

# HP Archive

This vintage Hewlett Packard document was  
preserved and distributed by

**[www. hparchive.com](http://www.hparchive.com)**

Please visit us on the web !

On-line curator: Tony Gerbic



**OPERATING AND SERVICE MANUAL**

**MODEL 11153A  
TRUE RMS CONVERTER**

-hp- Part No. 11153A-90000

Copyright Hewlett-Packard Company 1970  
P.O. Box 301, Loveland, Colorado 80537 U.S.A.

Printed: OCT 1970

## CERTIFICATION

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

## WARRANTY AND ASSISTANCE

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

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

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

**TABLE OF CONTENTS**

Section	Page	Section	Page
I. GENERAL INFORMATION .....	1-1	V. MAINTENANCE .....	5-1
1-1. Introduction .....	1-1	5-1. Introduction .....	5-1
1-4. Specifications .....	1-1	5-2. Test Equipment Required .....	5-1
Section	Page	5-3. Performance Checks .....	5-1
II. INSTALLATION .....	2-1	5-4. AC Voltage Accuracy Checks .....	5-1
2-1. Introduction .....	2-1	5-7. Adjustment Procedures .....	5-3
2-2. Initial Inspection .....	2-1	5-10. Amplifier Zero Adjustments .....	5-3
2-3. Installation .....	2-1	5-11. Mid Band and Low Freq. Adjustments .....	5-3
2-4. Repackaging for Shipment .....	2-2	5-12. High Frequency Adjustments .....	5-4
Section	Page	5-13. Servicing Information .....	5-5
III. OPERATING INSTRUCTIONS .....	3-1	5-14. Clean Handling Techniques .....	5-5
3-1. Introduction .....	3-1	5-15. Reed Replacement .....	5-5
3-2. AC Voltage Measurements .....	3-1	5-18. Thermocouple Replacement .....	5-7
3-3. AC or DC Coupled Measurement .....	3-1	5-19. AC Converter Assembly Exchange .....	5-7
3-4. Maximum Input Voltages .....	3-1	5-20. Troubleshooting .....	5-7
3-7. Response Time .....	3-1	5-21. Reed Relay Checks .....	5-7
3-10. Measuring Speed .....	3-1	5-24. Input Amp. Bias Adj. Range .....	5-7
3-11. Autoranging Time .....	3-1	5-25. Post Amp. Bias Adj. Range .....	5-7
3-12. High Frequency Measurements .....	3-1	5-26. Thermocouple Protection Circuit .....	5-8
3-13. AC Voltage Measurement Procedure .....	3-2	5-27. 1/10 Scale Adjustment Range .....	5-8
Section	Page	Section	Page
IV. THEORY OF OPERATION .....	4-1	VI. REPLACEABLE PARTS .....	6-1
4-1. Introduction .....	4-1	6-1. Introduction .....	6-1
4-2. Attenuator Amplifier .....	4-1	6-4. Ordering Information .....	6-1
4-5. Post Amplifier .....	4-1	6-6. Non-Listed Parts .....	6-1
4-6. Converter Thermocouple .....	4-1	Section	Page
4-7. Converter Amplifier .....	4-1	VII. CIRCUIT DIAGRAMS .....	7-1
4-8. Thermocouple Protection .....	4-1	7-1. Introduction .....	7-1
4-9. Output Attenuator and Filter .....	4-1	7-2. Notes .....	7-1
		Appendices	
		A. CODE LIST OF MANUFACTURERS	
		B. SALES AND SERVICE OFFICES	

**LIST OF TABLES**

Number	Page	Number	Page
1-1. Specifications .....	1-1	5-4. Input Amp. Bias .....	5-7
5-1. Required Test Equipment .....	5-0	5-5. Post Amp. Bias .....	5-8
5-2. AC Voltage Accuracy Checks .....	5-2	6-1. Replaceable Parts .....	6-2
5-3. VAC Reed Relay Checks .....	5-6		

**LIST OF ILLUSTRATIONS**

Number	Page	Number	Page
2-1. AC Converter Installation .....	2-1	5-2. Mid Band and Low Frequency Adjustments .....	5-4
2-2. Function Switch Limit Stops .....	2-2	5-3. 10 MHz, 1000 mV Adjustment .....	5-5
4-1. True RMS Converter Block Diagram .....	4-0	5-4. 1 MHz, 10 V Adjustment .....	5-5
5-1. AC Voltage Accuracy Checks .....	5-1	5-5. 1/10 Scale Coarse Adjustment .....	5-8



**LIST OF ILLUSTRATIONS (Cont'd)**

**Schematics and Diagrams**

Number	Page	Number	Page
7-1. A7 Converter Assembly .....	7-2	7-4. Post Amplifier and Converter Amplifier .....	7-5
7-2. Attenuator Amplifier and Post Attenuator .....	7-3		
7-3. A7 Converter Assembly .....	7-4	7-5. True RMS Converter Relay Connections .....	7-7

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION.

1-2. The Hewlett-Packard Model 11153A True RMS Converter is designed to be installed in the Model 3484A Multifunction Unit as an optional accessory, Option 043. The Model 3484A with the 11153A True RMS Converter installed allows the Model 3480A/B Digital Voltmeter to make true rms ac voltage measurements up to 1000 V. Five ranges of 100 mV, 1000 mV, 10 V, 100 V, and 1000 V are provided. Measurements up to 50% overrange are possible on all ranges except the 1000 V range. Range may be selected manually, automatically or remotely.

1-3. Two modes of ac voltage measurement are provided. The ac coupled mode, VAC(AC), makes ac measurements from 10 Hz to 10 MHz, while the dc coupled mode, VAC(DC), extends the range down to 1 Hz and makes true rms measurements of voltages containing both ac and dc. Mode of operation may be selected manually or remotely.

### 1-4. SPECIFICATIONS.

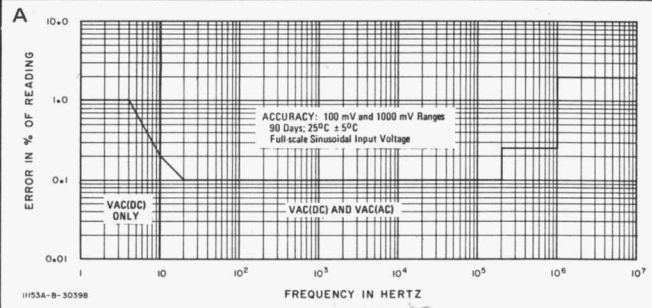
AC voltage measurement specifications for the 11153A/3484A/3480A/B combination are given in Table 1-1.

Table 1-1. Specifications.

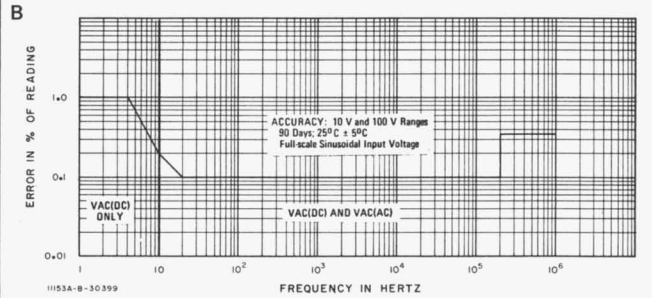
<p><b>Full Scale Voltage Ranges</b></p> <p>50% Overage capability on all ranges; maximum input 1500 V peak.</p> <p>Range Selection</p> <p style="padding-left: 20px;">Automatic Ranging</p> <p><b>Response</b></p> <p>AC Coupled – VAC(AC) Function</p> <p>DC Coupled – VAC(DC) Function</p> <p style="padding-left: 20px;">(Selection of AC or DC coupling may be manual or remote)</p> <p><b>Accuracy</b></p> <p>Conditions: 90 days, 25°C ± 5°C Full-scale sinusoidal input voltage</p> <p>DC</p> <p>AC</p>	<p>100 mV, 1000 mV, 10 V, 100 V, 1000 V</p> <p>Manual, Automatic, or Remote</p> <p>Upranges at 140% of range Downranges at 10% of range</p> <p>Responds to true rms value of ac input signal (Internally ac coupled)</p> <p>Responds to true rms value of dc and ac input signal</p> $\text{Reading} = \sqrt{(\text{DC})^2 + (\text{AC}_{\text{rms}})^2}$ <p>With external 10 microfarad coupling capacitor, responds to ac component only, for measurement down to 1 Hz.</p> <p>± 1.0%, all ranges (plus temperature coefficient error determined by Graph E when ambient temperature is between 0°C and 20°C or 30°C and 50°C)</p> <p>Graphs A, B, and C show accuracy specifications for full-scale sinusoidal input voltages. For inputs below full-scale, the full-scale accuracy specification must be modified by the multiplier indicated in Graph D to find the total error in percent of reading. In addition, at ambient temperatures between 0°C and 20°C or 30°C and 50°C, the temperature coefficient error as determined by Graph E must be added.</p>
--	---

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

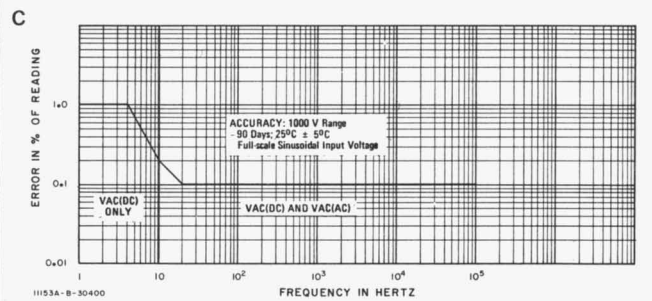
100 mV and 1000 mV Ranges  
Less than  $10^7$  Volt-Hertz



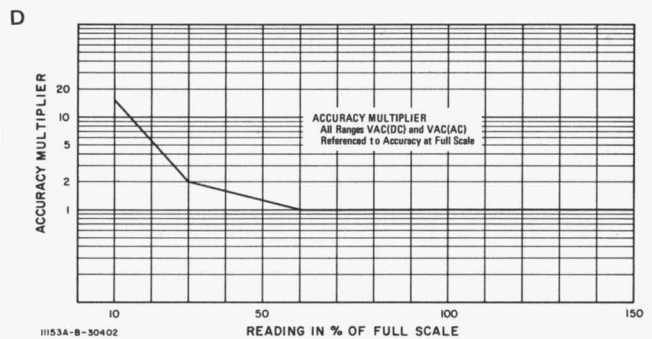
10 V and 100 V Ranges  
Less than  $10^8$  Volt-Hertz



1000 V Range  
Less than  $10^8$  Volt-Hertz



Accuracy Multiplier (below full-scale)



Temperature Coefficient (0°C to 50°C)

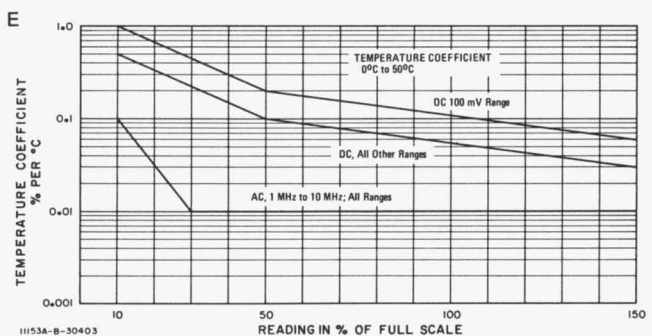
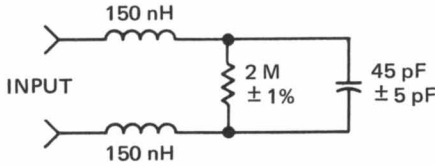
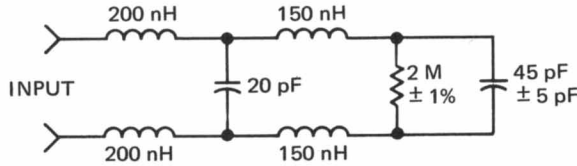


Table 1-1. Specifications. (Cont'd)

<p><b>Measuring Speed</b></p>	<p>950 microseconds</p>
<p>Reading Period</p>	<p>Variable from 1 to 25 per second with front panel control</p>
<p>Reading Rate (without range change)</p>	<p>Front panel pushbutton</p>
<p>Internal Trigger</p>	<p>0 to 1000 per second</p>
<p>Manual Trigger</p>	
<p>External Trigger</p>	
<p>Response Time (without range change) From 10% of full-scale to full-scale, or from full-scale to 10% of full-scale.</p>	<p>1 second to within 5 counts of final reading</p>
<p>AC Coupled – VAC(AC)</p>	<p>15 seconds to within 5 counts of final reading</p>
<p>DC Coupled – VAC(DC)</p>	
<p>Autorange Time</p>	
<p>AC Coupled – VAC(AC)</p>	<p>1 second per range change</p>
<p>DC Coupled – VAC(DC)</p>	<p>3 seconds per range change</p>
<p><b>Input Characteristics</b></p>	
<p>Input Impedance</p>	
<p>Front Terminals</p>	
<p>Rear Terminals</p>	
<p>Crest Factor</p>	<p>7:1 at full-scale, derated linearly from 35 Hz to 1.5:1 at 5 Hz Crest factor is less above full-scale and greater below full-scale than specified at full-scale. The relationship is approximately linear.</p>
<p>Maximum Input Voltage</p>	
<p>AC Coupled – VAC(AC)</p>	<p>1500 V peak ac 10 Vdc maximum, 100 mV range 100 Vdc maximum, all other ranges 1500 V maximum peak ac + dc</p>
<p>DC Coupled – VAC(DC)</p>	<p>1000 V rms 1500 V maximum peak ac + dc</p>
<p><b>Warm-up Time</b></p>	<p>30 minutes to rated full-scale accuracy</p>

## SECTION II INSTALLATION

### 2.1. INTRODUCTION.

This section contains information and instructions for installing the Model 11153A True RMS Converter assembly within the Model 3484A Multifunction Unit. Also included are instructions for repackaging for shipment.

### 2.2. INITIAL INSPECTION.

This assembly was carefully inspected both mechanically and electrically before shipment. It should be examined for physical damage in transit. When installed in the Model 3484A, the electrical performance of the Model 11153A should be tested, using the Performance Checks outlined in Paragraph 5-3. If there is damage or deficiency, see the warranty inside the front cover of this manual.

### 2.3. INSTALLATION.

Use the following procedure to install the 11153A True RMS Converter assembly in the 3484A Multifunction Unit.

- a. Remove 3484A bottom 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. With 3484A turned upside down, position ac converter assembly component side down over the hinges on the master board A3. See Figure 2-1. The converter input and output wires are on the hinge side of the assembly.
- c. Fasten the converter assembly to hinges, using 6-32 x 1/4 pan head screws with lockwasher, -hp- Part No. 2360-0113.
- d. Connect orange output wire to teflon connector in master board between left hinge and edge of board. See Figure 2-1.
- e. Connect red input wire to pin mounted in teflon insulator near front edge of master board as indicated in Figure 2-1. This pin is connected through a red wire to terminal switch.
- f. Connect black ground wire to pin on master board next to ground lug. (Figure 2-1.)
- g. Insert flex cable into connector J7 on master board.

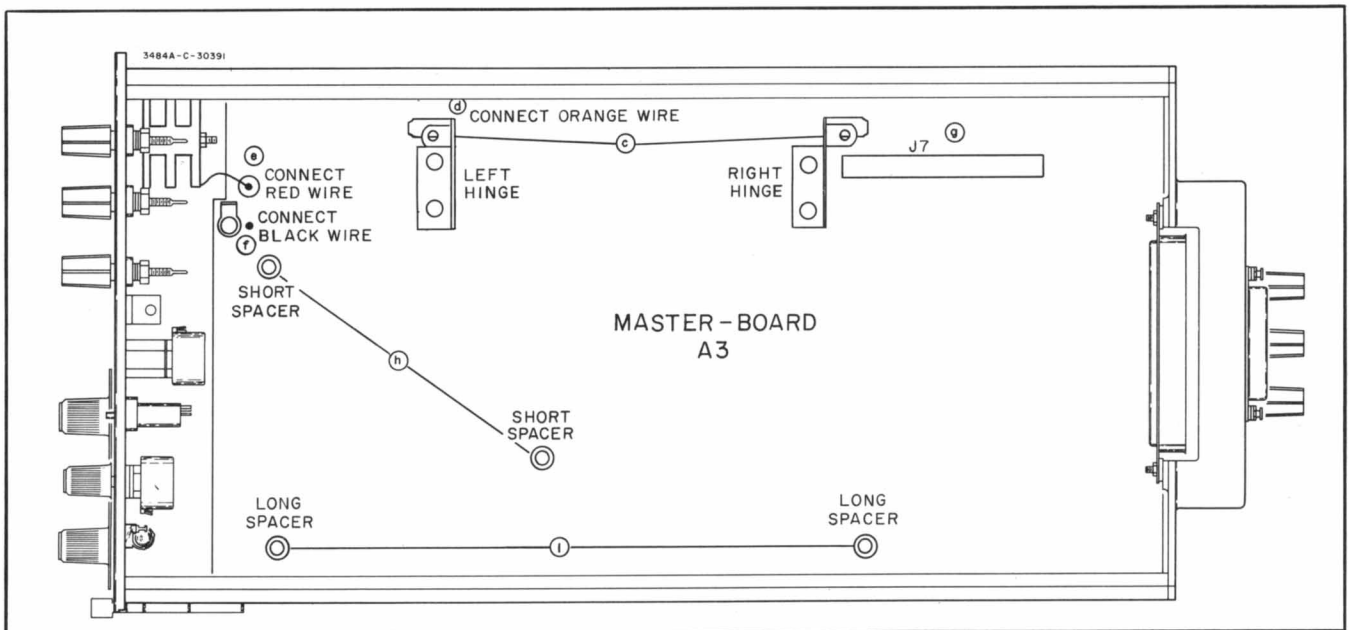


Figure 2-1. AC Converter Installation.

- h. Some 3484A units may be provided with two short spacers mounted in the master board at positions indicated by (h) in Figure 2-1. If these spacers are present, remove nuts from the screws projecting up through the converter assembly shields. Rotate the assembly to the horizontal position and fasten in place by inserting the two screws into short spacers.
- i. Secure assembly to long spacers at edge of master board, using 6-32 x 3/8 pan head screws with lock-washer, -hp- Part No. 2360-0117.
- j. Rotate FUNCTION switch counterclockwise to limit stop. If switch has two blank positions, omit Steps k through n and proceed to Step o. If switch rotates only to VDC, proceed with Step k.
- k. Set FUNCTION switch to VDC and remove knob by loosening the two set screws. Remove 3484A top guard cover.
- l. Remove FUNCTION switch mounting nut and carefully slide the switch as far as possible toward rear of instrument.
- m. Rotate the counterclockwise limit stop two positions counterclockwise as indicated in Figure 2-2. Make certain that the clockwise limit stop is in the correct position.
- n. Replace switch carefully so that stops stay in position. Replace switch mounting nut. Replace top guard cover. Proceed to Step p.
- o. Set FUNCTION switch to VDC and remove knob by loosening the two set screws.
- p. Two FUNCTION switch knobs are provided with the Model 11153A. -hp- Part No. 5060-5952 should be used if the instrument does not have an ohms converter, and Part No. 5060-5954 if instrument does have ohms. Select and install correct knob, orienting so that VDC is opposite mark on front panel. Secure knob with two set screws.
- q. Replace 3484A bottom guard cover.
- r. Check electrical performance of ac converter, using procedure outlined in Paragraph 5-3.

#### 2-4. REPACKAGING FOR SHIPMENT.

The following is a general guide for repackaging the 11153A converter assembly for shipment if it should become necessary to ship the converter assembly separate from the 3484A.

#### NOTE

If the assembly is to be shipped to Hewlett-Packard for repair or exchange, attach a tag to the assembly identifying the owner and indicating the repair to be accomplished or noting that the unit is being exchanged.

- a. If original container and packing material are available, wrap the assembly carefully and make sure the container is well sealed with strong tape.
- b. If original container is not available, wrap assembly carefully in suitable packing material, bearing in mind that the reed relays in particular are easily broken. Place in a suitable container and seal well with strong tape.
- c. Mark shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

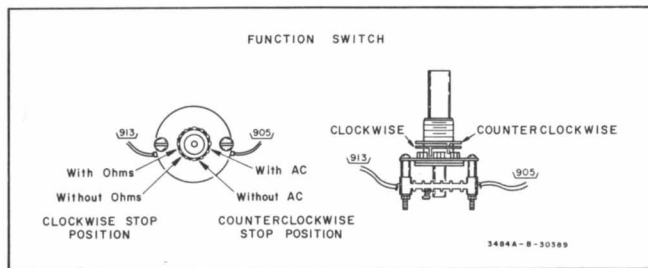


Figure 2-2. Function Switch Limit Stop.

## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION.

This section contains information which applies specifically to ac measurement operation of the Model 3484A (Option 043) and 3480A/B. Additional information concerning sample control and remote programming is contained in the Model 3484A Operating and Service Manual.

#### 3-2. AC VOLTAGE MEASUREMENTS.

#### 3-3. AC OR DC COUPLED MEASUREMENT.

The VAC(AC) function permits true rms voltage measurements of frequencies from 10 Hz to 10 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  $\mu$ F blocking capacitor.

#### 3-4. MAXIMUM INPUT VOLTAGES.

3-5. 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.

3-6. 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  $\mu$ F 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  $\mu$ A, or measurement error will result.

#### 3-7. RESPONSE TIME.

3-8. 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.

3-9. In VAC(AC) function, application of an input voltage having a large dc component will increase the response time because of the time constant of the ac converter input circuit. For example, after application of an input voltage of 100 Vdc on the 1000 mV range, the input coupling capacitor requires approximately 10 seconds to charge. After removal of the dc voltage, the capacitor requires about 20 seconds to discharge. Smaller dc voltage inputs require correspondingly shorter times.

#### 3-10. 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 in the 3484A Operating and Service Manual.

#### 3-11. 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.

#### 3-12. HIGH FREQUENCY MEASUREMENTS.

When making measurements of frequencies of 1 MHz and higher, impedance matching and cable length become important to measurement accuracy. Mismatched impedances may also cause reflections or excessive loading, resulting in improper operation of the circuit under measurement. Whenever possible, the characteristic impedance of the coaxial input cable should be equal to the source impedance, and the cable length should be as short as possible. In addition, a termination equal to the source impedance should be connected at the 3484A input terminals. If coaxial cable is unavailable or impractical, a twisted pair of as short a length as possible should be used to minimize pickup of stray signals.

**3-13. AC VOLTAGE MEASUREMENT PROCEDURE.**

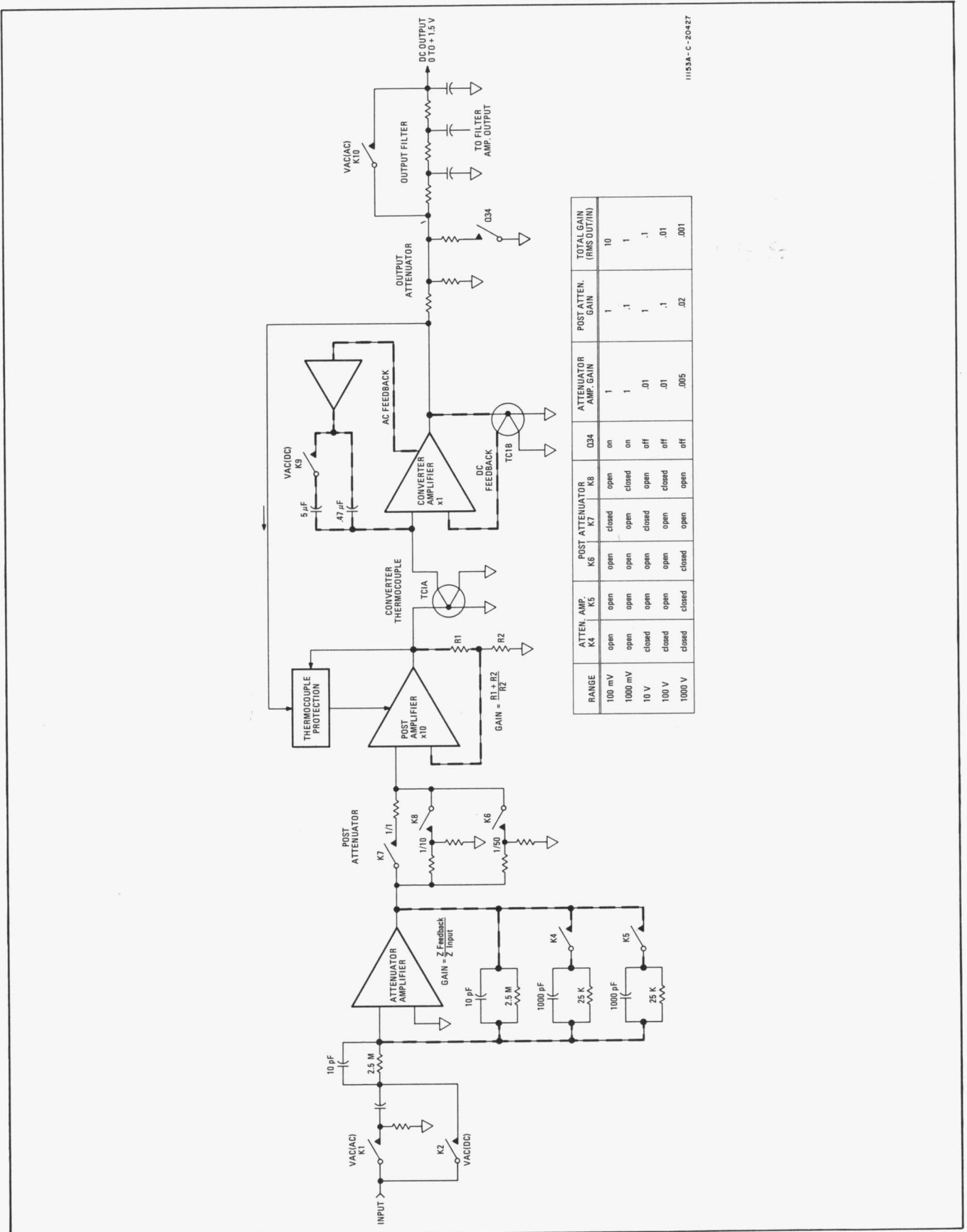
- a. Turn instrument on and allow to warm up for 30 minutes.
- b. Set FUNCTION switch to VAC(AC) or VAC(DC), or select FUNCTION remotely.
- c. Select RANGE manually or remotely, or set switch to AUTO.
- d. Adjust SAMPLE RATE control to desired sampling speed, or apply external trigger. Refer to Paragraph 3-7 in the 3484A Operating and Service Manual.

- 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 may 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.





11153A-C-20427

Figure 4-1. True RMS Converter Block Diagram.

## SECTION IV

### THEORY OF OPERATION

#### 4-1. INTRODUCTION.

A block diagram of the True RMS Converter is shown in Figure 4-1. 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.

#### 4-2. ATTENUATOR AMPLIFIER.

4-3. 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. Constant current sources are used at several points in the amplifier to maintain proper bias currents. The Attenuator Amplifier gain is equal to the feedback impedance divided by the input impedance. Range switching is accomplished by varying the attenuation of the Attenuator Amplifier and Post Attenuator as shown in the table given in Figure 4-1.

4-4. The Attenuator Guard (shown in Figure 7-1) is driven by an emitter-follower, maintaining the guard at nearly the same potential as the amplifier input. The Attenuator Guard is not connected to the input guard terminal.

#### 4-5. POST AMPLIFIER.

The Post Amplifier is a broadband non-inverting amplifier giving a gain of 10. This amplifier also has a differential input stage and a push-pull output stage. The output of the Post Amplifier drives the heating element of the Thermocouple.

#### 4-6. CONVERTER THERMOCOUPLE.

The Converter Thermocouple is one half of a specially designed dual thermocouple called a thermopile. Each half of the thermopile consists of 30 thermocouples in series, resulting in high sensitivity. The low thermal mass of the thin-film construction permits rapid response to input signal changes.

#### 4-7. CONVERTER AMPLIFIER.

One half of the dual thermocouple converts the ac signal to dc, and the other half is used in the dc feedback loop of the Converter Amplifier. Since a thermocouple is a non-linear device, the feedback offsets the non-linearity of the amplifier input signal, resulting in a linear dc output. Using the dual unit in this manner also minimizes the effect of ambient temperature drift. An integrating ac feedback loop is employed to filter out the ac component of the thermocouple output. A non-linear amplifier in the ac feedback loop offsets the non-linearity of the thermocouple output to provide a linear integrating action. Integrating capacitance is increased in the VAC(DC) mode to permit measurement of signals down to 1 Hz. The gain of 1 indicated in Figure 4-1 for the Converter Amplifier is the gain from the rms value of the Converter Thermocouple input to the dc output of the amplifier.

#### 4-8. THERMOCOUPLE PROTECTION.

To protect the thermocouple, a virtual short circuit is placed across the Post Amplifier output stage if operating conditions exist which might damage the thermocouple. An integrated circuit comparator amplifier, in conjunction with a bridge rectifier circuit, compares the Post Amplifier output to a predetermined level. If the output exceeds this level, the comparator causes a clamp circuit to short-circuit the Post Amplifier output stage. A second comparator amplifier compares the output of the Converter Amplifier to another predetermined level, and causes the clamp circuit to cut off the Post Amplifier output stage if the level is exceeded.

#### 4-9. OUTPUT ATTENUATOR AND FILTER.

The Output Attenuator is provided to adjust the True RMS Converter output to the specified accuracy. The Output Filter is bypassed in the VAC(AC) mode since ample filtering is provided by the 3484A 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 Converter output is 0 to +1.5 V on all ranges.

Table 5-1. Required Test Equipment.

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
AC Calibrator/ High Voltage Amplifier	Frequency: 10 Hz to 100 kHz Output Level: 100 mV to 1000 V Accuracy (mid band): $\pm 0.05\%$ or better Voltage Stability: $\pm 0.02\%$ for 6 months	Performance Checks Adjustments Troubleshooting	-hp- Model 745A AC Calibrator/746A High Voltage Amplifier
Test Oscillator	Frequency: 100 kHz to 10 MHz Output Level: 1 V rms Amplitude Flatness: $\pm 0.25\%$ (1 V output) Output Impedance: 50 ohms	Performance Checks Adjustments Troubleshooting	-hp- Model 652A Test Oscillator
AC Amplifier	Output voltage: 10 V to 100 V Frequency: 100 kHz to 1 MHz Voltage Gain: 20 Output Power: 25 VA	Performance Checks Adjustments	Optimization Inc. Model PA-25 Power Amplifier
DC Standard	Voltage: 1 V to 1000 V Accuracy: $\pm 0.01\%$	Performance Checks	-hp- Model 740B DC Standard/ Differential Voltmeter
DC Differential Voltmeter	Range: 1 V Resolution: 1 microvolt	Performance Checks Adjustments Troubleshooting	-hp- Model 3420A/B DC Differential Voltmeter or Model 740B
50 ohm Feed-Thru	50 ohms $\pm 1\%$	Performance Checks	-hp- Model 11048B Feed-Thru
Thermal Converters or Thermal Transfer Standards	Accuracy: $\pm 0.05\%$ to 10 MHz  Voltages: 1 V  10 V 100 V 1000 V	Performance Checks Adjustments	-hp- Model 11050A  Holt Model 6A, 11; or Engelhard Model 36850
DC Voltmeter	Voltage Range: 1 mV to 100 V	Adjustments	-hp- Model 412A DC Vacuum Tube Voltmeter
Ohmmeter	Range: 100 ohms to 10 megohms	Troubleshooting	-hp- Model 412A DC Vacuum Tube Voltmeter
Oscilloscope	Bandwidth: dc to 10 MHz Sweep: 0.2 microseconds to 5 sec/cm	Troubleshooting	-hp- Model 140A/1402A/ 1423A/Oscilloscope

## SECTION V MAINTENANCE

### 5-1. INTRODUCTION.

This section contains information necessary to maintain the Model 11153A. The following paragraphs describe the Performance Checks, Adjustment Procedures, Servicing, and Troubleshooting.

### 5-2. TEST EQUIPMENT REQUIRED.

Recommended test equipment for maintaining and checking the performance of the Model 11153A 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 11153A True RMS Converter. *The 3480A or 3480B used, as well as the DCV function of the 3484A must be operating within specifications.* The 3480A/B 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. It is recommended that the performance of the 11153A 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 11153A. 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 11153A is found to be out of specifications at any point in this procedure, refer to Paragraph 5-7, Adjustment Procedures, or to the Troubleshooting information, Paragraph 5-20.

### 5-4. AC VOLTAGE ACCURACY CHECKS.

5-5. Because of the wide voltage range and bandwidth of the ac converter, several test setups are required to generate the test signals needed to verify the accuracy specifications. In many cases, the accuracy of the signal source alone is not great enough to ensure a valid test of the 3484A ac converter. In such cases, accuracy of the test signal can be improved to an acceptable level by one of the two following methods:

- a. AC to DC Transfer Measurement. Using a test setup similar to that indicated in Figure 5-1, apply an accurate dc voltage to the thermal converter, and adjust the dc differential voltmeter for a null indication. Remove the dc input from the thermal con-

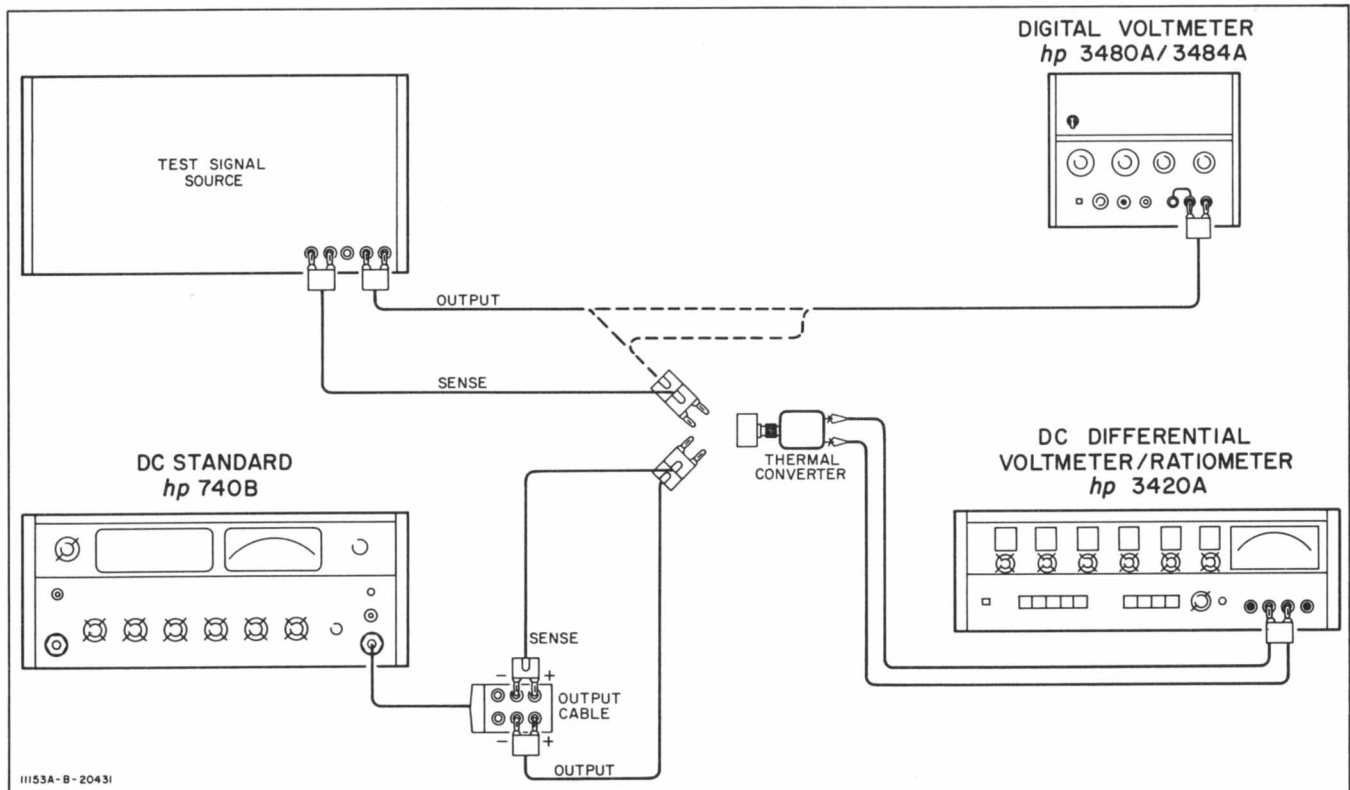


Figure 5-1. AC Voltage Accuracy Checks.

Table 5-2. AC Voltage Accuracy Checks.

3484A		TEST SIGNAL		3484A MAX. DISPLAY ERROR		TEST SIGNAL SOURCE		OTHER EQUIPMENT REQUIRED	
FUNCTION	RANGE	VOLTAGE	FREQUENCY						
VAC(AC) VAC(AC)	100 mV 100 mV	100 mV 100 mV	50 Hz 20 kHz	± 10 counts ± 10 counts	AC Calibrator				
VAC(DC) VAC(DC) VAC(DC)	1000 mV 1000 mV 1000 mV	100 mV 300 mV 1000 mV	1 kHz 1 kHz 1 kHz	± 15 counts ± 6 counts ± 10 counts					
VAC(AC)	1000 mV	1.5 V	20 kHz	± 15 counts					
VAC(AC)	10 V	10 V	1 kHz	± 10 counts					
VAC(AC)	100 V	100 V	1 kHz	± 10 counts					
VAC(AC) VAC(AC)	1000 mV 1000 mV	1000 mV 1000 mV	10 Hz 20 Hz	± 20 counts ± 10 counts	AC Calibrator		Correction Factor Chart or DC Standard, 1 V Thermal Converter and DC Differential Voltmeter		
VAC(AC) VAC(AC)	1000 V 1000 V	1000 V 1000 V	1 kHz 100 kHz	± 10 counts ± 10 counts	AC Calibrator and High Voltage Amplifier		Correction Factor Chart or DC Standard, 1000 V Thermal Converter and DC Differential Voltmeter.		
VAC(AC) VAC(AC)	100 mV 1000 mV	100 mV 1000 mV	10 MHz 10 MHz	± 200 counts ± 200 counts	Test Oscillator using "Reference Set" feature		50 ohm Feed-Thru Load at 3484A input terminals.		
VAC(AC) VAC(AC)	1000 mV 1000 mV	1000 mV 1000 mV	200 kHz 1 MHz	± 10 counts ± 25 counts	Test Oscillator		DC Standard, 1 V Thermal Converter, and DC Differential Voltmeter		
VAC(AC) VAC(AC)	10 V 10 V	10 V 10 V	200 kHz 1 MHz	± 10 counts ± 35 counts	Test Oscillator and Power Amplifier		DC Standard, 10 V Thermal Converter and DC Differential Voltmeter		
VAC(AC) VAC(AC)	100 V 100 V	100 V 100 V	200 kHz 1 MHz	± 10 counts ± 35 counts	Test Oscillator and Power Amplifier		DC Standard, 100 V Thermal Converter, and DC Differential Voltmeter		

verter and apply the ac signal to both the thermal converter and the 3484A input simultaneously. Adjust the ac test signal source output to return the dc differential voltmeter to a null indication. This results in an rms value of the ac signal equal to the rms value of the dc standard output.

- b. Correction Factor. During routine periodic calibration of an ac calibrator such as the -hp- Model 745A/746A, a chart of correction factors can be derived which lists the instrument's output voltage error at various voltage and frequency settings. The correction factors can then be used to increase the accuracy of the test signal when testing the 11153A ac converter. For example, if the 745A output is known to be 0.04% high at 1 V, 20 Hz, the 745A can be set for a precise 1 V output by setting the 745A Voltage Set Controls to 1.000000 V and adjusting the Error Measurement Control to +0.04%. The corrected voltage will then be sufficiently accurate to test the 11153A at 1 V, 20 Hz. Due to the good long-term voltage stability characteristic of the Model 745A and 746A, the correction factor chart should be valid for at least 6 months.

5-6. Table 5-2 lists the voltage and frequency points which should be checked to verify the accuracy of the 11153A, together with the test equipment needed for each check. If the equipment required for some checks is not available, a good indication of performance can still be obtained by checking the points for which suitable equipment is available. The general test setup shown in Figure 5-1 can be adapted according to the equipment needed for each check.

### 5-7. ADJUSTMENT PROCEDURES.

5-8. The following procedures should be performed only after it has been determined from the Performance Checks that the Model 11153A True RMS Converter is out of specifications. If any adjustment in this procedure cannot be made correctly, refer to the Troubleshooting Procedures, Paragraph 5-20.

5-9. The Model 3480A or 3480B and the DCV function of the Model 3484A *must be operating within specifications*. Access to all adjustments in this procedure may be gained by removing the 3480A/B bottom cover, or an extender cable may be used to operate the 3484A outside the 3480A/B if desired. The -hp- Model 11148A Extender Cable is available for this purpose. All adjustments must be made with the 3484A guard cover in place. The input LOW terminal is used as a ground connection for all measurements. Adjustments must be made in the order given.

### 5-10. AMPLIFIER ZERO ADJUSTMENTS.

- a. Turn 3480A/B/3484A on and allow to warm up for 1 hour.

- b. Set 3484A FUNCTION to VAC(AC), RANGE to 100 mV, TERMINAL to FRONT, SAMPLE RATE fully clockwise. FILTER switch setting has no effect in AC functions. Short input terminals.
- c. Connect a dc voltmeter, capable of resolving 100  $\mu$ V, between A7TP1 and input LOW terminal.
- d. Adjust A7R42 INPUT AMP BIAS for dc voltmeter reading of  $0 \pm 100 \mu$ V.
- e. Set 3484A RANGE to 1000 V.
- f. Connect dc voltmeter to A7TP2 and adjust A7R70 POST AMP BIAS for voltmeter reading of  $0 \pm 500 \mu$ V.
- g. Set 3484A RANGE to 100 mV and readjust A7R42 INPUT AMP BIAS if necessary for dc voltmeter reading of  $0 \pm 500 \mu$ V at A7TP2.
- h. Repeat Steps f and g if necessary until voltage at A7TP2 is  $< \pm 500 \mu$ V on all ranges.

### 5-11. MID BAND AND LOW FREQ. ADJUSTMENTS.

For necessary accuracy in performing the following mid band and low frequency adjustments, the ac calibrator and high voltage amplifier should be calibrated by a standards laboratory and a chart of correction factors obtained. The amount of error present at the voltages and frequencies used in the following adjustments should be taken into consideration when setting the ac calibrator output levels or the 3480A/B display.

- a. Connect 3480A/B/3484A and ac calibrator as shown in Figure 5-2. Connect 3484A GUARD to LOW. Allow calibrator to warm up for 1 hour.
- b. Set 3484A RANGE to 10 V, and adjust ac calibrator output to 10.0000 V at 100 kHz.
- c. Adjust A7R123 10 V MID BAND to obtain 3480A/B display of 10.000 V.
- d. Change ac calibrator output to 1.00000 V (100 kHz) and adjust A7R98 0.1 SCALE 10 V MID BAND for 3480A/B display of 1.000 V.
- e. Return ac calibrator output to 10.0000 V (100 kHz). Display should be 10.000 V  $\pm$  1 count. If not, repeat Steps c through e. (Adjustments A7R98 and A7R123 interact.)
- f. Set ac calibrator output to 100.000 mV at 100 kHz, and set 3484A RANGE to 100 mV.
- g. Adjust A7R129 100 MV MID BAND for display of 100.00 mV.
- h. Change ac calibrator frequency to 100 Hz (100.000 mV).

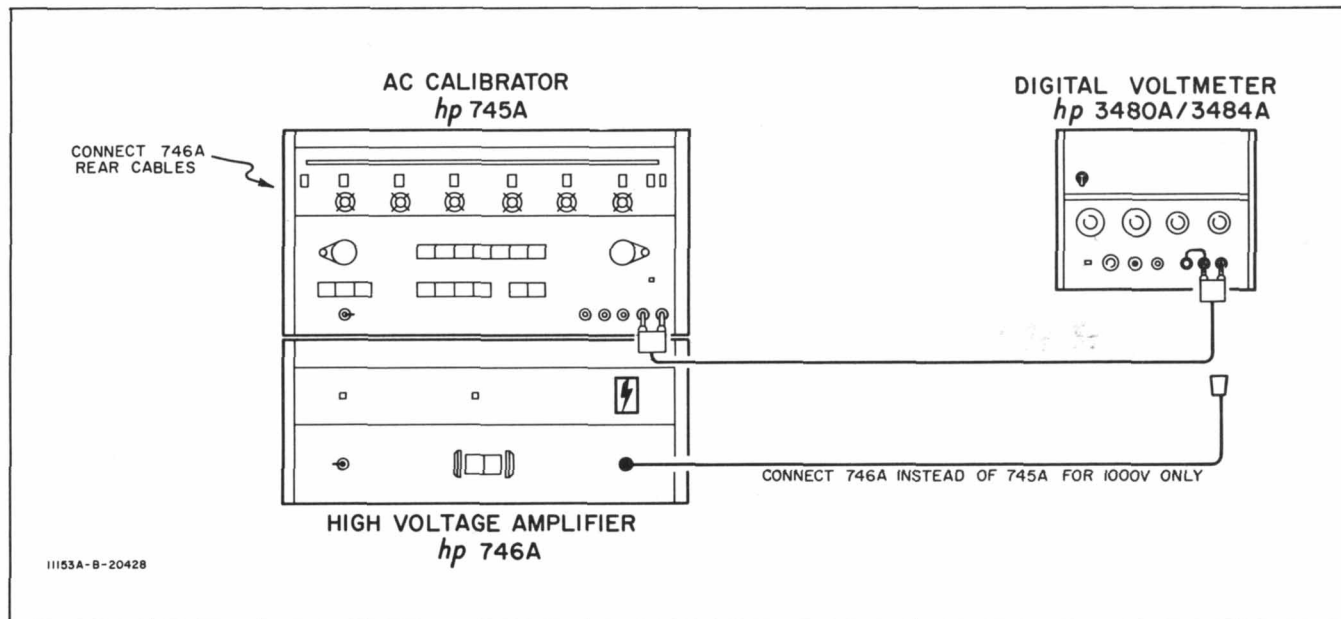


Figure 5-2. Mid Band and Low Frequency Adjustments.

- i. Adjust A7R13 100 MV LOW FREQ. for display of 100.00 mV
- j. Set 3484A RANGE to 1000 mV and adjust ac calibrator output level to 1000.00 mV (100 Hz).
- k. Adjust A7R56 1000 MV LOW FREQ. for display of 1000.0 mV.
- l. Set 3484A RANGE to 10 V and adjust ac calibrator output level to 10.0000 V (100 Hz).
- m. Adjust A7R14 10 V LOW FREQ. for display of 10.000 V.
- n. Set 3484A RANGE to 1000 V. Adjust ac calibrator/high voltage amplifier output to 1000.00 V at 100 kHz.
- o. Adjust A7R53 1000 V MID BAND for display of 1000.0 V.
- p. Change ac calibrator frequency to 100 Hz (1000.00 V). Adjust A7R15 1000 V LOW FREQ. for display of 1000.0 V.
- q. Reduce ac calibrator output to 1 mV and disconnect from 3484A input.
- c. Adjust test oscillator frequency to 1 kHz and adjust output level to obtain 3480A/B display of 1000.0 mV  $\pm$  1 count.
- d. Adjust dc differential voltmeter to obtain null reading.
- e. Change test oscillator frequency to 10 MHz and adjust output level to return dc differential voltmeter reading to null. Do not readjust differential voltmeter setting.
- f. Adjust A7R27 1000 MV HIGH FREQ. for 3480A/B display of 1000.0 mV  $\pm$  5 counts.
- g. Reduce test oscillator output to zero and replace 1 V thermal converter with 10 V thermal converter. Add power amplifier to test oscillator output as shown in Figure 5-4.
- h. Set 3484A RANGE to 10 V.
- i. Adjust test oscillator frequency to 1 kHz and adjust oscillator and amplifier output level to obtain 3480A/B display of 10.000 V  $\pm$  1 count.
- j. Adjust dc differential voltmeter for null reading.

## 5-12. HIGH FREQUENCY ADJUSTMENTS.

- a. Connect 3480A/B/3484A and test equipment as shown in Figure 5-3. Connect 3484A GUARD to LOW.
- b. Set 3484A FUNCTION to VAC(AC), RANGE to 1000 mV.
1. Adjust A7R25 10 V HIGH FREQ. for 3480A/B display of 10.000 V  $\pm$  3 counts.



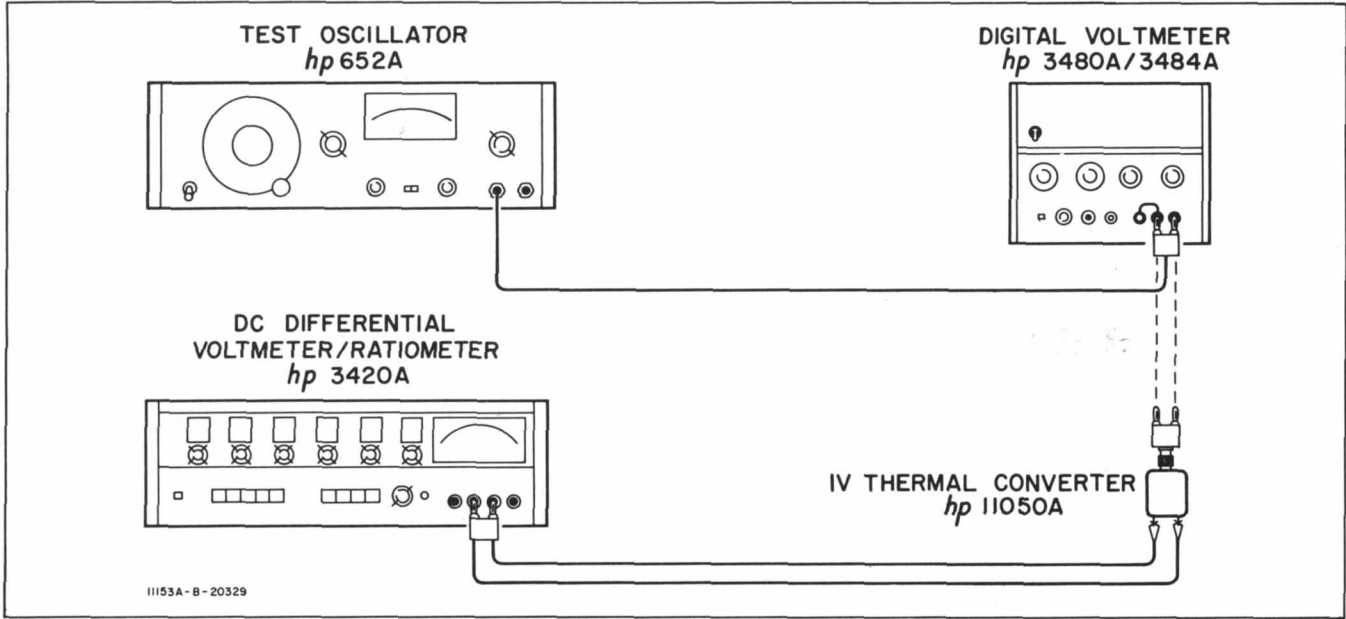


Figure 5-3. 10 MHz, 1000 mV Adjustment.

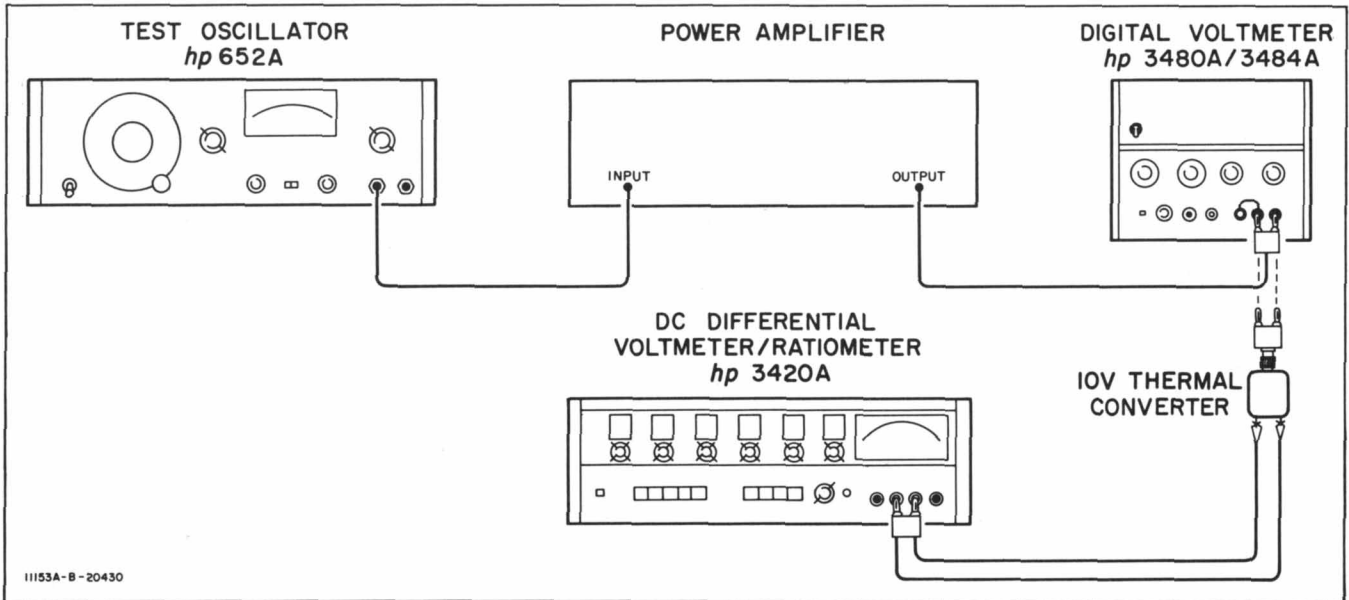


Figure 5-4. 1 MHz, 10 V Adjustment.

**5-13. SERVICING INFORMATION.**

**5-14. CLEAN HANDLING TECHNIQUES.**

Most areas of the ac converter assembly must be kept free from dirt or contamination, or performance of the instrument will be degraded. Wear clean cotton or rubber gloves when working within the 3484A, and make sure tools are clean. The printed circuit board may be handled without gloves if only the edges of the board are touched. Component replacement procedures outlined in the 3484A Operating and Service Manual, Paragraph 5-27, should be followed to avoid contamination of the printed circuit assembly.

**5-15. REED REPLACEMENT.**

5-16. Reed switches must be handled very carefully. Clean 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, because stress on the leads may break the glass seal or cause the switch to be inoperative. The leads of replacement switches for A7K1, 2, 9, 10, and 11 must be shortened by cutting an equal amount from each lead, so that the total reed 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. The leads of reed switches for A7K4 and 5 must NOT be shortened.



Table 5-3. VAC Reed Relay Checks.

CHECK	RESULT	POSSIBLE CAUSE/ INSTRUCTIONS
1. Apply 100 mV, 1 kHz to input on 100 mV range in VAC(AC) and then in VAC(DC).	Reading increases when input is applied in both VAC(AC) and VAC(DC). (Readings may be noisy or inaccurate.)  Reading increases in VAC(AC) only.  Reading increases in VAC(DC) only.  Steady or overload reading in both VAC(AC) and VAC(DC).	Perform Check 2.  A7K2 open  A7K1 open.  A7K11 open. Note: If A7K11 is not open, perform Check 4.
2. Connect an AC Voltmeter to A7TP1 and the input LOW terminal. Select 1000 mV range, VAC(AC) Apply 1000 mV, 1 kHz.	Approx. 1 Vac at A7TP1.  Approx. 10 mVac at A7TP1.	Perform Check 3.  A7K3 and A7K4 shorted, or A7K3 and A7K5 shorted.
3. Select 1000 V range, VAC(AC) Apply 100 V, 1 kHz.	Approx. 500 mV at A7TP1.  Approx. 1 V at A7TP1.  Approx. 8 to 10 Vac at A7TP1.	Perform Check 4.  A7K4 open, or A7K5 open. A7K3 open, or A7K4 and A7K5 open.
4. Remove ACVM form A7TP1. Connect short across input terminals. Switch through all ranges.	Reading is below 10% of range on all ranges.  Reads Overload on 100 mV and 10 V ranges.  Reads Overload on 1000 mV and 100 V ranges.  Reads Overload on 1000 V range.	Perform Check 5.  A7K7 open.  A7K8 open.  A7K6 open.
5. Apply 100 mV, 1 kHz on 100 mV range VAC(AC), and then apply 1000 mV on 1000 mV range.	Readings are 100 mV $\pm$ 10% and 1000 mV $\pm$ 10%.  100 mV range out of tolerance.  1000 mV range out of tolerance.	Perform Check 6.  A7K6 shorted, or A7K8 shorted.  A7K7 shorted.
6. Select 1000 mV range, VAC(DC) Apply 1000 mV, 10 Hz.	Settles to final reading in approx. 15 seconds. < 2 counts noise.  Settles in 3 to 4 seconds. Excessive noise.  Responds in approx. 15 seconds. Excessive noise.	Perform Check 7.  A7K10 shorted.  A7K9 open (A7K9A in instruments below Serial No. 100).
7. Select 1000 mV range, VAC(AC). Apply 1000 mV, 1 kHz.	Settles to final reading in 1 to 2 seconds.  Settles to final reading in approx. 5 seconds.  Settles to final reading in approx. 15 seconds.	Reed Relays not at fault.  A7K9 shorted (A7K9A in instruments below Serial No. 100).  A7K10 open.

5-17. Most reeds on the ac converter assembly are soldered in place, while A7K9, 10, and 11 are inserted into spring clips. The special reed replacement tool, -hp- Part No. 4040-0720, provided with the 3484A may be used to remove and replace reed switches which use the spring clips. Use of the tool is illustrated in the 3484A Operating and Service Manual.

**5-18. THERMOCOUPLE REPLACEMENT.**

When the thermocouple A7TC1 requires replacement, resistors A7R112 and A7R140 must also be replaced. These resistors are matched and supplied with the replacement thermocouple. Check the Thermocouple Protection Circuit using the procedure outlined in Paragraph 5-26 before replacing the thermocouple. It will also be necessary to perform the Adjustment Procedures, Paragraph 5-7, after replacing the thermocouple.

**5-19. AC CONVERTER ASSEMBLY EXCHANGE.**

A factory rebuilt and tested converter assembly, -hp- Part No. 11153-69501, may be purchased on an exchange basis. Contact your nearest -hp- Sales and Service Office, listed in Appendix B, for exchange details.

**5-20. TROUBLESHOOTING.**

If the True RMS Converter operates incorrectly and the trouble cannot be corrected by the Adjustment Procedures, Paragraph 5-7, the following troubleshooting information should be used to locate the source of trouble. Check for loose wires or other obvious sources of trouble, such as burned or loose components. Make sure that reed leads are not shorted to adjacent components, and that the flex cable is properly seated in the connector. Also, be sure the 3484A is operating properly in the DCV mode before attempting to troubleshoot the ac converter.



**BEFORE WORKING WITHIN THE 3484A, REFER TO PARAGRAPH 5-14, CLEAN HANDLING TECHNIQUES. DIRT OR CONTAMINATION IN THE INTERIOR OF THE 3484A MAY DEGRADE PERFORMANCE.**

**5-21. REED RELAY CHECKS.**

5-22. Many cases of reed relay failure will produce noticeable symptoms in the front panel display, such as very inaccurate or overload readings on some ranges, no response to input, noisy readings, or incorrect response time. Failure of a reed to operate properly may be caused by failure of the reed switch, the reed coil, or the reed drive circuit. A reed relay troubleshooting procedure is given in Table 5-3.

5-23. Some reed relay failures will cause little or no noticeable symptoms in ac measurements:

A7K3: If this reed is shorted, the symptom will be low readings at 100 kHz and higher on the 100 mV and 1000 mV ranges.

A7K1, K2, and K11: If any of these reeds are shorted, there will be little, if any, degradation in the operation of the 3484A in the AC functions. The symptom will be low input impedance in the DCV mode. Table 5-5 in the 3484A Operating and Service Manual lists the symptoms and causes of this type of failure and other failures which will primarily affect the DCV mode of operation.

**5-24. INPUT AMP. BIAS ADJ. RANGE.**

If A7R42 cannot be adjusted to the proper value in Paragraph 5-10d, and the circuit appears to be operating correctly in other respects, it may be necessary to readjust the range of A7R42 as follows:

- a. Replace jumper wires numbered 1, 2, and 3 (adjacent to A7R39, 40, 41) if cut.
- b. Measure voltage between A7TP1 and input LOW, and adjust A7R42 for most negative voltmeter reading .
- c. Cut jumper wires indicated in Table 5-4 according to voltage at A7TP1.
- d. Adjust A7R42 for voltage of  $0 \pm 100 \mu\text{V}$ .

Table 5-4. Input Amp. Bias

Voltage at A7TP1	Cut jumper:
0 to - 7.0 mV	none
-7.0 to -13.0 mV	1
-13.0 to -18.9 mV	2
-18.9 to -24.8 mV	1,2
-24.8 to -30.6 mV	3
-30.6 to -36.2 mV	1,3
-36.2 to -41.8 mV	2,3
-41.8 to -48.0 mV	1,2,3

**5-25. POST AMP. BIAS ADJ. RANGE.**

If A7R70 cannot be adjusted to the proper value in Paragraph 5-10f, and the circuit appears to be operating correctly in other respects, it may be necessary to readjust the range of A7R70 as follows:

- a. Replace jumper wires numbered 12 and 13 (adjacent to A7R141 and 142) if cut.
- b. Measure voltage between A7TP2 and input LOW, and adjust A7R70 for most positive voltmeter reading.

- c. Cut jumper wires indicated in Table 5-5 according to voltage at A7TP2.
- d. Adjust A7R70 for voltage of  $0 \pm 500 \mu\text{V}$ .

Table 5-5. Post Amp. Bias.

Voltage at A7TP2	Cut jumper:
0 to + 57.8 mV	none
+57.8 to +108.3 mV	12
+108.3 to +156.5 mV	13
+156.5 to +206.0 mV	12,13

**5-26. THERMOCOUPLE PROTECTION CIRCUIT.**

Before replacing a damaged thermocouple (A7TC1), the Thermocouple Protection circuit should be checked, using the following procedure, which requires a test oscillator and an oscilloscope.

- a. With the thermocouple A7TC1 removed from the instrument, set 3484A FUNCTION to VAC(AC), RANGE to 1000 mV.
- b. Adjust test oscillator output to 2.8 V at 1 kHz.
- c. Connect oscilloscope to A7TP2 and observe waveform. If waveform is a clipped wave approximately 5 V peak-to-peak, A7IC2 comparator circuit is operating correctly under constant input conditions. If not, troubleshoot A7IC2, its associated input circuit, and A7Q28, 29.
- d. If waveform in Step c is correct, install the thermocouple and A7R112, A7R140. (See Paragraph 5-18.)
- e. Adjust test oscillator output level to 1.8 V. If waveform at A7TP2 is a clipped wave approximately 4 V peak-to-peak, A7IC3 comparator is operating correctly with a constant input signal. If not, troubleshoot A7IC3 and its associated input circuit.
- f. If waveform in Step e is correct, set 3484A FUNCTION to VAC(DC), RANGE to 10 V.
- g. Adjust test oscillator output level to 3 V.

- h. Observe waveform at A7TP2 while changing 3484A RANGE to 1000 mV. When range is changed to 1000 mV, waveform should be clipped at about 5 V peak-to-peak for approximately 1 second, then reduce gradually to about 4 V peak-to-peak. A correct waveform indicates that protection circuits respond in the proper length of time.

**5-27. 1/10 SCALE ADJUSTMENT RANGE.**

5-28. If the correct adjustment of A7R98 cannot be made in Paragraph 5-11, Step d, it may be necessary to remove or replace one or more of jumper wires A through G. These jumpers are in the 14-pin IC socket as shown in the component location drawing accompanying the schematic diagram, Figure 7-2. Jumper A has the least effect on the Converter Amplifier output and Jumper G has the greatest effect, with the progression being approximately binary. Removing a jumper decreases the output voltage, and replacing a jumper increases the output. If all or most of the jumpers are removed, the amplifier output may go to zero with 1/10 scale input.

5-29. If either the Converter Amplifier A7IC1 or the Thermocouple A7TC1 has been replaced, it may be necessary to perform the following procedure in order to bring the adjustment into the proper range. An ac calibrator is required for this procedure.

- a. Set 3484A FUNCTION to VAC(AC), RANGE to 10 V.
- b. Adjust A7R98 and A7R123 fully clockwise.
- c. Remove jumper wires A through F from 14-pin IC socket. (See component location drawing with schematic diagram, Figure 7-2.) Place jumper in position G.
- d. Connect ac calibrator to 3484A input and adjust output frequency to 100 kHz.
- e. Follow the procedure in Figure 5-5, repeating until A7R98 can be adjusted properly (Step 3).
- f. Perform Adjustment Procedures outlined in Paragraph 5-7.

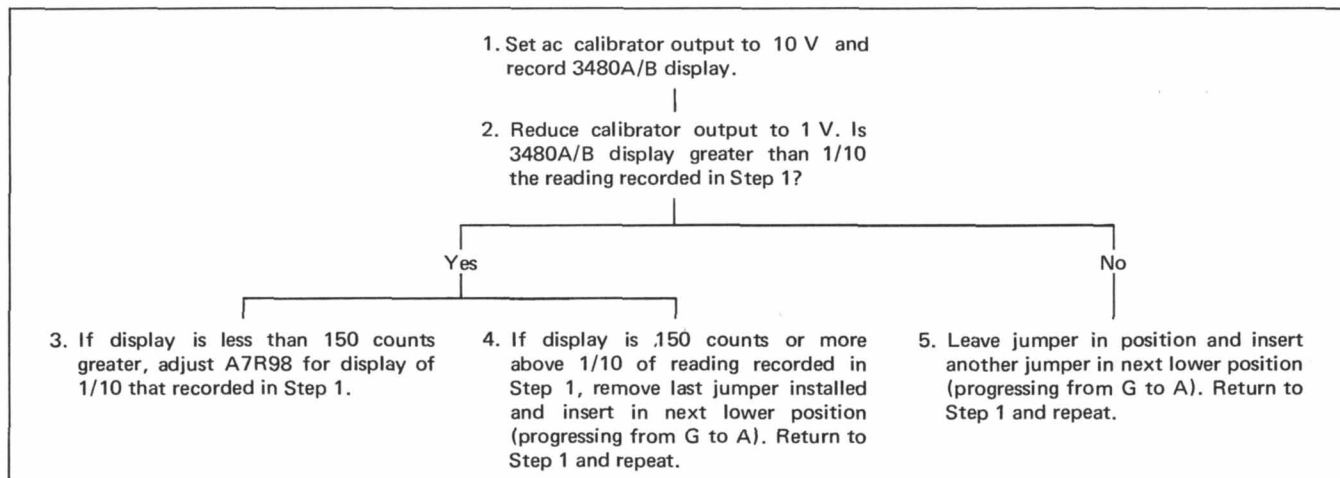


Figure 5-5. 1/10 Scale Coarse Adjustment.

## PERFORMANCE CHECK CARD

Hewlett-Packard Model 11153A  
 True RMS Converter  
 Serial No. \_\_\_\_\_

Tests performed by \_\_\_\_\_  
 Date \_\_\_\_\_

PARAGRAPH	DESCRIPTION				READING	TEST LIMITS	
	Function	Range	Input,	Frequency		Min.	Max.
5-4	AC Voltage Accuracy						
	VAC(AC)	100 mV	100 mV	50 Hz	_____	99.90 mV to 100.10 mV	
	VAC(AC)	100 mV	100 mV	20 kHz	_____	99.90 mV to 100.10 mV	
	VAC(DC)	1000 mV	100 mV	1 kHz	_____	98.5 mV to 101.5 mV	
	VAC(DC)	1000 mV	300 mV	1 kHz	_____	299.4 mV to 300.6 mV	
	VAC(DC)	1000 mV	1.5 V	20 kHz	_____	1498.5 mV to 1501.5 mV	
	VAC(AC)	10 V	10 V	1 kHz	_____	9.990 V to 10.010 V	
	VAC(AC)	100 V	100 V	1 kHz	_____	99.90 V to 100.10 V	
	VAC(AC)	1000 mV	1000 mV	10 Hz	_____	998.0 mV to 1002.0 mV	
	VAC(AC)	1000 mV	1000 mV	20 Hz	_____	999.0 mV to 1001.0 mV	
	VAC(AC)	1000 V	1000 V	1 kHz	_____	999.0 V to 1001.0 V	
	VAC(AC)	1000 V	1000 V	100 kHz	_____	999.0 V to 1001.0 V	
	VAC(AC)	100 mV	100 mV	10 MHz	_____	98.00 mV to 102.00 mV	
	VAC(AC)	1000 mV	1000 mV	10 MHz	_____	980.0 mV to 1020.0 mV	
	VAC(AC)	1000 mV	1000 mV	200 kHz	_____	999.0 mV to 1001.0 mV	
	VAC(AC)	1000 mV	1000 mV	1 MHz	_____	997.5 mV to 1002.5 mV	
	VAC(AC)	10 V	10 V	200 kHz	_____	9.990 V to 10.010 V	
	VAC(AC)	10 V	10 V	1 MHz	_____	9.965 V to 10.035 V	
	VAC(AC)	100 V	100 V	200 kHz	_____	99.90 V to 100.10 V	
	VAC(AC)	100 V	100 V	1 MHz	_____	99.65 V to 100.35 V	

# SECTION VI REPLACEABLE PARTS

## 6-1. INTRODUCTION.

6-2. This section contains information for ordering replacements 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

<p>Ag ..... silver Al ..... Aluminum A ..... Amper(e)s Au ..... gold</p> <p>C ..... capacitor cer ..... ceramic coef ..... coefficient com ..... common comp ..... composition conn ..... connection</p> <p>dep ..... deposited DPDT ..... double-pole double-throw DPST ..... double-pole single-throw</p> <p>elect ..... electrolytic encap ..... encapsulated</p> <p>F ..... farad(s) FET ..... field effect transistor fxd ..... fixed</p> <p>GaAs ..... gallium arsenide GHz ..... gigahertz = 10<sup>9</sup> hertz gd ..... guard(ed) Ge ..... germanium grd ..... ground(ed)</p> <p>H ..... henry(ies) Hz ..... mercury Hz ..... hertz (cycle) per second</p>	<p>ID ..... inside diameter impg ..... impregnated incd ..... incandescent ins ..... insulation(ed)</p> <p>kΩ ..... kilohm(s) = 10<sup>3</sup> ohms kHz ..... kilohertz = 10<sup>3</sup> hertz</p> <p>L ..... inductor lin ..... linear taper log ..... logarithmic taper</p> <p>mA ..... milliampere(s) = 10<sup>-3</sup> amperes MHz ..... megahertz = 10<sup>6</sup> hertz MΩ ..... megohm(s) = 10<sup>6</sup> ohms met flm ..... metal film mfr ..... manufacturer ms ..... millisecond mtg ..... mounting mV ..... millivolt(s) = 10<sup>-3</sup> volts μF ..... microfarad(s) μs ..... microsecond(s) μV ..... microvolt(s) = 10<sup>-6</sup> volts my ..... Mylar®</p> <p>nA ..... nanoampere(s) = 10<sup>-9</sup> amperes NC ..... normally closed Ne ..... neon NO ..... normally open NPD ..... negative positive zero (zero temperature coefficient)</p>	<p>ns ..... nanosecond(s) = 10<sup>-9</sup> seconds nsr ..... not separately replaceable</p> <p>Ω ..... ohm(s) obd ..... order by description OD ..... outside diameter</p> <p>p ..... peak pA ..... picoampere(s) pc ..... printed circuit pF ..... picofarad(s) = 10<sup>-12</sup> farads</p> <p>piv ..... peak inverse voltage p/o ..... part of pos ..... position(s) poly ..... polystyrene pot ..... potentiometer p-p ..... peak-to-peak ppm ..... parts per million prec ..... precision (temperature coefficient, long term stability, and/or tolerance)</p> <p>R ..... resistor Rh ..... rhodium rms ..... root-mean-square rot ..... rotary</p> <p>Se ..... selenium sect ..... section(s) Si ..... silicon sl ..... slide</p> <p>SPDT ..... single-pole double-throw SPST ..... single-pole single-throw</p> <p>Ta ..... tantalum TC ..... temperature coefficient TiO<sub>2</sub> ..... titanium dioxide tog ..... toggle tol ..... tolerance trim ..... trimmer TSTR ..... transistor</p> <p>V ..... volt(s) vacw ..... alternating current working voltage var ..... variable vdcw ..... direct current working voltage</p> <p>W ..... watt(s) w/ ..... with wiv ..... working inverse voltage w/o ..... without ww ..... wirewound</p> <p>* ..... optimum value selected at factory, average value shown (part may be omitted) ** ..... no standard type number assigned (selected or special type)</p>
--	---	---

©Dupont de Nemours

### DECIMAL MULTIPLIERS

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

### DESIGNATORS

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

Rev J

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
<b>A7</b>	<b>11153A</b>	<b>1</b>	<b>TRUE RMS CONVERTER ASSEMBLY</b>	<b>-hp-</b>	
	11153-69501	1	Rebuilt AC Converter Assembly See Paragraph 5-19	-hp-	
C1	0160-0127	8	C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C2	0150-0084	18	C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C3	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C4	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C5	0160-3475	1	C: fxd 0.47 microfarad 10% 200 vdcw	84411	HEW-178
C6A thru D	0160-3481	1	C: fxd matched set	-hp-	
C7 thru C9	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C10	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C11	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C12*, C13*			Factory selected value		
C14	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C15*			Factory selected value		
C16	0160-0196	1	C: fxd mica 24 pF 5%	14655	RDM15C240J3S obd
C17 thru C20	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C21	0160-3134	2	C: fxd cer 0.01 microfarad 10% 100 vdcw	72982	obd
C22	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C23	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C24	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C25	0150-0093	1	C: fxd 0.01 microfarad + 80% - 20% 100 vdcw	91418	TA obd
C26 thru C29	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C30	T-79540	1	C: fxd cer 18 pF 10% 500 vdcw	01121	SSSD obd
C31	0160-3134		C: fxd cer 0.01 microfarad 10% 100 vdcw	72982	obd
C32	0180-0194	2	C: fxd tant 150 microfarads 10% 15 vdcw	56289	150D157X9015S2-DYS
C33, C34	0150-0084		C: fxd cer 0.1 microfarad + 80% - 20% 100 vdcw	72982	8131-100-651-104Z
C35	0180-0194		C: fxd tant 150 microfarads 10% 15 vdcw	56289	150D157X9015S2-DYS
C36	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C37	0160-0127		C: fxd cer 1.0 microfarad 20% at 25°C 25 vdcw	56289	5C13C-CML
C38	0160-0300	1	C: fxd mylar 0.0027 microfarad 10% 200 vdcw	56289	192P27292-PTS
C39	0160-3583	1	C: fxd 5 microfarads 10% 50 vdcw	84411	X483W4 obd
C40	0160-3584	2	C: fxd 0.47 microfarad 10% 50 vdcw	84411	X483W4 obd
C41	0180-0197	2	C: fxd 2.2 microfarads 10% 20 vdcw	90201	TAS225K020PIA
C42	0160-2611	1	C: fxd mylar 1.0 microfarad 10% 50 vdcw	84411	HEW 101
C43	0150-0121	1	C: fxd cer 0.1 microfarad + 80% - 20% 50 vdcw	56289	5C50B1-CML
C44	0150-0050	3	C: fxd cer .001 microfarad + 80% - 20% 1000 vdcw	56289	C067B102E102ZE19-CDH
C45, C46	0160-3478	2	C: fxd 1.0 microfarad 10% 50 vdcw	84411	X483W4
C47	0160-3584	1	C: fxd 0.47 microfarad 10% 50 vdcw	84411	X483W4 obd
C48	0160-0127		C: fxd cer 1.0 microfarad 20% 25 vdcw	56289	5C13C-CML
C49	0180-0197		C: fxd 2.2 microfarads 10% 20 vdcw	90201	TAS225K02PIA
C50, C51	0150-0050		C: fxd cer .001 microfarad	56289	C067B102E102ZE19-CDH
C52			C: var Part of Cover: Adj, D, Part No. 11153-66505	-hp-	
CR1	1902-0686	3	Diode: Breakdown 6.2 V 2%	04713	SZ12170
CR2	1901-0040	47	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR3	1902-3205	1	Diode: Breakdown 15.0 V 5%	04713	SZ10939-233
CR4	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR5	1901-0524	1	Diode: Si	17856	FN 1124
CR6	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR7	1902-0049	1	Diode: Breakdown 6.19 V 5%	04713	SZ10939-122
CR8	1902-0686		Diode: Breakdown 6.2 V 2%	04713	SZ12170
CR9			Not assigned		
CR10	1902-3182	2	Diode: Breakdown 12.1 V 5%	04713	SZ10939-206
CR11, CR12	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR13	1902-3183	1	Diode: Breakdown 12.1 V 2%	04713	SZ10939-207
CR14	1910-0016	2	Diode: Ge 60 wiv	03877	S3185G
CR15	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088 obd
CR16, CR17	1902-3149	2	Diode: Breakdown 9.09 V 5%	04713	SZ10939-170



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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
<b>A7 (Cont'd)</b>						
CR18 thru CR21	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR22	1902-3182		Diode: Breakdown 12.1 V 5%	04713	SZ10939-206	
CR23, CR24	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR25	1902-3223	1	Diode: Breakdown 17.4 V 2%	04713	SZ10939-252	
CR26	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR27	1902-3171	2	Diode: Breakdown 11.0 V 5%	04713	SZ10939-194	
CR28	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR29	1902-3171		Diode: Breakdown 11 V 5%	04713	SZ10939-194	
CR30 thru CR32	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR33, CR34	1902-3136	2	Diode: Breakdown 8.06 V 5%	04713	SZ10939-155	
CR35	1902-0686		Diode: Breakdown 6.2 V 2%	04713	SZ12170	
CR36	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR37	1902-0041	1	Diode: Breakdown 5.11 V 5%	04713	SZ10939-98	
CR38	1902-3190	1	Diode: Breakdown 13 V 5%	04713	SZ10939-215	
CR39	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR40	1902-0025	3	Diode: Breakdown 10.0 V 5%	04713	SZ10939-182	
CR41 thru CR59	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR60	1902-0025		Diode: Breakdown 10.0 V 5%	04713	SZ10939-182	
CR61 thru CR65	1901-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
CR66	1902-0025		Diode: Breakdown 10.0 V 5%	04713	SZ10939-182	
CR67	1910-0016		Diode: Ge 60 wiv	03877	S3185G	
CR68 thru CR71	1910-0040		Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG-1088	obd
DS1	1970-0050	1	Tube: Surge voltage protector 230 V 15 %	25088	B1-A230	
IC1	1820-0432	1	IC: Linear amplifier	-hp-		
IC2, IC3	1820-0104	2	IC: Operational amplifier	12040	SL6471	
K1	0490-0802	1	Switch: Reed (does not include coil)	-hp-		
	9100-3216	8	Coil: Electromagnetic for K1	-hp-		
K2	0490-0917	1	Switch: Reed (does not include coil)	-hp-		
	9100-3216		Coil: Electromagnetic for K2	-hp-		
K3	0490-0945	1	Switch: Reed (does not include coil)	-hp-		
	9100-3226	1	Coil: Electromagnetic for K3	-hp-		
K4, K5	0490-0910		Switch: Reed (does not include coil)	-hp-		
	9100-3218	2	Coil: Electromagnetic for K4, K5	-hp-		
K6 thru K8	0490-0912	3	Switch: Reed (does not include coil)	-hp-		
	9100-3216		Coil: Electromagnetic for K6 thru K8	-hp-		
K9, K10	0490-0778	2	Switch: Reed (does not include coil)	-hp-		
	9100-3216		Coil: Electromagnetic for K9, K10	-hp-		
K11	0490-0801	1	Switch: Reed (does not include coil)	-hp-		
	9100-3216		Coil: Electromagnetic for K11	-hp-		
L1 thru L4	9100-1629	4	Coil: Choke 47 microhenries 5%	99800	1537-60	
Q1	1855-0342	1	TSTR: Field effect	17856	DN518	
Q2 thru Q4	1854-0071	9	TSTR: Si NPN 2N3391	01295	SKA1124	
Q5A, B	1853-0248	2	TSTR: Si PNP Dual	04713	SD36	
Q6	1853-0020	3	TSTR: Si PNP**	-hp-		
Q7	1853-0036	2	TSTR: Si PNP 2N3906	04713	SPS-3612	
Q8, Q9	1853-0288	4	TSTR: Si PNP	04713	SS2385	
Q10	1854-0485	3	TSTR: Si NPN	02735	60999	
Q11A, B	1854-0440	2	TSTR: Si NPN Dual	04713	SD42	
Q12	1854-0486	1	TSTR: Si NPN	04713	SS2384	
Q13	1855-0356	1	TSTR: Field effect si N channel	17856	FN1943	

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
<b>A7 (Cont'd)</b>					
Q14	1853-0258	2	TSTR: Si PNP 2N4035	07263	2N4035
Q15	1854-0260	2	TSTR: Si NPN 2N3227	04713	2N3227
Q16A, B	1853-0248		TSTR: Si PNP Dual	04713	SD36
Q17	1853-0020		TSTR: Si PNP**	-hp-	
Q18, Q19	1853-0288		TSTR: Si PNP	04713	SS2385
Q20	1854-0485		TSTR: Si NPN	02735	60999
Q21A, B	1854-0440		TSTR: Si NPN Dual	04713	SD42
Q22	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q23	1854-0485		TSTR: Si NPN	02735	60999
Q24	1853-0258		TSTR: Si PNP 2N4035	07263	2N4035
Q25	1854-0260		TSTR: Si NPN 2N3227	04713	2N3227
Q26	1855-0082	1	TSTR: Si PNP	04713	SS3723
Q27			Not assigned		
Q28	1854-0394	1	TSTR: Si NPN	04713	SS7390
Q29, Q30	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q31	1853-0020		TSTR: Si PNP**	-hp-	
Q32, Q33	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q34	1855-0340	1	TSTR: Si P channel	17856	PF392
Q35	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q36	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q37	1854-0401	1	TSTR: Si NPN 2N4259	02735	2N4259
R1, R2	0684-4701	11	R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R3	0698-3202	3	R: fxd flm 1.74 kilohms 1% 1/8 W	75042	CEA T-O
R4	0698-4471	2	R: fxd flm 7.15 kilohms 1% 1/8 W	75042	CEA T-O
R5	0698-3151	2	R: fxd flm 2.87 kilohms 1% 1/8 W	75042	CEA T-O
R6	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R7	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R8	0698-7639	1	R: fxd flm 10.0 megohms 1% 1500 V	19647	MG680
R9	0698-4123	1	R: fxd flm 499 ohms 1% 1/8 W	75042	CEA T-O
R10A thru F	0698-7502	1	R: fxd matched set	-hp-	
R11, R12	0684-1041	2	R: fxd comp 100 kilohms 10% 1/4 W	01121	CB1041
R13	2100-2969	1	R: var 100 kilohms 10%	73138	obd
R14, R15	2100-2945	3	R: var flm 1 kilohms 10%	73138	62PA
R16			Factory selected value		obd
R18	0698-4436	2	R: fxd flm 2.80 kilohms 1% 1/8 W	75042	CEA T-O
R19	0684-1051	2	R: fxd comp 1 megohm 10% 1/4 W	01121	CB1051
R20	0698-6631	2	R: fxd flm 2.50 kilohms 0.1% 1/8 W T-9	75042	CEA T-9
R21	0698-3202		R: fxd flm 1.74 kilohms 1% 1/8 W	75042	CEA T-O
R22	0698-6631		R: fxd flm 2.50 kilohms 0.1% 1/8 W T-9	75042	CEA T-9
R23	0698-4470	1	R: fxd flm 6.98 kilohms 1% 1/8 W	75042	CEA T-O
R24	0757-0449	1	R: fxd flm 20.0 kilohms 1% 1/8 W	75042	CEA T-O
R25	2100-2947	1	R: var flm 100 ohms 10%	73138	62PA
R26	0698-5099		R: fxd comp 3.9 megohms 10% 1/4 W	01121	CB3951
R27	2100-2949	2	R: var flm 200 ohms 10%	73138	62PA
R28A, B	0698-7790	1	R: fxd matched set	-hp-	
R29	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R30	0684-1011	5	R: fxd comp 100 ohms 10% 1/4 W	01121	CB1011
R31	0757-0406	1	R: fxd flm 182 ohms 1% 1/8 W	75042	CEA T-O
R32	0698-3443	1	R: fxd flm 287 ohms 1% 1/8 W	75042	CEA T-O
R33	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R34	0698-3153	1	R: fxd flm 3.83 kilohms 1% 1/8 W	75042	CEA T-O
R35, R36	0684-1011		R: fxd comp 100 ohms 10% 1/4 W	01121	CB1011
R37	0757-0395	1	R: fxd flm 56.2 ohms 1% 1/8 W T-3	75042	CEA T-3
R38A, B	0698-7503	1	R: fxd matched set	-hp-	
R39	0698-4355	1	R: fxd flm 12.4 ohms 1% 1/8 W	75042	CEA T-O
R40	0757-0291	1	R: fxd flm 24.9 ohms 1% 1/8 W	75042	CEA T-O
R41	0757-0277	2	R: fxd flm 49.9 ohms 1% 1/8 W	75042	CEA T-O
R42	2100-2991	1	R: var flm 20 ohms 10% 1/2 W	73138	62PA
R43	0698-3488	1	R: fxd flm 442 ohms 1% 1/8 W	75042	CEA T-O
R44	0757-0275	2	R: fxd flm 113 ohms 1% 1/8 W	75042	CEA T-O
R45	0698-4648	1	R: fxd flm 4.87 kilohms 1% 1/4 W	75042	CCA T-O



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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
<b>A7 (Cont'd)</b>					
R46	0698-4869	2	R: fxd flm 590 ohms 1% 1/2 W	75042	CEC T-0 obd
R47	0684-1001	4	R: fxd comp 10 ohms 10% 1/4 W	01121	CB1001
R48, R49	0698-7521	4	R: fxd flm 5.11 ohms 5% 1/4 W	75042	TF07 obd
R50	0684-1001		R: fxd comp 10 ohms 10% 1/4 W	01121	CB1001
R51	0698-4869		R: fxd flm 590 ohms 1% 1/2 W	75042	CEC T-0 obd
R52A, B	0698-7507	1	R: fxd matched set	-hp-	
R53	2100-2949		R: var flm 200 ohms 10% 1/2 W	73138	62PA obd
R54A, B	0698-7506	1	R: fxd matched set	-hp-	
R55	0698-3226	1	R: fxd flm 6.49 kilohms 1% 1/8 W	75042	CEA T-0 obd
R56	2100-2946	2	R: var flm 5 kilohms 10%	73138	62PA obd
R57	0698-6364	1	R: fxd flm 50.0 ohms 0.1% 1/8 W T-9	75042	CEA T-9 obd
R58	0684-4731	3	R: fxd comp 47 kilohms 10% 1/4 W	01121	CB4731
R59A, B	0698-7605	1	R: fxd matched set	-hp-	
R60	0698-4415	1	R: fxd flm 165 ohms 1% 1/8 W	75042	CEA T-0 obd
R61	0757-0284	1	R: fxd flm 150 ohms 1% 1/8 W	75042	CEA T-0 obd
R62	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R63	0757-0275		R: fxd flm 113 ohms 1% 1/8 W	75042	CEA T-0 obd
R64	0757-0200	1	R: fxd flm 5.62 kilohms 1% 1/8 W	75042	CEA T-0 obd
R65, R66	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R67			Not assigned		
R68	0698-7508	1	R: fxd flm 40.2 ohms 1% 1/8 W	75042	CEA T-0 obd
R69A, B	0698-7504	1	R: fxd matched set	-hp-	
R70	2100-2967	1	R: var 50 ohms 10%	73138	obd
R71	0757-0418	1	R: fxd flm 619 ohms 1% 1/8 W	75042	CEA T-0 obd
R72A, B	0698-7505	1	R: fxd matched set	-hp-	
R73	0757-0399	1	R: fxd flm 82.5 ohms 1% 1/8 W	75042	CEA T-0 obd
R74	0698-3279	1	R: fxd flm 4.99 kilohms 1% 1/8 W	75042	CEA T-0 obd
R75	0698-4864	2	R: fxd flm 499 ohms 1% 1/2 W	75042	CEC T-0 obd
R76, R77	0698-7521		R: fxd flm 5.11 ohms	75042	TF07 obd
R78	0698-4864		R: fxd flm 499 ohms 1% 1/2 W	75042	CEC T-0 obd
R79, R80	0684-1001		R: fxd comp 10 ohms 10% 1/4 W	01121	CB1001
R81	0684-1011		R: fxd comp 100 ohms 10% 1/4 W	01121	CB1011
R82	0757-0465	1	R: fxd flm 100 kilohms 1% 1/8 W	75042	CEA T-0 obd
R83, R84	0757-0280	3	R: fxd flm 1.00 kilohm 1% 1/8 W	75042	CEA-T-0 obd
R85	0757-0288	2	R: fxd flm 9.09 kilohms 1% 1/8 W	14674	C4 T-0 obd
R86	0698-4307	1	R: fxd flm 14.3 kilohms 1% 1/8 W	75042	CEA T-0 obd
R87	2100-2497	2	R: var 2 kilohms 10%	73138	62-207-1
R88	0757-0346	2	R: fxd 10.0 ohms 1% 1/8 W	75042	CEA T-0 obd
R89	0757-0288		R: fxd flm 9.09 kilohms 1% 1/8 W	14674	C4 T-0 obd
R90	0698-4541	2	R: fxd flm 442 kilohms 1% 1/8 W	14674	C4 T-0 obd
R91	2100-2655	1	R: var flm 100 kilohms 10% 1/2 W	73138	62-213-1
R92	0698-4473	2	R: fxd flm 8.06 kilohms 1% 1/8 W	75042	CEA T-0 obd
R93	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R94	2100-2497		R: var 2 kilohms 10%	73138	62-207-1
R95	0757-0429	1	R: fxd flm 1.82 kilohms 1% 1/8 W	75042	CEA T-0 obd
R96	0684-1821	2	R: fxd comp 1.8 kilohms 10% 1/4 W	01121	CB1821
R97	0684-4721	1	R: fxd comp 4.7 kilohms 10% 1/4 W	01121	CB4721
R98	2100-2945		R: var flm 1 kilohm 10%	73138	62PA obd
R99	0757-0476	1	R: fxd flm 301 kilohms 1% 1/8 W	75042	CEA T-0 obd
R100	0698-7652	1	R: fxd flm 49.9 kilohms 1% 1/8 W T-9	75042	CEA T-9 obd
R101	0698-7653	1	R: fxd flm 25.5 kilohms 1% 1/8 W T-9	75042	CEA T-9 obd
R102	0757-0445	1	R: fxd flm 13.0 kilohms 1% 1/8 W	75042	CEA T-0 obd
R103	0698-4472	1	R: fxd flm 7.68 kilohms 1% 1/8 W	75042	CEA T-0 obd
R104	0698-3155	1	R: fxd flm 4.64 kilohms 1% 1/8 W	75042	CEA T-0 obd
R105	0811-2960	1	R: fxd prec ww 650 kilohms 1%	07088	KP141 obd
R106	0684-1021	1	R: fxd comp 1 kilohm 10% 1/4 W	01121	CB1021
R107	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R108	0698-4441	1	R: fxd flm 3.74 kilohms 1% 1/8 W	75042	CEA T-0 obd
R109	0757-0447	2	R: fxd flm 16.2 kilohms 1% 1/8 W	75042	CEA T-0 obd
R110	0684-1821		R: fxd comp 1.8 kilohms 10% 1/4 W	01121	CB1821

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
<b>A7 (Cont'd)</b>					
R111	0684-1811	1	R: fxd comp 180 ohms 10% 1/4 W	01121	CB1811
R112*			See A7TC1		
R113	0757-0346	1	R: fxd flm 10.0 ohms 1% 1/8 W	75042	CEA T-0
R114	0757-0280		R: fxd flm 1.00 kilohms 1% 1/8 W	75042	CEA T-0
R115	0757-0402	1	R: fxd flm 110 ohms 1% 1/8 W	75042	CEA T-0
R116*, R117*			Factory selected value		
R118	0757-0407	1	R: fxd flm 200 ohms 1% 1/8 W	75042	CEA T-0
R119	0757-0274	1	R: fxd flm 1.21 kilohms 1% 1/8 W	75042	CEA T-0
R120	0757-0431	1	R: fxd flm 2.43 kilohms 1% 1/8 W	75042	CEA T-0
R121	0698-4444	1	R: fxd flm 4.87 kilohms 1% 1/8 W	75042	CEA T-0
R122	0698-4475	1	R: fxd flm 9.76 kilohms 1% 1/8 W	75042	CEA T-0
R123	2100-2951	1	R: var flm 2 kilohms 10%	73138	62PA
R124	0757-0283	1	R: fxd flm 2.00 kilohms 1% 1/8 W	75042	CEA T-0
R125	0757-0435	1	R: fxd flm 3.92 kilohms 1% 1/8 W	75042	CEA T-0
R126	0698-4473	1	R: fxd flm 8.06 kilohms 1% 1/8 W	75042	CEA T-0
R127	0757-0447		R: fxd flm 16.2 kilohms 1% 1/8 W	75042	CEA T-0
R128	0698-4492	1	R: fxd flm 32.4 kilohms 1% 1/8 W	75042	CEA T-0
R129	2100-2946		R: var flm 5 kilohms 10%	73138	62PA
R130, R131	0684-4731		R: fxd comp 47 kilohms 10% 1/4 W	01121	CB4731
R132	0683-6245	2	R: fxd comp 620 kilohms 5% 1/4 W	01121	CB6245
R133	0683-1255	1	R: fxd comp 1.2 megohms 5% 1/4 W	01121	CB1255
R134	0683-6245		R: fxd comp 620 kilohms 5% 1/4 W	01121	CB6245
R135	0684-8221	1	R: fxd comp 8.2 kilohms 10% 1/4 W	01121	CB8221
R136, R137	0684-2231	2	R: fxd comp 22 kilohms 10% 1/4 W	01121	CB2231
R138	0698-3497	1	R: fxd flm 6.04 kilohms 1% 1/8 W	75042	CEA T-0
R139	0684-6831	1	R: fxd comp 68 kilohms 10% 1/4 W	01121	CB6831
R140*			See A7TC1		
R141	0757-0390	1	R: fxd flm 36.5 ohms 1% 1/8 W	75042	CEA T-0
R142	0698-4393	1	R: fxd flm 73.2 ohms 1% 1/8 W	75042	CEA T-0
R143	0698-4436		R: fxd flm 2.80 kilohms 1% 1/8 W	75042	CEA T-0
R144, R145	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB-1031
R146	0757-0408	1	R: fxd flm 243 ohms 1% 1/8 W	75042	CEA T-0
R147, R148	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R149	0757-0449	3	R: fxd flm 20.0 kilohms 1% 1/8 W	75042	CEA T-0
R150	0698-3202		R: fxd flm 1.74 kilohms 1% 1/8 W	75042	CEA T-0
R151	0684-1011		R: fxd comp 100 ohms 10% 1/4 W	01121	CB1011
R152	0698-4428	1	R: fxd flm 1.69 kilohms 1% 1/8 W	75042	CEA T-0
R153	0698-4541		R: fxd flm 442 kilohms 1% 1/8 W	14674	C4 T-0
R154	0811-2961	1	R: fxd prec ww 600 kilohms 1%	07088	KP141
R155	0757-0346		R: fxd flm 10.0 ohms 1% 1/8 W	75042	CEA T-0
R156	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB1031
R157, R158	0757-0449		R: fxd flm 20.0 kilohms 1% 1/8 W	75042	CEA T-0
R159	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB4701
R160	0698-4471		R: fxd flm 7.15 kilohms 1% 1/8 W	75042	CEA T-0
R161	0698-3151		R: fxd flm 2.87 kilohms 1% 1/8 W	75042	CEA T-0
TC1	11153-82801	1	Thermocouple kit: Includes thermocouple, R112* and R140*, which are not separately replaceable.	-hp-	
	0340-0060	6	Terminal: Solder stud, teflon	98291	FT-E-15
	0360-1442	6	Terminal: Teflon insulated	98291	ST-2000SL
	0360-1482	23	Terminal: Solder stud, teflon	98291	ST-35ML
	T-79587	9	Pin: Brass/gold plate	14480	obd
	0380-0938	2	Spacer: Teflon	98291	B-1451-1
	1200-0767	1	IC Socket: 16 pin	91506	316-AG5D-3R
	1200-0424	1	IC Socket: 14 pin	31514	CSA2900-14B
	T-79585	2	IC Socket: 8 pin	17117	5566-235-5
	1205-0064	2	Heat sink: Dual, for Q1 and CR5	13103	3120
	1251-1636	10	Socket: Spring, miniature	71279	3388-1-03

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
<b>A7 (Cont'd)</b>					
	1600-0198	1	Shield: Input, A	-hp-	
	11153-05504	1	Cover: Input, B	-hp-	
	11153-05501	1	Cover: Attenuator, C	-hp-	
	11153-65505	1	Cover: Adj, D	-hp-	
	11153-05503	1	Cover: Output, E	-hp-	
	5060-5952	1	Knob Assy: Function (for instruments with VDC and VAC functions)	-hp-	
	5060-5954	1	Knob Assy: Function (for instruments with VDC, Ohms, and VAC function)	-hp-	
	11153-60101	1	Flex cable	-hp-	
	11153-01202	1	Strip: Clamp, for flex cable	-hp-	
11153-90000	1	Operating and Service Manual	-hp-		

## SECTION VII





### CIRCUIT DIAGRAMS

#### 7-1. INTRODUCTION.

This section contains the diagrams necessary to maintain the Model 11153A. Both schematic diagrams and pictorial views of the circuit boards are included. Figures 7-1 and 7-2 are a complete schematic diagram of the True RMS Converter. Figure 7-3 is a diagram of the function and range selection circuits.

#### 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. All relays shown de-enerized.

### A7 COMPONENT SIDE

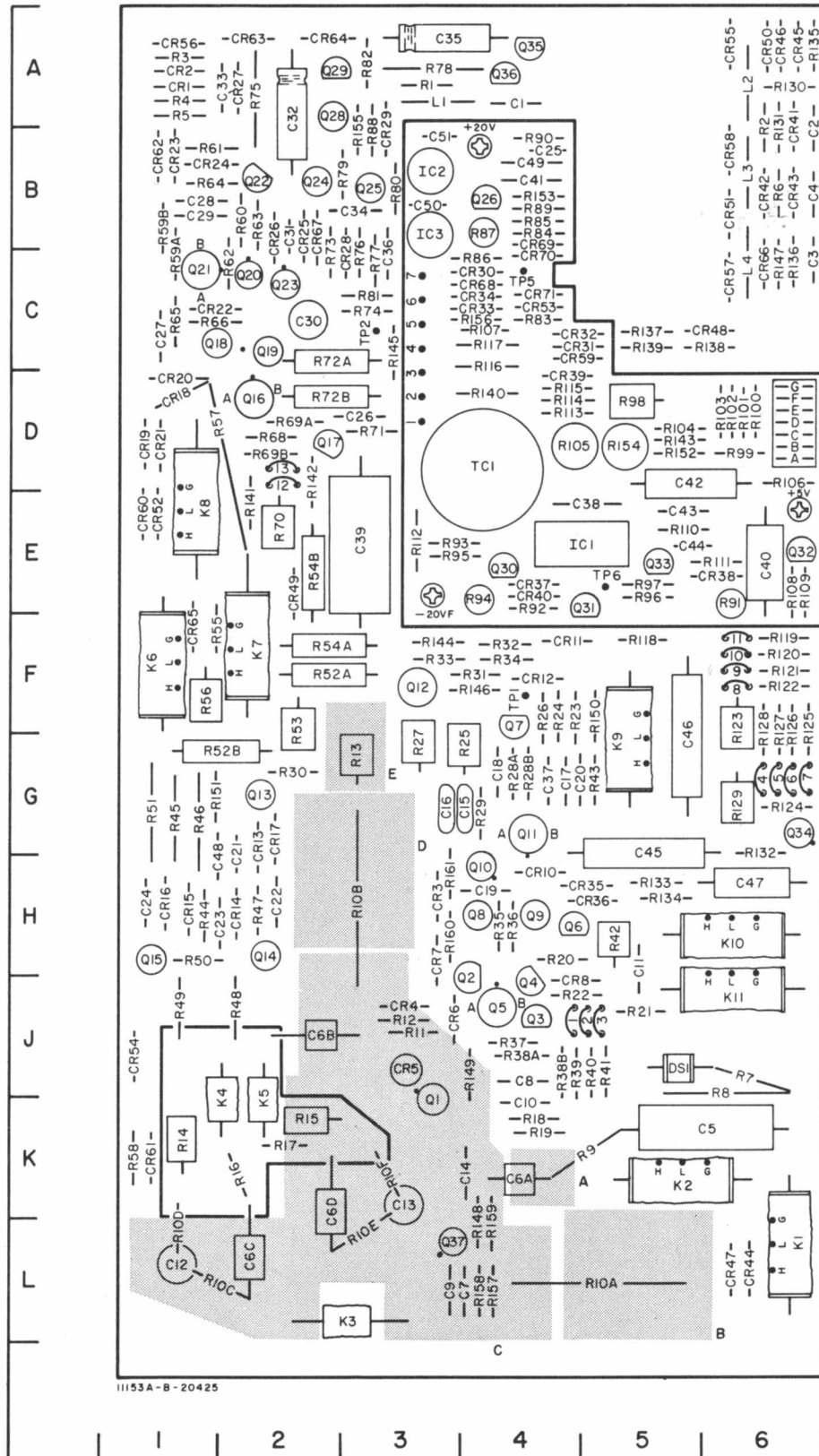


Figure 7-1. A7 Component Location.

## SECTION II INSTALLATION

### 2.1. INTRODUCTION.

This section contains information and instructions for installing the Model 11153A True RMS Converter assembly within the Model 3484A Multifunction Unit. Also included are instructions for repackaging for shipment.

### 2.2. INITIAL INSPECTION.

This assembly was carefully inspected both mechanically and electrically before shipment. It should be examined for physical damage in transit. When installed in the Model 3484A, the electrical performance of the Model 11153A should be tested, using the Performance Checks outlined in Paragraph 5-3. If there is damage or deficiency, see the warranty inside the front cover of this manual.

### 2.3. INSTALLATION.

Use the following procedure to install the 11153A True RMS Converter assembly in the 3484A Multifunction Unit.

- a. Remove 3484A bottom guard cover.



**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. With 3484A turned upside down, position ac converter assembly component side down over the hinges on the master board A3. See Figure 2-1. The converter input and output wires are on the hinge side of the assembly.
- c. Fasten the converter assembly to hinges, using 6-32 x 1/4 pan head screws with lockwasher, -hp- Part No. 2360-0113.
- d. Connect orange output wire to teflon connector in master board between left hinge and edge of board. See Figure 2-1.
- e. Connect red input wire to pin mounted in teflon insulator near front edge of master board as indicated in Figure 2-1. This pin is connected through a red wire to terminal switch.
- f. Connect black ground wire to pin on master board next to ground lug. (Figure 2-1.)
- g. Insert flex cable into connector J7 on master board.

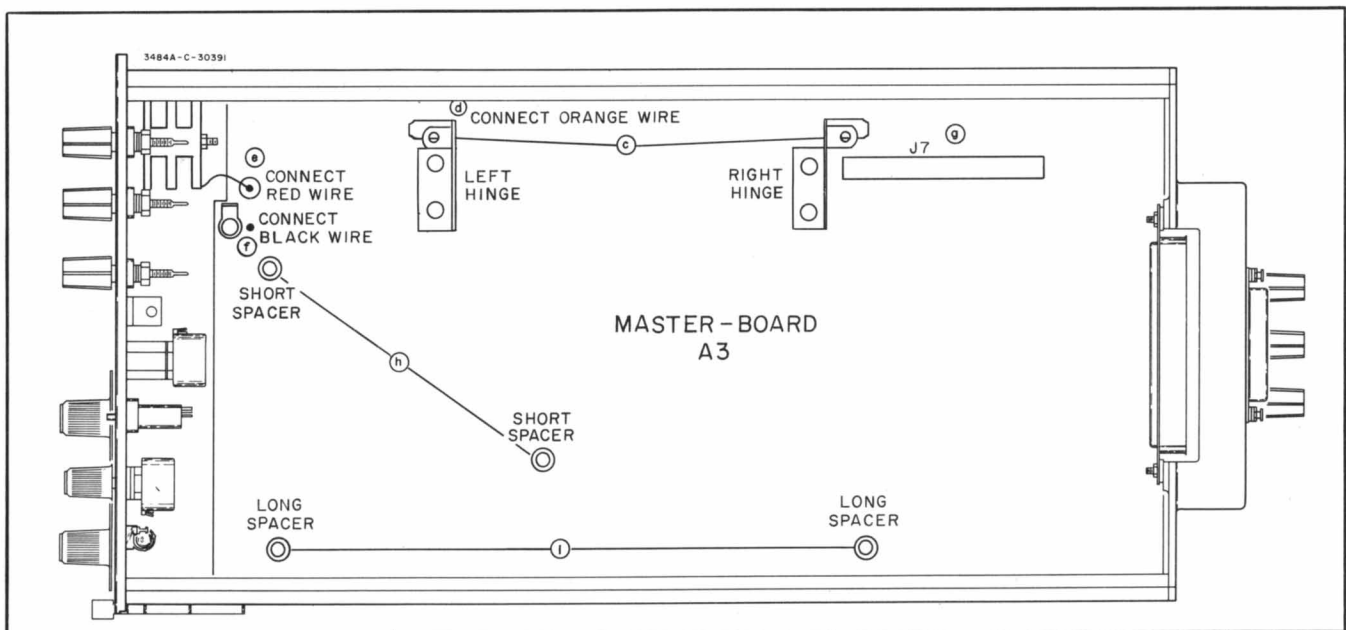


Figure 2-1. AC Converter Installation.

- h. Some 3484A units may be provided with two short spacers mounted in the master board at positions indicated by (h) in Figure 2-1. If these spacers are present, remove nuts from the screws projecting up through the converter assembly shields. Rotate the assembly to the horizontal position and fasten in place by inserting the two screws into short spacers.
- i. Secure assembly to long spacers at edge of master board, using 6-32 x 3/8 pan head screws with lock-washer, -hp- Part No. 2360-0117.
- j. Rotate FUNCTION switch counterclockwise to limit stop. If switch has two blank positions, omit Steps k through n and proceed to Step o. If switch rotates only to VDC, proceed with Step k.
- k. Set FUNCTION switch to VDC and remove knob by loosening the two set screws. Remove 3484A top guard cover.
- l. Remove FUNCTION switch mounting nut and carefully slide the switch as far as possible toward rear of instrument.
- m. Rotate the counterclockwise limit stop two positions counterclockwise as indicated in Figure 2-2. Make certain that the clockwise limit stop is in the correct position.
- n. Replace switch carefully so that stops stay in position. Replace switch mounting nut. Replace top guard cover. Proceed to Step p.
- o. Set FUNCTION switch to VDC and remove knob by loosening the two set screws.
- p. Two FUNCTION switch knobs are provided with the Model 11153A. -hp- Part No. 5060-5952 should be used if the instrument does not have an ohms converter, and Part No. 5060-5954 if instrument does have ohms. Select and install correct knob, orienting so that VDC is opposite mark on front panel. Secure knob with two set screws.
- q. Replace 3484A bottom guard cover.
- r. Check electrical performance of ac converter, using procedure outlined in Paragraph 5-3.

#### 2.4. REPACKAGING FOR SHIPMENT.

The following is a general guide for repackaging the 11153A converter assembly for shipment if it should become necessary to ship the converter assembly separate from the 3484A.

#### NOTE

If the assembly is to be shipped to Hewlett-Packard for repair or exchange, attach a tag to the assembly identifying the owner and indicating the repair to be accomplished or noting that the unit is being exchanged.

- a. If original container and packing material are available, wrap the assembly carefully and make sure the container is well sealed with strong tape.
- b. If original container is not available, wrap assembly carefully in suitable packing material, bearing in mind that the reed relays in particular are easily broken. Place in a suitable container and seal well with strong tape.
- c. Mark shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

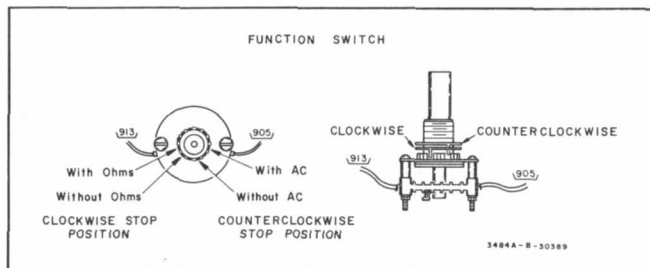


Figure 2-2. Function Switch Limit Stop.

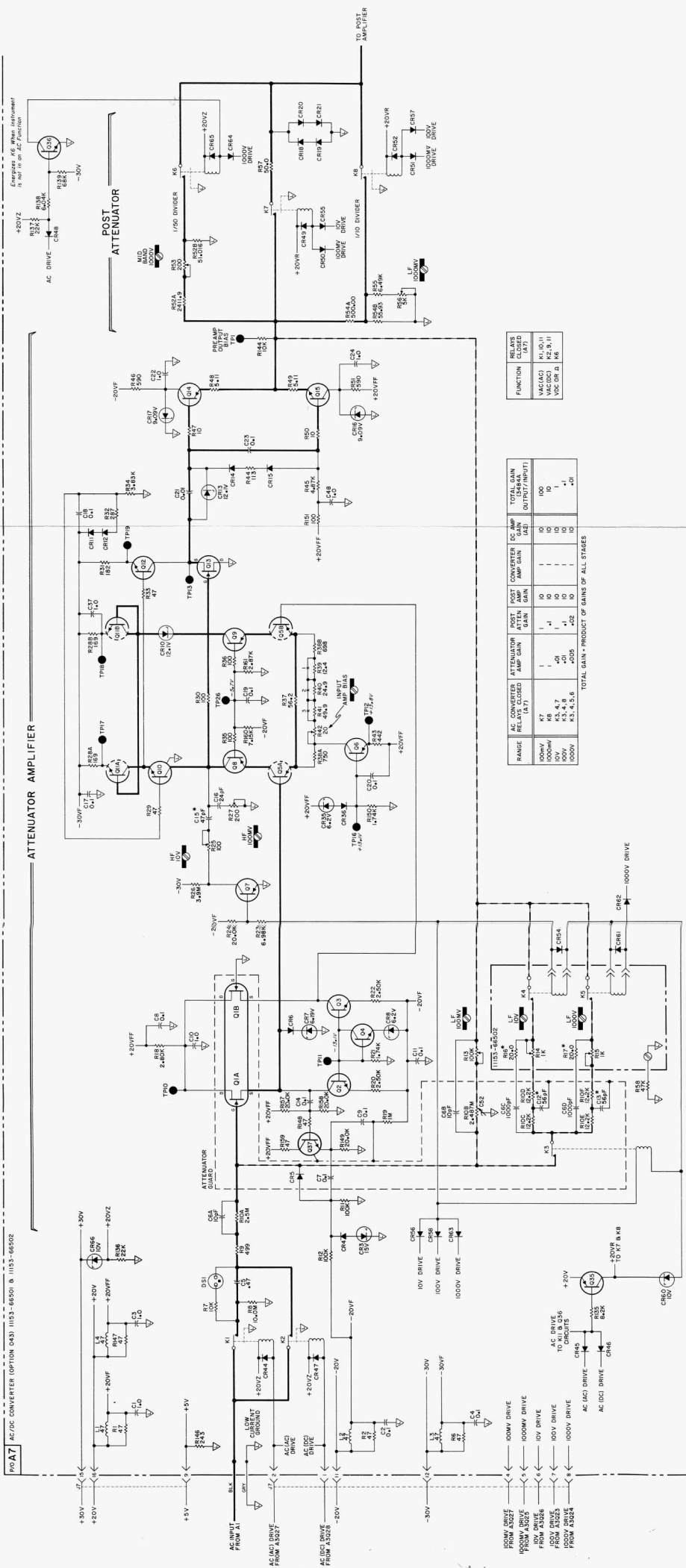
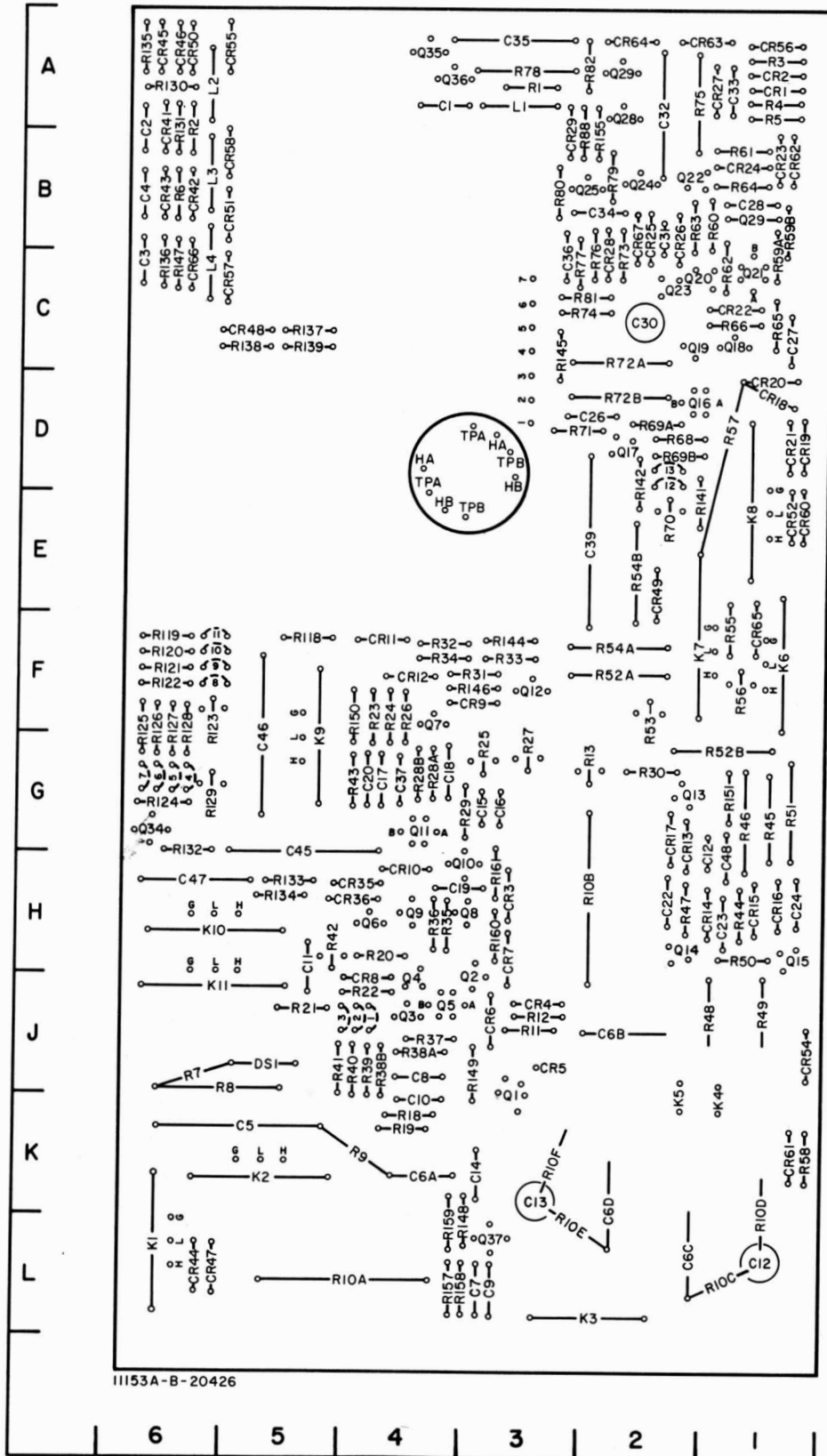


Figure 7-2. Schematic Diagram, Attenuator Amplifier and Post Attenuator.



# A7 CIRCUIT SIDE



## A7 COMPONENT LOCATIONS

	C	CR	IC	K	L	Q	R		C	CR	R		R		R
1	A4	A1	E5	L6	A3	K3	A3	38A			J4	77	C3	127	F6
2	B6	A1	B3	K5	A6	J4	B6	38B			J4	78	A3	128	F6
3	C6	H3	B3	L3	B6	J4	A1	39	E3	D4	J4	79	B3	129	G6
4	B6	J3		K2	C6	J4	A1	40	E6	E4	J5	80	B3	130	A6
5	K5	J3		K2		J4	A1	41	B4	B6	J5	81	C3	131	B6
6		J3		F1		H4	B6	42	D5	B6	H5	82	A3	132	G6
6A	K4							43	D5	B6	G5	83	C4	133	H5
6B	J2							44	D5	L6	H1	84	B4	134	H5
6C	L2							45	G5	A6	G1	85	B4	135	A6
6D	K2							46	G5	A6	G1	86	C4	136	C6
7	L4	H3		F2		F4	J6	47	H6	L6	H2	87	B4	137	C5
8	J4	J4		E1		H4	J6	48	G1	C6	J2	88	B3	138	C6
9	L3			G5		H4	K5	49	B4	E2	J1	89	B4	139	C5
10	K4	H4		H6		H4		50	B3	A6	H1	90	B4	140	D4
10A							L4	51	B3	B6	G1	91	E6	141	E2
10B							H3	52		E1		92	E4	142	D2
10C							L1	52A			F2	93	E3	143	D5
10D							L1	52B			G2	94	E4	144	F3
10E							L3	53	C4	F2		95	E3	145	C3
10F							K3	54	J1			96	E5	146	F4
11	H5	F4	J6		G4	J3	J3	54A		F2	F2	97	E5	147	C6
12	L1	F4			F3	J3	J3	54B		E2	E2	98	D5	148	L4
13	K3	G2			G2	G3	G3	55	A6	F1	F1	99	D6	149	J4
14	K4	H2			H2	K1	K1	56	A1	F1	F1	100	D6	150	F5
15	G4	H1			H1	K2	K2	57	C6	D1	D1	101	D6	151	G1
16	G3	H1			D2	K2	K2	58	B6	K1	K1	102	D6	152	D5
17	G4	G2			D2	K2	K2	59	C4			103	D6	153	B4
18	G4	D1			C1	K4	K4	59A		C1	C1	104	D5	154	D5
19	H4	D1			C2	K4	K4	59B		B1	B1	105	D4	155	B3
20	G4	D1			C2	H4	H4	60	E1	B2	B2	106	D6	156	C4
21	G2	D1			C1	J5	J5	61	K1	B1	B1	107	C4	157	L4
22	H2	C1			B2	J4	J4	62	B1	C2	C2	108	E6	158	L4
23	H2	B1			C2	F4	F4	63	A2	B2	B2	109	E6	159	L4
24	H1	B1			B2	F4	F4	64	A2	B1	B1	110	E5	160	H3
25	B4	B2			B3	G4	G4	65	F1	C1	C1	111	E6	161	H3
26	D3	B2			B4	F4	F4	66	C6	C1	C1	112	E3		
27	C1	A2			G3	G3	G3	67	B2			113	D4		
28	B1	C3			A2			68	C4	D2	D2	114	D4		
28A						G4	G4	69	B4			115	D4		
28B						G4	G4	69A		D2	D2	116	C4		
29	B1	B3			A2	G4	G4	69B		D2	D2	117	C4		
30	C2	C4			E4	G2	G2	70	C4	E2	E2	118	F5		
31	B2	C4			E5	F4	F4	71	C4	D3	D3	119	F6		
32	A2	C4			E6	F4	F4	72				120	F6		
33	A2	C4			E5	F3	F3	72A		C2	C2	121	F6		
34	B3	C4			G6	F4	F4	72B		D2	D2	122	F6		
35	A3	H5			A4	H4	H4	73		C2	C2	123	F6		
36	C3	H5			A4	H4	H4	74		C3	C3	124	G6		
37	G4	E4			L3	J4	J4	75		A2	A2	125	F6		
38	E5	E6						76		C3	C3	126	F6		

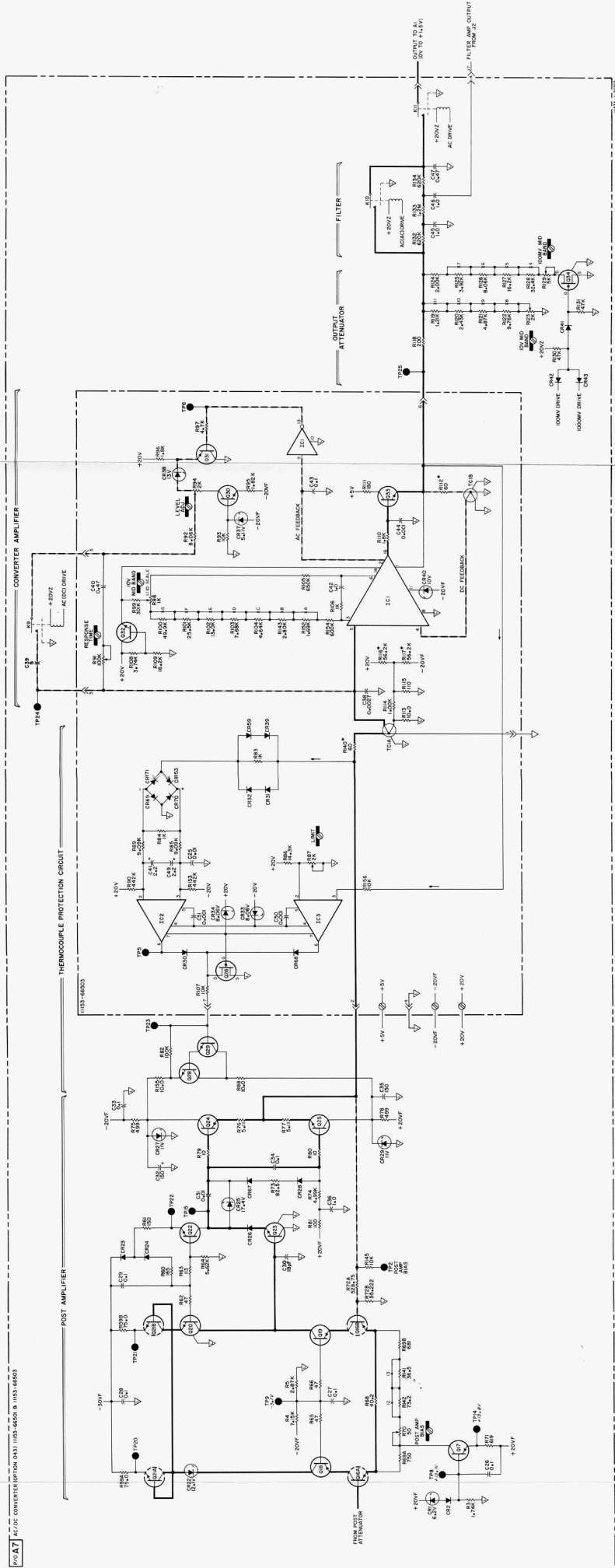
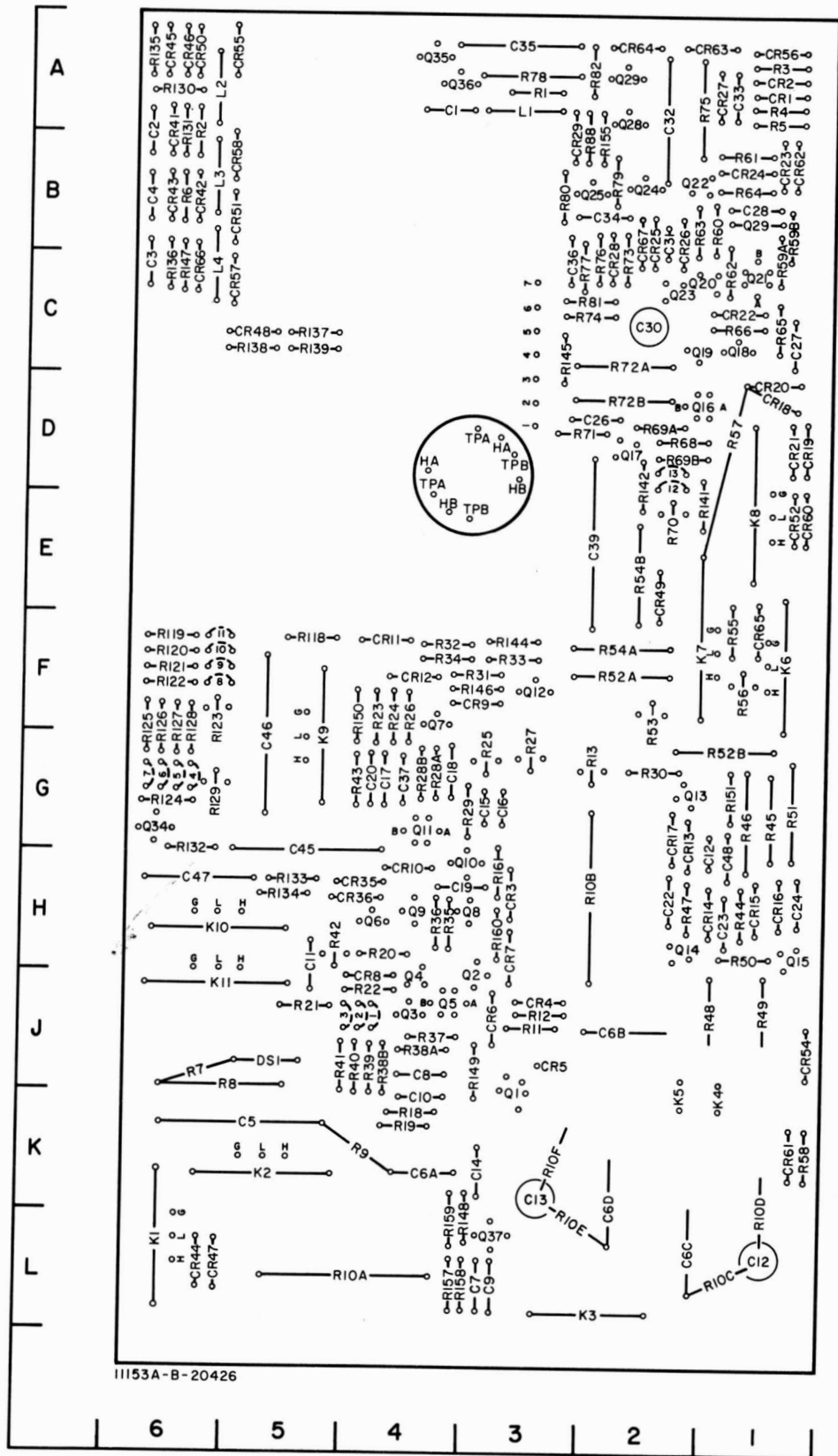


Figure 7-4. Schematic Diagram, Post Amplifier and Converter Amplifier.

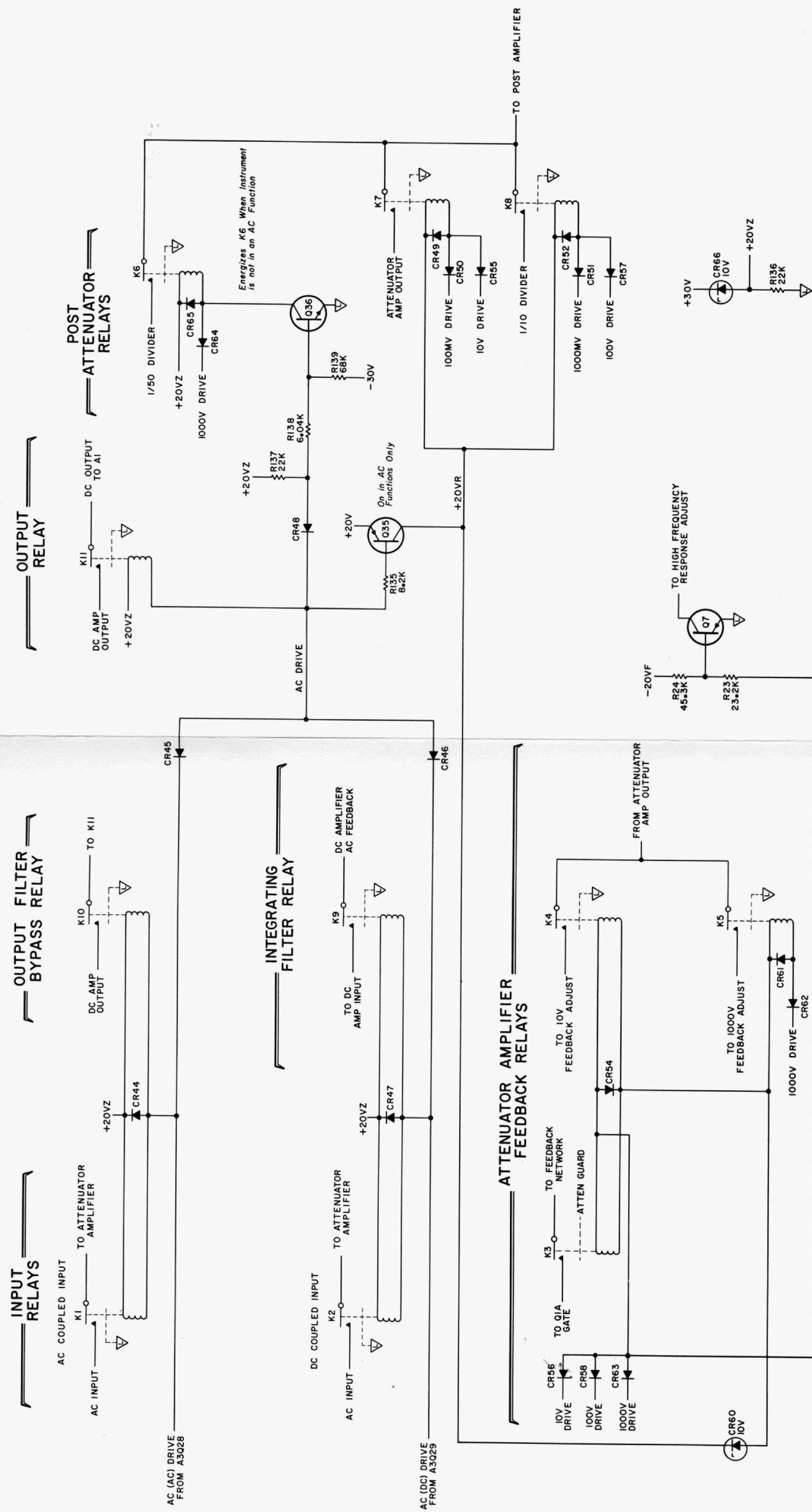
# A7 CIRCUIT SIDE



11153A-B-20426

## A7 COMPONENT LOCATIONS

	C	CR	IC	K	L	Q	R		C	CR	R		R		R
1	A4	A1	E5	L6	A3	K3	A3	38A			J4	77	C3	127	F6
2	B6	A1	B3	K5	A6	J4	B6	38B			J4	78	A3	128	F6
3	C6	H3	B3	L3	B6	J4	A1	39	E3	D4	J4	79	B3	129	G6
4	B6	J3		K2	C6	J4	A1	40	E6	E4	J5	80	B3	130	A6
5	K5	J3		K2		J4	A1	41	B4	B6	J5	81	C3	131	B6
6		J3		F1		H4	B6	42	D5	B6	H5	82	A3	132	G6
6A	K4							43	D5	B6	G5	83	C4	133	H5
6B	J2							44	D5	L6	H1	84	B4	134	H5
6C	L2							45	G5	A6	G1	85	B4	135	A6
6D	K2							46	G5	A6	G1	86	C4	136	C6
7	L4	H3		F2		F4	J6	47	H6	L6	H2	87	B4	137	C5
8	J4	J4		E1		H4	J6	48	G1	C6	J2	88	B3	138	C6
9	L3			G5		H4	K5	49	B4	E2	J1	89	B4	139	C5
10	K4	H4		H6		H4		50	B3	A6	H1	90	B4	140	D4
10A							L4	51	B3	B6	G1	91	E6	141	E2
10B							H3	52		E1		92	E4	142	D2
10C							L1	52A			F2	93	E3	143	D5
10D							L1	52B			G2	94	E4	144	F3
10E							L3	53		C4	F2	95	E3	145	C3
10F							K3	54		J1		96	E5	146	F4
11	H5	F4	J6		G4	J3	J3	54A			F2	97	E5	147	C6
12	L1	F4			F3	J3	J3	54B			E2	98	D5	148	L4
13	K3	G2			G2	G3	G3	55	A6	F1	F1	99	D6	149	J4
14	K4	H2			H2	K1	K1	56	A1	F1	F1	100	D6	150	F5
15	G4	H1			H1	K2	K2	57	C6	D1	D1	101	D6	151	G1
16	G3	H1			D2	K2	K2	58	B6	K1	K1	102	D6	152	D5
17	G4	G2			D2	K2	K2	59	C4			103	D6	153	B4
18	G4	D1			C1	K4	K4	59A		C1	C1	104	D5	154	D5
19	H4	D1			C2	K4	K4	59B		B1	B1	105	D4	155	B3
20	G4	D1			C2	H4	H4	60	E1	B2	B2	106	D6	156	C4
21	G2	D1			C1	J5	J5	61	K1	B1	B1	107	C4	157	L4
22	H2	C1			B2	J4	J4	62	B1	C2	C2	108	E6	158	L4
23	H2	B1			C2	F4	F4	63	A2	B2	B2	109	E6	159	L4
24	H1	B1			B2	F4	F4	64	A2	B1	B1	110	E5	160	H3
25	B4	B2			B3	G4	G4	65	F1	C1	C1	111	E6	161	H3
26	D3	B2			B4	F4	F4	66	C6	C1	C1	112	E3		
27	C1	A2			G3	G3	G3	67	B2			113	D4		
28	B1	C3			A2			68	C4	D2	D2	114	D4		
28A						G4	G4	69	B4			115	D4		
28B						G4	G4	69A		D2	D2	116	C4		
29	B1	B3			A2	G4	G4	69B		D2	D2	117	C4		
30	C2	C4			E4	G2	G2	70	C4	E2	E2	118	F5		
31	B2	C4			E5	F4	F4	71	C4	D3	D3	119	F6		
32	A2	C4			E6	F4	F4	72				120	F6		
33	A2	C4			E5	F3	F3	72A		C2	C2	121	F6		
34	B3	C4			G6	F4	F4	72B		D2	D2	122	F6		
35	A3	H5			A4	H4	H4	73		C2	C2	123	F6		
36	C3	H5			A4	H4	H4	74		C3	C3	124	G6		
37	G4	E4			L3	J4	J4	75		A2	A2	125	F6		
38	E5	E6						76		C3	C3	126	F6		



3484A-D-30364

Figure 7-5. True RMS Converter Relay 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	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A Common . . . . .	Any supplier of U. S.	05347	Ultronix, Inc. . . . .	San Mateo, Cal.	11236	CTS of Berne, Inc. . . . .	Berne, Ind.
00136	McCoy Electronics . . . . .	Mount Holly Springs, Pa.	05397	Union Carbine Corp., Elect. Div. . . . .	New York, N. Y.	11237	Chicago Telephone of California, Inc. . . . .	So. Pasadena, Cal.
00213	Sage Electronics Corp. . . . .	Rochester, N. Y.	05574	Viking Ind. Inc. . . . .	Canoga Park, Cal.	11242	Bay State Electronics Corp. . . . .	Waltham, Mass
00287	Cemco, Inc. . . . .	Danielson, Conn.	05593	Icore Electro-Plastics Inc. . . . .	Sunnyvale, Cal.	11312	Teledyne Inc., Microwave Div. . . . .	Palo Alto, Cal.
00334	Humidial . . . . .	Colton, Calif.	05616	Cosmo Plastic (c/o Electrical Spec. Co.) . . . . .	Cleveland, Ohio	11314	National Seal . . . . .	Downey, Cal.
00348	Mictron, Co., Inc. . . . .	Valley Stream, N. Y.	05624	Barber Colman Co. . . . .	Rockford, Ill.	11453	Precision Connector Corp. . . . .	Jamaica, N. Y.
00373	Garlock Inc. . . . .	Cherry Hill, N. J.	05728	Tiffen Optical Co. . . . .	Roslyn Heights, Long Island, N. Y.	11534	Duncan Electronics Inc. . . . .	Costa Mesa, Cal.
00656	Aerovox Corp. . . . .	New Bedford, Mass.	05729	Metro-Tel Corp. . . . .	Westbury, N. Y.	11711	General Instrument Corp., Semiconductor Division Products Group . . . . .	Newark, N. J.
00779	Amp. Inc. . . . .	Harrisburg, Pa.	05783	Stewart Engineering Co. . . . .	Santa Cruz, Cal.	11717	Imperial Electronic, Inc. . . . .	Buena Park, Cal.
00781	Aircraft Radio Corp. . . . .	Boonton, N. J.	05820	Wakefield Engineering Inc. . . . .	Wakefield, Mass.	11870	Melabs, Inc. . . . .	Palo Alto, Cal.
00809	Crown, Ltd. . . . .	Whitby, Ontario, Canada	06004	Warner Corp. . . . .	Bridgeport, Conn.	12136	Philadelphia Handle Co. . . . .	Camden, N. J.
00815	Northern Engineering Laboratories, Inc. . . . .	Burlington, Wis.	06090	Raychem Corp. . . . .	Redwood City, Cal.	12361	Grove Mfg. Co., Inc. . . . .	Shady Grove, Pa.
00853	Sangamo Electric Co., Pickens Div. . . . .	Pickens, S. C.	06175	Bausch and Lomb Optical Co. . . . .	Rochester, N. Y.	12574	Gulton Ind. Inc., Data System Div. . . . .	Albuquerque, N. M.
00866	Goe Engineering Co. . . . .	City of Industry, Cal.	06402	E. T. A. Products Co. of America . . . . .	Chicago, Ill.	12697	Claroast Mfg. Co. . . . .	Dover, N. H.
00891	Carl E. Holmes Corp. . . . .	Los Angeles, Cal.	06540	Amatom Electronic Hardware Co., Inc. . . . .	New Rochelle, N. Y.	12728	Elmar Filter Corp. . . . .	W. Haven, Conn.
00929	Microlab Inc. . . . .	Livingston, N. J.	06555	Beede Electrical Instrument Co., Inc. . . . .	Penacook, N. H.	12859	Nippon Electric Co., Ltd. . . . .	Tokyo, Japan
01002	General Electric Co., Capacitor Dept. . . . .	Hudson Falls, N. Y.	06666	General Devices Co., Inc. . . . .	Indianapolis, Ind.	12881	Metex Electronics Corp. . . . .	Clark, N. J.
01009	Alden Products Co. . . . .	Brockton, Mass.	06751	Components Inc., Ariz. Div. . . . .	Phoenix, Arizona	12930	Delta Semiconductor Inc. . . . .	Newport Beach, Cal.
01121	Allen Bradley Co. . . . .	Milwaukee, Wis.	06812	Torrington Mfg. Co., West Div. . . . .	Van Nuys, Cal.	12954	Dickson Electronics Corp. . . . .	Scottsdale, Arizona
01255	Litton Industries, Inc. . . . .	Beverly Hills, Cal.	06980	Varian Assoc. Etmac Div. . . . .	San Carlos, Cal.	13019	Airco Supply Co., Inc. . . . .	Wichita, Kansas
01281	TRW Semiconductors, Inc. . . . .	Lawndale, Cal.	07088	Kelvin Electric Co. . . . .	Van Nuys, Cal.	13061	Wilco Products . . . . .	Detroit, Mich.
01295	Texas Instruments, Inc., Transistor Products Div. . . . .	Dallas, Texas	07126	Digitran Co. . . . .	Pasadena, Cal.	13103	Thermolloy . . . . .	Dallas, Texas
01349	The Alliance Mfg. Co. . . . .	Alliance, Ohio	07137	Transistor Electronics Corp. . . . .	Minneapolis, Minn.	13327	Soliton Devices Inc. . . . .	Tappan, N. Y.
01538	Small Parts Inc. . . . .	Los Angeles, Cal.	07138	Westinghouse Electric Corp., Electronic Tube Div. . . . .	Elmira, N. Y.	13396	Telefunken (GmbH) . . . . .	Hanover, Germany
01589	Pacific Relays, Inc. . . . .	Van Nuys, Cal.	07149	Filmohm Corp. . . . .	New York, N. Y.	13835	Midland-Wright Div. of Pacific Industries, Inc. . . . .	Kansas City, Kansas
01670	Gudebrod Bros. Silk Co. . . . .	New York, N. Y.	07233	Cinch-Graphik Co. . . . .	City of Industry, Cal.	14099	Sem-Tech . . . . .	Newbury Park, Cal.
01930	Amerock Corp. . . . .	Rockford, Ill.	07256	Silicon Transistor Corp. . . . .	Carle Place, N. Y.	14193	Calif. Resistor Corp. . . . .	Santa Monica, Cal.
01960	Pulse Engineering Co. . . . .	Santa Clara, Cal.	07261	Avnet Corp. . . . .	Culver City, Cal.	14298	American Components, Inc. . . . .	Conshohocken, Pa.
02114	Ferroxcube Corp. of America . . . . .	Saugerties, N. Y.	07263	Fairchild Camera & Inst. Corp., Semiconductor Div. . . . .	Mountain View, Cal.	14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation . . . . .	West Palm Beach, Fla.
02116	Wheelock Signals, Inc. . . . .	Long Branch, N. J.	07322	Minnesota Rubber Co. . . . .	Minneapolis, Minn.	14493	Hewlett-Packard Company . . . . .	Loveland, Colo.
02286	Cole Rubber and Plastics Inc. . . . .	Sunnyvale, Cal.	07387	Birther Corp, The . . . . .	Monterey Park, Cal.	14655	Cornell Dublier Electric Corp . . . . .	Newark, N. J.
02660	Amphenol-Borg Electronics Corp. . . . .	Broadview, Ill.	07397	Sylvania Elect. Prod. Inc., Mt. View Operations . . . . .	Mountain View, Cal.	14674	Corning Glass Works . . . . .	Corning, N. Y.
02735	Radio Corp. of America, Semiconductor and Materials Division . . . . .	Somerville, N. J.	07700	Technical Wire Products Inc. . . . .	Cranford, N. J.	14752	Electro Cube Inc. . . . .	San Gabriel, Cal.
02771	Vocaline Co. of America, Inc. . . . .	Old Saybrook, Conn.	07829	Bodine Elect. Co. . . . .	Chicago, Ill.	14960	Williams Mfg. Co. . . . .	San Jose, Cal.
02777	Hopkins Engineering Co. . . . .	San Fernando, Cal.	07910	Continental Device Corp. . . . .	Hawthorne, Cal.	15106	The Sphere Co., Inc. . . . .	Little Falls, N. J.
02875	Hudson Tool & Die . . . . .	Newark, N. J.	07933	Raytheon Mfg. Co., Semiconductor Div. . . . .	Mountain View, Cal.	15203	Webster Electronics Co. . . . .	New York, N. Y.
03296	Nylon Molding Corp. . . . .	Springfield, N. J.	07980	Hewlett-Packard Co., New Jersey Division . . . . .	Rockaway, N. J.	15287	Scionics Corp. . . . .	Northridge, Cal.
03508	G. E. Semiconductor Prod. Dept. . . . .	Syracuse, N. Y.	08145	U. S. Engineering Co. . . . .	Los Angeles, Cal.	15291	Adjustable Bushing Co. . . . .	N. Hollywood, Cal.
03705	Apex Machine & Tool Co. . . . .	Dayton, Ohio	08289	Blinn, Delbert Co. . . . .	Pomona, Cal.	15558	Micron Electronics. Garden City, Long Island, N. Y.	
03797	Eldema Corp. . . . .	Compton, Calif.	08358	Burgess Battery Co. . . . .	Niagara Falls, Ontario, Canada	15566	Amprobe Inst. Corp. . . . .	Lybrook, N. Y.
03818	Parker Seal Co. . . . .	Los Angeles, Cal.	08524	Deutsch Fastener Corp. . . . .	Los Angeles, Cal.	15631	Cabletronics . . . . .	Costa Mesa, Cal.
03877	Transitron Electric Corp. . . . .	Wakefield, Mass.	08664	Bristol Co., The . . . . .	Waterbury, Conn.	15772	Twentieth Century Coil Spring Co. . . . .	Santa Clara, Cal.
03888	Pyrofilm Resistor Co., Inc. . . . .	Cedar Knolls, N. J.	08717	ITT Cannon Electric Inc., Phoenix Div. . . . .	Phoenix, Arizona	15801	Fenwal Elect. Inc. . . . .	Framingham, Mass.
03954	Singer Co., Diehl Div., FINDERNE Plant . . . . .	Sumerville, N. J.	08727	National Radio Lab. Inc. . . . .	Paramus, N. J.	15818	Amelco Inc. . . . .	Mountain View, Cal.
04009	Arrow, Hart and Hegeman Elect. Co. . . . .	Hartford, Conn.	08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc . . . . .	Lowell, Mass.	16037	Spruce Pine Mica Co. . . . .	Spruce Pine, N. C.
04013	Taruus Corp. . . . .	Lambertville, N. J.	08806	General Electric Co., Miniature Lamp Dept. . . . .	Cleveland, Ohio	16179	Omni-Spectra Inc. . . . .	Detroit, Ill.
04062	Arco Electronic Inc. . . . .	Great Neck, N. Y.	08984	Mel-Rain . . . . .	Indianapolis, Ind.	16352	Computer Diode Corp. . . . .	Lodi, N. J.
04217	Essex Wire . . . . .	Los Angeles, Cal.	09026	Babcock Relays Div. . . . .	Costa Mesa, Cal.	16554	Electroid Co. . . . .	Union, N. J.
04222	Hi-Q Division of Aerovox. . . . .	Myrtle Beach, S. C.	09097	Electronic Enclosures Inc. . . . .	Los Angeles, Calif.	16585	Boots Aircraft Nut Corp. . . . .	Pasadena, Cal.
04354	Precision Paper Tube Co. . . . .	Wheeling, Ill.	09134	Texas Capacitor Co. . . . .	Houston, Texas	16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div. . . . .	Brooklyn, N. Y.
04404	Palo Alto Division of Hewlett-Packard Co. . . . .	Palo Alto, Cal.	09145	Tech. Ind. Inc. Atohm Elect. . . . .	Burbank, Cal.	16758	Delco Radio Div. of G. M. Corp. . . . .	Kokomo, Ind.
04651	Sylvania Electric Products, Microwave Device Div. . . . .	Mountain View, Cal.	09250	Electro Assemblies, Inc. . . . .	Chicago, Ill.	17109	Thermonetics Inc. . . . .	Canoga Park, Cal.
04673	Dakota Engr. Inc. . . . .	Culver City, Cal.	09353	C & K Components Inc. . . . .	Newton, Mass.	17474	Tranex Company . . . . .	Mountain View, Cal.
04713	Motorola Inc. Semiconductor Prod. Div. . . . .	Phoenix, Arizona	09569	Mallory Battery Co. of Canada, Ltd. . . . .	Toronto, Ontario, Canada	17675	Hamlin Metal Products Corp. . . . .	Akron, Ohio
04732	Filttron Co., Inc. Western Div. . . . .	Culver City, Cal.	09795	Pennsylvania Florocarbon. Clifton Heights, Penn. . . . .	Clifton Heights, Penn.	17745	Angstrom Prec. Inc. . . . .	No. Hollywood, Cal.
04773	Automatic Electric Co. . . . .	Northlake, Ill.	09922	Burdny Corp. . . . .	Norwalk, Conn.	17856	Siliconix Inc. . . . .	Sunnyvale, Cal.
04796	Sequoia Wire Co. . . . .	Redwood City, Cal.	10214	General Transistor Western Corp. . . . .	Los Angeles, Cal.	17870	McGraw-Edison Co. . . . .	Manchester, N. H.
04811	Precision Coil Spring Co. . . . .	El Monte, Cal.	10411	Ti-Tal, Inc. . . . .	Berkeley, Cal.	18042	Power Design Pacific Inc. . . . .	Palo Alto, Cal.
04870	P. M. Motor Company . . . . .	Westchester, Ill.	10646	Carborundum Co. . . . .	Niagara Falls, N. Y.	18083	Clevite Corp. Semiconductor Div. . . . .	Palo Alto, Cal.
04919	Component Mfg. Service Co. . . . .	W. Bridgewater, Mass.				18324	Signetics Corp. . . . .	Sunnyvale, Cal.
05006	Twentieth Century Plastics, Inc. . . . .	Los Angeles, Cal.				18476	Ty-Car Mfg. Co., Inc. . . . .	Holliston, Mass.
05277	Westinghouse Electric Corp. Semiconductor Dept. . . . .	Youngwood, Pa.				18486	TRW Elect. Comp. Div. . . . .	Des Plaines, Ill.



## CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N. Y.	71482	C. P. Clare & Co.	Chicago, Ill.	78452	Thompson-Bremer & Co.	Chicago, Ill.
19701	Electra Mfg. Co.	Independence, Kansas	71590	Centralab Div. of		78471	Tilley Mfg. Co.	San Francisco, Cal.
20183	General Atronic Corp.	Philadelphia, Pa.		Globe Union Inc.	Milwaukee, Wis.	78488	Stackpole Carbon Co.	St. Marys, Pa.
21226	Executone, Inc.	Long Island City, N. Y.	71616	Commercial Plastics Co.	Chicago, Ill.	78493	Standard Thomson Corp.	Waltham, Mass.
21355	Fafnir Bearing Co., The	New Britain, Conn.	71700	Cornish Wire Co., The	New York, N. Y.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71707	Coto Coil Co., Inc.	Providence, R. I.	78790	Transformer Engineers	San Gabriel, Cal.
23020	General Reed Co.	Metuchen, N. J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78947	Ucinite Co.	Newtonville, Mass.
23042	Texscan Corp.	Indianapolis, Ind.	71785	Cinch Mfg. Co.		79136	Waldes Kohinoor Inc.	Long Island City, N. Y.
23783	British Radio Electronics Ltd.	Washington, D.C.		Howard B. Jones Div.	Chicago, Ill.	79142	Veeder Root, Inc.	Hartford, Conn.
24455	G. E. Lamp Division, Nela Park	Cleveland, Ohio	71984	Dow Corning Corp.	Midland, Mich.	79251	Wenco Mfg. Co.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	72136	Electro Motive Mfg. Co., Inc.		79727	Continental-Wirt Electronics Corp.	
24681	Memcor Inc., Comp. Div.	Huntington, Ind.			Willimantic, Conn.			Philadelphia, Pa.
26365	Gries Reproducer Corp.	New Rochelle, N. Y.	72619	Dialight Corp.	Brooklyn, N. Y.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N. J.	72656	Indiana General Corp.,		80031	Mepeco Division of Sessions Clock Co.	
26851	Compac/Hollister Co.	Hollister, Cal.		Electronics Div.	Keasby, N. J.			Morristown, N. J.
26992	Hamilton Watch Co.	Lancaster, Pa.	72699	General Instrument Corp.,		80033	Prestole Corp.	Toledo, Ohio
28480	Hewlett-Packard Co.	Palo Alto, Cal.		Cap Division	Newark, N. J.	80120	Schnitzer Alloy Products Co.	Elizabeth, N. J.
28520	Heyman Mfg. Co.	Kenilworth, N. J.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	80131	Electronic Industries Association.	
30817	Instrument Specialties Co.,		72825	Hugh H. Eby Inc.	Philadelphia, Pa.		Standard tube or semi-conductor device,	
	Inc.	Little Falls, N. J.	72928	Gudemann Co.	Chicago, Ill.		any manufacturer.	
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	72962	Elastic Stop Nut Corp.	Union, N. J.	80207	Unimax Switch, Div. Maxon Electronics	
35434	Lectrohm Inc.	Chicago, Ill.	72964	Robert M. Hadley Co.	Los Angeles, Cal.		Corp.	Wallingford, Conn.
36196	Stanwyck Coil Products,		72982	Erie Technological Products, Inc.	Erie, Pa.	80223	United Transformer Corp.	New York, N. Y.
	Ltd.	Hawkesbury, Ontario, Canada	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	80248	Oxford Electric Corp.	Chicago, Ill.
36287	Cunningham, W. H. & Hill,		73076	H. M. Harper Co.	Chicago, Ill.	80294	Bourns Inc.	Riverside, Cal.
	Ltd.	Toronto, Ontario, Canada	73138	Helipot Div. of Beckman Inst., Inc.		80411	Arco Div. of Robertshaw Controls Co.	
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.			Fullerton, Cal.			Columbus, Ohio
39543	Mechanical Industries Prod. Co.	Akron, Ohio	73293	Hughes Products Division of		80486	All Star Products Inc.	Defiance, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N. H.		Hughes Aircraft Co.	Newport Beach, Cal.	80509	Avery Label Co.	Monrovia, Cal.
40931	Honeywell Inc.	Minneapolis, Minn.	73445	Amperex Elect. Co.	Hicksville, L. I., N. Y.	80583	Hammarlund Co., Inc.	Mars Hill, N. C.
42190	Muter Co.	Chicago, Ill.	73506	Bradley Semiconductor Corp.		80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
43990	C. A. Norgren Co.	Englewood, Colo.			New Haven, Conn.	80813	Dimco Gray Co.	Dayton, Ohio
44655	Ohmite Mfg. Co.	Skokie, Ill.	73559	Carling Electric, Inc.	Hartford, Conn.	81030	International Inst. Inc.	Orange, Conn.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	73586	Circle F Mfg. Co.	Trenton, N. J.	81073	Grayhill Co.	LaGrange, Ill.
47904	Polaroid Corp.	Cambridge, Mass.	73682	George K. Garrett Co.,		81095	Triad Transformer Corp.	Venice, Cal.
48620	Precision Thermometer &			Div. MSL Industries, Inc.	Philadelphia, Pa.	81312	Winchester Elec. Div. Litton Ind., Inc.	
	Inst. Co.	Southampton, Pa.	73734	Federal Screw Products, Inc.	Chicago, Ill.			Oakville, Conn.
49956	Microwave & Power Tube Div.	Waltham, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	81349	Military Specification	
52090	Rowan Controller Co.	Westminster, Md.	73793	General Industries Co., The	Elyria, Ohio	81483	International Rectifier Corp.	El Segundo, Cal.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	81541	Airpax Electronics, Inc.	Cambridge, Maryland
54294	Shallcross Mfg. Co.	Selma, N. C.	73899	JFD Electronics Corp.	Brooklyn, N. Y.	81860	Barry Controls, Div. Barry Wright Corp.	
55026	Simpson Electric Co.	Chicago, Ill.	73905	Jennings Radio Mfg. Corp.	San Jose, Cal.			Watertown, Mass.
55933	Sonotone Corp.	Elmsford, N. Y.	73957	Groove-Pin Corp.	Ridgefield, N. J.	82042	Carter Precision Electric Co.	Skokie, Ill.
55938	Raytheon Co. Commercial Apparatus		74276	Signalite Inc.	Neptune, N. J.	82047	Sperit Faraday Inc., Copper Hewitt	
	& System Div.	So. Norwalk, Conn.	74455	J. H. Winns, and Sons	Winchester, Mass.		Electric Div.	Hoboken, N. J.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N. Y.	74861	Industrial Condenser Corp.	Chicago, Ill.	82116	Electric Regulator Corp.	Norwalk, Conn.
56289	Sprague Electric Co.	North Adams, Mass.	74868	R. F. Products Division of		82142	Jeffers Electronics Division of	
58474	Superior Elect. Co.	Bristol, Conn.		Amphenol-Borg Electronic Corp.			Speer Carbon Co.	Du Bois, Pa.
59446	Telex Corp.	Tulsa, Okla.	74970	E. F. Johnson Co.	Waseca, Minn.	82170	Fairchild Camera & Inst. Corp.,	
59730	Thomas & Betts Co.	Elizabeth, N. J.	75042	International Resistance Co.	Philadelphia, Pa.		Space & Defense Systems Div.	Paramus, N. J.
61741	Triplett Electrical Inst. Co.	Bluffton, Ohio	75263	Keystone Carbon Co., Inc.	St. Marys, Pa.	82209	Magurie Industries, Inc.	Greenwich, Conn.
61775	Union Switch and Signal Div. of		75378	CTS Knights, Inc.	Sandwich, Ill.	82219	Sylvania Electric Prod., Inc.	
	Westinghouse Air Brake Co.	Pittsburgh, Pa.	75382	Kulka Electric Corp.	Mt. Vernon, N. Y.		Electronic Tube Division	Emporium, Pa.
62119	Universal Electric Co.	Owosso, Mich.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82376	Astron Corp.	East Newark, Harrison, N. J.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	75915	Littlefuse, Inc.	Des Plaines, Ill.	82389	Switchcraft, Inc.	Chicago, Ill.
64959	Western Electric Co., Inc.	New York, N. Y.	76005	Lord Mfg. Co.	Erie, Pa.	82647	Metals & Controls Inc.,	
65092	Weston Inst. Inc. Weston-Newark	Newark, N. J.	76210	C. W. Marwedel	San Francisco, Cal.		Spencer Products	Attleboro, Mass.
66295	Wittek Mfg. Co.	Chicago, Ill.	76433	General Instrument Corp.,		82768	Phillips-Advance Control Co.	Joliet, Ill.
66346	Minnesota Mining & Mfg. Co.			Micamold Division	Newark, N. J.	82866	Research Products Corp.	Madison, Wis.
	Reverse Mincom Div.	St. Paul, Minn.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.	82877	Rolton Mfg. Co., Inc.	Woodstock, N. Y.
70276	Allen Mfg. Co.	Hartford, Conn.	76493	J. W. Miller Co.	Los Angeles, Cal.	82893	Vector Electronic Co.	Glendale, Cal.
70309	Allied Control	New York, N. Y.	76530	Cinch-Monadnock, Div. of United Carr		83058	Carr Fastener Co.	Cambridge, Mass.
70318	Allmetal Screw Product Co., Inc.			Fastener Corp.	San Leandro, Cal.	83086	New Hampshire Ball	
		Garden City, N. Y.	76545	Mueller Electric Co.	Cleveland, Ohio		Bearing, Inc.	Peterborough, N. H.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	76703	National Union	Newark, N. J.	83125	General Instrument Corp.,	
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.		Capacitor Div.	Darlington, S. C.
70563	Amperite Co., Inc.	Union City, N. J.	77068	The Bendix Corp.,		83148	ITT Wire and Cable Div.	Los Angeles, Cal.
70674	ADC Products Inc.	Minneapolis, Minn.		Electrodynamics Div.	N. Hollywood, Cal.	83186	Victory Eng. Corp.	Springfield, N. J.
70903	Belden Mfg. Co.	Chicago, Ill.	77075	Pacific Metals Co.	San Francisco, Cal.	83298	Bendix Corp., Red Bank Div.	Red Bank, N. J.
70998	Bird Electric Corp.	Cleveland, Ohio	77221	Phaostran Instrument and		83315	Hubbell Corp.	Mundelein, Ill.
71002	Birnback Radio Co.	New York, N. Y.		Electronic Co.	So. Pasadena, Cal.	83324	Rosan Inc.	Newport Beach, Cal.
71034	Billey Electric Co., Inc.	Erie, Pa.	77252	Philadelphia Steel and		83330	Smith, Herman H., Inc.	Brooklyn, N. Y.
71041	Boston Gear Works Div. of			Wire Corp.	Philadelphia, Pa.	83332	Tech Labs	Palisades Park, N. J.
	Murray Co. of Texas	Quincey, Mass.	77342	American Machine & Foundry Co.		83385	Central Screw Co.	Chicago, Ill.
71218	Bud Radio, Inc.	Willoughby, Ohio		Potter & Brumfield Div.	Princeton, Ind.	83501	Gavitt Wire and Cable Co., Div. of	
71279	Cambridge Thermionics Corp.	Cambridge, Mass.	77630	TRW Electronic Components Div.	Camden, N. J.		Amerace Corp.	Brookfield, Mass.
71286	Camloc Fastener Corp.	Paramus, N. J.	77638	General Instrument Corp.,		83594	Burroughs Corp., Electronic	
71313	Cardwell Condenser Corp.			Rectifier Division	Brooklyn, N. Y.		Tube Div.	Plainfield, N. J.
		Lindenhurst, L. I., N. Y.	77764	Resistance Products Co.	Harrisburg, Pa.	83740	Union Carbide Corp., Consumer	
71400	Bussmann Mfg. Div. of		77969	Rubbercraft Corp. of Calif.	Torrance, Cal.		Prod. Div.	New York, N. Y.
	McGraw-Edison Co.	St. Louis, Mo.	78189	Shakeproof Division of		83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
71436	Chicago Condenser Corp.	Chicago, Ill.		Illinois Tool Works	Elgin, Ill.	83821	Loyd Scruggs Co.	Festus, Mo.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.	78277	Sigma	So. Braintree, Mass.	83942	Aeronautical Inst. & Radio Co.	Lodi, N. J.
71450	CTS Corp.	Elkhart, Ind.	78283	Signal Indicator Corp.	New York, N. Y.	84171	Arco Electronics Inc.	Great Neck, N. Y.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.	78290	Struthers-Dunn Inc.	Pitman, N. J.	84396	A. J. Glesener Co., Inc.	San Francisco, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.				84411	TRW Capacitor Div.	Ogallala, Neb.



CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.	91929	Honeywell Inc., Micro Switch Division		96095	Hi-Q Div. of Aerovox Corp.	Olean, N. Y.
85454	Boonton Molding Company	Boonton, N. J.			Freeport, Ill.	96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
85471	A. B. Boyd Co.	San Francisco, Cal.	91961	Nahm-Bros. Spring Co.	Oakland, Cal.	96296	Solar Mfg. Co.	Los Angeles, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.	92180	Tru-Connector Corp.	Peabody, Mass.	96396	Microswitch, Div. of	
85660	Koiled Kords, Inc.	Hamden, Conn.	92367	Elgeet Optical Co., Inc.	Rochester, N. Y.		Minn.-Honeywell	Freeport, Ill.
85911	Seamless Rubber Co.	Chicago, Ill.	92607	Tensolite Insulated Wire Co., Inc.		96330	Carlton Screw Co.	Chicago, Ill.
86174	Seafair Bearing Co.	Los Angeles, Calif.			Tarrytown, N. Y.	96341	Microwave Associates, Inc.	Burlington, Mass.
86197	Clifton Precision Products Co., Inc.		92702	IMC Magnetics Corp.	Westbury, L. I., N. Y.	96501	Excel Transformer Co.	Oakland, Cal.
		Clifton Heights, Pa.	92966	Hudson Lamp Co.	Kearney, N. J.	96508	Xcelite, Inc.	Orchard Park, N. Y.
86579	Precision Rubber Products Corp.	Dayton, Ohio	93332	Sylvania Electric Prod. Inc.,		96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N. J.	93369	Robbins & Myers Inc.	Pallisades Park, N. J.	96881	Thomson Ind. Inc.	Long Island, N. Y.
86928	Seastrom Mfg. Co.	Glendale, Cal.	93410	Stemco Controls, Div. of Essex		97464	Industrial Retaining Ring Co.	Irvington, N. J.
87034	Marco Industries	Anaheim, Cal.			Wire Corp.	97539	Automatic & Precision Mfg.	Englewood, N. J.
87216	Philco Corporation (Lansdale Division)		93632	Waters Mfg. Co.	Culver City, Cal.	97979	Reon Resistor Corp.	Yonkers, N. Y.
		Lansdale, Pa.	93929	G. V. Controls	Livingston, N. J.	97983	Litton System Inc., Adler-Westrex	
87473	Western Fibrous Glass Products Co.		94137	General Cable Corp.	Bayonne, N. J.		Commun. Div.	New Rochelle, N. Y.
		San Francisco, Cal.	94144	Raytheon Co., Comp. Div.,		98141	R-Tronics, Inc.	Jamaica, N. Y.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.		Ind. Comp. Operations	Quincy, Mass.	98159	Rubber Teck, Inc.	Gardena, Cal.
87930	Tower Mfg. Corp.	Providence, R. I.	94148	Scientific Electronics		98220	Hewlett-Packard Co.,	
88140	Cutler-Hammer, Inc.	Lincoln, Ill.		Products, Inc.	Loveland, Colo.		Medical Elec. Div.	Pasadena, Cal.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.	94154	Wagner Elect. Corp.,		98278	Microdot, Inc.	So. Pasadena, Cal.
88698	General Mills, Inc.	Buffalo, N. Y.		Tung-Sol Div.	Newark, N. J.	98291	Seaelectro Corp.	Mamaronech, N. Y.
89231	Graybar Electric Co.	Oakland, Cal.	94197	Curtiss-Wright Corp.,		98376	Zero Mfg. Co.	Burbank, Cal.
89473	G. E. Distributing Corp.	Schenectady, N. Y.		Electronics Div.	East Patterson, N. J.	98410	Etc. Inc.	Cleveland, Ohio
89479	Security Co.	Detroit, Mich.	94222	South Chester Corp.	Chester, Pa.	98731	General Mills Inc., Electronics Div.	
89665	United Transformer Co.	Chicago, Ill.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.			Minneapolis, Minn.
90030	United Shoe Machinery Corp.	Beverly, Mass.	94375	Automatic Metal Products Co.	Brooklyn, N. Y.	98734	Paeco Division of Hewlett-Packard Co.	
90179	U. S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.	94682	Worcester Pressed Aluminum Corp.				Palo Alto, Cal.
		Belleville, Ill.	94696	Magnecraft Electric Co.	Chicago, Ill.	98821	North Hills Electronics, Inc.	Glen Cove, N. Y.
90365	Belleville Speciality Tool Mfg., Inc.		95023	George A. Philbrick Researchers, Inc.		98978	International Electronic Research Corp.	
		Chicago, Ill.			Boston, Mass.			Burbank, Cal.
90763	United Carr Fastener Corp.		95146	Alco Elect. Mfg. Co.	Lawrence, Mass.	99109	Columbia Technical Corp.	New York, N. Y.
90970	Bearing Engineering Co.	San Francisco, Cal.	95236	Allies Products Corp.	Dania, Fla.	99313	Varian Associates	Palo Alto, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.		95238	Continental Connector Corp.	Woodside, N. Y.	99378	Atlee Corp.	Winchester, Mass.
		Salem, Mass.	95263	Leecraft Mfg. Co., Inc.	Long Island, N. Y.	99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.	95265	National Coil Co.	Sheridan, Wyo.	99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.	95275	Vitramon, Inc.	Bridgeport, Conn.	99800	Delevan Electronics Corp.	East Aurora, N. Y.
91418	Radio Materials Co.	Chicago, Ill.	95348	Gordos Corp.	Bloomfield, N. J.	99848	Wilco Corporation	Indianapolis, Ind.
91506	Augat Inc.	Attleboro, Mass.	95354	Methode Mfg. Co.	Rolling Meadows, Ill.	99928	Branson Corp.	Whippany, N. J.
91637	Dale Electronics, Inc.	Columbus, Nebr.	95566	Arnold Engineering Co.	Marengo, Ill.	99934	Rembrandt, Inc.	Boston, Mass.
91662	Elco Corp.	Willow Grove, Pa.	95712	Dage Electric Co., Inc.	Franklin, Ind.	99942	Hoffman Electronics Corp.,	
91673	Epiphone Inc.	New York, N. Y.	95984	Siemon Mfg. Co.	Wayne, Ill.		Semiconductor Division	El Monte, Cal.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.	95987	Weckesser Co.	Chicago, Ill.	99957	Technology-Instrument Corp.	
91827	K F Development Co.	Redwood City, Cal.	96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.		of California	Newbury Park, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.						

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

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

**SUPPLEMENTAL CODE LIST OF MANUFACTURERS**

<b>Code No.</b>	<b>Manufacturer</b>	<b>Address</b>
17117	Electronic Molding Corp.	Pawtucket, Rhode Island
14480	Rollin J. Lobaugh	San Francisco, Calif.
90201	Mallory Capacitor Co.	Indianapolis, Indiana

## SALES &amp; SERVICE OFFICES

## UNITED STATES

## ALABAMA

P.O. Box 4207  
2003 Byrd Spring Road S.W.  
Huntsville 35802  
Tel: (205) 881-4591  
TWX: 810-726-2204

## ARIZONA

3009 North Scottsdale Road  
Scottsdale 85251  
Tel: (602) 945-7601  
TWX: 910-950-1282

5737 East Broadway  
Tucson 85716  
Tel: (602) 298-2313  
TWX: 910-952-1162

## CALIFORNIA

1430 East Orangethorpe Ave.  
Fullerton 92631  
Tel: (714) 870-1000

3939 Lankershim Boulevard  
North Hollywood 91604  
Tel: (213) 877-1282  
TWX: 910-499-2170

1101 Embarcadero Road  
Palo Alto 94303  
Tel: (415) 327-6500  
TWX: 910-373-1280

2220 Watt Ave.  
Sacramento 95825  
Tel: (916) 482-1463  
TWX: 910-367-2092

1055 Shafter Street  
San Diego 92106  
Tel: (714) 223-8103  
TWX: 910-335-2000

7965 East Prentice  
Englewood 80110  
Tel: (303) 771-3455  
TWX: 910-935-0705

## CONNECTICUT

508 Tolland Street  
East Hartford 06108  
Tel: (203) 289-9394  
TWX: 710-425-3416

111 East Avenue  
Norwalk 06851  
Tel: (203) 853-1251  
TWX: 710-468-3750

## DELAWARE

3941 Kennett Pike  
Wilmington 19807  
Tel: (302) 655-6161  
TWX: 510-666-2214

## FLORIDA

P.O. Box 24210  
2806 W. Oakland Park Blvd.  
Ft. Lauderdale 33307  
Tel: (305) 731-2020  
TWX: 510-955-4099

P.O. Box 20007  
Herndon Station 32814  
621 Commonwealth Avenue  
Orlando  
Tel: (305) 841-3970  
TWX: 810-850-0113

## GEORGIA

P.O. Box 28234  
450 Interstate North  
Atlanta 30328  
Tel: (404) 436-6181  
TWX: 810-766-4890

## ILLINOIS

5500 Howard Street  
Skokie 60076  
Tel: (312) 677-0400  
TWX: 910-223-3613

## INDIANA

3839 Meadows Drive  
Indianapolis 46205  
Tel: (317) 546-4891  
TWX: 810-341-3263

## LOUISIANA

P.O. Box 856  
1942 Williams Boulevard  
Baltimore 21207  
Tel: (504) 721-6201  
TWX: 810-955-5524

## MARYLAND

6707 Whitestone Road  
Baltimore 21207  
Tel: (301) 944-5400  
TWX: 710-862-0850

P.O. Box 1648  
2 Choke Cherry Road  
Rockville 20850  
Tel: (301) 948-6370  
TWX: 710-828-9684

## MASSACHUSETTS

32 Hartwell Ave.  
Lexington 02173  
Tel: (617) 861-8960  
TWX: 710-326-6904

## MICHIGAN

24315 Northwestern Highway  
Southfield 48075  
Tel: (313) 353-9100  
TWX: 810-224-4882

## MINNESOTA

2459 University Avenue  
St. Paul 55114  
Tel: (612) 645-9461  
TWX: 910-563-3734

## MISSOURI

11131 Colorado Ave.  
Kansas City 64137  
Tel: (816) 763-8000  
TWX: 910-771-2087

2812 South Brentwood Blvd.  
St. Louis 63144  
Tel: (314) 962-5000  
TWX: 910-760-1670

## NEW JERSEY

W. 120 Century Road  
Paramus 07652  
Tel: (201) 265-5000  
TWX: 710-990-4951

1060 N. Kings Highway  
Cherry Hill 08034  
Tel: (609) 667-4000  
TWX: 710-892-4945

## NEW MEXICO

P.O. Box 8366  
Station C  
6501 Lomas Boulevard N.E.  
Albuquerque 87108  
Tel: (505) 265-3713  
TWX: 910-989-1665

156 Wyatt Drive  
Las Cruces 88001  
Tel: (505) 526-2485  
TWX: 910-983-0550

## NEW YORK

1702 Central Avenue  
Albany 12205  
Tel: (518) 869-8462  
TWX: 710-441-8270

1219 Campville Road  
Endicott 13760  
Tel: (607) 754-0050  
TWX: 510-252-0890

82 Washington Street  
Poughkeepsie 12601  
Tel: (914) 454-7330  
TWX: 510-248-0012

39 Saginaw Drive  
Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

1025 Northern Boulevard  
Roslyn, Long Island 11576  
Tel: (516) 869-8400  
TWX: 510-223-0811

5858 East Molloy Road  
Syracuse 13211  
Tel: (315) 454-2486  
TWX: 710-541-0482

## NORTH CAROLINA

P.O. Box 5188  
1923 North Main Street  
High Point 27262  
Tel: (919) 885-8101  
TWX: 510-926-1516

## OHIO

25575 Center Ridge Road  
Cleveland 44145  
Tel: (216) 835-0300  
TWX: 810-427-9129

3460 South Dixie Drive  
Dayton 45439  
Tel: (513) 298-0351  
TWX: 810-459-1925

1120 Morse Road  
Columbus 43229  
Tel: (614) 846-1300

## OKLAHOMA

2919 United Founders Boulevard  
Oklahoma City 73112  
Tel: (405) 848-2801  
TWX: 910-830-6862

## OREGON

Westhills Mall, Suite 158  
4475 S.W. Scholls Ferry Road  
Portland 97225  
Tel: (503) 292-9171  
TWX: 910-464-6103

## PENNSYLVANIA

2500 Moss Side Boulevard  
Monroeville 15146  
Tel: (412) 271-0724  
TWX: 710-797-3650

1021 8th Avenue  
King of Prussia Industrial Park  
King of Prussia 19406  
Tel: (215) 265-7000  
TWX: 510-660-2670

## RHODE ISLAND

873 Waterman Ave.  
East Providence 02914  
Tel: (401) 434-5535  
TWX: 710-381-7573

## TEXAS

P.O. Box 1270  
201 E. Arapaho Rd.  
Richardson 75080  
Tel: (214) 231-6101  
TWX: 910-867-4723

P.O. Box 22813  
6300 Westpark Drive  
Suite 100  
Houston 77027  
Tel: (713) 781-6000  
TWX: 910-881-2645

231 Billy Mitchell Road  
San Antonio 78226  
Tel: (512) 434-4171  
TWX: 910-871-1170

## UTAH

2890 South Main Street  
Salt Lake City 84115  
Tel: (801) 487-0715  
TWX: 910-925-5681

## VERMONT

P.O. Box 2287  
Kennedy Drive  
South Burlington 05401  
Tel: (802) 658-4455  
TWX: 710-224-1841

## VIRGINIA

2890 South Main Street  
Richmond 23230  
Tel: (703) 285-3431  
TWX: 710-956-0157

## WASHINGTON

433-108th N.E.  
Bellevue 98004  
Tel: (206) 454-3971  
TWX: 910-443-2303

## \*WEST VIRGINIA

Charleston  
Tel: (304) 768-1232

## FOR U.S. AREAS NOT LISTED:

Contact the regional office nearest you: Atlanta, Georgia... North Hollywood, California... Paramus, New Jersey... Skokie, Illinois. Their complete addresses are listed above.

\*Service Only

## CANADA

## ALBERTA

Hewlett-Packard (Canada) Ltd.  
11745 Jasper Ave.  
Edmonton  
Tel: (403) 482-5561  
TWX: 610-831-2431

## BRITISH COLUMBIA

Hewlett-Packard (Canada) Ltd.  
4519 Canada Way  
North Burnaby 2  
Tel: (604) 433-8213  
TWX: 610-922-5059

## MANITOBA

Hewlett-Packard (Canada) Ltd.  
511 Bradford Ct.  
St. James  
Tel: (204) 786-7581  
TWX: 610-671-3531

## NOVA SCOTIA

Hewlett-Packard (Canada) Ltd.  
2745 Dutch Village Rd.  
Suite 203  
Halifax  
Tel: (902) 455-0511  
TWX: 610-271-4482

## ONTARIO

Hewlett-Packard (Canada) Ltd.  
880 Lady Ellen Place  
Ottawa 3  
Tel: (613) 722-4223  
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.  
50 Galaxy Blvd.  
Rexdale  
Tel: (416) 677-9611  
TWX: 610-492-4246

## QUEBEC

Hewlett-Packard (Canada) Ltd.  
275 Hymus Boulevard  
Pointe Claire  
Tel: (514) 697-4232  
TWX: 610-422-3022  
Telex: 01-20607

## FOR CANADIAN AREAS NOT LISTED:

Contact Hewlett-Packard (Canada) Ltd. in Pointe Claire, at the complete address listed above.

## CENTRAL AND SOUTH AMERICA

## ARGENTINA

Hewlett-Packard Argentina  
S.A. C.e.I.  
Lavalle 1171 - 3°  
Buenos Aires  
Tel: 35-0436, 35-0627, 35-0431  
Telex: 012-1009  
Cable: HEWPACKARG

## BRAZIL

Hewlett-Packard Do Brasil  
i.e.C. Ltda.  
Rua Coronel Oscar Porto, 691  
Sao Paulo - 8, SP  
Tel: 288-7111  
Cable: HEWPACK Sao Paulo

Hewlett-Packard Do Brasil  
i.e.C. Ltda.  
Rua da Matriz 29  
Botafogo ZC-02  
Rio de Janeiro, GB  
Tel: 246-4417  
Cable: HEWPACK Rio de Janeiro

## CHILE

Héctor Calcagni y Cia, Ltda.  
Bustos, 1932-3er Piso  
Casilla 13942  
Santiago  
Tel: 4-2396  
Cable: Calcagni Santiago

## COLOMBIA

Instrumentacion  
Henrik A. Langebaek & Kier  
Ltda.  
Carrera 7 No. 48-59  
Apartado Aereo 6287  
Bogota, 1 D.E.  
Tel: 45-78-06, 45-55-46  
Cable: AARIS Bogota  
Telex: 044-400

## COSTA RICA

Lic. Alfredo Gallegos Guardián  
Apartado 3243  
San José  
Tel: 21-86-13  
Cable: GALGUR San José

## ECUADOR

Laboratorios de Radio-Ingenieria  
Calle Guayaquil 1246  
Post Office Box 3199  
Quito  
Tel: 12496  
Cable: HORVATH Quito

## EL SALVADOR

Electrónica  
Apartado Postal 1589  
27 Avenida Norte 1133  
San Salvador  
Tel: 25-74-50  
Cable: ELECTRONICA  
San Salvador

## GUATEMALA

Olander Associates Latin America  
Apartado Postal 1226  
Ruta 4, 6-53, Zona 4  
Guatemala City  
Tel: 63958  
Cable: OLALA Guatemala City

## MEXICO

Hewlett-Packard Mexicana, S.A.  
de C.V.  
Moras 439  
Col. del Valle  
Mexico 12, D.F.  
Tel: 5-75-46-49

## NICARAGUA

Roberto Terán G.  
Apartado Postal 689  
Edificio Terán  
Managua  
Tel: 3451, 3452  
Cable: ROTERAN Managua

## PANAMA

Electrónico Balboa, S.A.  
P.O. Box 4929  
Ave. Manuel Espinosa No. 13-50  
Bldg. Alina  
Panama City  
Tel: 30833  
Cable: ELECTRON Panama City

## PERU

Fernando Ezeta B.  
Avenida Petit Thouars 4719  
Miraflores  
Casilla 3061  
Lima  
Tel: 45-2335  
Cable: FEPERU Lima

## PUERTO RICO

San Juan Electronics, Inc.  
P.O. Box 5167  
Ponce de Leon 154  
Pta. 3-Pta. de Tierra  
San Juan 00906  
Tel: (809) 725-3342  
Cable: SATRONICS San Juan  
Telex: SATRON 3450 332

## URUGUAY

Pablo Ferrando S.A.  
Comercial e Industrial  
Avenida Italia 2877  
Casilla de Correo 370  
Montevideo  
Tel: 40-3102  
Cable: RADIUM Montevideo

## VENEZUELA

Hewlett-Packard De Venezuela  
C.A.  
Apartado 50933  
Caracas  
Tel: 71.88.05, 71.88.69, 71.99.30  
Cable: HEWPACK Caracas

## FOR AREAS NOT LISTED,

CONTACT:  
Hewlett-Packard  
INTERCONTINENTAL  
3200 Hillview Ave.  
Palo Alto, California 94304  
Tel: (415) 326-7000  
TWX: 910-373-1267  
Cable: HEWPACK Palo Alto  
Telex: 034-8461

## EUROPE

**AUSTRIA**  
Unifabor GmbH  
Wissenschaftliche Instrumente  
Rummelhardtgasse 6/3  
P.O. Box 33  
Vienna A-1095  
Tel: (222) 42 61 81, 43 13 94  
Cable: LABORINSTRUMENT  
Vienna  
Telex: 75 762

**BELGIUM**  
Hewlett-Packard Benelux S.A.  
348 Boulevard du Souverain  
Brussels 1160  
Tel: 72 22 40  
Cable: PALOBEN Brussels  
Telex: 23 494

**DENMARK**  
Hewlett-Packard A/S  
Datavej 38  
DK-3460 Birkerød  
Tel: (01) 81 66 40  
Cable: HEWPACK AS  
Telex: 66 40

**EASTERN EUROPE**  
Hewlett-Packard S.A. Genf.  
Korrespondenz Büro Für Ost-europa  
(Czechoslovakia, Hungary,  
Poland, DDR, Rumania,  
Bulgaria)  
Innstrasse 23/2  
Postfach  
A-1204 Vienna, Austria  
Tel: (222) 33 66 06/09  
Cable: HEWPACK Vienna

**FINLAND**  
Hewlett-Packard Oy  
Bulevardi 26  
P.O. Box 12185  
Helsinki 12  
Tel: 13-730  
Cable: HEWPACKOY-Helsinki  
Telex: 12-1563

**FRANCE**  
Hewlett-Packard France  
Quartier de Courtaboeuf  
Boîte Postale No. 6  
91 Orsay  
Tel: 1-920 88 01  
Cable: HEWPACK Orsay  
Telex: 60048

Hewlett-Packard France  
4 Quai des Etroits  
69 Lyon 58me  
Tel: 78-42 63 45  
Cable: HEWPACK Lyon  
Telex: 31617

**GERMANY**  
Hewlett-Packard Vertriebs-GmbH  
Lietzenburgerstrasse 30  
1 Berlin 30  
Tel: (0311) 211 60 16  
Telex: 18 34 05

Hewlett-Packard Vertriebs-GmbH  
Herrenbergerstrasse 110  
703 Böblingen, Württemberg  
Tel: 07031-6671  
Cable: HEPAG Böblingen  
Telex: 72 65 739

Hewlett-Packard Vertriebs-GmbH  
Achenbachstrasse 15  
4 Düsseldorf 1  
Tel: (0211) 68 52 58/59  
Telex: 85 86 533

Hewlett-Packard Vertriebs-GmbH  
Berliner Strasse 117  
6 Nieder-Eschbach/Frankfurt 56  
Tel: (0611) 50 10 64  
Cable: HEWPACKSA Frankfurt  
Telex: 41 32 49 FRA

Hewlett-Packard Vertriebs-GmbH  
Beim Strohhause 26  
2 Hamburg 1  
Tel: (0411) 24 05 51/52  
Cable: HEWPACKSA Hamburg  
Telex: 21 53 32

Hewlett-Packard Vertriebs-GmbH  
Reginfriedstrasse 13  
8 München 9  
Tel: (0811) 69 59 71/75  
Cable: HEWPACKSA München  
Telex: 52 49 85

**GREECE**  
Kostas Karayannis  
18, Ermou Street  
Athens 126  
Tel: 230301,3,5  
Cable: RAKAR Athens  
Telex: 21 59 62 RKAR GR

**IRELAND**  
Hewlett-Packard Ltd.  
224 Bath Road  
Slough, Bucks, England  
Tel: Slough 753-3341  
Cable: HEWPIE Slough  
Telex: 84413

**ITALY**  
Hewlett-Packard Italiana S.p.A.  
20124 Milano  
Tel: (2) 6251 (10 lines)  
Cable: HEWPACKIT Milan  
Telex: 32046

Hewlett-Packard Italiana S.p.A.  
Palazzo Italia  
Piazza Marconi 25  
00144 Rome - Eur  
Tel: 6-521 2544  
Cable: HEWPACKIT Rome  
Telex: 61514

**NETHERLANDS**  
Hewlett-Packard Benelux, N.V.  
Weerdestein 117  
P.O. Box 7825  
Amsterdam, Z 11  
Tel: 020-42 7777  
Cable: PALOBEN Amsterdam  
Telex: 13 216

**NORWAY**  
Hewlett-Packard Norge A/S  
Box 149  
Nesveien 13  
N-1344 Haslum  
Tel: 2-53 83 60  
Cable: HEWPACK Oslo  
Telex: 16621

**PORTUGAL**  
Teletra  
Empresa Tecnica de  
Equipamentos  
Electricos, S.a.r.l.  
Rua Rodrigo da Fonseca 103  
P.O. Box 2531  
Lisbon 1  
Tel: 68 60 72  
Cable: TELETRA Lisboa  
Telex: 1598

**SPAIN**  
Ataio Ingenieros SA  
Ganduxer 76  
Barcelona 6  
Tel: 211-44-66  
Cable: TELEATAIO BARCELONA

Ataio Ingenieros SA  
Enrique Larreta 12  
Madrid, 16  
Tel: 215 35 43  
Cable: TELEATAIO Madrid  
Telex: 27249E

**SWEDEN**  
Hewlett-Packard (Sverige) AB  
Hagakergatan 9C  
S 431 04 Mölndal 4  
Tel: 031 - 27 68 00

Hewlett-Packard (Sverige) AB  
Svetsarvägen 7  
S171 20 Solna 1  
Tel: (08) 98 12 50  
Cable: MEASUREMENTS  
Stockholm  
Telex: 10721

**SWITZERLAND**  
Hewlett Packard (Schweiz) AG  
Zürcherstrasse 20  
8952 Schlieren  
Zurich  
Tel: (051) 98 18 21/24  
Cable: HPAG CH  
Telex: 53933

Hewlett Packard (Schweiz) A.G.  
Rue du Bois-du-Lan 7  
1217 Meyrin 2 Geneva  
Tel: (022) 41 54 00  
Cable: HEWPACKSA Geneva  
Telex: 2 24 86

**TURKEY**  
Telekom Engineering Bureau  
P.O. Box 376 - Galata  
Karakoy  
Istanbul  
Tel: 49 40 40  
Cable: TELEMATION Istanbul

**UNITED KINGDOM**  
Hewlett-Packard Ltd.  
224 Bath Road  
Slough, Bucks  
Tel: Slough 33341  
Cable: HEWPIE Slough  
Telex: 84413

Hewlett-Packard Ltd.  
The Graftons  
Stamford New Road  
Altrincham, Cheshire  
Tel: 061 928-8626  
Telex: 668068

**USSR**  
Please Contact  
Hewlett-Packard S.A.  
Rue du Bois-du-Lan 7  
1217 Meyrin 2 Geneva  
Tel: (022) 41 54 00  
Cable: HEWPACKSA Geneva  
Switzerland  
Telex: 2.24.86

**YUGOSLAVIA**  
Belram S.A.  
83 avenue des Mimosas  
Brussels 1150, Belgium  
Tel: 34 33 32, 34 26 19  
Cable: BELRAMEL Brussels  
Telex: 21790

**FOR AREAS NOT LISTED, CONTACT:**  
Hewlett-Packard S.A.  
Rue du Bois-du-Lan 7  
1217 Meyrin 2 Geneva  
Switzerland  
Tel: (022) 41 54 00  
Cable: HEWPACKSA Geneva  
Telex: 2.24.86

## AFRICA, ASIA, AUSTRALIA

**ANGOLA**  
Telectra Empresa Técnica  
de Equipamentos Eléctricos  
SAR  
Rua de Barbosa Rodrigues  
42-1°  
Box 6487  
Luanda  
Cable: TELETRA Luanda

**AUSTRALIA**  
Hewlett-Packard Australia  
Pty. Ltd.  
22-26 Weir Street  
Glen Iris, 3146  
Victoria  
Tel: 20.1371 (6 lines)  
Cable: HEWPARD Melbourne  
Telex: 31024

Hewlett-Packard Australia  
Pty. Ltd.  
61 Alexander Street  
Crows Nest 2065  
New South Wales  
Tel: 43.7866  
Cable: HEWPARD Sydney  
Telex: 21561

Hewlett-Packard Australia  
Pty. Ltd.  
97 Churchill Road  
Prospect 5082  
South Australia  
Tel: 65.2366  
Cable: HEWPARD Adelaide

Hewlett Packard Australia  
Pty. Ltd.  
2nd Floor, Suite 13  
Casablanca Buildings  
196 Adelaide Terrace  
Perth, W.A. 6000  
Tel: 21-3330  
Cable: HEWPARD Perth

Hewlett-Packard Australia  
Pty. Ltd.  
10 Woolley Street  
P.O. Box 191  
Dickson A.C.T. 2602  
Tel: 49-8194  
Cable: HEWPARD Canberra ACT

**CEYLON**  
United Electricals Ltd.  
P.O. Box 681  
Yahala Building  
Staples Street  
Colombo 2  
Tel: 5496  
Cable: HOTPOINT Colombo

**CYPRUS**  
Kyrnicos  
19 Gregorios & Xenopoulos Road  
P.O. Box 1152  
Nicosia  
Tel: 6282-75628  
Cable: HE-I-NAMI

**ETHIOPIA**  
African Salespower & Agency  
Private Ltd., Co.  
P.O. Box 718  
58/59 Cunningham St.  
Addis Ababa  
Tel: 12285  
Cable: ASACO Addisababa

**HONG KONG**  
Schmidt & Co. (Hong Kong) Ltd.  
P.O. Box 297  
1511, Prince's Building 15th Floor  
10, Chater Road  
Hong Kong  
Tel: 240168, 232735  
Cable: SCHMIDTCO Hong Kong

**INDIA**  
Blue Star Ltd.  
Kasturi Buildings  
Jamshedji Tata Rd.  
Bombay 20BR, India  
Tel: 29 50 21  
Telex: 2396  
Cable: BLUEFROST

Blue Star Ltd.  
Band Box House  
Prabhadevi  
Bombay 25DD, India  
Tel: 45 73 01  
Telex: 2396  
Cable: BLUESTAR

Blue Star Ltd.  
14/40 Civil Lines  
Kanpur, India  
Tel: 6 88 82  
Cable: BLUESTAR

Blue Star, Ltd.  
7 Hare Street  
P.O. Box 506  
Calcutta 1, India  
Tel: 23-0131  
Telex: 655  
Cable: BLUESTAR

Blue Star Ltd.  
34 Ring Road  
Lajpat Nagar  
New Delhi 24, India  
Tel: 62 32 76  
Telex: 463  
Cable: BLUESTAR

Blue Star, Ltd.  
96 Park Lane  
Secunderabad 3, India  
Tel: 7 63 91  
Cable: BLUEFROST

Blue Star, Ltd.  
23/24 Second Line Beach  
Madras 1, India  
Tel: 2 39 55  
Telex: 379  
Cable: BLUESTAR

Blue Star, Ltd.  
18 Kaiser Bungalow  
Dindli Road  
Jamshedpur, India  
Tel: 38 04  
Cable: BLUESTAR

**INDONESIA**  
Bah Bohn Trading Coy. N.V.  
Djaloh Merdeka 29  
Bandung  
Tel: 4915 51560  
Cable: ILMU  
Telex: 809

**IRAN**  
Telecom, Ltd.  
P. O. Box 1812  
240 Kh. Saba Shomali  
Teheran  
Tel: 43850, 48111  
Cable: BASCOM Teheran

**ISRAEL**  
Electronics & Engineering  
Div. of Motorola Israel Ltd.  
17 Aminadav Street  
Tel-Aviv  
Tel: 36941 (3 lines)  
Cable: BASTEL Tel-Aviv  
Telex: Bastel TV 033-569

**JAPAN**  
Yokogawa-Hewlett-Packard Ltd.  
Nisei Ibaragi Bldg.  
2-8 Kasuga  
Ibaragi-Shi  
Osaka  
Tel: 23-1641

Yokogawa-Hewlett-Packard Ltd.  
Ito Building  
No. 59, Kotori-cho  
Nakamura-ku, Nagoya City  
Tel: 551-0215

Yokogawa-Hewlett-Packard Ltd.  
Nitto Bldg.  
2300 Shinohara-cho,  
Kohoku-ku  
Yokohama 222  
Tel: (405) 432-1504/5

Yokogawa-Hewlett-Packard Ltd.  
Ohashi Building  
59 Yoyogi 1-chrome  
Shibuya-ku, Tokyo  
Tel: 03-370-2281-7  
Telex: 232-2024YHP  
Cable: YHPMARKET TOK 23-724

**KENYA**  
R. J. Tilbury Ltd.  
P. O. Box 2754  
Suite 517/518  
Hotel Ambassadeur  
Nairobi  
Tel: 25670, 68206, 58196  
Cable: ARJAYTEE Nairobi

**KOREA**  
American Trading Co., Korea, Ltd.  
P.O. Box 1103  
7th & 8th Floors  
Dae Kyung Bldg.  
107 Sejong Ro  
Chongro Ku  
Seoul  
Tel: 75-5841 (4 lines)  
Cable: AMTRACO Seoul

**LEBANON**  
Constantin E. Macridis  
Clemenceau Street  
P.O. Box 7213  
Beirut  
Tel: 220846  
Cable: ELECTRONUCLEAR Beirut

**MALAYSIA**  
MECOMB Malaysia Ltd.  
2 Lorong 13/6A  
Section 13  
Petaling Jaya, Selangor  
Cable: MECOMB Kuala Lumpur

**MOZAMBIQUE**  
A. N. Goncalves, LDA.  
4.1 Apt. 14 Av. D. Luis  
P.O. Box 107  
Lourenco Marques  
Cable: NEGON

**NEW ZEALAND**  
Hewlett-Packard (N.Z.) Ltd.  
32-34 Kent Terrace  
P.O. Box 9443  
Wellington, N.Z.  
Tel: 56-559  
Cable: HEWPACK Wellington

Hewlett Packard (N.Z.) Ltd.  
Pukuranga  
Tel: 573-733

**PAKISTAN (EAST)**  
Mushko & Company, Ltd.  
Zirat Chambers  
31, Jinnah Avenue  
Dacca  
Tel: 280058  
Cable: NEWDEAL Dacca

**PAKISTAN (WEST)**  
Mushko & Company, Ltd.  
Oosman Chambers  
Victoria Road  
Karachi 3  
Tel: 511027, 512927  
Cable: COOPERATOR Karachi

**PHILIPPINES**  
Electromex Inc.  
Makati Commercial Center  
2129 Pasong Tamo  
Makati, Rizal D 708  
P.O. Box 1028  
Manila  
Tel: 89-85-01  
Cable: ELEMEX Manila

**SINGAPORE**  
Mechanical and Combustion  
Engineering Company Ltd.  
9, Jalan Kilang  
Red Hill Industrial Estate  
Singapore, 3  
Tel: 642361-3  
Cable: MECOMB Singapore

**SOUTH AFRICA**  
Hewlett Packard South Africa  
(Pty.), Ltd.  
Breecastle House  
Bree Street  
Cape Town  
Tel: 3-6019, 3-6545  
Cable: HEWPACK Cape Town  
Telex: 5-0006

Hewlett Packard South Africa  
(Pty.), Ltd.  
P.O. Box 31716  
Braamfontein Transvaal  
Milnerton  
30 De Beer Street  
Johannesburg  
Tel: 724-4172 724-4195  
Telex: 0226 JH  
Cable: HEWPACK Johannesburg

Hewlett Packard South Africa  
(Pty.), Ltd.  
30B Glenwood Centre  
Corner Hunt & Moore Roads  
Durban  
P.O. Box 99  
Overport, Natal  
Tel: 347536

**TAIWAN REP. OF CHINA**  
Hwa Sheng Electronic Co., Ltd.  
P. O. Box 1558  
Room 404  
Chia Hsin Building  
No. 96 Chung Shan  
North Road, Sec. 2  
Taipei  
Tel: 555211 Ext. 532-539  
Cable: VICTRONIX Taipei

**TANZANIA**  
R. J. Tilbury Ltd.  
P.O. Box 2754  
Suite 517/518  
Hotel Ambassadeur  
Nairobi  
Tel: 25670, 68203, 68206, 58196  
Cable: ARJAYTEE Nairobi

**THAILAND**  
The International  
Engineering Co., Ltd.  
P. O. Box 39  
614 Sukhumvit Road  
Bangkok  
Tel: 910722 (7 lines)  
Cable: GYSOM  
TLX INTENCO BK-226 Bangkok

**UGANDA**  
R. J. Tilbury Ltd.  
P.O. Box 2754  
Suite 517/518  
Hotel Ambassadeur  
Nairobi  
Tel: 25670, 68203, 68206, 58196  
Cable: ARJAYTEE Nairobi

**VIETNAM**  
PENINSULAR Trading Inc.  
P.O. Box H-3  
216 Hien-Vuong  
Saigon  
Tel: 20.805  
Cable: PENINSULA Saigon

**ZAMBIA**  
R. J. Tilbury (Zambia) Ltd.  
P.O. Box 2792  
Lusaka  
Zambia, Central Africa

**FOR AREAS NOT LISTED, CONTACT:**  
Hewlett-Packard  
INTERCONTINENTAL  
3200 Hillview Ave.  
Palo Alto, California 94304  
Tel: (415) 326-7000  
TWX: 910-373-1267  
Cable: HEWPACK Palo Alto  
Telex: 034-8661

# hp MANUAL CHANGES

MODEL 11153A

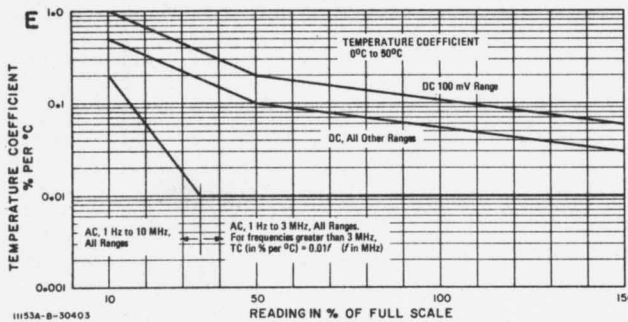
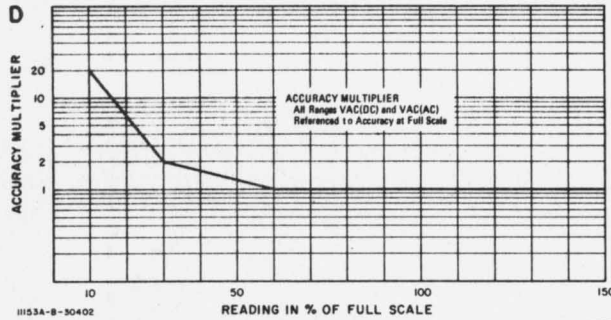
TRUE RMS CONVERTER

Manual Part No. 11153-90000

► New or Revised Item

## ERRATA

Page 1-2. Replace graphs D and E with the following.



Page 2-2. Paragraph 2-3 Step p, change Part No. 5060-5952 to 0370-0982 and change 5060-5954 to 0370-0984.

► Page 4-1. Paragraph 4-4, change Figure 7-1 to 7-2. Paragraph 4-5, change gaving to having.

Page 5-2. Change Max. Display Error on third line for VAC(DC), 1000 mV Range, 100 mV Test Signal Voltage from 15 counts to 20 counts.

Performance Check Card. Change test limits on third line to 98.0 mV to 102.0 mV.

Table 6-1. C12, C13 delete asterisks and add -hp- Part No. 0160-3580 C: fxd cer 56 pF 10% 500 vdcw.

C30 change -hp- Part No. to 0160-3687.

Under C52, change Part No. of Cover: Adj, D to 11153-05510.

Q7 change -hp- Part No. to 1853-0010.

Q35 change -hp- Part No. to 1853-0010.

R16, R17 (add R17) add -hp- Part No. 0757-0384 R: fxd flm 20 ohms 1% 1/8 W.

Change -hp- Part No. of IC Socket: 8 pin to 1200-0437.

Change -hp- Part No. of Cover: Input, B to 11153-05511.

Change -hp- Part No. of Cover: Adj, D to 11153-05510.

Change -hp- Part No. of Knob Assy: Function (for instruments with VDC and VAC functions) to 0370-0982.

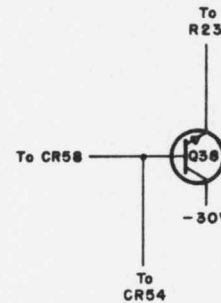
Change -hp- Part No. of Knob Assy: Function (for instruments with VDC, VAC, and Ohms functions) to 0370-0984.

► Change Q26 to TSTR: Si P channel.

CHANGE 1: FOR 11153A SERIAL NO. (scribed on 11153A printed circuit board) 1043A00151 AND ABOVE.

- Table 6-1. Add CR72 -hp- Part No. 1901-0040 Diode: Si Add Q27 -hp- Part No. 1853-0292 TSTR: Si PNP. Add Q38 -hp- Part No. 1854-0071 TSTR: Si NPN 2N3391. R23 change to -hp- Part No. 0757-0427 1.50 kilohms R24 change to -hp- Part No. 0698-3497 6.04 kilohms.
- Add R67 -hp- Part No. 0698-4462 R: fxd flm 768 ohms 1% 1/8 W. R118 change to -hp- Part No. 0698-4390 66.5 ohms. R119 change to -hp- Part No. 0698-4427 1.65 kilohms. R120 change to -hp- Part No. 0757-0433 3.32 kilohms. R121 change to -hp- Part No. 0698-3484 6.65 kilohms. R122 change to -hp- Part No. 0698-4425 1.54 kilohms. R124 change to -hp- Part No. 0698-3449 28.7 kilohms. R125 change to -hp- Part No. 0698-3495 866 ohms. R126 change to -hp- Part No. 0757-0414 432 ohms. R127 change to -hp- Part No. 0698-3441 215 ohms. R128 change to Not assigned. R129 change to -hp- Part No. 2100-2968 500 ohms.
- CR68 thru CR71 change to "CR68 thru 73".

Page 7-3. Add Q38 to Attenuator Amplifier as shown:

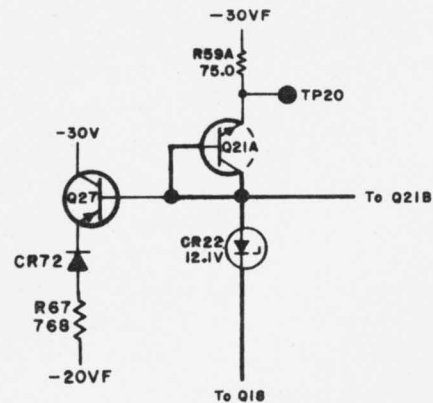


R23 change to 1.50K.

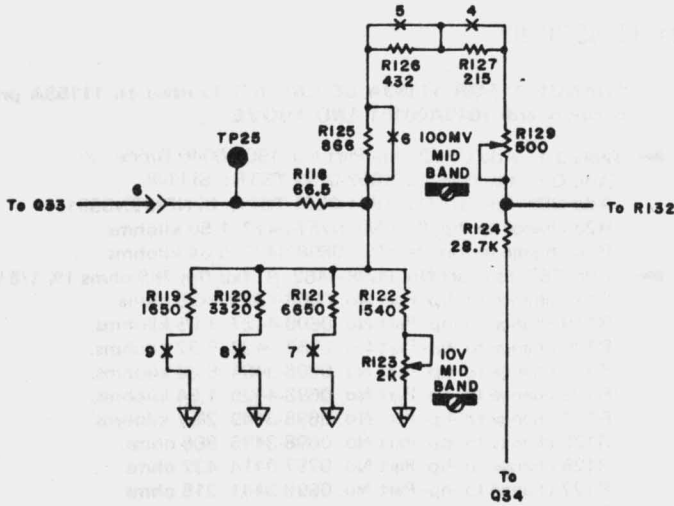
R24 change to 6.04K.

R19 change connection at lower end to ground  $\nabla$  instead of -20 V<sub>F</sub>.

Page 7-5. Add Q27 circuit to Post Amplifier as shown:



► Change Output Attenuator as shown:





# hp MANUAL CHANGES

MODEL 11153A

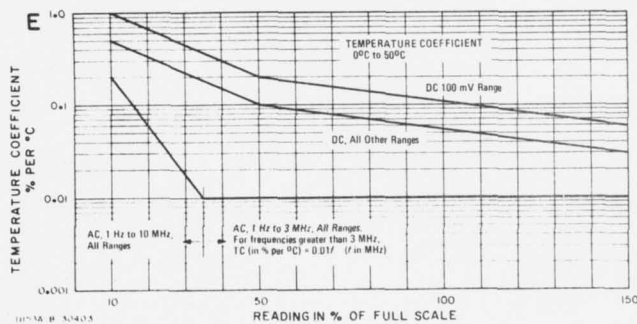
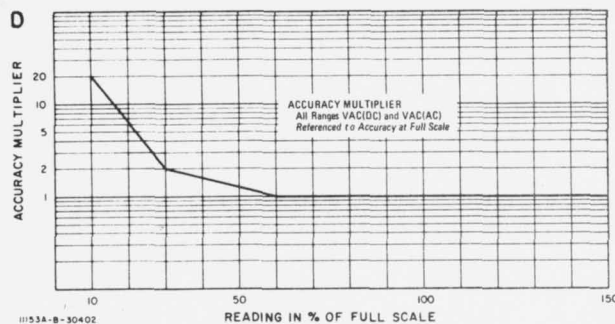
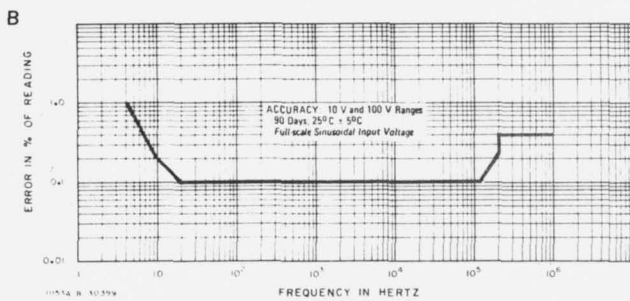
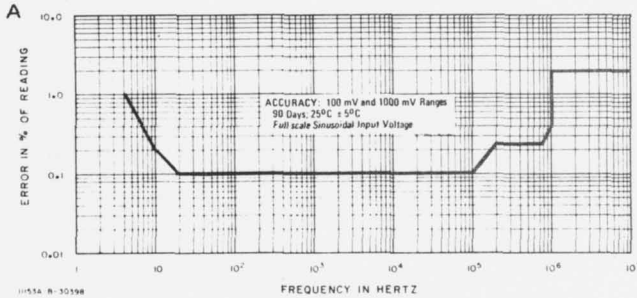
TRUE RMS CONVERTER

Manual Part No. 11153-90000

► New or Revised Item

## ERRATA

Page 1-2. Replace graphs with the following.



Page 2-2. Paragraph 2-3 Step p, change Part No. 5060-5952 to 0370-0982 and change 5060-5954 to 0370-0984.

Page 4-1. Paragraph 4-4, change Figure 7-1 to 7-2. Paragraph 4-5, change gaving to having.

Page 5-2. Change Max. Display Error on third line for VAC(DC), 1000 mV Range, 100 mV Test Signal Voltage from 15 counts to 20 counts.

► Page 5-4, Paragraph 5-12f. Change to: Adjust A7R27 1000 MV HIGH FREQ. for maximum 3480A/B reading within the range of 990 to 1000 mV. Paragraph 5-12i. Adjust A7R25 10 V HIGH FREQ. until the 3480A/B reads  $10.020 \pm 3$  counts or until the clockwise end of A7R25 is reached, producing a reading of between 10.007 and 10.023 V. Either condition is acceptable.

Performance Check Card. Change test limits on third line to 98.0 mV to 102.0 mV.

Table 6-1. C30 change -hp- Part No. to 0160-3687.

Under C52, change Part No. of Cover: Adj, D to 11153-05510.

Q7 change -hp- Part No. to 1853-0010.

Q35 change -hp- Part No. to 1853-0010.

R16, R17 (add R17) add -hp- Part No. 0757-0384 R: fxd flm 20 ohms 1% 1/8 W.

Change -hp- Part No. of IC Socket: 8 pin to 1200-0437.

Change -hp- Part No. of Cover: Input, B to 11153-05511.

Change -hp- Part No. of Cover: Adj, D to 11153-05510.

Change -hp- Part No. of Knob Assy: Function (for instruments with VDC and VAC functions) to 0370-0982.

Change -hp- Part No. of Knob Assy: Function (for instruments with VDC, VAC, and Ohms functions) to 0370-0984.

Change Q26 to TSTR: Si P channel.

Page 7-3 Change C16 to C16\*

**CHANGE 1: FOR 11153A SERIAL NO. (scribed on 11153A printed circuit board) 1043A00151 AND ABOVE.**

Table 6-1. Add CR72 - hp- Part No. 1901-0040 Diode: Si

Add Q27 -hp- Part No. 1853-0292 TSTR: Si PNP.

Add Q38 -hp- Part No. 1854-0071 TSTR: Si NPN 2N3391.

R23 change to -hp- Part No. 0757-0427 1.50 kilohms

R24 change to -hp- Part No. 0698-3497 6.04 kilohms.

Add R67 -hp- Part No. 0698-4462 R: fxd flm 768 ohms 1% 1/8 W.

R118 change to -hp- Part No. 0698-4390 66.5 ohms.

R119 change to -hp- Part No. 0698-4427 1.65 kilohms.

R120 change to -hp- Part No. 0757-0433 3.32 kilohms.

R121 change to -hp- Part No. 0698-3484 6.65 kilohms.

R122 change to -hp- Part No. 0698-4425 1.54 kilohms.

R124 change to -hp- Part No. 0698-3449 28.7 kilohms.

R125 change to -hp- Part No. 0698-3495 866 ohms.

R126 change to -hp- Part No. 0757-0414 432 ohms.

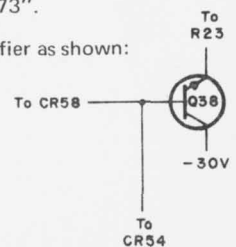
R127 change to -hp- Part No. 0698-3441 215 ohms.

R128 change to Not assigned.

R129 change to -hp- Part No. 2100-2968 500 ohms.

CR68 thru CR71 change to "CR68 thru 73".

Page 7-3. Add Q38 to Attenuator Amplifier as shown:



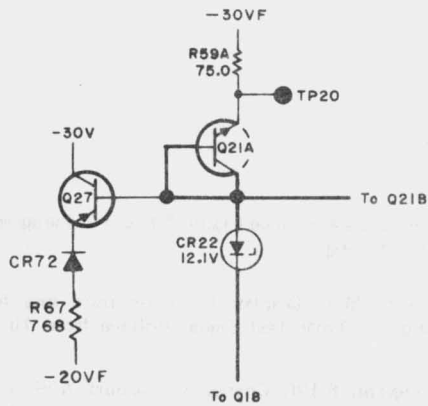
R23 change to 1.50K.

R24 change to 6.04K.

R19 change connection at lower end

to ground  $\nabla$  instead of -20 VF.

Page 7-5. Add Q27 circuit to Post Amplifier as shown:



Change Output Attenuator as shown:

