

P 48.9



OPERATING AND SERVICE MANUAL

(HP PART NO. 00465-90002)

MODEL 465A
AMPLIFIER

SERIALS PREFIXED: 530-

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TABLE OF CONTENTS

<p>Section I GENERAL DESCRIPTION 1-1 1-1. Description 1-1 1-5. Instrument Identification 1-1</p> <p>Section II INSTALLATION 2-1 2-1. Introduction 2-1 2-3. Initial Inspection 2-1 2-5. Power Requirements 2-1 2-7. Grounding Requirements 2-1 2-10. Installation 2-1 2-12. Rack Mounting 2-1 2-14. Combination Mounting 2-1 2-16. Repackaging For Shipment 2-1</p> <p>Section III OPERATING INSTRUCTIONS 3-1 3-1. General 3-1 3-4. Description of Controls 3-1</p> <p>Section IV THEORY OF OPERATION 4-1 4-1. Introduction 4-1 4-3. General Circuit Description 4-1 4-5. Detailed Circuit Description 4-1 4-7. First Amplification Stage 4-1 4-9. Second Amplification Stage 4-1 4-11. Output Circuitry 4-1 4-13. Feedback Circuitry 4-1 4-15. Regulated Power Supply 4-1</p>	<p>Section V MAINTENANCE 5-1 5-1. Introduction 5-1 5-3. Test Equipment Required 5-1 5-5. Performance Checks 5-1 5-7. Accuracy and Gain Check 5-1 5-8. Frequency Response Check 5-1 5-9. Input Impedance Check 5-2 5-10. Output Impedance Check 5-2 5-11. Distortion Check 5-2 5-12. Noise Check 5-4 5-13. Adjustment and Calibration Procedures 5-4 5-15. +45 V Adjustment (R32) 5-4 5-16. Bias Adjustment (R15) 5-4 5-17. 1 kHz Gain Adjust (R3* and R38*) 5-4 5-18. 1 MHz Adjust (C5) 5-4 5-19. Servicing Etched Circuit Board 5-4 5-22. Troubleshooting Technique 5-5</p> <p>Section VI REPLACEABLE PARTS 6-1 6-1. Introduction 6-1 6-4. Ordering Information 6-1 6-6. Non-Listed Parts 6-1</p> <p>APPENDIX A CODE LIST OF MANUFACTURERS B SALES AND SERVICE OFFICES C BACKDATING CHANGES</p>
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LIST OF TABLES

<p>Number Page 1-1. Specifications 1-0 5-1. Test Equipment Required 5-0 5-2. Frequency Response Test 5-2</p>	<p>Number Page 5-3. Distortion Check 5-3 5-4. Troubleshooting 5-5 6-1. Replaceable Parts 6-2</p>
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LIST OF ILLUSTRATIONS

<p>Number Page 1-1. Hewlett-Packard Model 465A Amplifier 1-0 3-1. Front and Rear Panel Controls, Indicators and Connectors 3-0 4-1. Model 465A Amplifier Block Diagram 4-0 5-1. Frequency Response Check 5-1</p>	<p>Number Page 5-2. Distortion Check 5-3 5-3. Shielded Load for Residual Noise Check 5-3 5-4. Top View 5-6 5-5. Amplifier Schematic 5-7/5-8</p>
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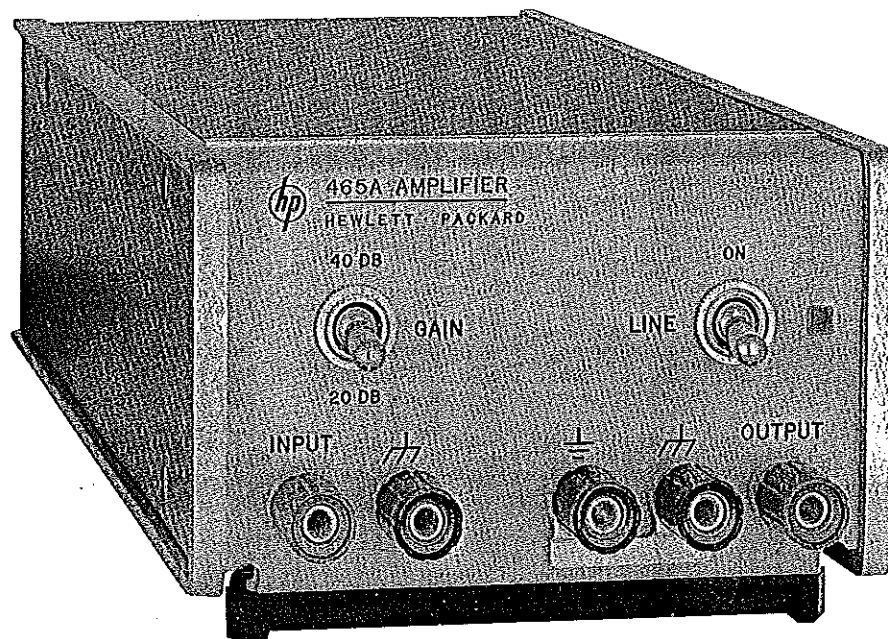


Figure 1-1. Hewlett-Packard Model 465A Amplifier

Table 1-1. Specifications

Voltage Gain: 20 dB (X10) or 40 dB (X100), open circuit.	Output Impedance: 50 ohms.
Gain Accuracy: ± 0.1 dB ($\pm 1\%$) at 1000 Hz.	Noise: $< 25 \mu\text{V}$ rms referred to input (with 1 M Ω source resistance).
Frequency Response: ± 0.1 dB, 100 Hz to 50 kHz < 2 dB down at 5 Hz and 1 MHz.	Temperature Range: 0 to 50°C.
Output: > 10 volts rms open circuit; > 5 volts rms into 50 ohms (1/2 W).	Power: 115 or 230 V $\pm 10\%$, 50 to 400 Hz, 10 watts at full load.
Distortion: < 1%, 10 Hz to 100 kHz, < 2%, 5 Hz to 10 Hz and 100 kHz to 1 MHz.	Weight: Net: 4 lbs. (1,8 kg) Shipping: 6 lbs. (2,7 kg.)
Input Impedance: 10 M Ω shunted by < 20 pF.	Dimensions: 1/3 module, 5-1/8" wide, 3-14/32" high, 11" deep (130 x 87 x 279 min.).

SECTION I GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 465A Amplifier is a general purpose amplifier and impedance converter (10 megohms to 50 ohms). This amplifier has selectable gain of 20 dB or 40 dB stable over a continuous frequency range of 5 Hz to 1 MHz.

1-3. The Model 465A Amplifier provides three-terminal input and output operation for isolation from the chassis. The input and output may be used in floating operation to ± 500 V DC with respect to chassis ground.

1-4. The solid state, low noise design of the 465A allows operation over a wide voltage range for appli-

cation as both a preamplifier and amplifier. The compact, solid state construction allows operation in a variety of environments.

1-5. IDENTIFICATION.

1-6. Hewlett-Packard uses a two-section, eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 465A described in this manual

1-7. If a letter prefixes the serial number, the instrument was manufactured outside the United States.

SECTION II INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 465A Amplifier. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and be in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument, using the procedure outlined in Paragraph 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 465A Amplifier can be operated from any source of 115 or 230 volts ($\pm 10\%$), 50-1000 Hz. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until desired line voltage appears. Power dissipation is 10 watts maximum.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-pronged conductor cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

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

2-10. INSTALLATION.

2-11. The Model 465A is fully transistorized. No special cooling is required; however, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F). The Model 465A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-12. RACK MOUNTING.

2-13. The Model 465A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The

adapter frame can be rack mounted only and accepts any combination of submodular units.

2-14. COMBINATION MOUNTING.

2-15. Combination mounting for the Model 465A may be done by using a Combining Case -hp- Model 1051A or 1052A depending on depth. The Combining Case is a full-module unit which accepts a combination of submodular units.

2-16. REPACKAGING FOR SHIPMENT.

2-17. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-18 if the original container is to be used; 2-19 if it is not. If you have any questions, contact your local -hp- Sales and Service Office.

NOTE

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

2-18. If original container is to be used, proceed as follows:

- a. Place instrument in original container with appropriate packing material if available. A container and packing material can be purchased from your nearest -hp- Sales and Service Office.
- b. Ensure that the container is well sealed with strong tape or metal bands.

2-19. If original container is not to be used, proceed as follows:

- a. Wrap instrument in heavy paper or plastic before placing in an inner container.
- b. Place packing material around all sides of instrument and protect panel face with cardboard strips.
- c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.
- d. Mark shipping container with "DELICATE INSTRUMENT", "FRAGILE" etc.

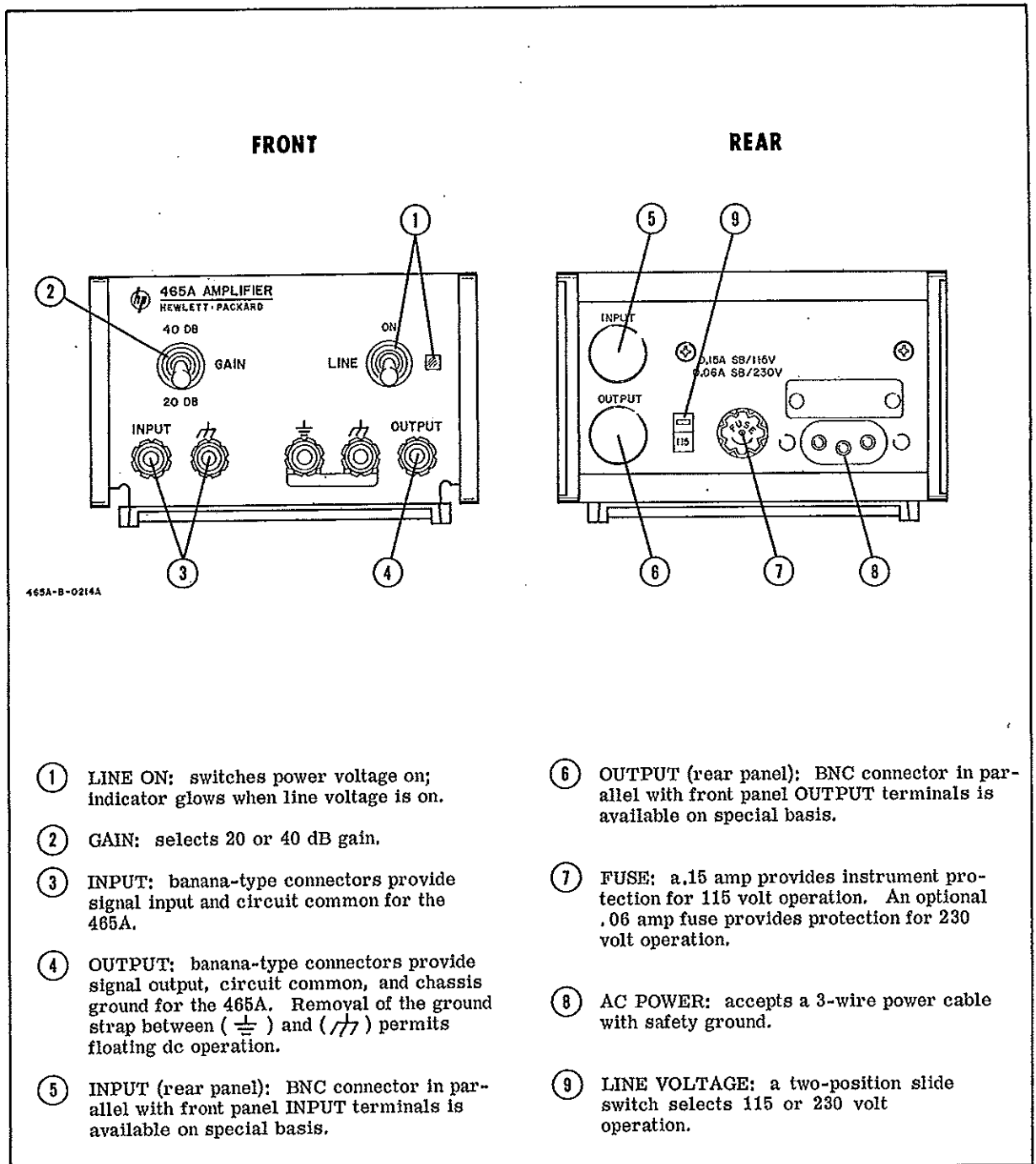


Figure 3-1. Front and Rear Panel Controls, Indicators and Connectors

SECTION III OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The Model 465A operation is accomplished by applying the signal to be amplified to the INPUT connectors. An input impedance of $10\text{ M}\Omega$ shunted by $< 20\text{ pF}$ minimizes circuit loading. A maximum input signal of 100 mV rms can be applied for 40 dB (X100) GAIN and 1.0 V rms can be applied for 20 dB (X10) GAIN. The required gain (20 dB or 40 dB) is selected by the front panel GAIN switch.

CAUTION

ENSURE THAT TRANSIENTS GREATER THAN $\pm 200\text{ VDC}$ OR $\pm 25\text{ VDC}$ ARE NOT APPLIED TO THE INPUT OR OUTPUT TERMINALS, RESPECTIVELY. OTHERWISE DAMAGE TO THE MODEL 465A MAY RESULT.

3-3. A maximum output of 10 V rms can be obtained across the OUTPUT connectors which have 50 ohm impedance. Floating operation to $\pm 500\text{ Vdc}$ can be done by removing the strap between circuit common and chassis ground.

3-4. DESCRIPTION OF CONTROLS.

3-5. Figure 3-1 describes the front and rear panel controls for the 465A.

CAUTION

ENSURE THAT COMMON (///) TERMINALS ARE CONNECTED BEFORE INPUT OR OUTPUT TERMINALS. OTHERWISE DAMAGE TO THE MODEL 465A MAY RESULT DUE TO TRANSIENTS.

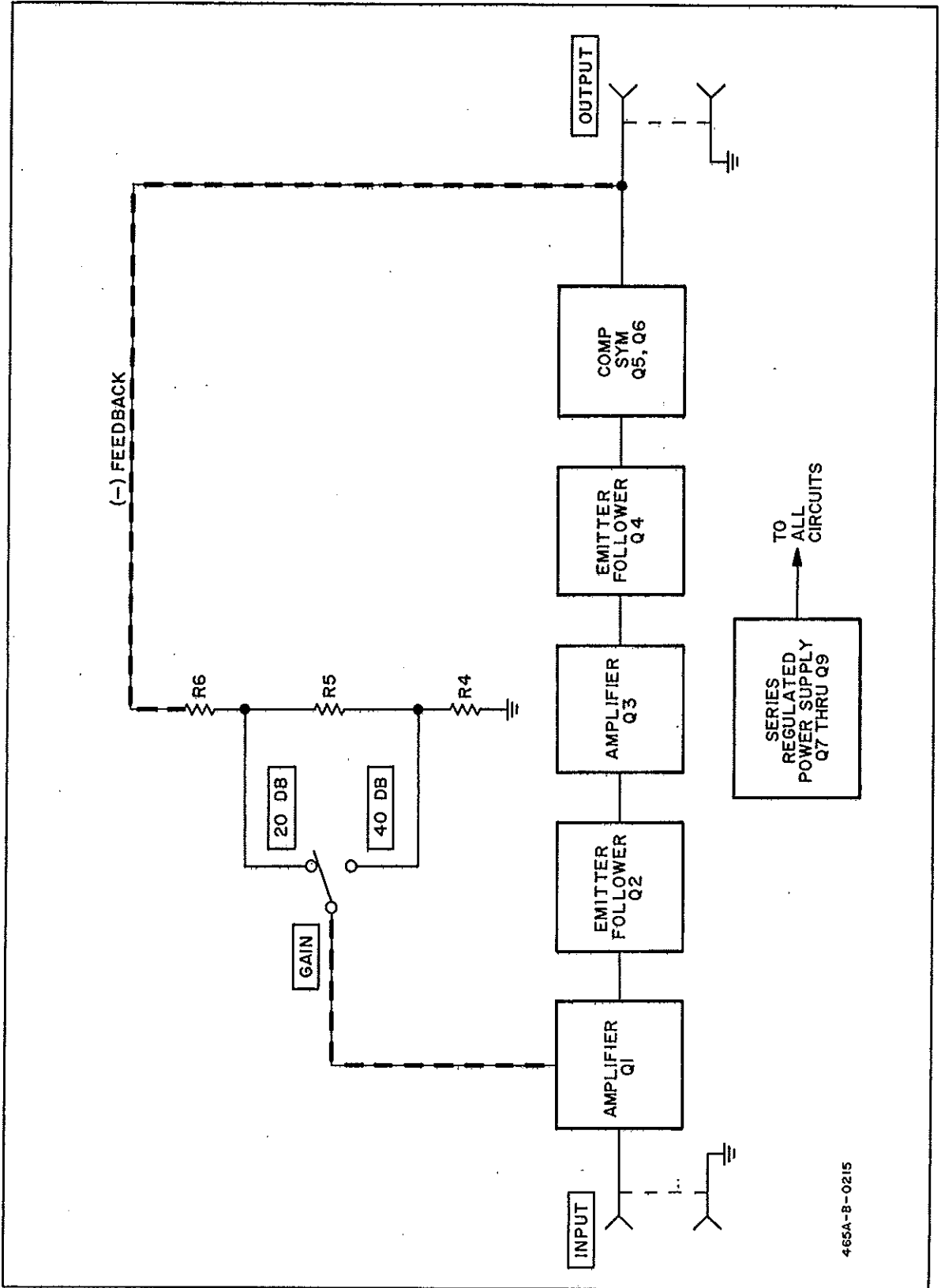


Figure 4-1. Model 465A Amplifier Block Diagram

465A-8-0215

SECTION IV THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The -hp- Model 465A Amplifier comprises an amplifier section and a power supply section. The amplifier section contains two amplifier stages, two emitter followers and a complementary symmetry pair. The power supply is the series regulated type.

4-3. GENERAL CIRCUIT DESCRIPTION.

4-4. Figure 4-1 shows the block diagram for the 465A Amplifier. Each amplifier stage (Q1 and Q3) is followed by an emitter follower (Q2 and Q4) to prevent loading of the amplifiers. The complementary symmetry pair (Q5 and Q6) provide power gain and low output impedance. Overall feedback, taken from the output and applied differentially to the initial amplification stage, decreases distortion and increases gain accuracy. Resistive voltage divider (R4, R5, and R6) changes the amount of feedback to obtain 20 or 40 dB gain as selected by the GAIN switch on the front panel. The regulated power supply provides a constant 45 volts to all amplifier circuits.

4-5. DETAILED CIRCUIT DESCRIPTION.

4-6. Refer to Figure 5-5 for the schematic diagram of the Model 465A Amplifier.

4-7. FIRST AMPLIFICATION STAGE.

4-8. The first amplification stage comprises field effect transistor Q1 and emitter follower Q2. Q1 provides high input impedance and low input noise. Emitter follower Q2 provides isolation while driving the second amplification stage. Q2 also bootstraps Q1 load resistor R10. This permits the field effect transistor to have a gain of approximately 40 dB while operating at an optimum current (for noise) from a 45 volt power supply. C6 and R12 stabilize the overall gain. R13 and C9 allow Q2 to operate as an emitter follower with reduced operating voltage to lower the power dissipation and the noise generation. R2 and R7 set the gate voltage for Q1; C2 bypasses any ac on the supply, preventing hum injection into Q1.

4-9. SECOND AMPLIFICATION STAGE.

4-10. The second amplification stage consists of amplifier Q3 and emitter follower Q4. Amplifier Q3 is a common emitter stage. When the GAIN switch is on 20 DB, Q3 has 20dB of gain. Q1 and Q3 together give a total of 60 dB gain, of which 40dB is used as feedback and 20dB is retained as the closed loop gain. When the GAIN switch is on 40 DB, C11 shunts R22, giving Q3 40dB of gain. The 40dB of feedback is still used, which allows the same gain shaping to be

used in both GAIN switch positions (20 DB and 40 DB). R19 maintains a charge on C11 (in the 20 DB position) to eliminate switching transients while changing gain. R15, R16, R17 and CR1 form the bias voltage divider for Q3, R15 provides bias adjustment and CR1 provides temperature compensation. Emitter follower Q4 isolates and drives the complementary symmetry pair Q5 and Q6.

4-11. OUTPUT CIRCUITRY.

4-12. Q5 and Q6 operate as complementary symmetry emitter followers. CR2 and CR3 forward bias Q5 and Q6 to prevent cross-over distortion. R24 and R25 determine the idling current flowing through Q5 and Q6. A true 50-ohm output impedance for a proper match to the 50-ohm cable or instrument is provided by R26. C15 is the dc blocking capacitor for output. R27 keeps the output voltage at zero volts dc.

4-13. FEEDBACK CIRCUITRY.

4-14. The feedback circuitry controls the amplifier gain by selecting the amount of voltage division by voltage divider R4, R5 and R6. C5 provides phase lead to improve the phase margin around 1MHz. C4 and C14 eliminate transients during GAIN switching by preventing dc voltages from being applied to the divider stick. Negative feedback is applied to field effect transistor Q1 and differentially compared with the input, which provides improved signal reproduction.

4-15. REGULATED POWER SUPPLY.

4-16. The regulated power supply provides the +45 volts used by the amplifier. A filter circuit, formed by L1, L2, C22 and C23 prevents any interference from being fed into the instrument power line. T1, CR4, CR5 and C16 form a full-wave rectifier. Diode CR6 sets a reference voltage for the emitter circuit of Q7. This reference voltage is compared to the power supply output by Q7, which amplifies the error signal to drive Q8. Transistor Q8, acting as a current amplifier, drives series regulator Q9. Q8 also improves the gain by isolating Q7. C19 and R35 provide gain shaping for high frequency stability of the power supply amplifier. C18 bootstraps R33 by driving it from the output of the regulator. This increases the voltage gain of Q7, which improves voltage regulation of the power supply. Resistors R30, R31 and R32 provide a divided dc voltage proportional to the dc output and close to the reference voltage provided by CR6. This gives Q7 its bias and reference signal, which controls the series regulator. C20 provides additional filtering for the +45 volt supply.

Table 5-1. Test Equipment Required

INSTRUMENT	CRITICAL SPECIFICATIONS	USE	RECOMMENDED MODEL
DC Voltmeter	Accuracy: $\pm 1\%$ Voltage Range: 50 V full scale	Calibration	-hp- Model 3440A/3445A Digital Voltmeter
AC Voltmeter	Accuracy: $\pm 0.1\%$ Frequency Range: 100 Hz - 50 kHz Accuracy: $\pm 2\%$ Frequency Range: 10 Hz - 1 MHz Voltage Range: 0.003 - 10 V	Performance Checks	-hp- Model 3440A/3445A Digital Voltmeter -hp- Model 331A Distortion Analyzer
Test Oscillator	Frequency Range: 10 Hz - 1 MHz Voltage Output: 1.0 V Frequency Response Accuracy: $\pm 0.25\%$	Performance Checks	-hp- Model 652A Test Oscillator
Oscillator	Frequency Range: 5 Hz - 600 kHz Voltage Output: 1.0 V at 0.5% Distortion	Performance Checks	-hp- Model 200 CD Oscillator
Distortion Analyzer	Frequency Range: 5 Hz - 600 kHz Sensitivity: 0.1% Distortion	Performance Checks	-hp- Model 331A Distortion Analyzer
Variable Voltage Line Transformer	Voltage Range: 103.5 - 126.5 V rms Output Power: 10 watt	Performance Checks	Superior Electric Company Type UC1MB
AC Differential Voltmeter	Accuracy: $\pm 0.2\%$ at 1 volt Range Frequency: 1 kHz	Calibration	-hp- Model 741B AC Δ Voltmeter
Oscilloscope	Frequency: 2 kHz Vertical Sensitivity: 10 mV/cm	Troubleshooting	-hp- Model 130C Oscilloscope
DC Power Supply	Voltage Output: + 45 V Current Limit: 75 mA	Troubleshooting	-hp- Model 6220B DC Power Supply
Ohmmeter	Ohms Range: 10 M Ω	Troubleshooting	-hp- Model 427A Multi-Function Meter
Resistor	50 Ω Feed Thru - Termination 1 M Ω , 1%, 1/2 W 50 Ω , 1%, 1/2 W 1 M Ω , Shielded Load	Performance Checks	-hp- 11048B -hp- Part No. 0757-0059 -hp- Part No. 0727-0023 See Figure 5-3

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for the proper maintenance of the -hp- Model 465A Amplifier. This section provides the necessary Performance Checks, Adjustment and Calibration Procedures, and Troubleshooting Techniques required to accomplish the above objective. Page 5-4a is included to record the results of the Performance Checks.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to perform the operations outlined in this section is listed in Table 5-1. This table describes the type of instrument required, critical specifications, type of operation to be conducted and the recommended model. If the specific model recommended is not available, equipment which meets or exceeds the critical specifications listed may be substituted.

5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks presented in this section are front panel procedures designed to compare the Model 465A with its published specifications. These operations may be incorporated in periodic maintenance, post-repair, or incoming quality control checks. These operations should be conducted before any attempt is made to adjust or calibrate the instrument. During these operations, the Model 465A power line voltage should be periodically varied $\pm 10\%$. A fifteen minute warm-up period should be allowed prior to conducting these checks.

5-7. ACCURACY AND GAIN CHECK.

- a. Figure 5-1 describes the recommended test arrangement. A Test Oscillator (-hp- Model 652A) and an AC Digital Voltmeter (-hp- Model 3440A/3445A) will be required for this check.
- b. Set oscillator frequency to 1 kHz and adjust amplitude for 1.00 V rms output. Verify with AC Voltmeter.
- c. Set Model 465A GAIN to 20 dB. The AC Voltmeter should read 10.0 ± 0.1 V at the 465A OUTPUT. If correct, adjust oscillator amplitude for a 1.0 V reading at the 465A OUTPUT.
- d. Switch the 465A GAIN to 40 dB. The AC Voltmeter should read 10.0 ± 0.1 V.
- e. If the 465A does not meet this check perform the adjustments described in Paragraph 5-17.

5-8. FREQUENCY RESPONSE CHECK.

- a. Figure 5-1 describes the recommended test arrangement. The -hp- 3440A/3445A operates only between 50 Hz and 100 kHz so an additional AC Voltmeter (-hp- Model 331A) is recommended for the 10 Hz and 1 MHz checks.

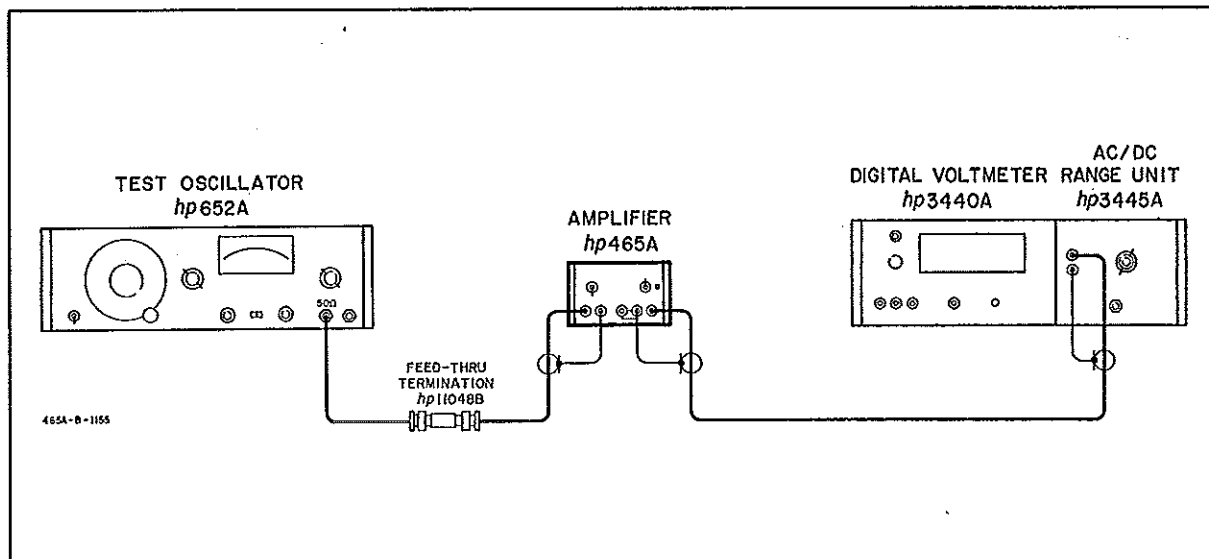


Figure 5-1. Frequency Response Check .

Table 5-2. Frequency Response Test

-hp- Model 465A Gain (dB)	Oscillator -hp- Model 652A		AC Voltmeter	
	Frequency (Hz)	Amplitude (volts)	-hp- Model	Reading (volts)
20	1K	1.0	3440A	9.0
20	10	1.0	331A	9.0 ± .9
20	100	1.0	3440A	9.0 ± .1
20	50K	1.0	3440A	9.0 ± .1
20	1M	1.0	331A	9.0 ± 1.8
40	1K	.1	3440A	9.0
40	10	.1	331A	9.0 ± .9
40	100	.1	3440A	9.0 ± .1
40	50K	.1	3440A	9.0 ± .1
40	1M	.1	331A	9.0 ± 1.8

- b. Set the 465A GAIN to 20 dB and adjust the oscillator to 1 kHz with the amplitude set for 9.0 volts at the 465A OUTPUT.
- c. Switch the oscillator to EXPAND function and set the meter to 0% with the REFERENCE controls.
- d. Change the oscillator frequency to 100 Hz and adjust the amplitude controls for 0% in the EXPAND function. The voltmeter should read 9.0 ± 0.1 V.
- e. Repeat step d for oscillator frequencies listed in Table 5-2. Use the -hp- 331A for the 10 Hz and 1 MHz checks.
- f. Reset oscillator frequency to 1 kHz and amplitude to 9.0 V when switching GAIN to 40 dB. Adjust reference to 0% with the REFERENCE controls. Repeat the above checks for the frequencies listed in Table 5-2.

5-9. INPUT IMPEDANCE CHECK.

- a. Use the test arrangement shown in Figure 5-1. Set the 465A GAIN to 20 dB.
- b. Set the oscillator frequency to 100 Hz and adjust the amplitude for 10 V at the 465A OUTPUT.
- c. Place a 1 M Ω resistor (-hp- Part No. 0757-0059) in series with the 465A INPUT and the oscillator. The OUTPUT should read 9.1 ± 0.4 V. This verifies an input impedance of 10 M Ω .
- d. Set oscillator frequency to 10 kHz and check oscillator output for 1.0 V amplitude. The 465A OUTPUT should read greater than 6.0 V. This verifies an input impedance of 10 M Ω shunted by < 20 pF.

5-10. OUTPUT IMPEDANCE CHECK.

- a. Use the test arrangement shown in Figure 5-1. Set the 465A GAIN to 20 dB.
- b. Set the oscillator frequency to 1 kHz and adjust the amplitude for 10.0 V at the 465A OUTPUT.
- c. Place a 50 ohm resistor (-hp- Part No. 0757-0023) across the 465A OUTPUT terminals. The AC voltmeter should read 5.0 ± 0.3 V. This verifies an output impedance of 50 ohms.

5-11. DISTORTION CHECK.

- a. Figure 5-2 describes the recommended test arrangement. Set the 465A GAIN to 20 dB.
- b. Set the oscillator frequency to 1 kHz and adjust the amplitude for 5 V with the Distortion analyzer in the VOLTMETER mode.
- c. Switch the distortion analyzer FUNCTION to SET LEVEL and adjust SENSITIVITY and VERNIER for full scale reading of 1.
- d. Change FUNCTION switch to DISTORTION and null the fundamental frequency with the BALANCE and FREQUENCY controls.
- e. Final null will indicate the distortion present. Table 5-3 states distortion < 1% at 1 kHz.
- f. Repeat the above test at the frequencies listed in Table 5-3. Adjust the oscillator amplitude to obtain a set level of 1 for each frequency setting. The distortion limits are listed in Table 5-3.
- g. Switch the 465A GAIN to 40 dB and adjust the oscillator amplitude for set level of 1. Repeat this test for the frequencies listed in Table 5-3.

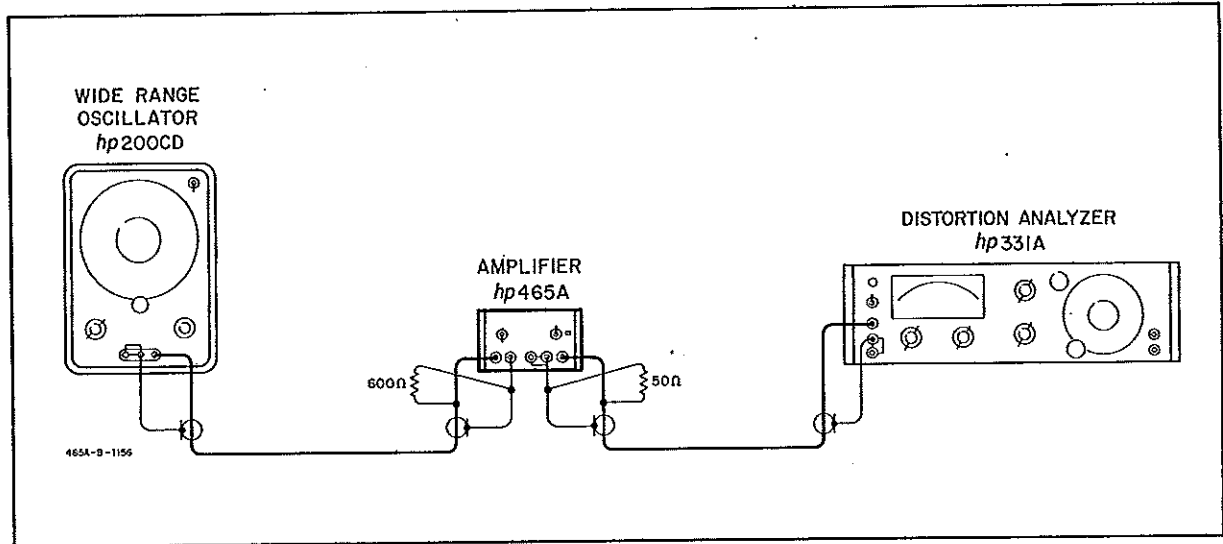


Figure 5-2. Distortion Check

5-12. NOISE CHECK.

- a. An AC Voltmeter (-hp- Model 331A) and a 1 MΩ shielded resistor (refer to Figure 5-3) will be required for this check.
- b. Set the 465A GAIN to 40 dB and the voltmeter RANGE to 0.003 V.
- c. Connect the 1 MΩ shielded resistor across the 465A INPUT. The voltmeter should read less than 2.5 mV (< 25 microvolts referred to the input).

Table 5-3. Distortion Check

465A Gain (dB)	Oscillator -hp- Model 200CD		-hp- Model 331A Distortion
	Frequency	Output	
20	5 Hz	1.0 V	<2%
20	10 Hz	1.0 V	<1%
20	1 kHz	1.0 V	<1%
20	100 kHz	1.0 V	<1%
20	600 kHz	1.0 V	<2%
40	5 Hz	0.1 V	<2%
40	10 Hz	0.1 V	<1%
40	1 kHz	0.1 V	<1%
40	100 kHz	0.1 V	<1%
40	600 kHz	0.1 V	<2%

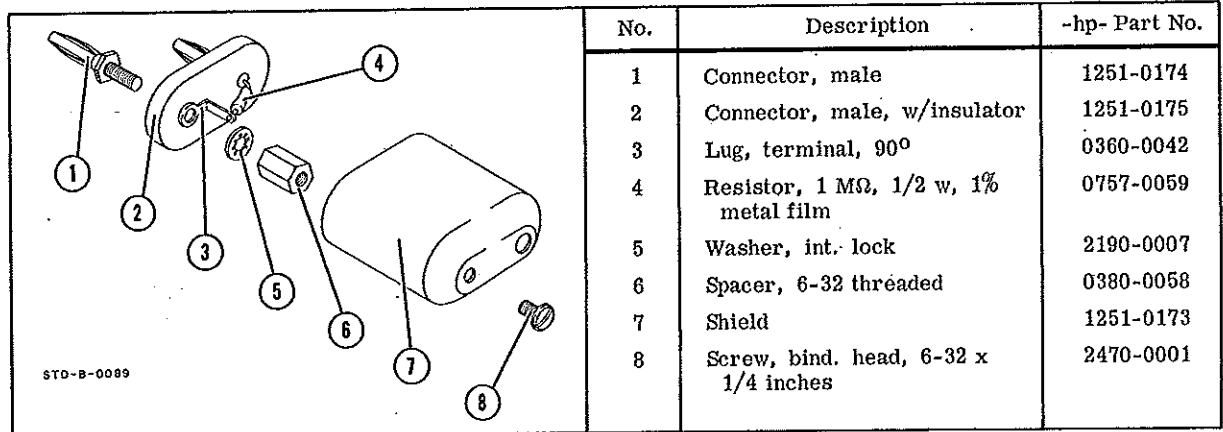


Figure 5-3. Shielded Load for Residual Noise Check

5-13. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-14. The following is a complete Adjustment and Calibration Procedure for the -hp- Model 465A Amplifier. These operations should be conducted only if it has previously been established by the Performance Checks, Paragraph 5-5, that the Model 465A is out of adjustment. Indiscriminate adjustment of the internal controls to "refine" readings may actually cause more difficulty. If the procedures outlined below do not rectify any discrepancies which may exist, and all connections and settings have been rechecked, refer to Paragraph 5-22., Troubleshooting Techniques, for possible cause and recommended corrective action.

5-15. +45 V ADJUSTMENT (R32).

- A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this adjustment. Set voltmeter RANGE to 100.
- Connect the positive lead to + side of C20 and the common lead to circuit ground. DC Voltmeter should read + 45. \pm 1 V.
- If not, adjust R32 for proper reading.

5-16. BIAS ADJUSTMENT (R15).

- Use a DC Voltmeter (-hp- Model 3440A/3445A) for this adjustment and set the RANGE to 100.
- Connect the positive lead to + side of C15 and the common lead to circuit ground. DC Voltmeter should read + 23.0 \pm 0.5 V.
- If not, adjust R15 for proper reading.

5-17. 1KHZ GAIN ADJUST (R3* and R38*).

- The 1 kHz gain is adjusted by selecting a fixed value for resistors R3 and R8 as outlined in the following steps.

Component	Value		
	low	normal	high
R3	680 Ω	1 K Ω	2 K Ω
R38	6.8 K Ω	10 K Ω	20 K Ω

- Connect Test Oscillator (-hp- Model 652A) to 465A INPUT using a 50 Ω feed thru termination (-hp- Model 11048B).
- Adjust oscillator output for 1 volt at 1 kHz using the -hp- Model 741B Differential Voltmeter and set 465A to 20 dB position.
- Connect AC Digital Voltmeter (-hp- Model 3440A/3445A) to 465A OUTPUT and select

- a value of R38 for 10.00 (\pm 0.05 volts) indication on Digital Voltmeter.
- Adjust oscillator output for 0.1 volt at 1 kHz using the Model 741B and set 465A to 40 dB position.
- Select a value of R3 for 10.00 (\pm 0.05 volt) indication on Digital Voltmeter.

5-18. 1 MHz ADJUST (C5).

- Use a Test Oscillator (-hp- Model 652A, and an AC Voltmeter (-hp- Model 331A) for this adjustment. Set the 465A GAIN to 20 dB.
- Set the oscillator FREQUENCY to 1 MHz and adjust output for 1.0 V (verify with voltmeter).
- Adjust C5 for a reading of 8.5 V at the 465A OUTPUT.

5-19. SERVICING ETCHED CIRCUIT BOARD.

5-20. The -hp- Model 465A has one etched circuit board. Use caution when removing it to avoid damaging mounted components. The -hp- part number for the assembly is silk screened on the exterior of the circuit board to identify it. Refer to Section VI for parts replacement and -hp- Part number information.

5-21. The etched circuit board is a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

- Use a low-heat (25 to 30 watts) small-tip soldering iron, and a small diameter rosin core solder.
- Circuit components can be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on lead. If a component is obviously damaged, clip leads as close to components as possible and then remove. Excessive heat can cause the circuit and board to separate, or cause damage to the component.
- Component lead hole should be cleaned with a toothpick or other appropriate device before inserting new lead.
- To replace components, shape new leads and insert them in holes. Reheat with iron, and add solder as required to insure a good electrical connection.
- Clean excess flux from the connection and adjoining area.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 465A
 Amplifier
 Instrument Serial No. _____

Tests performed by _____
 Date _____

Description		Check		
PERFORMANCE CHECKS		TEST LIMITS		
		MIN.	ACTUAL	MAX.
1. ACCURACY AND GAIN CHECK:				
20 dB		9.9 V	_____	10.1 V
40 dB		9.9 V	_____	10.1 V
2. FREQUENCY RESPONSE:				
<u>Gain (dB)</u>	<u>Freq.</u>			
20	1 kHz		9.0 V	
20	10 Hz	7.2 V	_____	10.8 V
20	100 Hz	8.9 V	_____	9.1 V
20	50 kHz	8.9 V	_____	9.1 V
20	1 MHz	7.2 V	_____	10.8 V
40	1 kHz		9.0 V	
40	10 Hz	7.2 V	_____	10.8 V
40	100 Hz	8.9 V	_____	9.1 V
40	50 kHz	8.9 V	_____	9.1 V
40	1 MHz	7.2 V	_____	10.8 V
3. INPUT IMPEDANCE:				
	Impedance at 100 Hz	8.7 V	_____	9.5 V
	Impedance at 10 kHz	> 6.0 V	_____	
4. OUTPUT IMPEDANCE:		4.7 V	_____	5.3 V
5. DISTORTION:				
<u>Gain (dB)</u>	<u>Freq.</u>			
20	1 kHz		_____	< 1%
20	5 Hz		_____	< 2%
20	10 Hz		_____	< 2%
20	100 kHz		_____	< 2%
20	600 kHz		_____	< 2%
40	1 kHz		_____	< 1%
40	5 Hz		_____	< 2%
40	10 Hz		_____	< 1%
40	100 kHz		_____	< 1%
40	600 kHz		_____	< 2%
6. NOISE CHECK:				< 2.5 mV

5-22. TROUBLESHOOTING TECHNIQUE.

5-23. This section contains procedures designed to assist in the isolation of malfunctions. These procedures are based on a systematic analysis of the instrument circuitry. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-13. An investigation should also be made to insure that the trouble is not a result of conditions external to the Model 465A.

5-24. Conduct a visual check of the Model 465A for possible burned or loose components, loose connections, or any other obvious conditions which might suggest a source of trouble.

5-25. Table 5-4 contains procedures which may be used as a guide in isolating malfunctions. The steps

in Table 5-4 describe the normal conditions which should be encountered during the checks.

5-26. The checks outlined in Table 5-4 are not designed to measure all circuit parameters, rather, only to localize the malfunction. Therefore, it is quite possible that additional measurements may be required to completely isolate the problem. Component values may vary slightly between instruments; therefore, it should not be necessary to precisely duplicate voltage values described.

5-27. The conditions discussed in Table 5-4 are based on the following criteria: (1) the + side of C14 is removed from circuit, opening the feedback loop; (2) Model 465A GAIN set to 40 dB; and (3) 1 mV, 2 kHz signal applied to Model 465A INPUT.

Table 5-4. Troubleshooting

- | | |
|---|---|
| ① Remove the + side of C14 from the circuit board. Set Model 465A GAIN to 40 db. Apply a 1.0 mV 2 kHz input signal. | ⑦ Check Q4, Q5 and Q6. Refer to Figure 5-5 for typical dc voltage levels. |
| ② Measure the dc voltage at the + side of C20. Should be +45 v (± 1 v). If correct, proceed to ③; if incorrect, go directly to ⑨. | ⑧ Check Q1, Q2 and Q3. Refer to Figure 5-5 for typical dc voltage levels. |
| ③ Observe the ac waveform at the Model 465A OUTPUT. Should be a sine wave with peak voltage of approximately 12.7 v (9 v rms). If incorrect, proceed to ④. | ⑨ Disconnect jumper wire at the + side of C20, removing power supply from circuit. Measure dc voltage at the + side of C20. Should be +45 v (± 1 v). If correct, proceed to ⑩; if incorrect, go directly to ⑪. |
| ④ Observe the ac waveform at the base of Q4. Should be a sine wave with peak voltage of approximately 12.7 v (9 v rms). If correct, proceed to ⑤; if incorrect, go directly to ⑧. | ⑩ Connect a DC Power Supply (-hp- Model 6220B) to the collectors of Q5 and Q6. Connect the high side to the collector of Q5; the low side to the collector of Q6. Adjust the power supply output to +45 v; set current limit to 75 ma. If power supply indicates current limit, check Q4, Q5, Q6 and CR2-3 for short. |
| ⑤ Observe the ac waveform at the junction of R24 and R25. Should be a sine wave with peak voltage approximately 12.7 v (9 v rms). If correct, proceed to ⑥; if incorrect, go directly to ⑦. | ⑪ Check Model 465A power supply to include T1 secondary, Q7, CR6, Q8 and Q9. Refer to Figure 5-5 for typical dc voltage levels. |
| ⑥ Check R26, R27 and C15. | |

Section V

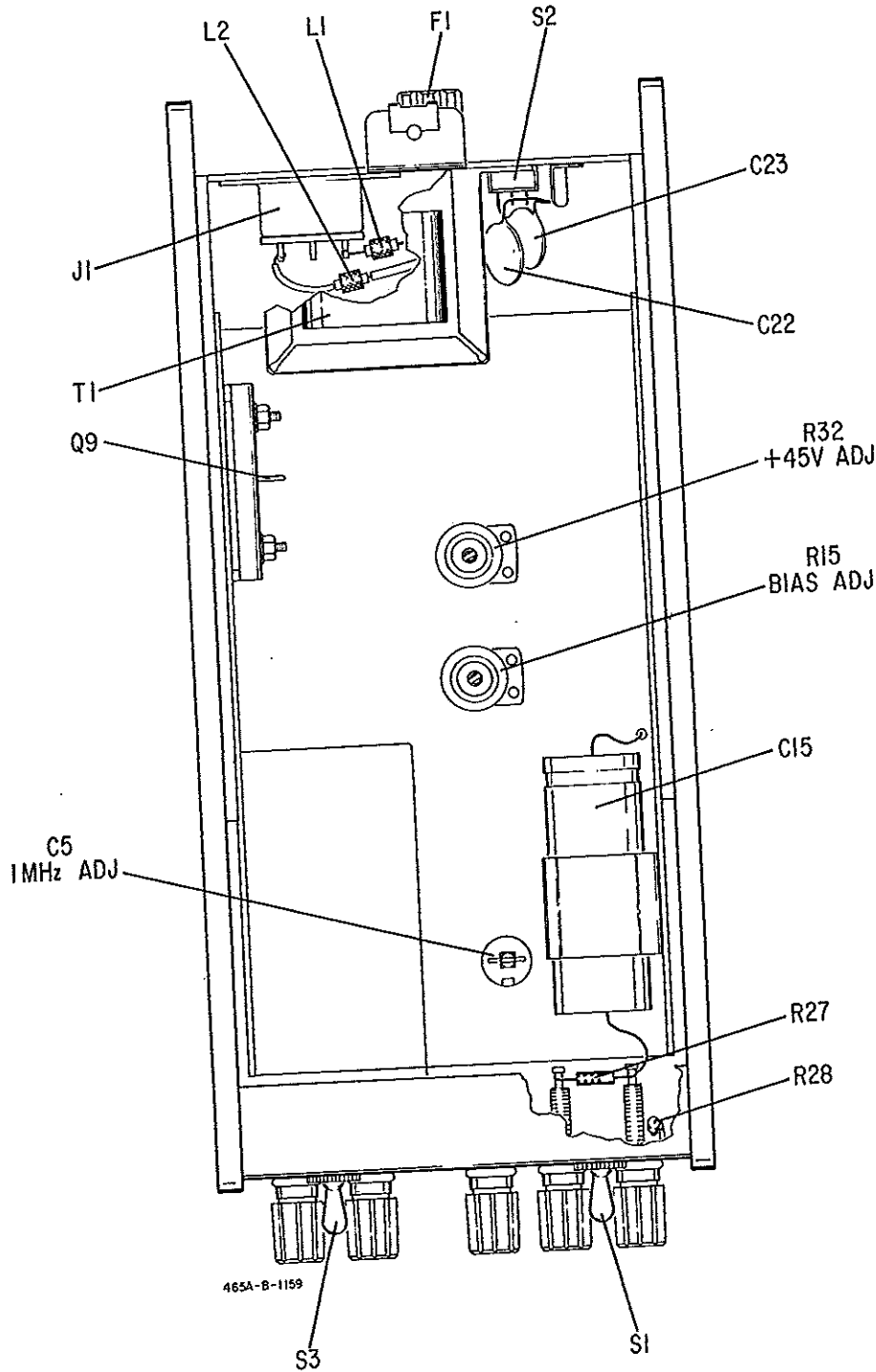
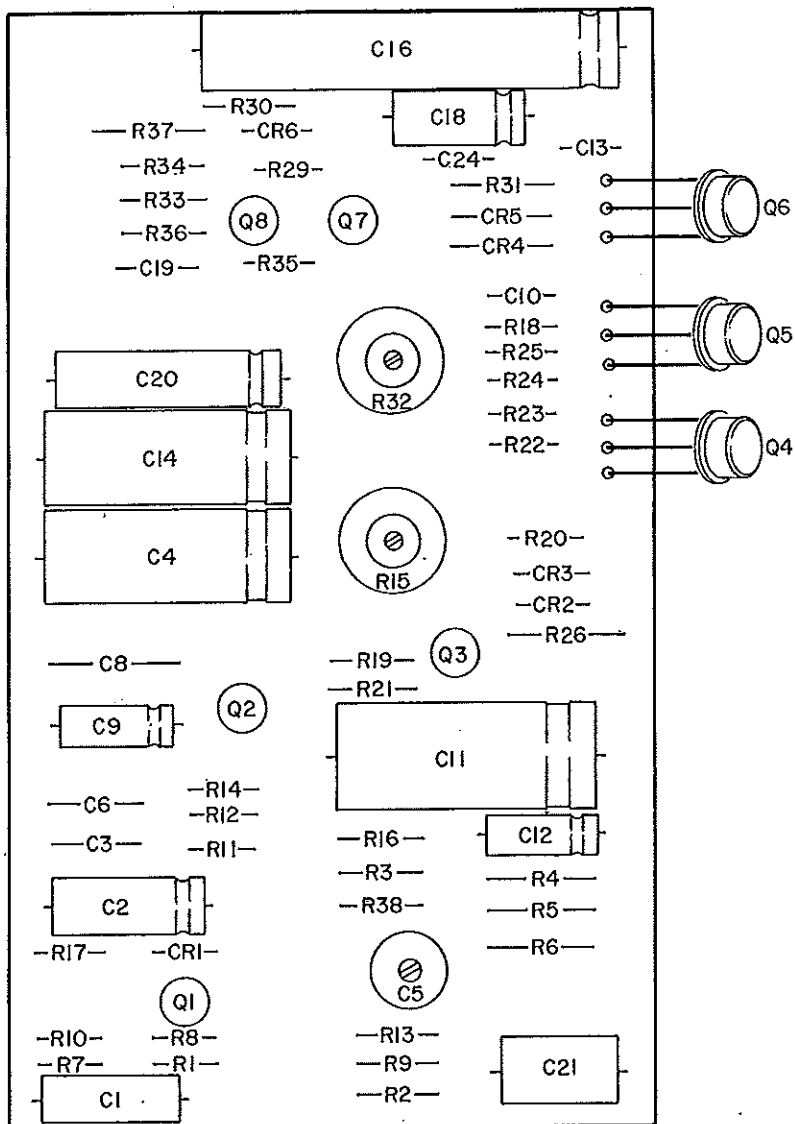


Figure 5-4. Top View



465A-B-1158

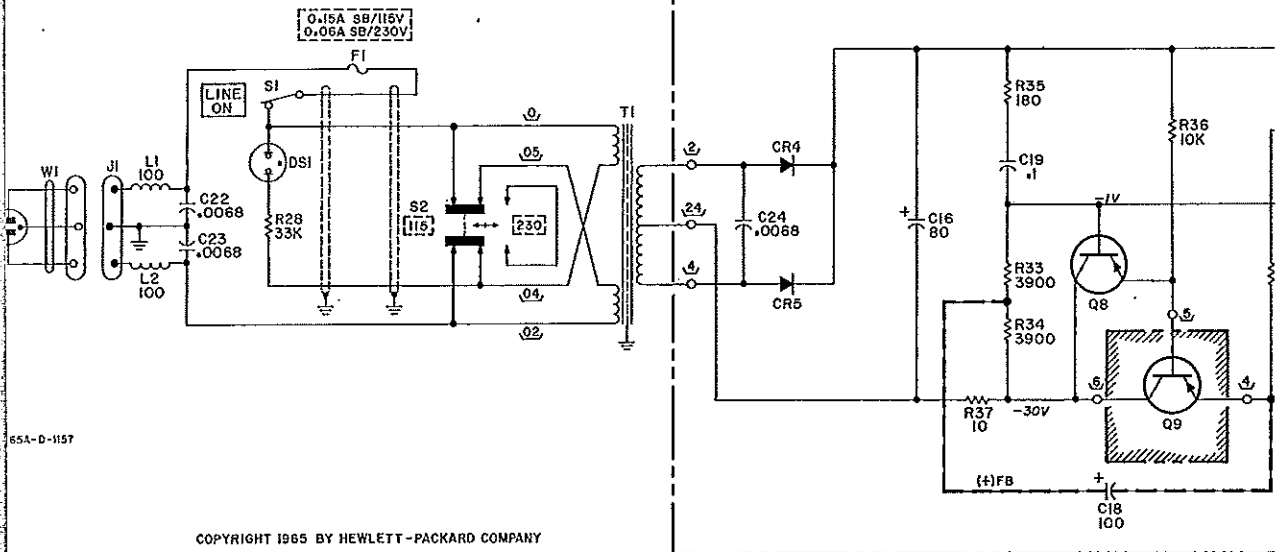
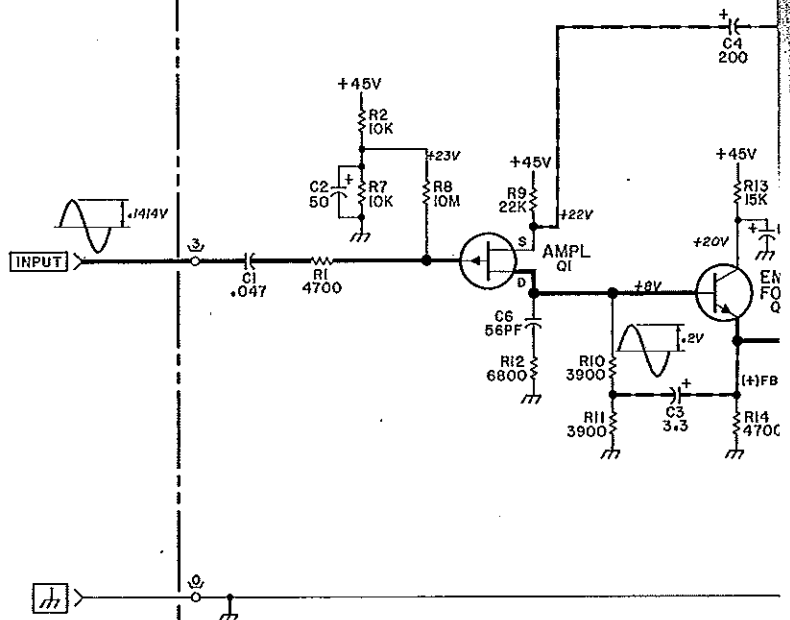
A1

(hp Part No. 00465-66501)

SCHEMATIC NOTES

- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
- COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
RESISTANCE IN OHMS
CAPACITANCE IN MICROFARADS
INDUCTANCE IN MICROHENRYS
- \perp DENOTES CHASSIS GROUND.
 /// DENOTES CIRCUIT COMMON
- DENOTES ASSEMBLY.
===== DENOTES MAIN SIGNAL PATH.
----- DENOTES FEEDBACK PATH.
- DENOTES FRONT PANEL MARKING.
□ DENOTES REAR PANEL MARKING.
⊗ DENOTES SCREWDRIVER ADJUST.
- * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
- /// DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
- 924 DENOTES WIRE COLOR; COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. 924 = WHITE, RED, YELLOW.)

AI AMPLIFIER - POWER SUPPLY ASSEMBLY (00465-66501)



65A-D-1157

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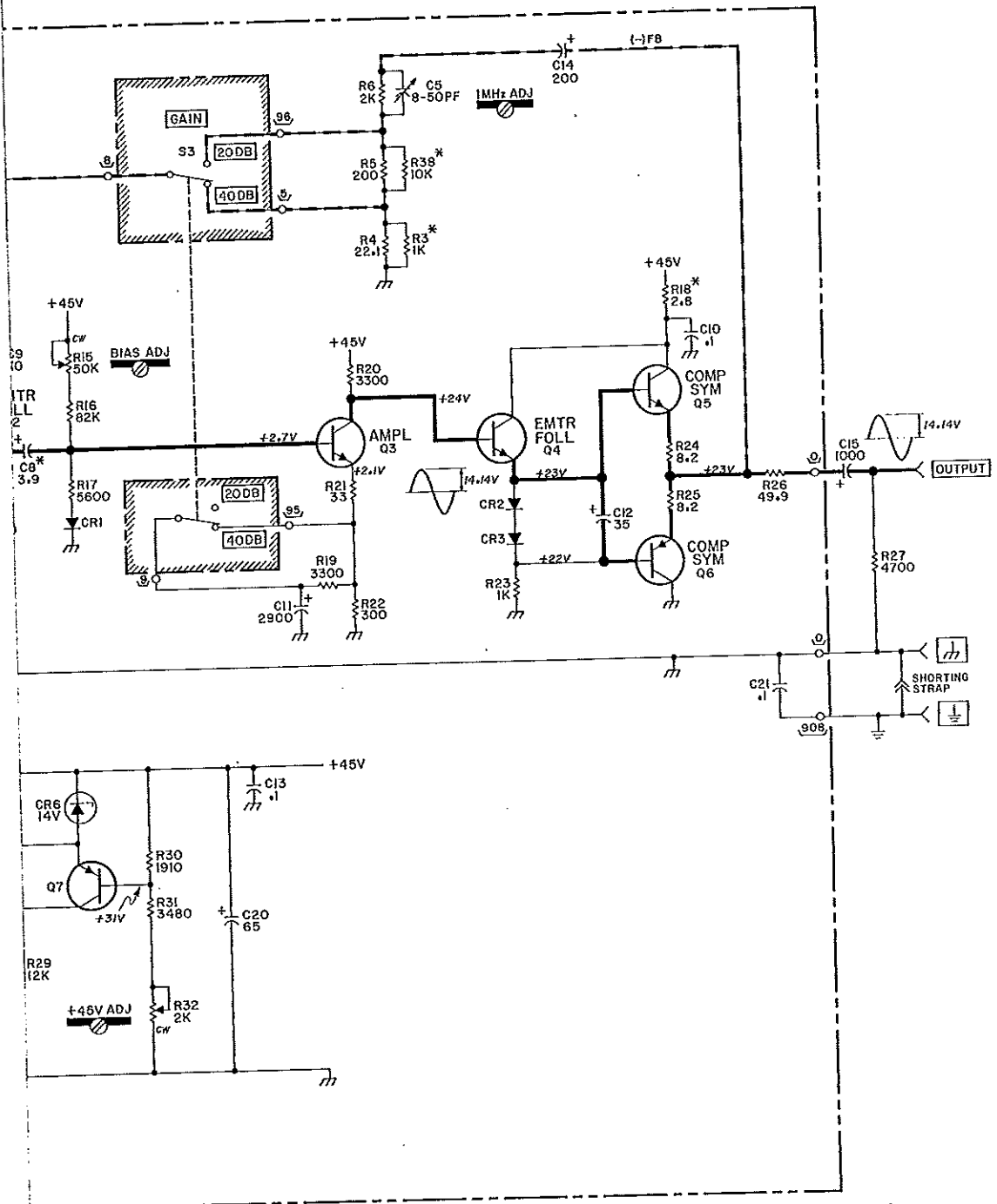


Figure 5-5. Amplifier Schematic

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphabetical 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.)
- d. Manufacturer's part number.

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

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part 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.

DESIGNATORS

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

ABBREVIATIONS

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

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	00465-86501	1	Board Etched Circuit Assembly Power Supply-Amplifier includes: C1 thru C24 Q1 thru Q8 CR1 thru CR6 R1 thru R38	-hp-	
A1C1	0170-0060	1	C: fxd my die 0.047 μ F \pm 10% 400 vdcw	01281	Type 663 UW
A1C2	0180-0105	1	C: fxd Al elect 50 μ F \pm 100% -10% 25 vdcw	56289	D34114
A1C3	0180-0161	1	C: fxd Ta elect 3.3 μ F \pm 20% 35 vdcw	56289	150D335X0035 B2
A1C4	0180-0284	2	C: fxd Al elect \pm 75% -10%	56289	D 38559
A1C5	0130-0017	1	C: var cer 8-50 pF	72982	557-019-U2PO-34R
A1C6	0140-0014	1	C: fxd molded mica 56 pF \pm 10%	04062	RCM15E560K
A1C7			Not assigned		
A1C8*	0180-0022	1	C: fxd Ta elect 3.9 μ F \pm 10% 35 vdcw	56289	150D395X9035 B2
A1C9	0180-0059	1	C: fxd elect 10 μ F \pm 100% -10% 25 vdcw	56289	30D106G025BB4
A1C10	0150-0084	3	C: fxd cer die 0.1 μ F \pm 80% -20% 50 vdcw	56289	33C41
A1C11	0180-1792	1	C: fxd Al elect 2900 μ F \pm 75% -10% 3 vdcw	56289	39D298G003GJ4DSB
A1C12	0180-0064	1	C: fxd elect 35 μ F \pm 100% -10% 6 vdcw	56289	30D156G006BB4
A1C13	0150-0084		C: fxd cer die 0.1 μ F \pm 80% -20% 50 vdcw	56289	33C41
A1C14	0180-0284		C: fxd Al elect \pm 75% -10%	56289	D38559
A1C15	0180-0378	1	C: fxd Al elect 1000 μ F \pm 100% -10% 30 vdcw	56289	(Type 34D) D40680-DSB
A1C16	0180-0110	1	C: fxd Al elect 80 μ F 75 vdcw	56289	41D D33191
A1C17			Not assigned		
A1C18	0180-0061	1	C: fxd elect 100 μ F \pm 100% -10% 150 vdcw	56289	30D107G015DD4
A1C19	0150-0084		C: fxd cer die 0.1 μ F \pm 80% -20% 50 vdcw	56289	33C41
A1C20	0180-0149	1	C: fxd Al elect \pm 100% -10%	56289	Type 30D
A1C21	0170-0022	1	C: fxd my die 0.1 μ F \pm 20% 600 vdcw	01281	HEW-17
A1C22 thru A1C24	0150-0097	4	C: fxd cer 0.0068 μ F \pm 2% 1000 vdcw	91418	B
A1CR1 thru A1CR3	1901-0025	1	Diode: Si 100 wiv 12 pF 100 ma	93332	D 3072
A1CR4, A1CR5	1901-0158	2	Diode: Si 200 piv	11711	obd
A1CR6	1902-0040	1	Diode: breakdown 400 mW	04713	SZ10939-224
A1Q1	1855-0004	1	TSTR: P channel	17856	U112
A1Q2	1854-0033	1	TSTR: Si NPN 2N3391	24446	2N3391
A1Q3	1854-0302	1	TSTR: Si NPN 2N3405	24446	obd
A1Q4, A1Q5	1854-0039	1	TSTR: Si NPN 2N3053	86684	2N3053
A1Q6	1853-0051	1	TSTR: Si PNP 2N4037	02735	2N4037
A1Q7, A1Q8	1850-0128	1	TSTR: Ge PNP 2N398B	86684	2N398B
A1R1	0687-4721	1	R: fxd comp 4700 Ω \pm 10% 1/2 W	01121	EB 4721
A1R2	0687-1031	2	R: fxd comp 10 K Ω \pm 10% 1/2 W	01121	EB 1031
A1R3*	0686-1025	1	R: fxd comp 1000 Ω \pm 5% 1/2 W	01121	EB 1025
A1R4	0757-0992	1	R: fxd prec met flm 22.1 Ω \pm 1% 1/2 W	19701	MF7C T-O obd
A1R5	0698-3186	1	R: fxd prec met flm 200 Ω \pm 1/2% 1/2 W	19701	CEC T-O obd
A1R6	0698-3187	1	R: fxd prec met flm 2000 Ω \pm 1/2% 1/2 W	19701	MF7C T-O obd
A1R7	0687-1031	2	R: fxd comp 10 K Ω \pm 10% 1/2 W	01121	EB 1031
A1R8	0687-1061	1	R: fxd comp 10 M Ω \pm 10% 1/2 W	01121	EB 1061
A1R9	0687-2231	1	R: fxd comp 22 K Ω \pm 10% 1/2 W	01121	EB 2231
A1R10, A1R11	0687-3921	2	R: fxd comp 3300 Ω \pm 10% 1/2 W	01121	EB 3921
A1R12	0687-6821	1	R: fxd comp 6800 Ω \pm 10% 1/2 W	01121	EB 6821
A1R13	0687-1531	2	R: fxd comp 15 K Ω \pm 10% 1/2 W	01121	EB 1531
A1R14	0687-4721	1	R: fxd comp 4700 Ω \pm 10% 1/2 W	01121	EB 4721
A1R15	2100-0094	1	R: var comp lin taper 50 K Ω \pm 30% 1/10 W	71450	UPE 70RE
A1R16	0686-8235	1	R: fxd comp 82 K Ω \pm 5% 1/2 W	01121	EB 8235

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1R17	0687-5621	1	R: fxd comp 5600Ω ±10% 1/2 W	01121	EB 5621
A1R18 *	0699-0001	1	R: fxd comp 2.7Ω ±10% 1/2 W	01121	EB 27G1
A1R19, A1R20	0687-3321	1	R: fxd comp 3300Ω ±10% 1/2 W	01121	EB 3321
A1R21	0686-3305	1	R: fxd comp 33Ω ±5% 1/2 W	01121	EB 3305
A1R22	0686-3015	1	R: fxd comp 300Ω ±5% 1/2 W	01121	EB 3015
A1R23	0687-1021	1	R: fxd comp 1000Ω ±10% 1/2 W	01121	EB 1021
A1R24, A1R25	0699-0003	1	R: fxd comp 8.2Ω ±10% 1/2 W	01121	EB 0003
A1R26	0757-0072	1	R: fxd 49.9 ohms ±1%	19701	MF7C T-O obd
A1R27	0687-4721	1	R: fxd comp 4700Ω ±10% 1/2 W	01121	EB 4721
A1R28	0684-3331	1	R: fxd comp 33K ±10% 1/4 W	01121	CB 3331
A1R29	0687-1231	1	R: fxd comp 12 KΩ ±10% 1/2 W	01121	EB 1231
A1R30	0698-3341	1	R: fxd prec met film 1910Ω ±1% 1/2 W	75042	CEC T-O obd
A1R31	0698-3411	1	R: fxd prec met film 3480Ω ±1% 1/2 W	75042	CEC T-O obd
A1R32	2100-0090	1	R: var comp lin 2000Ω ±30% 1/3 W	71450	UPM 70RE
A1R33, A1R34	0687-3921	1	R: fxd comp 3300Ω ±10% 1/2 W	01121	EB 3921
A1R35	0687-1811	1	R: fxd comp 180Ω ±10% 1/2 W	01121	EB 1811
A1R36	0687-1031	1	R: fxd comp 10 KΩ ±10% 1/2 W	01121	EB 1031
A1R37	0690-1001	1	R: fxd comp 10Ω ±10% 1 W	01121	GB 1001
A1R38 *	0686-1035	1	R: fxd comp 10 KΩ ±5% 1/2 W	01121	GB 1035
C1 thru C14			Not assigned		
C15	0180-0378	1	C: fxd Al elect 1000 μF +100% -10% 30 vdcw	56289	34D108H030JP41
C16 thru C21			Not assigned		
C22 and C23	0150-0097	1	C: fxd cer 0.0068 μF ±2% 1000 vdcw	91418	B
DS1	2140-0015	1	Lamp glow	24455	obd
F1	2110-0017	1	Fuse: cartridge 0.15 amp	98997	3AG-TL-15/100
	2110-0040	1	Fuse: 0.062A SB (for 230 V only)	98997	3AG-TL-15/100
L1 and L2	9140-0029	2	Coil: R. F.	99848	3100-15-101
Q1 thru Q8			Not assigned		
Q9	1850-0098	1	TSTR: Ge PNP	77068	B-1493
R1 thru R26			Not assigned		
R27	0687-4721	1	R: fxd comp 4700Ω ±10% 1/2 W	01121	EB 4721
R28	0684-3331	1	R: fxd comp 33 KΩ ±10% 1/4 W	01121	CB 3331
S1	3101-0037	1	Switch: toggle SPST 3 amp	04009	80350-A
S2	3101-0033	1	Switch: slide DPDT	79727	G-326
S3	3101-0038	1	Switch: toggle DPDT 3 amp	04009	83054-B
T1	9100-1324	1	Transformer: power	-hp-	
W1	8120-0078	1	Cable assembly power: black, extra limp, 7.5 ft. long	70903	KH-4147
			<u>MISCELLANEOUS</u>		
	0340-0099	1	Insulator: grey, plastic	-hp-	
	0340-0100	1	Insulator: grey, plastic	-hp-	
	0510-0888	1	Clamp: cradle	91506	6214-1 AN
	1200-0043	1	Insulator	71785	293011
	1200-0081	1	Insulator: bushing nylon	26365	974
	1205-0011	1	Heat dissipator: transistor	98978	TXBF-032-025B
	1205-0050	1	Heat: sink	91506	9017-1G1

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
	1251-0148	1	Connector: ac power cord receptacle	82389	AC-3
	1400-0084	1	Holder: fuse	75915	342014
	1490-0031	1	Stand: tilt	91260	obd
	1510-0010	2	Binding post: red	-hp-	
	1510-0011	2	Binding post: black	-hp-	
	5000-0700	1	Cover: side	-hp-	
	5000-0711	1	Cover: bottom	-hp-	
	5020-0700	1	Spacer: CAB	-hp-	
	5040-0234	1	Jewel: pilot light	-hp-	
	5040-0235	1	Base: pilot light	-hp-	
	5040-0700	1	Hinge	-hp-	
	5060-0700	1	Frame assembly	-hp-	
	5060-0709	1	Cover: top	-hp-	
	5060-0727	1	Foot: assembly	-hp-	
	5060-4916	1	Terminal: ground black	-hp-	
	00465-00101	1	Plate: right	-hp-	
	00465-00102	1	Plate: left	-hp-	
	00465-00201	1	Panel: front	-hp-	
	00465-00203	1	Panel: rear	-hp-	
	00465-01201	1	Bracket: transistor	-hp-	
	00465-90002	1	Manual: Operating and Service	-hp-	

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.	05245	Components Corp.	Chicago, Ill.	09145	Tech. Ind. Inc. Atom Elect.	Burbank, Calif.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05277	Westinghouse Electric Corp.	Youngwood, Pa.	09250	Electro Assemblies, Inc.	Chicago, Ill.
00213	Sage Electronics Corp.	Rochester, N. Y.		Semi-Conductor Dept.	San Mateo, Calif.	09353	C & K Components Inc.	Newtown, Mass.
00237	Comco Inc.	Danabson, Conn.	05347	Ultronix, Inc.	New York, N. Y.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
00334	Humidat	Colton, Calif.	05397	Union Carbide Corp., Elect. Div.	Canoga Park, Calif.			Norwalk, Conn.
00348	Microton Co., Inc.	Valley Stream, N. Y.	05574	Viking Ind. Inc.	Sunnyvale, Calif.	09922	Bundy Corp.	Los Angeles, Calif.
00373	Garlock Inc.	Cherry Hill, N. J.	05593	Core Electro-Plastics Inc.	Sunnyvale, Calif.	10411	Ti-Tal, Inc.	Berkeley, Calif.
00656	Aerovox Corp.	New Bedford, Mass.	05616	Cosmo Plastic	Cleveland, Ohio	10545	Carborundum Co.	Niagara Falls, N. Y.
00779	Amp. Inc.	Harrisburg, Pa.		(c/o Electrical Spec. Co.)	Rockford, Ill.	11236	CTS of Borne, Inc.	Borne, Ind.
00781	Aircraft Radio Corp.	Boonton, N. J.	05624	Barber Coleman Co.	Roslyn Heights, Long Island, N. Y.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	05728	Tiffen Optical Co.	Westbury, N. Y.	11242	Bay State Electronics Corp.	Waltham, Mass.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.	05783	Stewart Engineering Co.	Santa Cruz, Calif.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
00866	Gos Engineering Co.	City of Industry, Cal.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11314	National Seat	Downey, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgport, Conn.	11453	Precision Connector Corp.	Jamaica, N. Y.
00929	Microfab Inc.	Livingston, N. J.	06090	Raychem Corp.	Redwood City, Calif.	11534	Duacac Electronics Inc.	Gosta Mead, Calif.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
01009	Alden Products Co.	Brockton, Mass.	06402	E. T. A. Products Co. of America	Chicago, Ill.	11717	Imperial Electronic, Inc.	Buena Park, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.	06540	Amaton Electronic Hardware Co., Inc.	New Rochelle, N. Y.	11870	Melabs, Inc.	Palo Alto, Calif.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	06555	Beede Electrical Instrument Co., Inc.	Peasacook, N. H.	12040	National Semiconductor	Danbury, Conn.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.			Indianapolis, Ind.	12136	Philadelphia Handle Co.	Camden, N. J.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas	06666	General Devices Co., Inc.	Phoenix, Ariz.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
01349	The Alliance Mfg. Co.	Alliance, Ohio	06751	Components Inc., Ariz. Div.	Phoenix, Ariz.	12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	12697	Clarestal Mfg. Co.	Dover, N. H.
01670	Quadsbrod Bros. Silk Co.	New York, N. Y.	06980	Varian Assoc. Elmac Div.	San Carlos, Calif.	12859	Nippon Electric Co., Ltd.	W. Haven, Conn.
01930	Aerocock Corp.	Rockford, Ill.	07088	Keivin Electric Co.	Van Nuys, Calif.	12881	Metax Electronics Corp.	Tokyo, Japan
01961	Pulse Engineering Co.	Santa Clara, Calif.	07126	Digitrax Co.	Passadena, Calif.	12930	Delta Semiconductor Inc.	Clark, N. J.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07138	Transistor Electronics Corp.	Minneapolis, Minn.	12954	Dickson Electronics Corp.	Newport Beach, Calif.
02116	Wheelock Signals, Inc.	Long Branch, N. J.		Electronic Tube Div.	Elmira, N. Y.	13103	Theracolly	Scottsdale, Arizona
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.	07149	Filmohm Corp.	New York, N. Y.	13395	Telefunken (Omh)	Dallas, Texas
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.	07233	Cinch-Graphik Co.	City of Industry, Calif.	13835	Mitland-Wright Div. of Pacific Industries, Inc.	Hanover, Germany
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	07256	Silicon Transistor Corp.	Carle Place, N. Y.			Kansas City, Kansas
02771	Vocalins Co. of America, Inc.	Old Saybrook, Conn.	07261	Avnet Corp.	Culver City, Calif.	14099	Sea-Tech	Newbury Park, Calif.
02777	Hopkins Engineering Co.	San Fernando, Calif.	07263	Falchilla Camera & Inst. Corp.	Mountain View, Calif.	14298	American Components, Inc.	Santa Monica, Calif.
02825	Hudson Tool & Die Co.	Newark, N. J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	Coashohocken, Pa.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07387	Bircher Corp., The	Monterey Park, Calif.	14493	Hewlett-Packard Company	West Palm Beach, Fla.
03705	Apex Machine & Tool Co.	Dayton, Ohio	07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.	14655	Cornell Dubilier Electric Corp.	Loveland, Colo.
03797	Eldena Corp.	Compton, Calif.	07700	Technical Wire Products Inc.	Cranford, N. J.	14674	Corning Glass Works	Corning, N. Y.
03818	Parker Seal Co.	Los Angeles, Calif.	07829	Bodine Elect. Co.	Chicago, Ill.	14752	Electro Cube Inc.	San Gabriel, Calif.
03877	Transitron Electric Corp.	Wakelield, Mass.	07910	Continental Device Corp.	Hawthorne, Calif.	14950	Williams Mfg. Co.	San Jose, Calif.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.	15203	Webster Electronics Co.	New York, N. Y.
03954	Slinger Co., Dish Div.	Sunerville, N. J.	07980	Hewlett-Packard Co., Boonton Radio Div.	Boonton, N. J.	15287	Sciencos Corp.	Northridge, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08145	U. S. Engineering Co.	Los Angeles, Calif.	15291	Adjustable Bushing Co.	N. Hollywood, Calif.
04013	Taurus Corp.	Lambertville, N. J.	08289	Bilan, Delbert Co.	Pomona, Calif.	15558	Micron Electronics	Garden City, Long Island, N. Y.
04062	Arco Electronic Inc.	Great Neck, N. Y.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
04222	HI-Q Division of Aerovox	Myrtle Beach, S. C.	08524	Deutsch Fastener Corp.	Los Angeles, Calif.	15631	Cabletronics	Costa Mesa, Calif.
04354	Precision Paper Tube Co.	Wheeling, Ill.	08654	Bristol Co., The	Waterbury, Conn.	15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
04404	Dynac Division of Hewlett-Packard Co.	Palo Alto, Calif.	08717	Sloan Company	Sua Valley, Calif.	15801	Fenwal Elect. Inc.	Framingham, Mass.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona	15818	Amelco Inc.	Mt. View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.	08727	National Radio Lab. Inc.	Paramus, N. J.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	08792	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	16179	Omni-Spectra Inc.	Farmington, Mich.
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.	08805	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio	16352	Computer Diode Corp.	Lodi, N. J.
04773	Automatic Electric Co.	Northlake, Ill.	08984	Mel-Rain	Jedfanapolis, Ind.	16585	Boels Aircraft Nut Corp.	Passadena, Calif.
04796	Segola Wire Co.	Redwood City, Calif.	09926	Babcock Relays Div.	Costa Mesa, Calif.	16588	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
04811	Precision Coil Spring Co.	El Monte, Calif.	09134	Texas Capacitor Co.	Houston, Texas	16758	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
04870	P. M. Motor Company	Westchester, Ill.				17109	Thermonetics Inc.	Canoga Park, Calif.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.				17474	Traxac Company	Mountain View, Calif.
05005	Twentieth Century Plastics, Inc.	Los Angeles, Calif.				17554	Components Inc.	Bildeford, Ma.
						17675	Hamlin Metal Products Corp.	Akron, Ohio
						17745	Angstrom Prec. Inc.	No. Hollywood, Calif.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N. H.	62119	Universal Electric Co.	Owosso, Mich.	73899	JFD Electronics Corp.	Brooklyn, N. Y.
18042	Power Design Pacific Inc.	Palo Alto, Calif.	63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.	64959	Western Electric Co., Inc.	New York, N. Y.	73957	Groov-Pin Corp.	Ridgefield, N. J.
18324	Sigaetics Corp.	Palo Alto, Calif.	65092	Western Inst. Inc. Weston-Newark	Newark, N. J.	74276	Signalite Inc.	Neptune, N. J.
18476	Ty-Car Mfg. Co., Inc.	Sunnyvale, Calif.	66295	Wittek Mfg. Co.	Chicago, Ill.	74455	J. H. Wines, and Sons	Winchester, Mass.
18486	TRW Elect. Comp. Div.	Holliston, Mass.	66346	Minnesota Mining & Mfg. Co. Revere	Mincon Div. St. Paul, Minn.	74861	Industrial Condenser Corp.	Chicago, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.	70276	Altea Mfg. Co.	Hartford, Conn.	74868	R. F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
18612	Visbay Instruments Inc.	Malvern, Pa.	70309	Allied Control	New York, N. Y.	74970	E. F. Johnson Co.	Waseca, Minn.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.	70318	Alfmetal Screw Product Co., Inc.	Garden City, N. Y.	75042	International Resistance Co.	Philadelphia, Pa.
18911	Durant Mfg. Co.	Milwaukee, Wis.	70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	75378	CTS Knights Inc.	Sandwich, Ill.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.	70563	Amperite Co., Inc.	Union City, N. J.	75382	Kulka Electric Corporation	Mt. Vernon, N. Y.
19589	Coacoa	Baldwin Park, Calif.	70674	ADC Products Inc.	Minneapolis, Minn.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.
19844	LRC Electroates	Horseheads, N. Y.	70903	Belden Mfg. Co.	Chicago, Ill.	75915	Littlefuse, Inc.	Des Plaines, Ill.
19701	Electra Mfg. Co.	Independence, Kansas	70938	Bird Electronic Corp.	Cleveland, Ohio	76005	Lord Mfg. Co.	Erie, Pa.
20183	General Altronics Corp.	Philadelphia, Pa.	71002	Birnbach Radio Co.	New York, N. Y.	76210	G. W. Marwedel	San Francisco, Calif.
21266	Executone, Inc.	Long Island City, N. Y.	71034	Billay Electric Co., Inc.	Erie, Pa.	76433	General Instrument Corp., Micromold Division	Newark, N. J.
21335	Fafair Bearing Co., The	New Britain, Conn.	71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	76487	James Miller Mfg. Co., Inc.	Malden, Mass.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71218	Bud Radio, Inc.	Willoughby, Ohio	76493	J. W. Miller Co.	Los Angeles, Calif.
23042	Texscan Corp.	Indianapolis, Ind.	71279	Cambridge Thermionics Corp.	Cambridge, Mass.	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
23783	British Radio Electronics Ltd.	Washington, D. C.	71285	Canloc Fastener Corp.	Paramus, N. J.	76545	Mueller Electric Co.	Cleveland, Ohio
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71313	Cardwell Condenser Corp.	Lindenhurst L. I., N. Y.	76703	National Union	Newark, N. J.
24555	General Radio Co.	West Concord, Mass.	71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.	71436	Chicago Condenser Corp.	Chicago, Ill.	77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
24795	Paralco Inc.	San Juan Capistrano, Calif.	71447	Callif. Spring Co., Inc.	Pico-Rivera, Calif.	77075	Pacific Metals Co.	San Francisco, Calif.
26355	Giles Reproducer Corp.	New Rochelle, N. Y.	71450	GTS Corp.	Elkhart, Ind.	77221	Phanotron Instrument and Electronic Co.	South Pasadena, Calif.
26462	Grobet File Co. of America, Inc.	Carlstadt, N. J.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
26851	Compac/Hollister Co.	Hollister, Calif.	71471	Ginema, Div. Aerovox Corp.	Burbank, Calif.	77342	American Machine & Foundry Co. Potter & Brunfield Div.	Princeton, Ind.
26992	Hamilton Watch Co.	Lancaster, Pa.	71482	C. P. Clare & Co.	Chicago, Ill.	77630	TRW Electronic Components Div.	Camden, N. J.
27251	Specialties Mfg. Co., Inc.	Saratoga, Conn.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N. Y.
28480	Hewlett-Packard Co.	Palo Alto, Calif.	71616	Commercial Plastics Co.	Chicago, Ill.	77764	Resistance Products Co.	Harrisburg, Pa.
28520	Heyman Mfg. Co.	Kenilworth, N. J.	71707	Cornish Wire Co., The	New York, N. Y.	77959	Rubbercraft Corp. of Calif.	Torrance, Calif.
30817	Instrument Specialties Co., Inc.	Little Falls, N. J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78277	Signa	So. Braintree, Mass.
35434	Lectrohm Inc.	Chicago, Ill.	71984	Dow Corning Corp.	Midland, Mich.	78283	Signal Indicator Corp.	New York, N. Y.
36196	Slanawck Coil Products Ltd.	Hawkesbury, Ontario, Canada	72136	Electro Motive Mfg. Co., Inc.	Wilmington, Conn.	78290	Struthers-Dunn Inc.	Pittman, N. J.
36287	Cunningham, W. H. & Hill, Ltd.	Toronto Ontario, Canada	72619	Dialight Corp.	Brooklyn, N. Y.	78424	Specialty Leather Prod. Co.	Newark, N. J.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.	72656	Indiana General Corp., Electronics Div.	Keasby, N. J.	78452	Thompson-Bremer & Co.	Chicago, Ill.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	72699	General Instrument Corp., Cap. Div.	Newark, N. J.	78471	Tilley Mfg. Co.	San Francisco, Calif.
40920	Miniature Precision Bearings, Inc.	Keene, N. H.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	78488	Stackpole Carbon Co.	St. Marys, Pa.
42190	Muter Co.	Chicago, Ill.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.	78493	Standard Thomson Corp.	Waltham, Mass.
43990	C. A. Norgren Co.	Eglewood, Colo.	72928	Sedana Co.	Chicago, Ill.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
44655	Obmte Mfg. Co.	Skokie, Ill.	72962	Elastic Stop Nut Corp.	Union, N. J.	78790	Transformer Engineers	San Gabriel, Calif.
46384	Penn Eng. & Mfg. Corp.	Doylstown, Pa.	72964	Robert M. Hadley Co.	Los Angeles, Calif.	78947	Uclaitte Co.	Newtownville, Mass.
47904	Polaroid Corp.	Cambridge, Mass.	72982	Erie Technological Products, Inc.	Erie, Pa.	79136	Waldes Kohinor Inc.	Long Island City, N. Y.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73061	Haasna Mfg. Co., Inc.	Pittsford, Ind.	79142	Veeder Root, Inc.	Hartford, Conn.
49356	Microwave & Power Tube Div.	Waltham, Mass.	73076	H. M. Harper Co.	Chicago, Ill.	79251	Weaco Mfg. Co.	Chicago, Ill.
52090	Rowan Controller Co.	Westminster, Md.	73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.	79272	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
52983	Sandora Company	Waltham, Mass.	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
54294	Shaltcross Mfg. Co.	Selma, N. C.	73445	Amperex Elect. Co.	Hicksville, L. I., N. Y.	80031	Mepro Division of Sessions Clock Co.	Morrisville, N. J.
55026	Simpson Electric Co.	Chicago, Ill.	73505	Bradley Semiconductor Corp.	New Haven, Conn.	80120	Schnitzer Alloy Products Co.	Elizabeth, N. J.
55933	Sonotone Corp.	Ettersford, N. Y.	73559	Carling Electric, Inc.	Hartford, Conn.	80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	Washington, DC.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.	73586	Circle F Mfg. Co.	Trenton, N. J.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
56137	Spaulding Fibre Co., Inc.	Teosawanda, N. Y.	73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.	80223	United Transformer Corp.	New York, N. Y.
56289	Sprague Electric Co.	North Adams, Mass.	73734	Federal Screw Products Inc.	Chicago, Ill.	80248	Oxford Electric Corp.	Chicago, Ill.
59446	Telex Corp.	Tulsa, Okla.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	80294	Bouras Inc.	Riverside, Calif.
59730	Thomas & Betts Co.	Elizabeth, N. J.	73793	General Industries Co., The	Elyria, Ohio	80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
60741	Triplet Electrical Inst. Co.	Stufftop, Ohio	73846	Goshen Stamping & Tool Co.	Goshen, Ind.			
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.						

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
80486	All Star Products Inc.	Dellance, Ohio	86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N. J.	95566	Arnold Engineering Co.	Marengo, Ill.
80509	Avery Label Co.	Monrovia, Calif.	86928	Seaston Mfg. Co.	Glendale, Calif.	95712	Daga Electric Co., Inc.	Franklin, Ind.
80583	Hamamatsu Co., Inc.	Mars Hill, N. C.	87034	Marco Industries	Anahela, Calif.	95984	Simon Mfg. Co.	Wayne, Ill.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.	87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.	95987	Weckesser Co.	Chicago, Ill.
80813	Dimco Gray Co.	Dayton, Ohio	87473	Western Fibrous Glass Products Co.	San Francisco, Calif.	96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
81030	International Instruments Inc.	Orange, Conn.	87664	Van Waters & Rogers Inc.	San Francisco, Calif.	96095	Hi-Q Div. of Aerovox Corp.	Olean, N. Y.
81073	Grayhill Co.	LaGrange, Ill.	87930	Tower Mfg. Corp.	Providence, R. I.	96256	Thornderson-Weissner Inc.	Ht. Carmel, Ill.
81095	Triad Transformer Corp.	Venice, Calif.	88140	Cutler-Hammer, Inc.	Lincoln, Ill.	96296	Solar Manufacturing Co.	Los Angeles, Calif.
81312	Winchester Elec. Div. Lillon Ind., Inc.	Oakville, Conn.	88220	Gould-National Batteries, Inc.	St. Paul, Minn.	96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
81349	Military Specification		88698	Generat Mills, Inc.	Buffalo, N. Y.	96330	Carlton Screw Co.	Chicago, Ill.
81483	International Rectifier Corp.	El Segundo, Calif.	89231	Graybar Electric Co.	Oakland, Calif.	96341	Microwave Associates, Inc.	Burlington, Mass.
81541	Airpax Electronics, Inc.	Cambridge, Maryland	89473	G. E. Distributing Corp.	Schaectelady, N. Y.	96501	Excel Transformer Co.	Oakland, Calif.
81660	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.	89555	United Transformer Co.	Chicago, Ill.	96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
82042	Carter Precision Electric Co.	Skokie, Ill.	90030	United Shoe Machinery Corp.	Beverly, Mass.	96881	Thomson Ind. Inc.	Long Is., N. Y.
82047	Speith Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N. J.	90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.	97454	Industrial Refracting Ring Co.	Irlvington, N. J.
82116	Electric Regulator Corp.	Norwalk, Conn.	90970	Bearing Engineering Co.	San Francisco, Calif.	97539	Automatic & Precision Mfg.	Englewood, N. J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.	91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.	97979	Reon Resistor Corp.	Yonkers, N. Y.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paranus, N. J.	91260	Connor Spring Mfg. Co.	San Francisco, Calif.	97983	Lillon System Inc., Adler-Westrex Comm. Div.	New Rochelle, N. Y.
82209	Maguire Industries, Inc.	Greenwich, Conn.	91345	Miller Dial & Nameplate Co.	El Monte, Calif.	98141	R-Tronics, Inc.	Jamaica, N. Y.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.	91418	Radio Materials Co.	Chicago, Ill.	98159	Rubber Teck, Inc.	Gardena, Calif.
82376	Aston Corp.	East Newark, New Jersey	91506	Augat Inc.	Attleboro, Mass.	98220	Hewlett-Packard Co., Mosely Div.	Pasadena, Calif.
82389	Switchcraft, Inc.	Chicago, Ill.	91637	Dale Electronics, Inc.	Columbus, Nebr.	98278	Microdot, Inc.	So. Pasadena, Calif.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.	91652	Elco Corp.	Willow Grove, Pa.	98291	Sealectro Corp.	Mansfield, N. Y.
82768	Phillips-Advance Control Co.	Joliet, Ill.	91737	Genar Mfg. Co., Inc.	Wakefield, Mass.	98376	Zero Mfg. Co.	Burbank, Calif.
82866	Research Products Corp.	Madison, Wis.	91827	K F Development Co.	Redwood City, Calif.	98410	Etc Inc.	Cleveland, Ohio
82877	Rotron Mfg. Co., Inc.	Woodstock, N. Y.	91886	Malco Mfg. Co., Inc.	Chicago, Ill.	98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
82893	Vector Electronic Co.	Glendale, Calif.	91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.	98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.	91961	Nahn-Bros. Spring Co.	Oakland, Calif.	98821	North Hills Electronics, Inc.	Glen Cove, N. Y.
83058	Carr Fastener Co.	Cambridge, Mass.	92180	Tra-Connector Corp.	Peabody, Mass.	98978	International Electronic Research Corp.	Burbank, Calif.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N. H.	92357	Elgeet Optical Co., Inc.	Rochester, N. Y.	99109	Columbia Technical Corp.	New York, N. Y.
83125	General Instrument Corp., Capacitor Div.	Darlington, S. C.	92507	Tensolite Insulated Wire Co., Inc.	Fairytown, N. Y.	99313	Varlan Associates	Palo Alto, Calif.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.	92702	IMC Magnetics Corp.	Westbury Long Island, N. Y.	99378	Allee Corp.	Wichester, Mass.
83186	Victory Eng. Corp.	Springfield, N. J.	92966	Hudson Lamp Co.	Keeney, N. J.	99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
83298	Beadix Corp., Red Bank Div.	Red Bank, N. J.	93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.	99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
83315	Hubbell Corp.	Mundelein, Ill.	93359	Robbins & Myers Inc.	Pittsades Park, N. J.	99800	Delevan Electronics Corp.	East Aurora, N. Y.
83324	Rosan Inc.	Newport Beach, Calif.	93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio	99848	Hilco Corporation	Indianapolis, Ind.
83330	Smith, Herman H., Inc.	Brooklyn, N. Y.	93632	Waters Mfg. Co.	Culver City, Calif.	99928	Branson Corp.	Whippany, N. J.
83332	Tech Labs	Palisades Park, N. J.	93929	G. V. Controls	Livingson, N. J.	99934	Reabrandt, Inc.	Boston, Mass.
83385	Central Screw Co.	Chicago, Ill.	94137	General Cable Corp.	Bayonne, N. J.	99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.	94142	Phelps Dodge	Yonkers, N. Y.	99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N. J.	94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.			
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N. Y.	94148	Scientific Electronics Products, Inc.	Levensand, Colo.			
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	94154	Wager Elect. Corp., Tung-Sol Div.	Howark, N. J.			
83821	Loyd Scruggs Co.	Festus, Mo.	94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N. J.			
83942	Aeronautical Inst. & Radio Co.	Lodi, N. J.	94222	South Chester Corp.	Chester, Pa.			
84171	Arco Electronics Inc.	Great Neck, N. Y.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.			
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.	94375	Automatic Metal Products Co.	Brooklyn, N. Y.			
84411	TRW Capacitor Div.	Ogallala, Neb.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.			
84970	Sarkis Tarzian, Inc.	Bloomington, Ind.	94696	Magnecraft Electric Co.	Chicago, Ill.			
85454	Bonnton Molding Company	Bonnton, N. J.	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.			
85471	A. B. Boyd Co.	San Francisco, Calif.	95236	Allies Products Corp.	Dania, Fla.			
85474	R. M. Braccante & Co.	San Francisco, Calif.	95238	Continental Connector Corp.	Woodside, N. Y.			
85660	Kollid Koids, Inc.	Harden, Conn.	95263	Leecraft Mfg. Co., Inc.	Long Island, N. Y.			
85911	Seamless Rubber Co.	Chicago, Ill.	95265	National Coil Co.	Sheridan, Wyo.			
86174	Fairair Bearing Co.	Los Angeles, Calif.	95275	Vitramco, Inc.	Bridgeport, Conn.			
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	95348	Gordos Corp.	Bloomfield, N. J.			
86579	Precision Rubber Products Corp.	Dayton, Ohio	95354	Methodo Mfg. Co.	Rolling Meadows, 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.
0000Z	Willow Leather Products Corp.	Newark, N. J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Coofron	Oakland, Calif.
000RW	California Eastern Lab.	Burlington, Calif.
000YY	S. K. Smith Co.	Los Angeles, Calif.