



**HP-IB ISOLATED DAC  
POWER SUPPLY PROGRAMMER  
MODEL 59501B**

**OPERATING AND SERVICE MANUAL FOR  
SERIALS 2308A-00101 AND ABOVE**

**\*For Serials above 2308A-00101  
a change page may be included.**

MANUAL CHANGES  
 Models 59501B Power Supply Programmer  
 Manual HP P/N 059501-90004

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.

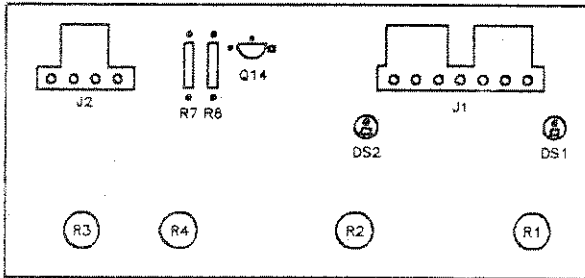
SERIAL		MAKE CHANGES
Prefix	Number	
All 2337A	--- 00550-up	Errata 1

In the replaceable parts list, on page 6-5, add HP Part No. 0960-0444, TQ. 1, MFR. CODE 28480, next to "Power Module on rear panel (includes voltage selection PC Board and Fuse)". On the same page, under Mechanical, change Top shell to HP Part No. 7101-0622 and Bottom shell to HP Part No. 7101-0623.

4/24/84

**CHANGE 1:**

On page 7-3, replace Figure 7-2B with the Figure shown below.



**ERRATA:**

On page 1-1 under ACCESSORIES (continued on page 1-2), change Rack Mounting Kit for one half module width unit from HP P/N 5061-0054 to 5061-0072, Rack Mounting Kit for two half module units from HP P/N 5061-0076 to HP P/N 5061-0074 and Rack Mounting Kit for two units from HP P/N 5061-0055 to HP P/N 5061-0071.

On page 1-3, in table 1-1, add the following specification;

PARD (ripple and noise):  
 2mV rms/10mV p-p

## SECTION I GENERAL INFORMATION

### 1-1 INTRODUCTION

1-2 This instruction manual contains operating and service instructions for the HP-IB Isolated D/A Power Supply Programmer Model 59501B. Installation instructions and sample programs are also provided. The 59501B allows HP power supplies to be digitally controlled via the Hewlett-Packard Interface Bus (HP-IB) from a calculator, computer, or other controller. The digital format is bit parallel, byte serial, ASCII coded format. The 59501B can also be used on the HP-IB as a digitally programmable low level dc signal source. Since the 59501B can be controlled (programmed) by various control devices such as HP 9800 desk-top computers, hereafter in this manual, the controlling device will be referred to as the "controller", except when specific programming examples are provided.

### 1-3 DESCRIPTION

1-4 The 59501B is basically a digital-to-analog (D/A) converter that provides an output voltage in response to digital data received on the HP-IB. Two programmable output ranges (1V and 10V) are available. In addition, a switch on the rear panel allows selecting either a unipolar or bipolar output mode. The unipolar mode provides a 0 to .999V or a 0 to 9.99V output range and the bipolar mode provides a -1V to +0.998V or a -10V to +9.98V output range. The 59501B's output can be used as a programming voltage for controlling a wide range of dc voltages and currents from HP power supplies or as a source voltage for testing electronic components such as integrated circuit packages (IC's).

1-5 Isolators within the 59501B protect other instrumentation on the HP-IB from damage that could be caused by power supply outputs. Also, an internal circuit ensures that the output is held near zero until programmed data is received. Power supply programming is accomplished through use of the 59501B's programmable output voltage and its front panel adjustments. By making the appropriate connections between the 59501B's rear terminals and the programming terminals on the supply, the output voltage (or current, if available) of the power supply can be programmed from zero to its full rated output. The 59501B's front panel adjustments provide fast and easy calibration of power supply outputs. The ZERO ADJUST

enables the user to correct for small offsets in power supply response to programmed inputs. The POWER SUPPLY FULL SCALE ADJUSTMENT (COARSE and FINE) allows the user to set the maximum output desired from the power supply when the 59501B is programmed to its maximum output. This method of programming is called voltage programming with gain. Power supply programming is described in greater detail in Section III.

1-6 Programming the 59501B is accomplished through the transmission of four consecutive digits (four ASCII characters). The first digit specifies output range and the next three digits specify the magnitude within the selected range. The high/low range capability provides a ten to one improvement in resolution. Internal conversion circuitry enables the 59501B to produce its maximum output voltage in approximately 250 $\mu$ sec from the time the digital data is received. Output current up to 10 milliamps is available and is automatically limited to protect the 59501B and the user equipment.

### 1-7 HP-IB CAPABILITIES

1-8 The 59501B has "listener" and "acceptor handshake" HP-IB functional capabilities. The LISTENING indicator on the front panel provides a convenient means of monitoring the 59501B's operating status. The 59501B does not have: controller, talker, source handshake, service request, device trigger, extended listener, extended talker, parallel poll, and remote/local HP-IB functional capabilities. All HP-IB functional capabilities are described in IEEE Standard 488-1975.

### 1-9 SPECIFICATIONS

1-10 Detailed specifications for the 59501B are given in Table 1-1.

### 1-11 ACCESSORIES

1-12 The System-II cabinet accessories listed below may be ordered with the 59501B unit or separately from your local Hewlett-Packard field sales office (refer to list at rear of manual for addresses). All accessories applicable to System-II modular cabinets are fully described and illustrated in the Hewlett-Packard Electronic Instruments and Systems catalog.

<u>HP Part No.</u>	<u>Description</u>
5061-0088	Two front handles that attach to each side of 3 1/2" high cabinets.
5061-0094	Kit of lock link hardware for joining together cabinets of equal depth. Units can be joined side-by-side or vertically. This kit is required whenever two (or more) sub-module units are to be rack mounted side-by-side.
1460-1345	Tilt stand snaps into standard foot supplied with instrument — must be used in pairs.
5061-0054	Rack mounting kit for one half module width unit, 3 1/2-inches high. Includes one rack flange (ear) and one half module width extension panel (adapter).
5061-0076	Rack mounting kit for two half module units, 3 1/2" high. Kit includes two rack flanges (ears). Also, lock-together kit (5061-0094) is required for joining the two units together. The cabinets must also be of equal depth.
5061-0055	Rack mounting kit for two units (one half module width and one quarter module width). Kit includes one rack flange and one quarter width extension adapter. Lock-together kit (5061-0094) is required for joining the two units.
5061-0096	Support shelf for mounting one or more 3 1/2" high units which are half module or quarter module width. Cabinet depths need not be equal.
5061-2021	Front filler panel (one quarter module width) for 3 1/2" high support shelf.
5061-2022	Front filler panel (one half module width) for 3 1/2" high support shelf.
1494-0015	Slide kit for support shelves mounted in HP rack enclosures.

## 1-13 INSTRUMENT AND MANUAL IDENTIFICATION

1-14 Hewlett-Packard instruments 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 instrument serial number; a different sequential number is assigned to each instrument, starting with 00101.

1-15 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 of Manual Backdating Changes define the difference between your instrument and the instrument described by this manual.

## 1-16 ORDERING ADDITIONAL MANUALS

1-17 One manual is shipped with each instrument. Additional manuals may be purchased 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.

## 1-18 RELATED DOCUMENTATION

1-19 In addition to this manual, the unit is shipped with Programming Note 59501A/HP85-1 (HP Part No. 59501-90003). This note also applies to the 59501B in all respects and provides programming examples for use with the HP85 or other BASIC language controllers, as well as CV/CC Programming Connections between the 59501A and various HP Power Supplies. This information supplements the programming examples for the 9825 given in Section III of this manual.

Table 1-1. Specifications, Model 59501A

D/A CONVERTER		POWER SUPPLY PROGRAMMING																			
<p><b>DC Output Voltage:</b> Programmable in high or low ranges within the voltage limits shown below. Output mode is unipolar or bipolar and is selectable via rear panel switch.</p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>0 to 9.99 Volts</td> <td>0 to +.999 Volts</td> </tr> <tr> <td>Bipolar</td> <td>-10 to +9.98 Volts</td> <td>-1 to +.998 Volts</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	0 to 9.99 Volts	0 to +.999 Volts	Bipolar	-10 to +9.98 Volts	-1 to +.998 Volts	<p><b>Programming Network Specifications:</b> In the following specifications, M represents the calibrated full scale value of the supply being programmed and P represents the actual programmed output. Note that the full scale value (M) can be any value within the supply's output range and is calibrated with the 59501B programmed to its maximum high range output.</p>										
	<u>High</u>	<u>Low</u>																			
Unipolar	0 to 9.99 Volts	0 to +.999 Volts																			
Bipolar	-10 to +9.98 Volts	-1 to +.998 Volts																			
<p><b>DC Output Current:</b> 10mA</p>		<p><b>Accuracy</b> (Does not include power supply errors): Specified at 23°C ± 5°C.</p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>.05%M + .25%P</td> <td>.01%M + .25%P</td> </tr> <tr> <td>Bipolar</td> <td>0.1%M + .25%P</td> <td>.02%M + .25%P</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	.05%M + .25%P	.01%M + .25%P	Bipolar	0.1%M + .25%P	.02%M + .25%P									
	<u>High</u>	<u>Low</u>																			
Unipolar	.05%M + .25%P	.01%M + .25%P																			
Bipolar	0.1%M + .25%P	.02%M + .25%P																			
<p><b>Resolution:</b></p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>10mV</td> <td>1mV</td> </tr> <tr> <td>Bipolar</td> <td>20mV</td> <td>2mV</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	10mV	1mV	Bipolar	20mV	2mV	<p><b>Isolation:</b> 600Vdc between HP-1B data lines and output terminals.</p>										
	<u>High</u>	<u>Low</u>																			
Unipolar	10mV	1mV																			
Bipolar	20mV	2mV																			
<p><b>Accuracy:</b> Specified at 23°C ± 5°C</p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>.1% + 5mV</td> <td>.1% + 1mV</td> </tr> <tr> <td>Bipolar</td> <td>.1% + 10mV</td> <td>.1% + 2mV</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	.1% + 5mV	.1% + 1mV	Bipolar	.1% + 10mV	.1% + 2mV	<p><b>Temperature Coefficient:</b></p> <table border="0"> <tr> <td>High</td> <td>.005%M/°C + .015%P/°C</td> </tr> <tr> <td>Low</td> <td>.01%M/°C + .015%P/°C</td> </tr> </table>		High	.005%M/°C + .015%P/°C	Low	.01%M/°C + .015%P/°C					
	<u>High</u>	<u>Low</u>																			
Unipolar	.1% + 5mV	.1% + 1mV																			
Bipolar	.1% + 10mV	.1% + 2mV																			
High	.005%M/°C + .015%P/°C																				
Low	.01%M/°C + .015%P/°C																				
<p>* <b>Stability:</b> Change in output over 8 hour interval under constant line, load, and ambient following a 30 minute warm-up.</p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>.04% + .5mV</td> <td>.04% + .1mV</td> </tr> <tr> <td>Bipolar</td> <td>.04% + 1mV</td> <td>.04% + .2mV</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	.04% + .5mV	.04% + .1mV	Bipolar	.04% + 1mV	.04% + .2mV	<p><b>Programming Resolution:</b></p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>0.1%M</td> <td>0.01%M</td> </tr> <tr> <td>Bipolar</td> <td>0.2%M</td> <td>0.02%M</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	0.1%M	0.01%M	Bipolar	0.2%M	0.02%M
	<u>High</u>	<u>Low</u>																			
Unipolar	.04% + .5mV	.04% + .1mV																			
Bipolar	.04% + 1mV	.04% + .2mV																			
	<u>High</u>	<u>Low</u>																			
Unipolar	0.1%M	0.01%M																			
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<p><b>Temperature Coefficient:</b></p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>High</u></td> <td style="text-align: center;"><u>Low</u></td> </tr> <tr> <td>Unipolar</td> <td>.01%/°C + .5mV/°C</td> <td>.01%/°C + .1mV/°C</td> </tr> <tr> <td>Bipolar</td> <td>.01%/°C + .5mV/°C</td> <td>.01%/°C + .1mV/°C</td> </tr> </table>			<u>High</u>	<u>Low</u>	Unipolar	.01%/°C + .5mV/°C	.01%/°C + .1mV/°C	Bipolar	.01%/°C + .5mV/°C	.01%/°C + .1mV/°C	<p><b>Programming Speed:</b> D/A Conversion Time plus the programming speed of the power supply.</p>										
	<u>High</u>	<u>Low</u>																			
Unipolar	.01%/°C + .5mV/°C	.01%/°C + .1mV/°C																			
Bipolar	.01%/°C + .5mV/°C	.01%/°C + .1mV/°C																			
<p><b>Zero Adjust:</b> Plus or minus 250 millivolts.</p>		<p><b>GENERAL</b></p>																			
<p><b>D/A Full Scale Adjust:</b> Plus or minus 5%.</p>		<p><b>Input Power:</b> Unit has ac power module which is settable to: 100/120/220/240Vac (-13%, +6%), 48-63Hz, 10VA. A 3-wire detachable line cord is supplied.</p>																			
<p><b>Programming Speed:</b> The time required for output to go from zero to 99% of programmed output change is 250μsec (measured with resistive load connected to output terminals).</p>		<p><b>Temperature Range:</b></p> <table border="0"> <tr> <td>Operating:</td> <td>0 to 55°C</td> </tr> <tr> <td>Storage:</td> <td>-40 to 75°C</td> </tr> </table>		Operating:	0 to 55°C	Storage:	-40 to 75°C														
Operating:	0 to 55°C																				
Storage:	-40 to 75°C																				
<p>* Stability is included in accuracy specification measurements over the temperature range indicated.</p>		<p><b>Dimensions:</b> (See Figure 2-1)</p>																			
		<p><b>Weight:</b></p> <table border="0"> <tr> <td>Net:</td> <td>1.82 kg. (4 lb.)</td> </tr> <tr> <td>Shipping:</td> <td>2.27 kg. (5 lb.)</td> </tr> </table>		Net:	1.82 kg. (4 lb.)	Shipping:	2.27 kg. (5 lb.)														
Net:	1.82 kg. (4 lb.)																				
Shipping:	2.27 kg. (5 lb.)																				

## 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 received, proceed as instructed in the following paragraphs.

### 2-3 Mechanical Check

2-4 If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken switches or connectors, and dents or scratches on the panel surfaces. If the instrument is damaged, file a claim with the carrier's agent and notify your local Hewlett-Packard Sales and Service Office as soon as possible (see list at rear of this manual for addresses).

### 2-5 Electrical Check

2-6 Check the electrical performance of the instrument as soon as possible after receipt. Section V of this manual contains procedures which will verify instrument operation on the HP-IB. These procedures are also suitable for incoming quality control inspection. Refer to the inside front cover of the manual for the Certification and Warranty statements.

### 2-7 REPACKAGING FOR SHIPMENT

2-8 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 specifying the owner, model number, full serial number, and service required, or a brief description of the trouble.

### 2-9 INSTALLATION DATA

2-10 The 59501B is shipped ready for operation on the

HP-IB. Before connecting it to a controller and applying power, read paragraph 2-26.

### 2-11 Outline Drawing

2-12 Figure 2-1 illustrates the outline shape and dimensions of Model 59501A.

### 2-13 Rack Mounting

2-14 The 59501B can be rack mounted in a standard 19-inch rack panel either by itself or alongside another half (or quarter) System-II module of equal height and depth. All rack mounting accessories for this unit are listed in paragraph 1-11. Also, complete installation instructions are included with each rack mounting kit.

### 2-15 Equipment Required

2-16 If an HP controller is used to program the 59501B, the following equipment is required:

HP Controller	HP-IB Interface Card	ROM
85A, 86A, 87A	82937A HP-IB I/O	
9825A	98034A HP-IB I/O	General I/O Extended I/O
9816A, 9826A, 9836A	(Standard)	(Standard)

### 2-17 HP-IB Connector

2-19 The HP-IB connector on the rear of the 59501B interfaces directly to the HP-IB. Figure 2-2 illustrates the pin configuration of the HP-IB connector which is a 24-pin,

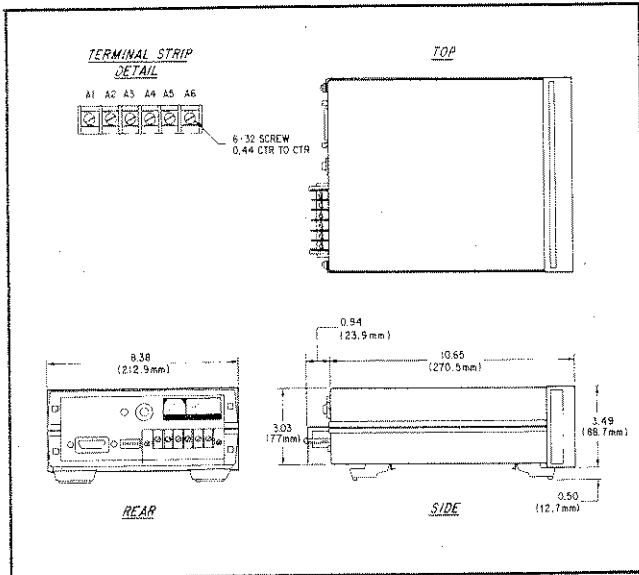


Figure 2-1. 59501B Outline Drawing

type 57 micro-ribbon connector. One HP-IB cable is supplied with each HP computer and calculator I/O card package. Extra cables may be ordered separately.

HP-IB Cable Model No.	Cable Length
10631A	1m (3.3 ft.)
10631B	2m (6.6 ft.)
10631C	4m (13.2 ft.)

**NOTE**

The HP-IB connector supplied with this unit contains metric fasteners (colored black). If your HP-IB cable connector contains standard mating screws (silver), make a conversion using the hardware and instructions included in Metric Conversion Kit (5060-0138).

2-19 The HP-IB cables use the same piggyback connector on both ends. Up to three connectors may be stacked one upon another. As many as 15 instruments (including the controller) may be connected to the same HP-IB.

**2-20 System Connections**

2-21 Figure 2-3 illustrates a controller (e. g., a 9825A calculator) and a 59501B unit connected to the HP-IB. In this case, the 98034A interface card provides HP-IB capability for the 9825A calculator and is installed in any one of the three slots in the rear of the calculator. The 98034A card is equipped with the proper cable and connector to mate with the HP-IB connector on the rear of the 59501B. Note that specific connections between the 59501B's output terminals and the user's device (e.g. programmable power supply)

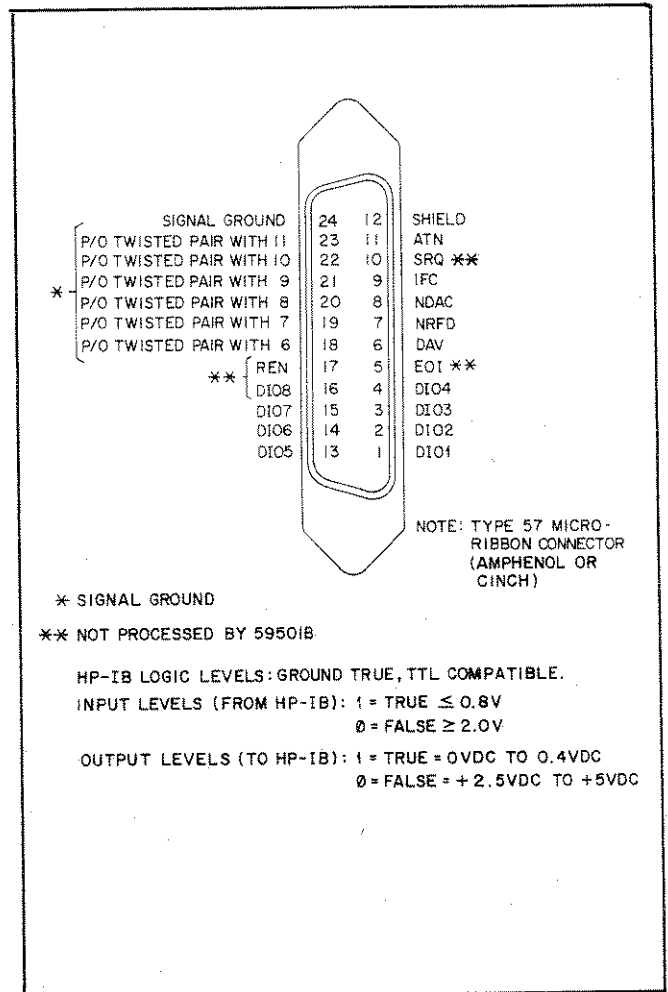


Figure 2-2. HP-IB Connector

are not illustrated on Figure 2-3. These connections depend upon the particular power supply being programmed and the type of control desired (output voltage or current). The connections required to program various HP power supplies are provided in Section III, paragraph 3-43 through 3-50.

**2-22 Setting Addresses**

2-23 The listen address for the 59501B is selected by address switches on the rear of the unit. The switches are factory set to the suggested listen address of & when the unit is shipped from the factory. As shown in Figure 2-4, there are seven address switches. The last two switches, 6 and 7 (XX), are ignored (have no affect). Switches 1, 4, and 5 are set to "0" and switches 2 and 3 are set to "1" to select a listen address of "&". Note that "&" is the suggested listen address and is one of 31 listen address possibilities. The address switch settings for each of the 31 listen address possibilities are listen in Table 2-1.

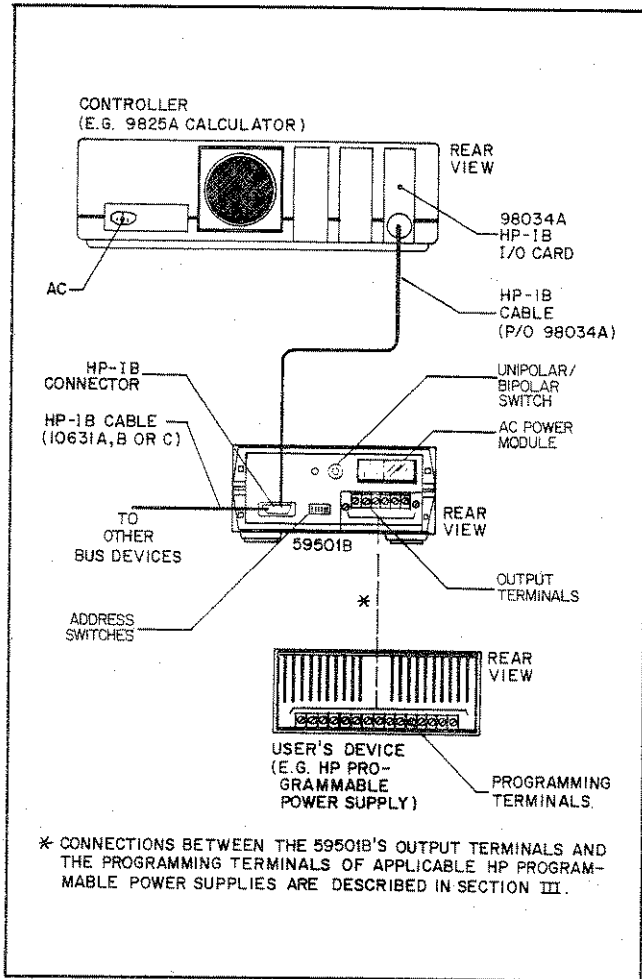


Figure 2-3. System Connections

2-24 The HP-IB bus interface cards for the HP calculators are shipped from the factory with a preset talk address of "U" and a preset listen address of "5". Before programming, write down the listen and/or talk address of all instruments connected to the HP-IB.

### 2-25 Unipolar/Bipolar Mode Switch

2-26 The UNIPOLAR/BIPOLAR mode switch is a push-in, push-out type switch located on the rear of the unit beneath the output terminal strip. In the UNIPOLAR mode (switch is in), the 59501B provides an output range of 0 to 0.999V or 0 to 9.99V. In the BIPOLAR mode (switch is out), the 59501B provides an output range of -1V to +0.998V or -10V to +9.998V. The switch is set to UNIPOLAR when the unit is shipped from the factory.

### 2-27 Input Power Requirements And Line Voltage Conversion

2-28 The 59501B may be operated continuously from a nominal 100V, 120V, 220V, or 240V (48-63Hz) power

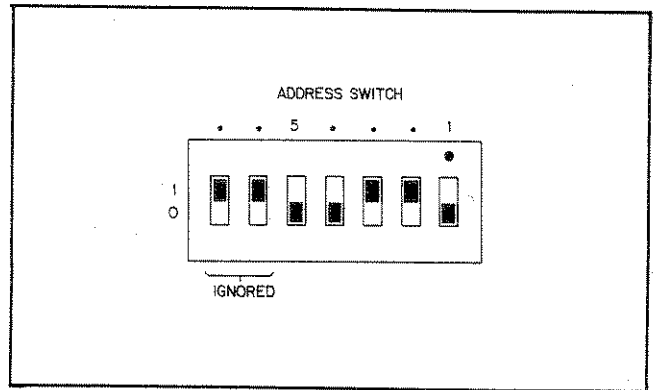


Figure 2-4. Listen Address Switches on Rear of 59501B

Table 2-1. Listen Addresses and Switch Settings

Address Switches					Listen Address Character
5	4	3	2	1	
0	0	0	0	0	SP
0	0	0	0	1	!
0	0	0	1	0	"
0	0	0	1	1	#
0	0	1	0	0	\$
0	0	1	0	1	%
0	0	1	1	0	&
0	0	1	1	1	'
0	1	0	0	0	(
0	1	0	0	1	)
0	1	0	1	0	*
0	1	0	1	1	+
0	1	1	0	0	,
0	1	1	0	1	-
0	1	1	1	0	.
0	1	1	1	1	/
1	0	0	0	0	@
1	0	0	0	1	1
1	0	0	1	0	2
1	0	0	1	1	3
1	0	1	0	0	4
1	0	1	0	1	5
1	0	1	1	0	6
1	0	1	1	1	7
1	1	0	0	0	8
1	1	0	0	1	9
1	1	0	1	0	:
1	1	0	1	1	;
1	1	1	0	0	<
1	1	1	0	1	=
1	1	1	1	0	>



source. A printed circuit board located within the ac power module on the rear panel selects the power source. Voltage choices are available on both sides of the PC board. Before connecting the instrument to the power source, check that the PC board selection matches the nominal line voltage of the source. The operating voltage that is selected is the one printed on the lower-left side of the PC board (see Figure 2-5). As shipped from the factory, the PC board in this unit is positioned for 120Vac operation. To select another input voltage proceed as follows:

- a. Remove power cable from instrument.
- b. Move plastic door on power module aside.
- c. Rotate FUSE PULL to the left and remove line fuse F1.
- d. Remove PC board from slot. Select operating voltage by orienting PC board to position the desired voltage on top-left side of PC board. Push board firmly into slot.
- e. Rotate FUSE PULL back into normal position and re-insert fuse F1 in holder using caution to select the correct value for F1 (125mA for 100V or 120V and 62.5mA slo-blo for 220V or 240V).
- f. Close plastic door and connect power cable.

2-29 When the instrument leaves the factory, a 125mA fuse is installed for 120V operation. An envelope containing a 62.5mA fuse for 220V/240V operation is attached to the instrument. Make sure that the correct fuse value for F1 is installed if the position of the PC board is changed.

### 2-30 Power Cable

2-31 This unit is factory equipped with a power cord plug that is the most appropriate for the user's location.

The replaceable parts section of this manual lists all of the power cords associated with this unit. If a different power cord is desired, contact your nearest HP Sales Office.

2-32 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.

2-33 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.

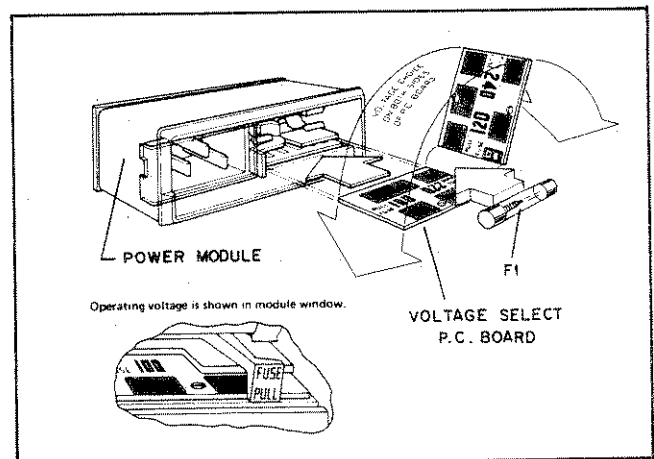


Figure 2-5. Line Voltage Conversion

## SECTION III OPERATING INSTRUCTIONS

### 3-1 INTRODUCTION

3-2 This section contains operating instructions and programming information for the 59501B Isolated DAC, Power Supply programmer. Since the 59501B can be used as a power supply programmer or as D/A converter (low level dc signal source), operating instructions and programming examples are provided to cover both applications. Additional information regarding use of the 59501B is provided in HP-IB/Power Supply Application Guide, HP Part No. 5952-3990.

### 3-3 PRE-OPERATIONAL CONSIDERATIONS

3-4 Before connecting the 59501B to an ac power source, ensure that the proper operating voltage (100, 120, 220, or 240Vac) has been selected and the proper fuse is installed (see paragraph 2-27). Also, check that the address switches are set correctly, the UNIPOLAR/BIPOLAR mode switch is set to the desired position, and all HP-IB system cabling is installed (see paragraphs 2-20 through 2-26). Connections between the 59501B and the user's device (e. g. HP Power Supply) are described in subsequent paragraphs.

### 3-5 CONTROLS AND INDICATORS

#### 3-6 Front Panel

3-7 The 59501B front panel contains a power on indicator, a status indicator and four controls (screwdriver adjustments) as shown in Figure 3-1.

3-8 The power on (ON) indicator ① (Figure 3-1) lights and the 59501B's internal supply voltages (+15V,  $\pm 15V$ ,  $V_{DD}$ ) are present when the line cord is plugged-in.

3-9 The LISTENING indicator ② lights when the 59501B is addressed to "listen" and remains lighted until an "unlisten" command or the interface clear signal is received from the controller. When lighted, it indicates that the 59501B is enabled to process data words received on the HP-IB. When it is not lighted, it indicates that the 59501B is inhibited from processing data words.

3-10 The front panel screwdriver adjustments allow fast and easy calibration of D/A and power supply outputs. Each adjustment is described below.

3-11 The ZERO ADJUST ③ allows the 59501B output to be adjusted to  $0V \pm 250$  millivolts when it is programmed to zero output. It can also be used to correct for small offsets in power supply response to programmed inputs when the 59501B is used as a power supply programmer.

3-12 The D/A FULL SCALE ADJUST ④ allows the 59501B output to be adjusted to maximum ( $\pm 5\%$ ) when it is programmed to maximum. For example, if the 59501B is programmed to its maximum unipolar output in the high range, the D/A FULL SCALE ADJUST is normally used to set the output to 9.99V. However, it can also be used to set the output between 9.49V and 10.49V (i. e.  $9.99V \pm 5\%$ ). The D/A FULL SCALE ADJUST is used when the 59501B is employed as a D/A (see paragraphs 3-73 through 3-80). When the 59501B is used as a power supply programmer, the POWER SUPPLY FULL SCALE ADJUST controls are utilized to set the power supply's output.

3-13 The POWER SUPPLY FULL SCALE ADJUST controls (COARSE and FINE) ⑤ enable the user to set the maximum output desired from the power supply when the 59501B is programmed to its maximum value. These adjustments can be used to calibrate the output of a power supply to its maximum rated output or to any lower value. For example, a 40Vdc power supply's output could be set to 20V when the 59501B is programmed to its maximum value. In this case, all 999 programming steps are utilized in programming the supply from 0 to 20V with a resolution of 20mV (approx.). Calibration of power supply outputs is described in paragraph 3-51 through 3-57.

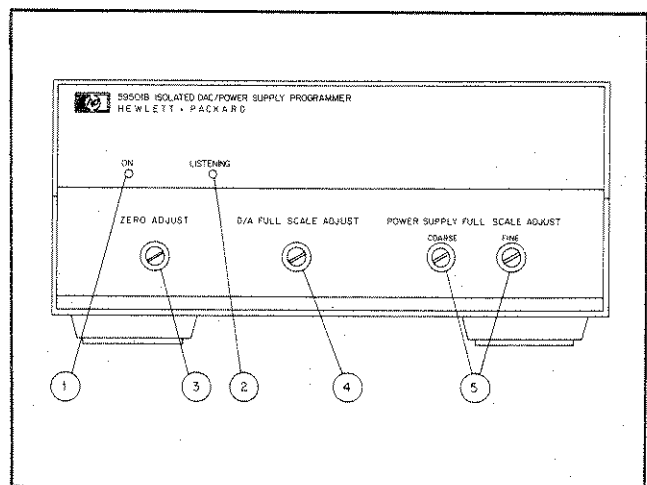


Figure 3-1. 59501B Front Panel

### 3-14 Rear Panel

3-15 The 59501B rear panel contains the HP-IB connector, the ADDRESS switches, the UNIPOLAR/BIPOLAR mode switch, the ac power module, and the output terminal strip as shown in Figure 3-2.

- HP-IB connector — Interfaces directly to HP-IB (paragraph 2-17).
- ADDRESS switches — Select "listen" address of 59501B (paragraph 2-22).
- UNIPOLAR/BIPOLAR switch — Selects either the unipolar or bipolar output mode (paragraph 2-25).
- Ac Power Module — Contains fuse and ac input voltage select PC board (paragraph 2-27).

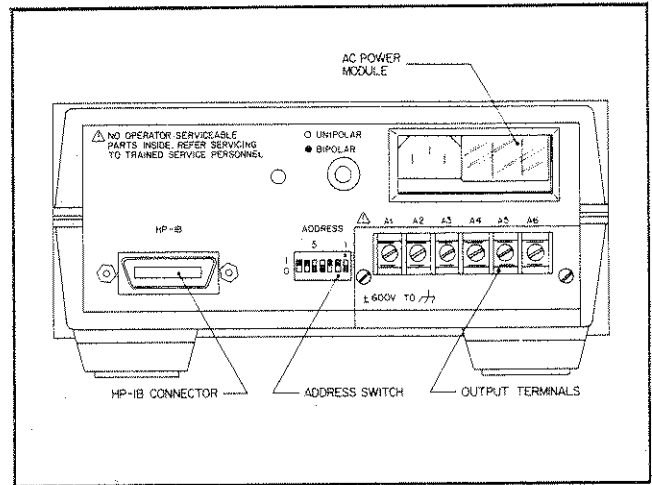


Figure 3-2. 59501B Rear Panel

3-16 The 59501B is interfaced with the user's device via the output terminal strip. Output terminals A1 and A2 allow access to the 59501B's D/A output while terminals A3 through A5 allow access to the power supply programming network. Figure 3-3 illustrates the connections required to program the output voltage of a typical HP power supply. In this case, a jumper is connected between terminals A2 and A3, and terminals A1, A4, and A5 are connected to the voltage programming terminals of the power supply. The method of programming and the connections required to program the output voltage or current of various HP supplies are described in paragraphs 3-35 through 3-72. When the 59501B is used as a low level dc signal source, only terminals A1 and A2 are connected to the user's device. Programming instructions for this application are given in paragraphs 3-73 through 3-80.

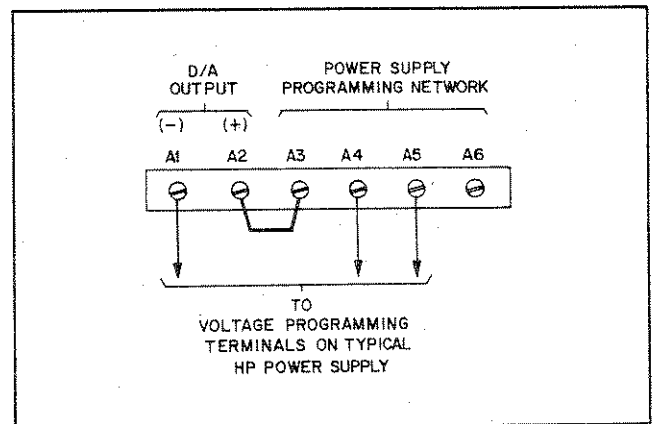
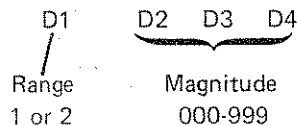


Figure 3-3. Rear Terminal Strip, Typical Connections

### 3-17 PROGRAMMING FUNDAMENTALS

3-18 The unipolar or bipolar output of the 59501B is programmed by a data word comprised of four ASCII characters (digits) received in the order shown below. The first digit specifies range and the next three digits specify the desired output within the selected range. The range digit must be the number 1 to specify low range or the number 2 to specify high range. The magnitude digits can be any number from 000 to 999.



3-19 The 59501B automatically provides an output voltage as soon as the four digits are received. This output is retained until the next four digits are received. The 59501B is programmed by the magnitude digits in BCD to produce the desired output voltage. In the unipolar mode, 000 equals 00.0% of full range, 500 equals 50.0% of full

range, and 999 equals 99.9% of full range. In the bipolar mode, 000 equals the maximum negative voltage output, 500 equals 0V output, and 999 equals the maximum positive voltage output.

### 3-20 Calculating Data Word Values

3-21 The following paragraphs describe the data word value calculations required to program the output of the 59501B. Similar calculations are required when programming power supply outputs using the 59501B. The programmable output range depends, of course, upon the power supply model being programmed. The desired output range of the particular power supply must be calibrated for programming with the 59501B. Power supply calibration procedures and sample programs are described in paragraphs 3-51 through 3-72.

3-22 Data word value calculations for the high (10V) and low (1V) 59501B output ranges are described below. Calculations are provided for both the unipolar and bipolar output modes. Each data word must be exactly four digits

long (one digit for range and three digits for magnitude). If more than four digits are sent to the 59501B, the desired output voltage will not appear at the output.

### 3-23 Unipolar Mode

3-24 Low Range. The desired 59501B output voltage values are from 0 to 0.999V programmable in 999 steps. The resolution in this range is equal to .999V/999, or 1mV per step. To calculate the correct data word value to produce the desired output within this range, proceed as follows:

1. The resolution in the low range is 1mV,  
Let  $D = .001$
2. The range digit is 1 for the low range, so add 1 to the left of the 3 magnitude digits,  
Let  $R = 1000$
3. The magnitude portion (M) is calculated by dividing the desired output voltage (V) by the least significant digit D. The magnitude portion must be rounded off to exactly 3 digits,  
 $M = \text{INT} (V/D + 0.5) = 3$  magnitude digits
4. Combine range and rounded off magnitude portion to obtain the correct data word value (N),  
 $N = R + M$

Example, desired voltage = 0.5123V

$$D = .001$$

$$R = 1000$$

$$M = \text{INT} (0.5123/.001 + 0.5)$$

$$M = \text{INT} (512.8)$$

$$N = 1000 + 512$$

$$N = 1512 = \text{data word value}$$

In this example, the desired output voltage is 0.5123 volts but the actual output is 0.512V because the resolution is 1mV (least significant digit equals .001):

$$V = M \times D$$

$$V = 512 \times .001$$

$$V = 0.512$$

3-25 High Range. The desired 59501B output voltage values are from 0 to 9.99V. The calculations are the same as for the low range, except resolution is 10mV and the high range is used. For the high range,

$$\text{Let } D = .01$$

$$\text{and } R = 2000$$

### 3-26 Bipolar Mode

3-27 Low Range. The desired 59501B output voltage values are from -1V to +0.998V programmable in 999 steps. For a -1V output, the magnitude digits are 000 and for a +0.998V output, the magnitude digits are 999. A 0V output is obtained when the magnitude digits are 500. Resolution in this range is equal to 1.998/999, or 2mV. To calculate the correct data word value to produce the desired

positive or negative output voltage within this range, proceed as follows:

1. The resolution in the -1V to 0.998V range is 2mV,  
Let  $D = .002$
2. The range digit is 1 for the low range, so add 1 to the left of the three magnitude digits,  
Let  $R = 1000$
3. The magnitude portion (M) is calculated by adding 1 to the desired negative or positive output voltage (V) and dividing this sum by the least significant digit D. The magnitude portion must be rounded off to exactly 3 digits.  
 $M = \text{INT} (V + 1)/D + 0.5$
4. Combine range and rounded off magnitude portion to obtain the correct data word value (N),  
 $N = R + M$

Example, desired voltage = -0.5123V

$$D = .002$$

$$R = 1000$$

$$M = \text{INT} (-0.5123 + 1)/.002 + 0.5$$

$$M = \text{INT} (+0.4877/.002 + 0.5)$$

$$M = \text{INT} (243.85 + 0.5)$$

$$M = \text{INT} (244.35)$$

$$N = 1000 + 244 = 1244$$

In this example, the desired output voltage is -0.5123V but the actual output is -0.512V because the resolution is 2mV (.002):

$$V = (M \times D) - 1$$

$$V = (244 \times .002) - 1$$

$$V = 0.488 - 1$$

$$V = -0.512V$$

3-28 High Range. The desired output voltage values are from -10V to +9.98V. Calculations are similar to those for the low range, except resolution is 20mV on the high range, and 10 must be added to desired positive or negative output voltage in order to calculate the correct magnitude digits. For this range, the equation for the magnitude portion (M) of the data word value is:

$$M = \text{INT} ((V + 10)/D + 0.5)$$

Example, desired voltage = -5.123V

$$D = .02$$

$$R = 2000$$

$$M = \text{INT} ((-5.123 + 10)/D + 0.5)$$

$$M = \text{INT} (243.85 + 0.5)$$

$$M = \text{INT} (244.35) = 244$$

$$N = 2000 + 244 = 2244$$

In this example, the desired output voltage is -5.123V but the actual output is -5.12V because the resolution is 20mV (.002):

$$V = (M \times D) - 10$$

$$V = (244 \times .02) - 10$$

$$V = 4.88 - 10$$

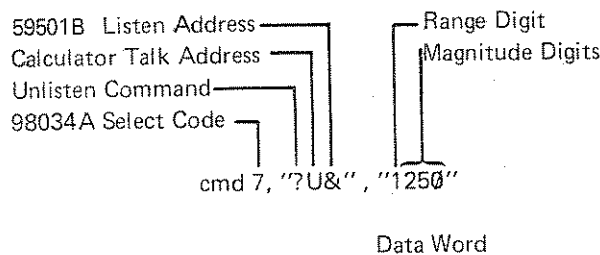
$$V = -5.12V$$

### 3-29 Sending Data Words

3-30 Before a data word is sent, a command must be issued establishing the controller as the "talker" and the 59501B as the "listener". The following examples assume that the controller (9825A calculator) has been assigned its standard talk and listen addresses of "U" and "5" respectively, and the 59501B has been assigned a listen address of "&".

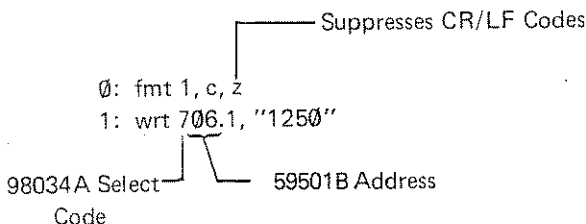
3-31 Example 1 illustrates a command statement issued by a 9825A calculator. Note that in addition to the calculator talk address "U" and the 59501B listen address "&", the address code of the HP-IB Interface Card (98034A) must be included. It is assumed that the interface card has been assigned its standard select code of "7". The 9825A command statement also includes a constant data value of "1250" which is sent to the 59501B.

**Example 1. Sending a Constant Data Value (9825A Command Statement)**



3-32 Example 2 illustrates a write statement (9825A calculator) which can also be used to address the 59501B to listen and send a constant data value. The 59501B listen address of "&" corresponds to an address of "06" as defined in the 9825A General I/O ROM manual (09825-90024) Chapter 4. Note the format statement (line 0) used in Example 3. The "c" specifies a character field, while the "z" is used to suppress carriage return/line feed codes at the end of the write statement. Suppression of the carriage return/line feed codes is essential when programming the 59501B. If they are not suppressed, they will be processed as data characters by 59501B resulting in an undesired output.

**Example 2. Sending a Constant Data Value (9825A Write Statement)**



3-33 Command statements can only be used to send data constants. Write (9825A) statements can be used to send data constants but must be used to send variables.

3-34 Example 3 illustrates how a write statement (9825A) is used to send variable data to the 59501B. If variable N in line 1 were equal to 1250, this example would program the same output as the previous examples. Format specification f4.0 deletes leading spaces and the z suppresses the CR/LF codes for the same reasons as described above.

**Example 3. Sending Variable Data (9825A Write Statement)**

```
0: fmt 1, f4.0, z
1: wrt 706.1, N
```

### 3-35 USING 59501B AS A POWER SUPPLY PROGRAMMER

3-36 Power supply programming is accomplished using the digitally controlled output voltage of the 59501B in conjunction with the ZERO ADJUST and POWER SUPPLY FULL SCALE ADJUST controls on the 59501B front panel. By making the appropriate connections between the 59501B's output terminals and the voltage programming terminals of a dc power supply, the output voltage (or current) of the power supply can be programmed from zero to the full rated output. This method of programming is called voltage programming with gain.

### 3-37 Voltage Programming With Gain

3-38 HP programmable power supplies have certain features in common. These features include: an internal reference (either a fixed regulated voltage or a fixed regulated constant current source), voltage and current comparators with their input terminals, and front panel controls (voltage and current) with connections at the rear panel terminals. A power supply can be controlled by making the appropriate connections on the rear panel and applying an external voltage (or in some cases current). For example, by disconnecting the internal reference voltage from the input circuits of the constant voltage comparator and replacing it with an external voltage source, the output voltage of the power supply is programmed by the value of the external voltage source.

3-39 Figure 3-4 illustrates the method by which a power supply's constant voltage output can be programmed using an external voltage with a voltage gain dependent upon the ratio of  $R_P$  to  $R_R$ . Note that this method is no different from the circuit normally used for constant voltage control of the output except that an external reference (the programming voltage source) has been substituted for the internal reference. On most supplies, external terminals are available so that the connections shown in Figure 3-4 can be accomplished without any internal wiring changes. In all HP remotely programmable power supplies, the summing point S is made available, and the configuration of Figure 3-4 can always be accomplished using the external programming voltage source  $E_P$  and external precision wire-wound resistors  $R_P$  and  $R_R$ . ( $R_R$  should not exceed 10k.) As indicated by the equation in Figure 3-4,  $R_P$  can be selected so that the resulting voltage gain is either less or greater than unity. It is possible to use the front panel control on the supply as the voltage gain control  $R_P$ .

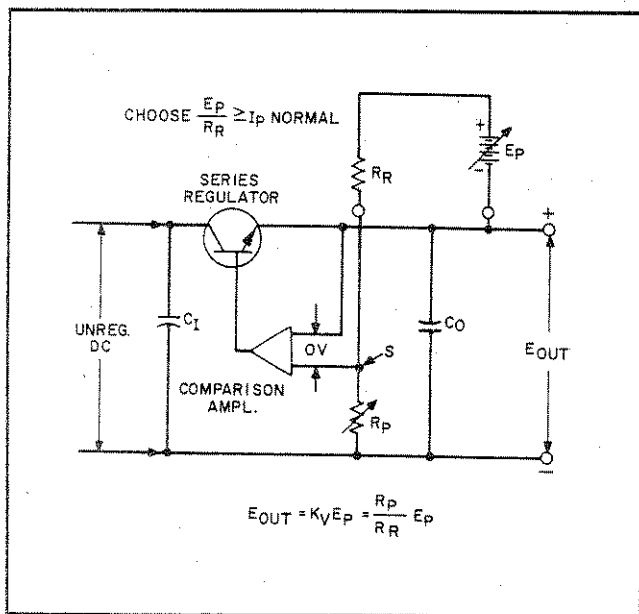


Figure 3-4. Voltage Programming with Variable Voltage Gain

3-40 **Constant Voltage.** Figure 3-5 illustrates the connections required for the 59501B to program the constant voltage (CV) output of a typical HP power supply. Note the similarities between Figures 3-4 and 3-5. The 59501B includes  $R_R$  (R76),  $R_P$  (COARSE and FINE POWER SUPPLY FULL SCALE ADJUST), and  $E_P$  (59501B output between terminals A1 and A2). The extra resistor (R77) between terminals A5 and A6 is used only when programming power supplies above 300 volts.

3-41 As shown in Figure 3-5, the supply's internal reference voltage ( $+V_{REF}$ ) and VOLTAGE control are disconnected (dotted lines) and are replaced with the 59501B's output voltage and POWER SUPPLY FULL SCALE ADJUST. Note that in the unipolar mode, 59501B output terminal A1 is negative with respect to A2. This polarity must be complied with when making connections. The connections shown in Figure 3-5 are typical for most supplies.

3-42 **Constant Current.** Figure 3-6 illustrates the connections required for the 59501B to program the output current of a typical HP power supply. Programming constant current consists of replacing the internal reference with the output voltage from the 59501B and replacing the internal CURRENT control with the POWER SUPPLY FULL SCALE ADJUST controls on the 59501B. With these connections, the voltage developed across POWER SUPPLY FULL SCALE ADJUST ( $R_P$ ) becomes the reference against which the voltage drop across the output current monitoring resistor ( $R_M$ ) is compared. The relationship between  $E_P$  and the supply's output current depends upon the resistance ratio  $R_P/R_R$  and on the constant current programming coefficient ( $K_P$ ) of the particular supply. The relationship between input voltage and output current is,

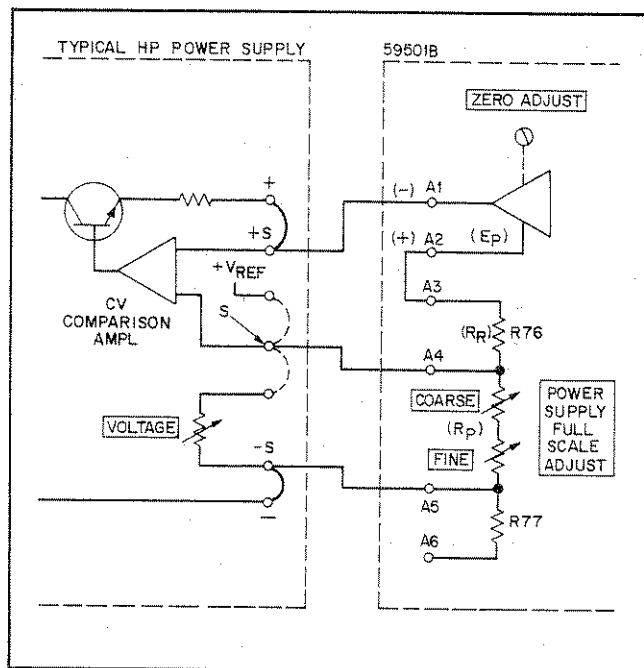
$$I_{OUT} = (E_P \times R_P) \div (K_P \times R_R)$$


Figure 3-5. Typical Connections for CV Programming

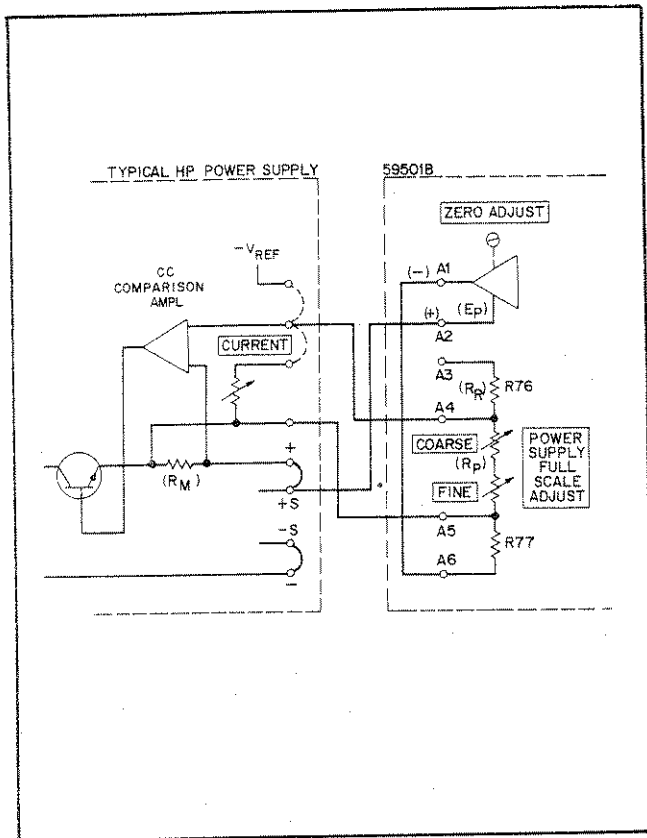


Figure 3-6. Typical Connections for CC Programming

### 3-43 59501B/HP Power Supply Connections

3-44 Table 3-1 lists the HP Power Supplies that can be programmed on the HP-IB using the 59501B. The table specifies if a supply is capable of CV and/or CC programming with the 59501B and also lists the applicable 59501B/power supply connection diagram. The accuracy of a power supply/59501B combination is the sum of the 59501B's accuracy plus the accuracy of the particular power supply. 59501B power supply programming accuracy specifications are given in Section I.

#### NOTE

*One 59501B can only program a supply's CV or CC output. If it is desired to program both CV and CC on the HP-IB, two 59501B's are required with their address switches set to different addresses.*

3-45 The leads (AWG No. 24, minimum) connecting the 59501B to the power supply should be twisted to reduce noise pickup. The longer the connecting leads, the more noise that can be introduced. Shielding will further improve noise rejection. After completing the connections, install the protective covers over the terminal strips on the 59501B and on the supply.

Table 3-1. HP Power Supply/ 59501B Capability Guide

Power Supply Model	59501B Programming Capabilities			
	CV	Figure	CC	Figure
6002A	Yes	3-7	Yes	3-14
6012A	Yes	3-8	Yes	3-15
6024A	Yes	3-9	Yes	3-16
6101A, 02A	Yes	3-7	No	--
6104A, 05A	Yes	3-7	Yes	3-17
6106A	Yes	3-7	No	--
6111A-13A	Yes	3-7	No	--
6114A, 15A	Yes	3-7	Yes	3-17
6116A	Yes	3-7	No	--
6177C, 81C, 86C	No	--	Yes	3-18
6200B-03B	Yes	3-7	Yes	3-14
6204B-06B	Yes	3-7	No	--
6207B, 09B	Yes	3-7	Yes	3-14
6220B, 24B, 26B	Yes	3-7	Yes	3-14
6227B, 28B	Yes	3-7	Yes	3-14
6253A, 55A	Yes	3-7	Yes	3-14
6256B-6274B	Yes	3-7	Yes	3-14
6281A, 84A, 89A, 94A, 99A	Yes	3-7	Yes	3-14
6282A, 85A, 86A, 90A, 91A, 96A	Yes	3-7	Yes	3-14
6427B-6448B	Yes	3-10	No	--
6453A, 56B, 59A	Yes	3-11	Yes	3-19
6464C	Yes	3-12	Yes	3-19
6466C-6483C	Yes	3-10	Yes	3-19
6823A, 24A	Yes	3-13	No	--
6825A-6827A	Yes	3-13	Yes	3-20

**3-46 CV Programming Connections.** Figures 3-7 through 3-13 illustrate the connections required to program the CV output of the applicable power supplies. The dotted line connections represent jumpers which must be removed. All other jumpers must be installed as illustrated. Note that only those power supply terminals pertinent to CV programming are shown. Complete terminal strip details are provided in the appropriate power supply Operating and Service Manual. Most of the supplies are programmed using the connections illustrated in Figure 3-7. The specific connections for each supply are tabulated on the diagram.

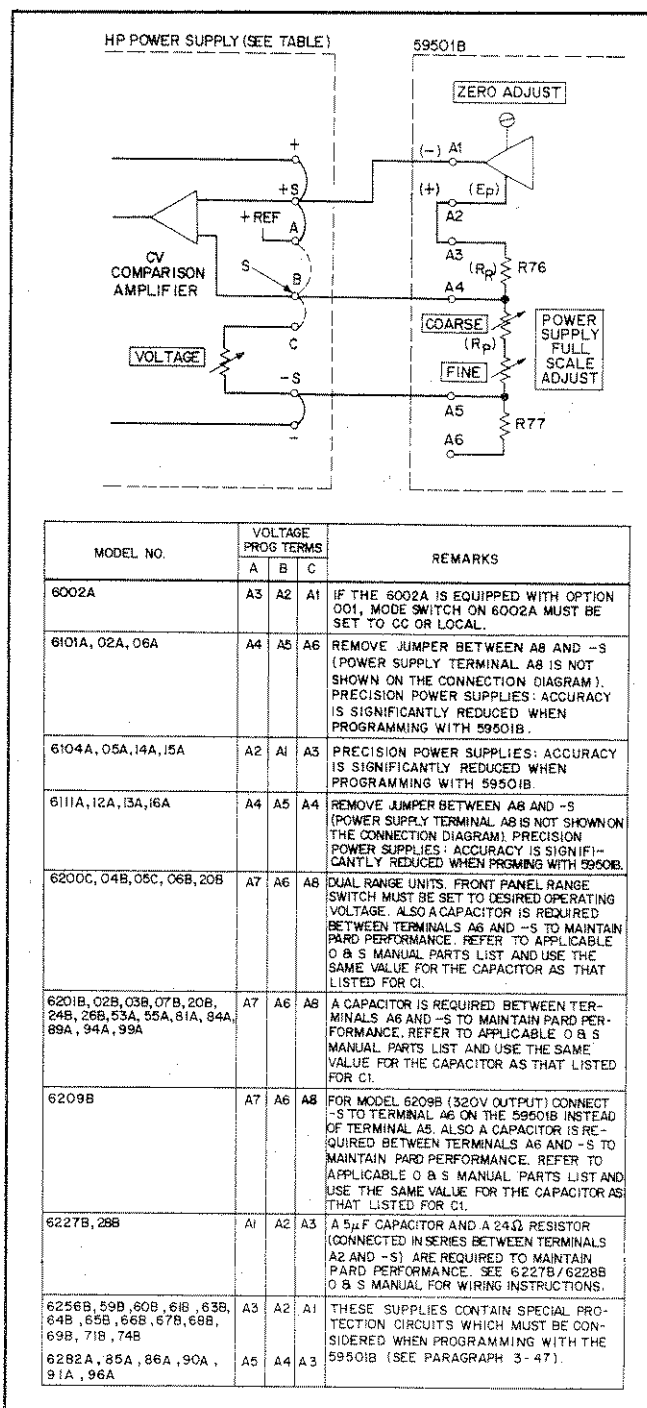
**3-47 Special Protection Circuit.** As indicated on Figure 3-7, some of the supplies contain a special protection circuit which must be considered when programming with the 59501A. The supplies affected are models 6256B through 6274B, 6282A, 6285A, 6286A, 6290A, 6291A, and 6296A. Down programming the output voltage of these supplies may activate the special protection circuit. When this occurs, the power supply's load cannot draw more than 10% (approx.) of rated output current until the protection circuit resets. If it is desired to program the output voltage down to a lower value without the need to draw full output current, the reset time is not important. The reset time can take from 500msec to 6 seconds depending upon the particular model, the load, and the starting and the ending voltage values. For example, the actual output voltage of a 6264B supply takes only 80msec for its output to go from 20 volts down to .1% (20 millivolts), but it will be about 800 milliseconds before the circuit resets allowing the full output current to be supplied to the load. Additional information concerning this protection circuit is provided in HP-IB/Power Supply Guide, HP Part No. 5952-3990.

**3-48 Special Option J30.** An additional circuit, designated special Option J30, is required when CV programming models 6427B through 6448B and 6466C through 6483C. The Option J30 circuit is a voltage-to-current converter and is required because the 59501B is essentially a constant voltage source. The above supplies utilize current sources in their programming networks. The programmable 0 – 10V output of the 59501B is connected to the Option J30 input terminals (+ and –) on the rear of the supply as shown in Figure 3-10. One characteristic of the J30 converter is that if its input is open circuited, the output of the power supply will rise to about 25% of its rating. With the 59501B connected, the open circuit condition is prevented because a protection circuit in the 59501B presents a low impedance to the J30 input when ac power is removed from the 59501B (see paragraph 4-13).

**3-49** If the Option J30 power supply's front panel VOLTAGE controls are left connected in the circuit, they must be set to maximum resistance (fully CW). If they are rotated CCW, the output of the supply will be decreased

for all programming voltage received from the 59501B. As indicated on Figure 3-10, the user may disable the front panel VOLTAGE controls and connect the 59501B's POWER SUPPLY FULL SCALE ADJUST in their place. Refer to the applicable power supply's Operating and Service Manual for additional connection information.

**NOTE:** The dotted line connections represent jumpers which must be removed. All other jumpers must be installed.



**Figure 3-7. CV Programming Connections for HP Power Supplies with +S Common**



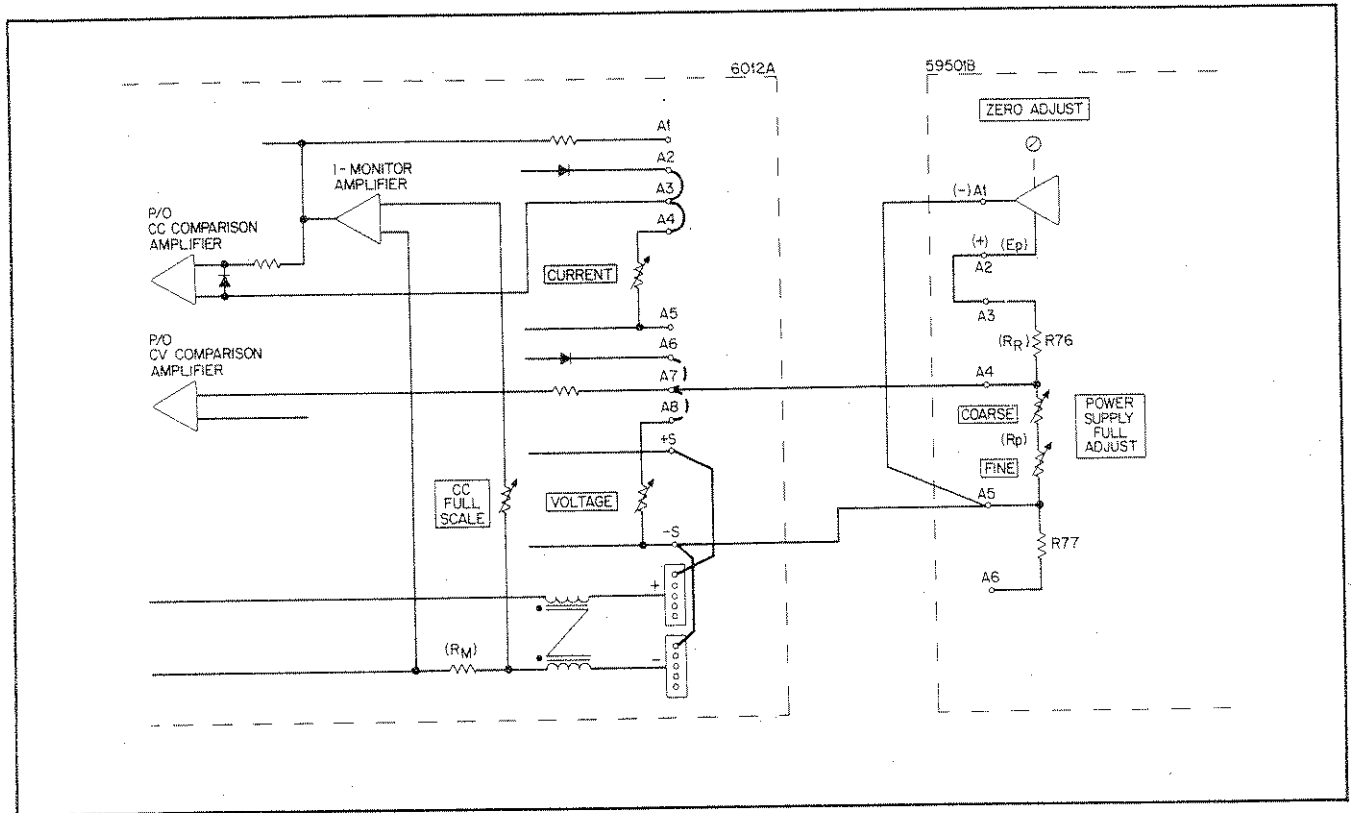


Figure 3-8. CV Programming Connections for HP Power Supply Model 6012A

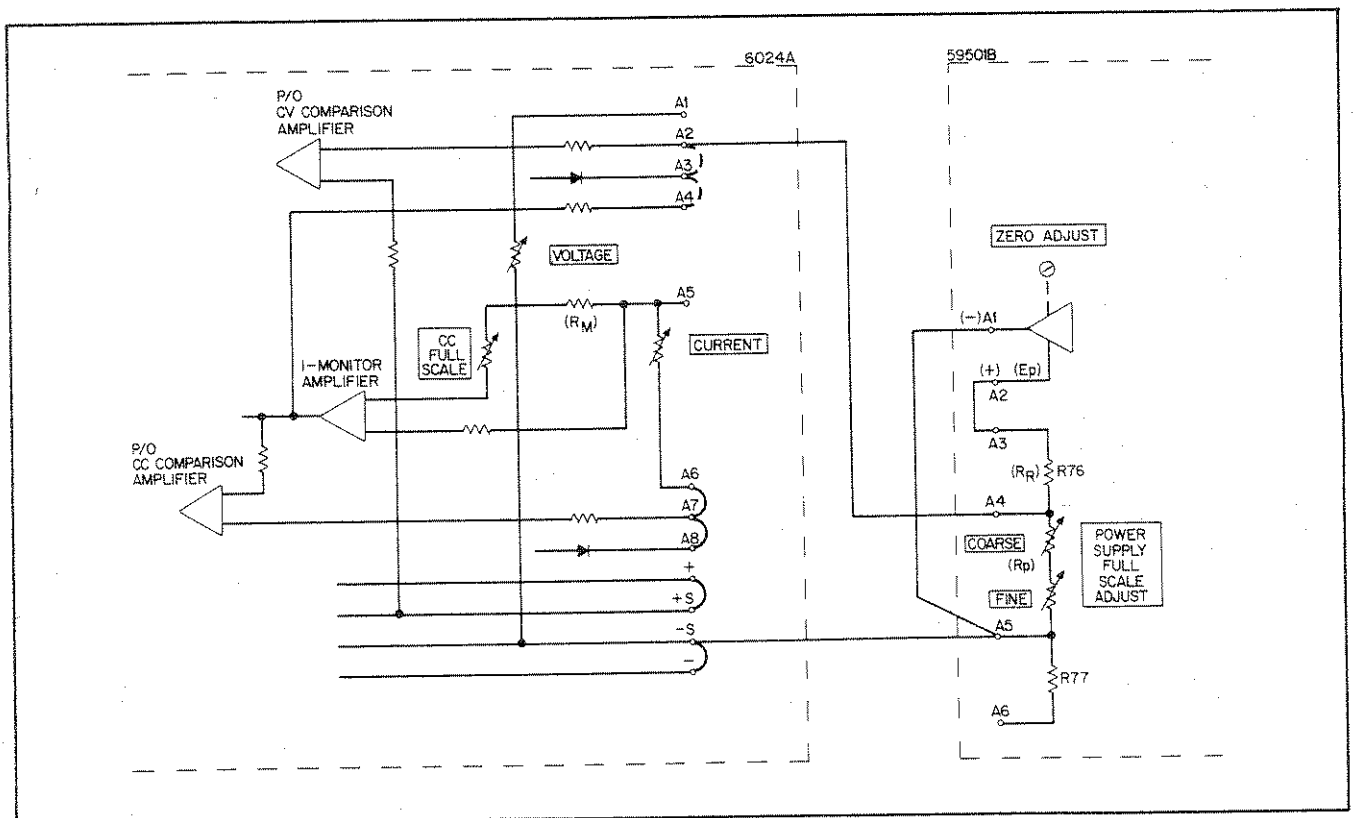


Figure 3-9. CV Programming Connections for HP Power Supply Model 6024A

NOTE: The dotted line connections represent jumpers which must be removed. All other jumpers must be installed.

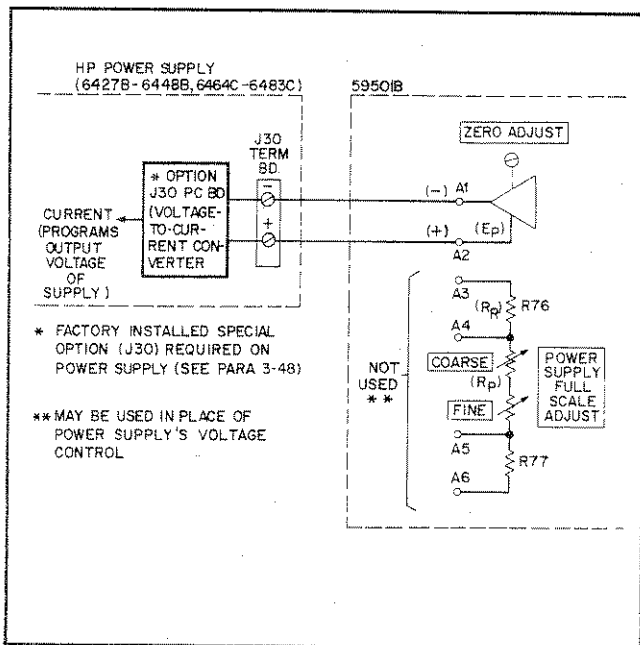


Figure 3-10. CV Programming Connections for HP Power Supply Models 6427B-6448B and 6466C-6483C

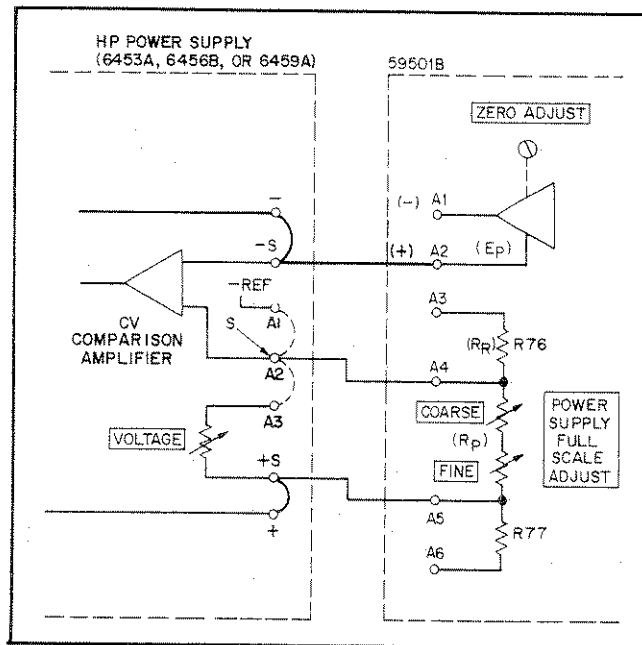


Figure 3-11. CV Programming Connections for HP Power Supply Models 6453A, 6456B, and 6459A

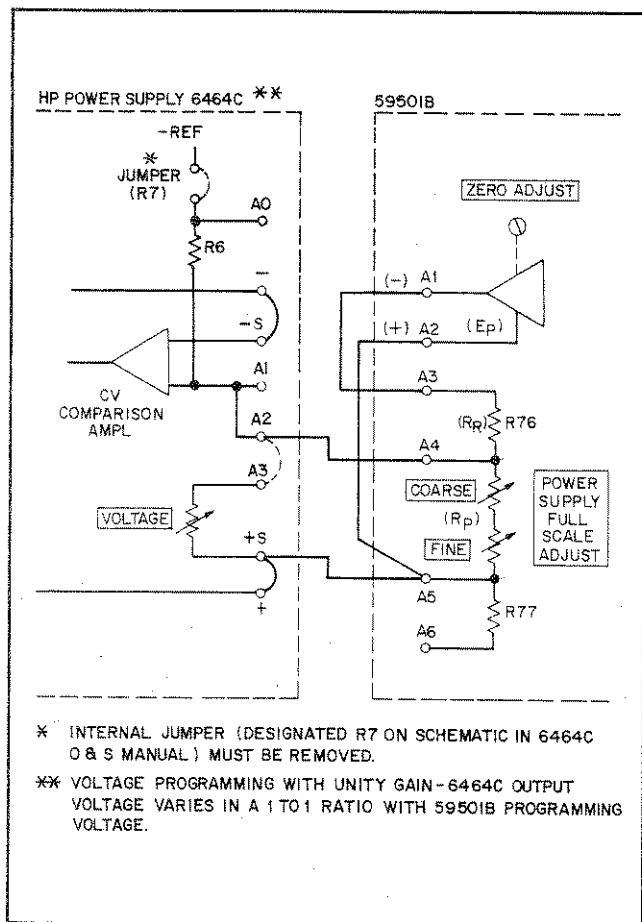


Figure 3-12. CV Programming Connections for HP Power Supply Model 6464C

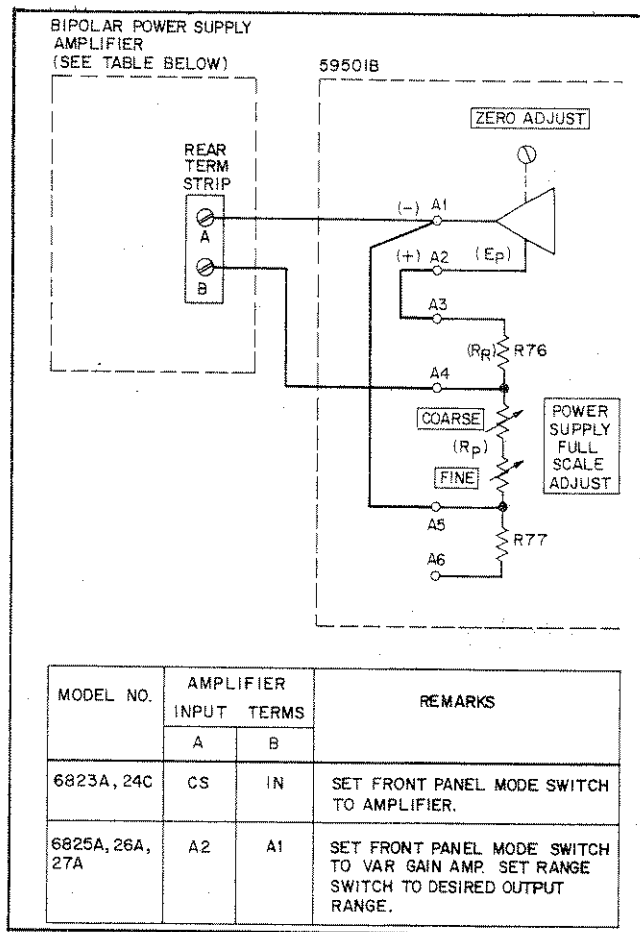


Figure 3-13. CV Programming Connections for Bipolar Power Supply Amplifiers 6423A, 6824C, 6825A-27A

**3-50 CC Programming Connections.** Figures 3-14 through 3-20 illustrate the connections required to program the CC output of the applicable power supplies. The dotted connections represent jumpers which must be removed on the supply's rear terminal strip. All other jumpers must be connected as illustrated. Note that only those power supply terminals pertinent to CC programming are shown. Complete terminal strip details are provided in the appropriate power supply Operating and Service manual. Most of the supplies are programmed utilizing the connection diagram of Figure 3-14. The specific connections for each supply are tabulated on the diagram. In all cases (Figures 3-14 through 3-20), the 59501B's programming output voltage is substituted for the supply's internal reference and the 59501B's POWER SUPPLY FULL SCALE ADJUST potentiometers replace the supply's front panel CURRENT control.

NOTE: The dotted line connections represent jumpers which must be removed. All other jumpers must be installed.

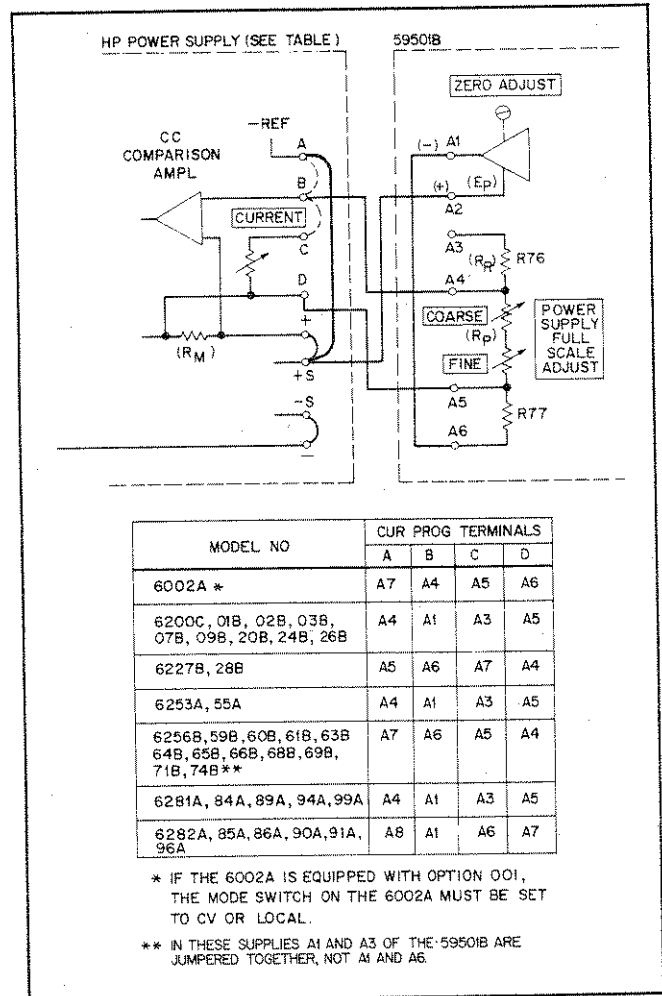


Figure 3-14. CC Programming Connections for HP Power Supply Models with +S Common

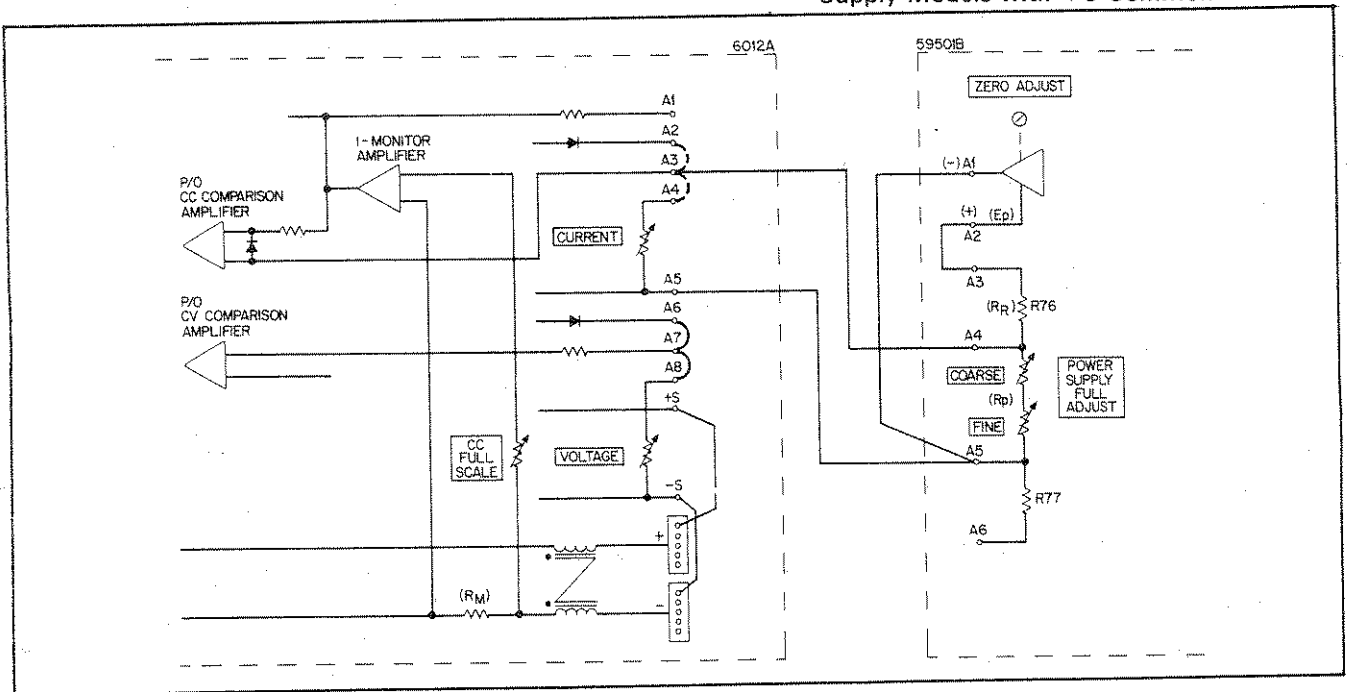


Figure 3-15. CC Programming Connections for HP Power Model 6012A

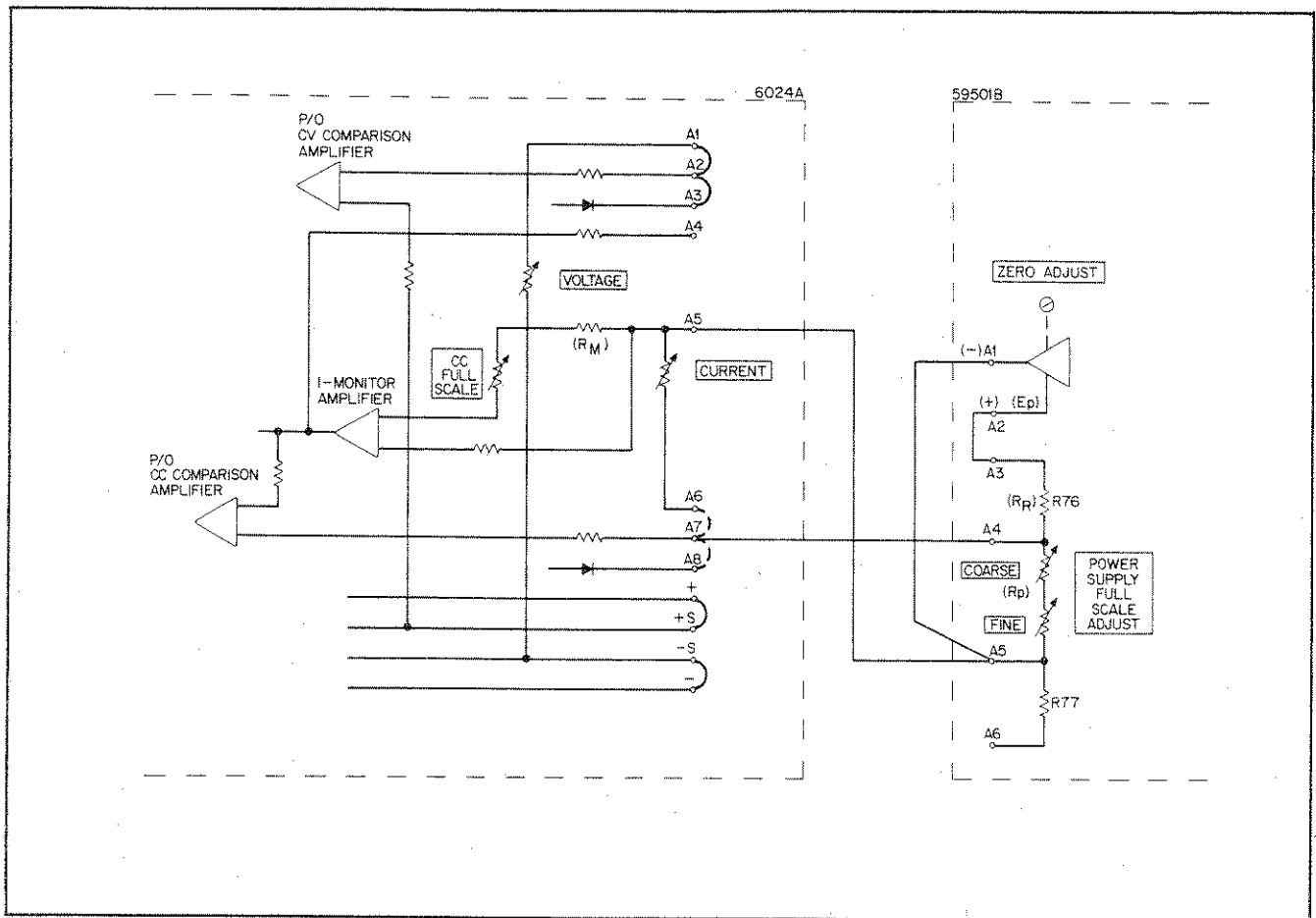


Figure 3-16. CC Programming Connections for HP Power Supply Model 6024A

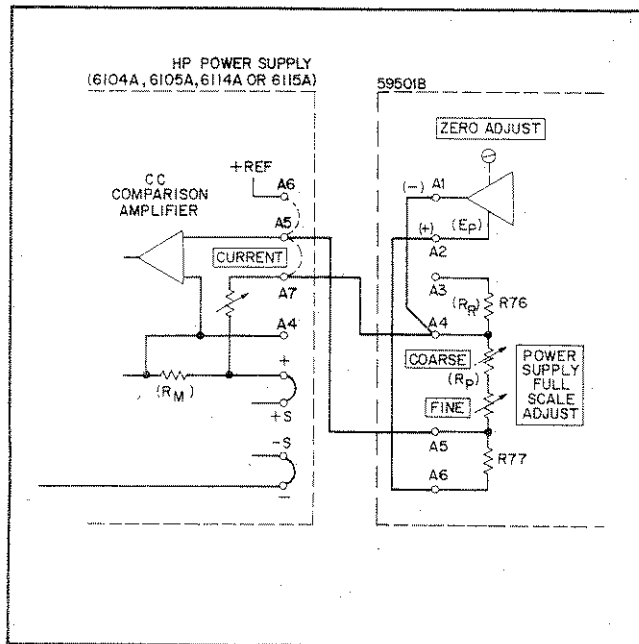


Figure 3-17. CC Programming Connections for HP Power Supply Models 6104A, 6105A, 6114A, and 6115A

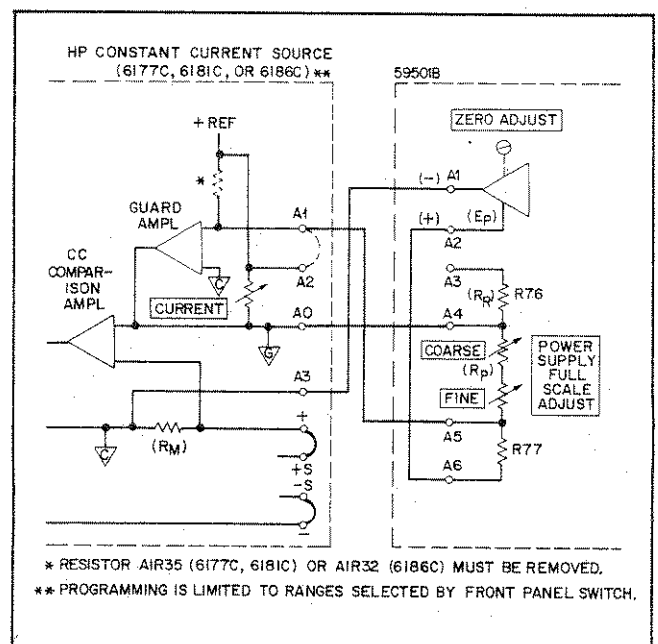


Figure 3-18. CC Programming Connections for HP Constant Current Sources 6177C, 6181C, 6186C

NOTE: The dotted line connections represent jumpers which must be removed. All other jumpers must be installed.

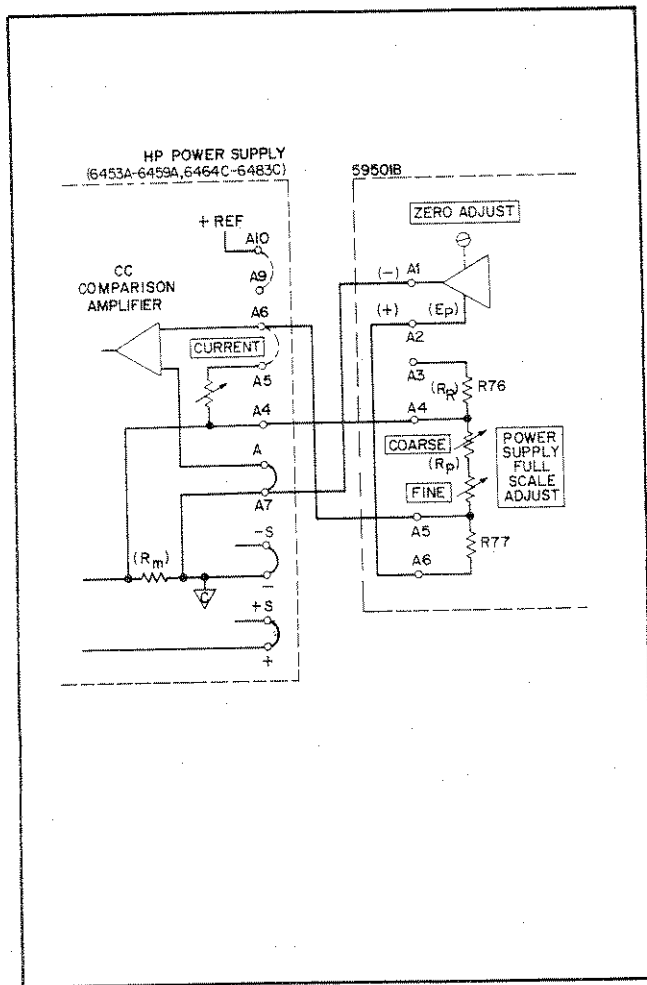


Figure 3-19. CC Programming Connections for HP Power Supply Models 6453A-6459A, 6464C-6483C

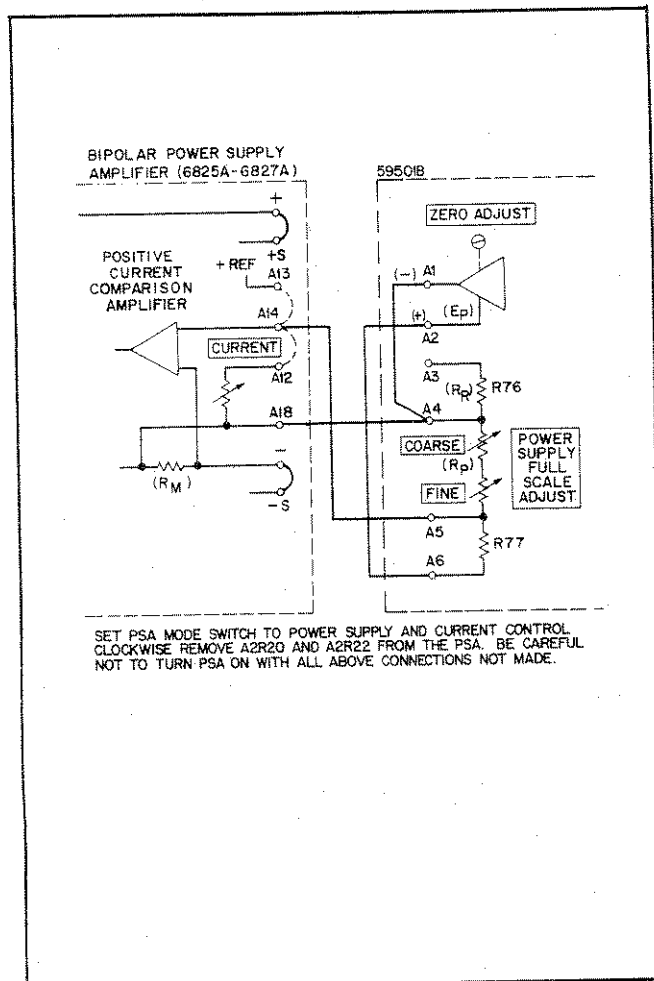


Figure 3-20. Positive CC Programming Connections for BPS/A's 6825A-6827A

### 3-51 Power Supply CV Programming

3-52 The following paragraphs provide calibration procedures and a sample program which are applicable to all supplies listed for CV programming in Table 3-1. Calibrating a supply for CV programming with the 59501B consists essentially of two adjustments:

1. Setting the supply's output to 0V when the 59501B is programmed to zero.
2. Setting the supply's output to a desired maximum value when the 59501B is programmed to maximum.

3-53 The maximum desired power supply output can be set to any value within the rating of the supply. For

example, if only 20V maximum is required for a model 6266B supply (40V rating), the 6266B output range should be calibrated for 0V to 20V. Since the 59501B is programmable in 999 steps (magnitude digits 000-999), resolution is 20/999 (about 20mV) in the high range and 2/999 (about 2mV) in the low range. If the supply is calibrated for the full 40V rating, the resolution is 40mV (approx.) even though the supply would never be programmed above 20V.

3-54 Note that for a 20V full scale output, it is usually better to calibrate the full scale setting to 99.9% of 20V or 19.98V. The reason for this is that the resolution will be 19.98/999 or exactly 20mV per step. However, if it is imperative to calibrate the output to exactly 20V, the resolution is 20/999, or 20.02002mV per step. Thus, the

user must determine the importance of having a round number for resolution when writing programs.

**3-55 Calibration.** To calibrate a 59501B/power supply combination for CV operating, proceed as follows:

- 3-56 Test Setup.
- Connect 59501B to an HP-IB controller.
  - Connect 59501B to power supply (CV programming), see Table 3-1.
  - Connect DVM between +S and -S terminals on the power supply.
  - On 59501B, set mode switch to UNIPOLAR and turn POWER SUPPLY FULL SCALE ADJUST (COARSE and FINE) fully CCW. Also, if power supply has a front panel CURRENT control, set it to mid-range (approx.)

- 3-57 Calibration Procedure.
- Apply power to the controller, the 59501B, and the power supply. Allow 30-minute warm-up.
  - With the power supply's output terminals (+ and -) open circuited, program the 59501B to maximum high range "2999."
  - Adjust POWER SUPPLY FULL SCALE ADJUST (COARSE and FINE) on 59501B for desired maximum output voltage (or 99.9% of desired max., see paragraph 3-54) using the DVM.
  - Program 59501B to zero output "2000."
  - Set ZERO ADJUST on 59501B for 0.000 reading on DVM.
  - Program 59501B to "2999" and set POWER SUPPLY FULL SCALE FINE ADJUST on 59501B for desired maximum output voltage. If necessary, use D/A FULL SCALE ADJUST to obtain the required resolution.

#### NOTE

*If the supply has a front panel CURRENT control, perform the following steps.*

- Program 59501B to zero output "2000". Connect a short across supply's output terminals.
- Program 59501B to "2999" and adjust the supply's front panel CURRENT control for the desired maximum output current. If a load change causes this current limit to be exceeded, the supply automatically crosses over to constant

current operation at this preset current limit and the output voltage drops proportionally. If desired, the front panel CURRENT control can be disabled and replaced with a fixed resistor of appropriate value (see applicable power supply Operating and Service Manual).

- Program "2000". Remove short from supply's output terminals and connect load.

**3-58 Sample Program.** A sample program for controlling power supply CV outputs is given in example 4. The program is written specifically for a 9825A calculator but could be modified for use with other calculators. The program contains calibration and setup routines and allows the operator to input specific voltage values on the keyboard. The program also includes automatic changing of ranges and error messages that indicate when the voltage requested by the operator exceeds the maximum value available or when a negative voltage is requested. A line-by-line explanation is given after the program. Programming fundamentals are provided in paragraphs 3-17 through 3-34.

3-59 The sample program requires use of the General I/O and Extended I/O ROM's. After keying in the program, press RUN on the calculator. All operations required to complete the program are given on the calculator display. After each operation is completed, press CONTINUE. The operator enters the maximum desired output voltage value (e. g. 20) when "Enter maximum output voltage" appears on the display. The program automatically uses 99.9% of this value (e. g. 19.98) to calibrate the supply (see paragraph 3-54). After connecting the load, the operator enters the desired output voltage (line 13) on the keyboard and press CONTINUE. If it is desired to recalibrate the power supply (change the maximum desired output voltage) press STOP and then press RUN.

#### NOTE

*The program listings provided in the following examples are taken from an HP 9866B printer. These listings are provided only because 9866B printouts are easier to read than printouts from the 9825A's internal strip printer. Also, a check sum is provided at the end of each 9825A program listing. Make sure that the check sum at the end of your keyed-in program matches the check sum provided in the listing.*

Example 4. 9825A Sample Program, Constant Voltage - Unipolar Mode

```

0: "UNIPOLAR Power Supply Voltage Output"
1: dsp "Set 59501B to UNIPOLAR";stp
2: dsp "Turn PSFS ADJ fully CCW";stp
3: ent "Enter maximum output voltage";E
4: E/1000+D;E-D+E
5: cmd 7;"?U&";"2999"
6: dsp "Set PSFS ADJ for";E;stp
7: cmd 7;"?U&";"2000"
8: dsp "Set ZERO ADJ for 0.000";stp
9: cmd 7;"?U&";"2999"
10: dsp "Adjust PSFS FINE ADJ for";E;stp
11: cmd 7;"?U&";"2000"
12: dsp "Connect load to supply";stp
13: ent "Enter desired output voltage";V
14: if V<0;dsp "No negative voltages";wait 3000;eto 13
15: if V>E;dsp "Voltage too high";wait 3000;eto 13
16: if V<=.1*E;1000+int(V/.1D+.5)+N;eto 18
17: 2000+int(V/D+.5)+N
18: fnt 1,f4.0;wrt 706.1;N;eto 13
19: end
#10217

```

COMMAND STATEMENT  
(SEE PARA 3-32)

FORMAT AND WRITE STATEMENTS  
(SEE PARA 3-36)

CHECK SUM

Explanation:

- 1-2: Setup instructions.
- 3: User enters desired maximum output voltage on keyboard (e. g. 10, 20, 50, 100, etc.).
- 4: Resolution is calculated and the maximum desired output is changed to 99.9% of voltage entered in line 3 (see paragraph 3-54).
- 5-10: Calibration routine using ZERO ADJUST and POWER SUPPLY FULL SCALE ADJUST (COARSE and FINE) controls on 59501B front panel.
- 11-12: Output is programmed to zero. Load is connected to power supply's output terminals (see applicable power supply Operating and Service manual).
- 13: User inputs desired voltage on keyboard.
- 14-15: If the voltage requested (line 13) is negative or too high, the appropriate error message appears on the display for three seconds and then the program returns to line 13.
- 16-17: Proper range is selected and correct data word value (N) is calculated for the voltage requested.
- 18: Data word (N) representing the desired output voltage is sent to the 59501B. Format f4.0 deletes leading spaces and z suppresses the carriage return/line feed codes (see paragraph 3-34).

### 3-60 BPS/A CV Programming

3-61 The following paragraphs provide calibration procedures and a sample program for bipolar power supply/amplifier (BPS/A) models 6824A through 6827A. Calibration consists of setting the BPS/A's desired bipolar output range when the 59501B is programmed to its maximum negative and positive limits. The desired bipolar range can be set to any value within the rating of the particular BPS/A. For example, the maximum output range of model 6826A is from -50V to +50V. To calibrate this range, the -50V output is calibrated with the 59501B programmed to "2000" and the +50V output is calibrated with the 59501B programmed to "2999". Since the 59501B is programmable in 999 steps, resolution is approximately 100mV (100/999). Note if it is desired to have a resolution equal to exactly 100mV, the positive limit is set to +49.9V instead of +50V. For this range (-50V to +49.9V), the resolution is exactly 100mV (99.9V/999).

**3-62 Calibration.** To calibrate a 59501B/BPS/A combination for CV operation proceed as follows:

#### 3-63 Test Setup.

- a. Connect 59501B to an HP-IB controller.
- b. Connect 59501B to BPS/A as shown in Figure 3-11.
- c. Connect DVM between +S and -S terminals (models 6825A-6827A) or between OS and CS terminals (models 6823A, 6824A). Connect DVM common to -S or OS terminal.
- d. On 59501B, set mode switch to BIPOLAR.
- e. On BPS/A, set mode switch to VAR GAIN AMP (models 6825A-6827A) or AMPLIFIER (models 6823A, 6824A). Also, turn VOLTAGE (Gain) controls on BPS/A fully CCW.
- f. On BPS/A models 6825A through 6827A only, set RANGE switch to desired output range and set CURRENT control to mid-range (approx.).

#### 3-64 Calibration Procedure.

- a. Apply power to the controller, the 59501B, and the BPS/A. Allow 30-minute warm-up.
- b. With the BPS/A's output terminals open circuited, program the 59501B to maximum positive output "2999".

- c. Adjust VOLTAGE control on BPS/A and D/A FULL SCALE ADJUST on 59501B for the desired maximum positive output (or 99.9% of desired max., see paragraph 3-60) using DVM.
- d. Program 59501B to maximum negative output "2000".
- e. Set ZERO ADJUST on 59501B for the desired maximum negative output from BPS/A using DVM.
- f. Program 59501B to maximum positive output "2999".
- g. Set D/A FULL SCALE ADJUST for the desired maximum positive output from BPS/A.
- h. Repeat steps d through g until best possible accuracy is achieved.

### NOTE

*The following steps apply only when calibrating BPS/A models 6825A-6827A.*

- i. Program 59501B to "2500". Connect a short across BPS/A's output terminals.
- j. Program 59501B to "2999" and adjust the BPS/A's front panel CURRENT control for the desired maximum output current. If a load changes causes this current limit to be exceeded, the supply automatically crosses over to constant current operation at this preset current limit and the output voltage drops proportionally.
- k. Program "2500". Remove short from output terminals and connect load.

**3-65 Sample Program.** Example 5 is a sample program using a 9825A calculator. The program contains calibration and setup routines and allows the operator to input specific positive or negative voltage values on the keyboard. The program also includes automatic changing of ranges and an error message if the voltage requested by the operator exceeds the maximum bipolar value available. A line-by-line explanation is given after the program. Programming fundamentals are provided in paragraphs 3-17 through 3-34.

3-66 The sample program in example 5 requires use of the General I/O and Extended I/O ROM's. After keying in the program press RUN on the calculator. All operations required to complete the program are given on the calculator display. After each operation is completed, press CONTINUE.



Example 5. 9825A Sample Program, Constant Voltage - Bipolar Mode

```

0: "BIPOLAR Power Supply Voltage Output":
1: fxd 3
2: dsp "Set 59501B to BIPOLAR";stp
3: dsp "Turn VOLT ADJ fully CCW";stp
4: ent "Enter max neg output voltage";M;abs(M)+M
5: 2M/1000+DIM-D+P
6: cmd 7,"?U&","2999"
7: dsp "Set VOLT & D/A FS for";P;stp
8: cmd 7,"?U&","2000"
9: ent "Enter DVM reading";X;abs(X)+X
10: (M+X)/2+Y
11: dsp "Set ZERO ADJ for";-Y;stp
12: cmd 7,"?U&","2999"
13: dsp "Readjust D/A FS ADJ for";P;stp
14: cmd 7,"?U&","2500"
15: dsp "Connect load to BPS/A";stp
16: ent "Enter desired voltage(+ or -)";V
17: if V<-M or V>P;dsp "Voltage too high";wait 3000;to 16
18: if V<=.1P and V>=-.1M;1000+int((V+.1M)/.1D+.5)+N;to 20
19: 2000+int((V+M)/D+.5)+N
20: fmt 1,f4.0,z;wrt 706.1;N;to 16
21: end
#28334

```

Explanation:

- 1: Sets fixed point format with three digits to the right of the decimal. This allows for better accuracy in the adjustments specified in lines 7 and 11.
- 2-3: Setup instructions.
- 4-13: Calibration routine using VOLTAGE (GAIN) control on BPS/A and the ZERO and D/A FULL SCALE ADJUST controls on the 59501B. Note that in line 10 an average value is calculated so that the adjustment can be completed in the minimum number of steps.
- 14-15: BPS/A output is programmed to zero. Load is connected to BPS/A output terminals.
- 16: User inputs desired output voltage (+ or -) on the keyboard.
- 17: If voltage requested (line 16) is too high, "Voltage too high" appears on the display for three seconds, and then the program returns to line 16.
- 18-19: Proper range is selected and correct data word value (N) is calculated to represent the voltage requested.
- 20: Data word (N), representing the requested output voltage (+ or -), is sent to the 59501B. Format f4.0 deletes leading spaces and z suppresses the carriage return/line feed characters. If leading spaces are not deleted and the CR/LF characters are not suppressed, the output will go to an undesired value (see paragraph 3-34).

### 3-67 CC Programming

3-68 The following paragraphs provide calibration procedures which are applicable to all power supplies listed for CC programming in Table 3-1. Calibrating the supply for CC programming with the 59501B consists essentially of two adjustments:

1. Setting the supply's output current to zero when the 59501B is programmed to zero.
2. Setting the supply's output current to a desired maximum value when the 59501B is programmed to maximum.

3-69 **Calibration.** To calibrate a 59501B/power supply combination for CC programming, proceed as follows:

3-70 Test Setup.

- a. Connect 59501B to an HP-IB controller.
- b. Connect 59501B to power supply (CC programming), see Table 3-1.
- c. Connect a resistive load in series with an external current monitoring resistor across supply's output terminals. Refer to Section V of applicable Operating and Service manual for resistor values, power ratings, and CC test setup diagram, etc. Connect a DVM across the current monitoring resistor.
- d. On 59501B, set mode switch to UNIPOLAR and turn POWER SUPPLY FULL SCALE ADJUST (COARSE and FINE) fully CCW.
- e. On power supply, set front panel VOLTAGE control fully CW.

3-71 Calibration Procedure.

- a. Apply power to the controller, the 59501B and the power supply. Allow 30-minute warm-up.
- b. Program 59501B to "2999" and set POWER SUPPLY FULL SCALE ADJUST (COARSE and FINE) for desired maximum output current. (Voltage reading on DVM must be converted to the equivalent output current).
- c. Program 59501B to "2000" and set ZERO ADJUST on 59501B for zero output current. Note that for power supply models 6427-6483, zero current may not be attainable. When calibrating the CC output of one of these supplies, choose a convenient point, e. g. 10% or 20% of maximum output and set ZERO ADJUST to obtain this value. Data words "2100" and "2200" correspond to the 10% and 20% output points, respectively.
- d. Program 59501B to "2999" and set POWER SUPPLY FULL SCALE FINE ADJUST on 59501B for desired maximum output current.

If necessary use D/A FULL SCALE ADJUST to obtain the required resolution.

- e. Turn off supply and open output terminals. Turn on supply.
- f. Adjust power supply's VOLTAGE control for the desired maximum output voltage. If a load change causes this voltage limit to be exceeded, the supply automatically crosses over to constant voltage operation at this voltage limit point and the output current drops proportionally. If desired, the front panel VOLTAGE control can be disabled and replaced with a fixed resistor of proper value (see applicable power supply Operating and Service manual).

3-72 **Sample Program.** The sample program provided in example 4 can easily be modified for CC programming by substituting I (current) for V (voltage) and by monitoring the output current using the test setup of paragraph 3-70.

### 3-73 USING 59501B AS A LOW LEVEL DC SIGNAL SOURCE

3-74 When used as a low level dc signal source, 59501B output terminals A1 and A2 are connected directly to the user's device. In this application, power supply programming network terminals A3 through A6 are normally not used. As described previously, two programmable output ranges are available in the selected operating mode (UNIPOLAR or BIPOLAR). The output ranges available at terminals A1 and A2 are as follows:

<u>Range</u>	<u>Unipolar</u>	<u>Bipolar</u>
High	0 to 9.99V	-10 to 9.98V
Low	0 to 0.999V	-1 to +0.998V

### 3-75 Unipolar Mode

3-76 **Calibration.** The ZERO ADJUST allows the output to be adjusted to zero ( $\pm 250$  millivolts) when the 59501B is programmed to zero (2000). The D/A FULL SCALE ADJUST allows the output to be adjusted to 9.99V ( $\pm 5\%$ ) when the 59501B is programmed to maximum (2999). The 59501B is normally calibrated to provide a unipolar output range from 0V to 9.99V. The reason for this is that the 59501B is programmable in 999 steps and using this range results in a round number for resolution (voltage change per step). For example, in the high range resolution is 9.99V/999 or 10mV per step. If the output is set to 10V, resolution is 10/999 or 10.01001mV per step. Calibration procedures for operating in the unipolar mode are provided in paragraph 5-29.

**3-77 Sample Program.** A sample program (9825A calculator) for controlling the unipolar output of the 59501B is given in example 6. The program includes a calibration routine and allows the operator to input specific voltage values on the keyboard. The program also provides automatic range changing and error messages that indicate if the voltage value requested exceeds 9.99V or if a negative voltage is requested. A line-by-line explanation is given after the program. Programming fundamentals are provided in paragraphs 3-29 through 3-34.

**3-78** The sample program requires use of the General I/O and Extended I/O ROM's. After keying in the program, press RUN. All operations required to complete the program are

given on the calculator display. After each operation is completed, press CONTINUE.

#### NOTE

*The program listings provided in the following examples are taken from an HP 9866B printer. These listings are provided only because 9866B printouts are easier to read than printouts from the 9825A's internal strip printer. Also, a check sum is provided at the end of each 9825A program listing. Make sure that the check sum at the end of your keyed-in program matches the check sum provided in the listing.*

#### Example 6. 9825 Sample Program, 59501B Unipolar Output

```

0: "UNIPOLAR Voltage Output!59501A":
1: dsp "Set 59501B to UNIPOLAR";stp
2: cmd 7,"?U&";"2000"
3: dsp "Set ZERO ADJUST for 0V";stp
4: cmd 7,"?U&";"2999"
5: dsp "Set D/A FS ADJ for 9.99V";stp
6: ent "Enter desired V(0 to 9.99V)";V
7: if V<0!sto 12
8: if V>9.99!sto 14
9: if V>.999!sto 16
10: .001+D!1000+R
11: sto 17
12: dsp "No Nesative Voltases"
13: wait 3000!sto 6
14: dsp "Voltage Too High"
15: wait 3000!sto 6
16: .01+D!2000+R
17: R+int(V/D+.5)+N
18: fmt 1,f4.0;zi!wrt 706.1;N!sto 6
19: end
*10751

```

#### Explanation:

- 1: Setup instructions.
- 2-5: Calibration instructions using ZERO ADJUST and D/A FULL SCALE ADJUST on 59501B.
- 6: User inputs desired output voltage (0 to 9.99) on keyboard.
- 7-17: Proper range is selected and correct data word value (N) is calculated to represent voltage requested. If the voltage requested (line 6) is too high or negative, the appropriate error message appears on the display for three seconds and, then the program returns to line 6.
- 18: Data word (N) is sent to the 59501B. Format f4.0 deletes leading spaces and z suppresses the carriage return/line feed characters. If leading spaces are not deleted and the CR/LF characters are not suppressed, the output will go to an undesired value (see paragraph 3-34).

### 3-79 Bipolar Mode

**3-80 Calibration.** The ZERO ADJUST allows the negative limit to be set to  $-10\text{V}$  when the 59501B is programmed to zero (2000). The D/A FULL SCALE ADJUST allows the positive limit to be set to  $+9.98\text{V}$  when the 59501B is programmed to maximum (2999). This range results in a resolution of  $19.98\text{V}/999$  or  $20\text{mV}$  per program-

ming step. Calibration procedures for operating in the bipolar mode are provided in paragraph 5-30.

**3-81 Sample Program.** A sample program for controlling the bipolar output of the 59501B is given in example 7. This program is similar to the unipolar mode program given in example 8 except that it allows keyboard input of bipolar voltage from  $-10\text{V}$  to  $+9.98\text{V}$ .

Example 7. 9825A Sample Program, 59501B Bipolar Output

```
0: "BIPOLAR Voltage Output;59501A":
1: fxd 3
2: dsp "Set 59501B to BIPOLAR";stp
3: cmd 7;"?U&";"2999"
4: dsp "Set D/A FS for +9.980";stp
5: cmd 7;"?U&";"2000"
6: ent "Enter DVM reading";X:abs(X)+X
7: (10+X)/2+Y
8: dsp "Set ZERO ADJ for ";-Y!stp
9: cmd 7;"?U&";"2999"
10: dsp "Readjust D/A FS for 9.980";stp
11: ent "Enter desired output voltage";V
12: if V<-10 or V>9.98!dsp "Voltage too high";wait 3000!sto 11
13: if V<=.998 and V>=-1!1000+int((V+1)/.002+.5)+N!sto 15
14: 2000+int((V+10)/.02+.5)+N
15: fmt 1,f4.0;ziwrt 706.1;N!sto 11
16: end
*21592
```

#### Explanation:

- 1: Sets fixed point format with three digits to the right of the decimal. This allows for better accuracy when performing the adjustment specified in line 8.
- 2: Setup instruction.
- 3-10: Calibration routine using ZERO ADJUST and D/A FULL SCALE ADJUST controls on the 59501B. Note that in line 7, an average value is calculated so that the adjustment can be completed in the minimum number of steps.
- 11: User inputs desired output voltage ( $-10$  to  $+9.98$ ) on keyboard.
- 12: If the voltage requested is too high, "Voltage too high" appears on the display for three seconds, and then the program returns to line 11.
- 13-14: Proper range is selected and correct data word value (N) is calculated.
- 15: Data word (N) representing the desired positive or negative output voltage is sent to the 59501B. Format f4.0 deletes leading spaces and z suppresses carriage return/line feed characters. If leading spaces are not deleted and CR/LF characters are not suppressed, the output will go to an undesired value (see paragraph 3-34).