Errata

Title & Document Type: **465A Amplifier Operating and Service Manual**

Manual Part Number: **00465-90003**

Revision Date: **April 1965**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

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Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

OPERATING AND SERVICE MANUAL

AMPLIFIER

465A

HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

MODEL 465A

AMPLIFIER

Serials Prefixed: 0970-

IMPORTANT NOTICE

Any changes made in instruments having serial numbers higher than the above number will be found in a "Manual Changes" supplement supplied with this manual. Be sure to examine this supplement for any changes which apply to your instrument and record these changes in the manual. Backdating information for instruments with lower serial numbers will be found in Appendix C.

-hp- Part No. 00465-90003

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

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HEWLETT hp PACKARD

CERTIFICATION

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

WARRANTY AND ASSISTANCE

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

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

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

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

1-5. INSTRUMENT AND MANUAL IDENTIFICATION

1-6. Instrument identification by serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix, separated by a letter designating the country in which the instrument was manufactured. If the four-digit prefix of the serial number of your instrument is lower than the prefix shown on the title page of this manual, backdating information located in Appendix C will define the differences between your instrument and the Model 465A described in this manual.

Table 1-1. Specifications

Voltage Gain: 20 dB (X10) or 40 dB (X100), open circuit.	Output Impedance: 50 ohms.
Gain Accuracy: ±0.1 dB (±1%) at 1000 Hz.	Noise: < 25 μV rms referred to input (with 1 MΩ 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 ±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 MΩ 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 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 mars 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 (±10%), 48-440 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. INSTALLATION.

2-10. 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.

2-11. RACK MOUNTING.

2-12. 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.

2-13. COMBINATION MOUNTING.

2-14. 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.

2-15. REPACKAGING FOR SHIPMENT.

2-16. 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.

2-17. 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.

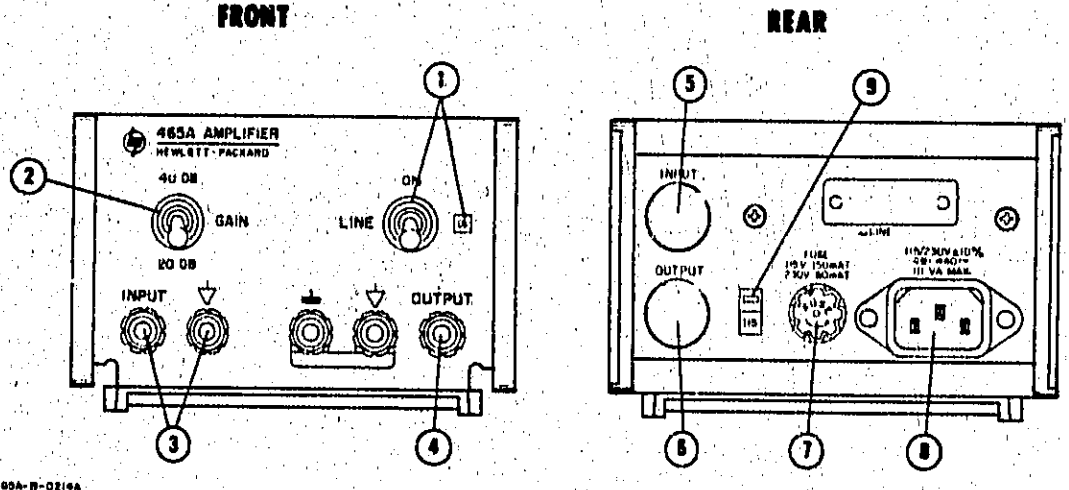
2-18. If original container is not to be used, proceed as follows:

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.



1. LINE ON: switches power voltage on; indicator glows when line voltage is on.
2. GAIN: selects 20 or 40 dB gain.
3. INPUT: banana-type connectors provide signal input and circuit common for the 465A.
4. OUTPUT: banana-type connectors provide signal output, circuit common, and chassis ground for the 465A. Removal of the ground strap between (⏚) and (⏚) permits floating dc operation.
5. INPUT (rear panel): BNC connector in parallel with front panel INPUT terminals is available on special basis.
6. OUTPUT (rear panel): BNC connector in parallel with front panel OUTPUT terminals is available on special basis.
7. FUSE: a.15 amp provides instrument protection for 115 volt operation. An optional .06 amp fuse provides protection for 230 volt operation.
8. AC POWER: accepts a 3-wire power cable with safety ground.
9. LINE VOLTAGE: a two-position slide switch selects 115 or 230 volt operation.

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 MΩ shunted by < 20 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 ±200 VDC OR ±25 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 ±500 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.

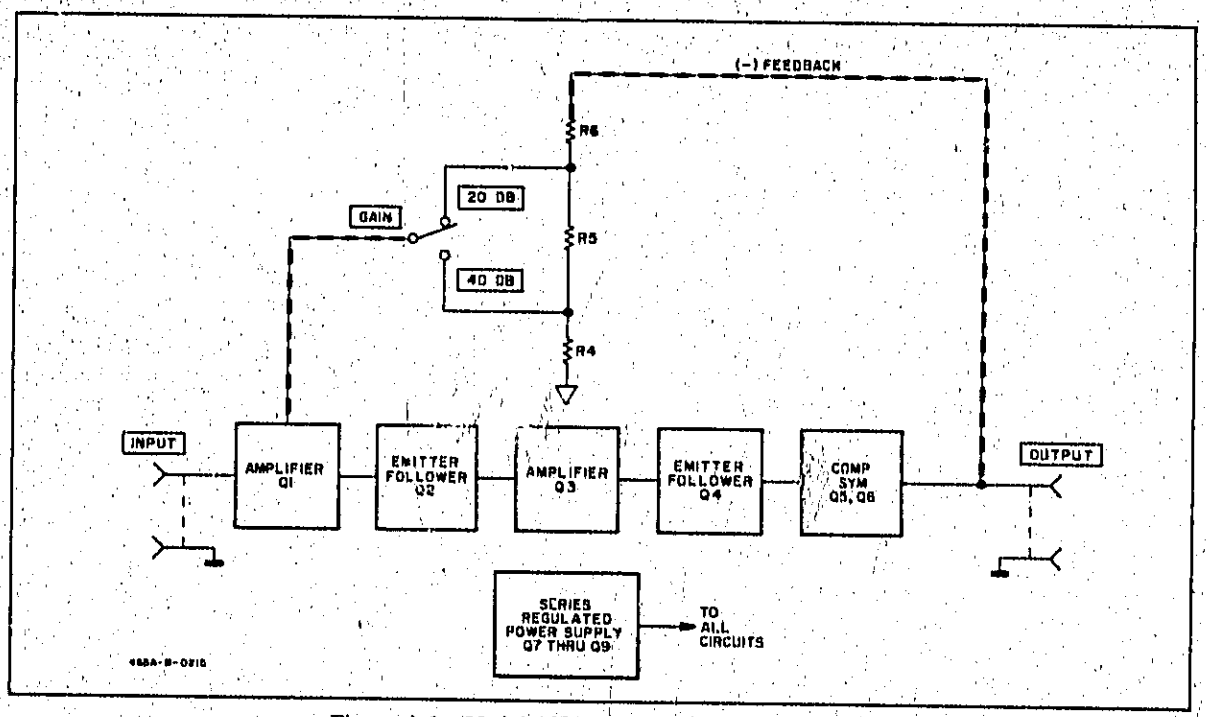


Figure 4-1. Model 465A Amplifier Block Diagram

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 20 dB of gain. Q1 and Q3 together give a total of 60 dB gain, of which 40 dB is used as feedback and 20 dB is retained as the closed loop gain. When the GAIN switch is on 40 DB, C11 shunts R22, giving Q3 40 dB of gain. The 40 dB 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: ± 1% Voltage Range: 50 V full scale	Calibration	-hp- Model 3440A/3445A Digital Voltmeter
AC Voltmeter	Accuracy: ± 0.1% Frequency Range: 100 Hz - 50 kHz Accuracy: ± 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: ±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: ± 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 MΩ	Troubleshooting	-hp- Model 427A Multi-Function Meter
Resistor	50Ω Feed Thru - Termination 1 MΩ, 1%, 1/2 W 50Ω, 1%, 1/2 W 1 MΩ, 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 ±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.

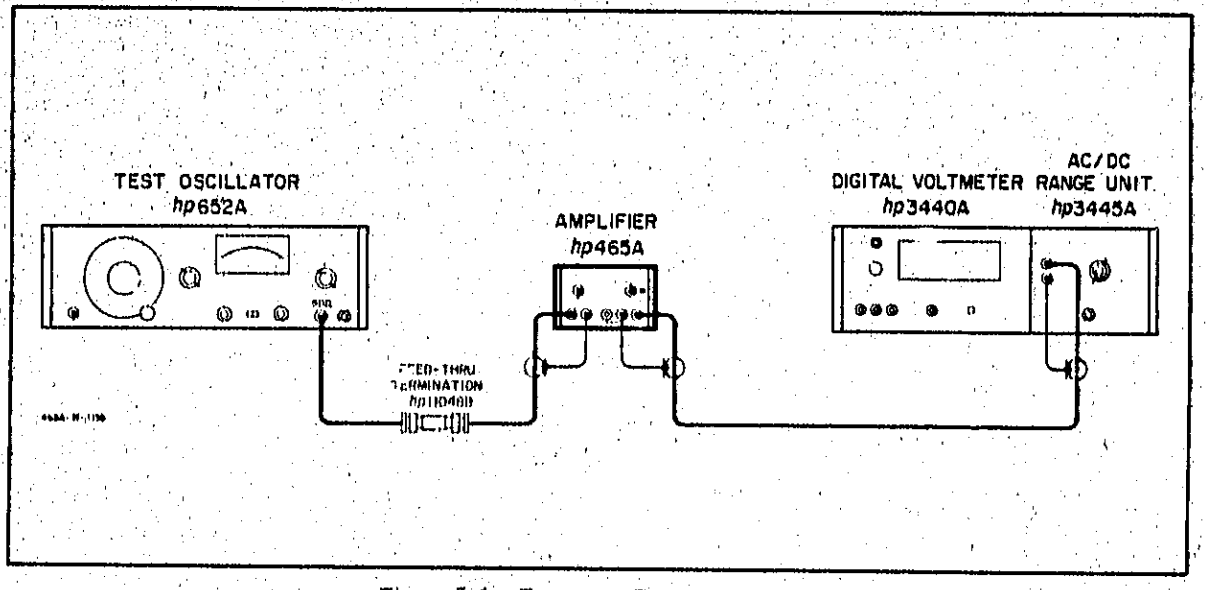


Figure 5-1. Frequency Response Check

Table 5-2. Frequency Response Test

-hp- Model 465A Gain (dB)	Oscillator -hp- Model 652A Frequency (Hz)	Amplitude (volts)	AC Voltmeter -hp- Model	Reading (volts)
20	1K	1.8	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	.18	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 MΩ 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 MΩ.

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 MΩ 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.

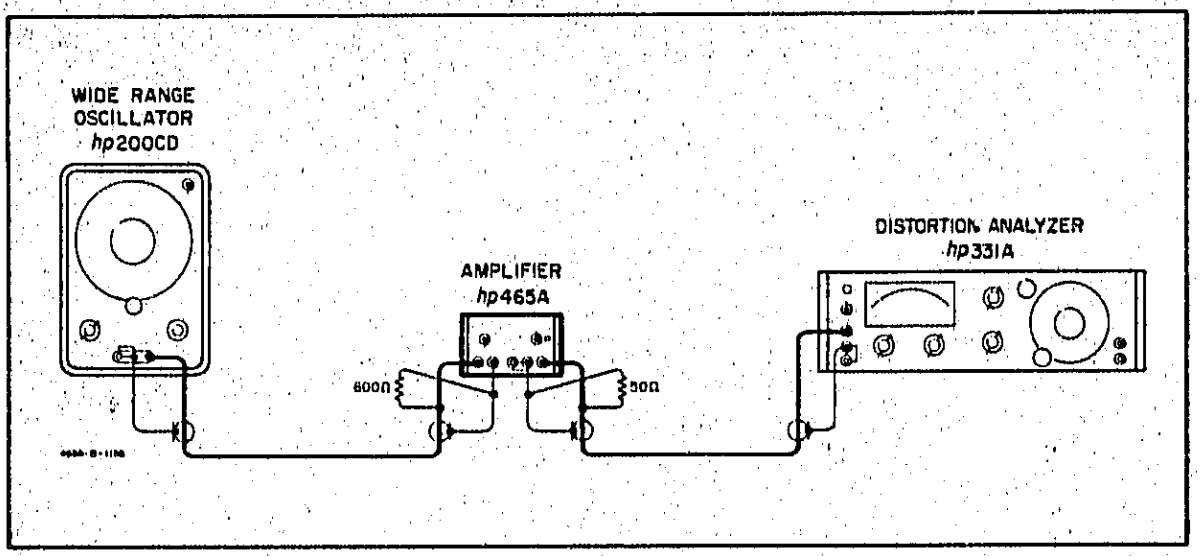


Figure 5-2. Distortion Check

5-12. NOISE CHECK.

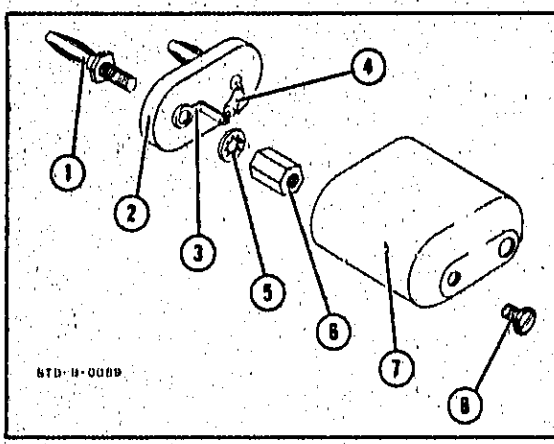
a. An AC Voltmeter (-hp- Model 331A) and a 1 MΩ shielded resistor (refer to Figure 5-3) will be required for this check.

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 Frequency	Output	-hp- Model 331A Distortion
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%



No.	Description	-hp- Part No.
1	Connector, male	1251-0174
2	Connector, male, w/insulator	1251-0175
3	Lug, terminal, 90°	0360-0042
4	Resistor, 1 MΩ, 1/2 w, 1% metal film	0757-0059
5	Washer, int. lock	2190-0007
6	Spacer, 6-32 threaded	0380-0058
7	Shield	1251-0173
8	Screw, bind. head, 6-32 x 1/4 inches	2470-0001

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. +47 V ADJUSTMENT (R32).

a. A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this adjustment. Set voltmeter RANGE to 100.

b. Connect the positive lead to + side of C20 and the common lead to circuit ground. DC Voltmeter should read + 47 ± 1 V.

c. If not, adjust R32 for proper reading.

5-16. BIAS ADJUSTMENT (R15).

a. Use a DC Voltmeter (-hp- Model 3440A/3445A) for this adjustment and set the RANGE to 100.

b. Connect the positive lead to + side of C15 and the common lead to circuit ground. DC Voltmeter should read + 23.0 ± 0.5 V.

c. If not, adjust R15 for proper reading.

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

a. The 1 kHz gain is adjusted by selecting a fixed value for resistors R3 and R38 as outlined in the following steps.

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

b. Connect Test Oscillator (-hp- Model 652A) to 465A INPUT using a 50Ω feed thru termination (-hp- Model 11048B).

c. Adjust oscillator output for 1 volt at 1 kHz using the -hp- Model 741B Differential Voltmeter and set 465A to 20 dB position.

d. Connect AC Digital Voltmeter (-hp- Model 3440A/3445A) to 465A OUTPUT and select a value of R38 for 10.00 (±0.05 volts) indication on Digital Voltmeter.

e. Adjust oscillator output for 0.1 volt at 1 kHz kHz using the Model 741B and set 465A to 40 dB position.

f. Select a value of R3 for 10.00 (±0.05 volt) indication on Digital Voltmeter.

5-18. 1 MHz ADJUST (C5).

a. Use a Test Oscillator (-hp- Model 652A and an AC Voltmeter (-hp- Model 331A) for this adjustment. Set the 465A GAIN to 20 dB.

b. Set the oscillator FREQUENCY to 1 MHz and adjust output for 1.0 V (verify with voltmeter).

c. 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.

a. Use a low-heat (25 to 30 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. 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.

c. Component lead hole should be cleaned with a toothpick or other appropriate device before inserting new lead.

d. 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.

e. 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		
1. ACCURACY AND GAIN CHECK:		MIN.	ACTUAL	MAX.
20 dB		9.9 V	_____	10.1 V
40 dB		9.9 V	_____	10.1 V
2. FREQUENCY RESPONSE:				
Gain (dB)	Freq.			
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:				
Gain (dB)	Freq.			
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 2kHz 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.	

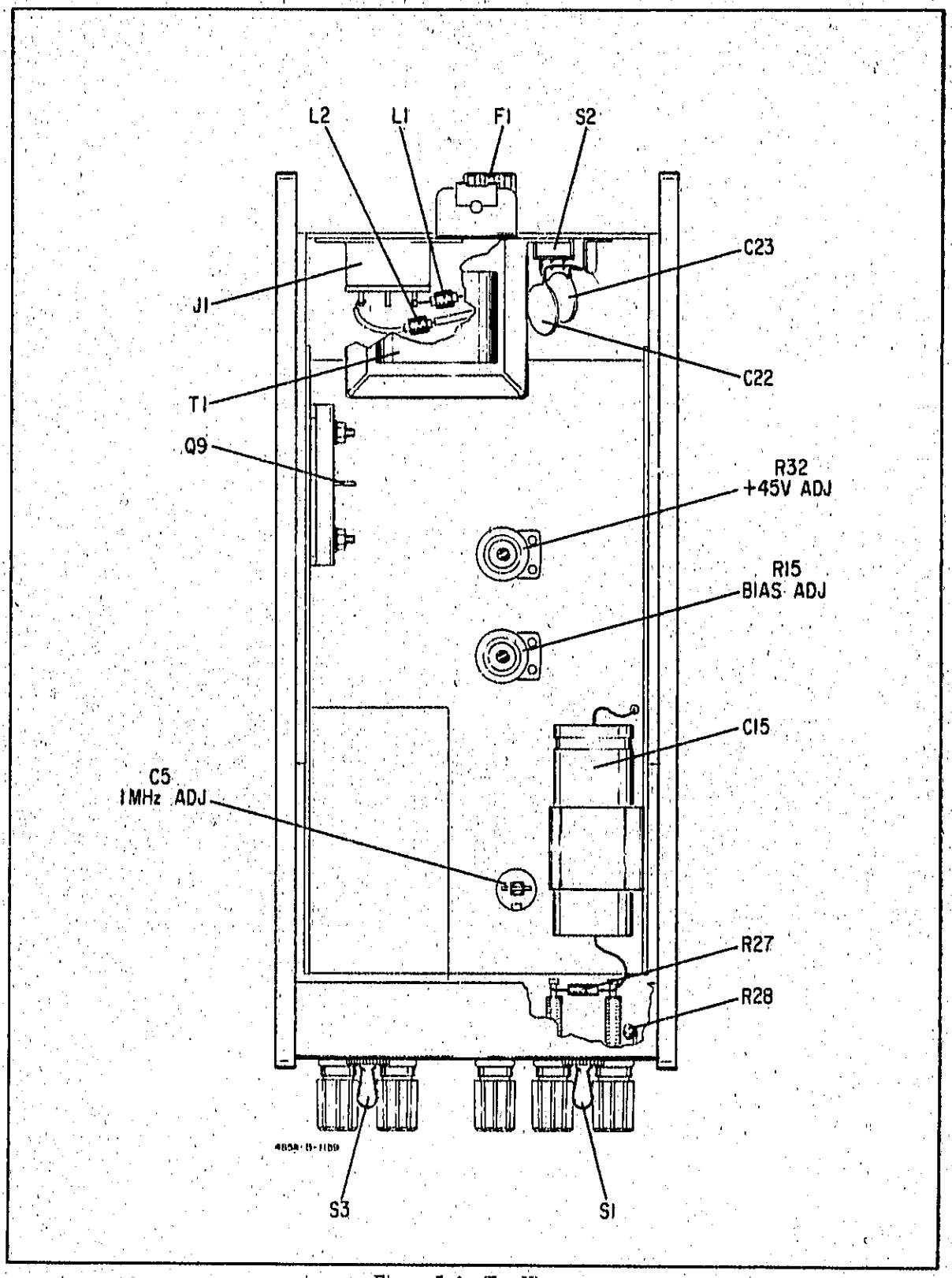
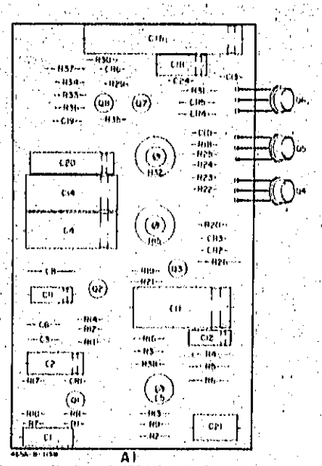


Figure 5-4. Top View



A1
(hp Part No. 00465-66501)

SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   - RESISTANCE IN OHMS
   - CAPACITANCE IN MICROFARADS
   - INDUCTANCE IN MICROHENRYS
3. ⏚ DENOTES EARTH GROUND.
   ▬ DENOTES CHASSIS GROUND.
   ⏚COM DENOTES CIRCUIT COMMON
4. ——— DENOTES ASSEMBLY
   ——— DENOTES MAIN SIGNAL PATH
   - - - DENOTES FEEDBACK PATH.
5. ▭ DENOTES FRONT PANEL MARKING.
   ▭ DENOTES REAR PANEL MARKING.
   ▰ DENOTES SCREWDRIVER ADJUST.
6. * AVERAGE VALUE SHOWN. OPTIMUM VALUE SELECTED AT FACTORY.
7. - - - DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
8. (024) DENOTES WIRE COLOR. COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDE STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. 024 = WHITE, RED, YELLOW.)

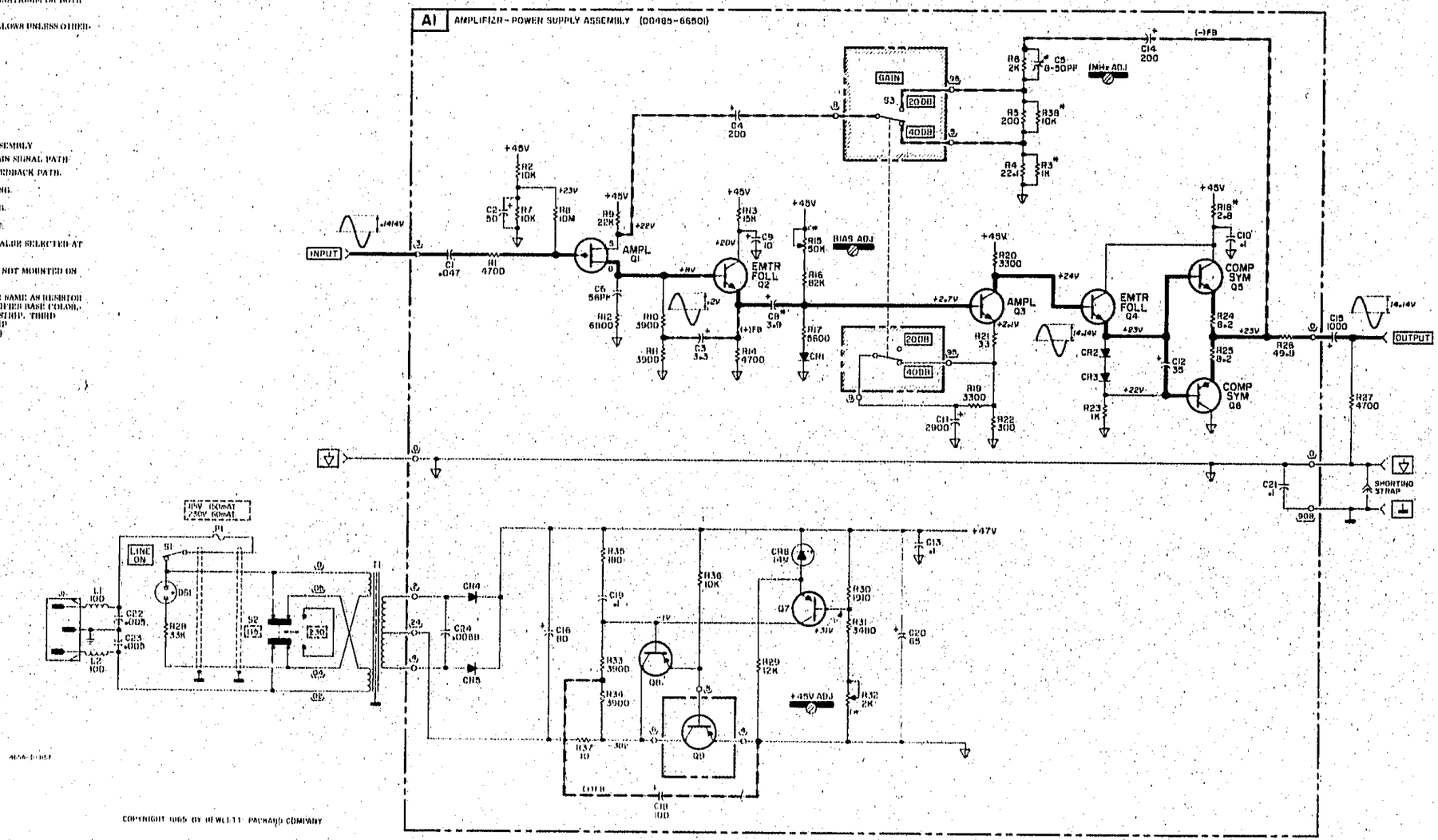


Figure 5-5. Amplifier Schematic.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical 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.

ABBREVIATIONS

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

(R) Dupont de Nemours

DECIMAL MULTIPLIERS

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

STD-B-2734

DESIGNATORS

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

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

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	00465-66501		1	Board Etched Circuit Assembly Power Supply-Amplifier includes: C1 thru C24 Q1 thru Q8 CR1 thru CR6 R1 thru R39	-hp-	
A1C1	0170-0060		1	C: fxd my die 0.047 μF ±10% 400 vdcw	01281	Type 663 UW
A1C2	0180-0105		1	C: fxd Al elect 50 μF +100% -10% 25 vdcw	56289	D34114
A1C3	0180-0161		1	C: fxd Ta elect 3.3 μF ±20% 35 vdcw	56289	150D335X0035 B2
A1C4	0180-0284		2	C: fxd Al elect +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 ±10%	04062	RCM15E560K
A1C7				Not assigned		
A1C8*	0180-0022		1	C: fxd Ta elect 3.9 μF ±10% 35 vdcw	56289	150D395X9035 B2
A1C9	0180-0059		1	C: fxd elect 10 μF +100% -10% 25 vdcw	56289	30D106G025BB4
A1C10	0150-0084		3	C: fxd cer dis 0.1 μF +80% -20% 50 vdcw	56289	33C41
A1C11	0180-1702		1	C: fxd Al elect 2000 μF +75% -10% 3 vdcw	56289	39D298G003GJ4DSD
A1C12	0180-0064		1	C: fxd elect 35 μF +100% -10% 6 vdcw	56289	30D156G006BD4
A1C13	0150-0084			C: fxd cer dis 0.1 μF +80% -20% 50 vdcw	56289	33C41
A1C14	0180-0284			C: fxd Al elect +75% -10%	56289	D38559
A1C15	0180-0378		1	C: fxd Al elect 1000 μF +100% -10% 30 vdcw	56289	(Type 34D) D40680-D8B
A1C16	0180-0110		1	C: fxd Al elect 80 μF 75 vdcw	56289	41D D33191
A1C17				Not assigned		
A1C18	0180-0061		1	C: fxd elect 100 μF +100% -10% 150 vdcw	56289	30D107G015DD4
A1C19	0150-0084			C: fxd cer dis 0.1 μF +80% -20% 50 vdcw	56289	33C41
A1C20	0180-0149		1	C: fxd Al elect +100% -10%	56289	Type 30D
A1C21	0170-0022		1	C: fxd my dis 0.1 μF ±20% 600 vdcw	01281	HEW-17
A1C22 thru A1C24	0150-0007		4	C: fxd cer 0.0068 μF ±2% 1000 vdcw	91418	B
A1CR1 thru A1CR3	1901-0025		1	Diode: Si 100 wiv 12 pF 100 ma	03332	D 3072
A1CR4, A1CR5	1901-0158		3	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			TSTR: Si NPN 2N3053	86684	2N3053
A1Q6	1853-0051		1	TSTR: Si PNP 2N4037	02735	2N4037
A1Q7, A1Q8	1853-0037		1	TSTR: Ge PNP 2N398B	86684	2N398B
A1R1	0687-4721		1	R: fxd comp 4700Ω ±10% 1/2 W	01121	EB 4721
A1R2	0687-1031		2	R: fxd comp 10 KΩ ±10% 1/2 W	01121	EB 1031
A1R3*	0686-1025		1	R: fxd comp 1000Ω ±5% 1/2 W	01121	EB 1025
A1R4	0757-0902		1	R: fxd prec met flm 22.1Ω ±1% 1/2 W	19701	MF7C T-O obd
A1R5	0698-3186		1	R: fxd prec met flm 200Ω ±1/2% 1/2 W	19701	CEC T-O obd
A1R6	0698-3187		1	R: fxd prec met flm 2000Ω ±1/2% 1/2 W	19701	MF7C T-O obd
A1R7	0687-1031		2	R: fxd comp 10 KΩ ±10% 1/2 W	01121	EB 1031
A1R8	0687-1061		1	R: fxd comp 10 MΩ ±10% 1/2 W	01121	EB 1061
A1R9	0687-2231		1	R: fxd comp 22 KΩ ±10% 1/2 W	01121	EB 2231
A1R10, A1R11	0687-3021		2	R: fxd comp 3300Ω ±10% 1/2 W	01121	EB 3021
A1R12	0687-6021		1	R: fxd comp 6800Ω ±10% 1/2 W	01121	EB 6821
A1R13	0687-1531		2	R: fxd comp 15 KΩ ±10% 1/2 W	01121	EB 1531
A1R14	0687-4721			R: fxd comp 4700Ω ±10% 1/2 W	01121	EB 4721
A1R15	2100-0094		1	R: var comp lin taper 50 KΩ ±30% 1/10 W	71450	UPE 70RE
A1R16	0686-8235		1	R: fxd comp 82 KΩ ±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			R: fxd comp 0.2Ω ±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 flm 1910Ω ±1% 1/2 W	75042	CEC T-O obd
A1R31	0698-3411		1	R: fxd prec met flm 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	0687-3021			R: fxd comp 3300Ω ±10% 1/2 W	01121	EB 3021
A1R35	0687-1811		1	R: fxd comp 180Ω ±10% 1/2 W	01121	EB 1811
A1R36	0687-1031			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	0160-3333			C: fxd cer 0.005 μF ±2% 1000 vdcw	91418	B
DS1	2140-0015		1	Lamp: glow	24455	obd
F1	2110-0320		1	Fuse: cartridge 0.15 amp	98997	3AG-TL-15/100
	2110-0311		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	1853-0063		1	TSTR: Ge PNP	77068	D-1493
R1 thru R26				Not assigned		
R27	0687-4721			R: fxd comp 4700Ω ±10% 1/2 W	01121	EB 4721
R28	0684-3331			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	3101-1234		1	Switch: slide DPDT	79727	G-326
S3	3101-0038		1	Switch: toggle DPDT 3 amp	04009	83054-B
T1	910.-1324		1	Transformer: power	-hp-	
W1	8120-1348		1	Cable assembly power: black, extra limp, 7.5 ft. long	70903	KH-4147
				MISCELLANEOUS		
	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-032-026B
	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.
	1251-2357			Connector: ac power cord receptacle	82389	AC-3
	1400-0084			Holder: fuse	75915	342014
	1490-0031			Stand: tilt	91260	obd
	5000-0700			Cover: side (blue)	-hp-	
	5000-8550			Cover: side (olive)	-hp-	
	5000-0711			Cover: bottom (blue)	-hp-	
	5000-8571			Cover: bottom (olive)	-hp-	
	5020-0700			Spacer: CAB	-hp-	
	5040-0234			Jewel: pilow light	-hp-	
	5040-0235			Base: pilot light	-hp-	
	5040-0700			Hinge	-hp-	
	5060-0700			Frame assembly	-hp-	
	5060-0700			Cover: top (blue)	-hp-	
	5060-8555			Cover: top (olive)	-hp-	
	5060-0727			Foot: assembly	-hp-	
	5060-4916			Terminal: ground black	-hp-	
	00465-00101			Plate: right	-hp-	
	00465-00102			Plate: left	-hp-	
	00465-00201			Panel: front (blue)	-hp-	
	00465-00202			Panel: front (olive)	-hp-	
	00465-00204			Panel: rear	-hp-	
	00465-01201			Bracket: transistor	-hp-	
	00465-90003			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
00000	U. S. A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Comco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00349	Micross, Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00809	Cruven, Ltd.	Whitby, Ontar., Canada
00813	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N. Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02206	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02878	Hudson Tool & Die	Newark, N. J.
03206	Nylon Molding Corp.	Springfield, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03767	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div., Finderne Plant	Somerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruna Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04217	Kaaen Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05008	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05583	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05816	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05824	Barber Colman Co.	Rockford, Ill.
05828	Tiffen Optical Co.	Hoslyn Heights, Long Island, N. Y.
05829	Metro-Tel Corp.	Westbury, N. Y.
05853	Stewart Engineering Co.	Santa Cruz, Cal.
05920	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	B. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Kimac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07128	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07232	Cinch-Graphik Co.	City of Industry, Cal.
07358	Silicon Transistor Corp.	Carle Place, N. Y.
07361	Avnet Corp.	Culver City, Cal.
07363	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07323	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp. The	Monterey Park, Cal.
07307	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Cal.
08280	Blinn, Delbert Co.	Pomona, Cal.
08359	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08684	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08808	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08884	Mel-Rain	Indianapolis, Ind.
08926	Babcock Relays Div.	Costa Mesa, Cal.
08987	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09211	Electro Assemblies, Inc.	Chicago, Ill.
09323	C & K Components Inc.	Newton, Mass.
09589	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09705	Pennsylvania Fluorocarbon Co.	Hilton Heights, Penn.
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11463	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Wichita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermalloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N. Y.
13606	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Semi-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14080	Williams Mfg. Co	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N. J.
15203	Webster Electronics Co.	New York, N. Y.
15287	Seiconics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15538	Micron Electronics, Garden City	Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N. J.
16554	Electroid Co.	Union, N. J.
16585	Boots Aircraft Ind. Corp.	Kokomo, Ind.
16699	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Trunes Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17740	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17850	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18085	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18478	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18698	TRW Elect. Comp. Div.	Des Plaines, Ill.
18569	Chunerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N. J.
19589	Conesa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LBC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
28365	Gries Reproducer Corp.	New Rochelle, N.Y.
28482	Grobert File Co. of America, Inc.	Carlstadt, N.J.
28851	Coppac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Sanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36267	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
38543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55033	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark.	Newark, N.J.
66295	Willek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co, Revere Mineral Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Birtley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.

Code No.	Manufacturer	Address
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71709	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72690	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72929	Cademan Co.	Chicago, Ill.
72982	Elastic Stop Nut Corp.	Union, N.J.
72984	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Bassen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73508	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. Mfg. Industries, Inc.,	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73845	Gosben Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	H.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	R.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76133	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostron Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.

Code No.	Manufacturer	Address
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Timerman Products, Inc.	Cleveland, Ohio
78750	Transformer Engineers	San Gabriel, Cal.
78947	Uehtitc Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Weico Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80240	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbian, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarland Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82210	Sylvania Electric Prod., Inc., Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rollon Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83188	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83319	Robbell Corp.	Mandeblein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tern Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavill Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Gleasener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
04870	Barker Tarzian, Inc.	Bloomington, Ind.
05454	Boonton Molding Company	Boonton, N.J.
05471	A. D. Boyd Co.	San Francisco, Cal.
05474	R. M. Bracamonte & Co.	San Francisco, Cal.
05660	Kollet Korda, Inc.	Hamden, Conn.
05911	Seamless Rubber Co.	Chicago, Ill.
06174	Fafnir Bearing Co.	Los Angeles, Calif.
06197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
06579	Precision Rubber Products Corp.	Dayton, Ohio
06884	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
06928	Seastrom Mfg. Co.	Glendale, Cal.
07034	Marco Industries	Anaheim, Cal.
07210	Philco Corporation (Lansdale Division)	Lansdale, Pa.
07473	Western Fibrous Glass Products Co.	San Francisco, Cal.
07664	Van Waters & Rogers Inc.	San Francisco, Cal.
07910	Tower Mfg. Corp.	Providence, R.I.
08140	Cutler-Hammer, Inc.	Lincoln, Ill.
08220	Gould-National Batteries, Inc.	St. Paul, Minn.
08698	General Mills, Inc.	Buffalo, N.Y.
08731	Graybar Electric Co.	Oakland, Cal.
09473	G.E. Distributing Corp.	Schenectady, N.Y.
09479	Security Co.	Detroit, Mich.
09665	United Transformer Co.	Chicago, Ill.
09030	United Shoe Machinery Corp.	Beverly, Mass.
09179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
09353	Belleville Specialty Tool Mfg., Inc.	Belleville, Ill.
09763	United Carr Fastener Corp.	Chicago, Ill.
09970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect., Inc., Salem Div.	Salem, Mass.
91260	Conner Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91508	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Mairo Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91981	Hahn-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Rigeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93389	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Remco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93832	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94149	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94378	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allied Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95588	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Sermon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96328	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96801	Thomson Ind, Inc	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Ideon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Tech, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Bic Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Palco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Reinbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

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

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

MANUAL BACKDATING CHANGES

MODEL 465A

AMPLIFIER

Manual Serial Prefixed: 530-
-hp- Part No. 00465-90002

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
530-00935 and below	1		

CHANGE 1

Serial Number 530-00935 and Below

1. Change A1R30 to R: fxd comp 1.91 KΩ, ±1%, 1/2 W
-hp- Part No. 0698-3341.
2. Change A1R31 to R: fxd comp 3.48 KΩ, ±1%, 1/2 W
-hp- Part No. 0698-3411.
3. Change A1R32 to R: var comp 2 KΩ, ±30%, lin 1/3 W
-hp- Part No. 2100-0090.
4. Change A1R35 to R: fxd comp 180Ω, ±10%, 1/2 W
-hp- Part No. 0687-1811.
5. Delete A1C17.

MANUAL CHANGES

-hp- MODEL 465A

AMPLIFIER

Manual Part Number 00465-90003

New or Revised Item

ERRATA

Page 5-7/5-8. Label INPUT/⏚ terminals J2. Label OUTPUT/⏚ / ⊥ terminals J3.

Page 6-2. Change description of A7Q7, Q8 to Tstr: Si PNP.

Page 6-3. Change description of Q9 to Tstr: Si PNP.

CHANGE NO. 1 for ALL Serial Numbers:

Page 1-1, Table 1-1. Change 50 to 400 Hz to 48 ~ 66 Hz.

Page 2-1, Paragraph 2-8. Change 440 Hz to 66 Hz.

Page 3-0, Figure 3-1, Index No. 4. Change (⏚) to (⊥) and (⏚) to (⏚).
On rear view, change 400 ~ to 66 Hz.
Add word SELECTOR above switch (Index No. 9).

CHANGE NO. 2 for Serial Numbers 0970A03911 and Above.

Page 6-4. Add 5061-0748, 3 (TO), Socket Ass'y: Xstr.

CHANGE NO. 3 for Serial Numbers 0970A04681 and Above.

Page 5-7/5-8, Figure 5-5. Change A1C21 to 0.09.

Page 6-2. Change A1C21 to 0160-4316, 0.09 μF.

CHANGE NO. 4 for Serial Numbers 0970A4161 and Above.

Page 6-3.

Add: J2, 1510-0091, 2, Binding Post Ass'y
J3, 1510-0091, 2, Binding Post Ass'y
1510-0107, 1, Binding Post Ass'y

Page 6-4.

Add: J1 as Reference Designator for 1251-2357, Connector: as power cord receptacle 00465-00602, Shield: Bottom.

Delete: 5060-4916, Terminal: ground black. For instruments with Serial Numbers 0970A4161 and above delete all references to grounding strap as it is no longer provided.

CHANGE NO. 5 for Serial Numbers 0970A04191 and Above.

Page 6-3. Change 1200-0043 to 0340-0580.

ERRATA

Page 5-2, Paragraph 5-10. Change as follows:

5-10. OUTPUT CHECK.

a. Connect the equipment as indicated in Figure 5-1, and set the 465A gain to 20 dB.

NOTE

Keep all cable lengths as short as possible.

b. Set the oscillator frequency to 50 kHz and increase oscillator amplitude until the 465A output reads greater than 10.0 V. This verifies the open circuit output voltage specification.

c. Connect a 50 Ω ± 2%, ½ Watt, Resistor, -hp- Part Number 0698-5871 or equivalent to the 465A OUTPUT. Note the output voltage; it should be greater than 5 volts. This verifies the maximum output voltage specification when operating into 50 ohms.

d. Reduce the oscillator amplitude until the output from the 465A reads 5.0 V.

e. Disconnect the 50 ohm load from the 465A OUTPUT, and note the voltmeter reading. It should indicate approximately 10.0 V. This verifies the output impedance. If the voltage observed is significantly different from 10 volts, i.e., ± 1.0 V, there is most likely a problem in the amplifier.

Page 5-2, Table 5-2. Delete the "AMPLITUDE (Volts)" column.

Page 5-4(a). Performance Check Test Card. Under Test Limits Column make the following changes.

1. For frequence response, change first and fifth entries from "7.2 V 10.8 V" to "8.1 V 9.9 V".

2. For distortion, change the third and fourth entries from < 2% to < 1%.

CHANGE NO. 6 Applies to All Serial Numbers Prefixed 0970.

Page 1-1, Table 1-1. Add a new section called Options. Option 910: An additional Operating and Service Manual, Part Number 00465-90003.

Page 2-1, Section II. Add new paragraph between 2-14 and 2-15.

Options.

Option 910. An additional Operating and Service Manual, Part Number 00465-90003.

CHANGE NO. 7 Applies to Serial Numbers 0978A04581 and Above.

Page 6-4, Table 6-1. Change the Part Number for the rear panel from 00465-00204 to 00465-00205. Add the following Part Numbers and Descriptions:

2110-0470	Fuhlr-Extr Post	
2110-0465	Cap	

Required Hardware

2110-0467	Nut-Hex	
1400-0090	Washer	Qty. 1
2190-0054	Washer	Qty. 1

CHANGE NO. 8 Applies to Serial Number 0978A04836 and Above.

Pages 6-2 and 6-3, Table 6-1. Change the following Part Numbers:

Reference Designator	From:	To:
A1	00465-66501	00465-66502
A1R15	2100-0096	2100-3253
A1R32	2100-0090	2100-0567

CHANGE NO. 9 Applies to All Serial Numbers.

Page 6-3, Table 6-1. Add the following Part Number and Description:

0340-0583 Insulator-Transistor

ERRATA.

Page 6-4. Add the following part:

hp Part No.	TQ	Description
2260-0001	2	Hex Nut

Page 5-2, Paragraph 5-11, Step a. Add the following sentence: "Connect the chassis ground (⏚) to the circuit common (⏚)."

Page 5-3, Paragraph 5-12, Step c. Add the following sentence: "Connect the chassis ground (⏚) to the circuit common (⏚)."

CHANGE NO. 10 Applies to Serial Number 0978A07651 and Above.

Page 6-2.

a. Change A1 PC assembly to 00465-66502.

b. Change A1R32 to 2100-0567, Resistor-Variable 2 kΩ trimmer.

c. Change A1R15 to 2100-3253, Resistor-Variable 50 kΩ 10%.

d. Change A1C8* to A1C8.

Page 6-3. Change A1R18* to A1R18.

CHANGE NO. 11 Applies to Serial Number 0978A04836 and Above.

Page 6-4.

a. Change Plate: right to Part Number 00465-00111.

b. Add the following parts:

hp Part No.	TQ	Description
0360-0024	1	Term-Lug-Sldr
1400-0507	1	Cable-Tie
2950-0144	5	Nut-Hex-Dbl Chan

CHANGE NO. 12 Applies to Serial Number 0978A05058 and Above.

Page 6-3. Change A1R28 to 0683-2235, Resistor-Fxd 22 k ohms 5% ¼ Watt.

Page 6-2. Change A1C3 to 0180-0022, Capacitor-Fxd 3.9 μF 35 V.

CHANGE NO. 13 Applies to Serial Number 0978A05178 and Above.

Page 6-3. Change Q9 to 1853-0305, Transistor: PNP 2N5875.

CHANGE NO. 14 Applies to Serial Number 0978A05431 and Above.

Page 6-3. Change S1 and S2 to 3101-0460.