

*Not whole T.O.*

*HEWLETT-PACKARD*

*SCANNED*

*5/19/99*

*TBm*

**USER'S GUIDE**  
**Dynamic Measurement DC Source**  
**HP Model 66332A**  
**System DC Power Supply**  
**HP Model 6632B, 6633B, 6634B,**

For instruments with Serial Numbers:

HP 66332A: US36320101 and up

HP 6632B: US36350101 and up

HP 6632B: US36390101 and up

HP 6632B: US36380101 and up



**HEWLETT  
PACKARD**

HP Part No. 5962-8121

Microfiche Part No. 5962-8122

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## Safety Summary

*The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.*

### GENERAL

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Any LEDs used in this product are Class 1 LEDs as per IEC 825-1.

### ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

### BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage, the correct fuse is installed, and all safety precautions are taken. Note the instrument's external markings described under "Safety Symbols".

### GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

**ATTENTION:** Un circuit de terre continu est essentiel en vue du fonctionnement sécuritaire de l'appareil. Ne jamais mettre l'appareil en marche lorsque le conducteur de mise ... la terre est d,branch,.

### FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

### DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

### DO NOT REMOVE THE INSTRUMENT COVER

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

*Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.*

## SAFETY SYMBOLS



Direct current



Alternating current



Both direct and alternating current



Three-phase alternating current



Earth (ground) terminal



Protective earth (ground) terminal



Frame or chassis terminal



Terminal is at earth potential. Used for measurement and control circuits designed to be operated with one terminal at earth potential.



Terminal for Neutral conductor on permanently installed equipment



Terminal for Line conductor on permanently installed equipment



On (supply)



Off (supply)



Standby (supply). Units with this symbol are not completely disconnected from ac mains when this switch is off. To completely disconnect the unit from ac mains, either disconnect the power cord or have a qualified electrician install an external switch.



In position of a bi-stable push control



Out position of a bi-stable push control



Caution, risk of electric shock



Caution, hot surface



Caution (refer to accompanying documents)

### WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

### Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

## Declaration Page

### DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Company

Manufacturer's Address: 150 Green Pond Road  
Rockaway, New Jersey 07866  
U.S.A.

declares that the Product

Product Name: a) Dynamic Measurement DC Source  
b) System DC Power Supply

Model Number: a) HP 66332A  
b) HP 6632B, 6633B, 6634B

conforms to the following Product Specifications:

Safety: IEC 1010-1:1990+A1(1992) / EN 61010-1:1993

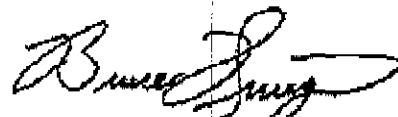
EMC: CISPR 11:1990 / EN 55011:1991 - Group 1 Class B  
IEC 801-2:1991 / EN 50082-1:1992 - 4 kV CD, 8 kV AD  
IEC 801-3:1984 / EN 50082-1:1992 - 3 V / m  
IEC 801-4:1988 / EN 50082-1:1992 - 0.5 kV Signal Lines  
1 kV Power Lines

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

New Jersey  
Location

January 1997  
Date



Bruce Krueger / Quality Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH,  
Department TRE, Herrenberger Strasse 130, D-71034 Boeblingen (FAX: +49-7031-14-3143)

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## Acoustic Noise Information

### Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenlärminformationsverordnung vom 18 Januar 1991.

- \* Schalldruckpegel  $L_p < 70$  dB(A)
- \* Am Arbeitsplatz
- \* Normaler Betrieb
- \* Nach EN 27779 (Typprüfung).

### Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.

- \* Sound Pressure  $L_p < 70$  dB(A)
- \* At Operator Position
- \* Normal Operation
- \* According to EN 27779 (Type Test).

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## Printing History

The edition and current revision of this manual are indicated below. Reprints of this manual containing minor corrections and updates may have the same printing date. Revised editions are identified by a new printing date. A revised edition incorporates all new or corrected material since the previous printing date.

Changes to the manual occurring between revisions are covered by change sheets shipped with the manual. In some cases, the manual change applies only to specific instruments. Instructions provided on the change sheet will indicate if a particular change applies only to certain instruments.

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Edition 1 \_\_\_\_\_ August, 1996  
Update 1 \_\_\_\_\_ January, 1997  
Update 2 \_\_\_\_\_ August, 1997

## Quick Reference

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### HP 66332A Dynamic Measurement DC Source and HP 6632B/6633B/6634B System DC Power Supplies

The HP 66332A is a 100 Watt, high performance dc power supply that provides dynamic measurement and analysis of voltage and current waveforms. It is designed to simplify the testing of digital cellular and mobile phones. For example, data acquired using its dynamic measurement capability can be used in determining the battery operating time of digital wireless communications products.

The HP 6632B/6633B/6634B are 100 Watt, high performance dc power supplies with output current measurement capability in the microampere range. They are well suited for testing portable battery-powered products.

Additionally, the combination of bench-top and system features in these dc sources provide versatile solutions for your design and test requirements.

#### Convenient bench-top features

- ◆ Up to 100 Watts output power
- ◆ Easy to use knob for voltage and current settings
- ◆ Highly visible vacuum-fluorescent front panel display
- ◆ Excellent load and line regulation; low ripple and noise
- ◆ Measurement capability down to microampere levels
- ◆ Current sinking up to the maximum rated output current
- ◆ Instrument state storage
- ◆ Portable case

#### Flexible system features

- ◆ HP-IB (IEEE-488) and RS-232 interfaces are standard
- ◆ SCPI (Standard Commands for Programmable Instruments) compatibility
- ◆ Triggered acquisition of digitized output current and voltage waveforms (HP 66332A only)
- ◆ I/O setup easily done from the front panel

## The Front Panel - At a Glance

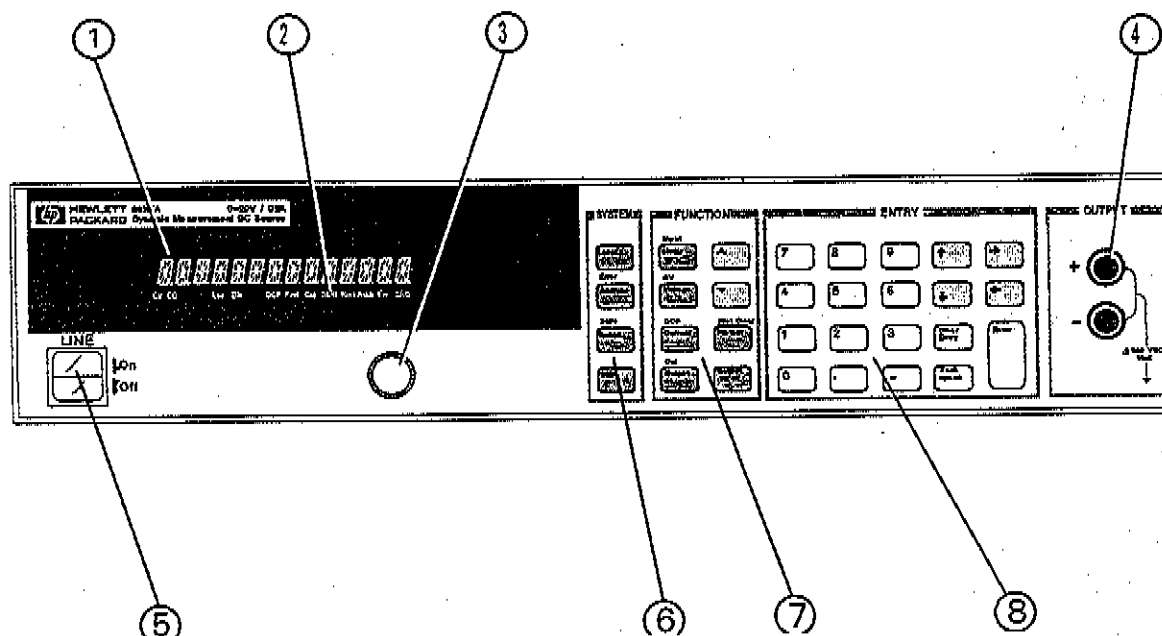
① 14-character display shows output measurements and programmed values.

② Annunciators indicate operating modes and status conditions.

③ Rotary control sets voltage, current, and menu parameters.

Use  and  to set the resolution; then adjust the value with the knob.

④ Optional front panel output connectors.



⑤ Turns the dc source on and off.

⑥ System keys:

- ◆ return to Local mode
- ◆ set the HP-IB address
- ◆ set the RS-232 interface
- ◆ display SCPI error codes
- ◆ save and recall instrument states.

⑦ Function keys:

- ◆ enable/disable output
- ◆ select metering functions
- ◆ program voltage and current
- ◆ set and clear protection functions
- ◆  and  scroll through the front panel menu commands.

⑧ Entry keys:

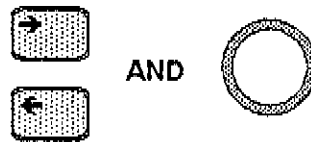
- ◆ enter values
- ◆ increment or decrement values
- ◆  and  select front panel menu parameters.
- ◆  and  select a digit in the numeric entry field.

## Front Panel Number Entry

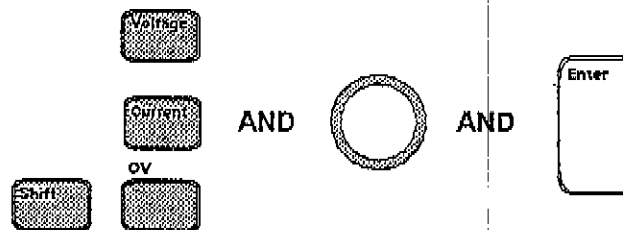
Enter numbers from the front panel using one of the following methods:

### Use the arrow keys and knob to change voltage or current settings

**NOTE** The output must be ON to see the displayed values change in Meter mode.



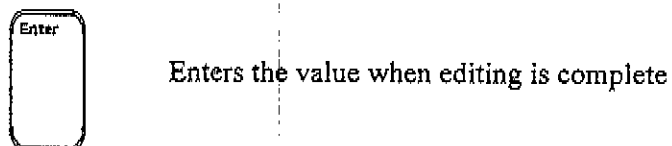
### Use the Function keys and knob to change the displayed settings



### Use the Arrow keys to edit individual digits in the displayed setting

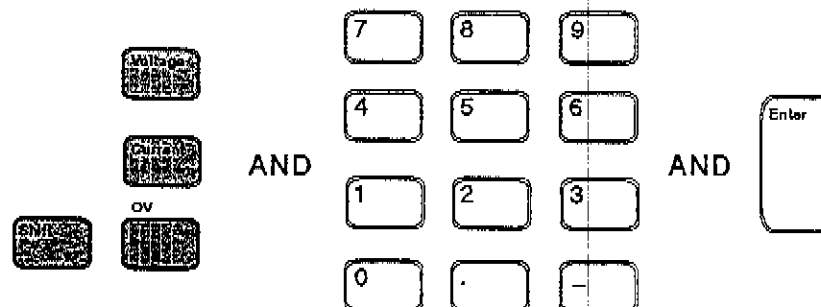
Increments the flashing digit   Moves the flashing digit to the right

Decrements the flashing digit   Moves the flashing digit to the left



### Use the Function keys and Entry keys to enter a new value

**NOTE** If you make a mistake, use the Backspace key to delete the number, or press the Meter key to return to meter mode.



## Front Panel Annunciators



CV CC      Unr Dis      OCP Prot Cal Shift Rmt Addr Err SRQ

|              |                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CV</b>    | The output is operating in constant voltage mode.                                                                                            |
| <b>CC</b>    | The output is operating in constant current mode.                                                                                            |
| <b>Unr</b>   | The output is unregulated.                                                                                                                   |
| <b>Dis</b>   | The output is OFF. Press the Output On/Off key to turn the output on.                                                                        |
| <b>OCP</b>   | The over-current protection state is ON. Press the OCP key to turn over-current protection off.                                              |
| <b>Prot</b>  | Indicates that the output has been disabled by one of the protection features. Press the Prot Clear key to clear the protection condition.   |
| <b>Cal</b>   | Calibration mode is ON. Scroll to the Cal Off command and press the Enter key to exit the calibration mode.                                  |
| <b>Shift</b> | The Shift key has been pressed.                                                                                                              |
| <b>Rmt</b>   | The selected Remote programming interface (either HP-IB or RS-232) is active. Press the Local key to return the unit to front panel control. |
| <b>Addr</b>  | The interface is addressed to talk or listen.                                                                                                |
| <b>Err</b>   | There is an error in the SCPI error queue. Press the Error key to view the error code.                                                       |
| <b>SRQ</b>   | The interface is requesting service.                                                                                                         |

## Immediate Action Keys

|                                                                                                                                                                         |                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|                                                                                      | A toggle switch that turns the output of the dc source on or off.                                      |
|                                                                                      | Activates front panel control when the unit is in remote mode (unless a Lockout command is in effect). |
|   | Resets the protection circuit and allows the unit to return to its last programmed state.              |
|   | A toggle switch that enables or disables overcurrent protection.                                       |

## Front Panel Menus - At a Glance

|         |       |                |                                                                  |
|---------|-------|----------------|------------------------------------------------------------------|
| Address |       | ADDRESS 7      | Sets the HP-IB Address                                           |
|         | ▼     | INTF HPIB      | Selects an interface (HPIB or RS232)                             |
|         | ▼     | BAUDRATE 300   | Selects baud rate (300, 600, 1200, 2400, 4800, 9600)             |
|         | ▼     | PARITY NONE    | Selects message parity (NONE, EVEN, ODD, MARK, SPACE)            |
|         | ▼     | FLOW NONE      | Selects flow control (XON-XOFF, NONE)                            |
|         | ▼     | LANG SCPI      | Selects language (SCPI or COMP)                                  |
| Recall  |       | *RCL 0         | Recalls instrument state                                         |
| Shift   | Save  | *SAV 0         | Saves present instrument state                                   |
| Shift   | Error | ERROR 0        | Displays errors in SCPI error queue                              |
| Meter   |       | 12.000V 0.204A | Measures output voltage and current                              |
|         | ▼     | 12.500V MAX    | Measures peak output voltage <sup>1</sup>                        |
|         | ▼     | 1.000V MIN     | Measures minimum output voltage <sup>1</sup>                     |
|         | ▼     | 12.330V HIGH   | Measures the high level of a voltage pulse waveform <sup>1</sup> |
|         | ▼     | 0.080V LOW     | Measures the low level of a voltage pulse waveform <sup>1</sup>  |
|         | ▼     | 12.000V RMS    | Measures rms voltage <sup>1</sup>                                |
|         | ▼     | 0.350A MAX     | Measures peak output current <sup>1</sup>                        |
|         | ▼     | 0.050A MIN     | Measures minimum output current <sup>1</sup>                     |
|         | ▼     | 0.400A HIGH    | Measures the high level of a current pulse waveform <sup>1</sup> |
|         | ▼     | 0.012A LOW     | Measures the low level of a current pulse waveform <sup>1</sup>  |
|         | ▼     | 0.210A RMS     | Measures rms current <sup>1</sup>                                |
| Voltage |       | VOLT 20.000    | Sets the output voltage                                          |
| Current |       | CURR 2.000     | Sets the output current                                          |
| Protect |       | OC -- -- --    | Protection status (example shows overcurrent tripped)            |
| Output  |       | *RST           | Places the dc source in the factory-default state                |
|         | ▼     | PON:STATE RST  | Select the power-on state command (RST or RCL0)                  |
|         | ▼     | PROT:DLY 0.08  | Sets the output protection delay in seconds                      |
|         | ▼     | RI LATCHING    | Sets the remote inhibit mode (LATCHING, LIVE, or OFF)            |
|         | ▼     | DFI OFF        | Sets the discrete fault indicator state (ON or OFF)              |
|         | ▼     | DFI:SOUR OFF   | Selects the DFI source (QUES, OPER, ESB, RQS, or OFF)            |
|         | ▼     | PORT RIDFI     | Sets the output port functions (RIDFI or DIGIO)                  |
|         | ▼     | DIGIO 7        | Sets and reads the I/O port value (0 through 7)                  |
|         | ▼     | RELAY ON       | Sets the output relay state (ON or OFF)                          |
|         | ▼     | RELAY NORM     | Sets the output relay polarity (NORM or REV)                     |
| Shift   | OV    | VOLT:PROT 22   | Sets overvoltage protection level                                |
| Shift   | Input | CURR:RANG HIGH | Sets current range (HIGH, LOW, or AUTO)                          |
|         | ▼     | CURR:DET ACDC  | Sets current measurement detector (ACDC or DC) <sup>1</sup>      |
| Shift   | Cal   | CAL ON         | Accesses calibration menu (See User's Guide).                    |

Use  and  to select menu parameters. Use  to exit any menu and return to metering mode.

<sup>1</sup>Not available on HP Models 6632B/6633B/6634B or in Compatibility mode

## SCPI Programming Commands - At a Glance

**NOTE** Most [optional] commands have been omitted for clarity. Refer to the Programming Guide for a complete description of all programming commands.

### ABORT

#### CALibrate

```
:CURRent [:POSitive]
:NEGative
:MEASure :LOWRange
:AC1
```

```
:DATA <n>
:LEVel P1 | P2 | P3 | P4
:PASSword <n>
:SAVE
:STATe <bool> [, <n>]
:VOLTage :PROTection
```

#### DISPlay

```
<bool>
:MODE NORMal | TEXT
:TEXT <display_string>
```

#### INITiate

```
:SEQuence[1][2]1
:NAME TRANSient | ACQuire1
:CONTInuous :SEQuence[1], <bool>
:NAME TRANSient, <bool>
```

#### MEASure | FETCh

```
:ARRay :CURRent?1
:VOLTage?1
[:CURRent][:DC]?2
:ACDC?1
:HIGH?1
:LOW?1
:MAX?1
:MIN?1
:VOLTage [:DC]?2
:ACDC?1
:HIGH?1
:LOW?1
:MAX?1
:MIN?1
```

#### OUTPut

```
<bool> [,NORelay]
:DFI <bool>
:SOURce QUES | OPER | ESB | RQS | OFF
:PON :STATe RST | RCL0
:PROTection :CLEar
:DElay <n>
:RI :MODE LATCHing | LIVE | OFF
```

### SENSe

```
:CURRent :RANGe <n>
:DETeCTOR ACDC | DC1
:FUNCTION "VOLT" | "CURR"1
:SWEep :OFFSet :POINTs <n>1
:POINTs <n>
:TINTerval <n>
[SOURce] CURRent <n>
:TRIGgered <n>
:PROTection :STATe <bool>
DIGital :DATA <n>
:FUNCTION RIDF | DIG
VOLTage <n>
:TRIGgered <n>
:PROTection <n>
:ALC :BANDwidth? | :BWIDTH?
```

### STATus

```
:PRESet
:OPERation [:EVENT]?
:CONDition?
:ENABle <n>
:NTRansition <n>
:PTRansition <n>
:QUESTionable [:EVENT]?
:CONDition?
:ENABle <n>
:NTRansition <n>
:PTRansition <n>
```

### SYSTEM

```
:ERRor?
:LANGUage SCPI | COMPatibility
:VERSion?
:LOCal
:REMote
:RWLock
```

### TRIGger

```
:SEQuence 2 | :ACQuire [:IMMediate]1
:COUNT :CURRent <n>1
:VOLTage <n>1
:HYSTeresis:CURRent <n>1
:VOLTage <n>1
:LEVel :CURRent <n>1
:VOLTage <n>1
:SLOPe :CURRent POS | NEG | EITH1
:VOLTage POS | NEG | EITH1
:SOURce BUS | INTernal1
[:SEQuence1 | :TRANSient][:IMMediate]
:SOURce BUS
:SEQuence1 :DEFine TRANSient
:SEQuence2 :DEFine ACQuire1
```

<sup>1</sup>Not available on HP Models 6632B/6633B/6634B

<sup>2</sup>Fetch commands not available on HP Model 6612B

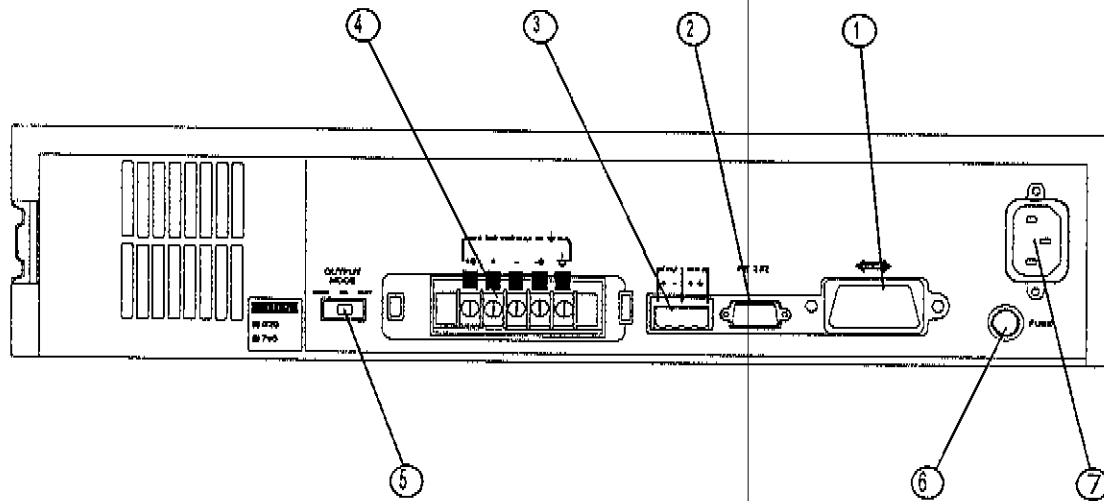
## The Rear Panel - At a Glance

① HP-IB (IEEE-488) interface connector

② RS-232 interface connector

③ INH/FLT (remote INHibit / internal FauLT) connector. Connector plug is removable.

④ Output and Remote sense terminal block.



⑤ Fast/Normal switch

⑥ Fuse holder

⑦ Power cord connector (IEC 320)

### Use the front panel Address menu to

- ◆ Select the HP-IB or RS-232 interface (see chapter 4 in User's Guide)
- ◆ Select the HP-IB bus address (see chapter 4 in User's Guide)
- ◆ Configure the RS-232 interface (see chapter 4 in User's Guide)

## Specifications

### Specifications

Table A-1 lists the specifications of the dc source. Specifications are warranted over the ambient temperature range of 0 to 55 °C. Unless otherwise noted, specifications apply after a 30-minute warm-up period.

**Table A-1. Performance Specifications**

| Parameter                                                                                                                                                                            |                                                                                                                                      | HP 6632B<br>HP66332A                                                                              | HP 6633B                                                                                            | HP 6634B                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Output Ratings                                                                                                                                                                       | Voltage:<br>Current:                                                                                                                 | 0 – 20 V<br>0 – 5A                                                                                | 0 – 50 V<br>0 – 2 A                                                                                 | 0 – 100 V<br>0 – 1A                                                                                  |
| Programming Accuracy<br>(@ 25C ±5°C)                                                                                                                                                 | Voltage:<br>+Current:                                                                                                                | 0.05% + 10 mV<br>0.05% + 2 mA                                                                     | 0.05% + 20 mV<br>0.05% + 1 mA                                                                       | 0.05% + 50 mV<br>0.05% + 0.5 mA                                                                      |
| DC Measurement<br>Accuracy<br>(via HP-IB or front panel<br>meters with respect to<br>actual output at 25C<br>±5°C)                                                                   | Voltage:<br><u>Low Current range</u><br>–20 mA to +20 mA:<br><u>High Current range</u><br>+20 mA to +rated I:<br>–20 mA to –rated I: | 0.03% + 3 mV<br><br>0.1% + 2.5 µA <sup>1</sup><br><br>0.2% + 0.5 mA <sup>2</sup><br>0.2% + 1.1 mA | 0.03% + 6 mV<br><br>0.1% + 2.5 µA <sup>1</sup><br><br>0.2% + 0.25 mA <sup>3</sup><br>0.2% + 0.85 mA | 0.03% + 12 mV<br><br>0.1% + 2.5 µA <sup>1</sup><br><br>0.2% + 0.25 mA <sup>3</sup><br>0.2% + 0.85 mA |
| Ripple and Noise<br>(in the range of 20 Hz to<br>20 MHz with outputs<br>ungrounded or with either<br>terminal grounded)                                                              | Normal mode voltage<br>(rms/p-p):<br>Fast mode voltage<br>(rms/p-p):<br>Current (rms):                                               | 0.3 mV/3 mV<br><br>1 mV/10 mV<br>2 mA                                                             | 0.5 mV/3 mV<br><br>1 mV/15 mV<br>2 mA                                                               | 0.5 mV/3 mV<br><br>2 mV/25 mV<br>2 mA                                                                |
| Load Regulation <sup>4</sup><br>(change in output voltage<br>or current for any load<br>change within ratings)                                                                       | Voltage:<br>Current:                                                                                                                 | 2 mV<br>1 mA                                                                                      | 4 mV<br>1 mA                                                                                        | 5 mV<br>1 mA                                                                                         |
| Line Regulation<br>(change in output voltage<br>or current for any line<br>change within ratings)                                                                                    | Voltage:<br>Current:                                                                                                                 | 0.5 mV<br>0.5 mA                                                                                  | 1 mV<br>0.25 mA                                                                                     | 1 mV<br>0.25 mA                                                                                      |
| Transient Response<br>Time                                                                                                                                                           | Normal mode:<br>Fast mode:                                                                                                           |                                                                                                   | < 100 µs<br>< 50 µs                                                                                 |                                                                                                      |
| (for the output voltage to recover to its previous level within 0.1% of the voltage rating of the unit following a change in load current of up to 50% of the output current rating) |                                                                                                                                      |                                                                                                   |                                                                                                     |                                                                                                      |

<sup>1</sup> This specification may degrade slightly when the unit is subjected to an RF field  $\geq 3$  V/meter.

<sup>2</sup> Applies in SCPI mode, with current detector set to DC. With current detector set to ACDC, accuracy is 0.2% + 2 mA. In COMPatibility mode, accuracy is 0.2% + 3 mA.

<sup>3</sup> Applies in SCPI mode, with current detector set to DC. With current detector set to ACDC, accuracy is 0.2% + 2 mA. In COMPatibility mode, accuracy is 0.2% + 1.5 mA.

<sup>4</sup> Applies at rear terminals with unit set to remote sensing and with sense terminals externally jumpered to their respective output terminals.

## Supplemental Characteristics

Table A-2 lists the supplemental characteristics, which are not warranted but are descriptions of typical performance determined either by design or type testing.

**Table A-2. Supplemental Characteristics**

| Parameter                                                         |                                                                      | HP 6632B<br>HP 66332A                                                                                                                                 | HP 6633B                                                                               | HP 6634B                                                                              |
|-------------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Input Ratings<br>(at full load)                                   | 100 Vac mains:<br>115 Vac mains:<br>220 Vac mains:<br>230 Vac mains: | 87–106 Vac, 47–63 Hz, 3.5 A, 250 W<br>104–127 Vac, 47–63 Hz, 3 A, 250 W<br>191–233 Vac, 47–63 Hz, 1.6 A, 250 W<br>207–253 Vac, 47–63 Hz, 1.5 A, 250 W |                                                                                        |                                                                                       |
| Output Programming<br>Range                                       | Voltage:<br>Current:<br>OVP:                                         | 0–20.475 V<br>0–5.1188 A<br>0–22 V                                                                                                                    | 0–51.188 V<br>0–2.0475 A<br>0–55 V                                                     | 0–102.38 V<br>0–1.0238 A<br>0–110 V                                                   |
| Average Programming<br>Resolution                                 | Voltage:<br>Current:<br>OVP:                                         | 5 mV<br>1.25 mA<br>100 mV                                                                                                                             | 12.5 mV<br>0.5 mA<br>250 mV                                                            | 25 mV<br>0.25 mA<br>500 mV                                                            |
| OVP Accuracy                                                      |                                                                      | 2.4% + 240 mV                                                                                                                                         | 2.4% + 600 mV                                                                          | 2.4% + 1.2 V                                                                          |
| Maximum Current<br>Measurement                                    |                                                                      | 6.66 A                                                                                                                                                | 2.43 A                                                                                 | 1.21 A                                                                                |
| Average Current<br>Measurement<br>Resolution                      | High Range:<br>Low Range:                                            | 203 $\mu$ A<br>0.6 $\mu$ A                                                                                                                            | 74 $\mu$ A<br>0.6 $\mu$ A                                                              | 37 $\mu$ A<br>0.6 $\mu$ A                                                             |
| Sink Current                                                      |                                                                      | –5 A                                                                                                                                                  | –2 A                                                                                   | –1 A                                                                                  |
| Sink Current<br>Tracking <sup>1</sup>                             | SCPI mode:<br>Compatibility mode:                                    | 0.4% + 2 mA<br>–250 mA                                                                                                                                | 0.4% + 1 mA<br>–100 mA                                                                 | 0.4% + 0.5 mA<br>–50 mA                                                               |
| Maximum Current in<br>Compatibility Mode                          |                                                                      | 20 mA                                                                                                                                                 | 8 mA                                                                                   | 4 mA                                                                                  |
| Programming<br>Accuracy<br>Temperature<br>Coefficient (change/°C) | Voltage:<br>Current:<br>OVP:                                         | 0.01% + 0.25 mV<br>0.01% + 30 $\mu$ A<br>0.015% + 4 mV                                                                                                | 0.01% + 0.5 mV<br>0.01% + 12 $\mu$ A<br>0.015% + 10 mV                                 | 0.01% + 1 mV<br>0.01% + 6 $\mu$ A<br>0.015% + 20 mV                                   |
| Readback Accuracy<br>Temperature<br>Coefficient (change/°C)       | Voltage:<br>Current (ACDC):<br>Current (DC):<br>Current (Low range): | 0.01% + 150 $\mu$ V<br>0.05% + 160 $\mu$ A<br>0.02% + 25 $\mu$ A<br>0.01% + 0.3 $\mu$ A                                                               | 0.01% + 500 $\mu$ V<br>0.05% + 80 $\mu$ A<br>0.02% + 10 $\mu$ A<br>0.01% + 0.3 $\mu$ A | 0.01% + 750 $\mu$ V<br>0.05% + 40 $\mu$ A<br>0.02% + 5 $\mu$ A<br>0.01% + 0.3 $\mu$ A |
| Drift <sup>2</sup>                                                | Voltage:<br>Current:                                                 | 0.01% + 0.5 mV<br>0.01% + 50 $\mu$ A                                                                                                                  | 0.01% + 1 mV<br>0.01% + 20 $\mu$ A                                                     | 0.01% + 1 mV<br>0.01% + 10 $\mu$ A                                                    |
| Output Voltage<br>Rise/Fall Time                                  | Normal mode:<br>Fast mode:                                           | 2 ms<br>400 $\mu$ s<br>(for a change from 10% to 90% or<br>90% to 10% of the total excursion)                                                         |                                                                                        |                                                                                       |
| Output Voltage<br>Settling Time                                   | Normal mode:<br>Fast mode:                                           | 6 ms<br>2 ms<br>(to settle within 1 LSB or 0.025% times<br>the rated voltage of the final value)                                                      |                                                                                        |                                                                                       |

<sup>1</sup> Between 0 and –5 mA, the sink current remains at –5 mA.

<sup>2</sup> Following a 30 minute warm-up, the change in output over 8 hours, under ambient temperature, constant load, and line operating conditions.

Table A-2. Supplemental Characteristics (continued)

| Parameter                                |                                                                    | HP 66332A                                                                                                                                                                              | HP 6632B/6633B/6634B |
|------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Dynamic Measurement Accuracy             | Instantaneous Voltage:<br>Instantaneous Current:                   | 0.03% + 5 mV<br>0.6% + 2 mA <sup>1</sup>                                                                                                                                               | not applicable       |
| Dynamic Measurement System               | Buffer Length:<br>Sampling Rate Range:                             | 4096 points<br>15.6 $\mu$ s–31,200s                                                                                                                                                    | not applicable       |
| Measurement Time<br>(voltage or current) |                                                                    | 50 ms average<br>(includes the default time of 30 ms <sup>2</sup> for acquiring data, and a 20 ms data processing overhead)                                                            |                      |
| Command Processing Time                  |                                                                    | 4 ms average<br>(for output to begin to change following receipt of digital data)                                                                                                      |                      |
| Remote Sense Capability                  |                                                                    | Up to 2 V can be dropped across each load lead.<br>(add 2 mV to the voltage load regulation specification for each 1 V change in the positive output lead due to load current change.) |                      |
| Savable Instrument States                |                                                                    | 4 (in locations 0 to 3)                                                                                                                                                                |                      |
| RS-232 Interface Capabilities            | Baud rates:<br>Data formats:<br>Language:                          | 300 600 1200 2400 4800 9600<br>7 bits even or odd parity; 8 bits without parity<br>SCPI or COMPatibility <sup>3</sup>                                                                  |                      |
| HP-IB Interface Capabilities             | Language:<br>Interface:                                            | SCPI or COMPatibility <sup>3</sup><br>AH1, C0, DC1, DT1, E1, L4, PP0, RL1, SH1, SR1, T6                                                                                                |                      |
| INH/FLT Characteristics                  | Maximum ratings:                                                   | 16.5 Vdc between terminals 1 and 2; 3 and 4;<br>and from terminals 1 or 2 to chassis ground                                                                                            |                      |
|                                          | INH Terminals:                                                     | Low-level output current = 1.25 mA max.<br>Low-level output voltage = 0.5 V max.                                                                                                       |                      |
|                                          | FLT Terminals:                                                     | Low-level input voltage = 0.8 V max.<br>High-level input voltage = 2 V min.<br>Low-level input current = 1 mA<br>Pulse width = 100 $\mu$ s min.<br>Time delay = 4 ms typical           |                      |
| Digital I/O Characteristics              | Maximum ratings:<br><br>Digital OUT Port 0,1,2<br>(open collector) | same as INH/FLT Characteristics<br><br>Output leakage @ 16V = 0.1 mA (ports 0,1)<br>= 12.5 mA (port 2)<br>Output leakage @ 5V = 0.1 mA (ports 0,1)<br>= 0.25 mA (port 2)               |                      |

<sup>1</sup>For full scale current changes with a risetime of 20  $\mu$ s, an additional 0.5% error exists in the first data point in the buffer after the change. The error percentage increases proportionally with the decrease in risetime.

<sup>2</sup>This time may be reduced by changing the default conditions of 2048 data points, however, measurement accuracy will be reduced.

<sup>3</sup>COMPatibility language is used to program the HP 663xA Series power supplies.

# A - Specifications

**Table A-2. Supplemental Characteristics (continued)**

| Parameter                                  |                                                                     | HP 66332A                                                                                                                                                                                                                                                             | HP 6632B/6633B/6634B |
|--------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Digital I/O Characteristics<br>(continued) | Digital IN Port 2:<br>(internal pull-up)                            | Low-level output sink current @ 0.5 V = 4 mA<br>Low-level output sink current @ 1 V = 50 mA<br>Low-level input current @ 0.4 V = 1.25 mA<br>High-level input current @ 5 V = 0.25 mA<br>Low-level input voltage = 0.8 V max.<br>High level input voltage = 2.0 V min. |                      |
| Isolation to Ground                        |                                                                     | 240 Vdc maximum from chassis ground                                                                                                                                                                                                                                   |                      |
| Recommended Calibration Interval           |                                                                     | 1 year<br>(from the date the unit is put into service)                                                                                                                                                                                                                |                      |
| Regulatory Compliance                      | Listing pending:<br>Certified to:<br>Conforms to:<br>Complies with: | UL 3111-1<br>CSA 22.2 No. 1010.1<br>IEC 1010-1<br>EMC directive 89/336/EEC (ISM Group1 Class B)                                                                                                                                                                       |                      |
| Dimensions<br>(see figure 3-1)             |                                                                     | Height 88.1mm (3.5in.)<br>Width 425.5mm (16.75in.)<br>Depth 364.4mm (14.3in.)                                                                                                                                                                                         |                      |
| Net weight                                 |                                                                     | 12.7 kg (28 lbs.)                                                                                                                                                                                                                                                     |                      |
| Shipping weight                            |                                                                     | 15 kg (33 lbs.)                                                                                                                                                                                                                                                       |                      |

## Verification and Calibration

### Introduction

This appendix includes verification and calibration procedures for the HP 66332A and HP 6632B/6633B/6634B dc source. Instructions are given for performing the procedures either from the front panel or from a controller over the HP-IB.

The verification procedures do not check all the operating parameters, but verify that the dc source is performing properly. Performance Tests, which check all the specifications of the dc source, are given in the applicable dc source Service Manual.

**Important** Perform the verification procedures before calibrating your dc source. If the dc source passes the verification procedures, the unit is operating within its calibration limits and does not need to be recalibrated.

### Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification and calibration.

**Table B-1. Equipment Required**

| Equipment                    | Characteristics                                                     | Recommended Model               |
|------------------------------|---------------------------------------------------------------------|---------------------------------|
| Digital Voltmeter            | Resolution: 10 nV @ 1 V<br>Readout: 8.5 digits<br>Accuracy: >20 ppm | HP 3458A                        |
| Current Monitor <sup>1</sup> | 15 A (0.1 $\Omega$ ), $\pm 0.04\%$ , TC=5ppm/ $^{\circ}$ C          | Guildline 9230/15               |
| Load Resistor                | 1.1 k $\Omega$ , 3 W min. TC=20ppm/ $^{\circ}$ C                    | HP p/n 0811-2878                |
| Power Supply                 | 20 V @ 5 A                                                          | HP 6643A or HP 6653A            |
| HP-IB Controller             | Full HP-IB capabilities                                             | HP Series 200/300 or equivalent |

<sup>1</sup>The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

### Test Setup

Figure B-1 shows the setup for the tests. Be certain to use load leads of sufficient wire gauge to carry the full output current (see chapter 3).

## B - Verification and Calibration

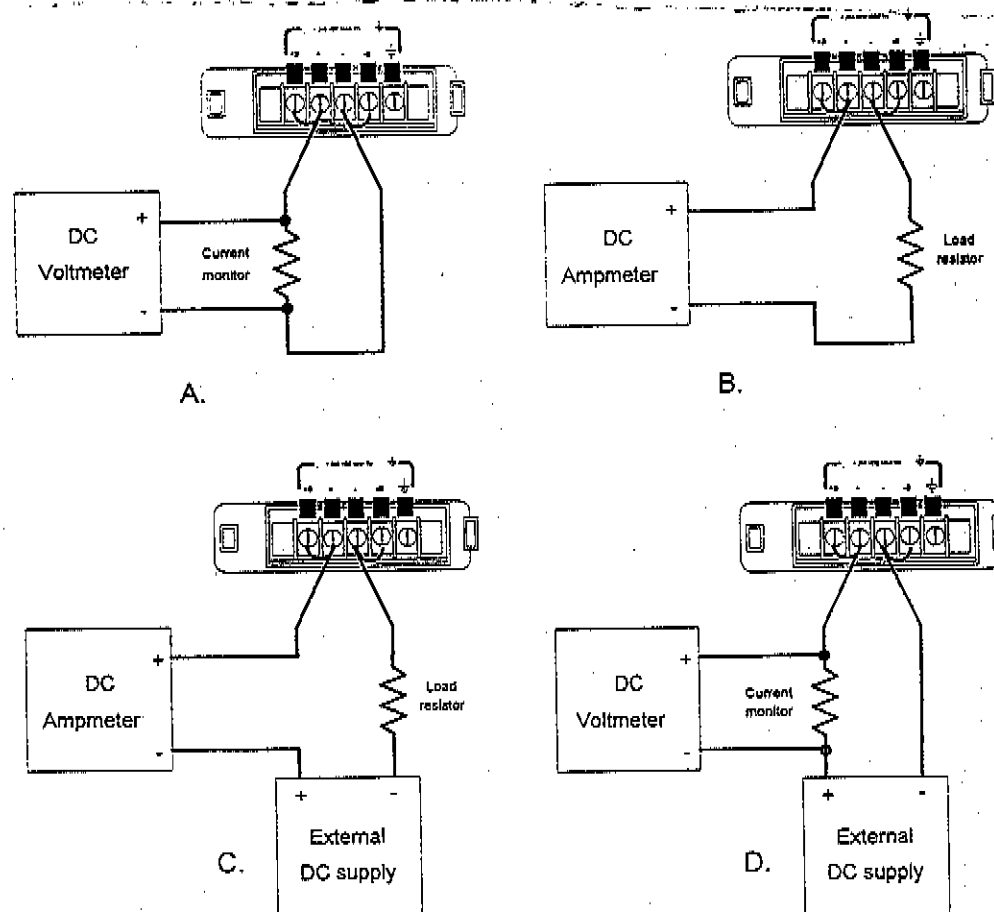


Figure B-1. Verification & Calibration Test Setup

## Performing the Verification Tests

**NOTE:** The verification procedure can only be performed using the SCPI language commands. Use either the front panel **Address** key to access the **LANG** command, or use the **SYSTEM:LANGUage** command to change the programming language to SCPI.

The following procedures assume you understand how to operate the dc source from the front panel as explained in chapter 5.

When performing the verification tests from an HP-IB controller, you may have to consider the relatively slow settling times and slew rates of the dc source as compared to computer and system voltmeters. Suitable **WAIT** statements can be inserted into the test program to give the dc source time to respond to the test commands.

Perform the following tests for operation verification in the order indicated.

1. Turn-On Checkout
2. Voltage Programming and Measurement Accuracy
3. Current Programming and Measurement Accuracy

## Turn-On Checkout

Perform the Turn-On Checkout as directed in chapter 4.

**NOTE:** The dc source must pass turn-on selftest before you can proceed with the verification tests.

## Voltage Programming and Measurement Accuracy

This test verifies the voltage programming, HP-IB measurement, and front panel meter functions. Values read back over the HP-IB should be the same as those displayed on the front panel. Measure the dc output voltage at the output terminals. Make sure the output mode switch is set to Normal and the sense terminals are directly jumpered to the output terminals.

| Action                                                                                                                                                             | Normal Result                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 1. Turn off the dc source and connect a DMM to the output terminals.                                                                                               |                                                           |
| 2. Turn on the dc source with no load on the output. Set the output voltage to 0 V and the output current to 2 A. Press <b>Output On/Off</b> to enable the output. | Output voltage near 0 V. Output current near 0 A.         |
| 3. Record voltage readings at the DMM and on the front panel display.                                                                                              | Readings within low voltage limits (see tables B-2,3,4).  |
| 4. Set the output voltage to 20 V.                                                                                                                                 | Output voltage near 20 V.                                 |
| 5. Record voltage readings at the DMM and on the front panel display.                                                                                              | Readings within high voltage limits (see tables B-2,3,4). |

## Current Programming and Measurement Accuracy

This test verifies the current programming and measurement. Connect the appropriate current monitor (see table B-1) as shown in figure B-1A.

### Current Programming and Measurement (High Range)

| Action                                                                                                                                                                         | Normal Result                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 1. Turn off the dc source and connect the DMM and current monitor as shown in figure B-1A.                                                                                     |                                                           |
| 2. Turn on the dc source, access the Input menu, and set the current sense detector to DC.                                                                                     | CURR:DET DC                                               |
| 3. Set the output voltage to 5 V and the current to 0 A. Press <b>Output On/Off</b> to enable the output.                                                                      | Output current near 0 A.                                  |
| 4. Divide the voltage drop across the current monitor by its resistance to convert the value to amperes. Record the value.                                                     | Readings within low current limits (see tables B-2,3,4).  |
| 5. Set the output current to its full scale value.                                                                                                                             |                                                           |
| 6. Divide the voltage drop across the current monitor by its resistance to convert the value to amperes. Record this value and the current reading on the front panel display. | Readings within high current limits (see tables B-2,3,4). |

## B - Verification and Calibration

### Current Measurement (Low Range)

| Action                                                                                                                                                | Normal Result                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 7. Turn off the dc source and connect a 1.1 k $\Omega$ load resistor. Set the DMM to operate in current mode and connect it as shown in figure B-1B.  |                                                                |
| 8. Turn on the dc source, access the Input menu, and set the current range to LOW.                                                                    | CURR:RANG LOW                                                  |
| 9. Set the output voltage to 0 V and the current to its full scale value. Press <b>Output On/Off</b> to enable the output.                            | Output current near 0 A.                                       |
| 10. Record the current reading from the DMM as well as from the front panel display. Enter the difference between the two readings in tables B-2,3,4. | Readings within low current measurement (see tables B-2,3,4).  |
| 11. Set the output voltage to its full scale value.                                                                                                   | Output current near +20 mA.                                    |
| 12. Record the current reading from the DMM as well as from the front panel display. Enter the difference between the two readings in tables B-2,3,4. | Readings within high current measurement (see tables B-2,3,4). |

### Current Sink Measurement

| Action                                                                                                                                                                                                                                                  | Normal Result                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| 13. Turn off the dc source and connect an external supply to the output of the unit as shown in figure B-1C. Set the DMM to operate in current mode and connect it as shown in the figure.                                                              |                                                                     |
| 14. Turn on the dc source, access the Input menu, and set the current range to LOW.                                                                                                                                                                     | CURR:RANG LOW                                                       |
| 15. Access the Input menu again, and set the current sense detector to DC.                                                                                                                                                                              | CURR:DET DC                                                         |
| 16. Turn on the external supply and program the output for 20 V and 1.5 A. Program the dc source to 0 V and 1 A. Press <b>Output On/Off</b> to enable the output.                                                                                       | Output current near -20 mA.                                         |
| 17. Record the current reading from the DMM as well as from the front panel display. Enter the difference between the two readings in tables B-2,3,4.                                                                                                   | Readings within low current sink measurement (see tables B-2,3,4).  |
| 18. Turn off the dc source and connect the current monitor and external supply to the output of the unit as shown in figure B-1D. Set the DMM to operate in dc voltage mode and connect it as shown in the figure.                                      |                                                                     |
| 19. Turn on the external supply and program the output for 20 V and 1 A. Program the dc source to 0 V and 1 A. Press <b>Output On/Off</b> to enable the output.                                                                                         | Output current near -1 A                                            |
| 20. Divide the voltage drop across the current monitor by its resistance to convert the value to amperes. Record this value as well as the current reading on the front panel display. Enter the difference between the two readings in tables B-2,3,4. | Readings within high current sink measurement (see tables B-2,3,4). |

Table B-2. Verification Test Record for HP 66332A or HP 6632B

| Model HP                                         | Report No.               | Date             |                          |
|--------------------------------------------------|--------------------------|------------------|--------------------------|
| Test Description                                 | Minimum Specification    | Recorded Results | Maximum Specification    |
| Voltage Programming and Measurement              |                          |                  |                          |
| Low Voltage $V_{out}$                            | -10 mV                   | _____ V          | +10 mV                   |
| Front Panel measurement                          | $V_{out}$ -3 mV          | _____ mV         | $V_{out}$ +3 mV          |
| High Voltage $V_{out}$                           | 19.980 V                 | _____ V          | 20.020 V                 |
| Front Panel measurement                          | $V_{out}$ -9 mV          | _____ mV         | $V_{out}$ +9 mV          |
| Current Programming and Measurement (High Range) |                          |                  |                          |
| Low Current $I_{out}$                            | -2 mA                    | _____ A          | 2 mA                     |
| High Current $I_{out}$                           | 4.9955 A                 | _____ A          | 5.0045 A                 |
| Front Panel measurement                          | $I_{out}$ -10.5 mA       | _____ mA         | $I_{out}$ +10.5 mA       |
| Current Measurement (Low Range)                  |                          |                  |                          |
| Low Current measurement                          | $I_{out}$ -2.5 $\mu$ A   | _____ $\mu$ A    | $I_{out}$ +2.5 $\mu$ A   |
| High Current measurement                         | $I_{out}$ -22.5 $\mu$ A  | _____ $\mu$ A    | $I_{out}$ +22.5 $\mu$ A  |
| Current Sink Measurement                         |                          |                  |                          |
| Low Current Sink measurement                     | $I_{sink}$ -22.5 $\mu$ A | _____ $\mu$ A    | $I_{sink}$ +22.5 $\mu$ A |
| High Current Sink measurement                    | $I_{sink}$ -11.1 mA      | _____ mA         | $I_{sink}$ +11.1 mA      |

Table B-3. Verification Test Record for HP 6633B

| Model HP                                         | Report No.               | Date             |                          |
|--------------------------------------------------|--------------------------|------------------|--------------------------|
| Test Description                                 | Minimum Specification    | Recorded Results | Maximum Specification    |
| Voltage Programming and Measurement              |                          |                  |                          |
| Low Voltage $V_{out}$                            | -20 mV                   | _____ V          | +20 mV                   |
| Front Panel measurement                          | $V_{out}$ -6 mV          | _____ mV         | $V_{out}$ +6 mV          |
| High Voltage $V_{out}$                           | 49.955 V                 | _____ V          | 50.045 V                 |
| Front Panel measurement                          | $V_{out}$ -21 mV         | _____ mV         | $V_{out}$ +21 mV         |
| Current Programming and Measurement (High Range) |                          |                  |                          |
| Low Current $I_{out}$                            | -1 mA                    | _____ A          | 1 mA                     |
| High Current $I_{out}$                           | 1.998 A                  | _____ A          | 2.002 A                  |
| Front Panel measurement                          | $I_{out}$ -4.25 mA       | _____ mA         | $I_{out}$ +4.25 mA       |
| Current Measurement (Low Range)                  |                          |                  |                          |
| Low Current measurement                          | $I_{out}$ -2.5 $\mu$ A   | _____ $\mu$ A    | $I_{out}$ +2.5 $\mu$ A   |
| High Current measurement                         | $I_{out}$ -22.5 $\mu$ A  | _____ $\mu$ A    | $I_{out}$ +22.5 $\mu$ A  |
| Current Sink Measurement                         |                          |                  |                          |
| Low Current Sink measurement                     | $I_{sink}$ -22.5 $\mu$ A | _____ $\mu$ A    | $I_{sink}$ +22.5 $\mu$ A |
| High Current Sink measurement                    | $I_{sink}$ -4.85 mA      | _____ mA         | $I_{sink}$ +4.85 mA      |

## B - Verification and Calibration

**Table B-4. Verification Test Record for HP 6634B**

| Model HP                                                | Report No.               | Date             |                          |
|---------------------------------------------------------|--------------------------|------------------|--------------------------|
| Test Description                                        | Minimum Specification    | Recorded Results | Maximum Specification    |
| <b>Voltage Programming and Measurement</b>              |                          |                  |                          |
| Low Voltage $V_{out}$                                   | -50 mV                   | V                | +50 mV                   |
| Front Panel measurement                                 | $V_{out}$ -12 mV         | mV               | $V_{out}$ +12 mV         |
| High Voltage $V_{out}$                                  | 99.90 V                  | V                | 100.10 V                 |
| Front Panel measurement                                 | $V_{out}$ -42 mV         | mV               | $V_{out}$ +42 mV         |
| <b>Current Programming and Measurement (High Range)</b> |                          |                  |                          |
| Low Current $I_{out}$                                   | -0.5 mA                  | A                | 0.5 mA                   |
| High Current $I_{out}$                                  | 0.999 A                  | A                | 1.001 A                  |
| Front Panel measurement                                 | $I_{out}$ -2.25 mA       | mA               | $I_{out}$ +2.25 mA       |
| <b>Current Measurement (Low Range)</b>                  |                          |                  |                          |
| Low Current measurement                                 | $I_{out}$ -2.5 $\mu$ A   | $\mu$ A          | $I_{out}$ +2.5 $\mu$ A   |
| High Current measurement                                | $I_{out}$ -22.5 $\mu$ A  | $\mu$ A          | $I_{out}$ +22.5 $\mu$ A  |
| <b>Current Sink Measurement</b>                         |                          |                  |                          |
| Low Current Sink measurement                            | $I_{sink}$ -22.5 $\mu$ A | $\mu$ A          | $I_{sink}$ +22.5 $\mu$ A |
| High Current Sink measurement                           | $I_{sink}$ -2.85 mA      | mA               | $I_{sink}$ +2.85 mA      |

## Performing the Calibration Procedure

**NOTE:** The calibration procedure can only be performed using the SCPI language commands. Use either the front panel **Address** key to access the **LANG** command, or use the **SYSTEM:LANGUage** command to change the programming language to SCPI.

Table B-1 lists the equipment required for calibration. Figure B-1 shows the test setup.

You do not have to do a complete calibration each time. If appropriate, you may calibrate only the voltage or current and proceed to "Saving the Calibration Constants". However, the voltage or current calibration sequence must be performed in its entirety. The following parameters may be calibrated:

- ♦ voltage programming and measurement
- ♦ overvoltage protection (OVP)
- ♦ current programming and measurement
- ♦ negative current programming
- ♦ low range measurement
- ♦ ac current measurement

## Front Panel Calibration Menu

The Entry keypad is used for calibration functions.

|                                                                                   |                                                                                   |                                                                                                                                                                                 |                                                                       |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
|  |  | Press this key to access the calibration menu.                                                                                                                                  |                                                                       |
|                                                                                   |                                                                                   | <b>Display</b>                                                                                                                                                                  | <b>Command Function</b>                                               |
|                                                                                   |                                                                                   | CAL ON <value>                                                                                                                                                                  | Turns calibration mode on when the correct password value is entered. |
|                                                                                   |                                                                                   | CAL OFF                                                                                                                                                                         | Turns calibration mode off                                            |
|                                                                                   |                                                                                   | CAL:LEV <char>                                                                                                                                                                  | Advance to next step in sequence (P1 or P2).                          |
|                                                                                   |                                                                                   | CAL:DATA <value>                                                                                                                                                                | Enter an external calibration measurement.                            |
|                                                                                   |                                                                                   | CAL:VOLT                                                                                                                                                                        | Begin voltage calibration sequence                                    |
|                                                                                   |                                                                                   | CAL:VOLT:PROT                                                                                                                                                                   | Begin voltage protection calibration                                  |
|                                                                                   |                                                                                   | CAL:CURRE                                                                                                                                                                       | Begin high range current calibration sequence                         |
|                                                                                   |                                                                                   | CAL:CURRE:NEG                                                                                                                                                                   | Begin negative current calibration sequence                           |
|                                                                                   |                                                                                   | CAL:CURRE:MEAS:LOW                                                                                                                                                              | Begin low range current measurement calibration                       |
|                                                                                   |                                                                                   | CAL:CURRE:MEAS:AC                                                                                                                                                               | Begin ac current calibration sequence                                 |
|                                                                                   |                                                                                   | CAL:SAVE                                                                                                                                                                        | Saves the calibration constants in non-volatile memory.               |
|                                                                                   |                                                                                   | CAL:PASS <value>                                                                                                                                                                | Set new calibration password.                                         |
| <b>Notes:</b>                                                                     |                                                                                   |                                                                                                                                                                                 |                                                                       |
| value = a numeric value                                                           |                                                                                   |                                                                                                                                                                                 |                                                                       |
| char = a character string parameter                                               |                                                                                   |                                                                                                                                                                                 |                                                                       |
|                                                                                   |                                                                                   | Use  and  | to scroll through the menu commands.                                  |
|                                                                                   |                                                                                   | Use  and  | to scroll through the menu parameters.                                |
|                                                                                   |                                                                                   | Use  and  | to select a digit in a numeric entry field.                           |

## Front Panel Calibration

These procedures assume you understand how to operate front panel keys (see chapter 5).

### Enable Calibration Mode

| Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Display                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1. Reset the unit by selecting <b>Output</b> , scrolling to *RST and pressing <b>Enter</b> .                                                                                                                                                                                                                                                                                                                                                                                                            | *RST                       |
| 2. Press <b>Output On/Off</b> to enable the output.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 00.003V 0.0006A            |
| 3. To begin calibration press <b>Shift Cal</b> , scroll to CAL ON and press <b>Enter</b> .                                                                                                                                                                                                                                                                                                                                                                                                              | CAL ON 0.0                 |
| 4. Enter the calibration password from Entry keypad and press <b>Enter</b> . If the password is correct the Cal annunciator will come on.<br>If CAL DENIED appears, then an internal switch has been set to prevent the calibration from being changed. (See the Service Manual.)<br>If the password is incorrect, an error occurs. If the active password is lost, the calibration function can be recovered by setting an internal switch that defeats password protection. (See the Service Manual.) | CAL DENIED<br>OUT OF RANGE |

## B - Verification and Calibration

### Voltage Programming and Measurement Calibration

| Action                                                                                                                                   | Display       |
|------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 5. Connect the DMM (dc volts mode) directly to the dc source. Do not connect the load resistor or current shunt.                         |               |
| 6. Press <b>Shift Cal</b> , scroll to CAL VOLT, and press <b>Enter</b> .                                                                 | CAL:VOLT      |
| 7. Press <b>Shift Cal</b> , scroll to CAL LEV, and press <b>Enter</b> to select the first calibration point.                             | CAL:LEV P1    |
| 8. Press <b>Shift Cal</b> , scroll to CAL DATA, and use the Entry keypad to enter the voltage value displayed on the DMM.                | CAL:DATA 0.00 |
| 9. Press <b>Shift Cal</b> , scroll to CAL LEV, use $\downarrow$ to scroll to P2 (the second calibration point), and press <b>Enter</b> . | CAL:LEV P2    |
| 10. Press <b>Shift Cal</b> , scroll to CAL DATA, and use the Entry keypad to enter the second voltage value displayed on the DMM.        | CAL:DATA 0.00 |

### Overvoltage Protection Calibration

| Action                                                                                                                                  | Display       |
|-----------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 11. Press <b>Shift Cal</b> , scroll to CAL VOLT PROT, and press <b>Enter</b> .                                                          | CAL:VOLT:PROT |
| 12. Wait for the dc source to compute the OVP calibration constant. The display returns to Meter mode when the calculation is complete. |               |

### Current Programming and High-Range Measurement Calibration

| Action                                                                                                                                                                                                                                          | Display       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 13. Connect the appropriate current monitor as shown in figure B-1A. Connect the DMM (in dc mode) across the current shunt.                                                                                                                     |               |
| 14. Press <b>Shift Cal</b> , scroll to CAL CURR, and press <b>Enter</b> .                                                                                                                                                                       | CAL:CURR      |
| 15. Press <b>Shift Cal</b> , scroll to CAL LEV, and press <b>Enter</b> to select the first calibration point.                                                                                                                                   | CAL:LEV P1    |
| 16. Press <b>Shift Cal</b> and scroll to CAL DATA. Wait for the DMM reading to stabilize. Then read the DMM and compute the first current value (DMM reading $\div$ shunt resistance). Use the Entry keypad to enter the first current value.   | CAL:DATA 0.00 |
| 17. Press <b>Shift Cal</b> , scroll to CAL LEV, use $\downarrow$ to scroll to P2 (the second calibration point), and press <b>Enter</b> .                                                                                                       | CAL:LEV P2    |
| 18. Press <b>Shift Cal</b> and scroll to CAL DATA. Wait for the DMM reading to stabilize. Then read the DMM and compute the second current value (DMM reading $\div$ shunt resistance). Use the Entry keypad to enter the second current value. | CAL:DATA 0.00 |

**Negative Current Programming Calibration**

| Action                                                                                                                                                                      | Display      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 19. Connect a negative supply to the output in series with the 1.1 k $\Omega$ load resistor. Set the DMM to operate in current mode and connect it as shown in figure B-1C. |              |
| 20. Press <b>Shift Cal</b> , scroll to CAL CURR NEG, and press <b>Enter</b> .                                                                                               | CAL:CURR:NEG |
| 21. Wait for the dc source to compute the negative current calibration constant. The display returns to Meter mode when the calculation is complete.                        |              |

**Low-Range Current Measurement Calibration**

| Action                                                                                                                                                                  | Display           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 22. Connect the 1.1 k $\Omega$ load resistor as shown in figure B-1B. Connect the DMM (in current mode) in series with the load.                                        |                   |
| 23. Press <b>Shift Cal</b> , scroll to CAL CURR MEAS LOW, and press <b>Enter</b> .                                                                                      | CAL:CURR:MEAS:LOW |
| 24. Press <b>Shift Cal</b> , scroll to CAL LEV, and press <b>Enter</b> to select the first calibration point.                                                           | CAL:LEV P1        |
| 25. Press <b>Shift Cal</b> and scroll to CAL DATA. Wait for the DMM reading to stabilize. Then use the Entry keypad and enter the current reading displayed on the DMM. | CAL:DATA 0.00     |

**AC Current Measurement Calibration (HP 66332A only)**

| Action                                                                                                                                         | Display          |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 26. Disconnect all loads from the dc source. Make sure the mode switch on the rear panel is set to Normal.                                     |                  |
| 27. Press <b>Shift Cal</b> , scroll to CAL CURR MEAS AC, and press <b>Enter</b> .                                                              | CAL:CURR:MEAS AC |
| 28. Wait for the dc source to compute the ac current calibration constant. The display returns to Meter mode when the calculation is complete. |                  |

**Saving the Calibration Constants**


---

**WARNING:** Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, omit this step. The dc source calibration will then remain unchanged.

---

| Action                                                                                                                                                  | Display  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 29. Press <b>Shift Cal</b> , scroll to CAL SAVE, and press <b>Enter</b> .                                                                               | CAL:SAVE |
| 30. Press <b>Shift Cal</b> , select CAL OFF, and press <b>Enter</b> to exit Calibration mode. *RST and *RCL will also set the calibration state to OFF. | CAL OFF  |

## Calibration Error Messages

Errors that can occur during calibration are shown in the following table.

**Table B-5. HP-IB Calibration Error Messages**

| Error | Meaning                                                                               |
|-------|---------------------------------------------------------------------------------------|
| 401   | CAL switch prevents calibration (This is a hardware disable, see the Service Manual.) |
| 402   | CAL password is incorrect                                                             |
| 403   | CAL not enabled                                                                       |
| 404   | Computed readback cal constants are incorrect                                         |
| 405   | Computed programming cal constants are incorrect                                      |
| 406   | Incorrect sequence of calibration commands                                            |

## Changing the Calibration Password

The factory default password is 0. You can change the password when the dc source is in calibration mode (which requires you to enter the existing password). Proceed as follows:

| Action                                                                                                                                                                                                                                  | Display    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1. Begin by pressing <b>Shift Cal</b> and scrolling to the CAL ON command.                                                                                                                                                              | CAL ON 0.0 |
| 2. Enter the existing password from Entry keypad and press <b>Enter</b>                                                                                                                                                                 |            |
| 3. Press <b>Shift Cal</b> and scroll to the CAL PASS command.                                                                                                                                                                           | CAL:PASS 0 |
| 4. Enter the new password from the keypad. You can use any number with up to six digits and an optional decimal point. If you want the calibration function to operate without requiring any password, change the password to 0 (zero). |            |

**NOTE:** If you want the calibration function to operate without requiring any password, change the password to 0 (zero).

## Calibration Over the HP-IB

You can calibrate the dc source by using SCPI commands within your controller programming statements. Be sure you are familiar with calibration from the front panel before you calibrate from a controller. Each front panel calibration command has a corresponding SCPI command. When you write your calibration program, perform the calibration procedure in the same order as the front panel procedure documented in this appendix.

The SCPI calibration commands are explained in chapter 3 of the dc source Programming Guide. Calibration error messages that can occur during HP-IB calibration are shown in table B-3.

## Error Messages

### Error Number List

This appendix gives the error numbers and descriptions that are returned by the dc source. Error numbers are returned in two ways:

- ◆ Error numbers are displayed on the front panel
- ◆ Error numbers and messages are read back with the SYSTem:ERRor? query.  
SYSTem:ERRor? returns the error number into a variable and returns two parameters: an NR1 and a string.

The following table lists the errors that are associated with SCPI syntax errors and interface problems. It also lists the device dependent errors. Information inside the brackets is not part of the standard error message, but is included for clarification.

When errors occur, the Standard Event Status register records them in bit 2, 3, 4, or 5 as described in the following table:

**Table C-1. Error Numbers**

| Error Number | Error String [Description/Explanation/Examples]                               |  |
|--------------|-------------------------------------------------------------------------------|--|
|              | Command Errors -100 through -199 (sets Standard Event Status Register bit #5) |  |
| -100         | Command error [generic]                                                       |  |
| -101         | Invalid character                                                             |  |
| -102         | Syntax error [unrecognized command or data type]                              |  |
| -103         | Invalid separator                                                             |  |
| -104         | Data type error [e.g., "numeric or string expected, got block data"]          |  |
| -105         | GET not allowed                                                               |  |
| -108         | Parameter not allowed [too many parameters]                                   |  |
| -109         | Missing parameter [too few parameters]                                        |  |
| -112         | Program mnemonic too long [maximum 12 characters]                             |  |
| -113         | Undefined header [operation not allowed for this device]                      |  |
| -121         | Invalid character in number [includes "9" in octal data, etc.]                |  |
| -123         | Numeric overflow [exponent too large; exponent magnitude >32 k]               |  |
| -124         | Too many digits [number too long; more than 255 digits received]              |  |
| -128         | Numeric data not allowed                                                      |  |

## Error Messages - C

| Selftest Errors 0 through 99 (sets Standard Event Status Register bit #3)              |                                                             |
|----------------------------------------------------------------------------------------|-------------------------------------------------------------|
| 0                                                                                      | No error                                                    |
| 1                                                                                      | Non-volatile RAM RD0 section checksum failed                |
| 2                                                                                      | Non-volatile RAM CONFIG section checksum failed             |
| 3                                                                                      | Non-volatile RAM CAL section checksum failed                |
| 4                                                                                      | Non-volatile RAM STATE section checksum failed              |
| 5                                                                                      | Non-volatile RST section checksum failed                    |
| 10                                                                                     | RAM selftest                                                |
| 11                                                                                     | VDAC/IDAC selftest 1                                        |
| 12                                                                                     | VDAC/IDAC selftest 2                                        |
| 13                                                                                     | VDAC/IDAC selftest 3                                        |
| 14                                                                                     | VDAC/IDAC selftest 4                                        |
| 15                                                                                     | OVDAC selftest                                              |
| 80                                                                                     | Digital I/O selftest error                                  |
| Device-Dependent Errors 100 through 32767 (sets Standard Event Status Register bit #3) |                                                             |
| 213                                                                                    | Ingrd receiver buffer overrun                               |
| 216                                                                                    | RS-232 receiver framing error                               |
| 217                                                                                    | RS-232 receiver parity error                                |
| 218                                                                                    | RS-232 receiver overrun error                               |
| 220                                                                                    | Front panel uart overrun                                    |
| 221                                                                                    | Front panel uart framing                                    |
| 222                                                                                    | Front panel uart parity                                     |
| 223                                                                                    | Front panel buffer overrun                                  |
| 224                                                                                    | Front panel timeout                                         |
| 401                                                                                    | CAL switch prevents calibration                             |
| 402                                                                                    | CAL password is incorrect                                   |
| 403                                                                                    | CAL not enabled                                             |
| 404                                                                                    | Computed readback cal constants are incorrect               |
| 405                                                                                    | Computed programming cal constants are incorrect            |
| 406                                                                                    | Incorrect sequence of calibration commands                  |
| 407                                                                                    | CV or CC status is incorrect for this command               |
| 408                                                                                    | Output mode switch must be in NORMAL position               |
| 601                                                                                    | Too many sweep points                                       |
| 602                                                                                    | Command only applies to RS-232 interface                    |
| 603                                                                                    | CURRENT or VOLTage fetch incompatible with last acquisition |
| 604                                                                                    | Measurement overrange                                       |

# D

## Line Voltage Conversion

**WARNING:** *Shock Hazard* Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

### Open the Unit

- ◆ Turn off ac power and disconnect the power cord from the unit.
- ◆ Remove the four screws that secure the cover (use a #2 Pozi drive).
- ◆ Slightly spread the bottom of the cover and pull it back to remove it from the unit.

### Configure the Power Transformer

- ◆ Locate the ac input wiring harness on the left side of the transformer.
- ◆ Use a needlenose pliers and connect the ac input wiring harness according to the information in the following figure:

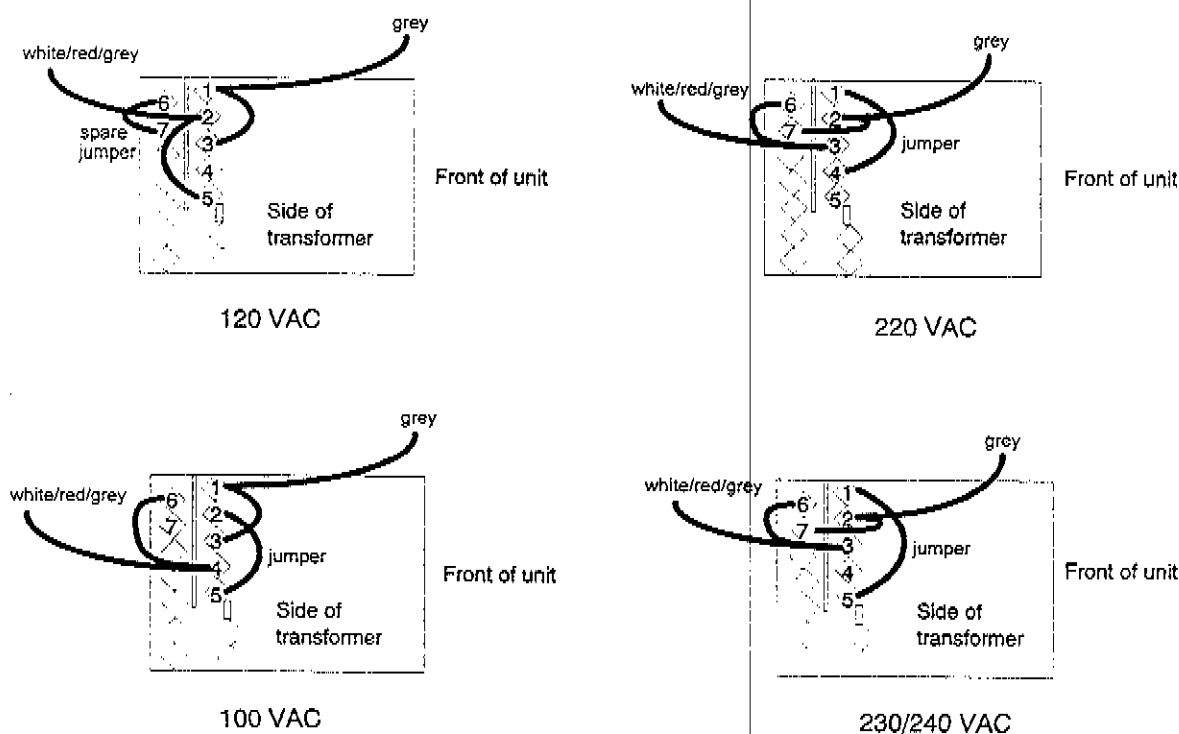


Figure D-1, Power Transformer AC Input Connections

## D - Line Voltage Conversion

### Install the Correct Line Fuse

- ♦ Unscrew the line fuse cap from the rear panel and install the correct fuse.  
For 100/120 Vac operation: 4 A; HP part number 2110-0055  
For 220/230 Vac operation: 2 A; HP part number 2110-0002
- ♦ Mark the voltage setting that the unit has been set to on the rear panel label.

### Close the Unit

- ♦ Replace the outer cover.
- ♦ Reconnect the power cord and turn on the unit.

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For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for location of your nearest sales/support office.

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