

# HP 6002A Power Supply



# HP 1000 Computer



## Programming Guide

Application Note 401-9

### Device Introduction

The HP 6002A DC Power Supply<sup>1</sup> employs a unique extended range technique which allows it to furnish maximum output power over a wide range of voltage and current combinations. The supply can provide a full 200 watts of output from 20V, 10A to 50V, 4A. The output is fully adjustable through the entire operating range of +0 to +50 volts and 0 to 10 amps by front-panel voltage and current controls.

Option 001, the HP-IB interface allows the supply to be digitally controlled from a calculator, computer, or other controller. Either the output voltage or current can be programmed.

A pair of switches on the rear panel of the supply allows selection of any one of three modes of operation: local, HP-IB constant voltage (CV), or HP-IB constant current (CC). The 6002A acts only as a listener on the bus.

### Addressing

Before the 6002A can accept programming information, it must be addressed to listen. The 6002A has listener capability only. The switches which allow the 6002A to be addressed as a listener are located on the rear panel. They are in the upper right hand-corner of the box, just to the right of the HP-IB connector.

There are seven switches, but only the left five are used. Note that the 6002A address cannot be read directly off of the rear panel in binary. The least significant bit is farthest to the left as shown in figure 9-1. The octal address shown is 5.

Constant voltage (CV) or constant current (CC) operation must also be set (also shown in figure 9-1). The HP-IB option 001 circuits are factory adjusted for CV operation<sup>2</sup>. See the "Programming" section for more details.



### System Preparations

#### LU Assignment

One logical unit should be assigned to the 6002A. Assuming the switches are set to an address of 5 as shown in figure 9-1, the LU assignment may be performed from File Manager,

:SYLU,17,10,5B

This statement would assign LU 17 to equipment table 10. The device address associated with LU 17 would be 5.

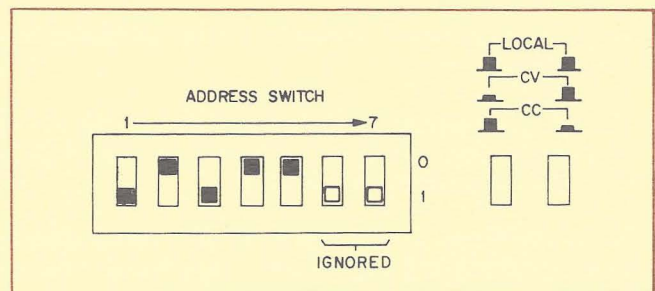


Figure 9-1. 6002A Listen Address and Mode Switches

<sup>1</sup>The 6002A Operating and Service Manual (06002-90001), the HP-IB Power Supply Interface Guide (5952-3990), and Application Note 401-1 (5953-2800) should be used with this note.

<sup>2</sup>Constant current (CC) adjustments are also discussed in Appendix A of the 6002A Operating and Service Manual (06002-90001).

## Buffering

The buffering option for the 6002A EQT should be turned off until the device has been tested for valid operation.

```
:SYEQ,10,UN
```

will set the 6002A EQT to the unbuffered mode.

Although the time-out for the 6002A EQT must be a compromise for all devices on the HP-IB, the 6002A time-out can be as short as one second. The time-out is an error condition for this device.

The 6002A either listens and accepts programming information, or an error condition exists (the 6002A hardware is inoperative). For this reason, it is usually satisfactory to allow the operating system to handle time-out errors. (The device configuration word defaults to this condition.) From File Manager, a system request may be used to set the time-out value:

```
:SYTD,10,100
```

will set the time-out on EQT 10 to one second.

## Configuration

The 6002A is a device which will need special configuration on HP-IB. Four ASCII characters are expected by the power supply. These characters do not include an end-of-record terminator. (The carriage return (CR), linefeed (LF) terminator will confuse the 6002A.) When an ASCII write request (a formatted "WRITE" from FORTRAN, for example) is performed in the HP 1000, a CRLF is automatically sent as the record terminator. By inserting the underline character ("\_") at the end of each output record, the end-of-record terminators may be suppressed. This method must be used each time a write request is made to the 6002A. See the example FORTRAN program in figure 9-4 for more details.

SRQ is not applicable to the 6002A. The default SRQ configuration is satisfactory.

DMA is not usually allocated for the 6002A so the device configuration word should be checked to see that a DMA channel is not inadvertently allocated.

The I, J, and P bits of the configuration word are not applicable to the 6002A, and may be left at their default values.

From File Manager,

```
:CN,17,25B,17000B
```

will assure that LU 17 (the 6002A) is configured correctly.

## Remote

The 6002A need not be configured into remote for programming.

## Programming

Because record terminators are not accepted, File Manager should not be used to check out the power supply.

The HP-IB option (001) is basically a digital-to-analog converter (DAC) that voltage-programs the power supply's constant voltage (CV) or constant current (CC) output in the high or low range. The DAC automatically provides a voltage-programming output to the power supply as soon as four digits are received. This output is retained until the next four digits are received. The DAC is programmed by the magnitude digits in BCD in such a way that 000 equal 00.0% of full range, 500 equals 50.0% of full range, and 999 equals 99.9% of full range.

The magnitude of the constant voltage (CV) or constant current (CC) output of the power supply is programmed by a data word comprised of four ASCII characters (digits) received in the order shown by figure 9-2. The first digit specifies range and the next three digits specify the desired magnitude (percentage of full scale).

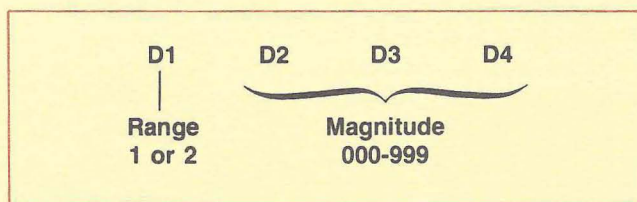


Figure 9-2. 6002A Data Word Format

```

0001 FTN4,L
0002 PROGRAM TVOUT(3),11-28-78 (GWG) TEST VOUT
0003 INTEGER VOUT
0004 COMMON ILU,ILST,IDLU Input parameters saved here.
0005 DATA NO/2HNO/,BUS/2HBU/
0006 IF(INPRM(ID).EQ.NO)GO TO 998 Obtain input parameters.
0007 6 WRITE(ILU,10)
0008 10 FORMAT("ENTER: REAL 'VOLTS' ; 50 MEANS END: _")
0009 READ(ILU,)VOLTS Read input voltage value from the user
terminal.
0010 IF(VOLTS.GT.50.)GO TO 999 If voltage is illegal, terminate the program.
0011 IF(VOUT(VOLTS).EQ.NO) GO TO 999 Call function to program the 6002A.
0012 GO TO 6
0013 998 WRITE(ILU,15)
0014 15 FORMAT(":RU,TVOUT,ILST,IDLU")
0015 999 STOP
0016 END
0017 C
0018 C
0019 C
0020 INTEGER FUNCTION VOUT(VOLTS),11-07-78 (GWG) VOLTS TO 6002A
0021 C
0022 C USER PROGRAM ERROR CHECKING MUST BE USED WITH THIS
0023 C FUNCTION CALL, NO BUFFERING, ERRORS ARE CHECKED BY
0024 C THE FUNCTION.
0025 C
0026 C OUT OF RANGE ERROR = -1
0027 C
0028 INTEGER RANGE,OUTV
0029 REAL RESOLU,VOLTS
0030 COMMON ILU,ILST,IDLU
0031 DATA NO/2HNO/,YES/2HYE/
0032 VOUT=YES
0033 IF(VOLTS.LT.0)GO TO 300
0034 50 IF(VOLTS.GE.10.)GO TO 100
0035 RESOLU=.01 Appendix A of the 6002A Operating and
Service Manual describes range program-
ming in detail.
0036 RANGE=1000
0037 GO TO 200
0038 100 IF(VOLTS.GE.50.)GO TO 300
0039 RESOLU=.05
0040 RANGE=2000
0041 200 OUTV= VOLTS/RESOLU +.05 + RANGE
0042 WRITE(IDLU,10)OUTV
0043 10 FORMAT(I4,"_") Note, the underline character must be used
to suppress the carriage return and linefeed.

```

Figure 9-4. Programming 6002A Voltages

```
0044      IERORV=IBERR(IDLU)
0045      IF(IERORV.EQ.0) RETURN
0046      WRITE(ILU,1000)IERORV
0047  1000  FORMAT("HP-IB ERROR "I3".")
0048      VOUT=NO
0049      RETURN
0050  300  WRITE(ILU,1001)
0051  1001  FORMAT("6002A VOLTAGE OUT OF RANGE.")
0052      RETURN
0053      END
```

Figure 9-4. Programming 6002A Voltages (Continued)

The range digit can be the number 1 specifying low range (0-10 volts for CV, 0-2A for CC) or the number 2 specifying high range (0-50 volts for CV, 0-10 amps for CC). The magnitude digits can be any number from 0-999 (see figure 9-3).

Since 999 is the maximum value for the magnitude digits, the programmable output ranges are as shown in figure 9-3.

Figure 9-4 shows a FORTRAN test program and a generalized subroutine which allows the 6002A to be programmed from 0-49.9 volts by inputting the desired voltage value from a user terminal. The equations required to do the operation are straight forward and can be found in the subroutine.<sup>3</sup> Range programming for the CC operation can be done in a similar fashion.

The following paragraphs provide detailed operating instructions required to program the 6002A for constant voltage or constant current operation. Refer to figures 9-5 and 9-6 for adjustments and component locations respectively.

Low Range CV	— 0 to 9.99V (99.9% of 10V)
High Range CV	— 0 to 49.95V (99.9% of 50V)
Low Range CC	— 0 to 1.998A (99.9% of 2A)
High Range CC	— 0 to 9.99A (99.9% of 10A)

Figure 9-3. 6002A Programmable Output Ranges

<sup>3</sup> See the 6002A Operating and Service Manual, Appendix A for more information concerning range programming.

## Constant Voltage Operation

To program the supply for constant voltage operation:

- Connect the supply to an HP 1000 controller.
- Set the mode switches on the rear of supply to the CV position.
- Turn on the supply.
- With the supply's output terminals open, program the supply for the desired output voltage.
- Connect a short across the supply's rear panel output terminals and adjust the 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.

## Constant Current Operation

To program the supply for constant current operation, you must first adjust HP-IB option 001 for CC operation (steps a through h).

- Turn off the supply and set mode switches to the CC position.
- Turn the VOLTAGE control on the front panel fully clockwise.

- c. Use the constant current test setup (figure 9-5) except set RL1 and RL2 to approximately 3.5 ohms each and use a 0.01 ohm resistor for current sampling resistor RS.
- d. Connect the power supply to the HP 1000 and turn it on. Allow a 30-minute warm up period.
- e. Adjust constant current (CC) zero output by connecting an oscilloscope to the +S and -S terminals and repeating one and two below.
  1. Alternately program data words 2000 (zero high range) and 1000 (zero low range) with a 50msec (approx.) delay between data words. Programming these words consecutively in FORTRAN is close enough. If this is a problem, use a "DO" loop between programming statements.
  2. Adjust the ZERO ADJUST potentiometer (A300R19) and the ZERO BALANCE ADJUST potentiometer (A300R4) for a straight line at zero as indicated on the scope. Potentiometers are adjusted simultaneously to obtain the desired scope indication.
- f. Adjust CC high range full scale output by programming data word 2999 and adjusting A300R7 for a reading of .0999V on a digital voltmeter (connected across R(S) as shown in figure 9-5).
- g. Adjust CC low range full scale output by programming data word 1999 and adjusting A300R9 for a reading of .01998V on a digital voltmeter (connected across R(S)).
- h. Recheck adjustments. If necessary, repeat steps e through g above.
- i. Turn off the supply and connect a short across the rear output terminals.
- j. Set the mode switches to CC and turn on the supply.
- k. Program the supply for the desired output current.
- l. Open the output terminals and adjust the front panel VOLTAGE control for the desired maximum output voltage. If a load change causes the voltage limit to be exceeded, the supply automatically crosses over to constant voltage operation at this point voltage limit and the output current drops proportionally.

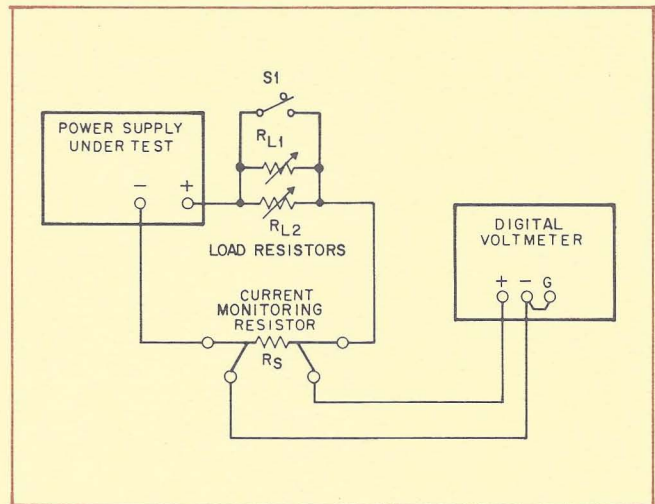


Figure 9-5. 6002A Constant Current Test Setup

## Performance

The 6002A is a listener-only on the HP-IB and is designed to be a programmable power supply with a versatile voltage and current and output range. Hence, its prime applications are found in the testing of electronic components and in supplying stimulus to various process control equipment. Actual performance testing would be more applicable to high speed, low current applications (i.e., ADC's used for waveform generation). If empirical measurements are desired, however, refer to the performance programs discussed in Chapter 5 of Application Note 401-1.

In actual applications of the 6002A, a stimulus is applied, and a response is expected or measured. The time between requesting the stimulus and the expected response is often useful information to the system programmer.

The 6002A will respond in less than 100 milliseconds when programmed from 0 to 99.9% of maximum rated output voltage. This response is independent of load. For programming the supply down (100% to 0.1% of maximum rated output), the output takes approximately 400 milliseconds without any load and approximately 200 milliseconds with a full load. The slower time to program down is due to the supply's output capacitor which discharges much more slowly without a load than with a load.

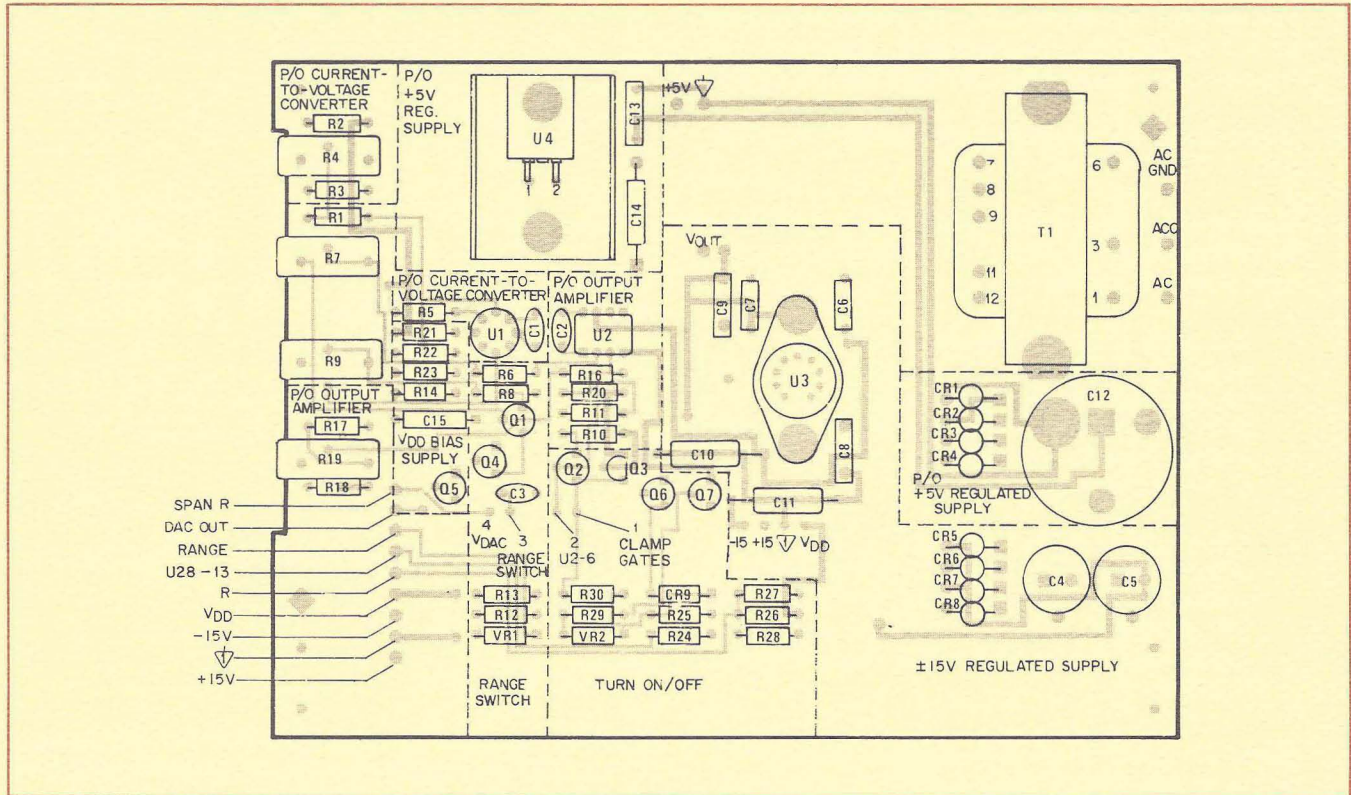


Figure 9-6. Component Adjustment Locations

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