6960 A

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6960A POWER SUPPLY

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

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OPERATING AND SERVICE MANUAL

MODEL 6960A

DC POWER SUPPLY

Serials Prefixed: G 604

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TABLE 1-1
SPECIFICATIONS

REGULATED OUTPUT:	2 ranges switched by push button switch 0-18 V/600 mA: Voltage continuously adjustable from 0-18 V dc. 600 mA over entire voltage range. 0-36V/300 mA: Voltage continuously adjustable from 0-36 V dc. 300 mA over entire voltage range.
LOAD REGULATION:	Less than 5 mV change in output voltage over full operating range.
LINE REGULATION:	Less than 5 mV change in output voltage for ± 10% power line changes.
RIPPLE AND NOISE:	Less than 150 µVrms.
TEMPERATURE STABILITY:	Less than 0.1 %/° C.
TEMPERATURE RANGE:	0 to 55° C.
OUTPUT IMPEDANCE:	Less than 0.02 Ω from DC to 1 Kc. Less than 0.5 Ω from 1 Kc to 50 kc.
RECOVERY TIME:	Less than 50 µs after a change from full load to no load.
METER ACCURACY:	± 5% of full scale.(METERS ON OPTION OI ONLY)
OVERLOAD PROTECTION:	Output current limiter continuously variable from 80 to 600 mA on 0-18 V range, 40 to 300 mA on 0-36 V range.
OUTPUT TERMINALS:	Three banana jacks spaced 3/4 inch apart. Positive and negative terminals are isolated from chassis. A maximum of 400 V may be connected between ground and either output terminal.
REMOTE PROGRAMMING:	About 200 Ω/V external resistance applied to rear-mounted terminals.
POWER:	110/220 V ± 10%, 50 to 60 cps, 40 watts. 115/230 V ± 10%, 50 to 60 cps, 40 watts.
DIMENSIONS:	6-3/32 inches (155 mm) high, 5-1/8 inches (130 mm) wide, 11 inches (279 mm) deep.
WEIGHT:	Shipping 10 lbs (4.6 kg)

SECTION I
GENERAL INFORMATION

1-1 Introduction

1-2 This is an operating and service manual for the Model 6960 A DC Power Supply. This manual is applicable only to instruments with the prefix number shown on the title page except as modified by change sheets.

1-3 Instrument Identification

1-4 Hewlett-Packard instruments use a two-section, eight-digit serial number, that is, 000-00000. The first three digits are an identification number; the last five digits are the instrument serial number. If the identification number on the instrument does not agree with the identification number shown on the manual title page, there are differences between the manual and instrument. These differences are described in manual change sheets having the proper identification number.

1-5 General Decription

1-6 The -hp- Model 6960A DC power supply produces a regulated DC voltage continuously adjustable from 0 to 36 V up to a current of 300 mA, or from 0 to 18 V up to a current of 600 mA, according to which range has been selected by means of the front panel push buttons. The supply makes load circuit performance independent of external power supply influences, has very low source impedance and excellent regulation against change in line and load.

This supply is especially useful as a source of power for transistor circuits because it features a protective circuit which electronically limits the maximum output

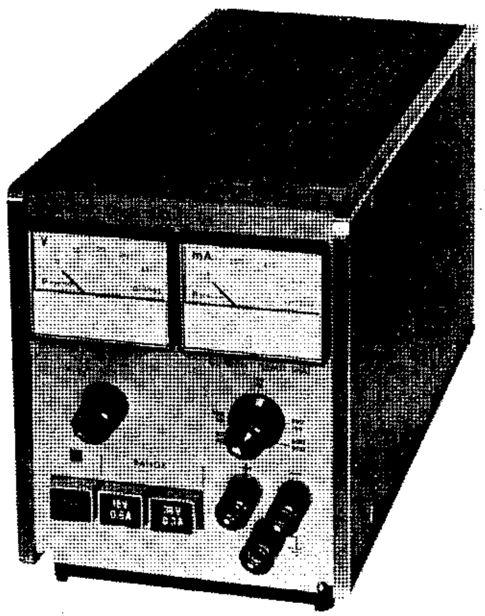


Fig. 1-1 Model 6960A Power Supply

current to values selected by a front panel control. Accidental damaging of expensive components by excessive current can thus be reduced to a minimum, if the CURRENT LIMIT control is set to a value just above the normal operating current of the external circuit. Another important application of the Model 6960A Power Supply is in electronic test systems where various fixed voltages have to be produced sequentially with a high degree of reproducability. This can be achieved because the output voltage of this supply may be programmed by an externally connected fixed resistor or a series of same. The output voltage will then be proportional to the value of this resistor; changing the resistor in predetermined steps will have corresponding effects on the output voltage.

Both output terminals of the power supply are insulated from chassis ground. Either terminal may be grounded as high as 400 V from ground. It is therefore possible to connect a number of supplies in series to obtain higher voltages than 36 V.

If more current than 600 mA is needed, there is the possibility of operating several power supplies in parallel.

Remote sensing can be used for minimizing the effect of supply lead resistiance and thus providing an exactly regulated voltage at the supplied circuit regardless of lead length.

SECTION II
INSTALLATION

2-1 Inspection

2-2 When the Model 6960A is received, inspect it for damage received in transit. Operate the instrument to make certain that it is functioning satisfactorily. If damage is evident, follow the procedures outlined in the "CLAIM FOR DAMAGE IN SHIPMENT" page of this manual (inside rear cover).

2-3 Power cable

2-4 The three conductor power cable supplied with the instrument is terminated in a three connector male power plug recommended by the VDE (Verein Deutscher Elektrotechniker).

WARNING

The third conductor grounds the instrument cabinet for the PROTECTION OF OPERATING PERSONNEL. If a two connector line power receptacle is used, the instrument cabinet should be grounded externally.

2-5 115 V or 230 V Operation

2-6 The instrument is designed to work from 110, 115 or 220, 230 volts ± 10 % line voltage. It is shipped from the factory wired for operation from a 110 V or 220 V source. It may be re-wired for operation from a 115 V or 230 V line by changing connection on transformer T1 from 4 A to 4 and from 2 A to 2 (see Figure 5–4). To operate from 220 V (230 V) line, set the slide switch on the rear panel to 230 V, to operate from 110 V (115 V), set the slide switch to 115 V. Fuse F1 should be 0.4 A slow blow for 220 V (230 V) and 0.8 slow blow for 110 V (115 V).

SECTION III

OPERATING INSTRUCTIONS

3-1 Operating Controls

Figure 3—1 shows the functions of the front panel controls and terminals and is self-explanatory.

3-2 To turn the instrument on, push in either of the range buttons, according to the voltage and current which is desired. Accidental setting of both buttons, 18 V and 36 V, will cause no damage to the unit; in this case the instrument has been switched to the 36 V — 300 mA range. Pushing in the button marked OFF turns the instrument off.

3-3 Current Limit Control

3-4 This knob adjusts the peak current output of the supply. The indication is nominal. To set the value exactly, remove the load and short the power supply terminals. Adjust the CURRENT LIMIT control until the meter indicates the required maximum current.

If the supply is to be used in an application where the current drawn from the instrument is not essentially uniform with respect to time, e.g. in pulse type circuits, then the fast acting character of the current limiting circuit must be taken into consideration. The average current may be within the supply rating or below the maximum current set with the CURRENT LIMIT control, but peak currents may be high enough to cause the supply to clip. The CURRENT LIMIT control must, consequently, be set to a value which is greater than the peak current requirements of the circuit.

The output terminals are connected internally to a 200 μF capacitor which helps supply high current peaks, provided they are of short duration. Any external capacity added will improve the peak current capability, but will decrease the safety provided by the current limit control. High range currents may then destroy external components before the average current inside the supply increases sufficiently to cause the limiting circuit to operate.

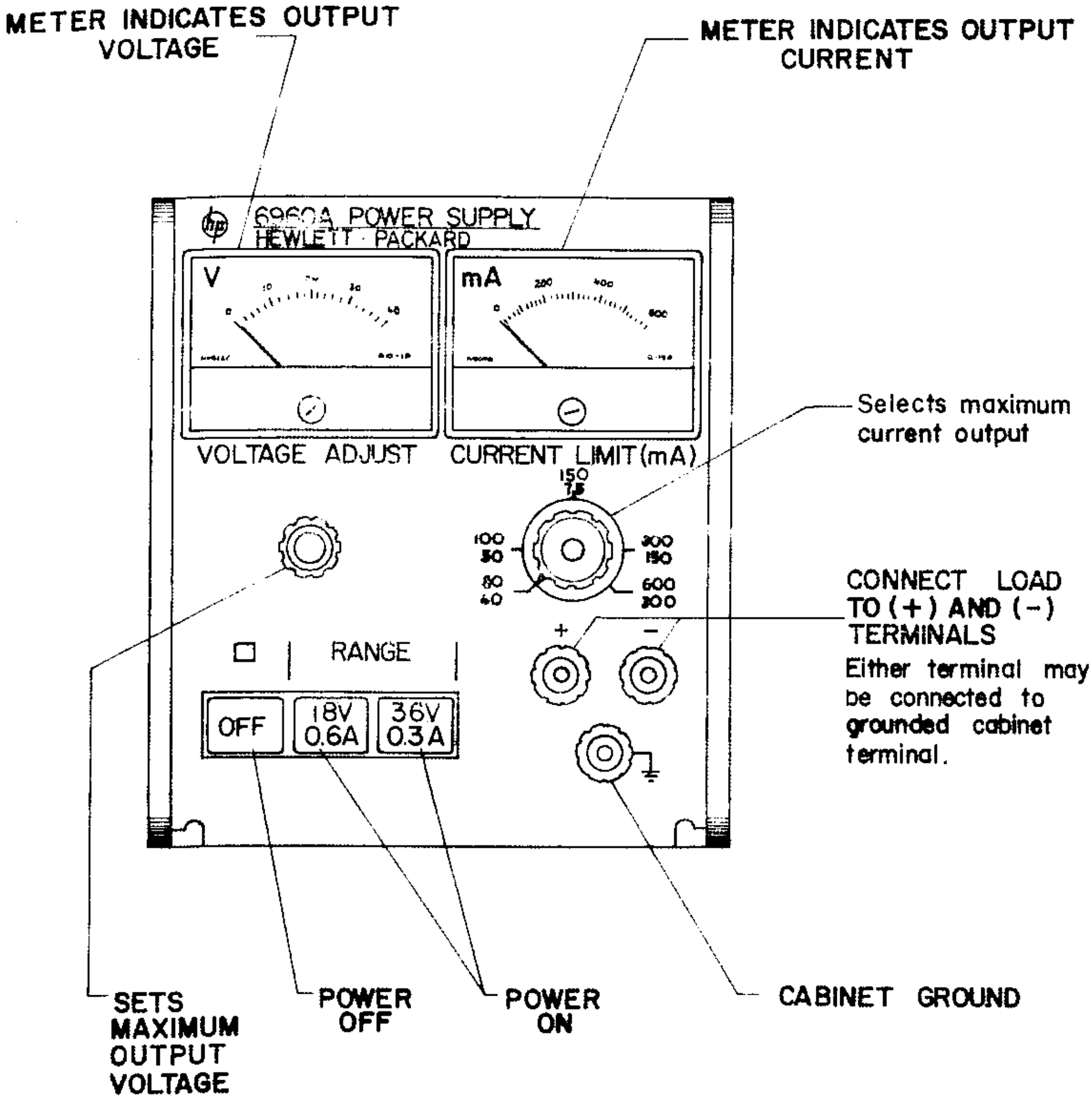


Fig. 3-1 Operating Controls

3-5 Connections to Load

3-6 The load may be connected to either the front or rear output terminals of the power supply as shipped from the factory. Sensing of the output voltage is automatically accomplished in both modes of operation.

The user should realize that the specifications describing the electrical characteristics of the power supply are given for measurements made directly at the terminals. Long leads between instrument and load deteriorate load regulation, which can only be maintained within the specifications of the power supply by using remote sensing as described later in this section of the manual.

3-7 Automatic Parallel Operation

3-8 Automatic parallel operation as used here is defined as a parallel operation of two or more power supplies with one unit (the master) acting as a control unit and the additional units (the slaves) acting as controlled units, where each supply automatically provides an equal share of current. Each Model 6960A can be used as master or slave unit.

The connections of the supplies have to be made in accordance with Fig. 3-2 C.

NOTE

All units must operate on the same voltage range (0-18V or 0-36V) !

Turn on the master unit first, then the slave units. Each supply will share the load current and the master unit will automatically limit the voltage and the current for all units.

Each slave unit still maintains its own short circuit protection and should be set to a current limit slightly greater than the maximum current set on the master unit. If the slave unit was set to a current limit slightly greater than the master unit and if the slave unit was turned on first, the equipment under test might be damaged by excessive current before the master unit was turned on and took over the current control.

3-9 Automatic Series Operation

3-10 Two or more supplies may be operated in series to obtain a higher voltage than that obtainable from a single supply. One unit (the master) acts as a control unit, which controls the additional units (the slaves). The master will set the total output voltage with each unit contributing the same amount of voltage. Any Model 6960A may be used as master or slave unit.

Connect the output terminals of the units so that the two terminals of the master are the most negative of all. The arrangements of interunit connections are shown in Fig. 3-2 b for two units and in Fig. 3-2 d for three or more units. The connection beween -S of the master and A 2, A 3 of the first slave has to be done by means of a 10 K Ω/0.5 W resistor.

Prior to turn on set the VOLTAGE ADJUST control on the master unit fully counterclockwise and the ones on all slave units fully clockwise. Then turn on all units and adjust the master unit to the desired voltage. If the slave units do not track the master unit, turn off all instruments and recheck your connections.

For minimum ripple across connected outputs, add a 5 /uF (or larger) / 50 V electrolytic capacitor from +S to A2 terminals on all slave units. All instruments must be operated on the same range. Do not connect more than ten units in series to avoid exceeding the 400V rating from +or - output terminals to chassis.

3-11 Remote Programming

3-12 The output voltage of Model 6960A may be changed by actuating the front panel VOLTAGE ADJUST control or by changing the value of the external programming resistor. If a number of Model 6960A's are connected in series or parallel, all units can be controlled by changing the programming resistor attached to the master unit only. Thus the output voltage may be programmed remotely by using stepping switches to change the value of the external resistor in accordance with a programmed procedure.

The connections on the rear terminal strip, shown in Fig. 3-2 e have only to be performed on the master unit. Then the output voltage will vary linearly with the programming resistor at a rate of approximately 200 Ω/V, that means, a 200 Ω resistor will give 1 V output, a 400 Ω resistor 2V output, etc.

When using a switch to change the programming resistance while the instrument is on, be sure to use a shorting contact type switch to keep the voltage of the supply from rising while switching. If the programming circuit is opened, even momentarily, the voltage from the supply will rise. This switching transient may damage the circuit under test.

3-13 Remote Sensing

When the rear terminals of the instrument are connected in the normal fashion, the voltage for regulation control (sensing voltage) is taken from the output of the supply at the front panel. This is not always the best point to obtain this voltage, because there may be a voltage drop in the supply leads between the load and the supply.

To get around this effect, a separate set of terminals for the sensing voltage (+S and -S) are provided on the rear of the instrument. These terminals permit a separate pair of leads to connect at the load to supply the sensing voltage. The leads carry no load current but are inside the regulation loop of the amplifier.

To use remote sensing, run a separate set of leads from the load to the sensing terminals. These leads do not need to be as heavy as the supply leads but they must be protected against hum pickup. Run either twisted pair open wire leads or shielded leads if hum pickup is severe. Connect the leads to the sensing terminals +S and −S on the rear of the instrument. At the load, attach these leads across the load. Remove the shorting link between (−) and (−S) and (+) and (+S).

CAUTION

Do not operate the instrument with the sensing leads open. Be sure to observe polarity when making these connections. Wrong connections may damage the supply.

If the instrument is operated in this manner, the maximum output current decreases at a rate of approximately 8% per every 100 MΩ of resistance in the minus load lead.

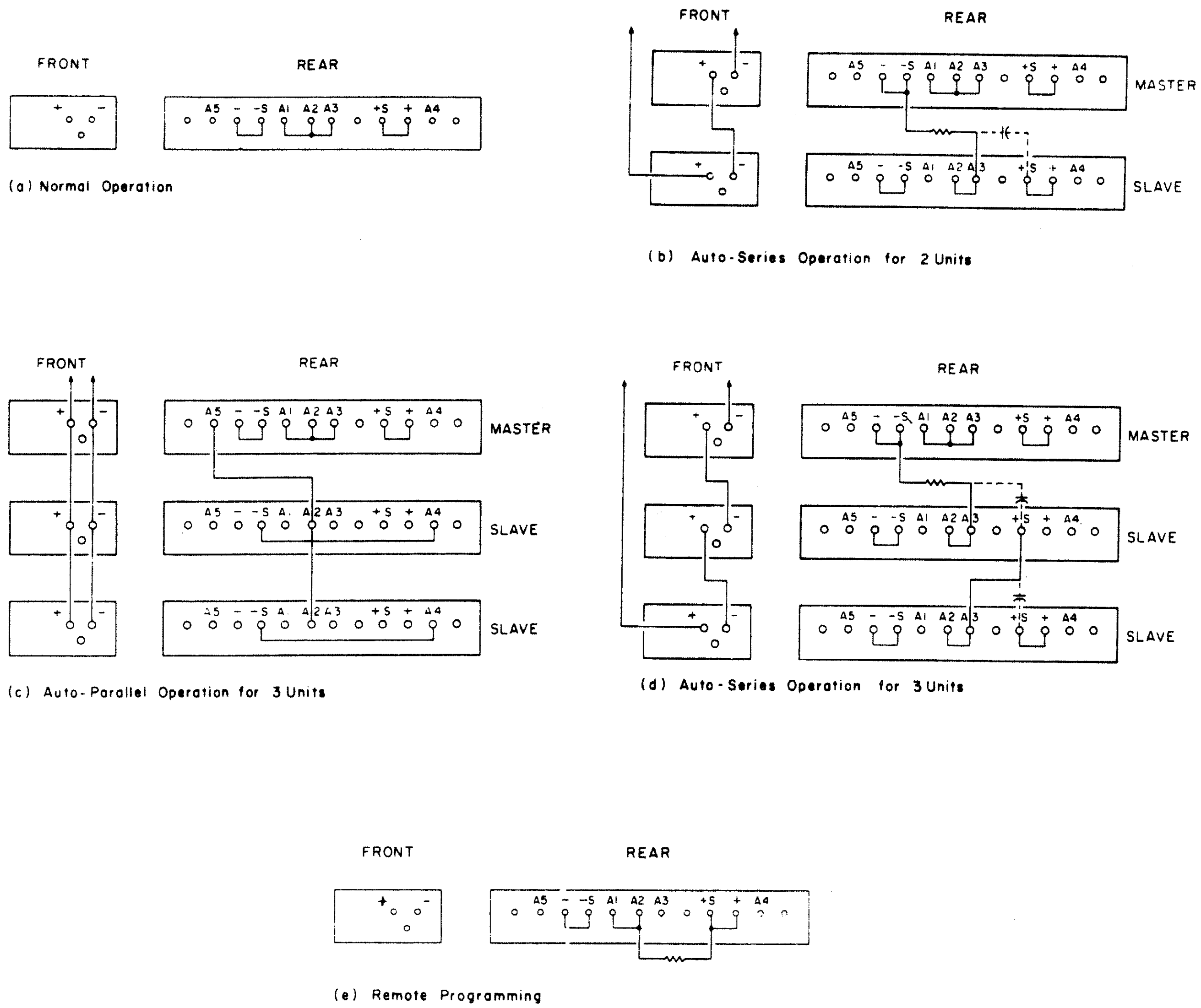


Figure 3-2 Terminal Connections

SECTION IV

PRINCIPLES OF OPERATION

4-1 Overall Block Diagram

4-2 As shown in Figure 4-1 the power transformer feeds two fullwave rectifiers. The rectified AC is filtered and controlled by a series regulator. The two built in series regulators can be operated either in series or parallel depending upon the selected range of the push button switch and are controlled from the error amplifier monitoring the output voltage of the supply.

The voltage monitoring error amplifier senses any change in the output voltage compared to a reference voltage. The output of the amplifier causes the resistance of the series regulator to be varied in such a way as to keep the output voltage constant. The programming current, determined by the reference voltage and the series resistor R 35, flows mainly through the VOLTAGE ADJUST potentiometer R 40. The product of the programming current and the value of R 40 equals the output voltage.

4-3 Circuit Description

4-4 The schematic diagram (Fig 5-4) shows all details of the circuit. Power transformer is shown to consist of three secondary windings of which the upper two are the main sources of DC power, while the lower supplies the reference and auxiliary voltage circuit. Rectifier bridges CR 3 to CR 6 and CR 7 to CR 10 are coupled by R 1. Filtering is provided by capacitors C2 and C3. Resistors

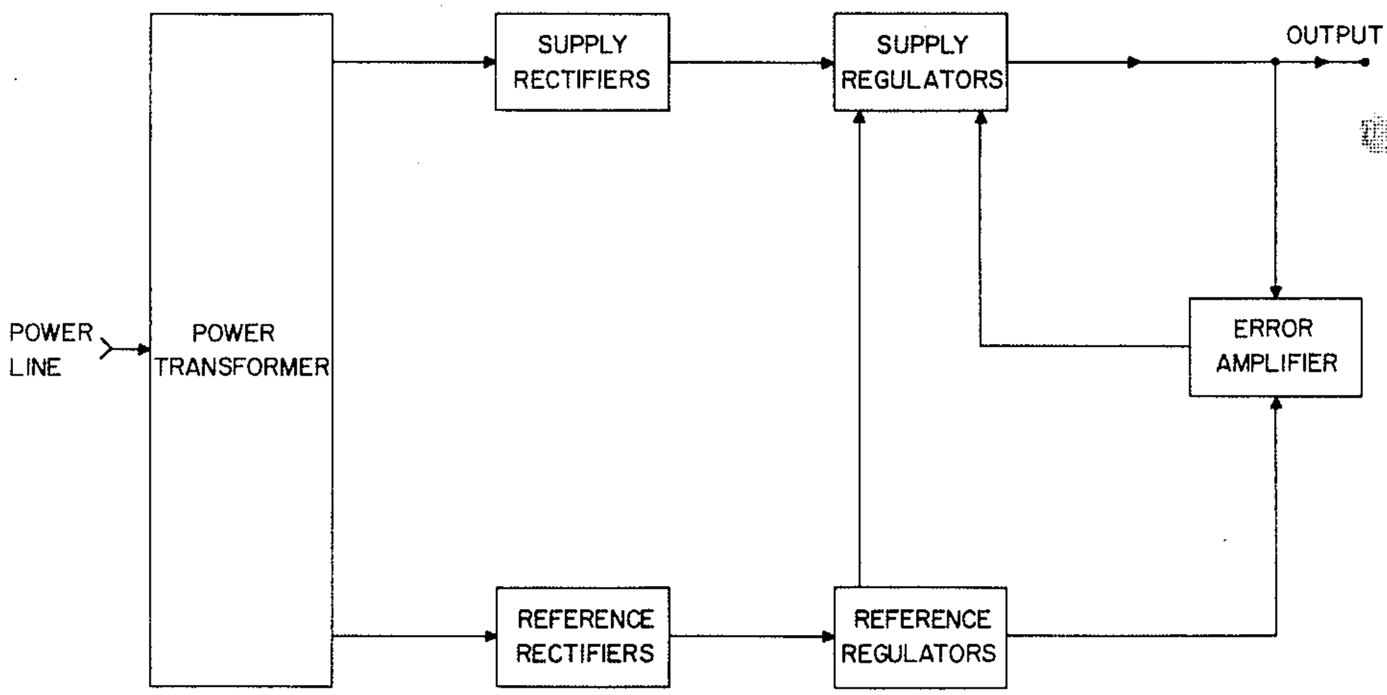


Fig. 4 - 1 Block Diagram

R 3 and R 4 allow a current flow through the rectifier bridges even when no output current is drawn from the instrument. Series regulators Q 1 and Q 2 act as variable resistors determining output voltage and current. The output current from one regulator is monitored by the resistor combinations R 39 B, R 9 and R 8, while R 39 A, R 9 and R 10 monitor the current from the other regulator. The voltage drop across these resistors is applied to the emitter of Q 5. When this potential exceeds a distinct value determined by R 39 A and B and the load current, transistor Q 5 is caused to clip. From then on Q 5 holds the base voltage and hence the emitter voltage of Q 1 through CR 13 and voltage amplifier Q 3, thus preventing any further increase in the load current. Voltage divider R 5, R 6 adjust the base-emitter voltage of transistor Q 2 if the power supply is driven in the 36 V / 300 mA range. The ammeter (M 1) indicates the output current by measuring the voltage across R 22 and the voltmeter M 2 indicates directly the output voltage of the power supply.

The voltage error amplifier consists of the two transistors Q 7 and Q 8 besides Q 3. In the constant voltage mode changes in the output voltage due to changes in load or line voltage are amplified and applied to the base of Q 1 in such a way as to keep the output voltage constant. R 23 is used to adjust the positive feedback from the collector of Q 8 to the base of Q 7. A proper adjustment of this feedback will result in no output voltage change when the load current is changed from no load to full load. It can even be adjusted to yield a negative output resistance, i. e., when a load is applied, the output voltage increases rather than decreases. Normally, this is adjusted to give zero output resistance and not a negative resistance.

CR 14 and CR 13 are disconnecting diodes. In the constant voltage mode CR 13 is closed, CR 14 open, so that the current error amplifier is out of circuit. In the constant current operation CR 13 will be automatically opened and CR 14 will be closed to isolate the voltage error amplifier.

The reference supply consists of a complete feedback amplifier, Q 4 and Q 6. The reference voltage itself is controlled by zener diodes CR 20 and CR 21, which also stabilizes the negative auxiliary voltages. R 41 helps to supply the thermal stability of the base potential of transistor Q 5. Manufacturing tolerances of CR 21 are compensated by factory adjustment of R 27 by means of shunt resistor R 38. The value of R 17 allows current changes proportional to line voltage changes. These current changes compensate possible variations of the current through CR 21 with line voltage variation and minimize changes in output voltage.

SECTION V
MAINTENANCE

5-1 Introduction

5-2 This section contains maintenance and service information for the Model 6960 A Power Supply. A performance check can be made with the instrument in its cabinet and is a good test as part of prevention maintenance and incoming quality control inspection.

5-3 General Maintenance Information

5-4 The power supply has no parts which have a definite limited life. The instrument should operate indefinitely with no routine maintenance. If any parts are replaced you should recheck the settings of R 7, R 10 (maximum short circuit current), R 23 (load regulation) and, if necessary, R 20 and R 21 (meter adjusts). Variations among parts may make it necessary to readjust the controls slightly. Reseal the controls with adhesive or point after adjustment, otherwise the setting will change with shock and vibration.

A list of possible troubles and the probable cause are tabulated in paragraph 5-12. In each case curing the trouble involves replacing the defective parts. Be careful when soldering on the etched circuit board.You can cause damage by excessive heat or improper technique.

5-5 Test Equipment Required

5-6 Test equipment required to test this instrument is listed in table 5-1. The necessary specifications required to obtain reliable test results are listed so that other equipment with equivalent specifications may be used.

Table 5-1 Recommended Test Equipment

Instrument Type	Required Characteristics	Use	Instrument Recommended
AC Voltmeter	Accuracy ± 3 % Floating input	Measure ripple	ⓗ Model 403B
DC Volt-Ammeter	Accuracy ± 1 % Voltage ± 2 % Current	Measure voltage and current	ⓗ Model 412A
Oscillator	100 Hz to 100 kHz Distortion 0.5 %	Measure internal impedance	ⓗ Model 200C or ⓗ Model 202C
Variable Transformer	Monitormeter 1 volt resolution and 1 % accuracy	Change AC input voltage	Any available variable transformer with monitoring meter
Load Resistor	Variable Resistor 150 Ω 50W	Load for measuring ripple, regulation etc.	Any resistor or combination of fixed resistors
Differential Voltmeter	10 mV-range necessary	Measure load and line regulation	ⓗ Model 740A

5-7 Performance Test

5-8 Before attempting to trouble shoot this instrument make sure the fault is with the instrument and not with the associated circuit under test. The performance test will enable you to determine this without having to remove this instrument from the cabinet. Be sure to perform this test before disturbing any ot the internal adjustments of the instrument. This test may also be used as an incoming inspection test to make sure the instrument has not been damaged in shipment, for periodic maintenance or to check operation of the instrument after repairs.

a) Voltage Range.

An external DC-Voltmeter having an accuracy of 1 % or better, i.g. the ⓗ Model 412A, is connected across the output terminals. The Model 6960A under test is to be operated in the 36V-300 mA range. Turn the VOLTAGE ADJUST clockwise until the 412A indicates 36V output. The knob must have been turned more than 180 degrees. Turn the VOLTAGE ADJUST fully counterclockwise. Output voltage should go through zero to between 2 and 100 mV negative.

b) Current Limiting.

Switch off Model 6960A under test and connect the Model 412A with the current range across the output terminals. Turn the CURRENT LIMIT fully clockwise. VOLTAGE ADJUST should be in a mid range position. Push the buttons 18 V-0.6 A or 36-0.3 A and wait 15 minutes. When the instrument has warmed up measure the maximum short circuit current in both ranges. The 412A should read about 340 mA in the 36V range and 680 mA in the 18 V range.

c) Ripple.

Attach the load resistor for 18 V and 0.6 A to the output terminals and adjust the output voltage and current to these ratings. Connect the floating input of AC-Voltmeter 403B (or equivalent) ungrounded AC-voltmeter to the output terminals. The readout of the 403B should not exceed 150 μV. In the 36 V-0.3 A range the same result should appear.

d) Load regulation.

For the connections, refer to block diagram in Figure 5-1. If the load is switched off and on the output voltage change in both ranges should not exceed 5 mV. The "internal resistance" of the power supply under test should be positive, that is, with load off the output voltage should be higher than with load on.

If you lack a good differential voltmeter, take a second Model 6960A or another constant voltage source and compare the output voltage changes to the power supply under test using a sensitive DC-voltmeter like the hp Model 412A or hp Model 425 A.

e) Line regulation.

Take the same connections as in paragraph 5-8d, change the line voltage of the Model 6960A under test by means of a variable line transformer between 198 V and 242 V. The change in output voltage should not exceed 5 mV on both ranges.

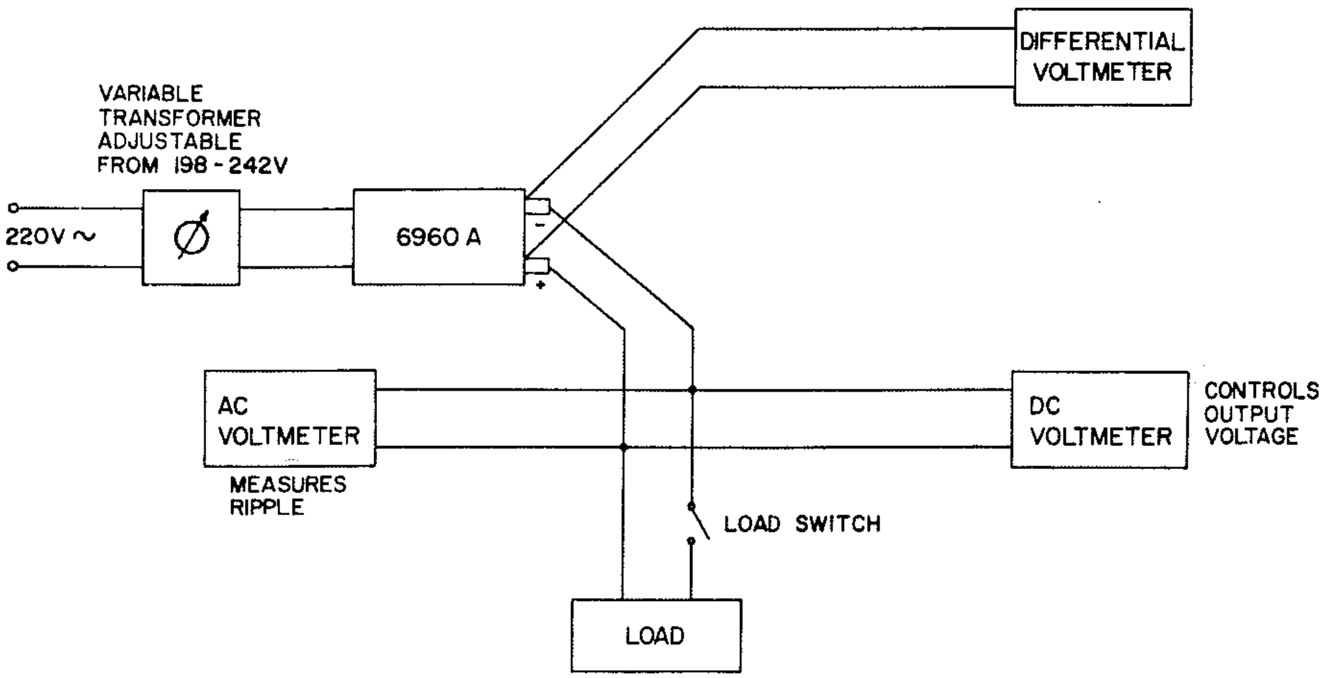


Fig. 5-1 Measuring Line, Load Regulation and Ripple

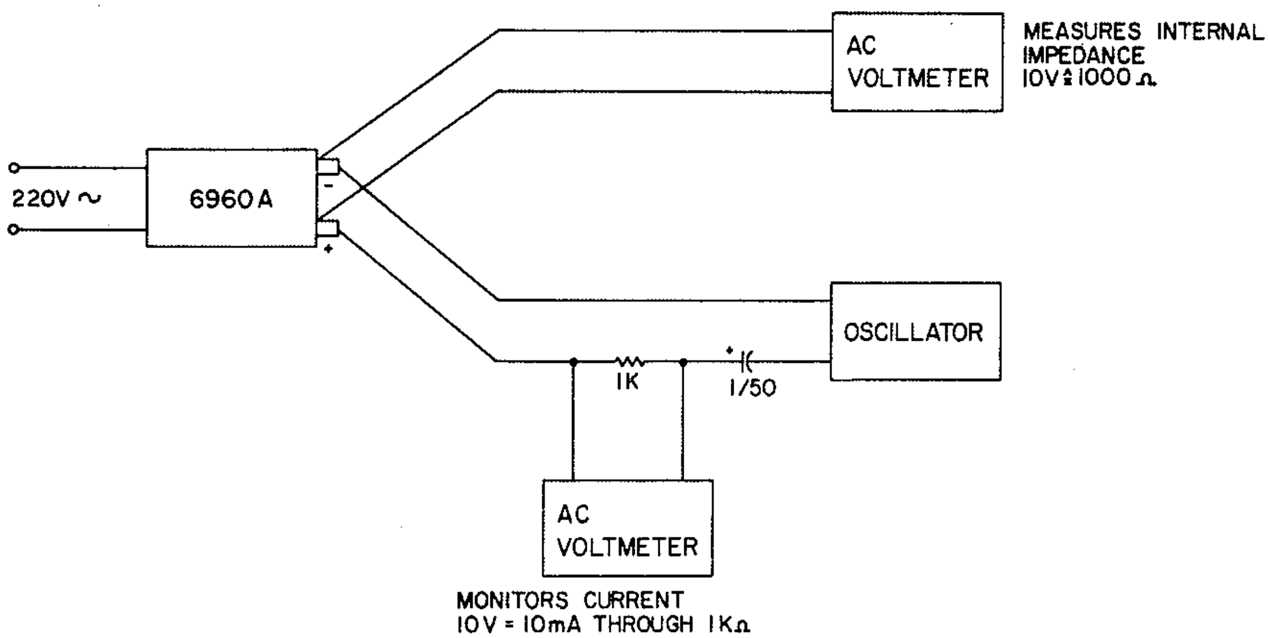


Fig. 5-2 Measuring AC Internal Impedance

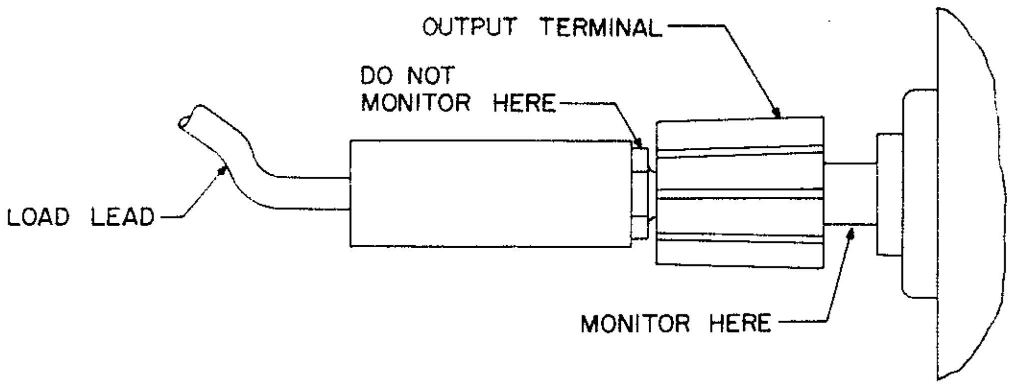


Fig. 5-3 Recommended Connection at the Power Supply

f) AC Internal Impedance.

Make your connections according to the block diagram in Figure 5-2. This measurement is made by driving a constant 10 mA alternating current through the power supply and measuring the voltage drop across the output terminals. The internal impedance can be easily calculated by Ohm's law.

By checking the internal impedance you should consider that the power supply's ripple and noise add to the voltmeter reading. For performing very exact measurements you have to filter out all ripple and noise voltages up to a frequency of about 500 cycles or to use a sensitive wave analyser.

Also take care to prevent stray ground loops which make impossible reliable measurement of internal impedance.

Up to 1 Kc the internal resistance of the Model 6960 A should be below 0.02 Ω
1 Kc up to 50 Kc below 0.5 Ω .

5-9 Detailed Test Procedure

5-10 The following test procedure should be performed only after the performance test has shown that this instrument is faulty. Do not perform this procedure as an incoming inspection or proof of performance check. The following test procedure contains extra checks to help you analyze the troubles in this instrument. These extra checks and the data they contain cannot be considered as specifications.

Because of internal adjustment or even possible replacement of components, top, bottom, and the side covers may have to be removed. Make sure that the ac fuse is inserted in the fuse holder. The VOLTAGE ADJUST on the front panel should be in a mid-range position, the CURRENT LIMIT control turned fully clockwise. Use an ohmmeter, e.g. ⓗ Model 412A, to make certain the negative output terminal, the positive output terminal, and the collectors of Q 1 and Q 2 are not grounded.

Now switch the Model 6960A on. Vary the output voltage in both voltage ranges with the VOLTAGE ADJUST to be sure that the voltage control is operative.

a) Meter Zero Set.

When the instrument is at normal operating temperature and then switched off, the meter pointers must rest on the zero calibration mark of the meter scale. If they are outside the zero mark, adjust the them as follows:

After turning off the instrument wait two minutes for power supply capacitors to discharge completely. Rotate adjustment screw below the meter scale clockwise until the meter pointer is to the left of zero and farther clockwise rotation will move the pointer upscale towards zero.

Turn the adjustment screw clockwise until the pointer is exactly over the zero mark on the scale. If the screw is turned too far repeat the procedure.

Turn meter adjustment screw slightly counterclockwise to break contact between adjustment screw and pointer mounting yoke, but not far enough to move the pointer downscale. If screw is turned too far, as shown by needle movement, repeat the procedure.

b) Volt Meter and Ammeter Calibration.

Set the output to exactly 36 V controlled by an external dc voltmeter which has better than 1 % full scale error, i.g. ⓗ Model 412A. Adjust the built-in voltmeter to exactly 36 V by means of variable resistor R 20. Switch the Model 6960A under test into the 18 V-0.6 A range and bring the output current to exactly 600 mA, controlled by an external dc ammeter like the ⓗ Model 412A. Adjust variable resistor R 21 so the front panel ammeter reads exactly 600 mA.

c) Maximum Short Circuit Current.

The short circuit current can be measured either by measuring the voltage drop across a 1 Ω precision resistor between the output terminals or by switching off the instrument and connecting the current leads of the model 412A across the output terminals and turning on the Model 6960A. The CURRENT LIMIT control must be set fully clockwise.

The maxium rating of short circuit current should be 360 mA or 720 mA respectively; the minimum ratings are 330 mA or 660 mA. The nominal and factory adjusted values are 340 mA and 680 mA. These ratings should be adjusted as follows, if the short circuit current turns out to be too high or too low.

At first select the 36 V-0.3 A range and adjust short circuit current by changing the position of R 7 to 340 mA. Then switch the power supply into the 18V-0.6 A range and adjust short circuit current with R 10 to 680 mA.

Caution : Do not allow current ratings of more than 400 mA to flow through either of the series regulators. This may destroy the series regulators Q 1 and Q 2 !

Attention: Before performing this adjust, the instrument has to be warmed up to its normal operating temperature.

d) Ripple.

Measure ripple according to paragraph 5-8 c. Change the line voltage of the power supply between 198 V and 242 V. Within the whole range the ripple voltage should not exceed 150 μ Veff. If there is a gradual rise of ripple over 150 μVrms while decreasing the line voltage towards 198 V, transistor Q 6 has stopped working. Remove R 38 and replace it with a decade resistance. Vary the input line voltage between 198 V and 242 V and adjust the decade so that in the whole range the ripple voltage remains below 150 μVrms. At the same time check the voltage between minus lead of capacitor C1 and -S. It should read -14V ± 2 %, otherwise transistor Q 4 will not regulate properly. Replace the decade value with a fixed resistor of equal value.

e) Load Regulation.

For measuring circuit refer to paragraph 5-8 d. If the output voltage change is greater than 5 mV while switching the load off and on, adjust resistor R 23 so that the change is within the specification. After setting R 23 turn the VOLTAGE ADJUST knob fully counterclockwise. A dc voltmeter across the output terminals of the power supply must indicate a negative voltage between -2 mV and -100 mV.

f) Line Regulation.

If the adjustment described in paragraph 5-10 d has been done carefully the output voltage change caused by input line voltage changes should normally be within the specification. If there are, nevertheless, excessive changes, remove R 37 and replace it with a decade resistance. The decade is adjusted so the change of output voltage lies within specification. Replace the decade with a fixed resistor of equal value.

5-11 Troubleshooting

5-12 Components within Hewlett-Packard instruments are conservatively operated to provide maximum instrument reliability. In spite of this, parts within an instrument may fail. In this case a systematic approach can greatly simplify and thereby speed up the repair.

CAUTION

Be careful not to short voltages across the transistors, small bias changes may ruin a transistor due to excessive dissipation. Be sure to turn the instrument off before doing any soldering.

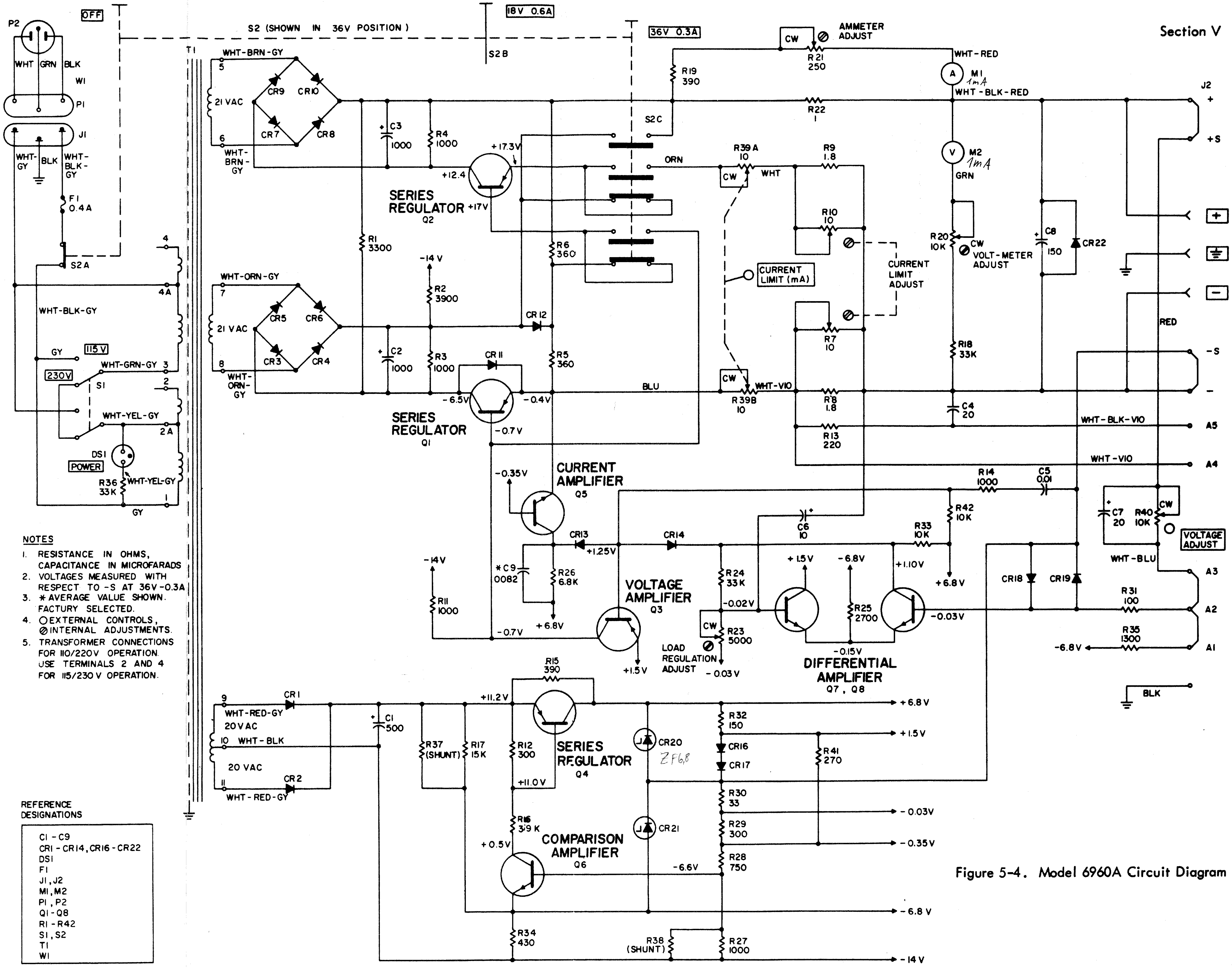
If there is no voltage throughout the instrument check the fuse and primary transformer circuit. Transistors Q 1 and Q 2 should have a voltage drop of about 5 to 6 V across them. If the pilot lamp is on but the dc output shows no voltage or excessive voltage with high ripple check all voltages produced by the auxiliary and reference voltage supply. These voltages should be at ratings shown in the schematic diagram and should not exhibit significant changes while varying the input line voltage. If all of these voltages are operating properly the trouble lies in the amplifier loop. Check each transistor of the amplifier, including the diodes CR 13 and CR 14 as well as the front panel potentiometer R 40 (VOLTAGE ADJUST).

Some symptoms indicate, with high degree of probability that certain components may be faulty. Refer to the trouble localization chart below.

Table 5-2 Trouble Localisation chart

Symptom	Check
Blown Line fuse	Primary circuit of T 1 T 1 itself, CR 1 to CR 10 C 1 to C 3.
Either 18 V or 36 V range only is working properly	Push button switch
Excessive short circuit current Poor current limiting.	R 7, R 10, R 39 AB, Q 5
Poor stability of output voltage	CR 20, CR 21, R 40
Poor load regulation	Q 8, Q 7, CR 14, Q 3
Poor line regulation	CR 21, Q 6, Q 4

After replacing faulty components carry out the performance test according to paragraph 5-7 and, if necessary, the adjustment procedure according to paragraph 5-9.



NOTES

1. RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS
2. VOLTAGES MEASURED WITH RESPECT TO -S AT 36V-0.3A
3. * AVERAGE VALUE SHOWN. FACTORY SELECTED.
4. ○ EXTERNAL CONTROLS, ⊘ INTERNAL ADJUSTMENTS.
5. TRANSFORMER CONNECTIONS FOR 110/220V OPERATION. USE TERMINALS 2 AND 4 FOR 115/230 V OPERATION.

REFERENCE DESIGNATIONS

- C1 - C9
- CR1 - CR14, CR16 - CR22
- DS1
- F1
- J1, J2
- M1, M2
- P1, P2
- Q1 - Q8
- R1 - R42
- S1, S2
- T1
- W1

Figure 5-4. Model 6960A Circuit Diagram

SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

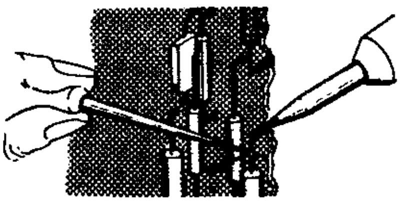
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

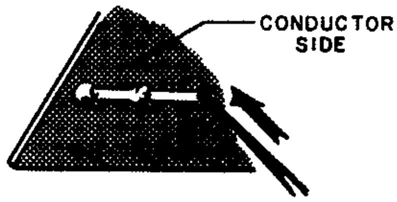
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.

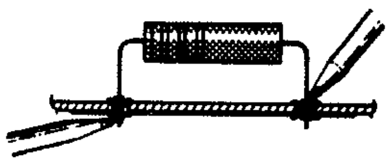


2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



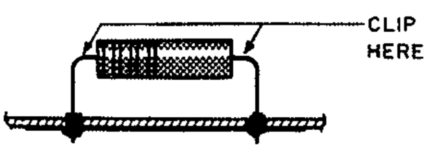
3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.

4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

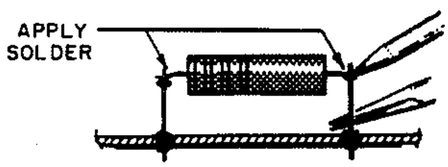


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.



2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

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 designations and indicates the description and ℎ𝑝 stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ℎ𝑝 stock 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 Table 6-3.

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 order a replacement part, address order or inquiry to your local Hewlett-Packard Field Office (see maps at rear of this manual for addresses).

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designation.

d. Description.

6-7. To order a part not listed in Tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	E	= misc electronic part	MP	= mechanical part	TB	= terminal board
B	= motor	F	= fuse	P	= plug	TP	= test point
C	= capacitor	FL	= filter	Q	= transistor	V	= vacuum tube, neon bulb, photocell, etc.
CP	= coupling	J	= jack	R	= resistor	W	= cable
CR	= diode	K	= relay	RT	= thermistor	X	= socket
DL	= delay line	L	= inductor	S	= switch	Y	= crystal
DS	= device signaling (lamp)	M	= meter	T	= transformer		

ABBREVIATIONS

A	= amperes
A.F.C	= automatic frequency control
AMPL	= amplifier
B.F.O.	= beat frequency oscillator
BE CU	= beryllium copper
BH	= binder head
BP	= bandpass
BRS	= brass
BWO	= backward wave oscillator
CCW	= counter-clockwise
CER	= ceramic
CMO	= cabinet mount only
COEF	= coefficient
COM	= common
COMP	= composition
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
CW	= clockwise
DEPC	= deposited carbon
DR	= drive
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farads
FH	= flat head
FIL H	= fillister head
FXD	= fixed
GE	= germanium
GL	= glass
GRD	= ground(ed)
H	= henries
HEX	= hexagonal
HG	= mercury
HR	= hour(s)
IF	= intermediate freq
IMPG	= impregnated
INCD	= incandescent
INCL	= include(s)
INS	= insulation(ed)
INT	= internal
K	= kilo = 1000
LIN	= linear taper
LK WASH	= lock washer
LOG	= logarithmic taper
LPF	= low pass filter
M	= milli = 10^{-3}
MEG	= meg = 10^{6}
METFLM	= metal film
MFR	= manufacturer
MINAT	= miniature
MOM	= momentary
MTG	= mounting
MY	= mylar
N	= nano (10^{-9})
N/C	= normally closed
NE	= neon
NI PL	= nickel plate
N/O	= normally open
NPO	= negative positive zero (zero temperature coefficient)
NRFR	= not recommended for field replacement
NSR	= not separately replaceable
OBD	= order by description
OH	= oval head
OX	= oxide
P	= peak
PC	= printed circuit
PF	= picofarads = 10^{-12} farads
PH BRZ	= phosphor bronze
PHL	= Phillips
PIV	= peak inverse voltage
P/O	= part of
POLY	= polystyrene
PORC	= porcelain
POS	= position(s)
POT	= potentiometer
PP	= peak-to-peak
PT	= point
RECT	= rectifier
RF	= radio frequency
RH	= round head
RMO	= rack mount only
RMS	= root-mean-square
S-B	= slow-blow
SCR	= screw
SE	= selenium
SECT	= section(s)
SEMICON	= semiconductor
SI	= silicon
SIL	= silver
SL	= slide
SPL	= special
SST	= stainless steel
SR	= split ring
STL	= steel
TA	= tantalum
TD	= time delay
TGL	= toggle
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TWT	= traveling wave tube
U	= micro = 10^{-6}
VAR	= variable
VDCW	= dc working volts
W/	= with
W	= watts
WW	= wirewound
W/O	= without

Table 6-1. REFERENCE DESIGNATION INDEX

Reference Designation	-hp- Stock No.	Description *	Note
C 1	0180-0502	C: FXD, Elect. 500 μF 29 VDCW	
C 2 thru C 3	0180-0518	C: FXD, Elect. 1000 μF 31 VDCW	
C 4	0180-0049	C: FXD, Elect. 20 μF 50 VDCW	
C 5	0150-0012	C: FXD, CER. 0.01 μF 1000 VDCW	
C 6	0180-0032	C: FXD, Elect. 10 μF 10 VDCW	
C 7		see C 4	
C 8	0180-0131	C: FXD, Elect. 150 μF 63 VDCW	
C 9	0150-0082	C: FXD, CER. 8200 μF 500 VDCW	
CR 1 thru CR 11	1901-0026	Diode — Silicon	
CR 12	1901-0025	Diode — Silicon	
CR 13 thru CR 14	1901-0033	Diode — Silicon	
CR 15		Not assigned	
CR 16 thru CR 18		see CR-12	
CR 19		see CR-1	
CR 20	1902-0048	Diode — Zener	
CR 21	1902-0057	Diode — Zener	
CR 22		see CR-1	
DS 1	2140-0015	Lamp — Neon	
F 1	2110-0019	220 V: Fuse cartridge 0.4 A, Slow blow	
F 1	2110-0020	110 V: Fuse cartridge 0.8 A, Slow blow	
J 1	1251-0148	Connector Power	
J 2	1510-0503	Binding Post Red	
J 2	1510-0009	Binding Post Black	
M 1	1120-0513	Meter Ampere	
M 2	1120-0512	Meter Volt	
P 1 thru P 2		see W 1	

* see List of Abbreviations in introduction to this section

Table 6-1. REFERENCE DESIGNATION INDEX (CON'T)

Reference Designation	-hp- Stock No.	Description *	Note
Q 1 thru Q 2	1850-0168	Transistor-Germanium	
Q 3	1850-0169	Transistor-Germanium	
Q 4	1850-0509	Transistor-Germanium	
Q 5 thru Q 8	1851-0017	Transistor-Germanium NPN 2 N 1304	
R 1	0690-3321	R: FxD, Comp. 3.3 K Ω 10 % 1 W	
R 2	0690-3921	R: FxD, Comp. 3.9 K Ω 10 % 1 W	
R 3 thru R 4	0693-1021	R: FxD, Comp. 1 K Ω 10 % 2 W	
R 5	0692-3615	R: FxD, Comp. 360 Ω 5 % 2 W	
R 6	0692-3315	R: FxD, Comp. 330 Ω 5 % 2 W	
R 7	2100-0507	R: VAR,WW 10 Ω 10 % 0.5 W	
R 8 thru R 9	0813-0503	R: FxD, WW 1.8 Ω 5 % 2 W	
R 10		see R 7	
R 11	0686-1025	R: FxD, Comp. 1 K Ω 5 % 0.5 W	
R 12	0686-3015	R: FxD, Comp. 300 Ω 5 % 0.5 W	
R 13	0687-2211	R: FxD, Comp. 220 Ω 10 % 0.5 W	
R 14	0687-1021	R: FxD, Comp. 1 K Ω 10 % 0.5 W	
R 15	0686-3915	R: FxD, Comp. 390 Ω 5 % 0.5 W	
R 16	0687-3921	R: FxD, Comp. 3.9 K Ω 10 % 0.5 W	
R 17	0687-1531	R: FxD, Comp. 15 K Ω 10 % 0.5 W	
R 18	0687-3331	R: FxD, Comp. 33 K Ω 10 % 0.5 W	
R 19	0687-3911	R: FxD, Comp. 390 Ω 10 % 0.5 W	
R 20	2100-0505	R: VAR,Comp. 10 K Ω 20 % 0.3 W	
R 21	2100-0503	R: VAR,Comp. 250 Ω 20 % 0.3 W	
R 22	0813-0502	R: FxD, WW 1 Ω 5 % 2 W	
R 23	2100-0504	R: VAR,Comp. 5 K Ω 20 % 0.3 W	
R 24	0686-3335	R: FxD, Comp. 33 K Ω 5 % 0.5 W	
R 25	0687-2721	R: FxD, Comp. 2.7 K Ω 10 % 0.5 W	
R 26	0687-6821	R: FxD, Comp. 6.8 K Ω 10 % 0.5 W	
R 27		see R 11	
R 28	0686-7515	R: FxD, Comp. 750 Ω 5 % 0.5 W	
R 29		see R 12	
R 30	0686-3305	R: FxD, Comp. 33 Ω 5 % 0.5 W	

* see List of Abbreviations in introduction to this section

Table 6-1. REFERENCE DESIGNATOR INDEX (CON'T)

Reference Designation	-hp- Stock No.	Description *		Note
R 31	0690-1011	R: FxD, Comp.	100 Ω 10 % 1 W	
R 32	0686-1515	R: FxD, Comp.	150 Ω 5 % 0.5 W	
R 33	0687-1031	R: FxD, Comp.	10 K Ω 10 % 0.5 W	
R 34	0689-4315	R: FxD, Comp.	430 Ω 5 % 1 W	
R 35	0760-0501	R: FxD, Met.FLM	1.3 K Ω 2 % 1 W	
R 36		see R 18		
R 37		Shunt Resistor		
R 38		Shunt Resistor		
R 39 A/B	2100-0506	R: VAR WW	2 x 10 Ω 10 % 2 WLIN	
R 40	2100-0234	R: VAR WW	10 K Ω 20 % 2 WLIN	
R 41	0687-2711	R: FxD, Comp.	270 Ω 10 % 0.5 W	
R 42		see R 33		
R 43	0683-0685	R: FxD, Comp.	6.80 Ω 5 % 0.25 W	
S 1	3101-0033	Switch-Slide		
S 2	3101-0503	Switch-Push Button		
T 1	9100-0513	Transformer-Power		
W 1	8120-0100	Standard, Power P2: Schuko Plug		
W 2	8120-0078	Special Order: Power Cord, P2: Nema Plug		
		Miscellaneous		
	0370-0133	Knob — Current Limit		
	0370-0137	Knob — Voltage Adjust		
	1400-0084	Fuseholder		

* see List of Abbreviations in introduction to this section

Table 6-2. REPLACEABLE PARTS

-hp- Stock No.	Description *		Mfr.	Mfr.Part.No.	TQ	RS
0150-0012	C: FxD, CER.	0.01 μF 1000 VDCW	56289	29C214A3	1	1
0150-0082	C: FxD, CER.	8200 μF 500 VDCW	28480	0150-0082	1	1
0180-0032	C: FxD, ELECT.	10 μF 10 VDCW	56289	D 32877	1	1
0180-0049	C: FxD, ELECT.	20 μF 50 VDCW	56289	D 33909	2	1
0180-0502	C: FxD, ELECT.	500 μF 29 VDCW	28480	0180-0502	1	1
0180-0131	C: FxD, ELECT.	150 μF 63 VDCW	28480	0180-0131	1	1
0180-0518	C: FxD, ELECT.	1000 μF 50 VDCW	28480	0180-0518	2	1
0370-0133	KNOB-CURRENT LIMIT		28480	0370-0133	1	1
0370-0137	KNOB-Voltage Adjust		28480	0370-0137	1	1
0686-1025	R: FxD, Comp.	1 K Ω 5 % 0.5 W	01121	EB-1025	2	1
0686-1515	R: FxD, Comp.	150 K Ω 5 % 0.5 W	01121	EB-1515	1	1
0683-0685	R: FxD, Comp.	6.8 Ω 5 % 0.25 W	28480	0683-0685	1	1
0686-3915	R: FxD, Comp.	390 Ω 5 % 0.5 W	01121	EB-3915	2	1
0686-3305	R: FxD, Comp.	33 Ω 5 % 0.5 W	01121	EB-3305	1	1
0686-3335	R: FxD, Comp.	33 Ω 5 % 0.5 W	01121	EB-3335	1	1
0686-7515	R: FxD, Comp.	750 Ω 10 % 0.5 W	01121	EB-7515	2	1
0687-1021	R: FxD, Comp.	1 Ω 10 % 0.5 W	01121	EB-1021	1	1
0687-1531	R: FxD, Comp.	15 K Ω 10 % 0.5 W	01121	EB-1531	2	1
0687-2211	R: FxD, Comp.	220 Ω 10 % 0.5 W	01121	EB-2211	1	1
0687-2711	R: FxD, Comp.	270 Ω 10 % 0.5 W	01121	EB-2711	1	1
0687-2721	R: FxD, Comp.	2.7 Ω 10 % 0.5 W	01121	EB-2721	1	1
0687-3331	R: FxD, Comp.	33 K Ω 10 % 0.5 W	01121	EB-3331	2	1
0687-3911	R: FxD, Comp.	390 Ω 10 % 0.5 W	01121	EB-3911	1	1
0687-3921	R: FxD, Comp.	3.9 K Ω 10 % 0.5 W	01121	EB-3921	1	1
0687-1031	R: FxD, Comp.	10 K Ω 10 % 0.5 W	01121	EB-1031	2	1
0678-6821	R: FxD, Comp.	6.8 K Ω 10 % 0.5 W	01121	EB-6821	1	1
0689-4315	R: FxD, Comp.	430 Ω 5 % 1 W	01121	GB-4315	1	1
0690-3321	R: FxD, Comp.	3.3 K Ω 10 % 1 W	01121	GB-3321	1	1
0690-1011	R: FxD, Comp.	100 Ω 10 % 1 W	01121	GB-1011	1	1
0690-3921	R: FxD, Comp.	3.9 K Ω 10 % 1 W	01121	GB-3921	1	1
0692-3615	R: FxD, Comp.	360 Ω 5 % 2 W	01121	GB-3615	2	1
0693-1021	R: FxD, Comp.	1 K Ω 10 % 2 W	01121	HB-1021	1	1
0692-3315	R: FxD, Comp.	330 Ω 5 % 2 W	01121	GB-3315	1	1
0760-0501	R: FxD, MET.FLM.	1.3 K Ω 2 % 1 W	28480	0760-0501	1	1

* see List of Abbreviations in introduction to this section

Table 6-2. REPLACEABLE PARTS (CONT'D)

-hp- Stock No.	Description *	Mfr.	Mfr.Part.No.	TQ	RS
0813-0502	R: FxD WW 1 Ω 5 % 2 W	28480	0813-0502	1	1
0813-0503	R: FxD WW 1.8 Ω 5 % 2 W	28480	0813-0503	2	1
1120-0512	Meter Volt	28480	1120-0512	1	1
1120-0513	Meter Ampere	28480	1120-0513	1	1
1251-0148	Connector – Power	0000U	H 1061-2	1	1
1400-0084	Fuseholder	75915	342014	1	1
2140-0015	Lamp – Neon			1	1
1510-0009	Binding Post Black	28480	1510-0501	1	1
1510-0503	Binding Post Red	28480	1510-0502	2	1
1850-0169	Transistor – Germanium	28480	1850-0169	1	1
1850-0168	Transistor – Germanium	28480	1850-0168	2	2
1850-0509	Transistor – Germanium	28480	1850-0509	1	1
1851-0017	Transistor – Germanium NPN 2N 1304	01295	2N 1304	4	4
1901-0025	Diode – Silicon	49956	RD 1526	4	4
1901-0026	Diode – Silicon	02735	34531	13	13
1901-0033	Diode – Silicon	07910	IN485B	2	2
1902-0048	Diode – Zener	28480	1902-0502	1	1
1902-0057	Diode – Zener	28480	1902-0048	1	1
2100-0234	R: VAR. WW 10 K Ω 20 % 2 WLIN	01121	Type J	1	1
2100-0503	R: VAR. Comp. 250 Ω 20 % 2 WLIN	28480	2100-0503	1	1
2100-0504	R: VAR. Comp. 5 K Ω 20 % 0.3 W	28480	2100-0504	1	1
2100-0505	R: VAR. Comp. 10 K Ω 20 % 0.3 W	28480	2100-0505	1	1
2100-0506	R: VAR. WW 2 x 10 Ω 10 % 2 WLIN	28480	2100-0506	1	1
2100-0507	R: VAR. WW 10 Ω 10 % 0.5 W	28480	2100-0507	2	1
2110-0019	220 V: Fuse Cartridge 0.44 A, slow blow	75915	313.400	1	10
2110-0020	110 V: Fuse Cartridge 0.8 A, slow blow	75915	313.800	1	10
3101-0033	Switch – Slide	42190	4633	1	1
3101-0503	Switch – Push Button	28480	3101-503	1	1
8120-0078	Special Order: Power Cord, P2: Nema plug	70903	KH4147	1	1
8120-0100	Standard: Power P2: Schuko plug	28480	8120-0100	1	1
9100-0513	Transformer – Power	28480	9100-0513	1	1

* see List of Abbreviations in introduction to this section

TABLE 6-3.
CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc., Electronics 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 Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
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, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
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.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, 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 Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device 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.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Linde Div., Kemet Dept.	Cleveland, Ohio
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	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semcor Div. Components Inc.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
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.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-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.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., CG Elect. 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, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Amelco Inc.	Mt. View, Calif.
15909	Daven Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	Bendix Corp., The Eclipse-Poineer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.

From FSC. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV 1962

TABLE 6-3.
CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
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.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
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	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	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, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Revere Wollansak Div. Minn. Mining & Mfg. Co.	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.
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 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.	Willoughby, Ohio
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, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
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 Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, 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.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, 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.
75378	CTS Knights Inc.	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	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
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 Div.	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	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Mass.
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.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.

From: FSC. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1962

HEWLETT hp PACKARD GmbH

MANUAL CHANGES

MODEL 6960 A

DC POWER SUPPLY

Manual Serial Prefixed: 604-
Manual Printed: AUG. 1967

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefixes		Make Manual Changes
G-604-	and above	

ERRATA: In Table 1-1, Specifications:
Delete: "Meters on Option 01 only".
In Section VI, Replaceable Parts:

			-hp- Stock No.
Change:	C9 to C9*	C:fxd., cer. (preferred value 0.0082uF,500VDCW)	0150-0082
	R5	R:fxd., to 330 Ohm, ±5%, 2W	0692-3315
	R6	R:fxd., to 360 Ohm, ±5%, 2W	0692-3615
	R43 to R43 *	R:fxd., comp. (preferred value 6.8 Ohm, ±5%, 0.25W)	0683-0685
	the "Reference Designator" of S2 to SW2		
Add:	R44	R:fxd., 47 Ohm, 0.25W, ±5% (connected in series with CR13)	0684-4701

In Section V, Figure 5-4, Circuit Diagram:

Add:	R43 *	(connected in series with CR16,17; part may be omitted).

9320-0535

HEWLETT hp PACKARD

ELECTRONIC INSTRUMENTATION SALES AND SERVICE

UNITED STATES

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

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

232 South Tucson Boulevard
Tucson 85716
Tel: (602) 623-2564
TWX: 910-952-1162

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

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

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

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

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

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

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

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

FLORIDA
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33138
Tel: (305) 758-3626
TWX: 810-848-7262

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

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
2340 Interstate Parkway
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

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

INDIANA
4002 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

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

P.O. Box 727
Twinbrook Station 20851
12303 Twinbrook Parkway
Rockville
Tel: (301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS
Middlesex Turnpike
Burlington 01803
Tel: (617) 272-9000
TWX: 710-332-0382

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

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

MISSOURI
9208 Wyoming Place
Kansas City 64114
Tel: (816) 333-2445
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 644-0220
TWX: 910-760-1670

NEW JERSEY
391 Grand Avenue
Englewood 07631
Tel: (201) 567-3933
TWX: 710-991-9707

NEW MEXICO
P.O. Box 8366
Station C 87108
6501 Lomas Boulevard N.E.
Albuquerque
Tel: (505) 255-5586
TWX: 910-989-1665

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

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462

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

236 East 75th Street
New York 10021
Tel: (212) 879-2023
TWX: 710-581-4376

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

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

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

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

NORTH CAROLINA
P.O. Box 5187
1923 North Main Street
High Point 27262
Tel: (919) 882-6873
TWX: 510-926-1516

OHIO
5579 Pearl Road
Cleveland 44129
Tel: (216) 884-9209
TWX: 810-421-8500

2460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

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

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

144 Elizabeth Street
West Conshohocken 19428
Tel: (215) 248-1600, 828-6200
TWX: 510-660-8715

TEXAS
P.O. Box 7166
3605 Inwood Road
Dallas 75209
Tel: (214) 357-1881
TWX: 910-861-4081

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4242 Richmond Avenue
Houston 77027
Tel: (713) 667-2407
TWX: 910-881-2645

GOVERNMENT CONTRACT OFFICE
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San Antonio 78226
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UTAH
2890 South Main Street
Salt Lake City 84115
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TWX: 910-925-5681

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
11656 N.E. Eighth Street
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard; 1501 Page Mill Road; Palo Alto, California 94304; Tel: (415) 326-7000; TWX: 910-373-1267; Telex: 34-8461

CANADA

ALBERTA
10010 - 105th Street
Edmonton
Tel: (403) 424-0718
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
2184 West Broadway
Vancouver
Tel: (604) 738-7520
TWX: 610-922-5050

NOVA SCOTIA
7001 Mumford Road
Suite 356
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

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

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
Toronto
Tel: (416) 249-9196
TWX: 610-492-2382

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-2819

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard Inter-Americas; 1501 Page Mill Road; Palo Alto, Calif. 94304; Tel: (415) 326-7000; TWX: 910-373-1267; Telex: 034-8461; Cable: HEWPACK Palo Alto

CENTRAL AND SOUTH AMERICA

ARGENTINA
Mauricio A. Suárez
Telecomunicaciones
Carlos Calvo 224
Buenos Aires
Tel: 30-6312, 34-9087
Cable: TELEPILOT Buenos Aires

BRAZIL
Ciental, Importacao e
Comércio Ltda.
Avenida 13 de Maio, 13-22° andar
Rio de Janeiro G.B.
Tel: 42-9483

Ciental, Importacao e
Comércio Ltda.
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