Errata

Title & Document Type: **6515A DC Power Supply Operating and Service Manual**

Manual Part Number: **06515-90001**

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Agilent Technologies

DC POWER SUPPLY

HVB SERIES, MODEL 6515A

SERIAL NUMBER PREFIX 6C

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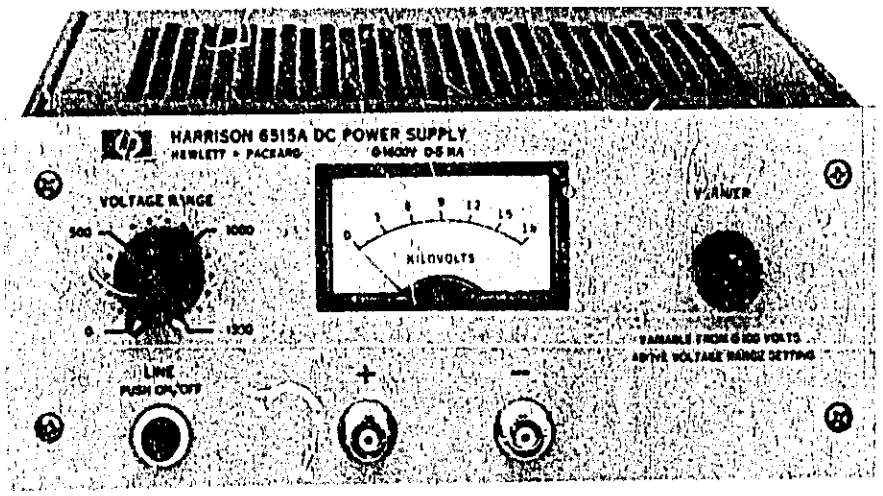


Figure 1-1. DC Power Supply, Model 6515A

SECTION I
GENERAL INFORMATION

1-1 DESCRIPTION

1-2 Model 6515A (Figure 1-1) is an all semiconductor high voltage supply suitable for either bench or relay rack operation. It is a compact, well-regulated Constant Voltage / Current Limited supply that will furnish 1600V at 5mA or can be adjusted throughout the output voltage range.

1-3 This supply is series regulated and utilizes a switched output piggyback technique; four series-connected low voltage supplies are connected via the VOLTAGE RANGE switch to the (+) output terminal. A fifth supply is connected via the series regulator to the (-) output terminal.

1-4 OVERLOAD PROTECTION

1-5 The VOLTAGE RANGE switch and VERNIER control select the constant voltage level. An internal potentiometer selects the current limit level. The supply will automatically crossover from constant voltage to current limit operation and vice versa if the output current or voltage exceeds these preset levels. Detailed characteristics of the output current limiting are given in paragraph 3-7.

1-6 The power supply is protected from reverse voltage (positive voltage applied to negative terminal) by an internal protection diode that shunts current across the output terminals when this condition exists, clamping the reverse voltage. Protection from reverse current (current forced into the power supply in the direction opposite to the output current) must be provided by preloading the power supply (Paragraph 3-18). The power supply cannot accept reverse current without damage.

1-7 COOLING

1-8 Convection cooling is used. No fan is required. The power supply has no moving parts (except for meter movement).

1-9 OUTPUT TERMINALS

1-10 Output power is available via two UG-931/U connectors at the front of the power supply. Mating connectors (UG-932/U) are supplied with the unit. The output terminals are isolated from the chassis and either the positive or the negative terminal may be connected to the chassis by shorting the center pin and case of the applicable UG-931/U connector, or by grounding a wire from the connector to the chassis. The power supply is insulated to permit operation up to 1,000 vdc off ground, i.e. the maximum potential between either output terminal and ground shall not exceed 2.6 KV DC.

1-11 SPECIFICATIONS

1-12 Detailed specifications for the power supply are given in Table 1-1.

1-13 OPTIONS

1-14 Options are factory modifications of a standard instrument that are requested by the customer. The following options are available for the instrument covered by this manual. Where necessary, detailed option information is included throughout the manual.

Option No.	Description
13	Three Digit Graduated Decadial Voltage Control: Includes a calibrated 10-turn control replacing the 10-turn vernier to provide resettability within 0.1%.

1-15 ACCESSORIES

1-16 The accessories listed in the following chart may be ordered with the power supply or separately from your local Hewlett-Packard sales office. (Refer to list at rear of manual for addresses.)

Part No.	Description
C05	8" Black Handle that can be attached to side of supply.
14513A	Rack Kit for mounting one 3 1/2" - high supply. (Refer to Section II for details.)
14523A	Rack Kit for mounting two 3 1/2" - high supplies. (Refer to Section II for details.)

1-17 INSTRUMENT IDENTIFICATION

1-18 Hewlett-Packard power supplies are identified by a three-part serial number tag. The first part is the power supply model number. The second part is the serial number prefix, which consists of a number-letter combination that denotes the date of a significant design change. The number designates the year, and the letter A through L designates the month, January through December respectively. The third part is the power supply serial number.

1-19 If the serial number prefix on your power supply does not agree with the prefix on the title page of this manual, change sheets are included to update the manual. Where applicable, backdating information is given in an appendix at the rear of the manual.

1-20 ORDERING ADDITIONAL MANUALS

1-21 One manual is shipped with each power supply. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at rear of this manual for addresses). Specify the model number, serial number prefix, and ℌ stock number provided on the title page.

Table 1-1. Specifications

OUTPUT:
0-1600 VDC, 0-5 milliamps.

INPUT:
105-125 VAC, single phase, 60 ± 0.3 Hz (cps), 162 ma, 19 watts max.

LOAD REGULATION:
Less than 0.01% or 16 millivolts (whichever is greater) output voltage change for full load change.

LINE REGULATION:
Less than 0.01% or 16 millivolts (whichever is greater) output voltage change for a line input change from 105 to 125 volts.

RIPPLE AND NOISE:
Less than 2 mv RMS. Less than 5 mv peak-to-peak.

TEMPERATURE COEFFICIENT:
Output voltage change per degree centigrade is less than 0.02% plus 2 millivolts.

STABILITY:
The total drift for 8 hours (after 30 minutes warmup) at a constant ambient is less than 0.05% plus 5 millivolts.

TEMPERATURE RATING:
Operating: 0to 50°C
Storage: -20 to +85°C

OUTPUT IMPEDANCE:
Less than 32 ohms from DC to 30 Hz (cps)
Less than 8 ohms from 30 Hz to 100 kHz
Less than 2 ohms from 100 kHz to 1 MHz

TRANSIENT RECOVERY TIME:
Less than 100 microseconds is required for output voltage recovery to within 0.01% or 16 mv of the nominal output voltage following a full load change in output current. The nominal output voltage is defined as the mean between the no load and full load voltage.

OVERLOAD PROTECTION:
A current limit circuit protects the supply for all overload conditions, including a short circuit applied directly across the output terminals.

CONTROLS:
Sixteen position rotary switch adjusts the output voltage in 100-volt steps; a 10-turn vernier permits continuous adjustment with a 100 MV resolution over any 100-volt span.

METER:
A 0-1800 volts mounted on the front panel.

OUTPUT TERMINALS:
A positive and a negative output terminal (type UG931 connectors) are included on the front panel. Two mating connectors (UG932) are included with each unit. Either side may be grounded by shorting one of the UG932 connectors, or the supply may be operated floating up to 1000 volts off ground.

RFI:
Conducted and radiated leakage limits are below those specified in MIL-I-6181D.

SIZE:
3 1/2" (89 mm) H x 8 1/2" (216 mm) W x 11 13/16" (300 mm)D.

WEIGHT:
12 pounds (5.44 kg) net, 15 pounds (6.8 kg) shipping.

FINISH:
Light gray front panel with dark gray case.

POWER CORD:
A 3-wire 5-foot (1.52 m) power cord is provided with each unit.

SECTION II
INSTALLATION

2-1 INITIAL INSPECTION

2-2 Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage is found, proceed as described in the Claim for Damage in Shipment section of the warranty page at the rear of this manual.

2-3 MECHANICAL CHECK

2-4 This check should confirm that there are no broken knobs or connectors, that the cabinet and panel surfaces are free of dents and scratches, and that the meter is not scratched or cracked.

2-5 ELECTRICAL CHECK

2-6 The instrument should be checked against its electrical specifications. Section V includes an "in-cabinet" performance check to verify proper instrument operation.

2-7 INSTALLATION DATA

2-8 The instrument is shipped ready for bench operation. It is necessary only to connect the instrument to a source of power and it is ready for operation.

2-9 LOCATION

2-10 This instrument is air cooled. Sufficient space should be allotted so that a free flow of cooling air can reach the sides and rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 50°C.

2-11 RACK MOUNTING

2-12 This instrument may be rack mounted in a standard 19 inch rack panel either alongside a similar unit or by itself. Figures 2-1 and 2-2 show how both types of installations are accomplished.

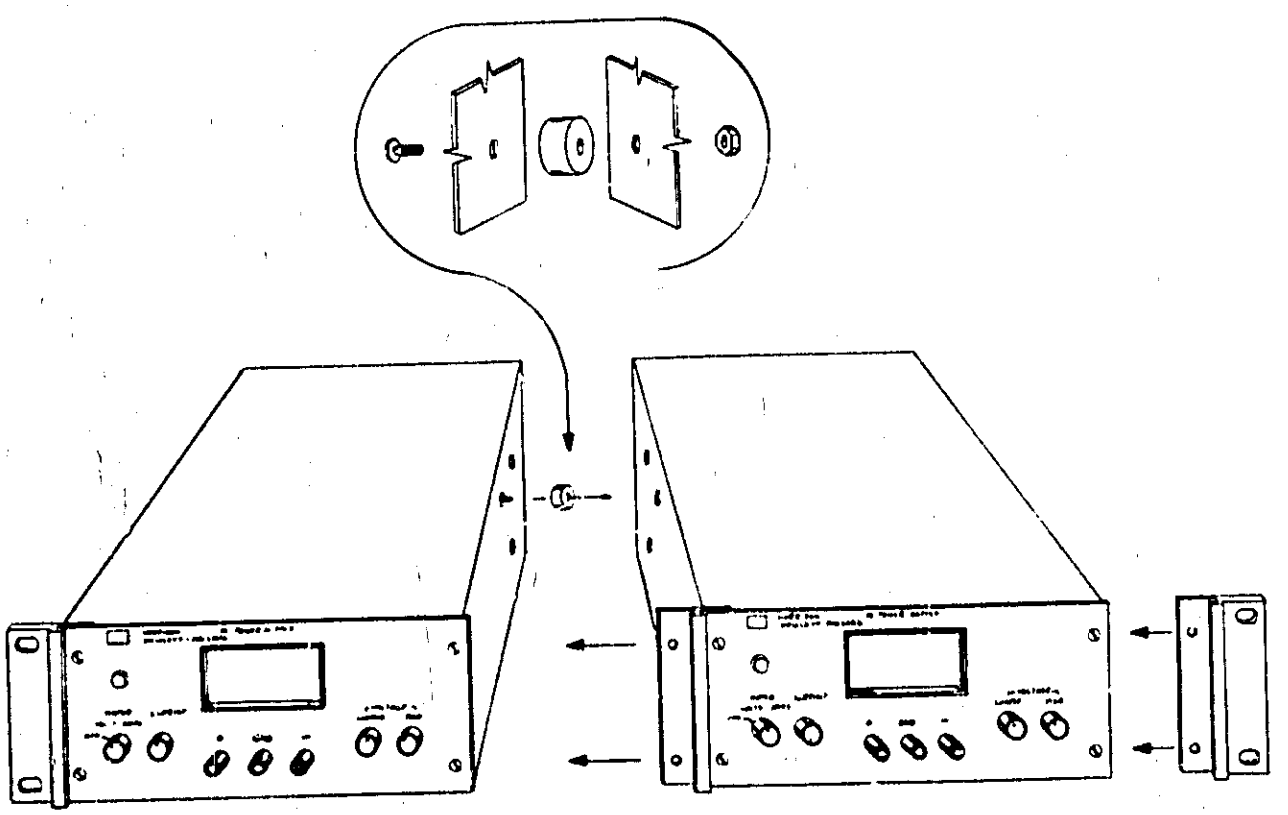


Figure 2-1. Rack Mounting, Two Units

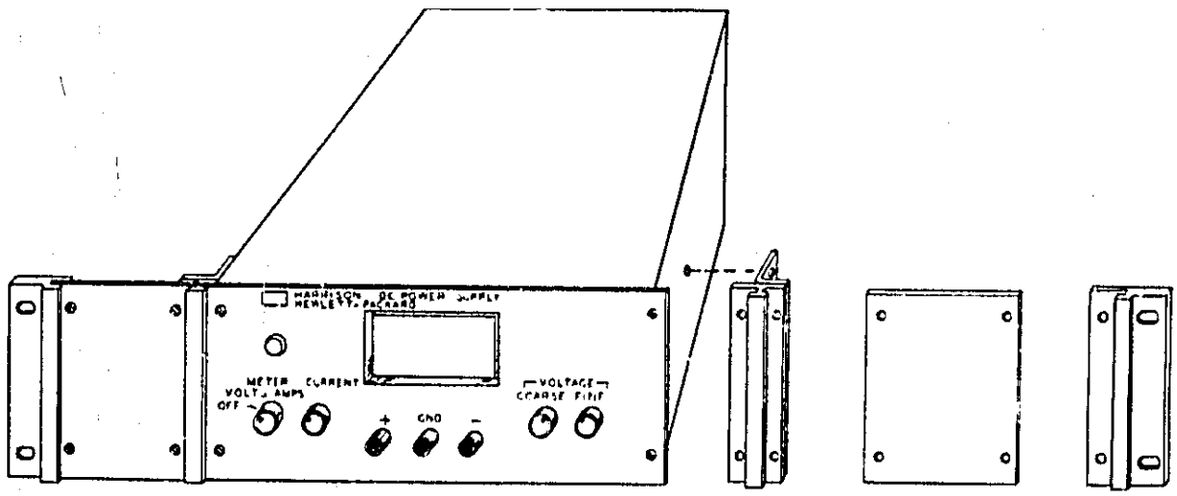


Figure 2-2. Rack Mounting, One Unit

2-13 To mount two units side-by-side, proceed as follows:

a. Remove the four screws from the front panels of both units.

b. Slide rack mounting ears between the front panel and case of each unit.

c. Slide combining strip between the front panels and cases of the two units.

d. After fastening rear portions of units together using the bolt, nut, and spacer, replace panel screws.

2-14 To mount a single unit in the rack panel, proceed as follows:

a. Bolt rack mounting ears, combining strips, and angle brackets to each side of center spacing panels. Angle brackets are placed behind combining straps as shown in Figure 2-2.

b. Remove four screws from front panel of unit.

c. Slide combining strips between front panel and case of unit.

d. Bolt angle brackets to front sides of case and replace front panel screws.

2-15 INPUT POWER REQUIREMENTS

2-16 This power supply is operated from a nominal 115 volt 60 cycle power source. The input power required when operated from a 115 volt 60 cycle power source at full load is 40 watts and 1 ampere.

2-17 POWER CABLE

2-18 To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three conductor power cable. The third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three-prong connector is the ground connection.

2-19 To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2-20 REPACKAGING FOR SHIPMENT

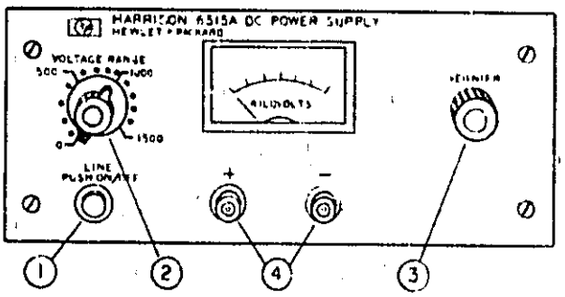
2-21 To insure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped. Be sure to attach a tag to the instrument which specifies the owner, model number, full serial number, and service required, or a brief description of the trouble.

OPERATION AND THEORY

SECTION III
OPERATING INSTRUCTIONS

3-1 CONTROLS AND INDICATORS

3-2 The controls and indicators are illustrated in Figure 3-1.



TURN-ON SEQUENCE

1. PUSH ON/OFF BUTTON AND ENSURE THAT LIGHT GOES ON.
2. SET VOLTAGE RANGE SWITCH TO THE NEAREST POSITION THAT IS LESS THAN THE DESIRED OUTPUT VOLTAGE.
3. TURN THE VERNIER CONTROL UNTIL THE METER INDICATES EXACTLY THE DESIRED OUTPUT VOLTAGE.
4. ATTACH A MULTIMETER TO THE OUTPUT AND SET THE VOLTAGE RANGE SWITCH TO AT LEAST 200 VOLTS. CHECK THAT THE CURRENT INDICATION ON THE MULTIMETER DOES NOT EXCEED 7.5 mA.
5. REMOVE METER AND CONNECT LOAD TO OUTPUT TERMINALS.

Figure 3-1. Front Panel Controls and Indicators

3-3 OPERATION

3-4 The power supply can be operated as a single unit (normal operation), in parallel, or in series. No provisions for remote programming or remote sensing have been made due to their limited use and insulation problems at 1,000 Vdc. For safety, ensure that the power supply chassis is grounded (either through power cord or by other means). The operator can ground either output terminal or operate the power supply up to 1,000 Vdc off ground (floating). It is not recommended that the power supply be floated above 300 vrms at low audio frequencies (less than 500 Hz).

WARNING

Serious injury to personnel can occur if the power supply chassis is ungrounded. The warranty is void if the chassis is ungrounded during operation

3-5 CONSTANT VOLTAGE OPERATION

3-6 To select a constant voltage output turn on the supply, and with no load connected, set the VOLTAGE RANGE switch to the nearest position that is less than the desired output voltage. Now turn the VERNIER control until the meter indicates exactly the desired output voltage.

3-7 CURRENT LIMIT PROVISIONS

3-8 The current limiting feature is designed mainly to protect the supply, not the load. It is internally adjusted so that the short-circuit output current will not exceed approximately 7.5 mA in the lower voltage ranges, 0 to 300 Volts. The range of this adjustment is 5 to 10 mA. However, in the higher voltage ranges the limit is substantially higher and no provisions are included for adjusting the level. The current limit for each voltage range is as follows:

VOLTAGE RANGE Switch Setting	Output Current Limit
0 - 300 V	7.5 mA
400 - 700 V	65 mA
800 - 1100	32 mA
1200 - 1500	35 mA

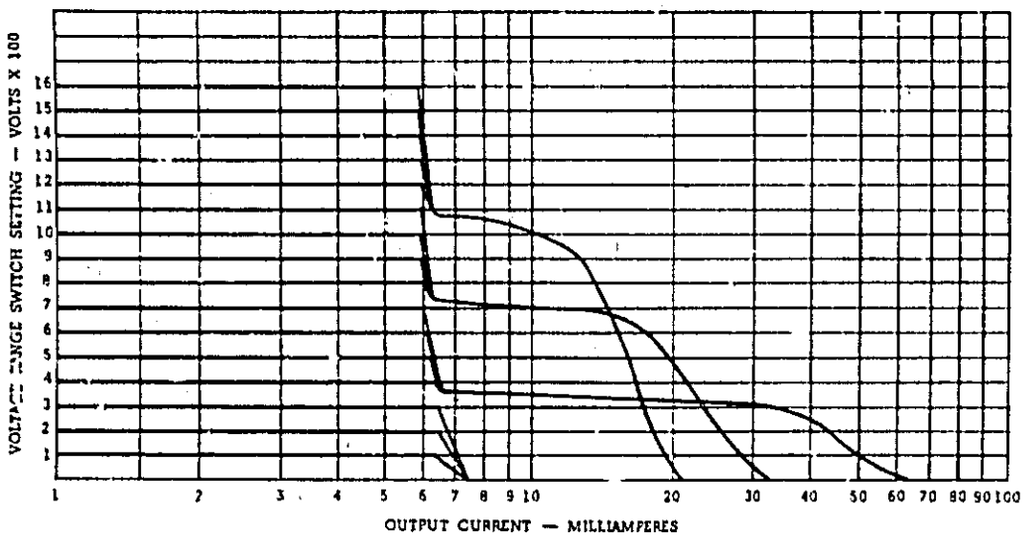


Figure 3-2. Output Current Limiting Characteristics

3-9 Figure 3-2 illustrates the output current characteristics of the supply from no load to full load for each position of the VOLTAGE RANGE switch. It also shows how the output voltage decreases toward zero as the current increases above the 7.5 mA limiting current.

3-10 OPERATION OF SUPPLY BEYOND RATED OUTPUT

3-11 The shaded area on the front panel meter face indicates the amount of output voltage that is available in excess of the normal rated output. Although the supply can be operated in this shaded region without being damaged, it cannot be guaranteed to meet all its performance specifications. However, if the line voltage is maintained above 115 Vac, the supply will probably operate within its specifications.

3-12 CONNECTING LOAD

3-13 Output terminals are provided on the front panel of the power supply. The terminals are marked + and −. The positive or negative output terminal may be grounded by shorting the center pin and case of the applicable UG-931/U plug or by grounding the wire from the plug to the chassis, or neither grounded (floating operation; permitted to 2,600 Vdc off ground).

WARNING

To avoid injury to personnel due to arcing, turn-off the power supply before connecting or disconnecting the load connectors.

3-14 Each load should be connected to the power supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the power supply. Each pair of connecting wires should be as short as possible to reduce noise pickup; in addition, a 0.1 to 1.0 μf capacitor should be connected between one terminal and the chassis, if the supply is floated off of ground.

3-15 If load considerations require that the output power distribution terminals be remotely located from the power supply, then the power supply output terminals should be connected to the remote distribution terminals via a pair of twisted or shielded wires and each load separately connected to the remote distribution terminals. A 0.1 to 1 μf capacitor should be connected across the remote distribution terminals to reduce high frequency coupling and noise.

3-16 OUTPUT CAPACITANCE

3-17 An internal capacitor, across the output terminals of the power supply, helps to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability, but will decrease the safety provided by the current limiting circuit. A high-current pulse may damage load components before the average output current is large enough to cause the current limiting circuit to operate.

3-18 REVERSE CURRENT LOADING

3-19 Active loads connected to the power supply may actually deliver a reverse current to the power supply during a portion of it's operating cycle. An external source cannot be allowed to pump current into the supply without loss of regulation and possible damage to the output capacitor. To avoid these effects, it is necessary to preload the supply with a dummy load resistor so that the power supply delivers current through the entire operating cycle of the load device.

3-20 REVERSE VOLTAGE LOADING

3-21 A diode is connected across the output terminals. Under normal operating conditions, the diode is reverse biased (anode connected to negative terminal). If a reverse voltage is applied to the output terminals (positive voltage applied to negative terminal), the diode will conduct, shunting current across the output terminals and limiting the voltage to the forward voltage drop of the diode. This diode protects the series transistors and the output electrolytic capacitors.

SECTION IV
PRINCIPLES OF OPERATION

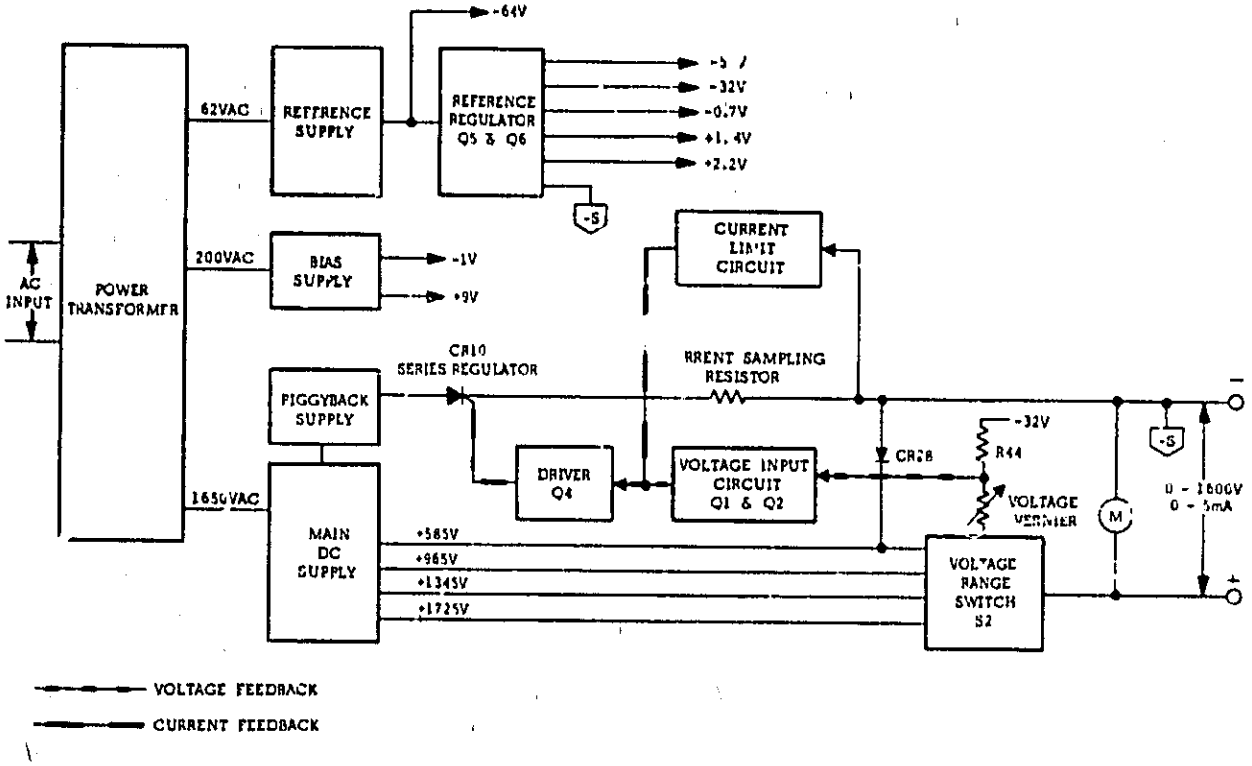


Figure 4-1. Overall Block Diagram

4-1 OVERALL BLOCK DISCUSSION (Figure 4-1)

4-2 Model 6515A, as illustrated in Figure 4-1, is a high voltage series SCR regulated supply. The input line voltage is stepped up and down by special power transformer T1, a voltage regulating transformer, sometimes referred to as a saturable reactor. T1 provides good regulation against line and load changes.

4-3 The rectifiers and filters convert the ac to raw dc current which is coupled through CR10 to the (-) output terminal. The regulator, part of the feedback loop is a reversed biased SCR referred to as a remote base transistor. It is made to alter its conduction to maintain a constant output voltage. The output voltage is adjusted by the VOLTAGE RANGE switch and the VERNIER control. Any instantaneous changes in the output voltage, caused by a change in the load current, are sensed at the VERNIER control. The changes are amplified by the voltage input circuit and the driver, and applied to the SCR series regulator to counteract the change.

4-4 The current limit circuit senses the voltage drop across the current sampling resistor. When this voltage exceeds a preset limit the current limit circuit couples a signal to the driver which limits the conduction of CR10.

4-5 The reference regulator provides stable reference voltages which are used throughout the unit for biasing and comparison purposes.

4-6 DETAILED CIRCUIT ANALYSIS (Refer to overall schematic diagram at rear of manual)

4-7 The regulating feedback loop, consisting of programming resistors R1 through R15 and R21, voltage input circuit, driver, current limit circuit, and series SCR regulator CR10, functions continuously to maintain the output voltage constant during constant voltage operation and the output current at a safe limit during current limit operation.

4-8 For purposes of this discussion, assume that the unit is in constant voltage operation and that

the programming resistors have been adjusted so that the supply is yielding the desired output voltage. Further assume that the (-) side of the supply is ground (common) and that the output voltage instantaneously rises (goes positive) due to a variation in the external load circuit.

4-9 Note that the change may be in the form of a slow rise in the output voltage or a positive going ac signal. An ac signal is coupled to the base of Q1 by capacitor C1 and a dc voltage is coupled by R2.

4-10 The instantaneous rise in output voltage causes the base of Q1 to go positive. Q1 now increases its conduction and its collector voltage goes negative. The negative going error voltage is amplified and inverted by Q2 and Q4, and coupled to the gate of CR10. The negative going input causes CR10 to decrease its conduction so that it drops more of the filtered dc, and reduces the output voltage to its original level.

4-11 If the external load resistance is decreased to a point where the load current exceeds the value selected by the current limit potentiometer R24, the negative voltage on the collector of Q1 forward biases CR7. Thus, the collector of Q7 is clamped at the negative voltage on the arm of potentiometer R24 and the output current is maintained at a constant safe maximum. Any further decreases in load resistance causes the output voltage to decrease proportionally. The range of potentiometer R24 enables current limiting between 5 and 10 ±1 mA.

4-12 MAIN DC SUPPLY

4-13 The 0-1600 Vdc output is generated by the main dc supply which consists of five low voltage supplies in series. The five supplies are CR31-CR34 (205V), CR11-CR13 (380V), CR12-CR14 (390V), CR15-CR17 (380V), CR16-CR18 (380V). The negative side of the 205 volt supply is connected to the regulator CR10, and four positive voltages, +585, +965, +1345, and +1725 volts are connected through the VOLTAGE RANGE switch S2 to the (+) output terminal. By switching the output voltage in four steps, the voltage across series regulator CR10 never exceeds 585 volts. Diode CR28 protects the supply when the output is short circuited. When the supply in delivering greater than 585 volts and the output is shorted, the anode of CR28 becomes more positive than +585V. Load current flows through CR28 and R33; and depending on the position of S2, current may flow through R30, R31, or R32. Resistor R33 determines the maximum short circuit current that flows through CR28.

4-14 SERIES REGULATOR

4-15 The conduction of the series regulator is controlled by the feedback voltage obtained from the driver. The conduction is varied to provide a voltage drop, which is subtracted from the main dc supply that results in the selected voltage available at the output terminals. Silicon Controlled Rectifier CR10 is a standard SCR used in a reverse bias configuration, referred to as a remote base transistor. The name is derived from the application and mechanical structure of the device. The gate lead in an SCR is one junction removed from the anode.

4-16 In this reverse bias configuration the SCR is always conducting and the characteristics are similar to a high voltage transistor with less than unity gain.

4-17 Diode CR8, connected across the series regulator, protects it against reverse voltages that could occur during parallel operation, if one supply is turned on before the other.

4-18 CONSTANT VOLTAGE INPUT CIRCUIT

4-19 This circuit (Q1 and Q2) continuously compares a fixed voltage received from the reference circuit with a portion of the output voltage and, if a difference exists, produces an error voltage whose amplitude and phase is proportional to the difference.

4-20 Diode CR1 prevents the emitter of Q1 from going more positive than circuit common (-S). This condition occurs when the output voltage is turned down (down programmed) rapidly. Diode CR3 prevents the base of Q1 from exceeding -0.7V in the negative direction. When the output voltage is turned up rapidly it drives the base of Q1 negative. Network C3 and R16 provide some negative feedback from collector to base to eliminate the posibility of oscillations.

4-21 DRIVER CIRCUIT

4-22 This circuit receives inputs from either the voltage input circuit or the current limit circuit. In constant voltage mode, driver Q4 maintains CR10 at the correct conduction level so that CR10 drops a sufficient voltage to hold the output constant. However, when the output current exceeds the current limit setting, the voltage at the arm of R24 forward biases CR7 and applies a negative voltage at the base of Q4. Transistor Q4 and CR10 are held in steady conduction until the external load is removed.

4-23 REFERENCE REGULATOR

4-24 This circuit supplies regulated dc bias voltages to the voltage input circuit and -32V programming voltage to VERNIER control R21. Diodes CR21 through CR24 and capacitor C10 rectify and filter the 62 Vac developed across the secondary of T1. The 66 Vdc is regulated by transistor Q5 which is tied to 6.2 V zener diode VR1. Various regulated dc outputs are developed across a series string of diodes VR2, CR19, CR20, CR2, CR4, CR5, and CR6. The -32 V programming voltage is developed by constant current amplifier Q6 which is connected to the -40 V reference voltage. Resistors R36 and R37 are selected to provide precisely the correct programming current. Procedures for selecting these resistors are included in the adjustment and calibration paragraphs in Section V, Maintenance.

4-25 Diodes CR20 and CR29 protect the constant current amplifier against excessive voltage excusions at the collector. With CR20 connected to -64 V and CR29 connected to -S, the collector of Q4 cannot swing beyond +0.7 to -64 V.

MAINTENANCE

SECTION V
MAINTENANCE

5-1 INTRODUCTION

5-2 Upon receipt of the power supply, the performance check (Paragraph 5-8) should be made. This check is suitable for incoming inspection. If a fault is detected in the power supply while making the performance check or during normal operation, proceed to the troubleshooting procedures (Paragraph 5-30). After troubleshooting and repair (Paragraph 5-37), perform any necessary adjustments and calibrations (Paragraph 5-39). Before returning the power supply to normal operation, repeat the performance check to ensure that the fault has been properly corrected and that no other faults exist. Before doing any maintenance checks, turn-on power supply, allow a half-hour warm-up, and read the general information regarding measurement techniques (Paragraph 5-3).

5-3 MEASUREMENT TECHNIQUES

5-4 All measurements given in this manual are with a positive power supply output (negative terminal grounded to chassis). When measuring performance of the power supply it is important that the connection to the output terminal does not introduce additional resistance. For voltage measurements, use a T-connector at the positive output terminal and connect the load to one output of the T-connector and the measuring device to the other output of the T-connector. For current measurements, connect a four-terminal current monitoring resistor in series with the load resistor and connect both to one output of the T-connector. Connect the measuring device across the current monitoring resistor.

5-5 When using an oscilloscope, ground the case at the same ground point as the grounded terminal of the power supply. Make certain that the case is not also grounded by some other means (power cord). Connect both oscilloscope input leads to the power supply ground and check that the oscilloscope is not exhibiting a ripple or transient due to ground loops, pick-up or other means.

5-6 TEST EQUIPMENT REQUIRED

5-7 Table 5-1 lists the test equipment required to perform the various procedures described in this section.

Table 5-1. Test Equipment

Type	Required Characteristics	Use	Recommended Model
AC Voltmeter	Accuracy: 2%. Sensitivity: 1mv full scale (min.).	Measure AC voltages	HP 403 B
Variable Voltage Transformer	Range: 90-130 volts. Equipped with voltmeter accurate within 1 volt, 1 KW rating.	Vary and measure AC input voltage	----
Oscilloscope	Sensitivity: 1 mv/cm (min.).	Measure ripple and transient response	HP 140 A plus 1400 A Plug-in.
Differential Voltmeter	Sensitivity: 1mv full scale (min.).	Measure regulation; Calibrate meter	HP 3420 See Note
Repetitive Load Switch	Rate: 60-400 Hz, 2μsec rise and fall time, 250V, 1A.	Measure transient	See Figure 5-3
Resistive Load	320K, 10W	Power supply load	----
Resistor	1 KΩ, ±1% 2 W non-inductive.	Measure impedance	----

Table 5-1. Test Equipment (Continued)

Type	Required Characteristics	Use	Recommended Model
Multimeter	Accuracy 1%	Measure output current and DC voltages	℗ 412 A
Capacitor	500μfd, 50 vdcw	Measure impedance	----
Resistor	2,000 ohms, ±5%, 20 W	Measure impedance	----
Audio Oscillator	5 cps - 600 KHz. Accuracy: 2%. Output: 10 vrms	Measure impedance	℗ 200 CD
Controlled-Temperature Oven	0-50°C	Measure temperature stability	----
Resistance Box	0-100Kᴖ. Accuracy: 0.1% + 1ᴖ. Make-before-break contacts.	Measure programming coefficients	℗ Model 6931A
Capacitor	1μf, 1600 wvdc	Measure ripple and noise	----
Voltage Divider	100: 1, up to 4KV, 0.01% Accuracy	Load regulation. Line regulation	Keithley Instruments, Inc. Model 6601A

NOTE

A satisfactory substitute for a differential voltmeter is to arrange a reference voltage source and null detector as shown in Figure 5-1. The reference voltage source is adjusted so that the voltage difference between the supply being measured and the reference voltage will have the required resolution for the measurement being made. The voltage difference will be a function of the null detector that is used. Examples of satisfactory null detectors are: ℗419A null detector, a DC coupled oscilloscope utilizing differential input, or a 50mv meter movement with a 100 division scale. For the latter, a 2mv change in voltage will result in a meter deflection of four divisions.

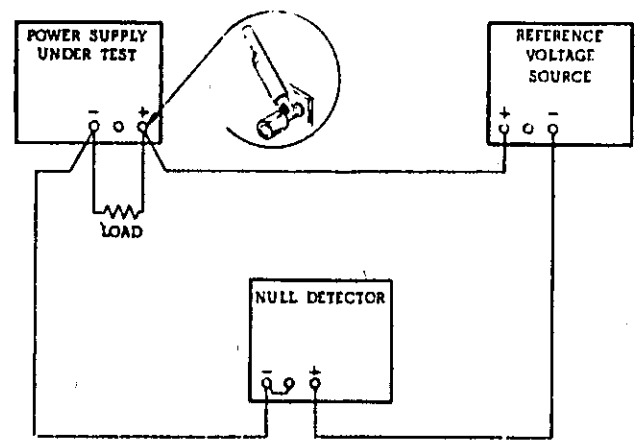


Figure 5-1. Differential Voltmeter Substitute Test Setup

CAUTION

Care must be exercised when using an electronic null detector in which one input terminal is grounded to avoid ground loops and circulating currents.

5-8 PERFORMANCE TEST

5-9 The following test can be used as an incoming inspection check and appropriate portions of the test can be repeated either to check the operation of the instrument after repairs or for periodic preventive maintenance tests.

5-10 The performance check is made using a 115-volt, 60-Hz (cps), single-phase input power source. The performance check is normally made at a constant ambient room temperature. The temperature range specification can be verified by doing the performance check (except temperature stability check) at a controlled temperature of 0°C and at a controlled temperature of 50°C. If the correct result is not obtained for a particular check, do not adjust any controls; proceed to troubleshooting.

5-11 RATED OUTPUT, METER, AND OUTPUT CONTROLS ACCURACY

5-12 Voltage. To check the accuracy of the output voltage, front panel voltmeter, and front panel voltage controls, proceed as follows:

a. Connect the differential voltmeter, load resistor, and the attenuator to the power supply as illustrated in Figure 5-2. Load resistance is approximately 320K ohms, 10 watts.

b. Turn the front panel VOLTAGE RANGE switch and VERNIER control until the front panel voltmeter indicates exactly 1600 Vdc.

c. The differentiel voltmeter should indicate 16 ± 0.32Vdc.

5-13 Current. To check the output current capability of the supply, proceed as follows:

a. Connect the multimeter (set to the 10 mA position) or another milliammeter in series with a 320K 10W load resistance, and attach the series combination to the output terminals.

b. Adjust the VOLTAGE RANGE switch and VERNIER control until the front panel voltmeter indicates 1600 Vdc.

c. The multimeter should indicate 5 mA.

5-14 LOAD REGULATION

5-15 To check constant voltage load regulation, proceed as follows:

a. Connect differential voltmeter, load resistor and attenuator to the power supply as illustrated in Figure 5-2.

b. Turn the front panel VOLTAGE RANGE switch and VERNIER control until the front panel voltmeter indicates exactly 1600 volts.

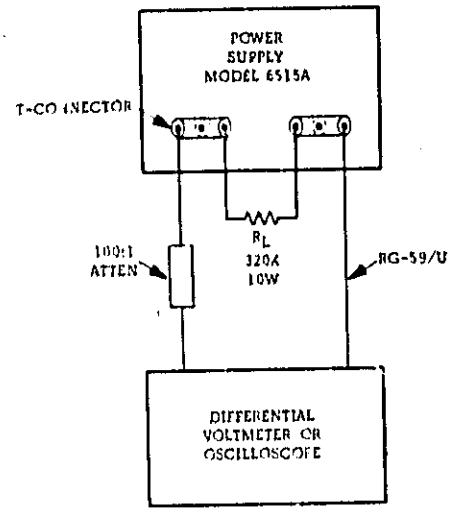


Figure 5-2. Line and Load Regulation, Test Setup

c. Read and record voltage indicated on differential voltmeter.

d. Disconnect load resistor.

e. Reading on differential voltmeter should not vary from reading recorded in step c by more than 160 mV.

5-16 LINE REGULATION

5-17 To check constant voltage line regulation, proceed as follows:

a Connect variable auto-transformer between input power source and power supply power input.

b. Connect differential voltmeter, load resistor, and attenuator as illustrated in Figure 5-2.

c. Adjust variable auto-transformer for 105 Vac input.

d. Adjust front panel VOLTAGE RANGE switch and VERNIER control until the front panel voltmeter indicates exactly 1600 Vdc.

e. Read and record voltage indicated on differential voltmeter.

f. Adjust variable auto transformer for 125 Vac input.

g. Reading on differential voltmeter should not vary from reading recorded in step e by more than 160 mV.

5-18 RIPPLE AND NOISE

5-19 To check the ripple and noise, proceed as follows:

a. Connect 320K ohm, 10W load resistor to the power supply output.

b. Connect the oscilloscope (in series with a 1μf capacitor rated for at least 1600 Vdc) to the power supply output.

c. Connect the variable voltage transformer between the input source and the power supply input. Adjust the variable voltage transformer to 125 Vac.

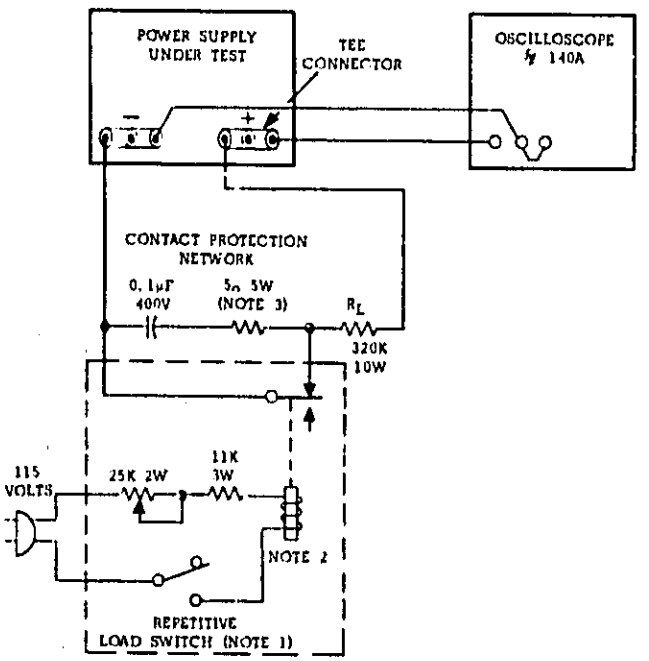
d. Adjust front panel VOLTAGE RANGE switch and VERNIER control until front panel voltmeter indicates 1600 Vdc.

e. The oscilloscope should indicate less than 5 mV P-P.

5-20 TRANSIENT RECOVERY TIME

5-21 To checkthe transient recovery time proceed as follows:

a. Connect test setup shown in Figure 5-3.



NOTES:

1. THIS DRAWING SHOWS A SUGGESTED METHOD OF BUILDING A LOAD SWITCH. HOWEVER, OTHER METHODS COULD BE USED; SUCH AS A TRANSISTOR SWITCHING NETWORK. MAXIMUM LOAD RATINGS OF LOAD SWITCH ARE: 5 AMPS, 500V, 250W (NOT 2500W).
2. USE MERCURY RELAY; CLARE TYPE HGP 1002 OR W.E. TYPE 276B.
3. USE WIRE WOUND RESISTOR.

Figure 5-3. Transient Recovery Time, Test Setup

b. Adjust front panel VOLTAGE RANGE switch and VERNIER until the front panel voltmeter indicates 200 Vdc.

c. Close line switch on repetitive load switch setup.

d. Adjust 25K potentiometer until a stable display is obtained on oscilloscope. Waveform should be within the tolerances shown in Figure 5-4 (output should return to within 20 mV of 200 Vdc in less than 100 μsec).

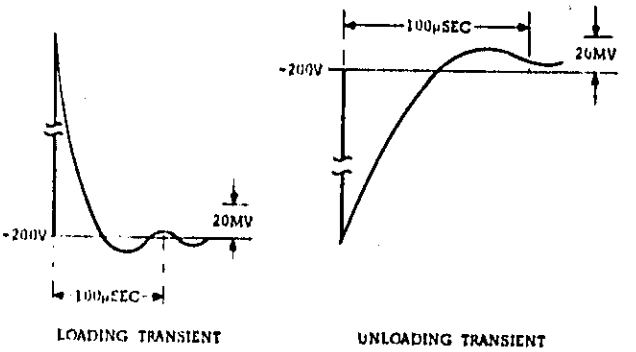


Figure 5-4. Transient Recovery Time, Waveforms

5-22 OUTPUT IMPEDANCE

5-23 To check the output impedance, proceed as follows:

a. Connect the test setup as shown in Figure 5-5. The best method of connecting the load resistor, oscillator, and AC voltmeter to the power supply is with two tee connectors on each power supply terminal. Clip lead connections can be used in lieu of the tee connectors providing that all connections are made directly to the power supply and lead lengths are short.

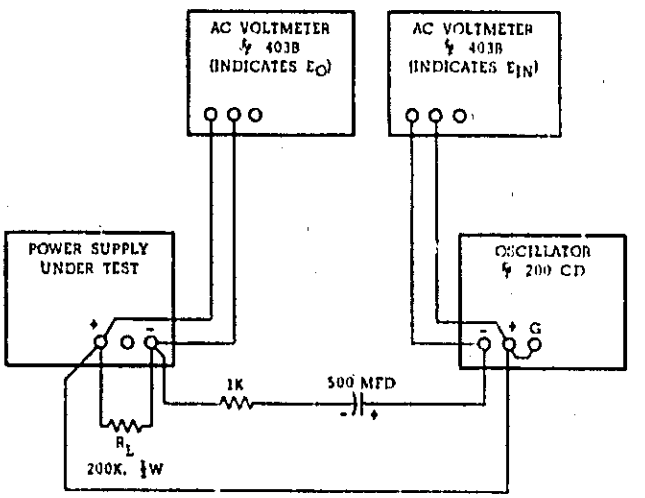


Figure 5-5. Output Impedance, Test Setup

b. Adjust front panel VOLTAGE RANGE switch and VERNIER until the front panel voltmeter indicates 200 Vdc.

c. Set AMPLITUDE control on oscillator to 10 volts (E_{IN}), and FREQUENCY control to 30 Hz (cps).

d. Record voltage across output terminals of the supply (E_O) as indicated on AC voltmeter.

e. Calculate the output impedance by the following formula:

$$Z_{out} = \frac{E_O R}{E_{in} - E_O}$$

where E_O = rms voltage across power supply output terminals

R = 1000 ohms

E_{in} = 10 volts

f. The output impedance (Z_{out}) should be less than 32 ohms.

g. Using the formula in step e, calculate output impedance at frequencies of 100 KHz and 1 MHz. Values should be less than 8 ohms and 2 ohms, respectively.

5-24 TEMPERATURE COEFFICIENT

5-25 To check the temperature coefficient, proceed as follows:

a. Connect the load resistance, attenuator, and differential voltmeter as illustrated in Figure 5-2.

b. Adjust front panel VOLTAGE RANGE switch and VERNIER until the front panel voltmeter indicates 1600 Vdc.

c. Insert the power supply into the temperature — controlled oven (differential voltmeter remains outside oven). Set the temperature to 30°C and allow 30 minutes warm-up.

d. Record the differential voltmeter indication.

e. Raise the temperature to 40°C and allow 30 minutes warm-up.

f. The differential voltmeter indication should change by less than 3.2 mV from indication recorded in step d.

5-26 OUTPUT STABILITY

5-27 To check the output stability, proceed as follows:

a. Connect the load resistance, attenuator, and differential voltmeter as illustrated in Figure 5-2.

b. Adjust front panel VOLTAGE RANGE switch and VERNIER until the differential voltmeter indicates 16 Vdc.

c. Allow 30 minutes warm-up then record the differential voltmeter indication.

d. After 8-hours, differential voltmeter should change by less than 8 mV from indication recorded in step c.

5-28 CURRENT LIMIT

5-29 To check the current limiting characteristics of the supply, proceed as follows:

a. Attach the multimeter or a milliammeter to the output terminals of the supply. Set the meter for approximately 10 mA. The internal resistance of the meter is low enough to overload the supply so that the output will current limit.

b. Set the VOLTAGE RANGE switch to 300 volts.

c. The meter should read approximately 7.5 mA.

5-30 TROUBLESHOOTING

5-31 Components within Hewlett-Packard power supplies are conservatively operated to provide maximum reliability. In spite of this, parts within a supply may fail. Usually the instrument must be immediately repaired with a minimum of "down time" and a systematic approach as outlined in succeeding paragraphs can greatly simplify and speed up the repair.

5-32 TROUBLE ANALYSIS

5-33 General. Before attempting to troubleshoot this instrument, ensure that the fault is with the instrument and not with an associated circuit. The performance test (Paragraph 5-8) enables this to be determined without having to remove the instrument from the cabinet.

5-34 Once it is determined that the power supply is at fault, check for obvious troubles such as open fuse, a defective power cable, or an input power failure. Next, remove the top and bottom covers (each held by four retaining screws) and inspect for open connections, charred components, etc. If the trouble source cannot be detected by visual inspection, follow the detailed procedure outlined in succeeding paragraphs. Once the defective component has been located (by means of visual inspection or trouble analysis) correct it and re-conduct the performance test. If a component is replaced, refer to the repair and replacement and adjustment and calibration paragraphs in this section.

5-35 A good understanding of the principles of operation is a helpful aid in troubleshooting, and it is recommended that the reader review Section IV of the manual before attempting to troubleshoot the unit in detail. Once the principles of operation are understood, logical application of this knowledge

used in conjunction with the normal voltage readings shown on the schematic ard the additional procedures given in the following paragraphs should suffice to isolate a fault to a component or small group of components. The normal voltages shown on the schematic are positioned adjacent to the applicable test points (identified by encircled numbers on the schematic diagram.

5-36 A list that includes the symptoms and probable causes of many possible troubles is included. If either high or low output voltage is a symptom, there are two methods of isolating the fault. The first is a simplified procedure that involves only measuring voltages; the second is a more thorough approach requiring that transistor stages be opened or shorted. Both methods are described as follows:

Symptom	Probable Cause
No output in all voltage ranges	a. CR28 shorted b. CR10 open
Low output or no output only in 0-300V ranges.	Refer to Table 5-2, then Table 5-3
High output	Refer to Table 5-2, then Table 5-4
Improper current limit value	a. R22,R24,R23 incorrect value
High Ripple	a. Check operating setup for ground loops b. If output floating, connect 1μf capacitor between output and ground c. Check for excessive internal ripple; refer to Table 5-2
Symptom (Continued)	Probable Cause (Continued)
	d. Ensure that supply is not current limiting under loaded conditions e. Check for low voltage across C6-C9 or C15 f. CR27 inoperative
Poor line regulation	a. Refer to Table 5-2
Poor load regulation	a. Improper measuring technique; refer to paragraph 5-3 b. Refer to Table 5-2 c. Ensure that supply is not current limiting under loaded conditions
Oscillates	a. C5,R17,C4,R18,C3
Poor stability	a. Noisy programming resistor R21 b. Check VR2,CR19,CR20, Q5,Q6,VR1,CR27, and CR29
Poor transient recovery	a. Check R18 and C3

1. First, the reference, bias, and filtered DC voltages as given in Table 5-2 should be checked. Then the voltage levels at critical points (base and collector) in the feedback loop should be measured and compared to the normal voltages given on the overall schematic diagram at the rear of the manual. This method of troubleshooting a feedback loop is not always conclusive; a better method is described in (2).

2. First, measure the reference, bias, and filtered DC voltages as given in Table 5-2. Then, drive each stage in the feedback loop, into conduction or cutoff by either shorting or opening the previous stage as indicated in Tables 5-3 or 5-4.

Table 5-2. Reference, Bias, and Filtered DC Voltage Troubleshooting

Step	Meter Common	Meter Positive	Normal Vdc	Normal Ripple (P-P)	Probable Cause
1	9	11	66	0.7V	C10,CR21-CR24
2	9	-S	64	0.65V	CR27,CR29
3	8	-S	50		
4	4	-S	32	5 mV	CR2,CR19,CR20

Table 5-2. Reference, Bias, and Filtered DC Voltage Troubleshooting (Continued)

Step	Meter Common	Meter Positive	Normal Vdc	Normal Ripple (P-P)	Probable Cause
5	19	-S	0.7	5 mV	CR2
6	-S	Junction CR5/CR6	1.4	5 mV	CR4, CR5
7	-S	11	2.2	5 mV	CR4, CR5, CR6
8	12	-S	1	20 mV	CR9, R28
9	-S	13	9	0.3 V	CR9, R28
10	12	13	10	0.16 V	C11, CR25, CR26
11	3	14	205	0.6 V	R25, CR31-CR34, C15
12	14	15	380	0.4 mV	R29, C6, CR11, CR13
13	15	16	380	4 mV	R30, C7, CR12, CR14
14	16	17	380	0.4 mV	R31, C8, CR15, CR17
15	17	18	380	0.4 mV	R32, C9, CR16, CR18

Table 5-3. Low Output Voltage Troubleshooting

Step	Action	Response	Probable Cause
1	Adjust the power supply output to 300 Vdc and disconnect the load from the output terminals		
2	Remove CR7 lead	a. Output increases b. Output remains low	a. R35, R24, or R23 defective b. Reconnect CR7 and proceed to Step 3
3	Open Q4 collector lead	a. Output remains low b. Output increases	a. CR10, R26, or R27 open b. Reconnect Q4 and proceed to Step 4
4	Open Q2 collector lead	a. Output remains low b. Output increases	a. Q4 shorted b. Reconnect Q2 and proceed to Step 5
5	Open Q1 collector lead	a. Output remains low b. Output increases	a. Q2 open b. Q1 shorted or associated components defective. Switch S2 shorted Resistors R1-R15, or R21 shorted

Table 5-4. High Output Voltage Troubleshooting

Step	Action	Response	Probable Cause
1	Adjust the power supply output to 300 Vdc and disconnect the load from the output terminals		
2	Remove CR7 lead	a. Output decreases	a. R35, R24, or R23 defective
		b. Output remains high	b. Reconnect CR7 and proceed to Step 3
3	Short Q4 emitter to collector	a. Output remains high	a. CR10, R26, R27, or CR8 shorted
		b. Output decreases	b. Remove short from Q4 and proceed to Step 4
4	Short Q2 emitter to collector	a. Output remains high	a. Q4 open
		b. Output decreases	b. Remove short from Q2 and proceed to Step 5
5	Short Q1 emitter to collector	a. Output remains high	a. Q2 shorted
		b. Output decreases	b. Q1 shorted or associated components defective Switch S2 open Resistors R1-R15, or R21 open.

5-37 REPAIR AND REPLACEMENT

5-38 Before servicing a printed wiring board, refer to Figure 5-6. Section VI of this manual contains a list of replaceable parts. Before replacing a semiconductor device, refer to Table 5-5 which lists the special characteristics of selected semiconductors. If the device to be replaced is not listed in Table 5-5, the standard manufacturers part number listed in Section VI is applicable.

After replacing a semiconductor device, refer to Table 5-6 for checks and adjustments that may be necessary.

5-39 ADJUSTMENT AND CALIBRATION

5-40 Adjustment and calibration may be required after performance testing, troubleshooting, or repair and replacement. Perform only those adjustments that affect the operation of the faulty circuit and no others.

Table 5-5. Selected Semiconductor Characteristics

Reference Designator	Characteristics	℄ Stock No.	Suggested Replacement
CR1, CR2, CR4-CR6 CR9, CR19, CR20	Si. Stabistor 200 mA 10 prv	1901-0461	1N4828 G.E.
CR3, CR7, CR21-CR27, CR29	Diode, Si.	1901-0033	1N279 Transitron
CR31-CR34	Rect. Si. 500 mA 200 prv	1901-0026	1N3253 R.C.A.
VR1	Diode, zener 6.2 V ±5%	1902-0049	1N753 Motorola

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.

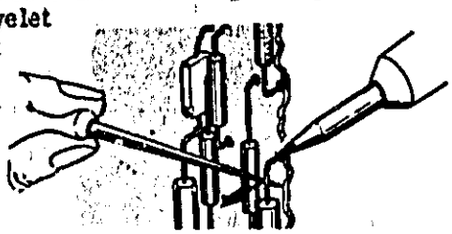
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

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.

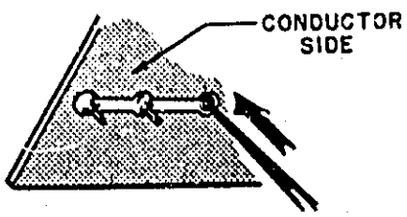
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

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.

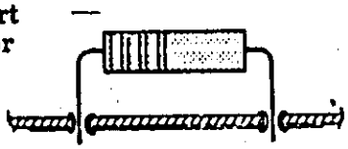
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.



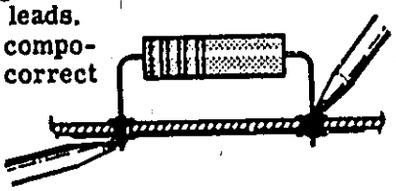
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



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

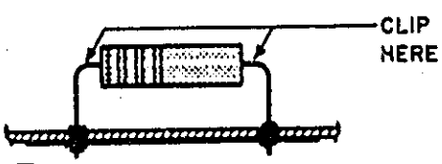


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

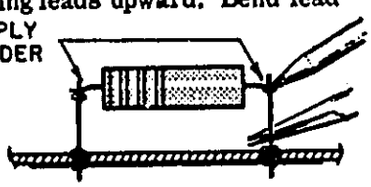


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

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.

Figure 5-6. Servicing Printed Wiring Boards

Table 5-6. Checks and Adjustments After Replacement of Semiconductor Devices

Reference Designator	Function	Check	Adjust
Q1,Q2	Voltage feedback amplifiers	Line and load regulation zero volt output	
Q4	Constant voltage and current limit driver	Line and load regulation. Current limit	R24
Q5	Reference series regulator	Reference voltages Current limit Programming current	R24 R36,R37
Q6	Constant programming current amplifier	Programming current	R36,R37
CR1,CR3	Protection diodes	Line and load regulation zero volt output	
CR2,CR4-CR6,CR19, CR20	Series reference diodes	Reference voltages Programming current	R36,R37
CR8	Series regulator protection diode	Output voltage	
CR9	Bias diode	-1 volt at point 12	
CR10	Series regulator	Line and load regulation	
CR27,CR29	Q6 protection diodes	Programming current	
CR28	Series regulator protection diode	Output voltage	

5-41 METER ZERO

5-42 Proceed as follows to mechanically zero meter:

a. Turn off instrument (after it has reached normal operating temperature) and allow 30 seconds for all capacitors to discharge.

b. Insert sharp pointed object (pen point or awl) into the small indentation near top of round black plastic disc located directly below meter face.

c. Rotate plastic disc clockwise (cw) until meter reads zero, then rotate ccw slightly in order to free adjustment screw from meter suspension. If pointer moves, repeat steps b and c.

5-43 METER ACCURACY ADJUSTMENT

5-44 To adjust the electrical meter accuracy, proceed as follows:

a. Connect the 100:1 attenuator and the differential voltmeter as illustrated in Figure 5-2.

b. Adjust the VOLTAGE RANGE switch and the VERNIER until the differential voltmeter indicates 12 volts.

c. Adjust R46 until the front panel voltmeter indicates exactly 1200 volts.

5-45 OUTPUT VOLTAGE (PROGRAMMING CURRENT) ADJUSTMENT

5-46 To adjust the output voltage, proceed as follows:

a. Connect the 100:1 attenuator and the differential voltmeter as illustrated in Figure 5-2.

b. Turn the VOLTAGE RANGE switch to 1500 Vdc and the VERNIER control fully counterclockwise.

c. Remove R36 and R37 and connect the decade box (set to approximately 200 ohms) to the standoff terminal in place of R37.

d. Adjust the decade box until the differential voltmeter indicates 15.0000Vdc.

e. Note the setting of the decade box and connect the next highest value resistor in the R36 position on the circuit board. This resistor should be a 1%, 1/4 W Metal Film type with a temperature coefficient not greater than 100 ppm per degree centigrade.

f. Readjust the decade box until the differential voltmeter again reads 15.0000Vdc.

g. Note the setting of the decade box and connect an equal value resistor to the standoff terminals for R37. This resistor should be 5%, 1/2 W carbon composition.

5-47 OUTPUT CURRENT LIMIT ADJUSTMENT

5-48 To adjust the limiting level of the output current, proceed as follows:

a. Attach the multimeter or a milliammeter to the output terminals of the supply. Set the meter for approximately 10 mA. The internal resistance of the meter is low enough to overload the supply so that the output will current limit.

b. Set the VOLTAGE RANGE switch to 300 volts.

c. Adjust current limit control R24 until the meter indicates 7.5 mA.

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-4 lists parts in alphanumeric order by reference designators and provides the following information:

a. Reference Designators. Refer to Table 6-1.

b. Description. Refer to Table 6-2 for abbreviations.

c. Total Quantity (TQ). Given only the first time the part number is listed except in instruments containing many sub-modular assemblies, in which case the TQ appears the first time the part number is listed in each assembly.

d. Manufacturer's Part Number or Type.

e. Manufacturer's Federal Supply Code Number. Refer to Table 6-3 for manufacturer's name and address.

f. Hewlett-Packard Part Number.

g. Recommended Spare Parts Quantity (RS) for complete maintenance of one instrument during one year of isolated service.

h. Parts not identified by a reference designator are listed at the end of Table 6-4 under Mechanical and/or Miscellaneous. The former consists of parts belonging to and grouped by individual assemblies; the latter consists of all parts not immediately associated with an assembly.

6-3 ORDERING INFORMATION

6-4 To order a replacement part, address order or inquiry to your local Hewlett-Packard sales office (see lists at rear of this manual for addresses). Specify the following information for each part: Model, complete serial number, and any Option or special modification (J) numbers of the instrument; Hewlett-Packard part number; circuit reference designator; and description. To order a part not listed in Table 6-4, give a complete description of the part, its function, and its location.

Table 6-1. Reference Designators

A	= assembly	E	= miscellaneous electronic part
B	= blower (fan)	F	= fuse
C	= capacitor	J	= jack, jumper
CB	= circuit breaker	K	= relay
CR	= diode	L	= inductor
DS	= device, signaling (lamp)	M	= meter
P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
Q	= transistor	VR	= zener diode
R	= resistor	X	= socket
S	= switch	Z	= integrated circuit or network
T	= transformer		
TB	= terminal block		
TS	= thermal switch		

Table 6-1. Reference Designators (Continued)

Table 6-2. Description Abbreviations

A	= ampere	mfr	= manufacturer
ac	= alternating current	mod.	= modular or modified
assy.	= assembly	mtg	= mounting
bd	= board	n	= nano = 10^{-9}
bkt	= bracket	NC	= normally closed
°C	= degree Centigrade	NO	= normally open
cd	= card	NP	= nickel-plated
coef	= coefficient	Ω	= ohm
comp	= composition	obd	= order by description
CRT	= cathode-ray tube	OD	= outside diameter
CT	= center-tapped	p	= pico = 10^{-12}
dc	= direct current	P.C.	= printed circuit
DPDT	= double pole, double throw	pot.	= potentiometer
		p-p	= peak-to-peak
DPST	= double pole, single throw	ppm	= parts per million
elect	= electrolytic	pvr	= peak reverse voltage
encap	= encapsulated	rect	= rectifier
F	= farad	rms	= root mean square
°F	= degree Farenheit	Si	= silicon
fxd	= fixed	SPDT	= single pole, double throw
Ge	= germanium	SPST	= single pole, single throw
H	= Henry	SS	= small signal
Hz	= Hertz	T	= slow-blow
IC	= integrated circuit	tan.	= tantulum
ID	= inside diameter	Ti	= titanium
incnd	= incandescent	V	= volt
k	= kilo = 10^{3}	var	= variable
m	= milli = 10^{-3}	ww	= wirewound
M	= mega = 10^{6}	W	= Watt
μ	= micro = 10^{-6}		
met.	= metal		

Table 6-3. Code List of Manufacturers

CODE NO.	MANUFACTURER	ADDRESS
00629	EBY Sales Co., Inc.	Jamaica, N.Y.
00656	Aerovox Corp.	New Bedford, Mass.
00853	Sangamo Electric Co. S. Carolina Div.	Pickens, S.C.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Semiconductor-Components Div.	Dallas, Texas
01686	RCL Electronics, Inc.	Manchester, N.H.
01930	Amerock Corp.	Rockford, Ill.
02107	Sparta Mfg. Co.	Dover, Ohio
02114	Ferroxcube Corp.	Saugerties, N.Y.
02606	Fenwal Laboratories	Morton Grove, Ill.
02660	Amphenol Corp.	Broadview, Ill.
02735	Radio Corp. of America, Solid State and Receiving Tube Div.	Somerville, N.J.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co. Inc.	Cedar Knolls, N.J.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04072	ADC Electronics, Inc.	Harbor City, Calif.
04213	Caddell & Burns Mfg. Co. Inc.	Mineola, N.Y.
04404	*Hewlett-Packard Co. Palo Alto Div.	Palo Alto, Calif.
04713	Motorola Semiconductor Prod. Inc.	Phoenix, Arizona
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	Grand Junction, Colo.
05820	Wakefield Engr. Inc.	Wakefield, Mass.
06001	General Elect. Co. Electronic Capacitor & Battery Dept.	Irmo, S.C.
06004	Bassik Div. Stewart-Warner Corp.	Bridgeport, Conn.
06486	IRC Div. of TRW Inc. Semiconductor Plant	Lynn, Mass.
06540	Amatom Electronic Hardware Co. Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co.	Penacook, N.H.
06666	General Devices Co. Inc.	Indianapolis, Ind.
06751	Semcor Div. Components, Inc.	Phoenix, Arizona
06776	Robinson Nugent, Inc.	New Albany, Ind.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07263	Fairchild Camera and Instrument Corp. Semiconductor Div.	Mountain View, Calif.
07387	Bircher Corp., The	Los Angeles, Calif.
07397	Sylvania Electric Prod. Inc. Sylvania Electronic Systems Western Div.	Mountain View, Calif.
07716	IRC Div. of TRW Inc. Burlington Plant	Burlington, Iowa
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Co. Components Div. Semiconductor Operation	Mountain View, Calif.
08484	Breeze Corporations, Inc.	Union, N.J.
08530	Reliance Mica Corp.	Brooklyn, N.Y.
08717	Sloan Company, The	Sun Valley, Calif.
08730	Vemaline Products Co. Inc.	Wyckoff, N.J.
08806	General Elect. Co. Miniature Lamp Dept.	Cleveland, Ohio
08863	Nylomatic Corp.	Norrisville, Pa.
08919	RCH Supply Co.	Vernon, Calif.
09021	Airco Speer Electronic Components	Bradford, Pa.
09182	*Hewlett-Packard Co. New Jersey Div.	Rockaway, N.J.
09213	General Elect. Co. Semiconductor Prod. Dept.	Buffalo, N.Y.
09214	General Elect. Co. Semiconductor Prod. Dept.	Auburn, N.Y.
09353	C & K Components Inc.	Newton, Mass.
09922	Burndy Corp.	Norwalk, Conn.
11115	Wagner Electric Corp. Tung-Sol Div.	Bloomfield, N.J.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of Cal. Inc.	So. Pasadena, Calif.
11502	IRC Div. of TRW Inc. Boone Plant	Boone, N.C.
11711	General Instrument Corp Rectifier Div.	Newark, N.J.
12136	Philadelphia Handle Co. Inc.	Camden, N.J.
12615	U.S. Terminals, Inc.	Cincinnati, Ohio
12617	Hamlin Inc.	Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Inc.	Dover, N.H.
13103	Thermalloy Co.	Dallas, Texas
14493	*Hewlett-Packard Co. Loveland Div.	Loveland, Colo.
14655	Cornell-Dubilier Electronics Div. Federal Pacific Electric Co.	Newark, N.J.
14936	General Instrument Corp. Semiconductor Prod. Group	Hicksville, N.Y.
15801	Fenwal Elect.	Framingham, Mass.
16299	Corning Glass Works, Electronic Components Div.	Raleigh, N.C.

*Use Code 28480 assigned to Hewlett-Packard Co., Palo Alto, California

Table 6-3. Code List of Manufacturers (Continued)

CODE NO.	MANUFACTURER	ADDRESS
16758	Delco Radio Div. of General Motors Corp.	Kokomo, Ind.
17545	Atlantic Semiconductors, Inc.	Asbury Park, N.J.
17803	Fairchild Camera and Instrument Corp Semiconductor Div. Transducer Plant	Mountain View, Calif.
17870	Daven Div. Thomas A. Edison Industries McGraw-Edison Co.	Orange, N.J.
18324	Signetics Corp.	Sunnyvale, Calif.
19315	Bendix Corp. The Navigation and Control Div.	Teterboro, N.J.
19701	Electra/Midland Corp.	Mineral Wells, Texas
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
22229	Union Carbide Corp. Electronics Div.	Mountain View, Calif.
22753	UID Electronics Corp.	Hollywood, Fla.
23936	Pamotor, Inc.	Pampa, Texas
24446	General Electric Co.	Schenectady, N.Y.
24455	General Electric Co. Lamp Div. of Consumer Prod. Group	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	LTV Electrosystems Inc Memcor/Components Operations	Huntington, Ind.
26982	Dynacool Mfg. Co. Inc.	Saugerties, N.Y.
27014	National Semiconductor Corp.	Santa Clara, Calif.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
28875	IMC Magnetics Corp. New Hampshire Div.	Rochester, N.H.
31514	SAE Advance Packaging, Inc.	Santa Ana, Calif.
31827	Budwig Mfg. Co.	Ramona, Calif.
33173	G.E. Co. Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
42190	Muter Co.	Chicago, Ill.
43334	New Departure-Hyatt Bearings Div. General Motors Corp.	Sandusky, Ohio
44655	Ohmite Manufacturing Co.	Skokie, Ill.
46384	Penn Engr. and Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
49956	Raytheon Co.	Lexington, Mass.
55026	Simpson Electric Co. Div. of American Gage and Machine Co.	Chicago, Ill.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Electric Co.	Bristol, Conn.
58849	Syntron Div. of FMC Corp.	Homer City, Pa.
59730	Thomas and Betts Co.	Philadelphia, Pa.
61637	Union Carbide Corp.	New York, N.Y.
63743	Ward Leonard Electric Co.	Mt. Vernon, N.Y.
70563	Amperite Co. Inc.	Union City, N.J.
70901	Beemer Engrg. Co.	Fort Washington, Pa.
70903	Belden Corp.	Chicago, Ill.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionic Corp.	Cambridge, Mass.
71400	Bussmann Mfg. Div. of McGraw & Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	I.T.T. Cannon Electric Inc.	Los Angeles, Calif.
71590	Globe-Union Inc. Centralab Div.	Milwaukee, Wis.
71700	General Cable Corp. Cornish Wire Co. Div.	Williamstown, Mass.
71707	Coto Coil Co. Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co. and Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co. Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72699	General Instrument Corp.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72962	Elastic Stop Nut Div. of Amerace Esna Corp.	Union, N.J.
72982	Erie Technological Products Inc.	Erie, Pa.
73096	Hart Mfg. Co.	Hartford, Conn.
73138	Beckman Instruments Inc. Helipot Div.	Fullerton, Calif.
73168	Fenwal, Inc.	Ashland, Mass.
73293	Hughes Aircraft Co. Electron Dynamics Div.	Torrance, Calif.
73445	Amperex Electronic Corp.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73734	Federal Screw Products, Inc.	Chicago, Ill.
74193	Heinemann Electric Co.	Trenton, N.J.
74545	Hubbell Harvey Inc.	Bridgeport, Conn.
74868	Amphenol Corp. Amphenol RF Div.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	IRC Div. of TRW, Inc.	Philadelphia, Pa.
75183	*Howard B. Jones Div. of Cinch Mfg. Corp.	New York, N.Y.
75376	Kurz and Kasch, Inc.	Dayton, Ohio
75382	Kilka Electric Corp.	Mt. Vernon, N.Y.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76381	Minnesota Mining and Mfg. Co.	St. Paul, Minn.
76385	Minor Rubber Co. Inc.	Bloomfield, N.J.
76487	James Millen Mfg. Co. Inc.	Malden, Mass.
76493	J.W. Miller Co.	Compton, Calif.

*Use Code 71785 assigned to Cinch Mfg. Co., Chicago, Ill.

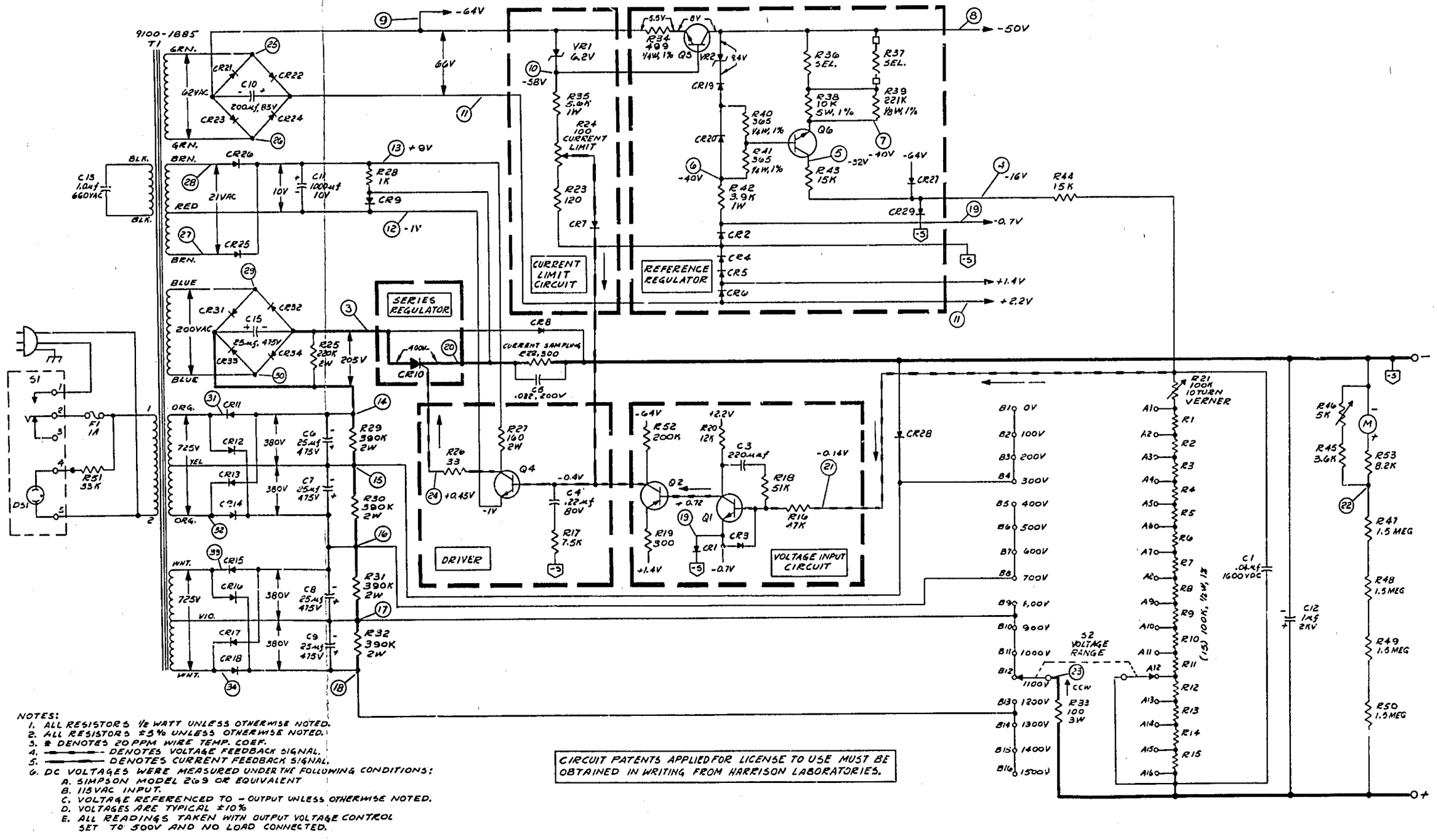
Table 6-3. Code List of Manufacturers (Continued)

CODE NO.	MANUFACTURER	ADDRESS
76530	Cinch	City of Industry, Calif.
76854	Oak Mfg. Co. Div. of Oak Electro/Netics Corp.	Crystal Lake, Ill.
77068	Bendix Corp., Electrodynamics Div.	No. Hollywood, Calif.
77122	Palnut Co.	Mountainside, N.J.
77147	Patton-MacGuyer Co.	Providence, R.I.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine and Foundry Co. Potter and Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Illinois Tool Works Inc. Shakeproof Div.	Elgin, Ill.
78452	Everlock Chicago, Inc.	Chicago, Ill.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78526	Stanwyck Winding Div. San Fernando Electric Mfg. Co. Inc.	Newburgh, N.Y.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78584	Stewart Stamping Corp.	Yonkers, N.Y.
79136	Waldes Kohinoor, Inc.	L.I.C., N.Y.
79307	Whitehead Metals Inc.	New York, N.Y.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Co.	Mt. Kisco, N.Y.
80031	Mepco Div. of Sessions Clock Co.	Morristown, N.J.
80294	Bourns, Inc.	Riverside, Calif.
81042	Howard Industries Div. of Msl Ind. Inc.	Racine, Wisc.
81078	Grayhill, Inc.	La Grange, Ill.
81483	International Rectifier Corp.	El Segundo, Calif.
81751	Columbus Electronics Corp.	Yonkers, N.Y.
82099	Goodyear Sundries & Mechanical Co. Inc.	New York, N.Y.
82142	Airco Speer Electronic Components	Du Bois, Pa.
82219	Sylvania Electric Products Inc. Electronic Tube Div. Receiving Tube Operations	Emporium, Pa.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls Inc. Control Products Group	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp. Electric Power Div.	Eatontown, N.J.
83330	Herman H. Smith, Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Div. of Amerace Esna Corp.	Brookfield, Mass.
83508	Grant Pulley and Hardware Co.	West Nyack, N.Y.
83594	Burroughs Corp. Electronic Components Div.	Plainfield, N.J.
83835	U.S. Radium Corp.	Morristown, N.J.
83877	Yardeny Laboratories, Inc.	New York, N.Y.
84171	Arco Electronics, Inc.	Great Neck, N.Y.
84411	TRW Capacitor Div.	Ogallala, Neb.
86684	RCA Corp. Electronic Components	Harrison, N.J.
86838	Rummel Fibre Co.	Newark, N.J.
87034	Marco & Oak Industries a Div. of Oak Electro/netics Corp.	Anaheim, Calif.
87216	Philco Corp. Lansdale Div.	Lansdale, Pa.
87585	Stockwell Rubber Co. Inc.	Philadelphia, Pa.
87929	Tower-Olschan Corp.	Bridgeport, Conn.
88140	Cutler-Hammer Inc. Power Distribution and Control Div. Lincoln Plant	Lincoln, Ill.
88245	Litton Precision Products Inc, USECO Div. Litton Industries	Van Nuys, Calif.
90634	Gulton Industries Inc.	Metuchen, N.J.
90763	United-Car Inc.	Chicago, Ill.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Willow Grove, Pa.
91929	Honeywell Inc. Div. Micro Switch	Freeport, Ill.
92825	Whitso, Inc.	Schiller Pk., Ill.
93332	Sylvania Electric Prod. Inc. Semiconductor Prod. Div.	Woburn, Mass.
93410	Essex Wire Corp. Stemco Controls Div.	Mansfield, Ohio
94144	Raytheon Co. Components Div. Ind. Components Oper.	Quincy, Mass.
94154	Wagner Electric Corp. Tung-Sol Div.	Livingston, N.J.
94222	Southco Inc.	Lester, Pa.
95263	Leecraft Mfg. Co. Inc.	L.I.C., N.Y.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95712	Bendix Corp. Microwave Devices Div.	Franklin, Ind.
95987	Weckesser Co. Inc.	Chicago, Ill.
96791	Amphenol Corp. Amphenol Controls Div.	Janesville, Wis.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97702	IMC Magnetics Corp. Eastern Div.	Westbury, N.Y.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98410	ETC Inc.	Cleveland, Ohio
98978	International Electronic Research Corp.	Burbank, Calif.
99934	Renbrandt, Inc.	Boston, Mass.

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr.	Mfr. Code	Stock No.	RS
C1	fxd, paper .04µf 1600vdc	1	MB-S4	Sprague	56289	0160-2552	1
C2,14	NOT ASSIGNED	-	-	-	-	-	-
C3	fxd, mica 220µµf 500vdc	1	RCM15E221J	Arco	84171	0140-0068	1
C4	fxd, film. 22µf 80vdc	1	192P2249R8	Sprague	56289	0160-2453	1
C5	fxd, film .082µf 200vdc	1	192P82392	Sprague	56289	0160-0167	1
C6-9,13	fxd, elect 25µf 475vdc	5	D40682	HLAB	09182	0180-1848	1
C10	fxd, elect 200µf 85vdc	1	D31642	HLAB	09182	0180-1854	1
C11	fxd, elect 1000µf 10vdc		D70714	HLAB	09182	0180-1858	1
C12	fxd, paper 1µf 2KV	1	264P90	Sprague	56289	0160-2483	1
C13	fxd, paper 1µf 660vac (Type 200P25A1)	Ref.	Supplied with T1				1
CR1,2,4-6, 9,19,20	Rect. si. 200ma 15prv	8		HLAB	09182	1901-0461	6
CR3,7,21-27,29	Diode si.	10		HLAB	09182	1901-0033	6
CR8,11-18, 28	Rect. si. 500ma 800prv	10	1N3256	R.C.A.	02735	1901-0388	6
CR10	SCR PFV min 0 PRV min 650V	1	C20EX115	G.E.	03508	1884-0039	1
CR30	NOT ASSIGNED	-	-	-	-	-	-
CR31-34	Rect. si. 500ma 200prv	4	1N3253	R.C.A.	02735	1901-0389	4
DS1	Lamp, neon part of si. ass'y	Ref.		HLAB	09182	2140-0244	1
F1	Fuse cartridge 1A@250V 3AG	1	312001	Littlefuse	75915	2110-0001	5
Q1,5,6	SS NPN si.	3	2N3390	G.E.	03508	1854-0202	3
Q2	SS PNP si.	1	2N2907A	Sprague	56289	1853-0099	1
Q3	NOT ASSIGNED	-	-	-	-	-	-
Q4	SS NPN si.	1	2N3417	G.E.	03508	1854-0087	1
R1-15	fxd, met. film 100KΩ ±1% 1/2w	15	Type CEC T-O	I.R.C.	07716	0757-0367	3
R16	fxd, comp 47KΩ ±5% 1/2w	1	EB-4735	A.B.	01121	0686-4735	1
R17	fxd, comp 7.5KΩ ±5% 1/2w	1	EB-7525	A.B.	01121	0686-7525	1
R18	fxd, comp 51KΩ ±5% 1/2w	1	EB-5135	A.B.	01121	0686-5135	1
R19,22	fxd, comp 300Ω ±5% 1/2w	2	EB-3015	A.B.	01121	0686-3015	1
R20	fxd, comp 12KΩ ±5% 1/2w	1	EB-1235	A.B.	01121	0686-1235	1
R21	var. ww 100KΩ ±5% (10 turn) 2w @ 25°C	1		HLAB	09182	2100-1869	1
R23	fxd, comp 120Ω ±5% 1/2w	1	EB-1215	A.B.	01121	0686-1215	1
R24	var. ww 100Ω	1	Type 110-F4	C.T.S.	11236	2100-0281	1
R25	fxd, met. ox 220KΩ ±5% 2w	1	Type C42S	Corning	16299	0698-3665	1
R26	fxd, comp 33Ω ±5% 1/2w	1	EB-3305	A.B.	01121	0686-3305	1
R27	fxd, met. ox 160Ω ±5% 2w	1	Type C42S	Corning	16299	0698-3625	1
R28	fxd, comp 1KΩ ±5% 1/2w	1	EB-1025	A.B.	01121	0686-1025	1
R29-32	fxd, met ox 390KΩ ±5% 2w	4	Type C42S	Corning	16299	0698-3669	1
R33	fxd, ww 100Ω ±5% 3w	1	242E1015	Sprague	56289	0813-0050	1
R34	fxd, met. film 499Ω ±1% 1/4w	1	Type CEB T-O	I.R.C.	07716	0698-3207	1
R35	fxd, comp 5.6KΩ ±5% 1w	1	GB-5625	A.B.	01121	0689-5625	1
R36	fxd, met. film SELECTIVE ±1% 1/4w	1	Type CEB T-O	I.R.C.	07716		1
R37	fxd, comp SELECTIVE ±5% 1/2w	1	Type EB	A.B.	01121		1
R38	fxd, ww 10KΩ ±1% 5w TC = 20ppm	1	Type 5SX	W.L.	63743	0811-1866	1
R39	fxd, met. film 221KΩ ±1% 1/8w	1	Type CEA T-O	I.R.C.	07716	0757-0473	1
R40,41	fxd, met. film 365Ω ±1% 1/4w	2	Type CEB T-O	I.R.C.	07716	0757-0723	1

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr.	Mfr. Code	Stock No.	RS
R42	fxd, comp 3.9Kn ±5% 1w	1	GB-3925	A.B.	01121	0689-3925	1
R43,44	fxd, comp 15Kn ±5% 1/2w	2	EB-1535	A.B.	01121	0686-1535	1
R45	fxd, comp 3.6Kn ±5% 1/2w	1	EB-3625	A.B.	01121	0686-3625	1
R46	var. ww 5Kn (Modify)	1	Type 110-F4	C.T.S.	11236	2100-1824	1
R47-50	fxd, comp 1.5 MEG ±5% 1/2w	4	EB-1555	A.B.	01121	0686-1555	1
R51	fxd, comp 33Kn ±5% 1/2w	1	EB-3335	A.B.	01121	0686-3335	1
R52	fxd, comp 200Kn ±5% 1/2w	1	EB-2045	A.B.	01121	0686-2045	1
R53	fxd, comp 8.2Kn ±5% 1/2w	1	EB-8225	A.B.	01121	0686-8225	1
S1	Switch, P.L. Lt. (red) ON/OFF S.P.D.T.	1	54-61681-26A1H	Oak	87034	3101-0100	1
S2	Switch wafer	1		HLAB	09182	3100-1909	1
T1	Power transformer cycle H428B	1		HLAB	09182	9100-1885	1
VR1	Diode, zener 6.2V ±5%	1		HLAB	09182	1902-0049	1
VR2	Diode, zener 9.4V ±5% T.C.	1	1N2163	Semcor	06751	1902-0762	1
	Side chassis - right	1		HLAB	09182	5000-6057	
	Side chassis - left	1		HLAB	09182	5000-6058	
	Blank panel - front	1		HLAB	09182	5000-6062	
	Panel front	1		HLAB	09182	06515-00001	
	Cover non-perf.	2		HLAB	09182	5000-6016	
	Chassis - rear	1		HLAB	09182	06515-00002	
	Heat sink - SCR	1		HLAB	09182	06515-20001	
	Bracket - pot.	1		HLAB	09182	06515-00003	
	Cable clamp 1/4 I.D.	1	T4-4	Whitehead	79307	1400-0330	1
	Line cord plug PH151 7 1/2 ft	1	HK 4096	Beldon	70903	8120-0050	1
	Strain relief bushing	1	SR-5P-1	Heyco	28520	0400-0013	1
	Knob 5/8 dia	1		HLAB	09182	0370-0137	1
	Knob, bar 1/4 insert pointer	1		HLAB	09182	0370-0077	1
	Extender, insul.	1	130	H.H. Smith	83330	1900-0077	1
	Panel bearing	1	119	H.H. Smith	83330	1410-0758	1
	BNC-HV Bulkhead MT. Jack Receptacle	2		HLAB	09182	1250-0735	1
	Cable plug (see parts with *)	2		HLAB	09182	5080-7109	1
	* BNC-HV Cable plug Body ass'y only	1	12651-1	Dage	95712	1250-0741	1
	* Center contact	1	1-026-9	Dage	95712	1250-0742	1
	* Clamp nut	1	834-32	Dage	95712	1250-0142	1
	* Clamp washer	1	832-2	Dage	95712	1250-0143	2
	* Clamp gasket	1	833-13	Dage	95712	1250-0145	1
	* Flat washer	1	2053-6	Dage	95712	1250-0145	1
	Fuse holder	1	342014	Littlefuse	75915	1400-0084	1
	Lockwasher	1	1224-08	Shakeproof	78189	2190-0037	1
	Nut	1	903-12	Littlefuse	75915	2950-0038	1
	Washer - neoprene	1	901-2	Littlefuse	75915	1400-0090	1
	Meter 2 1/4" size scale 0-1.8KV	1		HLAB	09182	1120-1125	1
	Bezel 1/6 MOD	1		HLAB	09182	4040-0295	1
	Spring	4		HLAB	09182	1460-0720	1
	Capacitor clamp	2	36-928	Sprague	56289	0160-2590	1
	Rubber bumper	4	MB 50	Stockwell	87575	0403-0088	1
	Fastener	12	C8091 632-24B	Tinnerman	89032	0510-0275	2
	Captive nut	6	CLA-632-2	Penn. Eng.	46384	0590-0393	2
	Shoulder washer	1		HLAB	09182	2190-0490	1

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr.	Mfr. Code	Stock No.	RS
	OPTION 13:						
	Voltage Decadial Control	1	RD-411	I. R. C	07716	1140-0020	



NOTES:
1. ALL RESISTORS 1/2 WATT UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ±5% UNLESS OTHERWISE NOTED.
3. * DENOTES 20 PPM WIRE TEMP. COEF.
4. ——— DENOTES VOLTAGE FEEDBACK SIGNAL.
5. ——— DENOTES CURRENT FEEDBACK SIGNAL.
6. DC VOLTAGES WERE MEASURED UNDER THE FOLLOWING CONDITIONS:
   A. SIMPSON MODEL 269 OR EQUIVALENT
   B. 115VAC INPUT.
   C. VOLTAGE REFERENCED TO – OUTPUT UNLESS OTHERWISE NOTED.
   D. VOLTAGES ARE TYPICAL ±10%
   E. ALL READINGS TAKEN WITH OUTPUT VOLTAGE CONTROL SET TO 300V AND NO LOAD CONNECTED.

CIRCUIT PATENTS APPLIED FOR LICENSE TO USE MUST BE OBTAINED IN WRITING FROM HARRISON LABORATORIES.

Model 6515A, Schematic Diagram

MANUAL CHANGES

MANUAL CHANGES

DC POWER SUPPLY
Model 6515A
Manual HP Part No. 06515-90001

Make all corrections in the manual according to errata below, then check the following table for your power supply serial number and enter any listed change(s) in the manual.

SERIAL		MAKE CHANGES
Prefix	Number	
ALL	–	Errata
6C	0551-1600	1
6C	1601-1840	1,2
1147A	1841-3100	1,2,3
1147A	3101-3350	1,2,3,4
1526A	3351-3410	1 thru 5
1543A	3411-3560	1 thru 6
1608A	3561-4030	1 thru 7
1712A	4301-4560, 4562-4612, 4614-4617, 4621, 4623, 4624, 4631-4660	1 thru 8
1712A	4561, 4613, 4618-4620, 4622, 4625-4630	1 thru 9
1833A	4661-4664, 4666, 4667, 4669-4671, 4673-4676, 4678, 4680, 4683-4738, 4740	1 thru 9
1933A	4665, 4668, 4672, 4677, 4679, 4681, 4682, 4739, 4741-4780	1 thru 10
1847A	4781-4860	1 thru 10
1920A	4861-4929, 4931-4934, 4936, 4938-4940, 4943-4946, 4948-4956, 4958-4962, 4964-4968	1 thru 11
1920A	4930, 4935, 4937, 4941 4942, 4947, 4957, 4963, 4969-4980	1 thru 12
1941A	4981-5040	1 thru 12
1952A	5041-5070	1 thru 13
2011A	5071-up	1 thru 14

ERRATA:

On the overall schematic diagram, make the following corrections:

(1) Reverse the polarity of CR9. Connect the anode to R28 and the cathode to the emitter of Q4.
(2) Change the voltage across VR2 to 9.4V.
(3) Change Q2 to PNP transistor.
(4) Change voltage across Q5 to 9V.
(5) Change voltage at TP4 to -16V.

CHANGE 1:

In the replaceable parts table change the "cable plug" to HP Part No. 1250-0927 and delete all the component parts listed under "cable plug".

ERRATA:

In replaceable parts table make the following changes:

Delete "Extender, isnulated" HP Part No. 1900-0077.
Add "Shaft" HP Part No. 06448-20004, quantity 1.
Add "Coupler" HP Part No. 5020-5786, quantity 1.

On page 1-1, change the first sentence of Paragraph 1-10 to read:

Output power is available via two type BNC-HV connectors at the front of the power supply.

CHANGE 2:

In the replaceable parts table, make the following changes:
The front panel on/off pushbutton and pilot light has been replaced with a toggle type switch (S1) and a separate pilot light (DS1) as follows:.
DS1: Add pilot light, HP Part No. 1450-0419.
S1: Change to toggle switch, HP Part No. 3101-1525.

The + and – BNC connectors on the front panel have been changed to HP Part No. 1250-1267.

CHANGE 3:

The Serial Prefix of this unit has been changed to 1147A. This is the only change.

ERRATA:

In the replaceable Parts List, change the HP Stock No. given for CR8, CR11-18, and CR28 to 1901-0330. Also change the number given for CR31-34 to 1901-0327.

CHANGE 4:

In Replaceable Parts List and on the schematic, change fuse F1 to 1/2A HP Part No. 2110-0012 for 115Vac operation and to 1/4A HP Part No. 2110-0004 for 230Vac operation.

ERRATA:

In parts list, change HP Part No. of C12 to 0160-4121.

In Table 1-1 and paragraph 5-18, change Ripple and Noise specification to 15mV peak-to-peak.

The standard colors for this instrument are now mint gray (for front panel) and olive gray (for all other external surfaces). Option X95 designates use of the former color scheme of light gray and blue gray. Option A85 designates use of a light gray front panel with olive gray used for all other external surfaces. New part numbers are shown on the next page.

DESCRIPTION	HP PART NUMBER		
	STANDARD	OPTION A85	OPTION X95
Front Panel, Lettered	06515-00005	06515-60004	←
Chassis, Right Side	60005-R	←	5000-6057
Chassis, Left Side	60006-L	←	5000-6058
Top Cover	5000-9419	←	5000-6016
Rear Chassis	06515-00006	←	06515-00002

CHANGE 5:

In the parts list, change the part number of CR11 thru CR18 to 1901-0030.

ERRATA:

Add Option 019 to the manual. To paragraph 1-14, add this description: "230Vac 50Hz input. Option 019 replaces the power transformer, line cord, and fuse to adapt the supply for 230Vac 50Hz operation." Also add these part numbers to the end of the parts list under the heading "OPTION 019."

Fuse 1/4A 250V	HP Part No. 2110-0004
Line cord	8120-1691
Transformer (230V)	9100-2612
Label	7120-5033

CHANGE 6:

Change the HP Part No. of ac power switch S1 on Page 6-6 of the parts list to 3101-1055. The new switch is more reliable.

ERRATA:

In parts list, change HP Part No. of pilot lamp DS1 to 1450-0566.

CHANGE 7:

Serial prefix is changed to 1608A. This is the only change.

ERRATA:

Add the following notice to paragraph 1-21:
"Effective December 1, 1975, extra manuals may be obtained by ordering Option 910 when ordering your instrument. The number of extra manuals depends on the number of Option 910's ordered."

The blue-gray meter bezel has been replaced by a black one, HP Part No. 4040-0414.

Effective January 1st, 1977, Option 013 (decadial for 10-turn voltage vernier) has been redesignated Option 015. Make this change wherever Option 013 is mentioned in the manual.

CHANGE 8:

This change eliminates oscillations at high temperatures. In the parts list and on schematic diagram (Voltage Input Circuit), change C3 to 0.001μF, HP Part No. 0160-0153.

CHANGE 9:

In the parts list and schematic:
Change zener diode VR2 to 9V HP Part No. 1902-0785
Change resistor R42 to 5.1K 1W, HP Part No. 0689-5125.
Change resistor R39 to 68.1K, 1%, HP Part No. 0757-0461.
Change resistor R34 to 681Ω HP Part No. 0757-0729.

The above changes are also effective on the units listed below from prior runs.

1712A-04561	1712A-04625
1712A-04613	1712A-04626
1712A-04618	1712A-04627
1712A-04619	1712A-04628
1712A-04620	1712A-04629
1712A-04622	1712A-04630

Note that the above changed parts are not interchangeable in any other units (earlier serial numbers) unless all (VR2, R34, R39, R42) are changed at the same time.

The following change pertains to units with serials 1833A-4661 and up that are configured for a 230 Vac input (Option 019):
Change fuse F1 to slow blow, 250mA, HP Part No. 2110-02(
Change fuse label to indicate the slow blow fuse.

CHANGE 10:

In the replaceable parts list table and on the schematic diagram, indicate that the nominal value for C3 is 510 pF, HP Part No. 0140-0047. The value for C3 is factory selected for optimum performance.

ERRATA:

Effective August 1, 1978, change the HP Part No. for fuseholder from 1400-0084 to fuseholder body 2100-0564 and fuseholder carrier 2100-0565. Change the HP Part No. for fuseholder nut from 2950-0131 to 2110-0569. If old fuseholder must be replaced for any reason, replace complete fuseholder and nut with new fuseholder parts. Do not replace new parts with old parts.

CHANGE 11:

In replaceable parts list and on schematic change fuse F1 to 250mA slow-blow, HP Part No. 2110-0201 for 115 operation.

CHANGE 12:

In the replaceable parts list, change the HP Part No. of CR11-CR18 to 1901-0036, qty. 8.

CHANGE 13:

In replacaable parts list, add C.S.A. (Canadian Standards Association) identification label HP Part No. 7120-8572. The Model 6515A is now C.S.A. certified for laboratory equipment.

▶ CHANGE 14:

In the replaceable parts list, change HP Part No. of S1 to 3101-2139; change R51 to 100K, HP Part No. 0686-1045; delete DS1. On the schematic, change S1 to two switch sections, one to break each side of the ac line as shown:

3-30-80