range	996.50	_____	000.50 1003.50
	(6 Months)			
	1 V Range	.99600 1.89285 1.98254	_____ _____ _____	.00050 1.00400 1.90715 1.99747
	10 V Range	9.9600 18.9285	_____ _____ _____	0.0050 10.0400 19.0715
	100 V Range	99.600 189.285	_____ _____ _____	00.050 100.400 190.715
	1000 V Range	996.00	_____ _____	000.50 1004.00
	(1 Year)			
	1 V Range	.99550 1.89000	_____ _____ _____	.00050 1.00550 1.91000
	10 V Range	9.9550 18.9000	_____ _____ _____	0.0050 10.0550 19.1000
	100 V Range	99.550 189.000	_____ _____ _____	00.050 100.550 191.000
	1000 V Range	995.50	_____ _____	000.50 1005.50
	AC Accuracy 100 kHz (30 Days)			
	1 V Range	.99200 1.88525	_____ _____ _____	.00050 1.00800 1.91475
	10 V Range	9.9200 18.8525	_____ _____ _____	0.0050 10.0800 19.1475
	100 V Range	99.200 188.525	_____ _____ _____	00.050 100.800 191.475
	1000 V Range	992.00	_____ _____	000.50 1008.00

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-13 (Cont'd)	(90 Days)			
	1 V Range	.99150	_____	.00050
		1.88430	_____	1.00850
			_____	1.91570
	10 V Range	9.9150	_____	0.0050
		18.8430	_____	10.0850
			_____	19.1570
	100 V Range	99.150	_____	00.050
		188.430	_____	100.850
			_____	191.570
	1000 V Range	991.50	_____	000.50
			_____	1008.50
	(6 Months)			
	1 V Range	.99100	_____	.00050
		1.88335	_____	1.00900
			_____	1.91665
	10 V Range	9.9100	_____	0.0050
		18.8335	_____	10.0900
			_____	19.1665
	100 V Range	99.100	_____	00.050
		188.335	_____	100.900
			_____	191.665
	1000 V Range	991.00	_____	000.50
			_____	1009.00
	(1 Year)			
	1 V Range	.98950	_____	.00050
		1.88050	_____	1.01050
			_____	1.91950
	10 V Range	9.8950	_____	0.0050
		18.8050	_____	1.01050
			_____	19.1950
	100 V Range	98.950	_____	00.050
		188.050	_____	101.050
			_____	191.950
	1000 V Range	989.50	_____	000.50
			_____	1010.50
5-14	Response Time		_____	⩽ 300 counts
5-15	Ohms Accuracy (30 Day)			
	100 Ω Range	99.940	_____	00.015
		189.900	_____	100.060
			_____	190.101
	1 kΩ Range	.99940	_____	.00015
		1.89900	_____	1.00060
		1.98895	_____	1.90101
			_____	1.99105

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-15 (Cont'd)			_____	0.0015
	10 kΩ	9.9940	_____	10.0060
	Range	18.9900	_____	19.0101
			_____	00.015
	100 kΩ	99.940	_____	100.060
	Range	189.900	_____	190.101
			_____	000.15
	1000 kΩ	999.40	_____	1000.60
	Range	1899.00	_____	1901.01
			_____	0.0015
	10 MΩ	.99940	_____	1.00060
	Range			
	(90 Day)			
			_____	00.015
	100 Ω	99.930	_____	100.070
	Range	189.881	_____	190.120
			_____	.00015
		.99930	_____	1.00070
	1 kΩ	1.89881	_____	1.90120
	Range	1.98891	_____	1.99109
			_____	0.0015
	10 kΩ	9.9930	_____	10.0070
	Range	18.9881	_____	19.0120
			_____	00.015
	100 kΩ	99.930	_____	100.070
	Range	189.881	_____	190.124
			_____	000.15
	1000 kΩ	999.30	_____	1000.70
	Range	1898.81	_____	1901.20
			_____	0.0015
	10 MΩ	.99685	_____	1.00315
	Range			
	(6 Months)			
			_____	00.020
	100 Ω	99.915	_____	100.085
	Range	189.877	_____	190.124
			_____	.00020
		.99915	_____	1.00085
	1 kΩ	1.89877	_____	1.90124
	Range	1.98871	_____	1.99129
			_____	0.0020
	10 kΩ	9.9915	_____	10.0085
	Range	18.9877	_____	19.0124
			_____	00.020
	100 kΩ	99.915	_____	100.085
	Range	189.877	_____	190.124
			_____	000.20
	1000 kΩ	998.70	_____	1001.30
	Range	1897.71	_____	1902.29

Paragraph Number	Test	Results		
		Minimum	Actual	Maximum
5-15 (Cont'd)				
	10 MΩ		_____	0.0020
	Range	.99630	_____	1.00370
	(1 Year)			
			_____	00.020
	100 Ω	99.870	_____	100.130
	Range	189.771	_____	190.229
			_____	.00020
	1 kΩ	.99870	_____	1.00130
	Range	1.89771	_____	1.90229
		1.98761	_____	1.99239
			_____	0.0020
	10 kΩ	9.9870	_____	10.0130
	Range	18.9771	_____	19.0229
			_____	00.020
	100 kΩ	99.870	_____	100.130
	Range	189.771	_____	190.229
			_____	000.20
	1000 kΩ	998.70	_____	1001.30
	Range	1897.71	_____	1902.39
	10 MΩ		_____	0.0020
	Range	.99480	_____	1.00520

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

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

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

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

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; i.e. Δ, Δ with a letter subscript, e.g. Δ_a, or Δ with a number subscript e.g. Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section 8). The number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

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

ABBREVIATIONS

Ag . . . . . silver
Al . . . . . aluminum
A . . . . . ampere(s)
Au . . . . . gold

C . . . . . capacitor
cer . . . . . ceramic
coef . . . . . coefficient
com . . . . . common
comp . . . . . composition
conn . . . . . connection

dep . . . . . deposited
DPDT . . . . . double-pole double-throw
DPST . . . . . double-pole single-throw

elect . . . . . electrolytic
encap . . . . . encapsulated

F . . . . . farad(s)
FET . . . . . field effect transistor
fxd . . . . . fixed

GaAs . . . . . gallium arsenide
GHz . . . . . gigahertz = 10^{+9} hertz
gd . . . . . guard(ed)
Ge . . . . . germanium
gnd . . . . . ground(ed)

H . . . . . henry(ies)
Hg . . . . . mercury

Hz . . . . . hertz (cycle(s) per second)

ID . . . . . inside diameter
impg . . . . . impregnated
incd . . . . . incandescent
ins . . . . . insulation(ed)

kΩ . . . . . kilohm(s) = 10^{+3} ohms
kHz . . . . . kilohertz = 10^{+3} hertz

L . . . . . inductor
lin . . . . . linear taper
log . . . . . logarithmic taper

mA . . . . . milliampere(s) = 10^{-3} amperes
MHz . . . . . megahertz = 10^{+6} hertz
MΩ . . . . . megohm(s) - 10^{+6} ohms
met flm . . . . . metal film
mfr . . . . . manufacturer
ms . . . . . millisecond
mtg . . . . . mounting
mV . . . . . millivolt(s) = 10^{-3} volts
μF . . . . . microfarad(s)
μs . . . . . microsecond(s)
μV . . . . . microvolt(s) = 10^{-6} volts
my . . . . . Mylar®

nA . . . . . nanoampere(s) = 10^{-9} amperes
NC . . . . . normally closed
Ne . . . . . neon
NO . . . . . normally open

NPO . . . . . negative positive zero (zero temperature coefficient)
ns . . . . . nanosecond(s) = 10^{-9} seconds
nsr . . . . . not separately replaceable

Ω . . . . . ohm(s)
obd . . . . . order by description
OD . . . . . outside diameter

p . . . . . peak
pA . . . . . picoampere(s)
pc . . . . . printed circuit
pF . . . . . picofarad(s) 10^{-12} farads
piv . . . . . peak inverse voltage
p/o . . . . . part of
pos . . . . . position(s)
poly . . . . . polystyrene
pot . . . . . potentiometer
p-p . . . . . peak-to-peak
ppm . . . . . parts per million
prec . . . . . precision (temperature coeffient, long term stability and/or tolerance)

R . . . . . resistor
Rh . . . . . rhodium
rms . . . . . root-mean-square
rot . . . . . rotary

Se . . . . . selenium
sect . . . . . section(s)
Si . . . . . silicon

sl . . . . . slide
SPDT . . . . . single-pole double-throw
SPST . . . . . single-pole single-throw

Ta . . . . . tantalum
TC . . . . . temperature coefficient
TiO_2 . . . . . titanium dioxide
tog . . . . . toggle
tol . . . . . tolerance
trim . . . . . trimmer
TSTR . . . . . transistor

V . . . . . volt(s)
vacw . . . . . alternating current working voltage
var . . . . . variable
vdcw . . . . . direct current working voltage

W . . . . . watt(s)
w/ . . . . . with
wiv . . . . . working inverse voltage
w/o . . . . . without
ww . . . . . wirewound

* . . . . . optimum value selected at factory, average value shown (part may be omitted)
** . . . . . no standard type number assigned selected or special type

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

A . . . . . assembly
B . . . . . motor
BT . . . . . battery
C . . . . . capacitor
CR . . . . . diode
DL . . . . . delay line
DS . . . . . lamp
E . . . . . misc electronic part
F . . . . . fuse

FL . . . . . filter
HR . . . . . heater
IC . . . . . integrated circuit
J . . . . . jack
K . . . . . relay
L . . . . . inductor
M . . . . . meter
MP . . . . . mechanical part
P . . . . . plug

Q . . . . . transistor
QCR . . . . . transistor-diode
R . . . . . resistor
RT . . . . . thermistor
S . . . . . switch
T . . . . . transformer
TB . . . . . terminal board
TC . . . . . thermocouple
TP . . . . . test point

TS . . . . . terminal strip
U . . . . . microcircuit
V . . . . . vacuum tube, neon bulb, photocell, etc.
W . . . . . cable
X . . . . . socket
XDS . . . . . lampholder
XF . . . . . fuseholder
Y . . . . . crystal
Z . . . . . network

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	34702-66501[a]	1			
A1C1	0160-3965	1	C:FXD 0.001 UF 20%	28480	0160-3965
A1C2	0170-0022	1	C:FXD MY 0.1UF 20% 600VDCW	09134	TYPE 24
A1C3	0160-3930	1	C:FXD 10 PF 2500 VDCW	28480	0160-3930
A1C4	0160-4425	1	C:FXD MICA 47 PF 5%	28480	0160-4425
A1C5	0121-0168	1	C:VAR TEFLON 0.25-1.50 PF 600VDCW	28480	0121-0168
A1C6	0121-0127	2	C:VAR AIR TRIMMER 1.7 TO 14.1 PF	28480	0121-0127
A1C7	0160-3972	1	C:FXD 1012 PF	28480	0160-3972
A1C8*	0140-0145	1	C:FXD MICA 22 PF 5%	28480	0140-0145
A1C9	0121-0478	1	C:VAR AIR 2.4-34.0 PF 650VDCW	74970	193-0010-005
A1C10	0160-3973	1	C:FXD 10350 PF	28480	0160-3973
A1C11	0121-0147	1	C:VAR AIR 2.3/19.3 PF	28480	0121-0147
A1C12	0170-0043	2	C:FXD MY .022 UF 10% 600 VDCW	28480	0170-0043
A1C13	0180-0210	1	C:FXD ELECT 3.3 UF 20% 15VDCW	56289	150D335X9015A2-DYS
A1C14	0180-1800	3	C:FXD ELECT 100 UF +100-10% 6VDCW	56289	300603(NP)
A1C15	0150-0014	1	C: FXD CER 0.005 UF 500 VDCW	96095	D1-4
A1C16	0180-0197	1	C: FXD ELECT 2.2 UF 10% 20 VDCW	56289	150D225X9020A2-DYS
A1C17	0160-2199	1	C: FXD MICA 30 pF 5%	72136	DBD
A1C18	0140-0196	2	C:FXD MICA 150 PF 1%	72136	DM15F151J0300WV1CR
A1C19	0180-1800		C:FXD ELECT 100 UF +100-10% 6VDCW	56289	300603(NP)
A1C20	0140-0196		C:FXD MICA 150 PF 1%	72136	DM15F151J0300WV1CR
A1C21	0180-1800		C:FXD ELECT 100 UF +100-10% 6VDCW	56289	300603(NP)
A1C22	0160-2132	1	C:FXD MY 0.56 UF 10% 50VDCW	56289	410P SPEC
A1C23	0170-0038	1	C:FXD MY 0.22 UF 10% 200VDCW	56289	148P22492 PUM
A1C24	0170-0040	1	C:FXD MY 0.047UF 10% 200 VDCW	56289	292P47392-PTS
A1C25	0180-0291	1 2	C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A1C26	0180-0228	2	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1C27, C28	0180-1701	2	C:FXD ELECT 6.8 UF 20% 6 VDCW	28480	0180-1701
A1C29	0180-0228		C:FXD ELECT 22 UF 10% 15 VDCW	56289	150D226X9015B2-DYS
A1C30	0160-3992	1	C:FXD 300 PF 10% 300 VDCW	95275	VY13C301-K
A1C31	0170-0043		C:FXD MY .022 UF 10% 600 VDCW	84411	HEW-93
A1CR1	1901-0376	2	DIODE: SILICON 35 V	28480	1901-0376
A1CR2	1901-0376		DIODE:SILICON 35V	28480	1901-0376
A1CR3	1902-3049	2	DIODE:BREAKDOWN 6.19V 5%	04713	SZ10939-122
A1CR4	1901-3040	6	DIODE:SILICON 50MA 30WV	07263	FDG1088
A1CR5	1902-3049		DIODE:BREAKDOWN 6.19V 5%	04713	SZ10939-122
A1CR6	1902-3182	1	DIODE BREAKDOWN:SILICON 12.1V 5%	28480	1902-3182
A1CR7	1901-3040		DIODE:SILICON 50MA 30WV	07263	FDG1088
A1CR8	1901-0518	2	DIODE:HOT CARRIER	28480	1901-0518
A1CR9	1901-0518		DIODE:HOT CARRIER	28480	1901-0518
A1CR10	1901-0546 [b]	2	DIODE:SI 30 WV 1.0 PA LEAKAGE	17856	FN1705
A1CR11	1901-0546		DIODE:SI 30 WV 1.0 PA LEAKAGE	17856	FN1705
A1CR12	1901-0029	1	DIODE:SILICON 500 PIV	28480	1901-0029
A1CR13	1901-0586	1	DIODE:SI 30 WV 10 PA LEAKAGE	28480	1901-0586
A1CR14	1902-3040	1	DIODE BREAKDOWN:14.0V 5%	28480	1902-0040
A1CR15	1902-3041	3	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A1CR16	1902-3177	1	DIODE:BREAKDOWN 6.2V 5%	04713	1N825
A1CR17	1902-3041		DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A1CR18	1902-3041		DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A1CR19	1901-3040		DIODE:SILICON 50MA 30WV	07263	FDG1088
A1CR20	1901-3040		DIODE:SILICON 50MA 30WV	07263	FDG1088
A1CR21	1901-3040		DIODE:SILICON 50MA 30WV	07263	FDG1088
A1CR22	1901-0040		DIODE: SILICON 50MA 30 WV	07263	FDG1088
A1CR23	1902-3149		DIODE: BREAKDOWN 9.09 V 5%	04713	SZ 10939-170
A1J1	1855-0412	2	TSTR:FET SI N-CHANNEL	17856	FN2960
A1J2	1853-3010	3	TSTR:SI PNP(SELECTED FROM 2N3251)	28480	1853-0010
A1J3	1853-0010		TSTR:SI PNP(SELECTED FROM 2N3251)	28480	1853-0010
A1J4	1854-0071	8	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1J5	1854-0404		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0404
A1J6	1854-0215		TSTR:SI NPN(SELECTED FROM 2N3704)	04713	SPS 3611
A1J7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1J8	1854-0215		TSTR:SI NPN(SELECTED FROM 2N3704)	04713	SPS 3611
A1J9	1853-0010		TSTR:SI PNP(SELECTED FROM 2N3251)	28480	1853-0010
A1J10	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1J11	1855-0412		TSTR:FET SI N-CHANNEL	17856	FN2960
A1J12	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1J13	1854-0629	2	TSTR:SI NPN	12040	NS48030
A1J14	1854-0629		TSTR:SI NPN	12040	NS48030
A1J15	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1R1	0698-8233	4	RESISTOR:MATCHED SET	28480	0698-8233
A1R2	0698-8233		RESISTOR:MATCHED SET	28480	0698-8233
A1R3	2100-3250	1	R:VAR 5K OHM	28480	2100-3250
A1R4	0698-8233		RESISTOR:MATCHED SET	28480	0698-8233
A1R5	2100-3248	1	R:VAR COMP 500 OHM	28480	2100-3248
A1R6	0698-8233		RESISTOR:MATCHED SET	28480	0698-8233
A1R7	2100-3259	1	R:VAR COMP 50 OHM	28480	2100-3259
A1R8	0811-3029	1	R:FXD WW 100K OHM 5% 10W	28480	0811-3029

[a] This Part No. does not include A1U15

[b] hp- Part No. 1901-0586 can also be used for CR10 and CR11. However both diodes should have the same part number.

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R9	0698-3648	1	R:FXD MET OX 20K OHM 5% 2W	28480	0698-3648
A1R10Δ	0698-8425	1	R: FXD MET FLM 20K OHM 10% 5W	28480	0698-8425
A1R11	0698-5100	2	R:FXD COMP 22 MEGOHM 10% 1/4W	28480	0698-5100
A1R12	0757-0443	1	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A1R13	2100-3154	1	R:VAR CERMET 100O OHM 10% TYPE P 3/4W	28480	2100-3154
A1R14	0698-4523	1	R:FXD FLM 169K OHM 1% 1/8W	28480	0698-4523
A1R15	0757-0461	1	R:FXD MET FLM 58.1K OHM 1% 1/8W	28480	0757-0461
A1R16	0757-0451	1	R:FXD MET FLM 24.3K OHM 1% 1/8W	28480	0757-0451
A1R17	0757-0442	1	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R18	0698-7652	1	R:FXD FLM 49.9K OHM 1.0% 1/8W	28480	0698-7652
A1R19	0698-8249	1	R:FXD FLM 23.7K OHM 1%	28480	0698-8249
A1R20	0698-3515	1	R:FXD FLM 5900 OHM 1% 1/8W	28480	0698-3515
A1R21	0698-3264	1	R:FXD FLM 11.8K OHM 1% 1/8W	28480	0698-3264
A1R22	0757-0449	1	R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A1R23	0698-3499	1	R:FXD FLM 40.2K OHM 1% 1/8W	28480	0698-3499
A1R24	0684-4721	1	R:FXD COMP 4700 OHM 10% 1/4W	01121	CB 4721
A1R25	0684-2241	1	R:FXD COMP 220K OHM 10% 1/4W	01121	CB 2241
A1R26	0684-1051	2	R:FXD COMP 1MEGOHM 1% 1/4W	01121	CB 1051
A1R27	0684-1821	1	R:FXD COMP 1800 OHM 10% 1/4W	01121	CB 1821
A1R28	0684-1021	1	R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021
A1R29	0698-4123	2	R:FXD MET FLM 499 OHM 1% 1/8W	28480	0698-4123
A1R30	0698-4123		R:FXD MET FLM 499 OHM 1% 1/8W	28480	0698-4123
A1R31	0757-0430	1	R:FXD MET FLM 2.21K OHM 1% 1/8W	28480	0757-0430
A1R32	0698-8182	1	R:FXD FLM 2.21K OHM 1% 1/8W	28480	0698-8182
A1R33	0698-8183	1	R:FXD FLM 499 OHM 1.0% 1/8W	28480	0698-8183
A1R34	0698-3243	1	R:FXD MET FLM 178K OHM 1% 1/8W	28480	0698-3243
A1R35	0698-7803	1	R:FXD FLM 575K OHM 1% 1/8W	28480	0698-7803
A1R36	0757-0486	1	R:FXD MET FLM 750K OHM 1% 1/8W	28480	0757-0486
A1R37	0813-0032	2	R:FXD WW 50K OHM 10% 5W	28480	0813-0032
A1R38	0684-1221	1	R:FXD COMP 1.2K OHM 10% 1/4W	01121	CB 1221
A1R39	0813-0032		R:FXD WW 50K OHM 10% 5W	28480	0813-0032
A1R40	0687-3921	1	R:FXD COMP 3900 OHM 10% 1/2W	01121	EB 3921
A1R41	0684-1031	3	R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R42	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R43	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A1R44	0684-8231	1	R:FXD COMP 82K OHM 10% 1/4W	01121	CB 8231
A1R45	0684-2221	1	R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
A1R46	0757-0446	2	R: FXD FLM 15 K OHM 1% 1/8 W	91637	CMF-1/10-32 T-1
A1P47	0684-4711	2	R:FXD COMP 470 OHM 10% 1/4W	01121	CB 4711
A1R48	0757-0446		R: FXD FLM 15 K OHM 1% 1/8 W	91637	CMF-1/10-32 T-1
A1R49	0684-2731	1	R:FXD COMP 27K OHM 10% 1/4W	01121	CB 2731
A1R50	0698-3274	1	R:FXD MET FLM 10K OHM 1% 1/8W	28480	0698-3274
A1R51	0684-1051		R:FXD COMP 1MEGOHM 1% 1/4W	01121	CB 1051
A1R52	0698-8218	5	RESISTOR:MATCHED SET	28480	0698-8218
A1R53	0698-8218		RESISTOR:MATCHED SET	28480	0698-8218
A1R54	0698-8218		RESISTOR:MATCHED SET	28480	0698-8218
A1R55	0698-8218		RESISTOR:MATCHED SET	28480	0698-8218
A1R56	0698-8218		RESISTOR:MATCHED SET	28480	0698-8218
A1R57	0684-4711		R:FXD COMP 470 OHM 10% 1/4W	01121	CB 4711
A1R58	0698-6391	1	R:FXD FLM 350 OHM 1% 1/8W	28480	0698-6391
A1R59	2100-3103	1	R:VAR CERMET 10K OHM 10% TYPE P 3/4W	28480	2100-3103
A1R60	0698-6350	1	R:FXD FLM 110 OHM 1% 1/8W	28480	0698-6350
A1R61	0698-5673	1	R:FXD MET FLM 3.9K OHM 1% 1/8W	28480	0698-5673
A1R62	0698-3437	1	R:FXD MET FLM 133 OHM 1% 1/8W	28480	0698-3437
A1R63	0698-8181	1	R:FXD FLM 24.3K OHM 1% 1/8W	28480	0698-8181
A1R64	2100-3154	1	R:VAR CERMET 1K OHM 10% TYPE P 3/4W	28480	2100-3154
A1R65	0684-6821	2	R:FXD COMP 6.8K OHM 10% 1/4W	01121	CB6821
A1R66	0684-6821		R:FXD COMP 6.8K OHM 10% 1/4W	01121	CB6821
A1R67	0684-3921		R:FXD COMP 3900 OHM 10% 1/4W	01121	CB3921
A1R68	0698-5100		R:FXD 22 MEGOHM 10% 1/4W	28480	0698-5100
A1R69*	0698-999P		PADDING LIST	28480	0698-999P
	0698-3700		RESISTOR 715 OHM 1% .125W	16299	C4-1/8-T0-715R-F
	0698-4424		RESISTOR 1400 OHM 1% .125W	16299	C4-1/8-T0-1401-F
	0698-4436		RESISTOR 2800 OHM 1% .125W	16299	C4-1/8-T0-2801-F
	0698-3493		RESISTOR 4120 OHM 1% .125W	16299	C4-1/8-T0-4121-F
	0698-4432		RESISTOR 2.10K OHM 1% .125W	16299	C4-1/8-T0-2101-F
	0698-3152		RESISTOR 3.48K OHM 1% .125W	16299	C4-1/8-T0-3481-F
A1S1	3101-1724	1	SWITCH: PUSHBUTTON	28480	3101-1724
A1S2	3101-1725	1	SWITCH: PUSHBUTTON	28480	3101-1725
~~A1U1~~ A1R1	1820-0223	3	IC:OPERATIONAL AMPLIFIER	12040	SL8641
A1U2	1820-0203		IC:OPERATIONAL AMPLIFIER	07263	SL8940
A1U3	1820-0203		IC:OPERATIONAL AMPLIFIER	07263	SL8940
A1W1	34702-61601 1		CABLE ASSY:(ACV SWITCH TO R10)	14493	34702-61601
A1W2	34702-61602 1		CABLE ASSY:(DCV SWITCH TO 1 V SWITCH)	14493	34702-61602
A1W3	34702-61603 1		CABLE ASSY:(1 V SWITCH TO ACV SWITCH)	14493	34702-61603

Δ use for all replacement

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MISCELLANEOUS		
	5040-7023		PUSHROD	28480	5040-7023
	5040-7032		FOOT-REAR	28480	5040-7032
	3050-0593	4	WASHER-SPRING	28480	3050-0593
Δa	0370-2486	9	KNOB:PUSHBUTTON SWITCH,	71590	J52305
	0370-0914	9	BEZEL:PUSHBUTTON KNOB, JADE GREY	28480	0370-0914
	5020-8315	2	CASE-BOTTOM	28480	5020-8315
	05300-40003	8	SUPPORT:BOARD	28480	05300-40003
	05300-40004	8	GUIDE:SLIDE	28480	05300-40004
	1460-1357	1	STAND:TILT	28480	05301-20005
	05301-40001	2	FOOT	28480	05301-40001
	1510-0091	4	BINDING POST	28480	1510-0091
	34702-00201	1	PANEL:FRONT	14493	34702-00201
	34702-01201	1	BRACKET:LEFT HAND	14493	34702-01201
	34702-01202	1	BRACKET:RIGHT HAND	14493	34702-01202
	34702-05501	1	SHIELD:PLATE	14493	34702-05501
	34702-05502	1	SHIELD:BOX	14493	34702-05502
	34702-60205	1	PANEL ASSY:REAR	28480	34702-60205
	1460-1311	1	SPRING:GROUND	00000	OBD
	1460-1312	1	SPRING:CLIP	00000	OBD
	34702-90002	1	MANUAL	28480	34702-90002
	1855-0308	1	TSTR:SI DUAL N-CHANNEL (Q15 ON A1ASSY)	28480	1855-0308
	3131-0347	2	SPRING CLIP: BRASS (FOR A151 AND A152)	28480	3131-0347
	1200-0474	1	14 PIN IC SOCKET	28480	1200-0474

Δa Instrument serial No's. 1212A00735 and below used -hp- Part No. 0370-0450

SECTION VII
TROUBLESHOOTING AND CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the Operating and Service Manual contains troubleshooting information and circuit diagrams for the Model 34702A Multimeter. Included are troubleshooting trees, a schematic diagram and a component locator.

7-3. SCHEMATIC DIAGRAM.

7-4. The circuits contained within the Model 34702A are shown on the schematic diagram (Figure 7-3). This diagram can be used to assist in understanding of the theory of operation as well as aid in troubleshooting the instrument. DC voltages and ac waveforms are given on the schematic.

7-5. COMPONENT LOCATION DIAGRAM.

7-6. The Component Location Diagram associated with the schematic shows the position of each part mounted on the pc assembly. Each part is identified by a reference designator.

7-7. TROUBLESHOOTING.

7-8. Troubleshooting Trees.

7-9. Figures 7-1 and 7-2 are troubleshooting trees designed to assist in the isolation of malfunctions. Figure 7-1 is a troubleshooting tree for the ac converter, Figure 7-2 is a troubleshooting tree for the ohms converter.

7-10. Troubleshooting Procedure.

7-11. The following procedure is recommended for troubleshooting the Model 34702A:

a. Ensure the mainframe plug-on (Display Module) is functioning properly.

b. Perform the following preliminary tests:

1. Apply ± 1.0000 V dc to the INPUT V terminals. Check for turnover error.

2. Apply full-scale voltages to the 10 V, 100 V, and 1000 V scales. Check for proper numerical display and decimal point location.

NOTE

The above checks verify proper functioning of many display module interconnections, range switches, and coaxial wiring.

c. Check the ac converter as follows:

1. Apply 1 V ac at 10 kHz to the INPUT V terminals.

2. Trace the propagation of this signal through the impedance converter, ac converter amplifier and filter circuitry.

3. If these circuits appear to be working, check the Input Attenuator.

(a) Apply full-scale voltages to the 34702A on the 10 V, 100 V, and 1000 V ranges. Do this at 10 kHz and 100 kHz.

(b) Note any inaccuracies in the readout. Any error is probably due to the input attenuator.

NOTE

Most frequency response problems are in the input attenuator.

4. Typical Problem Areas.

(a) Noise–check ac converter amplifier.

(b) Low output or zero output–check the ac converter amplifier.

(c) Any type of inaccuracy–check dc feedback amplifier U1 by replacement. Also, check Q1 for leakage (by replacement).

d. Check the dc section of the instrument:

1. Check for shorted trimmer capacitors.

2. Using an ohmmeter, measure the contact resistance of the switches. Each switch should indicate a short circuit. Dirty switches can be cleaned with MS-180 Freon Degreaser.

3. Coax cables may be shorted or open.

4. Resistors in the dc attenuator may change value.

e. Check the ohms current source:

1. Place the 34702A in ohms function and verify that an overload indication occurs (overrange "1" illuminates and rest of display blanks) with no resistance applied.

2. Check all ohms ranges at full-scale to determine which ranges are bad. When only the two highest ranges are inaccurate, check Q11 if the display indication is high. Check CR13 if the indication is low.

3. Referring to the schematic diagram, check the voltages on the two operational amplifiers. If the -7.2 V and -6.2 V references are incorrect or absent, check U3 and CR16.

f. Attempt the Performance Tests (Section V) in order to characterize the trouble. Also try the Adjustment Procedures. Some apparent malfunctions can be corrected by these adjustments. Also, inability to obtain correct adjustment will help localize the problem.

g. Check for burned or loose components, loose connections, or other conditions which might be the source of the trouble.

h. If the problem exists on the DCV and ACV functions but not on the ohms function, troubleshoot the DCV/ACV attenuator. If the trouble exists only on the OHMS or ACV function, refer to the respective troubleshooting tree.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUB-ASSEMBLY 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. (PERMANENTLY CONNECTED TO FRAME GROUND.)

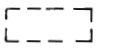
6.  ANY LETTER OR NUMBER IN TRIANGLE DENOTES A SPECIAL GROUND.

7. DENOTES ASSEMBLY.

8. DENOTES MAIN SIGNAL PATH.

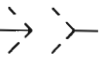
9. DENOTES FEEDBACK PATH.

10.  DENOTES FRONT PANEL MARKING.

11.  DENOTES REAR PANEL MARKING.

12.  DENOTES SCREWDRIVER ADJUST.

13.  AVERAGE VALUE SHOWN. OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER.

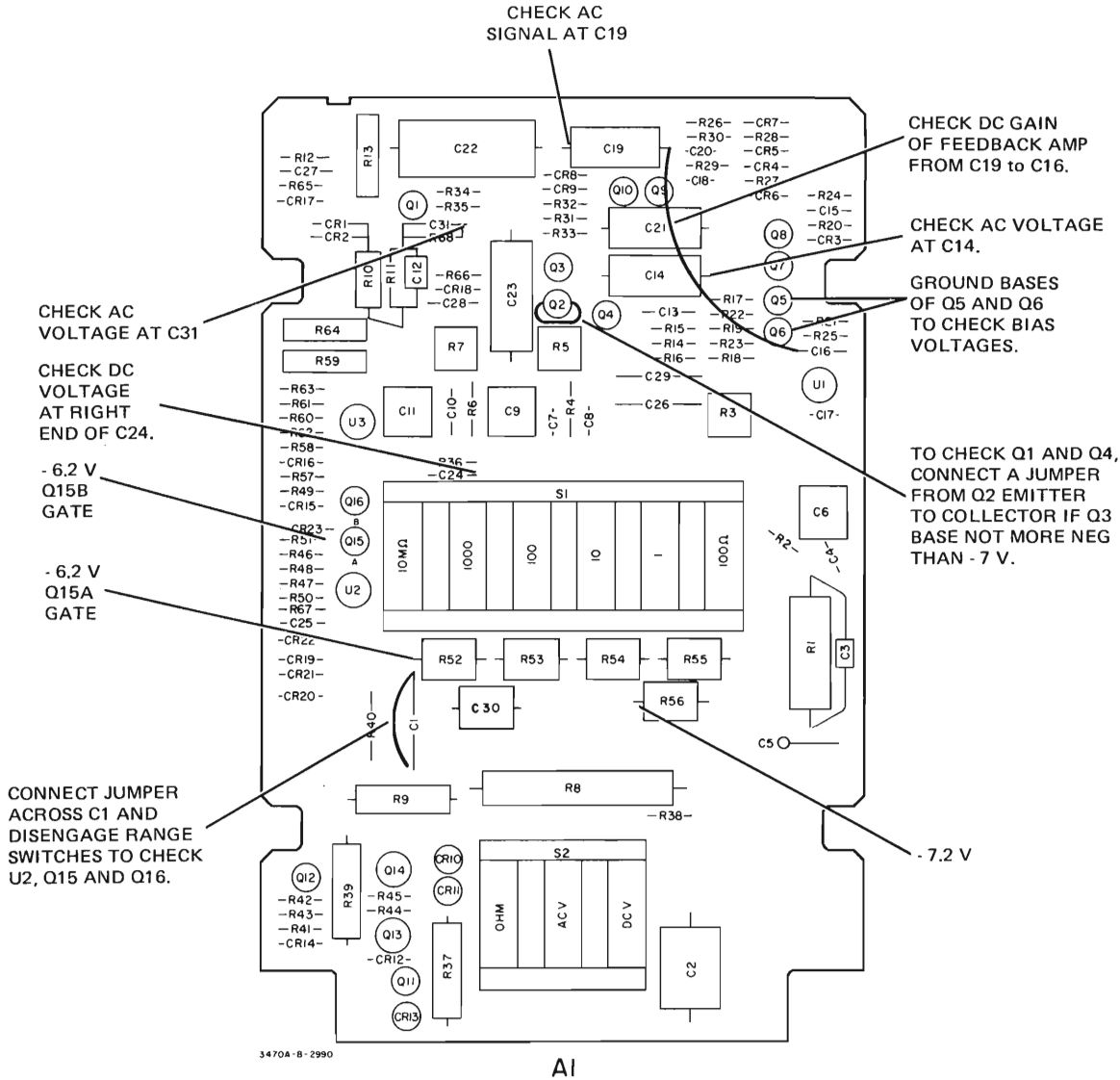
14.  DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15.  DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES STRIP.

16. ALL RELAYS ARE SHOWN DEENERGIZED.

17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 DIVIDER PROBE (10 MEGOHM, 10 pF). THE VOLTAGE LEVELS SHOWN ON THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ±10% IN MEASUREMENTS SHOULD BE ALLOWED.

18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM 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.



A1

hp Part No. 34702-66501

USE LO INPUT TERMINAL AS GROUND POINT FOR TROUBLESHOOTING.

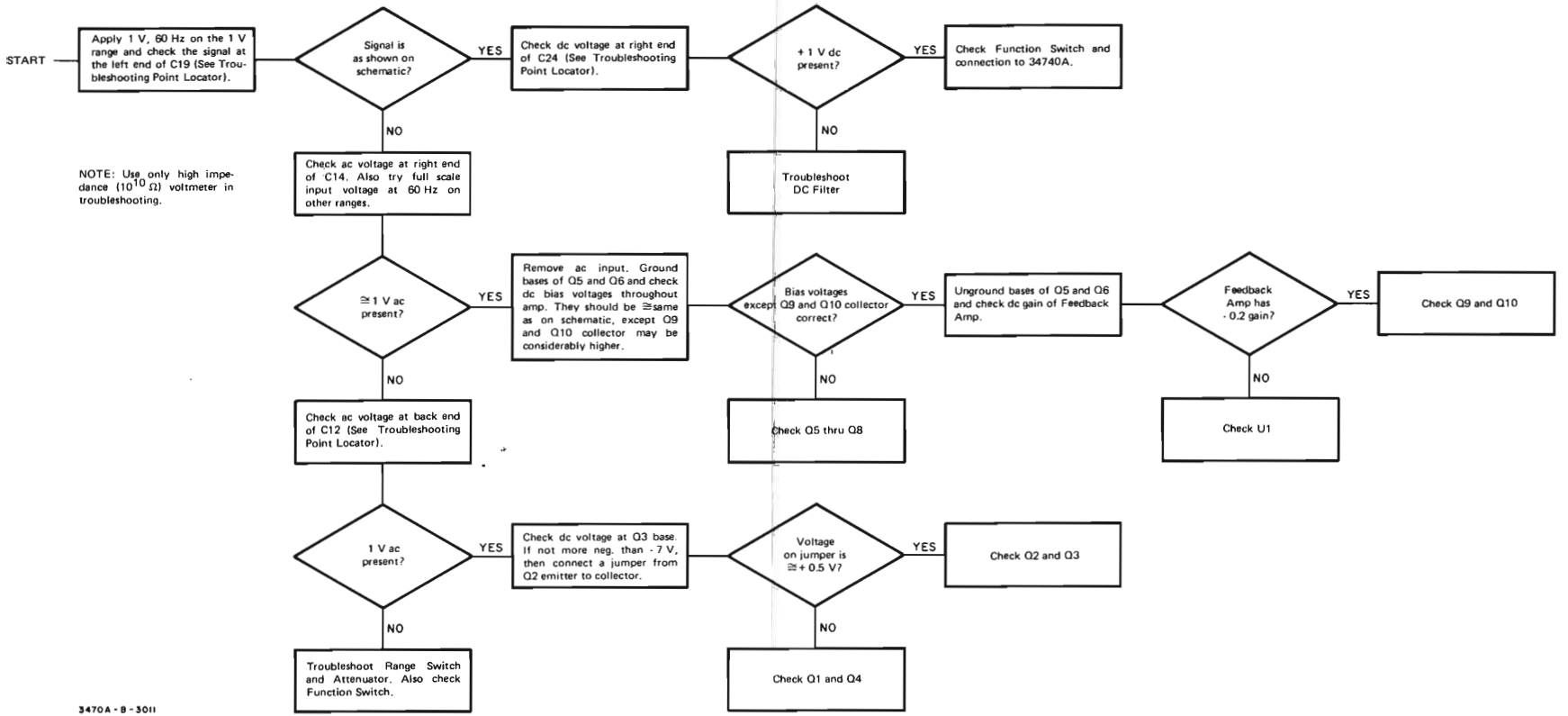


Figure 7-1. AC Converter Troubleshooting Tree.

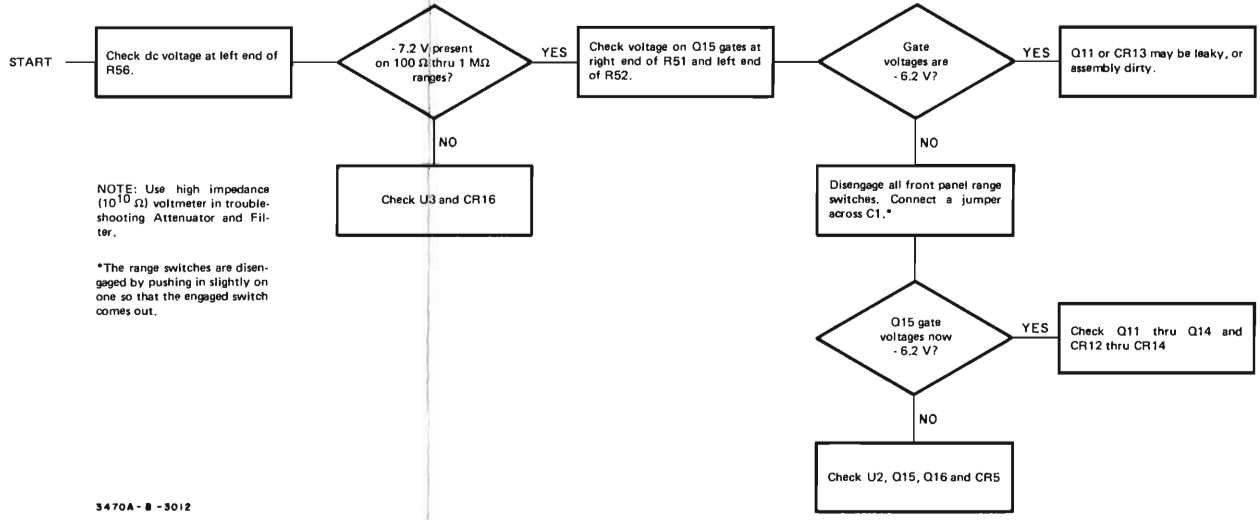
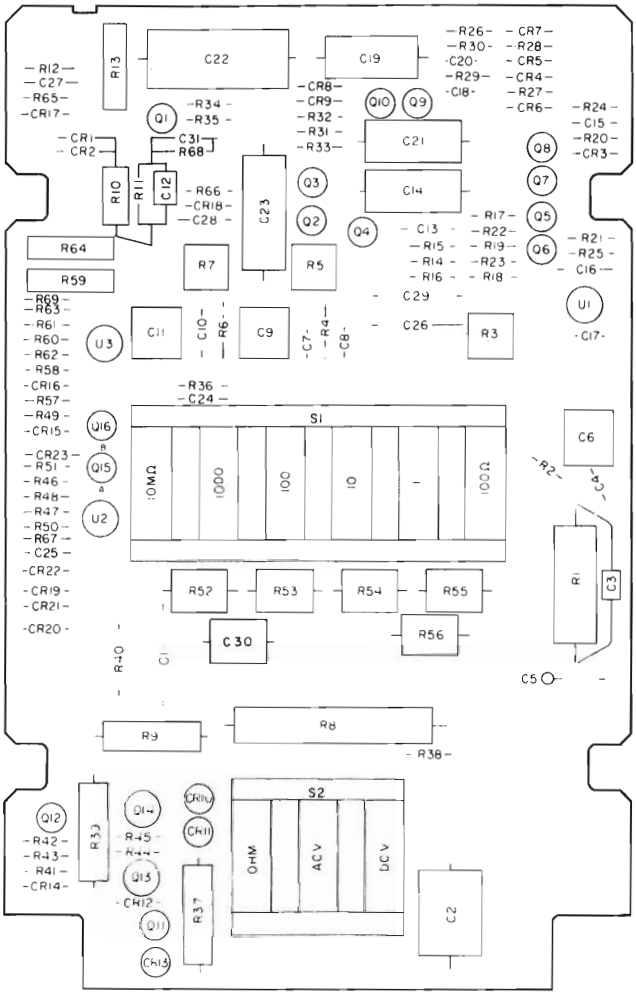


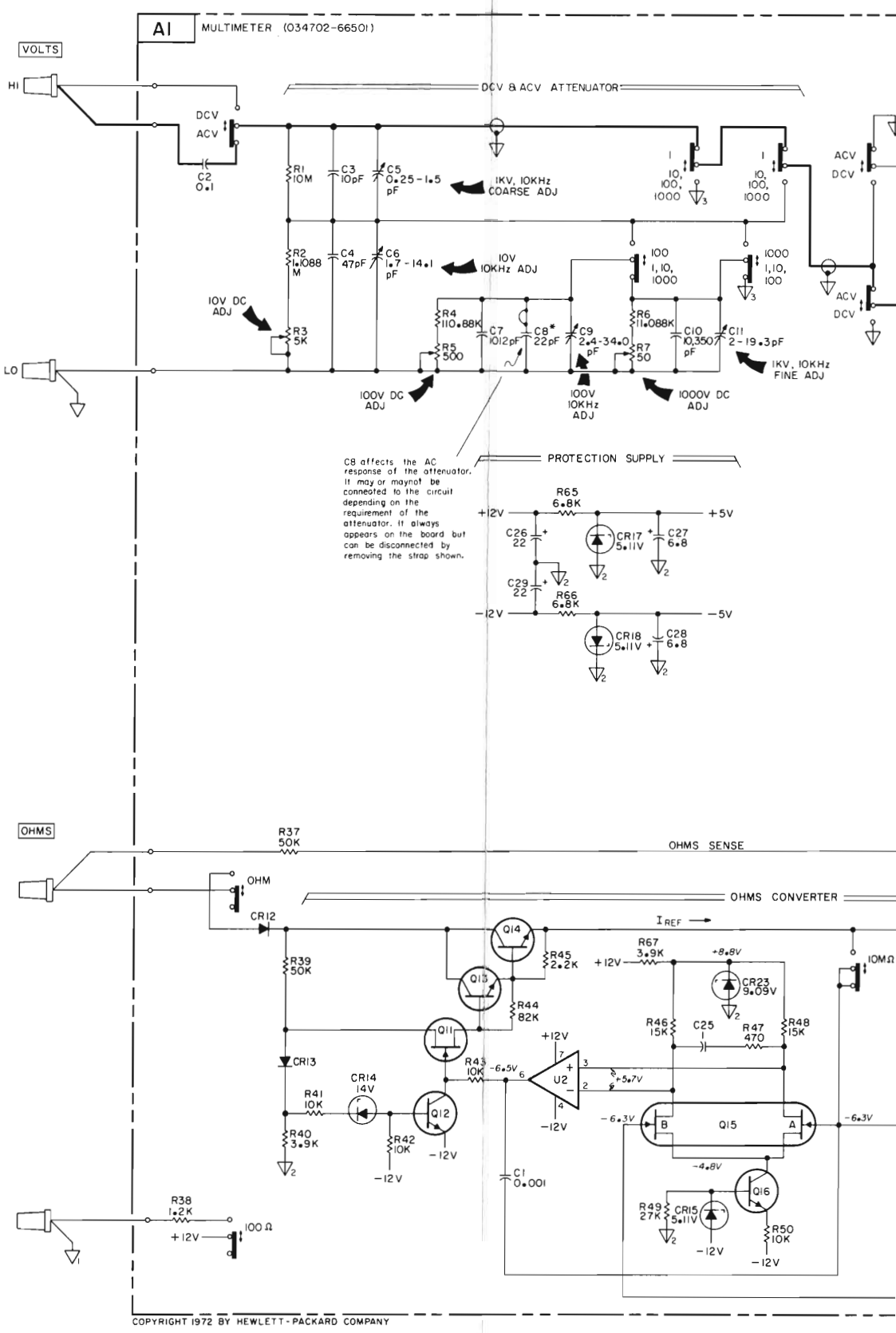
Figure 7-2. Ohms Converter Troubleshooting Tree.

For Serial No's 1212A00335
& below see backdating
Change No. 1 (Section 8)



A1

hp Part No. 34702-66501



NOTES

1) The 1 V and ACV switches are shown engaged (up); all others disengaged (down). All voltages except those in the Ohms Converter were observed with 1 V RMS at 10 kHz applied to the volts terminal. The voltages in the Ohms Converter were observed with the instrument set to "OHM (Ω)" function with 1 kΩ across the "OHMS" terminals.

2) Use only a high resistance ($10^{10}\Omega$) voltmeter in checking the Attenuator, Filter and Ohm Converter.

3) The 34702A connects together the following pins of the 34740A connector:

25 – 50	19 – 22
23 – 48	31 – 32
24 – 49	33 – 34
3 – 41	29 – 30
20 – 21	27 – 28

4) Transistor and IC Lead Configurations:

a. Plastic bipolar

c. Dual FET's

top view

b. Single FET

top view

d. TO5 IC's

top view

A1 MULTIMETER (034702-66501)

DISPLAY MODULE 34740A

VOLTS

HI

LO

OHMS

DCV & ACV ATTENUATOR

DCV
ACV
C2 0.1
R1 10M
C3 10pF
C5 0.25-1.5 pF
1KV, 10KHz COARSE ADJ
R2 1.1088 M
C4 47pF
C6 1.7-14.1 pF
10V 10KHz ADJ
10V DC ADJ
R3 5K
R4 110.88K
R5 500
C7 1012pF
C8* 22pF
C9 2.4-34.0 pF
R6 11.088K
R7 50
C10 10,350 pF
C11 2-19.3pF
1KV, 10KHz FINE ADJ
100V DC ADJ
100V 10KHz ADJ
1000V DC ADJ
I, 10, 100, 1000
I, 10, 100, 1000
100 I, 10, 1000
1000 I, 10, 100

C8 affects the AC response of the attenuator. It may or maynot be connected to the circuit depending on the requirement of the attenuator. It always appears on the board but can be disconnected by removing the strap shown.

PROTECTION SUPPLY

R65 6.8K
R66 6.8K
CR17 5.11V
CR18 5.11V
C26 22
C29 22
C27 6.8
C28 6.8
+12V
-12V
+5V
-5V

ACV
DCV
R8 100K
R9 20K
DCV BYPASS

IMPEDANCE CONVERTER

C31 0.022
C12 0.022
R68 22M
R11 22M
For Serial No.s 1212A00335 & below See backdating Change No. 1 (Section 8)
R10 20K
CR2
CR1
Q1
+5V
-5V
+12V
+1.18V
.994Vrms
R12 11K
Q2
+.52V
IV, 10KHz AC CAL ADJ
R13 1K
0V
C14 100
R18 49.9K
R19 23.7K
R17 10.0K
APPROX. UNITY GAIN IN Q2-Q3.
Q3
-.6V
1Vrms
R14 169K
R15 68.1K
C13 3.3
Q4 CURRENT SOURCE
-5.8V
R16 24.3K

AC CONVERTER

R22 20.0K
R23 40.2K
+6.9V
+3.1V
-.04V
Q5
Q6
Q7 CURRENT SOURCE
-.61V
-6.7V
C15 0.005
R20 5.90K
CR3 6.19V
R21 11.8K
Q8
Q9
Q10
R27 1.8K
+9.4V
CR4
CR5 6.19V
CR6 12.1V
CR7
+2.5V
+.2V
-9.7V
R24 4.7K
R28 1.0K
R29 499
C18 150pF
R30 499
C20 150pF
C16 2.2
R25 220K
U1
DC GAIN -.02
DC FEEDBACK AMP
R26 1.0M
C17 30pF
AC FEEDBACK

RECTIFIER

C19 100
CR8
CR9
R31 2.21K
R32 2.21K
C21 100
R33 499
FULL SCALE +4V 0V -4V
FULL SCALE +3.6V 0V -3.7V
+0.7V 0V -0.7V

FILTER

R34 178K
R35 576K
R36 750K
C22 0.56
C23 0.22
C24 0.047

FULL SCALE IV DC
OHM
ACV/DCV
ACV
DCV
CR11
CR10
C30 300pF
+5V
-5V

PROTECTION SUPPLY

OHMS SENSE

R37 50K
OHM
CR12

OHMS CONVERTER

I_{REF}
Q14
Q13
Q11
Q12
R45 2.2K
R44 82K
R39 50K
CR13
CR14 14V
R41 10K
R40 3.9K
R42 10K
R43 10K
U2
+12V
-12V
+6.5V
+5.7V
-6.3V
R67 3.9K
+8.8V
CR23 9.09V
R46 15K
C25
R47 470
R48 15K
Q15
-4.8V
Q16
R49 27K
CR15 5.11V
R50 10K
C1 0.001
R51 1M
R38 1.2K
100Ω
10MΩ 1000 100 10 1 100Ω
R52 900K
R53 90K
R54 9K
R55 900
R56 100
R_{REF}
-7.3V
R57 470
U3
R58 350
R59 10K
10MΩ ADJ
R60 110
R61 3.9K
R62 133
CR16 6.2V
R63 24.3K
R69 3480
R64 1K
100Ω THRU 1MΩ ADJ

NOTE
SWITCHES ARE SHOWN IN 1V AC POSITION. THE RANGE SWITCH IS S1; THE FUNCTION SWITCH IS S2.

BCD FUNCTION & RANGE

DCV ACV OHM 10MΩ 1000 100 10 1 100Ω

CR22
CR21
CR20
CR19

AC FUNCTION (L)
Ω FUNCTION (L)
10MΩ 1000V/KΩ 100V/KΩ 10V/KΩ 1V/KΩ 100Ω
RANGE (L)

BCD MODULE 34721B

42 POLARITY ENABLE (L) (LPOE)
37 DP4 (L)
38 DP3 (L)
39 DP2 (L)
40 DP1 (L)

+12V -12V

3470A-E-2822A

Figure 7-3. 34702A Schematic.

SECTION VIII
BACKDATING

8-1. INTRODUCTION.

8-2. This section makes your manual applicable to earlier instruments. Where component values or part numbers in an instrument differ from the replaceable parts list, yet are not listed in this section, the part numbers and values listed in the parts list should be used for replacement.

8-3. Where practical, backdating entries have been incorporated into the text of the manual rather than into this section. If a backdating change is too long or otherwise impractical to incorporate in the text, the entry to be changed will be flagged with a delta having a number subscript; e.g. (Δ_1). The subscript refers to the number of the corresponding change in backdating. Make all changes listed in this backdating which apply to your instrument.

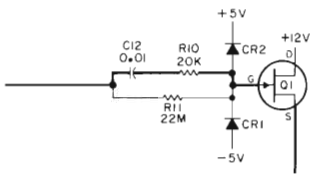
CHANGE NO. Δ_1: Applies to serial numbers 1212A0335 and below

Table 6-1:

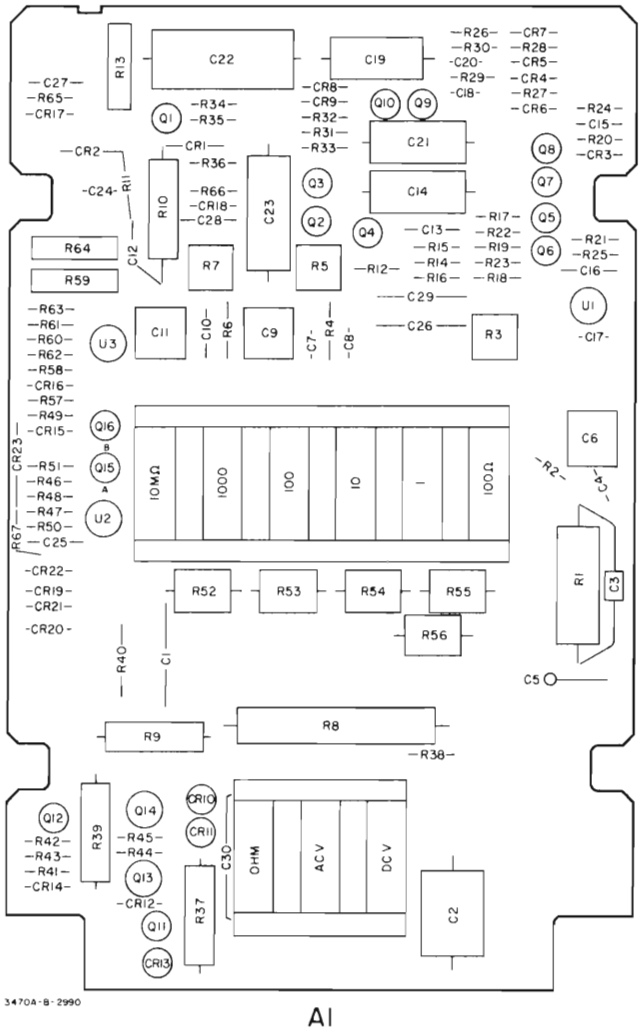
Delete A1C31, A1R68, and A1C8
Change A1C12 to C:fxd, .01 μF ± 20%
2000 vdcw, -hp- Part No. 0160-0996

Figure 7-5, Page 7-3 & 7-4:

Change the input circuit to A1Q1 as follows:



Change the component locator for the A1 Assembly as follows:



A1

hp Part No. 34702-66501

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon	Clifton Heights, Penn.
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Cupper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc., Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
919€1	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
15636	Elec-Tgtl Inc	Northridge, California 91325
23880	Stanford Applied Engineering	Santa Clara, California 95050

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ALABAMA
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2003 Byrd Spring Road S.W.
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TWX: 910-951-1330

5737 East Broadway
Tucson 85711
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
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TWX: 910-592-1288

3939 Lankershim Boulevard
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TWX: 910-499-2170

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Los Angeles 90045
Tel: (213) 649-2511
TWX: 910-328-6148

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2220 Watt Ave.
Sacramento 95825
Tel: (916) 482-1463
TWX: 910-367-2092

9606 Aero Drive
San Diego 92123
Tel: (714) 279-3200
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
12 Lunar Drive
New Haven 06525
Tel: (203) 389-6551
TWX: 710-465-2029

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P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
Tel: (305) 731-2020
TWX: 510-955-4099

P.O. Box 13910
6177 Lake Ellenor Dr.
Orlando, 32809
Tel: (305) 859-2900
TWX: 810-850-0113

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

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2875 So. King Street
Honolulu 96814
Tel: (808) 955-4455

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5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
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Tel: (317) 546-4891
TWX: 810-341-3263

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P.O. Box 856
3239 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

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6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
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P.O. Box 1648
2 Choke Cherry Road
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MASSACHUSETTS
32 Hartwell Ave.
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Tel: (617) 861-8960
TWX: 710-326-6904

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21840 West Nine Mile Road
Southfield 48075
Tel: (313) 353-9100
TWX: 810-224-4882

MINNESOTA
2459 University Avenue
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Tel: (612) 645-9461
TWX: 910-563-3734

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11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

148 Weldon Parkway
Maryland Heights 63043
Tel: (314) 567-1455
TWX: 910-764-0830

***NEVADA**
Las Vegas
Tel: (702) 382-5777

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 265-3713
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
6 Automation Lane
Computer Park
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Tel: (518) 458-1550
TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

New York City
Manhattan, Bronx
Contact Paramus, NJ Office
Tel: (201) 265-5000
Brooklyn, Queens, Richmond
Contact Woodbury, NY Office
Tel: (516) 921-0300

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

1 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300
TWX: 510-221-2168

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1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
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TWX: 810-459-1925

1120 Morse Road
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Oklahoma City 73132
Tel: (405) 721-0200
TWX: 910-830-6862

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Tualatin 97062
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TWX: 910-467-8714

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Monroeville 15146
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King of Prussia Industrial Park
King of Prussia 19406
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TWX: 510-660-2670

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873 Waterman Ave.
East Providence 02914
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TWX: 710-381-7573

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Tel: (901) 274-7472

TEXAS
P.O. Box 1270
201 E. Arapaho Rd.
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6300 Westpark Drive
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Houston 77027
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TWX: 910-881-2645

231 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

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2890 South Main Street
Salt Lake City 84115
Tel: (801) 487-0715
TWX: 910-925-5681

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P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 285-3431
TWX: 710-956-0157

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433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

***WEST VIRGINIA**
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Tel: (304) 768-1232

WISCONSIN
9431 W. Beloit Road
Suite 117
Milwaukee 53227
Tel: (414) 541-0550

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

*Service Only

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd.
11748 Kingsway Ave.
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Tel: (403) 452-3670
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
4519 Canada Way
North Burnaby 2
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TWX: 610-922-5059

MANITOBA
Hewlett-Packard (Canada) Ltd.
513 Century St.
Winnipeg
Tel: (204) 786-7581
TWX: 610-671-3531

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2745 Dutch Village Rd.
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Hewlett-Packard (Canada) Ltd.
1785 Woodward Dr.
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TWX: 610-562-8968

Hewlett-Packard (Canada) Ltd.
50 Galaxy Blvd.
Rexdale
Tel: (416) 677-9611
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OPERATING AND SERVICE MANUAL

BCD MODULE
34721B

HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

Manual Part No. 34721-90002
Microfiche Part No. 34721-90052

MODEL 34721B
BCD MODULE

Serial Numbers 1326A00101 and Greater

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. Backdating information given in the manual adapts it to earlier instruments.

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

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Revised: April 1975

PRINTED IN U.S.A.

Printed: JUNE 1973

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual contains installation and operating instructions as well as maintenance information which includes operational checks for the Model 34721B. A schematic diagram, theory of operation, and trouble-shooting information are provided for use in maintaining the 34721B BCD Module.

1-3. DESCRIPTION.

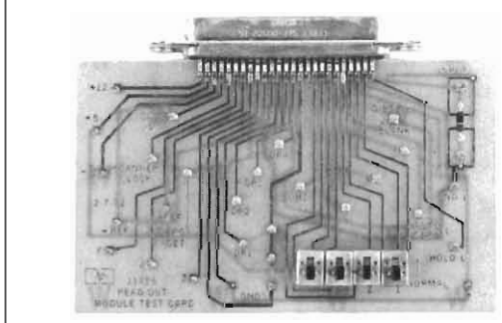
1-4. The Model 34721B converts character serial data from the 34740A or 34750A Display Module to parallel character information for output to a printer (-hp-Model 5055A or equivalent is required). It supplies BCD data, polarity, range, and function information. A "print command" signal which indicates when the data is ready to be printed is also provided.

1-5. OPERATION INFORMATION.

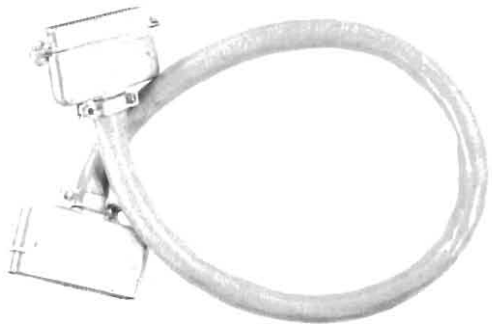
1-6. Table 1-1 lists general information relating to the operating characteristics of the Model 34721B. Operational checks are provided in Section V to verify proper operation of your instrument.

1-7. ACCESSORIES AVAILABLE (See Figure 1-1).

a. 11456A READOUT TEST CARD – Facilitates testing and troubleshooting the Model 34721B BCD Module.

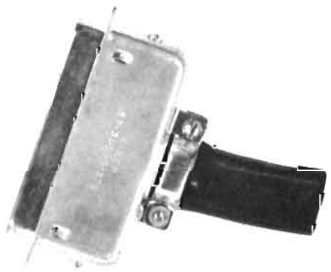


11456A
Readout Test Card



11148A
Extender Cable

562A - 16C
Printer Cable



1251 - 0086
Mating Connector

Figure 1-1. Accessories Available.

Table 1-1. Operating Information.

BCD DATA OUTPUTS

5 columns for digital decades
1 column for overrange digit
1 column for range
1 column for function
2 columns for polarity

INPUT CONTROL SIGNALS

Front Panel Lockout
(+) Printer Holdoff
External Trigger

OUTPUT CONTROL SIGNAL

Print Command

LOGIC LEVELS

"1" state = + 2.4 V to + 5 V
"O" state = 0 V to + 0.5 V
High reference: 5 V ± .25 V (1 kΩ impedance)
Low reference: 0 V (ground)

MAX OUTPUT RATE

Internal:
1, 2, 4, 8, and 16 Mainframe Samples/Print Cycle
Manual and External:
5/s with 34740A Option 060
8/s with 34740A Option 050

GENERAL

Operating Temperature: 0° C to 50° C
Storage Temperature: - 40° C to + 75° C
Power: from Display Module

CAUTION

Floating measurements may not be made when using the 34721B BCD Module with a grounded printer or other grounded devices.

b. 562A - 16C PRINTER CABLE – Connects the output of the Model 34721B to a Model 5055A Digital Recorder.

c. 11148A EXTENDER CABLE – Permits operation of the Model 34721B while separated from the display module or plug-on during troubleshooting.

d. MATING CONNECTOR – Connects to 50 pin connector on rear panel. -hp- Part No. 1251 - 0086. Manufactured by CINCH MANUFACTURING CO., Part No. 57 - 30500 - 375.

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. A three-section serial number (xxxx A xxxxx) is used to identify your Model 34721B. Figure 1-2 illustrates the meaning of the three parts of the number.

1-10. This manual is kept up - to - date with revised pages. If the serial number of your instrument is lower than the one on the title page of this manual, refer to the backdating information in Section 8 which adapts this manual to your instrument. All correspondence with Hewlett-Packard Company should include the complete serial number.

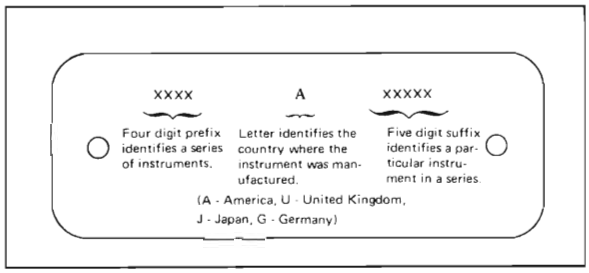


Figure 1-2. Instrument Serial Number.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains installation and shipping information for the Model 34721B BCD Module.

2-3. INITIAL INSPECTION.

2-4. Your instrument was carefully inspected prior to shipment and should meet all electrical specifications and be free of mars or scratches. To confirm this, the instrument should be inspected upon receipt for damage that might have occurred in transit. If there is damage due to shipping, file a claim with the carrier. If there are other electrical or mechanical deficiencies refer to the Statement of Warranty on the back of the title page. Use the procedures provided in Section V to check instrument performance.

2-5. INSTALLATION OF THE MODEL 34721B.

CAUTION

Installation or removal of plug-on modules is to be made by qualified personnel only.

2-6. Referring to Figure 2-1, install the Model 34721B between the Display Module and the bottom module using the following procedure:

a. Separate the Display Module from the bottom module if they are connected together. This is done by pulling the two side locks on the back of the Display Module to the rear and lifting the Display Module from the bottom module.

b. Position the Display Module over the Model 34721B so that the plastic keys on the sides of the two modules interlock.

c. Push the side locks toward the Display Module. This fastens the two modules together.

NOTE

Press downward on the 34721B connector assembly located in the center of the 34721B. This ensures that the 50 pin connector on the 34721B is properly mated to the Display Module connector.

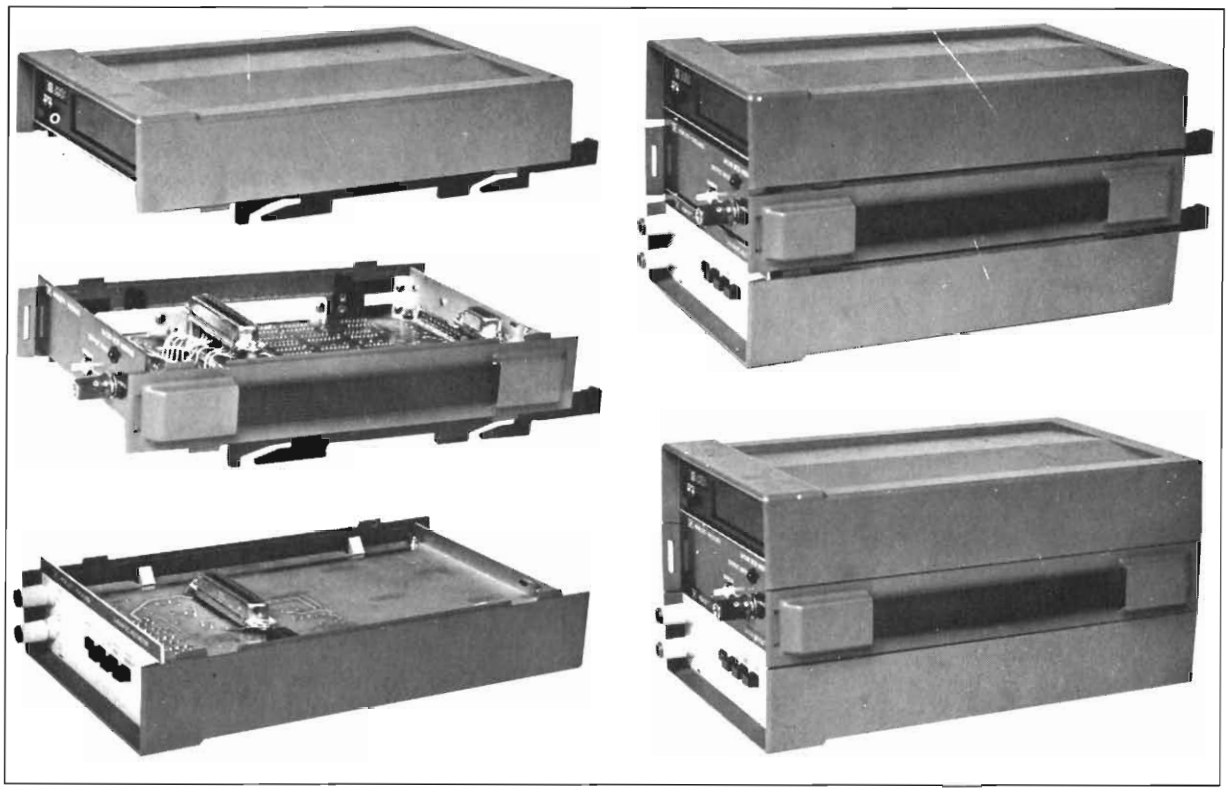


Figure 2-1. Installation of the Model 34721B.

d. Connect the ribbon cable supplied with the instrument to the appropriate connector of the Model 34721B (see Figure 2-2). Connect the other end of the cable to the 14 pin IC connector on the bottom module. The outer brown wire of the cable should be nearest the case of the instrument.

CAUTION

The cable should be looped at the end, not twisted, to align the plug and jack.

e. Pull the side locks on the Model 34721B rearward, and connect the bottom module to the 34721B. This can be accomplished in a manner similar to that previously described.

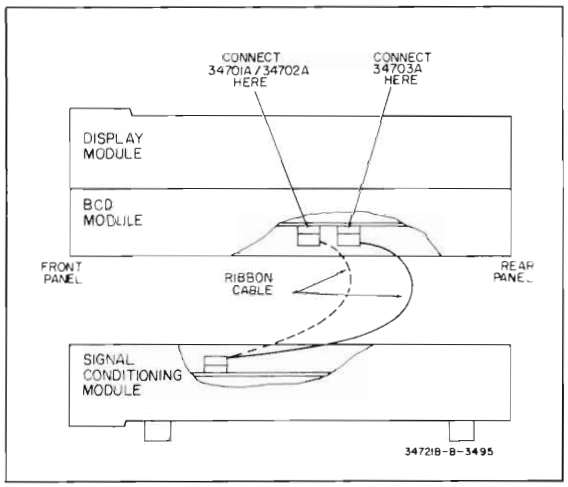


Figure 2-2. Routing of the Ribbon Cable.

2-7. CONNECTION TO THE PRINTER.

2-8. Figure 2-3 shows the rear panel connector and indicates the location of all output and control signals. Connect a 562A - 16C Printer Cable from this connector to the printer connector.

NOTE

See Section III of the Operating and Service Manual for the signal conditioning module to obtain a listing of the printer output codes and their meaning.

2-9. REPACKING FOR SHIPMENT.

2-10. If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument describing the work to be accomplished and identifying the owner of the instrument. Identify the instrument by serial number, model number and name in any correspondence. If you have any questions, contact your local Hewlett-Packard Sales and Service Office.

2-11. If the original shipping container is to be used, place the instrument in the container with appropriate packing material and seal the container well with strong tape or metal bands.

2-12. If an -hp- container is not to be used, use a heavy carton or wooden box with an inner container. Wrap the instrument with heavy paper or plastic and place cardboard strips across the face for protection before placing the instrument in the inner container. Use packing material around all sides of the inner container, and seal the outer container well with strong tape or metal bands. Mark the container with "DELICATE INSTRUMENT", or "FRAGILE".

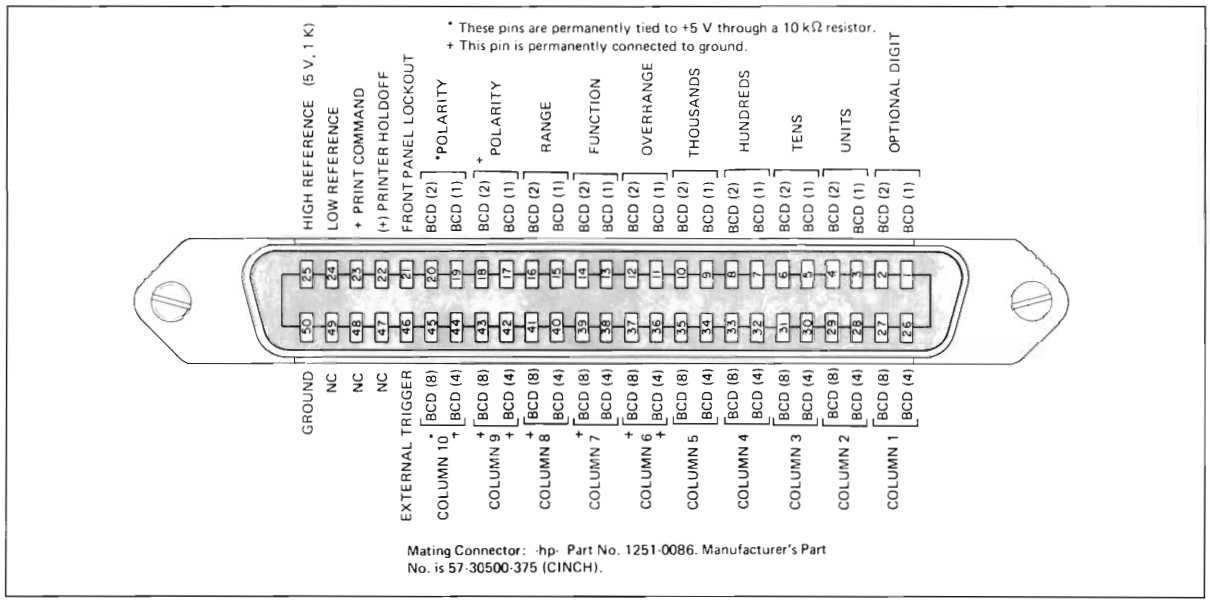


Figure 2-3. Output and Control Signal Connector.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains operating instructions for the Model 34721B. A Display Module (Model 34740A or 34750A) and a signal conditioning module such as the -hp- Model 34702A are required to operate the 34721B. This section contains identification of controls, indicators, and connectors, as well as operating instructions.

3-3. PANEL FEATURES.

3-4. Panel features of the instrument are described in Figure 3-1.

NOTE

While operating the Model 34721B, it may be noted that the Display Module indication continues to change while a sample is being taken. This mode of operation is normal since the 34721B does not control the measurement cycle of the Display Module.

3-5. OPERATION OF THE MODEL 34721B.

CAUTION

Do not make floating measurements when using the 34721B BCD Module with a grounded peripheral.

NOTE

When the 34721B is connected to an -hp- Model 34703A DCV/DCA/Ω Meter, the self test function of the 34703A cannot be used.

3-6. Connecting the Digital Recorder.

3-7. Connect the Digital Recorder (-hp- Model 5055A or equivalent) to the 50 pin connector at the rear of the 34721B using a 562A - 16C Printer Cable.

3-8. Selecting the Desired Mode of Operation.

3-9. A print command is issued at the conclusion of each 34721B sampling cycle. A sampling cycle can be initiated in any of the following ways:

a. Internally, using the OUTPUT RATE switch on the front panel;

b. Externally, by a pulse applied through the rear panel connector;

c. Manually, by depressing the "MANUAL" push-button.

To prevent undesired triggering caused by the internal OUTPUT RATE generator, the OUTPUT RATE switch should be set on HOLD position. Table 3-1 shows the sampling rate for each setting of the OUTPUT RATE switch using either Option 050 or Option 060 of the Display Module.

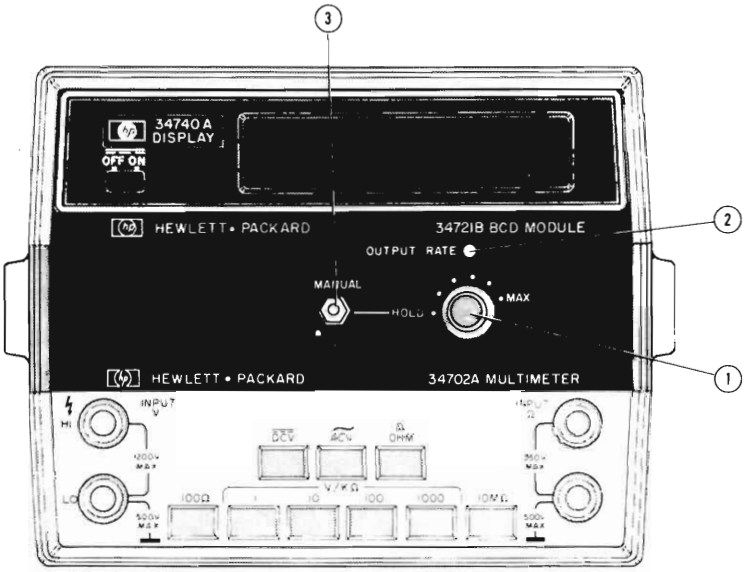
3-10. Output and Control Signals.

3-11. Figure 3-2 indicates the requirements for the various control signals which may be applied to the 34721B. The outputs of the BCD Module are also discussed. A Print Command is issued after a trigger has been applied and the Display Module has completed a measurement cycle. The Print Command initiates a print cycle of the printer. The Front Panel Lockout signal disables OUTPUT RATE and MANUAL switches on the 34721B front panel. Under this condition the instrument can be triggered only with an external trigger. The Printer Holdoff signal prevents the 34721B from issuing a print command.

Table 3-1. 34721B Sampling (Output) Rate.

Switch Position	Option 050 Sampling Rate (ms/Sample)	Option 060 Sampling Rate (ms/Sample)
HOLD	In this position the sample is initiated manually or externally.	In this position the sample is initiated manually or externally.
(1)	125	200
(2)	250	400
(3)	500	800
(4)	1000	1600
(5)	2000	3200

FRONT

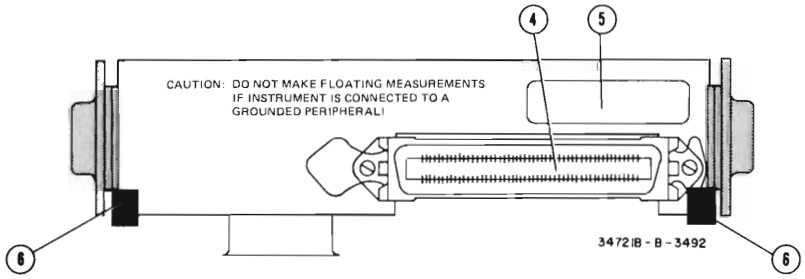


(1) Output Rate Switch: Controls sampling rate of the instrument. Table 3-1 shows the sampling rate for various positions of the switch. Hold position permits manual and external triggering without interaction with the Internal Output Rate Generator.

(2) Output Rate Light: Gives a visual indication of the sampling rate of the instrument.

(3) MANUAL Pushbutton: A single sampling cycle is initiated each time this button is depressed.

REAR

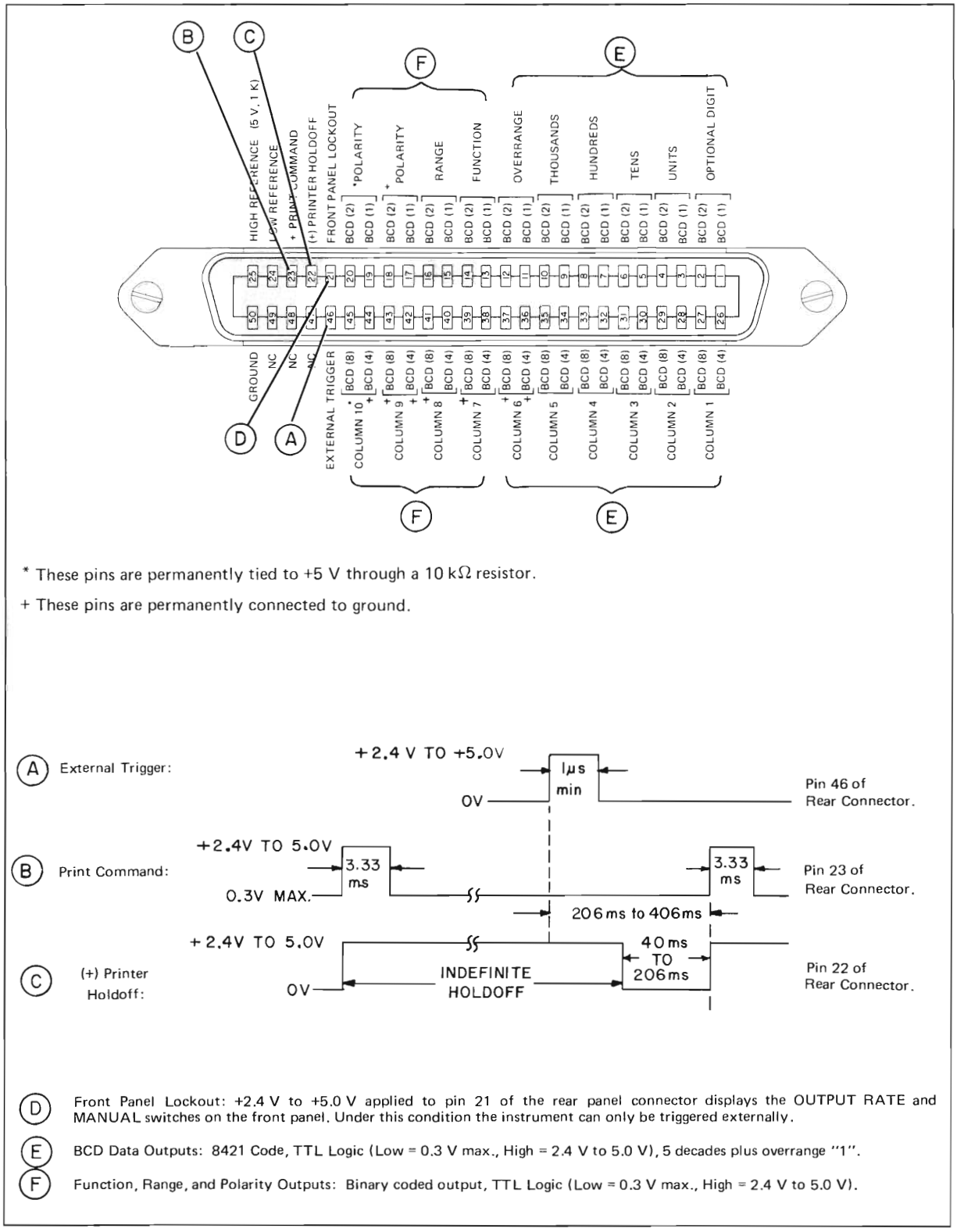


(4) Rear Panel Connector: **This connector provides parallel BCD outputs to the printer as well as other control signals.** The external triggering signal should be applied to pin 46 of this connector. The front panel lockout signal should be applied to pin 21.

(5) Serial Plate: Gives the instrument serial number.

(6) Side Lock: These locks fasten the 34721B to a signal conditioning Module. When pulled completely to the rear they release the signal conditioning module allowing it to be separated from the 34721B.

Figure 3-1. Front and Rear Panel Features.



* These pins are permanently tied to +5 V through a 10 kΩ resistor.

\+ These pins are permanently connected to ground.

(D) Front Panel Lockout: +2.4 V to +5.0 V applied to pin 21 of the rear panel connector displays the OUTPUT RATE and MANUAL switches on the front panel. Under this condition the instrument can only be triggered externally.

(E) BCD Data Outputs: 8421 Code, TTL Logic (Low = 0.3 V max., High = 2.4 V to 5.0 V), 5 decades plus overrange "1".

(F) Function, Range, and Polarity Outputs: Binary coded output, TTL Logic (Low = 0.3 V max., High = 2.4 V to 5.0 V).

Figure 3-2. Output and Control Signal Connector.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The -hp- Model 34721B provides parallel BCD output to a printer in a 3470 Measurement System. The instrument accepts bit parallel, character serial data from the Display Module and converts it to bit parallel, character parallel data. Four or five digits of BCD data plus sign range, and function data and an overrange "1" are available to the printer (-hp- Model 5055A recommended).

4-3. A basic block diagram is discussed in this section. This is followed by a more detailed diagram and a detailed discussion of each block.

4-4. BASIC BLOCK DIAGRAM (See Figure 4-1).

4-5. The 34721B consists of four basic blocks shown in Figure 4-1. These circuits accept data and timing signals from the Display and signal conditioning modules and provide a parallel BCD output to a printer.

4-6. Algorithmic State Machine.

4-7. The Model 34721B digital logic is an Algorithmic State Machine (ASM). Figure 4-2 is a block diagram of a typical ASM. An ASM is a sequential logic circuit that can be described completely with a flow chart. The "Next State Function" and "Output Function" blocks are combinational logic networks. A combinational network is a logic network whose output is completely determined by the present input states. Sequential logic circuits contain memory or storage elements such as flip-flops. As the circuits operate the state of the memory changes. The memory elements may have one state at first and later take on another state. The "Next State" that the memory goes to is dependent on the "Present State", the clock, and the external inputs that are supplied to the logic circuit. The output is dependent on the external inputs and the "Present State" of the memory. The "Present State" of the memory is dependent on the past sequence of inputs that have been applied.

4-8. 34721B ASM Block Diagram.

4-9. The block diagram in Figure 4-3 shows the major blocks of the Model 34721B. The inputs to the State Machine come from the Display Module and the signal conditioning module. The output of the State Machine consists of the parallel BCD code and the print command applied to the external printer.

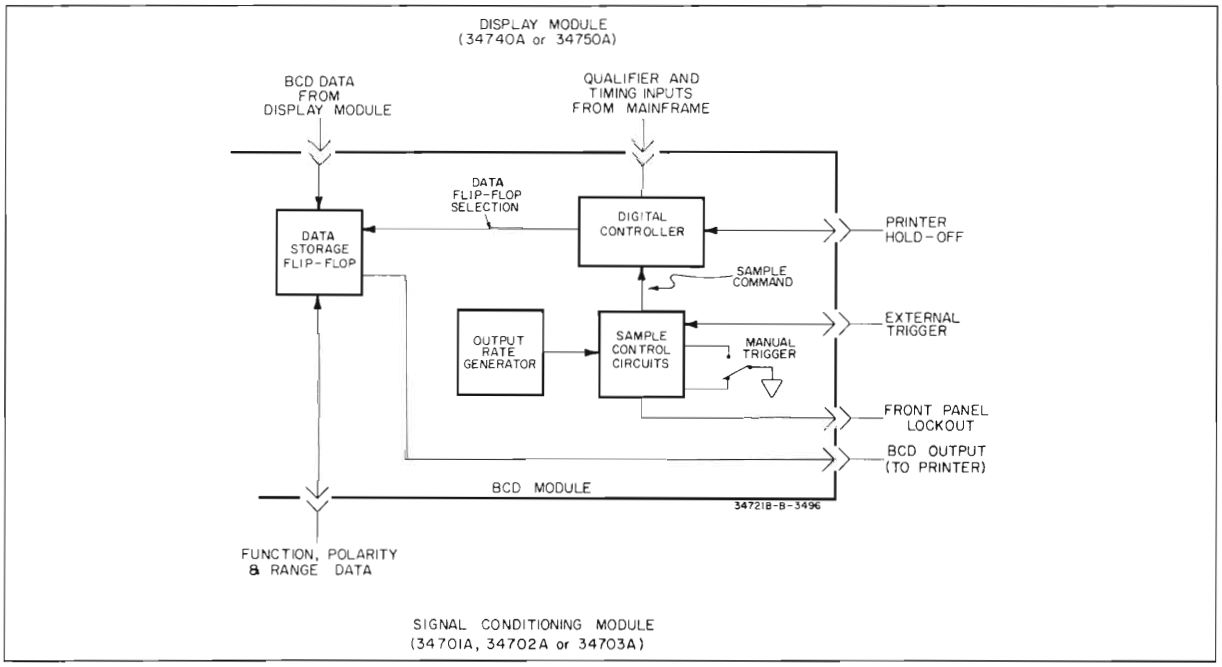


Figure 4-1. Basic Block Diagram.

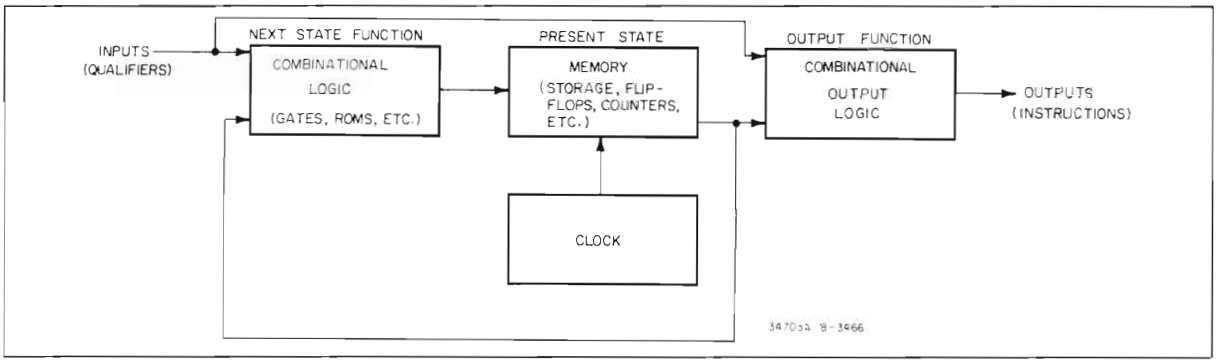


Figure 4-2. Block Diagram of Typical ASM.

4-10. Logic Flow Diagram.

4-11. Figure 4-4 is the Logic Flow Diagram for the Model 34721B. This flow chart indicates the sequence of events that takes place during every print cycle of the instrument.

4-12. SAMPLE CONTROL CIRCUITS (See Figure 4-5).

4-13. The Sample Control Circuits select the triggering mode of the 34721B, and prevent response to false triggers due to contact bounce. A measurement cycle of the instrument can be initiated externally from the external trigger input, manually from a front panel pushbutton, or internally from the output Rate Generator. A "HIGH" (2.4 V to 5.0 V) applied to the Front Panel Lockout disables the manual and internal sampling functions of the instrument. The waveforms in Figure 4-5 show the timing relationships of the circuits. The Trigger Catcher responds to only the first positive transition from the Trigger Selector. The output of the Trigger Catcher, in coincidence with LMATZ and $H \div 10^5$ initiates the Trigger Store Enable Pulse, (5). The negative transition of the pulse clears the Trigger Catcher. The positive transition sets the Trigger Store Flip-Flop, causing HTRG to go high. After a specified interval, depending on the sampling rate of the instrument, a pulse ROM (Read Only Memory) clears the Trigger Store Flip-Flop causing HTRG to go low. This indicates a store/print cycle of the 34721B is in process.

4-14. SAMPLE RATE GENERATOR (See Figure 4-3).

4-15. The Sample Rate Generator provides internally generated trigger pulses. Triggering rates from once per measurement cycle of the mainframe (Display) to once

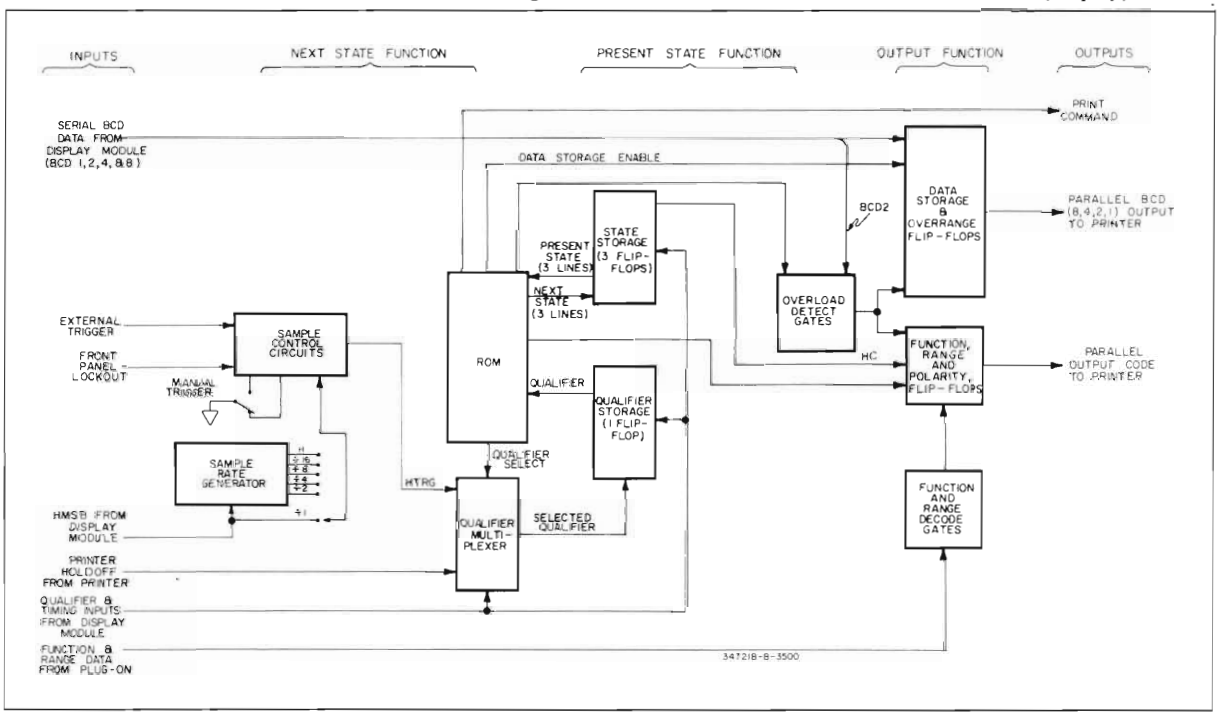


Figure 4-3. 34721B ASM Block Diagram.

every 16 cycles can be obtained. The Sample Rate Generator contains four flip-flops which are connected as a counter to provide the required outputs. Refer to Table 3-1 in Section III for information regarding print rates for the Display Module Options.

4-16. STATE AND QUALIFIER FLIP–FLOPS.

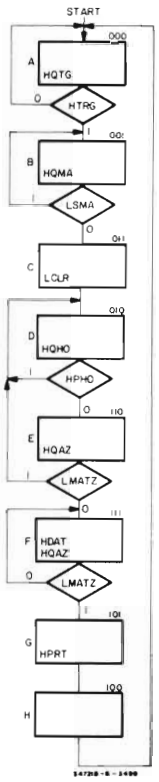
4-17. The output of the three State Flip-Flops is the "Present State" of the ASM. The state of these three lines (A through C) is described in octal code (see Figure 4-6). The "Next State" of the State Flip-Flops is determined by three lines of output from the ROM. The "Next State" output of the ROM is determined by the "Present State" of the State and Qualifier Flip-Flops. The "Next State" of the Qualifier Flip-Flop is determined by the output of the Qualifier Multiplexer (discussed in paragraph 4-20). Changes in state occur with each clock cycle. The time sequence of these changes is shown in Figure 4-7. The "Next State" may be the same as the "Present State" if the inputs to the flip-flops have not changed.

4-18. ROM (READ ONLY MEMORY).

4-19. Figure 4-8 shows the ROM, indicating its inputs and outputs. The ROM is a combinational logic block. As such, its outputs are defined by its inputs. There are eight inputs to the ROM, three from the State Flip-Flops, one from the Qualifier Flip-Flop, and four from the scanner in the Display Module. Three outputs from the ROM are applied to the inputs of the State Flip-Flops. These outputs, as modified by the input from the Qualifier Flip-Flop determine the "Next State" of the instrument. The state of the Qualifier Flip-Flop is determined by the output of the Qualifier Multiplexer. Six lines of the ROM output provide a clock signal for twenty-two Data Storage Flip-Flops. Each line clocks four flip-flops except for the last which clocks only the overrange and polarity flip-flops. The clocking sequence is determined by the inputs from the Display Module scanner. The time this sequence occurs is determined by the "Present State" of the instrument.

4-20. QUALIFIER MULTIPLEXER (See Figure 4-8).

4-21. The ROM provides four enable lines to the Qualifier Multiplexer. Depending on the condition of the enable lines, the Qualifier Multiplexer selects one of its four input signals. The selected signal is inverted and applied to the output. The output is the "Next State" input to the Qualifier Flip-Flop.



A (STATE 000). UNIT CYCLES IN THIS LOOP WAITING FOR A TRIGGER. WHEN TRIGGER (HTRG) LINE GOES HIGH IT MOVES TO STATE B.

B (STATE 001). UNIT LOOPS IN THIS STATE UNTIL LMSA GOES LOW (TIMING SIGNAL A GOES HIGH) INDICATING MAINFRAME HAS STARTED A NEW MEASUREMENT CYCLE, THEN GOES TO STATE C.

C (STATE 011). CLEAR SIGNAL (LCLR) GENERATED TO CLEAR TRIGGER CIRCUIT. THIS ACKNOWLEDGES THAT TRIGGER HAS BEEN RECEIVED AND ALLOWS UNIT TO ACCEPT NEW TRIGGER.

D (STATE 010). UNIT LOOPS IN STATE "D" IF PRINTER HOLDOFF (HPHO) IS HIGH. AS SOON AS PRINT CYCLE IS COMPLETE HPHO GOES LOW AND UNIT CONTINUES TO STATE E.

E (STATE 110). UNIT CYCLES IN THIS LOOP AS LONG AS LMATZ IS HIGH INDICATING THE MAINFRAME IS STILL MAKING A MEASUREMENT. RANGE AND FUNCTION INFORMATION CLOCKED INTO OUTPUT STORAGE. WHEN LMATZ GOES LOW, UNIT GOES TO STATE F.

F (STATE 111). NUMERIC DATA IN DISPLAY IS TRANSFERRED SEQUENTIALLY INTO THE OUTPUT DATA REGISTERS BY HDAT. HDAT GOING HIGH ALSO LIGHTS SAMPLE RATE INDICATOR. WHEN LMATZ GOES HIGH, A NEW MEASUREMENT CYCLE HAS STARTED AND UNIT MOVES TO STATE G.

G (STATE 101). DATA IS NOW AVAILABLE IN THE OUTPUT DATA REGISTERS AND A PRINT COMMAND IS ISSUED TO THE PRINTER.

H (STATE 100). THIS IS AN EXTRA STATE AND IS USED TO RETURN UNIT TO STATE A SO THAT SEQUENCE MAY START AGAIN.

Figure 4-4. Logic Flow Diagram.

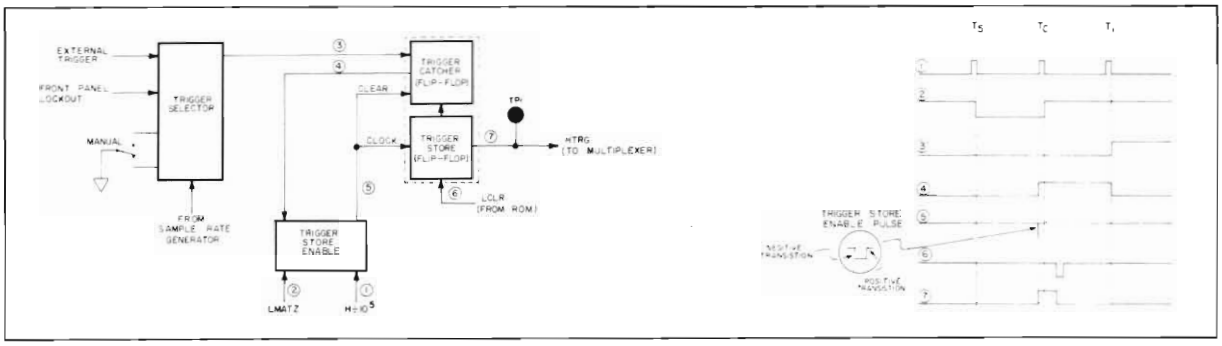


Figure 4-5. Sample Control Circuits.

4-22. FUNCTION AND RANGE DECODE GATES (See Figure 4-3).

4-23. The Function and Range Decode Gates accept function and range information from the signal conditioning module and decode it for storage on the Range and Function Flip-Flops. Six NAND gates are used for this purpose.

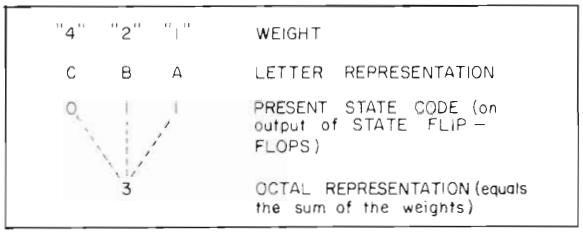


Figure 4-6. Octal Code.

4-24. FUNCTION, RANGE, OVERRANGE, AND POLARITY FLIP-FLOPS (See Figure 4-3).

4-25. The Function and Range Flip-Flops store the data from the Function and Range Decode Gates. This data is then applied through the connector on the rear panel to an external printer. Upon receipt of a "PRINT" command from the ROM the printer prints a decimal number which corresponds to the range and function data it receives. The Polarity and Overrange Flip-Flops receive data from the Display Module. This data is clocked into the flip-flops by a signal from the ROM and is printed simultaneously with the range and function data.

4-26. DATA STORAGE FLIP–FLOPS (See Figure 4-3).

4-27. The Data Storage Flip-Flops store four or five digits of decimal information in parallel BCD form for output to the printer. The fifth digit is useful only with the -hp- Model 34750A Display. It is always "O" when using the 34740A Display. BCD data from the Display Module is applied to the Data Storage Flip-Flops in serial form beginning with the least significant digit. The ROM clocks the flip-flops in a sequence which permits the proper flip-flops to be set by the current serial character from the Display. The data stored on the flip-flops is then printed simultaneously with the range and function data.

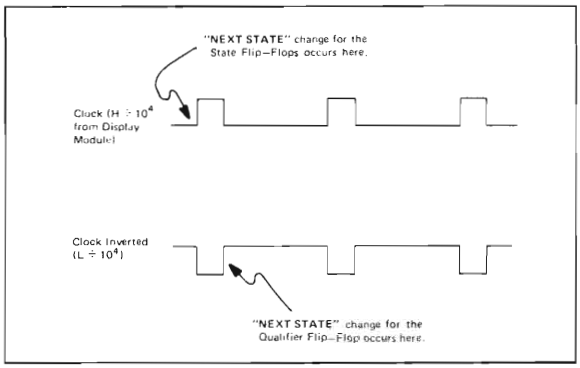


Figure 4-7. State Change Sequence.

4-28. OVERLOAD DETECT GATES (See Figure 4-3).

4-29. The Overload Detect Gates monitor BCD 2 from the Display Module. If BCD 2 is high while the overrange flip-flop is being clocked by the ROM, these gates issue an "overload" signal. This signal presets the Overrange and Data Storage Flip-Flops to 1's. On the next print cycle, the printer will print "1xxxxx" [1] or "1*****" depending on the setting of the printer "blank" switch.

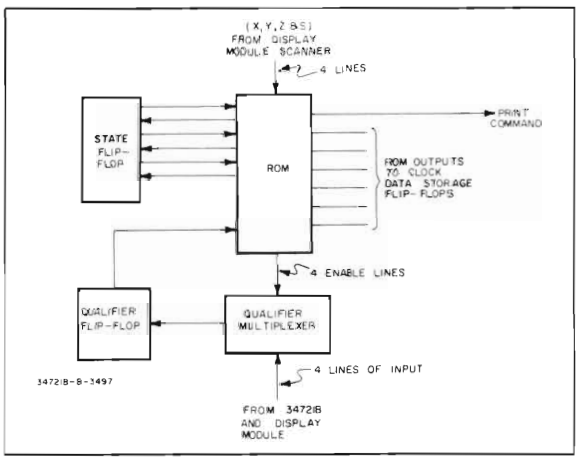


Figure 4-8. ROM and Qualifiers.

[1] x represents a blank.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for proper maintenance of the Model 34721B. The 34721B requires no specification checks or adjustments. An operational check for the instrument is provided in this section. Table 5-1 lists the test equipment required for the check.

NOTE

While operating the Model 34721B it may be noted that the Display Module indication continues to change while a sample is being taken. This mode of operation is normal since the 34721B has no control over measurement cycle of the Display Module.

5-3. OPERATIONAL CHECK.

CAUTION

Do not make floating measurements when using the 34721B BCD Module with a grounded peripheral.

a. Install the 34721B between the Display Module and a signal conditioning module such as the Model 34702A (see Paragraph 2-5). Connect the 562A - 16C cable between the 5055A Printer and the 50 pin output connector on the rear panel of the 34721B.

b. Set the OUTPUT RATE control to HOLD. Connect a dc standard to the signal conditioning module input and set the voltage to 1.7777 V as indicated on the Display Module (1.77777 V for 34750A Display).

NOTE

Some instability in the last two digits may be noted due to the dc standard. It is only necessary to ensure that a 7 is printed at least once in these digits.

c. Depress the MANUAL pushbutton several times and observe the printed output. Verify that the output is correct by comparing it with the Output Code table provided in Section III of the manual for the signal conditioning module. An example is given in Figure 5-1.

d. Change the voltage from the dc standard so that 1.8888 V appears on the Display Module (1.88888 V for 34750A). Repeat step c.

NOTE

Some instability in the last two digits may be noted due to the dc standard. It is only necessary to ensure that an 8 is printed at least once in these digits.

e. Disconnect the input voltage. Select each function and range on the signal conditioning module and check the printed output as per the example in Figure 5-1. Columns 1 through 6 can be ignored since the circuits which affect these digits were checked in steps c and d.

f. Turn the OUTPUT RATE switch clockwise, checking to see that the print rate of the printer increases at each step of the switch.

g. Disconnect the 34721B from the printer, and select HOLD mode. Connect the minus side of a 5 V source to pin 50 of the rear connector on the 34721B.

h. Momentarily apply + 5 V to pin 46 of the rear connector while observing the OUTPUT RATE light on the front panel. It should flash when + 5 V is applied.

i. Connect the + side of the 5 V supply used in step h to pin 21 of the rear panel connector. Attempt to trigger the instrument using the manual and OUTPUT RATE controls on the front panel. The OUTPUT RATE light should not flash.

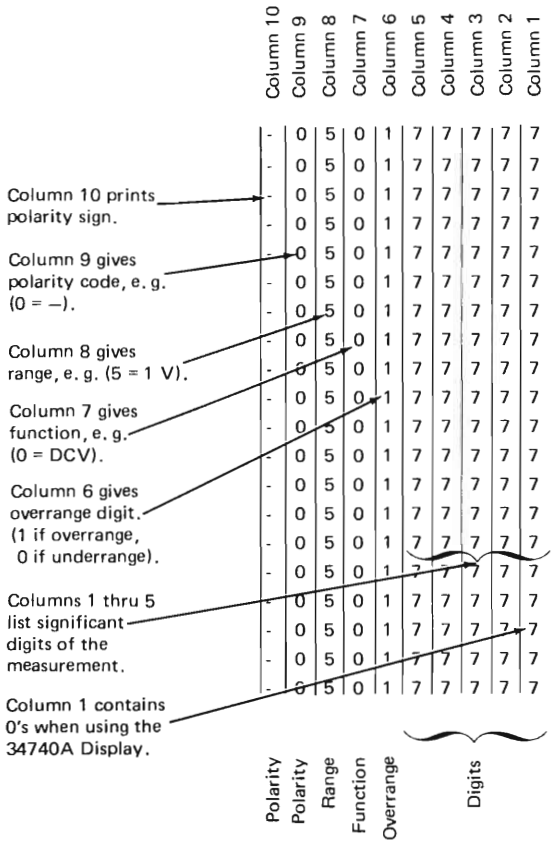
j. If the instrument fails to operate as required in any of the proceeding steps refer to troubleshooting in Section VII.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Recommended Model
Digital Recorder	Printing Rate: 8 lines/second minimum. Parallel BCD data entry (8421).	-hp- Model 5055A
DC Standard	0 V to + 5 V output, Accuracy: ± (0.002% of setting + 0.0004%) of range.	-hp- Model 740B
Interconnect cable	———	-hp- 562A-16C

Table 3-1. 34721B/5055A Output Codes (from 34702A Manual).

Number Printed	Polarity, Overload, Column 9	Range Column 8		Function Column 7	Overrange Column 6	Digits Columns 5 thru 1
		kΩ	Volts			
0	-			DCV	underrange	0
1	+	10000		ACV	overrange	1
2		1000	1000	kΩ		2
3		100	100			3
4		10	10			4
5		1	1			5
6		.1				6
7						7
8						8
9						9



The instrument has ≈ -1.77777 VDC applied. It is set to DC FUNCTION, 1 V RANGE.

Figure 5-1. 34721B/5055A Output Codes.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

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

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five - digit code. (See Appendix A for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

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

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PROPRIETARY PARTS.

6-9. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)
Al	aluminum			ns	nanosecond(s) = 10^{-9} seconds
A	ampere(s)	ID	inside diameter	nsr	not separately replaceable
Au	gold	impg	impregnated		
		incd	incandescent	Ω	ohm(s)
C	capacitor	ins	insulation(ed)	obd	order by description
cer	ceramic			OD	outside diameter
coef	coefficient	kΩ	kilohm(s) = 10^{+3} ohms		
com	common	kHz	kilohertz = 10^{+3} hertz	p	peak
comp	composition			pA	picoampere(s)
conn	connection	L	inductor	pc	printed circuit
		lin	linear taper	pF	picofarad(s) 10^{-12} farads
dep	deposited	log	logarithmic taper	piv	peak inverse voltage
DPDT	double-pole double-throw			p/o	part of
DPST	double-pole single-throw	mA	milliampere(s) = 10^{-3} amperes	pos	position(s)
		MHz	megahertz = 10^{+6} hertz	poly	polystyrene
elect	electrolytic	MΩ	megohm(s) - 10^{+6} ohms	pot	potentiometer
encap	encapsulated	met flm	metal film	p-p	peak-to-peak
		mfr	manufacturer	ppm	parts per million
F	farad(s)	ms	millisecond	prec	precision (temperature coeffient, long term stability and/or tolerance)
FET	field effect transistor	mtg	mounting		
fxd	fixed	mV	millivolt(s) = 10^{-3} volts		
		μF	microfarad(s)	R	resistor
GaAs	gallium arsenide	μs	microsecond(s)	Rh	rhodium
GHz	gigahertz = 10^{+9} hertz	μV	microvolt(s) = 10^{-6} volts	rms	root-mean-square
gd	guard(ed)	my	Mylar®	rot	rotary
Ge	germanium				
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes	Se	selenium
		NC	normally closed	sect	section(s)
H	henry(ies)	Ne	neon	Si	silicon
Hg	mercury	NO	normally open		

sl	slide	Ta	tantalum	V	volt(s)
SPDT	single-pole double-throw	TC	temperature coefficient	vacw	alternating current working voltage
SPST	single-pole single-throw	TiO_2	titanium dioxide	var	variable
		tog	toggle	vdcw	direct current working voltage
		tol	tolerance		
		trim	trimmer	W	watt(s)
		TSTR	transistor	w/	with
				wiv	working inverse voltage
				w/o	without
				ww	wirewound

* optimum value selected at factory, average value shown (part may be omitted)
** no standard type number assigned selected or special type

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

A	assembly	FL	filter	Q	transistor
B	motor	HR	heater	QCR	transistor-diode
BT	battery	IC	integrated circuit	R	resistor
C	capacitor	J	jack	RT	thermistor
CR	diode	K	relay	S	switch
DL	delay line	L	inductor	T	transformer
DS	lamp	M	meter	TB	terminal board
E	misc electronic part	MP	mechanical part	TC	thermocouple
F	fuse	P	plug	TP	test point

TS	terminal strip
U	microcircuit
V	vacuum tube, neon bulb, photocell, etc.
W	cable
X	socket
XDS	lampholder
XF	fuseholder
Y	crystal
Z	network

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3	34721-66503	1	CONNECTOR ASSY: 14 PIN	28480	34721-66503
A4	34721-66504	1	PC BOARD ASSY	28480	34721-66504
C1	0150-0093	2	C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
C2	0150-0023	7	C:FXD CER 2000 PF 20% 1000VDCW	56289	20C295A2-CDH
C3	0150-0023		C:FXD CER 2000 PF 20% 1000VDCW	56289	20C295A2-CDH
C4, C5	0150-0023		C:FXD CER 2000 PF 20% 1000VDCW	56289	20C295A2-CDH
C6	0150-0093		C:FXD CER 0.01 UF +80-20% 100VDCW	72982	801-K800011
C7 Δ_a	0140-0204		C:FXD MICA 47 PF 5% 500VDCW	14655	RDM15E470J5C
F1	2110-0046	1	FUSE:CARTRIDGE 1/2 AMP	28480	2110-0046
F1	1251-1636	1	CONNECTOR:SINGLE MALE CONTACT	28480	1251-1636
Q1	1854-0071	1	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
R1	0684-2221	4	R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
R2	0684-2221		R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
R3	0684-1031	4	R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
R4	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
R5	0684-2221		R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
R6	0684-2221		R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
R9	0684-3311	1	R:FXD COMP 330 OHM 10% 1/4W	01121	CB 3311
R11	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
R12	0684-2231	1	R:FXD COMP 22K OHM 10% 1/4W	01121	CB 2231
R13	0757-0283	1	R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
R14	0757-0444	1	R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
R15	0757-0442	1	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
R16	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
R17	1810-0055	2	RESISTIVE NETWORK:8 ALL 10K OHM 5%	28480	1810-0055
R18	1810-0055		RESISTIVE NETWORK:8 ALL 10K OHM 5%	28480	1810-0055
R19	0684-1021	1	R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021
U1	1820-0584	1	IC:TTL LP QUAD 2-INPT NOR GATE	12040	DM74L02N
U2	1820-0583	3	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
U3	1820-0601	1	IC:TTL, 4-BIT BINARY COUNTER	12040	DM85L93N
U4	1820-0596	17	IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U5	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U6†	1818-2173	1	IC:ROM	28480	1818-2173
U7	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U8	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
U9	1820-0585	1	IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L03N
U10	1820-0583		IC:TTL LP QUAD 2-INPT NAND GATE	12040	DM74L00N
U11	1820-0588	3	IC:TTL LP 4-INPT NAND GATE	12040	DM74L20N
U12	1820-0588		IC:TTL LP 4-INPT NAND GATE	12040	DM74L20N
U13	1820-0588		IC:TTL LP 4-INPT NAND GATE	12040	DM74L20N
U14	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U15	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U16	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U17	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U18	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U19	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U21	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U22	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U23	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U24	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U25	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U26	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U27	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
U28	1820-0596		IC:TTL LP DUAL EDGE TRIG, D F/F	12040	DM74L74N
XA1	1251-0087	1	CONNECTOR:FEMALE 50-PIN MINAT	28480	1251-0087
XA2	1200-0424	2	SOCKET:IC BLK 14 CONTACT	23880	CSA2900-148
XA3	1200-0424		SOCKET:IC BLK 14 CONTACT	23880	CSA2900-148
XA4	1200-0469	1	SOCKET:IC 28 CONTACT DUAL-INLINE TYPE	28480	1200-0469
A5	34721-66505	1	CONNECTOR ASSY:50 PIN	28480	34721-66505
			CHASSIS MOUNTED COMPONENTS		
CR1	1990-0419	1	DIODE:LIGHT EMITTER	28480	1990-0419
S1	3100-3253	1	SWITCH:ROTARY	28480	3100-3253
S2	3101-1261	1	SWITCH:PUSHBUTTON MOM SPST 1A 115VAC	09353	P8121
			MISCELLANEOUS PARTS		
	0370-1007	1	KNOB:POINTER,OLIVE BLK,FOR 0.125"SHAFT	28480	0370-1007
	05310-20004	2	FRAME:SIDE	28480	05310-20004
	05310-40001	4	GUIDE:SLIDE	28480	05310-40001
	1440-0096	2	HANDLE:STRAP	28480	1440-0096
	34721-00204	1	PANEL:FRONT	28480	34721-00204
	34721-01202	1	BRACKET,PC ASSY:LEFT (FOR A4 ASSY)	28480	34721-01202
	34721-01203	1	BRACKET,PC ASSY:RIGHT (FOR A4 ASSY)	28480	34721-01203

Δ_a Instrument Serial Numbers 1326A00150 & below did not dontain C7.

See introduction to this section for ordering information

Table 6-1. Replaceable Parts(Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	34721-60206	1	PANEL ASSY:REAR	28480	34721-60206
	5040-6000	1	CATCH:LEFT SIDE	28480	5040-6000
	5040-7001	1	CATCH:RIGHT SIDE	28480	5040-7001
	7122-0058	1	PLATE:SERIAL	28480	7122-0058
	9220-0178	1	BAG:PLASTIC	05006	BF
	8120-1855	1	CABLE:RIBBON	04919	F1002-14-8

See introduction to this section for ordering information

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the Operating and Service Manual contains troubleshooting information and a circuit diagram for the Model 34721B BCD Module. A timing diagram is also included to assist in troubleshooting.

7-3. TROUBLESHOOTING.

7-4. Figure 7-3 is a comprehensive troubleshooting tree for the Model 34721B. Before proceeding to this tree make the following preliminary checks:

a. Ensure the signal conditioning and plug-on modules are functioning properly. Normally, if the Model 34721B passes the operational check given in Paragraph 5-3 , the BCD Module is functioning as required. If the Model 34721B appears to be generating incorrect data check the Display and signal conditioning modules for proper operation first.

b. Determine the exact symptoms of failure. This can usually be accomplished by attempting the operational checks in Section V. Figure 7-1 is a brief flow chart which will assist isolation and characterization of the trouble.

c. Check for burned or loose components, or other unusual conditions which might be the source of trouble.

d. Proceed to the troubleshooting tree (Figure 7-3). If the end of the tree is reached without finding the trouble, carefully recheck symptoms to ensure you have interpreted them properly. Using the schematic and timing waveforms in this section of the manual attempt to localize the malfunction.

7-5. TIMING DIAGRAM.

7-6. Figure 7-2 shows the timing relationships between the major signals generated and used by the Model 34721B. Each signal has been assigned a number within a circle, e.g. . This number corresponds to an identical number on the schematic diagram. An illustration of the 34721-66504 printed circuit assembly, showing the physical location of each signal is also provided.

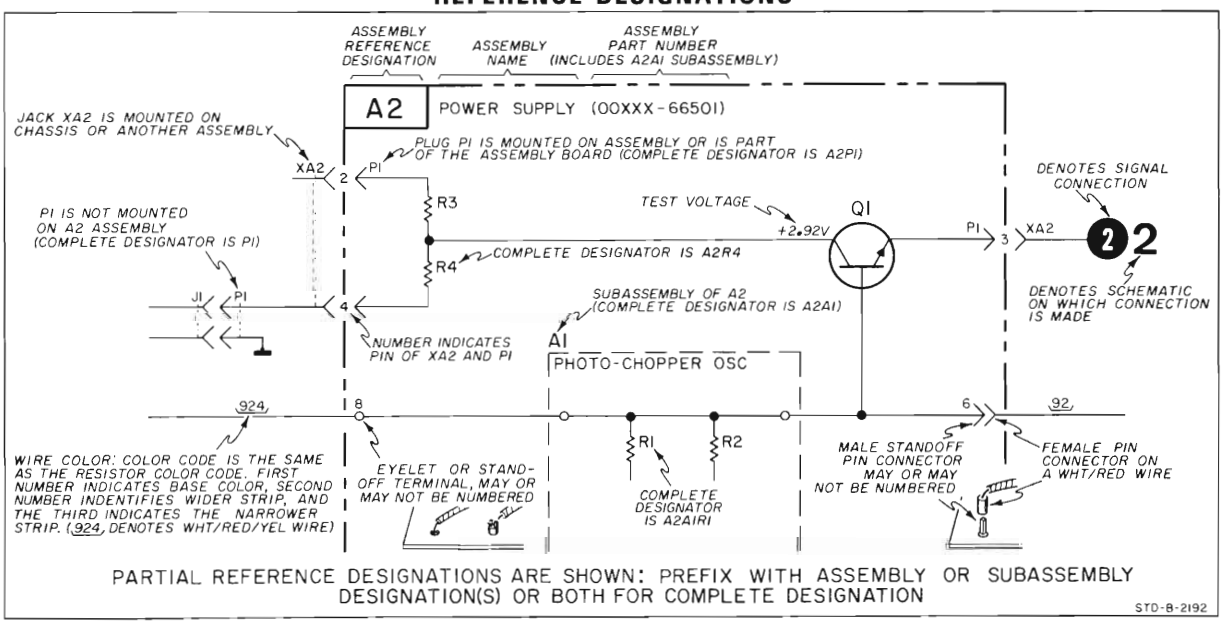
7-7. SCHEMATIC DIAGRAM.

7-8. Figure 7-4 is the schematic diagram of the Model 34721B. This diagram is provided to assist in troubleshooting the instrument.

7-9. COMPONENT LOCATION DIAGRAM.

7-10. A Component Location Diagram of the 34721-66504 printed circuit assembly is provided on the schematic diagram. This diagram shows the location of all components mounted on the assembly. Each component is identified by a reference designator which corresponds to the same component on the schematic diagram.

REFERENCE DESIGNATIONS



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUB-ASSEMBLY 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. (PERMANENTLY CONNECTED TO FRAME GROUND).

6. ANY LETTER OR NUMBER IN TRIANGLE DENOTES A SPECIAL GROUND.

7. DENOTES ASSEMBLY.

8. DENOTES MAIN SIGNAL PATH.

9. DENOTES FEEDBACK PATH.

10. DENOTES FRONT PANEL MARKING.

11. DENOTES REAR PANEL MARKING.

12. DENOTES SCREWDRIVER ADJUST.

13. * AVERAGE VALUE SHOWN. OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER.

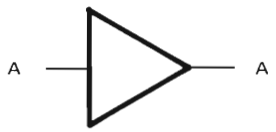
14. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15. 92 DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES STRIPE.

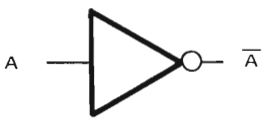
16. ALL RELAYS ARE SHOWN DEENERGIZED.

17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 DIVIDER PROBE (10 MEGOHM, 10 pF). THE VOLTAGE LEVELS SHOWN ON THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ± 10% IN MEASUREMENTS SHOULD BE ALLOWED.

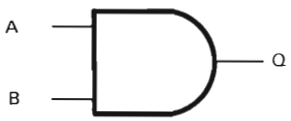
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ± 10% SHOULD BE ALLOWED.



DENOTES BUFFER

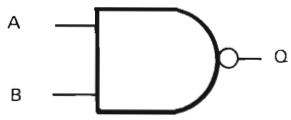


DENOTES INVERTER



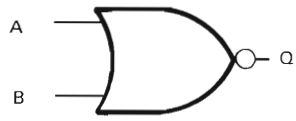
DENOTES AND GATE

A	B	Q
1	1	1
1	0	0
0	1	0
0	0	0



DENOTES NAND GATE

A	B	Q
1	1	0
1	0	1
0	1	1
0	0	1



DENOTES NOR GATE

A	B	Q
1	1	0
1	0	0
0	1	0
0	0	1

DENOTES "EXCLUSIVE" OR GATE

A	B	Q
1	1	0
1	0	1
0	1	1
0	0	0

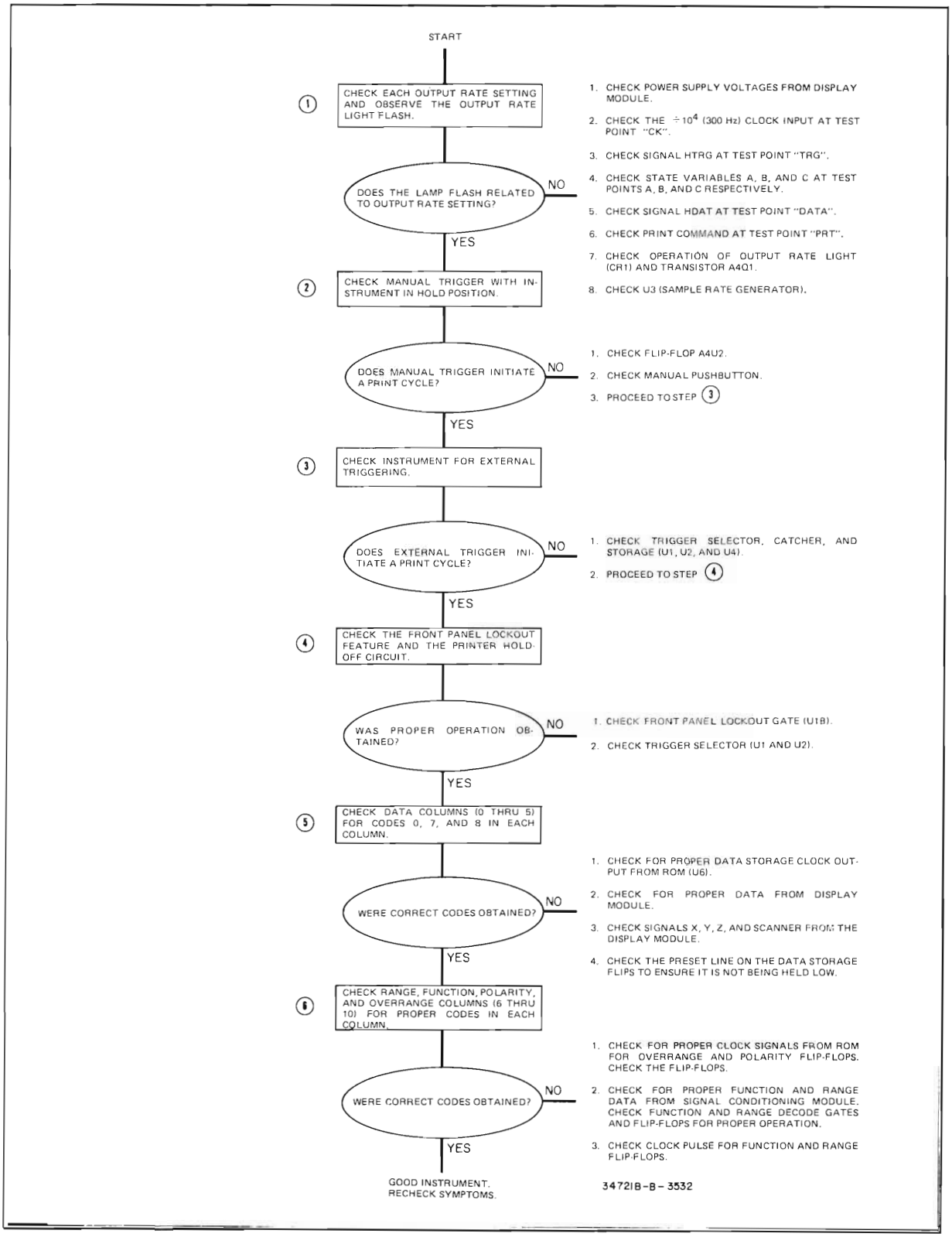
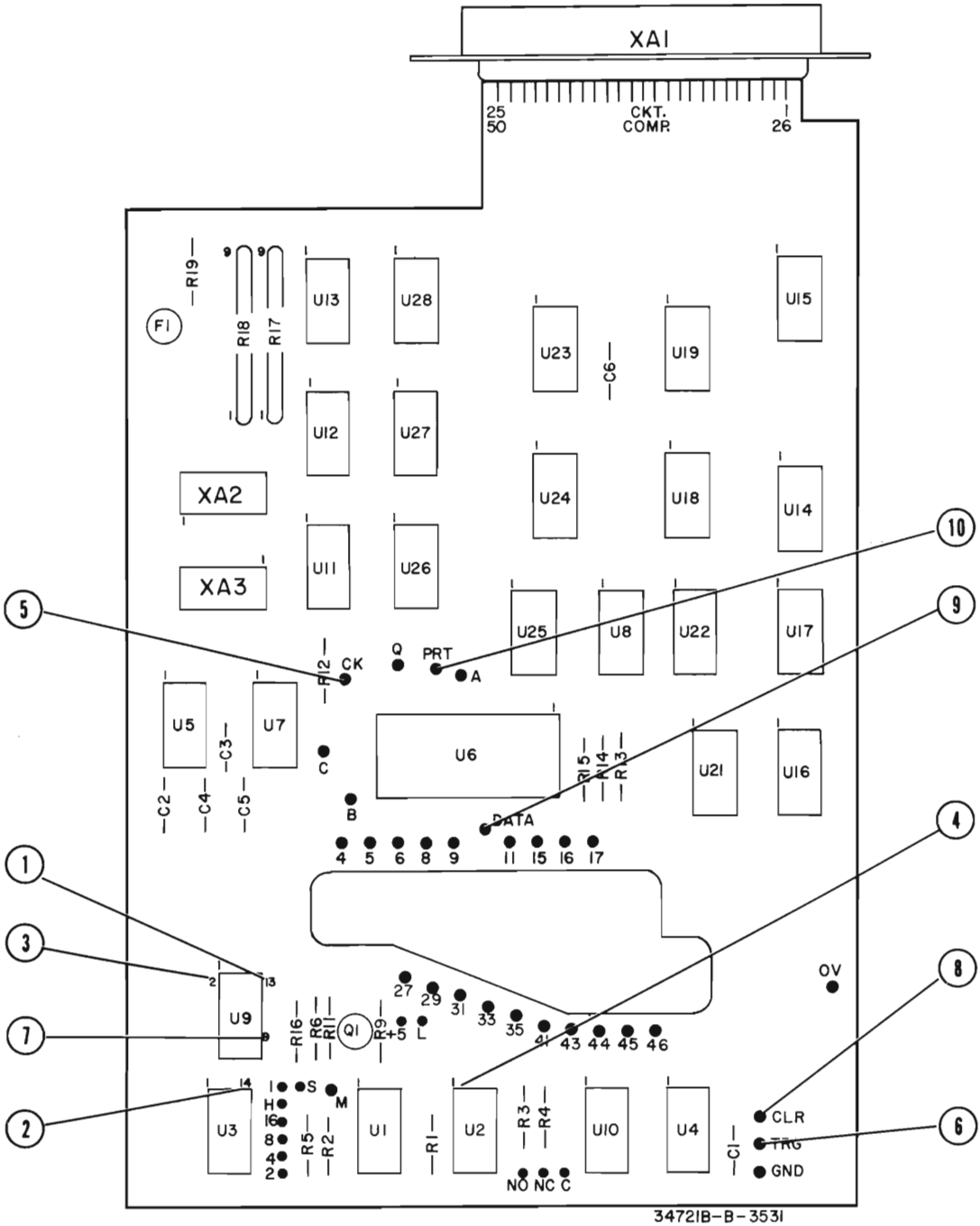


Figure 7-1. Preliminary Troubleshooting Flow Diagram.



A4

hp Part No. 034721-66504

Rev. A

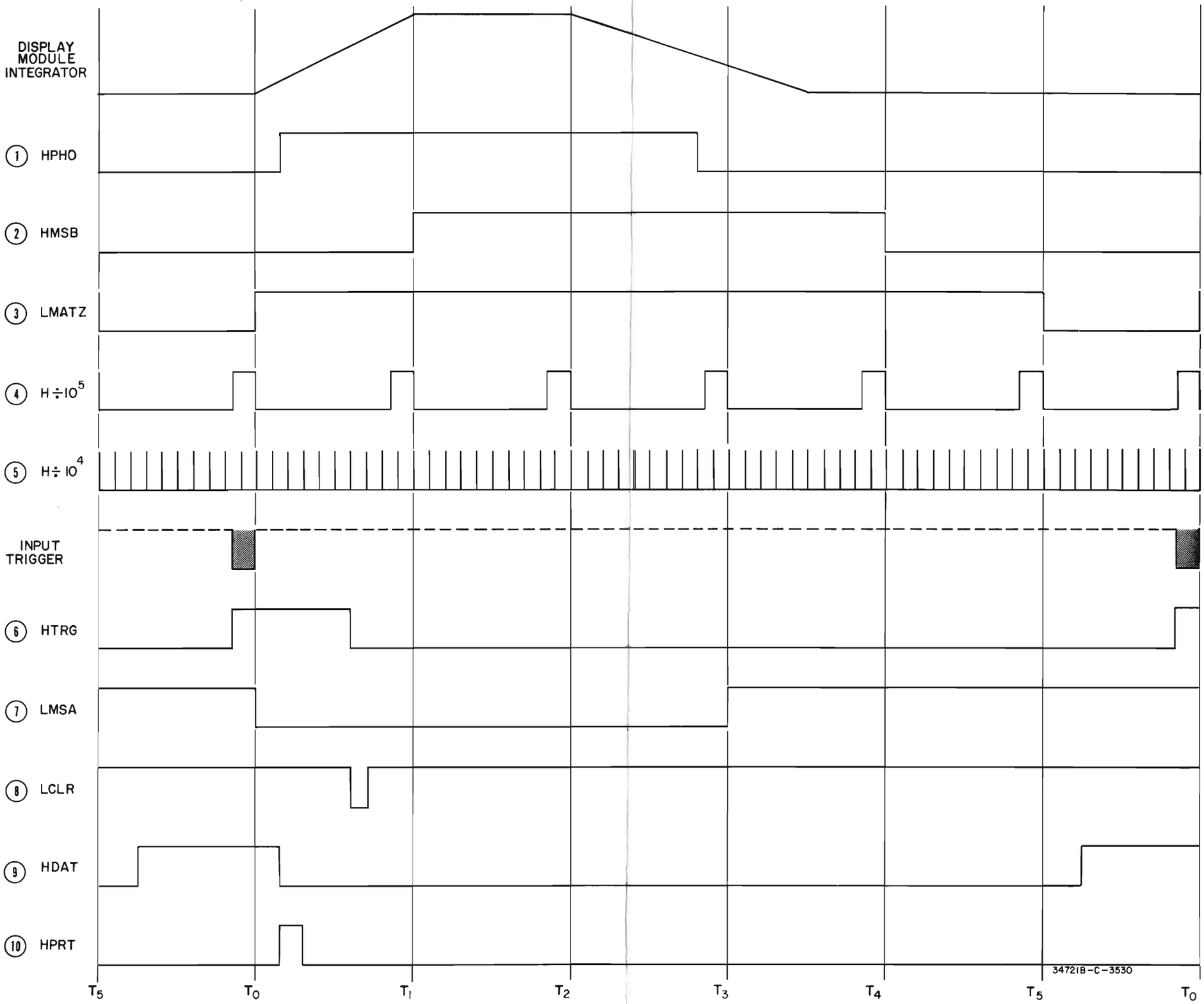
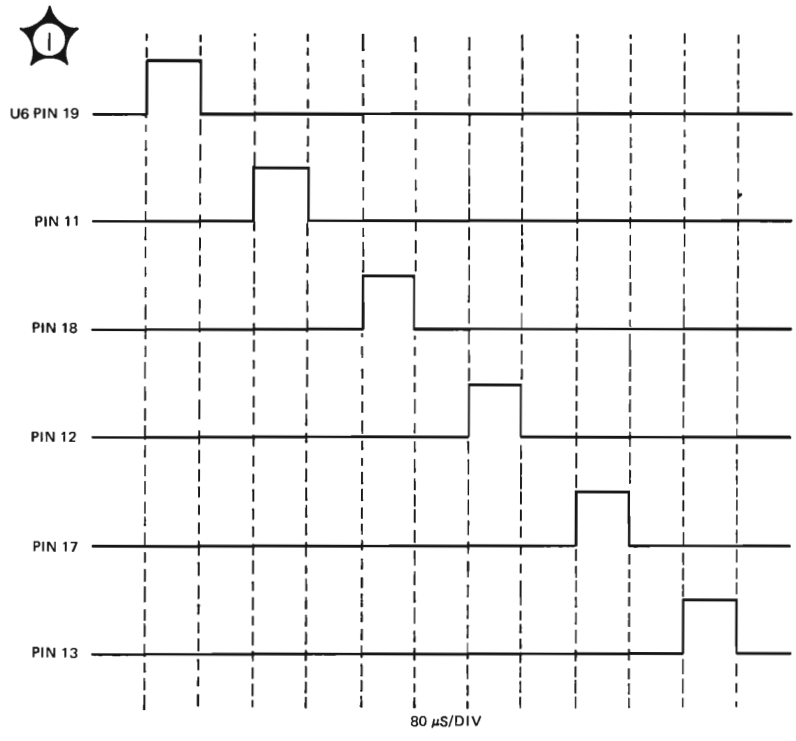
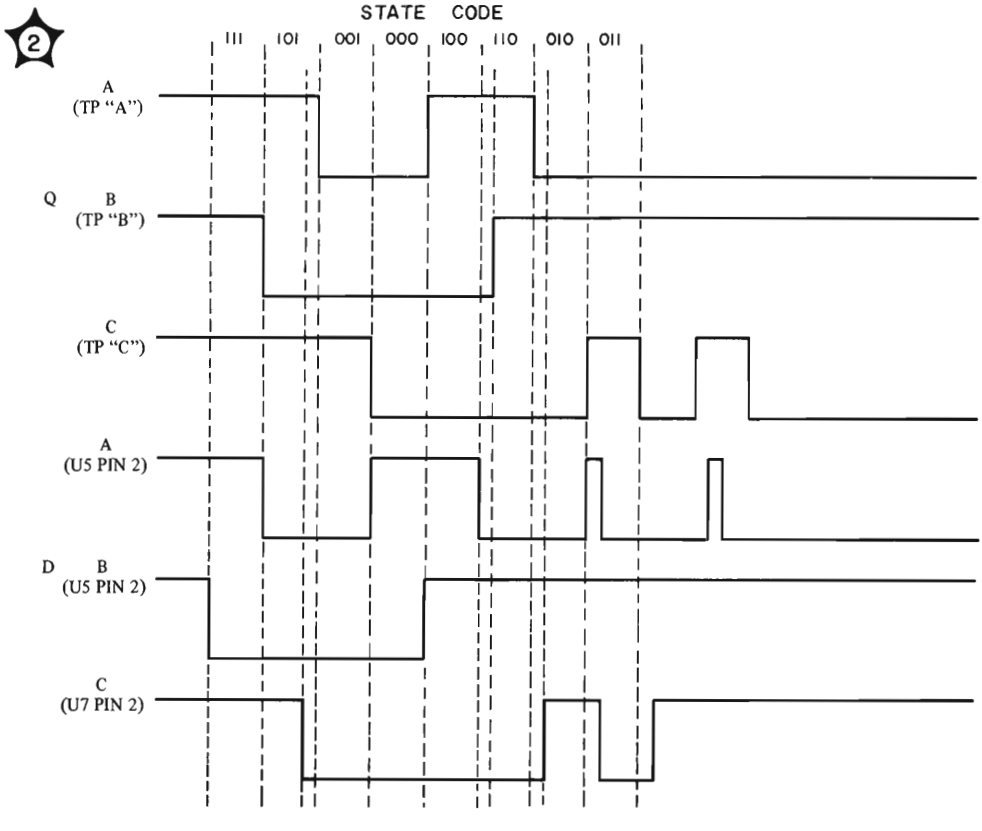


Figure 7-2. Timing Diagram.



TRIGGER OSCILLOSCOPE ON PIN 19.



START

(SEE NOTE 1)

SEPARATE THE SIGNAL CONDITIONING (BOTTOM) MODULE FROM THE BCD MODULE. USING AN 11148A INTERCONNECT CABLE (OR EQUIVALENT) CONNECT THE BCD MODULE TO THE SIGNAL CONDITIONING MODULE. ALSO CONNECT THE RIBBON CABLE SUPPLIED WITH THE INSTRUMENT BETWEEN THE MODULES.

BEGINNING WITH THE MAX POSITION OF THE OUTPUT RATE SWITCH, SET THE SWITCH TO EACH POSITION WHILE OBSERVING THE OUTPUT RATE LIGHT. AT ALL POSITIONS EXCEPT HOLD THE LIGHT SHOULD FLASH AT A RATE WHICH DECREASES AT EACH LOWER POSITION. IN HOLD POSITION THE LIGHT SHOULD FLASH ONLY WHEN THE MANUAL BUTTON IS DEPRESSED OR WHEN AN EXTERNAL TRIGGER IS APPLIED TO PIN 46 OF THE REAR PANEL CONNECTOR.

WERE THE CORRECT INDICATIONS NOTED?

NO

REPLACE THE DEFECTIVE IC.

YES

CHECK RIBBON CABLE TO ENSURE THAT IT IS PROPERLY CONNECTED BETWEEN THE BCD MODULE AND THE SIGNAL CONDITIONING MODULE. CHECK FLIP-FLOPS U26 AND U27 FOR PROPER OPERATION.

TEST THE FUNCTION DECODE GATES U11A AND B AND U12A. THIS CAN BE DONE BY SELECTING DCV FUNCTION AND DETERMINING WHETHER THE OUTPUTS OF THESE 3 GATES GO LOW. THEN CONSECUTIVELY SHORT EACH INPUT OF THE 3 GATES TO GROUND. THE OUTPUT OF THE RESPECTIVE GATE SHOULD GO HIGH EACH TIME ONE OF ITS INPUTS IS GROUNDED.

IS FUNCTION DATA CORRECT?

NO

CHECK RIBBON CABLE TO ENSURE THAT IT IS PROPERLY CONNECTED BETWEEN THE BCD MODULE AND THE SIGNAL CONDITIONING MODULE. CHECK FLIP-FLOPS U27 AND U28 FOR PROPER OPERATION.

WERE CORRECT INDICATIONS NOTED?

NO

REPLACE THE DEFECTIVE IC.

YES

TEST THE RANGE DECODE GATES U12B AND U13A AND B. THIS CAN BE DONE BY TEMPORARILY DISCONNECTING THE RIBBON CABLE FROM THE BCD MODULE AND OBSERVING THE OUTPUT OF EACH GATE. THEY SHOULD ALL GO LOW. THEN CONSECUTIVELY CONNECT EACH INPUT OF THE 3 GATES TO GROUND. THE OUTPUT OF THE RESPECTIVE GATE SHOULD GO HIGH EACH TIME ONE OF ITS INPUTS IS GROUNDED. RECONNECT THE RIBBON CABLE.

IS RANGE DATA CORRECT?

NO

CHECK A4U25 FOR PROPER OPERATION.

WAS CORRECT LEVEL NOTED?

NO

CHECK POLARITY OUTPUT FROM DISPLAY MODULE.

YES

CHECK THE LOGIC LEVEL AT PIN 12 OF A4U25. IT SHOULD BE HIGH FOR A + INPUT, LOW FOR A − INPUT.

IS POLARITY DATA CORRECT?

NO

OBSERVE THE DISPLAY MODULE INDICATION. IF IT GIVES A CORRECT INDICATION FOR A DIGIT WHICH IS DEFECTIVE IN THE BCD MODULE THE DATA STORAGE FLIP-FLOP FOR THAT DIGIT IS PROBABLY BAD. OTHERWISE, THE DISPLAY MODULE IS DEFECTIVE.

IS THE ROM OUTPUT CORRECT?

NO

ROM IS PROBABLY DEFECTIVE.

YES

CHECK THE ROM OUTPUT WHICH CLOCKS THE DATA FLIP-FLOPS OF THE MALFUNCTIONING DIGIT. IT SHOULD BE FLUCTUATING BETWEEN +.2 V AND +4.0 V (SEE WAVEFORMS IN ☆).

ARE ALL DIGITS INCORRECT?

YES

CHECK ROM OUTPUTS WHICH CLOCK THE DATA STORAGE FLIP-FLOPS. THEY SHOULD APPREAR AS SHOWN IN ☆. IF THEY DO NOT THE ROM IS PROBABLY DEFECTIVE. CHECK THE PRESET LINE (LPOV) FOR A CONSTANT LOW. IF THIS LINE IS ALWAYS LOW TROUBLESHOOT THE OVERLOAD DETECT CIRCUITS (U8 and U10C). IF THESE TWO CHECKS DO NOT REVEAL THE PROBLEM THE BCD DATA FROM THE DISPLAY MODULE IS PROBABLY INCORRECT.

NO

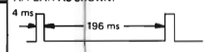
ARE DATA DIGITS CORRECT (NOT INCLUDING OVERRANGE)?

YES

IS PRINTER FUNCTIONING PROPERLY?

NO

SET THE OUTPUT RATE CONTROL TO MAX. CHECK THE WAVEFORM ON TEST POINT "PRT". IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

YES

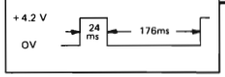
PRINTER IS MALFUNCTIONING.

NO

CHECK FOR +5 V ON PRINTER HOLDOFF (PIN 22). IF +5 V IS NOT PRESENT, A4U6 (ROM) PROBABLY DEFECTIVE.

YES

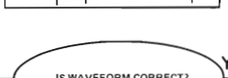
SET THE OUTPUT RATE SWITCH TO MAX. AND OBSERVE THE WAVEFORM ON TEST POINT "TRG" OF THE A4 ASSEMBLY. IT SHOULD APPEAR AS SHOWN:



DOES WAVEFORM APPEAR AS INDICATED?

YES

CHECK WAVEFORM AT TEST POINT DATA. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

NO

EXTERNALLY TRIGGER AN OSCILLOSCOPE ON TEST POINT "TRG". CHECK WAVEFORM AT TEST POINT "M". IT SHOULD BE A SERIES OF PULSES WITH WIDTHS VARYING BETWEEN 4 ms AND 33 ms.

YES

CHECK A4Q1 AND FRONT PANEL LIGHT (C11).

NO

CHECK WAVEFORM AT PIN 3 OF A4U1. IT SHOULD APPEAR AS SHOWN:

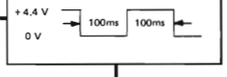
IS WAVEFORM CORRECT?

NO

CHECK FOR PIN 14 OF A4U3 SHORTED TO GROUND OR CLAMPED AT SOME VOLTAGE. THIS MAY BE DUE TO FAILURE OF A4U3. ALSO CHECK A5 CONNECTOR ASSEMBLY AND OUTPUT RATE SWITCH (S1).

YES

CHECK WAVEFORM AT PIN 1 OF A4U1. IT SHOULD APPEAR AS SHOWN:



IS WAVEFORM CORRECT?

NO

CHECK A4U1A AND A4U2C AND D FOR PROPER OPERATION. CHECK MANUAL PUSHBUTTON (S2)FOR PROPER OPERATION.

YES

SET OUTPUT RATE SWITCH (S1) TO HOLD. CHECK VOLTAGE LEVEL AT A4U1 PIN 2. IT SHOULD BE APPROXIMATELY 0 V. DEPRESS THE MANUAL PUSHBUTTON AND AGAIN OBSERVE THE VOLTAGE AT PIN 2. IT SHOULD CHANGE TO APPROXIMATELY +4.2 V.

WAS CORRECT INDICATION NOTED?

NO

CHECK A4U2C AND D AND MANUAL PUSHBUTTON (S2).

YES

CONNECT +5 V TO PIN 46 OF THE REAR PANEL CONNECTOR WHILE OBSERVING THE VOLTAGE AT PIN 6 OF A4U2. IT SHOULD CHANGE FROM ≈0 V TO ≈4.4 V.

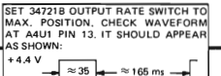
WAS INDICATION CORRECT?

NO

CHECK A4U2B AND A4U1B AND C.

YES

SET 34721B OUTPUT RATE SWITCH TO MAX. POSITION. CHECK WAVEFORM AT A4U1 PIN 13. IT SHOULD APPEAR AS SHOWN:



CHECK A4U9 AND ENABLE PULSES HQAZ, HQTG, HQMA, AND HQHO FROM THE ROM (U6). PINS 7 AND 21 HAVE A SERIES OF PULSES SIMILAR TO THAT PREVIOUSLY DESCRIBED. THE WAVEFORMS ON PINS 8 AND 22 ARE PULSES 4ms WIDE OCCURING EVERY 200ms.

IS WAVEFORM CORRECT?

YES

MONITOR TP "Q" AND MOMENTARILY SHORT TP "M" TO GND. TP Q SHOULD GO HIGH.

NO

1. BEFORE ENTERING THIS TROUBLESHOOTING TREE ENSURE THAT THE DISPLAY AND SIGNAL CONDITIONING MODULES ARE FUNCTIONING PROPERLY. ALSO CHECK THE VOLTAGES SUPPLIED TO THE 34721B FROM THE DISPLAY MODULE. CONNECT THE 34721B TO AN -hp- MODEL 5055A DIGITAL RECORDER OR EQUIVALENT.

2. LOGIC LEVELS
   HIGH - +2.4 to +5.0 V
   LOW - 0V to +.5 V

E IC.

CHECK A4U25 FOR PROPER OPERATION.

YES

WAS CORRECT LEVEL NOTED? — NO → CHECK POLARITY OUTPUT FROM DISPLAY MODULE.

CHECK THE LOGIC LEVEL AT PIN 12 OF A4U25. IT SHOULD BE HIGH FOR A + INPUT, LOW FOR A − INPUT.

NO

IS POLARITY DATA CORRECT? — YES →

T? — YES → PRINTER IS MALFUNCTIONING.

R HOLD-
RESENT,
CTIVE.

CHECK A4Q1 AND FRONT PANEL LIGHT (C11).

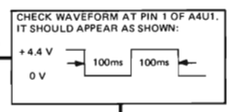
YES

T POINT
SHOWN:

IS WAVEFORM CORRECT? — NO → EXTERNALLY TRIGGER AN OSCILLOSCOPE ON TEST POINT "TRG". CHECK WAVEFORM AT TEST POINT "M". IT SHOULD BE A SERIES OF PULSES WITH WIDTHS VARYING BETWEEN 4 ms AND 33 ms.

CT? — YES

CHECK WAVEFORM AT PIN 1 OF A4U1. IT SHOULD APPEAR AS SHOWN:



HORTED
T SOME
TO FAIL-
A5 CON-
OUTPUT

IS WAVEFORM CORRECT? — YES → SET OUTPUT RATE SWITCH (S1) TO HOLD. CHECK VOLTAGE LEVEL AT A4U1 PIN 2. IT SHOULD BE APPROXIMATELY 0 V. DEPRESS THE MANUAL PUSHBUTTON AND AGAIN OBSERVE THE VOLTAGE AT PIN 2. IT SHOULD CHANGE TO APPROXIMATELY +4.2 V.

NO

CHECK A4U1A AND A4U2C AND D FOR PROPER OPERATION. CHECK MANUAL PUSHBUTTON (S2)FOR PROPER OPERATION.

WAS CORRECT INDICATION NOTED? — YES → CONNECT +5 V TO PIN 46 OF THE REAR PANEL CONNECTOR WHILE OBSERVING THE VOLTAGE AT PIN 6 OF A4U2. IT SHOULD CHANGE FROM ≈0 V TO ≈4.4 V.

NO

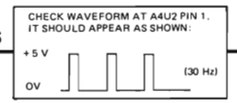
CHECK A4U2C AND D AND MANUAL PUSHBUTTON (S2).

WAS INDICATION CORRECT? — YES → SET 3472IB OUTPUT RATE SWITCH TO MAX. POSITION. CHECK WAVEFORM AT A4U1 PIN 13. IT SHOULD APPEAR AS SHOWN:

NO

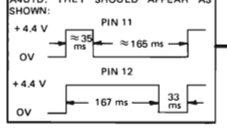
CHECK A4U2B AND A4U1B AND C.

IS WAVEFORM CORRECT? — YES → CHECK WAVEFORM AT A4U2 PIN 1. IT SHOULD APPEAR AS SHOWN:



NO

CHECK INPUTS AT PINS 11 AND 12 OF A4U1D. THEY SHOULD APPEAR AS SHOWN:



ARE WAVEFORMS CORRECT? — YES → CHECK A4U1D AND A4U2A.

NO

CHECK DISPLAY MODULE IF LMATZ IS NOT PRESENT AT PIN 12. CHECK A4U1D and A4U4.

CHECK A4U9 AND ENABLE PULSES HQAZ, HQTG, HOMA, AND HQHO FROM THE ROM (U6). PINS 7 AND 21 HAVE A SERIES OF PULSES SIMILAR TO THAT PREVIOUSLY DESCRIBED. THE WAVEFORMS ON PINS 8 AND 22 ARE PULSES 4ms WIDE OCCURING EVERY 200ms.

NO

IS WAVEFORM CORRECT? — YES → MONITOR TP "Q" AND MOMENTARILY SHORT TP "M" TO GND. TP Q SHOULD GO HIGH.

OBSERVE THE DISPLAY MODULE INDICATION. IF IT GIVES A CORRECT INDICATION FOR A DIGIT WHICH IS DEFECTIVE IN THE BCD MODULE THE DATA STORAGE FLIP-FLOP FOR THAT DIGIT IS PROBABLY BAD. OTHERWISE, THE DISPLAY MODULE IS DEFECTIVE.

YES

ROM IS PROBABLY DEFECTIVE. — NO ← IS THE ROM OUTPUT CORRECT?

CHECK THE ROM OUTPUT WHICH CLOCKS THE DATA FLIP-FLOPS OF THE MALFUNCTIONING DIGIT. IT SHOULD BE FLUCTUATING BETWEEN +.2 V AND +4.0 V (SEE WAVEFORMS IN ☆).

NO

ARE ALL DIGITS INCORRECT? — YES → CHECK ROM OUTPUTS WHICH CLOCK THE DATA STORAGE FLIP-FLOPS. THEY SHOULD APPREAR AS SHOWN IN ☆. IF THEY DO NOT THE ROM IS PROBABLY DEFECTIVE. CHECK THE PRESET LINE (LPOV) FOR A CONSTANT LOW. IF THIS LINE IS ALWAYS LOW TROUBLESHOOT THE OVERLOAD DETECT CIRCUITS (U8 and U10C). IF THESE TWO CHECKS DO NOT REVEAL THE PROBLEM THE BCD DATA FROM THE DISPLAY MODULE IS PROBABLY INCORRECT.

NO

ARE DATA DIGITS CORRECT (NOT INCLUDING OVERRANGE)? — YES →

CHECK U10, U14 AND U15.

NO

DOES THE DIGIT BLANK? — YES → TROUBLESHOOT THE DISPLAY MODULE.

GROUND PIN 1 OF A4U10. THE OPTIONAL DIGIT SHOULD BLANK.

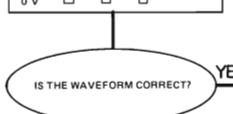
NO

DOES OPTIONAL DIGIT BLANK ON REQUIRED FUNCTIONS AND RANGES? — YES →

WAS CORRECT INDICATION OBSERVED? — YES → CHECK THE WAVEFORMS AT TEST POINTS "A", "B", AND "C". THEY SHOULD APPEAR AS SHOWN BY ☆ (UPPER THREE WAVEFORMS).

NO

CHECK THE WAVEFORM ON PIN 11 OF A4U7. IT SHOULD APPREAR AS SHOWN:



IS THE WAVEFORM CORRECT? — YES → U7 OR U6 PROBABLY DEFECTIVE.

NO

CHECK U8A FOR PROPER OPERATION. CHECK ÷10^4 CLOCK FROM DISPLAY MODULE.

ROM (U6) PROBABLY DEFECTIVE.

YES

ARE THE WAVEFORMS CORRECT? — NO → CHECK THE WAVEFORMS ON PINS 2 AND 12 OF U5 AND PIN 2 OF U7. THEY SHOULD APPEAR AS SHOWN IN ☆ (LOWER THREE WAVEFORMS).

YES

CHECK A4U25 FOR PROPER OPERATION.

NO

IS LOGIC LEVEL CORRECT? — YES → TROUBLESHOOT THE PRINTER.

APPLY 1.5 V TO THE SIGNAL CONDITIONING MODULE. CHECK THE LOGIC LEVEL ON U25 PIN 5. IT SHOULD BE HIGH.

NO

IS OVERRANGE "1" PRINTED WITH OVERRANGE VOLTAGE APPLIED? — YES →

U5 OR U7 PROBABLY DEFECTIVE.

YES

ARE THE WAVEFORMS CORRECT? — NO → ROM (U6) PROBABLY DEFECTIVE.

A4U4 HAS PROBABLY FAILED. MAKE SURE LCLR LINE FROM ROM IS NOT SHORTED TO GROUND.

YES

IS WAVEFORM CORRECT? — NO → CHECK ÷10^5 (30Hz) FROM DISPLAY MODULE.

CHECK U8B, C AND D AND U10C FOR PROPER OPERATION.

NO

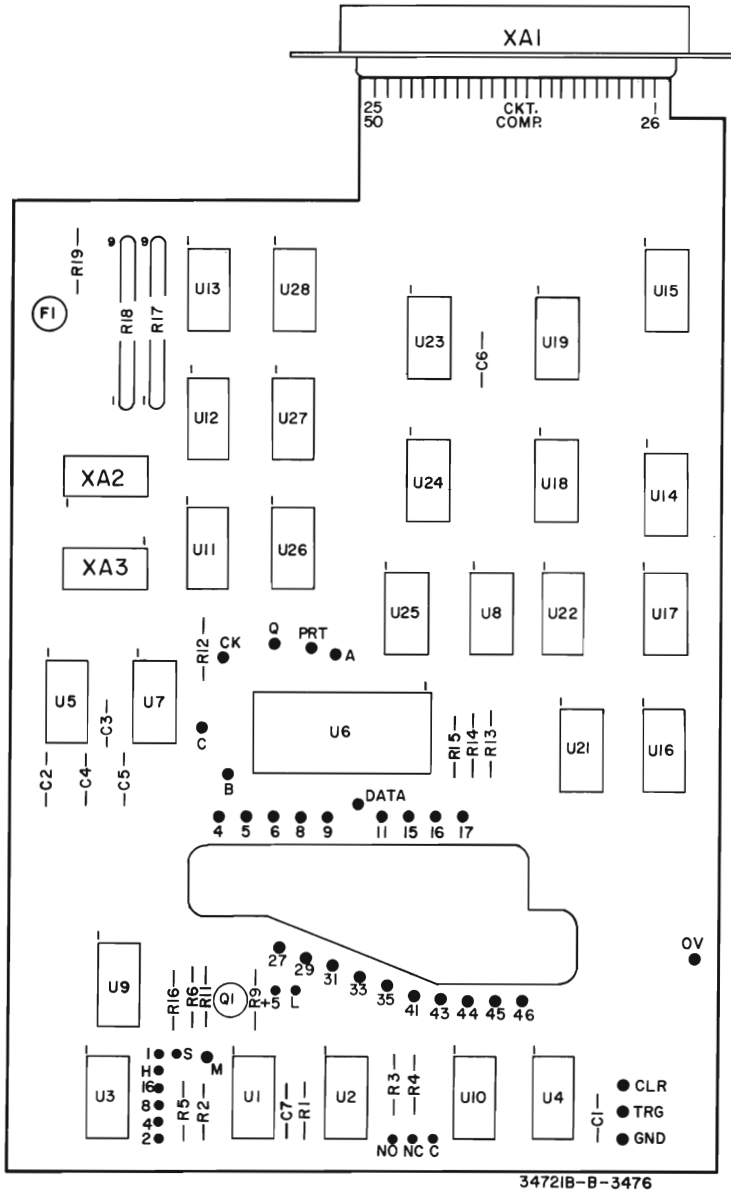
IS THE WAVEFORM CORRECT? — YES → CHECK DATA STORAGE FLIP-FLOPS TO ENSURE THEY ARE PRESETTING AS REQUIRED (ALL DATA FLIP-FLOP OUTPUTS HIGH WHEN LPOV IS LOW).

APPLY 2.2 V TO THE SIGNAL CONDITIONING MODULE. CHECK THE WAVEFORM ON TEST POINT "OV". IT SHOULD APPEAR AS SHOWN:

NO

IS CORRECT INDICATION PRINTED ON OVERLOAD (SEE PARAGRAPH 4-29)? — YES → GOOD INSTRUMENT. RECHECK SYMPTONS.

3472IB-D-3533



A4

hp Part No. 034721-66504

Rev. A

A4 BCD LOGIC
034721-66504

FROM DISPLAY

L5DB 35
BCD(1) 27
BCD(2) 29
BCD(4) 33
BCD(8) 31
POLARITY 41
Z 43
Y 44
X 45
SCANNER CLK 46
HMSA 5
LMATZ 4
HMSB 6
÷10⁴ 8
÷10⁵ 9
GND 3 11
+5V 15
-12V 16
+12V 17

TO SIGNAL CONDITIONING MODULE

A5

EXT TRIGGER XA1 46 — R1 2.2K — C7 47pF Δa — TRIGGER SELECTOR — U1C — U2B — U1D — H÷10 — U2A

FRONT PANEL LOCKOUT 21 — R2 2.2K — U1B — U1A

+5V — R3 10K — U2C — MANUAL — S2 NO C NC

+5V — R4 10K — U2D

OUTPUT RATE — MAX. ÷1 ÷2 ÷4 ÷8 ÷16 HOLD — SI — U3 — R5 2.2K — SAMPLE RATE GENERATOR

PRINTER HOLD OFF XA1 22 — R6 2.2K

PRINTER GROUND REF. XA1 24 50 — F1

+12V −12V +5V H÷10⁵ H÷10⁴

U10D 12,13 11

U4 — CLK1 CLR1 CLK2 D1 D2 Q1 Q2 — +5V — TRIGGER CATCHER AND STORAGE

FRONT PANEL LIGHT — CR1 — R9 330 — Q1 — R11 10K — DATA

CLR (LCLR) — C1 .01

U5 STATE FLIP-FLOP — H÷10⁴ — LA — A (A) C2 .002 — B (B) C3 .002 — (HDAT) 20

U6 ROM — O0 O1 O2 O3 O4 O5 O6 O7 O8 O9 O10 O11 O12 O13 O14 O15

U7 QUALIFIER FLIP-FLOP — STATE FLIP-FLOP — L÷10⁴ — U8A — CK — C HC C4 .002 (C) — Q (Q) — C5 .002

+12V — R13 2K — +10V — R14 12.1K — −2V — R15 10K — −12V +5V

(HQAZ) (HQTG) (HQMA) (HQHO) — U9A U9B U9C U9D — QUALIFIER MULTIPLEXER — R16 10K +5V — M

LA — U10C — OVERLOAD DETECT — U8D U8C U8B — (BCD2) (LPOV) — C6 .01 — OV

5TH DIGIT BLANK GATES — U10A U10B — PRT 10

XA1 + PRINT COMMAND 23

DATA STORAGE FLIP-FLOPS

U14	27 (8)	26 (4)	OPTIONAL DIGIT
U15	2 (2)	1 (1)	
U16	29 (8)	28 (4)	UNITS DIGIT
U17	4 (2)	3 (1)	
U18	31 (8)	30 (4)	TENS DIGIT
U19	6 (2)	5 (1)	
U21	33 (8)	32 (4)	HUNDREDS DIGIT
U22	8 (2)	7 (1)	
U23	35 (8)	34 (4)	THOUSANDS DIGIT
U24	10 (2)	9 (1)	

POLARITY & OVERRANGE FLIP-FLOPS — U25 — 11 (1) OR "1" — 17 (1) POL — 19 (1) POLARITY

FUNCTION & RANGE FLIP-FLOPS — +5V — R18 10K

U26	13 (1)	14 (2)	FUNCTION
U27	HC 38 (4)		
U28	15 (1)	16 (2)	RANGE
		40 (4)	

TO PRINTER 12,18,36,37,39,41,42,43,44

R19 1K +5V — 25 + REF

+5V — R17 10K — R18 10K

U11B U11A U12A U12B U13A U13B — FUNCTION & RANGE DECODE GATES

XA2 or XA3 — 14 12 10 8 1 4 2 7 — 13 11 9 3 6 5

U14-28 GND-PIN 7

GND

NOTE

THE CIRCLED NUMBERS e.g. (2) REFER TO THE WAVEFORMS ON FIGURE 7-2.

Δa Instrument Serial Numbers 1326A00150 and below did not contain C7.

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins EngineeringCo.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon Clifton Heights, Penn.	
09922	Burndy Corp	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics. Garden City, Long Island, N.Y.	
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N. Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N. Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N. J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G. E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N. Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N. J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N. J.
30817	Instrument Specialties Co., Inc.	Little Falls, N. J.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W. H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N. H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N. C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N. Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N. Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N. J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.
64959	Western Electric Co., Inc.	New York, N. Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N. J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N. Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N. Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N. J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N. Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N. J.
71313	Cardwell Condenser Corp.	Lindenhurst, L. I., N. Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C. P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N. Y.
71707	Coto Coil Co., Inc.	Providence, R. I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N. Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N. J.
72699	General Instrument Corp., Cap Division	Newark, N. J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N. J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L. I., N. Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N. J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N. Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N. J.
74276	Signalite Inc.	Neptune, N. J.
74455	J. H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R. F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N. Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N. J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N. J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N. J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N. Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N. Y.
78290	Struthers-Dunn Inc.	Pitman, N. J.
78452	Thompson-Bremer & Co.	Chicago, Ill
78471	Tilley Mfg. Co.	San Francisco, Cal
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N. Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N. J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N. J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N. Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N. C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N. J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N. J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N. J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N. Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N. H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S. C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N. J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N. J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N. Y.
83332	Tech Labs	Palisades Park, N. J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N. J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N. Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N. J.
84171	Arco Electronics Inc.	Great Neck, N. Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Cal.
85474	R.M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div.,	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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23880	STANFORD APPLIED ENGINEERING	SANTA CLARA, CALIF.

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