465A
AMPLIFIER

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

HP 465A

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. No other warranty is expressed or implied. We are not liable for consequential damages.

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

OPERATING AND SERVICE MANUAL

(HP PART NO. 00465-90000)

MODEL 465A
AMPLIFIER

SERIALS PREFIXED: 511-

01775-1

Printed: MARCH 1965

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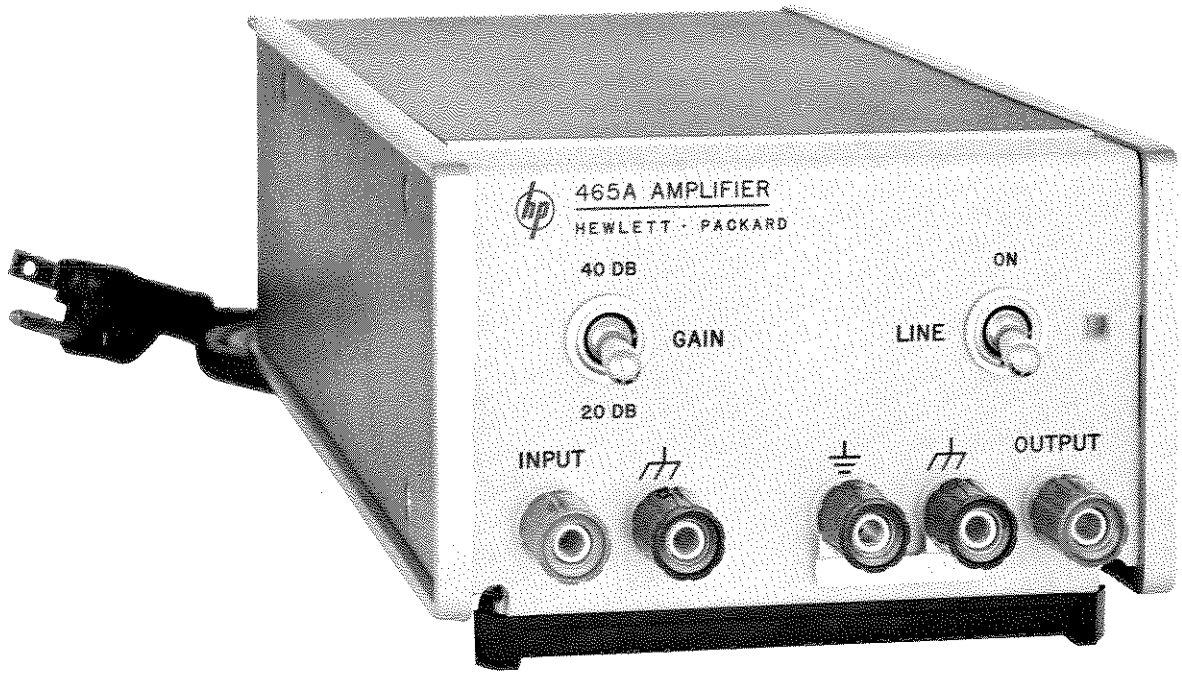


Figure 1-1. Hewlett-Packard Model 465A Amplifier

Table 1-1. Specifications

Voltage Gain: 20 db (X10) or 40 db(X100), open circuit.	Distortion: 1%, 5 cps to 100 kc; 2%, 100 kc to 1 Mc.
Gain Accuracy: ±0.1 db (±1%) at 1000 cps.	Input Impedance: 10 megohms shunted by < 20 pf.
Frequency Response: ±0.1 db, 100 cps to 50 kc; less than 2 db down, 5 cps to 1 Mc.	Output Impedance: 50 ohms
Output: greater than 5 volts rms into 50 ohms (1/2 watt); greater than 10 volts rms open circuit.	Noise: not greater than 25 μv rms referred to input (with 1 megohm across input).
	Weight: 3 lbs, 12 oz.

SCOPE

This manual contains the information necessary for operating and servicing the standard Model 465A Amplifier and the Model 465A/Option 01 Amplifier (rear input connectors in parallel with front panel connectors).

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp- Model 465A is a general-purpose amplifier, and an ideal impedance converter (10 megohms to 50 ohms). This amplifier has extremely stable 20 db or 40 db gain over a continuous frequency range of 5 cps to 1 megacycle. Either gain may be selected quickly with a switch on the front panel. The output stage provides low output impedance and wide dynamic range. The -hp- 465A is a three-terminal device isolated from chassis and may be floated up to 500 volts dc above chassis ground.

1-3. INSTRUMENT IDENTIFICATION.

1-4. 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.

1-5. If the first three digits of the two-section, eight-digit serial number are prefixed with an E or G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.

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%), 50-1000 cps. 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).

2-12. BENCH MOUNTING.

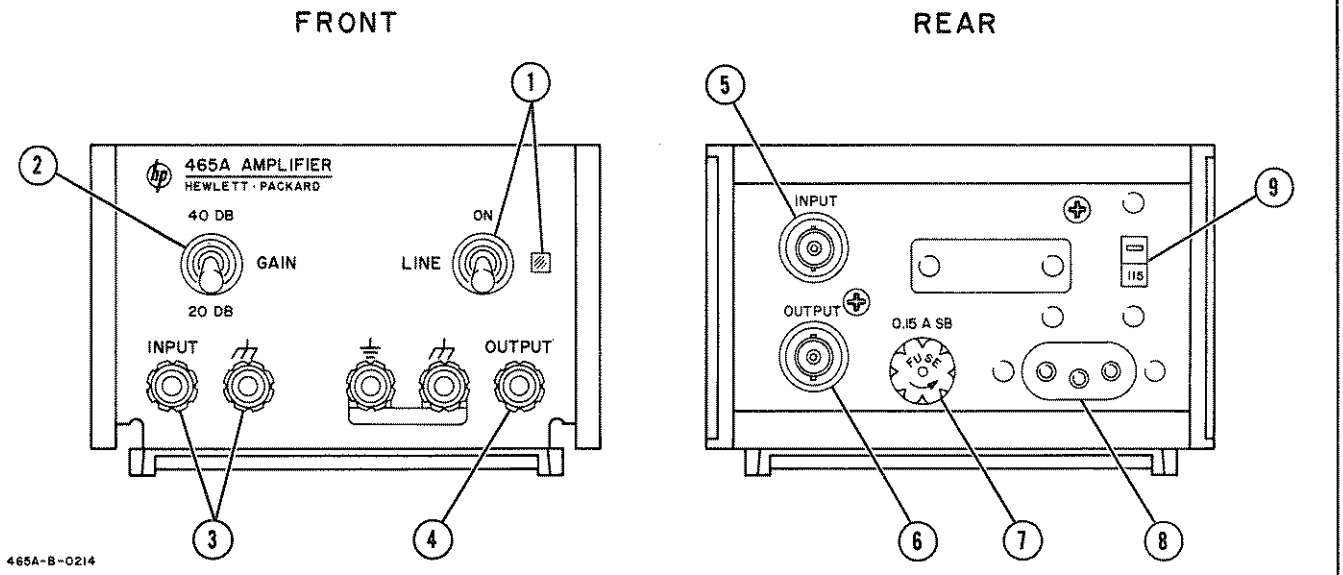
2-13. The Model 465A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. RACK MOUNTING.

2-15. The Model 465A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office (see Appendix B for office locations).

2-16. COMBINATION MOUNTING.

2-17. The Model 465A may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 11051A, 11052A, or both, depending on depth). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module instrument.



(1) LINE ON: switches power voltage on; indicator glows when line voltage is on.

(2) GAIN: selects 20 or 40 db gain.

(3) INPUT (front panel): banana-type connector that provides signal input and circuit common for the instrument.

(4) OUTPUT (front panel): banana-type connectors that provide signal output circuit common and chassis ground for the instrument. The ground strap between (⏚) and ⏚ permits floating dc operation.

(5) INPUT (rear panel): BNC connectors connected in parallel with the INPUT terminals on the front panel. (Option 01 only)

(6) OUTPUT (rear panel): BNC connectors connected in parallel with the OUTPUT terminals on the front panel. (Option 01 only)

(7) FUSE: contains a fuse which provides protection for the primary circuit of the instrument transformer. The fuse is used for both 115 and 230 volt operation.

(8) AC POWER: accepts a 3-wire power cable with safety ground.

(9) LINE VOLTAGE: a two-position slide switch; sets the 465A for 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 Amplifier can be operated as: (1) a general purpose amplifier/preamplifier, (2) oscilloscope preamplifier, (3) oscillator power amplifier, (4) impedance converter (5 x 10^8 power gain) and (5) in-system amplifier unit.

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. DESCRIPTION OF CONTROLS.

3-4. Figure 3-1 gives a description of the front panel 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.

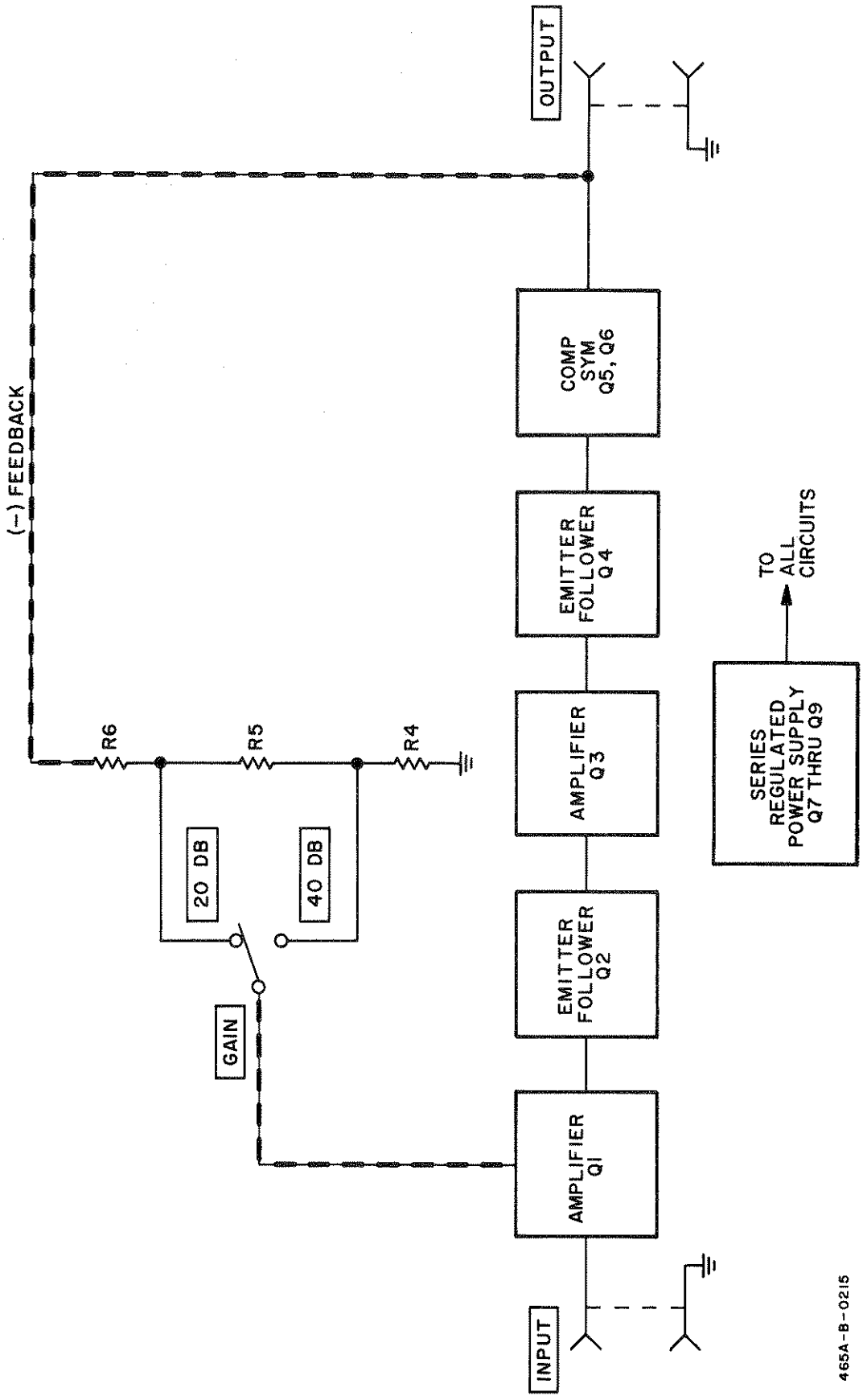


Figure 4-1. Model 465A Amplifier Block Diagram

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 the amplifier circuitry.

4-5. DETAILED CIRCUIT DESCRIPTION.

4-6. Refer to Figure 5-8 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; Q2 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 1 Mc. 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. C17 couples all ac output to Q7 to provide better ripple reduction.

Table 5-1. Test Equipment Required

Instrument	Critical Specifications	Use	Recommended Model
DC Voltmeter	Accuracy: ±2% Voltage Range: 50 v full scale	Performance Checks	-hp- Model 3440A/3445A AC-DC Digital Voltmeter
Test Oscillator	Frequency Range: 10 cps to 1 Mc Voltage Output: 1 v	Performance Checks	-hp- Model 651A Test Oscillator
Oscilloscope	Frequency: 2 kc Vertical Sensitivity: 10 v/cm	Troubleshooting	-hp- Model 130C Oscilloscope
AC Voltmeter	Accuracy: ±1%, 100 cps to 50 kc ±2%, 10 cps to 1 Mc Voltage Range: 10 v Frequency Range: 10 cps to 1 Mc	Performance Checks	-hp- Model 3440A/3445A AC-DC Digital Voltmeter -hp- Model 331A Distortion Analyzer
Variable Voltage Line Transformer	Voltage Range: 103.5 to 126.5 v Output Power: 10 watts	Performance Checks	Superior Electric Co. Type 3PN-116
Ohmmeter	Ohms Range: 10 M ohms	Troubleshooting	-hp- Model 3440A/3445A Multi-Function Unit
Frequency Response Test Set	Frequency: 10 cps to 1 Mc with external oscillator Voltage Output: 10 v	Performance Checks	-hp- Model 739AR Frequency Response Test Set
Distortion Analyzer	Frequency: 10 cps to 500 kc Sensitivity: 1% full scale	Performance Checks	-hp- Model 331A Distortion Analyzer
DC Power Supply	Voltage Output: +45 v Current Limit: 75 ma	Troubleshooting	-hp- Model 723A DC Power Supply
Resistor	1 M ohm, 1%, 1/2 w 50 ohms, 1%, 1 w 1 M ohm, shielded load	Performance Checks	-hp- Part No. 0757-0059 -hp- Part No. 0757-0024 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.

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. A Test Oscillator (-hp- Model 651A) and an AC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.

b. Set Model 465A to 20 db.

c. Connect test oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 1 kc; adjust amplitude for 1.00 v rms output (verify with ac voltmeter).

d. Connect ac voltmeter to Model 465A OUTPUT. Voltmeter should read between 9.90 and 10.1 v. If correct, adjust oscillator output amplitude for ac voltmeter reading of 1.0 v as measured at output of 465A. This corresponds to an input of 100 mv.

e. Switch Model 465A to 40 db. AC voltmeter should read between 9.90 and 10.1 v.

5-8. FREQUENCY RESPONSE CHECK.

a. Figure 5-1 describes the test arrangement recommended. A Test Oscillator (-hp- Model 651A), a Frequency Response Test Set (-hp- Model 739AR) and an AC Voltmeter (-hp- Model 331A and 3440A/3445A) will be required. -hp- Model 3440A/3445A will be used for frequencies from 50 cps to 100 kc; -hp- Model 331A will be used at all other frequencies.

b. Connect Model 465A as shown in Figure 5-1. Set GAIN to 20 DB.

c. Set ac voltmeter RANGE to 10 V.

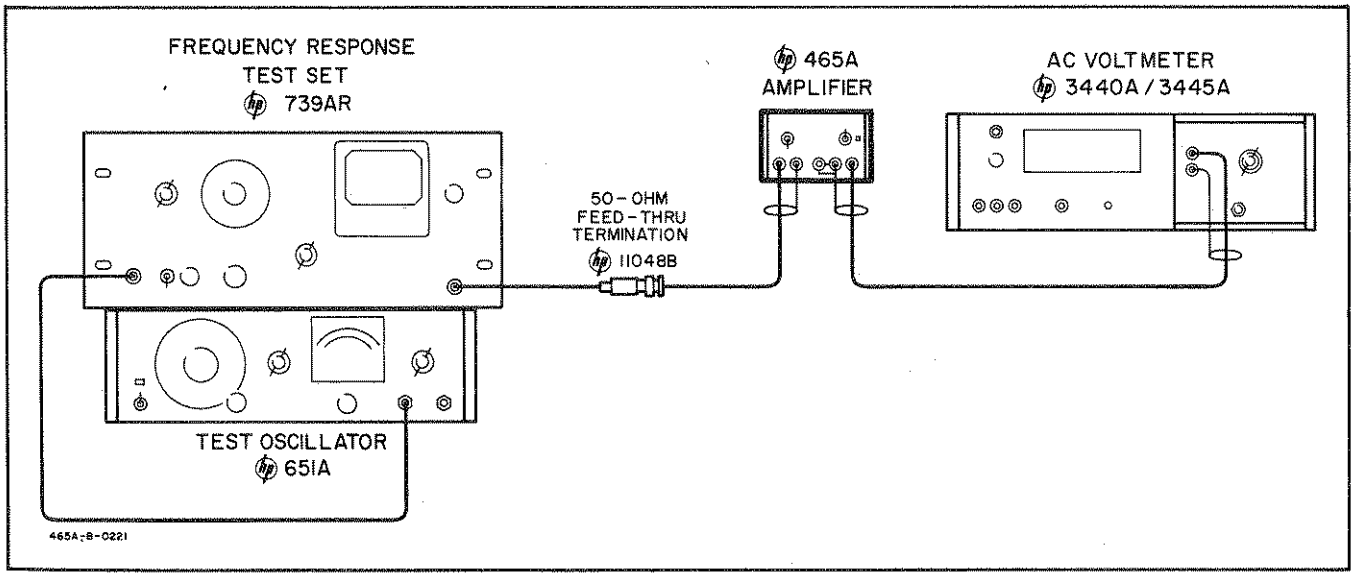


Figure 5-1. Frequency Response Check

Table 5-2. Frequency Response Test

-hp- Model 465A GAIN (db)	Oscillator -hp- Model 651A Range	Oscillator -hp- Model 651A Frequency (cps)	F.R.T.S. -hp- Model 739AR Output Attenuator	AC Voltmeter -hp- Model 3440A/3445A or 331A Range	AC Voltmeter -hp- Model 3440A/3445A or 331A Readings
20	1 K	1	1.0	10	9.0 v
20	10	1	1.0	10	08.1 to 09.9 v
20	100	1	1.0	10	08.9 to 09.1 v
20	10 K	5	1.0	10	08.9 to 09.1 v
20	1 M	1	1.0	10	7.2 to 10.8 v
40	1 K	1	.1	10	9.0 v
40	10	1	.1	10	08.1 to 09.9 v
40	100	1	.1	10	08.9 to 09.1 v
40	10 K	5	.1	10	08.9 to 09.1 v
40	1 M	1	.1	10	7.2 to 10.8 v

d. Set frequency response test set to EXTERNAL; OUTPUT ATTENUATOR to 1.0 .

e. Set oscillator frequency to 1 kc; adjust output amplitude to provide ac voltmeter reading of 9.0 v.

f. Adjust frequency response test set METER SET to convenient SET LEVEL.

g. Reset oscillator frequency to 10 cps. Adjust oscillator amplitude to re-establish SET LEVEL, if required. AC voltmeter should read between 8.1 and 9.9 v.

h. Repeat step g above for oscillator frequencies listed in Table 5-2. AC voltmeter should read within limits specified.

j. When going from 20 db to 40 db, re-adjust oscillator output for ac voltmeter reading of 9.0 v at 1 kc. Reset frequency response test set METER SET for SET LEVEL. Repeat above test using frequency setttings provided in Table 5-2.

5-9. INPUT IMPEDANCE CHECK.

a. A Test Oscillator (-hp- Model 651A), an AC Voltmeter (-hp- Model 3440A/3445A) and a 1 M ohm ±1%, 1/2 watt resistor (-hp- Part No. 0757-0059) will be required.

b. Set Model 465A GAIN to 20 db.

c. Connect ac voltmeter to Model 465A OUTPUT. Set RANGE to 10 V.

d. Connect oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 100 cps; adjust output amplitude for ac voltmeter reading of 10 v.

e. Insert 1 M ohm resistor in series with oscillator and Model 465A INPUT (resistor must be connected directly to Model 465A INPUT with nothing else across input terminals). AC voltmeter should read approximately 9.1 v (±0.4v). This verifies a Model 465A input resistance of 10 M ohms.

f. Reset oscillator frequency to 10 kc. Insure that oscillator output is still 1.0 v. AC voltmeter should read more than 6.0 v. This verifies a Model 465A input impedance of 10 M ohms, shunted by 20 pf.

5-10. OUTPUT IMPEDANCE CHECK.

a. A Test Oscillator (-hp- Model 651A), an AC Voltmeter (-hp- Model 331A) and a 50 ohm ±1%, 1 watt resistor (-hp- Part No. 0727-0024) will be required for this test.

b. Set Model 465A GAIN to 20 db.

c. Connect ac voltmeter to Model 465A OUTPUT; set RANGE to 10 V.

d. Connect oscillator OUTPUT to Model 465A INPUT. Set frequency to 1 kc; adjust output for ac voltmeter reading of 10 v.

e. Place 50 ohm resistor across Model 465A OUTPUT. AC voltmeter reading should drop to 5.0 v. This verifies Model 465A output impedance of 50 ohms.

5-11. DISTORTION CHECK.

a. Figure 5-2 describes the test arrangement recommended. A Test Oscillator (-hp- Model 651A), a Distortion Analyzer (-hp- Model 331A) and a Frequency Response Test Set (-hp- Model 739AR) will be required.

b. Connect Model 465A as shown in Figure 5-2.

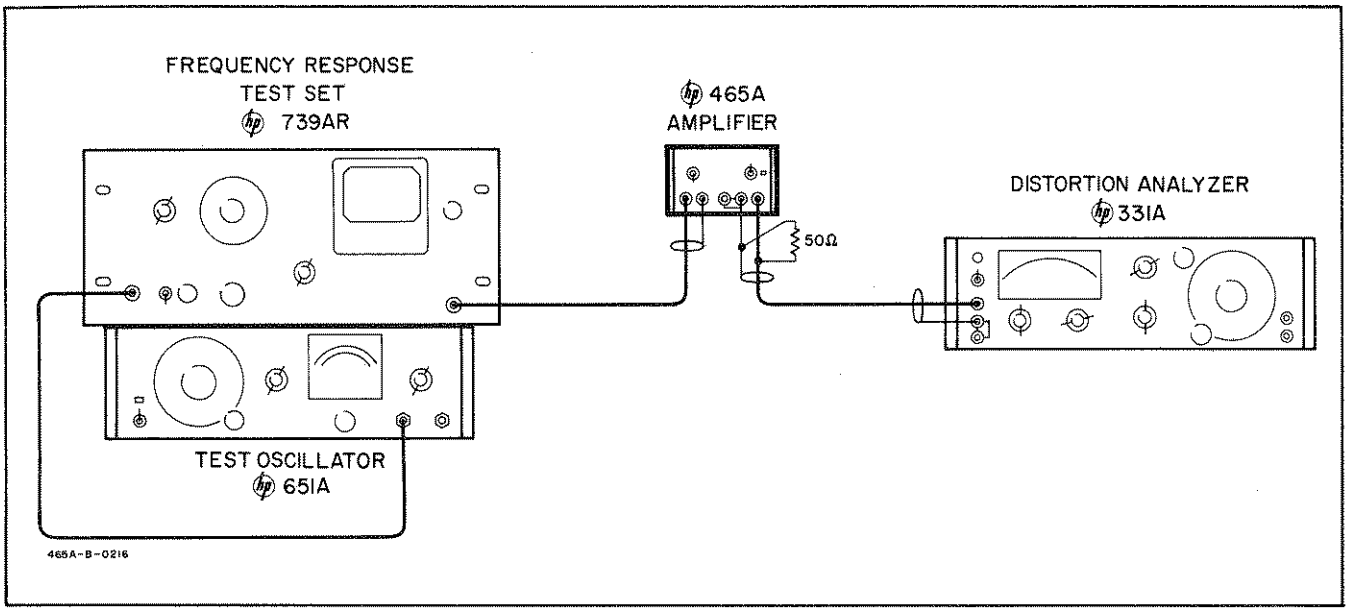


Figure 5-2. Distortion Check

c. Set Model 465A GAIN to 20 DB.

d. Set distortion analyzer to METER.

e. Set oscillator frequency to 1 kc; adjust oscillator output to provide distortion analyzer (voltmeter) reading of 5 v.

f. Adjust frequency response test set METER SET control to desired SET LEVEL.

g. Switch distortion analyzer FUNCTION to SET LEVEL;METER RANGE to SET LEVEL and SENSITIVITY for upscale meter deflection. Adjust VERNIER for full scale reading of 1 (100%).

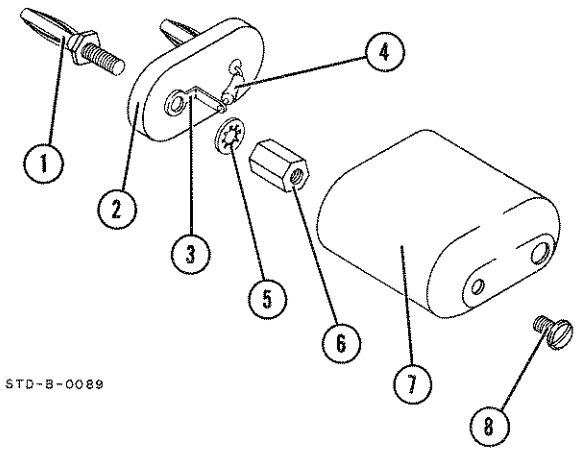
h. Rotate FUNCTION switch to DISTORTION. Null out fundamental of signal by alternately reducing METER RANGE and adjusting BALANCE and frequency control knob for null.

j. Final null will indicate amount of distortion (%) present in Model 465A output signal. At 1 kc, distortion should be less than 1%.

k. Repeat the above test for oscillator frequencies listed in Table 5-3. Entire test should be repeated with Model 465A GAIN set to 40 db. Refer to Table 5-3 for oscillator frequencies and distortion tolerances. Monitor frequency response test set SET LEVEL to insure constant oscillator output amplitude.

Table 5-3. Distortion Check

-hp- Model 465A Gain (db)	Oscillator -hp- Model 651A		Distortion Analyzer -hp- Model 331A	
	Frequency	Output	Frequency	Maximum Disposition
20	1 kc	1.0 v	1 kc	1%
20	50 kc	1.0 v	50 kc	1%
20	500 kc	1.0 v	500 kc	2%
20	10 cps	1.0 v	10 cps	1%
40	1 kc	0.1 v	1 kc	1%
40	50 kc	0.1 v	50 kc	1%
40	500 kc	0.1 v	500 kc	2%
40	10 cps	0.1 v	10 cps	1%



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 M Ω , 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

5-12. NOISE CHECK.

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

b. Connect ac voltmeter to Model 465A OUTPUT; RANGE to .003 V.

c. Set Model 465A GAIN to 40 db.

d. Connect 1 megohm shielded resistor across Model 465A INPUT.

e. AC voltmeter must read less than 2.5 mv (or 25 microvolts referred to input).

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. Indescriminate 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 5-21, Troubleshooting Techniques, for possible cause and recommended corrective action.

5-15. POWER SUPPLY ADJUST (+45 V).

a. A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.

b. Set voltmeter FUNCTION to DC; RANGE to 100.

c. Connect positive lead to + side of C20; common lead to common. DC voltmeter should read +45 v (±1 v).

d. If not, adjust R32 for proper reading.

5-16. BIAS ADJUST (R15).

a. A DC Voltmeter (-hp- Model 3440A/3445A) will be required for this test.

b. Set dc voltmeter FUNCTION to DC; RANGE to 100 V.

c. Connect positive lead to + side of C15; common lead to common. DC voltmeter should read +23 v (±0.5 v).

d. If not, adjust R15 to obtain proper reading.

5-17. 1 MC ADJUST (C5).

a. A Test Oscillator (-hp- Model 651A) and an AC Voltmeter (-hp- Model 331A) will be required for this test.

b. Set Model 465A GAIN to 20 db.

c. Connect oscillator OUTPUT to Model 465A INPUT. Set oscillator frequency to 1 Mc; adjust output to 1.0 v rms (use ac voltmeter to verify).

d. Connect ac voltmeter to Model 465A OUTPUT.

e. Adjust C5 for ac voltmeter reading of 8.5 v.

5-18. SERVICING ETCHED CIRCUIT BOARD.

5-19. 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.

5-20. 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.

5-21. TROUBLESHOOTING TECHNIQUE.

5-22. 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 can not 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.

5-23. 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.

5-24. Table 5-4 contains a summary of the front-panel symptoms that may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5-25. Table 5-5, in conjunction with Figure 5-4, contains procedures which may be used as a guide in isolating malfunctions. The steps in Table 5-5 describe the normal conditions which should be encountered during the checks (circled numbers (N)) in Figure 5-4.

5-26. The checks outlined in Table 5-5 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 5-5 and Figure 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 kc signal applied to Model 465A INPUT.

Table 5-4. Front Panel Troubleshooting

Front Panel Symptoms	Possible Cause
Line Lamp not glowing	Check fuse F1, L1, L2, S1, R28, S2 or T1
Functions properly on 20 db position only	Check R3, R4, R5, R6 and Bias Voltages
Functions properly on 40 db position only	Check Bias Voltages and Q1, Q2.

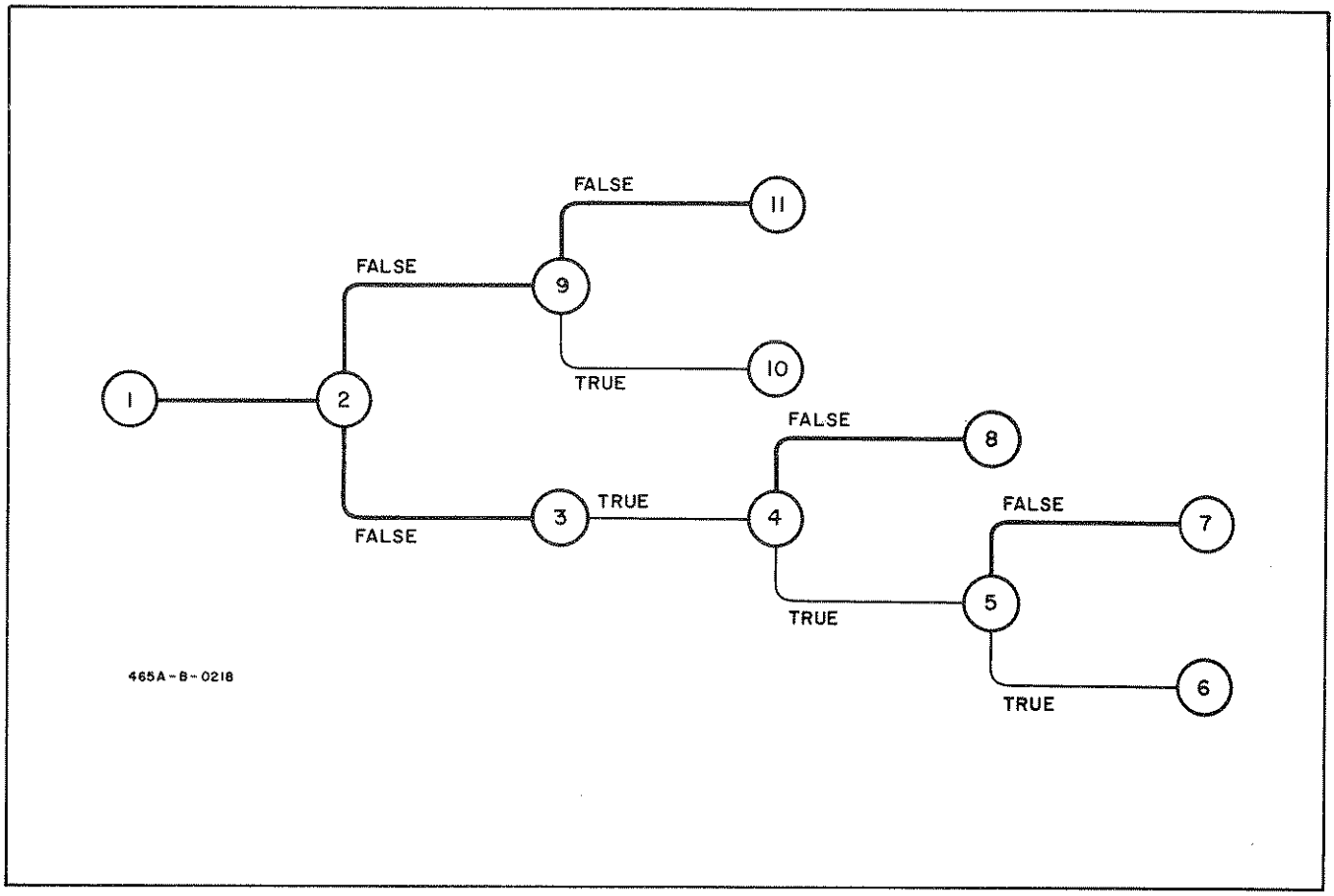


Figure 5-4. Troubleshooting Tree

Table 5-5. Troubleshooting

(1)	Remove the + side of C14 from the circuit board. Set Model 465A GAIN to 40 db. Apply a 1.0 mv, 2 kc input signal.
(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) .
(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) .
(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) .
(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) .
(6)	Check R26, R27 and C15.
(7)	Check Q4, Q5 and Q6. Refer to Figure 5-8 for typical dc voltage levels.
(8)	Check Q1, Q2 and Q3. Refer to Figure 5-8 for typical dc voltage levels.
(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) .
(10)	Connect a DC Power Supply (-hp- Model 723A) 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.
(11)	Check Model 465A power supply to include T1 secondary, Q7, CR6, Q8 and Q9. Refer to Figure 5-8 for typical dc voltage levels.

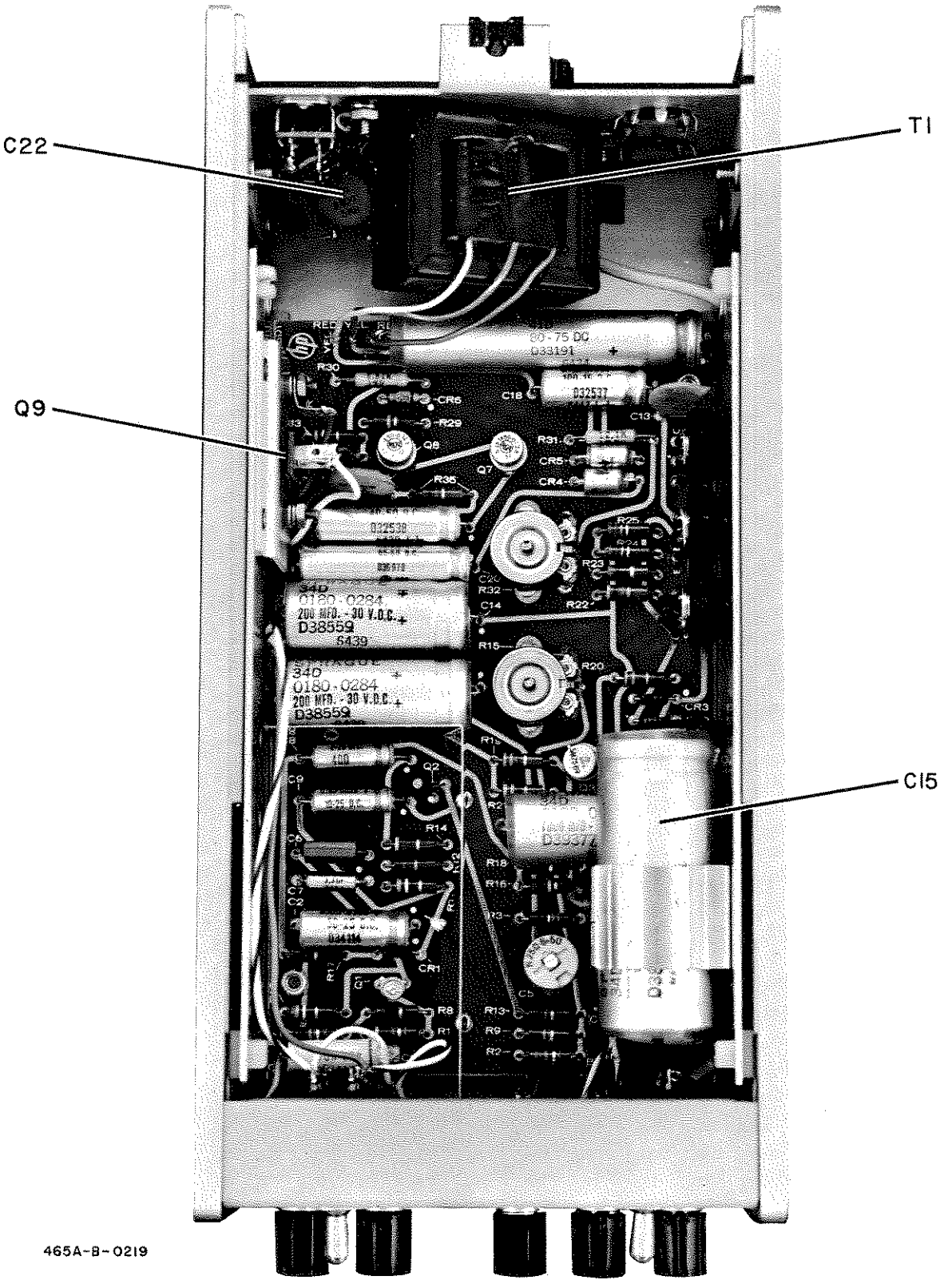
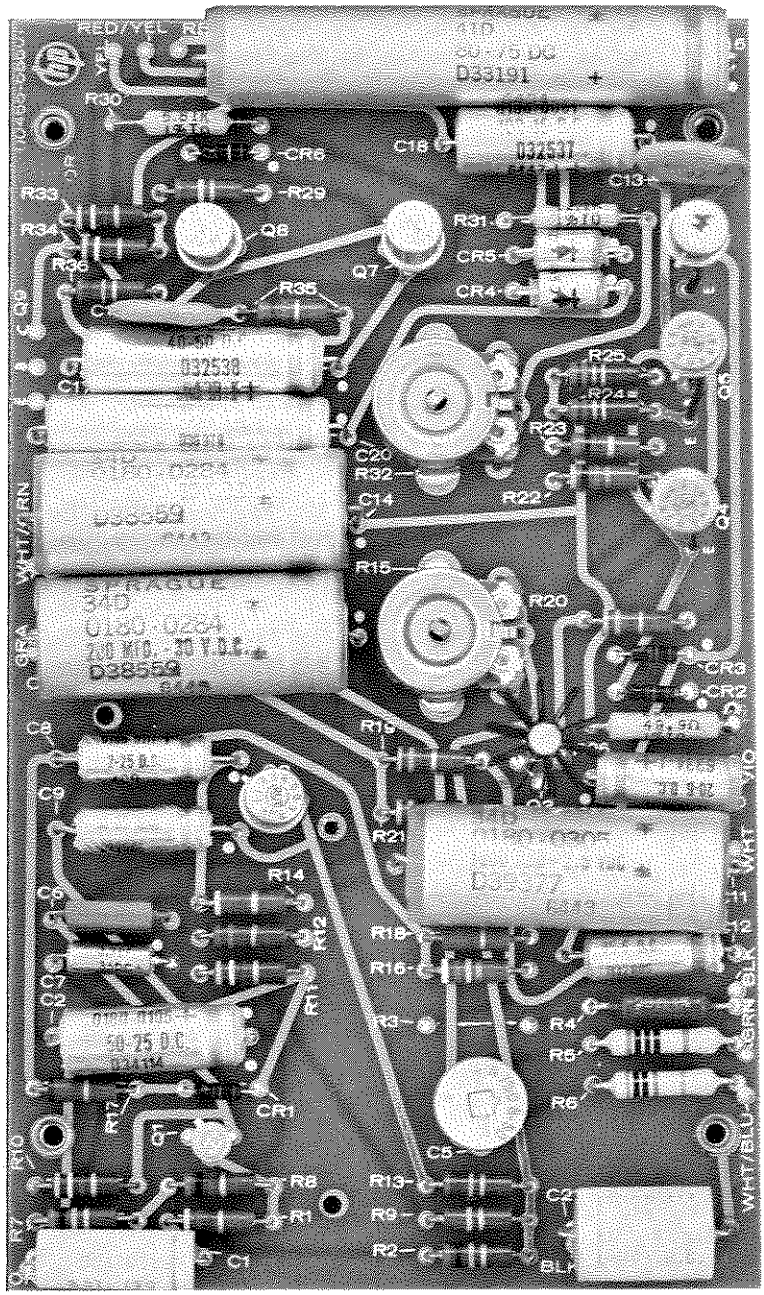
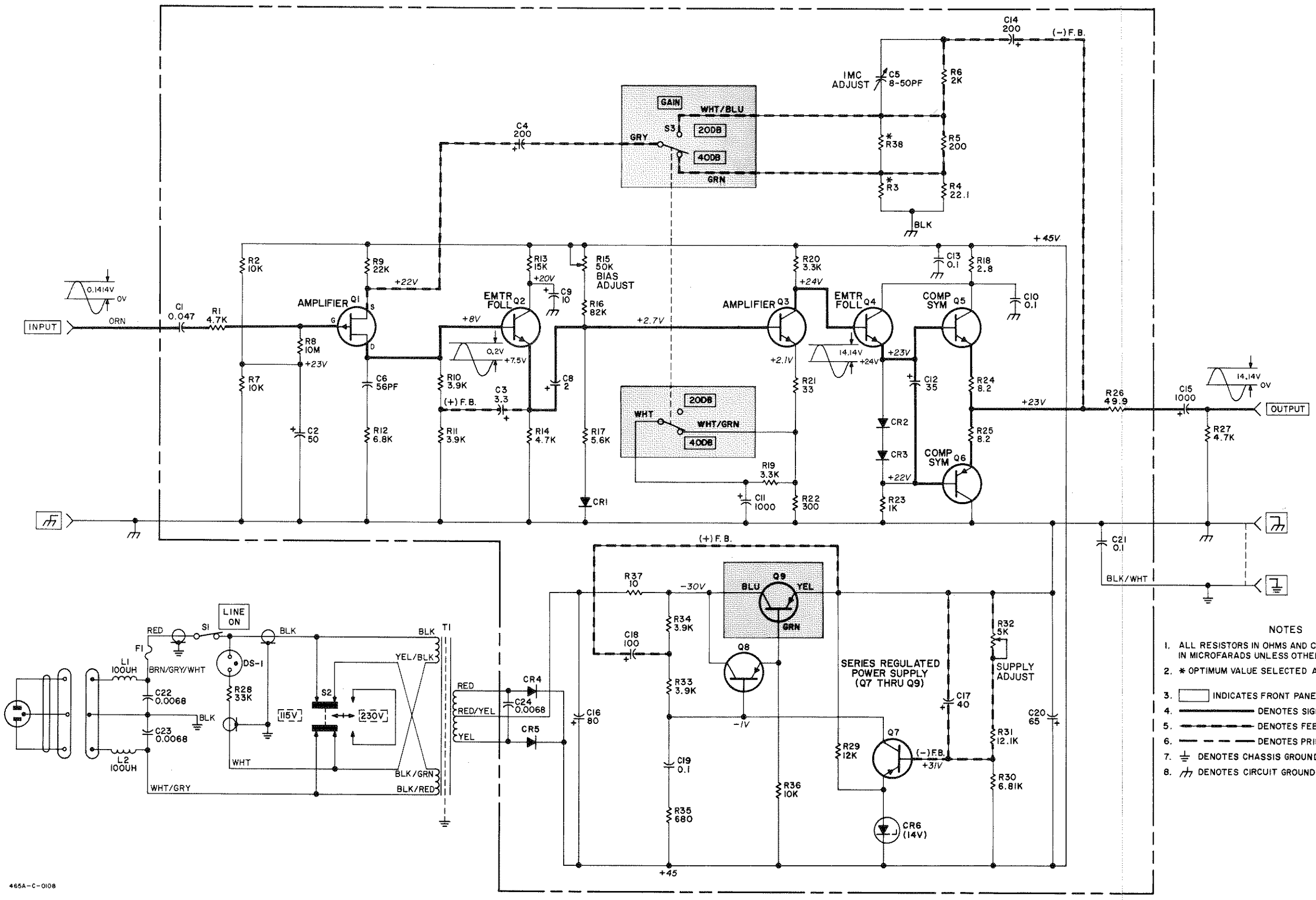


Figure 5-5. Top View



465A-A-0220

Figure 5-6. Printed Circuit Board, Parts Location



NOTES

1. ALL RESISTORS IN OHMS AND CAPACITORS IN MICROFARADS UNLESS OTHERWISE DESIGNATED.
2. * OPTIMUM VALUE SELECTED AT FACTORY.
3. ▭ INDICATES FRONT PANEL LOCATION.
4. ——— DENOTES SIGNAL PATH.
5. - - - - DENOTES FEEDBACK.
6. — — — — DENOTES PRINTED CIRCUIT BOARD.
7. ⏚ DENOTES CHASSIS GROUND.
8. ⏦ DENOTES CIRCUIT GROUND.

Figure 5-7. 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 and -hp- part number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their -hp- part number and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

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.

REFERENCE DESIGNATORS

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

ABBREVIATIONS

a	= amperes	elect	= electrolytic	mtg	= mounting	rot	= rotary
		encap	= encapsulated	my	= mylar	rms	= root-mean-square
bp	= bandpass					rmo	= rack mount only
bwo	= backward wave oscillator	f	= farads	NC	= normally closed	s-b	= slow-blow
		fxd	= fixed	Ne	= neon	Se	= selenium
c	= carbon			NO	= normally open	sect	= section(s)
cer	= ceramic	Ge	= germanium	NPO	= negative positive zero (zero temperature coefficient)	Si	= silicon
cmo	= cabinet mount only	grd	= ground (ed)			sil	= silver
coef	= coefficient					sl	= slide
com	= common	h	= henries	nsr	= not separately replaceable		
comp	= composition	Hg	= mercury			td	= time delay
conn	= connection					TiO_2	= titanium dioxide
crt	= cathode-ray tube	impg	= impregnated	obd	= order by description		
		incd	= incandescent			tog	= toggle
dep	= deposited	ins	= insulation (ed)			tol	= tolerance
				p	= peak	trim	= trimmer
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ℎ stock numbers.	K	= kilo = 1000	pc	= printed circuit board	twt	= traveling wave tube
						var	= variable
		lin	= linear taper	pf	= picofarads = 10^{-12} farads	w/	= with
		log	= logarithmic taper			W	= watts
				pp	= peak to peak	ww	= wirewound
		m	= milli = 10^{-3}	piv	= peak inverse voltage	w/o	= without
		M	= megohms				
		ma	= milliamperes	pos	= position (s)	*	= optimum value selected at factory, average value shown (part may be omitted)
		μ	= micro = 10^{-6}	poly	= polystyrene		
		minat	= miniature	pot	= potentiometer		
		mfgl	= metal film on glass	rect	= rectifier		
		mfr	= manufacturer				

Table 6-1. Reference Designation Index

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1	00465-66501	Board Etched Circuit Ass'y Power Supply-Amplifier, includes: C1 thru C24 Q1 thru Q8 CR1 thru CR6 R1 thru R37	
A1C1	0170-0060	C: fxd, my die, .047 mf ±10%, 400 vdcw	
A1C2	0180-0105	C: fxd, alum elect, 50 μf -10% +100%, 25 vdcw	
A1C3	0180-0161	C: fxd, tanta elect ±20%	
A1C4	0180-0284	C: fxd, alum elect -10% +75%	
A1C5	0130-0017	C: var, ceramic, 8-50 pf	
A1C6	0140-0014	C: fxd, molded mica, 56 pf ±10%	
A1C7		Not Assigned	
A1C8	0180-0111	C: fxd, alum elect, 2 μf, 25 vdcw	
A1C9	0180-0059	C: fxd, elect, 10 μf -10% +100%, 25 vdcw	
A1C10	0150-0084	C: fxd, ceramic die, .1 μf +80% -20%, 50 vdcw	
A1C11	0180-0305	C: fxd, alum elect -10% +100%	
A1C12	0180-0064	C: fxd, elect, 35 μf -10% +100%, 6 vdcw	
A1C13	0150-0084	C: fxd, ceramic die, .1 μf +80% -20%, 50 vdcw	
A1C14	0180-0284	C: fxd, alum elect -10% +75%	
A1C15		Not Assigned	
A1C16	0180-0110	C: fxd, alum elect, 80 μf, 75 vdcw	
A1C17	0180-0050	C: fxd, alum elect, 40 μf -15% +100%, 50 vdcw	
A1C18	0180-0061	C: fxd, elect, 100 μf +100% -10%, 150 vdcw	
A1C19	0150-0084	C: fxd, ceramic die, .1 μf +80% -20%, 50 vdcw	
A1C20	0180-0149	C: fxd, alum elect -10% +100%	
A1C21	0170-0022	C: fxd, my die, 0.1 μf ±20%, 600 vdcw	
A1C22 and A1C23		Not Assigned	
A1C24	0150-0097	C: fxd, ceramic, .0068 μf ±2%, 1000 vdcw	
A1CR1 thru A1CR3	1901-0025	Diode: Si	
A1CR4 and A1CR5	1901-0026	Diode: Si, 200 PIV	
A1CR6	1902-0040	Diode: breakdown, 400 mw	
A1Q1	1855-0004	Transistor: P channel	
A1Q2	1854-0033	Transistor: Si, NPN, 2N3391	
A1Q3	1854-0070	Transistor: Si, NPN	
A1Q4 and A1Q5	1854-0039	Transistor: Si, NPN, 2N3053	
A1Q6	1853-0017	Transistor: Si, PNP	
A1Q7 and A1Q8	1850-0128	Transistor: germanium, PNP, 2N398B	
A1R1	0687-4721	R: fxd, comp, 4700 ohms ±10%, 1/2 w	
A1R2	0687-1031	R: fxd, comp, 10 K ohms ±10%, 1/2 w	
A1R3		Not Assigned	
A1R4	0757-0992	R: fxd, met flm, 22.1 ohms ±1%, 1/2 w	
A1R5	0698-3186	R: fxd, 200 ohms ±1/2 %	
A1R6	0698-3187	R: fxd, 2 K ohms ±1/2 %	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1R7	0687-1031	R: fxd, comp, 10 K ohms ±10%, 1/2 w	
A1R8	0687-1061	R: fxd, comp, 10 M ohms ±10%, 1/2 w	
A1R9	0687-2231	R: fxd, comp, 22 K ohms ±10%, 1/2 w	
A1R10 and A1R11	0687-3921	R: fxd, comp, 3300 ohms ±10%, 1/2 w	
A1R12	0687-6821	R: fxd, comp, 6800 ohms ±10%, 1/2 w	
A1R13	0687-1531	R: fxd, comp, 15 K ohms ±10%, 1/2 w	
A1R14	0687-4721	R: fxd, comp, 4700 ohms ±10%, 1/2 w	
A1R15	2100-0094	R: var, comp, lin taper, 50 K ohms ±30%, 0.10 w	
A1R16	0686-8235	R: fxd, comp, 82 K ohms ±5%, 1/2 w	
A1R17	0687-5621	R: fxd, comp, 5600 ohms ±10%, 1/2 w	
A1R18	0698-0001	R: fxd, comp, 4.7 ohms ±5%, 1/2 w	
A1R19 and A1R20	0687-3321	R: fxd, comp, 3300 ohms ±10%, 1/2 w	
A1R21	0686-3305	R: fxd, comp, 33 ohms ±5%, 1/2 w	
A1R22	0686-3015	R: fxd, comp, 300 ohms ±5%, 1/2 w	
A1R23	0687-1021	R: fxd, comp, 1000 ohms ±10%, 1/2 w	
A1R24 and A1R25	0690-0003	R: fxd, comp, 8.2 ohms ±10%, 1/2 w	
A1R26	0757-0072	R: fxd, 49.9 ohms ±1%	
A1R27 and A1R28		Not Assigned	
A1R29	0687-1231	R: fxd, comp, 12 K ohms ±10%, 1/2 w	
A1R30	0757-0835	R: fxd, 6.81 K ohms ±1%	
A1R31	0757-0841	R: fxd, 12.1 K ohms ±1%	
A1R32	2100-0091	R: var, comp, lin taper, 5 K ohms ±30%, 0.15 w	
A1R33 and A1R34	0687-3921	R: fxd, comp, 3300 ohms ±10%, 1/2 w	
A1R35	0687-1511	R: fxd, comp, 150 ohms ±10%, 1/2 w	
A1R36	0687-1531	R: fxd, comp, 15 K ohms ±10%, 1/2 w	
A1R37	0687-1001	R: fxd, comp, 10 ohms ±10%, 1/2 w	
C1 thru C14		Not Assigned	
C15	0180-0378	C: fxd, alum elect -10% +100%	
C16 thru C21		Not Assigned	
C22 and C23	0150-0097	C: fxd, ceramic, .0068 μf ±2%, 1000 vdcw	
DS1	2140-0015	Lamp, glow	
F1	2110-0017	Fuse: cartridge, 0.15 amp	
L1 and L2	9140-0029	Coil - R. F.	
Q1 thru Q8		Not Assigned	
Q9	1850-0098	Transistor: germanium, PNP	
R1 thru R26		Not Assigned	
R27	0687-4721	R: fxd, comp, 4700 ohms ±10%, 1/2 w	
R28	0684-3331	R: fxd, comp, 33 K ohms ±10%, 1/4 w	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
S1	3101-0037	Switch: toggle, SPST, 3 amp	
S2	3101-0033	Switch: slide, DPDT	
S3	3101-0038	Switch: toggle, DPDT, 3 amp	
T1	9100-0343	Transformer: power	
W1	8120-0078	Cable Ass'y, Power: black, extra limp, 7.5 ft. long	
		MISCELLANEOUS	
	0340-0099	Insulator: grey, plastic	
	0340-0100	Insulator: grey, plastic	
	1200-0043	Insulator	
	1200-0081	Insulator	
	1205-0050	Heat - sink	
	>1250-0252	Connector: R.F.	
	1251-1009	Connector: power	
	1400-0084	Holder - fuse	
	1490-0031	Stand - tilt	
	1510-0010	Binding Post - red	
	1510-0011	Binding Post - black	
	5000-0700	Cover - side	
	5000-0711	Cover - bottom	
	5020-0700	Spacer - CAB	
	5040-0234	Jewel - pilot light	
	5040-0235	Base - pilot light	
	5040-0700	Hinge	
	5060-0700	Frame Ass'y	
	5060-0709	Cover - top	
	5060-0727	Foot - Ass'y	
	5060-4916	Terminal - ground, black	
	00465-00101	Plate - right	
	00465-00102	Plate - left	
	00465-00201	Panel - front	
	00465-00202	Panel - rear	
	00465-01201	Bracket - transistor	
	00465-90000	Manual - Operating and Service	

> Option 01 only
See introduction to this section

Table 6-2. Replaceable Parts

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0130-0017	C: var, ceramic, 8-50 pf	72982	557-019-U2PO-34 R	1	
0140-0014	C: fxd, molded mica, 56 pf ±10%	04062	RCM15E 560K	1	
0150-0084	C: fxd, ceramic, die, .1 μf +80% -20%, 50 vdcw	56289	33C41	3	
0150-0097	C: fxd, ceramic, .0068 μf ±2%, 1000 vdcw	91418	B	2	
0170-0022	C: fxd, my die, 0.1 μf ±20%, 600 vdcw	01281	HEW-17	1	
0170-0060	C: fxd, my die, .047 mf ±10%, 400 vdcw	01281	Type 663UW	1	
0180-0050	C: fxd, alum elect, 40 μf -15% +100%, 50 vdcw	56289	D32538	1	
0180-0059	C: fxd, elect, 10 μf -10% +100%, 25 vdcw	56289	30D106G025BB4	1	
0180-0061	C: fxd, elect, 100 μf +100% -10%, 15 vdcw	56289	30D107G015DD4	1	
0180-0064	C: fxd, elect, 35 μf -10% +100%, 6 vdcw	56289	30D156G006BB4	1	
0180-0105	C: fxd, alum elect, 50 μf -10%, +100%, 25 vdcw	56289	D34114	1	
0180-0110	C: fxd, alum elect, 80 μf, 75 vdcw	56289	41D D33191	1	
0180-0111	C: fxd, alum elect, 2 μf, 25 vdcw	56289	40D 173A2	1	
0180-0149	C: fxd, alum elect, -10% +100%	56289	Type 30D	1	
0180-0161	C: fxd, tanta elect, ±20%	56289	150D335 X 0035 B2	1	
0180-0284	C: fxd, alum elect -10% +75%	56289	D38559	2	
0180-0305	C: fxd, alum elect -10% +100%	56289	34D108H2R5FJ4	1	
0180-0378	C: fxd, alum elect, -10% +100%	56289	34D108H030JP4	1	
0340-0099	Insulator: grey, plastic	28480	0340-0099	1	
0340-0100	Insulator: grey, plastic	28480	0340-0100	1	
0684-3331	R: fxd, comp, 33 K ohms ±10%, 1/4 w	01121	CB 3331	1	
0686-3015	R: fxd, comp, 300 ohms ±5%, 1/2 w	01121	EB 3015	1	
0686-3305	R: fxd, comp, 33 ohms ±5%, 1/2 w	01121	EB 3305	1	
0686-8235	R: fxd, comp, 82 K ohms ±5%, 1/2 w	01121	EB 8235	1	
0687-1001	R: fxd, comp, 10 ohms ±10%, 1/2 w	01121	EB 1001	1	
0687-1021	R: fxd, comp, 1000 ohms ±10%, 1/2 w	01121	EB 1021	1	
0687-1031	R: fxd, comp, 10 K ohms ±10%, 1/2 w	01121	EB 1031	2	
0687-1061	R: fxd, comp, 10 M ohms ±10%, 1/2 w	01121	EB 1061	1	
0687-1231	R: fxd, comp, 12 K ohms ±10%, 1/2 w	01121	EB 1231	1	
0687-1511	R: fxd, comp, 150 ohms ±10%, 1/2 w	01121	EB 1511	1	
0687-1531	R: fxd, comp, 15 K ohms ±10%, 1/2 w	01121	EB 1531	2	
0687-2231	R: fxd, comp, 22 K ohms ±10%, 1/2 w	01121	EB 2231	1	
0687-3321	R: fxd, comp, 3300 ohms ±10%, 1/2 w	01121	EB 3321	1	
0687-3921	R: fxd, comp, 3.9 K ohms ±10%, 1/2 w	01121	EB 3921	2	
0687-4721	R: fxd, comp, 4700 ohms ±10%, 1/2 w	01121	EB 4721	3	
0687-5621	R: fxd, comp, 5600 ohms ±10%, 1/2 w	01121	EB 5621	1	
0687-6821	R: fxd, comp, 6800 ohms ±10%, 1/2 w	01121	EB 6821	1	
0698-0001	R: fxd, comp, 4.7 ohms ±5%, 1/2 w	01121	EB 47G5	1	
0698-3186	R: fxd, 200 ohms ±1/2%	19701	CEC T-O	1	
0698-3187	R: fxd, 2 K ±1/2%	19701	MF7C T-O	1	
0699-0003	R: fxd, comp, 8.2 ohms ±10%, 1/2 w	01121	EB 82G1	1	
0757-0072	R: fxd, 49.9 ohms ±1%	19701	MF7C T-O	1	
0757-0835	R: fxd, 6.81 K ohms ±1%	19701	MF7C T-O	1	
0757-0841	R: fxd, 12.1 K ohms ±1%	19701	MF7C T-O	1	
0757-0992	R: fxd, met flm, 22.1 ohms ±1%, 1/2 w	19701	MF7C T-O	1	

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
1200-0043	Insulator	71785	293011	1	
1200-0081	Insulator: bushing, nylon	26365	974	1	
1205-0050	Heat - sink	91506	9017-1G1	1	
>1250-0252	Connector: R. F.	06140	30288-1	2	
1251-1009	Connector: ac power cord receptacle	82389	AC-3	1	
1400-0084	Holder - fuse	75915	342014	1	
1490-0031	Stand - tilt	91260	obd #	1	
1510-0010	Binding Post - red	28480	1510-0010	2	
1510-0011	Binding Post - black	28480	1510-0011	2	
1850-0098	Transistor: germanium, PNP	77068	B-1493	1	
1850-0128	Transistor: germanium, PNP, 2N398B	86684	2N398B	1	
1853-0017	Transistor: Si, PNP	04713	obd #	1	
1854-0033	Transistor: Si, NPN, 2N3391	24446	2N3391	1	
1854-0039	Transistor: Si, NPN, 2N3053	86684	2N3053	1	
1854-0070	Transistor: Si, NPN	24446	obd #	1	
1855-0004	Transistor: P channel	17856	U112	1	
1901-0025	Diode: Si	93332	D3072	1	
1901-0026	Diode: Si, 200 PIV	11711	obd #	1	
1902-0040	Diode: breakdown, 400 mw	04713	SZ10939-224	1	
2100-0091	R: var, comp, lin taper, 5 K ohms ±30%, 0.15 w	71450	UPE 70RE	1	
2100-0094	R: var, comp, lin taper, 50 K ohms ±30%, 0.10 w	71450	UPE 70RE	1	
2110-0017	Fuse - cartridge, 0.15 amp	98997	3AG-TL-15/100	1	
2140-0015	Lamp, glow	24455	obd #	1	
3101-0033	Switch - slide, DPDT	79727	G-326	1	
3101-0037	Switch - toggle, SPST, 3 amp	04009	83050-A	1	
3101-0038	Switch - toggle, DPDT, 3 amp	04009	83054-B	1	
5000-0700	Cover - side	28480	5000-0700	1	
5000-0711	Cover - bottom	28480	5000-0711	1	
5020-0700	Spacer - CAB	28480	5020-0700	1	
5040-0234	Jewel - pilot light	28480	5040-0234	1	
5040-0235	Base - pilot light	28480	5040-0235	1	
5040-0700	Hinge	28480	5040-0700	1	
5060-0700	Frame Ass'y	28480	5060-0700	1	
5060-0709	Cover - top	28480	5060-0709	1	
5060-0727	Foot Ass'y	28480	5060-0727	1	
5060-4916	Terminal - ground, black	28480	5060-4916	1	
8120-0078	Cable Ass'y, power: black, extra limp, 7.5 ft. long	70903	KH-4147	1	
9100-0343	Transformer, power	28480	9100-0343	1	
9140-0029	Coil - R. F.	99848	3100-15-101	2	
00465-00101	Plate - right	28480	00465-00101	1	
00465-00102	Plate - left	28480	00465-00102	1	
00465-00201	Panel - front	28480	00465-00201	1	
00465-00202	Panel - rear	28480	00465-00202	1	
00465-01201	Bracket - transistor	28480	00465-01201	1	
00465-66501	Board Etched Circuit Ass'y Power Supply - Amplifier	28480	00465-66501	1	
00465-90000	Manual, Operating and Service	28480	00465-90000	1	

> Option 01 only

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

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.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N. J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Electronic Hardware Co. Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	G. S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	San Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Tri-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N. J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co. Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16352	Computer Diode Corp.	Lodi, N. J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Ill.
18583	Curtis Instrument Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Corp. Hawkesbury, Ontario, Canada	
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
53742	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, 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. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wiltek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71709	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N. Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoelt Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80129	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.

Galley 3 - Hewlett Packard Code List

From: FSC. Handbook Supplements
H4-1 Dated DECEMBER 1964
H4-2 Dated MARCH 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
81349	Military Specification	.....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronis, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
87930	Tower Mfg. Corp	Providence, R. I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Conner Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92160	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith Inc.	Port Monmouth, N. J.
93829	G. V. Controls	Livingston, N. J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94330	Wire Cloth Products Inc.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

J0D00	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000QQ	Cooltron	Oakland, Calif.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

From: FSC. Handbook Supplements
H4-1 Dated DECEMBER 1964
H4-2 Dated MARCH 1962

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