MODEL 3484A
MULTIFUNCTION UNIT

OPERATING AND SERVICE MANUAL

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3484A
MULTIFUNCTION UNIT

-hp- Part No. 03484-90000

Serials Prefixed: 975-

Printed: JULY 1970

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GENERAL INFORMATION

1-1. INTRODUCTION.

The -hp- Model 3484A Multifunction Unit, in conjunction with either the Model 3480A or 3480B Digital Voltmeter, makes 4-digit dc voltage measurements, with up to 50% overrange capability. Full scale ranges of 100 mV, 1000 mV, 10 V, 100 V, and 1000 V may be selected manually, automatically, or remotely. Polarity selection and display are automatic. The degree of filtering desired may also be selected manually or remotely. Resistance and true rms ac voltage measurements may be made if Options 042 and 043 are added.

1-2. OPTIONS.

1-3. ISOLATED REMOTE OPTION 041.

Option 041 provides remote programming connections which are isolated from the Model 3484A internal circuits. All external connections are referenced to chassis (power line) ground. This option is available for field installation as -hp- Model 11151A, Isolated Remote Assembly. Option 041 cannot be used unless the Model 3480A/B is equipped with Isolated BCD Output Option 004.

1-4. OHMS/DC CONVERTER OPTION 042.

Option 042 allows the Model 3484A to make resistance measurements on six ranges of 100 Ω, 1000 Ω, 10 kΩ, 100 kΩ, 1000 kΩ, and 10 MΩ full scale, with up to 50% overrange capability. Range may be selected manually, automatically, or remotely. This option is available for field installation as -hp- Model 11152A, Ohms/DC Converter Assembly.

1-5. TRUE RMS AC CONVERTER OPTION 043.

Option 043 allows the Model 3484A to make true rms ac voltage measurements on five ranges of 100 mV, 1000 mV, 10 V, 100 V, and 1000 V full scale, with up to 50% overrange capability. Range may be selected manually, automatically, or remotely. This option is available for field installation as -hp- Model 11153A, True RMS AC Converter Assembly.

1-6. SPECIFICATIONS.

Complete specifications for the Model 3484A and 3480A/B combination are given in Table 1-1.

1-7. INSTRUMENT AND MANUAL IDENTIFICATION.

Hewlett-Packard uses a two-section serial number. If the first section (serial prefix) of the serial number on your instrument does not agree with those on the title page of this manual, change sheets supplied with the manual will define the differences between your instrument and the Model 3484A described in this manual. 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.

1-8. ACCESSORY EQUIPMENT AVAILABLE.

1-9. The Model 11148A Plug-in Extender Cable allows the plug-in unit to operate outside the 3480A/B to facilitate servicing.

1-10. The Model 11149A Remote Programming Cable is 6 feet long and is terminated at one end by a connector which mates with the 3484A rear panel remote connector J14. The other end of the cable is unterminated.

1-11. For additional information regarding optional equipment, contact your nearest -hp- Sales and Service Office, listed in Appendix B.

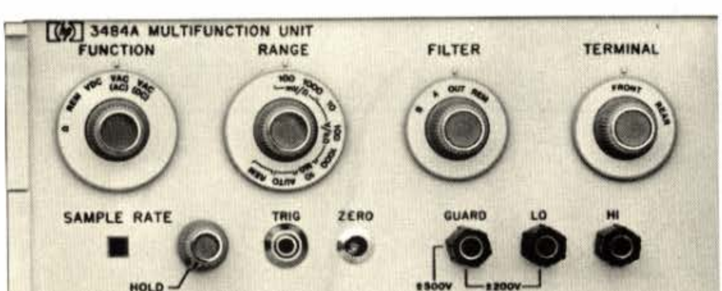


Figure 1-1. Model 3484A Multifunction Unit.

Table 1-1. Specifications.

The following specifications apply to the Model 3484A Multifunction Unit used in the Model 3480A/B Digital Voltmeter.

DC VOLTS	
Full Scale Voltage Ranges	100 mV, 1000 mV, 10 V, 100 V, 1000 V
50% Overrange capability on all ranges; maximum input ± 1200 V.	
Range Selection	Manual, Automatic, or Remote
Automatic Ranging	Upranges at 140% of range Downranges at 10% of range
Polarity Selection and Display	Automatic
Voltage Accuracy	
24 hours (23°C ± 1°C, less than 50% relative humidity)	± (0.01% of reading + 0.01% of range)
90 days (25°C ± 5°C, less than 95% relative humidity)	100 mV Range: ± (0.01% of reading + 0.02% of range) All other ranges: ± (0.01% of reading + 0.01% of range)
Temperature Coefficient 0°C to 55°C	100 mV Range: Filter Out: ± (0.001% of reading + 0.0005% of range)/°C Filter A or B: ± (0.001% of reading + 0.0015% of range)/°C All other ranges: ± (0.001% of reading + 0.0005% of range)/°C
Measuring Speed	
Reading Period	950 microseconds
Reading Rate (without range change)	
Automatic	Variable from 1 to 25 per second with front panel control
Manual Trigger	Front panel pushbutton
External Trigger	0 to 1000 per second
Response Time	Without range change: Filter out: 1 msec to within 1 count of final reading when triggered coincident with step input voltage. Filter A: 200 msec to within 1 count of final reading Filter B: 1 second to within 1 count of final reading
Autorange Time	Filter out: 4 msec per range change Filter A: 200 msec per range change Filter B: 1 second per range change

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

DC VOLTS (Cont'd)	
Input Characteristics	
Input Resistance	100 mV, 1000 mV and 10 V ranges: Greater than 10^{10} ohms 100 V, 1000 V ranges: 10 megohms ± 0.1%
Effective Common Mode Rejection (Ratio of peak common-mode voltage to resultant error in reading with 1 kilohm unbalance in either lead)	
DC	Greater than 80 dB
AC	50 to 60 Hz Filter out: Greater than 80 dB Filter A: Greater than 110 dB Filter B: Greater than 160 dB
Normal Mode Rejection (Ratio of peak normal-mode signal to resultant error in reading)	Filter out: 0 dB Filter A: Greater than 30 dB at 50 Hz and above Filter B: Greater than 80 dB at 50 Hz and above
Filter Selection	Manual or Remote
Zero Offset	
Voltage Stability (at constant temperature)	Less than 10 microvolts per week
Voltage Temperature Coefficient (0°C to 55°C)	Less than ± 1 microvolt per °C
Current (25°C ± 5°C)	Less than 10 pA
Current Temperature Coefficient (0°C to 55°C)	Less than 1 pA per °C
Noise	Less than 20 microvolts peak-to-peak (unfiltered). Peak-to-peak noise is less than 20 microvolts 95% of the time since the noise amplitude approximates a Gaussian distribution where the standard deviation (rms value) equals 5 microvolts.
Maximum Input Voltage	
Between HIGH and LOW terminals	± 1200 V peak
Between LOW and GUARD terminals	± 200 V peak
Between GUARD and Chassis	± 500 V peak

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

OHMS (OPTION 042)	
Full Scale Ranges	100 ohms, 1000 ohms, 10 kilohms, 100 kilohms, 1000 kilohms 10 megohms
50% Overrange capability on all ranges	
Range Selection	Manual, Automatic, or Remote
Automatic Ranging	Upranges at 140% of range Downranges at 10% of range
Measurement Accuracy	
24 hours (23°C ± 1°C, less than 50% relative humidity)	1000 ohm thru 1000 kilohm ranges: ± (0.01% of reading + 0.01% of range) 100 ohm range: ±(0.02% of reading + 0.05% of range) 10 megohm range: ±(0.1% of reading + 0.01% of range)
90 days (25°C ± 5°C, less than 95% relative humidity)	1000 ohm thru 1000 kilohm ranges: ±(0.02% of reading + 0.01% of range) 100 ohm range: ±(0.02% of reading + 0.05% of range) 10 megohm range: ±(0.1% of reading + 0.01% of range)
Measuring Speed	
Reading Period	950 microseconds
Reading Rate (Without range change)	
Automatic	Variable from 1 to 25 per second with front panel control
Manual Trigger	Front panel pushbutton
External Trigger	0 to 1000 per second
Response Time (Full scale step input, without range change)	100 ohm thru 100 kilohm ranges (Filter out): 1 msec to within 1 count of final reading 1000 kilohm range (Filter A): 200 msec to within 1 count of final reading 10 megohm range (Filter A): 2 seconds to within 1 count of final reading Note: Due to noise generated in the unknown resistance, filtering may be required for quiet readings with inputs greater than 100 kilohms. Response times for inputs below full scale, with filtering, are proportionately less than those shown.
Autorange Time	Filter out: 4 msec per range change Filter A: 200 msec per range change Filter B: 1 second per range change
Input Characteristics	
Voltage across unknown resistance	1 V at full scale on all ranges
Maximum current through unknown resistance	10 mA on 100 ohm range

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

AC VOLTS (OPTION 043)	AC COUPLED VAC (AC)	DC COUPLED VAC (DC)
Full Scale Voltage Ranges	100 mV, 1000 mV, 10 V, 100 V, 1000 V	100 mV, 1000 mV, 10 V, 100 V, 1000 V
50% Overrange capability on all ranges; maximum input 1500 V peak		
Range Selection	Manual or Remote	Manual or Remote
Automatic Ranging	Upranges at 140% of range Downranges at 10% of range	Upranges at 140% of range Downranges at 10% of range
Response	Responds to true rms value of ac input signal. (Internally ac coupled)	Responds to true rms value of ac and dc input signal. Reading = $\sqrt{(DC)^2 + (AC_{rms})^2}$ With external 10 microfarad coupling capacitor, responds to ac component only, for measurements down to 1 Hz.
Selection of AC or DC Coupling	Manual or Remote	Manual or Remote
Accuracy		
(10% to 150% of range; less than 10^8 Volt-Hertz)		
24 Hours (23°C ± 1°C, less than 50% relative humidity	20 Hz to 1 MHz: ±(0.05% of reading + 0.02% of range)	DC: ± 0.1% of range 1 Hz to 10 Hz: ± 1% of reading 10 Hz to 20 Hz: ±(0.1% of reading + 0.05% of range) 20 Hz to 1 MHz: ±(0.05% of reading + 0.02% of range)
90 days (25°C ± 5°C, less than 95% relative humidity)	20 Hz to 1 MHz: ±(0.05% of reading + 0.05% of range)	DC: ± 0.5% of range 1 Hz to 10 Hz: ± 1% of reading 10 Hz to 20 Hz: ± (0.1% of reading + 0.05% of range) 20 Hz to 1MHz: ± (0.05% of reading + 0.05% of range)
Measuring Speed		
Reading Period	950 microseconds	950 microseconds
Reading Rate (without range change)		
Automatic	Variable from 1 to 25 per second with front panel control	Variable from 1 to 25 per second with front panel control
Manual Trigger	Front panel pushbutton	Front panel pushbutton
External Trigger	0 to 1000 per second	0 to 1000 per second
Response Time (Full scale step input, without range change)	1 second to within 5 counts of final reading	15 seconds to within 5 counts of final reading
Autorange Time	1 second per range change	3 seconds per range change
Input Characteristics		
Input Resistance	2 megohms ± 1%	2 megohms ± 1%
Crest Factor	7:1 at full scale 70:1 at 10% of full scale	7:1 at full scale 70:1 at 10% of full scale
Maximum Input Voltage	1500 V peak ac 10 Vdc (100 mV range) 100 Vdc (all other ranges) 1500 V maximum ac + dc (peak)	1500 V peak ac 1500 Vdc 1500 V maximum ac + dc (peak)

Ratio (3480A/B Option 002)

Display is proportional to the ratio of the input dc voltage, ac voltage, or resistance to the external + 10 Vdc or + 100 Vdc reference voltage applied to rear panel Ratio terminals.

Ratio accuracy

(+ 10 V or + 100 V) ± 5% reference input: Same as accuracy specifications for basic function.

(+ 10 V or + 100 V) + 5% to + 35% or (+ 10 V or + 100 V) − 5% to − 13% Reference input: Add ± 0.02% of reading to basic accuracy specifications.

Ratio (Reference) Input Characteristics

Input Voltage: + 10 V or + 100 V referenced to circuit common and Low side of unknown input.

Input Resistance:
10 V Ref Range = 100 kilohms ± 1.5%
100 V Ref Range = 100 kilohms ± 0.5%

Ratio Measurement Selection: Manual or Remote

Ratio Range Selection: Manual

General Specifications

Operating Temperature: 0°C to 55°C

Storage Temperature: − 40°C to + 75°C

Options and Accessories Available

Option 041, Isolated Remote Control (Requires 3480A/B Option 004)	Model 11151A
Option 042, Ohms Converter	Model 11152A
Option 043, True rms AC Converter	Model 11153A

Other Accessories Available

Plug-in Extender Cable (for servicing plug-in units)	Model 11148A
Remote Program Cable (for all plug-in units)	Model 11149A

SECTION II
INSTALLATION

2-1. INTRODUCTION.

This section contains information and instructions necessary for installing the Model 3484A Multifunction Unit in the Model 3480A/B Digital Voltmeter. In addition, instructions are given for installing the available options in the 3484A. This section also includes initial inspection procedures and instructions for repackaging for shipment.

2-2. INITIAL INSPECTION.

This instrument was carefully inspected both mechanically and electrically before shipment. It should be free from mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit, and the electrical performance should be tested using the procedure outlined in Paragraph 5-3. If there is damage or deficiency, see the warranty inside the front cover of this manual.

2-3. INSTALLATION.

Instructions for installing the Model 3484A in the 3480A/B Digital Voltmeter are given in Figure 2-1. Installation instructions for the Model 3480A/B are given in the 3480A/B Operating and Service Manual.

2-4. INSTALLATION OF ISOLATED REMOTE OPTION 041.

The following procedure gives instructions for installing the Model 11151A Isolated Remote Assembly (Option 041) in the 3484A. If it is desired to operate remotely a 3484A having Isolated Remote, in a 3480A/B that does not have Isolated BCD Option 004, remove the Isolated Remote Assembly by reversing the installation procedure.

a. Visually check the assembly to make sure that the molded coils offset from one printed circuit board are adjacent to and aligned with the coils on the other board. See Figure 2-2.

b. Remove 3484A top and bottom guard covers.

CAUTION

MANY COMPONENTS AND AREAS WITHIN THE 3484A SHOULD NOT BE TOUCHED. DIRT OR FINGERPRINTS CAN CAUSE CONTAMINATION WHICH WILL DEGRADE THE OPERATION OF THE INSTRUMENT. WEAR CLEAN RUBBER OR COTTON GLOVES WHEN WORKING WITHIN THE INSTRUMENT.

c. Remove the small printed circuit board, having cable attached, from printed circuit connector J5 on the top side of the master board, near the rear of the instrument.

d. Hold the Isolated Remote Assembly as near as possible to the position it will occupy in the 3484A and insert the small printed circuit board into printed circuit connector J4. See Figure 2-2.

e. Insert the other end of the Isolated Remote Assembly into connector J5 on the master board.

f. If the 3484A has Option 043 true rms ac converter installed, remove hold down screws and tilt the ac converter assembly so that the master board is accessible.

g. Secure the Isolated Remote Assembly by installing a screw through the master board into the spacer on the Remote Assembly. This screw should be a 6-32 x 1/4 pan head pozidriv machine screw with lockwasher, -hp- Part No. 2360-0113.

h. Replace ac converter assembly.

i. Replace top and bottom guard covers.

2-5. INSTALLATION OF OHMS CONVERTER OPTION 042.

a. Remove 3484A top guard cover.

CAUTION

WEAR CLEAN RUBBER OR COTTON GLOVES WHEN WORKING WITHIN THE 3484A. DIRT OR FINGERPRINTS ON THE SWITCHES OR PRINTED CIRCUIT BOARDS WILL DEGRADE THE PERFORMANCE OF THE INSTRUMENT. BE CAREFUL NOT TO APPLY ANY PRESSURE TO REED RELAYS.

b. Insert Ohms Converter printed circuit board into connector J6 and secure at opposite end with two screws provided. (6-32 x 5/16 pan head pozidriv with external tooth lockwasher, -hp- Part No. 2360-0115)

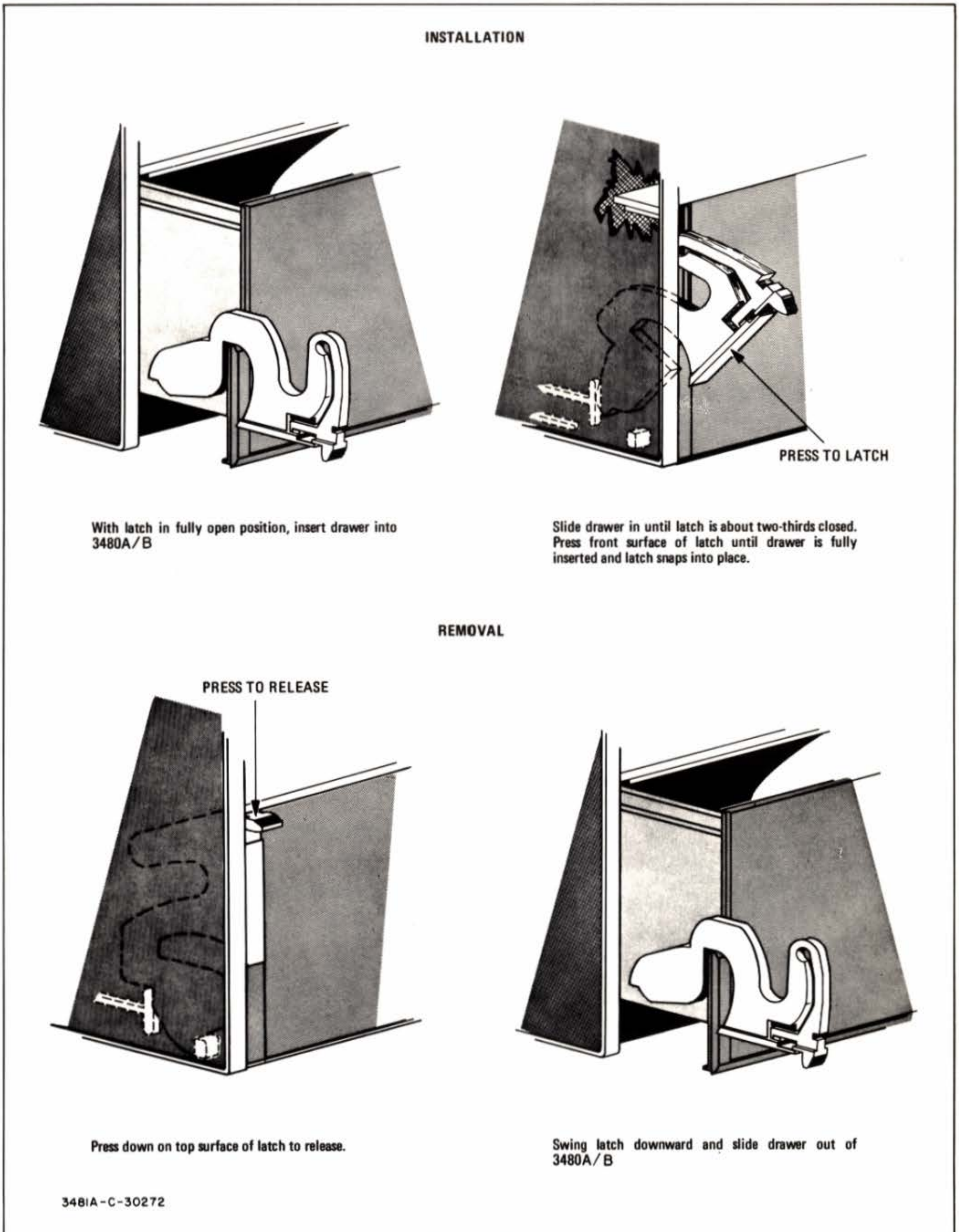


Figure 2-1. Plug-in Drawer Installation and Removal.

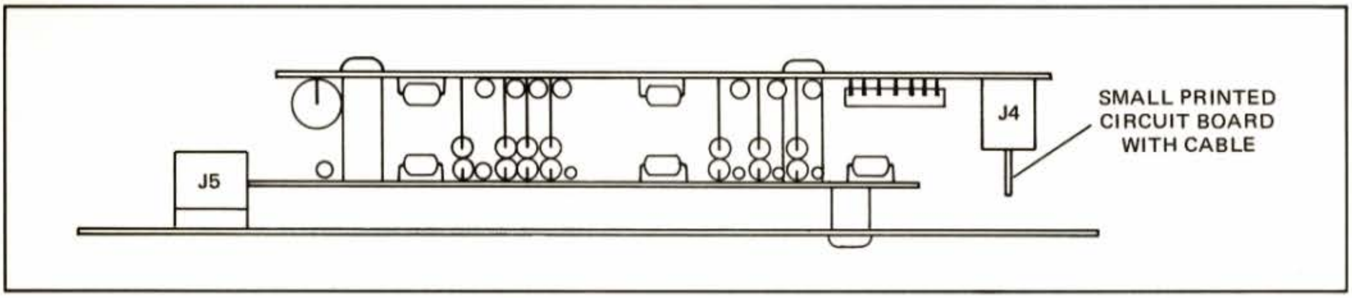


Figure 2-2. Isolated Remote Option Installation.

c. Route input lead from Ohms Converter under outer row of right-angle pins of connector J2, and connect to Attenuator Assembly A1 at point indicated in Figure 7-3, A1 Component Location drawing.

d. Turn RANGE switch fully clockwise to 100 mV range. Remove knob by loosening the two set screws.

e. Remove RANGE switch mounting nut and carefully slide the switch as far as possible toward the rear of the instrument.

f. Rotate the counterclockwise limit stop one position counterclockwise as indicated in Figure 2-3.

g. Replace switch carefully so that stop stays in position. Replace mounting nut.

h. Install new RANGE knob supplied. Orient knob so that 100 Ω range is opposite marker on front panel and secure with two set screws.

i. Four wires from RANGE switch are connected to pins labeled A, B, C, D near front center of bottom side of printed circuit board. Move all four wires to the set of pins farthest from front edge of board. Make certain that wires are kept in the same order.

j. Set FUNCTION switch to VDC and remove knob.

k. Remove FUNCTION switch mounting nut and carefully slide the switch as far as possible toward the rear of the instrument.

l. Rotate clockwise limit stop one position clockwise as shown in Figure 2-3. Make certain that the counterclockwise stop is in the correct position. If the AC Converter option is also being added, this stop should be rotated two positions counterclockwise.

m. Replace switch carefully so that stops stay in position. Replace mounting nut.

n. Two FUNCTION knobs are supplied with Ohms Converter Option, Model 11152A. -hp- Part No. 5060-5953 should be used if instrument does not have ac converter, and Part No. 5060-5954 if instrument does have ac, or if it is also being installed. Select and install correct knob, orienting so that VDC is opposite marker on front panel. Secure knob with two set screws.

o. Replace top guard cover.

p. Perform Ohmmeter Accuracy Check given in Paragraph 5-11.

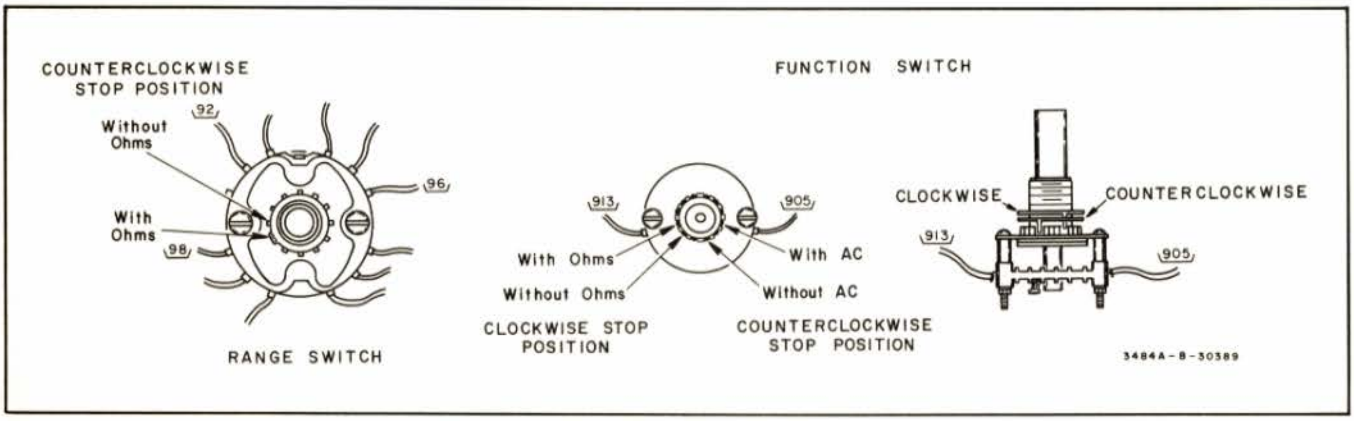


Figure 2-3. Location of Switch Limit Stops.

2-6. REPACKAGING FOR SHIPMENT.

2-7. The following paragraphs contain a general guide for repackaging the instrument for shipment. Refer to Paragraph 2-8 if the original container is to be used; 2-9 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 model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

2-8. Place instrument in original container with appropriate packing material and seal well with strong tape or metal bands. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

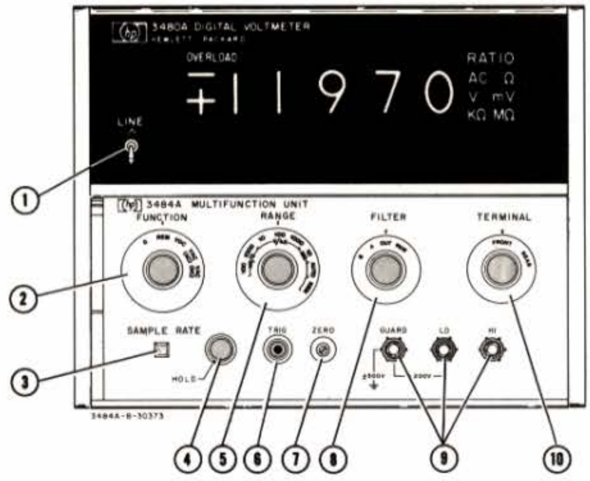
2-9. If original container is not to be used, proceed as follows:

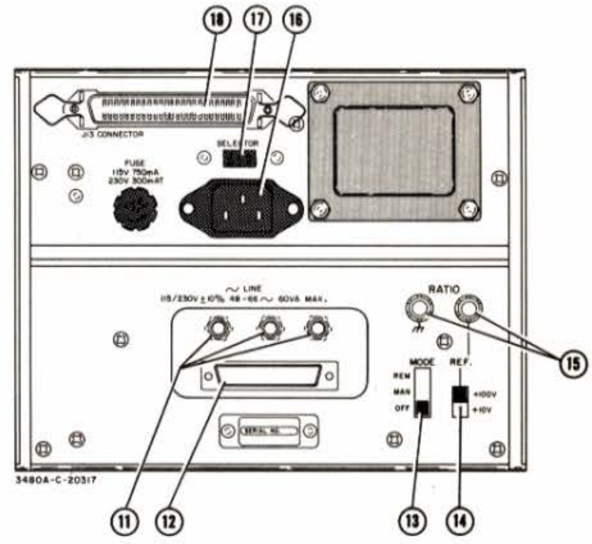
a. Wrap instrument in heavy paper or plastic before placing in an inner container.

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

d. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.





1. Power switch.
2. Function switch.
3. Sample Indicator. Flashes once for each sample period.
4. Sample Rate Control. Varies sample rate from 1/second to 25/second, or stops sampling when placed in HOLD position.
5. Range switch.
6. Manual Trigger Pushbutton. Instrument samples once each time pushbutton is pressed and released.
7. Front Panel Zero. Adjust display to zero with Input shorted.
8. Filter switch.
9. Front Input terminals.
10. Terminal switch. Selects front or rear input terminals.
11. Rear Input terminals.
12. Remote connector. Allows remote control of Range, Sampling, Filter, or Ratio mode (3480A/B Option 002).
13. Ratio mode switch. Permits manual or remote selection of Ratio mode (3480A/B Option 002).
14. Ratio Range switch. Selects 10 V or 100 V reference input range (3480A/B Option 002).
15. Ratio Reference Input terminals.
16. Power Input connector.
17. 115/230 switch. Sets 3480A/B to correspond to line voltage to be used.
18. BCD Output connector. Provides BCD output, 1-2-4-8, "1" state positive (3480A/B Option 003 or 004).

Figure 3-1. Front and Rear Panel.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

The information contained in this section applies to operation of the Model 3484A Multifunction Unit in either the Model 3480A or 3480B Digital Voltmeter. The following topics are presented:

3-2. FRONT AND REAR PANEL DESCRIPTION.

Figure 3-1 shows front and rear panel views of the Model 3484A installed in a Model 3480A, giving a brief description of controls and indicators. The Model 3480B controls are the same as the 3480A except for the difference in physical configuration of the instrument.

3-3. FUNCTION SELECTION.

Function may be selected either manually or remotely. When the FUNCTION switch is set to REM, selection of OHMS, VAC(AC), or VAC(DC) may be made by grounding the appropriate pin on Remote Connector J14. If no remote selection is made, the 3484A automatically selects the VDC function. Remote programming instructions are given in Paragraph 3-19, and Figure 3-3 shows the Remote Connector J14.

3-4. RANGE SELECTION.

Range may be selected manually, automatically, or remotely. Manual or remote range selection permits up to 50% overranging. The OVERLOAD indicator lights when the numerical display reaches 15000. As the input is increased above 15000 on any range, the display will continue to increase until a reading of 15999 is reached. However, readings above 15000 will not necessarily be correct.

3-5. AUTOMATIC RANGING.

Automatic upranging occurs at 140% of range (when display reaches 14000). Downranging occurs at 10% of range.

3-6. REMOTE RANGE SELECTION.

When the RANGE switch is in the REM position, remote selection of range may be made by grounding the appropriate pin on Remote Connector J14. If none of the range program lines is grounded, the 3484A will automatically select the highest range (1000 V or 10 MΩ). Remote programming instructions are given in Paragraph 3-19, and Figure 3-3 shows the Remote Connector J14.

3-7. SAMPLE CONTROL.

3-8. AUTOMATIC SAMPLING.

The automatic sampling rate is variable from one sample per second to 25 samples per second by means of the front panel SAMPLE RATE control. The SAMPLE indicator flashes once for each sample. At rates above approximately 15 samples per second the incandescent lamp does not have sufficient time to extinguish between samples, and remains on continuously.

3-9. MANUAL AND REMOTE SAMPLE CONTROL.

3-10. When the SAMPLE RATE control is set to HOLD or the Interface Hold line is grounded, a sample period may be initiated manually by pressing and releasing the TRIG pushbutton. The instrument may also be triggered at rates up to 1000 per second by an external switching device. The trigger input circuit is gated so that an External Trigger signal cannot be applied to the 3480A/B Sample Generator during a sample period.

3-11. Trigger input connection may be made through the rear panel Remote connector, or the BCD Output connector if the 3480A/B has Option 003 or 004. Figure 3-2 is a diagram of the Trigger input connections.

3-12. Remote Trigger Input.

3-13. The External Trigger input signal may be a circuit closure between Remote Connector J14 pin 19 and ground, J14 pin 25. If the 3480A/B has BCD Option 003 or 004, the Trigger input closure may be between BCD Output Connector J13 pin 46 and ground, J13 pin 50. The circuit closure must be at least 50 microseconds in duration, and the circuit must be open for at least 50 microseconds before a trigger command is given. Minimum time between trigger commands is 1 millisecond.

3-14. A transistor switch or pulse circuit may be used as an external triggering device. The input voltage level must be 0 to +0.5 V for at least 50 microseconds to initiate a sample,

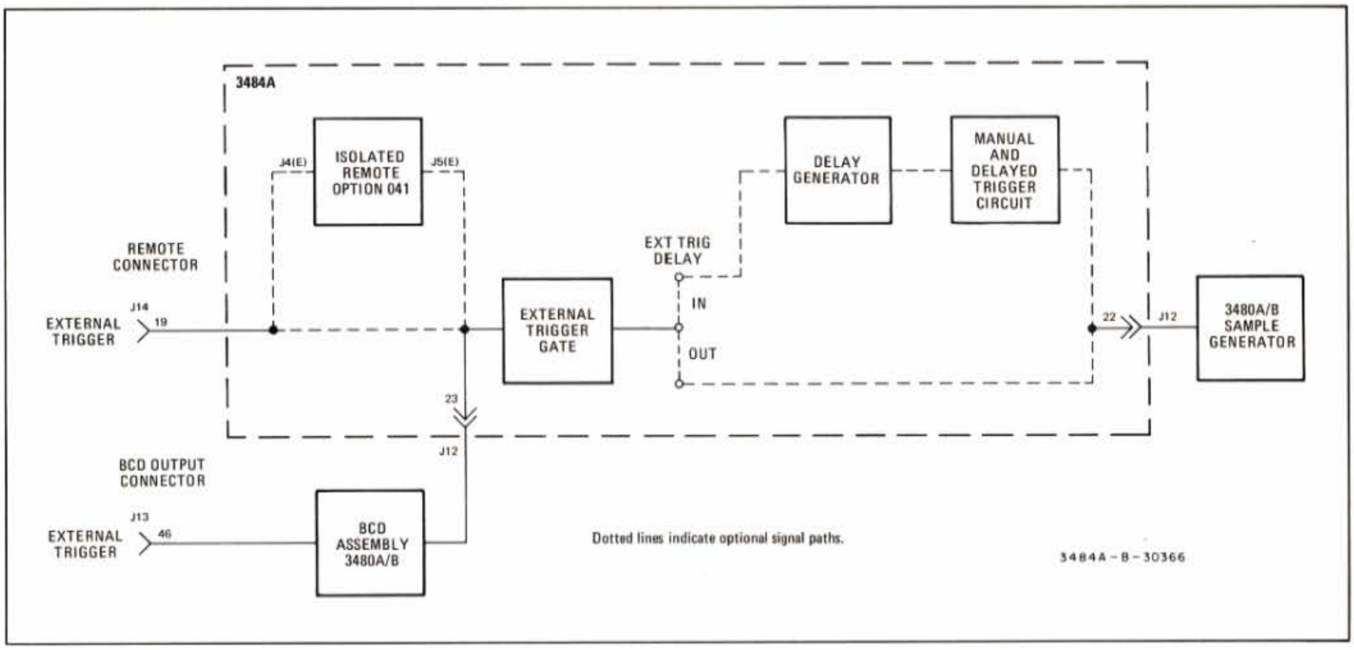


Figure 3-2. External Trigger Connections.

and + 2.4 V or greater for at least 50 microseconds preceding a trigger command. Time between trigger commands must be not less than 1 millisecond. Table 3-2 gives a summary of interface signal requirements.

3-15. REMOTE TRIGGERING RATE.

3-16. Delayed External Trigger.

A jumper wire connection on the Range and Function Assembly A3 permits the External Trigger (Encode) command to be delayed before triggering the 3480A/B Sample Generator to begin a measurement. The length of the delay and, consequently, the maximum triggering rate are dependent upon function and degree of filtering selected. In most functions and ranges, the delay corresponds to the response time of the instrument, resulting in a correct measurement when an External Trigger command is applied coincident with a change in input signal. Table 3-1 shows delay and response times for the various functions. The External Trigger input circuit is gated so that after initiation of a delayed trigger command, additional External Trigger commands are blocked until after the completion of the measurement.

3-17. Non-delayed External Trigger.

When the jumper on the Range and Function Assembly A3 is connected in the OUT position, the External Trigger command is applied immediately to the 3480A/B Sample Generator. Consequently, if the time between trigger commands is less than the response time for the function and filtering selected, some erroneous measurements may result. The non-delayed remote triggering rate may be up to 1000 per second. The External Trigger input circuit is gated in this mode of operation also, preventing additional trigger commands from reaching the Sample Generator during a measurement period.

Table 3-1. Delay and Response Times.

FUNCTION	DELAY TIME	RESPONSE TIME
VDC		
Filter OUT	4 msec	1 msec
Filter A	200 msec	200 msec
Filter B	1 sec	1 sec
VAC(AC)	1 sec	1 sec
VAC(DC)	3 sec	15 sec
OHMS		
100 ohm range thru 100 kilohm range, Filter OUT	4 msec	1 msec
1000 kilohm range, Filter A	200 msec	200 msec
10 megohm range Filter A	200 msec	2 sec

3-18. INTERFACE HOLD.

The Interface Hold (Inhibit) connection is available at the rear panel Remote Connector, J14 pin 17 (see Figure 3-3). This line also appears at the BCD Output Connector J13 pin 47, if the 3480A/B has one of the BCD Options. The Interface Hold connection allows the 3480A/B Sample Generator circuit to be put in the HOLD state by an external signal when the front panel SAMPLE RATE control is not in the HOLD position. The HOLD condition is produced by grounding the Interface Hold connection or applying a voltage level of 0 to + 0.5 V. An open circuit or a voltage level of + 2.4 V or greater allows the Sample Generator to free-run.

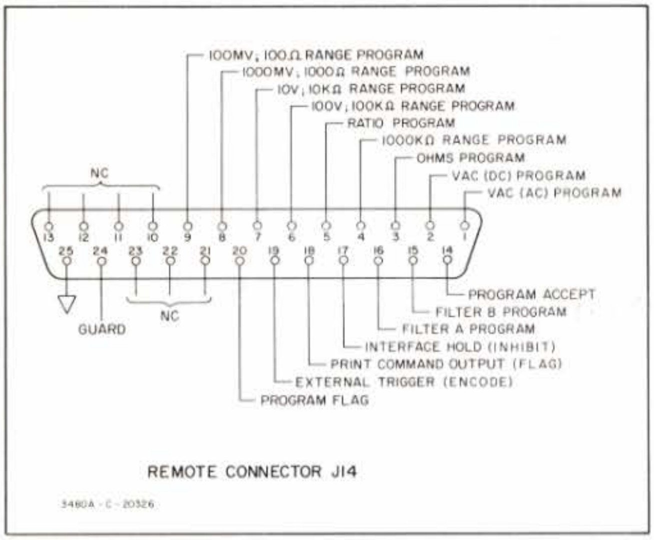


Figure 3-3. Remote Connector J14.

3-19. REMOTE PROGRAMMING.

3-20. STANDARD REMOTE PROGRAMMING.

Remote programming of function, range, or filter in a standard 3484A (not equipped with Isolated Remote Option 041) is accomplished by a continuous one-line connection to ground. The ground connection (J14 pin 25) is common to the LOW input terminal, and program input lines connect directly to the 3484A function, range, and filter selection circuits. Connections to Remote Connector J14 are shown in Figure 3-3, and Table 3-2 gives a summary of interface signal requirements.

3-21. ISOLATED REMOTE OPTION 041.

3-22. This option can be used only if the 3480A/B has Isolated BCD Option 004, which supplies power for Option 041. If it is desired to operate remotely a 3484A having Isolated Remote, in a 3480A/B that does not have Isolated BCD Option 004, the Isolated Remote Assembly must be removed from the 3484A. Refer to Paragraph 2-4.

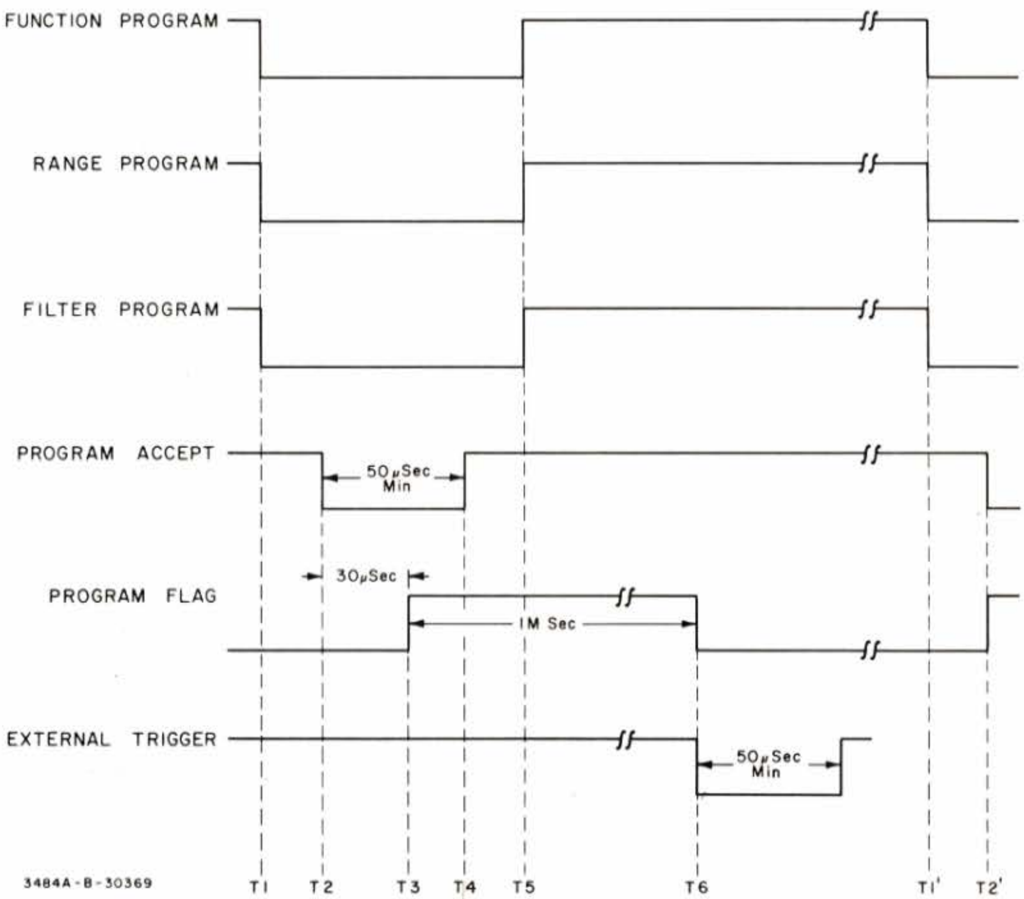
3-23. The Isolated Remote option allows the instrument to be operated remotely by signals that are completely isolated from the 3484A internal circuits. Connections to Remote Connector J14 are referenced to chassis (power line) ground, J14 pin 25. Signal connections to J14 are shown in Figure 3-3, and Table 3-2 gives a summary of interface signal requirements. The following paragraphs describe Isolated Program signal requirements that are different from requirements for non-isolated programming.

3-24. Function, Range, Filter, or Ratio Program.

Remote selection of function range, filtering, or ratio is accomplished by single line connection to ground. In addition, Isolated Remote programming requires a ground connection to the Program Accept line (J14 pin 14) for a minimum of 50 μsec to "set" the selected program into the Isolated Remote circuits. Program storage then allows the program lines to be returned to HIGH (or open) until it is desired to make a change in the program selected. Condi-

Table 3-2. Interface Signal Requirements.

SIGNAL	CONDITIONS
ENCODE (EXTERNAL TRIGGER) Initiates a measurement period.	**TRIGGER** = 0 V to + 0.5 V for minimum of 50 microseconds. Level between trigger commands must be + 2.4 V or greater or open circuit for minimum of 50 microseconds. Minimum time between trigger commands is 1 millisecond.
FLAG (PRINT COMMAND OUTPUT) Indicates receipt of Encode (Trigger) Command and completion of measurement period. Print Command Output is present only if 3480A/B includes BCD Option 003 or 004.	+ 2.4 V or greater indicates start of measurement period. 0 V to + 0.5 V indicates completion of measurement period (Print Command). Duration of HIGH portion of signal is dependent upon Filter and Delay programming.
INHIBIT (INTERFACE HOLD) Prevents instrument from sampling unless manual or external trigger command is given.	**INHIBIT** = 0 V to + 0.5 V. **FREE-RUN** = + 2.4 V or greater or open circuit.
REMOTE PROGRAM SELECTION or **ISOLATED REMOTE PROGRAM SELECTION** Function, Range, Filter, Ratio	**SELECT** = 0 V to + 0.5 V. **NOT SELECT** = + 2.4 V or greater or open circuit. Isolated remote signals referenced to chassis (power line) ground.
PROGRAM ACCEPT (ISOLATED REMOTE PROGRAM ONLY)	**PROGRAM ACCEPT** line must be 0 V to + 0.5 V for minimum of 50 microseconds to actuate. Line must be + 2.4 V or greater or open circuit between Program Accept Commands.
PROGRAM FLAG (ISOLATED REMOTE PROGRAM ONLY)	**PROGRAM FLAG** goes to + 2.4 V or greater to indicate receipt of Program Accept Command. Level goes to 0 V to + 0.5 V 1 millisecond later to indicate completion of programming.



T1 - Selection of desired range, filter, or function program lines.

T2 - Program Accept Command. T1 and T2 may occur simultaneously.

T3 - Approximately 30 microseconds after application of Program Accept Command, Program Flag signal goes HIGH to indicate receipt of Program Accept Command and execution of programming.

T4 - Program Accept line returns to HIGH (or open). Minimum time between T2 and T4 is 50 microseconds. Program changes may occur only during the time this line is LOW. Program Accept line need not be returned to HIGH unless a subsequent program change is desired.

T5 - Program selection lines may be returned to HIGH (or open) if desired. A line need not be returned to HIGH unless a subsequent program change is desired. T4 and T5 may occur simultaneously.

T6 - Program Flag signal goes LOW to indicate completion of programming. An External Trigger command may now be applied.

T1' - Selection of new program. All desired program lines must be LOW during Program Accept Command.

T2' - Program Accept Command to change program. Minimum time between T4 and T2' is 50 microseconds.

Figure 3-4. Isolated Remote Program Sequence.

tion of the remote program lines during the time the Program Accept line is HIGH has no effect on programming, because a program change can occur only while the Program Accept line is LOW.

3-25. Program Flag.

The Program Flag signal at J14 pin 20 goes HIGH when a Program Accept command is given, indicating receipt of this command. Approximately 1 millisecond later, Program Flag returns to LOW, indicating completion of programming. This time is required because range and filter selection in the 3484A are accomplished by means of reed relays. An External Trigger command should not be applied until after the Program Flag signal returns to LOW. Figure 3-4 shows the Isolated Remote Programming Sequence.

3-26. REMOTE PROGRAM CONNECTION.

A mating program cable, -hp- Model 11149A Remote Program Cable is available through your nearest -hp- Sales

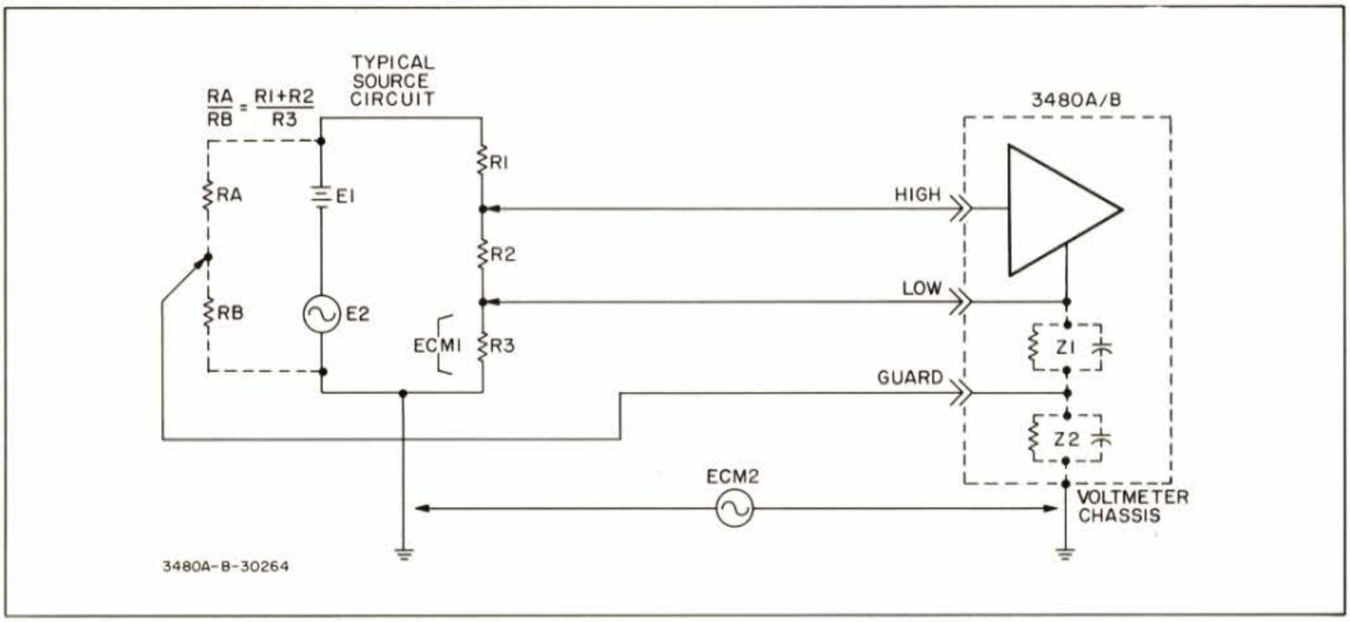


Figure 3-5. Guard Connection.

and Service Office, listed in Appendix B. The mating connector for Remote connector J14 is made up of the following parts:

Description	-hp- Part No.	ITT Cannon No.
Body: connector, 25-pin	1251-2417	DBC25P-FO
Boot: connector	1251-0392	DB-51212-1
Contact	1251-2384	030-1952-000
Lock: connector	1251-1042	DB-51221-1
Lock post (2 required)	1251-0218	D-53018

3-27. GUARD CONNECTION.

3-28. A GUARD terminal is provided at both front and rear panel inputs of the Model 3484A. Proper connection to this terminal provides high rejection of ac and dc common mode voltages. Common mode voltages are those existing in the source circuitry between the LOW measurement point and power line ground, and between the power line ground point of the source circuit and that of the 3480A/B. In Figure 3-5 the dc common mode voltage is ECMl due to El. The ac common mode voltages are ECMl due to E2, and ECM2. Zl and Z2 are leakage impedances between LOW, GUARD, and chassis (power line) ground.

3-29. If the GUARD terminal is connected to a dc potential equal to that of the LOW input terminal but at a point different from the LOW terminal connection, common mode voltages are effectively rejected. In Figure 3-5, the values of RA and RB are selected so that the ratio RA/RB = (Rl + R2)/R3, placing the LOW and GUARD terminals at the same dc voltage above ground. Since there is no potential difference between these terminals, current due to common mode voltages does not flow through the LOW terminal and Zl, but instead flows through the GUARD terminal and Z2, and does not affect the voltage measurement.

3-30. If common mode voltages are not expected to be a problem, the GUARD terminal should be connected to the LOW terminal.

3-31. More detailed information on purpose and methods of guarding may be found in -hp- Application Note No. 123, "Floating Measurements and Guarding." This application note is available through your nearest -hp- Sales and Service Office, listed in Appendix B.

3-32. DC VOLTAGE MEASUREMENTS.

3-33. FILTER SELECTION.

Filter selection may be made manually by means of the front panel FILTER switch, or remotely when the switch is set to the REM position. Normal mode rejection of ac noise input of 50 Hz and above is as follows for the three filter positions.

Filter Out: 0 dB
Filter A: >30 dB
Filter B: >80 dB

3-34. RESPONSE TIME.

The response time of the 3480/3484A amplifiers and filter affect the autoranging time, and may also be a factor in determining the optimum triggering rate for remote operation or system application. Remote triggering rate information is given in Paragraph 3-15. Following are the response times, without range change, for the three filter positions.

Filter Out: 1 msec to within 1 count of final reading
Filter A: 200 msec to within 1 count of final reading
Filter B: 1 sec to within 1 count of final reading

3-35. AUTORANGING TIME.

Time required for automatic ranging is partly dependent upon the degree of filtering selected. The following times are required per range change.

Filter Out: 4 msec
Filter A: 200 msec
Filter B: 1 sec

When autoranging occurs, the Print Command Output remains HIGH until after the correct range is reached and a measurement is taken on that range. This prevents a recorder from printing erroneous readings during autoranging.

3-36. MEASURING SPEED.

The automatic sampling rate is variable from one per second to 25 per second with the front panel control. When the control is adjusted fully counterclockwise to the HOLD position, or the Interface HOLD (Inhibit) line is grounded, the instrument may be triggered manually by means of the TRIG pushbutton, or remotely up to 1000 times per second. The remote triggering rate is discussed in Paragraph 3-15.

3-37. DC VOLTAGE MEASUREMENT PROCEDURE.

The following is a general procedure for making dc voltage measurements. Special measurement applications may require a different sequence.

a. Turn instrument on and allow to warm up for one hour.

b. Set FUNCTION switch to VDC or REM. If remote programming is used, VDC function results when none of the other functions is programmed. See Paragraph 3-3.

c. Set RANGE switch to correct range, or select AUTO or REM operation. Refer to Paragraph 3-4.

d. Select filtering manually or remotely. Refer to Paragraph 3-33.

e. Adjust SAMPLE RATE control to desired sampling speed, or apply external trigger signal. Refer to Paragraph 3-7.

f. Connect GUARD. Refer to Paragraph 3-27.

g. Select FRONT or REAR terminals. Connect input voltage and read measurement on front panel display.

3-38. RESISTANCE MEASUREMENTS (OPTION 042).

3-39. FILTER SELECTION.

Because of noise generated in the resistance under measurement, filtering may be required for quiet readings greater than 100 kΩ. In most cases, FILTER A position should be adequate. When measuring higher resistances on the 10 MΩ range, capacitance changes caused by movement of hands or test leads may cause changes in the measurement. Selection of FILTER B reduces this effect, but increases settling time of the reading.

3-40. RESPONSE TIME.

Times required to respond to full scale step inputs (to within 1 count of final reading) are as follows:

100 Ω thru 100 kΩ ranges (no filtering): 1 msec
1000 kΩ range (Filter A): 200 msec
10 MΩ range (Filter A): 2 sec

3-41. AUTORANGING TIME.

Time required for automatic ranging is partly dependent upon the degree of filtering selected. The following times are required per range change.

Filter Out: 4 msec
Filter A: 200 msec
Filter B: 1 sec

When autoranging occurs, the Print Command Output remains HIGH until after the correct range is reached and a measurement is taken on that range. This prevents a recorder from printing erroneous readings during autoranging.

3-42. MEASURING SPEED.

In resistance measurements, as in dc voltage measurements, the automatic sampling rate is variable from one per second to 25 per second with the front panel control. When the control is in the HOLD position or the Interface Hold (Inhibit) line is grounded, the instrument may be triggered manually with the TRIG pushbutton, or remotely up to 1000 times per second. The remote triggering rate is discussed in Paragraph 3-15.

3-43. OHMMETER CURRENT.

Current through the resistance being measured is varied according to range selected to produce a 1 V drop across a full-scale resistance. The value of current for each range is shown in Table 3-3.

Table 3-3. Ohmmeter Current.

RANGE	CURRENT
100 Ω	10 mA
1000 Ω	1 mA
10 k Ω	0.1 mA
100 k Ω	10 μA
1000 k Ω	1 μA
10 M Ω	0.1 μA

3-44. LOW RESISTANCE MEASUREMENTS.

When measuring low values of resistance, particularly on the 100 Ω range, internal wiring resistance and test lead resistance become a significant part of the measurement display. The internal wiring resistance may be as high as 50 milliohms on the 100 Ω range (5 counts in the least significant digit) with a direct short across the input terminals. Before making a low resistance measurement, short the test leads together and note the offset shown in the display. This offset represents test lead and wiring resistance and should be subtracted from the resistance measurement. Do not attempt to remove the offset by adjusting the front panel ZERO control. This will result in incorrect measurements on all ranges and functions.

3-45. RESISTANCE MEASUREMENT PROCEDURE.

a. Turn instrument on and allow to warm up for one hour.

b. If resistance to be measured is within a circuit, make sure power to the circuit is turned off and that no residual voltages are present.

c. Connect GUARD terminal to LOW.

d. Set FUNCTION switch to OHMS.

e. Select RANGE manually or remotely, or set to AUTO.

f. Adjust SAMPLE RATE control to desired sampling speed, or apply external trigger. Refer to Paragraph 3-7.

NOTE

When making measurements on the 1000 kΩ or 10 MΩ ranges, refer to Paragraph 3-39. When making measurements on the 100 Ω or 1000 Ω ranges, refer to Paragraph 3-44.

g. Select FRONT or REAR terminals and connect resistance to be measured across HIGH and LOW terminals and read measurement on front panel display.

3-46. AC VOLTAGE MEASUREMENTS (OPTION 043).

3-47. AC OR DC COUPLED MEASUREMENT.

The VAC(AC) function permits true rms voltage measurements of frequencies from 20 Hz to 1 MHz. The VAC(DC) mode extends the frequency range down to 1 Hz, and permits true rms measurement of ac plus dc. The response to a measurement containing both ac and dc is equal to $\sqrt{(DC)^2+(AC_{rms})^2}$. In addition, measurement of the ac component of signals down to 1 Hz may be made by adding an external 10 μF blocking capacitor.

3-48. MAXIMUM INPUT VOLTAGES.

3-49. Maximum input voltages permissible in the VAC(DC) function are 1500 V peak ac, 1500 Vdc, or a total peak value (ac + dc) of 1500 V.

3-50. In the VAC(AC) function, peak ac input limit is 1500 V and total peak voltage limit (ac + dc) is 1500 V. The dc voltage input limit on the 100 mV range is 10 V, and 100 V on all other ranges. The ac component of inputs having a dc component greater than the limits shown may be measured if an external 10 μF blocking capacitor is connected in series with the input HIGH terminal. The capacitor must have a voltage rating greater than the dc component of the input voltage. Leakage current through the external capacitor must not exceed 1 μA.

3-51. RESPONSE TIME.

Response time in the VAC(AC) mode is 1 second to within 5 counts of final reading. In the VAC(DC) mode, response time is 15 seconds to within 5 counts of final reading. FILTER switch setting has no effect on either response time or filtering.

3-52. MEASURING SPEED.

The automatic sampling rate is variable from one per second to 25 per second with the front panel control. When the control is in the HOLD position or the Interface Hold (Inhibit) line is grounded, the instrument may be triggered manually by means of the TRIG pushbutton, or remotely up to 1000 times per second. The slower response time of the ac converter should be taken into consideration when determining the remote triggering rate, which is discussed in Paragraph 3-15.

3-53. AUTORANGING TIME.

Autoranging time (per range change) is 1 second for the VAC(AC) mode and 3 seconds for the VAC(DC) mode. FILTER switch setting does not affect autoranging time in either ac function. When autoranging occurs, the Print Command Output remains HIGH until after the correct range is reached and a measurement is taken on that range. This prevents a recorder from printing erroneous readings during autoranging.

3-54. AC VOLTAGE MEASUREMENT PROCEDURE.

a. Turn instrument on and allow to warm up for one hour.

b. Set FUNCTION switch to VAC(AC) or VAC(DC). See Paragraph 3-47.

c. Select RANGE manually or remotely, or set switch to AUTO.

d. Adjust SAMPLE RATE control to desired sampling speed, or apply external trigger. Refer to Paragraph 3-7.

e. Connect GUARD terminal to LOW.

f. Select FRONT or REAR terminals. Connect input voltage and read measurement on front panel display.

NOTE

Due to the nature of the ac converter design, the display will not be zero when the input is shorted, and readings below 10% of full scale may not be accurate. If a measurement falls below 10% of scale, switch to the next lower range.

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

This section gives a brief description of the circuits and methods employed in the Model 3484A to enable the 3480A/B to make ac and dc voltage measurements of 100 mV to 1000 V full scale, and resistance measurements of 100 Ω to 10 MΩ full scale. Figure 4-1 is a Simplified Block Diagram of the 3484A. A complete Block Diagram is shown in Figure 7-2. Table 4-2 gives an explanation of Logic Symbols used in this manual.

4-2. DC CIRCUITS.

4-3. INPUT ATTENUATOR.

In dc voltage measurements, the Input Attenuator is bypassed on the 100 mV, 1000 mV, and 10 V ranges. Attenuation on the 100 V and 1000 V ranges is 100 to 1. Input resistance is greater than 10^{10} ohms on the three lower ranges, and 10 megohms on the two higher ranges. The Input Attenuator is also bypassed in resistance and ac voltage measurements. Attenuation is controlled by reed relays which are driven by signals from the Range and Function Assembly A3.

4-4. FEEDBACK ATTENUATOR.

The gain of the DC Amplifier is adjusted by varying the amount of feedback voltage. Since the amount of feedback is inversely proportional to the feedback resistance, the correct resistance for each range and function is selected by reed relays. These relays are also controlled by signals from the Range and Function Assembly. Table 4-1 lists the relays closed for each dc voltage range, together with the input attenuation and amplifier gain. In both ac voltage and ohms functions, A2K1 is closed, giving the DC Amplifier a gain of 10. Amplifier output is 0 to ± 15 V on all dc voltage ranges, and 0 to + 15 V on all ac voltage and ohms ranges.

Table 4-1. DC Voltage Range Relays.

VDC RANGE	RELAYS CLOSED	INPUT ATTEN.	AMP. GAIN	TOTAL GAIN
100 mV	A1K1	1/1	100	100
1000 mV	A1K1, A2K1	1/1	10	10
10 V	A1K1, A2K2	1/1	1	1
100 V	A1K2, A1K3, A2K1	100/1	10	0.1
1000 V	A1K2, A1K3, A2K2	100/1	1	0.01

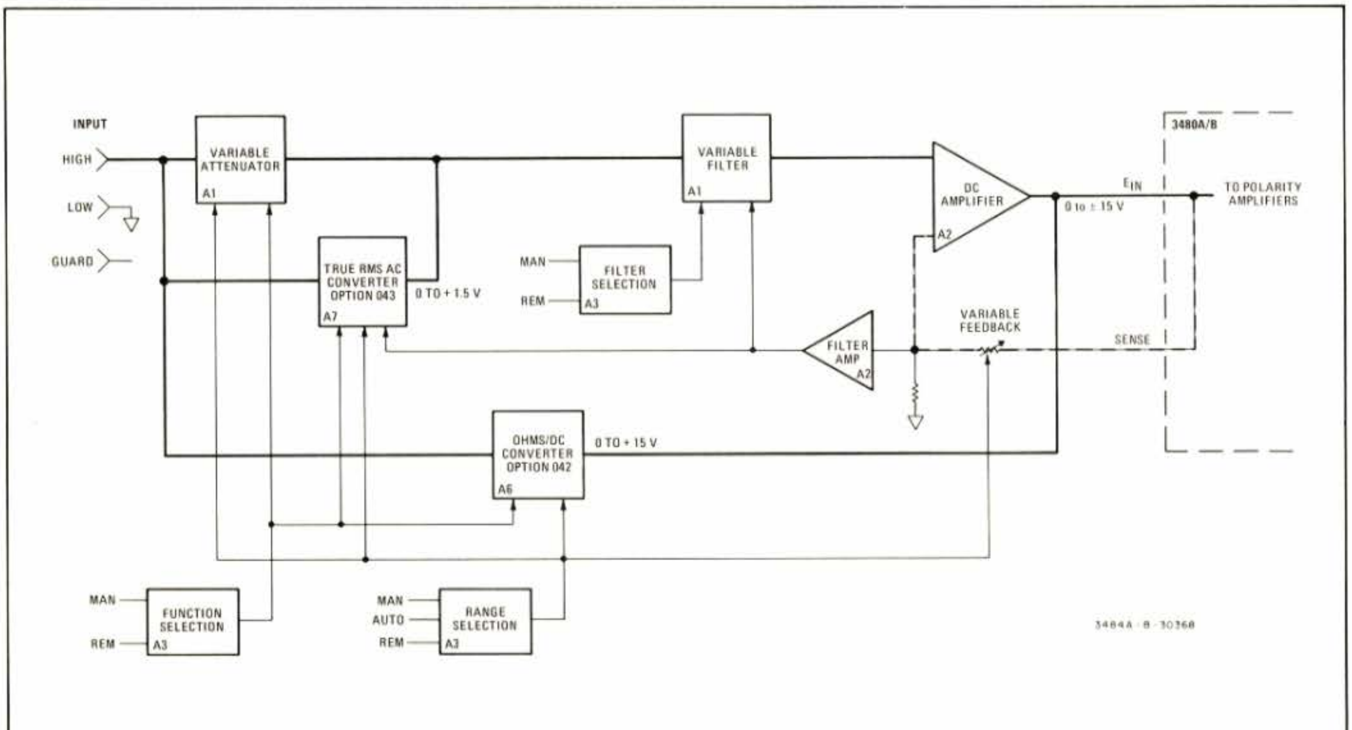
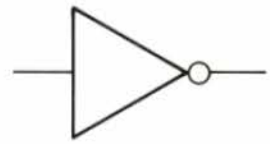


Figure 4-1. Simplified Block Diagram.

Table 4-2. Logic Symbols.

<table>
<tr><td colspan="2">HIGH, or "1" = + 2.4 V or greater
LOW, or "0" = 0 V to + 0.5 V</td></tr>
<tr><td>


NAND GATE
All inputs must be HIGH to produce a LOW output.
</td><td>


INVERTER
If input is HIGH, output is LOW, or LOW input produces HIGH output.
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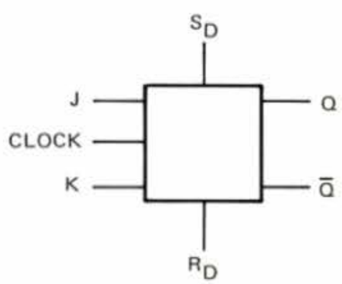
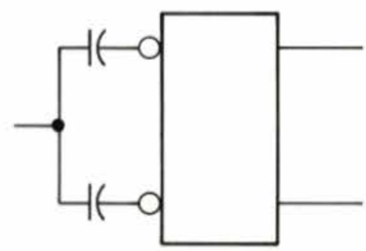


J-K FLIP-FLOP
When Clock input goes from HIGH to LOW, Q output assumes level of J input, $\overline{Q}$ output assumes level of K input.
LOW at S_D sets Q output HIGH.
LOW at R_D sets $\overline{Q}$ output HIGH.
</td><td>


FLIP-FLOP
A negative-going input pulse changes the state of the flip-flop.
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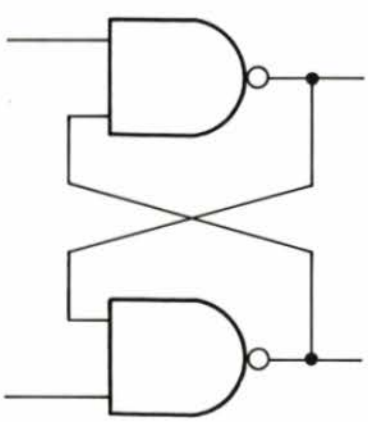
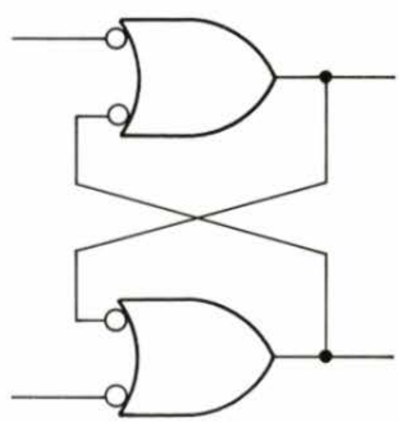


FLIP-FLOP
A LOW at either input causes the corresponding output to be HIGH.
</td><td>


FLIP-FLOP
A LOW at either input causes the corresponding output to be HIGH.
</td></tr>
</table>

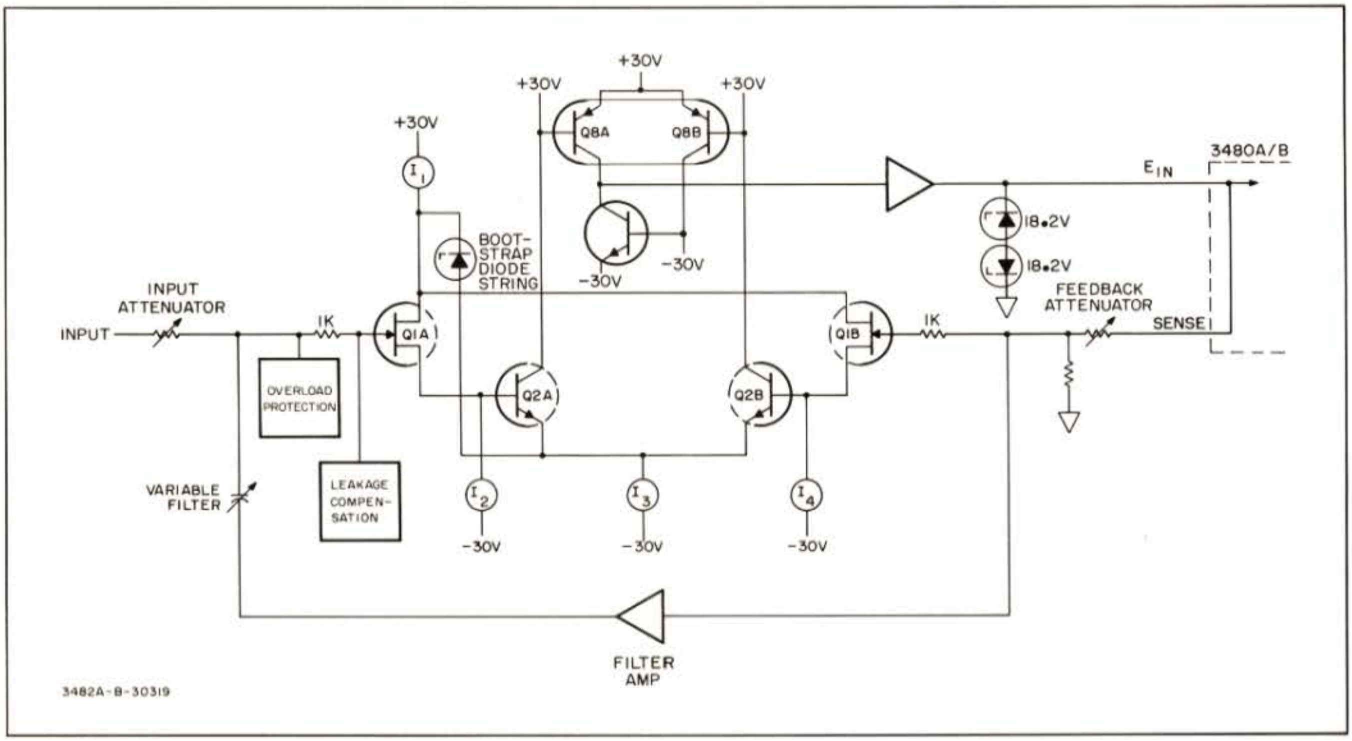


Figure 4-2. Simplified Diagram, DC Amplifier.

4-5. DC AMPLIFIER.

4-6. Figure 4-2 is a simplified diagram of the DC Amplifier. This is a non-inverting amplifier having a differential input stage and a push-pull output stage. The dual field effect transistors used in the input stage are employed as source-followers to provide input impedance greater than 10^{10} ohms on the three lower ranges.

4-7. The "bootstrap" diode string, in conjunction with constant current sources I1 and I3, is designed to improve the common mode rejection characteristics of the amplifier. Any common mode voltage appearing at the gates of IC1A and IC1B will be coupled to the emitters of Q2A and Q2B. This common emitter connection is "bootstrapped" to the common drain connection of IC1A and IC1B. Since constant current sources I1 and I3 maintain the proper bias currents for common mode voltages up to ± 15 V, this prevents the common mode voltage from appearing as a voltage change at the amplifier output.

4-8. The dual field effect transistor is a special part containing a heater which maintains a high temperature within the unit. Consequently, the performance of this part is affected very little by external temperature changes. The Leakage Compensation circuit prevents leakage current in the field effect transistor, IC1A, from causing an offset voltage at the input.

4-9. When the instrument is on the 100 mV range, the Overload Protection circuit limits the voltage at the gate of IC1A to about ± 1.8 V. On all other ranges, the limit is about ± 18 V. This circuit, in conjunction with the resistance and zener diodes in the input circuit, prevents an excessive input voltage from damaging the input transistor. Two zener diodes at the amplifier output limit the output voltage to about ± 18 V.

4-10. VARIABLE FILTER AND FILTER AMPLIFIER.

The Filter Amplifier, used in conjunction with RC filter components, permits a high degree of filtering with a relatively fast response time. Filter switching is accomplished by reed relays controlled by circuits on the Range and Function Assembly, A3. The Filter Amplifier is a unity gain non-inverting amplifier, having its output capacitively coupled to the input filter circuit.

4-11. MANUAL AND REMOTE FILTER SELECTION.

When the FILTER OUT position of the front panel switch is selected, a reed relay on the Attenuator Assembly bypasses the RC filter components, and the Filter Amplifier output is disconnected. When FILTER A is selected, the Filter Amplifier output and certain RC filter components are connected, and the bypass relay is opened. In the FILTER B position, additional filter capacitance is added. When the FILTER switch is set to the REM position, either Filter A or B may be selected remotely. If neither A or B is selected, the Filter Out condition results. The Filter Selection circuits also affect the amount of delay present in the Autoranging and External Trigger Delay circuits.

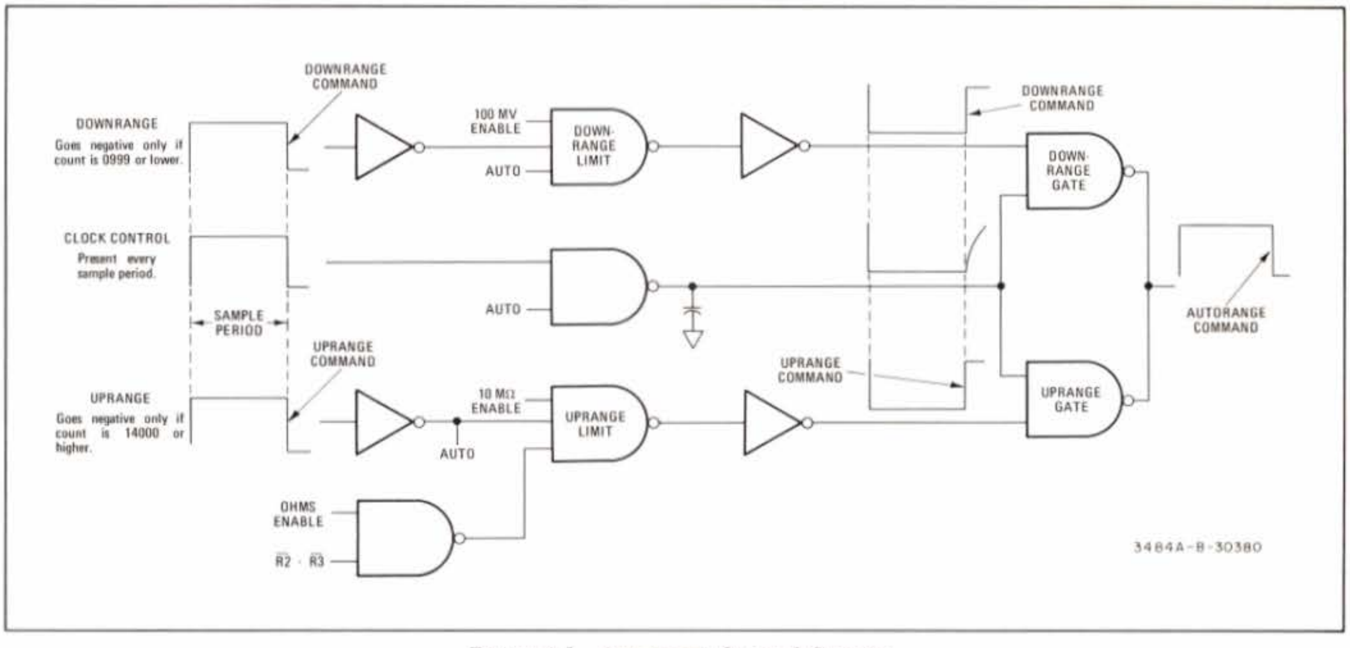


Figure 4-3. Autorange Control Circuits.

4-12. FUNCTION SELECTION CIRCUITS.

4-13. The Function Selection circuits (Figure 7-5), which consist mainly of integrated circuit inverters and NAND gates, require a voltage of 0 to + 0.5 V to select the desired function. When the FUNCTION switch is set to REM, gates are enabled to permit remote selection of OHMS, VAC(AC), or VAC(DC). If none of these are programmed, another gate causes the VDC function to be selected.

4-14. Selection circuits for the VAC(AC) and VAC(DC) functions are connected in a "make before break" configuration so that the input and output relays to the ac converter do not open when switching between these two functions. This is accomplished by the use of a 4.7μF capacitor in each selection circuit to provide sufficient delay.

4-15. The Enable signals from the Function Selection circuits are used to operate the Function Annunciator Lamp drive circuits, and to provide BCD function information to the 3480A/B. An Enable signal is LOW when that particular function has been selected.

4-16. RANGE SELECTION CIRCUITS.

4-17. AUTORANGE CONTROL.

When the RANGE switch is set to AUTO, the Autorange Control circuits are enabled to provide Autorange Commands to the Range Register. An Autorange Command results at the end of any sample period in which the measurement is 14000 or greater or less than 1000, unless either the highest or lowest range has been reached. Figure 4-3 is a diagram of the Autorange Control circuits.

4-18. Downrange Control.

The operation of the NAND gates used in the 3484A is such that all inputs must be HIGH to produce a LOW output. Conversely, if any input is LOW, the output will be HIGH. In autorange operation, the AUTO signal input to the Downrange Limit Gate is HIGH. On all ranges except 100 mV (100 Ω), the 100 mV Enable signal is also HIGH. Consequently, the gate output is controlled by the Downrange signal, which continues through to the Downrange Gate. At the same time, the Clock Control signal is also applied to the Downrange Gate, causing both inputs to be HIGH, producing an Autorange Command. When the lowest range is reached, the 100 mV Enable signal goes LOW. This causes the Downrange Limit Gate output to remain HIGH, preventing the Downrange signal from passing through.

4-19. Uprange Control.

4-20. In all functions except OHMS, the Ohms Enable and 10 MΩ Enable inputs to the Uprange Control circuits will both be HIGH. The $\overline{R2} \cdot \overline{R3}$ input will be LOW on all ranges except the 1000 V range; consequently, the lower input to the Uprange Limit Gate (Figure 4-3) will be HIGH. Since the 10 MΩ Enable input is also HIGH, The Uprange Limit Gate output will be controlled by the Uprange signal. This signal then continues through to the Uprange Gate coincident with the Clock Control signal, producing an Autorange Command. When the 1000 V range is reached, the $\overline{R2} \cdot \overline{R3}$ input goes HIGH. This causes the output of the Uprange Limit Gate to remain HIGH, preventing the Uprange signal from passing through.

4-21. When the OHMS function is selected, the Ohms Enable signal is LOW, causing the lower input to the Uprange Limit Gate to remain HIGH. The 10 MΩ Enable

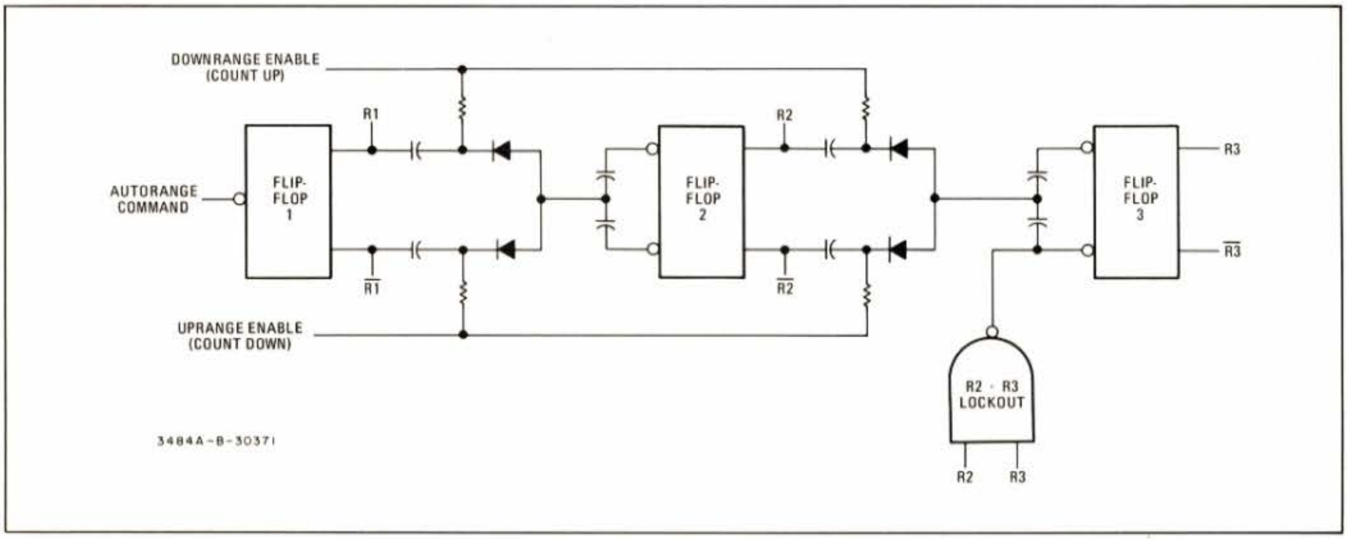


Figure 4-4. Simplified Range Register Diagram.

input will be HIGH on all ranges except 10 MΩ. When the 10 MΩ range is reached, this input goes LOW, preventing the Uprange signal from passing through the gate.

4-22. In addition to the Uprange and Downrange Limit gates, a gate circuit is provided at the input of the R3 Flip-Flop to prevent the Range Register from assuming a 011 or 111 state when first turned on. Either of these states would result in more than one Range Relay Driver being on at the same time.

4-23. RANGE REGISTER.

The Range Register consists of a three-stage binary counter which is enabled to count up or down by the Downrange and Uprange Enable signals. In Autorange operation, the six outputs of the Range Register are used to control the Range Relay Drivers.

4-24. Downranging.

At the end of a sample period which results in a measurement of 0999 or less, the Downrange Control circuits provide an Autorange Command to the Range Register. At the same time, the Downrange Enable line is LOW, allowing the Range Register to count up. As an example, assume that the input is 10 V and that the instrument is on the 10 V range, from which either upranging or downranging is possible. In this state, the Range Register content is 110, as shown in Table 4-3. If the input voltage is decreased to 0.9 V, the next measurement will be less than 0999, resulting in an Autorange (Downrange) Command. This negative-going signal changes the state of Flip-Flop 1, causing R1 output to go from HIGH to LOW. The Downrange Enable line is LOW and the diode in the R1 output line is forward biased, allowing the negative-going transition to pass through and change the state of Flip-Flop 2. In the same manner, the negative-going R2 output changes the state of Flip-Flop 3. The Range Register content then becomes 001, and the 1000 mV range is selected.

Table 4-3. Range Register Content.

RANGE		R1	R2	R3
	10 MΩ	0	0	0
1000 V	1000 kΩ	1	0	0
100 V	100 kΩ	0	1	0
10 V	10 kΩ	1	1	0
1000 mV	1000 Ω	0	0	1
100 mV	100 Ω	1	0	1

4-25. Upranging.

The Uprange Control circuits provide an Autorange Command to the Range Register at the end of a sample period which results in a measurement of 14000 or greater. At the same time, the Uprange Enable line is LOW, allowing the Range Register to count down. Assume, as in Paragraph 4-24, that the input is 10 V, and the instrument is on the 10 V range. The Range Register content is again 110. If the input voltage is increased to 15 V, the next measurement will be greater than 14000, resulting in an Autorange (Uprange) Command. This Autorange Command changes the state of Flip-Flop 1, causing output to go from HIGH to LOW. The Downrange Enable line is now HIGH and the diode in the R1 output line is reverse biased; consequently, the negative-going R1 output cannot pass through to change the state of Flip-Flop 2. Therefore, the Range Register content has been changed to 010, and the 100 V range has been selected.

4-26. RANGE REGISTER DECODING.

A series of gate circuits is used to decode the six Range Register outputs and produce an Enable signal for each range selected. The Enable signals operate the Range Relay Drivers to provide the correct attenuation and amplifier gain for each range. The Enable signals also operate Annunciator and Decimal Lamp Drivers and provide BCD range information to the 3480A/B.

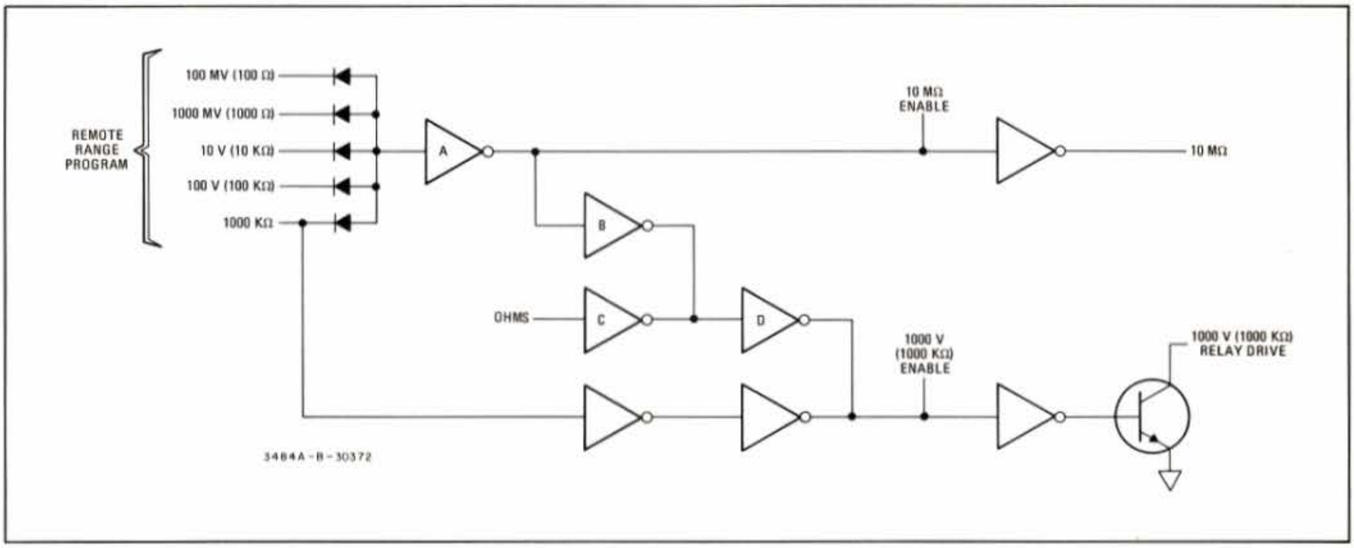


Figure 4-5. Remote Selection of Highest Range.

4-27. REMOTE RANGE SELECTION.

4-28. Power is supplied to the Remote Range Selection integrated circuits only when the RANGE switch is set to REM. Consequently, connections to the Remote Range Program lines cannot affect the other modes of range selection. In remote programming, a ground connection to a range program line causes the corresponding Enable signal to be LOW, turning on the relay driver for that range.

4-29. If none of the Remote Program lines is grounded, the highest range is automatically selected. Figure 4-5 shows the circuits which make this selection. If the OHMS function is selected and none of the program lines is grounded, Inverter A output (10 MΩ Enable) will be LOW selecting the 10 MΩ range. The LOW output of Inverter A would cause B output to be HIGH and D output to be LOW, enabling the 1000 kΩ range also, except that the OHMS input to Inverter C is HIGH, holding B and C outputs LOW.

4-30. If a voltage function is selected and none of the Remote Program lines is grounded, the output of Inverter A is again LOW and the 10 MΩ Enable signal is LOW. This Enable signal has no effect on the range selection because voltage is supplied to the Ohms/DC Converter relays only when the OHMS function is selected. The LOW output from Inverter A causes B output to be HIGH and D output to be LOW. The 1000 V Enable line is now LOW, selecting the 1000 V range.

4-31. MANUAL RANGE SELECTION.

When range is selected manually, the range Enable line is grounded through the RANGE switch, turning on the appropriate Range Relay Driver.

4-32. DELAY GENERATOR AND SAMPLE CONTROL CIRCUITS.

The Delay Generator provides sufficient delay time to allow for response time of the amplifier. This delay follows each autorange command, and may also follow an External Trigger command. At the end of the delay period, a trigger command is applied to the 3480A/B trigger circuit. A block diagram of the Delay Generator and associated circuits is shown in Figure 4-6.

4-33. Autorange Delay.

When an autorange command is applied to the Range Register, the same signal is applied to the Delay Generator, changing the state of the Delay Flip-Flop. An output from this flip-flop opens a transistor switch to allow a capacitance to begin charging. The total value of this capacitance, and hence the charging time constant, depends on the function and the degree of filtering that have been selected. When the capacitance has charged to the proper voltage, a relaxation oscillator produces a pulse which resets the Delay Flip-Flop. The Delay Flip-Flop output then triggers the Manual and Delayed Trigger Circuit, which causes the 3480A/B to take another measurement.

4-34. External Trigger Delay.

When the EXT TRIG DELAY jumper on the Range and Function Assembly A3 is connected in the IN position, a trigger command at the External Trigger input causes the Delay Flip-Flop to change state. This results in a prescribed delay between the time the External Trigger command is given and the time a trigger command is applied to the 3480A/B Sample Generator circuit. Again, the length of the delay depends on the function and the degree of filtering selected.

4-35. Hold Circuit.

When the autorange command changes the state of the Delay Flip-Flop, an output from the flip-flop is applied to the Hold Circuit. A LOW output from the Hold Circuit places the 3480A/B in a HOLD condition until after the

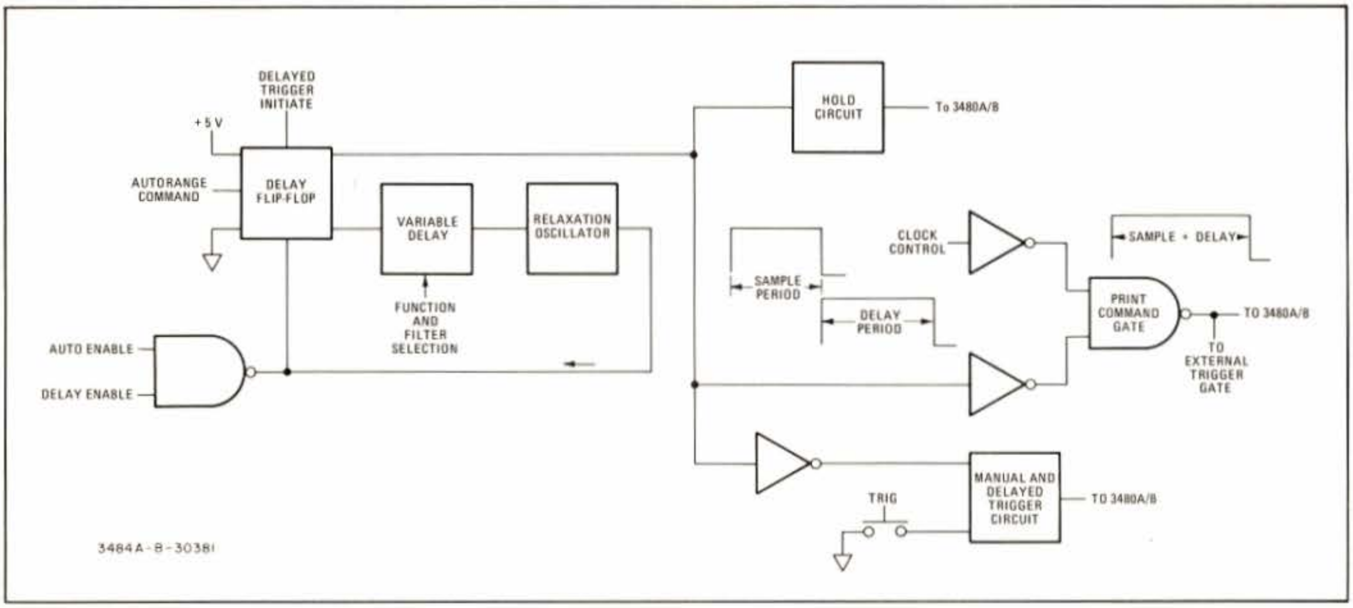


Figure 4-6. Delay Generator Block Diagram.

Delay Generator causes another sample to be initiated. This HOLD condition prevents the 3480A/B from sampling during an autorange cycle.

4-36. Print Command Circuit.

An output from the Delay Flip-Flip goes to the Print Command Circuit. During an autorange cycle, the output of the Print Command Circuit output goes HIGH at the beginning of the sample period and remains HIGH until after a measurement has been taken at the end of the delay period. This prevents a recorder from printing an erroneous reading during an autorange cycle. During an External Trigger delay, the Print Command signal goes HIGH at the beginning of the delay period and remains HIGH until after the measurement has been taken.

4-37. Manual and Delayed Trigger Circuit.

4-38. When the TRIG pushbutton is pressed , the output of the Manual Trigger Flip-Flop goes LOW. When the pushbutton is released, the flip-flop output returns to HIGH, resulting in a pulse through a coupling capacitor. This pulse turns on the output transistor for approximately 120 microseconds. The resultant negative-going output pulse is the trigger command to the 3480A/B Sample Generator Circuit.

4-39. During a delayed trigger cycle, initiated either by an autorange command or a delayed External Trigger command, an output from the Delay Flip-Flop performs the same electrical function as pressing the TRIG pushbutton. While the Delay Flip-Flop output is LOW, the capacitor in the Trigger circuit is grounded. Then when the Delay Flip-Flop is reset, a trigger command is applied to the 3480A/B.

4-40. Delay and External Trigger Gating.

4-41. The Delay and External Trigger Gating circuits are shown in Figure 4-7. When the EXT TRIG DELAY jumper on Range and Function Assembly A3 is connected in the OUT position, the output of Inverter D is LOW, holding the output of the Delayed Trigger Gate HIGH. In addition, the Delay Enable signal is HIGH, disabling the Delay Generator Flip-Flop. Also, one input to the Trigger Command Gate is HIGH, allowing this gate to be controlled by the External Trigger input.

4-42. Assume that the instrument is between samples (Print Command signal is LOW) when a negative-going External Trigger Command is applied. The LOW External Trigger command immediately causes Inverter C output to go HIGH, and the Trigger Command Gate output goes LOW. At the same time, the External Trigger Command applied to the Print Command Gate causes its output to begin to go HIGH, charging the capacitor at its output. As soon as the capacitor has charged to the threshold voltage of Inverter B, this output goes LOW, returning the Trigger Command Gate output to HIGH. The delay caused by the capacitor is approximately 55 microseconds. The resulting 55 microsecond negative-going pulse output of the Trigger Command Gate constitutes a trigger command to the 3480A/B Sample Generator.

4-43. During a sample period, The Print Command signal is HIGH. Inverter A output is then LOW, holding the Print Command Gate output HIGH. Inverter B output is then LOW and the Trigger Command output remains HIGH. Consequently, an External Trigger Command applied during a sample period is prevented from triggering the 3480A/B.

4-44. When the EXT TRIG DELAY jumper is connected in the IN position, the Delay Enable signal is LOW, enabling

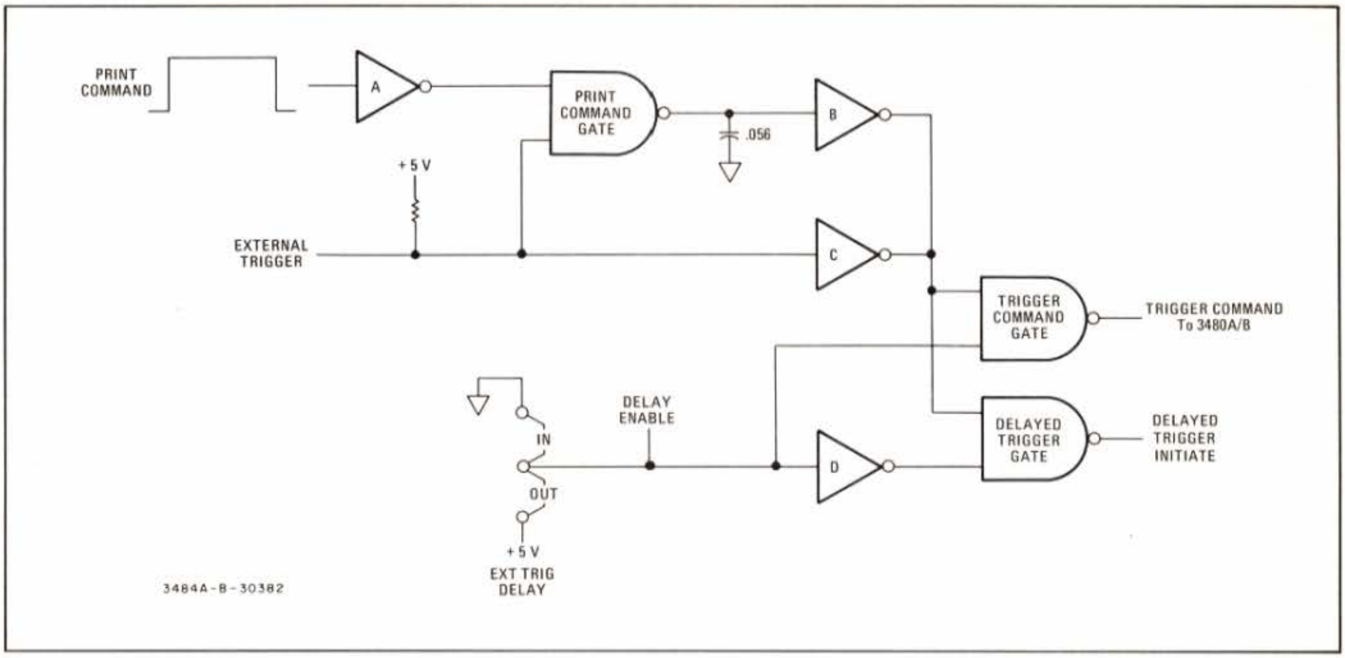


Figure 4-7. Delay and External Trigger Gating.

the Delay Generator. In addition, one input to the Delayed Trigger Gate is now HIGH, allowing this gate to be controlled by an External Trigger input. Also, one input to the Trigger Command Gate is LOW, holding the output HIGH. An External Trigger Command input (between sample periods) will now cause the output of the Delayed Trigger Gate to go LOW for 55 microseconds, triggering the Delay Generator. Following the delay period, the Delay Generator causes a trigger command to be applied to the 3480A/B. The External Trigger Command input is gated by the Print Command signal as in Paragraph 4-43.

4-45. ISOLATED REMOTE OPTION 041.

4-46. A typical Isolated Remote Circuit is shown in Figure 4-8. Isolation is provided by a pair of adjacent coils which act as a pulse transformer. In addition to a ground (LOW) connection at the Program Input, a Program Accept Command is required to accomplish isolated programming. This command must go from + 2.4 V or greater to + 0.5 V or less for a minimum of 50 microseconds.

4-47. Approximately 10 microseconds after application of a Program Accept Command, the ACC signal (Figure 4-8) goes LOW, resetting the flip-flop output to LOW. About 10 microseconds later, the $\overline{ACC}$ signal goes HIGH. If the Program Input line is HIGH (not programmed), the gate output goes LOW. This negative-going transition is coupled through the capacitor and pulse transformer. Phase inversion occurs in the transformer and the resulting positive pulse turns on the transistor to change the state of the flip-flop, returning the Program Output to HIGH. However, if the Program Input is LOW (programmed), the gate output is forced to remain HIGH and no signal is coupled through the pulse transformer. The flip-flop output then remains LOW, and the Program Output is in the programmed state.

4-48. A Program Flag signal is produced by a one-shot that is triggered by the Program Accept Command. Program Flag goes HIGH about 30 microseconds after application of a Program Accept Command, indicating receipt of this

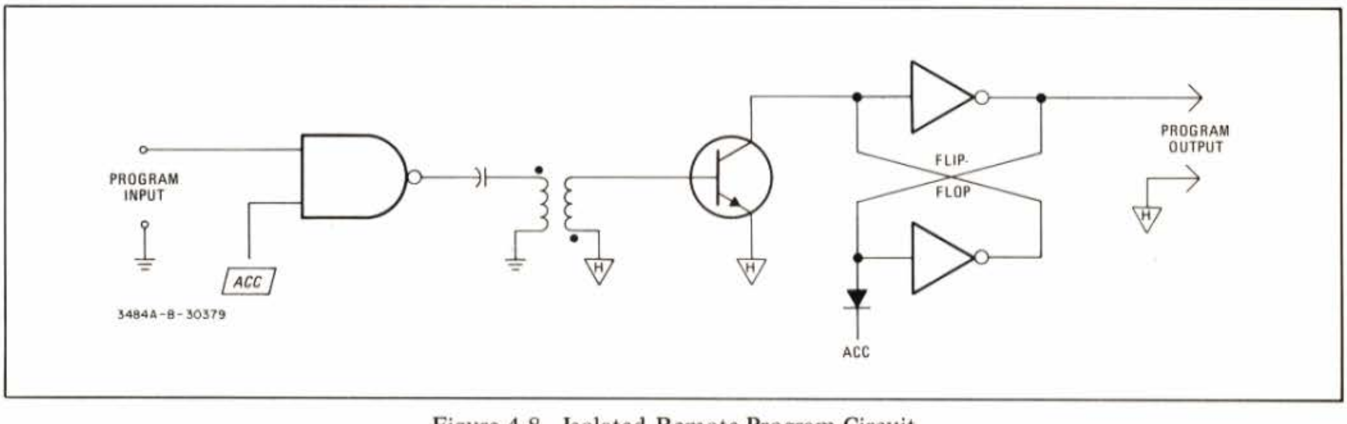


Figure 4-8. Isolated Remote Program Circuit.

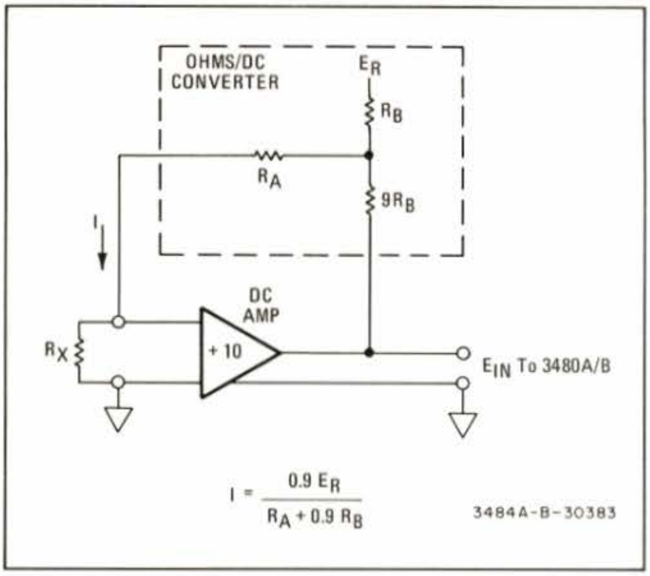


Figure 4-9. Simplified Ohmmeter Diagram.

command. Program Flag goes LOW approximately 1 millisecond later to indicate completion of programming.

4-49. OHMS/DC CONVERTER OPTION 042.

4-50. The Ohms/DC converter supplies a constant current to the resistance being measured, resulting in a voltage drop which is directly proportional to the resistance. The constant current is developed from the + 10 V reference supplied by the 3480A/B, and the value of current is adjusted for each range to produce a 1 V drop across a full-scale resistance. In OHMS function, the DC Amplifier gain is fixed at 10. Figure 4-9 shows a simplified diagram of the converter and amplifier.

4-51. Overload Protection is provided to prevent accidental damage to the precision resistors by an excessive voltage input while the instrument is in OHMS function. When excessive voltage is applied, the protection circuits cause the relays in the resistor network to de-energize, opening the resistor circuits.

4-52. TRUE RMS AC CONVERTER OPTION 043.

4-53. A block diagram of the True RMS AC Converter is shown in Figure 4-10. In the VAC(AC) mode of operation, the input is capacitively coupled; while in the VAC(DC) mode the input is direct coupled, allowing the instrument to measure the total rms value of a signal containing both ac and dc.

4-54. The Attenuator Amplifier is a broadband inverting amplifier having a differential input stage and a push-pull output stage. Dual field effect transistors used in the input stage are connected as source-followers to maintain a high input impedance. Range switching is accomplished by varying the attenuation of the Attenuator Amplifier and the Post Attenuator.

4-55. The Post Amplifier is a broadband non-inverting amplifier having a fixed gain of 10. This amplifier also has a differential stage and a push-pull output stage. The Thermocouple Protection Circuit limits the output of the Post Amplifier if the output voltages approaches a level which might damage the thermocouple.

4-56. The Converter Amplifier is an inverting dc amplifier having a gain of 1. This is the gain from the rms value of the Converter Thermocouple input to the dc output of the amplifier. One half of the specially designed dual thermocouple is used to convert the ac signal to dc, and the other half is used in the dc feedback loop of the amplifier. Because the thermocouple is a non-linear device, the two sections are used in this way so that the feedback offsets the non-linearity of the input to produce a linear amplifier output. The ac feedback loop employs an amplifier to provide faster response time. The value of the integrating capacitor is increased in the VAC(DC) mode to provide response down to 1 Hz.

4-57. The Output Filter is bypassed in the VAC(AC) mode since ample filtering is supplied by the Attenuator Assembly (A1). Because frequencies as low as 1 Hz may be measured in the VAC(DC) mode, the Output Filter is used. In addition, the Filter Amplifier output (from A2) is coupled into the filter to reduce response time. The True RMS AC Converter output is 0 to + 1.5 V on all ranges, and the DC Amplifier gain (A2) is fixed at 10 in both ac modes.

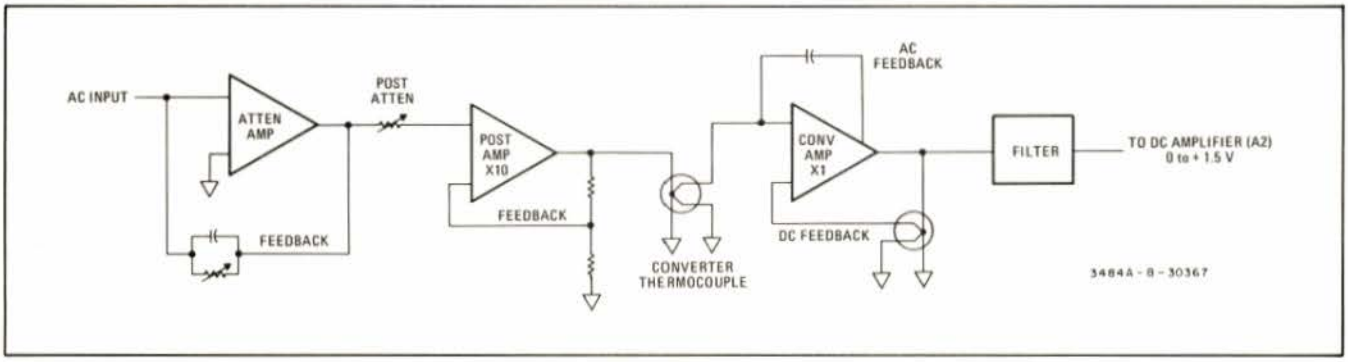


Figure 4-10. True RMS Converter Block Diagram.

Table 5-1. Required Test Equipment.

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Digital Voltmeter	Calibrated to specifications	All operations	-hp- Model 3480A or 3480B
DC Standard	Voltage Range: 0-1000 V Accuracy: 0.005%	Performance Checks Adjustments Troubleshooting	-hp- Model 740B DC Standard/ Differential Voltmeter
Variable Line Transformer	Output Voltage: 103 to 127 Vac (or 207 to 253 Vac)	Performance Checks	Superior Electric Co. Power stat 3PF116 (for 115 V line) 3PF216 (for 230 V line)
Oscillator	Frequency: 50-60 Hz Output Voltage: 10 V peak	Performance Checks	-hp- Model 200CD Wide Range Oscillator
AC Voltmeter	Accuracy: 3% Must be floating	Performance Checks	-hp- Model 427A Voltmeter
Resistors	10 megohm 1% 1 megohm 1% 1 kilohm 5%	Performance Checks Troubleshooting	-hp- 0698-7091, 10 M -hp- 0698-7332, 1 M -hp- 0683-1025, 1 K
Precision Resistors (See Par. 5-20)	Resistance: Calibrated within: 100 ohms 0.015% 1 kilohm 0.005% 10 kilohms 0.005% 100 kilohms 0.005% 1 megohm 0.005% 10 megohms 0.025%	Performance Checks Adjustments (Option 042)	Julie Research Laboratories, Inc. NB-102 NB-103 NB-104 NB-105 NB-106 NB-107
DC Voltmeter	Range: 100 mV full to 300 V full scale Must be floating	Adjustments Troubleshooting	-hp- Model 412A DC Vacuum Tube Voltmeter
DC Differential Voltmeter	Resolution: 0.1 mV Accuracy: 0.005%	Adjustments Troubleshooting	-hp- Model 3420A/B DC Differential Voltmeter
Oscilloscope	Bandwidth: dc to 450 kHz Sensitivity: 0.005 V/cm Sweep: 0.1 ms/cm	Troubleshooting	-hp- Model 140A Oscilloscope with -hp- Model 1401A and 1421A plug-ins

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

This section contains information necessary to maintain the Model 3484A. The following paragraphs describe the Performance Checks, Adjustment Procedures, and Troubleshooting Procedures.

5-2. TEST EQUIPMENT REQUIRED.

Recommended test equipment for maintaining and checking the performance of the Model 3484A is listed in Table 5-1. Test instruments other than those listed may be used if their specifications equal or exceed the required characteristics.

5-3. PERFORMANCE CHECKS.

Use the following procedures to verify proper operation of the Model 3484A. The 3480A/B/3484A and test equipment should be operated at a line voltage of 115 Vac (or 230 Vac) and ambient temperature of 20°C to 30°C unless otherwise stated. A calibrated 3480A or 3480B is required for the following performance checks. It is recommended that the performance of the 3484A be checked upon receipt and at 90-day intervals thereafter. A Performance Check Card is provided at the rear of this section for recording the performance of the 3484A. This card may be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check. If the 3484A is found to be out of specifications at any point in this procedure, refer to Paragraph 5-13, Adjustment Procedure, or to the Troubleshooting Procedure, Paragraph 5-34.

5-4. VDC ACCURACY AND LINEARITY CHECK.

The following procedure checks the accuracy of the attenuator and the accuracy and linearity of the dc amplifier on all ranges. The 3480A/B must be operating within specifications.

a. Connect Model 3480A/B/3484A and variable line transformer as shown in Figure 5-1. Do not connect dc standard to 3484A.

b. Set 3480A/B rear panel 115/230 switch to the line voltage to be used. Set variable line transformer to 115 V (or 230 V). Connect 3484A GUARD to LOW.

c. Turn on 3480A/B and test equipment and allow to warm up for one hour.

d. Set 3484A FUNCTION to VDC, RANGE to 100 mV, SAMPLE RATE fully clockwise, FILTER to OUT, TERMINAL to FRONT.

e. Short 3484A input HIGH to LOW. If 3480A/B display is not 00.00 mV, adjust 3484A front panel ZERO control for display of 00.00 mV, with polarity indicator alternating between + and −. Disconnect input short.

NOTE

A numerical display other than zero when the input terminals are open is normal and does not indicate a zero offset.

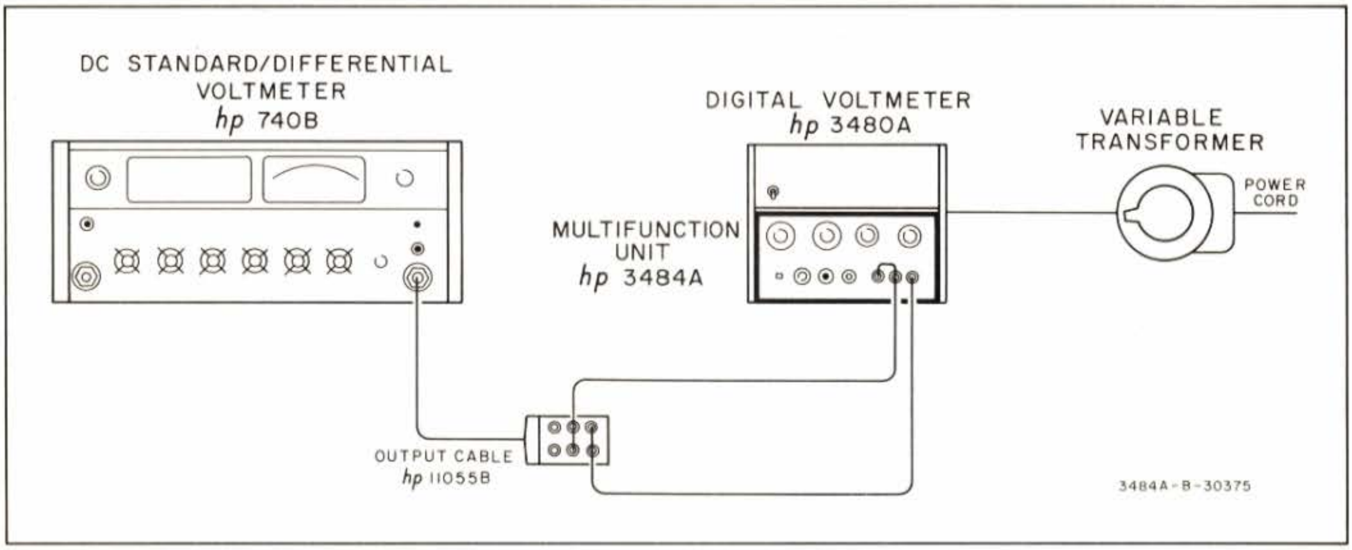


Figure 5-1. VDC Accuracy Check.

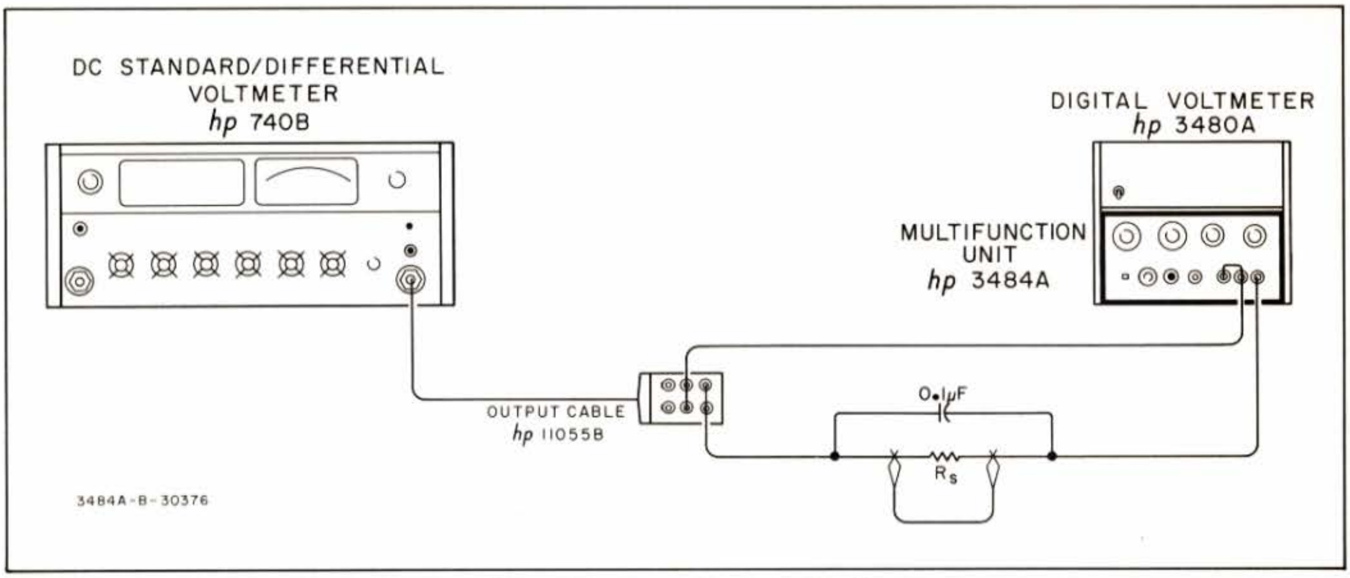


Figure 5-2. Input Resistance Check.

f. Connect dc standard output to 3484A input. Set dc standard output to .000000 V. If 3480A/B display indicates an offset, this must be taken into consideration when checking 3484A accuracy on the 100 mV range. If -hp- Model 740B is being used as dc standard, adjust 740B ZERO control to return 3480A/B display to zero.

g. Set dc standard output to +.100000 V (+100.00 mV). 3480A/B display should be +99.97 mV to +100.03 mV.

h. Reverse polarity of standard output. Display should be − 99.97 mV to − 100.03 mV.

i. Set dc standard output to positive and negative voltages listed in Table 5-2, setting 3484A RANGE switch to range shown for each voltage. Display should be within limits indicated in each case.

j. Repeat Steps g through i with line voltages of 103 V and 127 V (or 207 V and 253 V).

5-5. VDC INPUT RESISTANCE CHECK.

5-6. 100 mV, 1000 mV, and 10 V Ranges.

Input resistance on the three lower ranges is $> 10^{10}$ ohms, and is most easily checked on the 10 V range using the following procedure:

a. Connect dc standard to 3484A input as shown in Figure 5-2, using a 10 MΩ ± 1% resistor for R_S. The capacitor in parallel with R_S reduces the effect of noise. Connect jumper across R_S. Set 3484A RANGE to 10 V, FUNCTION to VDC.

b. Set dc standard output to + 10.000 V.

Table 5-2. DCV Accuracy and Linearity Check.

DC STANDARD VOLTAGE	3484A RANGE	DISPLAY LIMITS
± 100.000 mV	100 mV	± 99.97 mV to 100.03 mV
± 90.000 mV	100 mV	± 89.97 mV to 90.03 mV
± 80.000 mV	100 mV	± 79.97 mV to 80.03 mV
± 70.000 mV	100 mV	± 69.97 mV to 70.03 mV
± 60.000 mV	100 mV	± 59.97 mV to 60.03 mV
± 50.000 mV	100 mV	± 49.97 mV to 50.03 mV
± 40.000 mV	100 mV	± 39.98 mV to 40.02 mV
± 30.000 mV	100 mV	± 29.98 mV to 30.02 mV
± 20.000 mV	100 mV	± 19.98 mV to 20.02 mV
± 10.000 mV	100 mV	± 09.98 mV to 10.02 mV
± 100.00 mV	1000 mV	± 099.9 mV to 100.1 mV
± 300.00 mV	1000 mV	± 299.9 mV to 300.1 mV
± 500.00 mV	1000 mV	± 499.8 mV to 500.2 mV
± 700.00 mV	1000 mV	± 699.8 mV to 700.2 mV
± 900.00 mV	1000 mV	± 899.8 mV to 900.2 mV
± 1000.00 mV	1000 mV	± 999.8 mV to 1000.2 mV
± 10.0000 V	10 V	± 9.998 V to 10.002 V
± 9.0000 V	10 V	± 8.998 V to 9.002 V
± 7.0000 V	10 V	± 6.998 V to 7.002 V
± 5.0000 V	10 V	± 4.998 V to 5.002 V
± 3.0000 V	10 V	± 2.999 V to 3.001 V
± 1.0000 V	10 V	± 0.999 V to 1.001 V
± 10.000 V	100 V	± 09.99 V to 10.01 V
± 100.000 V	100 V	± 99.98 V to 100.02 V
± 1000.00 V*	1000 V	± 999.8 V to 1000.2 V
± 100.00 V	1000 V	± 099.9 V to 100.1 V

*If -hp- Model 740B is used as dc standard, do not apply negative voltage greater than − 500 V.

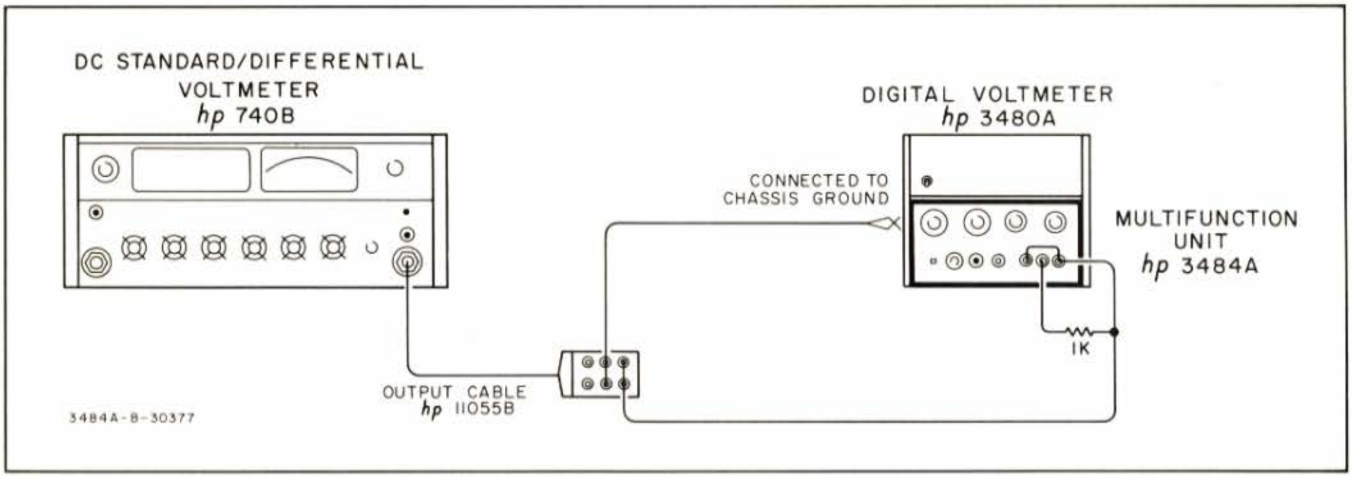


Figure 5-3. DC Common Mode Rejection Check.

c. Note 3480A/B display.

d. Remove jumper across 10 MΩ resistor and allow about 5 seconds for capacitor to charge. Display should then differ not more than 9 counts (0.009 V) from display noted in Step C. A change of 0.01 V (10 counts) indicates an input resistance of only 10^{10} ohms, using the formula

$$R_{input} = R_s \frac{E_{input} - \Delta E_{displayed}}{\Delta E_{displayed}}$$

5-7. 100 V and 1000 V Ranges.

Input resistance on the two higher ranges is 10 MΩ ± 0.1%, and may be checked on the 100 V range, using the following procedure.

a. Connect dc standard to 3484A input as shown in Figure 5-2, using a 1 MΩ ± 1% resistor for R_s. Connect jumper across R_s. Set 3484A RANGE to 100 V, FUNCTION to VDC.

b. Set dc standard output to + 10.000 V.

c. Note 3480A/B display.

d. Remove jumper across 1 MΩ resistor. Reading should change 0.90 V to 0.92 V, indicating an input resistance of 10 MΩ ± 0.1%. The formula in Paragraph 5-6, Step d, applies in this check also.

5-8. DC COMMON MODE REJECTION CHECK.

Effective common mode rejection is the ratio of the peak common mode voltage to resultant error in reading with 1 kΩ unbalance in either lead.

a. Connect a 1 kΩ resistor between 3484A HIGH and LOW terminals, and connect HIGH to GUARD as shown in Figure 5-3.

b. Set 3484A FUNCTION to VDC, RANGE to 10 V. Note 3480A/B display.

c. Connect dc standard to 3480A/B/3484A as shown in Figure 5-3, connecting LOW side of standard output to 3480A/B chassis ground. A rear panel mounting screw head makes a good ground connection. Do not use BCD output connector J13 as ground.

d. Set dc standard output to + 500.00 V. 3480A/B reading should not change more than 0.049 V, verifying dc common mode rejection > 80 dB, where

$$CMR = 20 \log \frac{\text{Peak common mode voltage}}{\text{Effect on reading (volts)}}$$

5-9. AC COMMON MODE REJECTION CHECK.

Effective ac common mode rejection with FILTER in either position A or B is the sum of rejection without filtering plus normal mode rejection provided by the filter. (See Paragraph 5-10.)

a. Connect a 1 kΩ resistor between 3484A HIGH and LOW terminals, and connect HIGH to GUARD as shown in Figure 5-4.

b. Set 3484A FUNCTION to VDC, RANGE to 10 V, FILTER to OUT. Note 3480A/B reading.

c. Connect oscillator output to 3484A HIGH and chassis ground as shown in Figure 5-4. A rear panel mounting screw head makes a good ground connection. Do not use the BCD connector J13 as ground.

d. Using ac voltmeter as a monitor, set oscillator output to 7.07 Vrms (10 V peak) at 60 Hz. AC voltmeter must be battery operated.

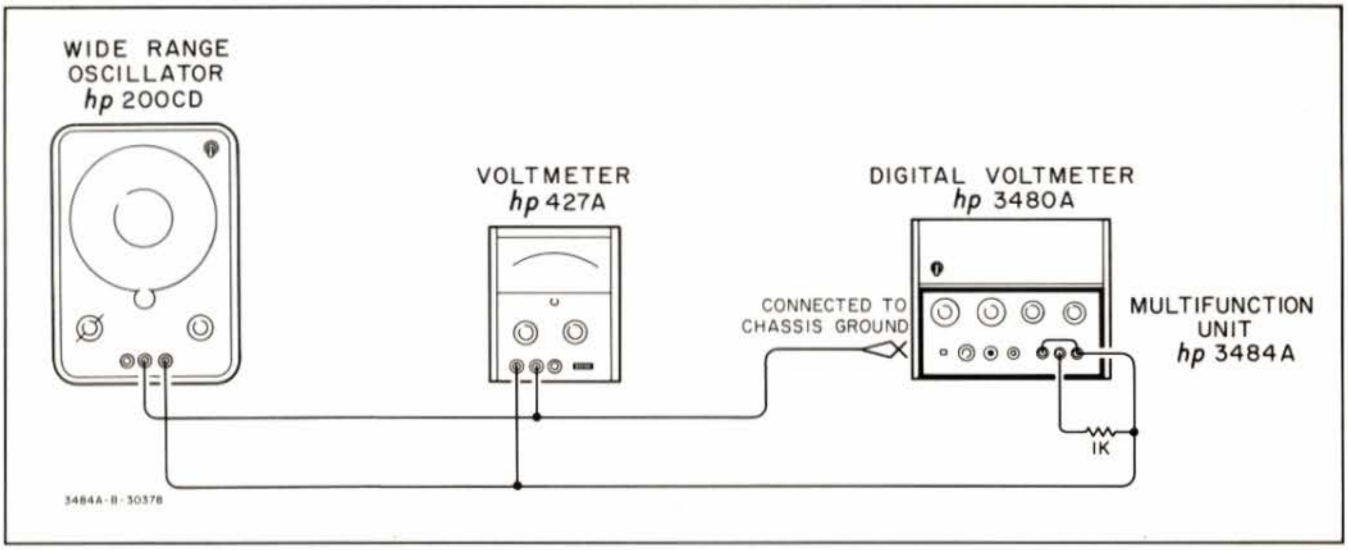


Figure 5-4. AC Common Mode Rejection Check.

e. 3480A/B reading should not change more than 0.001 V. This verifies ac common mode rejection of 80 dB at 60 Hz, using formula given in Paragraph 5-8, Step d.

5-10. AC NORMAL MODE REJECTION CHECK.

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

a. Connect oscillator, 1.0 μF capacitor, 33 kΩ resistor, and ac voltmeter to 3484A input as shown in Figure 5-5. The capacitor blocks any dc present in the oscillator output, and the resistor provides a low source impedance for the 3484A. The ac voltmeter must be battery operated.

b. Set 3484A FUNCTION to VDC, RANGE to 10 V, FILTER to A.

c. With oscillator turned off, note 3480A/B reading.

d. Turn oscillator on and adjust frequency to 50 Hz. Using ac voltmeter as a monitor, adjust oscillator output to 7.07 Vrms (10 V peak).

e. 3480A/B reading should not vary more than ± 0.316 V. This verifies normal mode rejection of 30 dB, using the formula

$$NMR = 20 \log \frac{\text{Peak ac superimposed voltage}}{\text{Effect on reading (volts)}}$$

f. Set FILTER switch to B. Readings should not vary more than ± 0.001 V. This verifies normal mode rejection of 80 dB, using the formula in Step e.

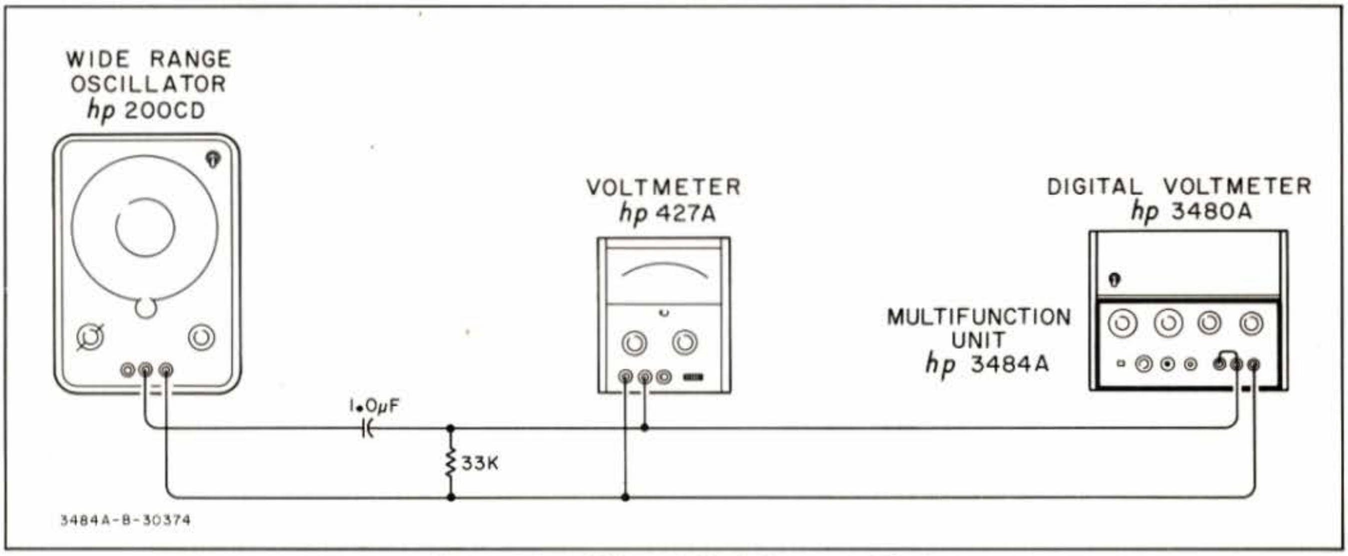


Figure 5-5. AC Normal Mode Rejection Check.

5-11. OHMMETER ACCURACY CHECK.

The following procedure prescribes full-scale value resistors for each range. If exact full-scale values are not available, values within ± 10% of full-scale may be used, providing the absolute value of each resistor is known to within the tolerance given in Table 5-3. The display should then read the absolute value of the resistor within the limits shown in Table 5-3. For example, if a resistor having a value of 9,976.1 Ω is used to check the 10 kΩ range, the display should be 9.976 kΩ ± 2 counts.

a. Set FUNCTION to OHMS, RANGE to 100 Ω, FILTER to OUT. Connect test leads to INPUT terminals. Connect GUARD to LOW.

NOTE

With test leads shorted together when the instrument is on the 100 Ω range, an offset reading will be noted in the display. This respresents internal wiring and test lead resistance. Some offset may also be noted on the 1000 Ω range. Do not attempt to remove the offset by adjusting the front panel ZERO control. To do so will result in incorrect measurements on all ranges and functions.

b. Short test leads together and note offset.

c. Connect 100 Ω ± 0.015% resistor to test leads. Display should be (100.00 Ω + offset) ± 7 counts.

d. Change RANGE to 1000 Ω. Short test leads together and note offset.

e. Connect 1000 Ω ± 0.002% resistor to test leads. Display should be (1000.0 Ω + offset) ± 2 counts.

f. Set RANGE to remaining positions as shown in Table 5-3, connecting appropriate resistor to test leads. Display should be within limits shown in each case. Due to noise generated in the resistor, FILTER A may be required for quiet readings greater than 100 kΩ, and FILTER B may be required on the 10 MΩ range.

Table 5-3. Ohmmeter Accuracy Check.

RANGE	INPUT RESISTANCE	DISPLAY LIMITS
100	100 ± 0.015%	(100.00 + offset) ± 7 counts
1000	1 k ± 0.005%	(1000.0 + offset) ± 2 counts
10 k	10 k ± 0.005%	10.000 k ± 2 counts
100 k	100 k ± 0.005%	100.00 k ± 2 counts
1000 k	1 M ± 0.005%	1000.0 k ± 2 counts
10 M	10 M ± 0.025%	10.000 M ± 11 counts

5-12. VAC ACCURACY (OPTION 043).

AC voltage accuracy checks are given in the Model 11153A Operating and Service Manual.

5-13. ADJUSTMENT PROCEDURES.

5-14. The following procedures should be performed only after it has been determined from the Performance Checks that the Model 3484A is out of specifications. If the correct adjustment cannot be made at any point in this procedure, refer to the Troubleshooting Procedure, Paragraph 5-34. Figure 5-6 shows the location of adjustments.

5-15. The Model 3480A or 3480B used must be operating within specifications. If a 3480A is used, an extender cable is required so that the 3484A may be operated outside the 3480A. An extender cable, -hp- Model 11148A, is available for this purpose. If a 3480B is used, access to the 3484A adjustments may be gained by removing the 3480B top and bottom covers. Unless otherwise stated in the procedure, all adjustments must be made with the 3484A guard covers in place. The input LOW terminal is used as a ground connection unless specified otherwise.

5-16. DC AMPLIFIER ZERO AND OFFSET CURRENT ADJUSTMENTS.

This procedure must be performed before making amplifier gain and attenuator adjustments.

a. Turn 3480A/B on and allow to warm up for one hour.

b. Set 3484A FUNCTION to VDC RANGE to 100 mV, SAMPLE RATE fully clockwise, FILTER to OUT, TERMINAL to FRONT. Connect GUARD to LOW and short HIGH to LOW.

c. Adjust front panel ZERO control to mechanical center.

d. Adjust COARSE ZERO (A2R7) for 3480A/B display of 00.00 ± 00.02 mV.

e. Adjust front panel ZERO for display of 00.00 mV, with polarity indicator alternating between + and –.

CAUTION

BE CAREFUL NOT TO SHORT TEST POINT OR CIRCUITS TO THE GUARD COVER WHEN MAKING MEASUREMENTS OR ADJUSTMENTS. IN THE FOLLOWING STEP, IF THE HOLE IN THE GUARD COVER IS TOO SMALL TO ACCOMMODATE THE VOLTMETER PROBE, THE GUARD COVER MAY BE REMOVED FOR THIS MEASUREMENT ONLY.

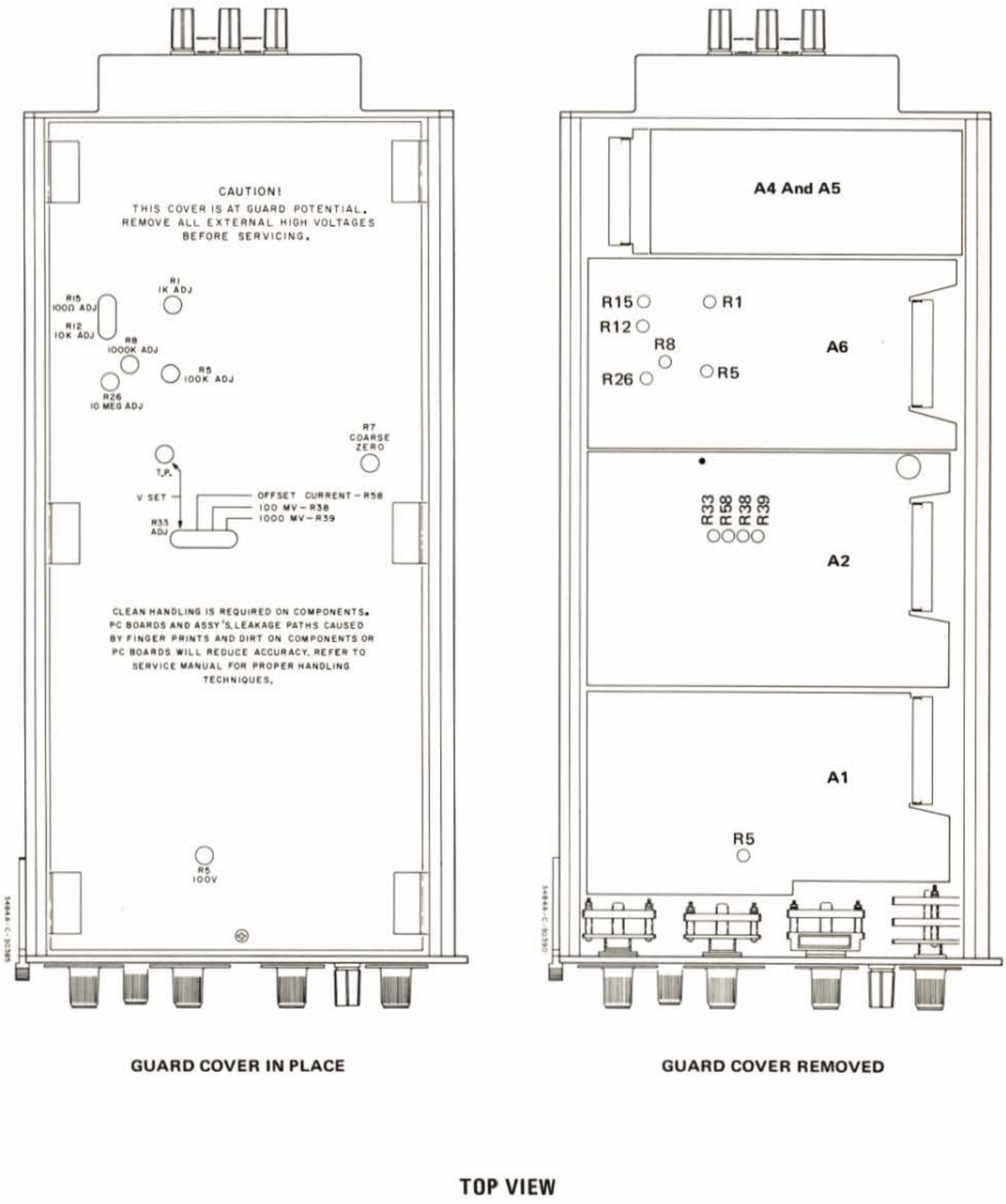


Figure 5-6. Location of Adjustments.

f. Connect a dc voltmeter between V SET test point and input LOW. Voltmeter reading should be less than 50 mV. If not, adjust V SET (A2R25) for reading of less than 50 mV. Disconnect dc voltmeter.

g. Remove 3480A/B top cover. Connect a dc differential voltmeter (or digital voltmeter able to resolve 200 μV) between input LOW and A3TP4 in 3480A/B.

h. Mechanically center front panel ZERO and adjust COARSE ZERO (A2R7) for differential voltmeter reading of < ± 200 μV.

i. Set FILTER switch to B. If differential voltmeter reading is greater than ± 200 μV, adjust OFFSET CURRENT (A2R58) for reading of < ± 200 μV.

j. Observe differential voltmeter reading while switching FILTER through OUT, A, and B. Differential voltmeter should remain within ± 200 μV. If not, repeat Steps c through j.

5-17. DC AMPLIFIER GAIN ADJUSTMENTS.

Amplifier zero adjustment, Paragraph 5-16, must be performed before proceeding with amplifier gain adjustments.

a. Connect a dc standard to 3484A input. Connect 3484A GUARD to LOW. Connect a dc differential voltmeter (or digital voltmeter) between 3484A input HIGH and A3TP4 is 3480A/B.

b. Set 3484A RANGE to 10 V, SAMPLE RATE fully clockwise, FILTER to OUT.

c. Adjust dc standard output to + 10.0000 V. Differential voltmeter reading should be < ± 400 μV. If reading is greater than ± 400 μV, refer to Troubleshooting Procedures, Paragraph 5-34.

d. Repeat Step C with - 10.0000 V input. Disconnect differential voltmeter.

e. Adjust dc standard output to + 99.995 mV. Set 3484A RANGE to 100 mV.

f. Adjust 100 mV (A2R38) for 3480A/B display alternating between + 99.99 mV and + 100.00 mV.

g. Reverse input polarity (to - 99.995 mV). Display should alternate between - 99.99 mV and - 100.00 mV. If not, adjust 100 mV (A2R38) slightly to split the difference between positive and negative indications.

h. Set 3484A RANGE to 1000 mV. Adjust dc standard output to + 999.95 mV.

i. Adjust 1000 mV (A2R39) for display alternating betweenn + 999.9 mV and + 1000.0 mV.

j. Reverse polarity of input (to - 999.95 mV). Display should alternate between - 999.9 mV and - 1000.0 mV. If not, adjust 1000 mV (A2R39) slightly to split difference between positive and negative indications.

5-18. DC ATTENUATOR ADJUSTMENT.

Amplifier zero and gain adjustments must be performed before adjusting attenuator.

a. With dc standard connected to 3484A input as in Paragraph 5-17, set 3482A RANGE to 100 V and adjust dc standard output to + 99.995 V.

WARNING

DO NOT TOUCH GUARD COVER. 100 V MAY APPEAR BETWEEN GUARD COVER AND INSTRUMENT FRAME.

b. Adjust 100 V (A1R5) for display alternating between + 99.99 V and + 100.00 V.

c. Perform dc accuracy and linearity check outlined in Paragraph 5-4.

5-19. OHMS CONVERTER ADJUSTMENTS (OPTION 042).

5-20. The following procedure uses full-scale value input resistors, listed in Table 5-1, for Ohms Converter adjustments. If exact full-scale values are not available, values within ± 10% of full-scale may be used, providing the absolute value of each resistor is known to within the tolerance given in Table 5-1. Adjustment should then be made to the absolute value of the resistor.

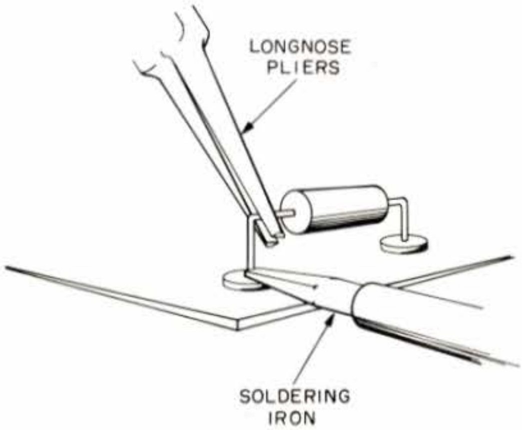
5-21. The DC Amplifier adjustments should be made before performing the following procedure. Test leads should be as short as possible to minimize lead resistance.

a. Set 3484A FUNCTION to OHMS, RANGE to 100 Ω, FILTER to OUT. Connect test leads to input HIGH and LOW and connect GUARD to LOW.

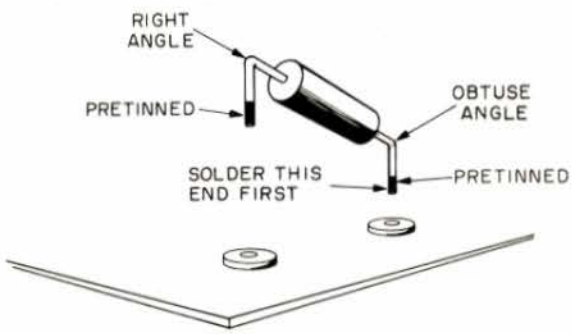
b. Short test leads together and note offset reading in 3480A/B display.

NOTE

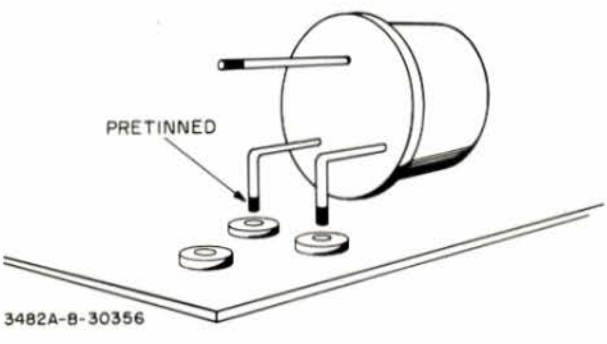
With test leads shorted together when the instrument is on the 100 Ω range, an offset reading will be noted in the display. This represents internal wiring and test lead resistance. Some offset may also



Apply heat to component side of board and remove one lead at a time. Do not remove old solder from hole.



To replace two-lead components, cut leads to proper length and tin ends (away from vicinity of printed circuit board). Bend one lead at a right angle and the other at an obtuse angle. Solder the latter lead first by heating component side of board and pushing lead into hole. Push component down and solder other lead in the same manner. Do not apply solder directly to the printed circuit board.



To replace a three-lead component, cut leads to proper length and tin ends. Bend two leads at nearly right angles. Solder bent leads one at a time by applying heat to component side of board. Bend component up and solder remaining lead into board.

Figure 5-7. Component Replacement.

be noted on the 1000 Ω range. Do not attempt to remove offset by adjusting the front panel ZERO control. To do so will result in incorrect measurements on all ranges and functions.

c. Connect test leads to 100 Ω resistor. Adjust R15 100 Ω ADJ for a display of 100.00 Ω plus the offset noted in Step b.

d. Set RANGE to 1000 Ω. Short test leads together and note offset.

e. Connect test leads to 1000 Ω resistor. Adjust R1 1K ADJ for display of 1000.0 Ω plus the offset noted in Step d.

f. Set RANGE to 10 kΩ. Connect test leads to 10 kΩ resistor. Adjust R12 10K ADJ for display of 10.000 kΩ.

g. Set RANGE to 100 kΩ, FILTER to A. Connect test leads to 100 kΩ resistor. Adjust R5 100K ADJ for display of 100.00 kΩ.

h. Set RANGE to 1000 kΩ. Connect test leads to 1 MΩ resistor. Adjust R8 1000K ADJ for display of 1000.0 kΩ.

i. Set RANGE to 10 MΩ. (For quiet readings at 10 MΩ, a FILTER B setting may be required. Response time will then be correspondingly slower). Adjust R26 10M ADJ for display of 10.000 MΩ. Movement of hands or test leads may cause the display to change, particularly if FILTER is set to A. Allow display to settle before making adjustment.

5-22. TRUE RMS AC CONVERTER ADJUSTMENTS.

Procedures for adjusting the ac converter are given in the Model 11153A Operating and Service Manual.

5-23. SERVICING INFORMATION.

5-24. CLEAN HANDLING TECHNIQUES.

5-25. Most areas within the 3484A must be kept free from dirt or contamination, or performance of the instrument will be degraded. The DC Attenuator and Amplifier assemblies and the Range, Filter, and Terminal switches are especially critical areas. These parts should be handled only with clean rubber or cotton gloves or clean tools. The printed circuit boards may be handled without gloves if only the edges of the boards are touched.

5-26. If the black thermal cover on the DC Amplifier assembly is removed, care must be taken during replacement to dress the wires carefully through the slotted edges of the cover. Make sure the twisted wires remain tightly twisted. Dirt or contamination on the surface of the glass-enclosed 20 kilomegohm resistor will tend to reduce input resistance on the three lower ranges. Teflon parts on any assembly must not be touched with the hands.

5-27. Component Replacement.

The following general rules should be observed when replacing components on the Attenuator and Amplifier assemblies or the upper left quarter of the Range assembly. Figure 5-7 illustrates methods for avoiding contamination when replacing components on a clean assembly.

1. Handle components and assemblies only with clean gloves or clean tools, or handle printed circuit boards by touching only the edges.

2. Lay printed circuit board on a clean surface, preferably a hard, flat surface.

3. Do not use solder on or near the printed circuit board; flux will contaminate the surface. Component leads should be tinned away from the vicinity of the board.

4. Do not use a solder removing tool. Leave old solder in the hole.

5. The soldering iron should be cleaned before each use by wiping on a wet sponge.

6. Always apply soldering iron heat to component side of printed circuit board.

5-28. REED REPLACEMENT.

5-29. Reed switches must be handled very carefully. Clean rubber gloves or finger cots must be worn, or the reed must be handled by the metal leads only. When replacing reed switches, be careful not to bend the leads. Stress on the leads may break the glass seal or cause the switch to be inoperative. The leads of most replacement reed switches must be shortened by cutting an equal amount from each lead, so that the total length is 1-7/16 inches. Use longnose pliers to hold the lead between the glass envelope and the cutting tool to avoid damaging the glass to metal seal.

5-30. Some reeds in the 3484A are soldered in place, while others are inserted into spring clips. A special tool, -hp- Part No. 4040-0720, is provided with the 3484A for the purpose of removing and replacing reed switches which use the spring clips. Figure 5-8 shows the proper use of the reed replacement tool.

5-31. DC AMPLIFIER ASSEMBLY REPAIR AND EXCHANGE.

5-32. Certain components associated with the differential amplifier stage are factory selected to provide proper operation of the amplifier under temperature variations. If A2IC1, A2Q2, A2Q8, or A2Q14, for example, must be

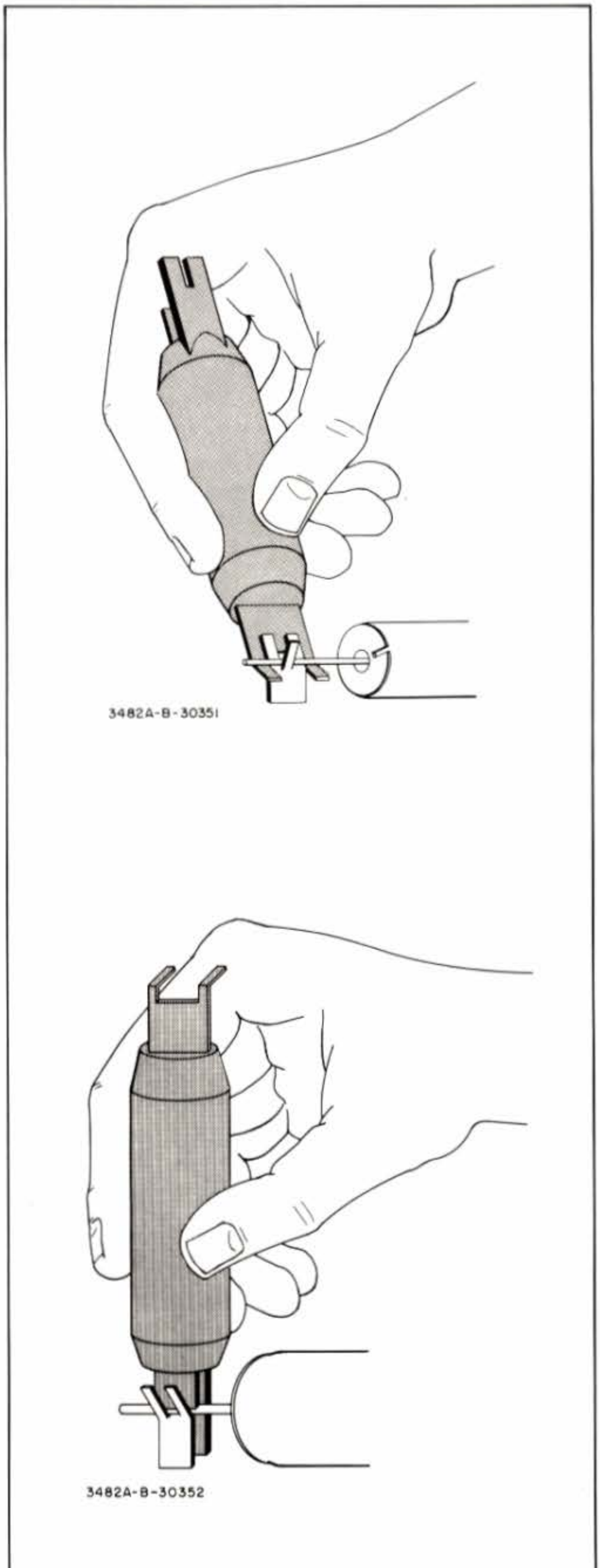


Figure 5-8. Reed Removal and Replacement.

replaced, the component selection procedure must be repeated. This procedure requires extensive tests using a temperature controlled chamber and widely varying temperatures. For this reason, the Amplifier Assembly A2 should be returned to the factory if any of these critical components must be replaced. The critical parts are shown in the shaded areas of the component location drawing in Figure 7-3.

5-33. A factory rebuilt and tested assembly, -hp- Part No. 03482-69502, may be purchased on an exchange basis. The -hp- Part No. of a new assembly is 03482-66502. Contact your nearest -hp- Sales and Service Office, listed in Appendix B, for exchange details and prices.

5-34. TROUBLESHOOTING.

If the Model 3484A operates incorrectly and the trouble cannot be corrected by the Adjustment Procedures, Paragraph 5-13, the following troubleshooting information should be used to locate the source of trouble. The troubleshooting procedures will help determine if the trouble is in the 3484A or the 3480A/B. Also check for loose wires or other obvious evidence of trouble, such as loose or burned components. Make sure that printed circuit boards are seated properly in connectors. In general, the troubleshooting information is identified by assembly and according to the symptoms experienced.

CAUTION

BEFORE WORKING WITHIN THE 3484A, REFER TO PARAGRAPH 5-24, CLEAN HANDLING TECHNIQUES. DIRT OR CONTAMINATION IN THE INTERIOR OF THE 3484A MAY DEGRADE PERFORMANCE.

5-35. DC AMPLIFIER ZERO OFFSET.

If the instrument exhibits a zero offset that cannot be corrected by performing the Amplifier Zero and Offset Current Adjustments in Paragraph 5-16, follow the procedure given in the Zero Offset Troubleshooting Tree, Figure 5-12.

5-36. DCV DISPLAY LIMITING.

Display "limiting" is the term used to describe the condition wherein the display reads correctly up to a certain point, but will not read higher. This limiting may occur at the amplifier input or output, or within the amplifier. The first check in the Limited Display Troubleshooting Tree, Figure 5-13, determines whether the trouble is in the 3484A or the 3480A/B.

5-37. DC AMPLIFIER GAIN ERRORS.

If readings are consistently high or low on a certain dc range, and the trouble cannot be corrected by performing the Adjustment Procedures in Paragraph 5-13, information in the following paragraphs and Table 5-4 should locate the source of trouble.

5-38. Attenuation is 1/1 in the three lower ranges and 1/100 in the 100 V and 1000 V ranges. If leakage resistance is present across attenuator resistors or reed contacts, or if attenuator relays do not operate properly, attenuation will not be correct. For example, referring to schematic diagram Figure 7-3, if A1K3 remains closed on the 100 mV, 1000 mV, and 10 V ranges, the display will be approxi-

Table 5-4. DC Amplifier Gain Errors.

SYMPTOM	PROBABLE CAUSE
Readings are high (or intermittently high) on 1000 mV range only.	High resistance connection in relay A2K1. Connect clip lead across reed switch of A2K1. Be careful not to put stress on reed. If display is correct, check reed connections. If connections are good, replace reed. If clip lead does not correct the reading, trouble may be in A2R39.
Readings are high (or intermittently high) on 10 V and 1000 V ranges.	High resistance connection in relay A2K2. Connect clip lead across reed switch of A2K2. Be careful not to put stress on reed. If display is correct, check reed connections. If connections are good, replace reed.
Readings are low on 100 mV range only.	Leakage resistance across A2K1 or 2. Disconnect either end of A2K2 reed switch. See Paragraph 5-25 for reed removal instructions. If this corrects trouble, check for leakage across reed or from reed to shield or coil. If trouble is not corrected, perform same check on A2K1.
Readings on 100 mV, 1000 mV and 10 V ranges are approximately half of correct value.	Relay A1K3 may remain closed.
Readings are correct with filter OUT, but are low with filter A or B or both.	Leakage resistance across a filter capacitor or from filter relay reed to coil or shield. With an input voltage applied, check dc voltages at junctions of A1R6 and 7, 7 and 8, and 8 and 9. Voltages should be equal to voltage at input end of A1R6. A lower voltage at any point (progressing from left to right on schematic) incicates leakage to ground at that point.
Low readings on all ranges and in all filter positions.	Leakage resistance across A1R2C or A1R5. Check A1K3 for leakage from reed to coil or shield.

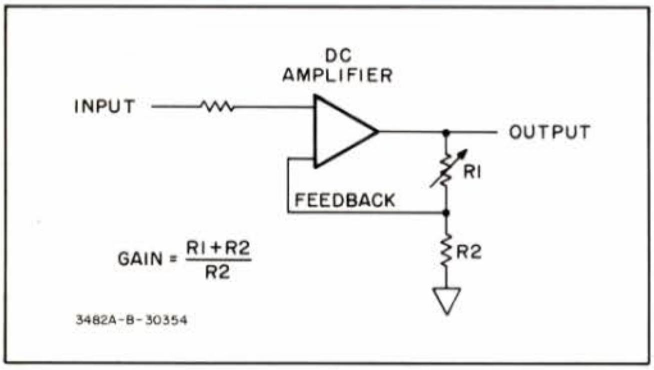


Figure 5-9. DC Amplifier Diagram.

mately half the correct value,due to the attenuation of R1, R2C, and R5. However attenuation will be correct on the two higher ranges.

5-39. If readings are correct with the filter OUT, but low on all ranges with the filter switch set to A or B, attenuation is occurring in the filter circuit. This problem could be caused by leakage through a filter capacitor or from a reed to relay shield.

5-40. The gain of the DC Amplifier is adjusted by varying the feedback resistance R1 in Figure 5-9. Leakage across a relay reed when the reed should be open will cause R1 to be low and the gain will be low. If a reed does not close, or the contact resistance becomes excessive, R1 will be high and the gain will be low.

5-41. DCV REED RELAY CHECKS.

In many cases, a malfunction can be traced to a faulty reed relay by interpreting the symptoms evident in the front panel display. Table 5-5 lists a number of such symptoms and the probable causes. Symptoms are listed with the ranges on which they appear. Check for each symptom on each range to determine which ranges are affected. Any problem which appears on only one range may be due to a defective relay drive circuit. A known voltage source, such as a dc standard, is required for these checks. An ohmmeter should be used to determine whether a reed switch is open or closed. Be careful not to apply stress to the leads of the reed switch.

5-42. RANGING CHECKS.

5-43. Selection of any range causes the Enable signal for that range to be LOW, enabling the associated Range Relay Driver which energizes the appropriate reed relays. If selection is manual, the Enable line is grounded through the RANGE switch. In remote range selection, a ground connection of the Remote Program line is applied to a series pair of inverters, causing the Enable line to be LOW. In autorange operation, outputs of the Range Register are decoded by a series of NAND gates to cause the proper Enable line to be LOW. The ranging logic circuits are shown in Figure 7-4.

5-44. Some troubles can be traced by analyzing the symptoms evident in the front panel display. For example, if a certain range cannot be selected by any of the three modes of selection, the trouble could be in the Range Relay Driver circuit. However, if the problem is limited to only one function, the trouble is more likely in the range relays for that function, or the Function Selection Circuits. (VAC(AC) and VAC(DC) functions use the same range relay circuits.) If the decimal and function indications are correct but the numerical display is off by a factor of 10 or 100, the trouble could be either in the range relays or driver circuit. On the other hand, if the numerical display is correct but either the decimal or function indication is incorrect, the trouble is probably in the Decimal and Annunciator Lamp Drivers (Figure 7-5).

5-45. Remote Range Check.

Two general types of malfunction may occur in the Remote Range Selection circuits. If may be impossible to select a certain range remotely, or a range may remain "selected" at all times. In either case, the trouble is probably in the remote selection inverters, A3IC1 and 5. If none of the remote range program lines is grounded, the 3484A automatically selects the highest range. Paragraph 4-29 and Figure 4-5 explain the method used to select the highest range in both voltage and ohms functions.

5-46. Autorange Check.

If the instrument does not autorange properly but manual selection is correct, refer to Autorange Troubleshooting Tree, Figure 5-14.

5-47. DELAY GENERATOR CHECKS.

5-48. The purpose of the Delay Generator is to prevent the 3480A/B from sampling, following an autorange signal, until the instrument has had time to change ranges and the amplifier has settled. At the end of the delay time, the Delay Generator resets and causes the 3480A/B to take a measurement.

5-49. Each time an autorange command is present at the Range Register input, this same signal changes the state of the Delay Flip-Flop, initiating a delay period. The length of the delay period depends upon the function and degree of filtering selected. The Delay Generator consists of three main parts; the Delay Flip-Flop, the delay timing capacitor circuits, and the reset circuit.

5-50. Delay Flip-Flop.

The Delayed Trigger Initiate signal at A3IC6 pin 2 must be HIGH and either the Auto Enable or Delay Enable input to the Delay Gate must be LOW, causing the level at pin 3 also to be HIGH in order for the Delay Flip-Flop to be triggered by an autorange command. If the flip-flop does not trigger, check voltages at these points. An emitter-to-collector short in A3Q8 would also cause pin 3 to be LOW and prevent triggering. If the flip-flop fails to trigger, no delay will

Table 5-5. DCV Reed Relay Checks.

RANGES AFFECTED	SYMPTOMS	POSSIBLE CAUSES
100 mV	Display is low by a factor of 10	A2K1 shorted
1000 mV 100 V	Display is high by a factor of 10	A2K1 open
100 mV	Display is low by a factor of 100	A2K2 shorted
1000 mV 100 V	Display is low by a factor of 10	A2K2 shorted
10 V 1000 V	Display is high by a factor of 100	A2K2 open
100 V 1000 V	Display is high by a factor of 50. Input Resistance (Paragraph 5-5) is 200 kilohms.	A1K1 shorted
100 mV 1000 mV 10 V	Display increases erratically (to OVERLOAD on lower ranges) even with input shorted. Display is noisy and does not respond correctly to any input voltage.	A1K1 open
100 V 1000 V	Display increases erratically even with input shorted. Display does not respond correctly to any input voltage.	A1K3 open
100 mV 1000 mV 10 V	Display is approximately one-half of input voltage. Input resistance (Paragraph 5-5) is 200 kilohms.	A1K3 shorted
100 V 1000 V	Display is zero for any input voltage.	A1K2 open
100 mV 1000 mV 10 V	Input resistance is 10 megohms (Paragraph 5-5).	A1K2 shorted
All Ranges	Input resistance is 10 megohms or less (Paragraph 5-5).	A7K1, A7K2, or A7K11 shorted
All Ranges	Display noise does not change regardless of Filter position selected.	A1K7 shorted
All Ranges	Display noise greater than +/−2 counts with Filter OUT and input shorted.	A1K7 open
All Ranges	Noise level not reduced sufficiently in Filter A. Fails AC Normal Mode Rejection Check (Paragraph 5-10). Noise most evident on 100 mV range.	A1K5A or B or both open
All Ranges	Noise level not reduced sufficiently in Filter B. Fails AC Normal Mode Rejection Check (Paragraph 5-10). Noise most evident on 100 mV range.	Any one or more of A1K4A, B, A1K6 open
All Ranges	Response to step input voltage too slow with Filter OUT.	A1K7 shorted

occur, and the instrument will continue to sample at the normal rate.

5-51. Delay Timing.

The delay introduced in each function and filter position is shown in Table 5-6. With the FUNCTION switch set to VDC, FILTER to OUT, and the SAMPLE RATE control fully clockwise, the 4 msec delay will not be noticed by observing the Sample Indicator. However, the 200 msec delay of Filter A and the 1 second delay of Filter B can be observed. If the correct delay is not present, the trouble may be in the Filter Selection circuit or in the delay selection logic circuits in the Delay Generator. The following procedure may be used to check the Delay Generator.

a. Connect an oscilloscope to test point DY.

b. Set 3484A FUNCTION to VDC, RANGE to AUTO, SAMPLE RATE fully clockwise, and FILTER to B.

c. Connect a jumper between the two test points marked FR. This should cause the instrument to autorange continuously.

d. Adjust oscilloscope controls so that length of delay (negative portion of waveform) can be determined. Should be approximately 1 second.

e. Set FILTER to A. Delay should be approximately 200 msec.

f. Set FILTER to OUT. Delay should be about 4 msec.

g. If instrument has AC Option 043, set FUNCTION to VAC(AC). FILTER setting is immaterial. Delay should again be 1 second.

h. Set FUNCTION to VAC(DC). Delay should be about 3 seconds.

Table 5-6. Delay Timing.

FUNCTION AND FILTER	DELAY
VDC or OHMS	
Filter OUT	4 msec
Filter A	200 msec
Filter B	1 sec
VAC(AC)	1 sec
VAC(DC)	3 sec

5-52. Delay Generator Reset Circuit.

If the Delay Generator reset circuit (A3Q6-8) does not function, the instrument will stop sampling when an autorange command occurs, whether the sampling is being controlled automatically or by external trigger. The Hold Circuit output goes LOW when the Delay Flip-Flop is triggered, and remains LOW until the flip-flop is reset. This output prevents the 3480A/B from sampling automatically. The Print Command signal is HIGH during the delay period. This signal is applied to a gating circuit to prevent external triggering during this time. These conditions will cause sampling to stop if the Delay Flip-Flop is not reset properly. However, if the RANGE switch is set to a position other than AUTO, the reset connection to the Delay Flip-Flop (A3IC6 pin 3) will be LOW, resetting the flip-flop. This allows the instrument to resume sampling.

5-53. ISOLATED REMOTE ASSEMBLY, OPTION 041.

5-54. The Isolated Remote option cannot be used unless the 3480A/B is equipped with Isolated BCD Option 004, which supplies power for the isolated circuits. If the + 5 V is not present at the isolated circuits on Isolated Remote Assembly A4, the trouble is probably in the 3480A/B or the interconnections.

5-55. The Program Accept circuits provide the signals which transfer the external programming information into the 3484A range and filter selection circuits. About 10 μsec after application of a Program Accept command, the ACC signal on Remote Program Assembly A5 resets all Program Flip-Flop outputs to LOW. The 10 μ delay is provided by A4C9. After an additional 10 μsec delay provided by A4C8, the $\overline{ACC}$ signal on assembly A4 sets the output of all unprogrammed flip-flops to HIGH. Only the outputs of the programmed lines are left LOW to accomplish the desired programming in the 3484A. The $\overline{ACC}$ signal also triggers the Program Flag one-shot, causing its output to go HIGH for 1 msec.

5-56. OHMS CONVERTER, OPTION 042.

A simplified diagram of the Ohms Converter is shown in Figure 5-11, listing the resistors used in each range to develop the proper current through the resistance being

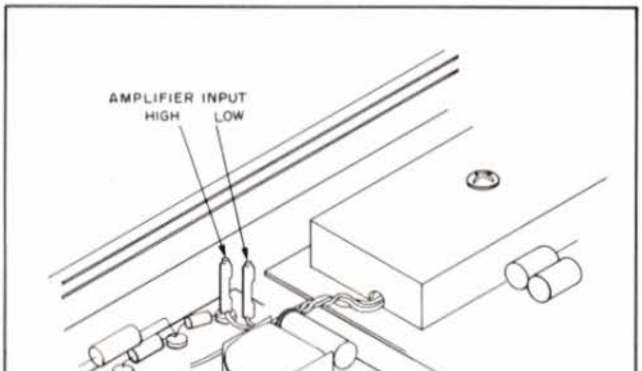


Figure 5-10. DC Amplifier Input Connections.

measured. In some cases, more than one current path is used. If trouble is not due to a faulty reed relay, an open resistor may be the cause. In all ranges except the 10 MΩ range, A6Q2 and A6Q4 (Figure 7-7) are off and A6Q3 is on, applying the + 10 V REF voltage to the resistor network. When the 10 MΩ range is selected A6Q2 is turned on, causing A6Q3 to be off and A2Q4 on. The resistive divider made up of A6R23-26 divides the reference voltage down to + 1 V at A6TP1.

5-57. Ohms Converter Reed Relay Checks.

In most cases of reed relay failure, the symptoms evident in the front panel display will indicate which relay is at fault. Table 5-7 lists a number of symptoms and the probable causes. Symptoms are listed with the ranges on which they appear. Check each range with full-scale and 1/10-scale input resistors to determine symptoms and the ranges affected. Any problem which appears on only one range may indicate a defective relay drive circuit. Resistors within ± 10% of full scale for each range are needed to perform these tests. Resistor values must be known to within 0.01%. An ohmmeter should be used to determine whether a reed switch is open or closed. Be careful not to apply stress to the leads of the reed switch.

5-58. FACTORY SELECTED COMPONENTS.

5-59. DC AMPLIFIER ASSEMBLY A2.

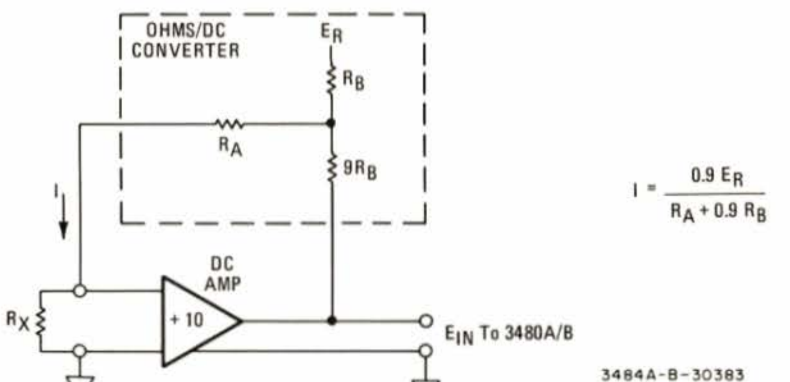
All the factory selected components on the DC Amplifier Assembly are within the circuits that are critical to the performance of the instrument under varying temperature conditions. Replacement of any of these components may affect accuracy with respect to temperature coefficient specifications. Therefore, if one of the factory selected components on this assembly requires replacement, the printed circuit assembly (A2) should be returned to the factory. See Paragraph 5-31 for repair and exchange information. If it is necessary to replace one of these components in the field, the replacement must be the same value as the original.

5-60. A6R7*

The value of A6R7* is selected to give A6R8, 1000K ADJ, the proper range of adjustment. If the 1000 kΩ range cannot be adjusted properly because of insufficient range of A6R8, A6R7* may be changed. If the display is too low, decrease the value of A6R7*, and if the display is too high, increase the value. The value may vary from 10 kΩ to 100 kΩ.

5-61. A6R25*.

The value of A6R25* is selected to provide the proper range for 10 MEG ADJ R26. If the 10 MΩ range cannot be adjusted properly due to insufficient range of A6R26, A6R25* may be replaced. If the display is too low, increase the value of A6R25*, and if the display is too high, decrease the value. The value may vary from 50 Ω to 100 Ω.



RANGE	E_R	R_A	R_B	$9R_B$	I
100	10 V	0	1 k (R13-16)	9 k (R10)	10 mA*
1000	10 V	(1) 9.1 k (R1-3)	1 k (R13-16)	9 k (R10)	1 mA
		(2) 0	100 k (R11,12,22-24)	900 k (R9)	
10 k	10 V	0	100 k (R11,12,22-24)	900 k (R9)	0.1 mA
100 k	10 V	810 k (R4,5 R6-8)	100 k (R11,12,22-24)	900 k (R9)	10 μA
1000 k	10 V	8.91 M (R6-8)	100 k (R11,12,22-24)	900 k (R9)	1 μA
10 M	1 V	8.91 M (R6-8)	100 k (R11,12,22-24)	900 k (R9)	0.1 μA

* A second current supply (R_A = R6-8; R_B = R11, 12, 22-24) is incidental to the 100 ohm range. The additional 1 microamp current supplied is not significant.

Figure 5-11. Ohms Converter Resistance.

Table 5-7. Ohms Converter Reed Relay Checks.

RANGES AFFECTED	SYMPTOMS	POSSIBLE CAUSES
100Ω	1 M input reads 100 ohms	A6K2 open
1000Ω 10 kΩ 100 kΩ 1000 kΩ 10 MΩ	100 ohm input reads full scale	A6K2 shorted
1000Ω	10 k input reads 1000 ohms	A6K3 open
10 kΩ 100 kΩ 1000 kΩ 10 MΩ	1000 ohm input reads 10 kilohms 1000 ohm input reads 90% of full scale	A6K3 shorted
100 kΩ	1 M input reads 100 kilohms	A6K4 open
100Ω 1000 kΩ 10 MΩ	100 ohm input reads 0.1% high 100 k input reads 1000 kilohms 100 k input reads 1 megohm	A6K4 shorted
1000Ω 10 kΩ	1000 ohm input reads 900 ohms 1 M input reads 10 kilohms	A6K5 open
100Ω 100 kΩ 1000 kΩ 10 MΩ	100 ohm input reads 1% high 10 k input reads full scale 10 k input reads 1 megohm	A6K5 shorted
All Ranges	Linearity is bad. On all ranges except 100 ohm range, readings are nearly correct for full-scale inputs. Readings are high toward lower end of range. On 100 ohm range, lower readings are nearly correct but full-scale input reads high.	A6K6 open
100Ω 1000Ω 10 kΩ 100 kΩ 1000 kΩ 10 MΩ	Readings are high by a factor of 10 or greater 1 M input reads OVERLOAD.	A2K1 open
All Ranges	With full-scale input applied on each range, readings are low by approximately a factor of 10.	A2K2 shorted
All Ranges	Resistance being measured appears to be in parallel with 10 megohms	A1K2 or A7K1 shorted.
All Ranges	Display is low. Readings for full-scale input vary from about 50% on 100 ohm range to about 10% of full-scale on 10 M range.	A1K3 shorted
All Ranges	With input open and filter out, display is erratic and noisy. With any input resistance, display is zero.	A1K8 or A6K1 open.

MANUAL CHANGES

MODEL 3484A

MULTIFUNCTION UNIT

Manual Part No. 03484-90000

► New or Revised Item

ERRATA

► **Page 5-6.** Figure 5-6, change R33 (V Set Adj) to R25.

Performance Check Card. Change last input voltage listed for 1000 mV range to ± 1000 mV.

Page 6-7. Change -hp- Part No. and description of Hinges to:
03484-01203 Hinge: AC converter assembly, left
03484-01204 Hinge: AC converter assembly, right

► **Page 6-9.** Delete A6R7 and replace A6R6 with A6R6A, R6B -hp- Part No. 0811-2985 R: fxd ww 4.45 megohms 0.01%.

► **Page 6-10.** MP10 change to Part No. 0340-0977
MP11 change to Part No. 0370-0978
MP12 change 5060-5949 to 0370-0979
MP12 change 5060-5950 to 0370-0980
MP14 change 5060-5951 to 0370-0981
MP14 change 5060-5952 to 0370-0982
MP14 change 5060-5953 to 0370-0983
MP14 change 5060-5954 to 0370-0984

► **Page 7-13.** Replace R6 and R7 with R6A, 4.45M and R6B, 4.45M.

CHANGE 1: FOR SERIAL NO. 975-00126 AND ABOVE.

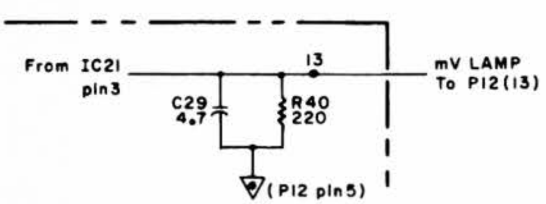
Page 6-2. Change -hp- Part No. of A1C1 to 0160-3623 C: fxd 0.082 microfarad 10%.

Page 6-5. Add A3C29 -hp- Part No. 0180-0309 C: fxd 4.7 microfarads 20% 10 vdcw.

Page 6-6. Add A3R40 -hp- Part No. 0684-2211 R: fxd comp 220 ohms 10% 1/4 W.

Page 7-5. Change value of A1C1 to 0.082.

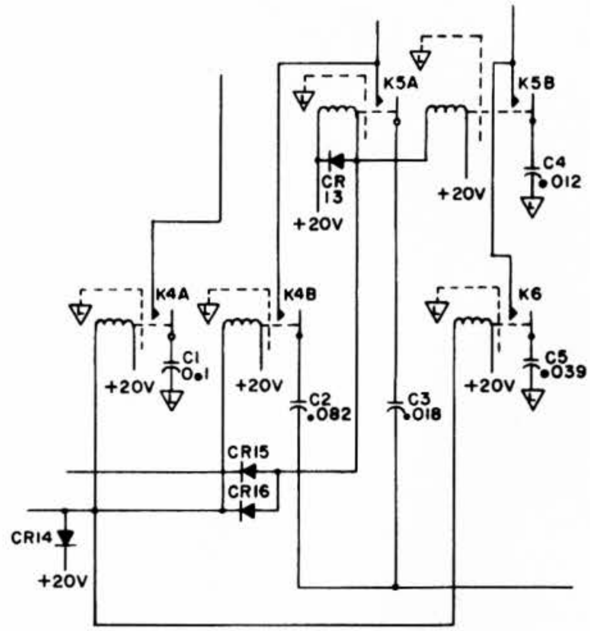
Page 7-9. Add C29 and R40 to A3 schematic as follows:



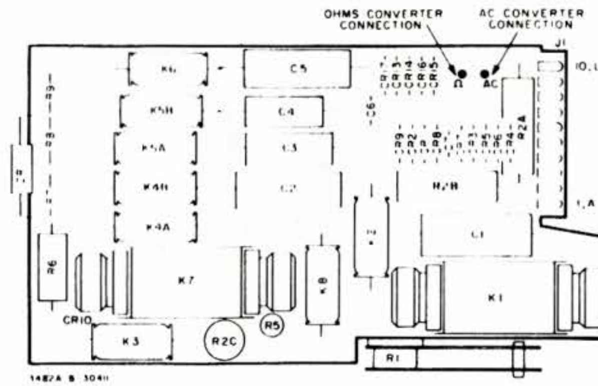
► **CHANGE 2: FOR SERIAL NO. 0975A00326 AND ABOVE.**

Page 6-2. Change Part No. of Coil: Electromagnetic for A1K2, 3, 4A, 4B, 5A, 5B, 6, and 8 from 9100-3216 to 0491-0057.

Page 7-5. Add separate coils for A1K4B and A1K5B as follows:



Add new A1 component location drawing.



A1
hp Part No. 03482-66501
SERIAL NO. 975-00326 AND ABOVE
Rev F

Page 6-11. Change Part No. of Shield: Guard, top to 03484-01205.

ZERO OFFSET TROUBLESHOOTING TREE

1. The first step determines whether trouble is in 3484A or 3480A/B.

2. If the display will not go to zero when polarity amplifier input is grounded, there is trouble in the 3480A/B.

3. If A2CR20 were shorted, amplifier input would be about + 18 V at all times.

4. If A2CR26 were shorted, amplifier input would be about - 18 V at all times.

5. This step eliminates the Attenuator Assembly from the High input circuit paths. If zero cannot be adjusted, High input circuit is probably all right.

6. If display goes to (or near) zero when A2R52 is removed from circuit, diode A2CR22 is probably bad. Display may not be zero on lower ranges because zero could not be adjusted properly in previous step. After replacing diode, perform Adjustment Procedures in Paragraph 5-13.

7. If display does not go to approximately zero when A2R52 is disconnected, A2CR22 is good. Display may not be zero on lower ranges because zero could not be adjusted properly in previous step. Reconnect A2R52 and proceed to Step 18.

8. If display goes to (or near) zero when A2R55 is removed from circuit, diode A2CR23 is probably bad. Display may not be zero on lower ranges because zero could not be adjusted properly in previous step. After replacing diode, perform Adjustment Procedures, Paragraph 5-13.

9. If display does not go to approximately zero when A2CR26 is disconnected, diode is good. Display may not be zero on lower ranges because zero could not be adjusted properly in previous step. Reconnect A2CR26 and proceed to Step 18.

10. This step substitutes a 1 megohm resistance in place of the Attenuator Assembly. If zero can be adjusted in this step, trouble is probably on the Attenuator Assembly.

11. Connecting amplifier input LOW lead directly to INPUT LOW eliminates low circuit paths on Attenuator Assembly. If zero still cannot be adjusted, Attenuator Assembly is apparently all right.

12. If zero adjusts with 1 megohm resistor replacing Attenuator resistance, trouble is probably leakage from a relay coil to the high circuit path. Switching ranges and filter positions may locate the faulty relay. The charts below the Attenuator schematic in Figure 7-3 list relays closed in the various ranges and filter positions.

13. If zero cannot be adjusted in Step 10, current is being injected into the circuit either by A2IC1A or the current compensating circuit A2Q11-13.

14. If zero adjusts with amplifier input LOW lead connected directly to INPUT LOW, trouble is probably leakage to a relay coil shield. Switching ranges and filter positions may locate the faulty relay. The charts below the Attenuator schematic in Figure 7-3 list relays closed in the various ranges and filter positions.

15. If zero will not adjust with amplifier LOW lead connected directly to INPUT terminal, trouble is on Amplifier Assembly. If A2CR39 is shorted, power supply ground currents may be injected into amplifier low circuit.

16. Preceding checks have isolated the trouble to A2IC1. Replacement of A2IC1 requires adjustment of several circuit parameters which must be done at the factory. See Paragraph 5-31.

17. A2Q11, 12, or 13 may be replaced if defective. The Adjustment Procedures, Paragraph 5-13, should be performed after repair.

18. This check eliminates A2IC1 from the circuit being tested. Range of A2R7 should be sufficient to saturate output in both directions.

19. Perform Amplifier Zero and Current Adjustment in Paragraph 5-16 after replacing A2CR39.

20. If display can be adjusted as indicated in Step 18, trouble is in A2IC1 and associated circuits. Filter Amplifier could be causing the zero offset. If Filter Amplifier output is $< \pm 20$ mV with its input grounded, trouble is in A2IC1 area.

21. If display cannot be adjusted as indicated in Step 18, trouble is in stages which follow A2IC1. Voltage readings should indicate defective component. Replacement of certain components requires extensive adjustment of circuit parameters, which must be done at the factory. Refer to Paragraph 5-31.

22. Previous checks indicate trouble is in A2IC1 or other components which directly affect operation of A2IC1. Replacement of A2IC1 or certain other components requires extensive adjustment of circuit parameters, which must be done at the factory. Refer to Paragraph 5-31.

23. Faulty operation of the Filter Amplifier may result in Zero offset.

PRELIMINARY CHECKS

1. Check power supply voltages.
2. Perform Adjustment Procedures, Paragraph 5-13. If amplifier cannot be adjusted, proceed with troubleshooting.

NOTES

1. Use INPUT LOW (black) terminal as ground connection unless otherwise stated.
2. After repair of Amplifier or Attenuator Assembly, perform Adjustment Procedures, Paragraph 5-13.
3. A zero offset may be the result of failure of the + 11 V power supply. In some instruments, an accidental short circuit of this supply, or transient voltages, may cause the output of the supply to go to zero and fail to recover. In this case, turning the instrument off and on again should return the supply to normal.

PASSES ⇧

FAILS ⇩

1. Set 3484A FUNCTION to VDC, RANGE to 100 mV, SAMPLE RATE fully clockwise, FILTER to OUT. Short HIGH and LOW terminals and connect GUARD to LOW. Remove 3480A/B top cover and connect jumper in 3480A/B from A3TP4 (Pol. Amp. In) to A3TP2 (Ground). Display should go to zero.
   - PASSES: Disconnect jumper between A3TP4 and A3TP2.
     - 3. If display is + 15999 on all ranges, disconnect either end of A2R52. Display should go to zero.
       - 6. Check A2CR22 for possible short.
       - 7. Reconnect A2R52. Proceed to Step 18.
     - 4. If display is − 15999 on all ranges, disconnect either end of A2R55. Display should go to zero.
       - 8. Check A2CR23 for possible short.
       - 9. Reconnect A2R55. Proceed to Step 18.
     - 5. Disconnect amplifier input HIGH (red) lead from Attenuator Assembly. See Figure 5-10. With clip lead, connect HIGH lead to INPUT HIGH terminal. Connect dc differential voltmeter (or digital voltmeter able to resolve 200 μV) between INPUT HIGH and 3480A/B A3TP4. Adjust COARSE ZERO (A2R7) and front panel ZERO for differential voltmeter reading < ± 200 μV.
       - 10. Connect a 1 MΩ resistor in series between INPUT HIGH and Amplifier HIGH lead. Perform Amplifier Zero and Offset Current Adjustments, Paragraph 5-16.
       - 11. Disconnect amplifier input LOW (black) lead from Attenuator Assembly (see Figure 5-10). With clip lead, connect LOW lead to INPUT LOW terminal. Adjust COARSE ZERO (A2R7) and front panel zero for differential voltmeter reading < ± 100 μV.
   - FAILS: 2. Trouble is in 3480A/B. Refer to 3480A/B Operating and Service Manual.

10. Connect a 1 MΩ resistor in series between INPUT HIGH and Amplifier HIGH lead. Perform Amplifier Zero and Offset Current Adjustments, Paragraph 5-16.

11. Disconnect amplifier input LOW (black) lead from Attenuator Assembly (see Figure 5-10). With clip lead, connect LOW lead to INPUT LOW terminal. Adjust COARSE ZERO (A2R7) and front panel zero for differential voltmeter reading $< \pm 100\ \mu V$.

12. Remove 1 MΩ resistor and connect amplifier HIGH lead back to proper pin on Attenuator Assembly. Troubleshoot HIGH circuit paths on Attenuator Assembly.

13. Remove 1 MΩ resistor and connect amplifier HIGH lead back to proper pin on Attenuator Assembly. Check voltages at A2Q11-13. Should be approximately as shown on schematic.

14. Replace amplifier LOW lead on Attenuator Assembly. Troubleshoot LOW circuit paths on Attenuator Assembly.

15. Replace amplifier HIGH and LOW leads to proper connections on Attenuator Assembly. Check A2CR39 for possible short. Breakdown voltage should be 2.37 V ± 5%.

16. If voltages are correct, A2IC1 is defective and Amplifier Assembly A2 must be returned to the factory. Refer to Paragraph 5-31.

17. Replace defective component and perform Adjustment Procedure, Paragraph 5-13.

18. Remove the black thermal cover on Amplifier Assembly. Using a clip lead connect test point BAL 1 to BAL 2 (marked 1 and 2 on printed circuit board). Rotate COARSE ZERO (A2R7) from one extreme to the other. Display should change from + 15999 to - 15999. (Adjust display to as near zero as possible with A2R7.)

19. Replace A2CR39.

20. If display can be adjusted from + 15999 to - 15999, disconnect jumper from BAL 1 to BAL 2. Connect clip lead from common connection of A2K1, 2, and 3 to INPUT LOW. Measure output voltage of Filter Amplifier at junction of A2R59, 60. Should be $< \pm 20$ mV.

21. If display cannot be adjusted from + 15999 to - 15999, disconnect jumper from BAL 1 to BAL 2. Measure voltages at A2Q2, 3, 8, 10, 15-18. Voltages should be approximately as shown on schematic. If defective components are outside of shaded areas on component location drawing of A2 in Figure 7-3, replace. If defective components are within shaded areas, refer to Paragraph 5-31.

22. Check dc voltages at A2Q4, 5, 11-14. Voltages should be approximately as shown on schematic. Also check diodes A2CR1-5. If defective components are outside of shaded areas on component location drawing of A2 in Figure 7-3, replace. If defective components are within shaded areas, refer to Paragraph 5-31.

23. Troubleshoot Filter Amplifier. Typical operating voltages are shown on schematic.

SYMPTOMS:

Zero offset with INPUT terminals shorted.
or
Display of ± 15999 with INPUT terminals shorted.

Figure 5-12. DC Zero Offset Troubleshooting Tree.

PRELIMINARY CHECK

Check power supply voltages.

NOTES

1. Use INPUT LOW (black) terminal as ground connection unless otherwise stated.
2. After repair of Amplifier Assembly, perform Adjustment Procedures, Paragraph 5-13.

3484A-C-30394

1. Set 3484A FUNCTION to VDC, RANGE to 10 V, SAMPLE RATE fully clockwise, FILTER OUT. Remove Amplifier Assembly A3 (or A8) from 3480A/B. Connect 3484A E_{in}(J2 pin 7) to Sense (J2 pin 9). Connect dc voltmeter between E_{in} and INPUT LOW terminal. Connect dc standard to 3484A INPUT. Set standard output to 15.990 V. (If limiting occurs on only one polarity, set dc standard output to this polarity.) DC voltmeter reading should be the same as dc standard output.

PASSES

2. If dc voltmeter reading is the same as INPUT voltage, trouble is in 3480A/B. Refer to 3480A/B Operating and Service Manual.

FAILS

3. Replace 3480A/B Amplifier Assembly and disconnect short from E_{in} to Sense. Disconnect dc voltmeter. Disconnect one end of either A2CR14 or 15. Display should be approximately 15.990 V.

4. If display is correct, and limiting occurred with positive input voltage, A2CR14 is probably shorted.

5. If display is correct, and limiting occurred with negative input voltage, A2CR15 is probably shorted.

6. If limiting is still present with positive input voltage reconnect A2CR14 or 15. Check A2CR20 and A2Q19.

7. If limiting is still present with negative input voltage, reconnect A2CR14 or 15. Check A2CR26 and A2Q20.

Figure 5-13. Limited DC Display Troubleshooting Tree.

SYMPTOMS

Display is correct up to a certain point, but will not go higher than this point. This condition is referred to in this procedure as limiting.

PRELIMINARY CHECKS

If SAMPLE indicator does not flash normally, check for waveform at CLK C test point at center of A3. If waveform is correct, troubleshoot Sample indicator lamp and drive circuits. If waveform is not present, check 3480A/B Sample Generator and Clock Control Multivibrator circuits.

NOTES

1. All components and test points referred to in this procedure are located on Range and Function Assembly A3.

2. Numerical display may not change during autoranging checks. Range is determined by decimal position and function annunciator as follows:

100 mv	xx.xx mV
1000 mV	xxx.x mV
10 V	x.xxx V
100 V	xx.xx V
1000 V	xxx.x V

PASSES

FAILS

1. Set FUNCTION to VDC, RANGE to 1000 V, SAMPLE RATE fully clockwise, FILTER to B. Short INPUT terminals. Short two FR test points together (upper left corner of A3). Turn RANGE switch to AUTO. These conditions cause the Uprange Gate to produce an Autorange Command after each sample period. With input shorted, Downrange Enable will be LOW after each sample, causing Range Register to downrange. Instrument should range continuously between 100 V, 10 V, 1000 mV, and 100 mV ranges. It should not go to the 1000 V range.

2. If instrument downranges as indicated in Step 1, Clock Control, Autorange, and Downrange Enable signals are correct and Uprange Gate is operating. Range Register operates properly in the downrange mode. Disconnect short from FR test points. With input shorted, instrument should downrange to 100 mV.

3. If display stays on one range, Uprange Gate (IC7), the preceding Inverter (IC2), or R1 Flip-Flop (IC6) may be defective.

4. If display downranges continuously between 1000 V, 100 V, 10 V, 1000 mV, and 100 mV ranges, CR8 may be shorted.

5. If display ranges between 1000 V, 100 V, and 10 V ranges, C14, C18, C25 may be shorted; C18, C24, CR8 may be open; R1 - R2 Lockout Gate (IC18) or R3 Flip-Flop (IC14) may be defective.

6. If display ranges between 100 V and 10 V, C9, C15, CR6, CR9 may be shorted; C9, C16, CR6 may be open; or R2 Flip-Flop (IC14) may be defective.

7. If display ranges between 100 V and 100 mV, C16 or C20 may be shorted.

8. If display ranges between 1000 mV and 100 mV, C9 may be shorted; C14, CR6 may be open; or R1, R2 Flip-Flops (IC14) may be defective.

9. If display upranges between 100 mV, 1000 mV, 10 V, and 100 V, CR7 may be shorted.

10. If mV light stays on while decimal changes as follows: right; center; center and right; center and left; C24 may be shorted or R3 Flip-Flop (IC14) may be defective.

11. Disconnect input short and apply 1.5 V to INPUT terminals. Should uprange to 10 V range.

12. If instrument does not downrange, trouble is probably in Downrange Gate, Downrange Limit Gate, or the associated inverters.

13. If instrument upranges correctly to 10 V range, increase input to 150 V. Should uprange to 1000 V range.

14. If display ranges between 100 mV and 1000 mV, C10 may be defective or CR7 may be open.

15. If display stays on 100 mV range, check Uprange Limit Gate and limit signals. Also check Uprange signal input from 3480A/B.

16. If instrument has passed all tests to this point, trouble may be due to intermittent or marginal operation of a circuit or component.

17. If display ranges between 10 V, 100 V, 100 mV, and 1000 mV, C19 may be shorted.

3484A-C-30393

Figure 5-14. Autorange Troubleshooting Tree.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 3484A
Multifunction Unit
Serial No. ______________

Tests performed by ______________
Date ______________

PARAGRAPH	DESCRIPTION	READING	TEST LIMITS
5-4	Accuracy and Linearity Check		

Input	Range	Pos.	Neg.	Min.	Max.
± 100.000 mV	100 mV	______	______	± 99.97 mV	to 100.03 mV
± 90.000 mV	100 mV	______	______	± 89.97 mV	to 90.03 mV
± 80.000 mV	100 mV	______	______	± 79.97 mV	to 80.03 mV
± 70.000 mV	100 mV	______	______	± 69.97 mV	to 70.03 mV
± 60.000 mV	100 mV	______	______	± 59.97 mV	to 60.03 mV
± 50.000 mV	100 mV	______	______	± 49.97 mV	to 50.03 mV
± 40.000 mV	100 mV	______	______	± 39.98 mV	to 40.02 mV
± 30.000 mV	100 mV	______	______	± 29.98 mV	to 30.02 mV
± 20.000 mV	100 mV	______	______	± 19.98 mV	to 20.02 mV
± 10.000 mV	100 mV	______	______	± 09.98 mV	to 10.02 mV
± 100.00 mV	1000 mV	______	______	± 099.9 mV	to 100.1 mV
± 300.00 mV	1000 mV	______	______	± 299.9 mV	to 300.1 mV
± 500.00 mV	1000 mV	______	______	± 499.8 mV	to 500.2 mV
± 700.00 mV	1000 mV	______	______	± 699.8 mV	to 700.2 mV
± 900.00 mV	1000 mV	______	______	± 899.8 mV	to 900.2 mV
± 1000.00 V	1000 mV	______	______	± 999.8 mV	to 1000.2 mV
± 10.0000 V	10 V	______	______	± 9.998 V	to 10.002 mV
± 9.0000 V	10 V	______	______	± 8.998 V	to 9.002 V
± 7.0000 V	10 V	______	______	± 6.998 V	to 7.002 V
± 5.0000 V	10 V	______	______	± 4.998 V	to 5.002 V
± 3.0000 V	10 V	______	______	± 2.999 V	to 3.001 V
± 1.0000 V	10 V	______	______	± 0.999 V	to 1.001 V
± 10.000 V	100 V	______	______	± 09.99 V	to 10.01 V
± 100.000 V	100 V	______	______	± 99.98 V	to 100.02 V
± 1000.00 V	1000 V	______	______	± 999.8 V	to 1000.2 V
- 1000.00 V	1000 V	______	______	- 999.8 V	to 1000.2 V
or (740B)					
- 500.00 V	1000 V	______	______	- 499.8 V	to 500.2 V
± 100.00 V	1000 V	______	______	± 099.1 V	to 100.1 V

PARAGRAPH	DESCRIPTION	READING	TEST LIMITS
5-5	VDC Input Resistance Check		
	100 mV, 1000 mV, 10 V ranges	______ volts change	0.009 V max change
	100 V, 1000 V ranges	______ volts change	0.90 to 0.92 V change
5-8	DC Common Mode Rejection Check	______ volts change	0.049 V max change
5-9	AC Common Mode Rejection Check	______ volts change	0.001 V max change
5-10	AC Normal Mode Rejection Check	______ volts change	0.001 V max change

PERFORMANCE CHECK TEST CARD (Cont'd)

PARAGRAPH	DESCRIPTION		READING	TEST LIMITS
5-11	Ohmmeter Accuracy Check			
	Range	Input		
	100 Ω	100 Ω	________	(100.00 Ω + offset) ± 7 counts
	1000 Ω	1 kΩ	________	(1000.0 Ω + offset) ± 2 counts
	10 kΩ	10 kΩ	________	10.000 kΩ ± 2 counts
	100 kΩ	100 kΩ	________	100.00 kΩ ± 2 counts
	1000 kΩ	1 MΩ	________	1000.0 kΩ ± 2 counts
	10 MΩ	10 MΩ	________	10.000 MΩ ± 11 counts

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 (TQ 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.)

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
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
grd .... 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 .... potiometer
p-p .... peak-to-peak
ppm .... parts per million
prec .... precision (temperature coefficient, 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}

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
V .... vacuum tube, neon bulb, photocell, etc.
W .... cable
X .... socket
XDS .... lampholder
XF .... fuseholder
Y .... crystal
Z .... network

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	**03482-66501**	**1**	**ATTENUATOR ASSEMBLY**	**-hp-**	
C1	0160-3419	1	C: fxd 0.10 microfarad 10% 100 vdcw	96733	C-65146-2
C2	0160-3556	1	C: fxd 0.082 microfarad 5% 50 vdcw	84411	HEW-213
C3	0160-3555	1	C: fxd 0.018 microfarad 5% 50 vdcw	84411	HEW-212
C4	0160-3472	1	C: fxd teflon 0.012 microfarad 5% 100 vdcw	96733	C-65149-1
C5	0160-3473	1	C: fxd teflon 0.039 microfarad 5% 100 vdcw	96733	C-65149-3
C6, C7	0150-0093	2	C: fxd 0.01 microfarad + 80% - 20% 100 vdcw	91418	TA obd
CR1 thru CR10	1901-0040	42	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR11	1902-0542	1	Diode Assy: Breakdown 20 V	-hp-	
CR12			Not assigned		
CR13 thru CR17	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
K1	0490-0877	2	Relay: Reed	-hp-	
K2, K3	0490-0802	3	Switch: Reed (does not include coil)	-hp-	
	9100-3216	4	Coil: Electromagnetic for K2 and K3	-hp-	
K4A/B, K5A/B	0490-0801	6	Switch: Reed, magnetic (does not include coil)	-hp-	
	9100-3217	2	Coil: Electromagnetic for K4 and K5	-hp-	
K6	0490-0801		Switch: Reed, magnetic (does not include coil)	-hp-	
	9100-3216		Coil: Electromagnetic for K6	-hp-	
K7	0490-0877		Relay: Reed	-hp-	
K8	0490-0802		Switch: Reed (does not include coil)	-hp-	
	9100-3216		Coil: Electromagnetic for K8	-hp-	
R1	0698-7619	1	R: fxd flm 100 kilohms 1% 5 W	19647	MP312 obd
	03482-01205	1	Shield: Resistor	-hp-	
	03482-01206	1	Heat Sink	-hp-	
	0380-0474	1	Spacer: bushing, teflon	98291	227262
	0520-0133	1	Screw: RH 2-56 x 1/2		
	0610-0001	1	Nut: Hex 2-56		
	2190-0045	1	Lockwasher: Helical No. 2		
	3050-0098	1	Washer: Flat No. 2		
	3050-0494	1	Washer: Flat, teflon		
	3050-0495	1	Washer: Shoulder, teflon		
R2A/B/C	0811-1141	1	Matched set: 2 - 4.95 megohms, 1 - 99.8 kilohms	-hp-	obd
R3, R4			Not assigned		
R5	2100-1986	1	R: var cermet flm 1 kilohm 10% 1/2 W	73138	62-206-1
R6	0698-7510	1	R: fxd carbon comp 620 kilohms 5% 2 W	01121	HB6245
R7	0683-1255	1	R: fxd comp 1.2 megohms 5% 1/2 W	01121	CB1255
R8	0683-6245	1	R: fxd comp 620 kilohms 5% 1/2 W	01121	CB6245
R9	0683-1025	5	R: fxd comp 1 kilohm 5% 1/4 W	01121	CB1025
	0340-0060	36	Terminal: Solder stud, teflon	98291	FT-E-15
	0360-1442	7	Terminal: Teflon insulated	98291	ST-2000SL
	0490-0811	20	Terminal: Reed relay	27264	SDX1988-G obd
	03482-05501	2	Shield: Reed coil for K1 and K7	-hp-	
	03484-01202	1	Shield: Attenuator	-hp-	
	2190-0918	2	Lockwasher: Helical No. 6		
	2360-0207	2	Screw: Pan head 6-32 x 7/8		
A2	**03482-66502**	**1**	**DC AMPLIFIER ASSEMBLY**	**-hp-**	
	03482-69502	1	Rebuilt DC Amplifier Assembly See Paragraph 5-31	-hp-	
C1	0140-0178	1	C: fxd mica 560 pF 2%	72136	RDM15F561G3C obd
C2	0140-0202	1	C: fxd mica 15 pF 5%	72136	RDM15C150J5C obd
C3	0160-0178	2	C: fxd mica 27 pF 5%	72136	RDM15E270J3S obd

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)					
C4	0160-0938	1	C: fxd mica 0.001 microfarad 5% 100 V	72136	RDM15E102J1C obd
C5	0180-0300	1	C: fxd 20 microfarad - 10% + 75% 15 vdcw	56289	30D206G015BB2-DSM
C6	0140-0198	1	C: fxd mica 200 pF 5%	72136	RDM15F201J3C obd
C7			Not assigned		
C8	0140-0197	1	C: fxd mica 180 pF 5% 300 V	72136	RDM15F181J3C obd
C9			Not assigned		
C10	0180-1702	1	C: fxd 180 microfarads 20% 6 vdcw	56289	150D187X0006B2-DYS
C11	0160-2018	1	C: fxd mica 250 pF 5% 100 V	00853	RDM15F251J5S obd
C12	0160-0178		C: fxd mica 27 pF 5%	72136	RDM15E270J3S obd
C13	0160-2208	1	C: fxd mica 330 pF 5%	00853	RDM15F331J3C obd
CR1 thru CR4	1901-0025	27	Diode: Si	03877	SG-817 obd
CR5	1902-0048	2	Diode: 5% - 6.81 V	04713	SZ10939-134
CR6, CR7	1901-0025		Diode: Si	03877	SG-817 obd
CR8	1902-0048		Diode: 5% - 6.81 V	04713	SZ10939-134
CR9	1901-0025		Diode: Si	03877	SG-817 obd
CR10	1902-0071	1	Diode: - 9.0 V 5%	04713	SZ11085 obd
CR11	1902-3190	1	Diode: 13.0 V 5%	04713	SZ10939-215
CR12, CR13	1902-0777	2	Diode: 6.2 V 5% IN 825	04713	IN825
CR14, CR15	1902-0766	4	Diode: - 18.2 V 5%	04713	SZ10939-257
CR16 thru CR19	1901-0025		Diode: Si	03877	SG-817 obd
CR20	1902-0766		Diode: - 18.2 V 5%	04713	SZ10939-257
CR21	1901-0025		Diode: Si	03877	SG-817 obd
CR22, CR23	1901-0546	2	Diode: Si	17856	FN1705
CR24, CR25	1901-0025		Diode: Si	03877	SG-817 obd
CR26	1902-0766		Diode: - 18.2 V 5%	04713	SZ10939-257
CR27 thru CR29	1901-0025		Diode: Si	03877	SG-817
CR30			Not assigned		
CR31 thru CR38	1901-0025		Diode: Si	03877	SG-817 obd
CR39, CR40	1902-3002	2	Diode: 2.37 V 5%	04713	SZ10939-Z
CR41, CR42	1901-0025		Diode: Si	03877	SG-817 obd
IC1	1820-0404	1	IC: Si N Channel	-hp-	
K1 thru K3	0490-0778	3	Switch: Reed, magnetic	-hp-	
	9100-1463	3	Coil: Electromagnetic for K1 thru K3	-hp-	
Q1			Not assigned		
Q2A/B	1854-0221	2	TSTR: Si dual NPN**	-hp-	
Q3 thru Q5	1854-0408	13	TSTR: Si NPN**	-hp-	
Q6	1853-0238	8	TSTR: Si PNP**	-hp-	
Q7	1854-0408		TSTR: Si NPN**	-hp-	
Q8A/B	1853-0262	1	TSTR: Dual PNP**	-hp-	
Q9			Not assigned		
Q10 thru Q13	1854-0408		TSTR: Si NPN**	-hp-	
Q14A/B	1854-0221		TSTR: Si dual NPN**	-hp-	
Q15	1853-0238		TSTR: Si PNP**	-hp-	
Q16, Q17	1854-0408		TSTR: Si NPN**	-hp-	
Q18	1853-0238		TSTR: Si PNP**	-hp-	
Q19	1854-0408		TSTR: Si NPN**	-hp-	
Q20	1853-0238		TSTR: Si PNP**	-hp-	
Q21	1854-0408		TSTR: Si NPN*	-hp-	
Q22, Q23	1853-0238		TSTR: Si PNP**	-hp-	
Q24	1854-0408		TSTR: Si NPN**	-hp-	
Q25, Q26	1853-0238		TSTR: Si PNP**	-hp-	
Q27	1855-0036		TSTR: Si N Channel*	-hp-	
Q28	1854-0408		TSTR: Si NPN**	-hp-	

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)					
R1	0683-1025		R: fxd comp 1 kilohm 5% 1/4 W	01121	CB1025
R2	0698-7379	1	R: fxd 2 x 10^{10} ohms 10%	63060	RX-1 obd
R3	0757-0280	3	R: fxd flm 1 kilohm 1% 1/8 W	14674	C4 obd
R4	0698-4480	1	R: fxd flm 15.8 kilohms 1% 1/8 W	01295	MC55D
R5	0698-3518	1	R: fxd flm 7.32 kilohms 1% 1/8 W	14674	C4 obd
R6	0698-4205	3	R: fxd flm 21 kilohms 1% 1/8 W	14674	C4 obd
R7	2100-0755	2	R: var 1 kilohm 5% ww	75042	CT-100-4 obd
R8	0698-4498	1	R: fxd flm 53.6 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R9	0698-3572	2	R: fxd flm 60.4 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R10	0757-0476	2	R: fxd flm 301 kilohms 1% 1/8 W	14674	C4 obd
R11	0757-0280		R: fxd flm 1 kilohm 1% 1/8 W	14674	C4 obd
R12	0757-0457	2	R: fxd flm 47.5 kilohms 1% 1/8 W	91637	MF-1/10-32 obd
R13, R14	0757-0283	2	R: fxd flm 2 kilohms 1% 1/8 W	14674	C4 obd
R15	0698-3572		R: fxd flm 60.4 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R16	0757-0476		R: fxd flm 301 kilohms 1% 1/8 W	14674	C4 obd
R17	0698-4516	1	R: fxd flm 113 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R18	0757-0280		R: fxd flm 1 kilohm 1% 1/8 W	14674	C4 obd
R19	0698-3265	1	R: fxd flm 118 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R20, R21	0757-0288	2	R: fxd flm 9.09 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R22, R23	0811-1139	1	Matched set: 2 - 45.5 kilohms	-hp-	
R24	0698-4470	1	R: fxd flm 6.98 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R25	2100-2216	3	R: var 5 kilohms 10% 1/2 W	73138	62-208-1
R26	0757-0402	1	R: fxd flm 110 ohms 1% 1/8 W	14674	C4 obd
R27*, R28*			Factory selected value		
R29	0698-4205		R: fxd flm 21 kilohms 1% 1/8 W	14674	C4 obd
R30	0757-0428	1	R: fxd flm 1.62 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R31*			Factory selected value		
R32	0757-0422	1	R: fxd flm 909 ohms 1% 1/8 W	14674	C4 obd
R33	2100-0755		R: var 1 kilohm 5% ww	75042	5T-100-4
R34	0698-4393	1	R: fxd flm 73.2 ohms 1% 1/8 W	14674	C4 obd
R35	0683-1025		R: fxd comp 1 kilohm 5% 1/4 W	01121	CB1025
R36	0698-3119	1	R: fxd met flm 6.98 kilohms 1% 1/2 W	91637	MFF-1/2-10 obd
R37	0811-2861	1	R: 988 kilohms 0.05% prec ww	-hp-	
R38	2100-2216		R: var 5 kilohms 10% 1/2 W	73138	62-208-1
R39	2100-1788	1	R: var 500 ohms 10%	73138	62-205-1
R40	0811-2860	1	R: 98.8 kilohms 0.05% prec ww	-hp-	
R41	0698-7479	1	R: fxd prec flm 10 kilohms 0.1%	18612	S102 obd
R42			Not assigned		
R43, R44	0757-0281	2	R: fxd flm 2.74 kilohms 1% 1/8 W	91637	MF-1/10-32 obd
R45	0683-1045	4	R: fxd comp 100 kilohms 5% 1/4 W	01121	CB1045
R46	0683-1825	2	R: fxd comp 1.8 kilohms 5% 1/4 W	01121	CB1825
R47, R48	0683-1015	4	R: fxd comp 100 ohms 5% 1/4 W	01121	CB1015
R49	0683-1045		R: fxd comp 100 kilohms 5% 1/4 W	01121	CB1045
R50	0683-1825		R: fxd comp 1.8 kilohms 5% 1/4 W	01121	CB1825
R51	0684-1241	2	R: fxd comp 120 kilohms 10% 1/4 W	01121	CB1241
R52	0684-1231	1	R: fxd comp 12 kilohms 10% 1/4 W	01121	CB1231
R53	0683-6235	1	R: fxd comp 62 kilohms 5% 1/4 W	01121	CB6235
R54	0684-1241		R: fxd comp 120 kilohms 10% 1/4 W	01121	CB1241
R55	0684-2231	22	R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R56	0683-1025		R: fxd comp 1 kilohm 5% 1/4 W	01121	CB1025
R57	0683-1045		R: fxd comp 100 kilohms 5% 1/4 W	01121	CB1045
R58	2100-2216		R: var 5 kilohms 10% 1/2 W	73138	62-208-1
R59, R60	0683-1015		R: fxd comp 100 ohms 5% 1/4 W	01121	CB1015
R61	0683-1025		R: fxd comp 1 kilohm 5% 1/4 W	01121	CB1025
R62	0683-1045		R: fxd comp 100 kilohms 5% 1/4 W	01121	CB1045
R63			Not assigned		
R64, R65	0757-0459	2	R: fxd flm 56.2 kilohms 1% 1/8 W	14674	C4 obd
R66	0757-0457		R: fxd flm 47.5 kilohms 1% 1/8 W	91637	MF-1/10-32 obd
R67, R68	0683-3045	2	R: fxd comp 300 kilohms 5% 1/4 W	01121	CB3045
R69			Not assigned		

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)					
R70	0698-4205		R: fxd flm 21 kilohms 1% 1/8 W	14674	C4 obd
R71*, R72*			Factory sleected value		
R73	0698-4395	1	R: fxd flm 78.7 ohms 1% 1/8 W	91637	CMF-1/10-32 obd
R74	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R75 thru R79			Not assigned		
R80*			Factory selected value		
	0340-0060		Terminal: Solder stud	98291	FT-E-15 obd
	0490-0811		Terminal: Reed relay	27264	SDX-1988-G obd
	5020-6822	1	Enclosure: Isothermal	-hp-	
A3	**03484-66503**	**1**	**RANGE AND FUNCTION ASSEMBLY**	**-hp-**	
C1	0160-0194	2	C: fxd mylar 0.015 microfarad 10% 200 vdcw	56289	192P15392-PTS
C2	0170-0024	1	C: fxd mylar 0.022 microfarad 20% 200 vdcw	56289	192P22302-PTS
C3	0160-0194		C: fxd mylar 0.015 microfarad 10% 200 vdcw	56289	192P15392-PTS
C4	0180-0197	1	C: fxd 2.2 microfarad 10% 20 vdcw	56289	150D225X9020A2-DYS
C5, C6	0180-0309	2	C: fxd 4.7 microfarad 20% 10 vdcw	90201	TA S475M010PIA
C7	0160-0157	1	C: fxd mylar 4700 pF 10% 200 vdcw	56289	192P47292-PTS
C8	0160-0170	1	C: fxd cer 0.22 microfarad + 80% - 20% 25 vdcw	56289	5C9B-CML
C9, C10	0160-0362	4	C: fxd mica 510 pF 5%	72136	RDM15F511J3C obd
C11	0160-3188	1	C: fxd mylar 0.27 microfarad 10% 50 vdcw	84411	HEW-101 obd
C12	0160-3405	1	C: fxd 2.0 microfarad 10% 50 vdcw	84411	HEW-138 obd
C13	0160-2611	1	C: fxd mylar 1.0 microfarad 10% 50 vdcw	84411	HEW-101 obd
C14	0140-0194	4	C: fxd mica 110 pF 5%	72136	RDM15F111J3C obd
C15	0140-0145	2	C: fxd mica 22 pF 5%	14655	obd
C16	0140-0194		C: fxd mica 110 pF 5%	72136	RDM15F111J3C obd
C17	0160-0154	1	C: fxd mylar 0.0022 microfarad 10% 200 vdcw	56289	192P22292-PTS
C18	0160-0362		C: fxd mica 510 pF 5%	72136	RDM15F511J3C obd
C19	0140-0145		C: fxd mica 22 pF 5%	14655	obd
C20	0160-0362		C: fxd mica 510 pF 5%	72136	RDM15F511J3C obd
C21	0160-0165	1	C: fxd mylar 0.056 microfarad 10% 200 vdcw	56289	192P56392-PTS
C22	0150-0121	1	C: fxd cer 0.1 microfarad - 20% + 80% 5 vdcw	56289	5C50B1-CML
C23	0150-0122	2	C: fxd 0.002 microfarad 20% 500 vdcw	72982	801-000-Y5S-202M
C24, C25	0140-0194		C: fxd mica 110 pF 5%	72136	RDM15F111J3C obd
C26	0160-2605	1	C: fxd 0.02 microfarad - 20% + 80% 25 vdcw	72982	5835V5U203Z
C27	0150-0122		C: fxd 0.002 microfarad 20% 500 vdcw	72982	801-000-Y5S-202M
C28	0180-1701	1	C: fxd 6.8 microfarad 20% 6 vdcw	56289	150D685X0006H2-DYS
CR1 thru CR5	1910-0016	7	Diode: Ge 60 wiv	03877	S3185G
CR6 thru CR12	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
CR13, CR14	1910-0016		Diode: Ge 60 wiv	03877	S3185G
CR15 thru CR23	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
CR24	1902-0041	1	Diode: Breakdown, Si 5.11 V 5%	04713	SZ10939-98
IC1, IC2	1820-0307	10	IC: Hex inverter	01295	SN14656
IC3	1820-0310	3	IC: 3-input NAND gate	01295	SN4505
IC4, IC5	1820-0307		IC: Hex inverter	01295	SN14656
IC6	1820-0202	1	IC: Flip-flop 16 pin dual	18324	SP322B
IC7 thru IC9	1820-0094	8	IC: DTL Quad 2-input Gate	04713	MC846P
IC10	1820-0307		IC: Hex inverter	01295	SN14656
IC11	1820-0310		IC: 3-input NAND gate	01295	SN4505
IC12	1820-0307		IC: Hex inverter	01295	SN14656
IC13	1820-0094		IC: DTL Quad 2-input Gate	04713	MC846P
IC14	1820-0349	1	IC: 2-input NAND gate	01295	SN15031
IC15	1820-0310		IC: 3-input NAND gate	01295	SN4505
IC16, IC17	1820-0307		IC: Hex inverter	01295	SN14656
IC18	1820-0094		IC: DTL Quad 2-input Gate	04713	MC846P

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3 (Cont'd)					
IC19	1820-0307		IC: Hex inverter	01295	SN14656
IC20	1820-0094		IC: DTL Quad 2-input Gate	04713	MC846P
IC21	1820-0409	1	IC: Digital	04713	SC8176
IC22	1820-0094		IC: DTL Quad 2-input Gate	04713	MC846P
IC23	1820-0307		IC: Hex inverter	01295	SN14656
IC24	1820-0094		IC: DTL Quad 2-input Gate	04713	MC846P
J1, J2	03484-27601	4	Connector: 20 pin	-hp-	
	03484-04701	4	Filler strip	-hp-	
J3, J4			Not assigned		
J5, J6	03484-27601		Connector: 20 pin	-hp-	
	03484-04701		Filler strip	-hp-	
J7	1251-1633	1	Connector: Printed circuit	71785	252-15-30-310
L1	9170-0016	1	Bead: Shielding, zinc ferrite	02114	56-590-65A1/3B
L2	9140-0210	1	Inductor: fxd 100 microhenry 5%	82142	15-1315-12J
Q1 thru Q6	1854-0071	25	TSTR: Si NPN 2N3391	01295	SKA1124
Q7	1853-0020	1	TSTR: Si PNP**	-hp-	
Q8 thru Q13	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q14	1854-0053	1	TSTR: Si NPN 2N2218	04713	2N2218
Q15, Q16	1854-0087	2	TSTR: Si NPN 2N3417	03508	4JX16N2989
Q17 thru Q19	1854-0022	3	TSTR: Si NPN**	-hp-	
Q20 thru Q32	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
R1	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R2	0684-1021	6	R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R3	0684-1831	2	R: fxd comp 18 kilohmms 10% 1/4 W	01121	CB1831
R4	0684-1031	7	R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R5	0684-2231		R: fxd comp 22 kilohm 10% 1/4 W	01121	CB2231
R6, R7	0684-1021		R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R8	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R9	0684-1511	1	R: fxd comp 150 ohms 10% 1/4 W	01121	CB1511
R10	0757-0436	1	R: fxd flm 4.32 kilohms 1% 1/8 W	14674	C4 T-O obd
R11, R12	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R13	0698-5912	1	R: fxd flm 1.20 megohm 1% 1/2 W	91637	MFF-1/2-10T-1 obd
R14 thru R16	0757-0441	3	R: fxd flm 8.25 kilohms 1% 1/8 W	91637	CMF-1/10-32 obd
R17 thru R19	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R20, R21	0684-1021		R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R22	0684-4721	2	R: fxd comp 4.7 kilohms 10% 1/4 W	01121	CB4721
R23	0684-1041	2	R: fxd comp 100 kilohms 10% 1/4 W	01121	CB1041
R24	0684-3921	2	R: fxd comp 3.9 kilohms 10% 1/4 W	01121	CB3921
R25	0684-1831		R: fxd comp 18 kilohms 10% 1/4 W	01121	CB1831
R26	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R27	0684-4721		R: fxd comp 4.7 kilohms 10% 1/4 W	01121	CB4721
R28	0684-1021		R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R29	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB1041
R30	0684-1811	1	R: fxd comp 180 ohms 10% 1/4 W	01121	CB1811
R31	0684-3921		R: fxd comp 3.9 kilohms 10% 1/4 W	01121	CB3921
R32 thru R34	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R35	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01131	CB1031
R36	0684-6821	1	R: fxd comp 6.8 kilohms 10% 1/4 W	01121	CB6821
R37	0757-0445	1	R: fxd flm 13.0 kilohm 1% 1/8 W	91637	CMF-1/10-32 obd
R38, R39	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
	1200-0432		IC Socket: Strip	27264	1938-4 obd
	1251-2501	42	Spring: IC socket	00779	50462-8

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3 (Cont'd)					
	1600-0195	1	Hinge: AC converter assembly	-hp-	
	1600-0196	1	Hinge: AC converter assembly	-hp-	
			PARTS REQUIRED FOR OPTION 041		
A4	**11151-66501**	**1**	**ISOLATED REMOTE ASSEMBLY (Transmitter)**	**-hp-**	
C1 thru C7	0160-0300	15	C: fxd mylar 0.0027 microfarad 10% 200 vdcw	56289	192P27292-PTS
C8, C9	0160-0161	3	C: fxd mylar .01 microfarad 10% 200 vdcw	56289	192P10392-PTS
C10 thru C14	0160-0300		C: fxd mylar 0.0027 microfarad 10% 200 vdcw	56289	192P27292-PTS
C15	0170-0066	1	C: fxd 0.027 microfarad 10% 200 vdcw	56289	192P27392-PTS
C16	0180-0197	1	C: fxd 2.2 microfarad 10% 20 vdcw	90201	TAS225K020P1A
C17	0160-0161		C: fxd mylar .01 microfarad 10% 200 vdcw	56289	192P10392-PTS
C18 thru C20	0160-0300		C: fxd mylar 0.0027 microfarad 10% 200 vdcw	56289	192P27292-PTS
CR1	1901-0040	1	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
IC1 thru IC3	1820-0094	3	IC: DTL quad 2-input gate	01295	SN4501
IC4, IC5	1820-0307	2	IC: Digital	01295	SN14656
J1	1251-2034	1	Connector: Printed circuit	71785	252-10-30-300
K1	0490-0851	1	Relay: Reed	-hp-	
L1 thru L13	9140-0210	13	Coil: Molded choke 100 microhenries 5%	82142	15-1315-12J
L14, L15	9140-0129	2	Coil: Molded choke 220 microhenries 5%	82142	15-1315-20J
Q1 thru Q6	1854-0071	6	TSTR: Si NPN	-hp-	
R1	0684-3921	1	R: fxd comp 3.9 kilohms 10% 1/4 W	01121	CB3921
R2	0684-8221	3	R: fxd comp 8.2 kilohms 10% 1/4 W	01121	CB8221
R3	0684-1031	1	R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R4	0684-1021	1	R: fxd comp 1 kilohms 10% 1/4 W	01121	CB1021
R5	0684-3311	1	R: fxd comp 330 ohms 10% 1/4 W	01121	CB3311
R6	0684-2221	1	R: fxd comp 2.2 kilohms 10% 1/4 W	01121	CB2221
R7	0684-8221		R: fxd comp 8.2 kilohms 10% 1/4 W	01121	CB8221
R8	0684-1541	1	R: fxd comp 150 kilohms 10% 1/4 W	01121	CB1541
R9	0684-8221		R: fxd comp 8.2 kilohms 10% 1/4 W	01121	CB8221
	0340-0060	2	Terminal: Solder stud, teflon insulator	98291	FT-E-15 obd
	11151-27401	1	Shield: Flex, printed circuit	-hp-	
A5	**11151-66502**	**1**	**REMOTE PROGRAM ASSEMBLY (Receiver)**	**-hp-**	
C1	0160-0153	1	C: fxd 0.001 microfarad 10% 200 vdcw	56289	192P10292-PTS
C2, C3	0160-0300	2	C: fxd 0.0027 microfarad 10% 200 vdcw	56289	192P27292-PTS
C4	0180-0197	1	C: fxd 2.2 microfarads 10% 20 vdcw	90201	TAS225K020PIA

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5 (Cont'd)					
CR1 thru CR5	1901-0040	11	Diode: Si 30 wiv 30 mA 2 pF 2 ns	01295	PG512
CR6	1910-0016	1	Diode: Ge 60 wiv 1 microsec	03877	S3185G
CR7 thru CR12	1910-0040		Diode: Si	01295	PG512
IC1 thru IC5	1820-0307	5	IC: Digital	01295	SN14656
L1 thru L13	9140-0129	13	Coil: Molded choke	82142	15-1315-20J
L14, L15	9140-0210	2	Coil: Molded choke	82142	15-1315-12J
Q1 thru Q14	1854-0071	14	TSTR: Si NPN**	-hp-	
R1	0684-2721	2	R: fxd comp 2.7 kilohms 10% 1/4 W	01121	CB2721
R2	0684-1041	1	R: fxd comp 100 kilohms 10% 1/4 W	01121	CB1041
R3	0684-1031	1	R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R4	0684-1021	1	R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R5	0684-2721		R: fxd comp 2.7 kilohms 10% 1/4 W	01121	CB2721
			PARTS REQUIRED FOR OPTION 042		
A6	**11152-66501**	**1**	**OHMS CONVERTER ASSEMBLY**	**-hp-**	
C1	0150-0093	4	C: fxd cer 0.01 microfarad + 80% - 20% 100 vdcw	72982	Type 801-K800011
C2	0180-0291	1	C: fxd 1.0 microfarad 10% 35 vdcw	90201	TAS105K035PIA
C3 thru C5	0150-0093		C: fxd cer 0.01 microfarad + 80% - 20% 100 vdcw	72982	Type 801-K800011
CR1 thru CR6	1901-0040	12	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
CR7	1902-3149	1	Diode: Breakdown 9.09 V 5%	04713	SZ10939-170
CR8 thru CR11	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
CR12	1901-0546	2	Diode: Si	03877	SG-817 obd
CR13	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
CR14	1901-0546		Diode: Si	03877	SG-817 obd
CR15	1902-3171	1	Diode: Breakdown 11 V 5%	04713	SZ10939-194
CR16	1902-0029	1	Diode: Breakdown 12.1 V 5%	04713	SZ11213-164
CR17	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG1088 obd
DS1	1970-0052	1	Tube: Surge Voltage Protector	25088	B1-C90/20
IC1	1820-0307	1	IC: Hex inverter	01295	SN14656
K1	0490-0802	1	Switch: Reed (does not include coil)	-hp-	
	9100-3216		Coil: Electromagnetic for K1	-hp-	
K2	0490-0911	1	Switch: Reed (does not include coil)	-hp-	
	9100-3216		Coil: Electromagnetic for K2	-hp-	
K3 thru K6	0490-0801	4	Switch: Reed (does not include coil)	-hp-	
	9100-3216	6	Coil: Electromagnetic for K3 thru K6	-hp-	
L1	9100-1480	1	Inductor: fxd 100 microhenries 10%	36196	obd

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A6 (Cont'd)						
Q1, Q2	1854-0071	8	TSTR: Si NPN 2N3391	01295	SKA1124	
Q3	1854-0087	4	TSTR: Si NPN 2N3417	03508	4JX16N2989	
Q4	1853-0020	1	TSTR: Si PNP**	-hp-		
Q5 thru Q9	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q10	1854-0087		TSTR: Si NPN 2N3417	03508	4JX16N2989	
Q11	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q12, Q13	1854-0087		TSTR: Si NPN 2N3417	03508	4JX16N2989	
R1	2100-2060	2	R: var 50 ohms 10% 1/2 W	73138	62-202-1	
R2	0811-2875	2	R: fxd prec ww 9 kilohms 0.05%	54294	PC8	obd
R3	0757-0398	1	R: fxd flm 75.0 ohms 1% 1/8 W	14674	C4 T-O	obd
R4	0811-2876	1	R: fxd prec ww 890 kilohm 0.05%	54294	PC7	obd
R5	2100-2497	1	R: var 2 kilohms 10% 1/2 W	73138	62-207-1	
R6	0698-7819	1	R: fxd 8.88 megohms 0.25%	-hp-		
R7*			Factory selected value			
R8	2100-2030	1	R: var 20 kilohms 10% 1/2 W	73138	62-210-1	
R9	0811-2871	1	R: fxd prec ww 900 kilohms 0.05%	54294	PC7	obd
R10	0811-2875		R: fxd prec ww 9 kilohms 0.05%	54294	PC8	obd
R11	0811-2877	1	R: fxd prec ww 90.9 kilohms 0.05%	54294	PC8	obd
R12	2100-2061	1	R: var 200 ohms 10% 1/2 W	73138	62-204-1	
R13	0811-2872	1	R: fxd prec ww 963 ohms 0.1%	54294	PC8	obd
R14	0757-0277	1	R: fxd flm 49.9 ohms 1% 1/8 W	91637	CMF-1/10-32-T-1	obd
R15	2100-1984	1	R: var 100 ohms 10% 1/2 W	73138	62-203-1	
R16	0757-0401	2	R: fxd flm 100 ohms 1% 1/8 W	91637	CMF-1/10-32T-1	obd
R17	0698-3449	2	R: fxd flm 28.7 kilohms 1% 1/8 W	14674	C4 7-0	obd
R18, R19	0684-1831	7	R: fxd comp 18 kilohms 10% 1/4 W	01121	CB1831	
R20	0698-3515	1	R: fxd flm 5.9 kilohms 1% 1/8 W	14674	C4 T-0	obd
R21	0698-3151	1	R: fxd flm 2.87 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R22	0757-0401		R: fxd flm 100 ohms 1% 1/8 W	91637	CMF-1/10-32T-1	obd
R23	0811-2873	1	R: fxd prec ww 9.90 kilohms 0.1%	54294	PC8	obd
R24	0811-2874	1	R: fxd prec ww 90.0 kilohms 0.01%	54294	PC8	obd
R25*			Factory selected value			
R26	2100-2060		R: var 50 ohms 10% 1/2 W	73138	62-202-1	
R27	0757-0449	2	R: fxd flm 20.0 kilohms 1% 1/8 W	14674	C4 T-0	obd
R28	0684-1831		R: fxd comp 18 kilohms 10% 1/4 W	01121	CB1831	
R29	0757-0283	1	R: fxd flm 2.00 kilohms 1% 1/8 W	14674	C4 T-0	obd
R30	0698-3572	1	R: fxd flm 60.4 kilohm 1% 1/8 W	91637	CMF-1/10-32	obd
R31	0757-0128	1	R: fxd flm 200 kilohms 1% 1/2 W	91637	MFF-1/2-T-1	obd
R32	0684-1831		R: fxd comp 18 kilohms 10% 1/4 W	01121	CB1831	
R33	0698-3449		R: fxd flm 28.7 kilohms 1% 1/8 W	14674	C4 7-0	obd
R34	0698-3516	1	R: fxd flm 6.34 kilohms 1% 1/8 W	14674	C4 T-0	obd
R35	0757-0449		R: fxd flm 20.0 kilohms 1% 1/8 W	14674	C4 T-0	obd
R36 thru R38	0684-1831		R: fxd comp 18 kilohms 10% 1/4 W	01121	CB1831	
	0340-0060	16	Terminal: Solder stud, teflon	98291	FT-E-15	obd
	0360-1512	4	Terminal: Solder stud	98291	ST-1000SL-1L	
	0490-0811	10	Terminal: Reed relay	27264	SDX1988-G	obd
			MISCELLANEOUS PARTS			
DS1	2140-0246	1	Lamp: Incandescent 6.3 V	24455	1739D	
	5040-0235	1	Base: Lampholder	-hp-		
	5040-0311	1	Lampholder: Clear	-hp-		
J1 thru J13			Not assigned			

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
MISC. PARTS (Cont'd)					
J14			Connector: Remote, consists of the following parts:		
	1251-2416	1	Body: R&P Connector	71468	DBC25S-FO obd
	1251-2376	17	Contact: R & P Connector	71468	030-1953-000
	1251-0218	2	Mounting Post: R & P Connector	71468	D-53018
			Mating connector for J14:		
	1251-0218		Lock post (2 required)	71468	D-53018
	1251-0392		Boot: Connector	71468	DB-51212-1
	1251-1042		Lock: Connector	71468	DB-51221-1
	1251-2384		Contact	71468	030-1952-000
	1251-2417		Body: Connector, 25 pin	71468	DBC25P-F0 obd
MP1	1510-0057	2	Binding Post: red	-hp-	
MP2	1510-0056	2	Binding Post: black	-hp-	
MP3	1510-0068	2	Binding Post: blue	-hp-	
			Mounting hardware for binding post:		
	0340-0704	9	Insulator: Binding post, mint gray	-hp-	
	3050-0228	6	Washer: Flat No. 6		
	2420-0002	6	Nut: Hex 6-32		
MP4	5020-6817	1	Rear panel	-hp-	
	2190-0047	8	Lockwasher: No. 6		
	2360-0196	8	Screw: FH 6-32 x 3/8		
MP5	03484-20102	1	Sidewall: right	-hp-	
	5040-4539	8	Bracket: Mounting	-hp-	
	03484-00502	2	Guide: Top cover	-hp-	
MP6	5020-6814	2	Guide: Vinyl	-hp-	
MP7	4040-0417		Latch	-hp-	
	0510-1033	1	Retainer: Push on, round	78553	C1617-010-1 obd
MP8	4040-0451	1	Front panel	-hp-	
	0510-1105	4	Retainer: Push on, round	78553	C1617-010-1 obd
MP9	03484-00201	1	Subpanel: Front	-hp-	
	5040-4539		Bracket: Mounting	-hp-	
	0380-0948		Spacer	-hp-	
	2190-0047		Lockwasher: No. 6		
	2360-0196		Screw: FH 6-32 x 3/8		
MP10	5060-5947	1	Knob Assy: Terminal	-hp-	
MP11	5060-5948	1	Knob Assy: Filter	-hp-	
MP12	5060-5949	1	Knob Assy: Range (for instruments without Ohms Option 042)	-hp-	
	5060-5950	1	Knob Assy: Range (for instruments with Ohms Option 042)	-hp-	
MP13	0370-1005	1	Knob: Sample rate	-hp-	
MP14	5060-5951	1	Knob Assy: Function (for instruments with VDC Function only)	-hp-	
	5060-5952	1	Knob Assy: Function (for instruments with VDC and VAC Functions, Option 043)	-hp-	
	5060-5953	1	Knob Assy: Function (for instruments with VDC and Ohms Functions, Option 042)	-hp-	
	5060-5954	1	Knob Assy: Function (for instruments with VDC Ohms Option 042, and VAC Option 043)	-hp-	
MP15	03484-20101	1	Sidewall: Left	-hp-	
	5040-4539		Bracket: Mounting	-hp-	
	03484-00502		Guide: Top cover	-hp-	
P12	1251-0099	1	Connector: Rack & panel	71785	57-10500-375
	0525-0058	2	Screw: RH 3-48		
	0590-0085	2	Nut: Hex 3-48		
	0890-0216	2	Teflon tubing: .225" long		
	2190-0030	2	Washer: Helical No. 3		
	3050-0228	4	Washer: Flat No. 6		
	3050-0229	2	Washer: Flat No. 4		
	3050-0448	4	Washer: Flat, teflon		

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
MISC. PARTS (Cont'd)					
R1, R2			Not assigned		
R3	2100-2878	1	R: var 250 kilohms	71450	BD90923
	2190-0054	1	Lockwasher: 1/2"		
	2950-0035	1	Nut: Hex 15/32-32		
R4			Not assigned		
R5	2100-2761	1	R: var 250 ohms 20% zero cont.	71450	obd
	1410-0112	1	Bushing	OOLAD	obd
	5020-0446	1	Nut: Hex	-hp-	
S1	3100-2718	1	Switch: Rotary, terminal	76854	Type AM
	2190-0016	4	Lockwasher: 3/8"		
	2950-0001	4	Nut: Hex 3/8-32		
S2	3100-1797	1	Switch: Rotary, range	76854	obd
	2190-0016		Lockwasher 3/8"		
	2950-0001		Nut: Hex 3/8-32		
S3	3100-2710	1	Switch: Rotary, filter	76854	obd
	2190-0016		Lockwasher: 3/8"		
	2950-0001		Nut: Hex 3/8-32		
S4	3100-2717	1	Switch: Rotary, function	76854	obd
	2190-0016		Lockwasher: 3/8"		
	2950-0001		Nut: Hex 3/8-32		
S5	3101-1242	1	Switch: Pushbutton	81073	46-101B
	2190-0027	1	Lockwasher: 1/4"		
	3101-0126	1	Nut: Switch mounting	81073	30C1023
	03484-01201	1	Shield: Guard, top	-hp-	
	2360-0194	2	Screw: FH 6-32 x 5/16		
	03484-61201	1	Shield: Guard, bottom	-hp-	
	2360-0194		Screw: FH 6-32 x 5/16		
	03484-90000	1	Operating and Service Manual	-hp-	
	03484-84401	**1**	**KIT: MAINTENANCE**	**-hp-**	
	0490-0801		Switch: Reed	-hp-	
	0490-0802		Switch: Reed	-hp-	
	2140-0246		Lamp: Incandescent 6.3 V	24455	1739D
	4040-0720		Tool: Reed assembly	-hp-	
	5060-5940		Extender Assembly	-hp-	

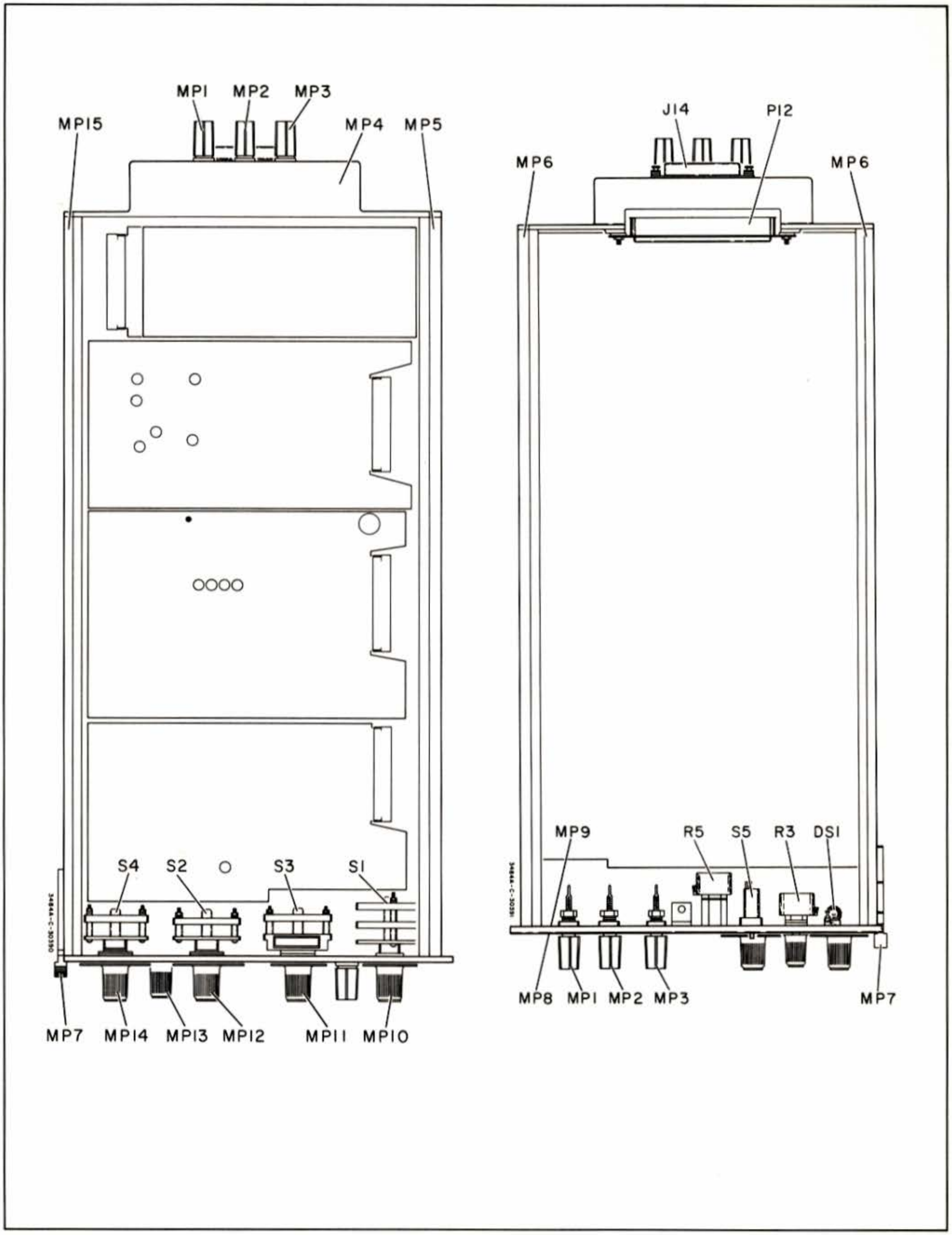


Figure 6-1. Location of Miscellaneous Parts.

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

This section contains the diagrams necessary to maintain the Model 3484A. Both schematic diagrams and pictorial views of the circuit boards are included. Figure 7-1 shows the location of the various assemblies, and Figure 7-2 is a functional block diagram. Connections to the plug-in connector P12 and the Remote connector J14 are shown in Figure 7-9. Schematic diagrams of the True RMS AC Converter Option 043 are included in the Model 11153A Operating and Service Manual.

7-2. NOTES.

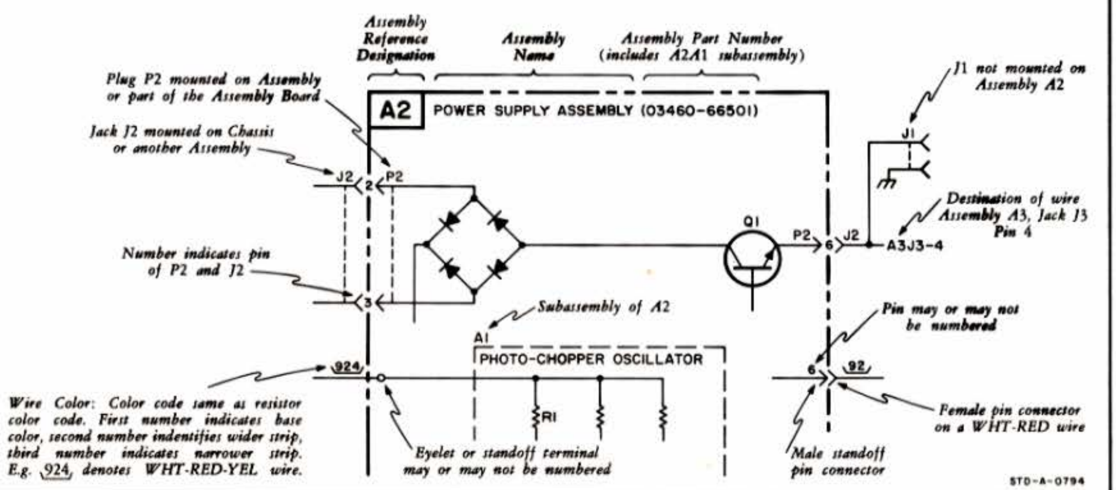
The following notes apply in general to all schematic diagrams:

1. Partial reference designators are shown within assembly outlines. Prefix with assembly number for complete designator.
2. Component values are shown as follows unless otherwise noted:
   Capacitance in microfarads
   Resistance in ohms
   Inductance in microhenries
3. * Average value shown. Optimum value selected at factory.
4. ▬ ▬ ▬ ▬ Denotes assembly.
5. ▬▬▬▬ Denotes main signal path.
6. ─ ─ ─ ─ Denotes feedback path.
7. Denotes screwdriver adjustment.
8. Denotes front panel marking.
9. Denotes components not located on assembly.
10. All rotary switches shown in extreme counterclockwise position.
11. All relays shown de-energized.

REFERENCE DESIGNATIONS

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

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1



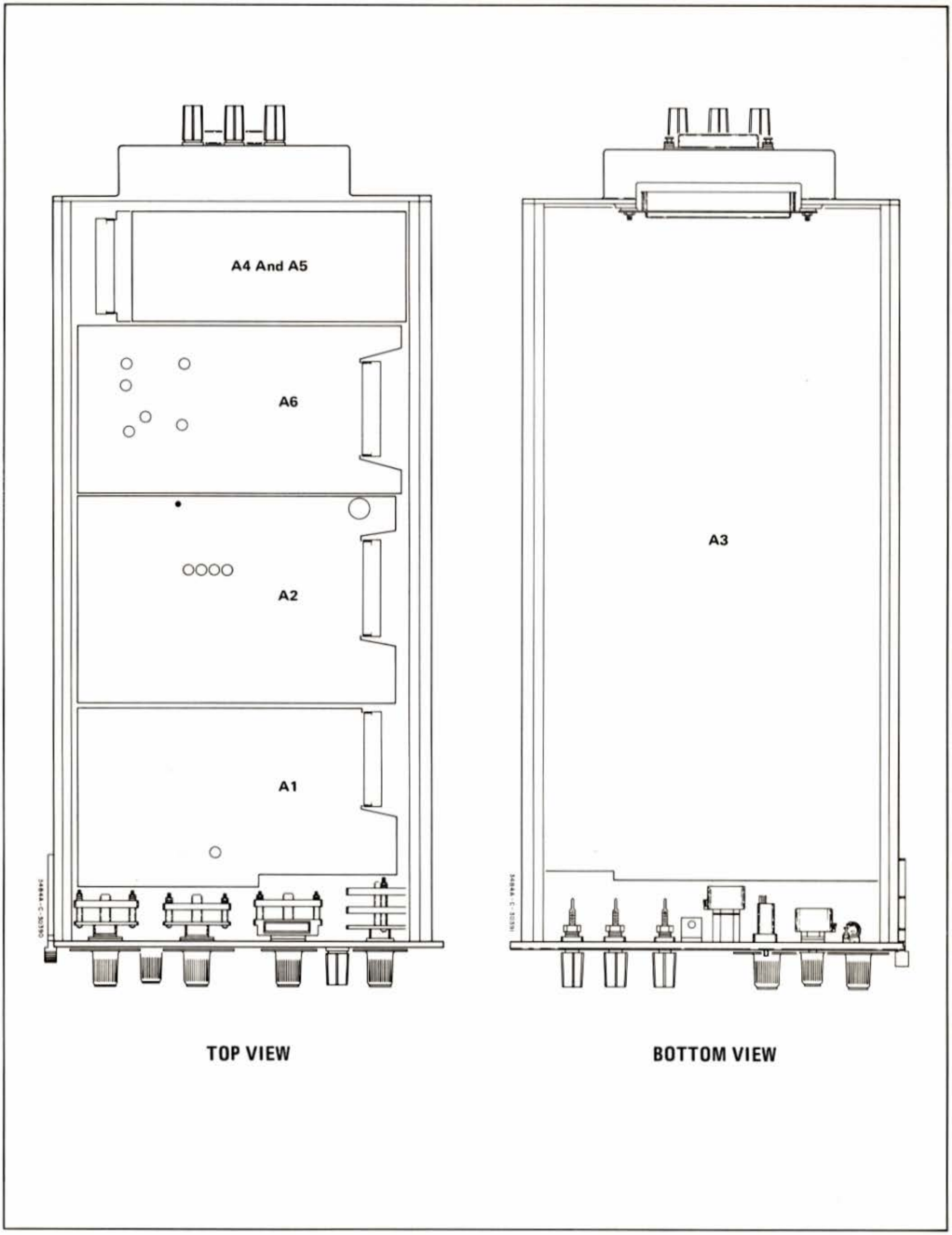
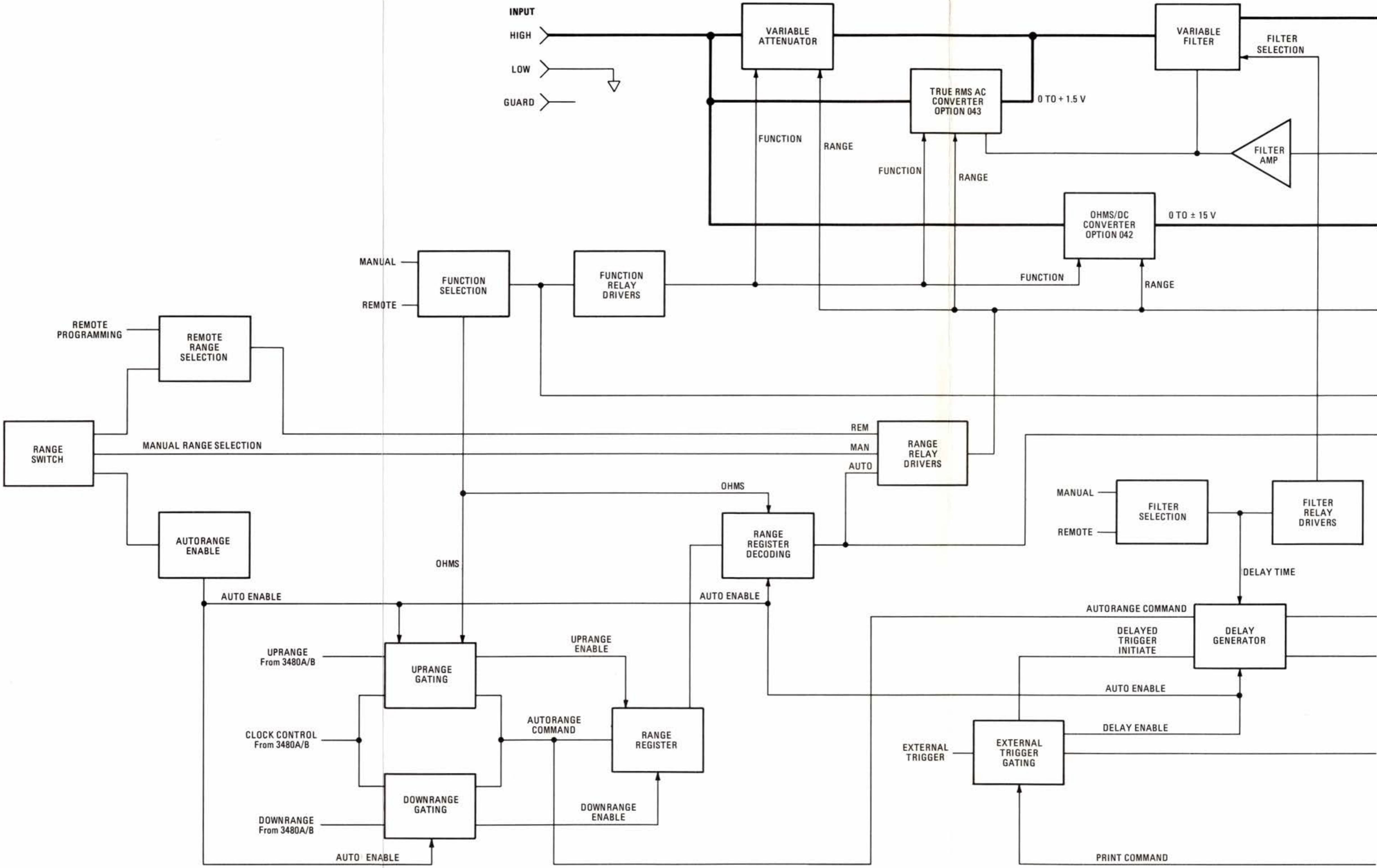


Figure 7-1. Location of Assemblies.


INPUT
HIGH
LOW
GUARD
VARIABLE ATTENUATOR
TRUE RMS AC CONVERTER OPTION 043
0 TO + 1.5 V
VARIABLE FILTER
FILTER SELECTION
FILTER AMP
FUNCTION
RANGE
FUNCTION
RANGE
OHMS/DC CONVERTER OPTION 042
0 TO ± 15 V
MANUAL
REMOTE
FUNCTION SELECTION
FUNCTION RELAY DRIVERS
FUNCTION
RANGE
REMOTE PROGRAMMING
REMOTE RANGE SELECTION
RANGE SWITCH
MANUAL RANGE SELECTION
REM
MAN
AUTO
RANGE RELAY DRIVERS
OHMS
AUTORANGE ENABLE
OHMS
RANGE REGISTER DECODING
MANUAL
REMOTE
FILTER SELECTION
FILTER RELAY DRIVERS
DELAY TIME
AUTO ENABLE
AUTO ENABLE
AUTORANGE COMMAND
DELAYED TRIGGER INITIATE
DELAY GENERATOR
UPRANGE From 3480A/B
UPRANGE GATING
UPRANGE ENABLE
AUTO ENABLE
CLOCK CONTROL From 3480A/B
AUTORANGE COMMAND
RANGE REGISTER
DELAY ENABLE
EXTERNAL TRIGGER
EXTERNAL TRIGGER GATING
DOWNRANGE GATING
DOWNRANGE From 3480A/B
DOWNRANGE ENABLE
AUTO ENABLE
PRINT COMMAND

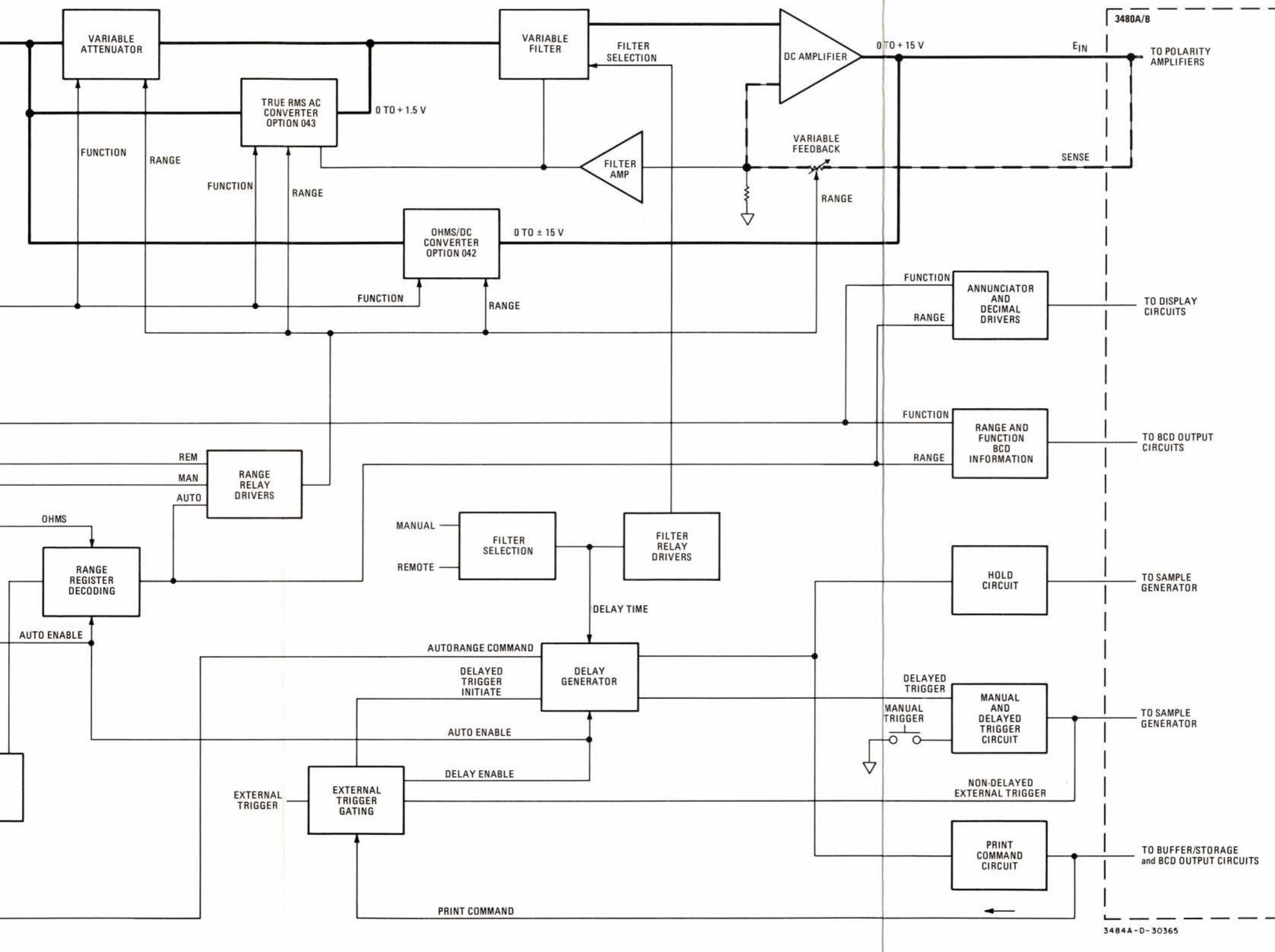
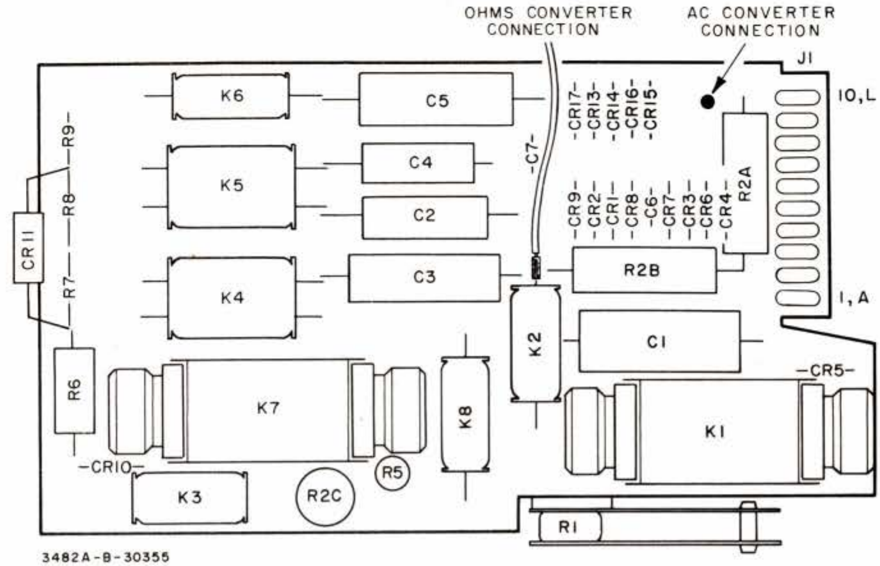
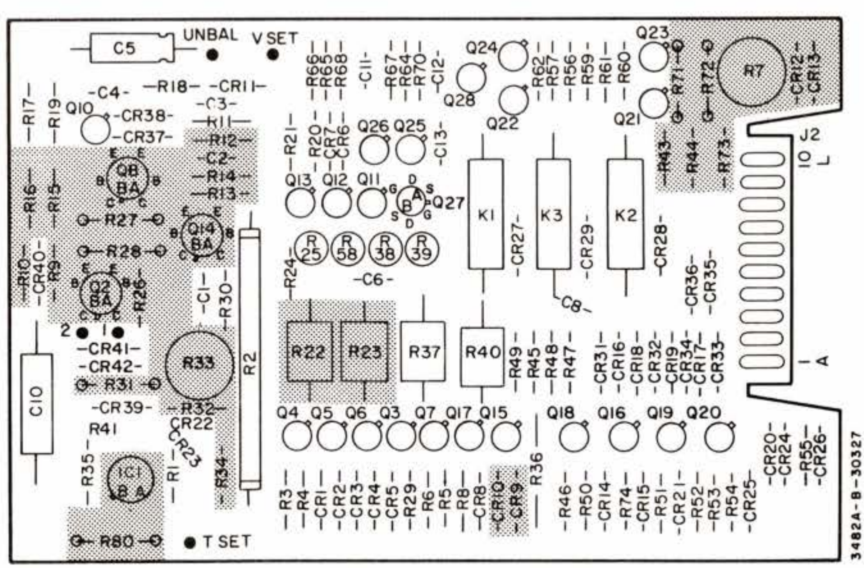


Figure 7-2. Block Diagram.



A1

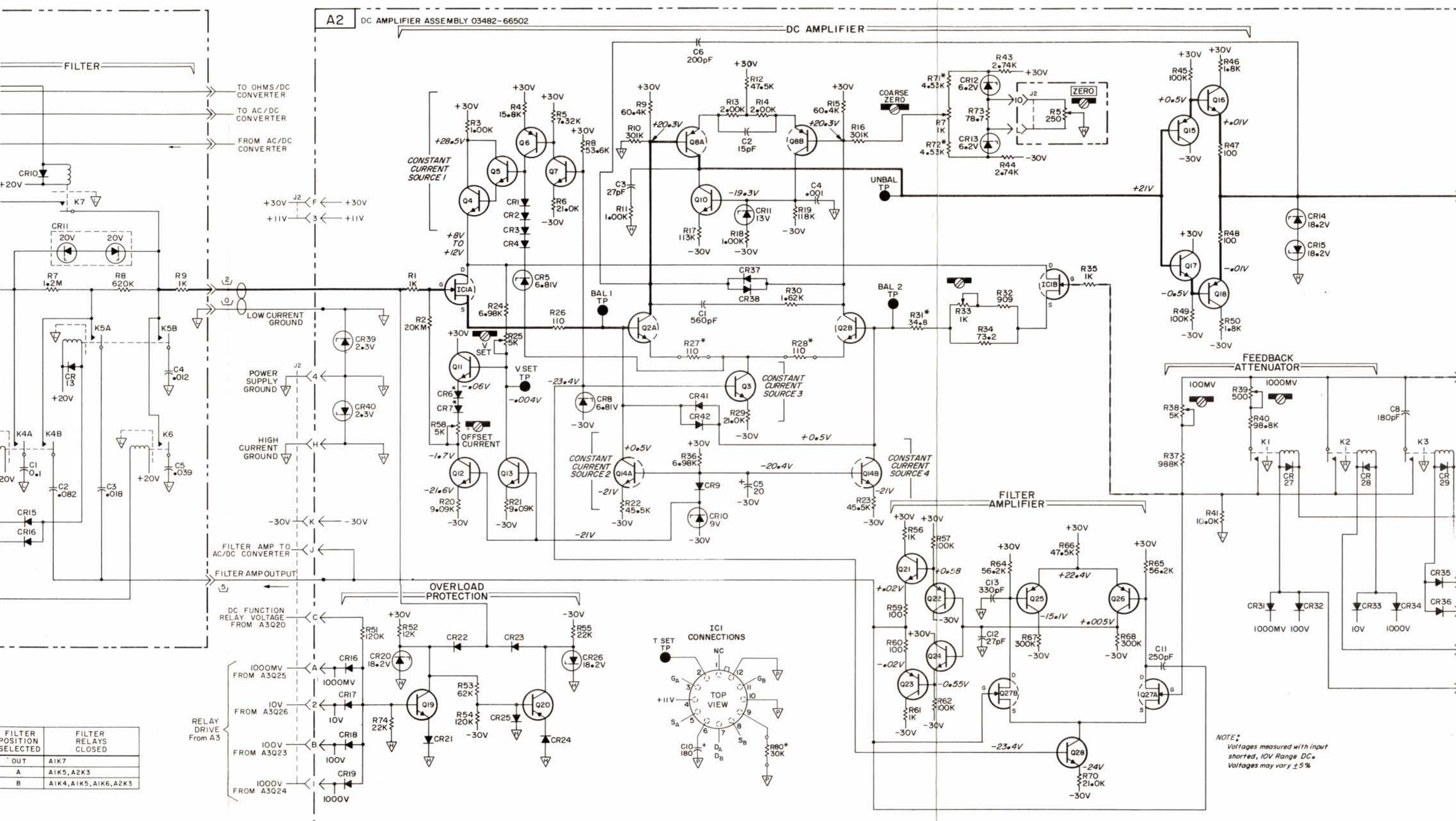
hp Part No. 03482-66501



A2

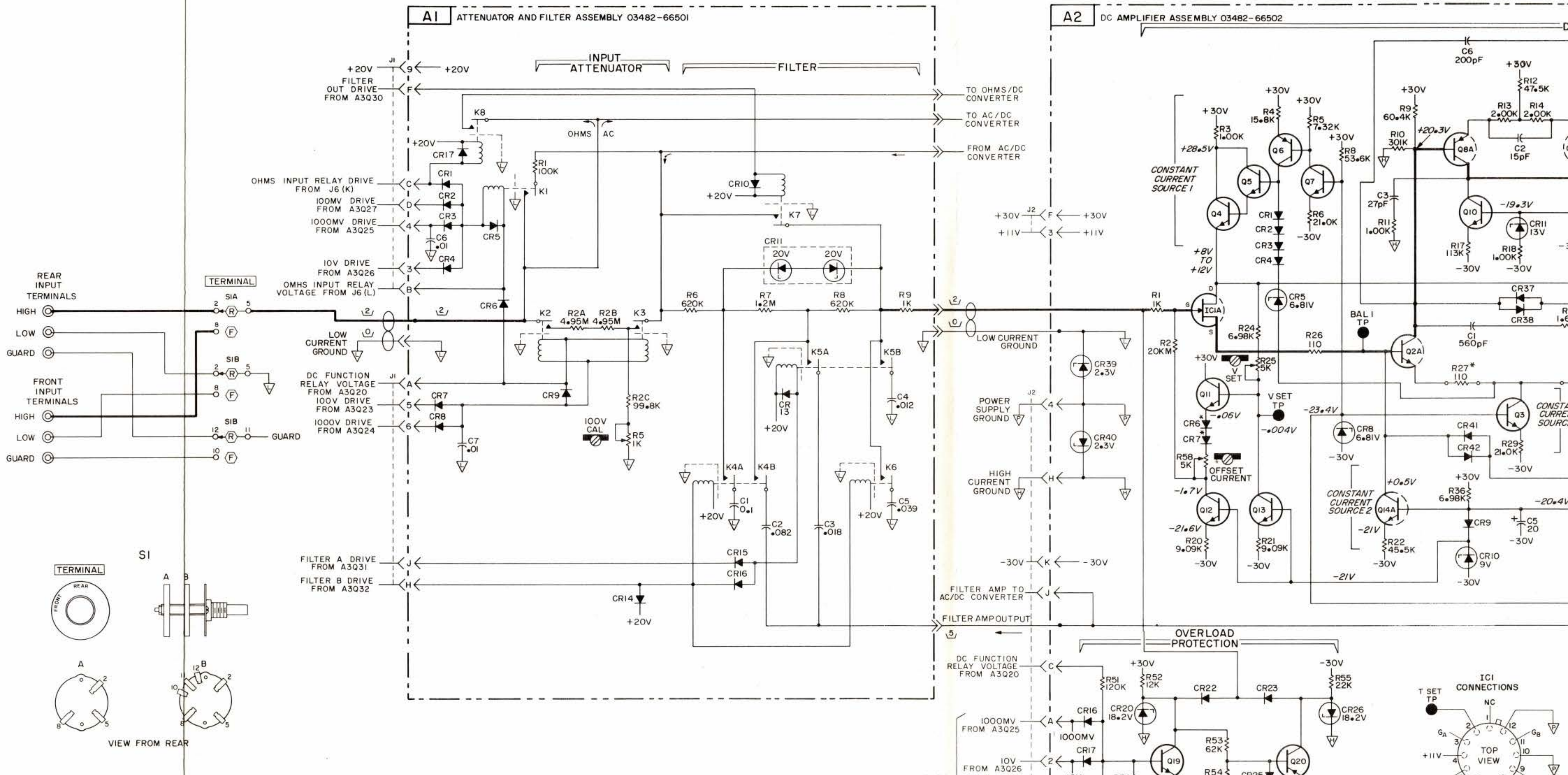
hp Part No. 03482-66502

Components in shaded areas are critical to operation under varying temperature conditions. If one of these components is defective, refer to Paragraph 5-31.



FILTER POSITION SELECTED	FILTER RELAYS CLOSED
OUT	A1K7
A	A1K5, A2K3
B	A1K4, A1K5, A1K6, A2K3

Figure 7-3. Schematic Diagram, DC Attenuator and Amplifier.

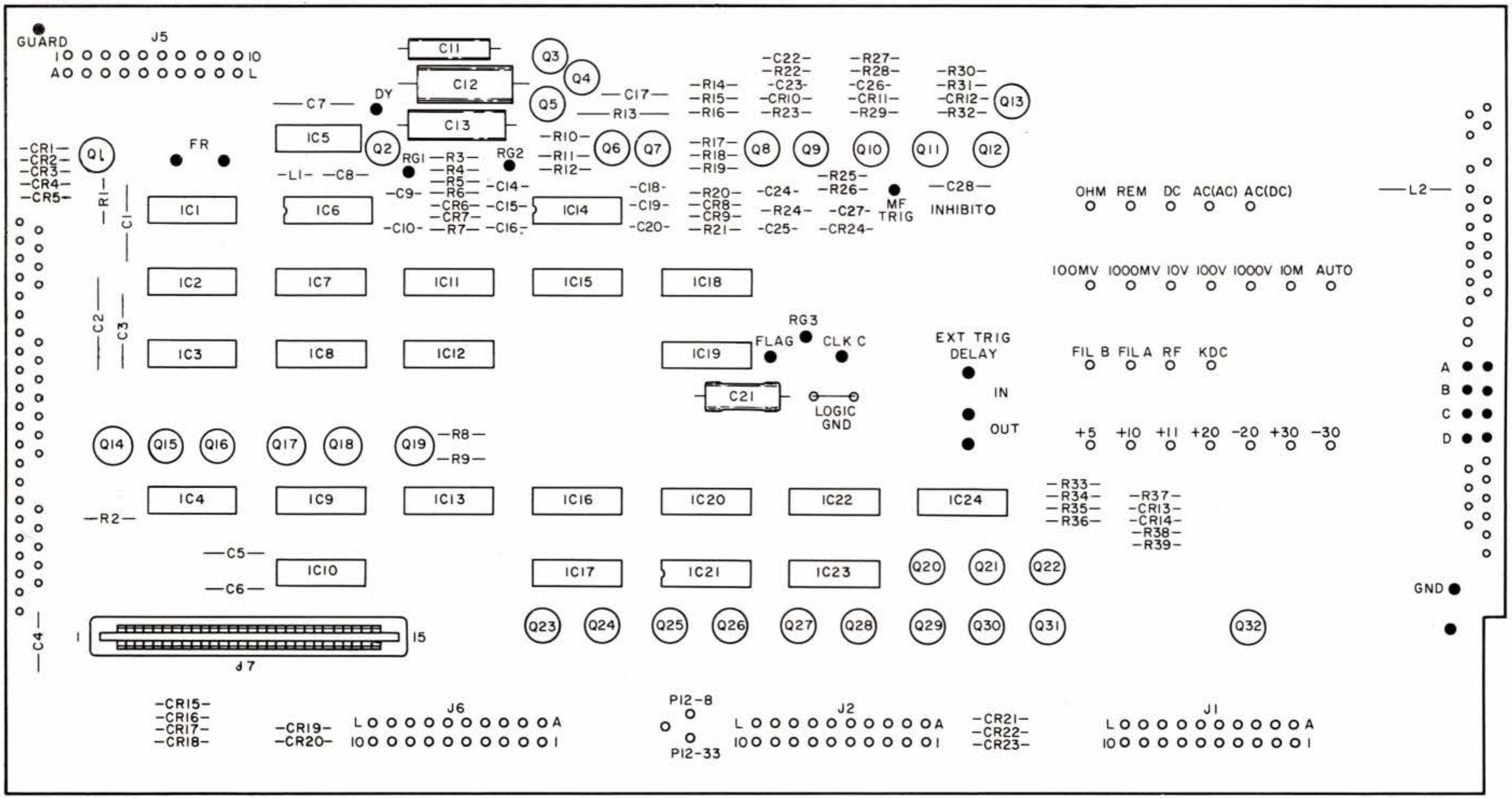


DC VOLTS RANGE	RELAYS CLOSED	INPUT ATTENUATOR	AMPLIFIER GAIN	TOTAL GAIN
100MV	A1K1	1/1	100	100
1000MV	A1K1, A2K1	1/1	10	10
10V	A1K1, A2K2	1/1	1	1
100V	A1K2, A1K3, A2K1	1/100	10	0.1
1000V	A1K2, A1K3, A2K2	1/100	1	0.01

FUNCTION	RELAYS CLOSED
OHMS	A1K1, A1K8, A2K1
VAC (AC)	A2K1
VAC (DC)	A2K1

FILTER POSITION SELECTED	FILTER RELAYS CLOSED
OUT	A1K7
A	A1K5, A2K3
B	A1K4, A1K5, A1K6, A2K3

3484A-J-30357

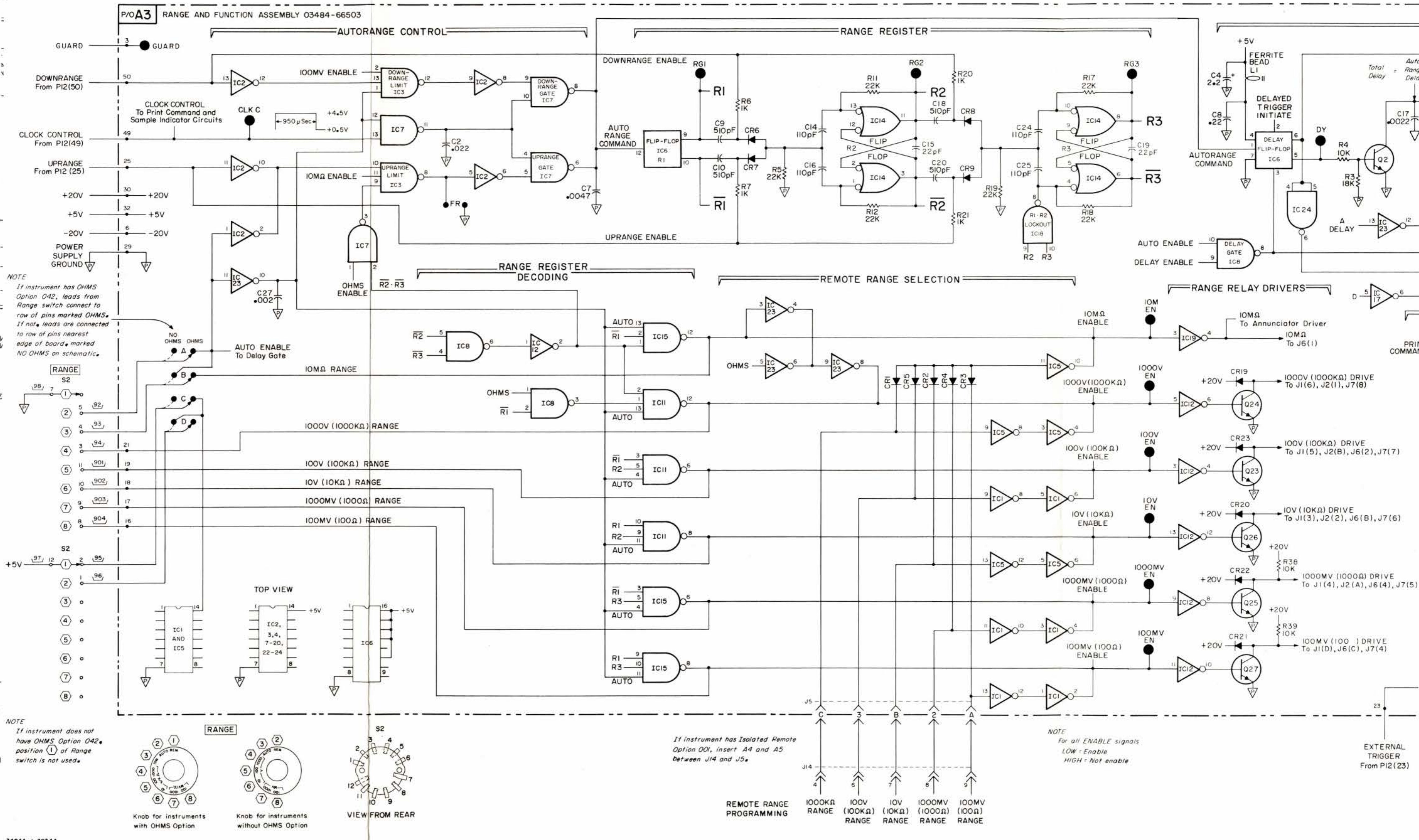


3484A-B-30387

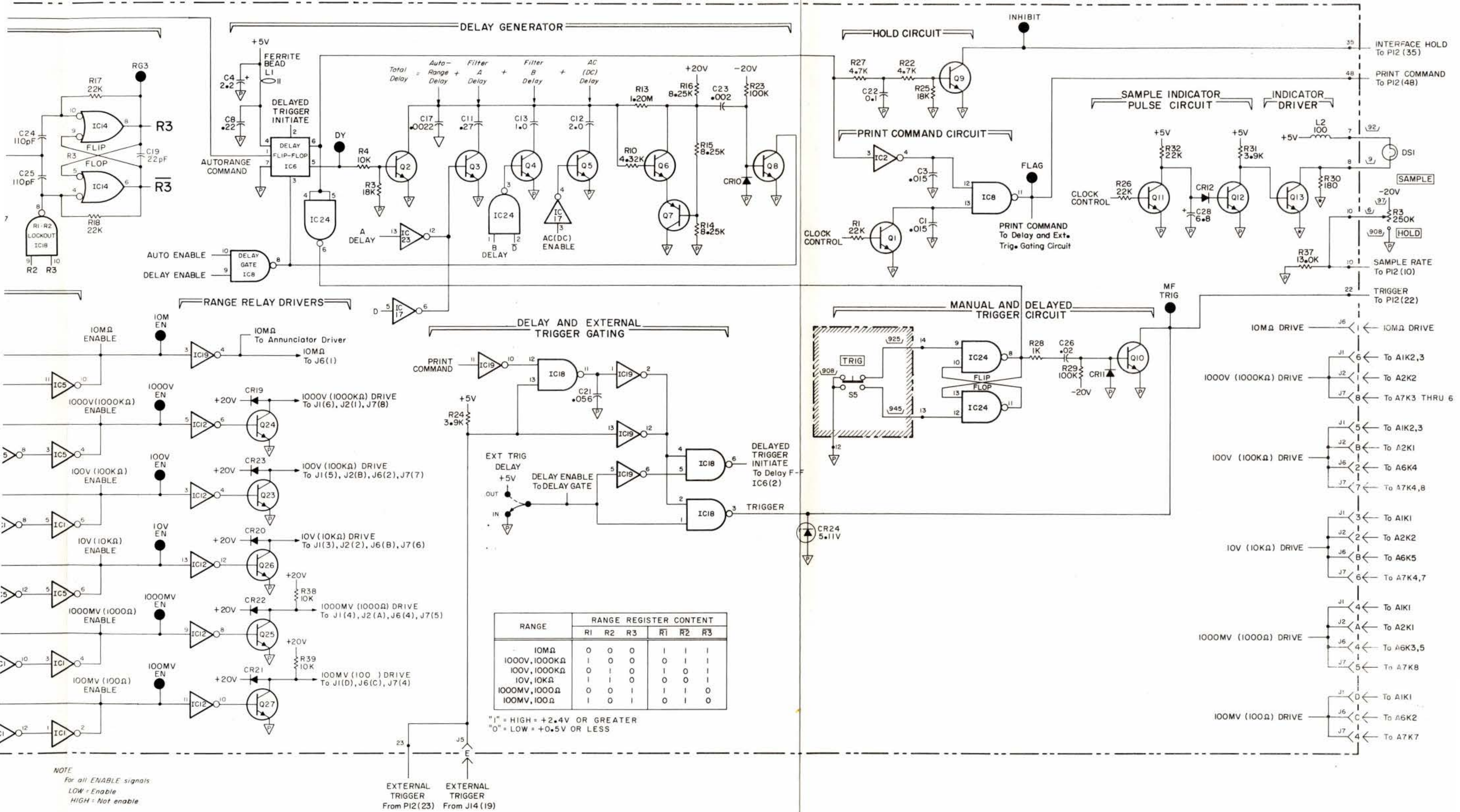
A3

hp Part No. 03484-66503

Rev A



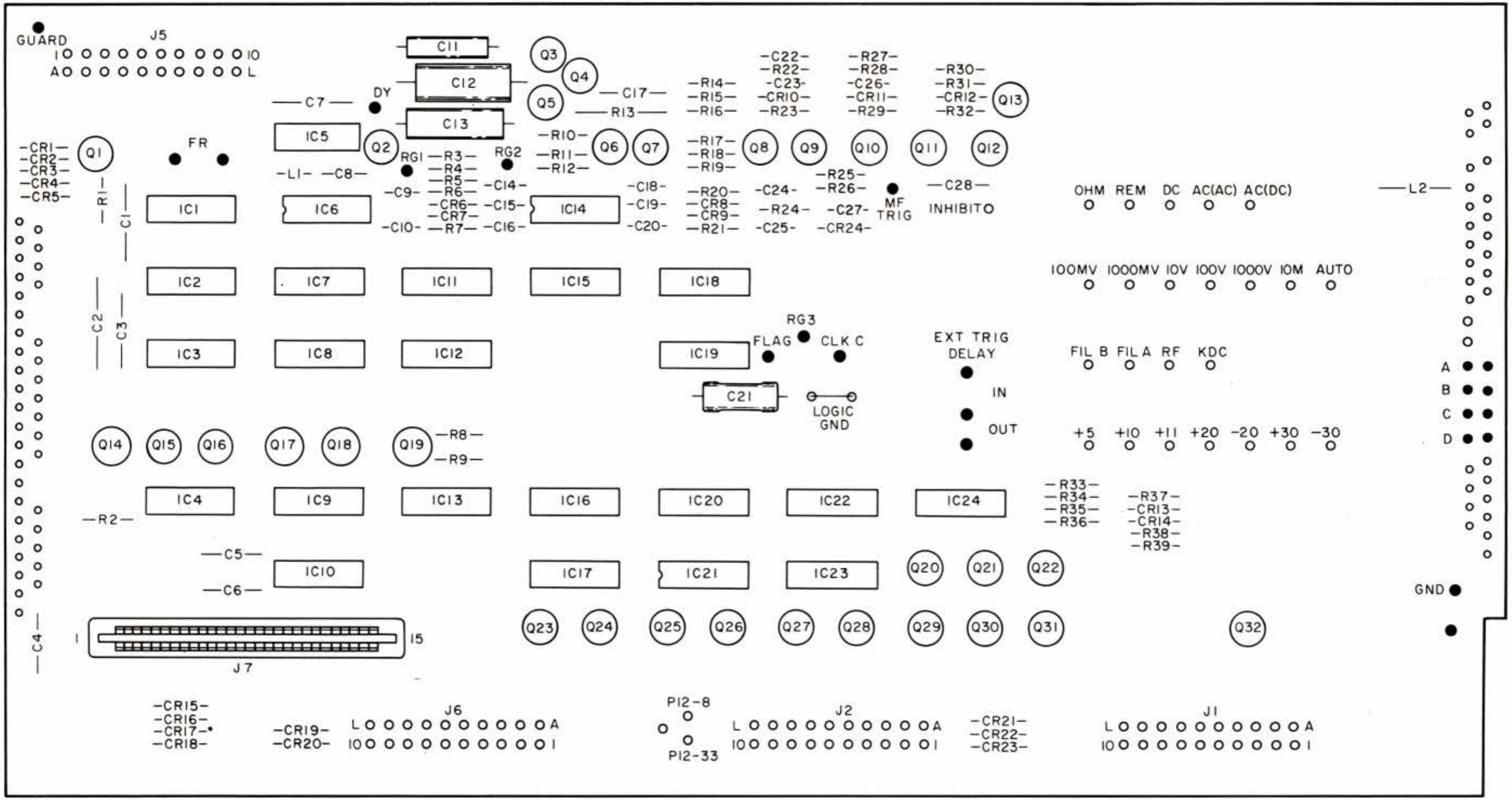
3484A-J-30344



RANGE	RANGE REGISTER CONTENT					
	R1	R2	R3	$\overline{R1}$	$\overline{R2}$	$\overline{R3}$
10MΩ	0	0	0	1	1	1
1000V, 1000KΩ	1	0	0	0	1	1
100V, 1000KΩ	0	1	0	1	0	1
10V, 10KΩ	1	1	0	0	0	1
1000MV, 1000Ω	0	0	1	1	1	0
100MV, 100Ω	1	0	1	0	1	0

"1" = HIGH = +2.4V OR GREATER
"0" = LOW = +0.5V OR LESS

Figure 7-4. Schematic Diagram, Ranging Circuits.

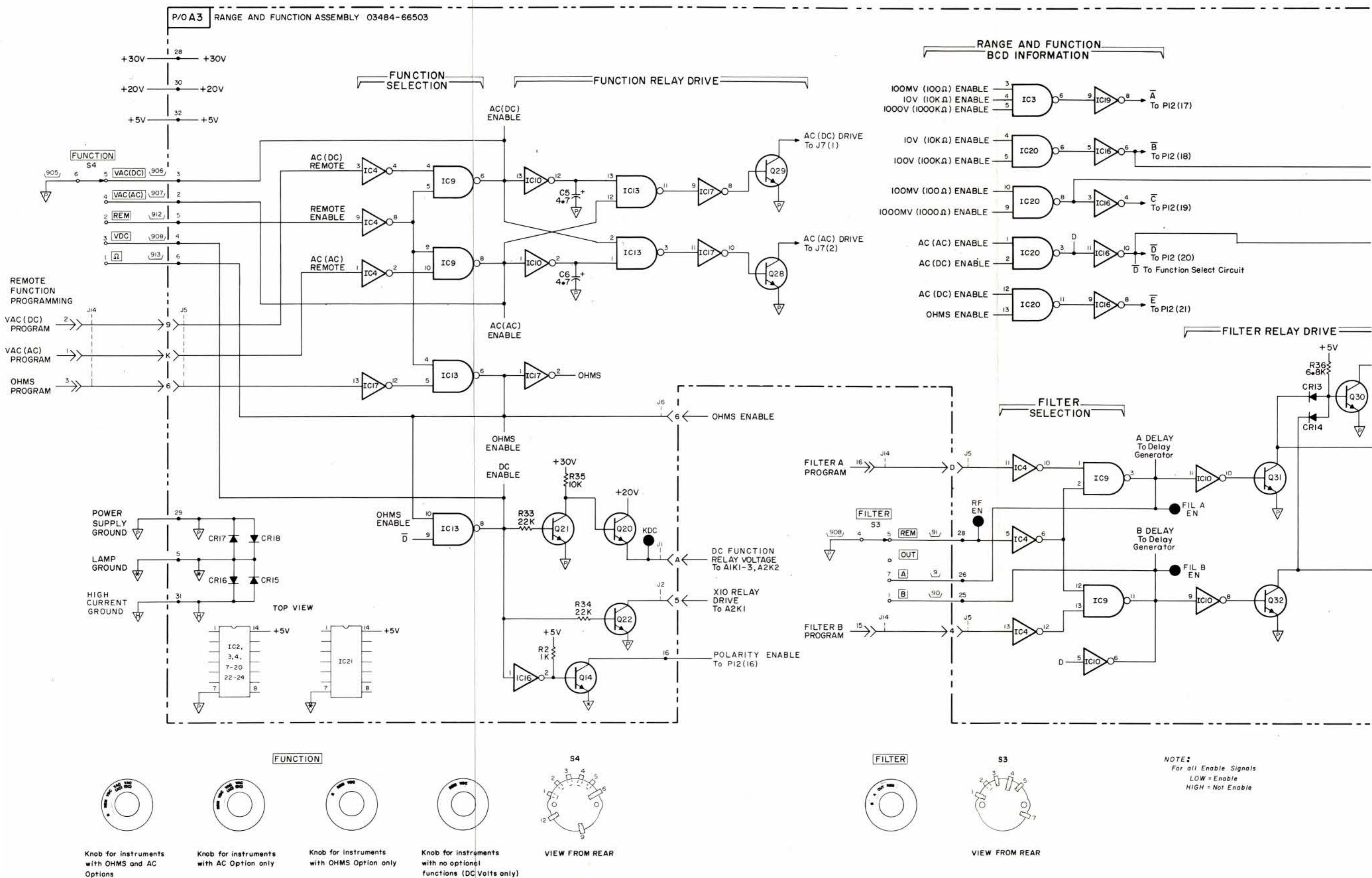


3484A-B-30387

A3

hp Part No. 03484-66503

Rev A



3484A-E-30343

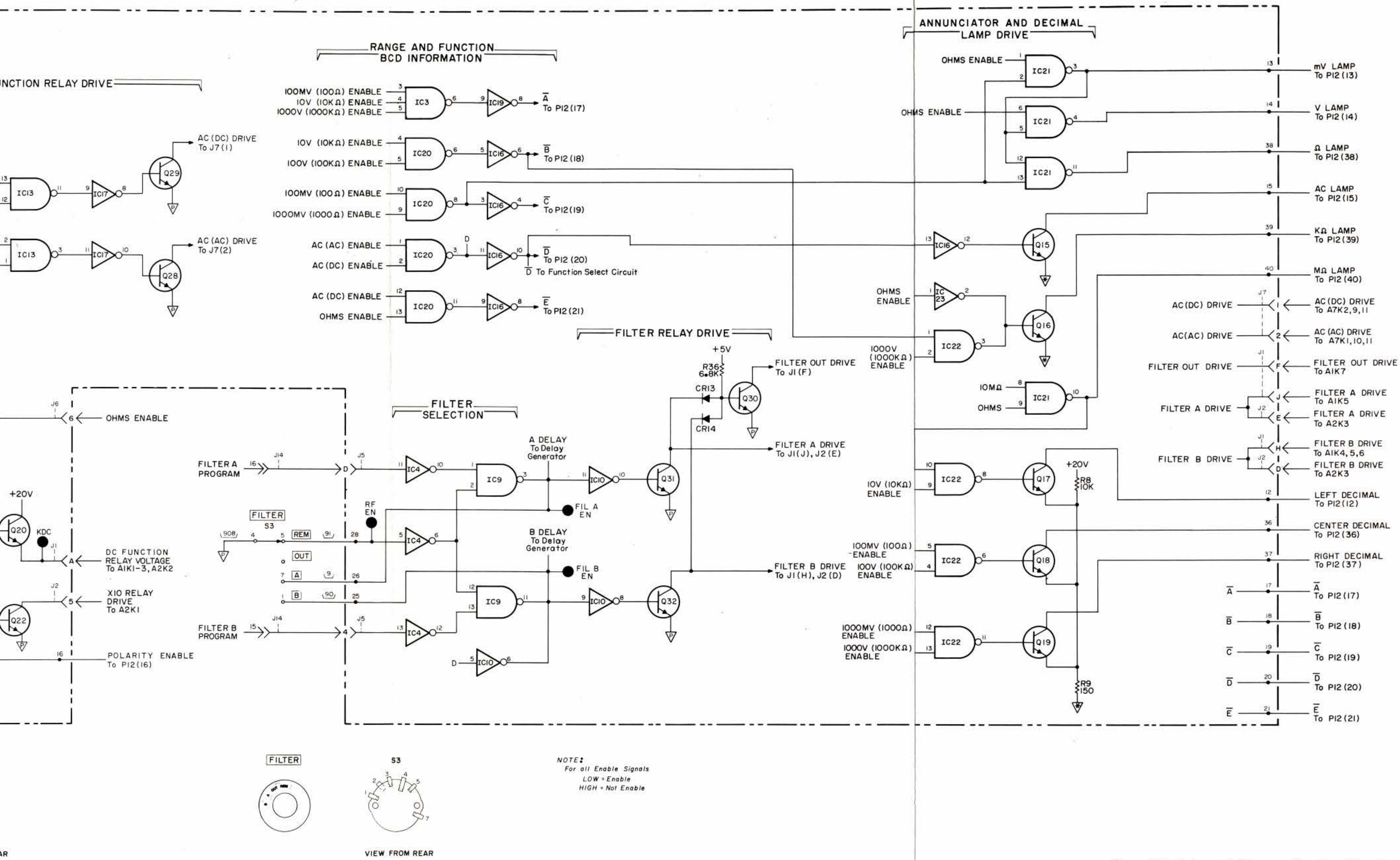
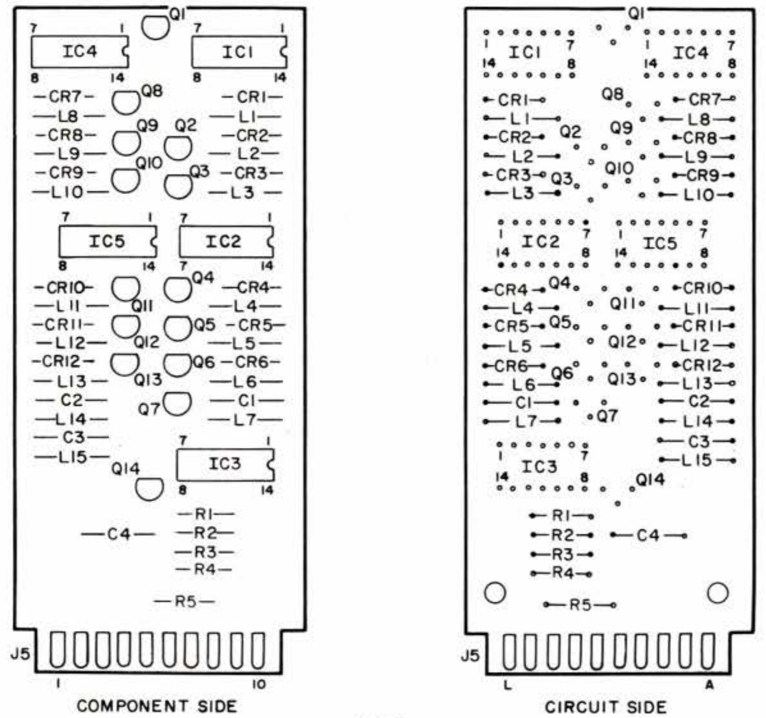


Figure 7-5. Schematic Diagram, Function Circuits.

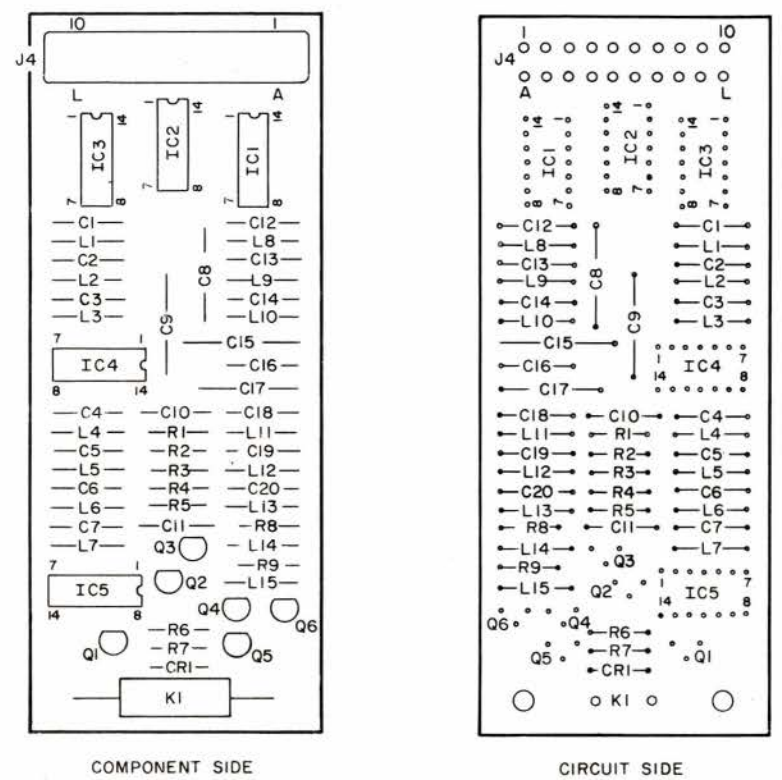


11151A-B-30318-B

A5

hp Part No. 11151-66502

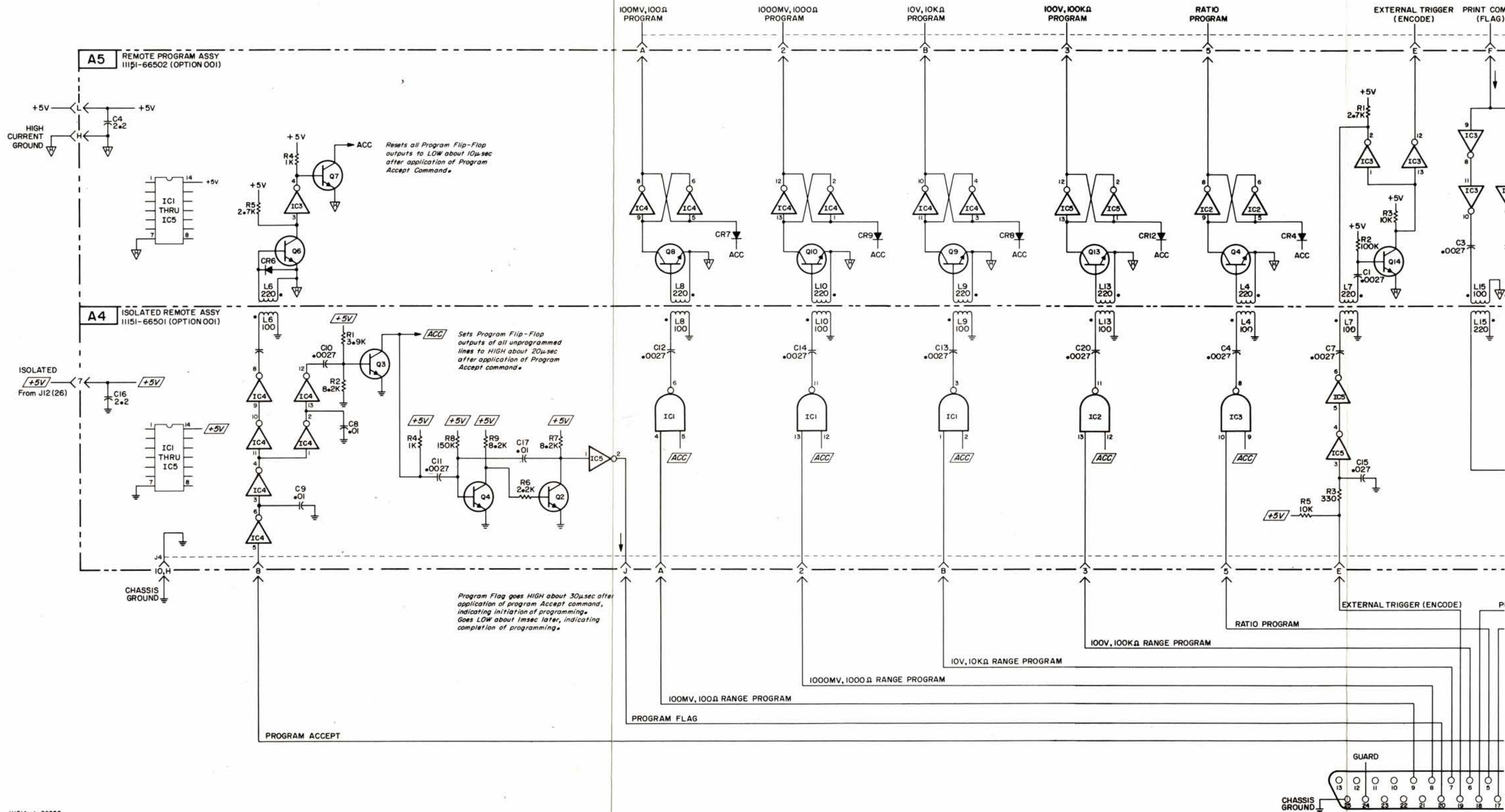
REMOTE PROGRAM ASSEMBLY



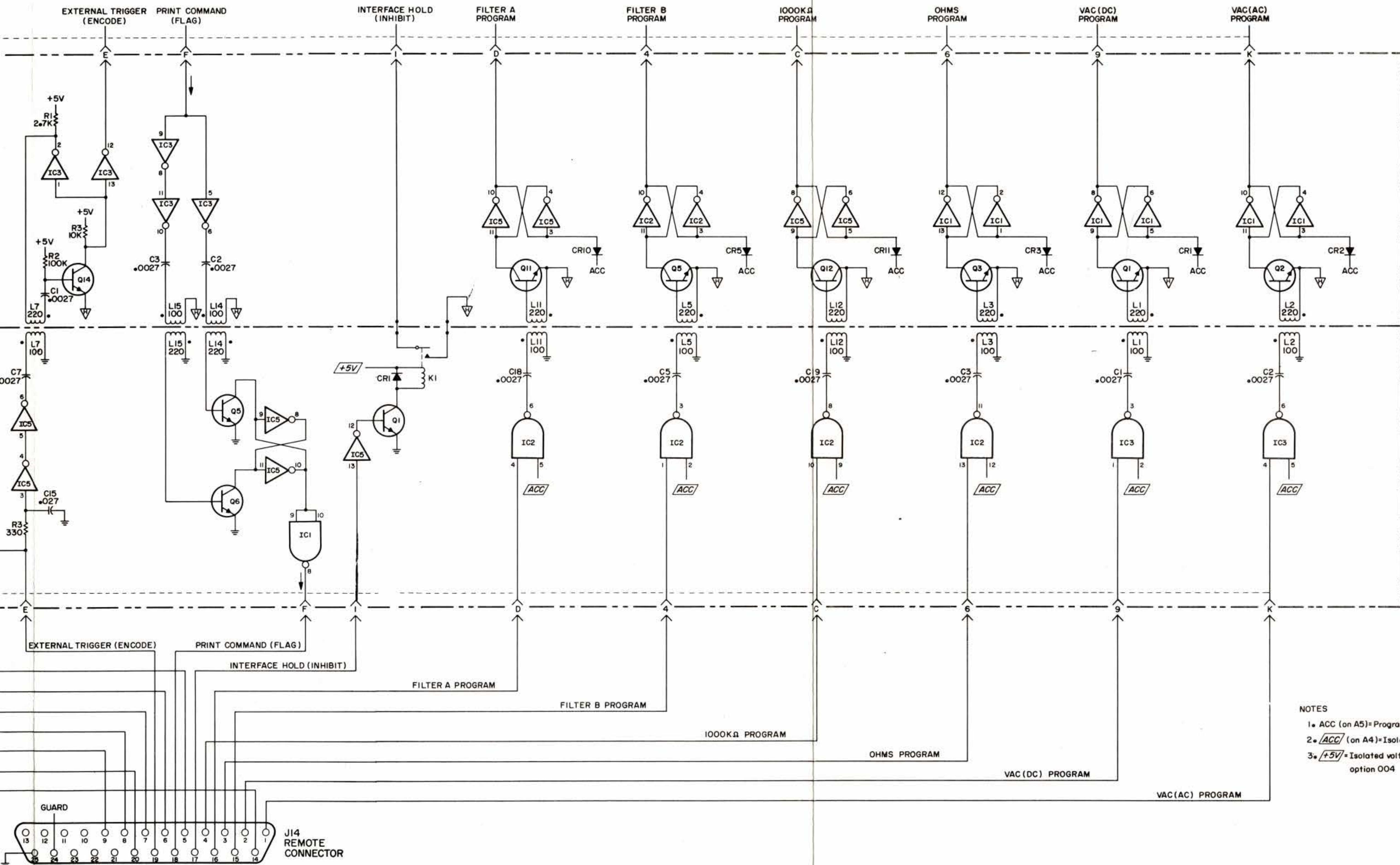
A4

hp Part No. 11151-66501

ISOLATED REMOTE ASSEMBLY



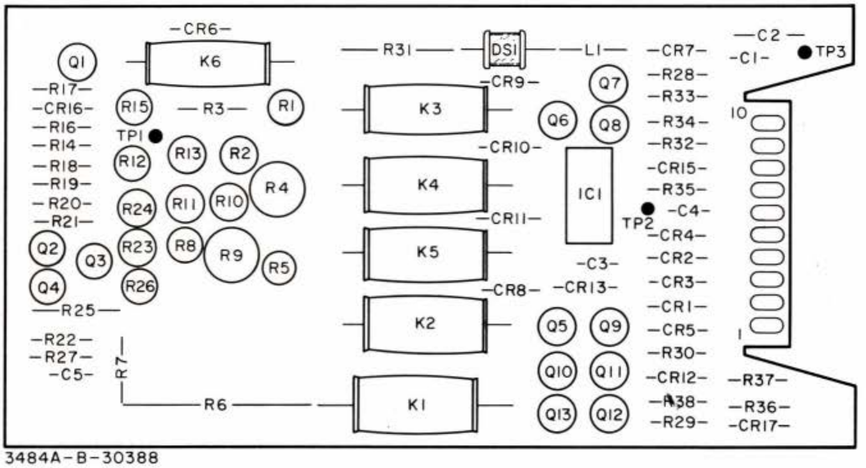
11151A-J-30353



NOTES

1. ACC (on A5) = Program Accept Signal
2. ACC (on A4) = Isolated Program Accept signal
3. +5V = Isolated voltage supplied by 3480A/B option 004

Figure 7-6. Schematic Diagram, Isolated Remote Option 041.



3484A-B-30388

A6

hp Part No. 11152-66501

Rev A

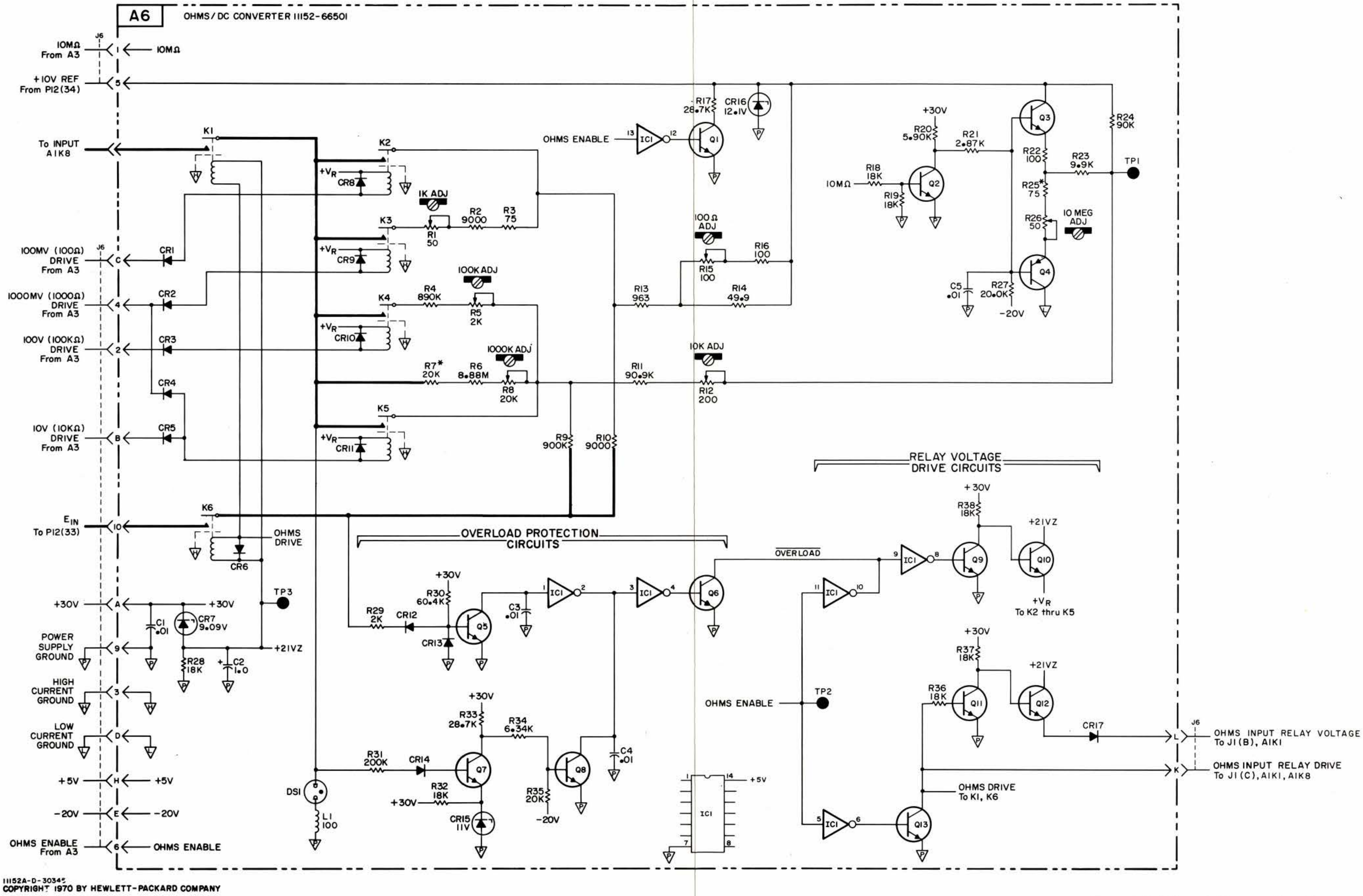


Figure 7-7. Schematic Diagram, Ohms Converter Option 042.

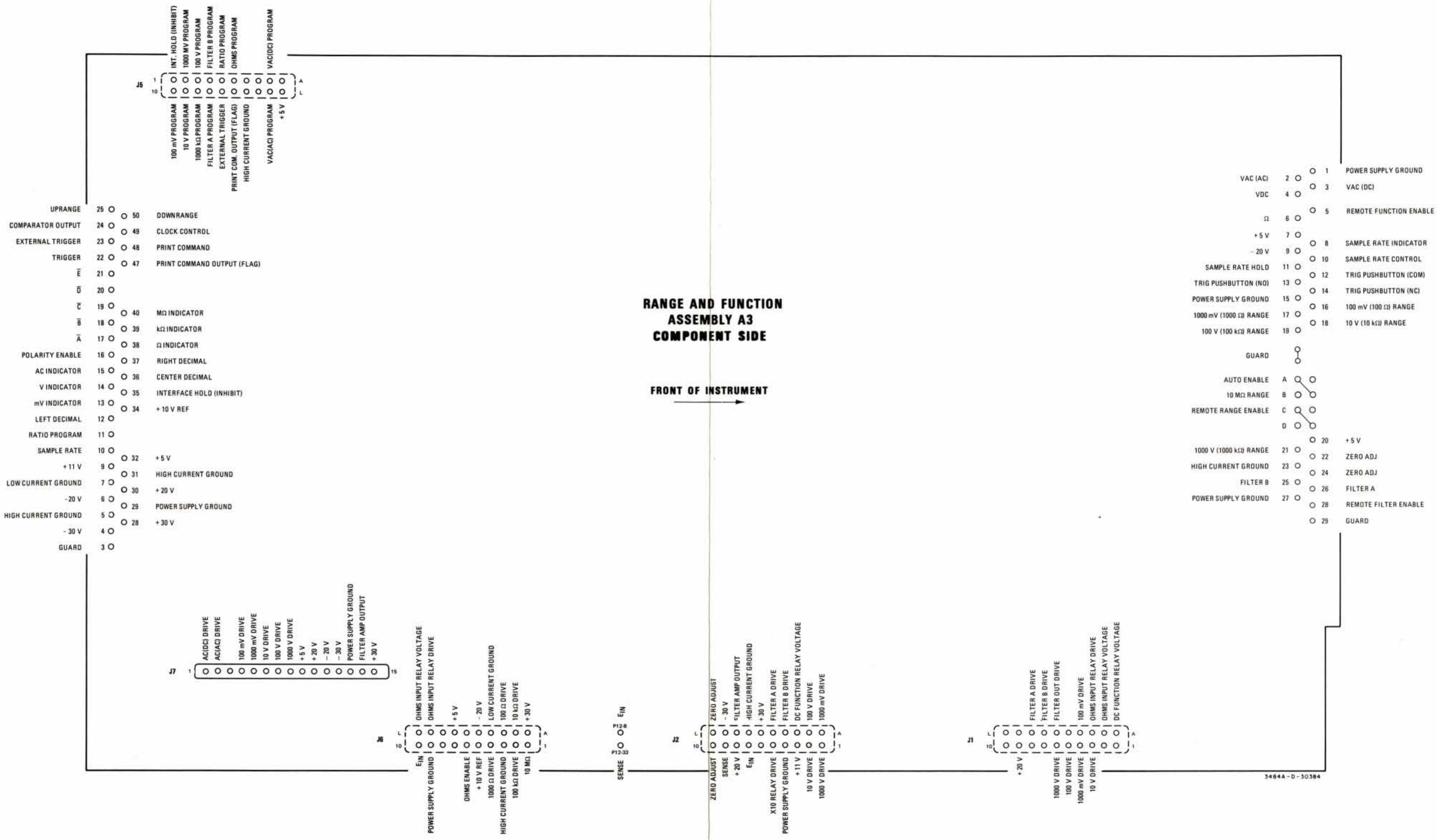


Figure 7-8. Connections to Range and Function Assembly A3.

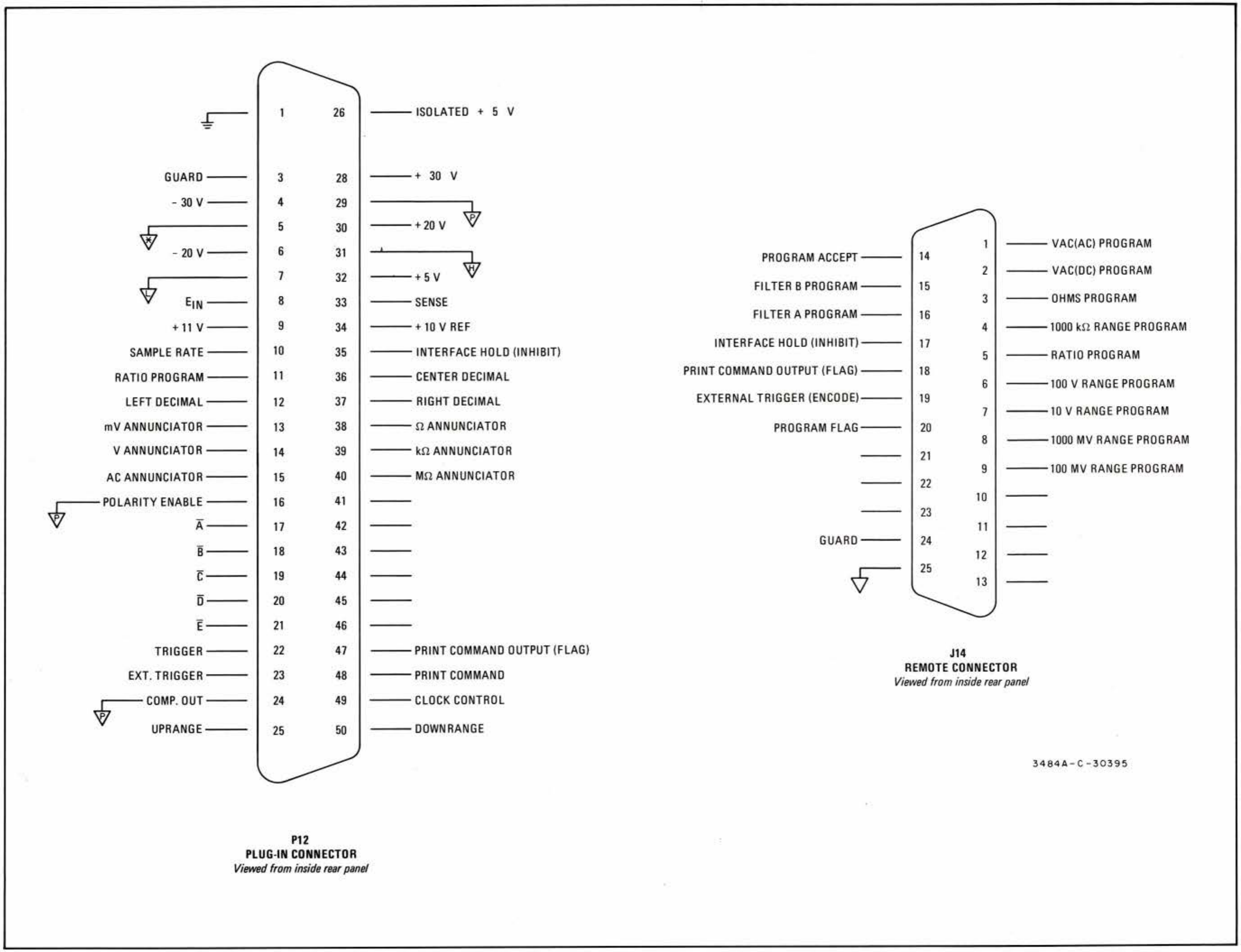


Figure 7-9. Plug-in Connector P12 and Remote Connector J14.

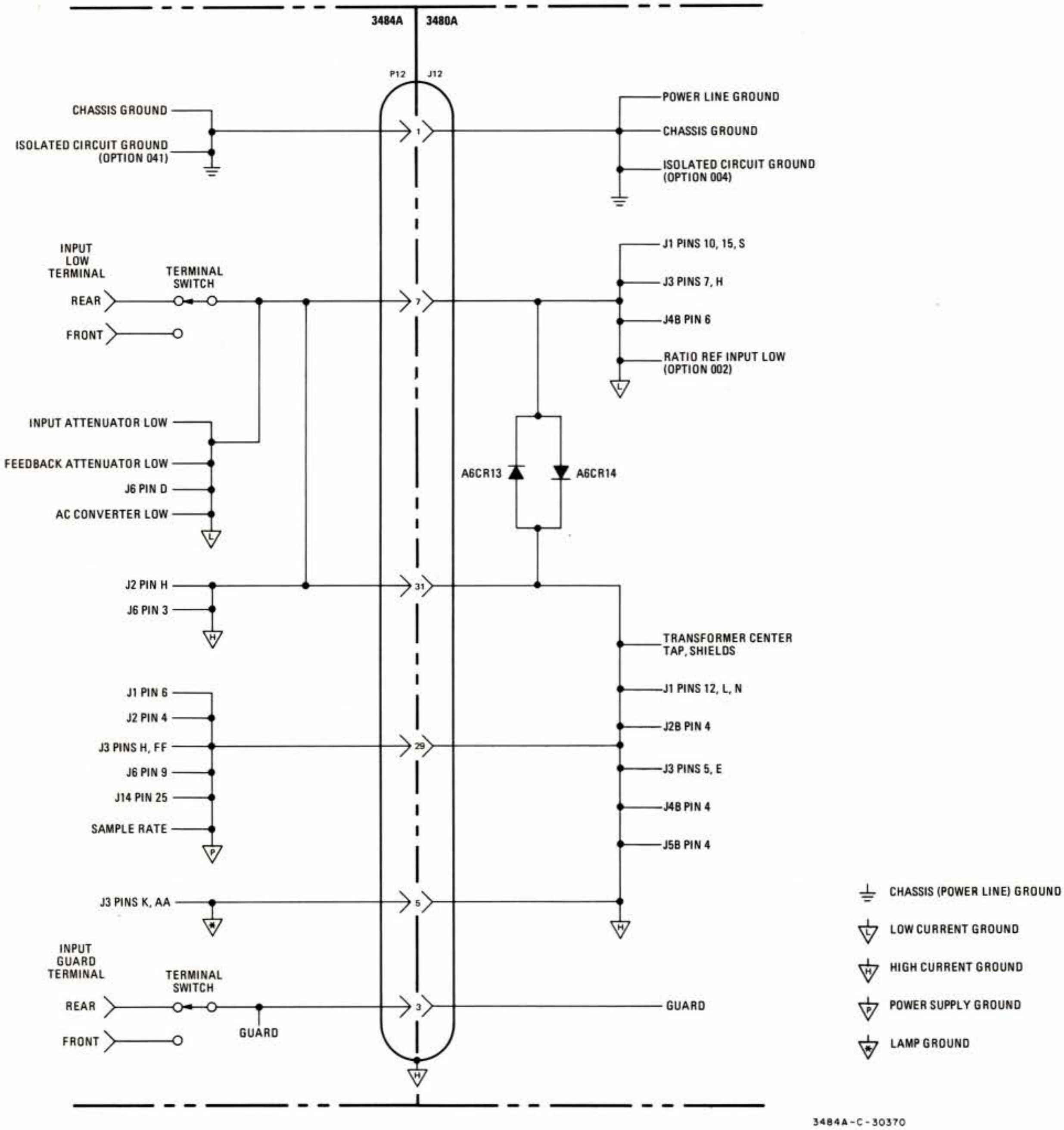


Figure 7-10. Ground Connections.

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.

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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., 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.

Code No.	Manufacturer	Address
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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SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
16365	Dayton Rogers Mfg. Co.	Minneapolis, Minn.
25088	Siemens America, Inc.	New York, N.Y.
27264	Molex Products Company	Downers Grove, Ill.
90201	Mallory Capacitor, Co.	Indianapolis, Ind.
00LAD	Colorado Screw Machine	Loveland, Colo.