TRIPLE OUTPUT
POWER SUPPLY
MODEL 6235A

OPERATING AND SERVICE MANUAL
FOR SERIALS 1752A-00101 AND ABOVE

* For Serials above 1752A-00101,
a change page may be included.

HP Part No. 06235-90001
Microfiche Part No. 06235-90002

Printed: January, 1978

HEWLETT hp PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period]. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the preventive maintenance procedures in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

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

TABLE OF CONTENTS

SECTION I
GENERAL INFORMATION

1-1 DESCRIPTION

1-2 The Model 6235A Triple Output Power Supply is a compact general purpose bench supply particularly useful for powering developmental IC circuits, both linear and digital. This constant-voltage/current-limiting supply combines two 0* to ±18V tracking outputs rated at 0.2A with a single 0* to +6V output rated at 1A. The +18V and −18V tracking outputs can also be used in series as a single 0 to 36V, 0.2A output. Connections to the outputs are made to binding posts on the front panel. The +6V and ±18V outputs share a common output terminal which is isolated from chassis ground. The chassis ground terminal is located on the supply's rear heat sink assembly.

1-3 Each output is protected against overload or short-circuit damage by separate fixed current limit circuits. The +18V and −18V outputs are each limited to 0.255A ±15% and the +6V output is limited to 1.275A ±15%.

1-4 Voltage controls, output terminals, and a combination voltmeter/ammeter are located on the front panel. One voltage control sets the 0 to +6V output and another simultaneously adjusts the 0 to +18V and 0 to −18V dual tracking outputs. A tracking ratio control sets the ratio between the +18V and −18V outputs. It can set the negative supply's output to any value between a minimum that is less than 0.5V and a maximum that is equal to the positive supply's output. A 1:1 ratio is useful when powering operational amplifiers and other circuits that require balanced positive and negative voltages. Once the tracking control has established a voltage ratio between the positive and negative outputs, the ratio remains constant as the ±18V voltage control varies both outputs.

1-5 The front panel also contains a line pushbutton switch with a simulated (non-electrical) on-off indicator, and four meter select pushbutton switches. One meter pushbutton selects either voltage or current monitoring and the remaining three pushbuttons select the output to be monitored and the proper meter range.

1-6 In addition to the standard 104-to-127Vac, 47-to-63Hz input, a 240Vac nominal line voltage option is available. The supply is furnished with a permanently attached 5-foot 3-wire grounding type line cord. The ac line fuse is in an extractor type fuseholder on the rear heatsink.

*Each output has a minimum operating voltage of ⩽ 50mV.

1-7 SPECIFICATIONS AND SUPPLEMENTAL CHARACTERISTICS

1-8 Table 1-1 provides specifications and supplemental characteristics for Triple Output Power Supply, Model 6235A. Specifications describe the supply's warranted performance characteristics. The supplemental characteristics are typical, but non-warranted, performance characteristics and are intended to provide additional information useful in applying the power supply.

1-9 OPTIONS

1-10 Options are factory modifications of a standard instrument that are requested by the customer. The following options are available with this instrument.

OPTION NO.	DESCRIPTION
028	Input power: 208-250Vac, 47-63Hz, single phase.
910	One additional operating and service manual shipped with the power supply.

1-11 Before the supply is shipped from the factory, an internal line voltage selector switch is set and the proper fuse installed for the line voltage specified on the order. A label on the rear heatsink identifies this line voltage option. The user can convert an instrument from one line voltage option to the other by following the instructions in paragraph 3-13.

1-12 SAFETY CONSIDERATIONS

1-13 This product is a Safety Class 1 insturment (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation.

1-14 ACCESSORIES

1-15 The accessory listed below may be ordered from your local Hewlett-Packard field sales office either with the

power supply or separately. (Refer to the list at the rear of the manual for addresses.)

HP PART NO.	DESCRIPTION
14522A	Rack Mounting Tray for mounting one or two 6235A supplies in a standard 19" relay rack.

1-16 INSTRUMENT AND MANUAL IDENTIFICATION

1-17 Hewlett-Packard power supplies are identified by a two part serial number. The first part is the serial number prefix, a number-letter combination that denotes the date of a significant design change and the country of manufacture. The first two digits indicate the year (10 = 1970, 11 = 1971, etc.) the second two digits indicate the week, and the letter "A" designates the U. S. A. as the country of manufacture. The second part is the power supply serial number. A different sequential number is assigned to each power supply, starting with 00101.

1-18 If the serial number on your instrument does not agree with those on the title page of the manual, Change Sheets supplied with the manual or Manual Backdating Changes define the difference between your instrument and the instrument described by this manual.

1-19 ORDERING ADDITIONAL MANUALS

1-20 One manual is shipped with each power supply. (Option 910 is ordered for each extra manual, see paragraph 1-9.) Additional manuals may also be purchased separately from your local Hewlett-Packard field office (see the list at the rear of this manual for addresses). Specify the model number, serial number prefix, and the HP Part Number provided on the title page.

Table 1-1. Specifications and Supplemental Characteristics

SPECIFICATIONS:

The following specifications describe the 6235A's warranted performance characteristics.

DC Output:

Voltage span over which output may be varied using front panel controls.

* Minimum operating voltage for each output is ⩽ 50 millivolts.

* 0 to +6V Output: Maximum rated output current is 1A. Short circuit output current is 1.275 ±15% and a fixed current limit circuit limits the output to this maximum at any output voltage setting.

0* to ±18V Output: Maximum rated current is 0.2A for each output. Short circuit output current is 0.255A ±15% and fixed current limit circuits limit the output of each supply to this maximum at any output voltage setting. Unbalanced loads within current rating are permitted.

Input Power:

Standard Option: 104-127Vac (120Vac nominal), 47-63Hz, single phase. (240Vac line voltage option available, see paragraph 1-9.)

Load Effect (Load Regulation):

Voltage load effect is given for a load current change equal to the current rating of the supply.

0 to +6V Output: 8mV
0 to ±18V Outputs: 10mV

Source Effect (Line Regulation):

Given for any line voltage change within rating.

0 to +6V Output: 8mV
0 to ±18V Outputs: 15mV

PARD (Ripple and Noise):

All Outputs: Less than 1mV rms and 5mV p-p (20Hz to 20MHz).

Load Transient Recovery Time:

All Outputs: Less than 50μsec for output recovery to within 15mV of nominal output voltage following a load change from a full load to half load (or vice versa).

Temperature Ranges:

Operating 0 to +40°C ambient. From 40°C to 55°C, output current is derated linearly to 50% at 55°C.

Storage: −40°C to +75°C.

Meter Ranges:

0 to +6V Output: 0 to 7V, 0 to 1.2A
0 to +18V Output: 0 to 21V, 0 to 0.24A
0 to −18V Output: 0 to 21V, 0 to 0.24A

Meter Accuracy:

Voltmeter: All Outputs: ±3% of full scale
Ammeter: All Outputs: ±4% of full scale

Weight:

Net: 5 lb (2.3 kg)
Shipping: 7 lb (3.2 kg)

Table 1-1. Specifications and Supplemental Characteristics (Continued)

SUPPLEMENTAL CHARACTERISTICS:

The following characteristics are intended to provide information useful in 6235A applications by giving typical, but non-warranted, performance parameters.

Regulation and Ripple (Typical performance parameters):

The maximum load regulation, line regulation, and ripple specifications listed on page 1-2 are given for 0 to 40°C temperature range. At an ambient temperature of 25°C, typical performance characteristics are as follows:

Load Regulation:
- 0 to +6V Output: 4mV
- 0 to ±18V Output: 6mV

Line Regulation:
- 0 to +6V Output: 4mV
- 0 to ±18V Output: 6mV

Ripple:
- All outputs: 0.2mV rms.

Tracking Accuracy (±18V Outputs):

The output voltage tracking ratio remains constant (within 1%) over the voltage range from 1 to 18 volts for any TRACK control setting.

Temperature Coefficient:

All Outputs: Less than 0.04% + 2mV voltage change per degree Celsius over the operating range from 0 to 40°C after 30 minutes warm-up.

Drift (Stability):

All Outputs: Less than 0.1% +10mV (dc to 20Hz) during 8 hours at constant line, load, and ambient after an initial warm-up time of 30 minutes.

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, file claim with carrier immediately. The Hewlett-Packard Sales and Service office should be notified as soon as possible.

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. Before applying power to the instrument, see the CAUTION notice in paragraph 3-11.

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 rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 40°C (up to 55°C with derating).

2-11 Outline Diagram

2-12 Figure 2-1 illustrates the outline shape and dimensions of this supply.

2-13 Rack Mounting

2-14 One or two 6235A's may be mounted in a standard 19-inch rack panel using rack mounting tray HP Part No. 14522A. Installation consists of bolting the rack mounting tray to the 19-inch rack and sliding the power supply(s) into the slot(s) provided in the tray. The power supply's rubber feet are seated in holes in the bottom of the tray.

2-15 Input Power Requirements

2-16 The supply may be operated continuously from a nominal 120V or 240V (47-63Hz) single phase power source. The supply is shipped from the factory ready to be operated from one of these power sources. A label on the rear heatsink identifies the line voltage option of your supply. The input voltage range and input current required for each of the nominal inputs are listed below. The maximum input power (high line, full load conditions) required for either input is 35 watts.

Option	Line Voltage Range	Maximum Input Current
Standard (120Vac)	104-127Vac	.26A
028 (240Vac)	208-250Vac	.14A

2-17 If desired, the user can convert the unit from one option to another by following the instructions in paragraph **3-13.** A unit is converted by resetting an internal line voltage selector switch, replacing the fuse and line cord plug, and changing the line voltage label.

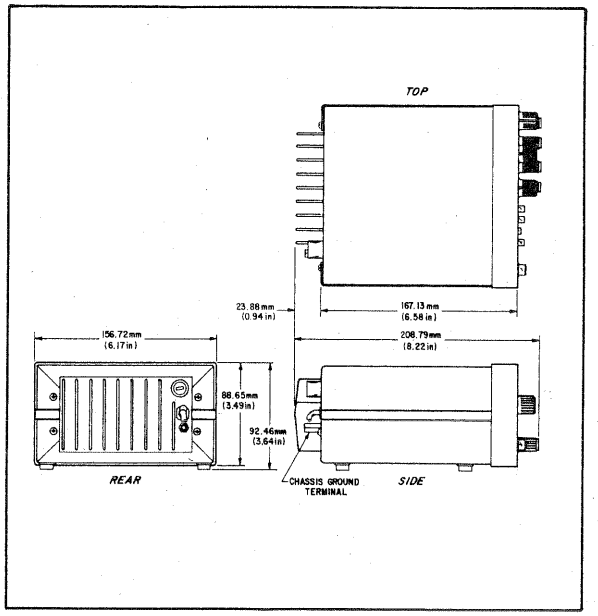

Figure 2-1. Outline Diagram

2-18 Power Cable

2-19 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. In no event shall this instrument be operated without an adequate cabinet ground connection.

2-20 To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter (if permitted by local regulations) and connect the green lead on the adapter to ground.

2-21 Model 6235A is equipped at the factory with a power cord plug appropriate for the user's location. Figure 2-2 illustrates the standard configuration of power cord plugs used by HP. Below each drawing is the HP Part Number for a replacement power cord equipped with a plug of that configuration. Notify the nearest HP Sales Office if you require a different power cord.

2-22 REPACKAGING FOR SHIPMENT

2-23 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 and provide the Authorized Return label necessary to expedite the handling of your instrument return. 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.

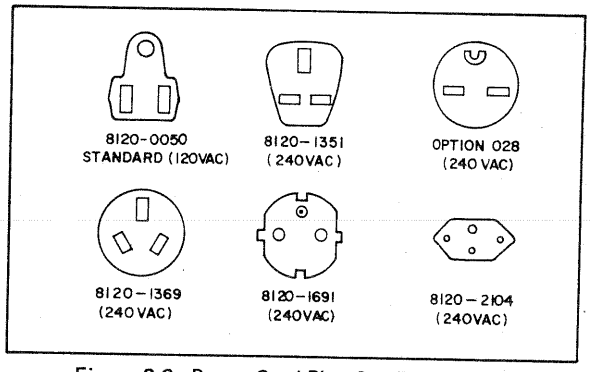

Figure 2-2. Power Cord Plug Configurations

SECTION III
OPERATING INSTRUCTIONS

3-1 INTRODUCTION

3-2 This section describes the operating controls and indicators, turn-on checkout procedures, and other operating considerations for the Model 6235A Triple Output Power Supply.

WARNING

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Only fuses with the required rated current and specified type should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

3-3 CONTROLS AND INDICATORS

3-4 Line Switch

3-5 The LINE pushbutton switch (item (1) , Figure 3-1) is pushed-in to turn the supply ON and released (out position) to turn the supply OFF. A simulated (non-electrical) ON indicator (within the pushbutton) "lights" when the button is pushed-in whether or not power is applied to the unit.

3-6 Voltage and Current Metering

3-7 Four meter select pushbutton switches (items (2) and (3)) permit the output voltage or current of any one supply (+6V, +18V, or −18V) to be monitored on the VOLTS/AMPS meter (4) . The V/A pushbutton (2) selects either voltage (out position) or current (in position). The +6, +18, and −18 output select pushbuttons (3) connect the desired output to the metering circuit when the applicable button is pushed-in. The three output select pushbuttons are mechanically interlocked so that only one can be pushed-in at a time. The voltmeter and ammeter ranges selected by the +6, +18, and −18 pushbuttons are listed below. The shaded areas on the meter scales indicate the amount of output voltage or current that may be available in excess of the normal rating.

OUTPUT	METER RANGES	
	VOLTS	AMPS
+6V	0-7	0-1.2
+18V	0-21	0-0.24
−18V	0-21	0-0.24

3-8 Voltage Controls

3-9 The +6 VOLTAGE control (5) sets the output voltage level of the +6V supply and the ±18 control (6) sets the output voltage levels of the dual tracking ±18V supplies. Precise tracking of the +18V and −18V outputs is achieved by controlling the positive output and using it as a reference voltage for the negative supply. The TRACK VOLTAGE control (7) sets the ratio between the −18V and +18V output voltages. Once the ratio is set, the +18 VOLTAGE control will control both outputs with a constant ratio maintained between the two outputs. The voltage controls (cermet potentiometers) have infinite resolution; thus, the resolution obtained depends only upon the user's care in setting the controls. Greater accuracy in setting the controls can be achieved by using a DVM to measure the outputs.

3-10 TURN-ON CHECKOUT PROCEDURES

3-11 The following steps describe the use of the Model 6235A front panel controls and indicators illustrated in Figure 3-1 and serve as a brief check that the supply is operational. Follow this checkout procedure or the more detailed performance test of paragraph 5-6 when the instrument is received and before it is connected to any load equipment. Proceed to the more detailed performance test beginning in paragraph 5-6 if any difficulties are encountered.

CAUTION

Before the supply is switched on, check the label on the heat sink to make certain that the supply's line voltage option agrees with the line voltage to be used. The supply will be damaged if its internal switch is set for a 120Vac input and 240Vac input power is applied.

a. Connect line cord to power source and push LINE switch (1) in.

b. Set meter select switches (2) , (3) to monitor

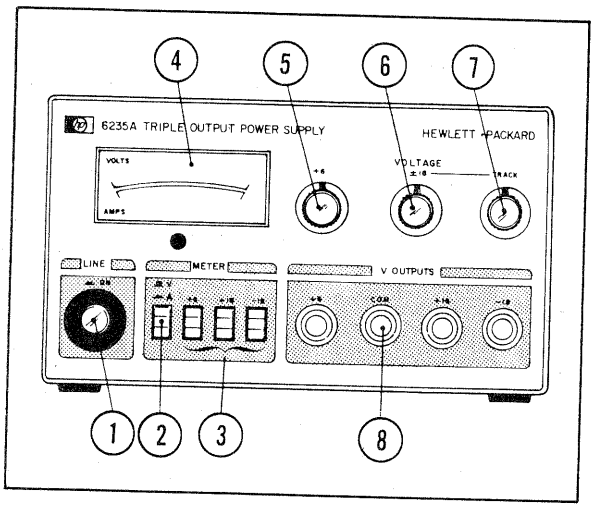

Figure 3-1. Controls and Indicators

+6V supply's output voltage. With no load connected, vary the +6 VOLTAGE control (5) over its range and check that the voltmeter (4) responds to the control setting.

c. Monitor the +18V supply's output voltage. With no load connected, vary the ±18 VOLTAGE control (6) over its range and check that the voltmeter responds to the control setting.

d. Monitor the −18V supply's output voltage. Turn TRACK VOLTAGE (7) control fully clockwise. With no load connected, vary the ±18 VOLTAGE control (6) over its range and check that the voltmeter responds to the control setting.

e. Monitor the +18V output and adjust ±18 VOLTAGE control for +18V indication on voltmeter. Monitor the −18V output and check the effect of the TRACK VOLTAGE control on the voltage of the −18V output. The −18V output should be adjustable from less than 0.5 volts to a maximum of 18 to 21 volts as the TRACK control is rotated from its fully CCW to its fully CW position.

f. Turn the +6, ±18, and TRACK VOLTAGE controls fully CW. Connect ammeter (e. g. Simpson Multimeter, Model 269), in turn, between each output and COM. The internal resistance of the meter is low enough to overload the supply so that the output will current limit. Verify that the current limit circuit in each supply is limiting the output current to:

Supply	Current Limit
+6V	1.275A ±15%
+18V	0.255A ±15%
−18V	0.255A ±15%

g. Remove meter and connect loads to the output terminals (see paragraph 3-23).

3-12 If this brief checkout procedure or later use of the supply reveals a possible malfunction, see Section V of this manual for detailed test, troubleshooting, and adjustment procedures.

3-13 LINE VOLTAGE OPTION CONVERSION

3-14 To convert the supply from one line voltage option to the other, proceed as follows:

1. Disconnect line cord from the power source.
2. Remove top cover from supply by removing 2 screws in rear of supply and sliding cover to the rear. The line voltage selector switch (S2) is mounted on the circuit board behind the meter.
3. Set S2 to the desired position (see Figure 3-2). The forward switch position (toward front panel) selects 120Vac input and the rear switch position (toward heat sink) selects the 240Vac input.
4. Check the rating of the installed fuse and replace it with correct value, if necessary. For 120Vac input, use a 0.4A slo-blow fuse (HP Part No. 2110-0340). For 240Vac input, use a 0.2A slo-blow fuse (HP Part No. 2110-0235).
5. Install proper line cord and plug (see paragraph 2-21).
6. Mark the supply clearly with a tag or label indicating the correct line voltage to be used.

3-15 OPERATION

3-16 This power supply can be operated individually or in parallel with another supply (see paragraph 3-27). All output terminals are isolated from chassis ground. The +6V and ±18V outputs use a single common output terminal (8) This common (COM) terminal or any one of the other output terminals may be grounded to the chassis ground terminal which is located on the supply's rear heat sink. All outputs may also be left floating. Loads can be connected separately between each of the 0 to 18V output terminals and the COM terminal, or between the +18V and −18V terminals for a 0 to 36V output. A single load can also be connected between the +6V and −18V terminals for a 0 to 24V output.

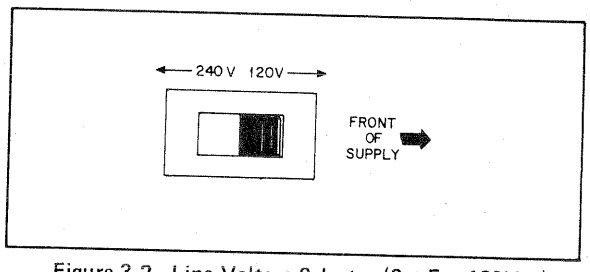

Figure 3-2. Line Voltage Selector (Set For 120Vac)

3-17 Tracking Ratio

3-18 The TRACK VOLTAGE control can be used to set a 1:1 ratio so that the voltage of the −18V supply tracks that of the +18V supply within 1% for convenience in varying the symmetrical voltages needed by operational amplifiers and other circuits using balanced positive and negative inputs. The TRACK control can also be used to set the negative supply's output from a minimum of less than 0.5 volts to a maximum equal to the +18V supply's output. Once the ratio is set, the ±18 VOLTAGE control will control both output and maintain a constant ratio between their voltages. To set the ratio between the −18V and +18V outputs, proceed as follows:

NOTE

Any accidental movement or mechanical vibration can vary the tracking ratio setting. Greater accuracy in setting the controls can be achieved by using a DVM to measure the ±18V outputs.

a. Set the 0 to +18V supply's output to the desired value using the ±18 VOLTAGE control.

b. Set the 0 to −18V supply's output to the desired value (equal to or lower than the magnitude of the +18V supply's output) using the TRACK VOLTAGE control.

3-19 Overcurrent Protection

3-20 All three outputs are individually protected against overload or short-circuit damage by separate current limiting circuits. The circuits for the +18V and −18V supplies are factory adjusted to limit the output current to 0.255A ±15%. The circuit for the +6V supply is factory adjusted to limit the output current to 1.275A ±15%. The current limits are set by adjusting resistors R3 in the +18V, R13 in the −18V and R23 in the +6V supply. (See paragraph 5-47 for current limit calibration procedures). No deterioration of a supply's performance occurs if the output current remains below the current limit setting. If a single load is connected between the +18V and −18V outputs, the circuit set for the lesser current limit will limit the output.

3-21 Operation Beyond Rated Output

3-22 The supply may be able to provide voltages and currents greater than its rated maximum outputs if the line voltage is at or above its nominal value. Operation can extend into the shaded areas on the meter faces without damage to the supply, but performance specifications cannot be guaranteed.

3-23 Connecting Loads

3-24 Connect each load to the power supply output terminals using separate pairs of connecting wires. This minimizes mutual coupling between loads and takes full advantage of the low output impedance of the supply. Load wires must be of adequately heavy gauge to maintain satisfactory regulation at the load. Make each pair of connecting wires as short as possible and twist or shield them to reduce noise pick-up. If shielded wire is used, connect one end of the shield to the power supply ground terminal and leave the other end unconnected. The 6235A's chassis ground terminal is located on the rear of the supply.

3-25 If load considerations require locating output power distribution terminals at a distance from the power supply, then the power supply output terminals should be connected to the remote distribution terminals by a pair of twisted or shielded wires and each load should be connected to the remote distribution terminals separately.

3-26 Parallel Operation

3-27 Two or more power supplies can be connected in parallel to obtain a total output current greater than that available from one supply. The total output current is the sum of the output currents of the individual supplies. The output voltage controls of one power supply should be set to the desired output voltage, and the other supply set for a slightly larger output voltage. The supply set to the lower output voltage will act as a constant voltage source, while the supply set to the higher output will act as a current-limited source, dropping its output voltage until it equals that of the other supply. The constant voltage source will deliver only that fraction of its rated output current necessary to fulfill the total current demand.

3-28 Special Operating Considerations

3-29 Pulse Loading. The power supply will automatically cross over from constant-voltage to current-limit operation in response to an increase in the output current over the preset limit. Although the preset limit may be set higher than the average output current, high peak currents as occur in pulse loading may exceed the preset current limit and cause crossover to occur and degrade performance.

3-30 Output Capacitance. 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

load protection provided by the current limiting circuit. A high-current output pulse may damage load components before the average output current is large enough to cause the current limiting circuit to operate.

3-31 Reverse Current Loading. An active load connected to the power supply may actually deliver a reverse current to the supply during a portion of its operating cycle. An external source cannot be allowed to pump current into the supply without risking 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.

3-32 Reverse Voltage Protection. Internal diodes connected with reverse polarity across the output terminals protect the output electrolytic capacitors and the driver transistors from the effects of a reverse voltage applied across a supply output. Since series regulator transistors cannot withstand reverse voltage either, diodes are also connected across them. When operating supplies in parallel, these diodes protect an unenergized supply that is in parallel with an energized supply.

3-33 Output Voltage Overshoot. During turn-on or turn-off of ac power, output plus overshoot will not exceed 1V if the output is set for less than 1V. If the control is set for 1V or higher, there is no overshoot.