Programming Note

59501A/HP 85-1

May 1982

SUPERSEDES: NONE

Introductory Operating Guide
for the 59501A D/A-Power Supply Programmer with the HP 85 Computer

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Introduction

This note is a guide to the basic operation of the 59501A, as either a remote power supply programmer or a programmable low level DC voltage source, with the HP 85 computer.

Familiarity with the HP 85 and its programming language, BASIC, makes the examples more meaningful. The HP 85’s capabilities are best described in the manuals listed in the section titled Related Documents. To acquaint yourself with the HP 85, review these manuals and use them as a reference as you gain experience. When you are familiar with the HP 85, this note will enable you to quickly write programs that control the 59501A.

Related Documents

In addition to the modes of operation described in this note, the 59501A, and HP 85 have other useful capabilities. The materials listed below contain complete documentation for all of these capabilities. They can be obtained through your nearest Hewlett-Packard sales office.

59501A Literature
Operating and Service Manual (59501-90001)

HP 85 Literature
Owner’s Manual and Programming Guide (00085-90002)
Quick Reference Guide (00085-90040)
I/O Programming Guide (00085-90142)

HP-IB Literature
Tutorial Description of the Hewlett-Packard Interface Bus (5952-0156)
Assembling the System

A. Required Equipment

The programs contained in this note require the following equipment:

1. 59501A HP-IB Isolated D/A Power Supply Programmer
2. HP 85 Computer
   a. ROM drawer (82936A)
   b. I/O programming ROM (00085-15003)
   c. HP-IB Interface (82937A)
3. For use as a power supply programmer:
   The Hewlett-Packard power supply you wish to program (see Table 1).

NOTE: A digital voltmeter (DVM) is necessary for proper calibration. The HP 3465B or equivalent is recommended.

B. Set-Up

With all ac power turned off:
1. Make sure that the I/O programming ROM and ROM drawer are in place in the HP 85.
2. Verify that the address switches on the back panel of the 59501A are set to 06. (See Figure 1).

![Address Switch](image)

3. Insert the HP-IB interface into one of the HP 85’s rear panel slots.
4. Attach the connector at the free end of the interface cable to the rear of the 59501A.

<table>
<thead>
<tr>
<th>HP Model #</th>
<th>Constant Voltage Operation</th>
<th>Constant Current Operation</th>
<th>HP Model #</th>
<th>Constant Voltage Operation</th>
<th>Constant Current Operation</th>
<th>HP Model #</th>
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<th>Constant Current Operation</th>
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<td>Fig. # 13</td>
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<td>17</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This mode is not available
5. For operation as a power supply programmer:
   a. Find the correct wiring diagram below, corresponding to power supply model number, and either CV or CC mode of operation. (See Table 1).
   b. Arrange the barrier strip jumpers on the power supply as illustrated in the diagram.
   c. Remove internal jumpers or components from the power supply if diagram requests.
   d. Wire the 59501A to the power supply as illustrated.
   e. Set range switch on power supply if applicable.
   f. Before permanently wiring the power supply to the 59501A, check the power supply operating and service manual for proper wiring technique and external components which may be needed to insure ripple and noise specifications.

6. For operation as a DC source:
   a. Wire load to 59501A as illustrated in Figure 2.

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**CV Programming Connections**

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Figure 2. Connecting the 59501A as a Low Level Voltage Source.

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Figure 3.

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Figure 4.

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Figure 5.

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Figure 6.
CV Programming Connections (Cont.)

![Diagram of CV Programming Connections](image1)

**Figure 20.**

**Figure 21.**

CC Programming Connections

![Diagram of CC Programming Connections](image2)

**Figure 22.**

**Figure 23.**
Figure 32.

Figure 33.

Figure 34.

Figure 35.
A. 59501A Programmer-Power Supply Combination

Before programming a 59501A-power supply combination, a two-step calibration procedure must be performed to match the particular power supply to the 59501A. A similar calibration is necessary when the 59501A is used as a low level DC signal source.

A-1. Unipolar Operation

Unipolar Constant Voltage Programming

Calibration

1. Connect the digital voltmeter between the +S and −S terminals on the power supply.
2. Set the mode switch on the rear of the 59501A to UNIPOLAR and turn the POWER SUPPLY FULL SCALE ADJUST potentiometers fully counterclockwise.
3. If the power supply has a front panel current control, set it to mid-range.
4. Apply power to the HP 85, the 59501A, and the power supply. Allow a 30 minute warm-up.

Unipolar Constant Current Programming Calibration

1. Connect a resistive load in series with an external current monitoring resistor across the supply's output terminals. Refer to Section V of the applicable operating and service manual for resistor values, power ratings, and CC test setup diagram.
2. Connect a digital voltmeter across the current monitoring resistor.
3. Set the mode switch on the rear of the 59501A to UNIPOLAR and turn the POWER SUPPLY FULL SCALE ADJUST potentiometers fully counterclockwise.
4. On the power supply, set the front panel VOLTAGE control fully clockwise.
5. Apply power to the HP 85, 59501A and the power supply. Allow a 30 minute warm-up.

Figure 36 is a program for constant voltage programming calibration of a 59501A-power supply combination. It contains set-up and calibration routines, automatic range changing, and will prompt with an error message if the voltage entered is negative.

Instructions:

Enter the program and press RUN. All required calibration operations are displayed on the CRT of the HP 85. The maximum desired output voltage (e.g. 20) should be entered when prompted by the program. The program automatically uses 99.9% of the value (e.g. 19.98) to calibrate the 59501A-power supply combination. To run the program again, press RUN then RUN.

Figure 36. Unipolar Power Supply Programmer Calibration Program.

The program listed in Figure 36 may be modified for constant current programming calibration of a 59501A power supply combination. Current must be substituted for voltage and the output current must be monitored using the above set-up.
A-2 Bipolar Power Supply Amplifier (BPS/A) Constant Voltage Calibration

1. Connect the DVM between the +S and −S terminals (Models 6825A-6827A) or between OS and CS terminals (Model 6824A), with the DVM common to +S or the OS terminal.
2. Set the mode switch on the rear of the 59501A to BIPOLAR.
3. On BPS/A, set mode switch to VAR GAIN AMP (6824A-6827A) or AMPLIFIER (6824A).
4. Turn the VOLTAGE controls on BPS/A fully counterclockwise.
5. On Models 6825A-6827A only, set the RANGE switch to the desired output range and set the CURRENT control to mid-range.

Figure 37 is a program for BPS/A constant voltage programming calibration. It contains set-up and calibration routines, automatic range changing, and will prompt with an error message if the voltage entered is out of range.

**Instructions:**

Enter the program and press RUN. All required calibration operations are displayed on the CRT of the HP 85. The maximum desired voltage (e.g. 20) should be entered when prompted by the program. The program automatically uses 99.9% of the value (e.g. 19.98) to calibrate the 59501A-BPS/A combination. To run the program again, press RUN then RUN.

The program listed in Figure 37 may be modified for constant current programming calibration of a 59501A-power supply combination. Reference instructions for unipolar constant current operation.

```
10 ' CALIBRATION FOR
20 ' BIPOLAR POWER SUPPLY
30 ' 59501A VOLTAGE OUTPUT
40 ' CLEAR
50 ' Set-up instructions
60 ' 76 DISPLAY "Set the 59501A mode switch to"
90 ' DISPLAY "BIPOLAR, then press CONT."
100 ' PAUSE
110 ' DISPLAY "Turn the POWER SUPPLY FULL"
120 ' DISPLAY "SCALE ADJUST pots fully"
130 ' DISPLAY "counter-clockwise, then"
140 ' DISPLAY "press CONT"
150 ' PAUSE
160 ' 170 DISPLAY "".
180 ' DISPLAY "Enter the power supply full"
190 ' DISPLAY "scale output voltage"
200 ' INPUT F
210 ' F=ABS(F)
220 ' F=999#F
230 ' 240 ' Calibration routine
250 ' 260 ' OUTPUT 7.06 USING "# F", 2999
270 ' DISPLAY "Set the POWER SUPPLY FULL SCALE"
280 ' DISPLAY "ADJUST and the D/A FULL SCALE"
290 ' DISPLAY "ADJUST for an output of"
300 ' DISPLAY F2;"volts."
310 ' DISPLAY "Then press CONT."
320 ' PAUSE
330 ' OUTPUT 7.06 USING "# F", 2999
340 ' DISPLAY ""
350 ' DISPLAY ""
360 ' DISPLAY "Enter DVM reading"
370 ' INPUT V
380 ' V=ABS(V)
390 ' DISPLAY ""
400 ' Y=(F+V)/2
410 ' Y=Y
420 ' DISPLAY "Set the ZERO ADJUST for an"
430 ' DISPLAY "output of", Y,"Volts."
440 ' DISPLAY "Then press CONT."
450 ' PAUSE
460 ' OUTPUT 7.06 USING "# F", 2999
470 ' DISPLAY ""
480 ' DISPLAY "Re-adjust the D/A FULL SCALE"
490 ' DISPLAY "ADJUST for an output of", F2
500 ' DISPLAY "Volts. Then press CONT."
510 ' PAUSE
520 ' DISPLAY ""
530 ' DISPLAY "CALIBRATION COMPLETE."
540 ' END
```

Figure 37. Bipolar Power Supply Programmer Calibration Program.
B. 59501A as a Low Level DC Signal Source

B-1. Unipolar Mode Calibration

1. Connect the DVM between the A1 and A2 output terminals of the 59501A. Connect the DVM common to the A1 terminal.
2. Set the mode switch on the rear of the 59501A to UNIPOLAR.
3. Apply power to the HP 85 and the 59501A. Allow a 30 minute warm-up.

Figure 38 is a program for calibrating the 59501A for use as a low level unipolar DC signal source. It includes set-up and calibration routines.

Instructions:

Enter the program and press RUN. All calibration operations are displayed on the CRT of the HP 85. To run the program again, press RESET then RUN.

```
10 REM CALIBRATION FOR
20 REM UNIPOLAR 59501A VOLTAGE
30 REM OUTPUT
40 REM
50 REM Set-up instructions
60 CLEAR
70 DISP "Set the 59501A mode switch to"
80 DISP "UNIPOLAR, then press CONT."
90 PAUSE
110 REM Calibration routine
130 OUTPUT 706 USING "$R,4D" ; 2999
150 DISP "Set the ZERO ADJUST for an"
160 DISP "output of 0.000 Volts."
170 DISP "Then press CONT."
180 PAUSE
190 OUTPUT 706 USING "$R,4D" ; 2999
200 DISP "Set the D/A FULL SCALE ADJUST"
210 DISP "for an output of 9.99 Volts."
220 DISP "Then press CONT."
230 PAUSE
250 DISP "CALIBRATION COMPLETE"
270 END
```

Figure 38. Unipolar D/A Calibration Program.

B-2. Bipolar Mode Calibration

1. Connect the DVM between the A1 and A2 output terminals of the 59501A. Connect the DVM common to the A1 terminal.
2. Set the mode switch on the rear of the 59501A to BIPOLAR.
3. Apply power to the HP 85 and the 59501A.

Figure 39 is a program for calibrating the 59501A for use as a low level bipolar DC signal source. It includes set-up and calibration routines.

Instructions:

Enter the program and press RUN. All calibration operations are displayed on the CRT of the HP 85. To run the program again, press RESET then RUN.

```
50 REM CALIBRATION FOR
60 REM BIPOLAR 59501A VOLTAGE
70 REM OUTPUT
80 REM
90 REM Set-up instructions
100 CLEAR
120 DISP "Set the 59501A mode switch to BIPOLAR, then press CONT."
130 PAUSE
150 OUTPUT 706 USING "$R,4D" ; 2999
170 DISP "Set the D/A FULL SCALE ADJUST"
190 DISP "for an output of 9.999 Volts."
210 DISP "Then press CONT."
230 PAUSE
250 OUTPUT 706 USING "$R,4D" ; 2999
270 DISP "Enter DVM reading"
290 INPUT V
310 Y=ADSC(V)
330 DISP "X/2"
350 Y=(Y+V)/2
360 Y=Y
370 DISP "Set the ZERO ADJUST for an"
390 DISP "output of$,Y\text{Volts.}"
410 DISP "Then press CONT."
430 PAUSE
450 OUTPUT 706 USING "$R,4D" ; 2999
470 DISP "Re-adjust the D/A FULL SCALE"
490 DISP "ADJUST for an output of 9.999"n
510 DISP "Volts. Then press CONT."
530 PAUSE
550 DISP "CALIBRATION COMPLETE"
570 END
```

Figure 39. Bipolar D/A Calibration Program.
The 59501A is an HP-IB instrument capable of performing a LISTEN function on the interface bus. It is programmed by a data word comprised of four digits. The first digit selects the range and the following three digits specify the desired output within the range, in terms of percentage of full scale. The 59501A output is either unipolar or bipolar, depending on the position of the mode switch on the back panel. Table 2 shows a few examples of programmed data words.

### Table 2
**Example Data Words**

<table>
<thead>
<tr>
<th>% of Power Supply Full Scale Output</th>
<th>59501A Output</th>
<th>Programmed Data Word</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIPOLAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99.9%</td>
<td>9.99 V</td>
<td>2999</td>
</tr>
<tr>
<td>50.0%</td>
<td>5.00 V</td>
<td>2500</td>
</tr>
<tr>
<td>9.99%</td>
<td>0.999 V</td>
<td>1999</td>
</tr>
<tr>
<td>5.00%</td>
<td>0.500 V</td>
<td>1500</td>
</tr>
<tr>
<td>0%</td>
<td>0 V</td>
<td>1000, 2000</td>
</tr>
<tr>
<td><strong>BIPOLAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>99.9%</td>
<td>9.99 V</td>
<td>2999</td>
</tr>
<tr>
<td>50.0%</td>
<td>5.00 V</td>
<td>2750</td>
</tr>
<tr>
<td>9.99%</td>
<td>0.999 V</td>
<td>1999</td>
</tr>
<tr>
<td>0%</td>
<td>0 V</td>
<td>2500, 1500</td>
</tr>
<tr>
<td>Negative Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td>-10 V</td>
<td>2000</td>
</tr>
<tr>
<td>10%</td>
<td>-1 V</td>
<td>1000</td>
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</table>

**NOTE:**
1. The programmed data word is converted into an integer. Decimal points are not allowed.
2. 0.5 is added to the word before the integer conversion, so the value will be rounded up if the first decimal place is 0.5 or greater.

---

### Figure 40. Range Decoding Flowchart.

**B. Programming with Constants**

**Note:** The 59501A-power supply combination must be calibrated before programming to avoid possible damage to the power supply.

**CV Power Supply Programming:**
To set the output voltage of a 60 V supply to 30 V.
1. Compute $30/60 = 50\%$.
2. Program

```
OUTPUT 706 USING "#4D';2500
HP 85 Command
HP-IB Select Code
Address of 59501A
"Image" or format of data word to be sent will follow
```

---

**A. Range Selection**
Before choosing the three magnitude digits, the range digit must be selected.

The low range covers 0-9.99% (0-0.999 volts), and the high range 0-99.9% (0-9.99 volts). For an output between 1 and 9.99 volts, the high range must be used. However, an output of less than 1 volt could be programmed with either range. Using only the high range makes programming slightly simpler, but range decoding provides for better resolution in the low end.

Figure 40 shows a method of implementing range decoding.
CC Power Supply Programming:
To set the output current of a 10 A supply to 0.661 A
1. Compute \( \frac{0.661}{10} = 0.661\% \)
2. Program

\[ \text{OUTPUT 706 USING "#.AD":1661} \]

Low Level DC Signal Source:
To output 6.72 V, program

\[ \text{OUTPUT 706 USING "#.AD":2672} \]

D. Example Programs

```
10 \# 59501A UNIPOLAR
20 \# POWER SUPPLY PROGRAMMER
30 \# EXAMPLE PROGRAM
40 \# CLEAR
50 \# "Enter the power supply/s"
60 \# "Full scale output voltage.
70 \# INPUT F
80 IF F<0 THEN BEEP @ DISP "Negative voltage not allowed." @ GOTO 60
90 \# "Enter the desired output voltage."
100 \# INPUT U
110 IF U<0 THEN BEEP @ DISP "Negative voltage not allowed." @ GOTO 110
120 \# Calculate percent of
130 \# power supply full scale
140 \# IF P<99 THEN BEEP @ DISP "Voltage too large." @ GOTO 140
150 \# 200 \# Select range
200 \# IF P<99 THEN GOTO 280
210 \# \# Low range calculations
220 \# M=INT(P*100+.5)
230 \# L=M+1000
240 \# GOTO 320
250 \# \# High range calculations
260 \# M=INT(P*100+.5)
270 \# D=M+2000
280 \# OUTPUT 706 USING "#.AD":D
290 \# "The programmed data word is":D
300 \# GOTO 110
310 \# END
```

C. Programming with Variables
Programming with variables allows the output value to be updated or changed with relative ease. The following programming examples may be entered into your HP 85 and run to demonstrate this type of programming. These programs ask for power supply output voltage, then scale that value up (or down) and calculate the correct 59501A programming word.

**NOTE:** The 59501A should be calibrated first, to obtain accurate output levels and avoid possible damage to the programmed power supply.

![Figure 41: Unipolar Power Supply Programming Example.](image-url)
Figure 42. Bipolar Power Supply Programming Example.

Signal Generation

The 59501A can easily be used to generate repetitive voltage waveforms. The following example computes the program data words, then generates a zero to ten volt sawtooth waveform.

Figure 43. D/A Mode Programming Example.

IEEE 488 interface functions implemented by the 59501A:

L2
AH1

Figure 44. HP-IB Capabilities